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AMENDED RECLAMATION PLAN
AMBOY LIMESTONE QUARRY

Omya, Inc.

San Bernardino County, California
CA Mine ID No. 91-36-0140

November 2015

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Amended Reclamation Plan
Amboy Limestone Quarry

Omya, Inc.

San Bernardino County, California
Reclamation Plan 96M-06
CA Mine ID No. 91-36-0140

November 2015

1.0 INTRODUCTION

The Amboy Quarry is located in the central Mojave Desert approximately 6 miles east of Amboy, and one mile north of Highway 66. The Quarry operates under the approved Reclamation Plan 96M-06 (1996 Plan) and the San Bernardino County Mining Conditional Use (CUP) Permit SAMR/95-0066/DN 913-181N (Appendix A).The Amended Reclamation Plan is an updated version of the 1996 Plan that addresses the concerns identified by the Office of Mine Reclamation (OMR) and current California Surface Mining and Reclamation Act (SMARA) requirements. It is a standalone Reclamation Plan that contains the relevant reclamation information from the 1996 Plan as well as the amendments that have been incorporated into the 1996 Plan.

The purpose of the amendments to the 1996 Plan includes the following:

- Expand the permitted reclamation boundary currently identified in the 1996 Plan to include a buffer area around the areas of disturbance associated with the mining activities.
- To clarify the boundaries and acreage of the areas of disturbance.
- To address items identified by the OMR letter dated March 19, 2013 (Appendix B).
- To address current SMARA standards.

This Amended Reclamation Plan was prepared in compliance with:

- SMARA, as amended (Public Resources Code Section 2710 et seq.);
- California Code of Regulations, Title 14, Division 2, Chapter 8, Subchapter 1, Article 9;

Figures 1, 2 and 3 provide the Generalized Development Plan, Mining Plan and Reclaimed Condition Plan.

Figure 1: Generalized Development Plan – Existing Conditions

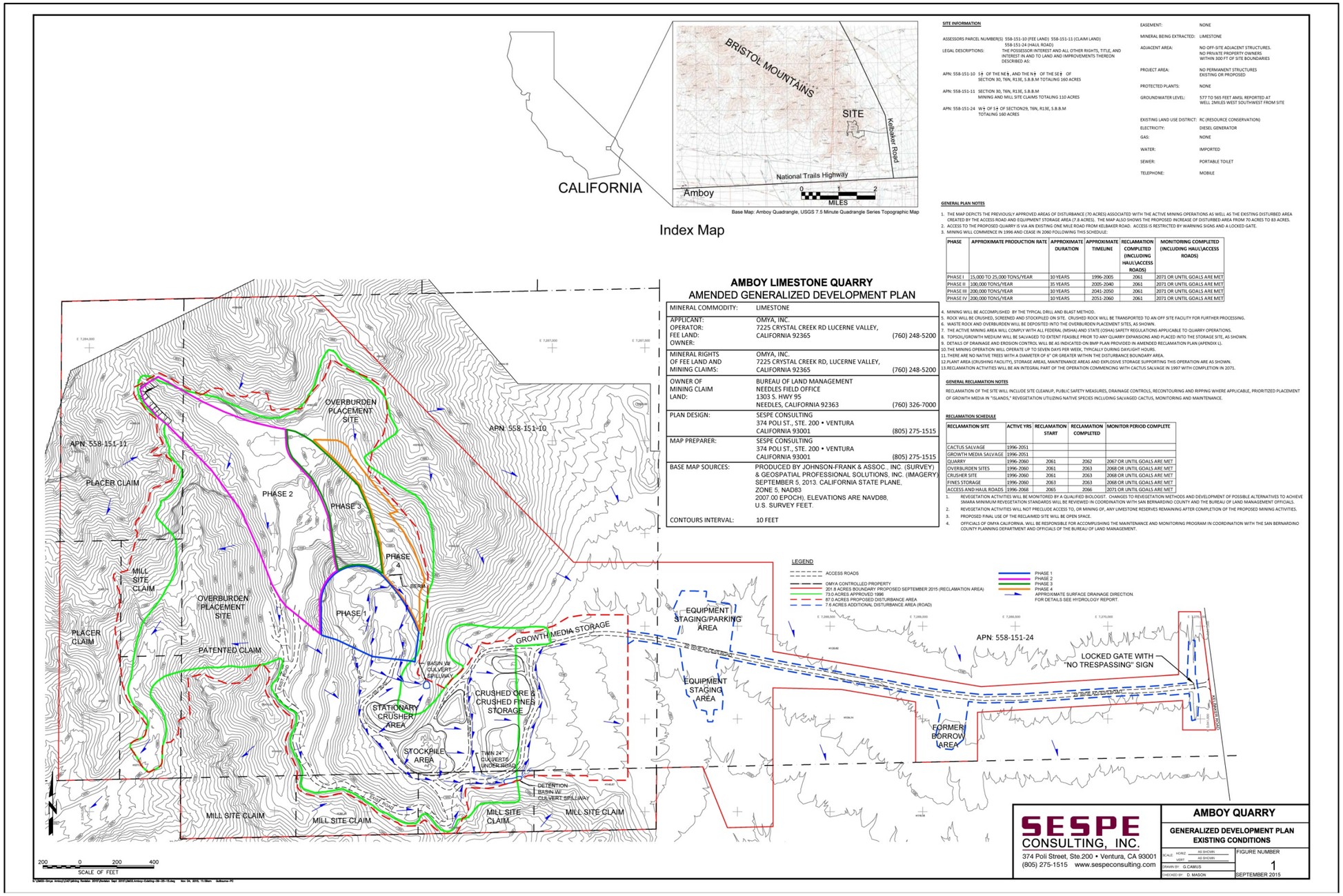


Figure 2: Amboy Quarry – Mining Plan

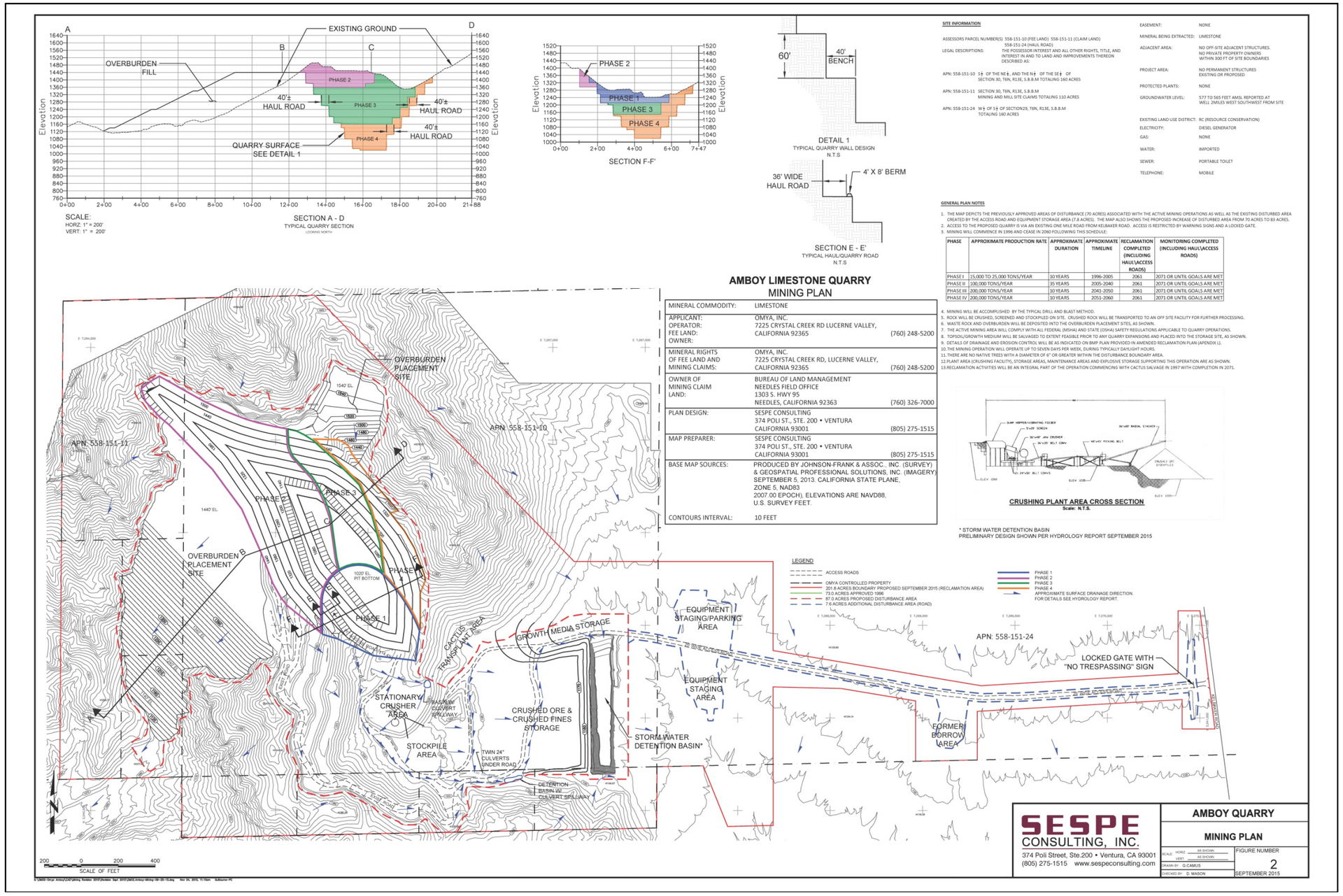
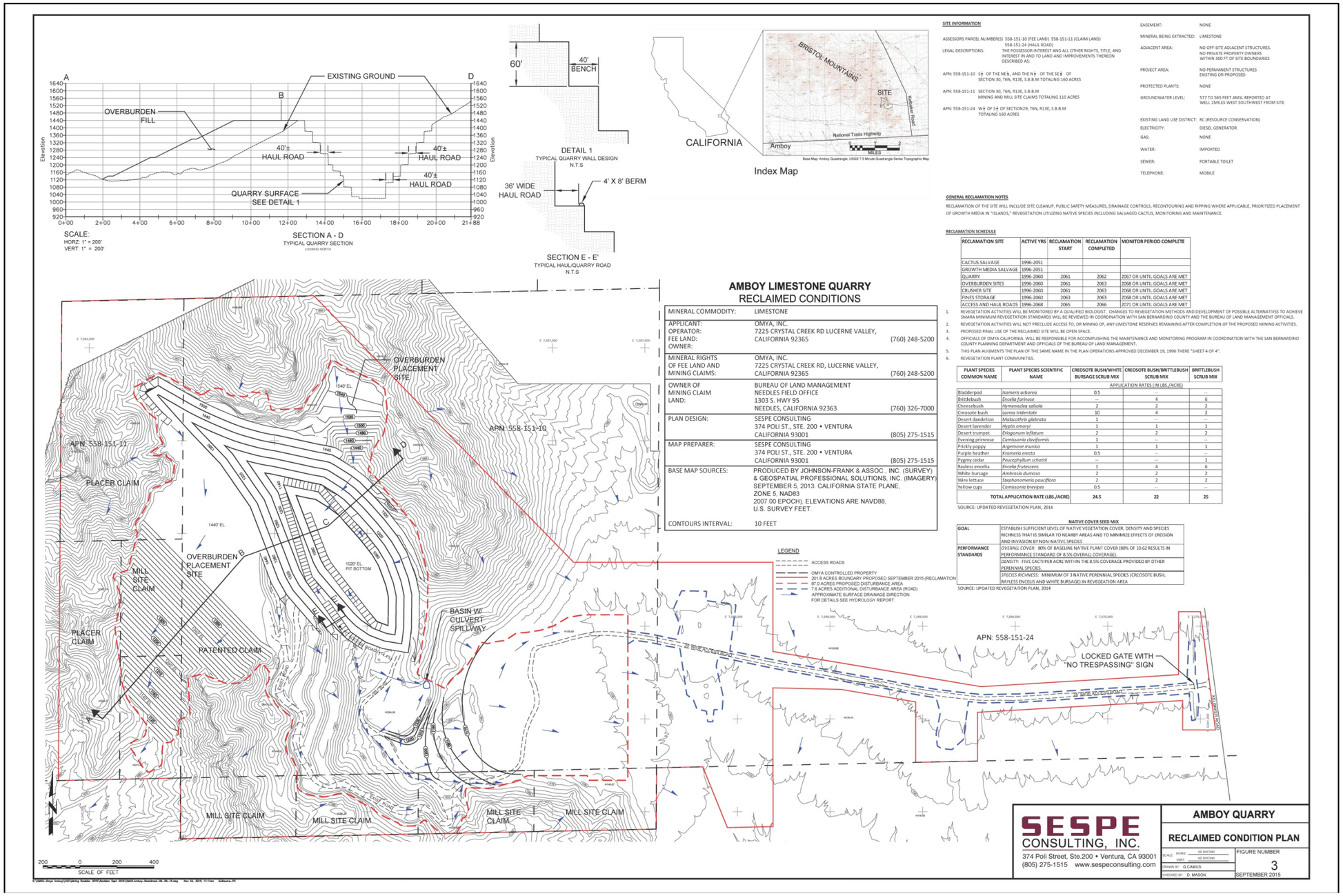


Figure 3: Amboy Quarry – Reclaimed Condition Plan



SITE INFORMATION

ASSESSORS PARCEL NUMBER(S): 558-151-10 (FEE LAND) 558-151-11 (CLAIM LAND) 558-151-24 (HAUL ROAD)

LEGAL DESCRIPTIONS: THE POSSESSOR INTEREST AND ALL OTHER RIGHTS, TITLE, AND INTEREST IN AND TO LAND AND IMPROVEMENTS THEREON DESCRIBED AS:

APN: 558-151-10 S½ OF THE NE¼, AND THE N½ OF THE SE¼ OF SECTION 30, T6N, R13E, S.B.B.M TOTALING 160 ACRES

APN: 558-151-11 SECTION 30, T6N, R13E, S.B.B.M MINING AND MILL SITE CLAIMS TOTALING 110 ACRES

APN: 558-151-24 W½ OF S½ OF SECTION29, T6N, R13E, S.B.B.M TOTALING 160 ACRES

EASEMENT: NONE

MINERAL BEING EXTRACTED: LIMESTONE

ADJACENT AREA: NO OFF-SITE ADJACENT STRUCTURES. NO PRIVATE PROPERTY OWNERS WITHIN 300 FT OF SITE BOUNDARIES

PROJECT AREA: NO PERMANENT STRUCTURES EXISTING OR PROPOSED

PROTECTED PLANTS: NONE

GROUNDWATER LEVEL: 577 TO 565 FEET AMSL REPORTED AT WELL 2MILES WEST SOUTHWEST FROM SITE

EXISTING LAND USE DISTRICT: RC (RESOURCE CONSERVATION)

ELECTRICITY: DIESEL GENERATOR

GAS: NONE

WATER: IMPORTED

SEWER: PORTABLE TOILET

TELEPHONE: MOBILE

GENERAL RECLAMATION NOTES

RECLAMATION OF THE SITE WILL INCLUDE SITE CLEANUP, PUBLIC SAFETY MEASURES, DRAINAGE CONTROLS, RECONTOURING AND RIPPING WHERE APPLICABLE, PRIORITIZED PLACEMENT OF GROWTH MEDIA IN "ISLANDS," REVEGETATION UTILIZING NATIVE SPECIES INCLUDING SALVAGED CACTUS, MONITORING AND MAINTENANCE.

RECLAMATION SCHEDULE

RECLAMATION SITE	ACTIVE YRS	RECLAMATION START	RECLAMATION COMPLETED	MONITOR PERIOD COMPLETE
CACTUS SALVAGE	1996-2051			
GROWTH MEDIA SALVAGE	1996-2051			
QUARRY	1996-2060	2061	2062	2067 OR UNTIL GOALS ARE MET
OVERBURDEN SITES	1996-2060	2061	2063	2068 OR UNTIL GOALS ARE MET
CRUSHER SITE	1996-2060	2061	2063	2068 OR UNTIL GOALS ARE MET
FINES STORAGE	1996-2060	2063	2063	2068 OR UNTIL GOALS ARE MET
ACCESS AND HAUL ROADS	1996-2068	2065	2066	2071 OR UNTIL GOALS ARE MET

1. REVEGETATION ACTIVITIES WILL BE MONITORED BY A QUALIFIED BIOLOGIST. CHANGES TO REVEGETATION METHODS AND DEVELOPMENT OF POSSIBLE ALTERNATIVES TO ACHIEVE SMARA MINIMUM REVEGETATION STANDARDS WILL BE REVIEWED IN COORDINATION WITH SAN BERNARDINO COUNTY AND THE BUREAU OF LAND MANAGEMENT OFFICIALS.
2. REVEGETATION ACTIVITIES WILL NOT PRECLUDE ACCESS TO, OR MINING OF, ANY LIMESTONE RESERVES REMAINING AFTER COMPLETION OF THE PROPOSED MINING ACTIVITIES.
3. PROPOSED FINAL USE OF THE RECLAIMED SITE WILL BE OPEN SPACE.
4. OFFICIALS OF OMYA CALIFORNIA. WILL BE RESPONSIBLE FOR ACCOMPLISHING THE MAINTENANCE AND MONITORING PROGRAM IN COORDINATION WITH THE SAN BERNARDINO COUNTY PLANNING DEPARTMENT AND OFFICIALS OF THE BUREAU OF LAND MANAGEMENT.
5. THIS PLAN AUGMENTS THE PLAN OF THE SAME NAME IN THE PLAN OPERATIONS APPROVED DECEMBER 19, 1996 THERE "SHEET 4 OF 4".
6. REVEGETATION PLANT COMMUNITIES.

PLANT SPECIES COMMON NAME	PLANT SPECIES SCIENTIFIC NAME	CREOSOTE BUSH/WHITE BURSAGE SCRUB MIX	CREOSOTE BUSH/BRITTLEBUSH SCRUB MIX	BRITTLEBUSH SCRUB MIX
		APPLICATION RATES (IN LBS./ACRE)		
Bladderpod	*Isomeris arborea*	0.5	--	--
Brittlebush	*Encelia farinose*	--	4	6
Cheesebush	*Hymenoclea salsola*	2	2	2
Creosote bush	*Larrea tridentate*	10	4	2
Desert dandelion	*Malacothrix glabrata*	1	--	--
Desert lavender	*Hyptis emoryi*	1	1	1
Desert trumpet	*Eriogonum inflatum*	2	2	2
Evening primrose	*Camissonia claviformis*	1	--	--
Prickly poppy	*Argemone munica*	1	1	1
Purple heather	*Krameria erecta*	0.5	--	--
Pygmy cedar	*Peucephyllum schottii*	--	--	1
Rayless encelia	*Encelia frutescens*	1	4	6
White bursage	*Ambrosia dumosa*	2	2	2
Wire lettuce	*Stephanomeria pauciflora*	2	2	2
Yellow cups	*Camissonia brevipes*	0.5	--	--
TOTAL APPLICATION RATE (LBS./ACRE)		24.5	22	25

SOURCE: UPDATED REVEGETATION PLAN, 2014

NATIVE COVER SEED MIX

GOAL	ESTABLISH SUFFICIENT LEVEL OF NATIVE VEGETATION COVER, DENSITY AND SPECIES RICHNESS THAT IS SIMILAR TO NEARBY AREAS AND TO MINIMIZE EFFECTS OF EROSION AND INVASION BY NON-NATIVE SPECIES
PERFORMANCE STANDARDS	OVERALL COVER: 80% OF BASELINE NATIVE PLANT COVER (80% OF 10.62 RESULTS IN PERFORMANCE STANDARD OF 8.5% OVERALL COVERAGE).
	DENSITY: FIVE CACTI PER ACRE WITHIN THE 8.5% COVERAGE PROVIDED BY OTHER PERENNIAL SPECIES.
	SPECIES RICHNESS: MINIMUM OF 3 NATIVE PERENNIAL SPECIES (CREOSOTE BUSH, RAYLESS ENCELIS AND WHITE BURSAGE) IN REVEGETATION AREA

SOURCE: UPDATED REVEGETATION PLAN, 2014

1.1 Project Background and Vested Rights

Historic land uses in the Amboy region have been dominated by the extraction of mineral resources and transportation lines. Mining and prospecting started about 1860, and by 1910, the town of Amboy had become an active mining town. The white limestone deposit at the Amboy Quarry was originally identified in the 1930's, and known as the Snowcap Deposit. By 1956, several prospects had been developed at the Snowcap property by Paul Tobeler. Tobeler received the patent (Number 1133668) for the 160 acre claim in 1952. Pluess-Staufer California (PSC) leased the claim from Tobeler during the 1970s and operated the mine into the early/mid 1990s.Ownership of the mine was transferred to Omya in 1997.

Extensive geological investigations have proven that the site has a large reserve of exceptionally pure crystalline limestone, suitable for food and pharmaceutical grade products and human consumption. The Amboy Quarry is among the few available sources of such high purity limestone in the western United States.

This Amended Reclamation Plan continues to apply to mining areas vested under Section 2776 of SMARA.

1.2 Background on Reclamation Plan 96M-06

PSC submitted the Amboy Limestone Quarry Plan of Operation and Reclamation Plan to the San Bernardino County (County) on April 7, 1996 and to the BLM on March 10, 1995. An Environmental Analysis (EA) (EA7-21Phases 1 and 2 of the Plan of Operations and Reclamation Plan) was completed in 1996 for Phases 1 and 2 of the mining operations and approved by the County and BLM in 1997. Phases 3 and 4 required consultation with the State Historic Preservation Office (SHPO) which was completed on July 1, 1997. Phases 3 and 4 were approved in 2001. In 2011, Omya submitted a proposed plan modification for a minor expansion to the area of disturbance to the County and BLM. In February of 2013, BLM issued Decision Record No. CA-D090-2012-0012-EA to expand the area of disturbance within the BLM land by 10.8 acres. In March 2013, the County and OMR (Appendix B) requested additional information regarding the proposed modification. These requests have been addressed in this Amended Reclamation Plan.

1.3 Project Phasing

Quarry development is being conducted in four phases. The mining schedule and production rates are provided in Table 1. Phase 1 has been completed. It should be noted that due to the economic downturns during the early 2000s, the life of the mine has been extended to approximately 65 years (versus 55 years). Due to the harsh environmental site conditions, the majority of the reclamation activities will not be concurrent with the mining phases but will begin when the active mining is completed in 2060, as shown in Table 1. Some reclamation activities such as plant and soil salvage will be conducted during the active mining phases.

Table 1: Mining Phases

Phase	Mining Duration	Tons/Year	Reclamation Start	Reclamation Complete (including haul/access roads)	Monitoring Complete (including haul/access roads)
Phase 1	1996-2005	15,000 to 25,000	2061	2066	2071 or until goals are met
Phase 2	2005-2040	100,000	2061	2066	2071 or until goals are met
Phase 3	2023-2050	200,000	2061	2066	2071 or until goals are met
Phase 4	2051-2060	200,000	2061	2066	2071 or until goals are met

Source: Pleuss-Staufer (California) Inc., Plan of Operations and Reclamation Plan 1996, Discussions with Omya 2015

2.0 GENERAL OWNERSHIP/OPERATION INFORMATION

2.1 Mine Operator and Property Owner Information

MINE NAME: Amboy Limestone Quarry

CA MINE ID NUMBER: 91-36-0140

LOCATION OF MINE: 18200 Kelbaker Road
Amboy, California92304

ASSESSOR PARCEL NUMBERS: 558-151-10 (Fee Land),558-151-11 (Claim Land) and 558-151-24 (Haul Road)

SAN BERNARDINO COUNTY CONDITIONAL USE PERMIT:
Permit Number: SAMR/95-0066/DN 913-181N
Date Approved: January 29, 1997
Expiration Date: January 4, 2052

A copy of this permit is provided in Appendix A.

SAN BERNARDINO COUNTY RECLAMATION PLAN NUMBER: 96M-06

MINE OPERATOR: Omya, Inc., a Division of Omya, Inc.
Contact: Ms. Shelby J. Olsen

TELEPHONE NUMBER: (513) 387-4696

MAILING ADDRESS: 9987 Carver Road, Suite 300
Cincinnati, Ohio 45242

OWNERS OF POSSESSORY INTEREST: Omya, Inc. and U.S. Department of the Interior, Bureau of Land Management

2.2 Lead Agency Information

LEAD AGENCY: County of San Bernardino, Land Use Services Department - Planning Division

STAFF CONTACT: George H. Kenline

TELEPHONE NUMBER: (909) 387-4105

MAILING ADDRESS: San Bernardino County
Land Use Services Department
385 N. Arrowhead Avenue
San Bernardino, CA 92415

2.3 General Mining Operation Information

START-UP DATE: Approximately 1970s by PSC
MINING TERMINATION DATE: 2060

RECLAMATION COMPLETION DATE: 2066

MONITORING COMPLETION DATE: 2071 or until goals are met

MINERAL RESOURCE ZONE (MRZ): The Amboy Limestone Quarry is neither classified nor designated.

EASEMENTS: None known

TOPOGRAPHIC MAP: USGS Amboy 7.5'topographic quadrangle
Section: 30
Township: 6 North
Range: 13 East
Meridian and Baseline: San Bernardino

Mining Operations: See Table 2

Table 2: Mining Operation Information

Component	1996 Plan	Amended Plan
Mineral Commodity	Limestone	Limestone
Estimated Average Production (tons-per-year)	15,000 to 200,000	15,000 to 200,000
Estimated Total Production (tons)	6,375,000	6,375,000
Number of Acres to be Mined	73	73
Number of Acres to be Disturbed	73 acres Mining Activities 7.8 acres Access Road/Equipment storage	87 acres Mining Activities 7.6acres Access Road/Equipment storage
Anticipated Elevation Level of Mining Ft. (AMSL)	1,080	1,020
Mining Termination Date	2050	2060
Reclamation Completion Date	2056	2066
Monitoring Completion Date	2061 or until goals are met	2071 or until goals are met

3.0 ENVIRONMENTAL SETTING

3.1 Topography, Drainage and Geohydrology

The quarry site is located near the base of the southern Bristol Mountains, one of several generally barren and rocky mountain ranges in the central Mojave Desert region. The deposit area is located between elevations ranging from 1,200 to 1,600 feet. Elevations in the Bristol Mountain range reach 3,000 feet. Alluvial areas are at elevations of 1,000 feet or less. Terrain in the deposit location is very stark, barren desert, comprised of steep and rugged bare rock outcrops, often lacking soil or vegetation.

3.2 Climate

Climate in the area is extremely harsh and is characterized by exceedingly hot summers, and mild warm winters. The Amboy area (particularly the area of the limestone deposit) is one of the hottest places in the country. Daytime temperatures during summer often exceed 125 °F. Precipitation of any type is uncommon, and rarely exceeds 1.5 inches per year.

3.3 Vegetation and Biological Resources

The following descriptions of the vegetation and biological resources in and around the Amboy Quarry are taken from the following updated reports:

- General Biological Assessment Report, June 2014, Himes Consulting, LLC (provided in Appendix C).
- Desert Tortoise Presence/Absence Survey Report, May 2014, Himes Consulting, LLC (provided in Appendix D).

3.3.1 Vegetation Communities

The quarry site is located within the Mojave Desert geographical region. Vegetation within the area is sparse due in part to the very arid climate and the presence of desert pavement. Vegetation within the site is characterized by the following three plant communities: creosote bush – white burr sage scrub community, brittle bush scrub, and creosote bush-brittle bush scrub. Although the site contains ephemeral drainages, the species composition is not substantially different from that of the surrounding uplands.

The General Biological Resources Assessment Report located in Appendix C provides a detailed description of the vegetation communities.

3.3.2 Wildlife

Wildlife and/or wildlife signs observed within the quarry site include desert cottontail, jackrabbit, kit fox, Nelson's bighorn sheep, desert woodrat, coyote, and white-tailed antelope squirrel. Birds include black-throated sparrows, white-throated swifts, Say's phoebe, western kingbird, house finch, hummingbird, mourning dove, northern mockingbird, turkey vulture, and common raven. Reptiles include western whiptail, common side-blotched lizard, southern desert horned lizard, zebra-tailed lizard, and desert iguana.

The General Biological Resources Assessment Report located in Appendix C for a detailed description of the wildlife.

3.3.3 Special Status Species

A total of 12 special species of plants and 8 species of wildlife occur within the vicinity of the quarry site, based on a California Natural Diversity Database (CNDDB) query of the 9 topographic quadrangles including and adjacent to Amboy. The majority of the special status species have little probability of occurring within the quarry site due to existing site conditions, habitat, range requirements and site elevation. Only desert tortoise, Death Valley sage, and Nelson's bighorn sheep have a potential to occur in the vicinity of the quarry site. No special status species were observed on the quarry site during field surveys conducted on April 7-8 and May 26-27, 2014.

Desert Tortoise

The only listed species that may occur within the quarry area is the desert tortoise (*Gopherus agassizii).* The desert tortoise is listed as threatened by the United States Fish and Wildlife Service (USFWS) and the State of California. No live tortoises, tortoise burrows, or tortoise sign were found during the 2014 protocol surveys (Himes Consulting, LLC). Habitat for the desert tortoise within the quarry site appears very poor due to the steep slopes and the presence of desert pavement in the alluvial areas.

Death Valley Sage

Death Valley sage (Salvia funereal) is known to occur in dry washes and limestone canyons and has been reported in the vicinity of the quarry site (CalFlora, 2014) as well as within the quarry site in 1995 (Tierra Madre Consultants, 1995). The previously known onsite locations were searched during the May 26, 2014 field survey and no plants were found in those areas. However, there are multiple reports of the species from nearby the quarry site, so the species has a moderate potential to occur within the quarry site.

Nelson's Bighorn Sheep

Nelson's bighorn sheep is a BLM sensitive species and a California Department of Fish and Wildlife (CDFW) Fully-Protected Mammal. Nelson's bighorn sheep have been observed in and around the quarry site as evidenced by their scat found during the field survey (Himes, 2014) in all areas within the site, including mountainous areas, slopes, disturbed areas and drainages. The steep canyon on the west side of the quarry appears to be traversed by the Nelson's bighorn sheep as frequently as adjacent mountain slopes. Because the quarry area boundaries consist of unfenced natural desert, the movement of Nelson's bighorn sheep around and within the site would not be affected.

The Biological Resources Assessment located in Appendix C provides a more detailed discussion of these species.

3.3.4 Critical Habitat

The quarry site is not located within any Federally designated critical habitat, or habitat designated as sensitive by the State. The closest designated critical habitat is the Chemehuevi Critical Habitat Unit for the desert tortoise, located approximately 8 miles east of the quarry site.

Further discussion of critical habitat is provided in the General Biological Resources Assessment Report (Appendix C).

3.3.5 Wildlife Movement

No large-scale wildlife movement corridors occur within or adjacent to the quarry site. The quarry boundary consists of unfenced natural desert, which allows the movement and dispersal of wildlife locally and between surrounding mountain ranges. Wildlife move within and around the quarry site as part of their short-range movements. Nelson's bighorn sheep have been observed to use all available habitats in and around the quarry site.

3.4 Jurisdictional Waters, Streambeds and Groundwater

A Jurisdictional Delineation (JD) was prepared by Himes Consulting, LLC in July 2014 (Appendix E) and a Hydrology Study and Drainage Analysis was conducted by Bonadiman and Associates, Inc. (2015) (Appendix F). The following discussion is based on these reports.

The quarry site is located within the Southern Mojave watershed (Hydrologic Unit Code 18100100). A total of approximately 1.76 acres of Waters of the State under the jurisdiction of the CDFW and Colorado River Basin Regional Water Quality Control Board (RWQCB) are estimated to occur within the quarry site. This area consists of ephemeral washes which flow only in direct response to storm events. Of this total, approximately 0.2 acres have already been disturbed under Streambed Alteration Agreement (SAA) No. 5-443-96 (Appendix G).Consultations with the CDFW and RWQCB have been conducted and will continue as needed to ensure compliance with regulatory requirements.

The Amboy Quarry does not discharge dredged or fill materials into Waters of the United States.

3.4.1 Federal Jurisdiction

Surface water from the site flows downstream towards Bristol Lake, a dry lakebed south of the quarry. As these waters collect and evaporate at Bristol Lake, they are considered isolated and do not connect to downstream navigable waters. Therefore these washes are not subject to Federal jurisdiction under Section 404 of the Clean Water Act. A letter from the U.S. Army Corps of Engineers (December 3, 1996) confirms that the Amboy Quarry does not discharge dredged or fill material into Waters of the U.S.A copy of this letter is provided in Appendix G

3.4.2 State Jurisdiction

Waters of the State are regulated by the CDFW under Section 1600-1616 of the California Fish and Game Code (1602 Permit) and the Colorado River Basin RWQCB (waste discharge).

A total of approximately 1.76 acres of Waters of the State are estimated to occur within the quarry site, including along the existing access road. This area consists of ephemeral washes which flow only in direct response to storm events. Of this total, approximately 0.2 acres have already been disturbed under Streambed Alteration Agreement No. 5-443-96.

3.4.3 Groundwater

The following discussion is based on the results of Slope Stability Investigation prepared for this Amended Reclamation Plan by CHJ Consultants (January 27, 2015). A copy of this report is provided in Appendix I. During December 2014, an investigation was conducted to explore and evaluate the geotechnical/geological engineering conditions at the quarry site and to provide slope stability evaluations for existing and future cut slopes and overburden placement sites. As part of the investigation, the groundwater conditions were also evaluated.

No evidence for springs or perched groundwater conditions was observed at the site during the CHJ geologic mapping or on the aerial photographs examined during their investigation. The quarry occupies an elevated position on a mountain ridge relative to alluvial plains abutting the Bristol Mountains. The lowest planned feature of the quarry is the final pit bottom at elevation 1,020 feet above mean sea level (amsl). The toe of the west overburden placement site is at elevation 1,090 feet amsl. Groundwater elevations ranging from 577 to 565 feet amsl are reported for a well located approximately 2 miles west-southwest (California Department of Water Resources, 2015). The quarry is located in an arid region; therefore, static groundwater or long-term seepage is not anticipated to affect the mine pit walls.

Based on discussions between CHJ and Omya, groundwater was not encountered in previously drilled exploratory borings(approximately 200 feet below ground surface) along the east drainage. Based on the planned excavation depths, the depth to groundwater in regional wells and the presence of non-liquefiable bedrock, the potential for liquefaction and other shallow groundwater-related hazards at the site is considered to be very low. Groundwater was therefore not considered in the global stability evaluation conducted by CHJ Consultants due to the lack of seepage or groundwater anticipated in the generally arid site environment.

3.5 Wildland Fire

The California Department of Forestry and Fire Protection (CAL FIRE) classifies the quarry site as outside of a Very High Fire Hazard Severity Zone (Non-VHFHSZ).

3.6 Regional Geologic Setting and Site Geology

During December 2014, a Slope Stability Investigation was performed by CHJ Consultants and the following discussion on the regional and site geology is taken from that report. A geologic map of the quarry site and a copy of the Slope Stability Investigation are located in Appendix I.

The Amboy region lies in the central part of the Mojave Desert, which is bounded on the north by the Garlock fault, the southwest by the San Andreas fault and to the east by the Colorado River. The area has undergone a long and complex geologic history which ranges from PreCambrian to recent geological time. Mountain ranges in the western portion of the Amboy region trend northwest, while mountain ranges in the southern and northern part of the region trend northerly.

The Bristol Mountains expose a series of Paleozoic age sedimentary rocks overlying a Precambrian basement in the central Mojave Desert. Paleozoic units include Cambrian, Devonian, Carboniferous and Permian age units. Ordovician and Silurian units are not present in the Bristol Mountains Paleozoic section. The limestone ore occurs in the Bullion Member of the Mississippian age Monte Cristo Limestone forming a unit up to 300 feet thick. The deposit trends north-south and dips east at approximately 45 degrees. Underlying (footwall) rocks include lower members of the Monte Cristo Limestone and Devonian age Sultan Limestone. Intrusive syenite units truncate the ore body to the north and west.

Locally, diabase dikes have metamorphosed cherty limestone to opaque wollastonite marble. Paleozoic rocks of the Bristol Mountains are correlatable with the regional Paleozoic section defined for the greater Mojave Desert region.

Bedding in the Monte Cristo Limestone (orebody) is generally suggested by gray color bands that dip eastward at moderate angles. Foliation within the metamorphosed limestones that dips east at angles

from 38 to 60 degrees with values between 40 and 47 degrees are typical. Wollastonite beds in the south quarry area and amphitheater section of the Amboy Quarry follow this moderately east-dipping bedding structure.

The lithologic units at the Amboy Quarry consist of sedimentary rocks that have been subjected to high-grade metamorphism. While bedding is generally well preserved in these materials, no potentially weak primary clay or silt beds were observed. Slope stability is anticipated to be influenced primarily by foliation, joint fabric near intrusive contacts and joint systems orthogonal to bedding/foliation.

Several high-angle faults exist that cut the limestone and shift contacts a few tens of feet without large displacement. A compound west-dipping normal fault that places Pennsylvanian Bird Spring Formation on top of the Monte Cristo Limestone at the mine ridge top has been previously identified. A major contact between limestone of the Bird Spring and Monte Cristo units and syenite is present along the northern mine boundary. Contact between the limestone units and syenite has been identified as intrusive. A well-developed joint system is present in the syeniten earth intrusive contact located at the north end of the existing quarry. This joint system, and possibly anastomosing high-angle faults, influences a system of compound south and southwest-dipping shear surfaces that form slip planes in several wedge failures and a block glide slope failure. A northwest-trending, down-to-the-northeast normal fault is also mapped between the Bird Spring and Monte Cristo limestone units along the northern ore boundary that dips southwest from 60 to 80 degrees on this structure. A high-angle fault system, coincident with a fault is dipping southwest at 78 degrees (undated maps) between Bird Spring and Monte Cristo limestone units, is present along the north wall of the "amphitheater" area of the quarry. This fault forms a steep south-facing dip surface with abundant slicken sides and clay/gouge infill.

A bedding-planel and slide formed in Monte Cristo limestone is present to the northwest of the mine area across the west drainage. This feature is identified by an accumulation of colluviums on the head of the slide mass and deflection of the drainage at the toe and appears to be an ancient feature. The mechanism of movement is interpreted as translation along east-dipping bedding/foliation planes based on the conformance of the slip surface with bedding in nearby outcrops. This feature is noted by previous studies as a landslide. The eastward-directed movement and bedding geometry suggests a potential for bedding-controlled slip surfaces in the mine area. This land slide mass will be partially concealed by the West Overburden Placement Sites. Based on the age, geometry and location of the slide, placement of overburden material against the slide will not destabilize or otherwise cause an unstable condition in native or overburden slopes.

Fill observed at the quarry site is associated with berm sand stockpiles in the area of quarrying, as well as with roadways and general processing areas.

3.7 Faults and Seismicity

The Amboy Quarry generally lies east of the more seismically active portion of the Mojave Desert that includes the Eastern California Shear Zone (ECSZ). The ECSZ is a regional area of distributed dextral shear that forms a system of predominantly northwest-trending, strike-slip faults traversing the Mojave Desert. The ECSZ accommodates strain between the Pacific-North American Plate boundary across a zone approximately 65 miles wide and is thought to transfer as much as 15 percent of the total plate boundary shear into the Great Basin area (Shermer and others, 1996). Several ECSZ faults ruptured in combination during the 1992 Landers earthquake. The closest fault of the ECSZ is the Pisgah-Bullion fault located about 31 miles southwest of the site. The Hector Mine earthquake of 1999 occurred along the Lavic Lake fault

located approximately 34 miles west of the quarry site and included rupture along the central portion of the Bullion fault. Other regional seismic sources include the North Frontal fault zone located along the northern flank of the San Bernardino Mountains approximately 70 miles to the west and the San Andreas fault zone located approximately 60 miles to the southwest.

Evidence of active faulting traversing the quarry area was not indicated in published and unpublished literature and maps or during the field mapping. Ground ruptured primary fault slip in the quarry area is not anticipated. Section 3.6 above provides a summary of the faults observed at the quarry site and additional detail is provided in the Slope Stability Investigation located in Appendix I.

3.8 Soils, Erosion, and Slope Stability

3.8.1 Soils

Actual soil is very limited to isolated areas of shallow poorly developed soil mixed with carbonate and granitic rocky material. Lowest elevations contain widely distributed marginal soils intermixed with weathered carbonate and granitic material and rocky slopewash debris.

3.8.2 Erosion, Sediment Transport and Windblown Dust

The undisturbed native limestone in the area is very resistant to erosion, and not highly fractured. During the mining operations, the fractured and crushed limestone is stockpiled and these stockpiles are subject to erosion, windblown dust and sediment transport issues. Best management practices (BMPs) and erosion control measures are used to minimize environmental effects associated with these activities and are further discussed in Section 6.4 Drainage, Diversion Structures and Erosion Control.

3.8.3 Slope Stability

The primary purpose of the Slope Stability Investigation (CHJ, December 2014) was to provide a slope stability evaluation for existing and future cut slopes and overburden placement site embankments. The following provides a summary of the conclusions and recommendations from the CHJ Report. Detailed discussions on the methodology and results are provided in the CHJ report located in Appendix I.

Slope Stability Investigation Conclusions

Based on the field investigations and slope stability analyses, CHJ concluded that the existing and proposed quarry excavation, stockpile, overburden placement sites and reclamation activities are feasible from geotechnical engineering and engineering geologic standpoints provided the recommendations contained in their report are implemented during mining. These recommendations are summarized in the following section below and discussed in detail in the CHJ Report. In addition, the slope stability calculations are provided in Appendix C of the CHJ Report (located in Appendix I of this document).

- In general, it appeared that past quarry operations have resulted in formation of grossly stable slopes and that the whole rock strength of ore and overburden rock is sufficient to accommodate the proposed overall slope angles.

- Based on CHJ's analyses, the proposed overall approximate 50- to 55-degree mine cut-slopes up to approximately 560 feet in height are suitably stable against gross failure for the anticipated long-term conditions, including the effects of seismic shaking. The proposed approximately 2(h):1(v) overburden fill slopes meet the factor of safety criteria for static and seismic conditions.

- Placement of overburden material against the existing ancient landslide mass in the west drainage will not result in unstable native or overburden slopes.

- Subsequent to blasting of the final rock slope walls, quarry operations may include the use of a scaling chain or mechanical equipment to assist in removal of loose or precarious block during removal of the ore. Adherence to the slope benching plan and consideration of newly exposed adverse structural features (if present) during future quarry work can result in stable slope after completion of quarry reclamation.

- No evidence of active faulting was observed on the site by CHJ during their investigation. Several inactive faults traverse the mine area.

- The potential for liquefaction and other shallow groundwater hazards within the reclamation area is considered to be remote.

- Moderate seismic shaking of the site can be expected to occur during the lifetime of the proposed mining and reclamation. This potential has been considered in the CHJ analyses and evaluation of slope stability.

- Raveling processes during and after quarry operation, with time, will result in deposition of talus on the benches. Talus left on the benches can facilitate revegetation and lend a more natural appearance to the reclaimed slopes. It is anticipated that boulders will be angular and relatively resistant to rolling.

Recommendations

The following provides a summary of Slope Stability Investigation recommendations. A detailed discussion of the recommendation can be found in the actual report located in Appendix I.

- Due to the existing wedge and block glide features at the north cut area of the quarry a potential for exposure of unstable rock masses exists at the northeast wall. Therefore, future excavation practice and slope design for the northeast wall should address the potential for wedge or planar failure along the steeply southwest-dipping, continuous, sheared rock surfaces.

- Visual monitoring should be conducted during excavation activities along the north-northeast wall during mining.

- Preparation of the final benched slope faces should include careful scaling to ensure removal of loose or potentially unstable blocks.

- If raveling or instability is evident, the bench width should be increased to provide a suitable buffer to daylighted or unstable features and a sufficient area to mitigate rockfall.
- The existing block glide should be stabilized, possibly by adding material to the toe of the slope, or removed by carefully scaling the block material without exposure of personnel or equipment to sudden sliding or movement.

- Certain benches identified in the report may be widened to provide a buffer to future movements of material in those particular areas.

- Based on the dip angle of planar and wedge structures exposed along the northeast cuts, it is anticipated that these features will be mitigated by the proposed benching scheme as mining proceeds to lower elevations, provided that adjustments are made to prevent daylighted slip planes or unstable wedges.

- Overall final cut slopes in the rock materials should be no steeper than design angles up to the maximum proposed height.

- Any large, unstable, rounded boulders on slopes steeper than approximately 2(h):1(v) should be removed or stabilized where accessible.

- Areas below loose rock, if left in place, should be restricted and indicated by means of signage or fencing.

- Ongoing monitoring of slope conditions for failure warning signs.

- Periodic observation of quarry benches above working areas for indication of potential instability should continue during mining operations.

- Final reclaimed fill slopes composed of overburden materials should be no steeper than 2(h):1(v) to the maximum proposed heights.

- Slopes should be protected with berms and/or levees as necessary to prevent slope erosion in the areas where natural slopes drain onto the reclaimed slopes.

4.0 MINING AND PROCESSING

4.1 History of Production and Utilization

As discussed in Section 1.1 Project Background, extraction of the limestone from this site began in approximately 1952 when Paul Tobler received a patent for a 160 acre claim. PSC leased the claim from Tobler in the 1970s and operated the mine into the early/mid 1990s. The ownership of the mine was transferred to Omya in 1997.

Because of the high purity and brightness of the crystalline limestone found at the Amboy Quarry, it has historically been used in pharmaceutical and food grade products as well as for whiting in a number of consumer goods. Currently all the crushed limestone from the Amboy Quarry is taken to the Omya Arizona plant located in Superior, Arizona. The Superior plant is registered with the United States Food and Drug Administration (FDA) as an Active Pharmaceutical Ingredient manufacturer and supplier. The Amboy Quarry limestone meets the stringent standards and specifications required for use in pharmaceutical and food products and is an important supplier of high purity limestone to the Superior Plant.

4.2 Land Use, Economic Considerations and Life of Operations

During the life of the mine approximately 6.3 million tons of exceptionally pure crystalline limestone will be extracted from the site. Limestone of such purity is suitable as pharmaceutical and food grade products for human consumption. The Amboy quarry is one of the few available existing sources of high purity limestone in the western United States and is one of the purest deposits in the world.

The land use in the area of the Amboy quarry has historically been used for mining activities, dating back to the 1860s. The property where the quarry is located consists of 480 acres of fee land and 130 acres of mining claims and mill sites. The original 160 acre claim was made in 1952 by Paul Tobler.

In addition to providing high purity limestone, the Amboy mine also helps to society by providing jobs; supporting Federal, State and local economies through direct purchase of equipment, materials, supplies and services; supporting Federal, State and local governments through payment of taxes and supporting the local community in various ways.

4.3 Mining Activities and Material Processing

Mining Phases

The mining operation at the Amboy Quarry is being conducted in four phases as shown on Figures 1 and 2. Table 1 (Section 1.2) provides a schedule for the quarry development. Due to the economic downturn in the early 2000s, the life of the mine is now estimated at 65 years. If during the life of the mine additional reserves are located or if the production rate is impacted again by changing economics, the mine plan may be modified and the life of the mine extended.

Mining is conducted by conventional methods. The ore is drilled and blasted in benches approximately 60 feet high. Ultimately more than 8 benches may be developed over a vertical interval of approximately 500 feet. Originally plans called for mining the deposit down to an elevation of 1,080 feet but the current mine plan has been adjusted to an elevation of 1,020 feet. Blasted material will either be crushed in a portable crusher and then hauled to the stockpile or transported directly to the permanent crusher and stockpile site(s) or overburden placement sites. Ore will be crushed on site, the crushed ore stockpiled and transported to the Superior, Arizona site for processing. Figure 2 provides the details of the Mine

Plan.

Phase 1 started in approximately 1996 and several benches have been established in the center of the deposit where access is easy and minimal overburden is present. Phase 1 has been completed. During Phase 2 production benches may be developed at 60 foot (vertical) intervals which will connect with the benches established in Phase 1. Quarry operations may occur during 8 – 9 months of the year. An additional two months or more per year is typically spent doing development work establishing benches, removing overburden and working on the road to the top of the ridge, in preparation of the next mining phase. Transporting the crushed rock to Superior, Arizona for processing may occur year round.

Phase 3 includes the development of the northeast portion of the deposit. Phase 3 development will occur while ore production continues from the Phase 2 portion of the deposit. It is scheduled to begin in 2041 for a period of 10 years. Phase 3 includes the removal of granite and limestone overburden and the establishment of additional ore production benches. Production during this Phase will increase to 200,000 tons/year and it is anticipated that the quarry will operate year round.

Phase 4 includes the development of the southeast portion of the deposit. Production will continue to come from the northeast portion and to deepen the pit. Once Phase 4 development in the southeast is finished, production will continue in the northeast portion of the quarry and mine the quarry pit to the final outer limit and final pit depth. Production during this phase will continue at 200,000 tons/year.

Some reclamation related activities will occur during the mining phases, such as vegetation and growth media salvage; however, most reclamation activity will only occur after all mining phases are complete.

Crushing System

Limestone ore from the quarry is crushed and stockpiled on site. No further processing of the ore occurs at the site. The crushed rock is transported to the Omya Superior, Arizona plant for processing.

No chemical additives are utilized in the crushing. There is no leaching, precipitating or chemical changes in the ore by natural or artificial means. Dust control is conducted by means of a foam dust suppression system.

A portable crusher is currently being used at the site. It is located in various areas of the site to allow for the most efficient crushing of the ore and/or project needs. As production increases, in addition to the portable crusher, a stationary crusher will be constructed. The stationary crusher will have multiple levels in order to best utilize the natural topographic changes at the site and will be located to allow the best access from the numerous quarry levels. The stationary crusher site will cover approximately 8.5 acres as shown in Figure 2.

Currently there are seven ore grades with stockpiles capable of holding approximately 35,000 tons of crushed ore. In order to provide additional flexibility and minimize offsite transport of sediment and windblown dust, the stockpile area boundary has been expanded as shown in Figure 2. It is anticipated that approximately 192,000 cubic yards of overburden may be used to build up the stockpile extension pad, which adds to the capacity of overburden placement sites.

Overburden and Waste Material Placement Sites

Overburden at the Amboy Quarry consists of medium to dark grey limestone which does not meet the specifications for ore, buff to brown dolomite, and various dark colored intrusive rocks (granite) and occasional dikes. Small amounts of limestone are also present. All the overburden and waste rock present at the deposit is naturally occurring material, and contains no acid producing materials or hazardous content.

There are two overburden placement sites and one crusher fines (waste) stockpile. The overburden placement sites are located near the quarry in order to minimize the haul distance, and not interfere with later quarry activities (see Figure 2).The overburden placement sites are underlain by stable slopes, and will allow for the formation of stable dump slopes. Overburden placement sites will be progressively phased and developed as the quarry is developed. The crusher fines are placed at the crushed ore stockpile and sent off-site to the extent possible as lower grade limestone product. Useable crusher fines may be used as supplements to the growth media, fill or discarded at the overburden placement sites. Table 3 below provides the overburden placement site capacities.

Table 3: Overburden Placement Site Capacities

Overburden Placement Sites	Approximate Capacity (cubic yards)
Overburden Placement Site 1 (West Canyon Fill Site)	2,600,000
Overburden Placement Site 2 (Northeast Fill Site)	131,000
Stockpile Extension Pad Site	192,000
Total Overburden Capacity	**2,923,000**

Source: Sespe Consulting

The volume of overburden to be moved per year is variable and depends on the development phase. Total estimated volume of overburden to be moved during the life of the quarry is 2,363,000 cubic yards (after 25% swell factor). The current estimated capacity of overburden sites, including the amount of overburden that will be needed to build the extension to the stockpile pad is approximately 2,923,000 cubic yards. Some overburden may also be utilized during quarry development for road construction and for crusher pads for the portable crusher. Therefore the mine plan provides sufficient capacity for overburden placement.

Overburden Placement Site 1: Overburden Placement Site 1is to the west of the deposit in the footwall of the limestone, and forms the steep ridge and the vehicular inaccessible canyon west of the quarry site. The steep, natural slope which forms the foundation, is rugged, and composed of stable and virtually bare rock outcrops, with no natural soil and very sparse vegetation. The overburden site covers about 16 acres and has a capacity of approximately 2,600,000cubic yards.

Overburden will be end dumped into the site by the end tipping method, and all material will be dumped from the same elevation. This method is common in mountainous terrain, where overburden sites are located over steep foundations and allows the overburden to compact under its own weight..

Ultimately the overburden material will abut against the opposite canyon wall. The abutment will allow the formation of a stable, surface compacted, buttressed fill pad. Several 100-foot-high, 2(h):1(v) slopes

separated by 25-foot-wide benches to a total height of approximately 350 feet will be constructed. Inclusion of benches in this overburden placement site results in overall slope angles of approximately 24 degrees.

As the overburden placement site is built rip rap will be placed at the toe of the slope. The rip rap will prevent undue off site sediment transport of material from the dump slope. Final configuration of the overburden site will not block the drainage (see Figure 2).

Overburden Placement Site 2: Overburden Placement Site 2 is located to the north of the quarry and incorporates approximately 5 acres. This site will be developed during Phases 2, 3 and 4 and has a capacity of about131,000 cubic yards. This site is planned as a continuous 150-foot-high, 2(h):1(v) fill-over-native slope with fill thickness of about 55 feet or less (see Figure 2).

Stockpile Pad Extension: It is anticipated that approximately 192,000 cubic yards of overburden will be used to extend the stockpile pad.

Crusher Fines Stockpile Site: During crushing of the limestone ore, the fines or ¼ inch material is separated from the rock. Some of the fines will be utilized as lower grade limestone product and possibly during the reclamation activities as growth media or fill, remaining fines will be discarded as waste material at the overburden placement sites. During the life of the quarry, approximately one million tons of fines will be generated.

As shown on Figure 2, crusher fines are stockpiled adjacent to and east of the crusher area.

Water Use

Water is used at the quarry primarily for dust control on the roads, at the crusher site, during blasting activities and for human use. Water used for dust control quickly evaporates and does not runoff. There are no water sources at the quarry site. Water is transported to the site by truck on an as needed basis from off-site suppliers.

5.0 RECLAMATION PLAN

5.1 Statement of Responsibility

As required by Public Resources Code §2772 (c)(10), the owner and operator accepts responsibility for reclaiming the mined lands in accordance with the provisions of this Amended Reclamation Plan. A signed copy of the statement is provided in Section 7.

5.2 Proposed End Use

After the four phases of mining are completed, the land will be reclaimed to open space. It will be revegetated with native species that are compatible with the local climate and environmental conditions. Reclamation will not preclude mining of the remaining limestone or other mineral resources which may occur at the site. When reclamation of the site is completed, it will achieve a land use compatible with the surrounding area, and prevailing resource management goals.

5.3 Proposed Time Schedule of Reclamation

Due to the harsh environmental conditions and minimal amounts of top soil, the majority of the reclamation activities cannot be initiated until all four mining phases are complete. Some minimal activities such as plant and growth media salvage may be conducted, as feasible, during the mining phases. Generally, access and haul roads are the last to be reclaimed, because they provide access to the other reclamation areas. In addition, access to the various sites must be maintained during the monitoring period. Table 4 below shows the general reclamation schedule for the reclamation.

Table 4: General Reclamation Schedule

Reclamation Site	Active Years	Reclamation Start	Reclamation Complete	Monitoring Period Complete
Cactus Salvage	1996-2051			
Growth Media Salvage	1996-2051			
Quarry	1996-2060	2061	2062	2067 or until goals are met
Overburden Placement Sites	1996-2060	2061	2063	2068 or until goals are met
Crusher Site	1996-2060	2061	2063	2068 or until goals are met
Fines Storage	1996-2060	2063	2063	2068 or until goals are met
Access and Haul Roads	1996-2068	2065	2066	2071 or until goals are met

Source: Pleuss-Staufer (California) Inc., Plan of Operations and Reclamation Plan 1996, discussions with Omya 2015

5.4 Impact of Reclamation on Future Mining

Once mining has reached the maximum economic limit, the majority of the currently identified high

quality limestone will have been removed. However, the existing mine plan is based on currently proven reserves and if during the life of the mine additional reserves are located, the mine plan may be modified and the life of the mine extended. Regardless, a limestone resource willremain after the mine plan is completed.

A directive of the San Bernardino County General Plan is the conservation of mineral resources. Because natural resources, particularly high purity, high brightness limestone resources are finite and limited, an effort will be made in the reclamation to conserve the remaining limestone resources which may be available when reclamation is completed, and which may have some conceivable future value.

5.5 Public Health and Safety

Safety measures will be incorporated throughout the active mining period, during reclamation of the quarry area and post reclamation, to reduce the potential risk of injury to the public. Once mining is completed a fence will be erected along dangerous highwalls with warning signs to prevent anyone from entering into the pit area. Quarry highwalls will be stable, and dangerous boulders or overhangs will be removed to the extent feasible.

Once reclamation is completed, access ramps and benches will have been ripped, growth media placed, and revegetated, and there will be no access to the site in conventional vehicles. Berms and or other barriers and warning signs will be placed to discourage unauthorized off-road vehicular access onto reclamation areas within the quarry.

During active mining operations, prior to any blasting activities, all workers at the site are be notified and a visual search of the area is conducted. Standard signals are used to notify personnel before and after blasts. Explosives are used only during daylight hours and are transported and used in accordance with all Federal, State and local regulations. When needed at the site, explosives are stored in approved magazines.

5.6 Control of Potential Contaminants and Non-Marketable Material

Water Quality

The quarry site is located within the Southern Mojave watershed (Hydrologic Unit Code 18100100). The area has an extremely arid climate with a few ephemeral washes that flow only in response to storm events. Groundwater elevations range from 577 to 565 feet above mean sea level (amsl) reported from the closest well 2 miles west-southwest of the quarry site. The deepest pit elevation is 1,020 feet amsl.

Several studies were conducted which addressed water quality. These include the Hydrology Study and Drainage Analysis (Bonadiman, 2015); JD (Himes, 2014) and the Slope Stability Study (CHJ, 2015). The following discussion is based on these reports and additional detail is provided in Sections 6.4 and 6.8.

The quarry pit will provide for a storage basin capable of capturing the full extent of a 100 year storm event eliminating stormwater runoff from that area of the mine. In the area of the overburden placement sites, stormwater is expected to permeate the rock and cobble conditions and follow the natural drainage course of the gulleys where they are located; therefore resulting in a low risk of sediment transport and no significant impacts to downstream areas. In the stockpile area and lower portions of the site, BMPs will be implemented to minimize sediment transport and windblown dust impacts to the ephemeral washes as described in the BMP Manual located in Appendix K.

A total of approximately 1.76 acres of Waters of the State under the jurisdiction of the CDFW and Colorado River Basin Regional Water Quality Control Board (RWQCB) are estimated to occur within the quarry site. All of these are ephemeral washes which flow only in direct response to storm events. Of this total, approximately 0.2 acres have already been disturbed under Streambed Alteration Agreement (SAA) No. 5-443-96 (Appendix G). Consultation with the CDFW and RWQCB are ongoing in regards to updating the SAA and finalizing the JD. The Amboy Quarry does not discharge dredged or fill materials into Waters of the U.S.; therefore, the site is not subject to the Industrial General Permit (IGP) Number 2014-0057-DWQ. As provided for by the IGP, a Notice of Non-Applicability (NONA) has been filed with the SWRCB (Appendix L).

No evidence for springs or perched groundwater conditions was observed at the site during the CHJ geologic mapping or on the aerial photographs examined during their investigation (CHJ 2015). The quarry occupies an elevated position on a mountain ridge relative to alluvial plains abutting the Bristol Mountains. The lowest planned feature of the quarry is the final pit bottom at elevation 1,020 feet amsl. The quarry is located in an arid region; therefore, static groundwater or long-term seepage is not anticipated to affect the mine pit walls nor are the mining activities expected to impact groundwater quality.

The use of hazardous materials during mining activities consists of fuels, lubricants, fluids associated with vehicles and equipment and blasting materials. All hazardous materials are stored in accordance with regulatory requirements and spill prevention and response procedures and BMPs are established and implemented to protect water quality. During the early phases fuel is and will be stored in a mobile fuel truck. During later phases, fuel will be stored in an approved above ground storage tank (AST) containing up to 10,000 gallons. Routine equipment maintenance occurs onsite at the crusher site. Any waste oil generated is collected and transported for offsite disposal by approved methods and properly trained personnel. No processing chemicals are used at the site.

Non-Marketable Material (Overburden, Waste Rock and Crusher Fines)

Non-marketable materials include overburden/waste rock and a certain amount of crusher fines. There are two overburden/waste rock placement sites and one crusher fines stockpile. The locations of these sites are shown on Figure 2, and their capacities are provided in Table 3. The overburden placement sites are underlain by stable slopes, and will allow for the formation of stable dump slopes. Overburden placement sites will be progressively phased and developed as the quarry is developed.

During crushing of the limestone ore, the fines or ¼ inch material is separated from the rock. Some of the fines will be utilized as lower grade limestone product and possibly during the reclamation activities as growth media, but some fines will be discarded as waste material. During the life of the quarry, approximately one million tons of crusher fines will be generated. As shown on Figure 2, crusher fines are stockpiled adjacent to and east of the crusher area. Fines will be covered by overburden to minimize erosion and windblown dust.

Refer to Section 4.2 for a detailed discussion on the overburden and waste materials generated at the Amboy Quarry.

5.7 Visual Resources

The Amboy Quarry is located in the southern Bristol Mountains which are visually stark and nearly devoid of vegetation. There are no major outstanding panoramic views or visual features in this area of the desert. When placed in the overall regional viewshed, the quarry will have only very minor visual impacts.

Reclamation of the quarry site will help mitigate the local visual impacts which may occur during the active mining phases. Overburden sites will be recontoured and graded to blend better with the surrounding terrain. Selective placement of growth media and revegetation with native species on accessible quarry benches and overburden sites will also mitigate the minimal visual impacts associated with the quarry.

5.8 Cultural and Archeological Resources

Cultural and archeological investigations at the Amboy Quarry and surrounding area were performed by CRM TECH (1995). Because of the harsh climate, the barren desert site, lack of water and naturally occurring food sources, the site has never been an area of permanent human habitation. Consultation with the State Historic Preservation Office was completed on July 1, 1997 and resulted in approval of all phases of mining operations.

6.0 SMARA RECLAMATION STANDARDS

The Amended Reclamation Plan extends the currently identified reclamation boundaries to include a buffer around the areas of disturbance associated with the mining activities. This provides greater flexibility to allow additional ore stockpiling near the access road and minimize the potential offsite effects of sediment transport and windblown dust. Figure 2 identifies the previous and revised areas of disturbance, overburden placement sites, ore stockpile sites and reclamation boundaries. Additional details of the reclamation are provided in Figure 3. The following sections describe how the Amended Reclamation Plan addresses the current SMARA regulations.

6.1 Wildlife Protection, CCR §3703

As discussed in Section 3.3.2 Wildlife, a General Biological Resource Assessment and a Desert Tortoise Presence/Absence Survey were conducted at the Amboy Quarry in 2014 (Himes Consulting). The results of these surveys and investigations indicated that there is the potential for three special status species to be present at the site: Death Valley Sage, Desert Tortoise and Nelson's bighorn sheep. Based on field observations, there was no evidence of Death Valley Sage or Desert Tortoise at that time. There were signs of Nelson's bighorn sheep.

Mitigation measures to protect wildlife and wildlife habitat have been identified in both the General Biological Resource Assessment and the Desert Tortoise Survey. In addition, wildlife protection measures are contained in the 2013 BLM Conditions of Approval and Environmental Assessment (Appendix J).The following provides a summary of the wildlife mitigation measures (refer to Appendices C, D and J for the specific mitigation measures and COAs):

- Expansion or clearing of new areas should be conducted outside of the nesting season (February 15 to September 15) to avoid impacts to migratory bird nesting activities.
- If jurisdictional washes will be impacted, permits should be obtained from the CDFW and the RWQCB.
- Provide desert tortoise training for all onsite personnel.
- Check for desert tortoise underneath all heavy equipment before moving.
- Dispose of trash in approved containers with lids to minimize the attraction of tortoise predators.
- Do not allow domestic dogs on the site during construction activities.
- Have an on-call biologist ready to assist the project manager should any tortoise-related issues arise.

6.2 Backfilling, Regrading, Slope Stability and Recontouring, CCR §3704

Backfilling

The quarry pit will not be backfilled because approximately 70% of the total volume of material removed from the Amboy Quarry will be ore, and the overburden is being placed where it will not be possible to retrieve the material for use as backfill.

Regrading and Recontouring

To the extent possible Omya will regrade and/or recontour all disturbed areas to provide for long term stability, promote effective drainage, blend with surrounding terrain, minimize potential visual impacts and meet reclamation goals. The final configurations of the overburden placement sites, the crusher site and the crusher fines stockpile site are provided in Figure 3. The CHJ Slope Report provided in Appendix

I evaluated the proposed final slope of these sites and concluded that the design met regulatory requirements. Section 4.2 provides a detailed discussion of these sites.

Slope Stability

A Slope Stability Investigation was performed by CHJ Consultants (2015). The following provides a summary of their findings. Section 3.8.3 discusses the conclusions and recommendations from the CHJ Report. A copy of the report is provided in Appendix I.

In general, it appears that past quarry operations have resulted in formation of grossly stable slopes and that the whole rock strength of ore and overburden rock is sufficient to accommodate the proposed overall slope angles.

A kinematic and global slope stability of the proposed reclamation slopes for representative material types was prepared for the Amboy Quarry by CHJ Consultants (2015). Structural data were plotted and evaluated using stereonet plotting software. Rock strength properties for global stability calculations were modeled using Hoek Brown criteria and the ultimate mining depths (highest slopes) anticipated in the mine pit. Direct shear tests were performed on representative overburden stockpile materials for use in evaluation of stockpile slopes.

The global stability of proposed mining slopes and proposed reclamation stockpiles was analyzed under both static and seismic conditions for rotational and composite failure surfaces. Selection of the slope configurations for the analysis of excavated slopes and stockpiles, which depicts the tallest anticipated continuous excavated or stockpile slopes proposed, is based on a most-conservative analysis approach. The whole rock strength of the Syenite unit exceeds that of the limestone unit; therefore, the models used the limestone strength values for global stability.

Groundwater was not considered in the global stability evaluation due to the lack of seepage or groundwater anticipated in the generally arid site environment.

The proposed overall approximate 50 to 55-degree mine cut-slopes up to approximately 560 feet in height are suitably stable against gross failure for the anticipated long-term conditions, including the effects of seismic shaking. The proposed approximately 2(h):1(v) overburden fill slopes meet the factor of safety criteria for static and seismic conditions.

Placement of overburden material against the existing ancient landslide mass in the west drainage will not result in unstable native or overburden slopes.

Subsequent to blasting of the final rock slope walls, quarry operations may include the use of a scaling chain or mechanical equipment to assist in removal of loose or precarious blocks during removal of the ore. Adherence to the slope benching plan and consideration of newly exposed adverse structural features (if present) during future quarry work can result in stable slopes after completion of quarry reclamation.

As indicated by calculation, sufficient static factors of safety in excess of 1.5 and seismic factors of safety in excess of 1.1 were indicated for the modeled proposed rock and overburden slope configurations and satisfy OMR criteria. The global rock and overburden slope configurations appear suitably stable for reclamation of the Amboy Quarry slopes according to regulatory requirements.

6.3 Revegetation Plan, CCR §3705

A Revegetation Plan was prepared for the Amboy Quarry by Biological Resource Specialists (BRS) in January 1998. A Revegetation Plan Update was prepared Himes Consulting in September 2014 (Appendix M).

6.3.1 Existing Vegetative Cover

Baseline vegetation transect were conducted by BRS in 1998 prior to development of the Amboy Quarry by Omya to document vegetative species density and diversity in undisturbed areas. This baseline transect data was used to provide information for revegetation goals and seeding mix and rate.

Total cover averaged 10.62 percent with a species diversity of 16. Ninety-four present of the relative ground cover was found from the following three species: creosote bush, rayless encelis, and white bursage.

6.3.2 Site Preparation for Revegetation

Following recontouring, compacted areas, accessible benches and the pit bottom will be scarified, as feasible, to a depth of at least one foot to aid in revegetation prior to receiving growth medium.

6.3.3 Revegetation Methods

Growth Media

During quarry development, growth media will be salvaged to the degree possible. However, the availability of growth medium is limited at the quarry since a large portion of the site consists of bedrock outcroppings with very limited soil. In addition, if growth media were to be present in the rock outcroppings, the steep slopes would preclude growth media salvage. However, the bedrock at the lower elevations of the site does have a thin alluvial cover. Surface material in the alluvial areas consists of occasional rocky bedrock outcrops, scattered shallow coarse textured soils, weathered carbonate and granitic materials, rock rubble, debris resulting from weathering and downslope movement of exposed bedrock and mixed alluvial/colluvial material. Marginal soils may be intermixed with these weathered carbonate and granitic materials and rocky slopewash debris. If feasible, this soil will be salvaged and stored in the growth media stockpile shown on Figure 2.

Growth media derived from carbonate and granitic materials generally has very low organic content and is considered to be of low productivity. It is characterized by a high runoff coefficient and generally high permeability. Any growth media which can be salvaged will be similar in character to this existing in place weathered rock materials.

Growth media that can be salvaged is be taken to a growth media storage site located in the southeast portion of the quarry (Figure 2). Berms will be placed around the growth media storage site to prevent erosion and loss. Seasonal rain and spontaneous vegetation by contained or windblown seeds may allow some revegetation of the storage site to occur, which will help reduce erosion of the stockpiles.

As growth medium is limited, available stockpiled growth medium will be applied in irregularly-shaped islands 2-3 feet thick. Accessible benches with the most visibility will receive the highest priority for growth media placement. Benches with no visibility, at the lower elevations or those that face to the west, will receive growth medium as possible based on supply.

Planting

Planting will be achieved by broadcast seeding. Seeds collected from the surrounding area will be used in the seeding effort, supplemented with purchased seed if needed. Pure live seed will be dispersed using a mechanical broadcast seeder. The seeded areas will be chain-dragged to achieve soil coverage of seeds. Natural colonization will supplement the revegetation efforts to promote long-term habitat productivity for the area.

Site preparation will occur in the fall, immediately prior to planting. Seeding will occur in late October or early November with plant growth occurring in the spring when temperature and moisture conditions are optimal.

No irrigation is proposed at this time, based on native conditions. The minimal precipitation should be sufficient to provide seed germination and root establishment of native species. The planting season was selected to maximize the amount of rainfall potential for germination and growth, encouraging long-term revegetation success. Irrigation is not proposed so as to discourage growth of non-native invasive species. Tests will be performed, if necessary, on the growth media to determine if soil amendments (fertilizer) are necessary to aid in revegetation.

6.3.4 Seed Mixes

A seed mix was designed for the project site to promote a plant community similar to that found in undisturbed areas. This seed mix will serve as a guideline for the revegetation plant community. However, final plant selection will occur at closure and will be based on availability, success rates, and cost. Seed types, amounts, and costs are provided by vegetation type in Table 5 below. Slight variations are provided by vegetation type, however overall vegetation communities are similar in species type and diversity. In addition, cacti will be transplanted, as feasible, at a rate of 5 plants per acre.

Table 5: Revegetation Plant Communities and Seed Mixes

Plant Species Common Name	Plant Species Scientific Name	Creosote Bush/ White Bursage Scrub Mix	Creosote Bush/ Brittlebush Scrub Mix	Brittlebush Scrub Mix
		Application Rates (in lbs./acre)		
Bladderpod	*Isomeris arborea*	0.5	--	--
Brittlebush	*Encelia farinose*	--	4	6
Cheesebush	*Hymenoclea salsola*	2	2	2
Creosotebush	*Larrea tridentate*	10	4	2
Desert dandelion	*Malacothrix glabrata*	1	--	--
Desert lavender	*Hyptis emoryi*	1	1	1
Desert trumpet	*Eriogonum inflatum*	2	2	2
Evening primrose	*Camissonia claviformis*	1	--	--
Prickly poppy	*Argemone munica*	1	1	1

Plant Species Common Name	Plant Species Scientific Name	Creosote Bush/ White Bursage Scrub Mix	Creosote Bush/ Brittlebush Scrub Mix	Brittlebush Scrub Mix
		Application Rates (in lbs./acre)		
Purple heather	*Krameria erecta*	0.5	--	--
Pygmy cedar	*Peucephyllum schottii*	--	--	1
Rayless encelia	*Encelia frutescens*	1	4	6
White bursage	*Ambrosia dumosa*	2	2	2
Wire lettuce	*Stephanomeria pauciflora*	2	2	2
Yellow cups	*Camissonia brevipes*	0.5	--	--
	TOTAL Application Rate (lbs./acre)	***24.5***	***22***	***25***

Source: Updated Revegetation Plan, 2014.

6.3.5 Cactus Salvage and Transplantation

During quarry development existing cactus species which could be impacted by mining will salvaged, if feasible. Most of the cacti in the area are barrel cacti. Because of the steep nearly inaccessible bedrock nature of some of the terrain, the number of plants that exist and which may be realistically salvaged is limited. Where it is possible to salvage cactus plants this will be done during their dormant season (September through February). The plants will be taken to a nursery area for long-term holding. North-facing sides of each side will be marked. Salvaged cacti will then be transplanted for revegetation after seeding at a rate of 5 cacti per acre or as available. Because the life of the quarry is longer than the life span of many of the plants, salvaged cacti may live their lives and die in the nursery area, not surviving to the reclamation phase.

6.3.6 Control of Non-Native Vegetation

Mining activities create and maintain disturbed conditions that can be suitable for the growth and reproduction of a variety of non-native invasive weeds. To discourage growth of non-native invasive species, irrigation is not proposed. Use of amendments, other than the initial inclusion of fertilizer in the seed mixtures, will be discouraged due to the rapid response of weedy species to such soil treatments.

6.3.7 Soil Analysis

As previously noted much of the quarry area forms very steep and rugged rocky outcrops completely devoid of soil, containing only sparse vegetation. When it is possible to salvage top soil and growth media, tests may be performed, if necessary, to determine if soil amendments (fertilizer) are necessary to aid in revegetation.

6.3.8 Performance Standards

Performance standards quantitatively evaluate the success of the revegetation effort and weed control in relation to similar native, undisturbed habitats.

Success of the revegetation will be judged based upon the effectiveness of the vegetation for the approved end use, and by comparing the quantified measures of vegetative cover, density and species-

richness of the reclaimed mined-lands to similar parameters of naturally occurring vegetation in the area. Reclamation will be considered complete for a given area when these standards have been achieved or the subsequent land uses has been establish.

The goal of revegetation at the Amboy Quarry is to establish a sufficient level of native vegetation cover, density and species richness that is similar to the nearby areas and to minimize effects of erosion and invasion by non-native species. This will be accomplished by establishing a vegetation cover on disturbed areas that is equivalent to 80% of the native plant cover. The vegetation transects indicated that the total native cover averages 10.62%; therefore, the goal is 8.5% cover.

Revegetation success will be assessed by conducting transects (50 m x 1 m) within each vegetative community type to evaluate density. Revegetation shall be deemed successful if it has reached 8.5 percent total cover or greater on an average property-wide basis (Table 6). If vegetative cover has not reached this goal, continued maintenance seeding and monitoring will be conducted annually until the goal is achieved.

Table 6: Revegetation Performance Standards

	Native Cover Seed Mix
Goal	Establish sufficient level of native vegetation cover, density and species richness that is similar to nearby areas and to minimize effects of erosion and invasion by non-native species
Performance Standards	*Overall Cover:* 80% of baseline native plant cover(80% of 10.62 results in performance standard of 8.5% overall coverage). *Density:*Five cacti per acre within the 8.5% coverage provided by other perennial species. *Species Richness:*Minimum of 3 native perennial species (creosote bush, rayless encelis and white bursage) in revegeation area

Source: Update Revegetation Plan, 2014.

6.3.9 Monitoring and Reporting

Periodic inspections of the revegetation efforts will occur for approximately five years during the establishment of the seedlings as part of ongoing reclamation maintenance, or until reclamation goals have been met. Maintenance seeding will be conducted in sparse areas if needed during this period. Manual removal of weeds such as Russian thistle (*Salsola kali*) will be conducted during the maintenance period.

The monitoring program will establish a recording form for compliance and verification. This record will contain pertinent actions and dates, copies of permits, correspondences and other relevant data, in addition to recorded data for various reclamation activities.

Monitoring is designed to evaluate the success of the seeding procedures and subsequent native plant growth over time and to implement contingency measures in the event the specified performance criteria are not achieved. Pursuant to §2773(a) of SMARA, the success of reclamation will be monitored annually for 5 years, or until performance standards are met, provided that, during the last 2 years, there has been no human intervention, including weeding. After seed introduction, monitoring will be conducted by a qualified applicant-appointed representative to gauge the success of the revegetation effort.

Maintenance seeding will be conducted in sparse areas if needed to achieve the performance criteria presented in Table 6above.

Annual reports and recommendations will be submitted to the County. Follow up monitoring will continue for 5 years, as described above, and will not cease until performance criteria have been met.

6.4 Drainage, Diversion Structures and Erosion Control, CCR §3706

Climate is arid in the deposit area and the water table is deep. The quarry site is situated on a ridge line between two gulleys which results in two major drainage areas on either side of the quarry. Figures1, 2 and 3 show the pre- and post-reclamation drainage areas around the quarry site. A detailed analysis of the site drainage is provided in the Hydrology Study and Drainage Analysis (Appendix F). The quarry site does not occur in a flood plain, no permanent surface water is present in the area and because of the rarity of any rainfall, there is also very little runoff. What little water may occasionally flow during storm events in ephemeral washes is lost quickly to evaporation or percolation into the porous alluvial material. The rare surface flow in the area never reaches any major drainage system.

The quarry is an open pit quarry. The final pit will be excavated below the existing drainage elevation, and thus the pit will intercept any runoff and sediment transported down the quarry slopes and into the bottom of the quarry pit. Any retention of runoff and minor flows from up gradient drainage segments in the pit area will not affect the overall hydrologic balance of the area, since the flow volume will be very small, and any water directed into the quarry will quickly evaporate or infiltrate through fractures into the ground water system, which is consistent with the natural hydrologic cycle of the area.

With the exception of minor upslope drainage which will be intercepted by the final quarry pit, the proposed quarry operation and reclamation will not alter existing drainage patterns, and will not result in any significant alteration of natural surface and ground water relationships or the hydrologic balance.

The haul road crosses minor shallow dry drainages (less than 1.0 foot deep) which are not suited for placing of culverts. The haul roads are designed to direct the very uncommon storm runoff into the quarry pit or off the roads where water will evaporate. Roads are designed with sediment catchments, rock lined drains, hay bales or other filters, to direct runoff off the roads, and prevent sediment from being transported off site. The BMPs that may be used during mining and reclamation activities are described in the BMP Manual (Appendix K). Drainage control structures will be inspected and maintained on a regular basis. The overburden placement sites consist primarily of rock and cobbles which are highly permeable. Stormwater is expected to permeate the fill and follow the natural drainage course of the gulley resulting in a low risk of sediment transportation. Overburden Placement Site 1 is located to the west of the quarry and will abut against the opposite canyon wall. This will allow for the formation of a stable, surface compacted, buttressed fill pad. Overburden Placement Site 2 is located to the north of the quarry. As the overburden placement sites are built, rip rap will be placed at the toe of the slopes. The rip rap will prevent undue offsite sediment transport of material from the overburden placement sites. Final configuration of the site will not block drainage.
The Hydrology and Hydraulics Report (Bonadiman September, 2015) evaluated the need for temporary sediment basins in the drainage areas. It was recommended that a sediment basin should be installed in the southeast portion of the site as shown on Figure 2. The basin will have a minimum surface area of 1.20 acres and a maximum depth of 5 feet, resulting in a capacity of no less than 5.99 acre feet. This equates to a volume equal to the 10-year, 6 hour storm volume plus a debris load of 200 CF per acre. The depth of the basin may be altered by increasing the surface area as needed; however it is recommended

that the minimum depth be 3 feet. As discussed in the Bonadiman report, this exceeds the SMARA 20-year, 1-hour requirement. All temporary basins will be designed based on the "Detention Basin Design Criteria for San Bernardino County".

The crusher fines and ore stockpiles are located to the south of the quarry. As described in the BMP Manual, BMPs such as watering and the placement of overburden for dust and erosion control, and use of fiber rolls, gravel bags, sand bag barriers, and/or straw bale barriers for runoff and sediment transport control.

Post-operational drainage control measures may include re-grading/re-contouring to promote and direct surface runoff, construction of berms in overburden placement areas and the crusher site to minimize runoff and erosion on outslopes, and construction of localized drainage controls including ditches, berms, water bars, and placement of erosion control materials. Given the variations in physical characteristics within the quarry site area, one or a combination of several drainage control measures may be used to optimize stability and erosion protection, and minimize offsite sediment transport.

A detailed description of the BMPs that may be used at the quarry site are provided in the BMP Manual located in Appendix K

6.5 Prime Agricultural Land Reclamation, CCR §3707

The Amboy Quarry does not contain any prime agricultural land.

6.6 Other Agricultural Land Reclamation, CCR §3708

The Amboy Quarry does not contain any agricultural land.

6.7 Building Structure and Equipment Removal, CCR §3709

A portable office trailer is currently being used as an office. A portable toilet is provided and serviced regularly. Electricity is supplied by a portable generator. A trailer van for storage of spare parts and tools and a skid mounted non-potable water tank may also be brought to the site. A larger mobile office may be brought on site during the later mining phases.

Fuel for the equipment and crusher is stored in approved aboveground storage containers. In the early phases fuel is being stored in mobile fuel and lube trucks. During later phases, fuel will be stored in an approved AST containing up to 10,000 gallons.

Once mining has been completed residual mining equipment, supporting structures, facilities, refuse and signs will be removed. Refuse, or spillage of oil, grease, or other materials will be cleaned up in a proper and legally acceptable manner. Fuel storage facilities will be removed and the site cleaned up at the end of reclamation, or when it is no longer necessary to utilize heavy equipment at the site.

Any mining contractors working at the site (if any) will remove any residual equipment or facilities, and will cleanup any refuse, spillage of oil, grease, or other materials in a proper and legally acceptable manner.

6.8 Stream Protection, Including Surface Water and Groundwater, CCR §3710

The quarry site is located within the Southern Mojave watershed (Hydrologic Unit Code 18100100). The area has an extremely arid climate with a few ephemeral washes that flow only in response to storm events. Groundwater elevations range from 577 to 565 feet amsl reported from the closest well 2 miles west-southwest of the quarry site. The deepest pit elevation is 1,020 feet amsl, therefore mining activities are not expected to impact groundwater quality.

As discussed in the JD (Appendix E), the Amboy Quarry does not discharge dredged or fill materials into Waters of the U.S.; therefore, the site is not subject to the Industrial General Permit (IGP) Number 2014-0057-DWQ and a formal SWPPP has not been prepared. As provided for by the IGP, a NONA has been filed with the SWRCB and a copy is provided in Appendix L.

However, a total of approximately 1.76 acres of Waters of the State under the jurisdiction of the CDFW and Colorado River Basin RWQCB are estimated to occur within the quarry site. All of these areas are ephemeral washes which flow only in direct response to storm events. Of this total, approximately 0.2 acres have already been disturbed under Streambed Alteration Agreement (SAA) No. 5-443-96 (Appendix G). Consultations with the CDFW and RWQCB have been conducted and will continue as needed to ensure compliance with regulatory requirements.

The use of hazardous materials during mining activities consists of fuels, lubricants, fluids associated with vehicles and equipment and blasting materials. All hazardous materials are stored in accordance with regulatory requirements and spill prevention and response procedures are established and implemented to protect water quality.

BMPs are used to protect water quality in the ephemeral washes from stormwater runoff, sediment transport and windblown dust. The BMP manual is provided in Appendix K.

6.9 Topsoil Salvage, Maintenance and Redistribution, CCR §3711

During quarry development, topsoil (growth media) will be salvaged to the degree possible. However, the availability of top soil is limited at the quarry since a large portion of the site consists of bedrock outcroppings with limited soil. In addition, if soil were to be present in the rock outcroppings, the steep slopes would preclude topsoil salvage. However, the bedrock at the lower elevations of the site does have a thin alluvial cover. Surface material in the alluvial areas consists of occasional rocky bedrock outcrops, scattered shallow coarse textured soils, weathered carbonate and granitic materials, rock rubble, debris resulting from weathering and downslope movement of exposed bedrock and mixed alluvial/colluvial material. Marginal soils may be intermixed with these weathered carbonate and granitic materials, rocky slopewash debris and/or crusher fines. If feasible, this soil will be salvaged and stored in the growth media stockpile shown on Figure 2.

Berms will be placed around the growth media storage site to prevent erosion and loss. Seasonal rain and spontaneous vegetation by contained or windblown seeds may allow some revegetation of the storage site to occur, which will help reduce erosion of the stockpiles.

As growth medium is limited, available stockpiled top soil will be applied in irregularly-shaped islands 2-3 feet thick. Accessible benches with the most visibility will receive the highest priority for growth media placement. Benches with no visibility, at the lower elevations or those that face to the west, will receive growth medium as possible based on supply.

6.10 Tailing and Mine Waste Management, CCR §3712

Mine waste at the Amboy Quarry consists of overburden, waste rock and crusher fines. There are two overburden placement sites and one crusher fines stockpile. The overburden placement sites are located near the quarry in order to minimize the haul distance, and not interfere with later quarry activities. The crusher fines are stockpiled adjacent to and east of the crusher area (see Figure 2).

The overburden placement sites are underlain by stable slopes, and will allow for the formation of stable dump slopes. Overburden placement sites will be progressively phased and developed as the quarry is developed. As the overburden placement site is built, rip rap will be placed at the toe of the slope. The rip rap will prevent undue off site sediment transport of material from the slope. Final configuration of the overburden placement sites will not block the natural drainage of the areas. Table 3 provides the overburden placement site capacities.

As noted previously the final quarry pit will be excavated below hydraulic grade. Larger rainfall events may create an accumulation of water in the bottom of the pit after a large rainfall event.

6.11 Closure of Surface Openings, CCR §3713

No surface openings as described in CCR §3713(b) have been or will be produced during mining or reclamation activities.

7.0 STATEMENT OF RESPONSIBILITY

I, the undersigned, hereby agree to accept full responsibility for reclamation of all mined lands as described and submitted herein and in conformance with the applicable requirements of the Surface Mining and Reclamation Act (Public Resources Code, Division 2, Chapter 9, Section 2710 et seq.); Articles 1 and 9 (Sections 3500 et seq. and 3700 et seq., respectively) of the Surface Mining and Reclamation Act Regulations (California Code of Regulations Title 14, Division 2, Chapter 8, Subchapter 1), and with any modifications requested by the administering agency as conditions of approval

Signature _____

Name JOHN H SIDDARTH

Signed this day of, 2015

8.0 FINANCIAL ASSURANCES

The project is currently in operation and financial assurances in place per SMARA requirements. An updated Financial Assurance Cost Estimate has been prepared and is included in Appendix M of this Amendment.

APPENDIX A

County of San Bernardino, Mining Conditional Use Permit

San Bernardino County Planning Department

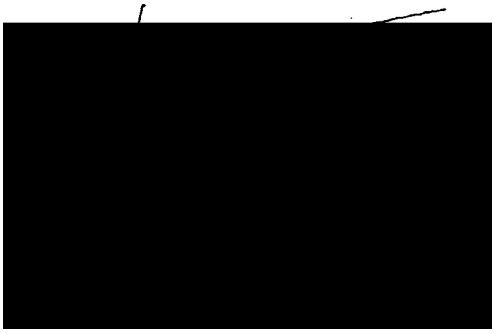
NEGATIVE DECLARATION (Planning Commission)

385 North **Arrowhead Avenue,** Third Floor, **San Bernardino, CA 92415-0182**

Proiect Description

DATES: 745DS N95009347SMB01 /009347M F 1
COMMUNITY: AMBOY/S1
FILE/INDX: **S**[A]MR/95-0066/DN913-181N
APPLICANT: PLUESS-STAUFER (CALIF.) INC.
PROPOSAL: MINING/RECLAMATION PLAN FOR LIMESTONE QUARRY ON 73 ACRES
_OCATION: 8 MILES EAST/NORTHEAST OF AMBOY, 1 MILE WEST OF KELBAKER RD.
REP(S): WEBBER & WEBBER, MINING CONSULTANTS

VICINITY MAP



OCTOBER 25, 1996

Effective date of Negative Declaration (after 10-day appeal period)

Plans and specifications for the referenced project are available for public inspection in the Planning Department.

Pursuant to provisions of the California Environmental Quality Act and the San Bernardino County Environmental Review Guidelines, the above referenced project has been determined not to have a significant effect upon the environment. An Environmental Impact Report will not be required.

Reasons to support this finding are included in the written Initial Study prepared by the San Bernardino County Planning Director.

The decision may be appealed by any aggrieved person, organization or agency to the County Board of Supervisors. Appeals shall be filed before the effective date of the Negative Declaration listed above. The Notice of Appeal shall be in writing and shall be filed with the appropriate fee at the San Bernardino County Government Center, Clerk of the Board of Supervisors, during normal business hours.

October 14, 1996

for Valery Pilmer, Director of Planning
Signature and Title

Date of ***Determination*** cc:

Attachments: Initial Study and any Mitigation Measure(s)

Rev. 7194 IAP

Notice of Determination

To: ❑ Office of Planning and Research
1400 Tenth Street, Room 121
Sacramento, CA 95814

From: San Bernardino County Planning Department
385 North Arrowhead Avenue, Third Floor San
Bernardino, CA 92415-0182

X Clerk of the Board of Supervisors
County of San Bernardino
385 North Arrowhead Avenue, Second Floor San Bernardino, CA
92415-0130

Documentary Handling Fee ($35.00)

Receipt Number _____

LID
C.
[redacted]

SUBJECT:

Project Description

DATES: - -- 345 DSN9500934 7SMB01/009347ME1 - -
COMMUNITY: AMBOY/S1
PILE/1NDX: SAMR/9$-0066/DN913-181 N
/APPLICANT: PLUESS-STAUFER (CALIF.) INC.
PROPOSAL: MINING/RECLAMATION PLAN FOR LIMESTONE O U O (ON 73 ACRES
LbCATION: 6 MILES EAST/NORTHEAST OF AMBOY 1 MILE WEST OF KELBAKER RD
REP('S): WEBBER & WEBBER MINING CONSULTANTS

Applicant'.

PLUESS-STAUFER (CALIF.)
Name
P 0 BOX 825
Address
LUCERNE VALLEY, CA 92356
Phone

Representative

WEBBER AND WEBBER
Name
1323 W. COLTON AVE #217
Address
REDLANDS, CA 92374
(909) 793-3416
Phone

State Clearing House Number 96091032

RICH TOUSLEE
Lead Agency Contact Person

(909) 387-4105
Area Code/Telephone Number

This is to advise that the SAN BERNARDINO COUNTY PLANNING COMMISSION has approve the above described
X Lead Agency **p** *Responsible Agency*

project on DECEMBER 19, 1996 *Date* with an effective date of JANUARY 4, 1997 *Date* and has made

the following determinations regarding the above project:

1. The project [0 will X will not] have a significant effect on the environment.
2. ❑ An Environmental Impact Report was prepared for this project pursuant to the provisions of CEQA.
   X A Negative Declaration was prepared for this project pursuant to the provisions of CEQA.
3. Mitigation measures [0 were X were not] made a condition of the approval of the project.
4. A statement of Overriding Considerations [❑ was X was not] adopted for this project.
5. Findings [X were ❑ were not] made pursuant to the provisions of CEQA.

This is to certify that the final EIR with comments and responses and record of project approval is available to the

General Public at: SAN BERNARDINO COUNTY PLANNING DEPARTMENT s

9'(_____,

Signature (Public Agency) **ate** *Title*

Date received for filing at OPR: *Planning* Department - *Revised August* **1994**

This Mining/Reclamation Plan, approved by the San Bernardino County:

_____ _____

Planning Commission

complies with the Mining/Reclamation Plan requirements of both the San Bernardino County Development Code, Title 8, Division 10, Chapter 1, Surface Mining and Land Reclamation and the California Surface Mining and Reclamation Act of 1975 (SMARA).

[redacted]

The issuance of a Conditional Use Permit for Mining/Reclamation by San Bernardino County neither constitutes an endorsement of the project, nor a testament to the validity of the ore body.

MINING CONDITIONAL USE PERMIT
AND
RECLAMATION PLAN

Project Title _____ Amboy Quarry _____

Reclamation Plan Number: _ 96M-06 _____ Expiration Date: 1/04/2052
Name of Project Proponent: _____ Pluess-Staufer (California), Inc.
Address of Project Proponent: P.O. Box 825 _____
Lucerne Valley, CA 92356

Project Location: Located 3/8 miles west of Kelbaker Rd, 7/8 miles north of National Trails Hwy, near the community of Amboy. (T 6N, R13E, Sec. 30)

Type of Operation: _ Open pit, Side Hill, Multi bench _____
Mineral Commodity: Limestone

Quantity of Ore __ 25,000 tpy (Phase I) _____
Operation Time Frame: ___ 55 years _____ Reclamation Time Frame: _ 10 years _____
Area to be mined and reclaimed: _____ 73 acres _____
Total holdings: _____ 210 acres _____
Maximum Anticipated Depth: __ Natural bedrock slopes up to 80' vertical cliffs, with overall 500' depth.
Reclaimed to: _____ Vacant open space. _____
Effect on Future Mining: _ Reclamation will not preclude future mining of the deposit. _____

State Agency: Department of Conservation
Office of Mine Reclamation
Reclamation Unit
801 K Street, M.S. 09-06
Sacramento, CA 95814
(916) 323-9198

Lead Agency: San Bernardino County
Planning Department
Environmental Team
385 N. Arrowhead Avenue
San Bernardino, CA 92415
(909) 387-4099

Lead Agency Contact Person:

/reee-t"
Richard L Touslee, Senior Associate Planner

Date: __ January 29, 1997

NOTE: This and supplemental documents for the non-proprietary portions of the project are on file and available for review at the state and lead agency addresses above.

MINING/RECLAMATION

GENERAL ON-GOING CONDITIONS

1 This conditional approval is for the establishment of Mining/Reclamation Plan No. 96M-06; a Mining Conditional Use Permit and Reclamation Plan to establish a limestone quarry in four phases on 73 acres. Final approval of Phases 2 through 4 which affect Federal land requires an approved Plan of Operations from the BLM. Any alteration or expansion of these facilities or increase in the developed area of the sites from that shown on the final approved plot plans may require submission of an additional application for review and approval. A copy of the Mining/Reclamation Plan shall be kept on site during operations at all times. A Mitigation Monitoring and Compliance Program has also been included as part of the Mining/Reclamation Plan approval.

2. The Mining Conditional Use Permit and Reclamation Plan shall be effective for a period of 55 years, expiring on January 4, 2052. The Conditional Use Permit shall be effective for a period of 55 years and as long as the Reclamation Plan is valid and the operation is in compliance with the conditions of approval. The Reclamation Plan shall be effective for an additional 10 years to allow for monitoring of revegetation efforts and other required reclamation activities.

3. The San Bernardino County Planning Director shall be notified in writing, within 30 days, about any:

   A) Change in operating procedures, or inactive periods of operation for one (1) year or more;

   B) Changes of Company ownership, address, or telephone number during the life of the Conditional Use Permit or Reclamation Plan;

   C) Any changes to provisions in lease agreements or real property that will affect the approved Mining/Reclamation Plan.

4. If the operation or Reclamation Plan procedures change from those outlined in the Final Mining/Reclamation Plan, an amendment shall be filed and approved 90 days before such changes are made effective.

5. A report summarizing the past year's mining and reclamation activity shall be filed with the State Department of Conservation, Office of Mine Reclamation and the Planning Department each year on an anniversary date to be determined by the Department of Conservation. Mine site inspections will occur in conjunction with the annual report or at other times as appropriate.

6. As determined necessary on a case by case basis, the applicant shall deposit funds with the County necessary to compensate staff time and expenses for review of monitoring reports and site inspections.

7. Implementation of the mitigation measures required for this project shall be verified according to the methods identified in the Mitigation Monitoring and Compliance Plan. Planning Department verification of compliance shall be requested through submittal of a Mitigation Monitoring and Compliance Application along with the required fee deposit.

8. The mining operation shall be conducted in a uniform manner, with exterior slopes and floors trimmed as the mining operation proceeds. Excavation shall be conducted so as to leave them in a reasonably neat and trim manner. Final pits shall be excavated and trimmed as per the approved Mining/Reclamation Plot Plans.

9. The applicant/operator shall maintain the mine, plant site and premises in a neat and orderly manner at all times. No refuse shall be maintained at any time in pit excavation, channel ditches or work areas. All rubbish shall be disposed of at established waste disposal sites. When, in the opinion of the County, storm or other waters in the excavation shall be considered a nuisance, the permittee shall be required to abate said nuisance.

10. If an area is to be used for temporary water storage or silt basin, the area shall be completely enclosed with a six foot (6') high chain link fence in accordance with the State of California Department of Transportation standard specifications and standard plan F-10, and provide a lockable gate at the location of access. Gates shall be kept locked at times when not in use.

11. At the time of termination of the operation for any reason, all equipment, buildings, structures and refuse associated with the operation shall be removed from the site, all hazards mitigated, and reclamation initiated within 90 days, as per the approved Reclamation Plan.

12. The applicant shall install Company identification signs on all company owned and operated haulage trucks used on public roads. The signs shall be located on both sides and the rear of each truck. The information contained on the sign shall include:

On the rear of the truck:	On the side of the truck:
a. How am I driving?	a. Company name.
b. Truck number.	b. Truck number.
c. Company phone number.	c. Company phone number.

The signing shall be printed in a minimum of 3" high lettering. The applicant shall have a person or an answering machine available during operating hours to answer the phone that corresponds to the phone number on the truck. The persons answering the phone number shall
be instructed as to how to take the calls, how to affect a solution, and be responsible for returning a call to the complainant with results of investigation. The applicant shall keep a log of all calls received and shall include documentation of response and/or resolution of complaints. The log shall be made available to the County upon request.

*13. All final quarry benches shall be designed so that they do not exceed the heights and bench widths identified in the slope stability analysis submitted and approved by mitigation condition #34. All remaining overburden pile slopes shall have no greater than a 2:1 slope ratio, horizontal to vertical. All finished slopes shall be contoured to blend with existing natural contours. Slope stability analysis of final reclamation slopes for overburden dump slopes which will exceed 100 feet will be conducted prior to setting the final toe position of the reclaimed overburden slope.

14. The applicant shall maintain the use of a spray bar system and/or other dust suppression systems on all crushing and processing equipment.

15. In the event of any soil contamination on-site, the applicant/operator shall remove to a County approved disposal site, any soils that become chemically contaminated so as to preclude any chemical leaching into the local ground water supply over time.

16. The operator shall wet sweep working mine areas on a regular basis and more frequently as needed during windy conditions. Water used for wet sweeping shall be non-potable to the extent that such a source is available and economical. Unsurfaced haul and access roads shall be maintained with biodegradable dust suppressants or covered with road base material. The applicant shall also shut down the operation on days of extreme wind conditions as defined by sustained wind forces of 30 mph or greater.

17. The applicant shall agree to defend, at his sole expense, any action brought against the County, its agents, officers, or employees, because of the issuance of such approval, or in the alternative, to relinquish such approval. The applicant shall reimburse the County, its agents, officers, or employees, for any Court costs and attorney's fees which the County, its agents, officers or employees shall be required by a court to pay as a result of such action. The County may, at its sole discretion, participate at its own expense in the defense of any such action but such participation shall not relieve applicant of his obligations under this condition.

18. This Conditional Use Permit shall become null and void if all conditions have not been complied with and the occupancy or use of the land has not taken place within three (3) years of the date of approval. One extension of time, not to exceed three (3) years may be granted upon written request and submittal of the appropriate fee, not less than 30 days prior to the date of expiration. PLEASE NOTE: This will be the only notice given for the above specified expiration date. The applicant is responsible for the initiation of an extension request.

19. The applicant/operator shall ascertain and comply with requirements of all Federal, State, County, and Local agencies as are applicable to the project areas. They include, but are not limited to: the San Bernardino County Departments of Planning, Environmental Health Services, Transportation/Flood Control, Fire Warden, Building and Safety , South Coast Air Quality Management District, State Fire Marshall, Colorado Regional Water Quality Control Board, CalTrans District 8, California Department of Fish and Game, Division of Mines and Geology, U.S. Fish and Wildlife Service, Mine Safety and Health Administration (MSHA), the

California Occupational Safety and Health Administration (Cal-OSHA), and California Highway Patrol.

20. Any advertising or identifying sign shall be constructed in compliance with the designated Official Land Use District for this site.

21. All signs proposed by this project may only be lit by steady, stationary, shielded light directed at the sign, by light inside the sign, by direct stationary neon lighting or by an alternating lighting system that changes no more than once per hour. The glare from the luminous source shall not exceed one-half (0.5) foot candle.

**22. The applicant shall provide San Bernardino County with an acceptable form of financial assurance for the mining/reclamation plan and mitigation measures. The financial assurance shall be available to the County, the BLM and the Department of Conservation. Any withdrawals made by the County, the BLM or Department of Conservation for reclamation shall be redeposited by the applicant within 30 days of notification.

The financial assurance shall be for $ 56,040.00. The assurance shall be established and in place prior to use or occupancy of the site. Each year, following the annual mine site inspection, the assurance amount shall be reviewed and, if necessary, adjusted to account for new lands disturbed by surface mining operations, inflation, and reclamation of lands accomplished in accordance with the approved reclamation plan.

The financial assurance is not established to replace the applicant's responsibility for reclamation or mitigation, but to assure funding for the Reclamation Plan and mitigation measures. Should the applicant fail to perform or operate within all of the requirements of the approved reclamation plan, the County or Department of Conservation will follow the procedures outlined in Sections 2773.1 and 2774.1 of the Surface Mining and Reclamation Act (SMARA), regarding the encashment of the assurance and applicable administrative penalties, to bring the applicant into compliance. The requirements for the assurance will terminate when the approved project, mitigation measures and final Mining/ Reclamation Plan have been completed.

23. Any lights used to illuminate the site shall be hooded and designed so as to reflect away from adjoining properties and public thoroughfares.

24. Additional fees may be required prior to issuance of development permits. Fees shall be paid as specified in adopted fee ordinances.

25. The applicant/owner shall process a Condition Compliance Review through the County in accordance with the direction stated in the Conditional Approval letter, for verification of conditions prior to the issuance of building permits. A minimum balance of $1,000.00 must be in the project account at the time the Condition Compliance Review is initiated. NOTE: Sufficient funds must remain in the account to cover the charges during the Compliance Review.

26. Adequate provisions shall be made to intercept and conduct the off-site tributary drainage flow around or through the site in a manner which will not adversely affect adjacent or downstream properties.

27. All conditions of this Conditional Use Permit are continuing conditions. Failure of the applicant and/or operator to comply with any or all of said conditions at any time may result in the revocation of the permit granted to use the property.

28. The applicant/owner shall pay a fee of $1,250.00 (one thousand two hundred fifty dollars) to the Department of Fish and Game, pursuant to California State Assembly Bill 3158. This fee shall be submitted to the Clerk of the Board of Supervisors within five (5) days after the date of conditional approval along with a $35.00 administrative handling fee required by the Clerk. The Planning Department shall then file the Notice of Determination within five (5) days after the effective date of conditional approval. The applicant should be aware that Section 21089(b) of the Public Resources code provides that any project approved under CEQA is not operative, vested or final until the required fee is paid. Proof of fee payment may be required prior to issuance of building permits or final

*29. An adequate number of portable toilets shall be provided and maintained so as not to create a public nuisance and shall be maintained by a DEHS permitted pumper. Portable unit shall provide hand washing capacity. Units shall be serviced at least weekly while in use. Submit copy of service contract from approved pumper to DEHS. For information, call DEHS/Wastewater Section at (909) 387-4666.

30. Water purveyor shall be EHS approved.

31. No landfilling of wastes shall occur on-site without an approved Solid Waste Facilities Permit. Refuse collection service shall be provided by a DEHS permitted waste hauler. Frequency of pick up shall be sufficient to avoid a public nuisance. Submit copy of service to DEHS Land Use Section. For information, contact the Local Enforcement Agency at (909) 387-4655.

32. Noise level shall be maintained at or below County Standards, Development Code Section 87.0905(b). For information, call DEHS at (909) 387-4666.

33. Applicant/Operator shall maintain site free from ponding water to avoid vector breeding, e.g., mosquitoes, midges, and gnats.

**34. A slope stability analysis shall be completed on all finished quarry highwalls with on-going monitoring of final interbench walls. The analysis shall be submitted to the County for review and approval to ensure that all final quarry slopes achieve a minimum slope stability factor of safety for open space. The analysis shall be completed by an independent California Registered Professional Civil Engineer or Certified Engineering Geologist. Should any final quarry slopes be found to be unstable, the applicant shall complete such additional work as is recommended by the geologist or engineer to ensure the slope's long-term stability.

**35. Avoid the Death Valley Sage during mining activities, salvage individuals for relocation outside of the area of disturbance, and/or collect seed for propagation and transplanting.

**36. Water used for all activities (other than for human consumption) shall be obtained from a non-potable water source to the extent that such a source is available, economical and would not contaminate the pharmaceutical grade limestone.

**37. Overburden sites will be recontoured and graded to blend better with the surrounding terrain. Partial backfilling of the pit, selective placement of growth media and revegetation with native species on accessible quarry benches and overburden sites shall occur.

**38. Dark overburden removed during the last mining phases shall be stockpiled for use as a final veneer to be applied over the final mined surfaces that are most visible from sensitive off-site locations.

39. The operator shall stockpile topsoil and vegetation from areas to be cleared or covered over to the extent practical and maintain the stockpiled material with temporary erosion control methods. Stockpiled topsoil shall be stored separately from silt and overburden material stockpiles. At the time of reclamation, areas being reclaimed shall have stockpiled silt and overburden material spread across the surface with stockpiled topsoil and vegetation spread over last. Revegetation shall be accomplished as per the final approved revegetation plan.

*40. The establishment of an offsite facility for loading ore onto railcars for transport, either in conjunction with or as a replacement for truck transport, shall be reviewed and approved via a Conditional Use Permit or other method in accordance with provisions of the County Development Code in effect at that time.

*41. During and subsequent to Phase II, overburden will be placed in drainage courses as necessary to fulfill the objectives of the approved mine plan. The operator shall assume responsibility and financial liability for any problems which may occur as a direct or indirect result of such placement.

PRIOR TO LAND DISTURBANCE OR OCCUPANCY:

Department of Public Health. Division of Environmental Health Services:

42. Submit verification of drinking water service from a DEHS approved entity to DEHS Land Use Section. For information, contact DEHS Water section at (909) 387-4666.

Planning Department:

**43. A preconstruction survey for Desert Tortoise is to be performed 24 hours prior to any ground disturbance. If tortoises are found at that time, construction shall be delayed until a Section 7 Consultation with the U.S. Fish and Wildlife Service is completed and discussions have been held with the California Department of Fish and Game relative to the need for a 2081 Management Agreement. The survey shall include the pit area of Phase I and the road shoulders/berms and adjacent area that may be affected by any road grading activity.

**44. Land disturbance, development and operation shall be limited to the Phase I area which includes the access out to Kelbaker Road until the following requirements have been completed:

A. A subsequent desert tortoise survey shall be completed and approved which surveys the zone of influence covering the haul road out to Kelbaker Road. The survey shall be accomplished during the months of normal tortoise activity.

B. Use of the haul road connecting the mine site to Kelbaker Road shall be limited to the months of dormant desert tortoise activity until the subsequent desert tortoise survey has been reviewed and approved. Any additional mitigation recommended by the survey shall be considered for incorporation into the mining CUP.

C. A Section 7 Consultation may be required in conjunction with the Plan of Operations review by the BLM. Any operating restrictions which are made a part of the written opinion shall be incorporated into the mining CUP. Should a monitoring period precede the Section 7 Consultation, the results of the monitoring shall be reviewed and accepted by the BLM and the County before a determination is made requiring the actual Consultation. Should a determination be made that a Section 7 Consultation is not required, written confirmation shall be made a part of the project file.

**45. Prior to ground disturbance in the Phase II area, a qualified biologist shall determine if the potential raptor nest site identified in the Tierra Madre Report dated April 3, 1995 is currently being used by prairie falcons. If the nest site is determined to be active, the following actions will be taken: 1) no mining will be allowed during active nesting {peak nesting season is from early April to early August. 2) As mining operations progress, ledges in pit walls may need to be constructed for raptor nesting and roosting sites (a qualified biologist shall provide guidance for such activity).

**46. Within one (1) year of project approval, the applicant , through a County approved Biologist or Botanist, shall complete a detailed Revegetation/Habitat Restoration Plan for reclamation of the site and submit it to the Planning Department for review and approval. The revegetation plan shall be incorporated into the final approved Mining/Reclamation Plan. The revegetation plan shall develop the goals

and detailed procedures of the revegetation program to document that these goals have been achieved. The analysis shall include a plan for the re-establishment of vegetation, concurrent with mining, in disturbed areas detailing :

A. The plant material, including all seedling and planting mixtures, sources, amount required and method of application. Specifications in the analysis shall be provided on the use of any seedlings, including planting method, size and grazing protection measures, weed control and finally the type, grade and application rate of fertilizers, if any.

B. The plan shall provide for sufficient lead time to collect and salvage plant propagules from on or near the site.

1 A seed collection program to salvage propagules and important seed resources.

D. Salvage and erosion control of growth medium for future resoiling on highwall and quarry pit benches and regraded road cuts.

E. A detailed monitoring/maintenance plan to monitor the success of the revegetation program and repair methods for eroded sites or areas requiring reseeding/replanting. The monitoring/maintenance plan shall also include a methodology to determine how the financial assurance will be released back to the applicant once successful revegetation has been completed.

F. Comments from the Department of Conservation, Office of Mine Reclamation shall be considered in the drafting of this plan.

If deemed successful by the Planning Department, in consultation with the implementing Biologist/Botanist, this program will be continued for the entire life of the project. If not successful, the operator shall diligently explore for an acceptable alternative means of reclaiming the site. All alternative shall be reviewed and approved the Planning Department prior to their implementation and shall be monitored by the applicant and consulting Biologist/Botanist to ensure success. Monitoring shall be conducted until the revegetation goals have been met.

**47. A fair share contribution to transportation route improvements identified in the Lucerne Valley Local Area Transportation Facilities Plan will be required

of the applicant to mitigate the cumulative traffic impacts of the project on the Lucerne Valley core area. Based on 8 truck trips per day for Phase I, the fee will be $1095.00, payable to San Bernardino County Transportation Department. Additional mitigation for truck trips estimated for later phases will require additional commensurate fees prior to beginning future phase development.

**48. Highway transport of quarry production on Interstate 40 and 15 into Barstow is limited to Monday through Saturday, excluding holidays, until additional traffic carrying capacity is added to Interstate Highway 40/15 in the vicinity of Barstow.

**49. Once annual production level reaches 200,000 tons per year, additional air quality, traffic and economic analysis will be conducted to determine the most appropriate haulage method, which may include rail haul, trucking or other methods which may become available in the future.

50. The Mining and Reclamation plan and maps shall be revised to reflect the project as approved by the County Planning Commission and the conditions of approval.

*51. The applicant shall have an approved Plan of Operations from the BLM prior to land disturbance on federal lands.

52. A Streambed Alteration Agreement may be required. Operator is to contact the California Department of Fish and Game(DFG) and either acquire the agreement prior to commencing operation in the expansion area, or provide written documentation from the DFG that no agreement is required.

53. The applicant shall obtain a Section 404 Permit under the Federal Clean Water Act from the U.S. Army Corps of Engineers or provide evidence that this permit is not required.

<u>Mojave Desert Air Quality Management District:</u>

**54. Prior to any land disturbance, the applicant shall prepare a Dust Control Plan and submit it to the MDAQMD for review and approval with a final copy provided to County Planning. The plan shall identify and implement the following measures:

a. Gravel, water spray and/or the use of chemical palliatives or other surface binding agents on all unpaved access roads (including the BLM access road), the process area, active mining level(s) and dust prone stockpiles as necessary to reduce PM_{10} emissions so as not to exceed the Mojave Desert AQMD's threshold of emissions.

b. Implement revegetation effort on mined out areas to reduce exposed surface areas and potential blowing dust.

c. Installation of a spray bar system and/or other dust suppression systems on all screening and processing facilities.

d. Limit speed of haul trucks on on-site roads to 15 miles per hour.

e. Blasting shall not occur during periods of high wind (sustained winds greater than 30 miles per hour).

f. Clear areas to be mined only as needed to reduce exposed surface areas.

g. Tune and maintain all equipment and use appropriate low sulfur fuel.

h. Maintain six (6) inches of freeboard in truck beds or cover loads (California Vehicle Code Section 23114).

Utilize product stockpiles and/or terrain to act as wind breaks for the crusher facility.

**55. Prior to use or occupancy of the site, applicant shall obtain all necessary permits from the Mojave Desert AQMD, including Permits to Construct and Operate, or provide evidence that said permits are not required.

PLUESS-STAUFER (CALIF.), INC.

AMBOY LIMESTONE QUARRY SITE

SAMR/95-0066/DN 913-181 N

MITIGATION MONITORING AND COMPLIANCE PROGRAM

This mitigation monitoring and compliance program has been prepared for use in implementing certain of the conditions of approval for SAMR/95-0066/DN913-181 N; a limestone quarry in four phases on 73 acres. The proposed quarry area is located on a 210 acre site which includes a patented 160 acre claim (fee land owned by Pluess-Staufer), and 50 acres of mill sites and placer claims located on Bureau of Land Management (BLM) land. The program has been prepared in compliance with State law and the conditions of approval applied to the project by San Bernardino County.

Assembly Bill 3180, effective January 1, 1989, requires adoption of a reporting or monitoring program for those conditions of approval placed on a project to mitigate or avoid adverse effects on the environment. The law states that the reporting or monitoring program shall be designed to ensure compliance during project implementation.

The monitoring program contains the following elements:

1) The conditions of approval that act as impact mitigation measures are recorded with the action and procedure necessary to ensure compliance. In some instances, one action may be used to verify implementation of several conditions of approval, such as grading plan review and erosion control plan review.

2) A procedure for compliance and verification has been outlined for each action necessary. This procedure designates who will take action, what action will be taken and when, and to whom and when compliance will be reported.

3) The program contains a separate Mitigation Monitoring and Compliance Record for each action. On each of these record sheets, the pertinent actions and dates will be logged, and copies of permits, correspondence or other relevant data will be attached. Copies of the records will be submitted to the Planning Department.

4) The program has been designed to be flexible. As monitoring progresses, changes to compliance procedures may be necessary based upon recommendations by those responsible for the program. As changes are made, new monitoring compliance procedures and records will be developed and incorporated into the program.

MITIGATION MONITORING AND COMPLIANCE PROGRAM

CONDITION

**22. The applicant shall provide San Bernardino County with an acceptable form of financial assurance for the mining/reclamation plan and mitigation measures. The financial assurance shall be available to the County, the BLM and the Department of Conservation. Any withdrawals made by the County, the BLM or Department of Conservation for reclamation shall be redeposited by the applicant within 30 days of notification.

The financial assurance shall be for $ 56,040.00. The assurance shall be established and in place prior to use or occupancy of the site. Each year, following the annual mine site inspection, the assurance amount shall be reviewed and, if necessary, adjusted to account for new lands disturbed by surface mining operations, inflation, and reclamation of lands accomplished in accordance with the approved reclamation plan.

The financial assurance is not established to replace the applicant's responsibility for reclamation or mitigation, but to assure funding for the Reclamation Plan and mitigation measures. Should the applicant fail to perform or operate within all of the requirements of the approved reclamation plan, the County or Department of Conservation will follow the procedures outlined in Sections 2773.1 and 2774.1 of the Surface Mining and Reclamation Act (SMARA), regarding the encashment of the assurance and applicable administrative penalties, to bring the applicant into compliance. The requirements for the assurance will terminate when the approved project, mitigation measures and final Mining/ Reclamation Plan have been completed.

IMPLEMENTATION AND VERIFICATION

Implementation shall be establishment of an acceptable form of financial assurance in the initial amount of $56,040. Operator shall maintain the assurance thereafter in an amount that reflects the actual cost of restoring the site. Verification shall be approval of the amount and form of the financial assurance by the Planning Department.

COMPLIANCE RECORD

WHEN REQUIRED: Financial assurance shall be established and in place prior to initiating operations on the site. Operator shall maintain the financial assurance thereafter for the life of the project.

WHEN REQUIRED: This is a general ongoing condition for the quarry site operation.

DATE COMPLETED:

SUBMITTED TO COUNTY BY:

FEE: CHECK NO.

APPROVED BY:

DATE APPROVED:

MITIGATION MONITORING AND COMPLIANCE PROGRAM

CONDITION

**34. A slope stability analysis shall be completed on all finished quarry highwalls with on-going monitoring of final interbench walls. The analysis shall be submitted to the County for review and approval to ensure that all final quarry slopes achieve a minimum slope stability factor of safety for open space. The analysis shall be completed by an independent California Registered Professional Civil Engineer or Certified Engineering Geologist. Should any final quarry slopes be found to be unstable, the applicant shall complete such additional work as is recommended by the geologist or engineer to ensure the slope's long-term stability.

IMPLEMENTATION AND VERIFICATION

A slope stability analysis for quarry highwalls shall be submitted upon completion of mining. Analyses shall be reviewed and approved by the Planning Department and the County Geologist.

COMPLIANCE RECORD

WHEN REQUIRED: This is a general on-going condition for the quarry operation.

DATE COMPLETED:

SUBMITTED TO COUNTY BY:

FEE: CHECK NO.

APPROVED BY:

DATE APPROVED:

MITIGATION MONITORING AND COMPLIANCE PROGRAM

CONDITION

**35 Avoid the Death Valley Sage during mining activities, salvage individuals for relocation outside of the area of disturbance, and/or collect seed for propagation and transplanting.

IMPLEMENTATION AND VERIFICATION

Prior to land disturbance in each phase, a qualified individual shall perform the salvage of Death Valley Sage plants and/or collect the seed for propagation and transplanting. The Revegetation/Habitat Restoration Plan shall outline specifics of how this is to be accomplished.

COMPLIANCE RECORD

WHEN REQUIRED: This a general on-going condition for the quarry site operation.

DATE COMPLETED:
SUBMITTED TO COUNTY BY:

FEE: CHECK NO.

APPROVED BY:

MITIGATION MONITORING AND COMPLIANCE PROGRAM

CONDITION

**36. Water used for all activities (other than for human consumption) shall be obtained from a non-potable water source to the extent that such a source is available, economical and would not contaminate the pharmaceutical grade limestone.

IMPLEMENTATION AND VERIFICATION

Provide applicable verification to the Planning Department (i.e. contract copies, pumping logs, etc..) in conjunction with the annual mine inspection report to demonstrate water source.

COMPLIANCE RECORD

WHEN REQUIRED: This a general on-going condition for the quarry operation.

DATE COMPLETED:

SUBMITTED TO COUNTY BY:

FEE: CHECK NO.

APPROVED BY:

MITIGATION MONITORING AND COMPLIANCE PROGRAM

CONDITION

**37. Overburden sites will be recontoured and graded to blend better with the surrounding terrain. Partial backfilling of the pit, selective placement of growth media and revegetation with native species on accessible quarry benches and overburden sites shall occur.

IMPLEMENTATION AND VERIFICATION

Reclamation of the quarry and overburden sites will occur as mining is completed in each phase in accordance with the approved reclamation plan. Verification shall be the annual mining inspection by Lead Agency staff.

COMPLIANCE RECORD

WHEN REQUIRED: This is a general on-going condition of the plant site operation.

DATE COMPLETED:

SUBMITTED TO COUNTY BY:

FEE: CHECK NO.

APPROVED BY:

DATE APPROVED:

MITIGATION MONITORING AND COMPLIANCE PROGRAM

CONDITION

**38. Dark overburden removed during the last mining phases shall be stockpiled for use as a final veneer to be applied over the final mined surfaces that are most visible from sensitive off-site locations.

IMPLEMENTATION AND VERIFICATION

Implementation shall be to stockpile dark overburden during Phases 3 and 4 to be used during the reclamation of surfaces which are most readily visible to sensitive offsite locations. Verification shall be during the annual mining inspection. Prior to initiation of Phase 4, Lead Agency shall establish with the operator which areas are to be overlain with the dark overburden final veneer.

COMPLIANCE RECORD

WHEN REQUIRED: This is a general on-going condition of the plant site operation.

DATE COMPLETED:

SUBMITTED TO COUNTY BY:

FEE: CHECK NO.

APPROVED BY:

DATE APPROVED:

MITIGATION MONITORING AND COMPLIANCE PROGRAM

CONDITION

**43. A preconstruction survey for Desert Tortoise is to be performed 24 hours prior to any ground disturbance. If tortoises are found at that time, construction shall be delayed until the Section 7 Consultation with the U.S. Fish and Wildlife Service is completed and discussions have been held with the California Department of Fish and Game relative to the need for a 2081 Management Permit. The survey shall include the pit area of Phase I and the road shoulders/berms and adjacent area that may be affected by any road grading activity.

IMPLEMENTATION AND VERIFICATION

Implementation shall be that a qualified biologist shall perform the preconstruction survey. Should a Section 7 Consultation be required, the operator shall initiate the process and ensure that no further land disturbance occurs until the Section 7 Consultation is completed. If tortoise-proof fencing is required, the operator shall obtain the services of an individual(s) qualified to install the fencing. Verification shall be submittal of a written report of the results by the biologist to the Planning Department.

COMPLIANCE RECORD

WHEN REQUIRED: Prior to initial land disturbance

DATE COMPLETED:

SUBMITTED TO COUNTY BY:

FEE: CHECK NO.

APPROVED BY:

DATE APPROVED:

MITIGATION MONITORING AND COMPLIANCE PROGRAM

CONDITION

**44. Land disturbance, development and operation shall be limited to the Phase I area which includes the access out to Kelbaker Road until the following requirements have been completed:

A. A subsequent desert tortoise survey shall be completed and • approved which surveys the zone of influence covering the haul road out to Kelbaker Road. The survey shall be accomplished during the months of normal tortoise activity.

B. Use of the haul road connecting the mine site to Kelbaker Road shall be limited to the months of dormant desert tortoise activity until the subsequent desert tortoise survey has been reviewed and approved. Any additional mitigation recommended by the survey shall be considered for incorporation into the mining CUP.

C. A Section 7 Consultation may required in conjunction with the Plan of Operations review by the BLM. Any operating restrictions which are made a part of the written opinion shall be incorporated into the mining CUP. Should a monitoring period precede the Section 7 Consultation, the results of the monitoring shall be reviewed and accepted by the BLM and the County before a determination is made requiring the actual Consultation. Should a determination be made that a Section 7 Consultation is not required, written confirmation shall be made a part of the project file.

IMPLEMENTATION AND VERIFICATION

Implementation shall be the restriction of mining to the Phase 1 area until the requirements in A-C are completed. Verification shall be the submittal of the biologists report to the Planning Department, the annual mining inspection by Lead Agency staff and coordination with the BLM by the Lead Agency.

COMPLIANCE RECORD

WHEN REQUIRED: This is a requirement for operation during Phase I with the biologist's survey/report to be accomplished during the first spring of Phase I operation.

DATE COMPLETED: SUBMITTED TO COUNTY BY: FEE:

APPROVED BY:

DATE

CHECK NO. APPROVED:

MITIGATION MONITORING AND COMPLIANCE PROGRAM

CONDITION

**45. Prior to ground disturbance in the Phase II area, a qualified biologist shall determine if the potential raptor nest site identified in the Tierra Madre Report dated April 3, 1995 is currently being used by prairie falcons. If the nest site is determined to be active, the following actions will be taken: 1) no mining will be allowed during active nesting {peak nesting season is from early April to early August}. 2) As mining operations progress, ledges in pit walls may need to be constructed for raptor nesting and roosting sites (a qualified biologist shall provide guidance for such activity).

IMPLEMENTATION AND VERIFICATION

Implementation shall be for the operator to obtain the services of a qualified biologist to conduct the site visit. Should the raptor nest site be determined to be occupied by prairie falcons, restrictions 1) and 2) above shall be observed. Verification shall be the biologists report submitted to the Planning Department.

COMPLIANCE RECORD

WHEN REQUIRED: Prior to ground disturbance in Phase II area.

DATE COMPLETED: SUBMITTED TO COUNTY BY: FEE:

APPROVED BY:

DATE

CHECK NO. APPROVED:

MITIGATION MONITORING AND COMPLIANCE PROGRAM

CONDITION

**46. Within one (1) year of project approval, the applicant , through a County approved Biologist or Botanist, shall complete a detailed Revegetation/Habitat Restoration Plan for reclamation of the site and submit it to the Planning Department for review and approval. The revegetation plan shall be incorporated into the final approved Mining/Reclamation Plan. The revegetation plan shall develop the goals and detailed procedures of the revegetation program to document that these goals have been achieved. The analysis shall include a plan for the re-establishment of vegetation, concurrent with mining, in disturbed areas detailing :

A. The plant material, including all seedling and planting mixtures, sources, amount required and method of application. Specifications in he analysis shall be provided on the use of any seedlings, including planting method, size and grazing protection measures, weed control and finally the type, grade and application rate of fertilizers, if any.

B. The plan shall provide for sufficient lead time to collect and salvage plant propagules from on or near the site.

C. A seed collection program to salvage propagules and important seed resources.

D. Salvage and erosion control of growth medium for future resoiling on highwall and quarry pit benches and regraded road cuts.

E. A detailed monitoring/maintenance plan to monitor the success of the revegetation program and repair methods for eroded sites or areas requiring reseeding/replanting. The monitoring/maintenance plan shall also include a methodology to determine how the financial assurance will be released back to the applicant once successful revegetation has been completed.

F. Comments from the Department of Conservation, Office of Mine Reclamation shall be considered in the drafting of this plan.

If deemed successful by the Planning Department, in consultation with the implementing Biologist/Botanist, this program will be continued for the entire life of the project. If not successful, the operator shall diligently explore for an acceptable alternative means of reclaiming the site. All alternative shall be reviewed and approved the Planning Department prior to their implementation and shall be monitored by the applicant and consulting Biologist/Botanist to ensure success. Monitoring shall be conducted until the revegetation goals have been met.

IMPLEMENTATION AND VERIFICATION

Implementation shall be a monitor requirement throughout the life of the operation. The Revegetation/Habitat Restoration Plan shall be prepared and submitted for review and approval. Verification shall be County monitoring of the 1 year point following project approval, as well as annual on-site inspections by Lead Agency staff.

COMPLIANCE RECORD

WHEN REQUIRED: Prior to 1 year from the project approval date.

DATE COMPLETED: SUBMITTED TO COUNTY BY: FEE:

APPROVED BY:

DATE

CHECK NO. APPROVED:

MITIGATION MONITORING AND COMPLIANCE PROGRAM

CONDITION

**47. A fair share contribution to transportation route improvements identified in the Lucerne Valley Local Area Transportation Facilities Plan will be required of the applicant to mitigate the cumulative traffic impacts of the project on the Lucerne Valley core area. Based on 8 truck trips per day for Phase I, the fee will be $1095.00 payable to San Bernardino County Transportation Department. Additional mitigation for truck trips estimated for later phases will require additional commensurate fees prior to beginning future phase development.

IMPLEMENTATION AND VERIFICATION

Implementation shall be the payment of the Phase I fee of $1095.00 prior to start of Phase I operation. Prior to initiation of each subsequent phase, the operator shall advise Lead Agency of projected tonnage and estimated number of truck trips so that the appropriate Transportation Facilities Plan fee can be determined. Payment of the fee shall precede start of operations in each subsequent phase. Verification shall be a receipt for payment of the fee for Phase I. Annual mine site inspections by Lead Agency staff shall verify the status of phasing.

COMPLIANCE RECORD

WHEN REQUIRED: Prior to commencement of each phase. DATE

COMPLETED:

SUBMITTED TO COUNTY BY:

FEE:

CHECK NO. APPROVED:

APPROVED BY:

DATE

MITIGATION MONITORING AND COMPLIANCE PROGRAM

CONDITION

**48. Highway transport of quarry production on Interstate 40 and 15 into Barstow is limited to Monday through Saturday, excluding holidays, until additional traffic carrying capacity is added to Interstate Highway 40/15 in the vicinity of Barstow.

IMPLEMENTATION AND VERIFICATION

Implementation shall be a condition of operation. Verification shall the annual mining inspection by Lead Agency staff.

COMPLIANCE RECORD

WHEN REQUIRED: This is an on-going condition of operation.

DATE COMPLETED: SUBMITTED TO COUNTY BY: FEE:

APPROVED BY:

CHECK NO.:

DATE APPROVED:

MITIGATION MONITORING AND COMPLIANCE PROGRAM

CONDITION

**49. Once annual production level reaches 200,000 tons per year, additional air quality, traffic and economic analysis will be conducted to determine the most appropriate haulage method, which may include rail haul, trucking or other methods which may become available in the future.

IMPLEMENTATION AND VERIFICATION

Implementation shall be that the operator shall coordinate with Lead Agency prior to reaching the 200,000 tons per year level and a determination made as to means of ore haulage in the future. The operator shall be restricted to the rail option unless an alternate means is reviewed and approved by Lead Agency. Verification shall be by annual mining inspection by Lead Agency staff.

COMPLIANCE RECORD

WHEN REQUIRED: This is a requirement for exceeding 200,000 tons per year of ore haulage.

DATE COMPLETED: SUBMITTED TO COUNTY BY: FEE:

APPROVED BY:

CHECK NO.:

DATE APPROVED:

MITIGATION MONITORING AND COMPLIANCE PROGRAM

CONDITION

**54. Prior to any land disturbance, the applicant shall prepare a Dust Control Plan and submit it to the MDAQMD for review and approval with a final copy provided to County Planning. The plan shall identify and implement the following measures:

a. Gravel, water spray and/or the use of chemical palliatives or other surface binding agents on all unpaved access roads (including the BLM access road), the process area, active mining level(s) and dust prone stockpiles as necessary to reduce $PM_{1}o$ emissions so as not to exceed the Mojave Desert AQMD's threshold of emissions.

b. Implement revegetation effort on mined out areas to reduce exposed surface areas and potential blowing dust.

c. Installation of a spray bar system and/or other dust suppression systems on all screening and processing facilities.

d. Limit speed of haul trucks on on-site roads to 15 miles per hour.

e. Blasting shall not occur during periods of high wind (sustained winds greater than 30 miles per hour).

f. Clear areas to be mined only as needed to reduce exposed surface areas.

g. Tune and maintain all equipment and use appropriate low sulfur fuel.

h. Maintain six (6) inches of freeboard in truck beds or cover loads (California Vehicle Code Section 23114).

I. Utilize product stockpiles and/or terrain to act as wind breaks for the crusher facility.

IMPLEMENTATION AND VERIFICATION

Implementation shall be submittal of the Dust Control Plan to the Mojave Desert AQMD. Verification shall be that occupancy of the site/commencement of operations shall not be allowed until this is accomplished.

COMPLIANCE RECORD

WHEN REQUIRED: This is a prior to occupancy condition of approval.

DATE COMPLETED: SUBMITTED TO COUNTY BY: FEE:

APPROVED BY:

CHECK NO.:

DATE APPROVED:

MITIGATION MONITORING AND COMPLIANCE PROGRAM

CONDITION

**55. Prior to use or occupancy of the site, applicant shall obtain all necessary permits from the Mojave Desert AQMD, including Permits to Construct and Operate, or provide evidence that said permits are not required.

IMPLEMENTATION AND VERIFICATION

Implementation shall be submittal of the applicable MDAQMD permits or a release from same stating that permits are not required.

COMPLIANCE RECORD

WHEN REQUIRED: This is a prior to occupancy condition of approval.

DATE COMPLETED: SUBMITTED TO COUNTY BY: FEE:

APPROVED BY:

CHECK NO.:

DATE APPROVED:

APPENDIX B

Office of Mine Reclamation Letter
March 19, 2013

DEPARTMENT OF CONSERVATION

Managing California's Working Lands

OFFICE OF MINE RECLAMATION

801 K STREET • MS 09-06 • SACRAMENTO, CALIFORNIA 95814

PHONE 916 / 323-9198 • **FAX** 916 / 445-6066 • **TDD** 916 / 324-2555 • **WEB SITE** conservation.ca.gov

March 19, 2013

VIA EMAIL: rpg.inc@earthlink.net
ORIGINAL SENT BY MAIL

Mr. Gus Romo
County of San Bernardino
385 N. Arrowhead Avenue, First Floor
San Bernardino, CA 92415-0182

Dear Mr. Romo:

AMBOY LIMESTONE QUARRY
RECLAMATION PLAN AMENDMENT
CA MINE ID #91-36-0140

The Department of Conservation's Office of Mine Reclamation (OMR) has reviewed the proposed amendment to the reclamation plan for the Amboy Limestone Quarry dated January 30, 2012. The submittal consists of an Environmental Assessment (EA) and Decision Record from the BLM, a Mining Revision Questionnaire form, a Mining and Reclamation Plan Summary form, and 2 map sheets. Additional documents included are the "Biological Resource Assessment" and "Desert Tortoise Presence/Absence Survey".

The operator, Omya California, Inc., is proposing to expand mining operations onto 11 acres adjacent to a currently permitted 73-acre project site for a period of 40 years. The amendment is required because most of proposed expansion includes existing mining disturbance that has encroached outside of the approved reclamation plan boundaries. This constitutes a violation and should have been noted as such on previous annual inspection reports.

The project site is adjacent to Kelbaker Road approximately six miles northeast of Amboy on both private land and land administered by the BLM. OMR staff conducted site visit on March 5, 2013 to discuss reclamation issues.

The Surface Mining and Reclamation Act of 1975 (SMARA) (Public Resources Code section 2710 et seq.) and the State Mining and Geology Board Regulations (California Code of Regulations (CCR) Title 14, Division 2, Chapter 8, Subchapter 1) require that specific items be addressed or included in reclamation plans. The following comments

prepared by Leah Gardner, Restoration Ecologist and John Wesling, Senior Engineering Geologist, are offered to assist in your review of this project. We recommend that the amended reclamation plan be supplemented to fully address these items. However, the comments OMR is providing should be considered as preliminary technical assistance only. We expect to have the opportunity to officially review a revised version of the amended reclamation plan in the near future.

CCR section 3502(d) states that each surface mining operation shall have no more than one approved reclamation plan applicable to that operation. The Mining/Reclamation Plan #96M-06 and Plan of Operations (POO) for the Amboy Quarry was approved by the County on January 4, 1997. The County and the Bureau of Land Management (BLM) use the terminology of an "addendum" or "revision" to the plan; however, under SMARA, any change to the approved reclamation plan, whether or not it is a substantial deviation, requires an amendment. Although the submitted map sheets are titled "Amended Generalized Development Plan" and "Amended Reclamation Plan", the submitted information does not constitute a reclamation plan. There needs to be an accompanying stand-alone document titled "Amended Reclamation Plan for Amboy Quarry" that includes and updates all the information from the original reclamation plan. Once approved, this document will supersede the 1997 plan and become the one reclamation plan governing the surface mining operation.

The cover letter with the submittal indicates that the County of San Bernardino (County) as lead agency for the Amboy Limestone Quarry does not consider the proposed changes to be substantial deviations from the approved reclamation plan. However, OMR notes that the mine has encroached outside of its approved reclamation plan boundaries in numerous locations that are shown on the submitted documents and in areas to the east of the quarry. Because these areas of outside encroachment are not covered by the reclamation plan, the mine can no longer be reclaimed per the approved plan. The total increase in acreage amounts to more than 17 acres, which is nearly a 25-percent increase in the size of the mine.

CCR section 3502(d) states in part: "When determining whether a change or expansion constitutes a substantial deviation; the lead agency shall take into consideration the following factors:

> A substantial increase in the disturbance of a surface area or in the maximum depth of mining;"

Additionally, CCR section 3502(e) provides that "an amended reclamation plan shall be filed if the lead agency determines, after an inspection, that the surface mining operation can no longer be reclaimed in accordance with its approved reclamation plan. Such amended plan shall incorporate current reclamation standards as described in Chapter 9 (commencing with section 2710) and Title 14 of the California code of Regulations commencing with section 3700."

CCR section 3502(g) further states that "the amended reclamation plan shall incorporate current reclamation standards for the entire area governed by the plan that is impacted by the deviation." When an amended reclamation plan is prepared in accordance with current reclamation standards for this operation, it must be submitted to OMR for review pursuant to SMARA section 2774(c) and (d).

Mining Operation and Closure

(Refer to SMARA sections 2770, 2772, 2773, CCR sections 3502, 3709, 3713)

1. SMARA section 2772(c)(2) requires that the reclamation plan include a description of the quantity and type of minerals to be mined. No quantity has been checked under item #5 of the Mining and Reclamation Plan Summary form for maximum total yearly production. This information should be included in the amended plan.
2. SMARA section 2772(c)(4) requires that the maximum anticipated depth of the surface mining operation be indicated in the reclamation plan. The Mining and Reclamation Plan Summary form provides a maximum depth of 400 feet. The depth of mining should be clearly stated and tied to a verifiable benchmark, such as mean sea level, that can be referenced in the field for compliance monitoring.
3. SMARA Section 2772(c)(5) also requires that a map of the site clearly show the limits of mining, reclamation, proposed access roads and existing roads on site, and utilities within or adjacent to the mine site. The map provided should include existing and proposed interim and final contours and drainage patterns, and depict existing areas of vegetation and proposed areas of revegetation. In addition, the map should include setbacks from adjacent property boundaries, soil and waste rock stockpiles, erosion control facilities, and existing and proposed structures. The final map(s) should be of readable scale. The following items should be addressed in the amended reclamation plan maps:

   a. The submitted maps do not include all existing and proposed disturbance at the proposed mine site. In addition to the proposed 11-acre expansion, OMR notes that the map omits more than six (6) acres of mining-related disturbance outside of the proposed expansion boundary. These areas of disturbance must also be included in the reclamation plan boundary.

      - The access road from Kelbaker Road to the main part of the mine site;
      - The staging area along the access road about one-half mile west of Kelbaker Road;
      - The apparent aggregate mining pit excavated between about 2003 and 2005 on the southern side of the access road about 1400 feet west of Kelbaker Road;
      - Desert washes that have been impacted with mining-related sediment;
      - The landslide encroachment area

b. OMR recommends that while the mine boundaries are being adjusted, they be adjusted to incorporate a setback zone, which would include adequate space as buffer for areas around all current and proposed mining to ensure that potential for offsite encroachments is minimized or eliminated.

c. The maps lack important details of reclamation of the site, such as details of restoring surface runoff in a non-erosive manner. See comments 7 and 8, below.

d. Maps lack complete explanations/legends defining features shown on the maps. All lines, symbols, patterns, etc. should be included in an explanation legend on each map.

e. Notes indicate that maps submitted for review "augment" other maps (e.g., Sheet 4 of 4 in the approved plan). Both sheets cover the same area, and it is unclear which sheet has precedent where they conflict with each other. Stand-alone maps should be completed to replace existing maps in the reclamation plan rather than augmenting existing maps.

f. Map Sheet 2 of 2 contain edited information in red where some acreages are crossed out, and revised numbers have been written on the map. The maps should be finalized with no informal editing.

g. The encroachment caused by a landslide that went outside the reclamation boundary (see comment 4 below).

Geotechnical Requirements

(Refer to CCR sections 3502, 3704)

4. CCR sections 3502 and 3704 require reclamation plans to include final slope design that is stable with a minimum slope stability factor of safety that is suitable for the proposed end use and that conforms with surrounding topography and/or end uses. The amended reclamation plan indicates that a steep cut slope will be installed at the northernmost part of the site where the mining operation has encroached outside of the approved reclamation boundary. Cross section A-A' on Sheet 2 of 2 indicates that the final slope will be benched with an overall inclination of steeper than 1H:1V (i.e., horizontal to vertical slope ratio). However, no engineering or geologic studies have been included to support the final cut slope design. The amended reclamation plan should be revised to include the rationale used to determine that the final design of the cut slopes will meet the slope stability requirements stated above. A slope stability study should be completed and submitted to OMR for review.

5. CCR section 3704(b) states that where backfilling is required for resource conservation purposes, fill material shall be backfilled to the standards required for the resource conservation use involved. The submitted information indicates that large dumps of mining waste will be created. However, no compaction requirements or description of the placement of the mining waste is provided. The reclamation plan should be revised to describe the placement and compaction requirements, if any, for the mining waste dumps at the site.

Hydrology and Water Quality

(Refer to SMARA sections 2772, 2773, CCR sections 3502, 3503, 3706, 3710, 3712)

6. CCR sections 3706 and 3710 require that surface and ground water be protected in accordance with the Porter-Cologne and Clean Water Acts as implemented by the Regional Water Quality Control Board and the State Water Resources Control Board. Regulations approved by the State Water Resources Control Board require that a mine site which discharges storm waters that may have contacted any overburden, raw material, intermediate products, by-products, or waste products on the mine site obtain a general industrial activities storm water permit and submit a Storm Water Pollution Prevention Plan (SWPPP). It is unclear if a permit and SWPPP have been obtained for this site. If a SWPPP and permit have been obtained, then it should be revised to address erosion and offsite sedimentation. If no permit and SWPPP have been obtained, OMR recommends that the applicant consult with the Regional Water Quality Control Board to determine if these requirements are applicable to this operation. If the permit and the SWPPP are obtained, the required information, monitoring requirements and water quality standards should be incorporated into the reclamation plan to satisfy erosion and sediment control requirements of SMARA.

7. CCR section 3706(c) requires that erosion and sedimentation be controlled during all phases of mining and reclamation, and provides for performance standards for drainage, diversion structures, and erosion control. Erosion control measures employed on site should be designed to handle runoff from not less than the 20 year, 1 hour intensity storm event (CCR section 3706(d)). Sedimentation basins observed appear to be ineffective at halting sediment from entering offsite drainages, and no sizing calculations and basin design specifications were provided for review. The drainage and basin sizing calculations for sediment basins and design of said basins should be included with a revised reclamation plan for OMR's review.

8. CCR section 3706(e) states that where natural drainages are altered by the mining activity, mitigation measures shall be proposed and specifically approved in the reclamation plan to insure that runoff shall not cause increased erosion or sedimentation. The submitted information does not address the mining-related

sediment deposited in the desert washes both on and off of the mine site. White sediment is observed in drainages on the eastern side of the site and extending offsite to a distance more than 1500 feet downstream of the currently approved reclamation boundary. Additionally, a larger, south-flowing desert wash on the western side of the site is being impacted with mining waste, and the approved reclamation plan shows additional mining waste being dumped there. There appear to be no safeguards against erosion and offsite transport of the mining waste along this drainage. An assessment by a qualified person should be completed to quantitatively assess impacts to the desert washes that have been impacted with sediment, monitor of the effects of sedimentation on the drainages, and provide recommendations to describe how the mine will comply with the requirements of the California Department of Fish and Game, Region Water Quality Control Board, and other agencies. The reclamation plan should be revised to describe mitigation measures and best management practices (BMPs) necessary to ensure that runoff shall not cause increased erosion and/or sedimentation.

9. CCR section 3503(a)(2) requires that overburden and product stockpiles be managed to minimize the potential for wind and water erosion. OMR observed a noticeable white dusting of the alluvial fans along the eastern side of the mine where the access road enters the main area of disturbance. This dust has encroached outside the reclamation boundary in the approved reclamation plan, and the proposed extension of the boundary does not encompass the area of wind-blown dust. The presence of the dust indicates that measures to protect the stockpiles of product and overburden are ineffective. The amended reclamation plan should be revised to include provisions for managing stockpiles in a manner that eliminates or diminishes the potential wind deflation and water erosion.

Environmental Setting and Protection of Fish and Wildlife Habitat

(Refer to CCR sections 3502, 3503, 3703, 3704, 3705, 3710, 3713)

10. The Biological Resource Assessment notes several different habitat types. As noted in our comment letter dated November 8, 1996 (enclosed), it is appropriate to have different seed mixes and performance standards for each habitat type rather than only one seed mix and set of standards for the entire mine site.

11. CCR section 3703(b) requires that wildlife habitat shall be established in a condition at least as good as that which existed before lands were disturbed by surface mining operations. The Biological Assessment notes the use of an unnamed drainage in Survey Area 4 as a wildlife corridor for Nelson's bighorn sheep and other animals. The reclamation plan should describe how this wildlife corridor will be avoided and/or reclaimed.

12. Death Valley sage (*Salvia funerea*) is not mentioned in the 2011 Biological Resource Assessment though it is discussed on page 17 of the 1996 POO/Reclamation Plan and pages 14-16 in the 1989 Initial Study/Negative Declaration. It is a rare species included in the CNPS Inventory of Rare and Endangered Plants on list 4.3 and was noted to occur in various locations on the mine site. Avoidance, salvaging individual plants, and collecting seed were recommended mitigation measures. These measures should be followed and applied to the expansion areas.

Resoiling and Revegetation

(Refer to SMARA section 2773, CCR sections 3503, 3704, 3705, 3707, 3711)

13. The approved reclamation plan has a revegetation section on pages 69-72 and 85-86. OMR files also contain a document titled "Revegetation Plan for the Amboy Limestone Quarry" prepared by Biological Resource Specialists, dated January 1998 (Revegetation Plan). Details, such as the seed mixes, differ between the two documents. It is difficult to determine which of the documents will guide revegetation efforts and whether OMR's comments of 1996 were ever addressed. OMR recommends that the amended reclamation plan include an updated revegetation plan that synthesizes this information.

14. OMR recommends revising the seed mixes. The application rates for the seed mixes in both the reclamation plan and the Revegetation Plan are too low and fail to provide rates in pounds of pure live seed (PLS) per acre. As noted above, OMR recommends having different seed mixes and performance standards for each habitat type rather than only one seed mix and set of standards for the entire mine site. Additional species can be added to the seed mixes, as proposed in our 1996 comment letter.

15. According to the 1998 revegetation plan, cactus plants were to be salvaged by both transplanting whole specimens and propagating from cuttings in an off-site nursery. There was no evidence that this had been done during out site inspection. This practice should be implemented for the expansion areas.

Administrative Requirements

(Refer to SMARA sections 2772, 2773, 2774, 2776, 2777, Public Resources Code section 21151.7)

SMARA section 2772(c)(10) states that the reclamation plan shall include an applicant's signed statement accepting responsibility for reclamation per the approved reclamation plan. This statement must be added to the amended reclamation plan prior to approval.

If you have any questions on these comments or require any assistance with other mine reclamation issues, please contact me at (916) 445-6175.

Sincerely,

Beth Hendrickson, Manager
Reclamation Unit

cc: Department of Fish and Wildlife
Regional Water Quality Control Board

encl. OMR comment letter dated November 8, 1996

APPENDIX C

General Biological Resources Assessment Report
June 2014

DRAFT
GENERAL BIOLOGICAL RESOURCES ASSESSMENT REPORT

OMYA AMBOY LIMESTONE QUARRY

Amboy USGS 7.5' quadrangle
Section 30, Township 6 North Range 13 East
CA Mine ID Number 91-36-0140
APNs

SAN BERNARDINO COUNTY, CALIFORNIA

Prepared for:

OMYA, Inc.
9987 Carver Road, Suite 300
Cincinnati, OH 45242
(513) 387-4696

Prepared by:

Himes Consulting, L.L.C.
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(480) 899-5708 ph. (602) 499-9253 mobile

Project Number 14-08

June 2014

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CERTIFICATION

"I hereby certify that the statements furnished above and in the attached exhibits present the data and information required for this biological survey report, and that the facts, statements, and information presented are true and correct to the best of my knowledge and believe. Field work conducted for this survey was performed by me or under my direct supervision. I certify that I have not signed a non-disclosure or consultant confidentiality agreement with the project applicant or applicant's representative and that I have no financial interest in the project."

DATE: 06-13-2014 SIGNED: _____

Report Author
Jill Himes
Senior Biologist

Prepared by:
Himes Consulting, L.L.C.
3301 W Genoa Way
Chandler, AZ 85226
(480) 899-5708

Fieldwork Performed By:

_____
Jill Himes
Senior Biologist

Rion Bowers
Senior Biologist

1.0 INTRODUCTION

The Amboy Limestone Quarry, operated by OMYA, Inc. (OMYA) is located approximately 6 miles northeast of Amboy in San Bernardino County, California. OMYA is in the process of amending their existing Mine Reclamation Plan to expand the permitted boundary to include a buffer area around their existing limestone quarry operations. Himes Consulting, L.L.C. conducted biological surveys of the proposed project boundary on April 7-8, and May 26-27, 2014. A previous Biological Assessment was conducted at the project site prior to operations by OMYA (Tierra Madre Consultants 1995).

1.1 PROJECT AND PROPERTY DESCRIPTION

Project Location. The Amboy Limestone Quarry has been mined by OMYA since 1996. The site is located approximately 6 miles northeast of the town of Amboy, approximately 10 miles south of Interstate 40, 3 miles north of Route 66 (National Trails Highway), and just west of Kelbaker Road (Figures 1 and 2; Appendix A). The project site is located in Section 30, Township 6 North, Range 13 East (San Bernardino Baseline and Meridian). Orange Blossom Wash lies approximately 3 miles to the northeast of the intersection of Kelbaker Road and the mine access road. The quarry lies at the southern tip of the Bristol Mountains, to the west of the Marble Mountains, and north of Bristol Lake.

Project Description. OMYA proposes to include a buffer area around their existing limestone quarry operations for a total of 201.8 acres. OMYA currently quarries a limestone deposit of exceptionally pure crystalline limestone, suitable for food grade products and supplements. Current disturbance within their property boundary is approximately 73 acres. No changes are proposed in their original disturbance boundary.

Property Description. The quarry is located at the southern tip of the southern Bristol Mountains. Terrain at the project site contains large areas of very steep, nearly vertical, and rugged rock outcrops with little vegetation. Lower elevations within the property consist of large expanses of desert pavement and creosote bush flats interspersed with ephemeral drainages. Elevations within the property range from approximately 1,900 feet (ft) above mean sea level (msl) in the northwest portion of the property to approximately 350 ft above msl at Kelbaker Road. Average annual precipitation is less than 1.5 inches in the region. Vegetation communities in the region are Mojave Desertscrub.

Land uses in the region include open space, mining, and transportation. Amboy has been a center for historic mining and railroad activities for over a century. Other mining and/or production in the Amboy area include salt, calcium chloride, gold, and garnet mining. The

predominant land use within the project site is active limestone quarrying. Major transportation routes include Route 66 to the south, Interstate 40 to the north, and Kelbaker Road immediately east of the site that connects the two highways. There are no residences within 5 miles of the project site.

2.0 SPECIES OF CONCERN

Species of concern include plants and animals listed as endangered or threatened by the U.S. Fish & Wildlife Service (USFWS), proposed for listing, or candidate for listing and species designated as special species of concern, rare, threatened, endangered, or fully protected by the State of California. In addition, species of concern include plants designated as sensitive by the California Native Plant Socieity (CNPS).

3.0 METHODOLOGY

3.1 LITERATURE REVIEW

A literature search was conducted to gather information on sensitive plants, animals, or habitats that may occur within the project site. The following sources were reviewed to gather site and species information:

- USGS 7.5-Minute Amboy, CA Topographic Quadrangle Map
- California Natural Diversity Database, query by topographic quadrangle
- California Native Plant Society On-Line Rare Plant Inventory
- USFWS San Bernardino County Species List
- Google Earth Aerial Imagery
- Past Project Site Biological Surveys

3.2 FIELD SURVEYS

Pedestrian field surveys of the project site were conducted by Himes Consulting biologists on April 7-8 and May 26-27, 2014 to assess habitat and record dominant vegetation and wildlife species (Appendix C). Representative photographs of the project site were taken and included in the Photograph Log (Appendix E). In addition, protocol surveys for the desert tortoise were conducted on April 7-8 and May 26, 2014 (Himes Consulting LLC 2014). Ten meter transects were conducted for 100 percent coverage within areas of potentially suitable habitat within the survey area to search for potential tortoise burrows and/or sign, including scat, shell fragments, prints, or live animals. Three additional belt transects were surveyed at approximately 200, 400, and 600 meters on each side of the mine. Vegetation and wildlife species were also recorded during the tortoise surveys.

Jurisdictional delineation surveys were conducted to evaluate and measure jurisdictional waters within the permit boundary. Himes Consulting LLC conducted field measurements of the ephemeral washes at regular intervals using a measuring tape on May 26-27, 2014 (Appendix E). Prior to the field delineation, USGS topographic quadrangle maps and aerial photographs were reviewed for potential ephemeral washes.

4.0 RESULTS

The following information was recorded for the survey area. Temperatures during the survey ranged from 71° Fahrenheit (F) to 97°F, with no precipitation. Cloud cover ranged from 0 to 50 percent. Wind speed was generally between 0 to 10 miles per hour.

4.1 VEGETATION COMMUNITIES

The project site is located within the Mojave Desert geographical region. Vegetation within the survey area is sparse due in part to the very arid climate and the presence of desert pavement. Vegetation within the permit boundary is characterized by three plant communities that most closely correspond with Sawyer et. al's (2009) creosote bush – white burr sage scrub community, brittle bush scrub, and creosote bush-brittle bush scrub (Figure 3). Detailed descriptions of these communities are provided below. While the site contains ephemeral drainages, the species composition is not substantially different from that of the surrounding uplands. In addition to the vegetation communities described below, approximately 73 acres of disturbed areas from quarrying, stockpiling, and staging areas also occur within the site. Common weeds observed throughout the project site include Russian thistle (*Salsola kali*), redstem filaree (*Erodium cicutarium*), sandmat (*Euphorbia polycarpa*), and Meditteranean grass (*Schismus barbatus*). A list of plants observed is provided in Appendix C.

4.1.1 Creosote Bush – White Burr Sage Scrub

Creosote bush (*Larrea tridentata*) and white burr sage (*Ambrosia dumosa*) are co-dominant in this shrubland alliance (Sawyer et al. 2009). This vegetation type occurs in minor washes and rills, alluvial fans, bajadas, and upland slopes which may be covered with desert pavement. Within the project site, this vegetation community occurs just east of the active mining area all the way to Kelbaker Road, the eastern boundary of the project site. White burr sage is generally higher in cover than creosote bush. Other shrubs include burrobrush (*Hymenoclea salsola*), brittle bush (*Encelia farinosa),* sweetbush *(Bebbia juncea),* saltbush (*Atriplex canescen),* catclaw acacia *(Acacia greggii*), desert lavender (*Hyptis emoryi*), desert trumpet (*Eriogonum inflatum*), smoke tree (*Psorothamnus spinosa*), white ratany (*Krameria grayi*), brittle

spineflower (*Chorizanthe brevicornu*), Mormon tea (*Ephedra viridis*), and bladderpod (*Cleome isomeris*). Parasitic dodder (*Cuscuta* sp.) was observed on some of the shrubs. Cacti observed include golden cholla (*Opuntia echinocarpa*), beavertail (*Opuntia basilaris*), diamond cholla (*Opuntia ramosissima*), pincushion cactus (*Mammillaria* sp.), and hedgehog cactus (*Echinocereus* sp.).

4.1.2 Brittle Bush Scrub

Brittle bush scrub was observed on the south-facing rocky hillside on north side of the mining area (Figure 3). This shrubland alliance is found on alluvial fans, bajadas, colluviums, rocky hillsides, and slopes of small washes and rills (Sawyer et al. 2009). Creosote bush is not conspicuous in this area, and is absent from large areas. Other plants observed in this community include white burr sage, beavertail, desert lavender, barrel cactus (*Ferocactus acanthodes*), pincushion cactus, and pygmy cedar (*Peucephyllum schottii*).

4.1.3 Creosote Bush Scrub – Brittle Bush Scrub

Creosote bush and brittle bush are co-dominant and equally conspicuous in this shrubland alliance, and are generally evenly distributed throughout the stand (Sawyer et al. 2009). This vegetation community is found within small washes, rills, alluvial fans, bajadas, and colluviums on upland slopes. Within the project area, it is found in areas to the west and south of the quarry. Other vegetation in this community includes white burr sage, desert lavender, desert trumpet, pincushion cactus, beavertail, hedgehog cactus, and diamond cholla.

4.2 WILDLIFE

Wildlife and/or wildlife sign observed within the project site are provided in Appendix C. Mammals include desert cottontail (*Sylvilagus auduboni*), jackrabbit (*Lepus californicus*), kit fox (*Vulpes vacrotis*), Nelson's bighorn sheep (*Ovis canadensis nelsoni*), desert woodrat (*Neotoma lepida*), coyote (*Canis latrans*), and white-tailed antelope squirrel (*Ammospermophilus leucurus*). Birds include black-throated sparrows (*Amphispiza bilineata*), white-throated swifts (*Aeronautes saxatalis*), Say's phoebe (*Sayornis sayi*), western kingbird (*Tyrannus verticali*), house finch (*Carpodacus mexicanus*), hummingbird (*Calypte costae*), mourning dove (*Zenaida macroura*), northern mockingbird (*Mimus polyglottis*), turkey vulture (*Corvus corax*), and common raven (*Corvus corax*). Reptiles observed consists of western whiptail (*Aspidoscelis tigris*), common side-blotched lizard (*Uma stansburiana*), southern desert horned lizard (*Phrynosoma platyrhinos calidarum*), zebra-tailed lizard (*Callisaurus draconoides*), and desert iguana (*Dipsosaurus dorsalis*).

4.3 SPECIAL STATUS SPECIES OBSERVED WITHIN THE PROJECT SITE

No special status plant or animal species were observed within the project site during field surveys conducted on April 7-8 and May 26-27, 2014.

4.4 SPECIAL STATUS SPECIES NOT OBSERVED BUT WITH THE POTENTIAL TO OCCUR

Special status species not observed in the project site but with the potential to occur based on habitat and range requirements are provided in Appendix D. A total of 12 species of plants and 8 species of wildlife occur within the vicinity of the project site, based on a CNDDB query of the 9 topographic quadrangles including and adjacent to Amboy, CA. The majority of the special status species have little probability of occurring within the project site due to existing site conditions, habitat, range requirements and site elevation. Descriptions of these species and the potential to occur are provided in Appendix D. Descriptions of the desert tortoise and Death Valley sage, which may occur in the project site, are provided below.

4.4.1 Desert Tortoise

The only listed species that may occur within the survey area is the desert tortoise (*Gopherus agassizii*). The desert tortoise is listed as threatened by the USFWS and the State of California. No live tortoises, tortoise burrows, or tortoise sign were found during the 2014 protocol surveys (Himes Consulting, LLC 2014). Habitat for the desert tortoise within the project limits appears very poor as the majority of the project site contains either steep slopes or desert pavement in the alluvial areas. No live tortoises, tortoise burrows, or tortoise sign were found during the belt transects.

4.4.2 Death Valley Sage

Death Valley sage (*Salvia funerea*), a shrub in the Mint Family (Lamiaceae), has spine-tipped leaves that are white wooly. The species is known to occur in dry washes and limestone canyon walls (Hickman 1993). Death Valley sage has been reported from the project vicinity (CalFlora 2014) and was reported from the project site in 1995 (Tierra Madre Consultants 1995). Previously known onsite locations were searched on May 26, 2014 with no plants found in those areas. However, there are multiple reports of the species from nearby the project area, so the species has a moderate potential to occur within the permit boundary.

4.5 CRITICAL HABITAT

The project site is not located within any federally designated critical habitat, or habitat designated as sensitive by the state. The closest designated critical habitat is the Chemehuevi Critical Habitat Unit for the desert tortoise, located approximately 8 miles east of the project site.

4.6 JURISDICTIONAL WATERS AND STREAMBEDS

The project site is located within the Southern Mojave watershed (Hydrologic Unit Code 18100100). Surface water from the site flows downstream towards Bristol Lake, a dry lakebed south of the project site. As these waters collect and evaporate at Bristol Lake, they are considered isolated and do not connect to downstream navigable waters. Therefore these washes are not subject to federal jurisdiction under Section 404 of the Clean Water Act. Waters of the state are regulated by the CDFW under Section 1600-1616 of the California Fish and Game Code (1602 Permit) and the Colorado River Basin Regional Water Quality Control Board (RWQCB) (water quality certification and waste discharge).

Jurisdictional waters are shown in Figure 4. A total of approximately 1.76 acres of waters of the State under the jurisdiction of the CDFW and Colorado River Basin RWQCB are estimated to occur within the permit boundary (see Figure 4), including along the existing access road. All of these are ephemeral washes which flow only in direct response to storm events. Of this total, approximately 0.2 acres have already been disturbed under Streambed Alteration Agreement No. 5-443-96.

4.7 WILDLIFE MOVEMENT

The quarry lies at the southern tip of the Bristol Mountains, to the west of the Marble Mountains, south of the Granite Mountains, and north of Bristol Lake and Cadiz Valley. Lucerne Valley and the San Bernardino Mountains lie to the southwest. Interstate 40, approximately 8 miles north of the project site, and Route 66, approximately 1 mile south of the project site, limit regional wildlife movement. Epps et. al (2013) studied big horn sheep movement in the project vicinity and found that big horn sheep generally occupy numerous small mountain ranges separated by flat desert, with infrequent but continual crossing of those flats to other mountainous areas. Wildlife corridors occur between mountain ranges (Epps et. al 2013). No large-scale wildlife movement corridors occur within or adjacent to the project site. The permit boundary consists of unfenced natural desert, which allows the movement and dispersal of wildlife locally and between surrounding mountain ranges.

Wildlife move within and around the project site as part of their short-range movements. Nelson's bighorn sheep have been observed to use all available habitats, as evidenced by their scat found in all areas within the permit boundary, including mountainous areas, slopes, disturbed areas, and drainages, with the exception of the flats closest to Kelbaker Road. The steep canyon on the west side of the quarry appears to be crossed as frequently as adjacent mountain slopes areas within the permit boundary. Routine, daily or seasonal movements of small to medium-sized animals are generally localized in nature. A more than 20 ft drop-off located in the center of the canyon on the western side of the permit boundary, as well as the presence of large boulders, limits use by of this canyon by small to medium-sized animals.

5.0 POTENTIAL IMPACTS

5.1 IMPACTS TO VEGETATION AND WILDLIFE

The existing limestone quarry has impacted approximately 73 acres. Additional impacts will continue within the 1996 permitted boundary. Disturbance planned outside the 1996 permitted boundary would impact approximately x acres of creosote bush – brittle bush scrub habitat. As this habitat type is abundant, widely distributed in the region, and not designated as a sensitive natural community, impacts to the vegetation community would be less than significant. Direct impacts to plants and wildlife are anticipated within this x-acre area. As these plant and wildlife types are common throughout the region, impacts would be less than significant. Indirect impacts to plants and wildlife immediately adjacent to impacted areas may also continue as a result of limestone fines transported by wind or rain.

5.2 IMPACTS TO SPECIAL STATUS SPECIES

As no special status species were observed onsite, including protocol surveys for the desert tortoise, impacts to special status species from continued operation of the quarry are anticipated to be less than significant.

5.3 IMPACTS TO JURISDICTIONAL WATERS AND STREAMBEDS

The drainage to the west of the existing mine would continue to be filled with overburden as permitted in 1996. Future impacts to other jurisdictional waters would need to be permitted through CDFW and/or the RWQCB.

5.4 IMPACTS TO WILDLIFE MOVEMENT

The Amboy Limestone Quarry is not located within an identified wildlife movement corridor, as the regional wildlife corridors are located between mountain ranges. Short-distance routine

wildlife movement occurs within the permit boundary. Therefore, continued use of the project site would not result in impacts to important wildlife routes. Impacts to wildlife movement would continue to be less than significant.

5.5 CONSISTENCY WITH HABITAT CONSERVATION PLANS

The following conservation plans have been implemented within the region of the project site:

- USFWS Desert Tortoise Recovery Plan
- Desert Bird Conservation Plan
- BLM West Mojave Plan
- California Desert Conservation Area Plan

The continued use of the Amboy Limestone Quarry would not pose significant conflicts with any of these plans.

6.0 MITIGATION MEASURES

The following mitigation measures are recommended to minimize impacts to biological resources:

- Expansion or clearing of new areas should be conducted outside of the nesting season (February 15 to September 15) to avoid impacts to migratory bird nesting activities.
- If jurisdictional washes will be impacted, permits should be obtained from the CDFW and the RWQCB.
- Provide desert tortoise training for all onsite personnel;
- Check for desert tortoise underneath all heavy equipment before moving;
- Dispose of trash in approved containers with lids to minimize the attraction of tortoise predators;
- Do not allow domestic dogs on the site during construction activities; and
- Have an on-call biologist ready to assist the project manager should any tortoise-related issues arise.

7.0 REFERENCES CITED

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APPENDIX A

MAPS

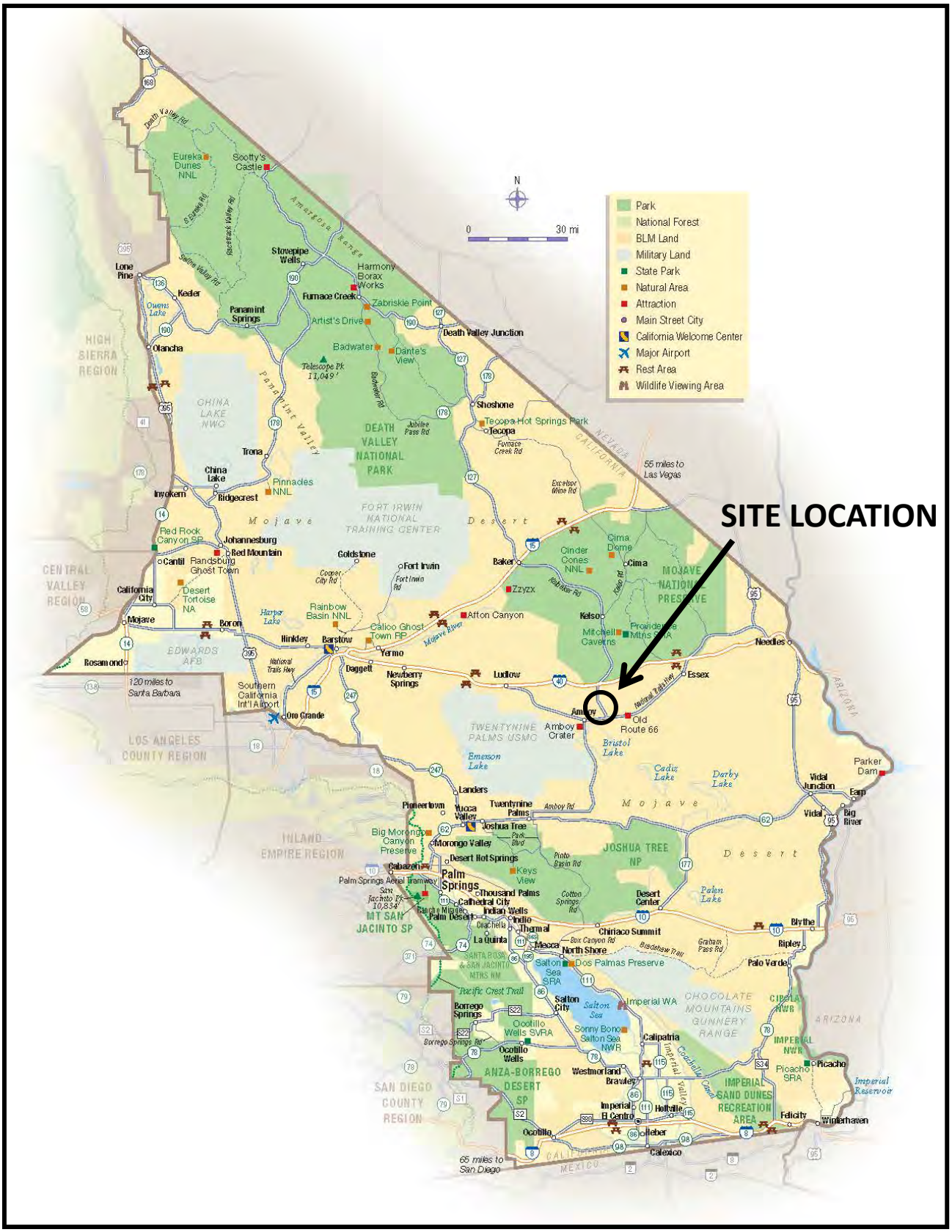

Figure 1. State Vicinity Map. OMYA Amboy Quarry. San Bernardino County, CA. Data source: www.visitcalifornia.com

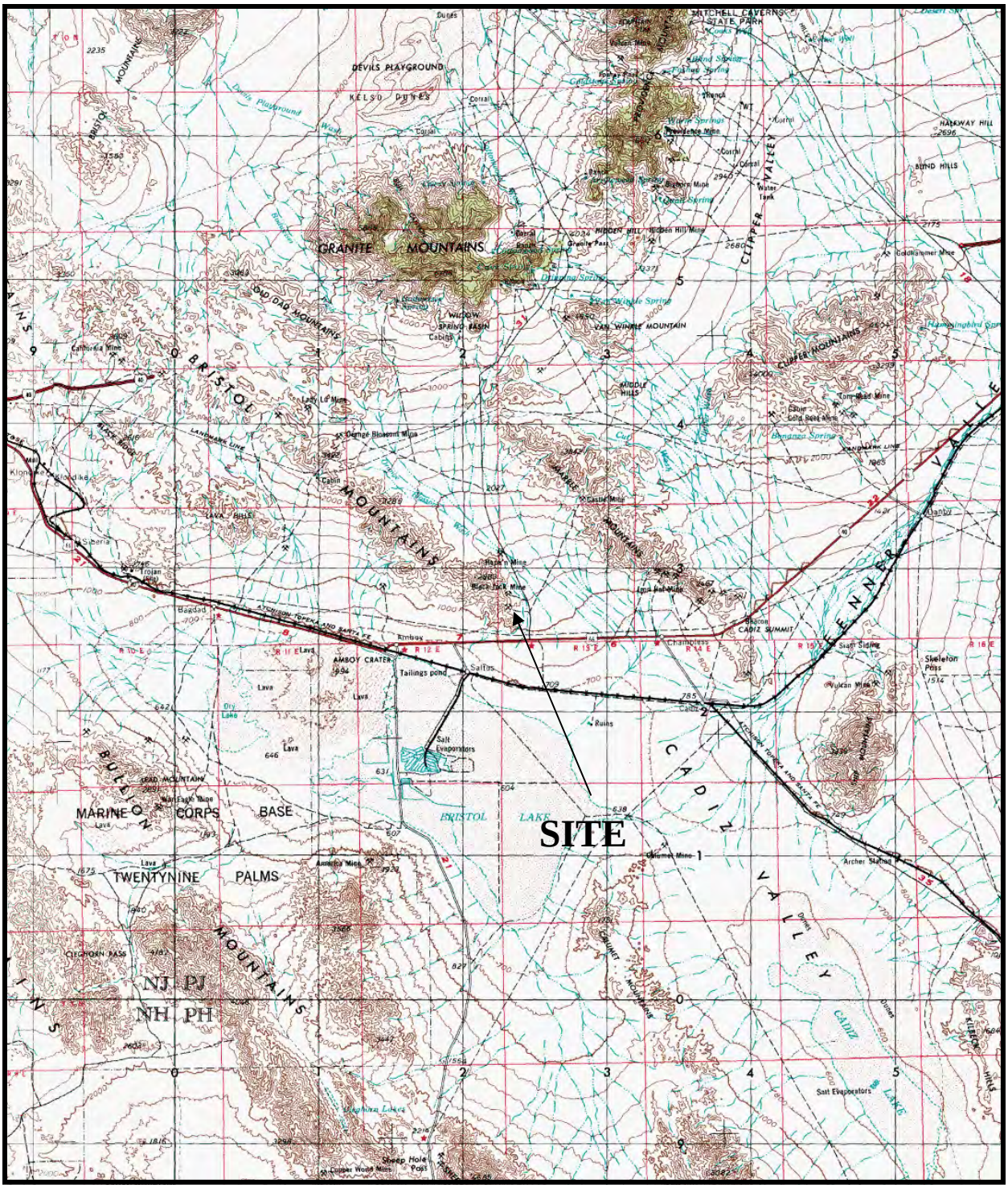

Figure 2. Vicinity Map.
OMYA Amboy Quarry.
USGS 1:250,000 Scale Topo Map: Needles, Calif.-AZ (1969)

0 2 miles

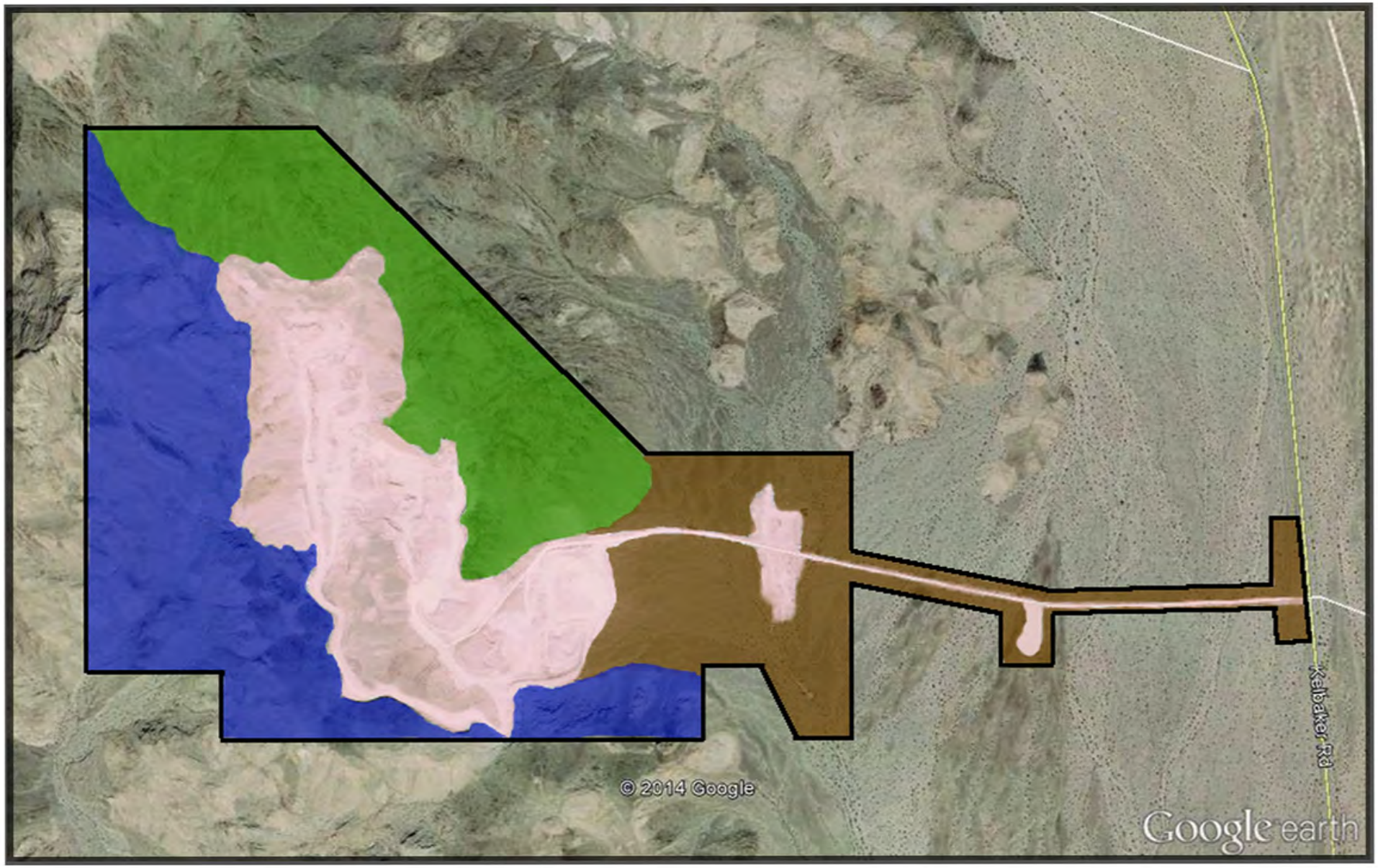

Figure 3. Vegetation Communities
OMYA Amboy Limestone Quarry

- Permit boundary
- Disturbed area
- Creosote bush - brittle bush scrub
- Brittle bush scrub
- Creosote bush - white burr sage scrub

0 1000 ft

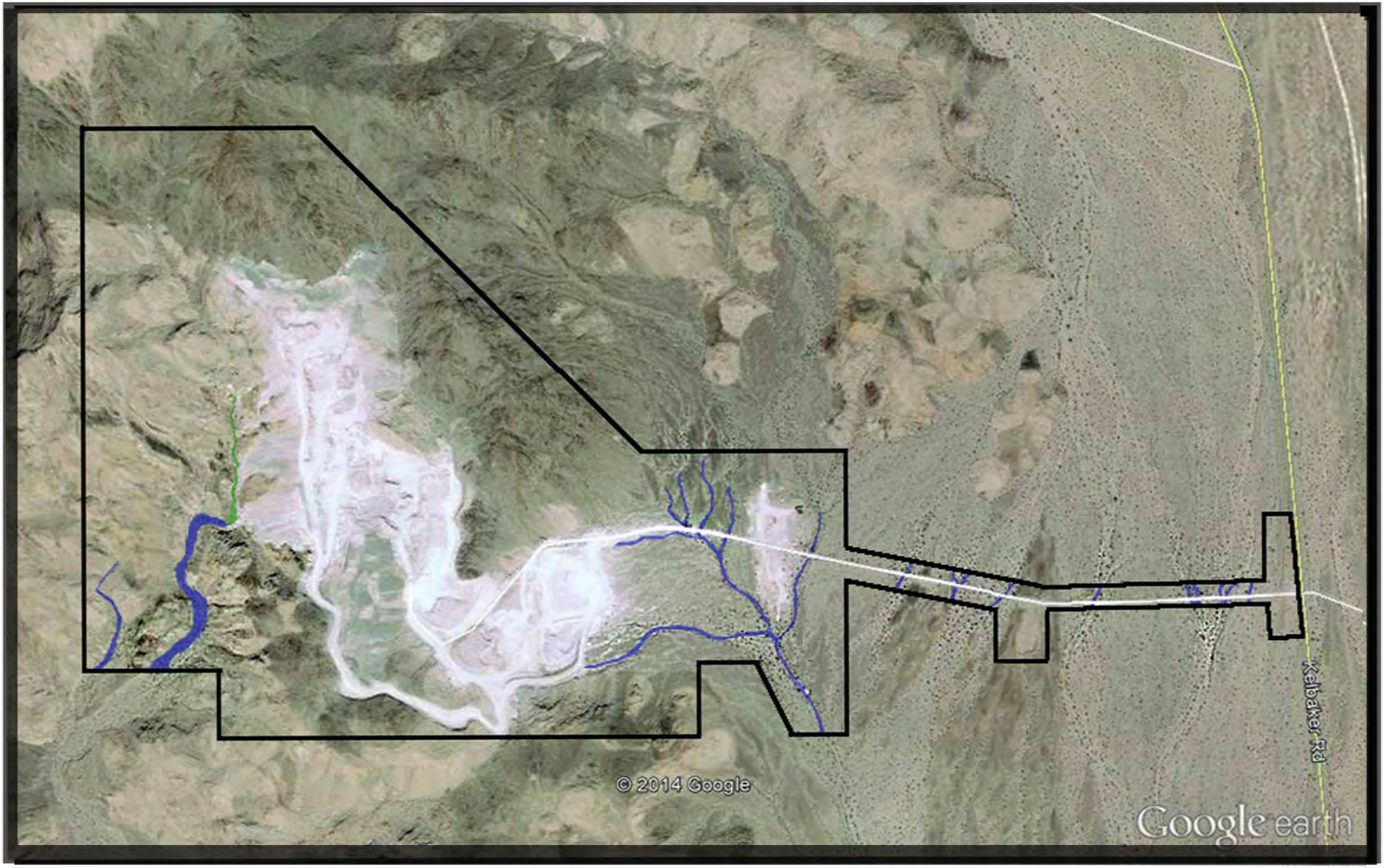

Figure 4. Jurisdictional Waters
OMYA Amoby Limestone Quarry

Waters of the State
Disturbed wash

0 1000 ft

APPENDIX B

SPECIES LISTS

U.S. Fish & Wildlife Service

Environmental Conservation Online System
Conserving the Nature of America
Enter Search Term(s):

Search

- ECOS>
- Species Reports>
- Species By County Report

Species By County Report

The following report contains Species that are known to or are believed to occur in this county. Species with range unrefined past the state level are now excluded from this report. If you are looking for the Section 7 range (for Section 7 Consultations), please visit the IPaC application.

County: San Bernardino, CA

Group	Name	Population	Status	Lead Office	Recovery Plan Name	Recovery Plan Action Status	Recovery Plan Stage
Amphibians	Arroyo (=arroyo southwestern) toad (*Anaxyrus californicus*)	Entire	Endangered	Ventura Fish And Wildlife Office	Arroyo Southwestern Toad (Bufo microscaphus californicus) Recovery Plan	View Implementation Progress	Final
	California red-legged frog (*Rana draytonii*)	Entire	Threatened	Sacramento Fish And Wildlife Office	Recovery Plan for the California Red-legged Frog (Rana aurora draytonii)	View Implementation Progress	Final
	Mountain yellow-legged frog (*Rana muscosa*)	southern California DPS	Endangered	Carlsbad Fish And Wildlife Office	-	-	-
Birds	California condor (*Gymnogyps californianus*)	Entire, except where listed as an experimental population below	Endangered	Hopper Mountain National Wildlife Refuge Complex	California Condor Recovery Plan, Third Revision	View Implementation Progress	Final Revision 3
	Yuma clapper rail (*Rallus longirostris yumanensis*)	U.S.A. only	Endangered	Arizona Ecological Services Field Office	Draft Revised Recovery Plan for the Yuma Clapper Rail	View Implementation Progress	Draft Revision 1
	Least Bell's vireo (*Vireo bellii pusillus*)	Entire	Endangered	Carlsbad Fish And Wildlife Office	Draft Recovery Plan for the Least Bell's Vireo	View Implementation Progress	Draft
	Coastal California gnatcatcher (*Polioptila californica californica*)	Entire	Threatened	Carlsbad Fish And Wildlife Office	-	-	-
	Southwestern willow flycatcher (*Empidonax*	Entire	Endangered	Arizona Ecological Services Field	Final Recovery Plan for the Southwestern Willow Flycatcher	View Implementation Progress	Final

	traillii extimus)			Office			
Fishes	Colorado pikeminnow (=squawfish) (*Ptychocheilus lucius*)	except Salt and Verde R. drainages, AZ	Endangered	Upper Colorado River Endangered Fish Recovery Program	Colorado Pikeminnow (Ptychocheilus lucius) Recovery Plan (Amendment and Supplement for Recovery Goals)	View Implementation Progress	Final Revision 2
	Mohave tui chub (*Gila bicolor ssp. mohavensis*)	Entire	Endangered	Ventura Fish And Wildlife Office	Recovery Plan for the Mohave Tui Chub, Gila bicolor mohavensis	View Implementation Progress	Final
	Unarmored threespine stickleback (*Gasterosteus aculeatus williamsoni*)	Entire	Endangered	Ventura Fish And Wildlife Office	Unarmored Threespine Stickleback Recovery Plan, Revised	View Implementation Progress	Final Revision 1
	Bonytail chub (*Gila elegans*)	Entire	Endangered	Upper Colorado River Endangered Fish Recovery Program	Bonytail Chub Revised Recovery Plan Goals	View Implementation Progress	Final Revision 1
	Razorback sucker (*Xyrauchen texanus*)	Entire	Endangered	Upper Colorado River Endangered Fish Recovery Program	Razorback Sucker - Recovery Goals	View Implementation Progress	Final Revision 1
	Santa Ana sucker (*Catostomus santaanae*)	3 CA river basins	Threatened	Carlsbad Fish And Wildlife Office	Recovery Outline for Santa Ana sucker (Catostomus santaanae)	Recovery efforts in progress, but no implementation information yet to display.	Outline
Flowering Plants	San Diego ambrosia (*Ambrosia pumila*)		Endangered	Carlsbad Fish And Wildlife Office	-	-	-
	Bear Valley sandwort (*Arenaria ursina*)		Threatened	Carlsbad Fish And Wildlife Office	-	-	-
	Lane Mountain milk-vetch (*Astragalus jaegerianus*)		Endangered	Ventura Fish And Wildlife Office	-	-	-
	Nevin's barberry (*Berberis nevinii*)		Endangered	Carlsbad Fish And Wildlife Office	-	-	-
	Thread-leaved brodiaea (*Brodiaea filifolia*)		Threatened	Carlsbad Fish And Wildlife Office	-	-	-
	Ash-grey paintbrush (*Castilleja cinerea*)		Threatened	Carlsbad Fish And Wildlife Office	-	-	-
	Southern mountain wild-buckwheat (*Eriogonum kennedyi var. austromontanum*)		Threatened	Carlsbad Fish And Wildlife Office	-	-	-
	San Bernardino bluegrass (*Poa*		Endangered	Carlsbad Fish And Wildlife	-	-	-

atropurpurea)		Office			
California taraxacum (*Taraxacum californicum*)	Endangered	Carlsbad Fish And Wildlife Office	-	-	-
Salt marsh bird's-beak (*Cordylanthus maritimus ssp. maritimus*)	Endangered	Carlsbad Fish And Wildlife Office	Salt Marsh Bird's-beak (Cordylanthus maritimus subsp. maritimus) Recovery Plan	View Implementation Progress	Final
Cushenbury buckwheat (*Eriogonum ovalifolium var. vineum*)	Endangered	Carlsbad Fish And Wildlife Office	San Bernardino Mountains Carbonate Plants Draft Recovery Plan	View Implementation Progress	Draft
Coachella Valley milk-vetch (*Astragalus lentiginosus var. coachellae*)	Endangered	Carlsbad Fish And Wildlife Office	-	-	-
Santa Ana River woolly-star (*Eriastrum densifolium ssp. sanctorum*)	Endangered	Carlsbad Fish And Wildlife Office	-	-	-
Parish's daisy (*Erigeron parishii*)	Threatened	Carlsbad Fish And Wildlife Office	San Bernardino Mountains Carbonate Plants Draft Recovery Plan	View Implementation Progress	Draft
San Bernardino Mountains bladderpod (*Lesquerella kingii ssp. bernardina*)	Endangered	Carlsbad Fish And Wildlife Office	San Bernardino Mountains Carbonate Plants Draft Recovery Plan	View Implementation Progress	Draft
Pedate checker-mallow (*Sidalcea pedata*)	Endangered	Carlsbad Fish And Wildlife Office	Recovery Plan for the Pedate Checkermallow (Sidalcea pedata) and Slender-petaled Mustard (Thelypodium stenopetalum)	View Implementation Progress	Final
Slender-petaled mustard (*Thelypodium stenopetalum*)	Endangered	Carlsbad Fish And Wildlife Office	Recovery Plan for the Pedate Checkermallow (Sidalcea pedata) and Slender-petaled Mustard (Thelypodium stenopetalum)	View Implementation Progress	Final
Slender-horned spineflower (*Dodecahema leptoceras*)	Endangered	Carlsbad Fish And Wildlife Office	-	-	-
Cushenbury milk-vetch (*Astragalus albens*)	Endangered	Carlsbad Fish And Wildlife Office	San Bernardino Mountains Carbonate Plants Draft Recovery Plan	View Implementation Progress	Draft
Triple-ribbed milk-vetch (*Astragalus tricarinatus*)	Endangered	Carlsbad Fish And Wildlife Office	-	-	-
Cushenbury oxytheca		Carlsbad Fish	San Bernardino		

	(*Oxytheca parishii var. goodmaniana*)		Endangered	And Wildlife Office	Mountains Carbonate Plants Draft Recovery Plan	View Implementation Progress	Draft
	Gambel's watercress (*Rorippa gambellii*)		Endangered	Ventura Fish And Wildlife Office	Recovery Plan for Marsh Sandwort (Arenaria paludicola) and Gambel's Watercress (Rorippa gambelii)	View Implementation Progress	Final
Insects	Quino checkerspot butterfly (*Euphydryas editha quino (=E. e. wrighti)*)	Entire	Endangered	Carlsbad Fish And Wildlife Office	Recovery Plan for the Quino Checkerspot Butterfly (Euphydryas editha quino)	View Implementation Progress	Final
	Delhi Sands flower-loving fly (*Rhaphiomidas terminatus abdominalis*)	Entire	Endangered	Carlsbad Fish And Wildlife Office	Delhi Sands Flower-Loving Fly (Rhaphiomidas terminatus abdominalis) Recovery Plan	View Implementation Progress	Final
Mammals	Stephens' kangaroo rat (*Dipodomys stephensi (incl. D. cascus)*)	Entire	Endangered	Carlsbad Fish And Wildlife Office	Draft Recovery Plan for Stephen's Kangaroo Rat (Dipodomys stephensi)	View Implementation Progress	Draft
	San Bernardino Merriam's kangaroo rat (*Dipodomys merriami parvus*)	Entire	Endangered	Carlsbad Fish And Wildlife Office	-	-	-
Reptiles	Coachella Valley fringe-toed lizard (*Uma inornata*)	Entire	Threatened	Carlsbad Fish And Wildlife Office	Coachella Valley Fringe-toed Lizard Recovery Plan	View Implementation Progress	Final
	Desert tortoise (*Gopherus agassizii*)	U.S.A., except in Sonoran Desert	Threatened	Nevada Fish And Wildlife Office	Revised Recovery Plan for the Mojave Population of the Desert Tortoise (Gopherus agassizii)	View Implementation Progress	Final Revision 1

Export options: CSV | EXCEL | XML | PDF

CNDD Results Topographic Query Results

Scientific_Name	Common_Name	Federal_St	State_Stat	CDFW_Sta	CA_Rare_	Quad_Name	Data_Status
Aquila chrysaetos	golden eagle	None	None	FP ; WL	-	Van Winkle Wash	Unprocessed
Falco mexicanus	prairie falcon	None	None	WL	-	Van Winkle Wash	Mapped and Unproce
Falco mexicanus	prairie falcon	None	None	WL	-	Amboy	Mapped and Unproce
Falco mexicanus	prairie falcon	None	None	WL	-	Cadiz	Unprocessed
Falco mexicanus	prairie falcon	None	None	WL	-	Brown Buttes	Mapped and Unproce
Lanius ludovicianus	loggerhead shrike	None	None	SSC	-	Amboy Crater	Unprocessed
Athene cunicularia	burrowing owl	None	None	SSC	-	Amboy	Unprocessed
Athene cunicularia	burrowing owl	None	None	SSC	-	Bristol Lake NW	Unprocessed
Oliarces clara	cheeseweed owlfly (cheesew	None	None	-	-	Cadiz	Mapped
Ovis canadensis nelsoni	desert bighorn sheep	None	None	FP	-	Cadiz	Mapped and Unproce
Ovis canadensis nelsoni	desert bighorn sheep	None	None	FP	-	Amboy	Mapped
Ovis canadensis nelsoni	desert bighorn sheep	None	None	FP	-	Amboy Crater	Mapped
Ovis canadensis nelsoni	desert bighorn sheep	None	None	FP	-	Van Winkle Wash	Mapped and Unproce
Ovis canadensis nelsoni	desert bighorn sheep	None	None	FP	-	Brown Buttes	Mapped
Ovis canadensis nelsoni	desert bighorn sheep	None	None	FP	-	East of Siberia	Mapped
Uma scoparia	Mojave fringe-toed lizard	None	None	SSC	-	Amboy Crater	Mapped and Unproce
Uma scoparia	Mojave fringe-toed lizard	None	None	SSC	-	Amboy	Mapped
Uma scoparia	Mojave fringe-toed lizard	None	None	SSC	-	Lead Mtn. NE	Mapped
Uma scoparia	Mojave fringe-toed lizard	None	None	SSC	-	Calumet Mine	Unprocessed
Gopherus agassizii	desert tortoise	Threatene	Threatene	-	-	Calumet Mine	Unprocessed
Gopherus agassizii	desert tortoise	Threatene	Threatene	-	-	Lead Mtn. NE	Mapped
Gopherus agassizii	desert tortoise	Threatene	Threatene	-	-	Bristol Lake NW	Mapped
Gopherus agassizii	desert tortoise	Threatene	Threatene	-	-	Van Winkle Wash	Mapped and Unproce
Gopherus agassizii	desert tortoise	Threatene	Threatene	-	-	East of Siberia	Mapped
Gopherus agassizii	desert tortoise	Threatene	Threatene	-	-	Brown Buttes	Mapped
Cryptantha clokeyi	Clokey's cryptantha	None	None	-	1B.2	Van Winkle Wash	Mapped
Cryptantha costata	ribbed cryptantha	None	None	-	4.3	Bristol Lake NW	Unprocessed
Cryptantha holoptera	winged cryptantha	None	None	-	4.3	Amboy	Unprocessed
Coryphantha alversonii	Alverson's foxtail cactus	None	None	-	4.3	Bristol Lake NW	Unprocessed
Coryphantha alversonii	Alverson's foxtail cactus	None	None	-	4.3	Lead Mtn. NE	Mapped and Unproce
Cuscuta californica var. api	pointed dodder	None	None	-	3	Cadiz	Unprocessed
Cuscuta californica var. api	pointed dodder	None	None	-	3	Amboy	Unprocessed
Ditaxis claryana	glandular ditaxis	None	None	-	2B.2	Amboy	Mapped
Euphorbia jaegeri	Orocopia Mountains spurge	None	None	-	1B.1	Amboy	Mapped

Euphorbia jaegeri	Orocopia Mountains spurge	None	None	-	1B.1		Cadiz	Mapped
Euphorbia jaegeri	Orocopia Mountains spurge	None	None	-	1B.1		East of Siberia	Mapped
Salvia funerea	Death Valley sage	None	None	-		4.3	Cadiz	Unprocessed
Salvia funerea	Death Valley sage	None	None	-		4.3	Amboy	Unprocessed
Penstemon stephensii	Stephens' beardtongue	None	None	-	1B.3		Brown Buttes	Mapped
Eriastrum harwoodii	Harwood's eriastrum	None	None	-	1B.2		Calumet Mine	Mapped
Castela emoryi	Emory's crucifixion-thorn	None	None	-	2B.2		Amboy	Mapped
Androstephium breviflorun	small-flowered androstephiur	None	None	-	2B.2		Amboy	Mapped
Androstephium breviflorun	small-flowered androstephiur	None	None	-	2B.2		Amboy Crater	Mapped

APPENDIX C

SPECIES OBSERVED

PLANT SPECIES OBSERVED

FLOWERING PLANTS – DICOTS

ASTERACEAE
Ambrosia dumosa (white bursage)
Encelia farinosa (brittlebush)
Hymenoclea salsola (burrobrush)
Bebbia juncea (sweetbush)
Peucephyllum schottii (pygmy cedar)

BIGNONIACEAE
Chilopsis linearis (desert willow)

CACTACEAE
Echniocereus sp. (hedgehog cactus)
Ferocactus acanthodes (barrel cactus)
Mammillaria sp. (pincushion cactus)
Opuntia basilaris (beavertail cactus)
Opuntia echinocarpa (golden cholla)
Opuntia ramosissima (diamond cholla)

CHENOPODIACEAE
Atriplex canescens (saltbush)
Salsola kali (Russian thistle)

CLEOMACEAE
Cleome isomeris (bladderpod)

CONVOLVULACEAE
Cuscuta sp. (dodder)

CUCURBITACEAE
Cucurbita palamata (coyote gourd)

EPHEDRACEAE
Ephedra viridis (Mormon tea)

EUPHORBIACEAE
Euphorbia polycarpa (sandmat)

FABACEAE
Acacia greggii (cactlaw)
Psorothamnus spinosa (smoke tree)

GERANIACEAE
Erodium cicutarium (redstem filaree)

KRAMERIACEAE
Krameria grayi (white ratany)

LAMIACEAE
Hyptis emoryi (desert lavender)

POLYGONACEAE
Chorizanthe brevicornu (brittle spineflower)
Eriogonum inflatum (desert trumpet)

ZYGOPHYLLACEAE
Larrea tridentata (creosotebush)

FLOWERING PLANTS- MONOCOTS

POACEAE
Schismus barbatus (Mediterranean grass)

WILDLIFE AND/OR WILDLIFE SIGN OBSERVED

MAMMALS

BOVIDAE
Ovis canadensis nelson (Nelson's bighorn sheep)

CANIDAE
Canis latrans (coyote)
Vulpes vacrotis (kit fox)

CRICETIDAE
Neotoma lepida (desert woodrat)

LEPORIDAE
Lepus californicus (black-tailed jackrabbit)
Sylvilagus auduboni (desert cottontail)

SCIURIDAE
Ammospermophilus leucurus (white-tailed antelope squirrel)

REPTILES

IGUANIDAE
Callisaurus draconoides (zebra-tailed lizard)
Dipsosaurus dorsalis (desert iguana)
Phyrnosoma platyrhinos calidarum (southern desert horned lizard)
Uta stansburiana (common side-blotched lizard)

TEIIDAE
Aspidoscelis tigris (western whiptail)

BIRDS

APODIDAE
Aeronautes saxatalis (white-throated swift)

CATHARTIDAE
Cathartes aura (turkey vulture)

COLUMBIDAE
Zenaida macroura (mourning dove)

CORVIDAE
Corvus corax (common raven)

EMBERIZIDAE
Amphispiza bilineata (black-throated sparrow)

FRINGILLIDAE
Carpodacus mexicanus (house finch)

MIMIDAE
Mimus polyglottis (Northern mockingbird)

TROCHILIDAE
Calypte costae (Costa's hummingbird)

TYRANNIDAE
Sayornis sayi (Say's phoebe)
Tyrannus verticalis (western kingbird)

APPENDIX D

SPECIAL STATUS SPECIES NOT OBSERVED BUT WITH THE POTENTIAL TO OCCUR ONSITE

SPECIAL STATUS SPECIES NOT OBSERVED BUT WITH POTENTIAL TO OCCUR WITHIN THE PROJECT SITE

Scientific Name	Common Name	Status	Habitat	Site Suitability	Potential to Occur
PLANTS					
Androstephium breviflorum	Pink funnel lily	CNPS 2B.2	Open desert scrub, sand to rocky soil, 100-1600 m, s Mojave Desert	Potentially suitable habitat present, but not observed onsite	Unlikely
Castela emoryi	Crucifixion thorn	CNPS 2B.2	Dry, gravelly washes, slopes, plains ±650 m, s Mojave Desert (except Desert Mnts)	Potentially suitable habitat present, but not observed onsite	Unlikely
Cryptantha clokeyi	Prickly cryptantha	CNPS 1B.2	Rocky to gravelly slopes, ridge crests, desert woodland 1050-1650 m in NW Mojave Desert.	Potentially suitable habitat present, but not observed onsite	Moderate
Cryptantha costata	Ribbed cryptantha	CNPS 4.3	Fine sand deposits, creosote-bush scrub, <600 m, E Mojave Desert.	Suitable fine sand deposits not observed onsite	Unlikely
Cryptantha holoptera	Winged cryptantha	CNPS 4.3	Gravelly to rocky soils, washes, slopes, ridges; 50-1220 m. E Mojave Desert.	Suitable habitat onsite	Moderate
Coryphantha alversonii	Alverson's foxtail cactus	CNPS 4.3	Sandy or rocky alluvium, creosote-bush scrub; 75-600 m, S Mojave Desert	Suitable habitat onsite	Moderate
Cuscuta californica var. apiculata	Pointed dodder	CNPS 3	Generally <500 m. in E Sonoran Desert (near Colorado River)	Not likely to occur due to species range	Unlikely

Ditaxis claryana	Glandular ditaxis	CNPS 2B.2	Sandy soils in creosote bush scrub <100 m. Sonoran Desert	Suitable habitat present.	Moderate
Euphorbia jaegeri	Orocopia mountains spurge	CNPS 1B.1	Rocky hillsides and along arroyos in desert scrub; 600 to 850 m	Only 4 known occurrences from Orocopia, Marble, and Bristol Mnts	Low
Eriastrum harwoodii	Harwood's eriastrum	CNPS 1B.2	Sand dunes in creosotebush scrub; <1000 m, Mojave Desert	No suitable habitat present	Unlikely
Salvia funerea	Death valley sage	CNPS 4.3	Dry washes and limestone canyon walls, <1700 m, NE Mojave Desert	Not observed but reported from project vicinity	Moderate
Penstemon stephensii	Stephens' beardtongue	CNPS 1B.3	Rocky slopes, washes, rock crevices in creosote bush scrub, pinyon juniper woodland; 1000-2200 m in Desert Mountains	Suitable habitat occurs in mountainous areas	Moderate
ANIMALS					
Aquila chrysaetos	Golden eagle	FP	Open country, especially in mountains to 3,700 m, canyon lands, and riverside cliffs; nest on steep escarpments.	Potential habitat in vicinity; however, no nearby water source and species not observed onsite	Unlikely
Athene cunicularia	Burrowing owl	SSC	Open areas, urban areas, desert scrub,	Low quality habitat due to low	Unlikely

			agricultural areas	prey base	
Falco mexicanus	Prairie falcon	WL	Inhabits dry, open terrain, breeding sites on cliffs	Potential habitat occurs – species not observed	Unlikely
Gopherus agasizzii	Desert tortoise	FT, ST	Sandy or gravelly desert habitats with soils suitable for burrow construction	Potential habitat occurs – species not observed	Low
Lanius ludovicianus	Loggerhead shrike	SSC	Prefers open habitats with scattered shrubs, trees, posts, fences, or utility lines.	Suitable habitat present	Moderate
Oliarces clara	Cheeseweed owlfly		Found under rocks or in flight over streams in the lower Colorado River drainage	No suitable habitat	Unlikely
Ovis canadensis nelsoni	Nelson's bighorn sheep	HA	Open, rocky steep areas with available water and forage	Suitable habitat	Present
Uma scoparia	Mojave fringe-toad lizard	SSC	Loose, windblown sand in sand dunes, dry lakebeds, riverbeds, or desert washes	Project site does not provide suitable sandy habitat.	Not present

Status Definitions:

HA = Harvested animal
FT = Federally threatened
ST = State threatened
SSC = CDFW Species of Special Concern
WL = CDFW Watch List
CNPS = California Native Plant Society
1A = Presumed extinct/extirpated in California
1B = Plants that are rare, threatened, or endangered in California and elsewhere
2A = Plants presumed extirpated in California, but more common elsewhere
2B = Plants rare, threatened, or endangered in California, but more common elsewhere
3 = Plants about which we need more information
4 = A watch list of plants of limited distribution.
.1 = Seriously endangered in California
.2 = Fairly endangered in California
.3 = Not very endangered in California

APPENDIX E

PHOTOGRAPH LOG

Photograph 1. View of existing stockpiles at the site and characteristic habitat; view facing W.

Photograph 2. View of desert pavement in the project vicinity, facing N.

Photograph 3. Steep slopes in the northeastern portion of the project site with bighorn sheep visible; view facing N.

Photograph 4. Waste rock in the southwestern corner of the project site; view facing upslope (N).

Photograph 5. View of canyon southeast of project site from the top of the slope, facing W.

Photograph 6. View of drop-off mid-way in canyon southeast of project site preventing wildlife movement; facing NW.

Photograph 7. View of creosote bush-brittle bush scrub with both plants equally conspicuous; slope immediately south of quarry.

Photograph 8. Brittle bush scrub community, showing creosote bush absent from large areas; view facing north.

Photograph 9. View of creosote bush-white burr sage scrub east of quarry stockpiles; facing S.

Photograph 10. Representative ephemeral wash in the eastern portion of the permit area; view facing downstream.

APPENDIX D

Desert Tortoise Presence/Absence Survey Report
May 2014

DESERT TORTOISE
PRESENCE/ABSENCE SURVEY REPORT

AMBOY LIMESTONE QUARRY

Amboy, CA 7.5" Quadrangle
Section 30, T6N R13W
CA Mine ID #91-36-0140

SAN BERNARDINO COUNTY, CA

Prepared For:

OMYA, Inc.
9987 Carver Road, Suite 300
Cincinnati, OH 45242

Prepared By:

Himes Consulting, L.L.C.
3301 W. Genoa Way
Chandler, AZ 85226
(480) 899-5708

Principal Investigator and Report Author: Jill Himes
Fieldwork By: Jill Himes & Rion Bowers

May 2014

Himes Consulting, LLC conducted U.S. Fish & Wildlife Service (USFWS) protocol surveys for the endangered desert tortoise (*Gopherus agassizi*) at OMYA's Amboy Limestone Quarry located in Section 30, Township 6 North, Range 13 East (San Bernardino Baseline and Meridian) in San Bernardino County, California. The site is located approximately 6 miles northeast of the town of Amboy, approximately 10 miles south of Interstate 40, 3 miles north of Route 66 (National Trails Highway), and just west of Kelbaker Road.

The purpose of the survey was to evaluate the presence or absence of the desert tortoise within the footprint of the proposed permit area, located on private lands. Ten meter pedestrian transects were conducted for 100 percent coverage within areas of potentially suitable habitat within the survey area to search for potential tortoise burrows and/or sign, including scat, shell fragments, prints, or live animals. Three additional belt transects were surveyed at 200, 400, and 600 meters on each side of the mine.

No live tortoises, tortoise burrows, or tortoise sign were found during the survey. Habitat for the desert tortoise within the project limits appears very poor as the majority of the project site contains either steep, nearly vertical slopes or desert pavement on the flat alluvial areas. No live tortoises, tortoise burrows, or tortoise sign were found during the belt transects. Results of the survey are consistent with previous tortoise surveys conducted at OMYA's Amboy Limestone Quarry in 1995 and 2011.

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METHODOLOGY	1
SURVEY RESULTS	2
RECOMMENDATIONS	3
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Appendix A Maps
Appendix B Photograph Log
Appendix C Species List

INTRODUCTION

The Amboy Limestone Quarry, operated by OMYA, Inc. is located approximately 6 miles northeast of Amboy in San Bernardino County, California. OMYA, Inc. is in the process of amending their existing Reclamation Plan to expand their permitted boundary to include a buffer area around their operations. The project site contains potential habitat for the desert tortoise (*Gopherus agassizii*). Himes Consulting, L.L.C. conducted a desert tortoise presence/absence survey of the proposed project boundary on April 7-8, and May 26, 2014. Previous desert tortoise surveys were conducted at the project site in 1995 (Tierra Madre Consultants) and in 2011 (Liliburn Corporation).

PROJECT AND PROPERTY DESCRIPTION

Project Location. The Amboy Limestone Quarry has been mined by OMYA since 1996. The site is located approximately 6 miles northeast of the town of Amboy, approximately 10 miles south of Interstate 40, 3 miles north of Route 66 (National Trails Highway), and just west of Kelbaker Road (Figures 1 and 2). The project site is located in Section 30, Township 6 North, Range 13 East (San Bernardino Baseline and Meridian). Orange Blossom Wash lies approximately 3 miles to the northeast of the intersection of Kelbaker Road and the mine access road. The quarry lies at the southern tip of the Bristol Mountains, to the west of the Marble Mountains, and north of Bristol Lake.

Project Description. OMYA, Inc. proposes to expand their existing operations to include an additional 11 acres over their existing disturbances of approximately 69 acres. OMYA has included a buffer area around their operations for a total of approximately 200 acres.

Property Description. The quarry is located at the southern tip of the southern Bristol Mountains. Terrain at the project site contains large areas of very steep, nearly vertical, and rugged rock outcrops with little vegetation. Lower elevations within the property consist of large expanses of desert pavement and creosote bush flats interspersed with ephemeral drainages. Elevations within the property range from approximately 1,900 feet (ft) above mean sea level (msl) in the northwest portion of the property to approximately 350 ft above msl at Kelbaker Road. Average annual precipitation is less than 1.5 inches in the region.

METHODOLOGY

Protocol surveys for the desert tortoise were conducted on April 7-8 and May 26, 2014 by Himes Consulting LLC personnel according to the U.S. Fish & Wildlife Service

(USFWS) 2010 field survey protocol (USFWS 2010). Ten meter transects were conducted for 100 percent coverage within areas of potentially suitable habitat within the survey area to search for potential tortoise burrows and/or sign, including scat, shell fragments, prints, or live animals (Figure 3). Areas of extreme vertical slope, previously quarried areas, and areas covered with desert pavement, were determined to not be suitable tortoise habitat and were not surveyed. Visibility throughout the project site was high in most areas due to sparse vegetation. All washes and banks within the survey area were thoroughly inspected for tortoise sign and potential burrows. Bases of shrubs were also inspected.

Three additional belt transects were surveyed at 200, 400, and 600 meters on each side of the mine. Extremely steep slopes were not included in the belt transects as habitat was not suitable.

RESULTS

The following information was recorded for the survey area. Temperatures during the survey ranged from 73° Fahrenheit (F) to 85°F, with no precipitation. Cloud cover ranged from 0 to 50 percent. Wind speed was generally between 0 to 10 miles per hour.

No live tortoises, tortoise burrows, or tortoise sign were found during the survey. Habitat for the desert tortoise within the project limits appears very poor as the majority of the project site contains either steep slopes or desert pavement in the alluvial areas. No live tortoises, tortoise burrows, or tortoise sign were found during the belt transects.

Vegetation communities within the survey area are described as Mohave Desertscrub by Brown (1994). Vegetation within the survey area is sparse due in part to the very arid climate and the presence of desert pavement. Vegetation is characterized by creosotebush (*Larrea tridentata*), white bursage (*Ambrosia dumosa*), burrobrush (*Hymenoclea salsola*), sweetbush (*Bebbia juncea*), brittlebush (*Encelia farinosa*), Mormon tea (*Ephedra viridis*), saltbush (*Atriplex canescens*), catclaw acacia (*Acacia greggii*), desert willow (*Chilopsis linearis*), desert lavender (*Hyptis emoryi*), and desert trumpet (*Eriogonum inflatum*). Dodder (*Cuscuta* sp.), the parasitic annual, was observed on many of the shrubs. Cacti in the area include diamond cholla (*Opuntia ramossisima*), golden cholla (*Opuntia echinocarpa*), beavertail (*Opuntia basilaris*), pincushion (*Mammillaria* sp.), barrel (*Ferocactus acanthodes*) and hedgehog (*Echinocereus* sp.). Common weeds observed include Russian thistle (*Salsola kali*) and redstem filaree (*Erodium cicutarium*).

Wildlife and/or wildlife sign observed in the area includes desert cottontail (*Sylvilagus auduboni*), jackrabbit (*Lepus californicus*), Nelson's bighorn sheep (*Ovis canadensis nelsoni*), desert woodrat (*Neotoma lepida*), coyote (*Canis latrans*), kit fox (*Vulpes vacrotis*), white-tailed antelope ground squirrel (*Ammospermophilus leucurus*), white-throated swift (*Aeronautes saxatalis*), mourning dove (*Zenaida macroura*), turkey vulture (*Cathartes aura*), northern mockingbird (*Mimus polyglottis*), common raven (*Corvus corax*), black-throated sparrow (*Amphispiza bilineata*), house finch (*Carpodacus mexicanus*), Costa's hummingbird (*Calypte costae*), Say's phoebe (*Sayornis sayi*), western kingbird (*Tyrannus verticalis*), western whiptail (*Aspidoscelis tigris*), common side-blotched lizard (*Uta stansburiana*), southern desert horned lizard (*Phrynosoma platyrhinos calidiarum*), zebra-tailed lizard (*Callisaurus draconoides*), and desert iguana (*Dipsosaurus dorsalis*).

RECOMMENDATIONS

No desert tortoise or sign were found during the presence/absence surveys. The majority of the survey areas are located in unsuitable habitat for the endangered desert tortoise. The following conservation measures for desert tortoise are recommended as part of the quarry operations:

- Provide desert tortoise training for all onsite personnel;
- Check for desert tortoise underneath all heavy equipment before moving;
- Dispose of trash in approved containers with lids to minimize the attraction of tortoise predators;
- Do not allow domestic dogs on the site during construction activities; and
- Have an on-call biologist ready to assist the project manager should any tortoise-related issues arise.

LITERATURE CITED

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Whitaker, John O. 1992. The Audubon Society Field Guide to North American Mammals. Eighth Printing. Published by Alfred A. Knopf, New York.

CERTIFICATION

"I hereby certify that the statements furnished above and in the attached exhibits present the data and information required for this biological survey report, and that the facts, statements, and information presented are true and correct to the best of my knowledge and believe. Field work conducted for this survey was performed by me or under my direct supervision. I certify that I have not signed a non-disclosure or consultant confidentiality agreement with the project applicant or applicant's representative and that I have no financial interest in the project."

DATE: 05-31-2014 SIGNED: _____

Report Author
Jill Himes
Senior Biologist

Prepared by:
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3301 W Genoa Way
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Fieldwork Performed By:

_____
Jill Himes
Senior Biologist

_____
Rion Bowers
Senior Biologist

APPENDIX A
MAPS

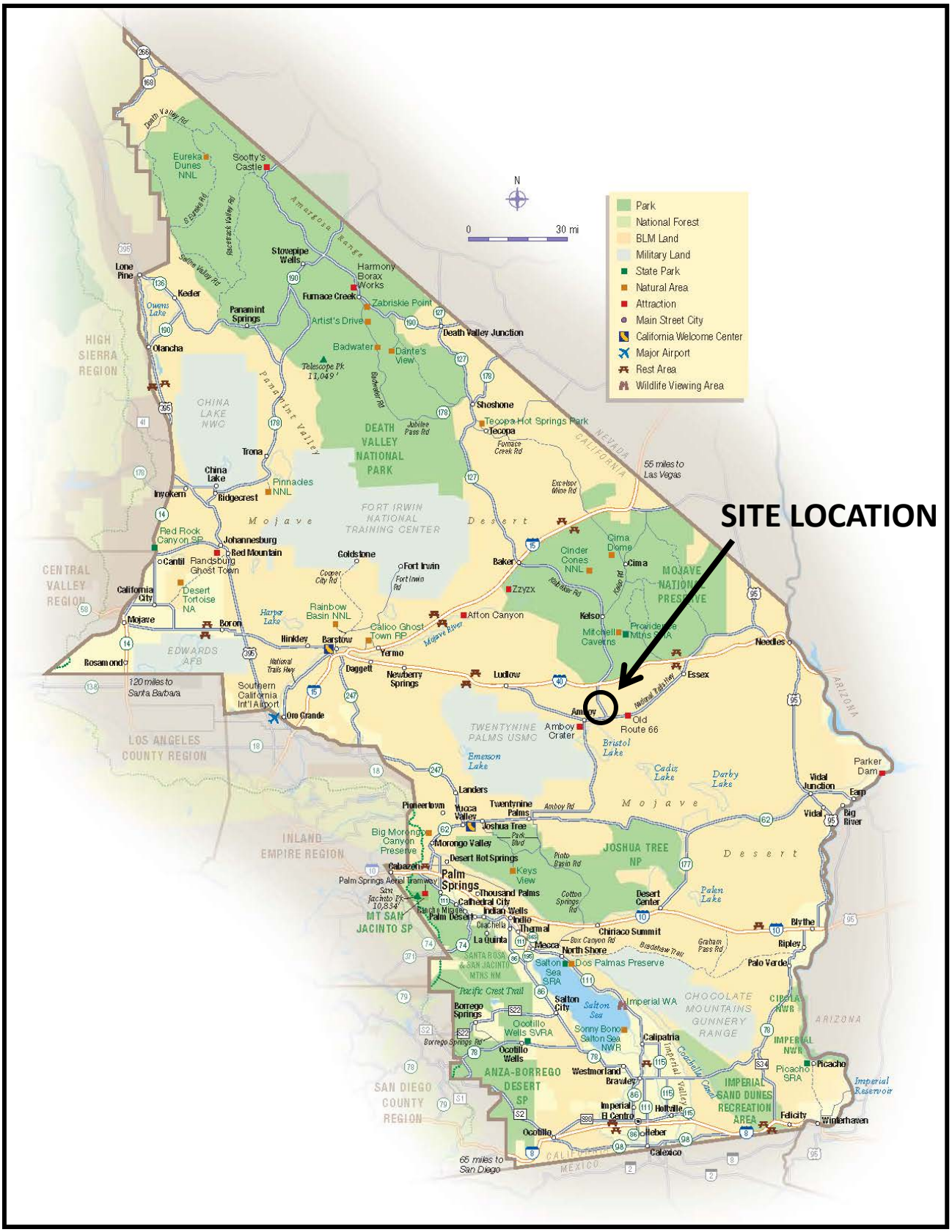

Figure 1. State Vicinity Map. OMYA Amboy Quarry. San Bernardino County, CA. Data source: www.visitcalifornia.com

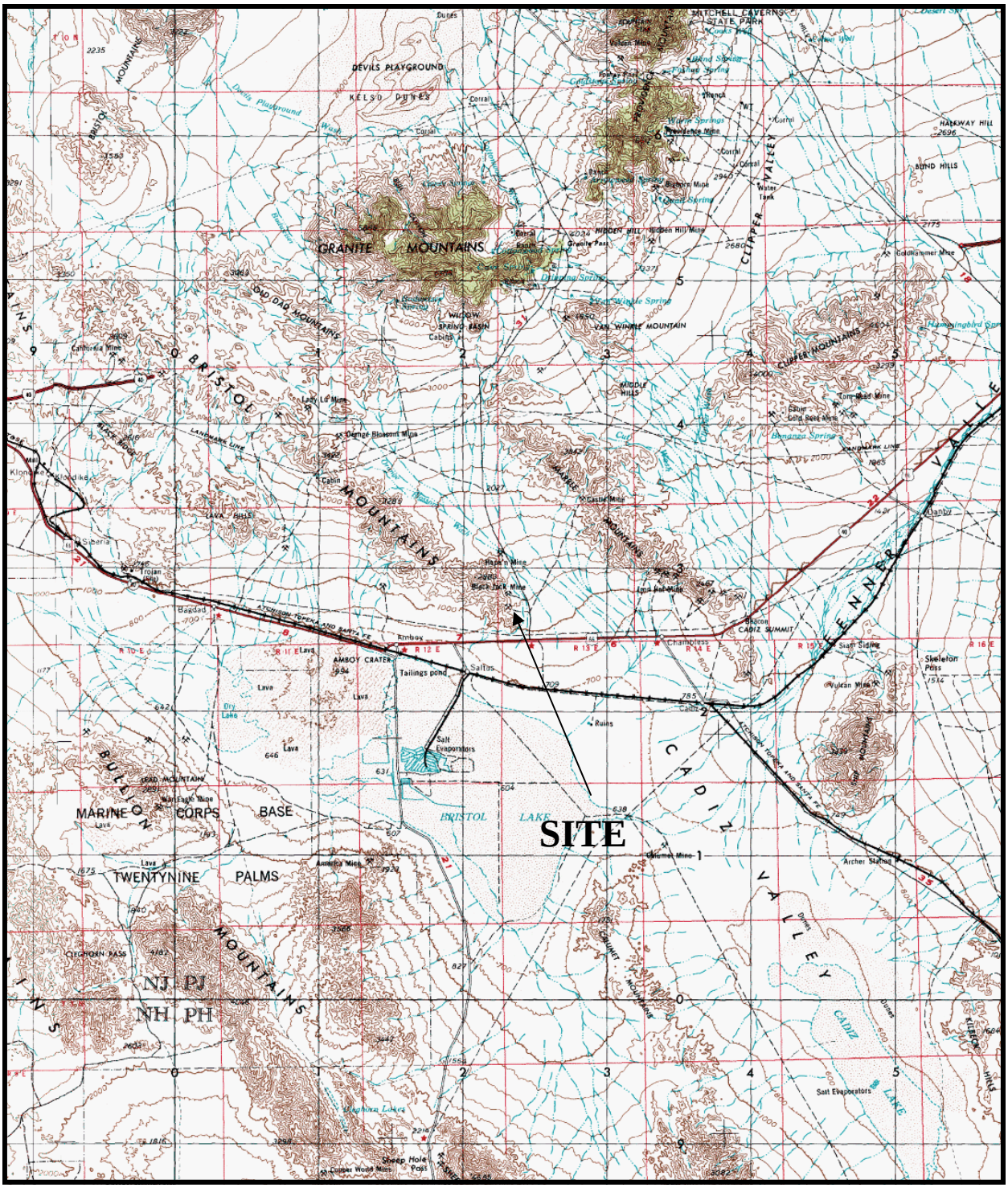

Figure 2. Vicinity Map.
OMYA Amboy Quarry.
USGS 1:250,000 Scale Topo Map: Needles, Calif.-AZ (1969)

0 2 miles

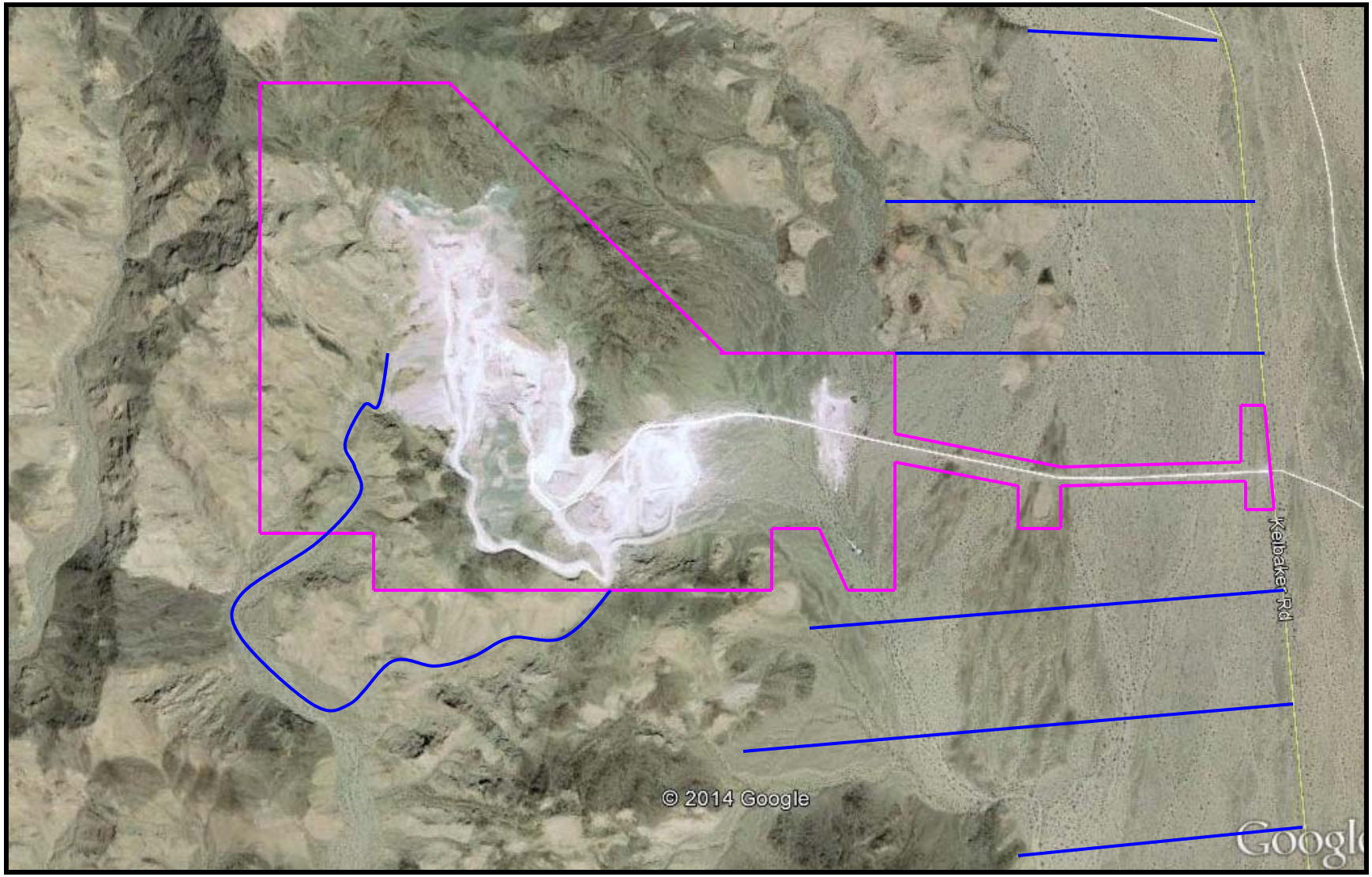

Figure 3. Survey Area and Belt Transects
OMYA Amboy Quarry Tortoise Survey
Google Aerial Photograph. 2014.

Survey Boundary
Belt Transects

0 1000 ft

APPENDIX B
PHOTOGRAPH LOG

Photograph 1. Typical desert pavement within the project site; view facing NE.

Photograph 2. View of existing stockpiles at the quarry and typical desert habitat; view facing west.

Photograph 3. View of desert pavement, facing N.

Photograph 4. View of steep slopes and quarry in the background, habitat adjacent to the access road in the foreground.

Photograph 5. Steep slopes in the northeastern portion of the project site with bighorn sheep visible; view facing N.

Photograph 6. Rocky slope at the southern tip of the project boundary.

Photograph 7. Waste rock in the southwestern corner of the project site; view facing upslope (N). No suitable tortoise habitat.

APPENDIX C
SPECIES LIST

PLANT SPECIES OBSERVED

FLOWERING PLANTS – DICOTS

ASTERACEAE
Ambrosia dumosa (white bursage)
Encelia farinosa (brittlebush)
Hymenoclea salsola (burrobrush)
Bebbia juncea (sweetbush)
Peucephyllum schottii (pygmy cedar)

BIGNONIACEAE
Chilopsis linearis (desert willow)

CACTACEAE
Echniocereus sp. (hedgehog cactus)
Ferocactus acanthodes (barrel cactus)
Mammillaria sp. (pincushion cactus)
Opuntia basilaris (beavertail cactus)
Opuntia echinocarpa (golden cholla)
Opuntia ramosissima (diamond cholla)

CHENOPODIACEAE
Atriplex canescens (saltbush)
Salsola kali (Russian thistle)

CLEOMACEAE
Cleome isomeris (bladderpod)

CONVOLVULACEAE
Cuscuta sp. (dodder)

CUCURBITACEAE
Cucurbita palamata (coyote gourd)

EPHEDRACEAE
Ephedra viridis (Mormon tea)

EUPHORBIACEAE
Euphorbia polycarpa (sandmat)

FABACEAE
Acacia greggii (cactlaw)
Psorothamnus spinosa (smoke tree)

GERANIACEAE
Erodium cicutarium (redstem filaree)

KRAMERIACEAE
Krameria grayi (white ratany)

LAMIACEAE
Hytpis emoryi (desert lavender)

POLYGONACEAE
Chorizanthe brevicornu (brittle spineflower)
Eriogonum inflatum (desert trumpet)

ZYGOPHYLLACEAE
Larrea tridentata (creosotebush)

FLOWERING PLANTS- MONOCOTS

POACEAE
Schismus barbatus (Mediterranean grass)

WILDLIFE AND/OR WILDLIFE SIGN OBSERVED

MAMMALS

BOVIDAE
Ovis canadensis nelson (Nelson's bighorn sheep)

CANIDAE
Canis latrans (coyote)
Vulpes vacrotis (kit fox)

CRICETIDAE
Neotoma lepida (desert woodrat)

LEPORIDAE
Lepus californicus (black-tailed jackrabbit)
Sylvilagus auduboni (desert cottontail)

SCIURIDAE
Ammospermophilus leucurus (white-tailed antelope squirrel)

REPTILES

IGUANIDAE
Callisaurus draconoides (zebra-tailed lizard)
Dipsosaurus dorsalis (desert iguana)
Phyrnosoma platyrhinos calidiarum (southern desert horned lizard)
Uta stansburiana (common side-blotched lizard)

TEIIDAE
Aspidoscelis tigris (western whiptail)

BIRDS

APODIDAE
Aeronautes saxatalis (white-throated swift)

CATHARTIDAE
Cathartes aura (turkey vulture)

COLUMBIDAE
Zenaida macroura (mourning dove)

CORVIDAE
Corvus corax (common raven)

EMBERIZIDAE
Amphispiza bilineata (black-throated sparrow)

FRINGILLIDAE
Carpodacus mexicanus (house finch)

MIMIDAE
Mimus polyglottis (Northern mockingbird)

TROCHILIDAE
Calypte costae (Costa's hummingbird)

TYRANNIDAE
Sayornis sayi (Say's phoebe)
Tyrannus verticalis (western kingbird)

APPENDIX E

Jurisdictional Delineation Report
July 2014

JURISDICTIONAL DELINEATION REPORT

OMYA ARIZONA INC.
AMBOY LIMESTONE QUARRY

SAN BERNARDINO COUNTY, CALIFORNIA

Prepared for:

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Project Number 14-08

July 2014

INTRODUCTION

The Amboy Limestone Quarry, operated by OMYA, Inc. (OMYA) is located approximately 6 miles northeast of Amboy in San Bernardino County, California. OMYA is in the process of amending their existing Mine Reclamation Plan to expand the permitted boundary and to include a buffer area around their existing limestone quarry operations. Himes Consulting, L.L.C. conducted a survey of potential jurisdictional waters on May 26-27, 2014.

A Streambed Alteration Agreement (No. 5-443-96) was received on January 9, 1997 for the original quarry operations. This agreement was renewed and extended until 2012. Under this agreement, approximately 0.2 acres have already been disturbed.

PROJECT DESCRIPTION AND LOCATION

Project Location. The Amboy Limestone Quarry has been mined by OMYA since 1996. The site is located approximately 6 miles northeast of the town of Amboy, approximately 10 miles south of Interstate 40, 3 miles north of Route 66 (National Trails Highway), and just west of Kelbaker Road (Figures 1 and 2). The project site is located in Section 30, Township 6 North, Range 13 East (San Bernardino Baseline and Meridian). Orange Blossom Wash lies approximately 3 miles to the northeast of the intersection of Kelbaker Road and the mine access road. The quarry lies at the southern tip of the Bristol Mountains, to the west of the Marble Mountains, and north of Bristol Lake.

Project Description. OMYA currently quarries a limestone deposit of exceptionally pure crystalline limestone, suitable for food grade products and supplements. Current disturbance within their property boundary is approximately 69 acres. Future disturbances include continuation of use of the overburden was pile (within original permit boundaries), expansion of the existing quarry to the northeast, and expansion of the eastern stockpile area. Total future disturbances are 11 acres. OMYA proposes to include a buffer area around their existing limestone quarry operations for a total of approximately 200 acres.

ENVIRONMENTAL SETTING

Existing Conditions. The quarry is located at the southern tip of the southern Bristol Mountains. Terrain at the project site contains large areas of very steep, nearly vertical, and rugged rock outcrops with little vegetation. Lower elevations within the property consist of large expanses of desert pavement and creosote bush flats interspersed with ephemeral drainages. Elevations within the property range from approximately 1,900

feet (ft) above mean sea level (msl) in the northwest portion of the property to approximately 350 ft above msl at Kelbaker Road.

Hydrology. The project site is located within the Southern Mojave watershed (Hydrologic Unit Code 18100100). Average annual precipitation is less than 1.5 inches in the region. Ephemeral washes within the project vicinity flow to the south-southwest to Bristol Lake, a dry lake, where they evaporate.

Vegetation. Vegetation communities within the project site consist of creosote bush (*Larrea tridentata*), white burr sage (*Ambrosia dumosa*) scrub, brittle bush (*Encelia farinosa*) scrub, and creosote bush – brittle bush scrub. Other shrubs within the project site include burrobrush (*Hymenoclea salsola*), sweetbush *(Bebbia juncea),* saltbush (*Atriplex canescen),* catclaw acacia *(Acacia greggii*), desert lavender (*Hyptis emoryi*), desert trumpet (*Eriogonum inflatum*), smoke tree (*Psorothamnus spinosa*), white ratany (*Krameria grayi*), brittle spineflower (*Chorizanthe brevicornu*), Mormon tea (*Ephedra viridis*), and bladderpod (*Cleome isomeris*). Cacti observed include golden cholla (*Opuntia echinocarpa*), beavertail (*Opuntia basilaris*), barrel cactus (*Ferocactus acanthodes*), diamond cholla (*Opuntia ramosissima*), pincushion cactus (*Mammillaria* sp.), and hedgehog cactus (*Echinocereus* sp.).

METHODS

Himes Consulting LLC conducted field measurements of ephemeral washes within the Amboy Limestone Quarry permitting boundary at regular intervals using a measuring tape on May 26 and 27, 2013. Prior to the field survey, recent aerial photographs were reviewed and assessed to evaluate potential waters present within the project site.

RESULTS

Federal Jurisdiction

Surface water from the site flows downstream towards Bristol Lake, a dry lakebed south of the project site. As these waters collect and evaporate at Bristol Lake, they are considered isolated and do not connect to downstream navigable waters. Therefore these washes are not subject to federal jurisdiction under Section 404 of the Clean Water Act. A letter from the US Army Corps of Engineers dated December 3, 1996, confirms that the original project did not discharge into waters of the U.S.

State Jurisdiction

Waters of the state are regulated by the California Department of Fish & Wildlife under Section 1600-1616 of the California Fish and Game Code (1602 Permit) and the Colorado River Basin Regional Water Quality Control Board (RWQCB) (waste discharge).

Jurisdictional waters are shown in Figure 3. A total of approximately 1.76 acres of waters of the State under the jurisdiction of the CDFW and Colorado River Basin RWQCB are estimated to occur within the permit boundary (see Figure 3), including along the existing access road. All of these are ephemeral washes which flow only in direct response to storm events. Of this total, approximately 0.2 acres have already been disturbed under Streambed Alteration Agreement No. 5-443-96.

TABLE 1
JURISDICTIONAL DELINEATION SUMMARY
OMY AMBOY LIMESTONE QUARRY

DRAINAGE	SQUARE FEET
A	9800
B	2900
C	1000
D	800
E	1625
F	810
G	1900
H	10750
I	1400
J	1400
K	840
L	1120
M	2660
N1	980
N2	840
N3	980
N4	2660
O	2520
P	26400
P1	5250
TOTAL	**76635**

TABLE 2

Jurisdictional Delineation - OMYA Amboy Limestone Quarry

Wash A

Meas.	Feet	Sq. Feet
0	6	
400	8	2800
650	10	2250
1000	8	3150
1200	8	1600
Total		9800

Wash B

Meas.	Feet	Sq. Feet
0	5	
200	3	800
800	4	1400
1000	3	700
Total		2900

Wash C

Meas.	Feet	Sq. Feet
0	3	
200	2	500
400	3	500
Total		1000

Wash D

Meas.	Feet	Sq. Feet
0	8	
100	8	800
Total		800

Wash E

Meas.	Feet	Sq. Feet
0	5	
250	8	1625
Total		1625

Wash F

Meas.	Feet	Sq. Feet
0	4	
180	5	810
Total		810

Wash G

Meas.	Feet	Sq. Feet
0	2	
200	5	700
500	3	1200
Total		1900

Wash H

Meas.	Feet	Sq. Feet
0	3	
500	16	4750
1000	8	6000
Total		10750

Wash I

Meas.	Feet	Sq. Feet
0	10	
140	10	1400
Total		1400

Wash J

Meas.	Feet	Sq. Feet
0	10	
140	10	1400
Total		1400

Wash K

Meas.	Feet	Sq. Feet
0	6	
140	6	840
Total		840

Wash L

Meas.	Feet	Sq. Feet
0	8	
140	8	1120
Total		1120

Wash M

Meas.	Feet	Sq. Feet
0	19	
140	19	2660
Total		2660

Wash N1

Meas.	Feet	Sq. Feet
0	7	
140	7	980
Total		980

Wash N2

Meas.	Feet	Sq. Feet
0	6	
140	6	840
Total		840

Wash N3

Meas.	Feet	Sq. Feet
0	7	
140	7	980
Total		980

Wash N4

Meas.	Feet	Sq. Feet
0	19	
140	19	2660
Total		2660

Wash O

Meas.	Feet	Sq. Feet
0	18	
140	18	2520
Total		2520

Wash P

Meas.	Feet	Sq. Feet
0	2	
400	10	2400
800	20	6000
1500	30	7500
1800	40	10500
Total		26400

Wash P1

Meas.	Feet	Sq. Feet
0	1	
500	20	5250
Total		5250
Total area		76635
Total disturbed area		8400

APPENDIX A
MAPS

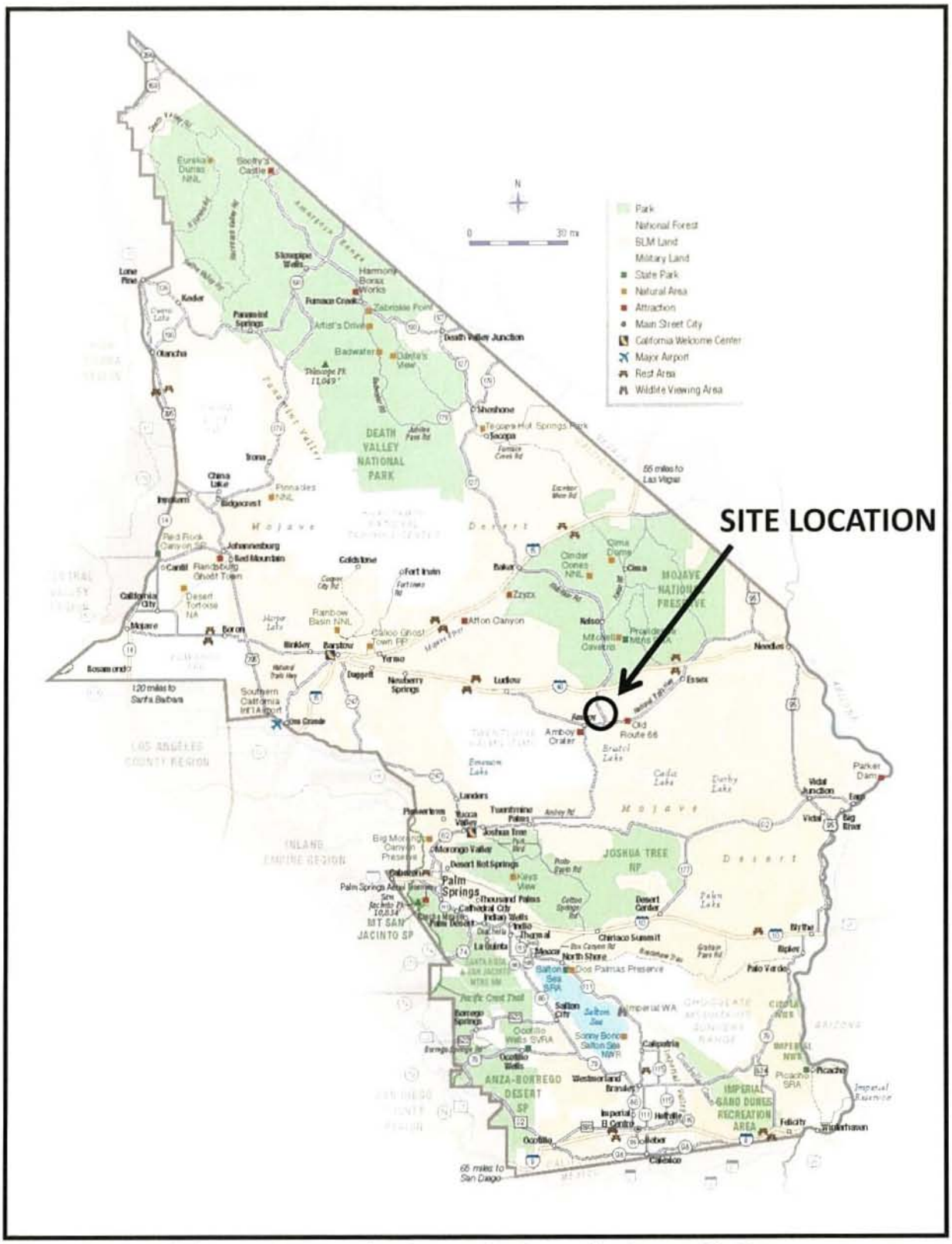


Figure 1. State Vicinity Map. OMYA Amboy Quarry. San Bernardino County, CA. Data source: www.visitcalifornia.com

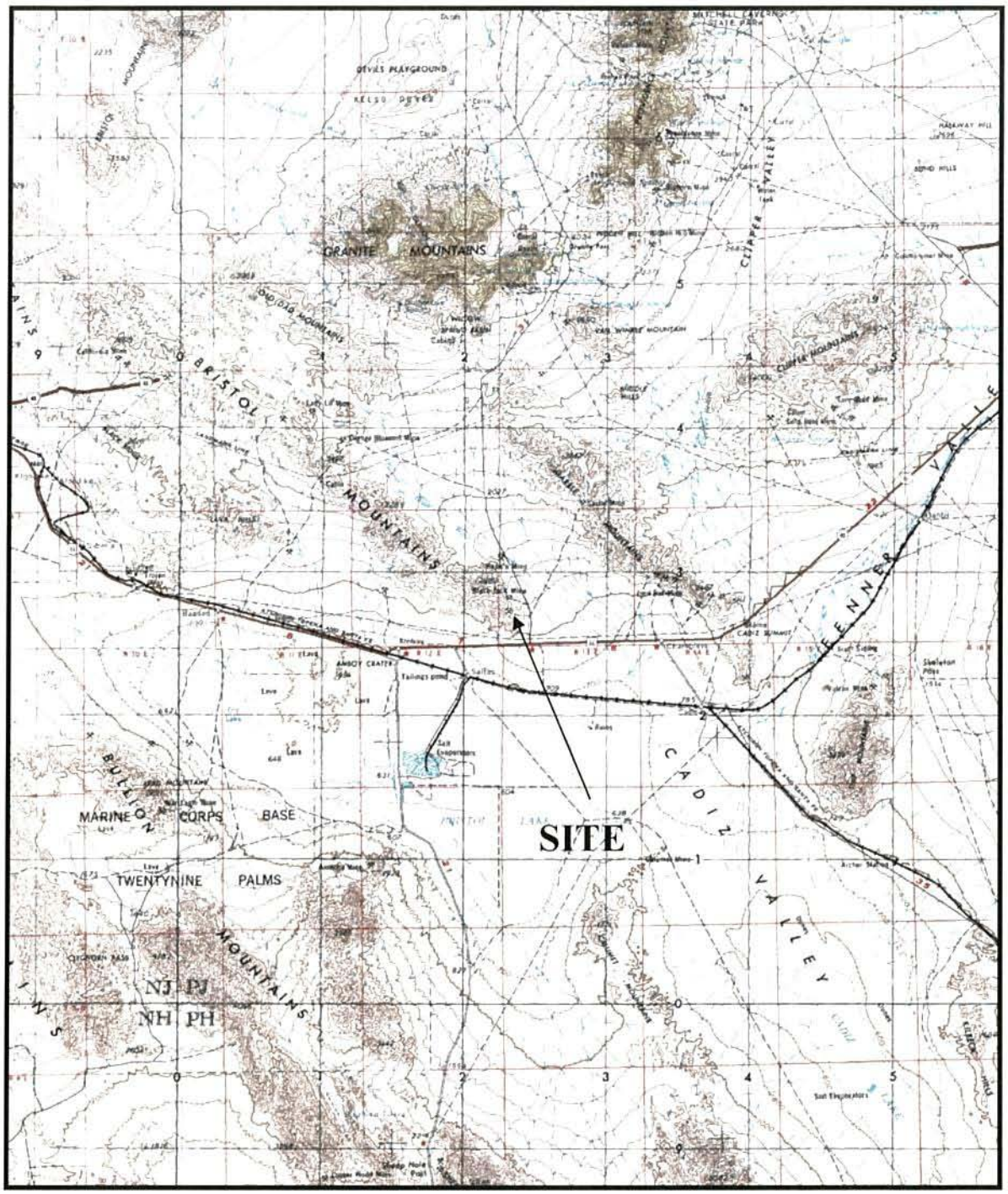


Figure 2. Vicinity Map.
OMYA Amboy Quarry.
USGS 1:250,000 Scale Topo Map: Needles, Calif.-AZ (1969)

0 2 miles

APPENDIX B

PHOTOGRAPH LOG

PHOTOGRAPH LOG

Photograph 1. Filled wash (Wash P); view facing downstream (SW).

Photograph 2. Filled wash, view facing upstream (N).

Photograph 3. Upstream end of Wash P (rock outcrop drop-off); view facing upstream.

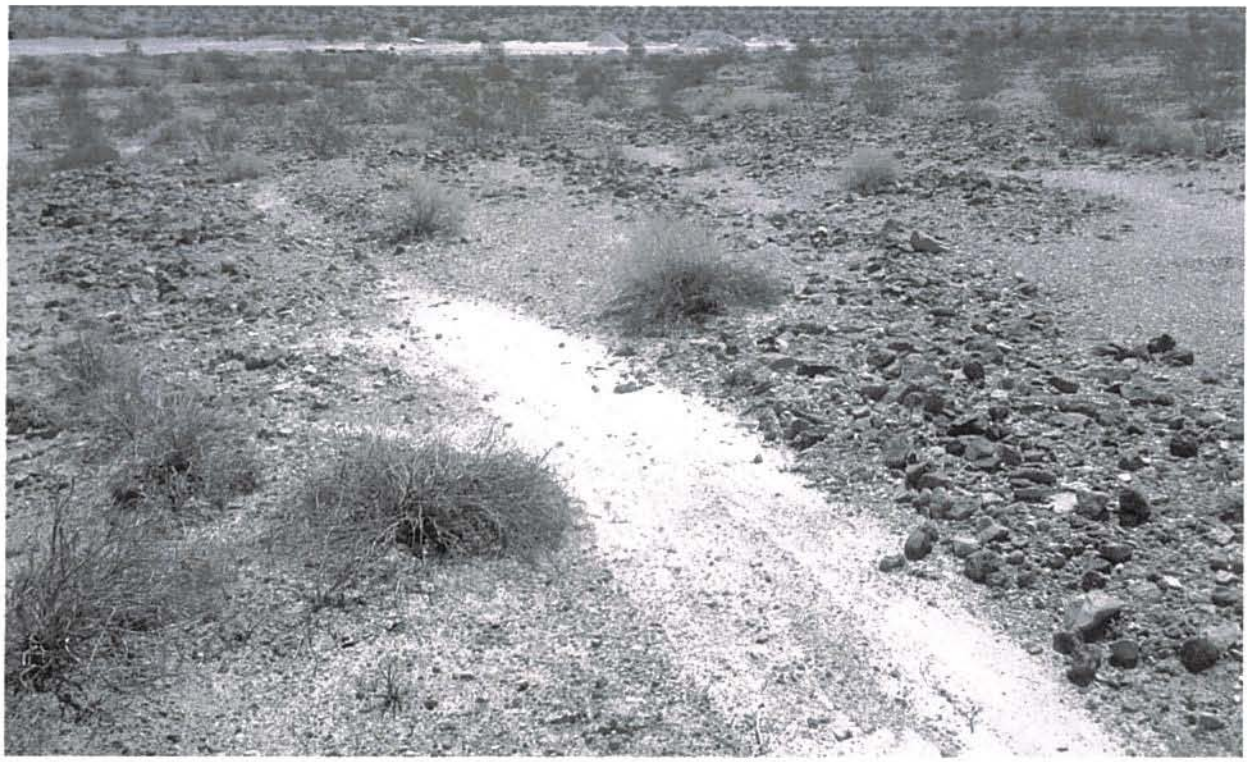
Photograph 4. View of Wash B, culverted, facing downstream. Streambed and bank visible.

Photograph 5. Wash B, view facing downstream.

Photograph 6. Small topographic change but no streambed or bank observed, vegetation is homogeneous; view facing W.

Photograph 7. No streambed and homogenous vegetation observed, view facing NW.

Photograph 8. Example of small topographic rills or swales with no jurisdictional waters observed.



Photograph 9. Example of deposited dust in low topographical area; no waters, bed, or bank observed.

Photograph 10. Drainage D, 8' wide; view facing downstream.

Photograph 11. Wash E, 8' wide, view facing upstream

Photograph 12. Wash E, view facing upstream.

Photograph 13. Wash A, view facing downstream.

Photograph 14. Wash M, view facing upstream.

Photograph 15. Tributary N1, view facing upstream.

Photograph 16. Tributary N2, view facing upstream

APPENDIX F

Hydrology Study and Drainage
September 2015

Hydrology Study & Drainage Analysis

Hydrology Study
& Drainage Analysis

Reclamation Plan 96M-06

(Approved by County January 4, 1997)

County of San Bernardino, CA

APN: 0558-151-10, 24 & 25

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September 2015

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A. Introduction

1.1 Purpose & Scope

The following Hydrology Study & Drainage Analysis has been prepared to determine Historical and proposed peak tributary and on-site 20 & 100-year flow rates, runoff volumes, and hydraulics for the proposed amendment to Reclamation Plan 96M-06 located northeasterly of the Town of Amboy, in the County of San Bernardino, CA. This report has been prepared to satisfy the County of San Bernardino hydrology requirements per the San Bernardino County Flood Control Hydrology/Hydraulics requirements for developments of this type and the requirements of the Surface Mining and Reclamation Act (SMARA).

The scope of this Study is as follows:

- Identification of the tributary watershed to the project site.
- Identification of floodplain(s) impacting the site.
- Identification and calculation of Historical conditions (prior to mining activity) tributary and on/off-site total peak flow rates and runoff volumes.
- Calculation of Existing conditions (current mining activity) tributary and on/off-site total peak flow rates and runoff volumes.
- Calculation of Final conditions (Reclamation Plan) on/off-site total peak flow rates, runoff volumes, hydraulics, flood impacts/mitigation, and sedimentation impacts/mitigation.
- Identification of proposed on-site hydrologic conditions & site/drainage plan.
- Summary of Findings & Conclusion

1.2 Project Overview

The project site is located within Sections 29 and 30 of Township 6 North, Range 13 East, and includes Assessor parcel numbers 0558-151-10, 24 & 25 and a portion of the adjacent Government lot. Located approximately 0.77 miles west of Kelbaker Road, 1.26 miles north of Route 66 and 5.82 miles east of the Town of Amboy in the County of San Bernardino, CA and is within the "Amboy" 7.5-minute quadrangles.

The subject property consists of three parcels totaling approximately 478.60 acres with a proposed project site of approximately 90.84 acres, consisting of both privately owned parcels, patented and unpatented mining claims. The majority of the privately owned parcels will remain in their native condition. The study watershed lies within the Colorado River Basin (California water Board Region 7).

The proposed project entails amendments to Reclamation Plan 96M-06 as approved by the County of San Bernardino on January 4, 1997. The project will have two major elements – the Mining Plan and the Reclamation Plan.

1.3 Existing Conditions

The project site is located in the hills west of Kelbaker Road, north of Route 66. The subject property is surrounded by undeveloped desert hills consisting of rough terrain with steep hills and valleys. The mining limits only include a portion of the parcels. The area outside of the mining limits will remain in its native condition. The hills to the north, east and west of the mining limits result in off-site tributaries of run-on to the mining site.

The site is situated on a ridge line between two gulleys; the site is hilly and slopes significantly to the south. The slopes of the gulleys to the east and west are steep. The site is mostly barren, typical for the desert region and is actively being mined.

In its natural condition tributary to the north of the site was divided by a natural ridge. The western portion flowed along the natural valley in a southern direction. The eastern portion flowed southwesterly also along a natural valley before turning to the east and discharging in an alluvial fan onto the desert floor.

Photo 1 – Looking North along access road

Photo 2 - Looking East at mining site.

Photo 3 – Looking East along SE corner of site, point of discharge.

Photo 4 - Looking North from SE corner of site.

Photo 5 – Looking south near NW corner of site, tailing fill area.

1.4 References

The following documents have been made part of this study by reference:

1.) San Bernardino County Department of Public Works Hydrology Manual, August 1986.

2.) Soils Survey CA695 (Mohave Desert Area, CA), NRCS – Current (Web).

3.) Flood Insurance Rate Map (FIRM), Flood Map Service Center – Current (Web).

4.) AutoCAD Files, Provided by Sespe Consulting – Dated March 12, 2015.

B. Methodology

1.1 General Methodology

The requirements and recommendations found in the San Bernardino County Hydrology Manual (August 1986) provided by the San Bernardino County Department of Public Works were used as the basis for the methodology and calculations found in this Study. On-site calculations were performed using the rational and unit hydrograph methods per County requirements for arid regions watershed.

For the 20-Year storm event, Antecedent Moisture Condition (AMC) I was used, per San Bernardino County, Department of Public Works memo date April 6, 2010. For the 100-Year storm event, Antecedent Moisture Condition (AMC) III was used. The San Bernardino County-approved software applications provided by Civil Design ® Corporation were used for all study calculations.

1.2 Sources of Topography

Mapping of existing conditions on-site and some tributary areas were established by 2-foot contour aerial topographic survey provided by Sespe Consulting. For areas outside of the mapping limits of the aerial topographic survey and historical conditions, USGS contours were used. Contour data was used for determination of drainage subarea delineations and elevations and for generation of 3D surfaces used in this report.

1.3 FEMA Floodplain Identification & Considerations

Per FEMA Map No. 060771C6150H, the site is located in a "Non-printed Flood Map Boundary" area

Refer to Exhibit "C" for surrounding area FIRM map used in this report.

1.4 Watershed Precipitation

Precipitation values for this report were generated from NOAA Atlas 14, Volume 6, Version 2, Precipitation Frequency Data Server, per San Bernardino County Department of Public Works memo date April 6, 2010. See Tables 1 & 2, below for the precipitation values used for the Historical and proposed conditions drainage areas analyzed in this report.

Table 1 – Precipitation Values (Rational Method Calculations)

STORM	PRECIPITATION
10-YEAR, 1-HOUR	**0.86**
100-YEAR, 1-HOUR	**1.59**

Table 2 – Precipitation Values (Unit Hydrograph Calculations)

STORM	PRECIPITATION
10-YEAR, 1-HOUR	**0.86**
100-YEAR, 1-HOUR	**1.59**
2-YEAR, 6-HOUR	**0.75**
100-YEAR, 6-HOUR	**2.43**
2-YEAR, 24-HOUR	**1.07**
100-YEAR, 24-HOUR	**3.56**

Refer to Exhibit "D" for the NOAA rainfall data used in this report.

1.5 Watershed Losses

Soil type classification for all drainage areas were derived from Historical NRCS hydrologic soils group data, per San Bernardino County, Department of Public Works memo date April 6, 2010. Type "C" soil is shown for the watershed area.

The Historical conditions study area is undeveloped desert hills, consisting of a poorly cover barren ground typical of the desert region. The proposed mining area was also assumed to be barren per the San Bernardino County Hydrology Manual, Figure C-3, the SCS Curve Number (AMC II) and percent impervious used within this report are summarized in the table below.

Table 2 –Soil Loss Rates

COVER TYPE	SOIL TYPE	QUALITY OF COVER	RUNOFF INDEX (AMC II)	IMPERVIOUS (%)
BARREN	**C**	~	**91**	**0**

1.6 Watershed Conveyances

Watershed conveyances have been estimated by averaging channel bottom widths and side slope for individual tributary areas. Manning's values for conveyances area are based on mountain streams, no vegetation in channel and steep banks. Values used in this report are summarized in the table below.

Table 3 – Manning's n for Channels (Chow, 1959).

Type of Channel and Description	Minimum	Normal	Maximum
a. bottom: gravels, cobbles, and few boulders	0.030	**0.040**	0.050
b. bottom: cobbles with large boulders	0.040	0.050	**0.070**

It should be noted that the tailing fill located on the south western portion of the reclamation plan is expected to consist of rock and cobble and be highly permeable. Stormwater runoff is expected to permeate the fill and follow the natural drainage course of the gulley.

Refer to Exhibits "D" for the runoff index number, percent impervious, hydrologic soils groups and land cover classification/quality used in this report.

C. Historical Conditions Hydrology Calculations

1.1. Historical Conditions Rational Method Calculations

Input values for the historical conditions rational method calculations prepared for this report are tabulated below:

Table 4 – Historical Conditions Rational Method Input Values – Off-Site

AREA	SIZE (AC)	TYPE	COVER	SOIL	SCS (AMC II)	IMPERVIOUS (%)	U.S. ELEV. (FT)	D.S. ELEV. (FT)	LENGTH (FT)
A1	9.62	BARREN	POOR	C	91	0%	1922.0	1580.0	1000.00
A2	66.14	BARREN	POOR	C	91	0%	1580.0	1090.0	2891.91
B1	8.06	BARREN	POOR	C	91	0%	1812.0	1515.6	1000.00
B2	17.75	BARREN	POOR	C	91	0%	1515.6	1280.0	1109.52
B3	59.26	BARREN	POOR	C	91	0%	1280.0	1137.0	1838.74

Output for the historical conditions rational method calculations are tabulated as follows:

Table 5 – Historical Conditions Rational Method Output Calculations

AREA	NODE	$Q_{20\text{-}1}$ (CFS)	$Q_{100\text{-}1}$ (CFS)
A	1-3	**186.96**	**321.80**
TC (MIN)		13	13
B	1-4	**160.12**	**295.66**
TC (MIN)		18	17

Refer to Attachment No. 1 for printouts of the "Historical Conditions Rational Method Calculations".
Refer to Exhibit "F" for the "Historical Conditions Hydrology Study Map".

1.2. Historical Conditions Unit Hydrograph Method Calculations

Input values for the historical conditions unit hydrograph method calculations prepared for this report are tabulated as follows:

Table 6 – Historical Conditions Unit Hydrograph Method Input Values

DRAINAGE AREA	SIZE (AC)	SCS	PERVIOUS FRACTION	TC_{100} (HRS)
A	75.76	91	1.00	0.22
B	85.07	91	1.00	0.28

Output for the historical conditions unit hydrograph method calculations are tabulated as follows:

Table 7 – Historical Conditions Unit Hydrograph Method Output Calculations

DRAINAGE AREA	SIZE (AC)	Q_{20-24} (CFS)	Q_{100-24} (CFS)	LAG_{100} (HR)
A	75.76	159.78	272.39	0.18
B	85.07	173.64	296.02	0.22

Table 8 – Historical Conditions Unit Hydrograph Method Output Calculations

DRAINAGE AREA	SIZE (AC)	VOL_{20-24} (AF)	VOL_{100-24} (AF)	LAG_{100} (HR)
A	75.76	**8.08**	**21.51**	0.18
B	85.07	**9.05**	**24.10**	0.22

Refer to Attachment No. 2 for printouts of the "Historical Conditions Unit Hydrograph Calculations".
Refer to Exhibit "F" for the "Historical Conditions Hydrology Study Map".

D. Existing Conditions Hydrology Calculations

1.3. Existing Conditions Rational Method Calculations

Input values for the existing conditions rational method calculations prepared for this report are tabulated below:

Table 9 –Existing Conditions Rational Method Input Values – Off-Site

AREA	SIZE (AC)	TYPE	COVER	SOIL	SCS (AMC II)	IMPERVIOUS (%)	U.S. ELEV. (FT)	D.S. ELEV. (FT)	LENGTH (FT)
A1	9.62	BARREN	POOR	C	91	0%	1922.0	1580.0	1000.00
A2	59.87	BARREN	POOR	C	91	0%	1580.0	1090.0	2891.91
B1	8.31	BARREN	POOR	C	91	0%	1812.0	1515.6	1000.00
B2	83.05	BARREN	POOR	C	91	0%	1515.6	1137.0	3564.62

Output for the Historical conditions rational method calculations are tabulated as follows:

Table 10 – Existing Conditions Rational Method Output Calculations

AREA	NODE	$Q_{20\text{-}1}$ (CFS)	$Q_{100\text{-}1}$ (CFS)
A	1-3	170.35	293.71
TC (MIN)		13	13
B	1-3	**201.71**	**355.19**
TC (MIN)		15	14

Refer to Attachment No. 3 for printouts of the "Existing Conditions Rational Method Calculations".
Refer to Exhibit "G" for the "Existing Conditions Hydrology Study Map".

1.4. Existing Conditions Unit Hydrograph Method Calculations

Input values for the existing conditions unit hydrograph method calculations prepared for this report are tabulated as follows:

Table 11 – Existing Conditions Unit Hydrograph Method Input Values

DRAINAGE AREA	SIZE (AC)	SCS	PERVIOUS FRACTION	TC_{100} (HRS)
A	69.49	91	1.00	0.22
B	91.36	91	1.00	0.23

Output for the existing conditions unit hydrograph method calculations are tabulated as follows:

Table 12 – Existing Conditions Unit Hydrograph Method Output Calculations

DRAINAGE AREA	SIZE (AC)	Q_{20-24} (CFS)	Q_{100-24} (CFS)	LAG_{100} (HR)
A	69.49	146.60	249.92	0.18
B	91.36	193.99	330.19	0.18

Table 13 – Existing Conditions Unit Hydrograph Method Output Calculations

DRAINAGE AREA	SIZE (AC)	VOL_{20-24} (AF)	VOL_{100-24} (AF)	LAG_{100} (HR)
A	69.49	**7.41**	**19.73**	0.18
B	91.36	**9.74**	**25.93**	0.18

Refer to Attachment No. 4 for printouts of the "Existing Conditions Unit Hydrograph Calculations".
Refer to Exhibit "G" for the "Existing Conditions Hydrology Study Map".

E. Reclamation Conditions Hydrology Calculations

1.1. Reclamation Conditions Rational Method Calculations

The tailing fill located on the south western portion of the reclamation plan is expected to consist of rock and cobble and be highly permeable. Stormwater runoff is expected to permeate the fill and follow the natural drainage course of the gulley. A manning value of 0.070 has been used for this tributary.

Input values for the reclamation conditions rational method calculations prepared for this report are tabulated below:

Table 14 – Reclamation Conditions Rational Method Input Values – Off-Site

AREA	SIZE (AC)	TYPE	COVER	SOIL	SCS (AMC II)	IMPERVIOUS (%)	U.S. ELEV. (FT)	D.S. ELEV. (FT)	LENGTH (FT)
A1	9.62	BARREN	POOR	C	91	0%	1922.0	1580.0	1000.00
A2	11.80	BARREN	POOR	C	91	0%	1580.0	1475.0	394.20
A3	42.12	BARREN	POOR	C	91	0%	1475.0	1090.0	2402.03
B1	8.35	BARREN	POOR	C	91	0%	1812.0	1500.0	1000.00
B2	37.76	BARREN	POOR	C	91	0%	1500.0	1020.0	669.84
C1	9.52	BARREN	POOR	C	91	0%	1470.0	1331.0	823.72
C2	41.69	BARREN	POOR	C	91	0%	1331.0	1129.0	1448.08

Output for the reclamation conditions rational method calculations are tabulated as follows:

Table 15 – Reclamation Conditions Rational Method Output Calculations

AREA	NODE	$Q_{20\text{-}1}$ (CFS)	$Q_{100\text{-}1}$ (CFS)
A	1-4	**142.81**	**250.49**
TC (MIN)		15	14
B	1-3	**136.62**	**225.68**
TC (MIN)		11	10
C	1-3	**123.11**	**213.25**
TC (MIN)		14	13

Refer to Attachment No. 3 for printouts of the "Reclamation Conditions Rational Method Calculations".
Refer to Exhibit "G" for the "Reclamation Conditions Hydrology Study Map".

1.2. Reclamation Conditions Unit Hydrograph Method Calculations

Input values for the reclamation conditions unit hydrograph method calculations prepared for this report are tabulated as follows:

Table 16 – Reclamation Conditions Unit Hydrograph Method Input Values

DRAINAGE AREA	SIZE (AC)	SCS	PERVIOUS FRACTION	TC_{100} (HRS)
A	63.54	91	1.00	0.23
B	46.11	91	1.00	0.17
C	51.21	91	1.00	0.22

Output for the reclamation conditions unit hydrograph method calculations are tabulated as follows:

Table 17 – Reclamation Conditions Unit Hydrograph Method Output Calculations

DRAINAGE AREA	SIZE (AC)	Q_{20-24} (CFS)	Q_{100-24} (CFS)	LAG_{100} (HR)
A	63.54	135.12	229.94	0.18
B	46.11	117.53	196.06	0.14
C	51.21	108.14	184.34	0.18

Table 18 – Reclamation Conditions Unit Hydrograph Method Output Calculations

DRAINAGE AREA	SIZE (AC)	VOL_{20-24} (AF)	VOL_{100-24} (AF)	LAG_{100} (HR)
A	63.54	**6.78**	**18.04**	0.18
B	46.11	**4.92**	**13.09**	0.14
C	51.21	**5.46**	**14.54**	0.18

Refer to Attachment No. 4 for printouts of the "Reclamation Conditions Unit Hydrograph Calculations".
Refer to Exhibit "G" for the "Reclamation Conditions Hydrology Study Map".

1.3. Reclamation Conditions Hydraulic Analysis

An analysis of the reclamation conditions on-site hydraulics was performed to accomplish the following:

1.) Verify that proposed Pit B is of adequate capacity to retain the entire drainage area B 100-year, 24-hour (5-day) runoff volume of 23.45 AF.

The on-site hydraulic analysis tabulated on the previous page is summarized as follows:

1.3.1 **Pit B** has a rim-full retention capacity of 1,300 a.f. at a total depth of 214 feet. Drainage area B yields a total 100-year, 24-hour (5-day) runoff volume of 23.45 AF at a depth of approximately 8.5 feet. Due to the small tributary to the north of Pit "B" and nature of the soil, debris flows are anticipated to be negligible and to be contained within the pit.

Refer to Attachment No. 4 for printout of the "5-Day Reclamation Conditions Unit Hydrograph Calculations".
Refer to Exhibit "G" for the "Reclamation Conditions Hydrology Study Map"

F. Temporary Sedimentation Basin Design

1.1 General Methodology

The requirements and recommendations found in the California Stormwater Best Management Practices (BMP) Handbook for Construction (January 2011) provided by the California Stormwater Quality Association (CASQA) were used as the basis for the methodology and calculations for sedimentation basin design found below. Unit Hydrograph method calculation for the 10-year, 6-hour flow rates and volumes were then compared to the sediment basin calculation methods found in CASQA, BMP, SE-2. Rational method 100-year, 1-hour flowrates times the 1000-year multiplier (1.35) was used for spillway sizing found in this report.

The following recommendations are based on existing conditions and may need to be reevaluated during the course of the mining operations as variations in tributary area and sedimentation loading may occur over time. Site discharge shall be monitored on an ongoing basis and adjustments to BMP's shall be made to control sediment discharge form the site.

1.2 Existing Conditions Unit Hydrograph Method Calculations

Input values for the existing conditions unit hydrograph method calculations for the 10-year, 6-hour storm are tabulated as follows:

Table 18 – Existing Conditions Unit Hydrograph Method Input Values for 10-year, 6-hour storm

DRAINAGE AREA	SIZE (AC)	SCS	PERVIOUS FRACTION	TC_{100} (HRS)
A	69.49	91	1.00	0.22
B	91.36	91	1.00	0.23

Output for the existing conditions unit hydrograph method calculations are tabulated as follows:

Table 19 – Existing Conditions Unit Hydrograph Method Output Calculations

DRAINAGE AREA	SIZE (AC)	Q_{10-6} (CFS)	VOL_{10-6} (AF)	LAG_{100} (HR)
A	69.49	112.20	4.24	0.18
B	91.36	148.56	5.57	0.18

Refer to Attachment No. 8 for printouts of the "10-year, 6-hour Unit Hydrograph Calculations".

1.3 Sediment Load

Based on the USGS "Sediment Yield and Runoff Frequency of Small Drainage Basins in the Mojave Desert, California and Nevada" an average sediment yield 28 metric tons per km2 per year is typical for the area depending on terrain and slope. This results in 2 CF per acre per year. However, a sediment yield of 200 CF per acre per year has been assumed for the site.

$$\frac{\text{28 metric tons}}{\text{Sq Km}} = \frac{\text{79.77 tons}}{\text{Sq mi}} = \frac{\text{0.1246 tons}}{\text{ac}} = \frac{\text{250lb}}{\text{ac}} = \frac{\text{2 cf}}{\text{ac}}$$

Refer to Attachment No. 8 for the USGS "Sediment Yield and Runoff Frequency of Small Drainage Basins in the Mojave Desert, California and Nevada" Handout.

1.4 Temporary Sedimentation Basin Recommendations

Due to the location and the nature of the soil within Area "A" it is unreasonable to think that a sedimentation base approximately eight (8) times the size of the possible storm water volume would be needed. Furthermore, due to the fact that Area "A" is composed mostly of existing terrain and the fact that the mine tailing being deposited in Area "A" would not result in the significant deposition of sediment and the fact that the mine tailings will act to slow runoff. Therefore, a sediment basin within this area is not justified.

However, it is recommended that sediment basin for Area "B" have a minimum surface area 1.20 AC and a maximum depth of 5 FT, resulting in a capacity no less than 5.99 AF, a volume equal to the 10-year, 6-hour storm volume plus a debris load of 200 CF per acre. The depth of this basin may be altered by increasing the surface area and reducing the depth as needed. However it is recommended that a minimum depth of 3 FT and a maximum depth of 5 FT shall be observed per CASQA BMP SE-2.

Table 21 – Temporary Sedimentation Basin Recommendations

DRAINAGE AREA	SIZE (AC)	SEDIMENT LOAD (CF/AC)	$VOL_{SEDIEMENT}$ (AF)	VOL_{10-6} (AF)	SA_{min} (SF)	Depth (FT)	V_{min} (AF)
B	91.36	200	0.42	5.57	1.20	5	5.99

*SAmin = Vmin / Depth

It should be noted that San Bernardino County Hydrology Manual does not have a direct method for determining the 1-hour storm volumes. However it can be estimated by the equation below.

$$((I_{20-1} - L) \times A) / 12 = Vol_{20-1}$$

Where:

I_{20-1} = 20-year, 1-hour rainfall intensity (in/hr)
L = Soil loss rate (in/hr)
A = Area (c-ft

Table 22 – Temporary Sedimentation Basin Recommendations

DRAINAGE AREA	SIZE (AC)	I_{20-1} (in/hr)	L (in/hr)	VOL_{20-1} (AF)
B	91.36	1.08	0.373	5.38

This results in a 20-year, 1-hour storm volume of 5.38 ac-ft, which is less than the 5.99 ac-ft recommended for the 10-yr, 6-hour storm. Therefor the recommended capacity of 5.99 AF exceeds the 20-year, 1-hour requirement of the Surface Mining and Reclamation Act (SMARA).

All temporary basins shall be design based on the "Detention Basin Design Criteria for San Bernardino County", as follows:

- No more than 50% of the basins volume shall be above natural grade.
- For above grade basins the top width of the levee shall be a minimum of 15'
- 3:1 maximum slope on wet side and 2:1 maximum slope on dry side.
- Maximum water depth should not exceed 6'.
- A spillway shall be design to pass the fully developed 1000 year peak flow rate ($Q_{1000} = 1.35\ Q_{100}$).
- A minimum of 1-foot of freeboard above the 1000-year HWL or 2-feet of freeboard above the 100 –year HWL, whichever is more stringent.
- Access to the basin shall be gated and locked.

The sedimentation basins shall be equipped with at least two (2) 12" outlet pipes each with a valve that is to remain closed. The inlet to the pipe shall be protected by a 24" perforated riser pipe wrapped with filter fabric. The basin shall be drained after each storm events when the sediment has had sufficient time to settle, typically 24 hours. The basin shall also be equipped with a spillway constructed of concrete or other non-erosive design capable of passing the 1000-year flow rate (1.35 x Q_{100}) as follows:

Table 23 – 1000-Year Flow Rates

DRAINAGE AREA	SIZE (AC)	Q_{100-24} (CFS)	Q_{100} to Q_{1000} FACTOR	$Q_{1000-24}$ (CFS)
A	69.49	249.92	1.35	**337.39**
B	91.36	330.19	1.35	**445.76**

Table 24 – Spillway

DRAINAGE AREA	SIZE (AC)	$Q_{1000-24}$ (CFS)	SIDE SLOPE	BASE WIDTH (FT)	SLOPE OF CHANNEL (%)	FREEBOARD (FT)	DEPTH OF FLOW (FT)
A	69.49	**337.39**	2:1	25.00	**1.00**	**2.00**	**1.09**
B	91.36	**445.76**	2:1	25.00	**1.00**	**2.00**	**1.29**

Refer to Attachment No. 8 for printouts of the "10-year, 6-hour Unit Hydrograph Calculations", "Spillway Sizing Calculations" and California Stormwater Quality Association (CASQA), Best Management Handbook, Best Management Practices Sediment Basin Handouts, SE-2.

G. Summary, Recommendations & Conclusion

1.1. Summary

A summary of the results of the rational and unit hydrograph calculations are tabulated below:

Table 25– Rational Method Calculations Peak Q Summary

HISTORICAL AREA	EXISTING AREA	REC. AREA	STORM EVENT	HISTORICAL CONDITIONS PEAK Q (CFS)	EXISTING CONDITIONS PEAK Q (CFS)**	RECLAMATION CONDITION PEAK Q (CFS)	INCREASE (CFS)*
A	A	A	20	**186.96**	**170.35**	**142.81**	***-44.15***
			100	**321.80**	**293.71**	**250.49**	***-71.31***
B	B	B	20	**160.12**	**201.71**	**136.62**	**~**
		C	20	~	~	**123.11**	***-37.01****
		B	100	**295.66**	**355.19**	**225.68**	**~**
		C	100	~	~	**213.25**	***-82.41****

*Above listed values reflect Area B being diverted into Pit B and not contributing to site runoff.
** Values have not been used to calculate increase.

Table 26 –Unit Hydrograph Calculations Volume Summary

HISTORICAL AREA	EXISTING AREA	REC. AREA	STORM EVENT	HISTORICAL CONDITIONS VOLUME (AF)	EXISTING CONDITIONS VOLUME (AF)**	RECLAMATION CONDITIONS VOLUME (AF)	INCREASE (AF)*
A	A	A	20	**8.08**	**7.41**	**6.78**	***-1.30***
			100	**21.51**	**19.73**	**18.04**	***-3.47***
B	B	B	20	**9.05**	**9.74**	**4.92**	**~**
		C	20	**~**	**~**	**5.46**	***-3.59****
		B	100	**24.10**	**25.93**	**13.09**	**~**
		C	100	**~**	**~**	**14.54**	***-9.56****

* Above listed values reflect Area B being diverted into Pit B and not contributing to site runoff.
** Values have not been used to calculate increase.

As indicated above, the site results in a decrease of runoff flow rates and volumes due to the proposed mining pit.

1.2. Recommendations

In order to control erosion during the ongoing mining phase it is recommended that the California Stormwater Quality Association, Best Management Handbook, Sediment Control measures be followed at all times. Sedimentation control measures include but are not limited to those included in Attachment 8. Sedimentation controls shall be installed, inspected and maintained as needed to eliminate discharge of sediments from the site.

Temporary sedimentation basins sizing calculations have been provided in Section F, Table 22 and spillway sizing calculations have been provided in Section F, Table 23. Storm flows at all discharge point shall mimic natural condition, as to avoid concentration of flow that can result in erosion. The installation of riprap may be necessary in order to spread flow and minimize erosive conditions.

Refer to Attachment No. 8 for printout of relevant Sediment Control handouts.

1.3. Conclusion

In its Reclamation state shown on Exhibit "H", drainage Area "A" results in a reduced tributary which in-turn reduces the peak flow rate as well and the volume of storm water discharge form the tributary. The tailings fill located on the south western portion of the reclamation plan is expected to consist of rock and cobble and be highly permeable. Storm water runoff is expected to permeate the fill and follow the natural drainage course of the gulley resulting in a low risk of sediment transportation. As such drainage Area "A" is not expected to have any significant impacts to downstream areas.

Drainage Area "B", including the proposed mining pit as well as tributary to the north will not contribute to off-site flow. The formation of the pit as a result of the mining operation will provide a storage basin capable of capturing the full extents of the 5-day 100-year, 24-hour storm event. Due to the small tributary to the north of Pit "B" and nature of the soil, debris flows are anticipated to be negligible and to be contained within the pit. As such drainage Area "B" is not expected to have any significant impacts to downstream areas.

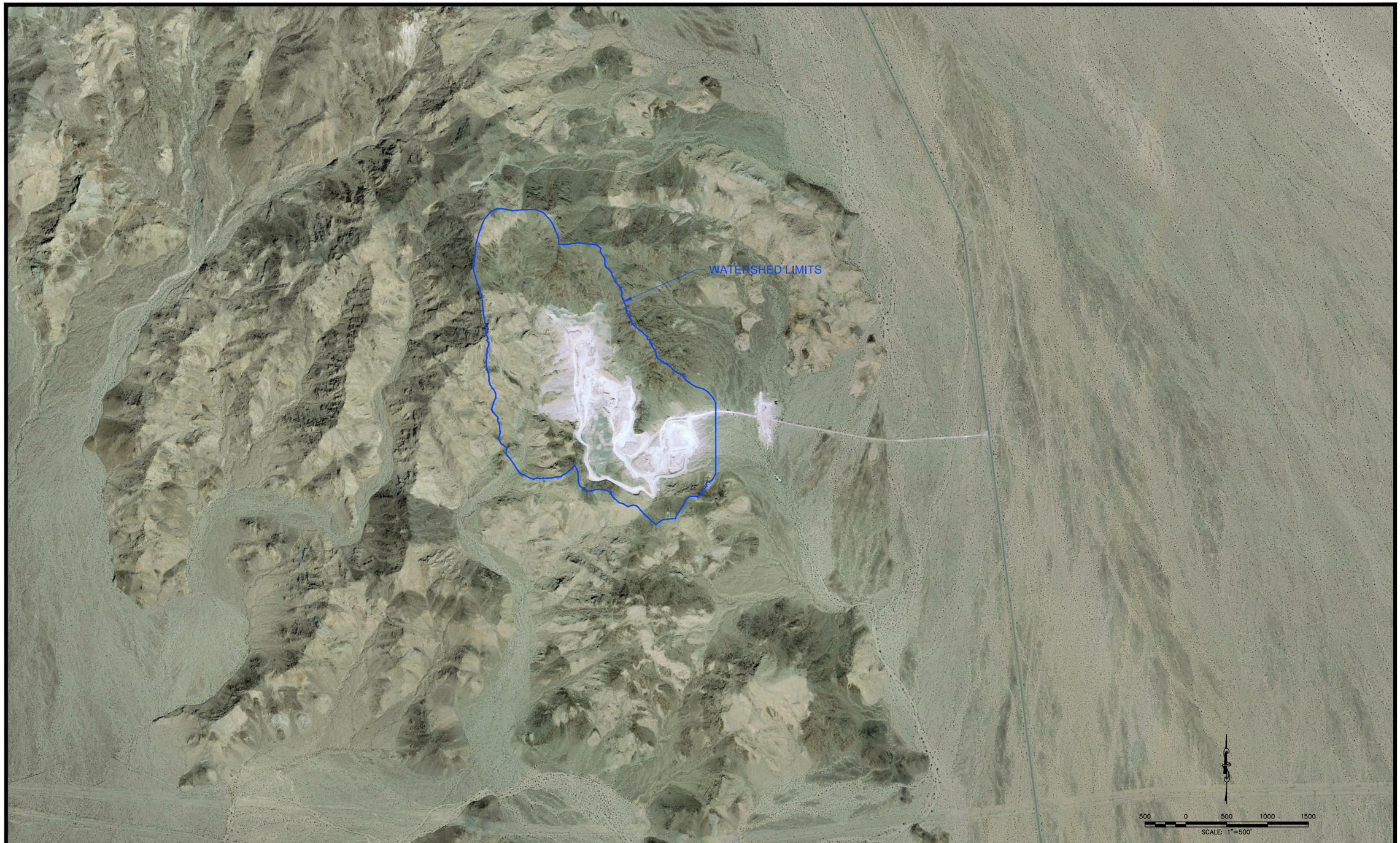
Drainage Area "C" will have a tributary far less than the historical area resulting in a reduced tributary which in-turn reduces the peak flow rate as well and the volume of storm water discharge form the tributary. The tributary is proposed to result in a sheet flow condition which will reduce the potential for sediment transportation. The installation of riprap may be necessary in order to spread flow and minimize erosive conditions at the discharge point. As such drainage Area "C" is not expected to have any significant impacts to downstream areas.

With the above mitigation measure the development of the Amboy mining site will not have a negative impact on downstream properties or facilities.

(END)

EXHIBIT “A”

Project Watershed
Aerial Orthophoto



AERIAL ORTHOPHOTO EXHIBIT

AMBOY PIT

COUNTY OF SAN BERNARDINO, CA

PREPARED BY:

BONADIMAN

CIVILDESIGN

PREPARED FOR:

OMYA CALIFORNIA, INC.,
A DIVISION OF OMYA INC.
7225 CRYSTAL CREEK ROAD
LUCERNE VALLEY, CA 92365

BY	MARK	REVISION DESCRIPTION	DATE

PREPARED FOR:	OMYA CALIFORNIA, INC.
JOB NO:	154166
PREPARED BY:	SG
CHECKED BY:	JTS

NOTE: JOSEPH E. BONADIMAN & ASSOCIATES, INC. DOES NOT WARRANTY THE ACCURACY OF THE G.I.S. DATA PRESENTED IN THIS EXHIBIT. THIS EXHIBIT MAY CONTAIN INFORMATION COPYRIGHTED TO THE COUNTY OF SAN BERNARDINO,CA.

AERIAL ORTHOPHOTO EXHIBIT
AMBOY PIT
COUNTY OF SAN BERNARDINO, CA

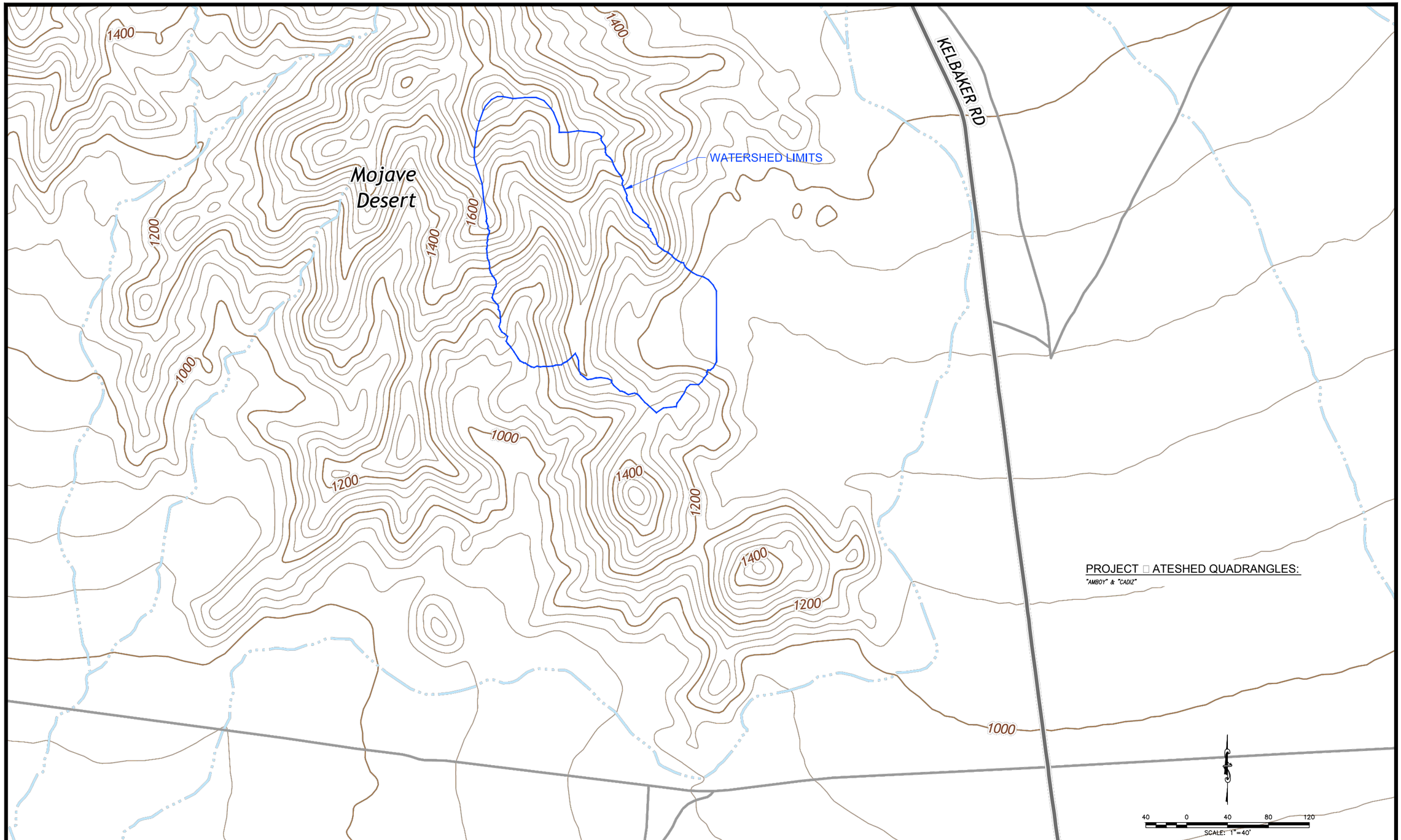
DISREGARD PRINTS BEARING EARLIER REVISION DATES → 04–10–14

A

SHEET 1 OF 1

EXHIBIT “B”

Project Watershed
USGS Quadrangle



USGS QUADRANGLE EXHIBIT
AMBOY PIT
COUNTY OF SAN BERNARDINO, CA

PREPARED BY:

BONADIMAN [redacted]

CIVILDESIGN

PREPARED FOR:

OMYA CALIFORNIA, INC.,
A DIVISION OF OMYA INC.
7225 CRYSTAL CREEK ROAD
LUCERNE VALLEY, CA 92365

BY	MARK	REVISION DESCRIPTION	DATE

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USGS QUADRANGLE EXHIBIT
AMBOY PIT
COUNTY OF SAN BERNARDINO, CA

DISREGARD PRINTS BEARING EARLIER REVISION DATES → 04-08-14

B

SHEET 1 OF 1

EXHIBIT “C”

FEMA Floodplain Maps

FEMA

Need Help ?

Flood Map Service Center

MSC Home | MSC Search | MSC Products and Tools | MSC How-To | MSC Email Subscriptions

Search by Address

Enter an address, place, or coordinates:

Enter an address, place, or

You are currently viewing flood map boundaries near the location entered. The flood map that best matches your location is highlighted. A new location may be chosen by panning or zooming the map and selecting a point, or by entering a new location in the search field.

You have selected a location in

SAN BERNADINO COUNTY AND INCORPORATED AREAS

There is no flood map printed for the selected location. Please view or download the FIRM Panel Index for more information. The Index can be found by selecting the "Get Additional Products" link at the bottom of this section and expanding the Effective FIRM Products list.

View NFHL data on FEMA GeoPlatform

Get additional products for SAN BERNADINO COUNTY AND INCORPORATED AREAS

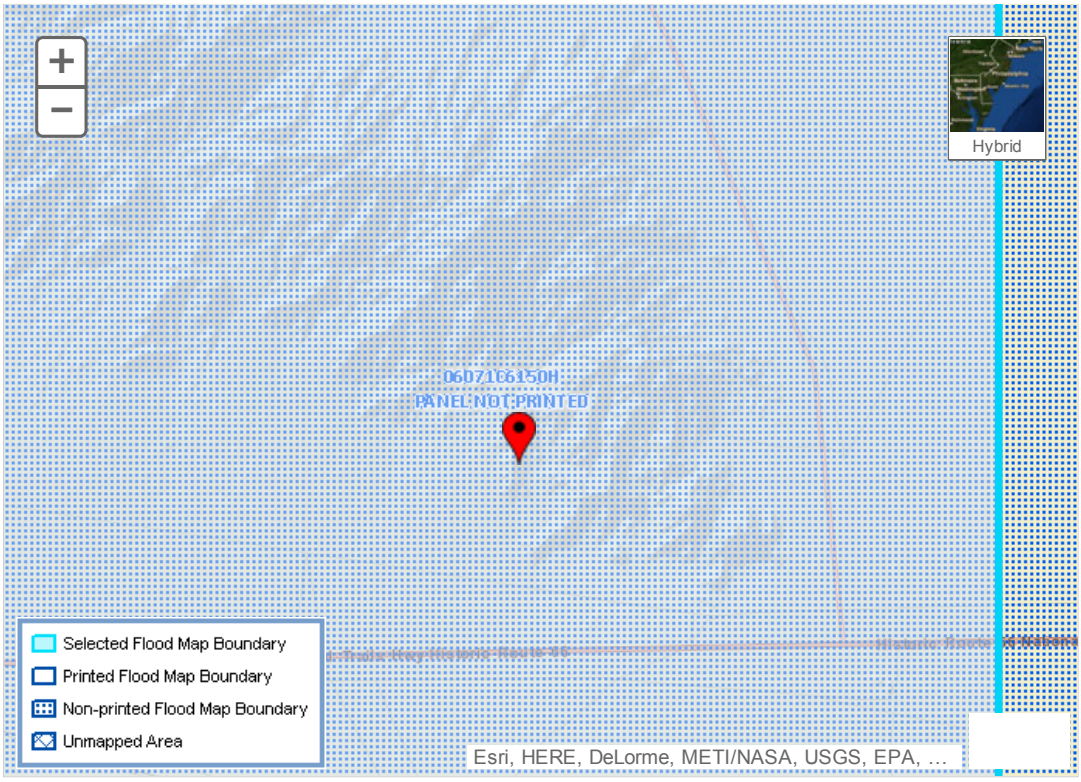

EXHIBIT “D”

NOAA Rainfall Data

NOAA Atlas 14, Volume 6, Version 2
Location name: California, US*
Latitude: 34.5802°, Longitude: -115.6598°
Elevation: 1274 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.093 (0.077-0.114)	0.142 (0.117-0.174)	0.211 (0.173-0.259)	0.269 (0.220-0.334)	0.355 (0.280-0.454)	0.424 (0.328-0.555)	0.500 (0.377-0.669)	0.581 (0.427-0.799)	0.699 (0.493-1.00)	0.798 (0.544-1.18)
10-min	0.134 (0.110-0.164)	0.204 (0.168-0.250)	0.302 (0.248-0.371)	0.386 (0.315-0.478)	0.508 (0.401-0.651)	0.608 (0.470-0.795)	0.716 (0.541-0.958)	0.833 (0.612-1.15)	1.00 (0.707-1.44)	1.14 (0.779-1.70)
15-min	0.162 (0.134-0.198)	0.247 (0.203-0.302)	0.365 (0.300-0.449)	0.467 (0.381-0.578)	0.615 (0.485-0.787)	0.736 (0.569-0.961)	0.866 (0.654-1.16)	1.01 (0.740-1.39)	1.21 (0.855-1.74)	1.38 (0.942-2.05)
30-min	0.228 (0.188-0.279)	0.347 (0.286-0.425)	0.514 (0.422-0.631)	0.657 (0.536-0.814)	0.865 (0.683-1.11)	1.04 (0.801-1.35)	1.22 (0.920-1.63)	1.42 (1.04-1.95)	1.71 (1.20-2.44)	1.95 (1.33-2.88)
60-min	0.297 (0.245-0.363)	0.452 (0.373-0.554)	0.670 (0.550-0.823)	0.856 (0.698-1.06)	1.13 (0.890-1.44)	1.35 (1.04-1.76)	1.59 (1.20-2.13)	1.85 (1.36-2.54)	2.22 (1.57-3.19)	2.54 (1.73-3.76)
2-hr	0.382 (0.315-0.467)	0.565 (0.466-0.692)	0.820 (0.674-1.01)	1.04 (0.847-1.29)	1.36 (1.07-1.74)	1.61 (1.25-2.11)	1.89 (1.43-2.53)	2.19 (1.61-3.01)	2.62 (1.85-3.75)	2.97 (2.03-4.41)
3-hr	0.432 (0.357-0.529)	0.634 (0.522-0.776)	0.913 (0.751-1.12)	1.15 (0.941-1.43)	1.50 (1.19-1.92)	1.79 (1.38-2.33)	2.09 (1.58-2.79)	2.42 (1.77-3.33)	2.89 (2.04-4.14)	3.27 (2.23-4.85)
6-hr	0.516 (0.426-0.631)	0.751 (0.619-0.920)	1.08 (0.884-1.32)	1.35 (1.10-1.68)	1.76 (1.39-2.25)	2.08 (1.61-2.72)	2.43 (1.83-3.25)	2.81 (2.06-3.86)	3.35 (2.36-4.80)	3.79 (2.58-5.62)
12-hr	0.590 (0.487-0.722)	0.867 (0.715-1.06)	1.25 (1.03-1.54)	1.58 (1.29-1.95)	2.05 (1.62-2.62)	2.43 (1.88-3.17)	2.83 (2.14-3.79)	3.27 (2.40-4.49)	3.88 (2.74-5.57)	4.39 (2.99-6.51)
24-hr	0.719 (0.634-0.831)	1.07 (0.946-1.24)	1.56 (1.37-1.81)	1.98 (1.73-2.31)	2.57 (2.18-3.10)	3.05 (2.54-3.74)	3.56 (2.89-4.46)	4.10 (3.25-5.28)	4.88 (3.73-6.52)	5.52 (4.08-7.61)
2-day	0.820 (0.724-0.948)	1.24 (1.09-1.43)	1.81 (1.59-2.10)	2.29 (2.00-2.68)	2.99 (2.53-3.60)	3.55 (2.95-4.36)	4.14 (3.37-5.20)	4.78 (3.79-6.15)	5.69 (4.35-7.60)	6.43 (4.76-8.87)
3-day	0.865 (0.763-1.00)	1.31 (1.15-1.51)	1.92 (1.69-2.23)	2.44 (2.13-2.86)	3.19 (2.70-3.84)	3.79 (3.15-4.66)	4.43 (3.61-5.56)	5.12 (4.06-6.59)	6.11 (4.67-8.16)	6.91 (5.12-9.53)
4-day	0.909 (0.802-1.05)	1.38 (1.21-1.59)	2.03 (1.78-2.35)	2.58 (2.25-3.02)	3.38 (2.86-4.07)	4.02 (3.34-4.93)	4.70 (3.82-5.90)	5.44 (4.31-7.00)	6.49 (4.96-8.68)	7.36 (5.45-10.1)
7-day	0.950 (0.839-1.10)	1.44 (1.27-1.67)	2.13 (1.87-2.47)	2.72 (2.37-3.18)	3.57 (3.02-4.30)	4.26 (3.54-5.23)	4.99 (4.06-6.26)	5.78 (4.58-7.44)	6.91 (5.28-9.23)	7.83 (5.80-10.8)
10-day	0.976 (0.861-1.13)	1.48 (1.31-1.72)	2.20 (1.93-2.55)	2.82 (2.46-3.29)	3.71 (3.15-4.47)	4.44 (3.69-5.44)	5.21 (4.23-6.53)	6.03 (4.78-7.76)	7.22 (5.51-9.65)	8.18 (6.06-11.3)
20-day	1.06 (0.938-1.23)	1.64 (1.44-1.90)	2.46 (2.16-2.85)	3.17 (2.77-3.70)	4.20 (3.56-5.06)	5.04 (4.19-6.18)	5.93 (4.82-7.44)	6.88 (5.46-8.85)	8.22 (6.28-11.0)	9.30 (6.88-12.8)
30-day	1.15 (1.01-1.32)	1.79 (1.58-2.07)	2.71 (2.39-3.15)	3.52 (3.07-4.11)	4.69 (3.97-5.65)	5.63 (4.68-6.92)	6.63 (5.39-8.32)	7.69 (6.09-9.89)	9.16 (7.00-12.2)	10.3 (7.65-14.2)
45-day	1.25 (1.11-1.45)	1.99 (1.76-2.31)	3.05 (2.68-3.54)	3.97 (3.47-4.64)	5.32 (4.51-6.41)	6.42 (5.33-7.87)	7.56 (6.15-9.48)	8.76 (6.94-11.3)	10.4 (7.96-13.9)	11.7 (8.67-16.2)
60-day	1.36 (1.20-1.57)	2.19 (1.93-2.53)	3.38 (2.97-3.92)	4.42 (3.86-5.17)	5.93 (5.02-7.14)	7.16 (5.95-8.78)	8.44 (6.87-10.6)	9.77 (7.75-12.6)	11.6 (8.86-15.5)	13.0 (9.64-18.0)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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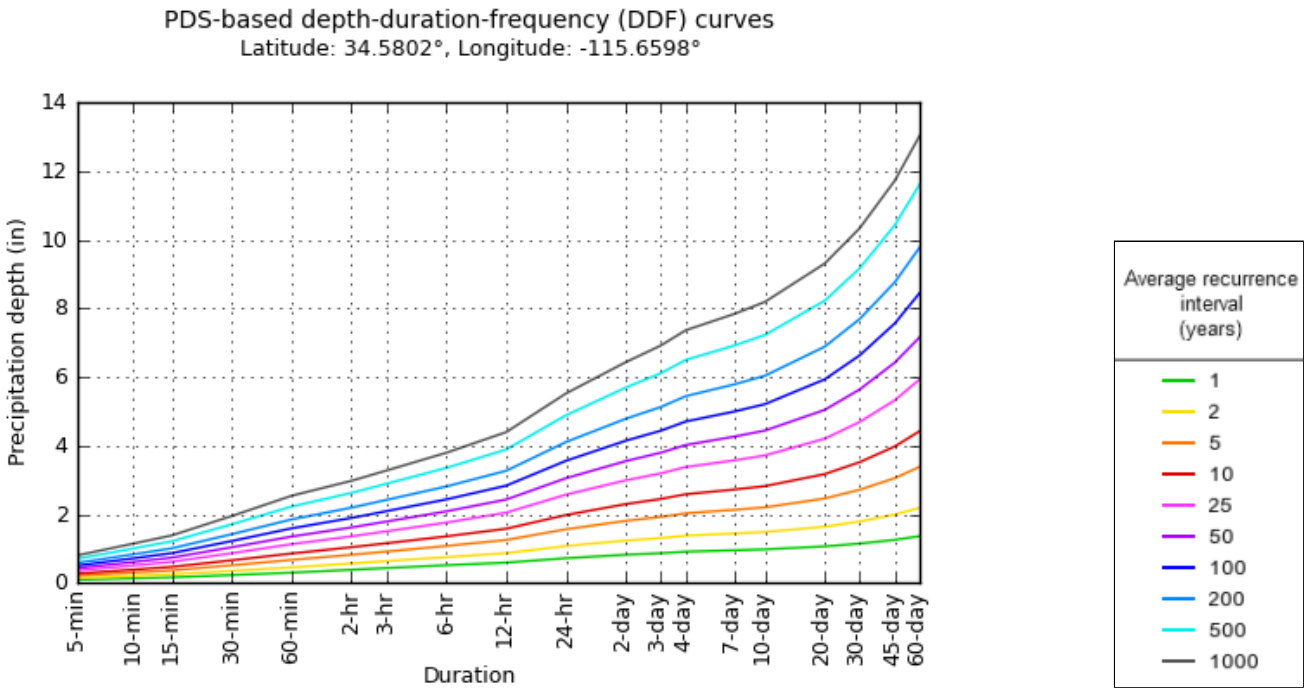
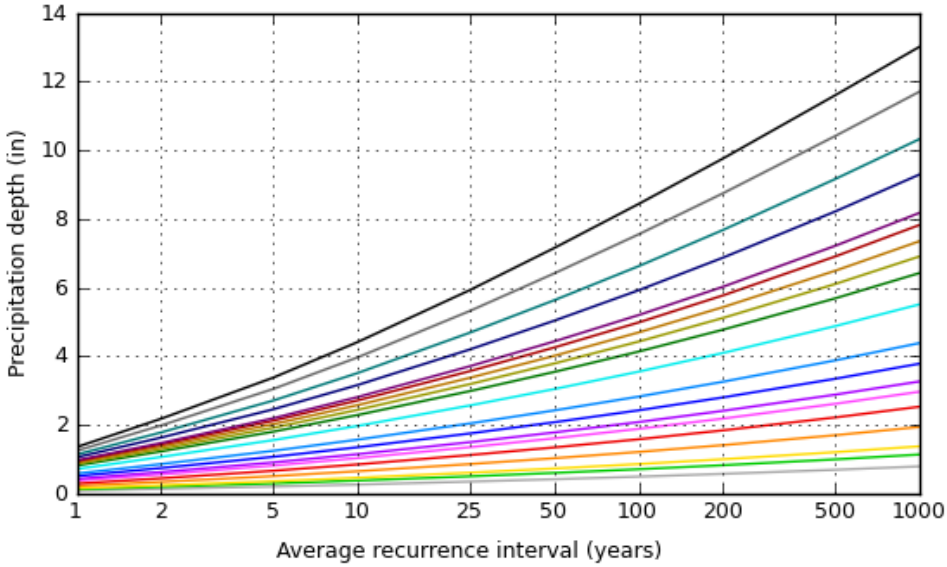
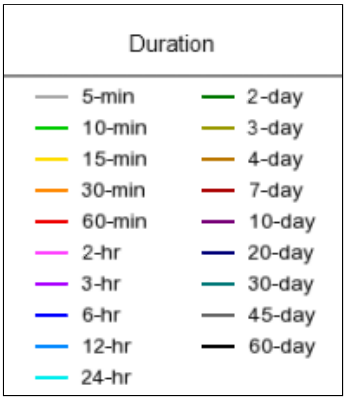
PF graphical





NOAA Atlas 14, Volume 6, Version 2

Created (GMT): Wed Apr 1 22:21:33 2015



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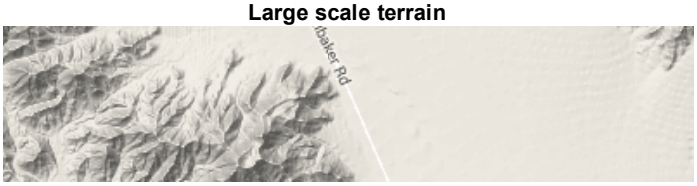
Maps & aerials

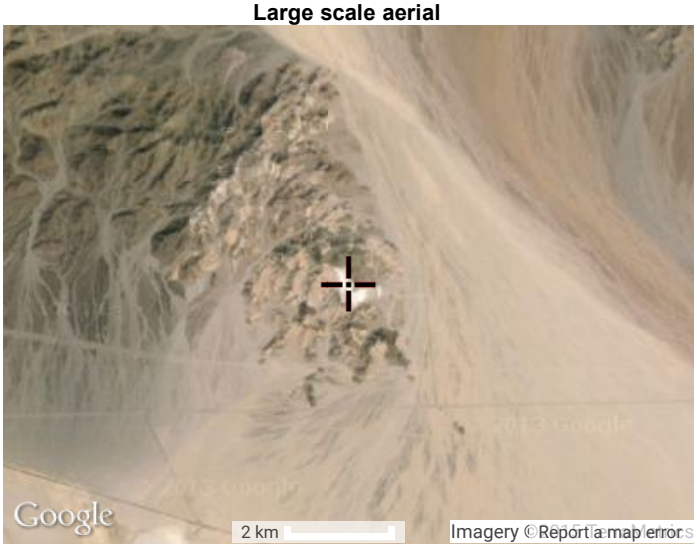
Small scale terrain

Large scale terrain



Large scale map

Large scale aerial



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US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
Office of Hydrologic Development
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Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

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EXHIBIT “E”

Runoff Index Numbers,
Impervious Cover
& NRCS Soils Maps

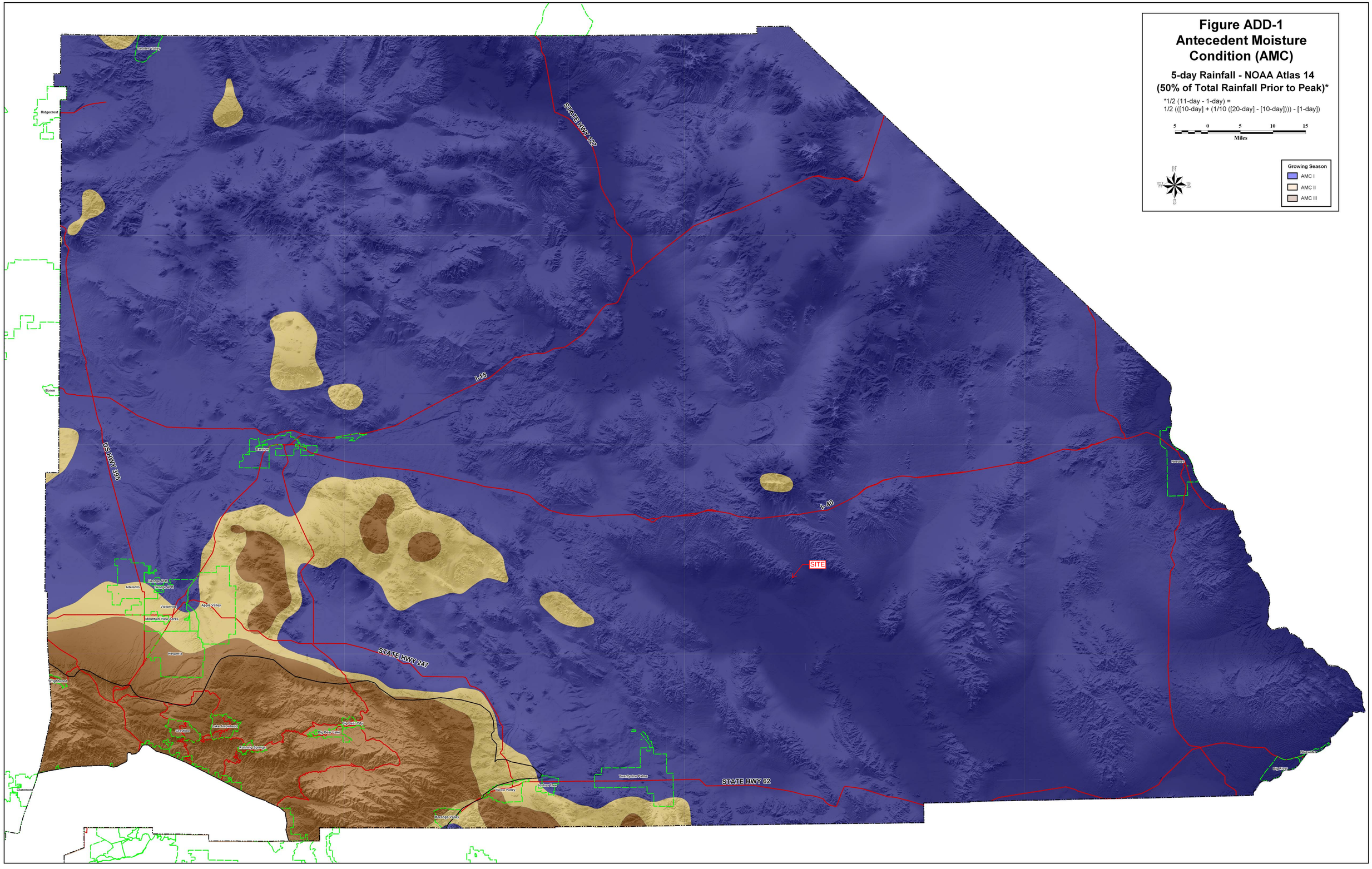


Figure ADD-1
Antecedent Moisture Condition (AMC)
5-day Rainfall - NOAA Atlas 14
(50% of Total Rainfall Prior to Peak)*
*1/2 (11-day - 1-day) =
1/2 (([10-day] + (1/10 ([20-day] - [10-day]))) - [1-day])
5 0 5 10 15
Miles
N
W
E
S
Growing Season
AMC I
AMC II
AMC III
STATE HWY 127
I-15
I-40
US HWY 395
STATE HWY 247
STATE HWY 62
SITE
Ridgecrest
Barstow Valley
Boron
Barstow
Needles
Adelanto
George AFB
George AFB
Victorville
Apple Valley
Mountain View Acres
Hesperia
Wrightwood
Crestline
Lake Arrowhead
Running Springs
Big Bear City
Big Bear Lake
Twentynine Palms
Yucca Valley
Joshua Tree
Morongo Valley
Claremont
Needles
Bluewater
Big River

Residential Landscaping (Lawn, Shrubs, etc.) - The pervious portions of commercial establishments, single and multiple family dwellings, trailer parks and schools where the predominant land cover is lawn, shrubbery and trees.

Row Crops - Lettuce, tomatoes, beets, tulips or any field crop planted in rows far enough apart that most of the soil surface is exposed to rainfall impact throughout the growing season. At plowing, planting and harvest times it is equivalent to fallow.

Small Grain - Wheat, oats, barley, flax, etc. planted in rows close enough that the soil surface is not exposed except during planting and shortly thereafter.

Legumes - Alfalfa, sweetclover, timothy, etc. and combinations are either planted in close rows or broadcast.

Fallow - Fallow land is land plowed but not yet seeded or tilled.

Woodland - grass - Areas with an open cover of broadleaf or coniferous trees usually live oak and pines, with the intervening ground space occupied by annual grasses or weeds. The trees may occur singly or in small clumps. Canopy density, the amount of ground surface shaded at high noon, is from 20 to 50 percent.

Woodland - Areas on which coniferous or broadleaf trees predominate. The canopy density is at least 50 percent. Open areas may have a cover of annual or perennial grasses or of brush. Herbaceous plant cover under the trees is usually sparse because of leaf or needle litter accumulation.

Chaparral - Land on which the principal vegetation consists of evergreen shrubs with broad, hard, stiff leaves such as manzonita, ceanothus and scrub oak. The brush cover is usually dense or moderately dense. Diffusely branched evergreen shrubs with fine needle-like leaves, such as chamise and redchank, with dense high growth are also included in this soil cover.

Annual Grass - Land on which the principal vegetation consists of annual grasses and weeds such as annual bromes, wild barley, soft chess, ryegrass and filaree.

Irrigated Pasture - Irrigated land planted to perennial grasses and legumes for production of forage and which is cultivated only to establish or renew the stand of plants. Dry land pasture is considered as annual grass.

Meadow - Land areas with seasonally high water table, locally called cienegas. Principal vegetation consists of sod-forming grasses interspersed with other plants.

Orchard (Deciduous) - Land planted to such deciduous trees as apples, apricots, pears, walnuts, and almonds.

Orchard (Evergreen) - Land planted to evergreen trees which include citrus and avocados and coniferous plantings.

Turf - Golf courses, parks and similar lands where the predominant cover is irrigated mowed close-grown turf grass. Parks in which trees are dense may be classified as woodland.

POOR: Heavily grazed or regularly burned areas. Less than 50 percent of the ground surface is protected by plant cover or brush and tree canopy.

FAIR: Moderate cover with 50 percent to 75 percent of the ground surface protected by vegetation.

GOOD: Heavy or dense cover with more than 75 percent of the ground surface protected by vegetation.

In most cases, watershed existing conditions cover type and quality can be readily determined by a field review of a watershed. In ultimate planned open spaces, the soil cover condition shall be considered as "good." Figure C-3 provides the CN values for various types and quality of ground cover. Impervious areas shall be assigned a CN of 98. It is noted that for ultimately developed conditions, the CN for urban landscaping (turf) is provided in Figure C-3.

C.4. WATERSHED DEVELOPMENT CONDITIONS

Ultimate development of the watershed should normally be assumed since watershed urbanization is reasonably likely within the expected life of most hydraulic facilities. Long range master plans for the County and incorporated cities should be reviewed to insure that reasonable land use assumptions are made for the ultimate development of the watershed. A field review shall also be made to confirm existing use and drainage patterns. Particular attention shall be paid to existing and proposed landscape practices, as it is common in some areas to use ornamental gravels underlain by impervious plastic materials in place of lawns and shrubs. Appropriate actual impervious percentages can then be selected from Figure C-4. It should be noted that the recommended values from these figures are for average conditions and, therefore, some adjustment for particular applications may be required.

Runoff Index Numbers of Hydrologic Soil-Cover Complexes For Pervious Areas-AMC II

Cover Type (3)	Quality of Cover (2)	Soil Group A	B	C	D
NATURAL COVERS -					
Barren (Rockland, eroded and graded land)		78	86	91	93
Chaparrel, Broadleaf (Manzonita, ceanothus and scrub oak)	Poor	53	70	80	85
	Fair	40	63	75	81
	Good	31	57	71	78
Chaparrel, Narrowleaf (Chamise and redshank)	Poor	71	82	88	91
	Fair	55	72	81	86
Grass, Annual or Perennial	Poor	67	78	86	89
	Fair	50	69	79	84
	Good	38	61	74	80
Meadows or Cienegas (Areas with seasonally high water table, principal vegetation is sod forming grass)	Poor	63	77	85	88
	Fair	51	70	80	84
	Good	30	58	71	78
Open Brush (Soft wood shrubs - buckwheat, sage, etc.)	Poor	62	76	84	88
	Fair	46	66	77	83
	Good	41	63	75	81
Woodland (Coniferous or broadleaf trees predominate. Canopy density is at least 50 percent.)	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	25	55	70	77
Woodland, Grass (Coniferous or broadleaf trees with canopy density from 20 to 50 percent)	Poor	57	73	82	86
	Fair	44	65	77	82
	Good	33	58	72	79
URBAN COVERS -					
Residential or Commercial Landscaping (Lawn, shrubs, etc.)	Good	32	56	69	75
Turf (Irrigated and mowed grass)	Poor	58	74	83	87
	Fair	44	65	77	82
	Good	33	58	72	79
AGRICULTURAL COVERS -					
Fallow (Land plowed but not tilled or seeded)		77	86	91	94

SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

CURVE NUMBERS FOR PERVIOUS AREAS

FIGURE C-3 (1 OF 2)

Runoff Index Numbers of Hydrologic Soil-Cover Complexes For Pervious Areas-AMC II

Cover Type (3)	Quality of Cover (2)	Soil Group A	B	C	D
AGRICULTURAL COVERS (Continued)					
Legumes, Close Seeded (Alfalfa, sweetclover, timothy, etc.)	Poor	66	77	85	89
	Good	58	72	81	85
Orchards, Evergreen (Citrus, avocados, etc.)	Poor	57	73	82	86
	Fair	44	65	77	82
	Good	33	58	72	79
Pasture, Dryland (Annual grasses)	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Pasture, Irrigated (Legumes and perennial grass)	Poor	58	74	83	87
	Fair	44	65	77	82
	Good	33	58	72	79
Row Crops (Field crops - tomatoes, sugar beets, etc.)	Poor	72	81	88	91
	Good	67	78	85	89
Small grain (Wheat, oats, barley, etc.)	Poor	65	76	84	88
	Good	63	75	83	87

Notes:

1. All runoff index (RI) numbers are for Antecedent Moisture Condition (AMC) II.
2. Quality of cover definitions:

   Poor-Heavily grazed or regularly burned areas. Less than 50 percent of the ground surface is protected by plant cover or brush and tree canopy.

   Fair-Moderate cover with 50 percent to 75 percent of the ground surface protected.

   Good-Heavy or dense cover with more than 75 percent of the ground surface protected.
3. See Figure C-2 for definition of cover types.

SAN BERNARDINO COUNTY

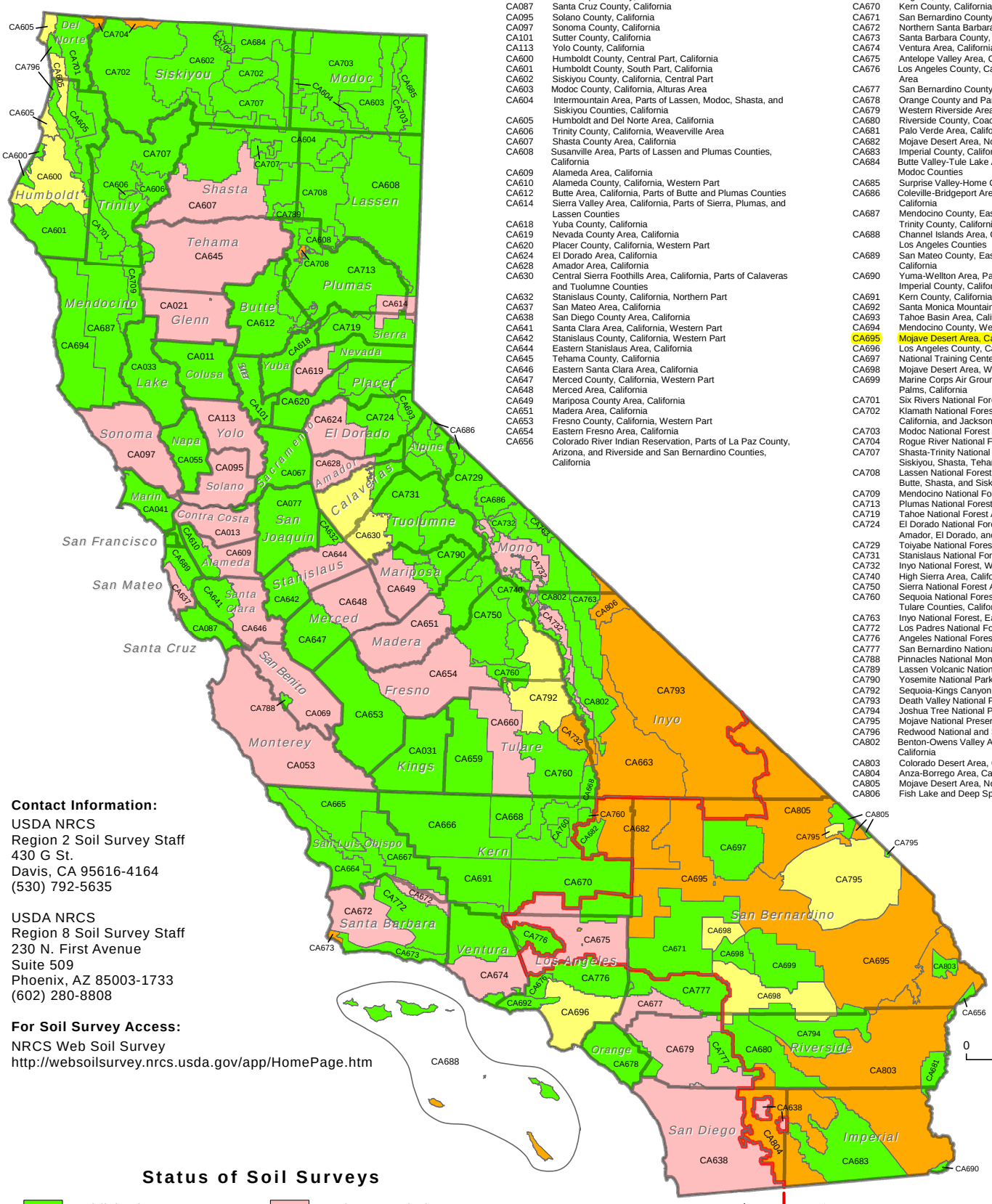
HYDROLOGY MANUAL

NUMBERS FOR PERVIOUS AREAS

California Soil Survey Status

Soil Surveys Areas in California are Managed by the Regional Offices in Davis, CA and Phoenix, AZ

United States Department of Agriculture
NRCS Natural Resources Conservation Service



Soil Survey Area Legend

CA011 Colusa County, California
CA013 Contra Costa County, California
CA021 Glenn County, California
CA031 Kings County, California
CA033 Lake County, California
CA041 Marin County, California
CA053 Monterey County, California
CA055 Napa County, California
CA067 Sacramento County, California
CA069 San Benito County, California
CA077 San Joaquin County, California
CA087 Santa Cruz County, California
CA095 Solano County, California
CA097 Sonoma County, California
CA101 Sutter County, California
CA113 Yolo County, California
CA600 Humboldt County, Central Part, California
CA601 Humboldt County, South Part, California
CA602 Siskiyou County, California, Central Part
CA603 Modoc County, California, Alturas Area
CA604 Intermountain Area, Parts of Lassen, Modoc, Shasta, and Siskiyou Counties, California
CA605 Humboldt and Del Norte Area, California
CA606 Trinity County, California, Weaverville Area
CA607 Shasta County Area, California
CA608 Susanville Area, Parts of Lassen and Plumas Counties, California
CA609 Alameda Area, California
CA610 Alameda County, California, Western Part
CA612 Butte Area, California, Parts of Butte and Plumas Counties
CA614 Sierra Valley Area, California, Parts of Sierra, Plumas, and Lassen Counties
CA618 Yuba County, California
CA619 Nevada County Area, California
CA620 Placer County, California, Western Part
CA624 El Dorado Area, California
CA628 Amador Area, California
CA630 Central Sierra Foothills Area, California, Parts of Calaveras and Tuolumne Counties
CA632 Stanislaus County, California, Northern Part
CA637 San Mateo Area, California
CA638 San Diego County Area, California
CA641 Santa Clara Area, California, Western Part
CA642 Stanislaus County, California, Western Part
CA644 Eastern Stanislaus Area, California
CA645 Tehama County, California
CA646 Eastern Santa Clara Area, California
CA647 Merced County, California, Western Part
CA648 Merced Area, California
CA649 Mariposa County Area, California
CA651 Madera Area, California
CA653 Fresno County, California, Western Part
CA654 Eastern Fresno Area, California
CA656 Colorado River Indian Reservation, Parts of La Paz County, Arizona, and Riverside and San Bernardino Counties, California
CA659 Tulare County, Western Part, California
CA660 Tulare County, California, Central Part
CA663 Inyo County Area, California
CA664 San Luis Obispo County, California, Coastal Part
CA665 San Luis Obispo County, California, Paso Robles Area
CA666 Kern County, California, Northwestern Part
CA667 San Luis Obispo County, California, Carrizo Plain Area
CA668 Kern County, Northeastern Part, and Southeastern Part of Tulare County, California
CA669 Edwards Air Force Base, California, Parts of Kern, Los Angeles, and San Bernardino Counties
CA670 Kern County, California, Southeastern Part
CA671 San Bernardino County, California, Mojave River Area
CA672 Northern Santa Barbara Area, California
CA673 Santa Barbara County, California, South Coastal Part
CA674 Ventura Area, California
CA675 Antelope Valley Area, California
CA676 Los Angeles County, California, West San Fernando Valley Area
CA677 San Bernardino County Southwestern Part, California
CA678 Orange County and Part of Riverside County, California
CA679 Western Riverside Area, California
CA680 Riverside County, Coachella Valley Area, California
CA681 Palo Verde Area, California
CA682 Mojave Desert Area, Northwest Part, California
CA683 Imperial County, California, Imperial Valley Area
CA684 Butte Valley-Tule Lake Area, California, Parts of Siskiyou and Modoc Counties
CA685 Surprise Valley-Home Camp Area, California and Nevada
CA686 Coleville-Bridgeport Area, Parts of Alpine and Mono Counties, California
CA687 Mendocino County, Eastern Part and Southwestern Part of Trinity County, California
CA688 Channel Islands Area, California, Parts of Santa Barbara and Los Angeles Counties
CA689 San Mateo County, Eastern Part, and San Francisco County, California
CA690 Yuma-Wellton Area, Parts of Yuma County, Arizona and Imperial County, California
CA691 Kern County, California, Southwest Part
CA692 Santa Monica Mountains National Recreation Area
CA693 Tahoe Basin Area, California and Nevada
CA694 Mendocino County, Western Part, California
CA695 Mojave Desert Area, California
CA696 Los Angeles County, California, Southeastern Part
CA697 National Training Center, Fort Irwin, California
CA698 Mojave Desert Area, West Central Part, California
CA699 Marine Corps Air Ground Combat Center at Twentynine Palms, California
CA701 Six Rivers National Forest Area, California
CA702 Klamath National Forest Area, Parts of Siskiyou County, California, and Jackson County, Oregon
CA703 Modoc National Forest Area, California
CA704 Rogue River National Forest Area, California
CA707 Shasta-Trinity National Forest Area, Parts of Humboldt, Siskiyou, Shasta, Tehama, and Trinity Counties, California
CA708 Lassen National Forest, California, Parts of Lassen, Plumas, Butte, Shasta, and Siskiyou Counties
CA709 Mendocino National Forest Area, California
CA713 Plumas National Forest Area, California
CA719 Tahoe National Forest Area, California
CA724 El Dorado National Forest Area, California, Parts of Alpine, Amador, El Dorado, and Placer Counties
CA729 Toiyabe National Forest Area, California
CA731 Stanislaus National Forest, California, Parts
CA732 Inyo National Forest, Western Part, California
CA740 High Sierra Area, California
CA750 Sierra National Forest Area Parts of Fresno, California
CA760 Sequoia National Forest Parts of Fresno, Kern and Tulare Counties, California
CA763 Inyo National Forest, Eastern Part, California and Nevada
CA772 Los Padres National Forest Area, California
CA776 Angeles National Forest Area, California
CA777 San Bernardino National Forest Area, California
CA788 Pinnacles National Monument, California
CA789 Lassen Volcanic National Park, California
CA790 Yosemite National Park, California
CA792 Sequoia-Kings Canyon National Park, California
CA793 Death Valley National Park Area, California and Nevada
CA794 Joshua Tree National Park, California
CA795 Mojave National Preserve Area, California
CA796 Redwood National and State Parks, California
CA802 Benton-Owens Valley Area, Parts of Inyo and Mono Counties, California
CA803 Colorado Desert Area, California
CA804 Anza-Borrego Area, California
CA805 Mojave Desert Area, Northeast Part, California
CA806 Fish Lake and Deep Springs Valleys Area, California

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For Soil Survey Access:

NRCS Web Soil Survey
http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

Status Map Compiled by:
Russ Almaraz
USDA NRCS
Soil Survey Staff
Davis, CA

May, 2013

Status of Soil Surveys

- Published
- Initial Mapping in Progress
- Update Needed
- Nonproject
- Regional Office Boundary

Soil Surveys Managed by the Region 2 Office, Davis, CA

Soil Surveys Managed by the Region 8 Office, Phoenix, AZ

This soil survey status map is a periodically updated draft and is for general planning purposes only.

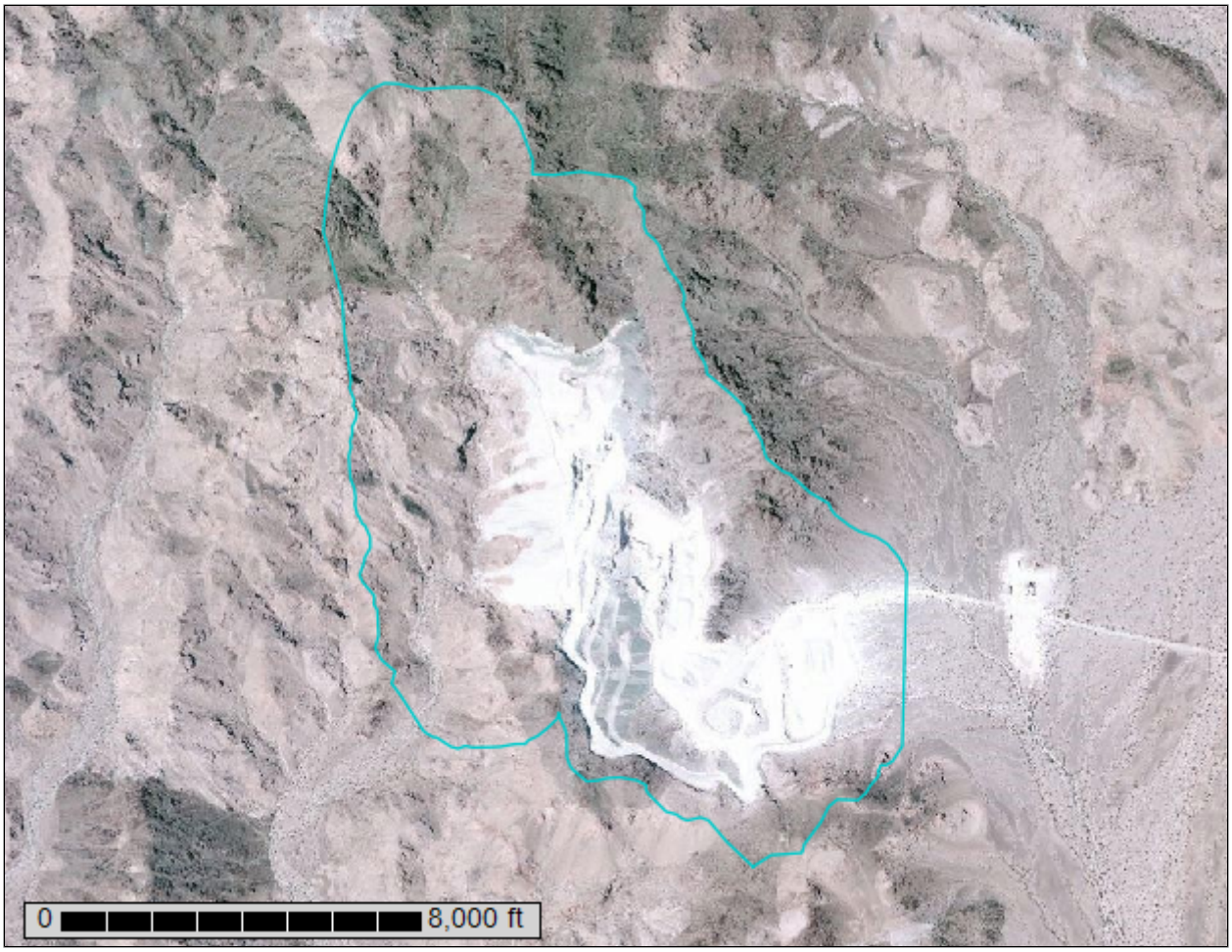
United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Mojave Desert Area, California



April 7, 2015

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (http://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the

individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

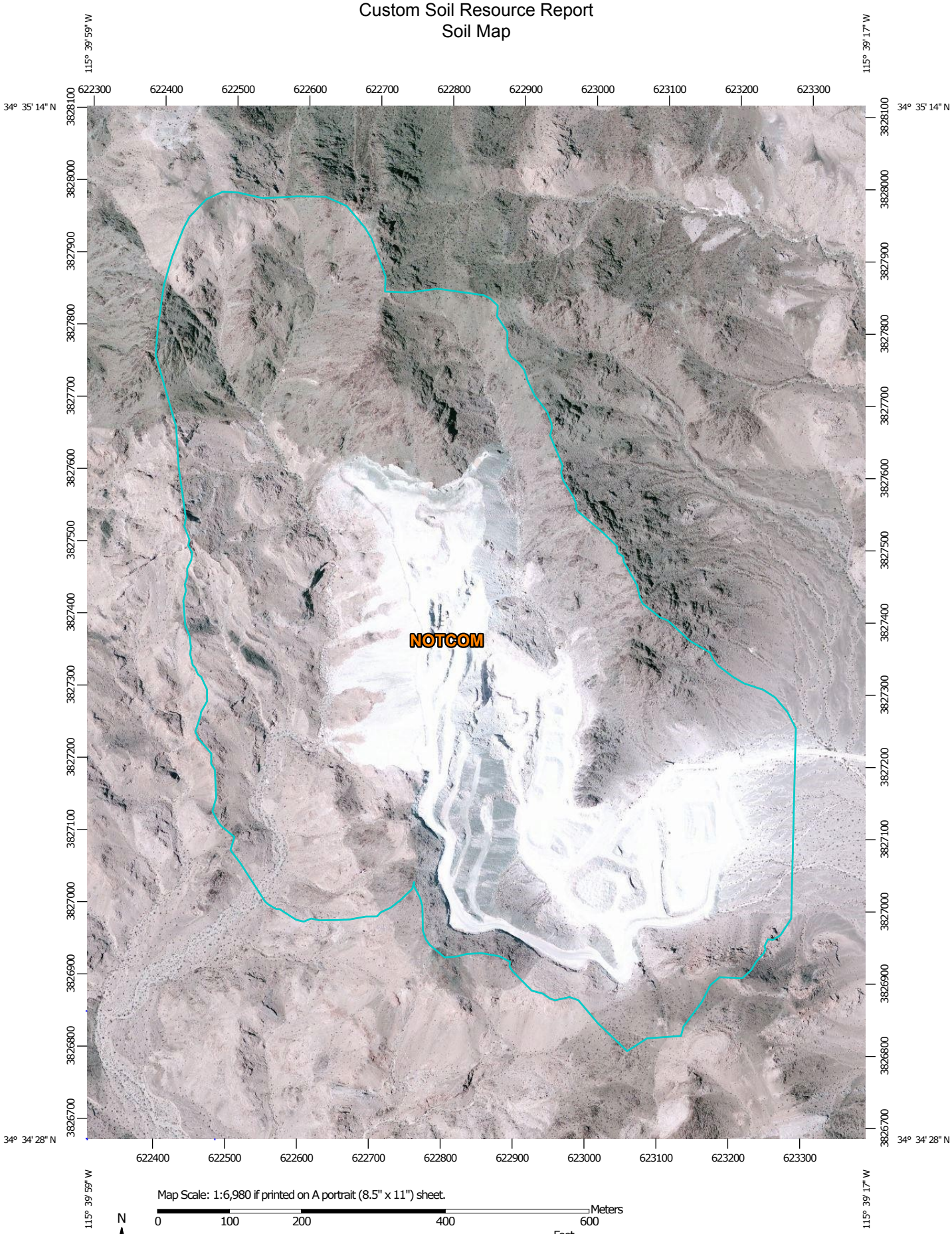
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map



Map Scale: 1:6,980 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 100 200 400 600

Feet: 0 300 600 1200 1800

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 11N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Mojave Desert Area, California
Survey Area Data: Version 13, Sep 9, 2014

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Apr 24, 2011—May 7, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Mojave Desert Area, California (CA695)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
NOTCOM	No Digital Data Available	160.9	100.0%
Totals for Area of Interest		**160.9**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Mojave Desert Area, California

NOTCOM—No Digital Data Available

Map Unit Composition

Notcom: 100 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Notcom

Properties and qualities

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Appendix A Hydrologic Soil Groups

Soils are classified into hydrologic soil groups (HSG's) to indicate the minimum rate of infiltration obtained for bare soil after prolonged wetting. The HSG's, which are A, B, C, and D, are one element used in determining runoff curve numbers (see chapter 2). For the convenience of TR-55 users, exhibit A-1 lists the HSG classification of United States soils.

The infiltration rate is the rate at which water enters the soil at the soil surface. It is controlled by surface conditions. HSG also indicates the transmission rate—the rate at which the water moves within the soil. This rate is controlled by the soil profile. Approximate numerical ranges for transmission rates shown in the HSG definitions were first published by Musgrave (USDA 1955). The four groups are defined by SCS soil scientists as follows:

Group A soils have low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sand or gravel and have a high rate of water transmission (greater than 0.30 in/hr).

Group B soils have moderate infiltration rates when thoroughly wetted and consist chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission (0.15-0.30 in/hr).

Group C soils have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine texture. These soils have a low rate of water transmission (0.05-0.15 in/hr).

Group D soils have high runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very low rate of water transmission (0-0.05 in/hr).

In exhibit A-1, some of the listed soils have an added modifier; for example, "Abrazo, gravelly." This refers to a gravelly phase of the Abrazo series that is found in SCS soil map legends.

Disturbed soil profiles

As a result of urbanization, the soil profile may be considerably altered and the listed group classification may no longer apply. In these circumstances, use the following to determine HSG according to the texture of the new surface soil, provided that significant compaction has not occurred (Brakensiek and Rawls 1983).

HSG	*Soil textures*
A	Sand, loamy sand, or sandy loam
B	Silt loam or loam
C	Sandy clay loam
D	Clay loam, silty clay loam, sandy clay, silty clay, or clay

Drainage and group D soils

Some soils in the list are in group D because of a high water table that creates a drainage problem. Once these soils are effectively drained, they are placed in a different group. For example, Ackerman soil is classified as A/D. This indicates that the drained Ackerman soil is in group A and the undrained soil is in group D.

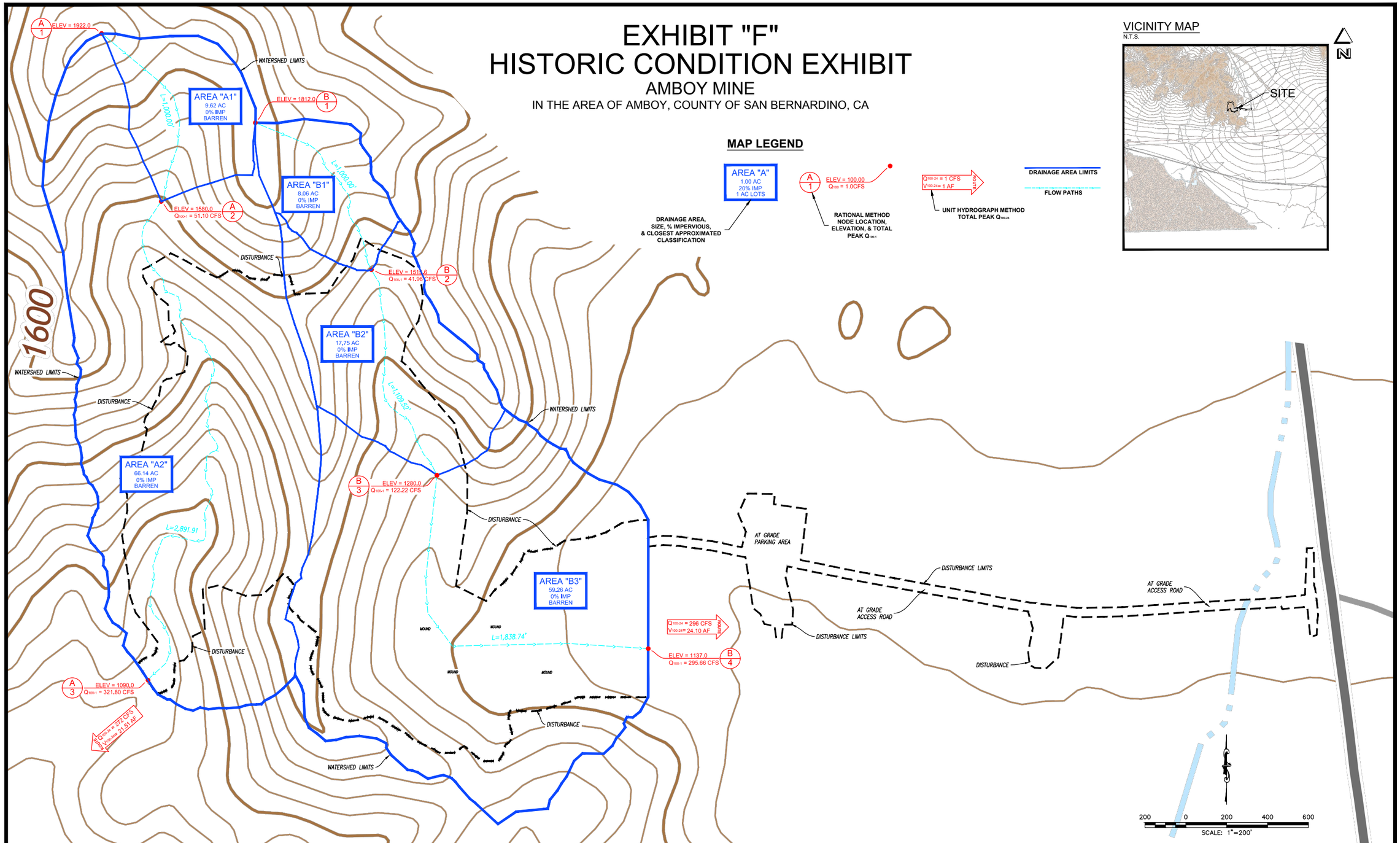
Exhibit A: Hydrologic Soil Groups for the United States

ALONA	B
ALONEMILL	B
ALONSO	B
ALONZEVILLE	B
ALOVAR	C
ALPENA	A
ALPHA	B
ALPIN	A
ALPINEPEAK	C
ALPON	B
ALPOWA	B
ALRED	B
ALROS	C
ALS	A
ALSASH	B
ALSCO	B
ALSEA	B
ALSPAUGH	C
ALSTAD	C
ALSTONY	B
ALSTOWN	B
ALSUP	C
ALTA	B
ALTAMONT	D
ALTAPEAK	B
ALTAR	B
ALTASLOUGH	C
ALTAVISTA	C
ALTDORF	D
ALTHOUSE	B
ALTICREST	C
ALTITA	C
ALTMAR	B
ALTO	C
ALTOGA	C
ALTON	A
ALTUDA	D
ALTURAS	C
ALTUS	B
ALTVAN	B
ALUF	A
ALUM	B
ALUSA	D
ALVADA	B/D
ALVARADO	B
ALVIN	B
ALVISO	D
ALVODEST	D
ALVOR	D
ALWILDA	B
ALZADA	D
ALZOLA	C
AMABILIS	C
AMADON	D
AMADOR	D
AMAGON	D
AMAL	B
AMALIA	B
AMALU	D
AMANA	B
AMANDA	C
AMARILLO	B
AMASA	B
AMBER	B
AMBIA	D
AMBOAT	D
AMBOY	C
AMBRANT	B
AMBRAW	B/D
AMBROSIA	A
AMCEC	B
AMELAR	B
AMELIA	C
AMENE	D
AMENIA	B
AMENSON	D
AMERICANOS	B
AMERICUS	A
AMERIMINE	B
AMERY	B
AMES	C/D
AMESHA	B
AMHERST	D
AMIRET	B
AMISTAD	D
AMITY	D
AMMON	B
AMNICON	D
AMODAC	C
AMOLE	C
AMOR	B
AMORUS	D
AMOS	C
AMOSTOWN	C
AMPAD	C
AMPHION	C
AMSDEN	B
AMSTERDAM	B
AMTOFT	D
AMUZET	A
AMUZET, Gravelly	B
AMWELL	C
AMY	D
ANACAPA	B
ANACOCO	D
ANACONDA	B
ANAHEIM	C
ANAHUAC	D
ANALULU	B
ANAMAC	B
ANAMITE	D
ANAN	D
ANAPRA	B
ANASAZI	C
ANATOLIAN	C
ANATONE	D
ANAUD	D
ANAVERDE	B
ANAWALT	D
ANCENY	B
ANCHO	B
ANCHO, Saline	C
ANCHOR POINT	D
ANCHORAGE	A
ANCHUSTEQUI	D
ANCHUTZ	B
ANCLOTE	B/D
ANCO	C
ANDERGEORGE	B
ANDERLY	C
ANDERSON	B
ANDERSON, Hard Substratum	C
ANDOK	B
ANDOVER	D
ANDRADA	D
ANDREGG	B
ANDRES	C
ANDREWS	C
ANDRUSIA	A
ANDRY	D
ANDYS	B
ANED	D
ANELA	B
ANGELICA	B/D
ANGELINA	D
ANGELPEAK	B
ANGELUS	B
ANGIE	D
ANGLE	A
ANGLEN	C
ANGOLA	C
ANGORA	B
ANGUS	B
ANHALT	D
ANIAK	D
ANIGON	B
ANIMAS	C
ANNABERG	D
ANNAHOOTZ	A
ANNALAKE	B
ANNAROSE	B
ANNAW	B
ANNEMAINE	C
ANNISQUAM	C
ANNISTON	B
ANNLAKE	B/D
ANNONA	D
ANNROMA	D
ANNUM	B
ANOCON	C
ANOKA	B
ANONES	C
ANOWELL	D
ANSGAR	B/D
ANSPING	B
ANT FLAT	D
ANTARES	A
ANTARES	C
ANTELOPE SPRINGS	D
ANTERO	D
ANTHOLOP	D
ANTIGO	B
ANTILON	C
ANTIOCH	D
ANTOINE	B
ANTOKEN	C
ANTON	D
ANTONITO	C
ANTOSA	B
ANTWERP	C
ANUNDE	B
ANVIL	C
APALACHEE	D
APALO	B
APELDORN	D
APEX	B
APISON	B
APMAT	B
APMAY	B
APOLLO	B
APOPKA	A
APPAM	B
APPANOOSE	D
APPERSON	C
APPLEDELLIA	C
APPLEGATE	C
APPLERIVER	B
APPLESEED	D
APPLESHALL	D
APPLING	B
APPOMATTOX	B
APPOQUINMINK	D
APRON	B
APT	B
APTAKISIC	B
APTOS	C
AQUANDIC HUMAQUEPTS	C
AQUARIUS	C
AQUATNA	D
AQUILLA	A
AQUIMA	B
AQUINAS	C
ARADA	B
ARADARAN	C
ARAGON	C
ARAMBURU	C
ARAPAHOE	B/D
ARARAT	B
ARAT	D
ARAVAIPA	C
ARAWAK	B
ARBELA	C
ARBOLES	C
ARBOR	B
ARBUCKLE	C
ARBUS	B
ARBUTUS	A
ARCADIAN	D
ARCATA	B
ARCHABAL	B
ARCHBOLD	A
ARCHER	C
ARCHIN, Cool	C
ARCHIN	D
ARCO	B/C
ARD	C
ARDENING	B
ARDENMONT	B
ARDEP	C
ARDILLA	C
ARDTOO	B
ARECIBO	A
ARENA	C/D
ARENALES	A
ARENOSA	A
ARGALT	D
ARGEE	C
ARGENTA	C
ARGONNE	B
ARGORA	B
ARGOVAR	D
ARGYLE	B
ARIDIC USTIFLUVENTS	B
ARIEL	C
ARIMO	B
ARISTINE	C
ARIVACA	C
ARIVACA, Very Cobbly	D
ARIZER	B
ARKABUTLA	C
ARKAQUA	C
ARKONA	B
ARKPORT	B
ARKRIGHT	B
ARKSON	B
ARKTON	C
ARLAND	B
ARLE	C
ARLEN	B
ARLINGTON, Thick Solum	B
ARLINGTON	C
ARLOVAL	A
ARLYNDA	D
ARMENDARIS	C
ARMENIA	D
ARMESA	B
ARMESPAN	B
ARMINGTON	D
ARMISTEAD	C
ARMITAGE	C
ARMO	B
ARMOINE	D
ARMPUP	C
ARNESS	D
ARNEY	B
ARNHEIM	D
ARNO	D
ARNOLD	A
ARNTZ	C
AROL	D
AROSA	C
ARP	C
ARRADA	D
ARRASTRE	B
ARRIBA	C
ARRINGTON	B
ARRIOLA	D
ARRITOLA	D
ARROD	D
ARROLIME	C
ARRON	D
ARROWHEAD	C
ARROYADA	D
ARROYO SECO	B
ARSITE	D
ARTA	C
ARTIL	A
ARTNOC	B
ARTRAY	D
ARUJO	B
ARUNDEL	C
ARVA	D
ARVADA	C
ARVANA	C
ARVILLA	B
ARWITE	B
ARZO	C
ASAAYI	D
ASABEAN	B
ASBILL	D
ASCAR	C
ASHART	D
ASHBURN	B
ASHCAMP	C
ASHCROFT	B
ASHDALE	B
ASHDOS	C
ASHERTON	B
ASHFORD	D
ASHFORK	D

EXHIBIT “F”

Historical Hydrologic Conditions
Study Map

EXHIBIT "F"
HISTORIC CONDITION EXHIBIT
AMBOY MINE
IN THE AREA OF AMBOY, COUNTY OF SAN BERNARDINO, CA

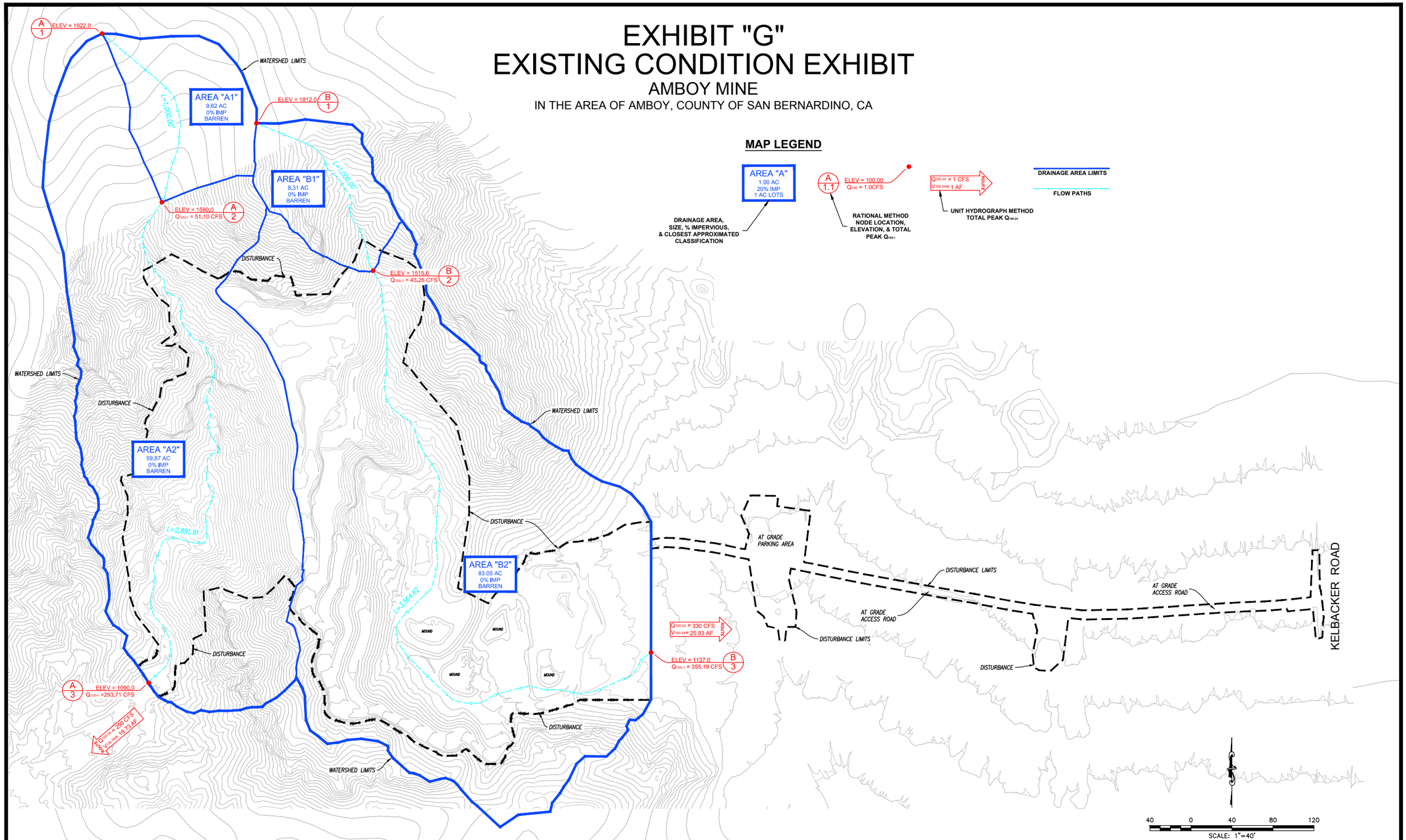


HISTORIC CONDITION EXHIBIT AMBOY PIT COUNTY OF SAN BERNARDINO, CA	PREPARED BY: BONADIMAN TEL. (909) 900-3000 CIVILDESIGN	PREPARED FOR: OMYA CALIFORNIA, INC., A DIVISION OF OMYA INC. 7225 CRYSTAL CREEK ROAD LUCERNE VALLEY, CA 92365	BY / MARK / REVISION DESCRIPTION / DATE	PREPARED FOR: OMYA CALIFORNIA, INC. JOB NO: 154166 PREPARED BY: SG CHECKED BY: JTS NOTE: JOSEPH E. BONADIMAN & ASSOCIATES, INC. DOES NOT WARRANTY THE ACCURACY OF THE G.I.S. DATA PRESENTED IN THIS EXHIBIT. THIS EXHIBIT MAY CONTAIN INFORMATION COPYRIGHTED TO THE COUNTY OF SAN BERNARDINO,CA.	HISTORIC CONDITION EXHIBIT AMBOY PIT COUNTY OF SAN BERNARDINO, CA DISREGARD PRINTS BEARING EARLIER REVISION DATES → 09-25-15	F SHEET 1 OF 1

EXHIBIT “G”

Existing Hydrologic Conditions
Study Map

EXHIBIT "G"
EXISTING CONDITION EXHIBIT
AMBOY MINE
IN THE AREA OF AMBOY, COUNTY OF SAN BERNARDINO, CA

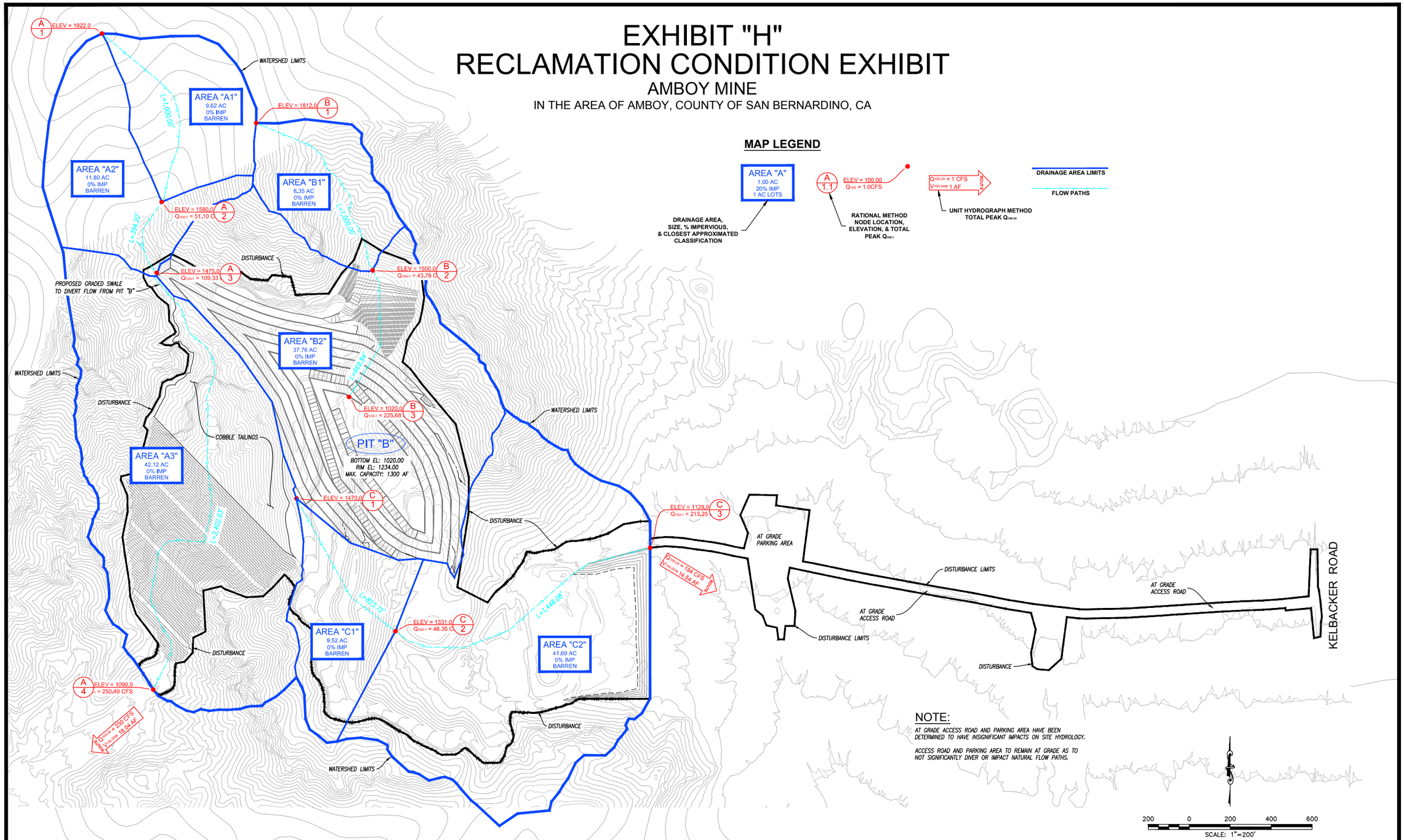


EXISTING CONDITION EXHIBIT AMBOY PIT COUNTY OF SAN BERNARDINO, CA	PREPARED BY: BONADIMAN TEL. (909) 888-5000 CIVILDESIGN	PREPARED FOR: OMYA CALIFORNIA, INC., A DIVISION OF OMYA INC. 7225 CRYSTAL CREEK ROAD LUCERNE VALLEY, CA 92365	BY / MARK / REVISION DESCRIPTION / DATE	PREPARED FOR: OMYA CALIFORNIA, INC. JOB NO: 154166 PREPARED BY: SG CHECKED BY: JTS NOTE: JOSEPH E. BONADIMAN & ASSOCIATES, INC. DOES NOT WARRANTY THE ACCURACY OF THE G.I.S. DATA PRESENTED IN THIS EXHIBIT. THIS EXHIBIT MAY CONTAIN INFORMATION COPYRIGHTED TO THE COUNTY OF SAN BERNARDINO,CA.	EXISTING CONDITION EXHIBIT AMBOY PIT COUNTY OF SAN BERNARDINO, CA DISREGARD PRINTS BEARING EARLIER REVISION DATES → 09–25–15	G SHEET 1 OF 1

EXHIBIT “H”

Reclamation Hydrologic Conditions Study Map

EXHIBIT "H"
RECLAMATION CONDITION EXHIBIT
AMBOY MINE
IN THE AREA OF AMBOY, COUNTY OF SAN BERNARDINO, CA



NOTE:

AT GRADE ACCESS ROAD AND PARKING AREA HAVE BEEN DETERMINED TO HAVE INSIGNIFICANT IMPACTS ON SITE HYDROLOGY.

ACCESS ROAD AND PARKING AREA TO REMAIN AT GRADE AS TO NOT SIGNIFICANTLY DIVER OR IMPACT NATURAL FLOW PATHS.

RECLAMATION CONDITION EXHIBIT
AMBOY PIT
COUNTY OF SAN BERNARDINO, CA

PREPARED BY:
BONADIMAN
TEL. (909) 905-3005
CIVILDESIGN

PREPARED FOR:
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A DIVISION OF OMYA INC.
7225 CRYSTAL CREEK ROAD
LUCERNE VALLEY, CA 92365

BY	MARK	REVISION DESCRIPTION	DATE

PREPARED FOR:	OMYA CALIFORNIA, INC.
JOB NO:	154166
PREPARED BY:	SG
CHECKED BY:	JTS

NOTE: JOSEPH E. BONADIMAN & ASSOCIATES, INC. DOES NOT WARRANTY THE ACCURACY OF THE G.I.S. DATA PRESENTED IN THIS EXHIBIT. THIS EXHIBIT MAY CONTAIN INFORMATION COPYRIGHTED TO THE COUNTY OF SAN BERNARDINO,CA.

RECLAMATION CONDITION EXHIBIT
AMBOY PIT
COUNTY OF SAN BERNARDINO, CA

DISREGARD PRINTS BEARING EARLIER REVISION DATES → 09-25-15

G

SHEET 1 OF 1

ATTACHMENT 1

Historical Conditions
Rational Method Calculations
(20-Year, 1-Hour)
(100-Year, 1-Hour)

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            San Bernardino County Rational Hydrology Program

                (Hydrology Manual Date - August 1986)

 CIVILCADD/CIVILDESIGN  Engineering Software, (c) 1989-2012 Version 7.2
      Rational Hydrology Study        Date: 04/09/15
----------------------------------------------------------------------
154166 - AMBOY - SAN BERNARDINO COUNTY
HISTORIC CONDITIONS "A"
20-YEAR, 1-HOUR STORM
BY:JTS  DATE: 04-09-15
----------------------------------------------------------------------


Program License Serial Number 6320

----------------------------------------------------------------------
 *********   Hydrology Study Control Information **********

----------------------------------------------------------------------
Rational hydrology study storm event year is    20.0
   10 Year storm 1 hour rainfall  =      0.860(In.)
  100 Year storm 1 hour rainfall  =      1.590(In.)
Computed rainfall intensity:
Storm year =    20.00   1 hour rainfall =     1.080 (In.)
Slope used for rainfall intensity curve b =  0.7000
Soil antecedent moisture condition (AMC) = 1


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        1.000 to Point/Station        2.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Soil classification AP and SCS  values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2)  = 91.00
Adjusted SCS curve number for AMC 1 = 79.80
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.373(In/Hr)
Initial subarea data:
Initial area flow distance =  1000.000(Ft.)
Top (of initial area) elevation =  1922.000(Ft.)
Bottom (of initial area) elevation =  1580.000(Ft.)
Difference in elevation =   342.000(Ft.)
Slope =    0.34200  s(%)=      34.20
TC = k(0.465)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =    9.135 min.
Rainfall intensity =      4.032(In/Hr) for a    20.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.817
Subarea runoff =     31.680(CFS)
Total initial stream area =        9.620(Ac.)
Pervious area fraction = 1.000
Initial area Fm value =    0.373(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        2.000 to Point/Station        3.000
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```
**** IMPROVED CHANNEL TRAVEL TIME ****
_____________________________________________________________________
Upstream point elevation =  1580.000(Ft.)
Downstream point elevation =  1090.000(Ft.)
Channel length thru subarea  =  2891.910(Ft.)
Channel base width      =   10.000(Ft.)
Slope or 'Z' of left channel bank =   2.000
Slope or 'Z' of right channel bank =   2.000
Estimated mean flow rate at midpoint of channel =    109.349(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =   10.000(Ft.)
Flow(q) thru subarea =    109.349(CFS)
Depth of flow =   0.797(Ft.), Average velocity =  11.837(Ft/s)
Channel flow top width =   13.187(Ft.)
Flow Velocity =   11.84(Ft/s)
Travel time  =    4.07 min.
Time of concentration =   13.21 min.
Critical depth =      1.406(Ft.)
 Adding area flow to channel
Soil classification AP and SCS  values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2)  = 91.00
Adjusted SCS curve number for AMC 1 = 79.80
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.373(In/Hr)
Rainfall intensity =      3.115(In/Hr) for a    20.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.792
Subarea runoff =    155.279(CFS) for   66.140(Ac.)
Total runoff =    186.959(CFS)
Effective area this stream =       75.76(Ac.)
Total Study Area (Main Stream No. 1) =       75.76(Ac.)
Area averaged Fm value =    0.373(In/Hr)
Depth of flow =   1.086(Ft.), Average velocity =  14.145(Ft/s)
Critical depth =      1.938(Ft.)
End of computations, Total Study Area =           75.76 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.
Note: These figures do not consider reduced effective area
effects caused by confluences in the rational equation.

Area averaged pervious area fraction(Ap) = 1.000
Area averaged SCS curve number =  91.0
```

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            San Bernardino County Rational Hydrology Program

                (Hydrology Manual Date - August 1986)

 CIVILCADD/CIVILDESIGN  Engineering Software, (c) 1989-2012 Version 7.2
      Rational Hydrology Study        Date: 04/09/15
----------------------------------------------------------------------
154166 - AMBOY - SAN BERNARDINO COUNTY
HISTORIC CONDDITION "B"
20-YEAR, 1-HOUR STORM
BY: JTS  DATE: 04-09-15
----------------------------------------------------------------------


Program License Serial Number 6320

----------------------------------------------------------------------
 *********   Hydrology Study Control Information **********

----------------------------------------------------------------------
Rational hydrology study storm event year is    20.0
   10 Year storm 1 hour rainfall  =      0.860(In.)
  100 Year storm 1 hour rainfall  =      1.590(In.)
Computed rainfall intensity:
Storm year =    20.00   1 hour rainfall =     1.080 (In.)
Slope used for rainfall intensity curve b =  0.7000
Soil antecedent moisture condition (AMC) = 1


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        1.000 to Point/Station        2.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Soil classification AP and SCS  values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2)  = 91.00
Adjusted SCS curve number for AMC 1 = 79.80
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.373(In/Hr)
Initial subarea data:
Initial area flow distance =  1000.000(Ft.)
Top (of initial area) elevation =  1812.000(Ft.)
Bottom (of initial area) elevation =  1515.600(Ft.)
Difference in elevation =   296.400(Ft.)
Slope =    0.29640  s(%)=      29.64
TC = k(0.465)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =    9.400 min.
Rainfall intensity =      3.952(In/Hr) for a    20.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.815
Subarea runoff =     25.962(CFS)
Total initial stream area =        8.060(Ac.)
Pervious area fraction = 1.000
Initial area Fm value =    0.373(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        2.000 to Point/Station        3.000
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```
**** IMPROVED CHANNEL TRAVEL TIME ****
_____________________________________________________________________
Upstream point elevation =  1515.600(Ft.)
Downstream point elevation =  1280.000(Ft.)
Channel length thru subarea  =  1109.520(Ft.)
Channel base width      =   10.000(Ft.)
Slope or 'Z' of left channel bank =   2.000
Slope or 'Z' of right channel bank =   2.000
Estimated mean flow rate at midpoint of channel =     48.973(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =   10.000(Ft.)
Flow(q) thru subarea =     48.973(CFS)
Depth of flow =   0.466(Ft.), Average velocity =   9.621(Ft/s)
Channel flow top width =   11.863(Ft.)
Flow Velocity =    9.62(Ft/s)
Travel time  =    1.92 min.
Time of concentration =   11.32 min.
Critical depth =      0.852(Ft.)
 Adding area flow to channel
Soil classification AP and SCS  values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2)  = 91.00
Adjusted SCS curve number for AMC 1 = 79.80
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.373(In/Hr)
Rainfall intensity =      3.470(In/Hr) for a    20.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.803
Subarea runoff =     45.965(CFS) for   17.750(Ac.)
Total runoff =     71.927(CFS)
Effective area this stream =       25.81(Ac.)
Total Study Area (Main Stream No. 1) =       25.81(Ac.)
Area averaged Fm value =    0.373(In/Hr)
Depth of flow =   0.584(Ft.), Average velocity =  11.029(Ft/s)
Critical depth =      1.086(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        3.000 to Point/Station        4.000
**** IMPROVED CHANNEL TRAVEL TIME ****
_____________________________________________________________________
Upstream point elevation =  1280.000(Ft.)
Downstream point elevation =  1137.000(Ft.)
Channel length thru subarea  =  1838.740(Ft.)
Channel base width      =  100.000(Ft.)
Slope or 'Z' of left channel bank =   2.000
Slope or 'Z' of right channel bank =   2.000
Estimated mean flow rate at midpoint of channel =    116.064(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =   10.000(Ft.)
Flow(q) thru subarea =    116.064(CFS)
Depth of flow =   0.269(Ft.), Average velocity =   4.296(Ft/s)
Channel flow top width =  101.075(Ft.)
Flow Velocity =    4.30(Ft/s)
Travel time  =    7.13 min.
Time of concentration =   18.46 min.
Critical depth =      0.348(Ft.)
 Adding area flow to channel
```

```
Soil classification AP and SCS  values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2)  = 91.00
Adjusted SCS curve number for AMC 1 = 79.80
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.373(In/Hr)
Rainfall intensity =      2.465(In/Hr) for a    20.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.764
Subarea runoff =     88.190(CFS) for   59.260(Ac.)
Total runoff =    160.117(CFS)
Effective area this stream =       85.07(Ac.)
Total Study Area (Main Stream No. 1) =       85.07(Ac.)
Area averaged Fm value =    0.373(In/Hr)
Depth of flow =   0.326(Ft.), Average velocity =   4.881(Ft/s)
Critical depth =      0.430(Ft.)
End of computations, Total Study Area =           85.07 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.
Note: These figures do not consider reduced effective area
effects caused by confluences in the rational equation.

Area averaged pervious area fraction(Ap) = 1.000
Area averaged SCS curve number =  91.0
```

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            San Bernardino County Rational Hydrology Program

                (Hydrology Manual Date - August 1986)

 CIVILCADD/CIVILDESIGN  Engineering Software, (c) 1989-2012 Version 7.2
      Rational Hydrology Study        Date: 04/09/15
----------------------------------------------------------------------
154166 - AMBOY - SAN BERNARDINO COUNTY
HISTORIC CONDITIONS "A"
100-YEAR, 1-HOUR STORM
BY:JTS  DATE: 04-09-15
----------------------------------------------------------------------


Program License Serial Number 6320

----------------------------------------------------------------------
 *********   Hydrology Study Control Information **********

----------------------------------------------------------------------
Rational hydrology study storm event year is   100.0
   10 Year storm 1 hour rainfall  =      0.860(In.)
  100 Year storm 1 hour rainfall  =      1.590(In.)
Computed rainfall intensity:
Storm year =   100.00   1 hour rainfall =     1.590 (In.)
Slope used for rainfall intensity curve b =  0.7000
Soil antecedent moisture condition (AMC) = 3


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        1.000 to Point/Station        2.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Soil classification AP and SCS  values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2)  = 91.00
Adjusted SCS curve number for AMC 3 = 98.20
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.036(In/Hr)
Initial subarea data:
Initial area flow distance =  1000.000(Ft.)
Top (of initial area) elevation =  1922.000(Ft.)
Bottom (of initial area) elevation =  1580.000(Ft.)
Difference in elevation =   342.000(Ft.)
Slope =    0.34200  s(%)=      34.20
TC = k(0.465)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =    9.135 min.
Rainfall intensity =      5.938(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.895
Subarea runoff =     51.099(CFS)
Total initial stream area =        9.620(Ac.)
Pervious area fraction = 1.000
Initial area Fm value =    0.036(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        2.000 to Point/Station        3.000
```

```
**** IMPROVED CHANNEL TRAVEL TIME ****
_____________________________________________________________________
Upstream point elevation =  1580.000(Ft.)
Downstream point elevation =  1090.000(Ft.)
Channel length thru subarea  =  2891.910(Ft.)
Channel base width      =   10.000(Ft.)
Slope or 'Z' of left channel bank =   2.000
Slope or 'Z' of right channel bank =   2.000
Estimated mean flow rate at midpoint of channel =    186.480(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =   10.000(Ft.)
Flow(q) thru subarea =    186.480(CFS)
Depth of flow =   1.084(Ft.), Average velocity =  14.134(Ft/s)
Channel flow top width =   14.337(Ft.)
Flow Velocity =   14.13(Ft/s)
Travel time  =    3.41 min.
Time of concentration =   12.54 min.
Critical depth =      1.938(Ft.)
 Adding area flow to channel
Soil classification AP and SCS  values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2)  = 91.00
Adjusted SCS curve number for AMC 3 = 98.20
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.036(In/Hr)
Rainfall intensity =      4.755(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.893
Subarea runoff =    270.698(CFS) for   66.140(Ac.)
Total runoff =    321.797(CFS)
Effective area this stream =       75.76(Ac.)
Total Study Area (Main Stream No. 1) =       75.76(Ac.)
Area averaged Fm value =    0.036(In/Hr)
Depth of flow =   1.478(Ft.), Average velocity =  16.811(Ft/s)
Critical depth =      2.656(Ft.)
End of computations, Total Study Area =           75.76 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.
Note: These figures do not consider reduced effective area
effects caused by confluences in the rational equation.

Area averaged pervious area fraction(Ap) = 1.000
Area averaged SCS curve number =  91.0
```

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            San Bernardino County Rational Hydrology Program

                (Hydrology Manual Date - August 1986)

 CIVILCADD/CIVILDESIGN  Engineering Software, (c) 1989-2012 Version 7.2
      Rational Hydrology Study        Date: 04/09/15
----------------------------------------------------------------------
154166 - AMBOY - SAN BERNARDINO COUNTY
HISTORIC CONDDITION "B"
100-YEAR, 1-HOUR STORM
BY: JTS  DATE: 04-09-15
----------------------------------------------------------------------


Program License Serial Number 6320

----------------------------------------------------------------------
 *********   Hydrology Study Control Information **********

----------------------------------------------------------------------
Rational hydrology study storm event year is   100.0
   10 Year storm 1 hour rainfall  =      0.860(In.)
  100 Year storm 1 hour rainfall  =      1.590(In.)
Computed rainfall intensity:
Storm year =   100.00   1 hour rainfall =     1.590 (In.)
Slope used for rainfall intensity curve b =  0.7000
Soil antecedent moisture condition (AMC) = 3


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        1.000 to Point/Station        2.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Soil classification AP and SCS  values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2)  = 91.00
Adjusted SCS curve number for AMC 3 = 98.20
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.036(In/Hr)
Initial subarea data:
Initial area flow distance =  1000.000(Ft.)
Top (of initial area) elevation =  1812.000(Ft.)
Bottom (of initial area) elevation =  1515.600(Ft.)
Difference in elevation =   296.400(Ft.)
Slope =    0.29640  s(%)=      29.64
TC = k(0.465)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =    9.400 min.
Rainfall intensity =      5.820(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.894
Subarea runoff =     41.958(CFS)
Total initial stream area =        8.060(Ac.)
Pervious area fraction = 1.000
Initial area Fm value =    0.036(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        2.000 to Point/Station        3.000
```

```
**** IMPROVED CHANNEL TRAVEL TIME ****
_____________________________________________________________________
Upstream point elevation =  1515.600(Ft.)
Downstream point elevation =  1280.000(Ft.)
Channel length thru subarea  =  1109.520(Ft.)
Channel base width      =   10.000(Ft.)
Slope or 'Z' of left channel bank =   2.000
Slope or 'Z' of right channel bank =   2.000
Estimated mean flow rate at midpoint of channel =     81.120(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =   10.000(Ft.)
Flow(q) thru subarea =     81.120(CFS)
Depth of flow =   0.627(Ft.), Average velocity =  11.503(Ft/s)
Channel flow top width =   12.507(Ft.)
Flow Velocity =   11.50(Ft/s)
Travel time  =    1.61 min.
Time of concentration =   11.01 min.
Critical depth =      1.172(Ft.)
 Adding area flow to channel
Soil classification AP and SCS  values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2)  = 91.00
Adjusted SCS curve number for AMC 3 = 98.20
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.036(In/Hr)
Rainfall intensity =      5.211(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.894
Subarea runoff =     78.258(CFS) for   17.750(Ac.)
Total runoff =    120.216(CFS)
Effective area this stream =       25.81(Ac.)
Total Study Area (Main Stream No. 1) =       25.81(Ac.)
Area averaged Fm value =    0.036(In/Hr)
Depth of flow =   0.788(Ft.), Average velocity =  13.171(Ft/s)
Critical depth =      1.484(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        3.000 to Point/Station        4.000
**** IMPROVED CHANNEL TRAVEL TIME ****
_____________________________________________________________________
Upstream point elevation =  1280.000(Ft.)
Downstream point elevation =  1137.000(Ft.)
Channel length thru subarea  =  1838.740(Ft.)
Channel base width      =  100.000(Ft.)
Slope or 'Z' of left channel bank =   2.000
Slope or 'Z' of right channel bank =   2.000
Estimated mean flow rate at midpoint of channel =    207.986(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =   10.000(Ft.)
Flow(q) thru subarea =    207.986(CFS)
Depth of flow =   0.381(Ft.), Average velocity =   5.414(Ft/s)
Channel flow top width =  101.525(Ft.)
Flow Velocity =    5.41(Ft/s)
Travel time  =    5.66 min.
Time of concentration =   16.67 min.
Critical depth =      0.508(Ft.)
 Adding area flow to channel
```

```
Soil classification AP and SCS  values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2)  = 91.00
Adjusted SCS curve number for AMC 3 = 98.20
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.036(In/Hr)
Rainfall intensity =      3.897(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.892
Subarea runoff =    175.447(CFS) for   59.260(Ac.)
Total runoff =    295.664(CFS)
Effective area this stream =       85.07(Ac.)
Total Study Area (Main Stream No. 1) =       85.07(Ac.)
Area averaged Fm value =    0.036(In/Hr)
Depth of flow =   0.471(Ft.), Average velocity =   6.222(Ft/s)
Critical depth =      0.641(Ft.)
End of computations, Total Study Area =           85.07 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.
Note: These figures do not consider reduced effective area
effects caused by confluences in the rational equation.

Area averaged pervious area fraction(Ap) = 1.000
Area averaged SCS curve number =  91.0
```

ATTACHMENT 2

Historical Conditions
Hydrograph Calculations
(20-Year, 1-Hour)
(100-Year, 1-Hour)

U n i t H y d r o g r a p h A n a l y s i s

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Study date 04/09/15

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San Bernardino County Synthetic Unit Hydrology Method
Manual date - August 1986

Program License Serial Number 6320

154166 - AMBOY - SAN BERNARDINO COUNTY
HISTORIC CONDITIONS "A"
20-YEAR, 24-HOUR STORM
BY: JTS, DATE: 04-09-15

Storm Event Year = 20

Antecedent Moisture Condition = 1

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

English Units used in output format

Area averaged rainfall intensity isohyetal data:

Sub-Area (Ac.)	Duration (hours)	Isohyetal (In)
Rainfall data for year 10		
75.76	1	0.86
Rainfall data for year 2		
75.76	6	0.75
Rainfall data for year 2		
75.76	24	1.07
Rainfall data for year 100		
75.76	1	1.59
Rainfall data for year 100		
75.76	6	2.43
Rainfall data for year 100		
75.76	24	3.56

```
-----------------------------------------------------------------
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

******** Area-averaged max loss rate, Fm ********


SCS curve  SCS curve     Area     Area     Fp(Fig C6)    Ap      Fm
No.(AMCII) NO.(AMC 1)    (Ac.)    Fraction     (In/Hr)  (dec.)   (In/Hr)
 91.0      79.8         75.76      1.000     0.373    1.000    0.373

Area-averaged adjusted loss rate Fm (In/Hr) =  0.373

********* Area-Averaged low loss rate fraction, Yb **********

Area       Area          SCS CN    SCS CN      S     Pervious
 (Ac.)      Fract         (AMC2)    (AMC1)           Yield Fr
    75.76   1.000         91.0      79.8       2.53     0.356

Area-averaged catchment yield fraction, Y =  0.356
Area-averaged low loss fraction, Yb =  0.644
User entry of time of concentration  =   0.220 (hours)
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Watershed area =      75.76(Ac.)
Catchment Lag time =   0.176 hours
Unit interval =   5.000 minutes
Unit interval percentage of lag time = 47.3485
Hydrograph baseflow =     0.00(CFS)
Average maximum watershed loss rate(Fm) =  0.373(In/Hr)
Average low loss rate fraction (Yb) = 0.644 (decimal)
DESERT S-Graph Selected
Computed peak 5-minute rainfall =  0.512(In)
Computed peak 30-minute rainfall =  0.877(In)
Specified peak 1-hour rainfall =  1.080(In)
Computed peak 3-hour rainfall =  1.446(In)
Specified peak 6-hour rainfall =  1.739(In)
Specified peak 24-hour rainfall =  2.536(In)


Rainfall depth area reduction factors:
Using a total area of      75.76(Ac.) (Ref: fig. E-4)

5-minute factor = 0.996     Adjusted rainfall =  0.511(In)
30-minute factor = 0.996    Adjusted rainfall =  0.874(In)
1-hour factor = 0.996       Adjusted rainfall =  1.076(In)
3-hour factor = 1.000       Adjusted rainfall =  1.445(In)
6-hour factor = 1.000       Adjusted rainfall =  1.738(In)
24-hour factor = 1.000      Adjusted rainfall =  2.535(In)
-------------------------------------------------------------------

                  U n i t  H y d r o g r a p h
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Interval          'S' Graph          Unit Hydrograph
Number            Mean values             ((CFS))
-------------------------------------------------------------------
            (K =       916.22 (CFS))

  1                3.621                   33.180
```

2	27.374	217.630
3	58.032	280.896
4	71.898	127.044
5	79.947	73.746
6	85.264	48.711
7	89.111	35.247
8	91.816	24.784
9	93.936	19.428
10	95.547	14.758
11	96.789	11.384
12	97.673	8.097
13	98.224	5.043
14	98.770	5.010
15	99.332	5.148
16	99.712	3.478
17	100.000	2.640

Peak Unit Number	Adjusted mass rainfall (In)	Unit rainfall (In)
1	0.5105	0.5105
2	0.6285	0.1180
3	0.7098	0.0813
4	0.7738	0.0640
5	0.8274	0.0536
6	0.8739	0.0465
7	0.9153	0.0414
8	0.9527	0.0374
9	0.9870	0.0343
10	1.0186	0.0317
11	1.0482	0.0295
12	1.0759	0.0277
13	1.0993	0.0234
14	1.1214	0.0221
15	1.1424	0.0210
16	1.1624	0.0200
17	1.1815	0.0191
18	1.1998	0.0183
19	1.2174	0.0176
20	1.2342	0.0169
21	1.2505	0.0163
22	1.2663	0.0157
23	1.2815	0.0152
24	1.2962	0.0147
25	1.3105	0.0143
26	1.3244	0.0139
27	1.3379	0.0135
28	1.3511	0.0131
29	1.3639	0.0128
30	1.3764	0.0125
31	1.3885	0.0122
32	1.4004	0.0119
33	1.4121	0.0116
34	1.4234	0.0114
35	1.4346	0.0111
36	1.4455	0.0109
37	1.4561	0.0106
38	1.4664	0.0104

39	1.4766	0.0102
40	1.4866	0.0100
41	1.4964	0.0098
42	1.5060	0.0096
43	1.5155	0.0095
44	1.5248	0.0093
45	1.5339	0.0092
46	1.5430	0.0090
47	1.5518	0.0089
48	1.5605	0.0087
49	1.5691	0.0086
50	1.5776	0.0085
51	1.5859	0.0083
52	1.5941	0.0082
53	1.6023	0.0081
54	1.6102	0.0080
55	1.6181	0.0079
56	1.6259	0.0078
57	1.6336	0.0077
58	1.6412	0.0076
59	1.6487	0.0075
60	1.6561	0.0074
61	1.6634	0.0073
62	1.6706	0.0072
63	1.6777	0.0071
64	1.6848	0.0070
65	1.6917	0.0070
66	1.6986	0.0069
67	1.7054	0.0068
68	1.7122	0.0067
69	1.7188	0.0067
70	1.7254	0.0066
71	1.7320	0.0065
72	1.7384	0.0065
73	1.7450	0.0065
74	1.7514	0.0065
75	1.7578	0.0064
76	1.7642	0.0063
77	1.7705	0.0063
78	1.7767	0.0062
79	1.7829	0.0062
80	1.7890	0.0061
81	1.7951	0.0061
82	1.8011	0.0060
83	1.8070	0.0060
84	1.8129	0.0059
85	1.8188	0.0058
86	1.8246	0.0058
87	1.8303	0.0058
88	1.8360	0.0057
89	1.8417	0.0057
90	1.8473	0.0056
91	1.8529	0.0056
92	1.8584	0.0055
93	1.8639	0.0055
94	1.8693	0.0054
95	1.8747	0.0054

96	1.8800	0.0054
97	1.8853	0.0053
98	1.8906	0.0053
99	1.8958	0.0052
100	1.9010	0.0052
101	1.9062	0.0052
102	1.9113	0.0051
103	1.9164	0.0051
104	1.9214	0.0050
105	1.9265	0.0050
106	1.9314	0.0050
107	1.9364	0.0049
108	1.9413	0.0049
109	1.9462	0.0049
110	1.9510	0.0048
111	1.9558	0.0048
112	1.9606	0.0048
113	1.9653	0.0047
114	1.9701	0.0047
115	1.9748	0.0047
116	1.9794	0.0047
117	1.9840	0.0046
118	1.9886	0.0046
119	1.9932	0.0046
120	1.9978	0.0045
121	2.0023	0.0045
122	2.0068	0.0045
123	2.0112	0.0045
124	2.0157	0.0044
125	2.0201	0.0044
126	2.0245	0.0044
127	2.0288	0.0044
128	2.0332	0.0043
129	2.0375	0.0043
130	2.0418	0.0043
131	2.0460	0.0043
132	2.0503	0.0042
133	2.0545	0.0042
134	2.0587	0.0042
135	2.0628	0.0042
136	2.0670	0.0041
137	2.0711	0.0041
138	2.0752	0.0041
139	2.0793	0.0041
140	2.0834	0.0041
141	2.0874	0.0040
142	2.0914	0.0040
143	2.0954	0.0040
144	2.0994	0.0040
145	2.1034	0.0040
146	2.1073	0.0039
147	2.1112	0.0039
148	2.1151	0.0039
149	2.1190	0.0039
150	2.1229	0.0039
151	2.1267	0.0038
152	2.1305	0.0038

153	2.1343	0.0038
154	2.1381	0.0038
155	2.1419	0.0038
156	2.1457	0.0038
157	2.1494	0.0037
158	2.1531	0.0037
159	2.1568	0.0037
160	2.1605	0.0037
161	2.1642	0.0037
162	2.1678	0.0037
163	2.1714	0.0036
164	2.1751	0.0036
165	2.1787	0.0036
166	2.1822	0.0036
167	2.1858	0.0036
168	2.1894	0.0036
169	2.1929	0.0035
170	2.1964	0.0035
171	2.1999	0.0035
172	2.2034	0.0035
173	2.2069	0.0035
174	2.2104	0.0035
175	2.2138	0.0035
176	2.2173	0.0034
177	2.2207	0.0034
178	2.2241	0.0034
179	2.2275	0.0034
180	2.2309	0.0034
181	2.2342	0.0034
182	2.2376	0.0034
183	2.2409	0.0033
184	2.2443	0.0033
185	2.2476	0.0033
186	2.2509	0.0033
187	2.2542	0.0033
188	2.2574	0.0033
189	2.2607	0.0033
190	2.2640	0.0032
191	2.2672	0.0032
192	2.2704	0.0032
193	2.2736	0.0032
194	2.2768	0.0032
195	2.2800	0.0032
196	2.2832	0.0032
197	2.2864	0.0032
198	2.2895	0.0032
199	2.2927	0.0031
200	2.2958	0.0031
201	2.2989	0.0031
202	2.3020	0.0031
203	2.3051	0.0031
204	2.3082	0.0031
205	2.3113	0.0031
206	2.3143	0.0031
207	2.3174	0.0031
208	2.3204	0.0030
209	2.3235	0.0030

210	2.3265	0.0030
211	2.3295	0.0030
212	2.3325	0.0030
213	2.3355	0.0030
214	2.3385	0.0030
215	2.3414	0.0030
216	2.3444	0.0030
217	2.3473	0.0029
218	2.3503	0.0029
219	2.3532	0.0029
220	2.3561	0.0029
221	2.3590	0.0029
222	2.3619	0.0029
223	2.3648	0.0029
224	2.3677	0.0029
225	2.3706	0.0029
226	2.3734	0.0029
227	2.3763	0.0029
228	2.3791	0.0028
229	2.3820	0.0028
230	2.3848	0.0028
231	2.3876	0.0028
232	2.3904	0.0028
233	2.3932	0.0028
234	2.3960	0.0028
235	2.3988	0.0028
236	2.4016	0.0028
237	2.4044	0.0028
238	2.4071	0.0028
239	2.4099	0.0027
240	2.4126	0.0027
241	2.4153	0.0027
242	2.4181	0.0027
243	2.4208	0.0027
244	2.4235	0.0027
245	2.4262	0.0027
246	2.4289	0.0027
247	2.4316	0.0027
248	2.4342	0.0027
249	2.4369	0.0027
250	2.4396	0.0027
251	2.4422	0.0027
252	2.4449	0.0026
253	2.4475	0.0026
254	2.4501	0.0026
255	2.4527	0.0026
256	2.4554	0.0026
257	2.4580	0.0026
258	2.4606	0.0026
259	2.4632	0.0026
260	2.4657	0.0026
261	2.4683	0.0026
262	2.4709	0.0026
263	2.4735	0.0026
264	2.4760	0.0026
265	2.4786	0.0025
266	2.4811	0.0025

267	2.4836	0.0025
268	2.4862	0.0025
269	2.4887	0.0025
270	2.4912	0.0025
271	2.4937	0.0025
272	2.4962	0.0025
273	2.4987	0.0025
274	2.5012	0.0025
275	2.5037	0.0025
276	2.5062	0.0025
277	2.5086	0.0025
278	2.5111	0.0025
279	2.5135	0.0025
280	2.5160	0.0024
281	2.5184	0.0024
282	2.5209	0.0024
283	2.5233	0.0024
284	2.5257	0.0024
285	2.5281	0.0024
286	2.5305	0.0024
287	2.5330	0.0024
288	2.5354	0.0024

Unit Period (number)	Unit Rainfall (In)	Unit Soil-Loss (In)	Effective Rainfall (In)
1	0.0024	0.0015	0.0009
2	0.0024	0.0015	0.0009
3	0.0024	0.0016	0.0009
4	0.0024	0.0016	0.0009
5	0.0024	0.0016	0.0009
6	0.0024	0.0016	0.0009
7	0.0025	0.0016	0.0009
8	0.0025	0.0016	0.0009
9	0.0025	0.0016	0.0009
10	0.0025	0.0016	0.0009
11	0.0025	0.0016	0.0009
12	0.0025	0.0016	0.0009
13	0.0025	0.0016	0.0009
14	0.0025	0.0016	0.0009
15	0.0025	0.0016	0.0009
16	0.0025	0.0016	0.0009
17	0.0026	0.0016	0.0009
18	0.0026	0.0017	0.0009
19	0.0026	0.0017	0.0009
20	0.0026	0.0017	0.0009
21	0.0026	0.0017	0.0009
22	0.0026	0.0017	0.0009
23	0.0026	0.0017	0.0009
24	0.0026	0.0017	0.0009
25	0.0026	0.0017	0.0009
26	0.0027	0.0017	0.0009
27	0.0027	0.0017	0.0010
28	0.0027	0.0017	0.0010
29	0.0027	0.0017	0.0010
30	0.0027	0.0017	0.0010

31	0.0027	0.0017	0.0010
32	0.0027	0.0018	0.0010
33	0.0027	0.0018	0.0010
34	0.0027	0.0018	0.0010
35	0.0028	0.0018	0.0010
36	0.0028	0.0018	0.0010
37	0.0028	0.0018	0.0010
38	0.0028	0.0018	0.0010
39	0.0028	0.0018	0.0010
40	0.0028	0.0018	0.0010
41	0.0028	0.0018	0.0010
42	0.0029	0.0018	0.0010
43	0.0029	0.0018	0.0010
44	0.0029	0.0019	0.0010
45	0.0029	0.0019	0.0010
46	0.0029	0.0019	0.0010
47	0.0029	0.0019	0.0010
48	0.0029	0.0019	0.0010
49	0.0030	0.0019	0.0011
50	0.0030	0.0019	0.0011
51	0.0030	0.0019	0.0011
52	0.0030	0.0019	0.0011
53	0.0030	0.0019	0.0011
54	0.0030	0.0020	0.0011
55	0.0031	0.0020	0.0011
56	0.0031	0.0020	0.0011
57	0.0031	0.0020	0.0011
58	0.0031	0.0020	0.0011
59	0.0031	0.0020	0.0011
60	0.0031	0.0020	0.0011
61	0.0032	0.0020	0.0011
62	0.0032	0.0020	0.0011
63	0.0032	0.0021	0.0011
64	0.0032	0.0021	0.0011
65	0.0032	0.0021	0.0011
66	0.0032	0.0021	0.0012
67	0.0033	0.0021	0.0012
68	0.0033	0.0021	0.0012
69	0.0033	0.0021	0.0012
70	0.0033	0.0021	0.0012
71	0.0033	0.0022	0.0012
72	0.0034	0.0022	0.0012
73	0.0034	0.0022	0.0012
74	0.0034	0.0022	0.0012
75	0.0034	0.0022	0.0012
76	0.0034	0.0022	0.0012
77	0.0035	0.0022	0.0012
78	0.0035	0.0022	0.0012
79	0.0035	0.0023	0.0012
80	0.0035	0.0023	0.0013
81	0.0036	0.0023	0.0013
82	0.0036	0.0023	0.0013
83	0.0036	0.0023	0.0013
84	0.0036	0.0023	0.0013
85	0.0037	0.0024	0.0013
86	0.0037	0.0024	0.0013
87	0.0037	0.0024	0.0013

88	0.0037	0.0024	0.0013
89	0.0038	0.0024	0.0013
90	0.0038	0.0024	0.0013
91	0.0038	0.0025	0.0014
92	0.0038	0.0025	0.0014
93	0.0039	0.0025	0.0014
94	0.0039	0.0025	0.0014
95	0.0039	0.0025	0.0014
96	0.0039	0.0025	0.0014
97	0.0040	0.0026	0.0014
98	0.0040	0.0026	0.0014
99	0.0040	0.0026	0.0014
100	0.0041	0.0026	0.0014
101	0.0041	0.0026	0.0015
102	0.0041	0.0027	0.0015
103	0.0042	0.0027	0.0015
104	0.0042	0.0027	0.0015
105	0.0042	0.0027	0.0015
106	0.0043	0.0027	0.0015
107	0.0043	0.0028	0.0015
108	0.0043	0.0028	0.0015
109	0.0044	0.0028	0.0016
110	0.0044	0.0028	0.0016
111	0.0045	0.0029	0.0016
112	0.0045	0.0029	0.0016
113	0.0045	0.0029	0.0016
114	0.0046	0.0029	0.0016
115	0.0046	0.0030	0.0016
116	0.0047	0.0030	0.0017
117	0.0047	0.0030	0.0017
118	0.0047	0.0031	0.0017
119	0.0048	0.0031	0.0017
120	0.0048	0.0031	0.0017
121	0.0049	0.0032	0.0017
122	0.0049	0.0032	0.0018
123	0.0050	0.0032	0.0018
124	0.0050	0.0032	0.0018
125	0.0051	0.0033	0.0018
126	0.0052	0.0033	0.0018
127	0.0052	0.0034	0.0019
128	0.0053	0.0034	0.0019
129	0.0054	0.0034	0.0019
130	0.0054	0.0035	0.0019
131	0.0055	0.0035	0.0020
132	0.0055	0.0036	0.0020
133	0.0056	0.0036	0.0020
134	0.0057	0.0036	0.0020
135	0.0058	0.0037	0.0020
136	0.0058	0.0037	0.0021
137	0.0059	0.0038	0.0021
138	0.0060	0.0038	0.0021
139	0.0061	0.0039	0.0022
140	0.0061	0.0039	0.0022
141	0.0062	0.0040	0.0022
142	0.0063	0.0040	0.0022
143	0.0064	0.0041	0.0023
144	0.0065	0.0042	0.0023

145	0.0065	0.0042	0.0023
146	0.0065	0.0042	0.0023
147	0.0067	0.0043	0.0024
148	0.0067	0.0043	0.0024
149	0.0069	0.0044	0.0025
150	0.0070	0.0045	0.0025
151	0.0071	0.0046	0.0025
152	0.0072	0.0046	0.0026
153	0.0074	0.0048	0.0026
154	0.0075	0.0048	0.0027
155	0.0077	0.0049	0.0027
156	0.0078	0.0050	0.0028
157	0.0080	0.0051	0.0028
158	0.0081	0.0052	0.0029
159	0.0083	0.0054	0.0030
160	0.0085	0.0054	0.0030
161	0.0087	0.0056	0.0031
162	0.0089	0.0057	0.0032
163	0.0092	0.0059	0.0033
164	0.0093	0.0060	0.0033
165	0.0096	0.0062	0.0034
166	0.0098	0.0063	0.0035
167	0.0102	0.0066	0.0036
168	0.0104	0.0067	0.0037
169	0.0109	0.0070	0.0039
170	0.0111	0.0072	0.0040
171	0.0116	0.0075	0.0041
172	0.0119	0.0077	0.0042
173	0.0125	0.0080	0.0044
174	0.0128	0.0082	0.0046
175	0.0135	0.0087	0.0048
176	0.0139	0.0089	0.0049
177	0.0147	0.0095	0.0053
178	0.0152	0.0098	0.0054
179	0.0163	0.0105	0.0058
180	0.0169	0.0109	0.0060
181	0.0183	0.0118	0.0065
182	0.0191	0.0123	0.0068
183	0.0210	0.0135	0.0075
184	0.0221	0.0142	0.0079
185	0.0277	0.0178	0.0099
186	0.0295	0.0190	0.0105
187	0.0343	0.0221	0.0122
188	0.0374	0.0241	0.0133
189	0.0465	0.0300	0.0166
190	0.0536	0.0311	0.0225
191	0.0813	0.0311	0.0502
192	0.1180	0.0311	0.0869
193	0.5105	0.0311	0.4794
194	0.0640	0.0311	0.0329
195	0.0414	0.0266	0.0147
196	0.0317	0.0204	0.0113
197	0.0234	0.0151	0.0083
198	0.0200	0.0129	0.0071
199	0.0176	0.0113	0.0063
200	0.0157	0.0101	0.0056
201	0.0143	0.0092	0.0051

202	0.0131	0.0085	0.0047
203	0.0122	0.0078	0.0043
204	0.0114	0.0073	0.0041
205	0.0106	0.0068	0.0038
206	0.0100	0.0064	0.0036
207	0.0095	0.0061	0.0034
208	0.0090	0.0058	0.0032
209	0.0086	0.0055	0.0031
210	0.0082	0.0053	0.0029
211	0.0079	0.0051	0.0028
212	0.0076	0.0049	0.0027
213	0.0073	0.0047	0.0026
214	0.0070	0.0045	0.0025
215	0.0068	0.0044	0.0024
216	0.0066	0.0042	0.0023
217	0.0065	0.0042	0.0023
218	0.0063	0.0041	0.0023
219	0.0062	0.0040	0.0022
220	0.0060	0.0039	0.0021
221	0.0058	0.0038	0.0021
222	0.0057	0.0037	0.0020
223	0.0056	0.0036	0.0020
224	0.0054	0.0035	0.0019
225	0.0053	0.0034	0.0019
226	0.0052	0.0033	0.0018
227	0.0051	0.0033	0.0018
228	0.0050	0.0032	0.0018
229	0.0049	0.0031	0.0017
230	0.0048	0.0031	0.0017
231	0.0047	0.0030	0.0017
232	0.0046	0.0030	0.0016
233	0.0045	0.0029	0.0016
234	0.0044	0.0029	0.0016
235	0.0044	0.0028	0.0016
236	0.0043	0.0028	0.0015
237	0.0042	0.0027	0.0015
238	0.0041	0.0027	0.0015
239	0.0041	0.0026	0.0015
240	0.0040	0.0026	0.0014
241	0.0040	0.0025	0.0014
242	0.0039	0.0025	0.0014
243	0.0038	0.0025	0.0014
244	0.0038	0.0024	0.0013
245	0.0037	0.0024	0.0013
246	0.0037	0.0024	0.0013
247	0.0036	0.0023	0.0013
248	0.0036	0.0023	0.0013
249	0.0035	0.0023	0.0013
250	0.0035	0.0023	0.0012
251	0.0035	0.0022	0.0012
252	0.0034	0.0022	0.0012
253	0.0034	0.0022	0.0012
254	0.0033	0.0021	0.0012
255	0.0033	0.0021	0.0012
256	0.0032	0.0021	0.0012
257	0.0032	0.0021	0.0011
258	0.0032	0.0020	0.0011

259	0.0031	0.0020	0.0011
260	0.0031	0.0020	0.0011
261	0.0031	0.0020	0.0011
262	0.0030	0.0020	0.0011
263	0.0030	0.0019	0.0011
264	0.0030	0.0019	0.0011
265	0.0029	0.0019	0.0011
266	0.0029	0.0019	0.0010
267	0.0029	0.0019	0.0010
268	0.0029	0.0018	0.0010
269	0.0028	0.0018	0.0010
270	0.0028	0.0018	0.0010
271	0.0028	0.0018	0.0010
272	0.0028	0.0018	0.0010
273	0.0027	0.0018	0.0010
274	0.0027	0.0017	0.0010
275	0.0027	0.0017	0.0010
276	0.0027	0.0017	0.0009
277	0.0026	0.0017	0.0009
278	0.0026	0.0017	0.0009
279	0.0026	0.0017	0.0009
280	0.0026	0.0017	0.0009
281	0.0025	0.0016	0.0009
282	0.0025	0.0016	0.0009
283	0.0025	0.0016	0.0009
284	0.0025	0.0016	0.0009
285	0.0025	0.0016	0.0009
286	0.0024	0.0016	0.0009
287	0.0024	0.0016	0.0009
288	0.0024	0.0016	0.0009

Total soil rain loss = 1.26(In)
Total effective rainfall = 1.28(In)
Peak flow rate in flood hydrograph = 159.78(CFS)

++

24 - H O U R S T O R M
R u n o f f H y d r o g r a p h

Hydrograph in 5 Minute intervals ((CFS))

```
Time(h+m) Volume Ac.Ft   Q(CFS)  0       50.0     100.0     150.0     200.0
-----------------------------------------------------------------------
  0+ 5       0.0002      0.03  Q         |         |         |         |
  0+10       0.0017      0.21  Q         |         |         |         |
  0+15       0.0048      0.46  Q         |         |         |         |
  0+20       0.0087      0.57  Q         |         |         |         |
  0+25       0.0130      0.63  Q         |         |         |         |
  0+30       0.0177      0.67  Q         |         |         |         |
  0+35       0.0226      0.71  Q         |         |         |         |
  0+40       0.0276      0.73  Q         |         |         |         |
  0+45       0.0328      0.75  Q         |         |         |         |
  0+50       0.0380      0.77  Q         |         |         |         |
  0+55       0.0434      0.78  Q         |         |         |         |
  1+ 0       0.0488      0.79  Q         |         |         |         |
```

1+ 5	0.0543	0.80	Q	|	|	|	|
1+10	0.0598	0.80	Q	|	|	|	|
1+15	0.0654	0.81	Q	|	|	|	|
1+20	0.0711	0.82	Q	|	|	|	|
1+25	0.0767	0.82	Q	|	|	|	|
1+30	0.0824	0.83	Q	|	|	|	|
1+35	0.0881	0.83	Q	|	|	|	|
1+40	0.0939	0.83	Q	|	|	|	|
1+45	0.0996	0.84	Q	|	|	|	|
1+50	0.1054	0.84	Q	|	|	|	|
1+55	0.1112	0.84	Q	|	|	|	|
2+ 0	0.1171	0.85	Q	|	|	|	|
2+ 5	0.1229	0.85	Q	|	|	|	|
2+10	0.1288	0.85	Q	|	|	|	|
2+15	0.1347	0.86	Q	|	|	|	|
2+20	0.1407	0.86	Q	|	|	|	|
2+25	0.1466	0.87	Q	|	|	|	|
2+30	0.1526	0.87	Q	|	|	|	|
2+35	0.1586	0.87	Q	|	|	|	|
2+40	0.1647	0.88	Q	|	|	|	|
2+45	0.1707	0.88	Q	|	|	|	|
2+50	0.1768	0.89	Q	|	|	|	|
2+55	0.1830	0.89	Q	|	|	|	|
3+ 0	0.1891	0.89	Q	|	|	|	|
3+ 5	0.1953	0.90	Q	|	|	|	|
3+10	0.2015	0.90	Q	|	|	|	|
3+15	0.2077	0.91	QV	|	|	|	|
3+20	0.2140	0.91	QV	|	|	|	|
3+25	0.2203	0.91	QV	|	|	|	|
3+30	0.2266	0.92	QV	|	|	|	|
3+35	0.2330	0.92	QV	|	|	|	|
3+40	0.2394	0.93	QV	|	|	|	|
3+45	0.2458	0.93	QV	|	|	|	|
3+50	0.2522	0.94	QV	|	|	|	|
3+55	0.2587	0.94	QV	|	|	|	|
4+ 0	0.2652	0.95	QV	|	|	|	|
4+ 5	0.2718	0.95	QV	|	|	|	|
4+10	0.2783	0.95	QV	|	|	|	|
4+15	0.2849	0.96	QV	|	|	|	|
4+20	0.2916	0.96	QV	|	|	|	|
4+25	0.2983	0.97	QV	|	|	|	|
4+30	0.3050	0.97	QV	|	|	|	|
4+35	0.3117	0.98	QV	|	|	|	|
4+40	0.3185	0.98	QV	|	|	|	|
4+45	0.3253	0.99	QV	|	|	|	|
4+50	0.3322	0.99	QV	|	|	|	|
4+55	0.3390	1.00	QV	|	|	|	|
5+ 0	0.3460	1.01	QV	|	|	|	|
5+ 5	0.3529	1.01	QV	|	|	|	|
5+10	0.3599	1.02	QV	|	|	|	|
5+15	0.3670	1.02	QV	|	|	|	|
5+20	0.3740	1.03	QV	|	|	|	|
5+25	0.3812	1.03	QV	|	|	|	|
5+30	0.3883	1.04	QV	|	|	|	|
5+35	0.3955	1.04	QV	|	|	|	|
5+40	0.4027	1.05	QV	|	|	|	|
5+45	0.4100	1.06	Q V	|	|	|	|

5+50	0.4173	1.06	Q V	|	|	|	|
5+55	0.4247	1.07	Q V	|	|	|	|
6+ 0	0.4321	1.08	Q V	|	|	|	|
6+ 5	0.4396	1.08	Q V	|	|	|	|
6+10	0.4471	1.09	Q V	|	|	|	|
6+15	0.4546	1.09	Q V	|	|	|	|
6+20	0.4622	1.10	Q V	|	|	|	|
6+25	0.4698	1.11	Q V	|	|	|	|
6+30	0.4775	1.11	Q V	|	|	|	|
6+35	0.4852	1.12	Q V	|	|	|	|
6+40	0.4930	1.13	Q V	|	|	|	|
6+45	0.5008	1.14	Q V	|	|	|	|
6+50	0.5087	1.14	Q V	|	|	|	|
6+55	0.5166	1.15	Q V	|	|	|	|
7+ 0	0.5246	1.16	Q V	|	|	|	|
7+ 5	0.5326	1.17	Q V	|	|	|	|
7+10	0.5407	1.17	Q V	|	|	|	|
7+15	0.5488	1.18	Q V	|	|	|	|
7+20	0.5570	1.19	Q V	|	|	|	|
7+25	0.5653	1.20	Q V	|	|	|	|
7+30	0.5736	1.21	Q V	|	|	|	|
7+35	0.5819	1.21	Q V	|	|	|	|
7+40	0.5904	1.22	Q V	|	|	|	|
7+45	0.5988	1.23	Q V	|	|	|	|
7+50	0.6074	1.24	Q V	|	|	|	|
7+55	0.6160	1.25	Q V	|	|	|	|
8+ 0	0.6246	1.26	Q V	|	|	|	|
8+ 5	0.6334	1.27	Q V	|	|	|	|
8+10	0.6422	1.28	Q V	|	|	|	|
8+15	0.6510	1.29	Q V	|	|	|	|
8+20	0.6599	1.30	Q V	|	|	|	|
8+25	0.6689	1.31	Q V	|	|	|	|
8+30	0.6780	1.32	Q V	|	|	|	|
8+35	0.6871	1.33	Q V	|	|	|	|
8+40	0.6963	1.34	Q V	|	|	|	|
8+45	0.7056	1.35	Q V	|	|	|	|
8+50	0.7150	1.36	Q V	|	|	|	|
8+55	0.7244	1.37	Q V	|	|	|	|
9+ 0	0.7339	1.38	Q V	|	|	|	|
9+ 5	0.7435	1.39	Q V	|	|	|	|
9+10	0.7532	1.40	Q V	|	|	|	|
9+15	0.7629	1.42	Q V	|	|	|	|
9+20	0.7728	1.43	Q V	|	|	|	|
9+25	0.7827	1.44	Q V	|	|	|	|
9+30	0.7927	1.45	Q V	|	|	|	|
9+35	0.8028	1.47	Q V	|	|	|	|
9+40	0.8130	1.48	Q V	|	|	|	|
9+45	0.8233	1.49	Q V	|	|	|	|
9+50	0.8337	1.51	Q V	|	|	|	|
9+55	0.8441	1.52	Q V	|	|	|	|
10+ 0	0.8547	1.54	Q V	|	|	|	|
10+ 5	0.8654	1.55	Q V	|	|	|	|
10+10	0.8762	1.57	Q V	|	|	|	|
10+15	0.8871	1.58	Q V	|	|	|	|
10+20	0.8981	1.60	Q V	|	|	|	|
10+25	0.9092	1.61	Q V	|	|	|	|
10+30	0.9205	1.63	Q V	|	|	|	|

```
10+35       0.9318      1.65  Q   V     |          |          |          |
10+40       0.9433      1.67  Q   V     |          |          |          |
10+45       0.9549      1.68  Q   V     |          |          |          |
10+50       0.9666      1.70  Q   V     |          |          |          |
10+55       0.9785      1.72  Q   V     |          |          |          |
11+ 0       0.9905      1.74  Q   V     |          |          |          |
11+ 5       1.0026      1.76  Q   V     |          |          |          |
11+10       1.0149      1.78  Q    V    |          |          |          |
11+15       1.0273      1.80  Q    V    |          |          |          |
11+20       1.0399      1.83  Q    V    |          |          |          |
11+25       1.0526      1.85  Q    V    |          |          |          |
11+30       1.0655      1.87  Q    V    |          |          |          |
11+35       1.0786      1.90  Q    V    |          |          |          |
11+40       1.0918      1.92  Q    V    |          |          |          |
11+45       1.1052      1.95  Q    V    |          |          |          |
11+50       1.1188      1.97  Q    V    |          |          |          |
11+55       1.1326      2.00  Q    V    |          |          |          |
12+ 0       1.1465      2.03  Q    V    |          |          |          |
12+ 5       1.1607      2.05  Q    V    |          |          |          |
12+10       1.1750      2.07  Q    V    |          |          |          |
12+15       1.1894      2.09  Q    V    |          |          |          |
12+20       1.2039      2.12  Q    V    |          |          |          |
12+25       1.2187      2.14  Q     V   |          |          |          |
12+30       1.2337      2.18  Q     V   |          |          |          |
12+35       1.2489      2.21  Q     V   |          |          |          |
12+40       1.2644      2.25  Q     V   |          |          |          |
12+45       1.2801      2.28  Q     V   |          |          |          |
12+50       1.2961      2.32  Q     V   |          |          |          |
12+55       1.3124      2.36  Q     V   |          |          |          |
13+ 0       1.3290      2.41  Q     V   |          |          |          |
13+ 5       1.3459      2.45  Q     V   |          |          |          |
13+10       1.3631      2.50  Q     V   |          |          |          |
13+15       1.3806      2.55  Q     V   |          |          |          |
13+20       1.3985      2.60  Q     V   |          |          |          |
13+25       1.4168      2.66  Q      V  |          |          |          |
13+30       1.4355      2.71  Q      V  |          |          |          |
13+35       1.4546      2.77  Q      V  |          |          |          |
13+40       1.4742      2.84  Q      V  |          |          |          |
13+45       1.4942      2.91  Q      V  |          |          |          |
13+50       1.5147      2.98  Q      V  |          |          |          |
13+55       1.5357      3.05  Q      V  |          |          |          |
14+ 0       1.5573      3.13  Q      V  |          |          |          |
14+ 5       1.5795      3.22  Q      V  |          |          |          |
14+10       1.6024      3.32  Q      V  |          |          |          |
14+15       1.6260      3.43  Q       V |          |          |          |
14+20       1.6504      3.54  Q       V |          |          |          |
14+25       1.6756      3.66  Q       V |          |          |          |
14+30       1.7017      3.78  Q       V |          |          |          |
14+35       1.7287      3.92  Q       V |          |          |          |
14+40       1.7567      4.07  Q       V |          |          |          |
14+45       1.7858      4.23  Q       V |          |          |          |
14+50       1.8161      4.40  Q       V |          |          |          |
14+55       1.8478      4.60  Q        V|          |          |          |
15+ 0       1.8810      4.82  Q        V|          |          |          |
15+ 5       1.9159      5.06  |Q       V|          |          |          |
15+10       1.9526      5.34  |Q       V|          |          |          |
15+15       1.9915      5.65  |Q       V|          |          |          |
```

```
15+20       2.0329      6.01  |Q        V         |         |         |
15+25       2.0775      6.47  |Q        V         |         |         |
15+30       2.1271      7.20  |Q        V         |         |         |
15+35       2.1830      8.12  |Q        V         |         |         |
15+40       2.2454      9.06  |Q        |V        |         |         |
15+45       2.3156     10.19  | Q       |V        |         |         |
15+50       2.3969     11.81  | Q       |V        |         |         |
15+55       2.5026     15.34  |  Q      | V       |         |         |
16+ 0       2.6743     24.93  |   Q     |  V      |         |         |
16+ 5       3.0525     54.91  |         Q    V   |         |         |
16+10       4.0173    140.09  |         |        V|       Q |         |
16+15       5.1177    159.78  |         |         |    V    |Q        |
16+20       5.7002     84.57  |         |     Q   |       V |         |
16+25       6.0712     53.88  |         Q         |         V         |
16+30       6.3349     38.30  |      Q  |         |         |V        |
16+35       6.5353     29.09  |    Q    |         |         | V       |
16+40       6.6885     22.25  |   Q     |         |         |  V      |
16+45       6.8137     18.17  |  Q      |         |         |  V      |
16+50       6.9154     14.77  | Q       |         |         |   V     |
16+55       6.9991     12.15  | Q       |         |         |   V     |
17+ 0       7.0666      9.81  |Q        |         |         |   V     |
17+ 5       7.1208      7.86  |Q        |         |         |    V    |
17+10       7.1713      7.33  |Q        |         |         |    V    |
17+15       7.2186      6.88  |Q        |         |         |    V    |
17+20       7.2577      5.67  |Q        |         |         |    V    |
17+25       7.2908      4.81  Q         |         |         |     V   |
17+30       7.3138      3.34  Q         |         |         |     V   |
17+35       7.3351      3.10  Q         |         |         |     V   |
17+40       7.3552      2.92  Q         |         |         |     V   |
17+45       7.3744      2.78  Q         |         |         |     V   |
17+50       7.3926      2.65  Q         |         |         |     V   |
17+55       7.4101      2.54  Q         |         |         |     V   |
18+ 0       7.4269      2.44  Q         |         |         |     V   |
18+ 5       7.4431      2.35  Q         |         |         |     V   |
18+10       7.4588      2.28  Q         |         |         |     V   |
18+15       7.4740      2.22  Q         |         |         |      V  |
18+20       7.4888      2.15  Q         |         |         |      V  |
18+25       7.5032      2.09  Q         |         |         |      V  |
18+30       7.5172      2.03  Q         |         |         |      V  |
18+35       7.5309      1.98  Q         |         |         |      V  |
18+40       7.5441      1.93  Q         |         |         |      V  |
18+45       7.5570      1.88  Q         |         |         |      V  |
18+50       7.5697      1.83  Q         |         |         |      V  |
18+55       7.5820      1.79  Q         |         |         |      V  |
19+ 0       7.5940      1.75  Q         |         |         |      V  |
19+ 5       7.6058      1.71  Q         |         |         |      V  |
19+10       7.6173      1.67  Q         |         |         |      V  |
19+15       7.6285      1.64  Q         |         |         |      V  |
19+20       7.6396      1.60  Q         |         |         |      V  |
19+25       7.6504      1.57  Q         |         |         |      V  |
19+30       7.6610      1.54  Q         |         |         |      V  |
19+35       7.6714      1.51  Q         |         |         |      V  |
19+40       7.6816      1.48  Q         |         |         |       V |
19+45       7.6916      1.46  Q         |         |         |       V |
19+50       7.7015      1.43  Q         |         |         |       V |
19+55       7.7112      1.41  Q         |         |         |       V |
20+ 0       7.7207      1.38  Q         |         |         |       V |
```

```
20+ 5       7.7300      1.36  Q          |          |          |        V |
20+10       7.7393      1.34  Q          |          |          |        V |
20+15       7.7483      1.32  Q          |          |          |        V |
20+20       7.7573      1.30  Q          |          |          |        V |
20+25       7.7661      1.28  Q          |          |          |        V |
20+30       7.7747      1.26  Q          |          |          |        V |
20+35       7.7833      1.24  Q          |          |          |        V |
20+40       7.7917      1.22  Q          |          |          |        V |
20+45       7.8000      1.21  Q          |          |          |        V |
20+50       7.8082      1.19  Q          |          |          |        V |
20+55       7.8163      1.17  Q          |          |          |        V |
21+ 0       7.8243      1.16  Q          |          |          |        V |
21+ 5       7.8322      1.14  Q          |          |          |        V |
21+10       7.8399      1.13  Q          |          |          |        V |
21+15       7.8476      1.12  Q          |          |          |        V |
21+20       7.8552      1.10  Q          |          |          |        V |
21+25       7.8627      1.09  Q          |          |          |        V |
21+30       7.8701      1.08  Q          |          |          |        V |
21+35       7.8774      1.06  Q          |          |          |         V|
21+40       7.8847      1.05  Q          |          |          |         V|
21+45       7.8918      1.04  Q          |          |          |         V|
21+50       7.8989      1.03  Q          |          |          |         V|
21+55       7.9059      1.02  Q          |          |          |         V|
22+ 0       7.9128      1.01  Q          |          |          |         V|
22+ 5       7.9197      1.00  Q          |          |          |         V|
22+10       7.9265      0.98  Q          |          |          |         V|
22+15       7.9332      0.97  Q          |          |          |         V|
22+20       7.9398      0.96  Q          |          |          |         V|
22+25       7.9464      0.95  Q          |          |          |         V|
22+30       7.9529      0.95  Q          |          |          |         V|
22+35       7.9594      0.94  Q          |          |          |         V|
22+40       7.9658      0.93  Q          |          |          |         V|
22+45       7.9721      0.92  Q          |          |          |         V|
22+50       7.9784      0.91  Q          |          |          |         V|
22+55       7.9846      0.90  Q          |          |          |         V|
23+ 0       7.9907      0.89  Q          |          |          |         V|
23+ 5       7.9968      0.89  Q          |          |          |         V|
23+10       8.0029      0.88  Q          |          |          |         V|
23+15       8.0088      0.87  Q          |          |          |         V|
23+20       8.0148      0.86  Q          |          |          |         V|
23+25       8.0207      0.85  Q          |          |          |         V|
23+30       8.0265      0.85  Q          |          |          |         V|
23+35       8.0323      0.84  Q          |          |          |         V|
23+40       8.0380      0.83  Q          |          |          |         V|
23+45       8.0437      0.83  Q          |          |          |         V|
23+50       8.0494      0.82  Q          |          |          |         V|
23+55       8.0550      0.81  Q          |          |          |         V|
24+ 0       8.0605      0.81  Q          |          |          |         V|
24+ 5       8.0658      0.77  Q          |          |          |         V|
24+10       8.0698      0.58  Q          |          |          |         V|
24+15       8.0722      0.34  Q          |          |          |         V|
24+20       8.0737      0.23  Q          |          |          |         V|
24+25       8.0748      0.16  Q          |          |          |         V|
24+30       8.0756      0.12  Q          |          |          |         V|
24+35       8.0762      0.09  Q          |          |          |         V|
24+40       8.0767      0.07  Q          |          |          |         V|
24+45       8.0770      0.05  Q          |          |          |         V|
```

```
   24+50       8.0773      0.04  Q         |         |         |        V|
   24+55       8.0774      0.03  Q         |         |         |        V|
   25+ 0       8.0776      0.02  Q         |         |         |        V|
   25+ 5       8.0777      0.01  Q         |         |         |        V|
   25+10       8.0777      0.01  Q         |         |         |        V|
   25+15       8.0778      0.01  Q         |         |         |        V|
   25+20       8.0778      0.00  Q         |         |         |         V
-----------------------------------------------------------------------
```

U n i t H y d r o g r a p h A n a l y s i s

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Study date 04/09/15

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San Bernardino County Synthetic Unit Hydrology Method
Manual date - August 1986

Program License Serial Number 6320

154166 - AMBOY - SAN BERNARDINO COUNTY
HISTORIC CONDITION "B"
20-YEAR, 24-HOUR STORM
BY: JTS DATE: 04-09-15

Storm Event Year = 20

Antecedent Moisture Condition = 1

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

English Units used in output format

Area averaged rainfall intensity isohyetal data:

Sub-Area (Ac.)	Duration (hours)	Isohyetal (In)
Rainfall data for year 10		
85.07	1	0.86
Rainfall data for year 2		
85.07	6	0.75
Rainfall data for year 2		
85.07	24	1.07
Rainfall data for year 100		
85.07	1	1.59
Rainfall data for year 100		
85.07	6	2.43
Rainfall data for year 100		
85.07	24	3.56

```
-----------------------------------------------------------------
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

******** Area-averaged max loss rate, Fm ********


SCS curve  SCS curve     Area     Area     Fp(Fig C6)    Ap      Fm
No.(AMCII) NO.(AMC 1)    (Ac.)    Fraction     (In/Hr)  (dec.)   (In/Hr)
 91.0      79.8         85.07      1.000     0.373    1.000    0.373

Area-averaged adjusted loss rate Fm (In/Hr) =  0.373

********* Area-Averaged low loss rate fraction, Yb **********

Area       Area          SCS CN    SCS CN      S     Pervious
 (Ac.)      Fract         (AMC2)    (AMC1)           Yield Fr
    85.07   1.000         91.0      79.8       2.53     0.356

Area-averaged catchment yield fraction, Y =  0.356
Area-averaged low loss fraction, Yb =  0.644
User entry of time of concentration  =   0.280 (hours)
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Watershed area =      85.07(Ac.)
Catchment Lag time =   0.224 hours
Unit interval =   5.000 minutes
Unit interval percentage of lag time = 37.2024
Hydrograph baseflow =     0.00(CFS)
Average maximum watershed loss rate(Fm) =  0.373(In/Hr)
Average low loss rate fraction (Yb) = 0.644 (decimal)
DESERT S-Graph Selected
Computed peak 5-minute rainfall =  0.512(In)
Computed peak 30-minute rainfall =  0.877(In)
Specified peak 1-hour rainfall =  1.080(In)
Computed peak 3-hour rainfall =  1.446(In)
Specified peak 6-hour rainfall =  1.739(In)
Specified peak 24-hour rainfall =  2.536(In)


Rainfall depth area reduction factors:
Using a total area of      85.07(Ac.) (Ref: fig. E-4)

5-minute factor = 0.996     Adjusted rainfall =  0.510(In)
30-minute factor = 0.996    Adjusted rainfall =  0.874(In)
1-hour factor = 0.996       Adjusted rainfall =  1.075(In)
3-hour factor = 0.999       Adjusted rainfall =  1.445(In)
6-hour factor = 1.000       Adjusted rainfall =  1.738(In)
24-hour factor = 1.000      Adjusted rainfall =  2.535(In)
-------------------------------------------------------------------

                  U n i t  H y d r o g r a p h
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Interval          'S' Graph          Unit Hydrograph
Number            Mean values             ((CFS))
-------------------------------------------------------------------
            (K =      1028.82 (CFS))

  1                2.453                  25.238
```

2	15.615	135.411
3	44.808	300.341
4	62.667	183.742
5	72.342	99.531
6	78.814	66.587
7	83.398	47.156
8	86.976	36.813
9	89.667	27.683
10	91.740	21.327
11	93.476	17.861
12	94.846	14.100
13	95.989	11.762
14	96.911	9.485
15	97.603	7.114
16	98.066	4.768
17	98.467	4.118
18	98.913	4.587
19	99.355	4.556
20	99.659	3.125
21	100.000	1.562

Peak Unit Number	Adjusted mass rainfall (In)	Unit rainfall (In)
1	0.5103	0.5103
2	0.6283	0.1180
3	0.7095	0.0813
4	0.7735	0.0640
5	0.8270	0.0536
6	0.8735	0.0465
7	0.9149	0.0413
8	0.9523	0.0374
9	0.9865	0.0343
10	1.0182	0.0317
11	1.0477	0.0295
12	1.0754	0.0277
13	1.0989	0.0234
14	1.1210	0.0221
15	1.1420	0.0210
16	1.1620	0.0200
17	1.1811	0.0191
18	1.1994	0.0183
19	1.2170	0.0176
20	1.2339	0.0169
21	1.2502	0.0163
22	1.2660	0.0157
23	1.2812	0.0152
24	1.2960	0.0148
25	1.3103	0.0143
26	1.3242	0.0139
27	1.3377	0.0135
28	1.3509	0.0132
29	1.3637	0.0128
30	1.3762	0.0125
31	1.3884	0.0122
32	1.4003	0.0119
33	1.4119	0.0116
34	1.4233	0.0114

35	1.4345	0.0111
36	1.4454	0.0109
37	1.4560	0.0106
38	1.4664	0.0104
39	1.4765	0.0102
40	1.4865	0.0100
41	1.4963	0.0098
42	1.5060	0.0096
43	1.5154	0.0095
44	1.5247	0.0093
45	1.5339	0.0092
46	1.5429	0.0090
47	1.5517	0.0089
48	1.5605	0.0087
49	1.5691	0.0086
50	1.5775	0.0085
51	1.5859	0.0083
52	1.5941	0.0082
53	1.6022	0.0081
54	1.6102	0.0080
55	1.6181	0.0079
56	1.6258	0.0078
57	1.6335	0.0077
58	1.6411	0.0076
59	1.6486	0.0075
60	1.6560	0.0074
61	1.6633	0.0073
62	1.6705	0.0072
63	1.6776	0.0071
64	1.6847	0.0070
65	1.6917	0.0070
66	1.6986	0.0069
67	1.7054	0.0068
68	1.7121	0.0067
69	1.7188	0.0067
70	1.7254	0.0066
71	1.7319	0.0065
72	1.7384	0.0065
73	1.7449	0.0065
74	1.7514	0.0065
75	1.7578	0.0064
76	1.7641	0.0063
77	1.7704	0.0063
78	1.7767	0.0062
79	1.7828	0.0062
80	1.7890	0.0061
81	1.7950	0.0061
82	1.8010	0.0060
83	1.8070	0.0060
84	1.8129	0.0059
85	1.8187	0.0058
86	1.8245	0.0058
87	1.8303	0.0058
88	1.8360	0.0057
89	1.8416	0.0057
90	1.8472	0.0056
91	1.8528	0.0056

92	1.8583	0.0055
93	1.8638	0.0055
94	1.8692	0.0054
95	1.8746	0.0054
96	1.8800	0.0054
97	1.8853	0.0053
98	1.8906	0.0053
99	1.8958	0.0052
100	1.9010	0.0052
101	1.9061	0.0052
102	1.9113	0.0051
103	1.9163	0.0051
104	1.9214	0.0050
105	1.9264	0.0050
106	1.9314	0.0050
107	1.9363	0.0049
108	1.9412	0.0049
109	1.9461	0.0049
110	1.9510	0.0048
111	1.9558	0.0048
112	1.9605	0.0048
113	1.9653	0.0047
114	1.9700	0.0047
115	1.9747	0.0047
116	1.9794	0.0047
117	1.9840	0.0046
118	1.9886	0.0046
119	1.9932	0.0046
120	1.9977	0.0045
121	2.0022	0.0045
122	2.0067	0.0045
123	2.0112	0.0045
124	2.0156	0.0044
125	2.0200	0.0044
126	2.0244	0.0044
127	2.0288	0.0044
128	2.0331	0.0043
129	2.0374	0.0043
130	2.0417	0.0043
131	2.0460	0.0043
132	2.0502	0.0042
133	2.0544	0.0042
134	2.0586	0.0042
135	2.0628	0.0042
136	2.0670	0.0041
137	2.0711	0.0041
138	2.0752	0.0041
139	2.0793	0.0041
140	2.0833	0.0041
141	2.0874	0.0040
142	2.0914	0.0040
143	2.0954	0.0040
144	2.0994	0.0040
145	2.1033	0.0040
146	2.1073	0.0039
147	2.1112	0.0039
148	2.1151	0.0039

149	2.1190	0.0039
150	2.1228	0.0039
151	2.1267	0.0038
152	2.1305	0.0038
153	2.1343	0.0038
154	2.1381	0.0038
155	2.1419	0.0038
156	2.1456	0.0038
157	2.1493	0.0037
158	2.1531	0.0037
159	2.1568	0.0037
160	2.1604	0.0037
161	2.1641	0.0037
162	2.1678	0.0037
163	2.1714	0.0036
164	2.1750	0.0036
165	2.1786	0.0036
166	2.1822	0.0036
167	2.1858	0.0036
168	2.1893	0.0036
169	2.1929	0.0035
170	2.1964	0.0035
171	2.1999	0.0035
172	2.2034	0.0035
173	2.2069	0.0035
174	2.2103	0.0035
175	2.2138	0.0035
176	2.2172	0.0034
177	2.2207	0.0034
178	2.2241	0.0034
179	2.2275	0.0034
180	2.2308	0.0034
181	2.2342	0.0034
182	2.2376	0.0034
183	2.2409	0.0033
184	2.2442	0.0033
185	2.2475	0.0033
186	2.2508	0.0033
187	2.2541	0.0033
188	2.2574	0.0033
189	2.2607	0.0033
190	2.2639	0.0032
191	2.2672	0.0032
192	2.2704	0.0032
193	2.2736	0.0032
194	2.2768	0.0032
195	2.2800	0.0032
196	2.2832	0.0032
197	2.2863	0.0032
198	2.2895	0.0032
199	2.2926	0.0031
200	2.2958	0.0031
201	2.2989	0.0031
202	2.3020	0.0031
203	2.3051	0.0031
204	2.3082	0.0031
205	2.3112	0.0031

206	2.3143	0.0031
207	2.3173	0.0031
208	2.3204	0.0030
209	2.3234	0.0030
210	2.3264	0.0030
211	2.3295	0.0030
212	2.3325	0.0030
213	2.3354	0.0030
214	2.3384	0.0030
215	2.3414	0.0030
216	2.3444	0.0030
217	2.3473	0.0029
218	2.3502	0.0029
219	2.3532	0.0029
220	2.3561	0.0029
221	2.3590	0.0029
222	2.3619	0.0029
223	2.3648	0.0029
224	2.3677	0.0029
225	2.3706	0.0029
226	2.3734	0.0029
227	2.3763	0.0029
228	2.3791	0.0028
229	2.3819	0.0028
230	2.3848	0.0028
231	2.3876	0.0028
232	2.3904	0.0028
233	2.3932	0.0028
234	2.3960	0.0028
235	2.3988	0.0028
236	2.4016	0.0028
237	2.4043	0.0028
238	2.4071	0.0028
239	2.4098	0.0027
240	2.4126	0.0027
241	2.4153	0.0027
242	2.4180	0.0027
243	2.4207	0.0027
244	2.4234	0.0027
245	2.4261	0.0027
246	2.4288	0.0027
247	2.4315	0.0027
248	2.4342	0.0027
249	2.4369	0.0027
250	2.4395	0.0027
251	2.4422	0.0027
252	2.4448	0.0026
253	2.4475	0.0026
254	2.4501	0.0026
255	2.4527	0.0026
256	2.4553	0.0026
257	2.4579	0.0026
258	2.4605	0.0026
259	2.4631	0.0026
260	2.4657	0.0026
261	2.4683	0.0026
262	2.4709	0.0026

263	2.4734	0.0026
264	2.4760	0.0026
265	2.4785	0.0025
266	2.4811	0.0025
267	2.4836	0.0025
268	2.4861	0.0025
269	2.4887	0.0025
270	2.4912	0.0025
271	2.4937	0.0025
272	2.4962	0.0025
273	2.4987	0.0025
274	2.5012	0.0025
275	2.5036	0.0025
276	2.5061	0.0025
277	2.5086	0.0025
278	2.5111	0.0025
279	2.5135	0.0025
280	2.5160	0.0024
281	2.5184	0.0024
282	2.5208	0.0024
283	2.5233	0.0024
284	2.5257	0.0024
285	2.5281	0.0024
286	2.5305	0.0024
287	2.5329	0.0024
288	2.5353	0.0024

Unit Period (number)	Unit Rainfall (In)	Unit Soil-Loss (In)	Effective Rainfall (In)
1	0.0024	0.0015	0.0009
2	0.0024	0.0015	0.0009
3	0.0024	0.0016	0.0009
4	0.0024	0.0016	0.0009
5	0.0024	0.0016	0.0009
6	0.0024	0.0016	0.0009
7	0.0025	0.0016	0.0009
8	0.0025	0.0016	0.0009
9	0.0025	0.0016	0.0009
10	0.0025	0.0016	0.0009
11	0.0025	0.0016	0.0009
12	0.0025	0.0016	0.0009
13	0.0025	0.0016	0.0009
14	0.0025	0.0016	0.0009
15	0.0025	0.0016	0.0009
16	0.0025	0.0016	0.0009
17	0.0026	0.0016	0.0009
18	0.0026	0.0017	0.0009
19	0.0026	0.0017	0.0009
20	0.0026	0.0017	0.0009
21	0.0026	0.0017	0.0009
22	0.0026	0.0017	0.0009
23	0.0026	0.0017	0.0009
24	0.0026	0.0017	0.0009
25	0.0026	0.0017	0.0009
26	0.0027	0.0017	0.0009

27	0.0027	0.0017	0.0010
28	0.0027	0.0017	0.0010
29	0.0027	0.0017	0.0010
30	0.0027	0.0017	0.0010
31	0.0027	0.0017	0.0010
32	0.0027	0.0018	0.0010
33	0.0027	0.0018	0.0010
34	0.0027	0.0018	0.0010
35	0.0028	0.0018	0.0010
36	0.0028	0.0018	0.0010
37	0.0028	0.0018	0.0010
38	0.0028	0.0018	0.0010
39	0.0028	0.0018	0.0010
40	0.0028	0.0018	0.0010
41	0.0028	0.0018	0.0010
42	0.0029	0.0018	0.0010
43	0.0029	0.0018	0.0010
44	0.0029	0.0019	0.0010
45	0.0029	0.0019	0.0010
46	0.0029	0.0019	0.0010
47	0.0029	0.0019	0.0010
48	0.0029	0.0019	0.0010
49	0.0030	0.0019	0.0011
50	0.0030	0.0019	0.0011
51	0.0030	0.0019	0.0011
52	0.0030	0.0019	0.0011
53	0.0030	0.0019	0.0011
54	0.0030	0.0020	0.0011
55	0.0031	0.0020	0.0011
56	0.0031	0.0020	0.0011
57	0.0031	0.0020	0.0011
58	0.0031	0.0020	0.0011
59	0.0031	0.0020	0.0011
60	0.0031	0.0020	0.0011
61	0.0032	0.0020	0.0011
62	0.0032	0.0020	0.0011
63	0.0032	0.0021	0.0011
64	0.0032	0.0021	0.0011
65	0.0032	0.0021	0.0011
66	0.0032	0.0021	0.0012
67	0.0033	0.0021	0.0012
68	0.0033	0.0021	0.0012
69	0.0033	0.0021	0.0012
70	0.0033	0.0021	0.0012
71	0.0033	0.0022	0.0012
72	0.0034	0.0022	0.0012
73	0.0034	0.0022	0.0012
74	0.0034	0.0022	0.0012
75	0.0034	0.0022	0.0012
76	0.0034	0.0022	0.0012
77	0.0035	0.0022	0.0012
78	0.0035	0.0022	0.0012
79	0.0035	0.0023	0.0012
80	0.0035	0.0023	0.0013
81	0.0036	0.0023	0.0013
82	0.0036	0.0023	0.0013
83	0.0036	0.0023	0.0013

84	0.0036	0.0023	0.0013
85	0.0037	0.0024	0.0013
86	0.0037	0.0024	0.0013
87	0.0037	0.0024	0.0013
88	0.0037	0.0024	0.0013
89	0.0038	0.0024	0.0013
90	0.0038	0.0024	0.0013
91	0.0038	0.0025	0.0014
92	0.0038	0.0025	0.0014
93	0.0039	0.0025	0.0014
94	0.0039	0.0025	0.0014
95	0.0039	0.0025	0.0014
96	0.0039	0.0025	0.0014
97	0.0040	0.0026	0.0014
98	0.0040	0.0026	0.0014
99	0.0040	0.0026	0.0014
100	0.0041	0.0026	0.0014
101	0.0041	0.0026	0.0015
102	0.0041	0.0027	0.0015
103	0.0042	0.0027	0.0015
104	0.0042	0.0027	0.0015
105	0.0042	0.0027	0.0015
106	0.0043	0.0027	0.0015
107	0.0043	0.0028	0.0015
108	0.0043	0.0028	0.0015
109	0.0044	0.0028	0.0016
110	0.0044	0.0028	0.0016
111	0.0045	0.0029	0.0016
112	0.0045	0.0029	0.0016
113	0.0045	0.0029	0.0016
114	0.0046	0.0029	0.0016
115	0.0046	0.0030	0.0016
116	0.0047	0.0030	0.0017
117	0.0047	0.0030	0.0017
118	0.0047	0.0031	0.0017
119	0.0048	0.0031	0.0017
120	0.0048	0.0031	0.0017
121	0.0049	0.0032	0.0017
122	0.0049	0.0032	0.0018
123	0.0050	0.0032	0.0018
124	0.0050	0.0032	0.0018
125	0.0051	0.0033	0.0018
126	0.0052	0.0033	0.0018
127	0.0052	0.0034	0.0019
128	0.0053	0.0034	0.0019
129	0.0054	0.0034	0.0019
130	0.0054	0.0035	0.0019
131	0.0055	0.0035	0.0020
132	0.0055	0.0036	0.0020
133	0.0056	0.0036	0.0020
134	0.0057	0.0036	0.0020
135	0.0058	0.0037	0.0020
136	0.0058	0.0037	0.0021
137	0.0059	0.0038	0.0021
138	0.0060	0.0038	0.0021
139	0.0061	0.0039	0.0022
140	0.0061	0.0039	0.0022

141	0.0062	0.0040	0.0022
142	0.0063	0.0040	0.0022
143	0.0064	0.0041	0.0023
144	0.0065	0.0042	0.0023
145	0.0065	0.0042	0.0023
146	0.0065	0.0042	0.0023
147	0.0067	0.0043	0.0024
148	0.0067	0.0043	0.0024
149	0.0069	0.0044	0.0025
150	0.0070	0.0045	0.0025
151	0.0071	0.0046	0.0025
152	0.0072	0.0046	0.0026
153	0.0074	0.0048	0.0026
154	0.0075	0.0048	0.0027
155	0.0077	0.0049	0.0027
156	0.0078	0.0050	0.0028
157	0.0080	0.0051	0.0028
158	0.0081	0.0052	0.0029
159	0.0083	0.0054	0.0030
160	0.0085	0.0054	0.0030
161	0.0087	0.0056	0.0031
162	0.0089	0.0057	0.0032
163	0.0092	0.0059	0.0033
164	0.0093	0.0060	0.0033
165	0.0096	0.0062	0.0034
166	0.0098	0.0063	0.0035
167	0.0102	0.0066	0.0036
168	0.0104	0.0067	0.0037
169	0.0109	0.0070	0.0039
170	0.0111	0.0072	0.0040
171	0.0116	0.0075	0.0041
172	0.0119	0.0077	0.0042
173	0.0125	0.0080	0.0045
174	0.0128	0.0083	0.0046
175	0.0135	0.0087	0.0048
176	0.0139	0.0090	0.0050
177	0.0148	0.0095	0.0053
178	0.0152	0.0098	0.0054
179	0.0163	0.0105	0.0058
180	0.0169	0.0109	0.0060
181	0.0183	0.0118	0.0065
182	0.0191	0.0123	0.0068
183	0.0210	0.0135	0.0075
184	0.0221	0.0143	0.0079
185	0.0277	0.0178	0.0099
186	0.0295	0.0190	0.0105
187	0.0343	0.0221	0.0122
188	0.0374	0.0241	0.0133
189	0.0465	0.0299	0.0166
190	0.0536	0.0311	0.0225
191	0.0813	0.0311	0.0502
192	0.1180	0.0311	0.0869
193	0.5103	0.0311	0.4792
194	0.0640	0.0311	0.0329
195	0.0413	0.0266	0.0147
196	0.0317	0.0204	0.0113
197	0.0234	0.0151	0.0083

198	0.0200	0.0129	0.0071
199	0.0176	0.0113	0.0063
200	0.0157	0.0101	0.0056
201	0.0143	0.0092	0.0051
202	0.0132	0.0085	0.0047
203	0.0122	0.0079	0.0043
204	0.0114	0.0073	0.0041
205	0.0106	0.0068	0.0038
206	0.0100	0.0064	0.0036
207	0.0095	0.0061	0.0034
208	0.0090	0.0058	0.0032
209	0.0086	0.0055	0.0031
210	0.0082	0.0053	0.0029
211	0.0079	0.0051	0.0028
212	0.0076	0.0049	0.0027
213	0.0073	0.0047	0.0026
214	0.0070	0.0045	0.0025
215	0.0068	0.0044	0.0024
216	0.0066	0.0042	0.0023
217	0.0065	0.0042	0.0023
218	0.0063	0.0041	0.0023
219	0.0062	0.0040	0.0022
220	0.0060	0.0039	0.0021
221	0.0058	0.0038	0.0021
222	0.0057	0.0037	0.0020
223	0.0056	0.0036	0.0020
224	0.0054	0.0035	0.0019
225	0.0053	0.0034	0.0019
226	0.0052	0.0033	0.0018
227	0.0051	0.0033	0.0018
228	0.0050	0.0032	0.0018
229	0.0049	0.0031	0.0017
230	0.0048	0.0031	0.0017
231	0.0047	0.0030	0.0017
232	0.0046	0.0030	0.0016
233	0.0045	0.0029	0.0016
234	0.0044	0.0029	0.0016
235	0.0044	0.0028	0.0016
236	0.0043	0.0028	0.0015
237	0.0042	0.0027	0.0015
238	0.0041	0.0027	0.0015
239	0.0041	0.0026	0.0015
240	0.0040	0.0026	0.0014
241	0.0040	0.0025	0.0014
242	0.0039	0.0025	0.0014
243	0.0038	0.0025	0.0014
244	0.0038	0.0024	0.0013
245	0.0037	0.0024	0.0013
246	0.0037	0.0024	0.0013
247	0.0036	0.0023	0.0013
248	0.0036	0.0023	0.0013
249	0.0035	0.0023	0.0013
250	0.0035	0.0023	0.0012
251	0.0035	0.0022	0.0012
252	0.0034	0.0022	0.0012
253	0.0034	0.0022	0.0012
254	0.0033	0.0021	0.0012

255	0.0033	0.0021	0.0012
256	0.0032	0.0021	0.0012
257	0.0032	0.0021	0.0011
258	0.0032	0.0020	0.0011
259	0.0031	0.0020	0.0011
260	0.0031	0.0020	0.0011
261	0.0031	0.0020	0.0011
262	0.0030	0.0020	0.0011
263	0.0030	0.0019	0.0011
264	0.0030	0.0019	0.0011
265	0.0029	0.0019	0.0011
266	0.0029	0.0019	0.0010
267	0.0029	0.0019	0.0010
268	0.0029	0.0018	0.0010
269	0.0028	0.0018	0.0010
270	0.0028	0.0018	0.0010
271	0.0028	0.0018	0.0010
272	0.0028	0.0018	0.0010
273	0.0027	0.0018	0.0010
274	0.0027	0.0017	0.0010
275	0.0027	0.0017	0.0010
276	0.0027	0.0017	0.0009
277	0.0026	0.0017	0.0009
278	0.0026	0.0017	0.0009
279	0.0026	0.0017	0.0009
280	0.0026	0.0017	0.0009
281	0.0025	0.0016	0.0009
282	0.0025	0.0016	0.0009
283	0.0025	0.0016	0.0009
284	0.0025	0.0016	0.0009
285	0.0025	0.0016	0.0009
286	0.0024	0.0016	0.0009
287	0.0024	0.0016	0.0009
288	0.0024	0.0016	0.0009

Total soil rain loss = 1.26(In)
Total effective rainfall = 1.28(In)
Peak flow rate in flood hydrograph = 173.64(CFS)

++

24 - H O U R S T O R M
R u n o f f H y d r o g r a p h

Hydrograph in 5 Minute intervals ((CFS))

```
Time(h+m) Volume Ac.Ft   Q(CFS)  0       50.0     100.0     150.0     200.0
-----------------------------------------------------------------------
  0+ 5       0.0001      0.02  Q         |         |         |         |
  0+10       0.0011      0.14  Q         |         |         |         |
  0+15       0.0038      0.39  Q         |         |         |         |
  0+20       0.0076      0.55  Q         |         |         |         |
  0+25       0.0120      0.64  Q         |         |         |         |
  0+30       0.0168      0.70  Q         |         |         |         |
  0+35       0.0219      0.74  Q         |         |         |         |
  0+40       0.0273      0.78  Q         |         |         |         |
```

0+45	0.0328	0.80	Q				
0+50	0.0385	0.82	Q				
0+55	0.0443	0.84	Q				
1+ 0	0.0502	0.86	Q				
1+ 5	0.0562	0.87	Q				
1+10	0.0623	0.88	Q				
1+15	0.0685	0.89	Q				
1+20	0.0747	0.90	Q				
1+25	0.0809	0.91	Q				
1+30	0.0872	0.92	Q				
1+35	0.0936	0.92	Q				
1+40	0.1000	0.93	Q				
1+45	0.1064	0.93	Q				
1+50	0.1129	0.94	Q				
1+55	0.1194	0.94	Q				
2+ 0	0.1259	0.95	Q				
2+ 5	0.1324	0.95	Q				
2+10	0.1390	0.95	Q				
2+15	0.1456	0.96	Q				
2+20	0.1522	0.96	Q				
2+25	0.1589	0.97	Q				
2+30	0.1656	0.97	Q				
2+35	0.1723	0.98	Q				
2+40	0.1790	0.98	Q				
2+45	0.1858	0.98	Q				
2+50	0.1926	0.99	Q				
2+55	0.1995	0.99	Q				
3+ 0	0.2063	1.00	Q				
3+ 5	0.2132	1.00	Q				
3+10	0.2202	1.01	Q				
3+15	0.2271	1.01	QV				
3+20	0.2341	1.02	QV				
3+25	0.2412	1.02	QV				
3+30	0.2482	1.03	QV				
3+35	0.2553	1.03	QV				
3+40	0.2624	1.04	QV				
3+45	0.2696	1.04	QV				
3+50	0.2768	1.05	QV				
3+55	0.2840	1.05	QV				
4+ 0	0.2913	1.06	QV				
4+ 5	0.2986	1.06	QV				
4+10	0.3060	1.07	QV				
4+15	0.3133	1.07	QV				
4+20	0.3207	1.08	QV				
4+25	0.3282	1.08	QV				
4+30	0.3357	1.09	QV				
4+35	0.3432	1.09	QV				
4+40	0.3508	1.10	QV				
4+45	0.3584	1.10	QV				
4+50	0.3660	1.11	QV				
4+55	0.3737	1.12	QV				
5+ 0	0.3815	1.12	QV				
5+ 5	0.3892	1.13	QV				
5+10	0.3970	1.13	QV				
5+15	0.4049	1.14	QV				
5+20	0.4128	1.15	QV				
5+25	0.4207	1.15	QV				

5+30	0.4287	1.16	QV	|	|	|	|
5+35	0.4367	1.17	QV	|	|	|	|
5+40	0.4448	1.17	QV	|	|	|	|
5+45	0.4529	1.18	Q V	|	|	|	|
5+50	0.4611	1.19	Q V	|	|	|	|
5+55	0.4693	1.19	Q V	|	|	|	|
6+ 0	0.4776	1.20	Q V	|	|	|	|
6+ 5	0.4859	1.21	Q V	|	|	|	|
6+10	0.4942	1.21	Q V	|	|	|	|
6+15	0.5027	1.22	Q V	|	|	|	|
6+20	0.5111	1.23	Q V	|	|	|	|
6+25	0.5196	1.24	Q V	|	|	|	|
6+30	0.5282	1.24	Q V	|	|	|	|
6+35	0.5368	1.25	Q V	|	|	|	|
6+40	0.5455	1.26	Q V	|	|	|	|
6+45	0.5542	1.27	Q V	|	|	|	|
6+50	0.5630	1.27	Q V	|	|	|	|
6+55	0.5718	1.28	Q V	|	|	|	|
7+ 0	0.5807	1.29	Q V	|	|	|	|
7+ 5	0.5897	1.30	Q V	|	|	|	|
7+10	0.5987	1.31	Q V	|	|	|	|
7+15	0.6077	1.32	Q V	|	|	|	|
7+20	0.6169	1.33	Q V	|	|	|	|
7+25	0.6261	1.33	Q V	|	|	|	|
7+30	0.6353	1.34	Q V	|	|	|	|
7+35	0.6446	1.35	Q V	|	|	|	|
7+40	0.6540	1.36	Q V	|	|	|	|
7+45	0.6635	1.37	Q V	|	|	|	|
7+50	0.6730	1.38	Q V	|	|	|	|
7+55	0.6826	1.39	Q V	|	|	|	|
8+ 0	0.6922	1.40	Q V	|	|	|	|
8+ 5	0.7020	1.41	Q V	|	|	|	|
8+10	0.7118	1.42	Q V	|	|	|	|
8+15	0.7216	1.43	Q V	|	|	|	|
8+20	0.7316	1.44	Q V	|	|	|	|
8+25	0.7416	1.45	Q V	|	|	|	|
8+30	0.7517	1.47	Q V	|	|	|	|
8+35	0.7619	1.48	Q V	|	|	|	|
8+40	0.7721	1.49	Q V	|	|	|	|
8+45	0.7825	1.50	Q V	|	|	|	|
8+50	0.7929	1.51	Q V	|	|	|	|
8+55	0.8034	1.53	Q V	|	|	|	|
9+ 0	0.8140	1.54	Q V	|	|	|	|
9+ 5	0.8246	1.55	Q V	|	|	|	|
9+10	0.8354	1.56	Q V	|	|	|	|
9+15	0.8463	1.58	Q V	|	|	|	|
9+20	0.8572	1.59	Q V	|	|	|	|
9+25	0.8683	1.60	Q V	|	|	|	|
9+30	0.8794	1.62	Q V	|	|	|	|
9+35	0.8906	1.63	Q V	|	|	|	|
9+40	0.9020	1.65	Q V	|	|	|	|
9+45	0.9134	1.66	Q V	|	|	|	|
9+50	0.9250	1.68	Q V	|	|	|	|
9+55	0.9367	1.69	Q V	|	|	|	|
10+ 0	0.9484	1.71	Q V	|	|	|	|
10+ 5	0.9603	1.73	Q V	|	|	|	|
10+10	0.9723	1.74	Q V	|	|	|	|

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10+15       0.9844      1.76  Q   V     |          |          |          |
10+20       0.9967      1.78  Q   V     |          |          |          |
10+25       1.0090      1.80  Q   V     |          |          |          |
10+30       1.0215      1.81  Q   V     |          |          |          |
10+35       1.0342      1.83  Q   V     |          |          |          |
10+40       1.0469      1.85  Q   V     |          |          |          |
10+45       1.0598      1.87  Q   V     |          |          |          |
10+50       1.0729      1.89  Q   V     |          |          |          |
10+55       1.0860      1.91  Q   V     |          |          |          |
11+ 0       1.0994      1.94  Q   V     |          |          |          |
11+ 5       1.1128      1.96  Q   V     |          |          |          |
11+10       1.1265      1.98  Q   V     |          |          |          |
11+15       1.1403      2.00  Q    V    |          |          |          |
11+20       1.1542      2.03  Q    V    |          |          |          |
11+25       1.1684      2.05  Q    V    |          |          |          |
11+30       1.1827      2.08  Q    V    |          |          |          |
11+35       1.1972      2.10  Q    V    |          |          |          |
11+40       1.2119      2.13  Q    V    |          |          |          |
11+45       1.2267      2.16  Q    V    |          |          |          |
11+50       1.2418      2.19  Q    V    |          |          |          |
11+55       1.2571      2.22  Q    V    |          |          |          |
12+ 0       1.2726      2.25  Q    V    |          |          |          |
12+ 5       1.2883      2.28  Q    V    |          |          |          |
12+10       1.3041      2.30  Q    V    |          |          |          |
12+15       1.3201      2.32  Q    V    |          |          |          |
12+20       1.3363      2.35  Q    V    |          |          |          |
12+25       1.3527      2.38  Q    V    |          |          |          |
12+30       1.3693      2.41  Q     V   |          |          |          |
12+35       1.3862      2.45  Q     V   |          |          |          |
12+40       1.4033      2.49  Q     V   |          |          |          |
12+45       1.4207      2.53  Q     V   |          |          |          |
12+50       1.4384      2.57  Q     V   |          |          |          |
12+55       1.4565      2.62  Q     V   |          |          |          |
13+ 0       1.4748      2.66  Q     V   |          |          |          |
13+ 5       1.4935      2.71  Q     V   |          |          |          |
13+10       1.5125      2.76  Q     V   |          |          |          |
13+15       1.5319      2.82  Q     V   |          |          |          |
13+20       1.5517      2.87  Q     V   |          |          |          |
13+25       1.5719      2.93  Q     V   |          |          |          |
13+30       1.5925      2.99  Q      V  |          |          |          |
13+35       1.6136      3.06  Q      V  |          |          |          |
13+40       1.6351      3.13  Q      V  |          |          |          |
13+45       1.6572      3.20  Q      V  |          |          |          |
13+50       1.6797      3.28  Q      V  |          |          |          |
13+55       1.7029      3.36  Q      V  |          |          |          |
14+ 0       1.7266      3.45  Q      V  |          |          |          |
14+ 5       1.7510      3.54  Q      V  |          |          |          |
14+10       1.7761      3.64  Q      V  |          |          |          |
14+15       1.8020      3.76  Q      V  |          |          |          |
14+20       1.8288      3.88  Q       V |          |          |          |
14+25       1.8564      4.01  Q       V |          |          |          |
14+30       1.8850      4.14  Q       V |          |          |          |
14+35       1.9145      4.29  Q       V |          |          |          |
14+40       1.9451      4.44  Q       V |          |          |          |
14+45       1.9769      4.62  Q       V |          |          |          |
14+50       2.0100      4.80  Q       V |          |          |          |
14+55       2.0445      5.01  |Q       V|          |          |          |
```

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15+ 0       2.0805      5.23  |Q       V|         |         |         |
15+ 5       2.1184      5.50  |Q       V|         |         |         |
15+10       2.1582      5.77  |Q       V|         |         |         |
15+15       2.2002      6.11  |Q       V|         |         |         |
15+20       2.2448      6.47  |Q       V|         |         |         |
15+25       2.2927      6.95  |Q        V         |         |         |
15+30       2.3449      7.59  |Q        V         |         |         |
15+35       2.4037      8.53  |Q        V         |         |         |
15+40       2.4691      9.50  |Q        V         |         |         |
15+45       2.5425     10.66  | Q       |V        |         |         |
15+50       2.6262     12.17  | Q       |V        |         |         |
15+55       2.7310     15.21  |  Q      | V       |         |         |
16+ 0       2.8869     22.63  |   Q     | V       |         |         |
16+ 5       3.2140     47.50  |         Q|   V    |         |         |
16+10       3.9474    106.49  |         |      V  |Q        |         |
16+15       5.1433    173.64  |         |         | V       |   Q     |
16+20       5.9363    115.15  |         |         |  Q  V   |         |
16+25       6.4209     70.36  |         |   Q     |       V |         |
16+30       6.7676     50.33  |         Q         |        V|         |
16+35       7.0291     37.97  |      Q  |         |         |V        |
16+40       7.2397     30.59  |     Q   |         |         |V        |
16+45       7.4084     24.49  |   Q     |         |         | V       |
16+50       7.5469     20.10  |   Q     |         |         |  V      |
16+55       7.6658     17.27  |  Q      |         |         |  V      |
17+ 0       7.7661     14.56  | Q       |         |         |   V     |
17+ 5       7.8529     12.60  | Q       |         |         |   V     |
17+10       7.9271     10.77  | Q       |         |         |    V    |
17+15       7.9892      9.02  |Q        |         |         |    V    |
17+20       8.0408      7.49  |Q        |         |         |    V    |
17+25       8.0878      6.84  |Q        |         |         |    V    |
17+30       8.1339      6.69  |Q        |         |         |    V    |
17+35       8.1770      6.26  |Q        |         |         |     V   |
17+40       8.2129      5.21  |Q        |         |         |     V   |
17+45       8.2415      4.15  Q         |         |         |     V   |
17+50       8.2637      3.22  Q         |         |         |     V   |
17+55       8.2845      3.02  Q         |         |         |     V   |
18+ 0       8.3043      2.88  Q         |         |         |     V   |
18+ 5       8.3233      2.76  Q         |         |         |     V   |
18+10       8.3416      2.66  Q         |         |         |     V   |
18+15       8.3593      2.57  Q         |         |         |     V   |
18+20       8.3765      2.49  Q         |         |         |      V  |
18+25       8.3931      2.42  Q         |         |         |      V  |
18+30       8.4093      2.35  Q         |         |         |      V  |
18+35       8.4250      2.28  Q         |         |         |      V  |
18+40       8.4403      2.22  Q         |         |         |      V  |
18+45       8.4551      2.16  Q         |         |         |      V  |
18+50       8.4696      2.10  Q         |         |         |      V  |
18+55       8.4837      2.05  Q         |         |         |      V  |
19+ 0       8.4975      2.00  Q         |         |         |      V  |
19+ 5       8.5110      1.96  Q         |         |         |      V  |
19+10       8.5241      1.91  Q         |         |         |      V  |
19+15       8.5370      1.87  Q         |         |         |      V  |
19+20       8.5496      1.83  Q         |         |         |      V  |
19+25       8.5620      1.79  Q         |         |         |      V  |
19+30       8.5741      1.76  Q         |         |         |      V  |
19+35       8.5860      1.72  Q         |         |         |      V  |
19+40       8.5976      1.69  Q         |         |         |      V  |
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19+45       8.6090      1.66  Q          |          |          |        V |
19+50       8.6203      1.63  Q          |          |          |        V |
19+55       8.6313      1.60  Q          |          |          |        V |
20+ 0       8.6421      1.57  Q          |          |          |        V |
20+ 5       8.6528      1.55  Q          |          |          |        V |
20+10       8.6633      1.52  Q          |          |          |        V |
20+15       8.6736      1.50  Q          |          |          |        V |
20+20       8.6838      1.47  Q          |          |          |        V |
20+25       8.6938      1.45  Q          |          |          |        V |
20+30       8.7036      1.43  Q          |          |          |        V |
20+35       8.7133      1.41  Q          |          |          |        V |
20+40       8.7229      1.39  Q          |          |          |        V |
20+45       8.7323      1.37  Q          |          |          |        V |
20+50       8.7416      1.35  Q          |          |          |        V |
20+55       8.7508      1.33  Q          |          |          |        V |
21+ 0       8.7598      1.31  Q          |          |          |        V |
21+ 5       8.7688      1.30  Q          |          |          |        V |
21+10       8.7776      1.28  Q          |          |          |        V |
21+15       8.7863      1.26  Q          |          |          |        V |
21+20       8.7949      1.25  Q          |          |          |        V |
21+25       8.8034      1.23  Q          |          |          |        V |
21+30       8.8118      1.22  Q          |          |          |        V |
21+35       8.8201      1.20  Q          |          |          |        V |
21+40       8.8283      1.19  Q          |          |          |         V|
21+45       8.8364      1.18  Q          |          |          |         V|
21+50       8.8444      1.16  Q          |          |          |         V|
21+55       8.8523      1.15  Q          |          |          |         V|
22+ 0       8.8601      1.14  Q          |          |          |         V|
22+ 5       8.8679      1.13  Q          |          |          |         V|
22+10       8.8756      1.11  Q          |          |          |         V|
22+15       8.8832      1.10  Q          |          |          |         V|
22+20       8.8907      1.09  Q          |          |          |         V|
22+25       8.8981      1.08  Q          |          |          |         V|
22+30       8.9055      1.07  Q          |          |          |         V|
22+35       8.9128      1.06  Q          |          |          |         V|
22+40       8.9200      1.05  Q          |          |          |         V|
22+45       8.9271      1.04  Q          |          |          |         V|
22+50       8.9342      1.03  Q          |          |          |         V|
22+55       8.9412      1.02  Q          |          |          |         V|
23+ 0       8.9482      1.01  Q          |          |          |         V|
23+ 5       8.9551      1.00  Q          |          |          |         V|
23+10       8.9619      0.99  Q          |          |          |         V|
23+15       8.9687      0.98  Q          |          |          |         V|
23+20       8.9754      0.97  Q          |          |          |         V|
23+25       8.9820      0.97  Q          |          |          |         V|
23+30       8.9886      0.96  Q          |          |          |         V|
23+35       8.9951      0.95  Q          |          |          |         V|
23+40       9.0016      0.94  Q          |          |          |         V|
23+45       9.0080      0.93  Q          |          |          |         V|
23+50       9.0144      0.93  Q          |          |          |         V|
23+55       9.0207      0.92  Q          |          |          |         V|
24+ 0       9.0270      0.91  Q          |          |          |         V|
24+ 5       9.0331      0.88  Q          |          |          |         V|
24+10       9.0383      0.76  Q          |          |          |         V|
24+15       9.0417      0.50  Q          |          |          |         V|
24+20       9.0440      0.34  Q          |          |          |         V|
24+25       9.0458      0.25  Q          |          |          |         V|
```

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   24+30       9.0471      0.19  Q          |          |          |         V|
   24+35       9.0481      0.15  Q          |          |          |         V|
   24+40       9.0489      0.12  Q          |          |          |         V|
   24+45       9.0495      0.09  Q          |          |          |         V|
   24+50       9.0500      0.07  Q          |          |          |         V|
   24+55       9.0504      0.06  Q          |          |          |         V|
   25+ 0       9.0507      0.04  Q          |          |          |         V|
   25+ 5       9.0510      0.03  Q          |          |          |         V|
   25+10       9.0512      0.03  Q          |          |          |         V|
   25+15       9.0513      0.02  Q          |          |          |         V|
   25+20       9.0514      0.02  Q          |          |          |         V|
   25+25       9.0515      0.01  Q          |          |          |         V|
   25+30       9.0515      0.01  Q          |          |          |         V|
   25+35       9.0516      0.00  Q          |          |          |         V|
   25+40       9.0516      0.00  Q          |          |          |         V|
-----------------------------------------------------------------------
```

U n i t H y d r o g r a p h A n a l y s i s

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Study date 04/09/15

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San Bernardino County Synthetic Unit Hydrology Method
Manual date - August 1986

Program License Serial Number 6320

154166 - AMBOY - SAN BERNARDINO COUNTY
HISTORIC CONDITIONS "A"
100-YEAR, 24-HOUR STORM
BY: JTS, DATE: 04-09-15

Storm Event Year = 100

Antecedent Moisture Condition = 3

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

English Units used in output format

Area averaged rainfall intensity isohyetal data:

Sub-Area (Ac.)	Duration (hours)	Isohyetal (In)
Rainfall data for year 10		
75.76	1	0.86
Rainfall data for year 2		
75.76	6	0.75
Rainfall data for year 2		
75.76	24	1.07
Rainfall data for year 100		
75.76	1	1.59
Rainfall data for year 100		
75.76	6	2.43
Rainfall data for year 100		
75.76	24	3.56

```
-----------------------------------------------------------------
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

******** Area-averaged max loss rate, Fm ********


SCS curve  SCS curve     Area     Area     Fp(Fig C6)    Ap      Fm
No.(AMCII) NO.(AMC 3)    (Ac.)    Fraction     (In/Hr)  (dec.)   (In/Hr)
 91.0      98.2         75.76      1.000     0.036    1.000    0.036

Area-averaged adjusted loss rate Fm (In/Hr) =  0.036

********* Area-Averaged low loss rate fraction, Yb **********

Area       Area          SCS CN    SCS CN      S     Pervious
 (Ac.)      Fract         (AMC2)    (AMC3)           Yield Fr
    75.76   1.000         91.0      98.2       0.18     0.941

Area-averaged catchment yield fraction, Y =  0.941
Area-averaged low loss fraction, Yb =  0.059
User entry of time of concentration  =   0.220 (hours)
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Watershed area =      75.76(Ac.)
Catchment Lag time =   0.176 hours
Unit interval =   5.000 minutes
Unit interval percentage of lag time = 47.3485
Hydrograph baseflow =     0.00(CFS)
Average maximum watershed loss rate(Fm) =  0.036(In/Hr)
Average low loss rate fraction (Yb) = 0.059 (decimal)
DESERT S-Graph Selected
Computed peak 5-minute rainfall =  0.754(In)
Computed peak 30-minute rainfall =  1.291(In)
Specified peak 1-hour rainfall =  1.590(In)
Computed peak 3-hour rainfall =  2.062(In)
Specified peak 6-hour rainfall =  2.430(In)
Specified peak 24-hour rainfall =  3.560(In)


Rainfall depth area reduction factors:
Using a total area of      75.76(Ac.) (Ref: fig. E-4)

5-minute factor = 0.996     Adjusted rainfall =  0.752(In)
30-minute factor = 0.996    Adjusted rainfall =  1.287(In)
1-hour factor = 0.996       Adjusted rainfall =  1.584(In)
3-hour factor = 1.000       Adjusted rainfall =  2.061(In)
6-hour factor = 1.000       Adjusted rainfall =  2.429(In)
24-hour factor = 1.000      Adjusted rainfall =  3.560(In)
-------------------------------------------------------------------

                  U n i t  H y d r o g r a p h
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Interval          'S' Graph          Unit Hydrograph
Number            Mean values             ((CFS))
-------------------------------------------------------------------
            (K =       916.22 (CFS))

  1                3.621                   33.180
```

2	27.374	217.630
3	58.032	280.896
4	71.898	127.044
5	79.947	73.746
6	85.264	48.711
7	89.111	35.247
8	91.816	24.784
9	93.936	19.428
10	95.547	14.758
11	96.789	11.384
12	97.673	8.097
13	98.224	5.043
14	98.770	5.010
15	99.332	5.148
16	99.712	3.478
17	100.000	2.640

Peak Unit Number	Adjusted mass rainfall (In)	Unit rainfall (In)
1	0.7518	0.7518
2	0.9256	0.1738
3	1.0453	0.1197
4	1.1395	0.0942
5	1.2184	0.0789
6	1.2869	0.0685
7	1.3478	0.0609
8	1.4029	0.0551
9	1.4534	0.0505
10	1.5000	0.0467
11	1.5435	0.0435
12	1.5844	0.0408
13	1.6150	0.0307
14	1.6440	0.0289
15	1.6713	0.0274
16	1.6974	0.0260
17	1.7222	0.0248
18	1.7460	0.0237
19	1.7687	0.0228
20	1.7906	0.0219
21	1.8116	0.0211
22	1.8319	0.0203
23	1.8516	0.0196
24	1.8705	0.0190
25	1.8889	0.0184
26	1.9067	0.0178
27	1.9241	0.0173
28	1.9409	0.0168
29	1.9573	0.0164
30	1.9732	0.0160
31	1.9888	0.0156
32	2.0040	0.0152
33	2.0188	0.0148
34	2.0333	0.0145
35	2.0475	0.0142
36	2.0613	0.0139
37	2.0748	0.0134
38	2.0879	0.0132

39	2.1008	0.0129
40	2.1135	0.0126
41	2.1259	0.0124
42	2.1380	0.0122
43	2.1500	0.0120
44	2.1618	0.0117
45	2.1733	0.0115
46	2.1847	0.0114
47	2.1958	0.0112
48	2.2068	0.0110
49	2.2176	0.0108
50	2.2283	0.0106
51	2.2387	0.0105
52	2.2491	0.0103
53	2.2593	0.0102
54	2.2693	0.0100
55	2.2792	0.0099
56	2.2889	0.0098
57	2.2986	0.0096
58	2.3080	0.0095
59	2.3174	0.0094
60	2.3267	0.0093
61	2.3358	0.0091
62	2.3448	0.0090
63	2.3537	0.0089
64	2.3625	0.0088
65	2.3712	0.0087
66	2.3798	0.0086
67	2.3883	0.0085
68	2.3967	0.0084
69	2.4050	0.0083
70	2.4133	0.0082
71	2.4214	0.0081
72	2.4294	0.0080
73	2.4387	0.0093
74	2.4478	0.0092
75	2.4569	0.0091
76	2.4659	0.0090
77	2.4748	0.0089
78	2.4836	0.0088
79	2.4923	0.0087
80	2.5010	0.0087
81	2.5096	0.0086
82	2.5181	0.0085
83	2.5265	0.0084
84	2.5348	0.0084
85	2.5431	0.0083
86	2.5513	0.0082
87	2.5595	0.0081
88	2.5675	0.0081
89	2.5756	0.0080
90	2.5835	0.0079
91	2.5914	0.0079
92	2.5992	0.0078
93	2.6069	0.0078
94	2.6146	0.0077
95	2.6223	0.0076

96	2.6299	0.0076
97	2.6374	0.0075
98	2.6448	0.0075
99	2.6523	0.0074
100	2.6596	0.0074
101	2.6669	0.0073
102	2.6742	0.0073
103	2.6814	0.0072
104	2.6885	0.0071
105	2.6956	0.0071
106	2.7027	0.0071
107	2.7097	0.0070
108	2.7166	0.0070
109	2.7235	0.0069
110	2.7304	0.0069
111	2.7372	0.0068
112	2.7440	0.0068
113	2.7507	0.0067
114	2.7574	0.0067
115	2.7640	0.0066
116	2.7706	0.0066
117	2.7772	0.0066
118	2.7837	0.0065
119	2.7902	0.0065
120	2.7966	0.0064
121	2.8030	0.0064
122	2.8094	0.0064
123	2.8157	0.0063
124	2.8220	0.0063
125	2.8283	0.0063
126	2.8345	0.0062
127	2.8407	0.0062
128	2.8468	0.0061
129	2.8529	0.0061
130	2.8590	0.0061
131	2.8651	0.0060
132	2.8711	0.0060
133	2.8770	0.0060
134	2.8830	0.0059
135	2.8889	0.0059
136	2.8948	0.0059
137	2.9006	0.0058
138	2.9064	0.0058
139	2.9122	0.0058
140	2.9180	0.0058
141	2.9237	0.0057
142	2.9294	0.0057
143	2.9351	0.0057
144	2.9407	0.0056
145	2.9464	0.0056
146	2.9519	0.0056
147	2.9575	0.0056
148	2.9630	0.0055
149	2.9685	0.0055
150	2.9740	0.0055
151	2.9795	0.0055
152	2.9849	0.0054

153	2.9903	0.0054
154	2.9957	0.0054
155	3.0010	0.0053
156	3.0063	0.0053
157	3.0116	0.0053
158	3.0169	0.0053
159	3.0221	0.0052
160	3.0274	0.0052
161	3.0326	0.0052
162	3.0377	0.0052
163	3.0429	0.0052
164	3.0480	0.0051
165	3.0531	0.0051
166	3.0582	0.0051
167	3.0633	0.0051
168	3.0683	0.0050
169	3.0734	0.0050
170	3.0784	0.0050
171	3.0833	0.0050
172	3.0883	0.0050
173	3.0932	0.0049
174	3.0982	0.0049
175	3.1031	0.0049
176	3.1079	0.0049
177	3.1128	0.0049
178	3.1176	0.0048
179	3.1224	0.0048
180	3.1272	0.0048
181	3.1320	0.0048
182	3.1368	0.0048
183	3.1415	0.0047
184	3.1462	0.0047
185	3.1509	0.0047
186	3.1556	0.0047
187	3.1603	0.0047
188	3.1649	0.0046
189	3.1696	0.0046
190	3.1742	0.0046
191	3.1788	0.0046
192	3.1834	0.0046
193	3.1879	0.0046
194	3.1925	0.0045
195	3.1970	0.0045
196	3.2015	0.0045
197	3.2060	0.0045
198	3.2105	0.0045
199	3.2149	0.0045
200	3.2194	0.0044
201	3.2238	0.0044
202	3.2282	0.0044
203	3.2326	0.0044
204	3.2370	0.0044
205	3.2413	0.0044
206	3.2457	0.0043
207	3.2500	0.0043
208	3.2543	0.0043
209	3.2587	0.0043

210	3.2629	0.0043
211	3.2672	0.0043
212	3.2715	0.0043
213	3.2757	0.0042
214	3.2799	0.0042
215	3.2842	0.0042
216	3.2884	0.0042
217	3.2926	0.0042
218	3.2967	0.0042
219	3.3009	0.0042
220	3.3050	0.0041
221	3.3092	0.0041
222	3.3133	0.0041
223	3.3174	0.0041
224	3.3215	0.0041
225	3.3256	0.0041
226	3.3296	0.0041
227	3.3337	0.0041
228	3.3377	0.0040
229	3.3418	0.0040
230	3.3458	0.0040
231	3.3498	0.0040
232	3.3538	0.0040
233	3.3577	0.0040
234	3.3617	0.0040
235	3.3657	0.0040
236	3.3696	0.0039
237	3.3735	0.0039
238	3.3774	0.0039
239	3.3813	0.0039
240	3.3852	0.0039
241	3.3891	0.0039
242	3.3930	0.0039
243	3.3968	0.0039
244	3.4007	0.0038
245	3.4045	0.0038
246	3.4084	0.0038
247	3.4122	0.0038
248	3.4160	0.0038
249	3.4198	0.0038
250	3.4235	0.0038
251	3.4273	0.0038
252	3.4311	0.0038
253	3.4348	0.0037
254	3.4385	0.0037
255	3.4423	0.0037
256	3.4460	0.0037
257	3.4497	0.0037
258	3.4534	0.0037
259	3.4571	0.0037
260	3.4607	0.0037
261	3.4644	0.0037
262	3.4681	0.0037
263	3.4717	0.0036
264	3.4753	0.0036
265	3.4790	0.0036
266	3.4826	0.0036

267	3.4862	0.0036
268	3.4898	0.0036
269	3.4933	0.0036
270	3.4969	0.0036
271	3.5005	0.0036
272	3.5040	0.0036
273	3.5076	0.0035
274	3.5111	0.0035
275	3.5146	0.0035
276	3.5182	0.0035
277	3.5217	0.0035
278	3.5252	0.0035
279	3.5287	0.0035
280	3.5321	0.0035
281	3.5356	0.0035
282	3.5391	0.0035
283	3.5425	0.0035
284	3.5460	0.0034
285	3.5494	0.0034
286	3.5528	0.0034
287	3.5563	0.0034
288	3.5597	0.0034

Unit Period (number)	Unit Rainfall (In)	Unit Soil-Loss (In)	Effective Rainfall (In)
1	0.0034	0.0002	0.0032
2	0.0034	0.0002	0.0032
3	0.0034	0.0002	0.0032
4	0.0034	0.0002	0.0032
5	0.0035	0.0002	0.0033
6	0.0035	0.0002	0.0033
7	0.0035	0.0002	0.0033
8	0.0035	0.0002	0.0033
9	0.0035	0.0002	0.0033
10	0.0035	0.0002	0.0033
11	0.0035	0.0002	0.0033
12	0.0036	0.0002	0.0033
13	0.0036	0.0002	0.0034
14	0.0036	0.0002	0.0034
15	0.0036	0.0002	0.0034
16	0.0036	0.0002	0.0034
17	0.0036	0.0002	0.0034
18	0.0036	0.0002	0.0034
19	0.0037	0.0002	0.0034
20	0.0037	0.0002	0.0035
21	0.0037	0.0002	0.0035
22	0.0037	0.0002	0.0035
23	0.0037	0.0002	0.0035
24	0.0037	0.0002	0.0035
25	0.0038	0.0002	0.0035
26	0.0038	0.0002	0.0035
27	0.0038	0.0002	0.0036
28	0.0038	0.0002	0.0036
29	0.0038	0.0002	0.0036
30	0.0038	0.0002	0.0036

31	0.0039	0.0002	0.0036
32	0.0039	0.0002	0.0036
33	0.0039	0.0002	0.0037
34	0.0039	0.0002	0.0037
35	0.0039	0.0002	0.0037
36	0.0039	0.0002	0.0037
37	0.0040	0.0002	0.0037
38	0.0040	0.0002	0.0037
39	0.0040	0.0002	0.0038
40	0.0040	0.0002	0.0038
41	0.0040	0.0002	0.0038
42	0.0041	0.0002	0.0038
43	0.0041	0.0002	0.0038
44	0.0041	0.0002	0.0039
45	0.0041	0.0002	0.0039
46	0.0041	0.0002	0.0039
47	0.0042	0.0002	0.0039
48	0.0042	0.0002	0.0039
49	0.0042	0.0002	0.0040
50	0.0042	0.0002	0.0040
51	0.0042	0.0003	0.0040
52	0.0043	0.0003	0.0040
53	0.0043	0.0003	0.0040
54	0.0043	0.0003	0.0040
55	0.0043	0.0003	0.0041
56	0.0043	0.0003	0.0041
57	0.0044	0.0003	0.0041
58	0.0044	0.0003	0.0041
59	0.0044	0.0003	0.0042
60	0.0044	0.0003	0.0042
61	0.0045	0.0003	0.0042
62	0.0045	0.0003	0.0042
63	0.0045	0.0003	0.0043
64	0.0045	0.0003	0.0043
65	0.0046	0.0003	0.0043
66	0.0046	0.0003	0.0043
67	0.0046	0.0003	0.0044
68	0.0046	0.0003	0.0044
69	0.0047	0.0003	0.0044
70	0.0047	0.0003	0.0044
71	0.0047	0.0003	0.0045
72	0.0048	0.0003	0.0045
73	0.0048	0.0003	0.0045
74	0.0048	0.0003	0.0045
75	0.0049	0.0003	0.0046
76	0.0049	0.0003	0.0046
77	0.0049	0.0003	0.0046
78	0.0049	0.0003	0.0046
79	0.0050	0.0003	0.0047
80	0.0050	0.0003	0.0047
81	0.0050	0.0003	0.0047
82	0.0051	0.0003	0.0048
83	0.0051	0.0003	0.0048
84	0.0051	0.0003	0.0048
85	0.0052	0.0003	0.0049
86	0.0052	0.0003	0.0049
87	0.0052	0.0003	0.0049

88	0.0053	0.0003	0.0050
89	0.0053	0.0003	0.0050
90	0.0053	0.0003	0.0050
91	0.0054	0.0003	0.0051
92	0.0054	0.0003	0.0051
93	0.0055	0.0003	0.0052
94	0.0055	0.0003	0.0052
95	0.0056	0.0003	0.0052
96	0.0056	0.0003	0.0053
97	0.0056	0.0003	0.0053
98	0.0057	0.0003	0.0053
99	0.0057	0.0003	0.0054
100	0.0058	0.0003	0.0054
101	0.0058	0.0003	0.0055
102	0.0058	0.0003	0.0055
103	0.0059	0.0004	0.0056
104	0.0059	0.0004	0.0056
105	0.0060	0.0004	0.0057
106	0.0060	0.0004	0.0057
107	0.0061	0.0004	0.0057
108	0.0061	0.0004	0.0058
109	0.0062	0.0004	0.0058
110	0.0063	0.0004	0.0059
111	0.0063	0.0004	0.0060
112	0.0064	0.0004	0.0060
113	0.0064	0.0004	0.0061
114	0.0065	0.0004	0.0061
115	0.0066	0.0004	0.0062
116	0.0066	0.0004	0.0062
117	0.0067	0.0004	0.0063
118	0.0067	0.0004	0.0063
119	0.0068	0.0004	0.0064
120	0.0069	0.0004	0.0065
121	0.0070	0.0004	0.0065
122	0.0070	0.0004	0.0066
123	0.0071	0.0004	0.0067
124	0.0071	0.0004	0.0067
125	0.0073	0.0004	0.0068
126	0.0073	0.0004	0.0069
127	0.0074	0.0004	0.0070
128	0.0075	0.0004	0.0070
129	0.0076	0.0004	0.0071
130	0.0076	0.0005	0.0072
131	0.0078	0.0005	0.0073
132	0.0078	0.0005	0.0074
133	0.0079	0.0005	0.0075
134	0.0080	0.0005	0.0075
135	0.0081	0.0005	0.0077
136	0.0082	0.0005	0.0077
137	0.0084	0.0005	0.0079
138	0.0084	0.0005	0.0079
139	0.0086	0.0005	0.0081
140	0.0087	0.0005	0.0081
141	0.0088	0.0005	0.0083
142	0.0089	0.0005	0.0084
143	0.0091	0.0005	0.0085
144	0.0092	0.0005	0.0086

145	0.0080	0.0005	0.0076
146	0.0081	0.0005	0.0076
147	0.0083	0.0005	0.0078
148	0.0084	0.0005	0.0079
149	0.0086	0.0005	0.0081
150	0.0087	0.0005	0.0082
151	0.0089	0.0005	0.0084
152	0.0090	0.0005	0.0085
153	0.0093	0.0005	0.0087
154	0.0094	0.0006	0.0088
155	0.0096	0.0006	0.0091
156	0.0098	0.0006	0.0092
157	0.0100	0.0006	0.0094
158	0.0102	0.0006	0.0096
159	0.0105	0.0006	0.0099
160	0.0106	0.0006	0.0100
161	0.0110	0.0007	0.0103
162	0.0112	0.0007	0.0105
163	0.0115	0.0007	0.0109
164	0.0117	0.0007	0.0111
165	0.0122	0.0007	0.0115
166	0.0124	0.0007	0.0117
167	0.0129	0.0008	0.0121
168	0.0132	0.0008	0.0124
169	0.0139	0.0008	0.0130
170	0.0142	0.0008	0.0133
171	0.0148	0.0009	0.0139
172	0.0152	0.0009	0.0143
173	0.0160	0.0009	0.0150
174	0.0164	0.0010	0.0154
175	0.0173	0.0010	0.0163
176	0.0178	0.0011	0.0168
177	0.0190	0.0011	0.0178
178	0.0196	0.0012	0.0185
179	0.0211	0.0012	0.0198
180	0.0219	0.0013	0.0206
181	0.0237	0.0014	0.0223
182	0.0248	0.0015	0.0234
183	0.0274	0.0016	0.0258
184	0.0289	0.0017	0.0272
185	0.0408	0.0024	0.0384
186	0.0435	0.0026	0.0409
187	0.0505	0.0030	0.0475
188	0.0551	0.0030	0.0521
189	0.0685	0.0030	0.0655
190	0.0789	0.0030	0.0759
191	0.1197	0.0030	0.1167
192	0.1738	0.0030	0.1708
193	0.7518	0.0030	0.7488
194	0.0942	0.0030	0.0912
195	0.0609	0.0030	0.0579
196	0.0467	0.0028	0.0439
197	0.0307	0.0018	0.0289
198	0.0260	0.0015	0.0245
199	0.0228	0.0013	0.0214
200	0.0203	0.0012	0.0191
201	0.0184	0.0011	0.0173

202	0.0168	0.0010	0.0158
203	0.0156	0.0009	0.0146
204	0.0145	0.0009	0.0136
205	0.0134	0.0008	0.0126
206	0.0126	0.0007	0.0119
207	0.0120	0.0007	0.0112
208	0.0114	0.0007	0.0107
209	0.0108	0.0006	0.0102
210	0.0103	0.0006	0.0097
211	0.0099	0.0006	0.0093
212	0.0095	0.0006	0.0089
213	0.0091	0.0005	0.0086
214	0.0088	0.0005	0.0083
215	0.0085	0.0005	0.0080
216	0.0082	0.0005	0.0077
217	0.0093	0.0005	0.0087
218	0.0090	0.0005	0.0085
219	0.0087	0.0005	0.0082
220	0.0085	0.0005	0.0080
221	0.0083	0.0005	0.0078
222	0.0081	0.0005	0.0076
223	0.0079	0.0005	0.0074
224	0.0077	0.0005	0.0072
225	0.0075	0.0004	0.0071
226	0.0074	0.0004	0.0069
227	0.0072	0.0004	0.0068
228	0.0071	0.0004	0.0066
229	0.0069	0.0004	0.0065
230	0.0068	0.0004	0.0064
231	0.0066	0.0004	0.0063
232	0.0065	0.0004	0.0061
233	0.0064	0.0004	0.0060
234	0.0063	0.0004	0.0059
235	0.0062	0.0004	0.0058
236	0.0061	0.0004	0.0057
237	0.0060	0.0004	0.0056
238	0.0059	0.0003	0.0055
239	0.0058	0.0003	0.0054
240	0.0057	0.0003	0.0054
241	0.0056	0.0003	0.0053
242	0.0055	0.0003	0.0052
243	0.0055	0.0003	0.0051
244	0.0054	0.0003	0.0051
245	0.0053	0.0003	0.0050
246	0.0052	0.0003	0.0049
247	0.0052	0.0003	0.0049
248	0.0051	0.0003	0.0048
249	0.0050	0.0003	0.0047
250	0.0050	0.0003	0.0047
251	0.0049	0.0003	0.0046
252	0.0048	0.0003	0.0045
253	0.0048	0.0003	0.0045
254	0.0047	0.0003	0.0044
255	0.0047	0.0003	0.0044
256	0.0046	0.0003	0.0043
257	0.0046	0.0003	0.0043
258	0.0045	0.0003	0.0042

259	0.0045	0.0003	0.0042
260	0.0044	0.0003	0.0042
261	0.0044	0.0003	0.0041
262	0.0043	0.0003	0.0041
263	0.0043	0.0003	0.0040
264	0.0042	0.0003	0.0040
265	0.0042	0.0002	0.0039
266	0.0041	0.0002	0.0039
267	0.0041	0.0002	0.0039
268	0.0041	0.0002	0.0038
269	0.0040	0.0002	0.0038
270	0.0040	0.0002	0.0038
271	0.0040	0.0002	0.0037
272	0.0039	0.0002	0.0037
273	0.0039	0.0002	0.0037
274	0.0038	0.0002	0.0036
275	0.0038	0.0002	0.0036
276	0.0038	0.0002	0.0036
277	0.0037	0.0002	0.0035
278	0.0037	0.0002	0.0035
279	0.0037	0.0002	0.0035
280	0.0037	0.0002	0.0034
281	0.0036	0.0002	0.0034
282	0.0036	0.0002	0.0034
283	0.0036	0.0002	0.0034
284	0.0035	0.0002	0.0033
285	0.0035	0.0002	0.0033
286	0.0035	0.0002	0.0033
287	0.0035	0.0002	0.0032
288	0.0034	0.0002	0.0032

Total soil rain loss = 0.15(In)
Total effective rainfall = 3.41(In)
Peak flow rate in flood hydrograph = 272.39(CFS)

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24 - H O U R S T O R M
R u n o f f H y d r o g r a p h

Hydrograph in 5 Minute intervals ((CFS))

```
Time(h+m) Volume Ac.Ft   Q(CFS)  0       75.0     150.0     225.0     300.0
-----------------------------------------------------------------------
  0+ 5       0.0007      0.11  Q         |         |         |         |
  0+10       0.0063      0.80  Q         |         |         |         |
  0+15       0.0180      1.71  Q         |         |         |         |
  0+20       0.0327      2.12  Q         |         |         |         |
  0+25       0.0490      2.37  Q         |         |         |         |
  0+30       0.0664      2.53  Q         |         |         |         |
  0+35       0.0847      2.65  Q         |         |         |         |
  0+40       0.1036      2.74  Q         |         |         |         |
  0+45       0.1230      2.82  Q         |         |         |         |
  0+50       0.1428      2.88  Q         |         |         |         |
  0+55       0.1629      2.92  Q         |         |         |         |
  1+ 0       0.1833      2.96  Q         |         |         |         |
```

1+ 5	0.2039	2.99	Q	|	|	|	|
1+10	0.2247	3.02	Q	|	|	|	|
1+15	0.2456	3.05	Q	|	|	|	|
1+20	0.2668	3.07	Q	|	|	|	|
1+25	0.2881	3.09	Q	|	|	|	|
1+30	0.3094	3.10	Q	|	|	|	|
1+35	0.3309	3.11	Q	|	|	|	|
1+40	0.3524	3.13	Q	|	|	|	|
1+45	0.3740	3.14	Q	|	|	|	|
1+50	0.3958	3.15	Q	|	|	|	|
1+55	0.4176	3.17	Q	|	|	|	|
2+ 0	0.4395	3.18	Q	|	|	|	|
2+ 5	0.4615	3.19	Q	|	|	|	|
2+10	0.4836	3.21	Q	|	|	|	|
2+15	0.5057	3.22	Q	|	|	|	|
2+20	0.5280	3.23	Q	|	|	|	|
2+25	0.5504	3.25	QV	|	|	|	|
2+30	0.5729	3.26	QV	|	|	|	|
2+35	0.5954	3.28	QV	|	|	|	|
2+40	0.6181	3.29	QV	|	|	|	|
2+45	0.6409	3.31	QV	|	|	|	|
2+50	0.6638	3.32	QV	|	|	|	|
2+55	0.6867	3.34	QV	|	|	|	|
3+ 0	0.7098	3.35	QV	|	|	|	|
3+ 5	0.7330	3.37	QV	|	|	|	|
3+10	0.7563	3.38	QV	|	|	|	|
3+15	0.7797	3.40	QV	|	|	|	|
3+20	0.8032	3.41	QV	|	|	|	|
3+25	0.8268	3.43	QV	|	|	|	|
3+30	0.8506	3.45	QV	|	|	|	|
3+35	0.8744	3.46	QV	|	|	|	|
3+40	0.8984	3.48	QV	|	|	|	|
3+45	0.9224	3.50	QV	|	|	|	|
3+50	0.9466	3.51	QV	|	|	|	|
3+55	0.9709	3.53	QV	|	|	|	|
4+ 0	0.9953	3.55	QV	|	|	|	|
4+ 5	1.0199	3.56	QV	|	|	|	|
4+10	1.0446	3.58	QV	|	|	|	|
4+15	1.0693	3.60	QV	|	|	|	|
4+20	1.0943	3.62	Q V	|	|	|	|
4+25	1.1193	3.64	Q V	|	|	|	|
4+30	1.1445	3.65	Q V	|	|	|	|
4+35	1.1698	3.67	Q V	|	|	|	|
4+40	1.1952	3.69	Q V	|	|	|	|
4+45	1.2208	3.71	Q V	|	|	|	|
4+50	1.2464	3.73	Q V	|	|	|	|
4+55	1.2723	3.75	Q V	|	|	|	|
5+ 0	1.2982	3.77	Q V	|	|	|	|
5+ 5	1.3244	3.79	Q V	|	|	|	|
5+10	1.3506	3.81	Q V	|	|	|	|
5+15	1.3770	3.83	Q V	|	|	|	|
5+20	1.4035	3.85	Q V	|	|	|	|
5+25	1.4302	3.87	Q V	|	|	|	|
5+30	1.4570	3.90	Q V	|	|	|	|
5+35	1.4840	3.92	Q V	|	|	|	|
5+40	1.5112	3.94	Q V	|	|	|	|
5+45	1.5385	3.96	Q V	|	|	|	|

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 5+50       1.5659      3.99  Q V       |          |          |          |
 5+55       1.5935      4.01  Q V       |          |          |          |
 6+ 0       1.6213      4.03  Q  V      |          |          |          |
 6+ 5       1.6492      4.06  Q  V      |          |          |          |
 6+10       1.6773      4.08  Q  V      |          |          |          |
 6+15       1.7056      4.10  Q  V      |          |          |          |
 6+20       1.7340      4.13  Q  V      |          |          |          |
 6+25       1.7626      4.15  Q  V      |          |          |          |
 6+30       1.7914      4.18  Q  V      |          |          |          |
 6+35       1.8204      4.21  Q  V      |          |          |          |
 6+40       1.8495      4.23  Q  V      |          |          |          |
 6+45       1.8788      4.26  Q  V      |          |          |          |
 6+50       1.9083      4.29  Q  V      |          |          |          |
 6+55       1.9380      4.31  Q  V      |          |          |          |
 7+ 0       1.9679      4.34  Q  V      |          |          |          |
 7+ 5       1.9980      4.37  Q  V      |          |          |          |
 7+10       2.0283      4.40  Q  V      |          |          |          |
 7+15       2.0588      4.43  Q  V      |          |          |          |
 7+20       2.0895      4.46  Q  V      |          |          |          |
 7+25       2.1204      4.49  Q  V      |          |          |          |
 7+30       2.1515      4.52  Q   V     |          |          |          |
 7+35       2.1828      4.55  Q   V     |          |          |          |
 7+40       2.2144      4.58  Q   V     |          |          |          |
 7+45       2.2462      4.61  Q   V     |          |          |          |
 7+50       2.2781      4.65  Q   V     |          |          |          |
 7+55       2.3104      4.68  Q   V     |          |          |          |
 8+ 0       2.3428      4.71  Q   V     |          |          |          |
 8+ 5       2.3755      4.75  Q   V     |          |          |          |
 8+10       2.4085      4.78  Q   V     |          |          |          |
 8+15       2.4416      4.82  Q   V     |          |          |          |
 8+20       2.4751      4.85  Q   V     |          |          |          |
 8+25       2.5088      4.89  Q   V     |          |          |          |
 8+30       2.5427      4.93  Q   V     |          |          |          |
 8+35       2.5769      4.97  Q   V     |          |          |          |
 8+40       2.6114      5.01  Q   V     |          |          |          |
 8+45       2.6461      5.05  Q   V     |          |          |          |
 8+50       2.6812      5.09  Q   V     |          |          |          |
 8+55       2.7165      5.13  Q    V    |          |          |          |
 9+ 0       2.7521      5.17  Q    V    |          |          |          |
 9+ 5       2.7880      5.21  Q    V    |          |          |          |
 9+10       2.8242      5.26  Q    V    |          |          |          |
 9+15       2.8608      5.30  Q    V    |          |          |          |
 9+20       2.8976      5.35  Q    V    |          |          |          |
 9+25       2.9347      5.40  Q    V    |          |          |          |
 9+30       2.9722      5.44  Q    V    |          |          |          |
 9+35       3.0101      5.49  Q    V    |          |          |          |
 9+40       3.0482      5.54  Q    V    |          |          |          |
 9+45       3.0867      5.59  Q    V    |          |          |          |
 9+50       3.1256      5.64  Q    V    |          |          |          |
 9+55       3.1648      5.70  Q    V    |          |          |          |
10+ 0       3.2044      5.75  Q    V    |          |          |          |
10+ 5       3.2444      5.81  Q     V   |          |          |          |
10+10       3.2848      5.86  Q     V   |          |          |          |
10+15       3.3256      5.92  Q     V   |          |          |          |
10+20       3.3668      5.98  Q     V   |          |          |          |
10+25       3.4084      6.04  Q     V   |          |          |          |
10+30       3.4505      6.11  Q     V   |          |          |          |
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10+35       3.4930      6.17  Q     V   |          |          |          |
10+40       3.5359      6.24  Q     V   |          |          |          |
10+45       3.5793      6.30  Q     V   |          |          |          |
10+50       3.6232      6.37  Q     V   |          |          |          |
10+55       3.6676      6.44  Q     V   |          |          |          |
11+ 0       3.7125      6.52  Q     V   |          |          |          |
11+ 5       3.7579      6.59  Q     V   |          |          |          |
11+10       3.8038      6.67  Q      V  |          |          |          |
11+15       3.8503      6.75  Q      V  |          |          |          |
11+20       3.8973      6.83  Q      V  |          |          |          |
11+25       3.9449      6.91  Q      V  |          |          |          |
11+30       3.9931      7.00  Q      V  |          |          |          |
11+35       4.0420      7.09  Q      V  |          |          |          |
11+40       4.0914      7.18  Q      V  |          |          |          |
11+45       4.1415      7.28  Q      V  |          |          |          |
11+50       4.1923      7.37  Q      V  |          |          |          |
11+55       4.2438      7.48  Q      V  |          |          |          |
12+ 0       4.2960      7.58  |Q     V  |          |          |          |
12+ 5       4.3487      7.65  |Q      V |          |          |          |
12+10       4.4002      7.49  Q       V |          |          |          |
12+15       4.4502      7.26  Q       V |          |          |          |
12+20       4.4999      7.22  Q       V |          |          |          |
12+25       4.5498      7.24  Q       V |          |          |          |
12+30       4.6001      7.30  Q       V |          |          |          |
12+35       4.6509      7.38  Q       V |          |          |          |
12+40       4.7024      7.48  Q       V |          |          |          |
12+45       4.7547      7.59  |Q      V |          |          |          |
12+50       4.8078      7.71  |Q      V |          |          |          |
12+55       4.8617      7.84  |Q       V|          |          |          |
13+ 0       4.9167      7.98  |Q       V|          |          |          |
13+ 5       4.9727      8.13  |Q       V|          |          |          |
13+10       5.0297      8.28  |Q       V|          |          |          |
13+15       5.0879      8.45  |Q       V|          |          |          |
13+20       5.1473      8.63  |Q       V|          |          |          |
13+25       5.2080      8.81  |Q       V|          |          |          |
13+30       5.2701      9.01  |Q       V|          |          |          |
13+35       5.3336      9.22  |Q       V|          |          |          |
13+40       5.3986      9.44  |Q        V          |          |          |
13+45       5.4653      9.68  |Q        V          |          |          |
13+50       5.5336      9.93  |Q        V          |          |          |
13+55       5.6038     10.19  |Q        V          |          |          |
14+ 0       5.6759     10.47  |Q        V          |          |          |
14+ 5       5.7501     10.78  |Q        V          |          |          |
14+10       5.8268     11.12  |Q        V          |          |          |
14+15       5.9060     11.51  |Q        V          |          |          |
14+20       5.9879     11.89  |Q        |V         |          |          |
14+25       6.0727     12.31  |Q        |V         |          |          |
14+30       6.1605     12.74  |Q        |V         |          |          |
14+35       6.2515     13.22  |Q        |V         |          |          |
14+40       6.3461     13.74  |Q        |V         |          |          |
14+45       6.4446     14.30  |Q        |V         |          |          |
14+50       6.5474     14.92  |Q        | V        |          |          |
14+55       6.6550     15.62  | Q       | V        |          |          |
15+ 0       6.7678     16.38  | Q       | V        |          |          |
15+ 5       6.8865     17.25  | Q       | V        |          |          |
15+10       7.0120     18.22  | Q       |  V       |          |          |
15+15       7.1452     19.34  | Q       |  V       |          |          |
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15+20       7.2874     20.64  | Q       |  V      |         |         |
15+25       7.4417     22.41  | Q       |  V      |         |         |
15+30       7.6202     25.92  |  Q      |   V     |         |         |
15+35       7.8295     30.38  |   Q     |   V     |         |         |
15+40       8.0668     34.46  |   Q     |    V    |         |         |
15+45       8.3365     39.16  |    Q    |    V    |         |         |
15+50       8.6497     45.48  |     Q   |     V   |         |         |
15+55       9.0257     54.59  |      Q  |     V   |         |         |
16+ 0       9.5149     71.03  |        Q|      V  |         |         |
16+ 5      10.3177    116.57  |         |    Q   V|         |         |
16+10      11.9908    242.93  |         |         | V       | Q       |
16+15      13.8668    272.39  |         |         |    V    |     Q   |
16+20      14.9716    160.42  |         |         |Q     V  |         |
16+25      15.7390    111.43  |         |   Q     |        V|         |
16+30      16.3107     83.01  |         |Q        |         V         |
16+35      16.7545     64.43  |       Q |         |         |V        |
16+40      17.1059     51.03  |     Q   |         |         |V        |
16+45      17.3987     42.52  |    Q    |         |         | V       |
16+50      17.6435     35.54  |   Q     |         |         | V       |
16+55      17.8507     30.09  |   Q     |         |         |  V      |
17+ 0      18.0251     25.33  |  Q      |         |         |  V      |
17+ 5      18.1722     21.35  | Q       |         |         |  V      |
17+10      18.3073     19.62  | Q       |         |         |   V     |
17+15      18.4322     18.14  | Q       |         |         |   V     |
17+20      18.5403     15.69  | Q       |         |         |   V     |
17+25      18.6357     13.86  |Q        |         |         |   V     |
17+30      18.7128     11.19  |Q        |         |         |   V     |
17+35      18.7843     10.38  |Q        |         |         |   V     |
17+40      18.8515      9.76  |Q        |         |         |    V    |
17+45      18.9151      9.24  |Q        |         |         |    V    |
17+50      18.9757      8.80  |Q        |         |         |    V    |
17+55      19.0336      8.41  |Q        |         |         |    V    |
18+ 0      19.0892      8.07  |Q        |         |         |    V    |
18+ 5      19.1429      7.79  |Q        |         |         |    V    |
18+10      19.1964      7.77  |Q        |         |         |    V    |
18+15      19.2505      7.85  |Q        |         |         |    V    |
18+20      19.3039      7.75  |Q        |         |         |    V    |
18+25      19.3562      7.61  |Q        |         |         |     V   |
18+30      19.4075      7.45  Q         |         |         |     V   |
18+35      19.4577      7.28  Q         |         |         |     V   |
18+40      19.5067      7.12  Q         |         |         |     V   |
18+45      19.5546      6.96  Q         |         |         |     V   |
18+50      19.6015      6.80  Q         |         |         |     V   |
18+55      19.6473      6.65  Q         |         |         |     V   |
19+ 0      19.6921      6.51  Q         |         |         |     V   |
19+ 5      19.7360      6.37  Q         |         |         |     V   |
19+10      19.7790      6.24  Q         |         |         |     V   |
19+15      19.8211      6.11  Q         |         |         |     V   |
19+20      19.8623      5.99  Q         |         |         |     V   |
19+25      19.9028      5.88  Q         |         |         |      V  |
19+30      19.9425      5.76  Q         |         |         |      V  |
19+35      19.9815      5.65  Q         |         |         |      V  |
19+40      20.0197      5.55  Q         |         |         |      V  |
19+45      20.0572      5.45  Q         |         |         |      V  |
19+50      20.0941      5.36  Q         |         |         |      V  |
19+55      20.1304      5.27  Q         |         |         |      V  |
20+ 0      20.1660      5.18  Q         |         |         |      V  |
```

```
20+ 5      20.2011      5.09  Q          |          |          |       V  |
20+10      20.2356      5.01  Q          |          |          |       V  |
20+15      20.2696      4.93  Q          |          |          |       V  |
20+20      20.3031      4.86  Q          |          |          |       V  |
20+25      20.3361      4.79  Q          |          |          |       V  |
20+30      20.3685      4.72  Q          |          |          |       V  |
20+35      20.4006      4.65  Q          |          |          |       V  |
20+40      20.4321      4.58  Q          |          |          |        V |
20+45      20.4633      4.52  Q          |          |          |        V |
20+50      20.4940      4.46  Q          |          |          |        V |
20+55      20.5243      4.40  Q          |          |          |        V |
21+ 0      20.5542      4.34  Q          |          |          |        V |
21+ 5      20.5837      4.29  Q          |          |          |        V |
21+10      20.6129      4.23  Q          |          |          |        V |
21+15      20.6417      4.18  Q          |          |          |        V |
21+20      20.6701      4.13  Q          |          |          |        V |
21+25      20.6982      4.08  Q          |          |          |        V |
21+30      20.7260      4.03  Q          |          |          |        V |
21+35      20.7535      3.99  Q          |          |          |        V |
21+40      20.7806      3.94  Q          |          |          |        V |
21+45      20.8075      3.90  Q          |          |          |        V |
21+50      20.8340      3.85  Q          |          |          |        V |
21+55      20.8603      3.81  Q          |          |          |        V |
22+ 0      20.8862      3.77  Q          |          |          |        V |
22+ 5      20.9119      3.73  Q          |          |          |        V |
22+10      20.9374      3.69  Q          |          |          |        V |
22+15      20.9625      3.66  Q          |          |          |        V |
22+20      20.9875      3.62  Q          |          |          |         V|
22+25      21.0121      3.58  Q          |          |          |         V|
22+30      21.0366      3.55  Q          |          |          |         V|
22+35      21.0608      3.51  Q          |          |          |         V|
22+40      21.0847      3.48  Q          |          |          |         V|
22+45      21.1084      3.45  Q          |          |          |         V|
22+50      21.1320      3.41  Q          |          |          |         V|
22+55      21.1553      3.38  Q          |          |          |         V|
23+ 0      21.1783      3.35  Q          |          |          |         V|
23+ 5      21.2012      3.32  Q          |          |          |         V|
23+10      21.2239      3.29  Q          |          |          |         V|
23+15      21.2464      3.26  Q          |          |          |         V|
23+20      21.2686      3.24  Q          |          |          |         V|
23+25      21.2907      3.21  Q          |          |          |         V|
23+30      21.3126      3.18  Q          |          |          |         V|
23+35      21.3344      3.15  Q          |          |          |         V|
23+40      21.3559      3.13  Q          |          |          |         V|
23+45      21.3773      3.10  Q          |          |          |         V|
23+50      21.3985      3.08  Q          |          |          |         V|
23+55      21.4195      3.05  Q          |          |          |         V|
24+ 0      21.4403      3.03  Q          |          |          |         V|
24+ 5      21.4603      2.90  Q          |          |          |         V|
24+10      21.4753      2.18  Q          |          |          |         V|
24+15      21.4840      1.26  Q          |          |          |         V|
24+20      21.4899      0.85  Q          |          |          |         V|
24+25      21.4940      0.61  Q          |          |          |         V|
24+30      21.4971      0.44  Q          |          |          |         V|
24+35      21.4994      0.33  Q          |          |          |         V|
24+40      21.5011      0.25  Q          |          |          |         V|
24+45      21.5023      0.18  Q          |          |          |         V|
```

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   24+50      21.5032      0.13  Q         |         |         |        V|
   24+55      21.5039      0.10  Q         |         |         |        V|
   25+ 0      21.5044      0.07  Q         |         |         |        V|
   25+ 5      21.5047      0.05  Q         |         |         |        V|
   25+10      21.5050      0.04  Q         |         |         |        V|
   25+15      21.5051      0.02  Q         |         |         |        V|
   25+20      21.5052      0.01  Q         |         |         |         V
-----------------------------------------------------------------------
```

U n i t H y d r o g r a p h A n a l y s i s

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Study date 04/09/15

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San Bernardino County Synthetic Unit Hydrology Method
Manual date - August 1986

Program License Serial Number 6320

154166 - AMBOY - SAN BERNARDINO COUNTY
HISTORIC CONDITION "B"
100-YEAR, 24-HOUR STORM
BY: JTS DATE: 04-09-15

Storm Event Year = 100

Antecedent Moisture Condition = 3

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

English Units used in output format

Area averaged rainfall intensity isohyetal data:

Sub-Area (Ac.)	Duration (hours)	Isohyetal (In)
Rainfall data for year 10		
85.07	1	0.86
Rainfall data for year 2		
85.07	6	0.75
Rainfall data for year 2		
85.07	24	1.07
Rainfall data for year 100		
85.07	1	1.59
Rainfall data for year 100		
85.07	6	2.43
Rainfall data for year 100		
85.07	24	3.56

```
-----------------------------------------------------------------
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

******** Area-averaged max loss rate, Fm ********


SCS curve  SCS curve     Area     Area     Fp(Fig C6)    Ap      Fm
No.(AMCII) NO.(AMC 3)    (Ac.)    Fraction     (In/Hr)  (dec.)   (In/Hr)
 91.0      98.2         85.07      1.000     0.036    1.000    0.036

Area-averaged adjusted loss rate Fm (In/Hr) =  0.036

********* Area-Averaged low loss rate fraction, Yb **********

Area       Area          SCS CN    SCS CN      S     Pervious
 (Ac.)      Fract         (AMC2)    (AMC3)           Yield Fr
    85.07   1.000         91.0      98.2       0.18     0.941

Area-averaged catchment yield fraction, Y =  0.941
Area-averaged low loss fraction, Yb =  0.059
User entry of time of concentration  =   0.280 (hours)
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Watershed area =      85.07(Ac.)
Catchment Lag time =   0.224 hours
Unit interval =   5.000 minutes
Unit interval percentage of lag time = 37.2024
Hydrograph baseflow =     0.00(CFS)
Average maximum watershed loss rate(Fm) =  0.036(In/Hr)
Average low loss rate fraction (Yb) = 0.059 (decimal)
DESERT S-Graph Selected
Computed peak 5-minute rainfall =  0.754(In)
Computed peak 30-minute rainfall =  1.291(In)
Specified peak 1-hour rainfall =  1.590(In)
Computed peak 3-hour rainfall =  2.062(In)
Specified peak 6-hour rainfall =  2.430(In)
Specified peak 24-hour rainfall =  3.560(In)


Rainfall depth area reduction factors:
Using a total area of      85.07(Ac.) (Ref: fig. E-4)

5-minute factor = 0.996     Adjusted rainfall =  0.751(In)
30-minute factor = 0.996    Adjusted rainfall =  1.286(In)
1-hour factor = 0.996       Adjusted rainfall =  1.584(In)
3-hour factor = 0.999       Adjusted rainfall =  2.061(In)
6-hour factor = 1.000       Adjusted rainfall =  2.429(In)
24-hour factor = 1.000      Adjusted rainfall =  3.560(In)
-------------------------------------------------------------------

                  U n i t  H y d r o g r a p h
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Interval          'S' Graph          Unit Hydrograph
Number            Mean values             ((CFS))
-------------------------------------------------------------------
            (K =      1028.82 (CFS))

  1                 2.453                   25.238
```

2	15.615	135.411
3	44.808	300.341
4	62.667	183.742
5	72.342	99.531
6	78.814	66.587
7	83.398	47.156
8	86.976	36.813
9	89.667	27.683
10	91.740	21.327
11	93.476	17.861
12	94.846	14.100
13	95.989	11.762
14	96.911	9.485
15	97.603	7.114
16	98.066	4.768
17	98.467	4.118
18	98.913	4.587
19	99.355	4.556
20	99.659	3.125
21	100.000	1.562

Peak Unit Number	Adjusted mass rainfall (In)	Unit rainfall (In)
1	0.7515	0.7515
2	0.9252	0.1737
3	1.0448	0.1197
4	1.1390	0.0942
5	1.2179	0.0789
6	1.2863	0.0685
7	1.3472	0.0609
8	1.4023	0.0551
9	1.4527	0.0504
10	1.4994	0.0467
11	1.5429	0.0435
12	1.5837	0.0408
13	1.6144	0.0307
14	1.6433	0.0290
15	1.6707	0.0274
16	1.6968	0.0261
17	1.7217	0.0249
18	1.7454	0.0238
19	1.7682	0.0228
20	1.7901	0.0219
21	1.8112	0.0211
22	1.8315	0.0203
23	1.8512	0.0196
24	1.8702	0.0190
25	1.8886	0.0184
26	1.9064	0.0179
27	1.9238	0.0173
28	1.9406	0.0169
29	1.9570	0.0164
30	1.9730	0.0160
31	1.9886	0.0156
32	2.0038	0.0152
33	2.0186	0.0148
34	2.0332	0.0145

35	2.0473	0.0142
36	2.0612	0.0139
37	2.0747	0.0134
38	2.0878	0.0132
39	2.1007	0.0129
40	2.1134	0.0126
41	2.1258	0.0124
42	2.1379	0.0122
43	2.1499	0.0120
44	2.1617	0.0117
45	2.1732	0.0115
46	2.1846	0.0114
47	2.1957	0.0112
48	2.2067	0.0110
49	2.2175	0.0108
50	2.2282	0.0106
51	2.2387	0.0105
52	2.2490	0.0103
53	2.2592	0.0102
54	2.2692	0.0100
55	2.2791	0.0099
56	2.2888	0.0098
57	2.2985	0.0096
58	2.3080	0.0095
59	2.3173	0.0094
60	2.3266	0.0093
61	2.3357	0.0091
62	2.3447	0.0090
63	2.3537	0.0089
64	2.3625	0.0088
65	2.3712	0.0087
66	2.3798	0.0086
67	2.3883	0.0085
68	2.3967	0.0084
69	2.4050	0.0083
70	2.4132	0.0082
71	2.4213	0.0081
72	2.4294	0.0080
73	2.4386	0.0093
74	2.4478	0.0092
75	2.4568	0.0091
76	2.4658	0.0090
77	2.4747	0.0089
78	2.4835	0.0088
79	2.4923	0.0087
80	2.5009	0.0087
81	2.5095	0.0086
82	2.5180	0.0085
83	2.5264	0.0084
84	2.5348	0.0084
85	2.5431	0.0083
86	2.5513	0.0082
87	2.5594	0.0081
88	2.5675	0.0081
89	2.5755	0.0080
90	2.5834	0.0079
91	2.5913	0.0079

92	2.5991	0.0078
93	2.6069	0.0078
94	2.6146	0.0077
95	2.6222	0.0076
96	2.6298	0.0076
97	2.6373	0.0075
98	2.6448	0.0075
99	2.6522	0.0074
100	2.6595	0.0074
101	2.6668	0.0073
102	2.6741	0.0073
103	2.6813	0.0072
104	2.6884	0.0071
105	2.6955	0.0071
106	2.7026	0.0071
107	2.7096	0.0070
108	2.7165	0.0070
109	2.7235	0.0069
110	2.7303	0.0069
111	2.7371	0.0068
112	2.7439	0.0068
113	2.7506	0.0067
114	2.7573	0.0067
115	2.7640	0.0066
116	2.7706	0.0066
117	2.7771	0.0066
118	2.7837	0.0065
119	2.7901	0.0065
120	2.7966	0.0064
121	2.8030	0.0064
122	2.8093	0.0064
123	2.8157	0.0063
124	2.8220	0.0063
125	2.8282	0.0063
126	2.8344	0.0062
127	2.8406	0.0062
128	2.8468	0.0061
129	2.8529	0.0061
130	2.8589	0.0061
131	2.8650	0.0060
132	2.8710	0.0060
133	2.8770	0.0060
134	2.8829	0.0059
135	2.8888	0.0059
136	2.8947	0.0059
137	2.9006	0.0058
138	2.9064	0.0058
139	2.9122	0.0058
140	2.9179	0.0058
141	2.9237	0.0057
142	2.9294	0.0057
143	2.9350	0.0057
144	2.9407	0.0056
145	2.9463	0.0056
146	2.9519	0.0056
147	2.9574	0.0056
148	2.9630	0.0055

149	2.9685	0.0055
150	2.9739	0.0055
151	2.9794	0.0055
152	2.9848	0.0054
153	2.9902	0.0054
154	2.9956	0.0054
155	3.0009	0.0053
156	3.0063	0.0053
157	3.0116	0.0053
158	3.0168	0.0053
159	3.0221	0.0052
160	3.0273	0.0052
161	3.0325	0.0052
162	3.0377	0.0052
163	3.0428	0.0052
164	3.0480	0.0051
165	3.0531	0.0051
166	3.0582	0.0051
167	3.0632	0.0051
168	3.0683	0.0050
169	3.0733	0.0050
170	3.0783	0.0050
171	3.0833	0.0050
172	3.0882	0.0050
173	3.0932	0.0049
174	3.0981	0.0049
175	3.1030	0.0049
176	3.1079	0.0049
177	3.1127	0.0049
178	3.1176	0.0048
179	3.1224	0.0048
180	3.1272	0.0048
181	3.1320	0.0048
182	3.1367	0.0048
183	3.1415	0.0047
184	3.1462	0.0047
185	3.1509	0.0047
186	3.1556	0.0047
187	3.1602	0.0047
188	3.1649	0.0046
189	3.1695	0.0046
190	3.1741	0.0046
191	3.1787	0.0046
192	3.1833	0.0046
193	3.1879	0.0046
194	3.1924	0.0045
195	3.1969	0.0045
196	3.2014	0.0045
197	3.2059	0.0045
198	3.2104	0.0045
199	3.2149	0.0045
200	3.2193	0.0044
201	3.2237	0.0044
202	3.2282	0.0044
203	3.2325	0.0044
204	3.2369	0.0044
205	3.2413	0.0044

206	3.2456	0.0043
207	3.2500	0.0043
208	3.2543	0.0043
209	3.2586	0.0043
210	3.2629	0.0043
211	3.2672	0.0043
212	3.2714	0.0043
213	3.2757	0.0042
214	3.2799	0.0042
215	3.2841	0.0042
216	3.2883	0.0042
217	3.2925	0.0042
218	3.2967	0.0042
219	3.3008	0.0042
220	3.3050	0.0041
221	3.3091	0.0041
222	3.3132	0.0041
223	3.3173	0.0041
224	3.3214	0.0041
225	3.3255	0.0041
226	3.3296	0.0041
227	3.3336	0.0041
228	3.3377	0.0040
229	3.3417	0.0040
230	3.3457	0.0040
231	3.3497	0.0040
232	3.3537	0.0040
233	3.3577	0.0040
234	3.3617	0.0040
235	3.3656	0.0040
236	3.3696	0.0039
237	3.3735	0.0039
238	3.3774	0.0039
239	3.3813	0.0039
240	3.3852	0.0039
241	3.3891	0.0039
242	3.3929	0.0039
243	3.3968	0.0039
244	3.4006	0.0038
245	3.4045	0.0038
246	3.4083	0.0038
247	3.4121	0.0038
248	3.4159	0.0038
249	3.4197	0.0038
250	3.4235	0.0038
251	3.4273	0.0038
252	3.4310	0.0038
253	3.4348	0.0037
254	3.4385	0.0037
255	3.4422	0.0037
256	3.4459	0.0037
257	3.4496	0.0037
258	3.4533	0.0037
259	3.4570	0.0037
260	3.4607	0.0037
261	3.4644	0.0037
262	3.4680	0.0037

263	3.4717	0.0036
264	3.4753	0.0036
265	3.4789	0.0036
266	3.4825	0.0036
267	3.4861	0.0036
268	3.4897	0.0036
269	3.4933	0.0036
270	3.4969	0.0036
271	3.5004	0.0036
272	3.5040	0.0036
273	3.5075	0.0035
274	3.5111	0.0035
275	3.5146	0.0035
276	3.5181	0.0035
277	3.5216	0.0035
278	3.5251	0.0035
279	3.5286	0.0035
280	3.5321	0.0035
281	3.5356	0.0035
282	3.5390	0.0035
283	3.5425	0.0035
284	3.5459	0.0034
285	3.5494	0.0034
286	3.5528	0.0034
287	3.5562	0.0034
288	3.5596	0.0034

Unit Period (number)	Unit Rainfall (In)	Unit Soil-Loss (In)	Effective Rainfall (In)
1	0.0034	0.0002	0.0032
2	0.0034	0.0002	0.0032
3	0.0034	0.0002	0.0032
4	0.0034	0.0002	0.0032
5	0.0035	0.0002	0.0033
6	0.0035	0.0002	0.0033
7	0.0035	0.0002	0.0033
8	0.0035	0.0002	0.0033
9	0.0035	0.0002	0.0033
10	0.0035	0.0002	0.0033
11	0.0035	0.0002	0.0033
12	0.0036	0.0002	0.0033
13	0.0036	0.0002	0.0034
14	0.0036	0.0002	0.0034
15	0.0036	0.0002	0.0034
16	0.0036	0.0002	0.0034
17	0.0036	0.0002	0.0034
18	0.0036	0.0002	0.0034
19	0.0037	0.0002	0.0034
20	0.0037	0.0002	0.0035
21	0.0037	0.0002	0.0035
22	0.0037	0.0002	0.0035
23	0.0037	0.0002	0.0035
24	0.0037	0.0002	0.0035
25	0.0038	0.0002	0.0035
26	0.0038	0.0002	0.0035

27	0.0038	0.0002	0.0036
28	0.0038	0.0002	0.0036
29	0.0038	0.0002	0.0036
30	0.0038	0.0002	0.0036
31	0.0039	0.0002	0.0036
32	0.0039	0.0002	0.0036
33	0.0039	0.0002	0.0037
34	0.0039	0.0002	0.0037
35	0.0039	0.0002	0.0037
36	0.0039	0.0002	0.0037
37	0.0040	0.0002	0.0037
38	0.0040	0.0002	0.0037
39	0.0040	0.0002	0.0038
40	0.0040	0.0002	0.0038
41	0.0040	0.0002	0.0038
42	0.0041	0.0002	0.0038
43	0.0041	0.0002	0.0038
44	0.0041	0.0002	0.0039
45	0.0041	0.0002	0.0039
46	0.0041	0.0002	0.0039
47	0.0042	0.0002	0.0039
48	0.0042	0.0002	0.0039
49	0.0042	0.0002	0.0040
50	0.0042	0.0002	0.0040
51	0.0042	0.0003	0.0040
52	0.0043	0.0003	0.0040
53	0.0043	0.0003	0.0040
54	0.0043	0.0003	0.0040
55	0.0043	0.0003	0.0041
56	0.0043	0.0003	0.0041
57	0.0044	0.0003	0.0041
58	0.0044	0.0003	0.0041
59	0.0044	0.0003	0.0042
60	0.0044	0.0003	0.0042
61	0.0045	0.0003	0.0042
62	0.0045	0.0003	0.0042
63	0.0045	0.0003	0.0043
64	0.0045	0.0003	0.0043
65	0.0046	0.0003	0.0043
66	0.0046	0.0003	0.0043
67	0.0046	0.0003	0.0044
68	0.0046	0.0003	0.0044
69	0.0047	0.0003	0.0044
70	0.0047	0.0003	0.0044
71	0.0047	0.0003	0.0045
72	0.0048	0.0003	0.0045
73	0.0048	0.0003	0.0045
74	0.0048	0.0003	0.0045
75	0.0049	0.0003	0.0046
76	0.0049	0.0003	0.0046
77	0.0049	0.0003	0.0046
78	0.0049	0.0003	0.0046
79	0.0050	0.0003	0.0047
80	0.0050	0.0003	0.0047
81	0.0050	0.0003	0.0047
82	0.0051	0.0003	0.0048
83	0.0051	0.0003	0.0048

84	0.0051	0.0003	0.0048
85	0.0052	0.0003	0.0049
86	0.0052	0.0003	0.0049
87	0.0052	0.0003	0.0049
88	0.0053	0.0003	0.0050
89	0.0053	0.0003	0.0050
90	0.0053	0.0003	0.0050
91	0.0054	0.0003	0.0051
92	0.0054	0.0003	0.0051
93	0.0055	0.0003	0.0052
94	0.0055	0.0003	0.0052
95	0.0056	0.0003	0.0052
96	0.0056	0.0003	0.0053
97	0.0056	0.0003	0.0053
98	0.0057	0.0003	0.0053
99	0.0057	0.0003	0.0054
100	0.0058	0.0003	0.0054
101	0.0058	0.0003	0.0055
102	0.0058	0.0003	0.0055
103	0.0059	0.0004	0.0056
104	0.0059	0.0004	0.0056
105	0.0060	0.0004	0.0057
106	0.0060	0.0004	0.0057
107	0.0061	0.0004	0.0057
108	0.0061	0.0004	0.0058
109	0.0062	0.0004	0.0058
110	0.0063	0.0004	0.0059
111	0.0063	0.0004	0.0060
112	0.0064	0.0004	0.0060
113	0.0064	0.0004	0.0061
114	0.0065	0.0004	0.0061
115	0.0066	0.0004	0.0062
116	0.0066	0.0004	0.0062
117	0.0067	0.0004	0.0063
118	0.0067	0.0004	0.0063
119	0.0068	0.0004	0.0064
120	0.0069	0.0004	0.0065
121	0.0070	0.0004	0.0065
122	0.0070	0.0004	0.0066
123	0.0071	0.0004	0.0067
124	0.0071	0.0004	0.0067
125	0.0073	0.0004	0.0068
126	0.0073	0.0004	0.0069
127	0.0074	0.0004	0.0070
128	0.0075	0.0004	0.0070
129	0.0076	0.0004	0.0071
130	0.0076	0.0005	0.0072
131	0.0078	0.0005	0.0073
132	0.0078	0.0005	0.0074
133	0.0079	0.0005	0.0075
134	0.0080	0.0005	0.0075
135	0.0081	0.0005	0.0077
136	0.0082	0.0005	0.0077
137	0.0084	0.0005	0.0079
138	0.0084	0.0005	0.0079
139	0.0086	0.0005	0.0081
140	0.0087	0.0005	0.0081

141	0.0088	0.0005	0.0083
142	0.0089	0.0005	0.0084
143	0.0091	0.0005	0.0085
144	0.0092	0.0005	0.0086
145	0.0080	0.0005	0.0076
146	0.0081	0.0005	0.0076
147	0.0083	0.0005	0.0078
148	0.0084	0.0005	0.0079
149	0.0086	0.0005	0.0081
150	0.0087	0.0005	0.0082
151	0.0089	0.0005	0.0084
152	0.0090	0.0005	0.0085
153	0.0093	0.0005	0.0087
154	0.0094	0.0006	0.0088
155	0.0096	0.0006	0.0091
156	0.0098	0.0006	0.0092
157	0.0100	0.0006	0.0094
158	0.0102	0.0006	0.0096
159	0.0105	0.0006	0.0099
160	0.0106	0.0006	0.0100
161	0.0110	0.0007	0.0103
162	0.0112	0.0007	0.0105
163	0.0115	0.0007	0.0109
164	0.0117	0.0007	0.0111
165	0.0122	0.0007	0.0115
166	0.0124	0.0007	0.0117
167	0.0129	0.0008	0.0121
168	0.0132	0.0008	0.0124
169	0.0139	0.0008	0.0131
170	0.0142	0.0008	0.0133
171	0.0148	0.0009	0.0140
172	0.0152	0.0009	0.0143
173	0.0160	0.0009	0.0150
174	0.0164	0.0010	0.0154
175	0.0173	0.0010	0.0163
176	0.0179	0.0011	0.0168
177	0.0190	0.0011	0.0179
178	0.0196	0.0012	0.0185
179	0.0211	0.0012	0.0198
180	0.0219	0.0013	0.0206
181	0.0238	0.0014	0.0224
182	0.0249	0.0015	0.0234
183	0.0274	0.0016	0.0258
184	0.0290	0.0017	0.0272
185	0.0408	0.0024	0.0384
186	0.0435	0.0026	0.0409
187	0.0504	0.0030	0.0475
188	0.0551	0.0030	0.0521
189	0.0685	0.0030	0.0655
190	0.0789	0.0030	0.0759
191	0.1197	0.0030	0.1167
192	0.1737	0.0030	0.1707
193	0.7515	0.0030	0.7485
194	0.0942	0.0030	0.0912
195	0.0609	0.0030	0.0579
196	0.0467	0.0028	0.0439
197	0.0307	0.0018	0.0289

198	0.0261	0.0015	0.0245
199	0.0228	0.0013	0.0214
200	0.0203	0.0012	0.0191
201	0.0184	0.0011	0.0173
202	0.0169	0.0010	0.0159
203	0.0156	0.0009	0.0147
204	0.0145	0.0009	0.0136
205	0.0134	0.0008	0.0126
206	0.0126	0.0007	0.0119
207	0.0120	0.0007	0.0113
208	0.0114	0.0007	0.0107
209	0.0108	0.0006	0.0102
210	0.0103	0.0006	0.0097
211	0.0099	0.0006	0.0093
212	0.0095	0.0006	0.0089
213	0.0091	0.0005	0.0086
214	0.0088	0.0005	0.0083
215	0.0085	0.0005	0.0080
216	0.0082	0.0005	0.0077
217	0.0093	0.0005	0.0087
218	0.0090	0.0005	0.0085
219	0.0087	0.0005	0.0082
220	0.0085	0.0005	0.0080
221	0.0083	0.0005	0.0078
222	0.0081	0.0005	0.0076
223	0.0079	0.0005	0.0074
224	0.0077	0.0005	0.0072
225	0.0075	0.0004	0.0071
226	0.0074	0.0004	0.0069
227	0.0072	0.0004	0.0068
228	0.0071	0.0004	0.0066
229	0.0069	0.0004	0.0065
230	0.0068	0.0004	0.0064
231	0.0066	0.0004	0.0063
232	0.0065	0.0004	0.0061
233	0.0064	0.0004	0.0060
234	0.0063	0.0004	0.0059
235	0.0062	0.0004	0.0058
236	0.0061	0.0004	0.0057
237	0.0060	0.0004	0.0056
238	0.0059	0.0003	0.0055
239	0.0058	0.0003	0.0054
240	0.0057	0.0003	0.0054
241	0.0056	0.0003	0.0053
242	0.0055	0.0003	0.0052
243	0.0055	0.0003	0.0051
244	0.0054	0.0003	0.0051
245	0.0053	0.0003	0.0050
246	0.0052	0.0003	0.0049
247	0.0052	0.0003	0.0049
248	0.0051	0.0003	0.0048
249	0.0050	0.0003	0.0047
250	0.0050	0.0003	0.0047
251	0.0049	0.0003	0.0046
252	0.0048	0.0003	0.0045
253	0.0048	0.0003	0.0045
254	0.0047	0.0003	0.0044

255	0.0047	0.0003	0.0044
256	0.0046	0.0003	0.0043
257	0.0046	0.0003	0.0043
258	0.0045	0.0003	0.0042
259	0.0045	0.0003	0.0042
260	0.0044	0.0003	0.0042
261	0.0044	0.0003	0.0041
262	0.0043	0.0003	0.0041
263	0.0043	0.0003	0.0040
264	0.0042	0.0003	0.0040
265	0.0042	0.0002	0.0039
266	0.0041	0.0002	0.0039
267	0.0041	0.0002	0.0039
268	0.0041	0.0002	0.0038
269	0.0040	0.0002	0.0038
270	0.0040	0.0002	0.0038
271	0.0040	0.0002	0.0037
272	0.0039	0.0002	0.0037
273	0.0039	0.0002	0.0037
274	0.0038	0.0002	0.0036
275	0.0038	0.0002	0.0036
276	0.0038	0.0002	0.0036
277	0.0037	0.0002	0.0035
278	0.0037	0.0002	0.0035
279	0.0037	0.0002	0.0035
280	0.0037	0.0002	0.0034
281	0.0036	0.0002	0.0034
282	0.0036	0.0002	0.0034
283	0.0036	0.0002	0.0034
284	0.0035	0.0002	0.0033
285	0.0035	0.0002	0.0033
286	0.0035	0.0002	0.0033
287	0.0035	0.0002	0.0032
288	0.0034	0.0002	0.0032

Total soil rain loss = 0.15(In)
Total effective rainfall = 3.41(In)
Peak flow rate in flood hydrograph = 296.02(CFS)

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24 - H O U R S T O R M
R u n o f f H y d r o g r a p h

Hydrograph in 5 Minute intervals ((CFS))

```
Time(h+m) Volume Ac.Ft   Q(CFS)  0       75.0     150.0     225.0     300.0
-----------------------------------------------------------------------
  0+ 5       0.0006      0.08  Q         |         |         |         |
  0+10       0.0041      0.52  Q         |         |         |         |
  0+15       0.0143      1.48  Q         |         |         |         |
  0+20       0.0286      2.08  Q         |         |         |         |
  0+25       0.0451      2.40  Q         |         |         |         |
  0+30       0.0632      2.62  Q         |         |         |         |
  0+35       0.0824      2.79  Q         |         |         |         |
  0+40       0.1025      2.91  Q         |         |         |         |
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0+45	0.1232	3.02	Q	|	|	|	|
0+50	0.1446	3.09	Q	|	|	|	|
0+55	0.1664	3.16	Q	|	|	|	|
1+ 0	0.1885	3.22	Q	|	|	|	|
1+ 5	0.2111	3.27	Q	|	|	|	|
1+10	0.2339	3.32	Q	|	|	|	|
1+15	0.2570	3.35	Q	|	|	|	|
1+20	0.2803	3.38	Q	|	|	|	|
1+25	0.3038	3.41	Q	|	|	|	|
1+30	0.3274	3.44	Q	|	|	|	|
1+35	0.3513	3.46	Q	|	|	|	|
1+40	0.3753	3.49	Q	|	|	|	|
1+45	0.3995	3.51	Q	|	|	|	|
1+50	0.4237	3.52	Q	|	|	|	|
1+55	0.4481	3.54	Q	|	|	|	|
2+ 0	0.4726	3.55	Q	|	|	|	|
2+ 5	0.4971	3.57	Q	|	|	|	|
2+10	0.5218	3.58	Q	|	|	|	|
2+15	0.5466	3.60	Q	|	|	|	|
2+20	0.5715	3.61	Q	|	|	|	|
2+25	0.5965	3.63	Q	|	|	|	|
2+30	0.6216	3.64	QV	|	|	|	|
2+35	0.6468	3.66	QV	|	|	|	|
2+40	0.6721	3.68	QV	|	|	|	|
2+45	0.6975	3.69	QV	|	|	|	|
2+50	0.7231	3.71	QV	|	|	|	|
2+55	0.7487	3.73	QV	|	|	|	|
3+ 0	0.7745	3.74	QV	|	|	|	|
3+ 5	0.8004	3.76	QV	|	|	|	|
3+10	0.8264	3.78	QV	|	|	|	|
3+15	0.8526	3.79	QV	|	|	|	|
3+20	0.8788	3.81	QV	|	|	|	|
3+25	0.9052	3.83	QV	|	|	|	|
3+30	0.9317	3.85	QV	|	|	|	|
3+35	0.9583	3.87	QV	|	|	|	|
3+40	0.9850	3.88	QV	|	|	|	|
3+45	1.0119	3.90	QV	|	|	|	|
3+50	1.0389	3.92	QV	|	|	|	|
3+55	1.0661	3.94	QV	|	|	|	|
4+ 0	1.0933	3.96	QV	|	|	|	|
4+ 5	1.1207	3.98	QV	|	|	|	|
4+10	1.1483	4.00	QV	|	|	|	|
4+15	1.1759	4.02	QV	|	|	|	|
4+20	1.2037	4.04	QV	|	|	|	|
4+25	1.2317	4.06	Q V	|	|	|	|
4+30	1.2598	4.08	Q V	|	|	|	|
4+35	1.2880	4.10	Q V	|	|	|	|
4+40	1.3164	4.12	Q V	|	|	|	|
4+45	1.3449	4.14	Q V	|	|	|	|
4+50	1.3736	4.16	Q V	|	|	|	|
4+55	1.4025	4.19	Q V	|	|	|	|
5+ 0	1.4314	4.21	Q V	|	|	|	|
5+ 5	1.4606	4.23	Q V	|	|	|	|
5+10	1.4899	4.25	Q V	|	|	|	|
5+15	1.5193	4.28	Q V	|	|	|	|
5+20	1.5489	4.30	Q V	|	|	|	|
5+25	1.5787	4.32	Q V	|	|	|	|

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 5+30       1.6086      4.35  Q V       |          |          |          |
 5+35       1.6387      4.37  Q V       |          |          |          |
 5+40       1.6690      4.40  Q V       |          |          |          |
 5+45       1.6995      4.42  Q V       |          |          |          |
 5+50       1.7301      4.45  Q V       |          |          |          |
 5+55       1.7609      4.47  Q V       |          |          |          |
 6+ 0       1.7919      4.50  Q V       |          |          |          |
 6+ 5       1.8230      4.52  Q  V      |          |          |          |
 6+10       1.8544      4.55  Q  V      |          |          |          |
 6+15       1.8859      4.58  Q  V      |          |          |          |
 6+20       1.9176      4.61  Q  V      |          |          |          |
 6+25       1.9495      4.63  Q  V      |          |          |          |
 6+30       1.9816      4.66  Q  V      |          |          |          |
 6+35       2.0139      4.69  Q  V      |          |          |          |
 6+40       2.0464      4.72  Q  V      |          |          |          |
 6+45       2.0791      4.75  Q  V      |          |          |          |
 6+50       2.1121      4.78  Q  V      |          |          |          |
 6+55       2.1452      4.81  Q  V      |          |          |          |
 7+ 0       2.1785      4.84  Q  V      |          |          |          |
 7+ 5       2.2121      4.87  Q  V      |          |          |          |
 7+10       2.2458      4.90  Q  V      |          |          |          |
 7+15       2.2798      4.94  Q  V      |          |          |          |
 7+20       2.3140      4.97  Q  V      |          |          |          |
 7+25       2.3485      5.00  Q  V      |          |          |          |
 7+30       2.3832      5.04  Q  V      |          |          |          |
 7+35       2.4181      5.07  Q   V     |          |          |          |
 7+40       2.4533      5.11  Q   V     |          |          |          |
 7+45       2.4887      5.14  Q   V     |          |          |          |
 7+50       2.5243      5.18  Q   V     |          |          |          |
 7+55       2.5602      5.21  Q   V     |          |          |          |
 8+ 0       2.5964      5.25  Q   V     |          |          |          |
 8+ 5       2.6328      5.29  Q   V     |          |          |          |
 8+10       2.6695      5.33  Q   V     |          |          |          |
 8+15       2.7065      5.37  Q   V     |          |          |          |
 8+20       2.7438      5.41  Q   V     |          |          |          |
 8+25       2.7813      5.45  Q   V     |          |          |          |
 8+30       2.8191      5.49  Q   V     |          |          |          |
 8+35       2.8572      5.53  Q   V     |          |          |          |
 8+40       2.8956      5.58  Q   V     |          |          |          |
 8+45       2.9343      5.62  Q   V     |          |          |          |
 8+50       2.9734      5.67  Q   V     |          |          |          |
 8+55       3.0127      5.71  Q   V     |          |          |          |
 9+ 0       3.0524      5.76  Q    V    |          |          |          |
 9+ 5       3.0923      5.81  Q    V    |          |          |          |
 9+10       3.1327      5.85  Q    V    |          |          |          |
 9+15       3.1733      5.90  Q    V    |          |          |          |
 9+20       3.2143      5.95  Q    V    |          |          |          |
 9+25       3.2557      6.01  Q    V    |          |          |          |
 9+30       3.2974      6.06  Q    V    |          |          |          |
 9+35       3.3395      6.11  Q    V    |          |          |          |
 9+40       3.3820      6.17  Q    V    |          |          |          |
 9+45       3.4248      6.22  Q    V    |          |          |          |
 9+50       3.4681      6.28  Q    V    |          |          |          |
 9+55       3.5117      6.34  Q    V    |          |          |          |
10+ 0       3.5558      6.40  Q    V    |          |          |          |
10+ 5       3.6003      6.46  Q    V    |          |          |          |
10+10       3.6452      6.52  Q     V   |          |          |          |
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10+15       3.6906      6.59  Q     V   |          |          |          |
10+20       3.7364      6.65  Q     V   |          |          |          |
10+25       3.7827      6.72  Q     V   |          |          |          |
10+30       3.8294      6.79  Q     V   |          |          |          |
10+35       3.8767      6.86  Q     V   |          |          |          |
10+40       3.9244      6.93  Q     V   |          |          |          |
10+45       3.9727      7.01  Q     V   |          |          |          |
10+50       4.0214      7.08  Q     V   |          |          |          |
10+55       4.0707      7.16  Q     V   |          |          |          |
11+ 0       4.1206      7.24  Q     V   |          |          |          |
11+ 5       4.1710      7.32  Q     V   |          |          |          |
11+10       4.2220      7.41  Q      V  |          |          |          |
11+15       4.2737      7.50  Q      V  |          |          |          |
11+20       4.3259      7.58  |Q     V  |          |          |          |
11+25       4.3788      7.68  |Q     V  |          |          |          |
11+30       4.4323      7.77  |Q     V  |          |          |          |
11+35       4.4865      7.87  |Q     V  |          |          |          |
11+40       4.5413      7.97  |Q     V  |          |          |          |
11+45       4.5970      8.07  |Q     V  |          |          |          |
11+50       4.6533      8.18  |Q     V  |          |          |          |
11+55       4.7104      8.29  |Q     V  |          |          |          |
12+ 0       4.7683      8.40  |Q     V  |          |          |          |
12+ 5       4.8268      8.49  |Q      V |          |          |          |
12+10       4.8849      8.45  |Q      V |          |          |          |
12+15       4.9414      8.21  |Q      V |          |          |          |
12+20       4.9972      8.10  |Q      V |          |          |          |
12+25       5.0531      8.11  |Q      V |          |          |          |
12+30       5.1093      8.16  |Q      V |          |          |          |
12+35       5.1660      8.24  |Q      V |          |          |          |
12+40       5.2234      8.33  |Q      V |          |          |          |
12+45       5.2815      8.44  |Q      V |          |          |          |
12+50       5.3405      8.56  |Q      V |          |          |          |
12+55       5.4005      8.70  |Q      V |          |          |          |
13+ 0       5.4614      8.85  |Q       V|          |          |          |
13+ 5       5.5234      9.01  |Q       V|          |          |          |
13+10       5.5865      9.17  |Q       V|          |          |          |
13+15       5.6509      9.35  |Q       V|          |          |          |
13+20       5.7166      9.53  |Q       V|          |          |          |
13+25       5.7837      9.74  |Q       V|          |          |          |
13+30       5.8522      9.94  |Q       V|          |          |          |
13+35       5.9222     10.17  |Q       V|          |          |          |
13+40       5.9938     10.40  |Q       V|          |          |          |
13+45       6.0672     10.66  |Q        V          |          |          |
13+50       6.1424     10.92  |Q        V          |          |          |
13+55       6.2196     11.21  |Q        V          |          |          |
14+ 0       6.2989     11.50  |Q        V          |          |          |
14+ 5       6.3804     11.84  |Q        V          |          |          |
14+10       6.4643     12.19  |Q        V          |          |          |
14+15       6.5512     12.61  |Q        V          |          |          |
14+20       6.6410     13.03  |Q        |V         |          |          |
14+25       6.7338     13.48  |Q        |V         |          |          |
14+30       6.8298     13.94  |Q        |V         |          |          |
14+35       6.9294     14.46  |Q        |V         |          |          |
14+40       7.0327     15.00  |Q        |V         |          |          |
14+45       7.1402     15.61  | Q       |V         |          |          |
14+50       7.2521     16.25  | Q       | V        |          |          |
14+55       7.3692     17.00  | Q       | V        |          |          |
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15+ 0       7.4917     17.78  | Q       | V       |         |         |
15+ 5       7.6205     18.71  | Q       | V       |         |         |
15+10       7.7561     19.70  | Q       | V       |         |         |
15+15       7.9000     20.88  | Q       |  V      |         |         |
15+20       8.0528     22.18  | Q       |  V      |         |         |
15+25       8.2179     23.97  |  Q      |  V      |         |         |
15+30       8.4025     26.81  |  Q      |  V      |         |         |
15+35       8.6192     31.46  |   Q     |   V     |         |         |
15+40       8.8657     35.79  |   Q     |   V     |         |         |
15+45       9.1458     40.67  |    Q    |    V    |         |         |
15+50       9.4669     46.63  |     Q   |    V    |         |         |
15+55       9.8492     55.51  |      Q  |     V   |         |         |
16+ 0      10.3285     69.59  |        Q|      V  |         |         |
16+ 5      11.0733    108.14  |         |   Q   V |         |         |
16+10      12.4254    196.32  |         |         V     Q   |         |
16+15      14.4641    296.02  |         |         |   V     |        Q|
16+20      15.9071    209.52  |         |         |     VQ  |         |
16+25      16.8761    140.70  |         |       Q |       V |         |
16+30      17.6078    106.26  |         |   Q     |        V|         |
16+35      18.1762     82.53  |         |Q        |         V         |
16+40      18.6418     67.61  |        Q|         |         V         |
16+45      19.0253     55.68  |      Q  |         |         |V        |
16+50      19.3481     46.87  |     Q   |         |         | V       |
16+55      19.6290     40.79  |    Q    |         |         | V       |
17+ 0      19.8715     35.21  |   Q     |         |         | V       |
17+ 5      20.0848     30.98  |   Q     |         |         |  V      |
17+10      20.2717     27.13  |  Q      |         |         |  V      |
17+15      20.4337     23.53  |  Q      |         |         |  V      |
17+20      20.5742     20.39  | Q       |         |         |   V     |
17+25      20.7027     18.67  | Q       |         |         |   V     |
17+30      20.8252     17.78  | Q       |         |         |   V     |
17+35      20.9394     16.58  | Q       |         |         |   V     |
17+40      21.0395     14.54  |Q        |         |         |   V     |
17+45      21.1257     12.52  |Q        |         |         |    V    |
17+50      21.1996     10.72  |Q        |         |         |    V    |
17+55      21.2690     10.07  |Q        |         |         |    V    |
18+ 0      21.3348      9.55  |Q        |         |         |    V    |
18+ 5      21.3978      9.15  |Q        |         |         |    V    |
18+10      21.4594      8.94  |Q        |         |         |    V    |
18+15      21.5212      8.97  |Q        |         |         |    V    |
18+20      21.5823      8.88  |Q        |         |         |    V    |
18+25      21.6423      8.71  |Q        |         |         |    V    |
18+30      21.7010      8.52  |Q        |         |         |     V   |
18+35      21.7583      8.33  |Q        |         |         |     V   |
18+40      21.8144      8.14  |Q        |         |         |     V   |
18+45      21.8691      7.95  |Q        |         |         |     V   |
18+50      21.9226      7.77  |Q        |         |         |     V   |
18+55      21.9750      7.60  |Q        |         |         |     V   |
19+ 0      22.0261      7.43  Q         |         |         |     V   |
19+ 5      22.0762      7.27  Q         |         |         |     V   |
19+10      22.1253      7.12  Q         |         |         |     V   |
19+15      22.1733      6.97  Q         |         |         |     V   |
19+20      22.2203      6.83  Q         |         |         |     V   |
19+25      22.2665      6.70  Q         |         |         |     V   |
19+30      22.3117      6.57  Q         |         |         |      V  |
19+35      22.3561      6.45  Q         |         |         |      V  |
19+40      22.3997      6.33  Q         |         |         |      V  |
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19+45      22.4425      6.21  Q          |          |          |       V  |
19+50      22.4845      6.10  Q          |          |          |       V  |
19+55      22.5258      6.00  Q          |          |          |       V  |
20+ 0      22.5664      5.89  Q          |          |          |       V  |
20+ 5      22.6063      5.80  Q          |          |          |       V  |
20+10      22.6456      5.70  Q          |          |          |       V  |
20+15      22.6842      5.61  Q          |          |          |       V  |
20+20      22.7223      5.52  Q          |          |          |       V  |
20+25      22.7597      5.44  Q          |          |          |       V  |
20+30      22.7966      5.36  Q          |          |          |       V  |
20+35      22.8330      5.28  Q          |          |          |       V  |
20+40      22.8688      5.20  Q          |          |          |       V  |
20+45      22.9041      5.13  Q          |          |          |        V |
20+50      22.9390      5.06  Q          |          |          |        V |
20+55      22.9734      4.99  Q          |          |          |        V |
21+ 0      23.0073      4.93  Q          |          |          |        V |
21+ 5      23.0408      4.86  Q          |          |          |        V |
21+10      23.0738      4.80  Q          |          |          |        V |
21+15      23.1065      4.74  Q          |          |          |        V |
21+20      23.1387      4.68  Q          |          |          |        V |
21+25      23.1705      4.62  Q          |          |          |        V |
21+30      23.2020      4.57  Q          |          |          |        V |
21+35      23.2331      4.51  Q          |          |          |        V |
21+40      23.2638      4.46  Q          |          |          |        V |
21+45      23.2942      4.41  Q          |          |          |        V |
21+50      23.3243      4.36  Q          |          |          |        V |
21+55      23.3540      4.31  Q          |          |          |        V |
22+ 0      23.3834      4.27  Q          |          |          |        V |
22+ 5      23.4124      4.22  Q          |          |          |        V |
22+10      23.4412      4.18  Q          |          |          |        V |
22+15      23.4697      4.13  Q          |          |          |        V |
22+20      23.4979      4.09  Q          |          |          |        V |
22+25      23.5258      4.05  Q          |          |          |         V|
22+30      23.5534      4.01  Q          |          |          |         V|
22+35      23.5807      3.97  Q          |          |          |         V|
22+40      23.6078      3.93  Q          |          |          |         V|
22+45      23.6346      3.89  Q          |          |          |         V|
22+50      23.6612      3.86  Q          |          |          |         V|
22+55      23.6875      3.82  Q          |          |          |         V|
23+ 0      23.7136      3.79  Q          |          |          |         V|
23+ 5      23.7394      3.75  Q          |          |          |         V|
23+10      23.7650      3.72  Q          |          |          |         V|
23+15      23.7904      3.69  Q          |          |          |         V|
23+20      23.8156      3.65  Q          |          |          |         V|
23+25      23.8405      3.62  Q          |          |          |         V|
23+30      23.8653      3.59  Q          |          |          |         V|
23+35      23.8898      3.56  Q          |          |          |         V|
23+40      23.9141      3.53  Q          |          |          |         V|
23+45      23.9382      3.50  Q          |          |          |         V|
23+50      23.9622      3.47  Q          |          |          |         V|
23+55      23.9859      3.45  Q          |          |          |         V|
24+ 0      24.0094      3.42  Q          |          |          |         V|
24+ 5      24.0322      3.31  Q          |          |          |         V|
24+10      24.0518      2.85  Q          |          |          |         V|
24+15      24.0647      1.87  Q          |          |          |         V|
24+20      24.0734      1.26  Q          |          |          |         V|
24+25      24.0799      0.94  Q          |          |          |         V|
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   24+30      24.0848      0.72  Q         |         |         |        V|
   24+35      24.0887      0.56  Q         |         |         |        V|
   24+40      24.0917      0.44  Q         |         |         |        V|
   24+45      24.0940      0.35  Q         |         |         |        V|
   24+50      24.0959      0.27  Q         |         |         |        V|
   24+55      24.0974      0.22  Q         |         |         |        V|
   25+ 0      24.0986      0.17  Q         |         |         |        V|
   25+ 5      24.0995      0.13  Q         |         |         |        V|
   25+10      24.1001      0.10  Q         |         |         |        V|
   25+15      24.1007      0.07  Q         |         |         |        V|
   25+20      24.1011      0.06  Q         |         |         |        V|
   25+25      24.1014      0.04  Q         |         |         |        V|
   25+30      24.1016      0.03  Q         |         |         |        V|
   25+35      24.1017      0.02  Q         |         |         |        V|
   25+40      24.1017      0.01  Q         |         |         |         V
-----------------------------------------------------------------------
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ATTACHMENT 3

Existing Conditions
Rational Method Calculations
(20-Year, 1-Hour)
(100-Year, 1-Hour)

```
            San Bernardino County Rational Hydrology Program

                (Hydrology Manual Date - August 1986)

 CIVILCADD/CIVILDESIGN  Engineering Software, (c) 1989-2012 Version 7.2
      Rational Hydrology Study        Date: 04/10/15
----------------------------------------------------------------------
154166 - AMBOY - SAN BERNARDINO COUNTY
EXISTING CONDITION "A"
20-YEAR, 1-HOUR STORM
BY: JTS  DATE: 04-10-15
----------------------------------------------------------------------


Program License Serial Number 6320

----------------------------------------------------------------------
 *********   Hydrology Study Control Information **********

----------------------------------------------------------------------
Rational hydrology study storm event year is    20.0
   10 Year storm 1 hour rainfall  =      0.860(In.)
  100 Year storm 1 hour rainfall  =      1.590(In.)
Computed rainfall intensity:
Storm year =    20.00   1 hour rainfall =     1.080 (In.)
Slope used for rainfall intensity curve b =  0.7000
Soil antecedent moisture condition (AMC) = 1


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        1.000 to Point/Station        2.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Soil classification AP and SCS  values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2)  = 91.00
Adjusted SCS curve number for AMC 1 = 79.80
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.373(In/Hr)
Initial subarea data:
Initial area flow distance =  1000.000(Ft.)
Top (of initial area) elevation =  1922.000(Ft.)
Bottom (of initial area) elevation =  1580.000(Ft.)
Difference in elevation =   342.000(Ft.)
Slope =    0.34200  s(%)=      34.20
TC = k(0.465)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =    9.135 min.
Rainfall intensity =      4.032(In/Hr) for a    20.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.817
Subarea runoff =     31.680(CFS)
Total initial stream area =        9.620(Ac.)
Pervious area fraction = 1.000
Initial area Fm value =    0.373(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        2.000 to Point/Station        3.000
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```
**** IMPROVED CHANNEL TRAVEL TIME ****
_____________________________________________________________________
Upstream point elevation =  1580.000(Ft.)
Downstream point elevation =  1090.000(Ft.)
Channel length thru subarea  =  2891.910(Ft.)
Channel base width      =   10.000(Ft.)
Slope or 'Z' of left channel bank =   2.000
Slope or 'Z' of right channel bank =   2.000
Estimated mean flow rate at midpoint of channel =    101.043(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =   10.000(Ft.)
Flow(q) thru subarea =    101.043(CFS)
Depth of flow =   0.761(Ft.), Average velocity =  11.524(Ft/s)
Channel flow top width =   13.044(Ft.)
Flow Velocity =   11.52(Ft/s)
Travel time  =    4.18 min.
Time of concentration =   13.32 min.
Critical depth =      1.344(Ft.)
 Adding area flow to channel
Soil classification AP and SCS  values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2)  = 91.00
Adjusted SCS curve number for AMC 1 = 79.80
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.373(In/Hr)
Rainfall intensity =      3.097(In/Hr) for a    20.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.792
Subarea runoff =    138.670(CFS) for   59.870(Ac.)
Total runoff =    170.350(CFS)
Effective area this stream =       69.49(Ac.)
Total Study Area (Main Stream No. 1) =       69.49(Ac.)
Area averaged Fm value =    0.373(In/Hr)
Depth of flow =   1.029(Ft.), Average velocity =  13.722(Ft/s)
Critical depth =      1.828(Ft.)
End of computations, Total Study Area =           69.49 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.
Note: These figures do not consider reduced effective area
effects caused by confluences in the rational equation.

Area averaged pervious area fraction(Ap) = 1.000
Area averaged SCS curve number =  91.0
```

San Bernardino County Rational Hydrology Program

(Hydrology Manual Date - August 1986)

CIVILCADD/CIVILDESIGN Engineering Software, (c) 1989-2012 Version 7.2
Rational Hydrology Study Date: 04/10/15

154166 - AMBOY - SAN BERNARDINO COUNTY
EXISTING CONDITIONS "B"
20-YEAR, 1-HOUR STORM
BY: JTS DATE: 04-10-15

Program License Serial Number 6320

********* Hydrology Study Control Information **********

```
Rational hydrology study storm event year is    20.0
   10 Year storm 1 hour rainfall  =      0.860(In.)
  100 Year storm 1 hour rainfall  =      1.590(In.)
Computed rainfall intensity:
Storm year =    20.00   1 hour rainfall =     1.080 (In.)
Slope used for rainfall intensity curve b =  0.7000
Soil antecedent moisture condition (AMC) = 1


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        1.000 to Point/Station        2.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Soil classification AP and SCS  values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2)  = 91.00
Adjusted SCS curve number for AMC 1 = 79.80
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.373(In/Hr)
Initial subarea data:
Initial area flow distance =  1000.000(Ft.)
Top (of initial area) elevation =  1812.000(Ft.)
Bottom (of initial area) elevation =  1515.600(Ft.)
Difference in elevation =   296.400(Ft.)
Slope =    0.29640  s(%)=      29.64
TC = k(0.465)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =    9.400 min.
Rainfall intensity =      3.952(In/Hr) for a    20.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.815
Subarea runoff =     26.768(CFS)
Total initial stream area =        8.310(Ac.)
Pervious area fraction = 1.000
Initial area Fm value =    0.373(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        2.000 to Point/Station        3.000
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```
**** IMPROVED CHANNEL TRAVEL TIME ****
_____________________________________________________________________
Upstream point elevation =  1515.600(Ft.)
Downstream point elevation =  1137.000(Ft.)
Channel length thru subarea  =  3564.620(Ft.)
Channel base width      =   10.000(Ft.)
Slope or 'Z' of left channel bank =   2.000
Slope or 'Z' of right channel bank =   2.000
Estimated mean flow rate at midpoint of channel =    114.267(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =   10.000(Ft.)
Flow(q) thru subarea =    114.267(CFS)
Depth of flow =   0.936(Ft.), Average velocity =  10.286(Ft/s)
Channel flow top width =   13.743(Ft.)
Flow Velocity =   10.29(Ft/s)
Travel time  =    5.78 min.
Time of concentration =   15.18 min.
Critical depth =      1.438(Ft.)
 Adding area flow to channel
Soil classification AP and SCS  values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2)  = 91.00
Adjusted SCS curve number for AMC 1 = 79.80
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.373(In/Hr)
Rainfall intensity =      2.826(In/Hr) for a    20.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.781
Subarea runoff =    174.943(CFS) for   83.050(Ac.)
Total runoff =    201.711(CFS)
Effective area this stream =       91.36(Ac.)
Total Study Area (Main Stream No. 1) =       91.36(Ac.)
Area averaged Fm value =    0.373(In/Hr)
Depth of flow =   1.295(Ft.), Average velocity =  12.369(Ft/s)
Critical depth =      2.031(Ft.)
End of computations, Total Study Area =           91.36 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.
Note: These figures do not consider reduced effective area
effects caused by confluences in the rational equation.

Area averaged pervious area fraction(Ap) = 1.000
Area averaged SCS curve number =  91.0
```

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            San Bernardino County Rational Hydrology Program

                (Hydrology Manual Date - August 1986)

 CIVILCADD/CIVILDESIGN  Engineering Software, (c) 1989-2012 Version 7.2
      Rational Hydrology Study        Date: 04/10/15
----------------------------------------------------------------------
154166 - AMBOY - SAN BERNARDINO COUNTY
EXISTING CONDITION "A"
100-YEAR, 1-HOUR STORM
BY: JTS  DATE: 04-10-15
----------------------------------------------------------------------


Program License Serial Number 6320

----------------------------------------------------------------------
 *********   Hydrology Study Control Information **********

----------------------------------------------------------------------
Rational hydrology study storm event year is   100.0
   10 Year storm 1 hour rainfall  =      0.860(In.)
  100 Year storm 1 hour rainfall  =      1.590(In.)
Computed rainfall intensity:
Storm year =   100.00   1 hour rainfall =     1.590 (In.)
Slope used for rainfall intensity curve b =  0.7000
Soil antecedent moisture condition (AMC) = 3


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        1.000 to Point/Station        2.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Soil classification AP and SCS  values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2)  = 91.00
Adjusted SCS curve number for AMC 3 = 98.20
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.036(In/Hr)
Initial subarea data:
Initial area flow distance =  1000.000(Ft.)
Top (of initial area) elevation =  1922.000(Ft.)
Bottom (of initial area) elevation =  1580.000(Ft.)
Difference in elevation =   342.000(Ft.)
Slope =    0.34200  s(%)=      34.20
TC = k(0.465)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =    9.135 min.
Rainfall intensity =      5.938(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.895
Subarea runoff =     51.099(CFS)
Total initial stream area =        9.620(Ac.)
Pervious area fraction = 1.000
Initial area Fm value =    0.036(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        2.000 to Point/Station        3.000
```

```
**** IMPROVED CHANNEL TRAVEL TIME ****
_____________________________________________________________________
Upstream point elevation =  1580.000(Ft.)
Downstream point elevation =  1090.000(Ft.)
Channel length thru subarea  =  2891.910(Ft.)
Channel base width      =   10.000(Ft.)
Slope or 'Z' of left channel bank =   2.000
Slope or 'Z' of right channel bank =   2.000
Estimated mean flow rate at midpoint of channel =    172.435(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =   10.000(Ft.)
Flow(q) thru subarea =    172.435(CFS)
Depth of flow =   1.037(Ft.), Average velocity =  13.777(Ft/s)
Channel flow top width =   14.147(Ft.)
Flow Velocity =   13.78(Ft/s)
Travel time  =    3.50 min.
Time of concentration =   12.63 min.
Critical depth =      1.844(Ft.)
 Adding area flow to channel
Soil classification AP and SCS  values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2)  = 91.00
Adjusted SCS curve number for AMC 3 = 98.20
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.036(In/Hr)
Rainfall intensity =      4.732(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.893
Subarea runoff =    242.610(CFS) for   59.870(Ac.)
Total runoff =    293.709(CFS)
Effective area this stream =       69.49(Ac.)
Total Study Area (Main Stream No. 1) =       69.49(Ac.)
Area averaged Fm value =    0.036(In/Hr)
Depth of flow =   1.404(Ft.), Average velocity =  16.339(Ft/s)
Critical depth =      2.500(Ft.)
End of computations, Total Study Area =           69.49 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.
Note: These figures do not consider reduced effective area
effects caused by confluences in the rational equation.

Area averaged pervious area fraction(Ap) = 1.000
Area averaged SCS curve number =  91.0
```

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            San Bernardino County Rational Hydrology Program

                (Hydrology Manual Date - August 1986)

 CIVILCADD/CIVILDESIGN  Engineering Software, (c) 1989-2012 Version 7.2
      Rational Hydrology Study        Date: 04/10/15
----------------------------------------------------------------------
154166 - AMBOY - SAN BERNARDINO COUNTY
EXISTING CONDITIONS "B"
100-YEAR, 1-HOUR STORM
BY: JTS  DATE: 04-10-15
----------------------------------------------------------------------


Program License Serial Number 6320

----------------------------------------------------------------------
 *********   Hydrology Study Control Information **********

----------------------------------------------------------------------
Rational hydrology study storm event year is   100.0
   10 Year storm 1 hour rainfall  =      0.860(In.)
  100 Year storm 1 hour rainfall  =      1.590(In.)
Computed rainfall intensity:
Storm year =   100.00   1 hour rainfall =     1.590 (In.)
Slope used for rainfall intensity curve b =  0.7000
Soil antecedent moisture condition (AMC) = 3


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        1.000 to Point/Station        2.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Soil classification AP and SCS  values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2)  = 91.00
Adjusted SCS curve number for AMC 3 = 98.20
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.036(In/Hr)
Initial subarea data:
Initial area flow distance =  1000.000(Ft.)
Top (of initial area) elevation =  1812.000(Ft.)
Bottom (of initial area) elevation =  1515.600(Ft.)
Difference in elevation =   296.400(Ft.)
Slope =    0.29640  s(%)=      29.64
TC = k(0.465)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =    9.400 min.
Rainfall intensity =      5.820(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.894
Subarea runoff =     43.260(CFS)
Total initial stream area =        8.310(Ac.)
Pervious area fraction = 1.000
Initial area Fm value =    0.036(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        2.000 to Point/Station        3.000
```

```
**** IMPROVED CHANNEL TRAVEL TIME ****
_____________________________________________________________________
Upstream point elevation =  1515.600(Ft.)
Downstream point elevation =  1137.000(Ft.)
Channel length thru subarea  =  3564.620(Ft.)
Channel base width      =   10.000(Ft.)
Slope or 'Z' of left channel bank =   2.000
Slope or 'Z' of right channel bank =   2.000
Estimated mean flow rate at midpoint of channel =    199.252(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =   10.000(Ft.)
Flow(q) thru subarea =    199.252(CFS)
Depth of flow =   1.286(Ft.), Average velocity =  12.321(Ft/s)
Channel flow top width =   15.145(Ft.)
Flow Velocity =   12.32(Ft/s)
Travel time  =    4.82 min.
Time of concentration =   14.22 min.
Critical depth =      2.000(Ft.)
 Adding area flow to channel
Soil classification AP and SCS  values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2)  = 91.00
Adjusted SCS curve number for AMC 3 = 98.20
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.036(In/Hr)
Rainfall intensity =      4.355(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.893
Subarea runoff =    311.926(CFS) for   83.050(Ac.)
Total runoff =    355.186(CFS)
Effective area this stream =       91.36(Ac.)
Total Study Area (Main Stream No. 1) =       91.36(Ac.)
Area averaged Fm value =    0.036(In/Hr)
Depth of flow =   1.778(Ft.), Average velocity =  14.735(Ft/s)
Critical depth =      2.813(Ft.)
End of computations, Total Study Area =           91.36 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.
Note: These figures do not consider reduced effective area
effects caused by confluences in the rational equation.

Area averaged pervious area fraction(Ap) = 1.000
Area averaged SCS curve number =  91.0
```

ATTACHMENT 4

Existing Conditions
Hydrograph Calculations
(20-Year, 1-Hour)
(100-Year, 1-Hour)

U n i t H y d r o g r a p h A n a l y s i s

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Study date 04/10/15

++

San Bernardino County Synthetic Unit Hydrology Method
Manual date - August 1986

Program License Serial Number 6320

154166 - AMBOY - SAN BERNARDINO COUNTY
EXISTING CONDITION "A"
20-YEAR, 24-HOUR STORM
BY: JTS DATE: 04-10-15

Storm Event Year = 20

Antecedent Moisture Condition = 1

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

English Units used in output format

Area averaged rainfall intensity isohyetal data:

Sub-Area (Ac.)	Duration (hours)	Isohyetal (In)
Rainfall data for year 10		
69.49	1	0.86
Rainfall data for year 2		
69.49	6	0.75
Rainfall data for year 2		
69.49	24	1.07
Rainfall data for year 100		
69.49	1	1.59
Rainfall data for year 100		
69.49	6	2.43
Rainfall data for year 100		
69.49	24	3.56

```
-----------------------------------------------------------------
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

******** Area-averaged max loss rate, Fm ********


SCS curve  SCS curve     Area     Area     Fp(Fig C6)    Ap      Fm
No.(AMCII) NO.(AMC 1)    (Ac.)    Fraction     (In/Hr)  (dec.)   (In/Hr)
 91.0      79.8         69.49      1.000     0.373    1.000    0.373

Area-averaged adjusted loss rate Fm (In/Hr) =  0.373

********* Area-Averaged low loss rate fraction, Yb **********

Area       Area          SCS CN    SCS CN      S     Pervious
 (Ac.)      Fract         (AMC2)    (AMC1)           Yield Fr
    69.49   1.000         91.0      79.8       2.53     0.356

Area-averaged catchment yield fraction, Y =  0.356
Area-averaged low loss fraction, Yb =  0.644
User entry of time of concentration  =   0.220 (hours)
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Watershed area =      69.49(Ac.)
Catchment Lag time =   0.176 hours
Unit interval =   5.000 minutes
Unit interval percentage of lag time = 47.3485
Hydrograph baseflow =     0.00(CFS)
Average maximum watershed loss rate(Fm) =  0.373(In/Hr)
Average low loss rate fraction (Yb) = 0.644 (decimal)
DESERT S-Graph Selected
Computed peak 5-minute rainfall =  0.512(In)
Computed peak 30-minute rainfall =  0.877(In)
Specified peak 1-hour rainfall =  1.080(In)
Computed peak 3-hour rainfall =  1.446(In)
Specified peak 6-hour rainfall =  1.739(In)
Specified peak 24-hour rainfall =  2.536(In)


Rainfall depth area reduction factors:
Using a total area of      69.49(Ac.) (Ref: fig. E-4)

5-minute factor = 0.997     Adjusted rainfall =  0.511(In)
30-minute factor = 0.997    Adjusted rainfall =  0.874(In)
1-hour factor = 0.997       Adjusted rainfall =  1.076(In)
3-hour factor = 1.000       Adjusted rainfall =  1.446(In)
6-hour factor = 1.000       Adjusted rainfall =  1.738(In)
24-hour factor = 1.000      Adjusted rainfall =  2.535(In)
-------------------------------------------------------------------

                  U n i t  H y d r o g r a p h
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Interval          'S' Graph          Unit Hydrograph
Number            Mean values             ((CFS))
-------------------------------------------------------------------
            (K =       840.39 (CFS))

  1                3.621                   30.434
```

2	27.374	199.619
3	58.032	257.648
4	71.898	116.529
5	79.947	67.643
6	85.264	44.679
7	89.111	32.329
8	91.816	22.733
9	93.936	17.820
10	95.547	13.537
11	96.789	10.442
12	97.673	7.427
13	98.224	4.626
14	98.770	4.595
15	99.332	4.722
16	99.712	3.190
17	100.000	2.421

Peak Unit Number	Adjusted mass rainfall (In)	Unit rainfall (In)
1	0.5107	0.5107
2	0.6287	0.1180
3	0.7101	0.0813
4	0.7741	0.0640
5	0.8276	0.0536
6	0.8742	0.0465
7	0.9155	0.0414
8	0.9530	0.0374
9	0.9872	0.0343
10	1.0189	0.0317
11	1.0485	0.0296
12	1.0762	0.0277
13	1.0996	0.0234
14	1.1217	0.0221
15	1.1427	0.0210
16	1.1627	0.0200
17	1.1818	0.0191
18	1.2000	0.0183
19	1.2176	0.0175
20	1.2345	0.0169
21	1.2507	0.0163
22	1.2665	0.0157
23	1.2817	0.0152
24	1.2964	0.0147
25	1.3107	0.0143
26	1.3246	0.0139
27	1.3381	0.0135
28	1.3512	0.0131
29	1.3640	0.0128
30	1.3765	0.0125
31	1.3886	0.0122
32	1.4005	0.0119
33	1.4121	0.0116
34	1.4235	0.0114
35	1.4346	0.0111
36	1.4455	0.0109
37	1.4561	0.0106
38	1.4665	0.0104

39	1.4767	0.0102
40	1.4866	0.0100
41	1.4964	0.0098
42	1.5061	0.0096
43	1.5155	0.0095
44	1.5248	0.0093
45	1.5340	0.0091
46	1.5430	0.0090
47	1.5519	0.0089
48	1.5606	0.0087
49	1.5692	0.0086
50	1.5776	0.0085
51	1.5860	0.0083
52	1.5942	0.0082
53	1.6023	0.0081
54	1.6103	0.0080
55	1.6182	0.0079
56	1.6260	0.0078
57	1.6336	0.0077
58	1.6412	0.0076
59	1.6487	0.0075
60	1.6561	0.0074
61	1.6634	0.0073
62	1.6706	0.0072
63	1.6777	0.0071
64	1.6848	0.0070
65	1.6918	0.0070
66	1.6987	0.0069
67	1.7055	0.0068
68	1.7122	0.0067
69	1.7189	0.0067
70	1.7255	0.0066
71	1.7320	0.0065
72	1.7385	0.0065
73	1.7450	0.0065
74	1.7515	0.0065
75	1.7579	0.0064
76	1.7642	0.0063
77	1.7705	0.0063
78	1.7767	0.0062
79	1.7829	0.0062
80	1.7890	0.0061
81	1.7951	0.0061
82	1.8011	0.0060
83	1.8071	0.0060
84	1.8130	0.0059
85	1.8188	0.0058
86	1.8246	0.0058
87	1.8304	0.0058
88	1.8361	0.0057
89	1.8417	0.0057
90	1.8473	0.0056
91	1.8529	0.0056
92	1.8584	0.0055
93	1.8639	0.0055
94	1.8693	0.0054
95	1.8747	0.0054

96	1.8801	0.0054
97	1.8854	0.0053
98	1.8906	0.0053
99	1.8959	0.0052
100	1.9011	0.0052
101	1.9062	0.0052
102	1.9113	0.0051
103	1.9164	0.0051
104	1.9215	0.0050
105	1.9265	0.0050
106	1.9315	0.0050
107	1.9364	0.0049
108	1.9413	0.0049
109	1.9462	0.0049
110	1.9510	0.0048
111	1.9558	0.0048
112	1.9606	0.0048
113	1.9654	0.0047
114	1.9701	0.0047
115	1.9748	0.0047
116	1.9794	0.0047
117	1.9841	0.0046
118	1.9887	0.0046
119	1.9932	0.0046
120	1.9978	0.0045
121	2.0023	0.0045
122	2.0068	0.0045
123	2.0113	0.0045
124	2.0157	0.0044
125	2.0201	0.0044
126	2.0245	0.0044
127	2.0289	0.0044
128	2.0332	0.0043
129	2.0375	0.0043
130	2.0418	0.0043
131	2.0461	0.0043
132	2.0503	0.0042
133	2.0545	0.0042
134	2.0587	0.0042
135	2.0629	0.0042
136	2.0670	0.0041
137	2.0712	0.0041
138	2.0753	0.0041
139	2.0793	0.0041
140	2.0834	0.0041
141	2.0874	0.0040
142	2.0915	0.0040
143	2.0955	0.0040
144	2.0994	0.0040
145	2.1034	0.0040
146	2.1073	0.0039
147	2.1113	0.0039
148	2.1152	0.0039
149	2.1190	0.0039
150	2.1229	0.0039
151	2.1267	0.0038
152	2.1306	0.0038

153	2.1344	0.0038
154	2.1382	0.0038
155	2.1419	0.0038
156	2.1457	0.0038
157	2.1494	0.0037
158	2.1531	0.0037
159	2.1568	0.0037
160	2.1605	0.0037
161	2.1642	0.0037
162	2.1678	0.0037
163	2.1715	0.0036
164	2.1751	0.0036
165	2.1787	0.0036
166	2.1823	0.0036
167	2.1858	0.0036
168	2.1894	0.0036
169	2.1929	0.0035
170	2.1965	0.0035
171	2.2000	0.0035
172	2.2035	0.0035
173	2.2069	0.0035
174	2.2104	0.0035
175	2.2139	0.0035
176	2.2173	0.0034
177	2.2207	0.0034
178	2.2241	0.0034
179	2.2275	0.0034
180	2.2309	0.0034
181	2.2343	0.0034
182	2.2376	0.0034
183	2.2410	0.0033
184	2.2443	0.0033
185	2.2476	0.0033
186	2.2509	0.0033
187	2.2542	0.0033
188	2.2575	0.0033
189	2.2607	0.0033
190	2.2640	0.0032
191	2.2672	0.0032
192	2.2704	0.0032
193	2.2737	0.0032
194	2.2769	0.0032
195	2.2800	0.0032
196	2.2832	0.0032
197	2.2864	0.0032
198	2.2895	0.0032
199	2.2927	0.0031
200	2.2958	0.0031
201	2.2989	0.0031
202	2.3020	0.0031
203	2.3051	0.0031
204	2.3082	0.0031
205	2.3113	0.0031
206	2.3144	0.0031
207	2.3174	0.0031
208	2.3205	0.0030
209	2.3235	0.0030

210	2.3265	0.0030
211	2.3295	0.0030
212	2.3325	0.0030
213	2.3355	0.0030
214	2.3385	0.0030
215	2.3415	0.0030
216	2.3444	0.0030
217	2.3474	0.0029
218	2.3503	0.0029
219	2.3532	0.0029
220	2.3562	0.0029
221	2.3591	0.0029
222	2.3620	0.0029
223	2.3649	0.0029
224	2.3677	0.0029
225	2.3706	0.0029
226	2.3735	0.0029
227	2.3763	0.0029
228	2.3792	0.0028
229	2.3820	0.0028
230	2.3848	0.0028
231	2.3877	0.0028
232	2.3905	0.0028
233	2.3933	0.0028
234	2.3961	0.0028
235	2.3988	0.0028
236	2.4016	0.0028
237	2.4044	0.0028
238	2.4071	0.0028
239	2.4099	0.0027
240	2.4126	0.0027
241	2.4154	0.0027
242	2.4181	0.0027
243	2.4208	0.0027
244	2.4235	0.0027
245	2.4262	0.0027
246	2.4289	0.0027
247	2.4316	0.0027
248	2.4343	0.0027
249	2.4369	0.0027
250	2.4396	0.0027
251	2.4422	0.0027
252	2.4449	0.0026
253	2.4475	0.0026
254	2.4501	0.0026
255	2.4528	0.0026
256	2.4554	0.0026
257	2.4580	0.0026
258	2.4606	0.0026
259	2.4632	0.0026
260	2.4658	0.0026
261	2.4683	0.0026
262	2.4709	0.0026
263	2.4735	0.0026
264	2.4760	0.0026
265	2.4786	0.0025
266	2.4811	0.0025

267	2.4837	0.0025
268	2.4862	0.0025
269	2.4887	0.0025
270	2.4912	0.0025
271	2.4937	0.0025
272	2.4962	0.0025
273	2.4987	0.0025
274	2.5012	0.0025
275	2.5037	0.0025
276	2.5062	0.0025
277	2.5086	0.0025
278	2.5111	0.0025
279	2.5136	0.0025
280	2.5160	0.0024
281	2.5184	0.0024
282	2.5209	0.0024
283	2.5233	0.0024
284	2.5257	0.0024
285	2.5282	0.0024
286	2.5306	0.0024
287	2.5330	0.0024
288	2.5354	0.0024

Unit Period (number)	Unit Rainfall (In)	Unit Soil-Loss (In)	Effective Rainfall (In)
1	0.0024	0.0015	0.0009
2	0.0024	0.0015	0.0009
3	0.0024	0.0016	0.0009
4	0.0024	0.0016	0.0009
5	0.0024	0.0016	0.0009
6	0.0024	0.0016	0.0009
7	0.0025	0.0016	0.0009
8	0.0025	0.0016	0.0009
9	0.0025	0.0016	0.0009
10	0.0025	0.0016	0.0009
11	0.0025	0.0016	0.0009
12	0.0025	0.0016	0.0009
13	0.0025	0.0016	0.0009
14	0.0025	0.0016	0.0009
15	0.0025	0.0016	0.0009
16	0.0025	0.0016	0.0009
17	0.0026	0.0016	0.0009
18	0.0026	0.0017	0.0009
19	0.0026	0.0017	0.0009
20	0.0026	0.0017	0.0009
21	0.0026	0.0017	0.0009
22	0.0026	0.0017	0.0009
23	0.0026	0.0017	0.0009
24	0.0026	0.0017	0.0009
25	0.0026	0.0017	0.0009
26	0.0027	0.0017	0.0009
27	0.0027	0.0017	0.0010
28	0.0027	0.0017	0.0010
29	0.0027	0.0017	0.0010
30	0.0027	0.0017	0.0010

31	0.0027	0.0017	0.0010
32	0.0027	0.0018	0.0010
33	0.0027	0.0018	0.0010
34	0.0027	0.0018	0.0010
35	0.0028	0.0018	0.0010
36	0.0028	0.0018	0.0010
37	0.0028	0.0018	0.0010
38	0.0028	0.0018	0.0010
39	0.0028	0.0018	0.0010
40	0.0028	0.0018	0.0010
41	0.0028	0.0018	0.0010
42	0.0029	0.0018	0.0010
43	0.0029	0.0018	0.0010
44	0.0029	0.0019	0.0010
45	0.0029	0.0019	0.0010
46	0.0029	0.0019	0.0010
47	0.0029	0.0019	0.0010
48	0.0029	0.0019	0.0010
49	0.0030	0.0019	0.0011
50	0.0030	0.0019	0.0011
51	0.0030	0.0019	0.0011
52	0.0030	0.0019	0.0011
53	0.0030	0.0019	0.0011
54	0.0030	0.0020	0.0011
55	0.0031	0.0020	0.0011
56	0.0031	0.0020	0.0011
57	0.0031	0.0020	0.0011
58	0.0031	0.0020	0.0011
59	0.0031	0.0020	0.0011
60	0.0031	0.0020	0.0011
61	0.0032	0.0020	0.0011
62	0.0032	0.0020	0.0011
63	0.0032	0.0021	0.0011
64	0.0032	0.0021	0.0011
65	0.0032	0.0021	0.0011
66	0.0032	0.0021	0.0012
67	0.0033	0.0021	0.0012
68	0.0033	0.0021	0.0012
69	0.0033	0.0021	0.0012
70	0.0033	0.0021	0.0012
71	0.0033	0.0022	0.0012
72	0.0034	0.0022	0.0012
73	0.0034	0.0022	0.0012
74	0.0034	0.0022	0.0012
75	0.0034	0.0022	0.0012
76	0.0034	0.0022	0.0012
77	0.0035	0.0022	0.0012
78	0.0035	0.0022	0.0012
79	0.0035	0.0023	0.0012
80	0.0035	0.0023	0.0013
81	0.0036	0.0023	0.0013
82	0.0036	0.0023	0.0013
83	0.0036	0.0023	0.0013
84	0.0036	0.0023	0.0013
85	0.0037	0.0024	0.0013
86	0.0037	0.0024	0.0013
87	0.0037	0.0024	0.0013

88	0.0037	0.0024	0.0013
89	0.0038	0.0024	0.0013
90	0.0038	0.0024	0.0013
91	0.0038	0.0025	0.0014
92	0.0038	0.0025	0.0014
93	0.0039	0.0025	0.0014
94	0.0039	0.0025	0.0014
95	0.0039	0.0025	0.0014
96	0.0039	0.0025	0.0014
97	0.0040	0.0026	0.0014
98	0.0040	0.0026	0.0014
99	0.0040	0.0026	0.0014
100	0.0041	0.0026	0.0014
101	0.0041	0.0026	0.0015
102	0.0041	0.0027	0.0015
103	0.0042	0.0027	0.0015
104	0.0042	0.0027	0.0015
105	0.0042	0.0027	0.0015
106	0.0043	0.0027	0.0015
107	0.0043	0.0028	0.0015
108	0.0043	0.0028	0.0015
109	0.0044	0.0028	0.0016
110	0.0044	0.0028	0.0016
111	0.0045	0.0029	0.0016
112	0.0045	0.0029	0.0016
113	0.0045	0.0029	0.0016
114	0.0046	0.0029	0.0016
115	0.0046	0.0030	0.0016
116	0.0047	0.0030	0.0017
117	0.0047	0.0030	0.0017
118	0.0047	0.0031	0.0017
119	0.0048	0.0031	0.0017
120	0.0048	0.0031	0.0017
121	0.0049	0.0032	0.0017
122	0.0049	0.0032	0.0018
123	0.0050	0.0032	0.0018
124	0.0050	0.0032	0.0018
125	0.0051	0.0033	0.0018
126	0.0052	0.0033	0.0018
127	0.0052	0.0034	0.0019
128	0.0053	0.0034	0.0019
129	0.0054	0.0034	0.0019
130	0.0054	0.0035	0.0019
131	0.0055	0.0035	0.0020
132	0.0055	0.0036	0.0020
133	0.0056	0.0036	0.0020
134	0.0057	0.0036	0.0020
135	0.0058	0.0037	0.0020
136	0.0058	0.0037	0.0021
137	0.0059	0.0038	0.0021
138	0.0060	0.0038	0.0021
139	0.0061	0.0039	0.0022
140	0.0061	0.0039	0.0022
141	0.0062	0.0040	0.0022
142	0.0063	0.0040	0.0022
143	0.0064	0.0041	0.0023
144	0.0065	0.0042	0.0023

145	0.0065	0.0042	0.0023
146	0.0065	0.0042	0.0023
147	0.0067	0.0043	0.0024
148	0.0067	0.0043	0.0024
149	0.0069	0.0044	0.0025
150	0.0070	0.0045	0.0025
151	0.0071	0.0046	0.0025
152	0.0072	0.0046	0.0026
153	0.0074	0.0048	0.0026
154	0.0075	0.0048	0.0027
155	0.0077	0.0049	0.0027
156	0.0078	0.0050	0.0028
157	0.0080	0.0051	0.0028
158	0.0081	0.0052	0.0029
159	0.0083	0.0054	0.0030
160	0.0085	0.0054	0.0030
161	0.0087	0.0056	0.0031
162	0.0089	0.0057	0.0032
163	0.0091	0.0059	0.0033
164	0.0093	0.0060	0.0033
165	0.0096	0.0062	0.0034
166	0.0098	0.0063	0.0035
167	0.0102	0.0066	0.0036
168	0.0104	0.0067	0.0037
169	0.0109	0.0070	0.0039
170	0.0111	0.0072	0.0040
171	0.0116	0.0075	0.0041
172	0.0119	0.0077	0.0042
173	0.0125	0.0080	0.0044
174	0.0128	0.0082	0.0046
175	0.0135	0.0087	0.0048
176	0.0139	0.0089	0.0049
177	0.0147	0.0095	0.0052
178	0.0152	0.0098	0.0054
179	0.0163	0.0105	0.0058
180	0.0169	0.0109	0.0060
181	0.0183	0.0118	0.0065
182	0.0191	0.0123	0.0068
183	0.0210	0.0135	0.0075
184	0.0221	0.0142	0.0079
185	0.0277	0.0179	0.0099
186	0.0296	0.0190	0.0105
187	0.0343	0.0221	0.0122
188	0.0374	0.0241	0.0133
189	0.0465	0.0300	0.0166
190	0.0536	0.0311	0.0225
191	0.0813	0.0311	0.0502
192	0.1180	0.0311	0.0869
193	0.5107	0.0311	0.4796
194	0.0640	0.0311	0.0329
195	0.0414	0.0266	0.0147
196	0.0317	0.0204	0.0113
197	0.0234	0.0151	0.0083
198	0.0200	0.0129	0.0071
199	0.0175	0.0113	0.0062
200	0.0157	0.0101	0.0056
201	0.0143	0.0092	0.0051

202	0.0131	0.0085	0.0047
203	0.0122	0.0078	0.0043
204	0.0114	0.0073	0.0040
205	0.0106	0.0068	0.0038
206	0.0100	0.0064	0.0036
207	0.0095	0.0061	0.0034
208	0.0090	0.0058	0.0032
209	0.0086	0.0055	0.0031
210	0.0082	0.0053	0.0029
211	0.0079	0.0051	0.0028
212	0.0076	0.0049	0.0027
213	0.0073	0.0047	0.0026
214	0.0070	0.0045	0.0025
215	0.0068	0.0044	0.0024
216	0.0066	0.0042	0.0023
217	0.0065	0.0042	0.0023
218	0.0063	0.0041	0.0023
219	0.0062	0.0040	0.0022
220	0.0060	0.0039	0.0021
221	0.0058	0.0038	0.0021
222	0.0057	0.0037	0.0020
223	0.0056	0.0036	0.0020
224	0.0054	0.0035	0.0019
225	0.0053	0.0034	0.0019
226	0.0052	0.0033	0.0018
227	0.0051	0.0033	0.0018
228	0.0050	0.0032	0.0018
229	0.0049	0.0031	0.0017
230	0.0048	0.0031	0.0017
231	0.0047	0.0030	0.0017
232	0.0046	0.0030	0.0016
233	0.0045	0.0029	0.0016
234	0.0044	0.0029	0.0016
235	0.0044	0.0028	0.0016
236	0.0043	0.0028	0.0015
237	0.0042	0.0027	0.0015
238	0.0041	0.0027	0.0015
239	0.0041	0.0026	0.0015
240	0.0040	0.0026	0.0014
241	0.0040	0.0025	0.0014
242	0.0039	0.0025	0.0014
243	0.0038	0.0025	0.0014
244	0.0038	0.0024	0.0013
245	0.0037	0.0024	0.0013
246	0.0037	0.0024	0.0013
247	0.0036	0.0023	0.0013
248	0.0036	0.0023	0.0013
249	0.0035	0.0023	0.0013
250	0.0035	0.0023	0.0012
251	0.0035	0.0022	0.0012
252	0.0034	0.0022	0.0012
253	0.0034	0.0022	0.0012
254	0.0033	0.0021	0.0012
255	0.0033	0.0021	0.0012
256	0.0032	0.0021	0.0012
257	0.0032	0.0021	0.0011
258	0.0032	0.0020	0.0011

259	0.0031	0.0020	0.0011
260	0.0031	0.0020	0.0011
261	0.0031	0.0020	0.0011
262	0.0030	0.0020	0.0011
263	0.0030	0.0019	0.0011
264	0.0030	0.0019	0.0011
265	0.0029	0.0019	0.0011
266	0.0029	0.0019	0.0010
267	0.0029	0.0019	0.0010
268	0.0029	0.0018	0.0010
269	0.0028	0.0018	0.0010
270	0.0028	0.0018	0.0010
271	0.0028	0.0018	0.0010
272	0.0028	0.0018	0.0010
273	0.0027	0.0018	0.0010
274	0.0027	0.0017	0.0010
275	0.0027	0.0017	0.0010
276	0.0027	0.0017	0.0009
277	0.0026	0.0017	0.0009
278	0.0026	0.0017	0.0009
279	0.0026	0.0017	0.0009
280	0.0026	0.0017	0.0009
281	0.0025	0.0016	0.0009
282	0.0025	0.0016	0.0009
283	0.0025	0.0016	0.0009
284	0.0025	0.0016	0.0009
285	0.0025	0.0016	0.0009
286	0.0024	0.0016	0.0009
287	0.0024	0.0016	0.0009
288	0.0024	0.0016	0.0009

Total soil rain loss = 1.26(In)
Total effective rainfall = 1.28(In)
Peak flow rate in flood hydrograph = 146.60(CFS)

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24 - H O U R S T O R M
R u n o f f H y d r o g r a p h

Hydrograph in 5 Minute intervals ((CFS))

```
Time(h+m) Volume Ac.Ft   Q(CFS)  0       50.0     100.0     150.0     200.0
-----------------------------------------------------------------------
  0+ 5       0.0002      0.03  Q         |         |         |         |
  0+10       0.0015      0.20  Q         |         |         |         |
  0+15       0.0044      0.42  Q         |         |         |         |
  0+20       0.0080      0.52  Q         |         |         |         |
  0+25       0.0120      0.58  Q         |         |         |         |
  0+30       0.0162      0.62  Q         |         |         |         |
  0+35       0.0207      0.65  Q         |         |         |         |
  0+40       0.0253      0.67  Q         |         |         |         |
  0+45       0.0300      0.69  Q         |         |         |         |
  0+50       0.0349      0.70  Q         |         |         |         |
  0+55       0.0398      0.71  Q         |         |         |         |
  1+ 0       0.0448      0.72  Q         |         |         |         |
```

1+ 5	0.0498	0.73	Q	|	|	|	|
1+10	0.0549	0.74	Q	|	|	|	|
1+15	0.0600	0.74	Q	|	|	|	|
1+20	0.0652	0.75	Q	|	|	|	|
1+25	0.0704	0.75	Q	|	|	|	|
1+30	0.0756	0.76	Q	|	|	|	|
1+35	0.0808	0.76	Q	|	|	|	|
1+40	0.0861	0.76	Q	|	|	|	|
1+45	0.0914	0.77	Q	|	|	|	|
1+50	0.0967	0.77	Q	|	|	|	|
1+55	0.1020	0.77	Q	|	|	|	|
2+ 0	0.1074	0.78	Q	|	|	|	|
2+ 5	0.1128	0.78	Q	|	|	|	|
2+10	0.1182	0.78	Q	|	|	|	|
2+15	0.1236	0.79	Q	|	|	|	|
2+20	0.1290	0.79	Q	|	|	|	|
2+25	0.1345	0.79	Q	|	|	|	|
2+30	0.1400	0.80	Q	|	|	|	|
2+35	0.1455	0.80	Q	|	|	|	|
2+40	0.1510	0.80	Q	|	|	|	|
2+45	0.1566	0.81	Q	|	|	|	|
2+50	0.1622	0.81	Q	|	|	|	|
2+55	0.1678	0.82	Q	|	|	|	|
3+ 0	0.1735	0.82	Q	|	|	|	|
3+ 5	0.1791	0.82	Q	|	|	|	|
3+10	0.1848	0.83	Q	|	|	|	|
3+15	0.1905	0.83	QV	|	|	|	|
3+20	0.1963	0.83	QV	|	|	|	|
3+25	0.2021	0.84	QV	|	|	|	|
3+30	0.2079	0.84	QV	|	|	|	|
3+35	0.2137	0.85	QV	|	|	|	|
3+40	0.2195	0.85	QV	|	|	|	|
3+45	0.2254	0.85	QV	|	|	|	|
3+50	0.2313	0.86	QV	|	|	|	|
3+55	0.2373	0.86	QV	|	|	|	|
4+ 0	0.2433	0.87	QV	|	|	|	|
4+ 5	0.2493	0.87	QV	|	|	|	|
4+10	0.2553	0.88	QV	|	|	|	|
4+15	0.2613	0.88	QV	|	|	|	|
4+20	0.2674	0.88	QV	|	|	|	|
4+25	0.2736	0.89	QV	|	|	|	|
4+30	0.2797	0.89	QV	|	|	|	|
4+35	0.2859	0.90	QV	|	|	|	|
4+40	0.2921	0.90	QV	|	|	|	|
4+45	0.2984	0.91	QV	|	|	|	|
4+50	0.3047	0.91	QV	|	|	|	|
4+55	0.3110	0.92	QV	|	|	|	|
5+ 0	0.3173	0.92	QV	|	|	|	|
5+ 5	0.3237	0.93	QV	|	|	|	|
5+10	0.3301	0.93	QV	|	|	|	|
5+15	0.3366	0.94	QV	|	|	|	|
5+20	0.3431	0.94	QV	|	|	|	|
5+25	0.3496	0.95	QV	|	|	|	|
5+30	0.3562	0.95	QV	|	|	|	|
5+35	0.3628	0.96	QV	|	|	|	|
5+40	0.3694	0.96	QV	|	|	|	|
5+45	0.3761	0.97	Q V	|	|	|	|

5+50	0.3828	0.97	Q V	|	|	|	|
5+55	0.3895	0.98	Q V	|	|	|	|
6+ 0	0.3963	0.99	Q V	|	|	|	|
6+ 5	0.4032	0.99	Q V	|	|	|	|
6+10	0.4100	1.00	Q V	|	|	|	|
6+15	0.4170	1.00	Q V	|	|	|	|
6+20	0.4239	1.01	Q V	|	|	|	|
6+25	0.4309	1.02	Q V	|	|	|	|
6+30	0.4380	1.02	Q V	|	|	|	|
6+35	0.4450	1.03	Q V	|	|	|	|
6+40	0.4522	1.04	Q V	|	|	|	|
6+45	0.4594	1.04	Q V	|	|	|	|
6+50	0.4666	1.05	Q V	|	|	|	|
6+55	0.4738	1.06	Q V	|	|	|	|
7+ 0	0.4812	1.06	Q V	|	|	|	|
7+ 5	0.4885	1.07	Q V	|	|	|	|
7+10	0.4959	1.08	Q V	|	|	|	|
7+15	0.5034	1.08	Q V	|	|	|	|
7+20	0.5109	1.09	Q V	|	|	|	|
7+25	0.5185	1.10	Q V	|	|	|	|
7+30	0.5261	1.11	Q V	|	|	|	|
7+35	0.5338	1.11	Q V	|	|	|	|
7+40	0.5415	1.12	Q V	|	|	|	|
7+45	0.5493	1.13	Q V	|	|	|	|
7+50	0.5571	1.14	Q V	|	|	|	|
7+55	0.5650	1.15	Q V	|	|	|	|
8+ 0	0.5729	1.15	Q V	|	|	|	|
8+ 5	0.5809	1.16	Q V	|	|	|	|
8+10	0.5890	1.17	Q V	|	|	|	|
8+15	0.5971	1.18	Q V	|	|	|	|
8+20	0.6053	1.19	Q V	|	|	|	|
8+25	0.6136	1.20	Q V	|	|	|	|
8+30	0.6219	1.21	Q V	|	|	|	|
8+35	0.6302	1.22	Q V	|	|	|	|
8+40	0.6387	1.23	Q V	|	|	|	|
8+45	0.6472	1.24	Q V	|	|	|	|
8+50	0.6558	1.25	Q V	|	|	|	|
8+55	0.6644	1.26	Q V	|	|	|	|
9+ 0	0.6732	1.27	Q V	|	|	|	|
9+ 5	0.6820	1.28	Q V	|	|	|	|
9+10	0.6908	1.29	Q V	|	|	|	|
9+15	0.6998	1.30	Q V	|	|	|	|
9+20	0.7088	1.31	Q V	|	|	|	|
9+25	0.7179	1.32	Q V	|	|	|	|
9+30	0.7271	1.33	Q V	|	|	|	|
9+35	0.7363	1.35	Q V	|	|	|	|
9+40	0.7457	1.36	Q V	|	|	|	|
9+45	0.7551	1.37	Q V	|	|	|	|
9+50	0.7647	1.38	Q V	|	|	|	|
9+55	0.7743	1.40	Q V	|	|	|	|
10+ 0	0.7840	1.41	Q V	|	|	|	|
10+ 5	0.7938	1.42	Q V	|	|	|	|
10+10	0.8037	1.44	Q V	|	|	|	|
10+15	0.8137	1.45	Q V	|	|	|	|
10+20	0.8238	1.47	Q V	|	|	|	|
10+25	0.8340	1.48	Q V	|	|	|	|
10+30	0.8443	1.50	Q V	|	|	|	|

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10+35       0.8547      1.51  Q   V     |          |          |          |
10+40       0.8652      1.53  Q   V     |          |          |          |
10+45       0.8759      1.55  Q   V     |          |          |          |
10+50       0.8866      1.56  Q   V     |          |          |          |
10+55       0.8975      1.58  Q   V     |          |          |          |
11+ 0       0.9085      1.60  Q   V     |          |          |          |
11+ 5       0.9196      1.62  Q   V     |          |          |          |
11+10       0.9309      1.64  Q    V    |          |          |          |
11+15       0.9423      1.65  Q    V    |          |          |          |
11+20       0.9538      1.67  Q    V    |          |          |          |
11+25       0.9655      1.70  Q    V    |          |          |          |
11+30       0.9773      1.72  Q    V    |          |          |          |
11+35       0.9893      1.74  Q    V    |          |          |          |
11+40       1.0014      1.76  Q    V    |          |          |          |
11+45       1.0137      1.78  Q    V    |          |          |          |
11+50       1.0262      1.81  Q    V    |          |          |          |
11+55       1.0388      1.83  Q    V    |          |          |          |
12+ 0       1.0516      1.86  Q    V    |          |          |          |
12+ 5       1.0646      1.88  Q    V    |          |          |          |
12+10       1.0777      1.90  Q    V    |          |          |          |
12+15       1.0909      1.92  Q    V    |          |          |          |
12+20       1.1043      1.94  Q    V    |          |          |          |
12+25       1.1178      1.97  Q     V   |          |          |          |
12+30       1.1316      2.00  Q     V   |          |          |          |
12+35       1.1455      2.03  Q     V   |          |          |          |
12+40       1.1597      2.06  Q     V   |          |          |          |
12+45       1.1741      2.09  Q     V   |          |          |          |
12+50       1.1888      2.13  Q     V   |          |          |          |
12+55       1.2037      2.17  Q     V   |          |          |          |
13+ 0       1.2190      2.21  Q     V   |          |          |          |
13+ 5       1.2344      2.25  Q     V   |          |          |          |
13+10       1.2502      2.29  Q     V   |          |          |          |
13+15       1.2663      2.34  Q     V   |          |          |          |
13+20       1.2828      2.39  Q     V   |          |          |          |
13+25       1.2995      2.44  Q      V  |          |          |          |
13+30       1.3167      2.49  Q      V  |          |          |          |
13+35       1.3342      2.54  Q      V  |          |          |          |
13+40       1.3521      2.60  Q      V  |          |          |          |
13+45       1.3705      2.67  Q      V  |          |          |          |
13+50       1.3893      2.73  Q      V  |          |          |          |
13+55       1.4086      2.80  Q      V  |          |          |          |
14+ 0       1.4284      2.88  Q      V  |          |          |          |
14+ 5       1.4488      2.96  Q      V  |          |          |          |
14+10       1.4697      3.05  Q      V  |          |          |          |
14+15       1.4914      3.15  Q       V |          |          |          |
14+20       1.5138      3.25  Q       V |          |          |          |
14+25       1.5369      3.35  Q       V |          |          |          |
14+30       1.5607      3.47  Q       V |          |          |          |
14+35       1.5855      3.59  Q       V |          |          |          |
14+40       1.6112      3.73  Q       V |          |          |          |
14+45       1.6379      3.88  Q       V |          |          |          |
14+50       1.6657      4.04  Q       V |          |          |          |
14+55       1.6947      4.22  Q        V|          |          |          |
15+ 0       1.7251      4.42  Q        V|          |          |          |
15+ 5       1.7570      4.64  Q        V|          |          |          |
15+10       1.7907      4.89  Q        V|          |          |          |
15+15       1.8264      5.18  |Q       V|          |          |          |
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15+20       1.8644      5.51  |Q        V         |         |         |
15+25       1.9052      5.93  |Q        V         |         |         |
15+30       1.9507      6.61  |Q        V         |         |         |
15+35       2.0020      7.45  |Q        V         |         |         |
15+40       2.0592      8.31  |Q        |V        |         |         |
15+45       2.1236      9.34  |Q        |V        |         |         |
15+50       2.1982     10.84  | Q       |V        |         |         |
15+55       2.2952     14.08  | Q       | V       |         |         |
16+ 0       2.4528     22.88  |   Q     |  V      |         |         |
16+ 5       2.7998     50.39  |         Q    V    |         |         |
16+10       3.6850    128.54  |         |        V|    Q    |         |
16+15       4.6947    146.60  |         |         |    V   Q|         |
16+20       5.2292     77.60  |         |    Q    |        V |         |
16+25       5.5696     49.43  |        Q|         |         V         |
16+30       5.8116     35.14  |      Q  |         |         |V        |
16+35       5.9954     26.69  |    Q    |         |         | V       |
16+40       6.1360     20.41  |   Q     |         |         |  V      |
16+45       6.2508     16.67  |  Q      |         |         |  V      |
16+50       6.3441     13.55  | Q       |         |         |   V     |
16+55       6.4209     11.14  | Q       |         |         |   V     |
17+ 0       6.4828      8.99  |Q        |         |         |   V     |
17+ 5       6.5324      7.21  |Q        |         |         |    V    |
17+10       6.5787      6.72  |Q        |         |         |    V    |
17+15       6.6222      6.31  |Q        |         |         |    V    |
17+20       6.6580      5.20  |Q        |         |         |    V    |
17+25       6.6884      4.41  Q         |         |         |     V   |
17+30       6.7095      3.06  Q         |         |         |     V   |
17+35       6.7290      2.84  Q         |         |         |     V   |
17+40       6.7475      2.68  Q         |         |         |     V   |
17+45       6.7650      2.55  Q         |         |         |     V   |
17+50       6.7818      2.43  Q         |         |         |     V   |
17+55       6.7978      2.33  Q         |         |         |     V   |
18+ 0       6.8132      2.24  Q         |         |         |     V   |
18+ 5       6.8280      2.15  Q         |         |         |     V   |
18+10       6.8424      2.09  Q         |         |         |     V   |
18+15       6.8564      2.03  Q         |         |         |      V  |
18+20       6.8700      1.97  Q         |         |         |      V  |
18+25       6.8832      1.92  Q         |         |         |      V  |
18+30       6.8961      1.86  Q         |         |         |      V  |
18+35       6.9085      1.81  Q         |         |         |      V  |
18+40       6.9207      1.77  Q         |         |         |      V  |
18+45       6.9326      1.72  Q         |         |         |      V  |
18+50       6.9441      1.68  Q         |         |         |      V  |
18+55       6.9554      1.64  Q         |         |         |      V  |
19+ 0       6.9665      1.60  Q         |         |         |      V  |
19+ 5       6.9773      1.57  Q         |         |         |      V  |
19+10       6.9878      1.53  Q         |         |         |      V  |
19+15       6.9981      1.50  Q         |         |         |      V  |
19+20       7.0083      1.47  Q         |         |         |      V  |
19+25       7.0182      1.44  Q         |         |         |      V  |
19+30       7.0279      1.41  Q         |         |         |      V  |
19+35       7.0374      1.39  Q         |         |         |      V  |
19+40       7.0468      1.36  Q         |         |         |       V |
19+45       7.0560      1.34  Q         |         |         |       V |
19+50       7.0650      1.31  Q         |         |         |       V |
19+55       7.0739      1.29  Q         |         |         |       V |
20+ 0       7.0827      1.27  Q         |         |         |       V |
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20+ 5       7.0913      1.25  Q          |          |          |        V |
20+10       7.0997      1.23  Q          |          |          |        V |
20+15       7.1080      1.21  Q          |          |          |        V |
20+20       7.1162      1.19  Q          |          |          |        V |
20+25       7.1243      1.17  Q          |          |          |        V |
20+30       7.1323      1.15  Q          |          |          |        V |
20+35       7.1401      1.14  Q          |          |          |        V |
20+40       7.1478      1.12  Q          |          |          |        V |
20+45       7.1554      1.11  Q          |          |          |        V |
20+50       7.1630      1.09  Q          |          |          |        V |
20+55       7.1704      1.08  Q          |          |          |        V |
21+ 0       7.1777      1.06  Q          |          |          |        V |
21+ 5       7.1849      1.05  Q          |          |          |        V |
21+10       7.1921      1.04  Q          |          |          |        V |
21+15       7.1991      1.02  Q          |          |          |        V |
21+20       7.2061      1.01  Q          |          |          |        V |
21+25       7.2129      1.00  Q          |          |          |        V |
21+30       7.2197      0.99  Q          |          |          |        V |
21+35       7.2265      0.98  Q          |          |          |         V|
21+40       7.2331      0.96  Q          |          |          |         V|
21+45       7.2397      0.95  Q          |          |          |         V|
21+50       7.2462      0.94  Q          |          |          |         V|
21+55       7.2526      0.93  Q          |          |          |         V|
22+ 0       7.2589      0.92  Q          |          |          |         V|
22+ 5       7.2652      0.91  Q          |          |          |         V|
22+10       7.2714      0.90  Q          |          |          |         V|
22+15       7.2776      0.89  Q          |          |          |         V|
22+20       7.2837      0.88  Q          |          |          |         V|
22+25       7.2897      0.88  Q          |          |          |         V|
22+30       7.2957      0.87  Q          |          |          |         V|
22+35       7.3016      0.86  Q          |          |          |         V|
22+40       7.3075      0.85  Q          |          |          |         V|
22+45       7.3133      0.84  Q          |          |          |         V|
22+50       7.3190      0.83  Q          |          |          |         V|
22+55       7.3247      0.83  Q          |          |          |         V|
23+ 0       7.3303      0.82  Q          |          |          |         V|
23+ 5       7.3359      0.81  Q          |          |          |         V|
23+10       7.3415      0.80  Q          |          |          |         V|
23+15       7.3470      0.80  Q          |          |          |         V|
23+20       7.3524      0.79  Q          |          |          |         V|
23+25       7.3578      0.78  Q          |          |          |         V|
23+30       7.3632      0.78  Q          |          |          |         V|
23+35       7.3685      0.77  Q          |          |          |         V|
23+40       7.3737      0.76  Q          |          |          |         V|
23+45       7.3790      0.76  Q          |          |          |         V|
23+50       7.3841      0.75  Q          |          |          |         V|
23+55       7.3893      0.75  Q          |          |          |         V|
24+ 0       7.3944      0.74  Q          |          |          |         V|
24+ 5       7.3992      0.71  Q          |          |          |         V|
24+10       7.4029      0.53  Q          |          |          |         V|
24+15       7.4050      0.31  Q          |          |          |         V|
24+20       7.4065      0.21  Q          |          |          |         V|
24+25       7.4075      0.15  Q          |          |          |         V|
24+30       7.4082      0.11  Q          |          |          |         V|
24+35       7.4088      0.08  Q          |          |          |         V|
24+40       7.4092      0.06  Q          |          |          |         V|
24+45       7.4095      0.04  Q          |          |          |         V|
```

```
   24+50       7.4097      0.03  Q         |         |         |        V|
   24+55       7.4099      0.02  Q         |         |         |        V|
   25+ 0       7.4100      0.02  Q         |         |         |        V|
   25+ 5       7.4101      0.01  Q         |         |         |        V|
   25+10       7.4102      0.01  Q         |         |         |        V|
   25+15       7.4102      0.00  Q         |         |         |        V|
   25+20       7.4102      0.00  Q         |         |         |         V
-----------------------------------------------------------------------
```

U n i t H y d r o g r a p h A n a l y s i s

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Study date 04/13/15

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San Bernardino County Synthetic Unit Hydrology Method
Manual date - August 1986

Program License Serial Number 6320

154166 - AMBOY - SAN BERNARDINO COUNTY
EXISTING CONDITIONS "B"
20-YEAR, 24-HOUR STORM
BY: JTS DATE: 04-13-15

Storm Event Year = 20

Antecedent Moisture Condition = 1

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

English Units used in output format

Area averaged rainfall intensity isohyetal data:

Sub-Area (Ac.)	Duration (hours)	Isohyetal (In)
Rainfall data for year 10		
91.36	1	0.86
Rainfall data for year 2		
91.36	6	0.75
Rainfall data for year 2		
91.36	24	1.07
Rainfall data for year 100		
91.36	1	1.59
Rainfall data for year 100		
91.36	6	2.43
Rainfall data for year 100		
91.36	24	3.56

```
-----------------------------------------------------------------
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

******** Area-averaged max loss rate, Fm ********


SCS curve  SCS curve     Area     Area     Fp(Fig C6)    Ap      Fm
No.(AMCII) NO.(AMC 1)    (Ac.)    Fraction     (In/Hr)  (dec.)   (In/Hr)
 91.0      79.8         91.36      1.000     0.373    1.000    0.373

Area-averaged adjusted loss rate Fm (In/Hr) =  0.373

********* Area-Averaged low loss rate fraction, Yb **********

Area       Area          SCS CN    SCS CN      S     Pervious
 (Ac.)      Fract         (AMC2)    (AMC1)           Yield Fr
    91.36   1.000         91.0      79.8       2.53     0.356

Area-averaged catchment yield fraction, Y =  0.356
Area-averaged low loss fraction, Yb =  0.644
User entry of time of concentration  =   0.230 (hours)
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Watershed area =      91.36(Ac.)
Catchment Lag time =   0.184 hours
Unit interval =   5.000 minutes
Unit interval percentage of lag time = 45.2899
Hydrograph baseflow =     0.00(CFS)
Average maximum watershed loss rate(Fm) =  0.373(In/Hr)
Average low loss rate fraction (Yb) = 0.644 (decimal)
DESERT S-Graph Selected
Computed peak 5-minute rainfall =  0.512(In)
Computed peak 30-minute rainfall =  0.877(In)
Specified peak 1-hour rainfall =  1.080(In)
Computed peak 3-hour rainfall =  1.446(In)
Specified peak 6-hour rainfall =  1.739(In)
Specified peak 24-hour rainfall =  2.536(In)


Rainfall depth area reduction factors:
Using a total area of      91.36(Ac.) (Ref: fig. E-4)

5-minute factor = 0.996     Adjusted rainfall =  0.510(In)
30-minute factor = 0.996    Adjusted rainfall =  0.873(In)
1-hour factor = 0.996       Adjusted rainfall =  1.075(In)
3-hour factor = 0.999       Adjusted rainfall =  1.445(In)
6-hour factor = 1.000       Adjusted rainfall =  1.738(In)
24-hour factor = 1.000      Adjusted rainfall =  2.535(In)
-------------------------------------------------------------------

                  U n i t  H y d r o g r a p h
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Interval          'S' Graph          Unit Hydrograph
Number            Mean values             ((CFS))
-------------------------------------------------------------------
            (K =      1104.88 (CFS))

  1                 3.365                   37.178
```

2	24.923	238.187
3	55.845	341.662
4	70.325	159.988
5	78.657	92.055
6	84.140	60.576
7	88.185	44.695
8	91.006	31.166
9	93.225	24.522
10	94.928	18.816
11	96.264	14.764
12	97.275	11.166
13	97.957	7.544
14	98.440	5.328
15	98.980	5.974
16	99.485	5.579
17	99.796	3.427
18	100.000	2.259

Peak Unit Number	Adjusted mass rainfall (In)	Unit rainfall (In)
1	0.5102	0.5102
2	0.6281	0.1179
3	0.7093	0.0812
4	0.7733	0.0639
5	0.8268	0.0535
6	0.8733	0.0465
7	0.9146	0.0413
8	0.9520	0.0374
9	0.9862	0.0342
10	1.0179	0.0317
11	1.0474	0.0295
12	1.0751	0.0277
13	1.0986	0.0234
14	1.1207	0.0221
15	1.1417	0.0210
16	1.1617	0.0200
17	1.1809	0.0191
18	1.1992	0.0183
19	1.2168	0.0176
20	1.2337	0.0169
21	1.2500	0.0163
22	1.2658	0.0158
23	1.2810	0.0152
24	1.2958	0.0148
25	1.3101	0.0143
26	1.3240	0.0139
27	1.3376	0.0135
28	1.3507	0.0132
29	1.3636	0.0128
30	1.3761	0.0125
31	1.3883	0.0122
32	1.4002	0.0119
33	1.4119	0.0117
34	1.4233	0.0114
35	1.4344	0.0112
36	1.4453	0.0109
37	1.4559	0.0106

38	1.4663	0.0104
39	1.4765	0.0102
40	1.4865	0.0100
41	1.4963	0.0098
42	1.5059	0.0096
43	1.5154	0.0095
44	1.5247	0.0093
45	1.5338	0.0092
46	1.5428	0.0090
47	1.5517	0.0089
48	1.5604	0.0087
49	1.5690	0.0086
50	1.5775	0.0085
51	1.5858	0.0083
52	1.5940	0.0082
53	1.6021	0.0081
54	1.6101	0.0080
55	1.6180	0.0079
56	1.6258	0.0078
57	1.6335	0.0077
58	1.6411	0.0076
59	1.6486	0.0075
60	1.6560	0.0074
61	1.6633	0.0073
62	1.6705	0.0072
63	1.6776	0.0071
64	1.6847	0.0071
65	1.6916	0.0070
66	1.6985	0.0069
67	1.7053	0.0068
68	1.7121	0.0067
69	1.7187	0.0067
70	1.7253	0.0066
71	1.7319	0.0065
72	1.7383	0.0065
73	1.7449	0.0065
74	1.7514	0.0065
75	1.7578	0.0064
76	1.7641	0.0063
77	1.7704	0.0063
78	1.7766	0.0062
79	1.7828	0.0062
80	1.7889	0.0061
81	1.7950	0.0061
82	1.8010	0.0060
83	1.8069	0.0060
84	1.8128	0.0059
85	1.8187	0.0058
86	1.8245	0.0058
87	1.8302	0.0058
88	1.8359	0.0057
89	1.8416	0.0057
90	1.8472	0.0056
91	1.8528	0.0056
92	1.8583	0.0055
93	1.8638	0.0055
94	1.8692	0.0054

95	1.8746	0.0054
96	1.8799	0.0054
97	1.8853	0.0053
98	1.8905	0.0053
99	1.8958	0.0052
100	1.9010	0.0052
101	1.9061	0.0052
102	1.9112	0.0051
103	1.9163	0.0051
104	1.9214	0.0050
105	1.9264	0.0050
106	1.9313	0.0050
107	1.9363	0.0049
108	1.9412	0.0049
109	1.9461	0.0049
110	1.9509	0.0048
111	1.9557	0.0048
112	1.9605	0.0048
113	1.9653	0.0047
114	1.9700	0.0047
115	1.9747	0.0047
116	1.9793	0.0047
117	1.9840	0.0046
118	1.9886	0.0046
119	1.9931	0.0046
120	1.9977	0.0045
121	2.0022	0.0045
122	2.0067	0.0045
123	2.0112	0.0045
124	2.0156	0.0044
125	2.0200	0.0044
126	2.0244	0.0044
127	2.0288	0.0044
128	2.0331	0.0043
129	2.0374	0.0043
130	2.0417	0.0043
131	2.0460	0.0043
132	2.0502	0.0042
133	2.0544	0.0042
134	2.0586	0.0042
135	2.0628	0.0042
136	2.0669	0.0041
137	2.0711	0.0041
138	2.0752	0.0041
139	2.0792	0.0041
140	2.0833	0.0041
141	2.0873	0.0040
142	2.0914	0.0040
143	2.0954	0.0040
144	2.0993	0.0040
145	2.1033	0.0040
146	2.1072	0.0039
147	2.1112	0.0039
148	2.1151	0.0039
149	2.1189	0.0039
150	2.1228	0.0039
151	2.1266	0.0038

152	2.1305	0.0038
153	2.1343	0.0038
154	2.1381	0.0038
155	2.1418	0.0038
156	2.1456	0.0038
157	2.1493	0.0037
158	2.1530	0.0037
159	2.1567	0.0037
160	2.1604	0.0037
161	2.1641	0.0037
162	2.1677	0.0037
163	2.1714	0.0036
164	2.1750	0.0036
165	2.1786	0.0036
166	2.1822	0.0036
167	2.1858	0.0036
168	2.1893	0.0036
169	2.1928	0.0035
170	2.1964	0.0035
171	2.1999	0.0035
172	2.2034	0.0035
173	2.2069	0.0035
174	2.2103	0.0035
175	2.2138	0.0035
176	2.2172	0.0034
177	2.2206	0.0034
178	2.2240	0.0034
179	2.2274	0.0034
180	2.2308	0.0034
181	2.2342	0.0034
182	2.2375	0.0034
183	2.2409	0.0033
184	2.2442	0.0033
185	2.2475	0.0033
186	2.2508	0.0033
187	2.2541	0.0033
188	2.2574	0.0033
189	2.2606	0.0033
190	2.2639	0.0032
191	2.2671	0.0032
192	2.2704	0.0032
193	2.2736	0.0032
194	2.2768	0.0032
195	2.2800	0.0032
196	2.2831	0.0032
197	2.2863	0.0032
198	2.2895	0.0032
199	2.2926	0.0031
200	2.2957	0.0031
201	2.2988	0.0031
202	2.3020	0.0031
203	2.3050	0.0031
204	2.3081	0.0031
205	2.3112	0.0031
206	2.3143	0.0031
207	2.3173	0.0031
208	2.3204	0.0030

209	2.3234	0.0030
210	2.3264	0.0030
211	2.3294	0.0030
212	2.3324	0.0030
213	2.3354	0.0030
214	2.3384	0.0030
215	2.3414	0.0030
216	2.3443	0.0030
217	2.3473	0.0029
218	2.3502	0.0029
219	2.3531	0.0029
220	2.3561	0.0029
221	2.3590	0.0029
222	2.3619	0.0029
223	2.3648	0.0029
224	2.3677	0.0029
225	2.3705	0.0029
226	2.3734	0.0029
227	2.3762	0.0029
228	2.3791	0.0028
229	2.3819	0.0028
230	2.3848	0.0028
231	2.3876	0.0028
232	2.3904	0.0028
233	2.3932	0.0028
234	2.3960	0.0028
235	2.3988	0.0028
236	2.4015	0.0028
237	2.4043	0.0028
238	2.4071	0.0028
239	2.4098	0.0027
240	2.4125	0.0027
241	2.4153	0.0027
242	2.4180	0.0027
243	2.4207	0.0027
244	2.4234	0.0027
245	2.4261	0.0027
246	2.4288	0.0027
247	2.4315	0.0027
248	2.4342	0.0027
249	2.4368	0.0027
250	2.4395	0.0027
251	2.4422	0.0027
252	2.4448	0.0026
253	2.4474	0.0026
254	2.4501	0.0026
255	2.4527	0.0026
256	2.4553	0.0026
257	2.4579	0.0026
258	2.4605	0.0026
259	2.4631	0.0026
260	2.4657	0.0026
261	2.4683	0.0026
262	2.4708	0.0026
263	2.4734	0.0026
264	2.4760	0.0026
265	2.4785	0.0025

266	2.4810	0.0025
267	2.4836	0.0025
268	2.4861	0.0025
269	2.4886	0.0025
270	2.4912	0.0025
271	2.4937	0.0025
272	2.4962	0.0025
273	2.4987	0.0025
274	2.5011	0.0025
275	2.5036	0.0025
276	2.5061	0.0025
277	2.5086	0.0025
278	2.5110	0.0025
279	2.5135	0.0025
280	2.5159	0.0024
281	2.5184	0.0024
282	2.5208	0.0024
283	2.5232	0.0024
284	2.5257	0.0024
285	2.5281	0.0024
286	2.5305	0.0024
287	2.5329	0.0024
288	2.5353	0.0024

Unit Period (number)	Unit Rainfall (In)	Unit Soil-Loss (In)	Effective Rainfall (In)
1	0.0024	0.0015	0.0009
2	0.0024	0.0015	0.0009
3	0.0024	0.0016	0.0009
4	0.0024	0.0016	0.0009
5	0.0024	0.0016	0.0009
6	0.0024	0.0016	0.0009
7	0.0025	0.0016	0.0009
8	0.0025	0.0016	0.0009
9	0.0025	0.0016	0.0009
10	0.0025	0.0016	0.0009
11	0.0025	0.0016	0.0009
12	0.0025	0.0016	0.0009
13	0.0025	0.0016	0.0009
14	0.0025	0.0016	0.0009
15	0.0025	0.0016	0.0009
16	0.0025	0.0016	0.0009
17	0.0026	0.0016	0.0009
18	0.0026	0.0017	0.0009
19	0.0026	0.0017	0.0009
20	0.0026	0.0017	0.0009
21	0.0026	0.0017	0.0009
22	0.0026	0.0017	0.0009
23	0.0026	0.0017	0.0009
24	0.0026	0.0017	0.0009
25	0.0026	0.0017	0.0009
26	0.0027	0.0017	0.0009
27	0.0027	0.0017	0.0010
28	0.0027	0.0017	0.0010
29	0.0027	0.0017	0.0010

30	0.0027	0.0017	0.0010
31	0.0027	0.0017	0.0010
32	0.0027	0.0018	0.0010
33	0.0027	0.0018	0.0010
34	0.0027	0.0018	0.0010
35	0.0028	0.0018	0.0010
36	0.0028	0.0018	0.0010
37	0.0028	0.0018	0.0010
38	0.0028	0.0018	0.0010
39	0.0028	0.0018	0.0010
40	0.0028	0.0018	0.0010
41	0.0028	0.0018	0.0010
42	0.0029	0.0018	0.0010
43	0.0029	0.0018	0.0010
44	0.0029	0.0019	0.0010
45	0.0029	0.0019	0.0010
46	0.0029	0.0019	0.0010
47	0.0029	0.0019	0.0010
48	0.0029	0.0019	0.0010
49	0.0030	0.0019	0.0011
50	0.0030	0.0019	0.0011
51	0.0030	0.0019	0.0011
52	0.0030	0.0019	0.0011
53	0.0030	0.0019	0.0011
54	0.0030	0.0020	0.0011
55	0.0031	0.0020	0.0011
56	0.0031	0.0020	0.0011
57	0.0031	0.0020	0.0011
58	0.0031	0.0020	0.0011
59	0.0031	0.0020	0.0011
60	0.0031	0.0020	0.0011
61	0.0032	0.0020	0.0011
62	0.0032	0.0020	0.0011
63	0.0032	0.0021	0.0011
64	0.0032	0.0021	0.0011
65	0.0032	0.0021	0.0011
66	0.0032	0.0021	0.0012
67	0.0033	0.0021	0.0012
68	0.0033	0.0021	0.0012
69	0.0033	0.0021	0.0012
70	0.0033	0.0021	0.0012
71	0.0033	0.0022	0.0012
72	0.0034	0.0022	0.0012
73	0.0034	0.0022	0.0012
74	0.0034	0.0022	0.0012
75	0.0034	0.0022	0.0012
76	0.0034	0.0022	0.0012
77	0.0035	0.0022	0.0012
78	0.0035	0.0022	0.0012
79	0.0035	0.0023	0.0012
80	0.0035	0.0023	0.0013
81	0.0036	0.0023	0.0013
82	0.0036	0.0023	0.0013
83	0.0036	0.0023	0.0013
84	0.0036	0.0023	0.0013
85	0.0037	0.0024	0.0013
86	0.0037	0.0024	0.0013

87	0.0037	0.0024	0.0013
88	0.0037	0.0024	0.0013
89	0.0038	0.0024	0.0013
90	0.0038	0.0024	0.0013
91	0.0038	0.0025	0.0014
92	0.0038	0.0025	0.0014
93	0.0039	0.0025	0.0014
94	0.0039	0.0025	0.0014
95	0.0039	0.0025	0.0014
96	0.0039	0.0025	0.0014
97	0.0040	0.0026	0.0014
98	0.0040	0.0026	0.0014
99	0.0040	0.0026	0.0014
100	0.0041	0.0026	0.0014
101	0.0041	0.0026	0.0015
102	0.0041	0.0027	0.0015
103	0.0042	0.0027	0.0015
104	0.0042	0.0027	0.0015
105	0.0042	0.0027	0.0015
106	0.0043	0.0027	0.0015
107	0.0043	0.0028	0.0015
108	0.0043	0.0028	0.0015
109	0.0044	0.0028	0.0016
110	0.0044	0.0028	0.0016
111	0.0045	0.0029	0.0016
112	0.0045	0.0029	0.0016
113	0.0045	0.0029	0.0016
114	0.0046	0.0029	0.0016
115	0.0046	0.0030	0.0016
116	0.0047	0.0030	0.0017
117	0.0047	0.0030	0.0017
118	0.0047	0.0031	0.0017
119	0.0048	0.0031	0.0017
120	0.0048	0.0031	0.0017
121	0.0049	0.0032	0.0017
122	0.0049	0.0032	0.0018
123	0.0050	0.0032	0.0018
124	0.0050	0.0032	0.0018
125	0.0051	0.0033	0.0018
126	0.0052	0.0033	0.0018
127	0.0052	0.0034	0.0019
128	0.0053	0.0034	0.0019
129	0.0054	0.0034	0.0019
130	0.0054	0.0035	0.0019
131	0.0055	0.0035	0.0020
132	0.0055	0.0036	0.0020
133	0.0056	0.0036	0.0020
134	0.0057	0.0036	0.0020
135	0.0058	0.0037	0.0020
136	0.0058	0.0037	0.0021
137	0.0059	0.0038	0.0021
138	0.0060	0.0038	0.0021
139	0.0061	0.0039	0.0022
140	0.0061	0.0039	0.0022
141	0.0062	0.0040	0.0022
142	0.0063	0.0040	0.0022
143	0.0064	0.0041	0.0023

144	0.0065	0.0042	0.0023
145	0.0065	0.0042	0.0023
146	0.0065	0.0042	0.0023
147	0.0067	0.0043	0.0024
148	0.0067	0.0043	0.0024
149	0.0069	0.0044	0.0025
150	0.0070	0.0045	0.0025
151	0.0071	0.0046	0.0025
152	0.0072	0.0046	0.0026
153	0.0074	0.0048	0.0026
154	0.0075	0.0048	0.0027
155	0.0077	0.0049	0.0027
156	0.0078	0.0050	0.0028
157	0.0080	0.0051	0.0028
158	0.0081	0.0052	0.0029
159	0.0083	0.0054	0.0030
160	0.0085	0.0054	0.0030
161	0.0087	0.0056	0.0031
162	0.0089	0.0057	0.0032
163	0.0092	0.0059	0.0033
164	0.0093	0.0060	0.0033
165	0.0096	0.0062	0.0034
166	0.0098	0.0063	0.0035
167	0.0102	0.0066	0.0036
168	0.0104	0.0067	0.0037
169	0.0109	0.0070	0.0039
170	0.0112	0.0072	0.0040
171	0.0117	0.0075	0.0041
172	0.0119	0.0077	0.0042
173	0.0125	0.0081	0.0045
174	0.0128	0.0083	0.0046
175	0.0135	0.0087	0.0048
176	0.0139	0.0090	0.0050
177	0.0148	0.0095	0.0053
178	0.0152	0.0098	0.0054
179	0.0163	0.0105	0.0058
180	0.0169	0.0109	0.0060
181	0.0183	0.0118	0.0065
182	0.0191	0.0123	0.0068
183	0.0210	0.0135	0.0075
184	0.0221	0.0143	0.0079
185	0.0277	0.0178	0.0099
186	0.0295	0.0190	0.0105
187	0.0342	0.0220	0.0122
188	0.0374	0.0241	0.0133
189	0.0465	0.0299	0.0166
190	0.0535	0.0311	0.0224
191	0.0812	0.0311	0.0501
192	0.1179	0.0311	0.0868
193	0.5102	0.0311	0.4791
194	0.0639	0.0311	0.0328
195	0.0413	0.0266	0.0147
196	0.0317	0.0204	0.0113
197	0.0234	0.0151	0.0083
198	0.0200	0.0129	0.0071
199	0.0176	0.0113	0.0063
200	0.0158	0.0101	0.0056

201	0.0143	0.0092	0.0051
202	0.0132	0.0085	0.0047
203	0.0122	0.0079	0.0043
204	0.0114	0.0073	0.0041
205	0.0106	0.0068	0.0038
206	0.0100	0.0064	0.0036
207	0.0095	0.0061	0.0034
208	0.0090	0.0058	0.0032
209	0.0086	0.0055	0.0031
210	0.0082	0.0053	0.0029
211	0.0079	0.0051	0.0028
212	0.0076	0.0049	0.0027
213	0.0073	0.0047	0.0026
214	0.0071	0.0045	0.0025
215	0.0068	0.0044	0.0024
216	0.0066	0.0042	0.0023
217	0.0065	0.0042	0.0023
218	0.0063	0.0041	0.0023
219	0.0062	0.0040	0.0022
220	0.0060	0.0039	0.0021
221	0.0058	0.0038	0.0021
222	0.0057	0.0037	0.0020
223	0.0056	0.0036	0.0020
224	0.0054	0.0035	0.0019
225	0.0053	0.0034	0.0019
226	0.0052	0.0033	0.0018
227	0.0051	0.0033	0.0018
228	0.0050	0.0032	0.0018
229	0.0049	0.0031	0.0017
230	0.0048	0.0031	0.0017
231	0.0047	0.0030	0.0017
232	0.0046	0.0030	0.0016
233	0.0045	0.0029	0.0016
234	0.0044	0.0029	0.0016
235	0.0044	0.0028	0.0016
236	0.0043	0.0028	0.0015
237	0.0042	0.0027	0.0015
238	0.0041	0.0027	0.0015
239	0.0041	0.0026	0.0015
240	0.0040	0.0026	0.0014
241	0.0040	0.0025	0.0014
242	0.0039	0.0025	0.0014
243	0.0038	0.0025	0.0014
244	0.0038	0.0024	0.0013
245	0.0037	0.0024	0.0013
246	0.0037	0.0024	0.0013
247	0.0036	0.0023	0.0013
248	0.0036	0.0023	0.0013
249	0.0035	0.0023	0.0013
250	0.0035	0.0023	0.0012
251	0.0035	0.0022	0.0012
252	0.0034	0.0022	0.0012
253	0.0034	0.0022	0.0012
254	0.0033	0.0021	0.0012
255	0.0033	0.0021	0.0012
256	0.0032	0.0021	0.0012
257	0.0032	0.0021	0.0011

258	0.0032	0.0020	0.0011
259	0.0031	0.0020	0.0011
260	0.0031	0.0020	0.0011
261	0.0031	0.0020	0.0011
262	0.0030	0.0020	0.0011
263	0.0030	0.0019	0.0011
264	0.0030	0.0019	0.0011
265	0.0029	0.0019	0.0011
266	0.0029	0.0019	0.0010
267	0.0029	0.0019	0.0010
268	0.0029	0.0018	0.0010
269	0.0028	0.0018	0.0010
270	0.0028	0.0018	0.0010
271	0.0028	0.0018	0.0010
272	0.0028	0.0018	0.0010
273	0.0027	0.0018	0.0010
274	0.0027	0.0017	0.0010
275	0.0027	0.0017	0.0010
276	0.0027	0.0017	0.0009
277	0.0026	0.0017	0.0009
278	0.0026	0.0017	0.0009
279	0.0026	0.0017	0.0009
280	0.0026	0.0017	0.0009
281	0.0025	0.0016	0.0009
282	0.0025	0.0016	0.0009
283	0.0025	0.0016	0.0009
284	0.0025	0.0016	0.0009
285	0.0025	0.0016	0.0009
286	0.0024	0.0016	0.0009
287	0.0024	0.0016	0.0009
288	0.0024	0.0016	0.0009

Total soil rain loss = 1.26(In)
Total effective rainfall = 1.28(In)
Peak flow rate in flood hydrograph = 193.99(CFS)

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24 - H O U R S T O R M
R u n o f f H y d r o g r a p h

Hydrograph in 5 Minute intervals ((CFS))

```
Time(h+m) Volume Ac.Ft   Q(CFS)  0       50.0     100.0     150.0     200.0
-----------------------------------------------------------------------
  0+ 5       0.0002      0.03  Q         |         |         |         |
  0+10       0.0018      0.24  Q         |         |         |         |
  0+15       0.0055      0.53  Q         |         |         |         |
  0+20       0.0101      0.67  Q         |         |         |         |
  0+25       0.0152      0.75  Q         |         |         |         |
  0+30       0.0207      0.80  Q         |         |         |         |
  0+35       0.0266      0.84  Q         |         |         |         |
  0+40       0.0326      0.87  Q         |         |         |         |
  0+45       0.0388      0.90  Q         |         |         |         |
  0+50       0.0451      0.92  Q         |         |         |         |
  0+55       0.0515      0.93  Q         |         |         |         |
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1+ 0	0.0580	0.95	Q				
1+ 5	0.0646	0.96	Q				
1+10	0.0713	0.97	Q				
1+15	0.0780	0.97	Q				
1+20	0.0847	0.98	Q				
1+25	0.0916	0.99	Q				
1+30	0.0984	1.00	Q				
1+35	0.1053	1.00	Q				
1+40	0.1122	1.00	Q				
1+45	0.1192	1.01	Q				
1+50	0.1262	1.01	Q				
1+55	0.1332	1.02	Q				
2+ 0	0.1402	1.02	Q				
2+ 5	0.1473	1.03	Q				
2+10	0.1543	1.03	Q				
2+15	0.1615	1.03	Q				
2+20	0.1686	1.04	Q				
2+25	0.1758	1.04	Q				
2+30	0.1830	1.05	Q				
2+35	0.1903	1.05	Q				
2+40	0.1976	1.06	Q				
2+45	0.2049	1.06	Q				
2+50	0.2122	1.07	Q				
2+55	0.2196	1.07	Q				
3+ 0	0.2270	1.08	Q				
3+ 5	0.2345	1.08	Q				
3+10	0.2419	1.09	Q				
3+15	0.2495	1.09	QV				
3+20	0.2570	1.10	QV				
3+25	0.2646	1.10	QV				
3+30	0.2722	1.11	QV				
3+35	0.2799	1.11	QV				
3+40	0.2876	1.12	QV				
3+45	0.2953	1.12	QV				
3+50	0.3031	1.13	QV				
3+55	0.3109	1.13	QV				
4+ 0	0.3187	1.14	QV				
4+ 5	0.3266	1.14	QV				
4+10	0.3345	1.15	QV				
4+15	0.3425	1.16	QV				
4+20	0.3505	1.16	QV				
4+25	0.3585	1.17	QV				
4+30	0.3666	1.17	QV				
4+35	0.3748	1.18	QV				
4+40	0.3829	1.19	QV				
4+45	0.3911	1.19	QV				
4+50	0.3994	1.20	QV				
4+55	0.4077	1.21	QV				
5+ 0	0.4160	1.21	QV				
5+ 5	0.4244	1.22	QV				
5+10	0.4329	1.22	QV				
5+15	0.4414	1.23	QV				
5+20	0.4499	1.24	QV				
5+25	0.4585	1.25	QV				
5+30	0.4671	1.25	QV				
5+35	0.4757	1.26	QV				
5+40	0.4845	1.27	QV				

5+45	0.4932	1.27	Q V	|	|	|	|
5+50	0.5021	1.28	Q V	|	|	|	|
5+55	0.5109	1.29	Q V	|	|	|	|
6+ 0	0.5199	1.30	Q V	|	|	|	|
6+ 5	0.5288	1.30	Q V	|	|	|	|
6+10	0.5379	1.31	Q V	|	|	|	|
6+15	0.5469	1.32	Q V	|	|	|	|
6+20	0.5561	1.33	Q V	|	|	|	|
6+25	0.5653	1.34	Q V	|	|	|	|
6+30	0.5745	1.34	Q V	|	|	|	|
6+35	0.5838	1.35	Q V	|	|	|	|
6+40	0.5932	1.36	Q V	|	|	|	|
6+45	0.6026	1.37	Q V	|	|	|	|
6+50	0.6121	1.38	Q V	|	|	|	|
6+55	0.6217	1.39	Q V	|	|	|	|
7+ 0	0.6313	1.40	Q V	|	|	|	|
7+ 5	0.6410	1.40	Q V	|	|	|	|
7+10	0.6507	1.41	Q V	|	|	|	|
7+15	0.6605	1.42	Q V	|	|	|	|
7+20	0.6704	1.43	Q V	|	|	|	|
7+25	0.6803	1.44	Q V	|	|	|	|
7+30	0.6903	1.45	Q V	|	|	|	|
7+35	0.7004	1.46	Q V	|	|	|	|
7+40	0.7105	1.47	Q V	|	|	|	|
7+45	0.7207	1.48	Q V	|	|	|	|
7+50	0.7310	1.49	Q V	|	|	|	|
7+55	0.7414	1.50	Q V	|	|	|	|
8+ 0	0.7518	1.52	Q V	|	|	|	|
8+ 5	0.7623	1.53	Q V	|	|	|	|
8+10	0.7729	1.54	Q V	|	|	|	|
8+15	0.7836	1.55	Q V	|	|	|	|
8+20	0.7944	1.56	Q V	|	|	|	|
8+25	0.8052	1.57	Q V	|	|	|	|
8+30	0.8161	1.59	Q V	|	|	|	|
8+35	0.8271	1.60	Q V	|	|	|	|
8+40	0.8382	1.61	Q V	|	|	|	|
8+45	0.8494	1.62	Q V	|	|	|	|
8+50	0.8606	1.64	Q V	|	|	|	|
8+55	0.8720	1.65	Q V	|	|	|	|
9+ 0	0.8835	1.66	Q V	|	|	|	|
9+ 5	0.8950	1.68	Q V	|	|	|	|
9+10	0.9067	1.69	Q V	|	|	|	|
9+15	0.9184	1.71	Q V	|	|	|	|
9+20	0.9303	1.72	Q V	|	|	|	|
9+25	0.9422	1.74	Q V	|	|	|	|
9+30	0.9543	1.75	Q V	|	|	|	|
9+35	0.9664	1.77	Q V	|	|	|	|
9+40	0.9787	1.78	Q V	|	|	|	|
9+45	0.9911	1.80	Q V	|	|	|	|
9+50	1.0036	1.82	Q V	|	|	|	|
9+55	1.0162	1.83	Q V	|	|	|	|
10+ 0	1.0290	1.85	Q V	|	|	|	|
10+ 5	1.0419	1.87	Q V	|	|	|	|
10+10	1.0549	1.89	Q V	|	|	|	|
10+15	1.0680	1.91	Q V	|	|	|	|
10+20	1.0812	1.92	Q V	|	|	|	|
10+25	1.0946	1.94	Q V	|	|	|	|

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10+30       1.1082      1.96  Q   V     |          |          |          |
10+35       1.1218      1.99  Q   V     |          |          |          |
10+40       1.1357      2.01  Q   V     |          |          |          |
10+45       1.1496      2.03  Q   V     |          |          |          |
10+50       1.1638      2.05  Q   V     |          |          |          |
10+55       1.1780      2.07  Q   V     |          |          |          |
11+ 0       1.1925      2.10  Q   V     |          |          |          |
11+ 5       1.2071      2.12  Q   V     |          |          |          |
11+10       1.2219      2.15  Q    V    |          |          |          |
11+15       1.2368      2.17  Q    V    |          |          |          |
11+20       1.2520      2.20  Q    V    |          |          |          |
11+25       1.2673      2.23  Q    V    |          |          |          |
11+30       1.2828      2.25  Q    V    |          |          |          |
11+35       1.2986      2.28  Q    V    |          |          |          |
11+40       1.3145      2.31  Q    V    |          |          |          |
11+45       1.3306      2.34  Q    V    |          |          |          |
11+50       1.3470      2.37  Q    V    |          |          |          |
11+55       1.3635      2.41  Q    V    |          |          |          |
12+ 0       1.3803      2.44  Q    V    |          |          |          |
12+ 5       1.3974      2.47  Q    V    |          |          |          |
12+10       1.4146      2.50  Q    V    |          |          |          |
12+15       1.4319      2.52  Q    V    |          |          |          |
12+20       1.4495      2.55  Q    V    |          |          |          |
12+25       1.4672      2.58  Q     V   |          |          |          |
12+30       1.4853      2.62  Q     V   |          |          |          |
12+35       1.5036      2.66  Q     V   |          |          |          |
12+40       1.5222      2.70  Q     V   |          |          |          |
12+45       1.5412      2.75  Q     V   |          |          |          |
12+50       1.5604      2.80  Q     V   |          |          |          |
12+55       1.5800      2.85  Q     V   |          |          |          |
13+ 0       1.6000      2.90  Q     V   |          |          |          |
13+ 5       1.6203      2.95  Q     V   |          |          |          |
13+10       1.6410      3.01  Q     V   |          |          |          |
13+15       1.6621      3.07  Q     V   |          |          |          |
13+20       1.6837      3.13  Q     V   |          |          |          |
13+25       1.7057      3.20  Q      V  |          |          |          |
13+30       1.7281      3.26  Q      V  |          |          |          |
13+35       1.7511      3.34  Q      V  |          |          |          |
13+40       1.7746      3.41  Q      V  |          |          |          |
13+45       1.7987      3.50  Q      V  |          |          |          |
13+50       1.8234      3.58  Q      V  |          |          |          |
13+55       1.8486      3.67  Q      V  |          |          |          |
14+ 0       1.8746      3.77  Q      V  |          |          |          |
14+ 5       1.9013      3.87  Q      V  |          |          |          |
14+10       1.9288      3.99  Q      V  |          |          |          |
14+15       1.9572      4.13  Q       V |          |          |          |
14+20       1.9865      4.26  Q       V |          |          |          |
14+25       2.0169      4.40  Q       V |          |          |          |
14+30       2.0482      4.55  Q       V |          |          |          |
14+35       2.0807      4.72  Q       V |          |          |          |
14+40       2.1144      4.89  Q       V |          |          |          |
14+45       2.1494      5.08  |Q      V |          |          |          |
14+50       2.1858      5.29  |Q      V |          |          |          |
14+55       2.2239      5.53  |Q       V|          |          |          |
15+ 0       2.2638      5.79  |Q       V|          |          |          |
15+ 5       2.3056      6.08  |Q       V|          |          |          |
15+10       2.3497      6.40  |Q       V|          |          |          |
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15+15       2.3965      6.78  |Q       V|         |         |         |
15+20       2.4461      7.21  |Q        V         |         |         |
15+25       2.4995      7.76  |Q        V         |         |         |
15+30       2.5587      8.59  |Q        V         |         |         |
15+35       2.6254      9.68  |Q        V         |         |         |
15+40       2.6997     10.79  | Q       |V        |         |         |
15+45       2.7833     12.13  | Q       |V        |         |         |
15+50       2.8799     14.02  | Q       |V        |         |         |
15+55       3.0043     18.07  |  Q      | V       |         |         |
16+ 0       3.2034     28.90  |    Q    |  V      |         |         |
16+ 5       3.6384     63.17  |         | Q V     |         |         |
16+10       4.7258    157.88  |         |        V|         |Q        |
16+15       6.0618    193.99  |         |         |   V     |       Q |
16+20       6.7875    105.37  |         |         |Q     V  |         |
16+25       7.2473     66.77  |         |  Q      |        V|         |
16+30       7.5738     47.40  |        Q|         |         |V        |
16+35       7.8243     36.38  |      Q  |         |         | V       |
16+40       8.0152     27.72  |    Q    |         |         | V       |
16+45       8.1715     22.69  |   Q     |         |         |  V      |
16+50       8.2993     18.56  |  Q      |         |         |   V     |
16+55       8.4054     15.41  |  Q      |         |         |   V     |
17+ 0       8.4928     12.69  | Q       |         |         |   V     |
17+ 5       8.5634     10.24  | Q       |         |         |    V    |
17+10       8.6231      8.67  |Q        |         |         |    V    |
17+15       8.6809      8.39  |Q        |         |         |    V    |
17+20       8.7335      7.64  |Q        |         |         |    V    |
17+25       8.7760      6.17  |Q        |         |         |     V   |
17+30       8.8115      5.15  |Q        |         |         |     V   |
17+35       8.8379      3.84  Q         |         |         |     V   |
17+40       8.8625      3.58  Q         |         |         |     V   |
17+45       8.8859      3.39  Q         |         |         |     V   |
17+50       8.9081      3.23  Q         |         |         |     V   |
17+55       8.9294      3.09  Q         |         |         |     V   |
18+ 0       8.9498      2.96  Q         |         |         |     V   |
18+ 5       8.9695      2.85  Q         |         |         |     V   |
18+10       8.9885      2.76  Q         |         |         |     V   |
18+15       9.0070      2.69  Q         |         |         |     V   |
18+20       9.0250      2.61  Q         |         |         |      V  |
18+25       9.0425      2.53  Q         |         |         |      V  |
18+30       9.0594      2.46  Q         |         |         |      V  |
18+35       9.0759      2.40  Q         |         |         |      V  |
18+40       9.0920      2.33  Q         |         |         |      V  |
18+45       9.1076      2.27  Q         |         |         |      V  |
18+50       9.1229      2.22  Q         |         |         |      V  |
18+55       9.1378      2.16  Q         |         |         |      V  |
19+ 0       9.1524      2.11  Q         |         |         |      V  |
19+ 5       9.1666      2.07  Q         |         |         |      V  |
19+10       9.1805      2.02  Q         |         |         |      V  |
19+15       9.1942      1.98  Q         |         |         |      V  |
19+20       9.2075      1.94  Q         |         |         |      V  |
19+25       9.2206      1.90  Q         |         |         |      V  |
19+30       9.2334      1.86  Q         |         |         |      V  |
19+35       9.2460      1.83  Q         |         |         |      V  |
19+40       9.2584      1.79  Q         |         |         |       V |
19+45       9.2705      1.76  Q         |         |         |       V |
19+50       9.2824      1.73  Q         |         |         |       V |
19+55       9.2941      1.70  Q         |         |         |       V |
```

20+ 0	9.3056	1.67	Q	|	|	|	V |
20+ 5	9.3170	1.64	Q	|	|	|	V |
20+10	9.3281	1.62	Q	|	|	|	V |
20+15	9.3391	1.59	Q	|	|	|	V |
20+20	9.3499	1.57	Q	|	|	|	V |
20+25	9.3605	1.54	Q	|	|	|	V |
20+30	9.3710	1.52	Q	|	|	|	V |
20+35	9.3813	1.50	Q	|	|	|	V |
20+40	9.3915	1.48	Q	|	|	|	V |
20+45	9.4016	1.46	Q	|	|	|	V |
20+50	9.4115	1.44	Q	|	|	|	V |
20+55	9.4212	1.42	Q	|	|	|	V |
21+ 0	9.4309	1.40	Q	|	|	|	V |
21+ 5	9.4404	1.38	Q	|	|	|	V |
21+10	9.4498	1.36	Q	|	|	|	V |
21+15	9.4591	1.35	Q	|	|	|	V |
21+20	9.4682	1.33	Q	|	|	|	V |
21+25	9.4773	1.32	Q	|	|	|	V |
21+30	9.4863	1.30	Q	|	|	|	V |
21+35	9.4951	1.28	Q	|	|	|	V|
21+40	9.5039	1.27	Q	|	|	|	V|
21+45	9.5125	1.26	Q	|	|	|	V|
21+50	9.5210	1.24	Q	|	|	|	V|
21+55	9.5295	1.23	Q	|	|	|	V|
22+ 0	9.5379	1.21	Q	|	|	|	V|
22+ 5	9.5462	1.20	Q	|	|	|	V|
22+10	9.5543	1.19	Q	|	|	|	V|
22+15	9.5624	1.18	Q	|	|	|	V|
22+20	9.5705	1.17	Q	|	|	|	V|
22+25	9.5784	1.15	Q	|	|	|	V|
22+30	9.5863	1.14	Q	|	|	|	V|
22+35	9.5941	1.13	Q	|	|	|	V|
22+40	9.6018	1.12	Q	|	|	|	V|
22+45	9.6094	1.11	Q	|	|	|	V|
22+50	9.6170	1.10	Q	|	|	|	V|
22+55	9.6245	1.09	Q	|	|	|	V|
23+ 0	9.6319	1.08	Q	|	|	|	V|
23+ 5	9.6393	1.07	Q	|	|	|	V|
23+10	9.6466	1.06	Q	|	|	|	V|
23+15	9.6538	1.05	Q	|	|	|	V|
23+20	9.6610	1.04	Q	|	|	|	V|
23+25	9.6681	1.03	Q	|	|	|	V|
23+30	9.6751	1.02	Q	|	|	|	V|
23+35	9.6821	1.01	Q	|	|	|	V|
23+40	9.6890	1.01	Q	|	|	|	V|
23+45	9.6959	1.00	Q	|	|	|	V|
23+50	9.7027	0.99	Q	|	|	|	V|
23+55	9.7095	0.98	Q	|	|	|	V|
24+ 0	9.7162	0.97	Q	|	|	|	V|
24+ 5	9.7226	0.93	Q	|	|	|	V|
24+10	9.7276	0.72	Q	|	|	|	V|
24+15	9.7306	0.43	Q	|	|	|	V|
24+20	9.7326	0.29	Q	|	|	|	V|
24+25	9.7340	0.21	Q	|	|	|	V|
24+30	9.7350	0.15	Q	|	|	|	V|
24+35	9.7358	0.11	Q	|	|	|	V|
24+40	9.7364	0.09	Q	|	|	|	V|

```
   24+45       9.7369      0.07  Q         |         |         |        V|
   24+50       9.7372      0.05  Q         |         |         |        V|
   24+55       9.7375      0.04  Q         |         |         |        V|
   25+ 0       9.7377      0.03  Q         |         |         |        V|
   25+ 5       9.7378      0.02  Q         |         |         |        V|
   25+10       9.7379      0.01  Q         |         |         |        V|
   25+15       9.7380      0.01  Q         |         |         |        V|
   25+20       9.7380      0.00  Q         |         |         |        V|
   25+25       9.7380      0.00  Q         |         |         |         V
-----------------------------------------------------------------------
```

U n i t H y d r o g r a p h A n a l y s i s

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Study date 04/10/15

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San Bernardino County Synthetic Unit Hydrology Method
Manual date - August 1986

Program License Serial Number 6320

154166 - AMBOY - SAN BERNARDINO COUNTY
EXISTING CONDITION "A"
100-YEAR, 24-HOUR STORM
BY: JTS DATE: 04-10-15

Storm Event Year = 100

Antecedent Moisture Condition = 3

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

English Units used in output format

Area averaged rainfall intensity isohyetal data:

Sub-Area (Ac.)	Duration (hours)	Isohyetal (In)
Rainfall data for year 10		
69.49	1	0.86
Rainfall data for year 2		
69.49	6	0.75
Rainfall data for year 2		
69.49	24	1.07
Rainfall data for year 100		
69.49	1	1.59
Rainfall data for year 100		
69.49	6	2.43
Rainfall data for year 100		
69.49	24	3.56

```
-----------------------------------------------------------------
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

******** Area-averaged max loss rate, Fm ********


SCS curve  SCS curve     Area     Area     Fp(Fig C6)    Ap      Fm
No.(AMCII) NO.(AMC 3)    (Ac.)    Fraction     (In/Hr)  (dec.)   (In/Hr)
 91.0      98.2         69.49      1.000     0.036    1.000    0.036

Area-averaged adjusted loss rate Fm (In/Hr) =  0.036

********* Area-Averaged low loss rate fraction, Yb **********

Area       Area          SCS CN    SCS CN      S     Pervious
 (Ac.)      Fract         (AMC2)    (AMC3)           Yield Fr
    69.49   1.000         91.0      98.2       0.18     0.941

Area-averaged catchment yield fraction, Y =  0.941
Area-averaged low loss fraction, Yb =  0.059
User entry of time of concentration  =   0.220 (hours)
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Watershed area =      69.49(Ac.)
Catchment Lag time =   0.176 hours
Unit interval =   5.000 minutes
Unit interval percentage of lag time = 47.3485
Hydrograph baseflow =     0.00(CFS)
Average maximum watershed loss rate(Fm) =  0.036(In/Hr)
Average low loss rate fraction (Yb) = 0.059 (decimal)
DESERT S-Graph Selected
Computed peak 5-minute rainfall =  0.754(In)
Computed peak 30-minute rainfall =  1.291(In)
Specified peak 1-hour rainfall =  1.590(In)
Computed peak 3-hour rainfall =  2.062(In)
Specified peak 6-hour rainfall =  2.430(In)
Specified peak 24-hour rainfall =  3.560(In)


Rainfall depth area reduction factors:
Using a total area of      69.49(Ac.) (Ref: fig. E-4)

5-minute factor = 0.997     Adjusted rainfall =  0.752(In)
30-minute factor = 0.997    Adjusted rainfall =  1.287(In)
1-hour factor = 0.997       Adjusted rainfall =  1.585(In)
3-hour factor = 1.000       Adjusted rainfall =  2.061(In)
6-hour factor = 1.000       Adjusted rainfall =  2.429(In)
24-hour factor = 1.000      Adjusted rainfall =  3.560(In)
-------------------------------------------------------------------

                  U n i t  H y d r o g r a p h
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Interval          'S' Graph          Unit Hydrograph
Number            Mean values             ((CFS))
-------------------------------------------------------------------
            (K =       840.39 (CFS))

  1                3.621                   30.434
```

2	27.374	199.619
3	58.032	257.648
4	71.898	116.529
5	79.947	67.643
6	85.264	44.679
7	89.111	32.329
8	91.816	22.733
9	93.936	17.820
10	95.547	13.537
11	96.789	10.442
12	97.673	7.427
13	98.224	4.626
14	98.770	4.595
15	99.332	4.722
16	99.712	3.190
17	100.000	2.421

Peak Unit Number	Adjusted mass rainfall (In)	Unit rainfall (In)
1	0.7520	0.7520
2	0.9258	0.1738
3	1.0456	0.1198
4	1.1398	0.0942
5	1.2188	0.0789
6	1.2873	0.0685
7	1.3482	0.0609
8	1.4033	0.0551
9	1.4538	0.0505
10	1.5005	0.0467
11	1.5440	0.0435
12	1.5848	0.0408
13	1.6155	0.0307
14	1.6444	0.0289
15	1.6718	0.0274
16	1.6978	0.0260
17	1.7226	0.0248
18	1.7463	0.0237
19	1.7691	0.0227
20	1.7909	0.0218
21	1.8119	0.0210
22	1.8322	0.0203
23	1.8518	0.0196
24	1.8708	0.0190
25	1.8891	0.0184
26	1.9070	0.0178
27	1.9243	0.0173
28	1.9411	0.0168
29	1.9575	0.0164
30	1.9734	0.0159
31	1.9889	0.0155
32	2.0041	0.0152
33	2.0189	0.0148
34	2.0334	0.0145
35	2.0476	0.0142
36	2.0614	0.0139
37	2.0748	0.0134
38	2.0880	0.0132

39	2.1009	0.0129
40	2.1135	0.0126
41	2.1259	0.0124
42	2.1381	0.0122
43	2.1501	0.0120
44	2.1618	0.0117
45	2.1734	0.0115
46	2.1847	0.0114
47	2.1959	0.0112
48	2.2069	0.0110
49	2.2177	0.0108
50	2.2283	0.0106
51	2.2388	0.0105
52	2.2491	0.0103
53	2.2593	0.0102
54	2.2693	0.0100
55	2.2792	0.0099
56	2.2890	0.0098
57	2.2986	0.0096
58	2.3081	0.0095
59	2.3175	0.0094
60	2.3267	0.0092
61	2.3359	0.0091
62	2.3449	0.0090
63	2.3538	0.0089
64	2.3626	0.0088
65	2.3713	0.0087
66	2.3799	0.0086
67	2.3884	0.0085
68	2.3968	0.0084
69	2.4051	0.0083
70	2.4133	0.0082
71	2.4214	0.0081
72	2.4295	0.0080
73	2.4387	0.0093
74	2.4479	0.0092
75	2.4570	0.0091
76	2.4659	0.0090
77	2.4748	0.0089
78	2.4837	0.0088
79	2.4924	0.0087
80	2.5010	0.0087
81	2.5096	0.0086
82	2.5181	0.0085
83	2.5265	0.0084
84	2.5349	0.0084
85	2.5432	0.0083
86	2.5514	0.0082
87	2.5595	0.0081
88	2.5676	0.0081
89	2.5756	0.0080
90	2.5835	0.0079
91	2.5914	0.0079
92	2.5992	0.0078
93	2.6070	0.0078
94	2.6147	0.0077
95	2.6223	0.0076

96	2.6299	0.0076
97	2.6374	0.0075
98	2.6449	0.0075
99	2.6523	0.0074
100	2.6597	0.0074
101	2.6670	0.0073
102	2.6742	0.0073
103	2.6814	0.0072
104	2.6886	0.0071
105	2.6956	0.0071
106	2.7027	0.0070
107	2.7097	0.0070
108	2.7167	0.0070
109	2.7236	0.0069
110	2.7304	0.0069
111	2.7372	0.0068
112	2.7440	0.0068
113	2.7507	0.0067
114	2.7574	0.0067
115	2.7641	0.0066
116	2.7707	0.0066
117	2.7772	0.0066
118	2.7838	0.0065
119	2.7902	0.0065
120	2.7967	0.0064
121	2.8031	0.0064
122	2.8095	0.0064
123	2.8158	0.0063
124	2.8221	0.0063
125	2.8283	0.0063
126	2.8345	0.0062
127	2.8407	0.0062
128	2.8469	0.0061
129	2.8530	0.0061
130	2.8591	0.0061
131	2.8651	0.0060
132	2.8711	0.0060
133	2.8771	0.0060
134	2.8830	0.0059
135	2.8889	0.0059
136	2.8948	0.0059
137	2.9007	0.0058
138	2.9065	0.0058
139	2.9123	0.0058
140	2.9180	0.0058
141	2.9238	0.0057
142	2.9295	0.0057
143	2.9351	0.0057
144	2.9408	0.0056
145	2.9464	0.0056
146	2.9520	0.0056
147	2.9575	0.0056
148	2.9631	0.0055
149	2.9686	0.0055
150	2.9740	0.0055
151	2.9795	0.0055
152	2.9849	0.0054

153	2.9903	0.0054
154	2.9957	0.0054
155	3.0010	0.0053
156	3.0064	0.0053
157	3.0117	0.0053
158	3.0169	0.0053
159	3.0222	0.0052
160	3.0274	0.0052
161	3.0326	0.0052
162	3.0378	0.0052
163	3.0429	0.0052
164	3.0481	0.0051
165	3.0532	0.0051
166	3.0583	0.0051
167	3.0633	0.0051
168	3.0684	0.0050
169	3.0734	0.0050
170	3.0784	0.0050
171	3.0834	0.0050
172	3.0883	0.0050
173	3.0933	0.0049
174	3.0982	0.0049
175	3.1031	0.0049
176	3.1080	0.0049
177	3.1128	0.0049
178	3.1177	0.0048
179	3.1225	0.0048
180	3.1273	0.0048
181	3.1321	0.0048
182	3.1368	0.0048
183	3.1416	0.0047
184	3.1463	0.0047
185	3.1510	0.0047
186	3.1557	0.0047
187	3.1603	0.0047
188	3.1650	0.0046
189	3.1696	0.0046
190	3.1742	0.0046
191	3.1788	0.0046
192	3.1834	0.0046
193	3.1879	0.0046
194	3.1925	0.0045
195	3.1970	0.0045
196	3.2015	0.0045
197	3.2060	0.0045
198	3.2105	0.0045
199	3.2150	0.0045
200	3.2194	0.0044
201	3.2238	0.0044
202	3.2282	0.0044
203	3.2326	0.0044
204	3.2370	0.0044
205	3.2414	0.0044
206	3.2457	0.0043
207	3.2501	0.0043
208	3.2544	0.0043
209	3.2587	0.0043

210	3.2630	0.0043
211	3.2672	0.0043
212	3.2715	0.0043
213	3.2758	0.0042
214	3.2800	0.0042
215	3.2842	0.0042
216	3.2884	0.0042
217	3.2926	0.0042
218	3.2968	0.0042
219	3.3009	0.0042
220	3.3051	0.0041
221	3.3092	0.0041
222	3.3133	0.0041
223	3.3174	0.0041
224	3.3215	0.0041
225	3.3256	0.0041
226	3.3297	0.0041
227	3.3337	0.0041
228	3.3378	0.0040
229	3.3418	0.0040
230	3.3458	0.0040
231	3.3498	0.0040
232	3.3538	0.0040
233	3.3578	0.0040
234	3.3617	0.0040
235	3.3657	0.0040
236	3.3696	0.0039
237	3.3736	0.0039
238	3.3775	0.0039
239	3.3814	0.0039
240	3.3853	0.0039
241	3.3892	0.0039
242	3.3930	0.0039
243	3.3969	0.0039
244	3.4007	0.0038
245	3.4046	0.0038
246	3.4084	0.0038
247	3.4122	0.0038
248	3.4160	0.0038
249	3.4198	0.0038
250	3.4236	0.0038
251	3.4273	0.0038
252	3.4311	0.0038
253	3.4348	0.0037
254	3.4386	0.0037
255	3.4423	0.0037
256	3.4460	0.0037
257	3.4497	0.0037
258	3.4534	0.0037
259	3.4571	0.0037
260	3.4608	0.0037
261	3.4644	0.0037
262	3.4681	0.0037
263	3.4717	0.0036
264	3.4754	0.0036
265	3.4790	0.0036
266	3.4826	0.0036

267	3.4862	0.0036
268	3.4898	0.0036
269	3.4934	0.0036
270	3.4969	0.0036
271	3.5005	0.0036
272	3.5041	0.0036
273	3.5076	0.0035
274	3.5111	0.0035
275	3.5147	0.0035
276	3.5182	0.0035
277	3.5217	0.0035
278	3.5252	0.0035
279	3.5287	0.0035
280	3.5322	0.0035
281	3.5356	0.0035
282	3.5391	0.0035
283	3.5426	0.0035
284	3.5460	0.0034
285	3.5494	0.0034
286	3.5529	0.0034
287	3.5563	0.0034
288	3.5597	0.0034

Unit Period (number)	Unit Rainfall (In)	Unit Soil-Loss (In)	Effective Rainfall (In)
1	0.0034	0.0002	0.0032
2	0.0034	0.0002	0.0032
3	0.0034	0.0002	0.0032
4	0.0034	0.0002	0.0032
5	0.0035	0.0002	0.0033
6	0.0035	0.0002	0.0033
7	0.0035	0.0002	0.0033
8	0.0035	0.0002	0.0033
9	0.0035	0.0002	0.0033
10	0.0035	0.0002	0.0033
11	0.0035	0.0002	0.0033
12	0.0036	0.0002	0.0033
13	0.0036	0.0002	0.0034
14	0.0036	0.0002	0.0034
15	0.0036	0.0002	0.0034
16	0.0036	0.0002	0.0034
17	0.0036	0.0002	0.0034
18	0.0036	0.0002	0.0034
19	0.0037	0.0002	0.0034
20	0.0037	0.0002	0.0035
21	0.0037	0.0002	0.0035
22	0.0037	0.0002	0.0035
23	0.0037	0.0002	0.0035
24	0.0037	0.0002	0.0035
25	0.0038	0.0002	0.0035
26	0.0038	0.0002	0.0035
27	0.0038	0.0002	0.0036
28	0.0038	0.0002	0.0036
29	0.0038	0.0002	0.0036
30	0.0038	0.0002	0.0036

31	0.0039	0.0002	0.0036
32	0.0039	0.0002	0.0036
33	0.0039	0.0002	0.0037
34	0.0039	0.0002	0.0037
35	0.0039	0.0002	0.0037
36	0.0039	0.0002	0.0037
37	0.0040	0.0002	0.0037
38	0.0040	0.0002	0.0037
39	0.0040	0.0002	0.0038
40	0.0040	0.0002	0.0038
41	0.0040	0.0002	0.0038
42	0.0041	0.0002	0.0038
43	0.0041	0.0002	0.0038
44	0.0041	0.0002	0.0039
45	0.0041	0.0002	0.0039
46	0.0041	0.0002	0.0039
47	0.0042	0.0002	0.0039
48	0.0042	0.0002	0.0039
49	0.0042	0.0002	0.0040
50	0.0042	0.0002	0.0040
51	0.0042	0.0003	0.0040
52	0.0043	0.0003	0.0040
53	0.0043	0.0003	0.0040
54	0.0043	0.0003	0.0040
55	0.0043	0.0003	0.0041
56	0.0043	0.0003	0.0041
57	0.0044	0.0003	0.0041
58	0.0044	0.0003	0.0041
59	0.0044	0.0003	0.0042
60	0.0044	0.0003	0.0042
61	0.0045	0.0003	0.0042
62	0.0045	0.0003	0.0042
63	0.0045	0.0003	0.0043
64	0.0045	0.0003	0.0043
65	0.0046	0.0003	0.0043
66	0.0046	0.0003	0.0043
67	0.0046	0.0003	0.0044
68	0.0046	0.0003	0.0044
69	0.0047	0.0003	0.0044
70	0.0047	0.0003	0.0044
71	0.0047	0.0003	0.0045
72	0.0048	0.0003	0.0045
73	0.0048	0.0003	0.0045
74	0.0048	0.0003	0.0045
75	0.0049	0.0003	0.0046
76	0.0049	0.0003	0.0046
77	0.0049	0.0003	0.0046
78	0.0049	0.0003	0.0046
79	0.0050	0.0003	0.0047
80	0.0050	0.0003	0.0047
81	0.0050	0.0003	0.0047
82	0.0051	0.0003	0.0048
83	0.0051	0.0003	0.0048
84	0.0051	0.0003	0.0048
85	0.0052	0.0003	0.0049
86	0.0052	0.0003	0.0049
87	0.0052	0.0003	0.0049

88	0.0053	0.0003	0.0050
89	0.0053	0.0003	0.0050
90	0.0053	0.0003	0.0050
91	0.0054	0.0003	0.0051
92	0.0054	0.0003	0.0051
93	0.0055	0.0003	0.0052
94	0.0055	0.0003	0.0052
95	0.0056	0.0003	0.0052
96	0.0056	0.0003	0.0053
97	0.0056	0.0003	0.0053
98	0.0057	0.0003	0.0053
99	0.0057	0.0003	0.0054
100	0.0058	0.0003	0.0054
101	0.0058	0.0003	0.0055
102	0.0058	0.0003	0.0055
103	0.0059	0.0004	0.0056
104	0.0059	0.0004	0.0056
105	0.0060	0.0004	0.0057
106	0.0060	0.0004	0.0057
107	0.0061	0.0004	0.0057
108	0.0061	0.0004	0.0058
109	0.0062	0.0004	0.0058
110	0.0063	0.0004	0.0059
111	0.0063	0.0004	0.0060
112	0.0064	0.0004	0.0060
113	0.0064	0.0004	0.0061
114	0.0065	0.0004	0.0061
115	0.0066	0.0004	0.0062
116	0.0066	0.0004	0.0062
117	0.0067	0.0004	0.0063
118	0.0067	0.0004	0.0063
119	0.0068	0.0004	0.0064
120	0.0069	0.0004	0.0065
121	0.0070	0.0004	0.0065
122	0.0070	0.0004	0.0066
123	0.0071	0.0004	0.0067
124	0.0071	0.0004	0.0067
125	0.0073	0.0004	0.0068
126	0.0073	0.0004	0.0069
127	0.0074	0.0004	0.0070
128	0.0075	0.0004	0.0070
129	0.0076	0.0004	0.0071
130	0.0076	0.0005	0.0072
131	0.0078	0.0005	0.0073
132	0.0078	0.0005	0.0074
133	0.0079	0.0005	0.0075
134	0.0080	0.0005	0.0075
135	0.0081	0.0005	0.0077
136	0.0082	0.0005	0.0077
137	0.0084	0.0005	0.0079
138	0.0084	0.0005	0.0079
139	0.0086	0.0005	0.0081
140	0.0087	0.0005	0.0081
141	0.0088	0.0005	0.0083
142	0.0089	0.0005	0.0084
143	0.0091	0.0005	0.0085
144	0.0092	0.0005	0.0086

145	0.0080	0.0005	0.0076
146	0.0081	0.0005	0.0076
147	0.0083	0.0005	0.0078
148	0.0084	0.0005	0.0079
149	0.0086	0.0005	0.0081
150	0.0087	0.0005	0.0082
151	0.0089	0.0005	0.0084
152	0.0090	0.0005	0.0085
153	0.0092	0.0005	0.0087
154	0.0094	0.0006	0.0088
155	0.0096	0.0006	0.0091
156	0.0098	0.0006	0.0092
157	0.0100	0.0006	0.0094
158	0.0102	0.0006	0.0096
159	0.0105	0.0006	0.0099
160	0.0106	0.0006	0.0100
161	0.0110	0.0007	0.0103
162	0.0112	0.0007	0.0105
163	0.0115	0.0007	0.0109
164	0.0117	0.0007	0.0111
165	0.0122	0.0007	0.0115
166	0.0124	0.0007	0.0117
167	0.0129	0.0008	0.0121
168	0.0132	0.0008	0.0124
169	0.0139	0.0008	0.0130
170	0.0142	0.0008	0.0133
171	0.0148	0.0009	0.0139
172	0.0152	0.0009	0.0143
173	0.0159	0.0009	0.0150
174	0.0164	0.0010	0.0154
175	0.0173	0.0010	0.0163
176	0.0178	0.0011	0.0168
177	0.0190	0.0011	0.0178
178	0.0196	0.0012	0.0184
179	0.0210	0.0012	0.0198
180	0.0218	0.0013	0.0206
181	0.0237	0.0014	0.0223
182	0.0248	0.0015	0.0233
183	0.0274	0.0016	0.0258
184	0.0289	0.0017	0.0272
185	0.0408	0.0024	0.0384
186	0.0435	0.0026	0.0409
187	0.0505	0.0030	0.0475
188	0.0551	0.0030	0.0521
189	0.0685	0.0030	0.0655
190	0.0789	0.0030	0.0759
191	0.1198	0.0030	0.1168
192	0.1738	0.0030	0.1708
193	0.7520	0.0030	0.7490
194	0.0942	0.0030	0.0913
195	0.0609	0.0030	0.0579
196	0.0467	0.0028	0.0439
197	0.0307	0.0018	0.0288
198	0.0260	0.0015	0.0245
199	0.0227	0.0013	0.0214
200	0.0203	0.0012	0.0191
201	0.0184	0.0011	0.0173

202	0.0168	0.0010	0.0158
203	0.0155	0.0009	0.0146
204	0.0145	0.0009	0.0136
205	0.0134	0.0008	0.0126
206	0.0126	0.0007	0.0119
207	0.0120	0.0007	0.0112
208	0.0114	0.0007	0.0107
209	0.0108	0.0006	0.0102
210	0.0103	0.0006	0.0097
211	0.0099	0.0006	0.0093
212	0.0095	0.0006	0.0089
213	0.0091	0.0005	0.0086
214	0.0088	0.0005	0.0083
215	0.0085	0.0005	0.0080
216	0.0082	0.0005	0.0077
217	0.0093	0.0005	0.0087
218	0.0090	0.0005	0.0085
219	0.0087	0.0005	0.0082
220	0.0085	0.0005	0.0080
221	0.0083	0.0005	0.0078
222	0.0081	0.0005	0.0076
223	0.0079	0.0005	0.0074
224	0.0077	0.0005	0.0072
225	0.0075	0.0004	0.0071
226	0.0074	0.0004	0.0069
227	0.0072	0.0004	0.0068
228	0.0070	0.0004	0.0066
229	0.0069	0.0004	0.0065
230	0.0068	0.0004	0.0064
231	0.0066	0.0004	0.0063
232	0.0065	0.0004	0.0061
233	0.0064	0.0004	0.0060
234	0.0063	0.0004	0.0059
235	0.0062	0.0004	0.0058
236	0.0061	0.0004	0.0057
237	0.0060	0.0004	0.0056
238	0.0059	0.0003	0.0055
239	0.0058	0.0003	0.0054
240	0.0057	0.0003	0.0054
241	0.0056	0.0003	0.0053
242	0.0055	0.0003	0.0052
243	0.0055	0.0003	0.0051
244	0.0054	0.0003	0.0051
245	0.0053	0.0003	0.0050
246	0.0052	0.0003	0.0049
247	0.0052	0.0003	0.0049
248	0.0051	0.0003	0.0048
249	0.0050	0.0003	0.0047
250	0.0050	0.0003	0.0047
251	0.0049	0.0003	0.0046
252	0.0048	0.0003	0.0045
253	0.0048	0.0003	0.0045
254	0.0047	0.0003	0.0044
255	0.0047	0.0003	0.0044
256	0.0046	0.0003	0.0043
257	0.0046	0.0003	0.0043
258	0.0045	0.0003	0.0042

259	0.0045	0.0003	0.0042
260	0.0044	0.0003	0.0042
261	0.0044	0.0003	0.0041
262	0.0043	0.0003	0.0041
263	0.0043	0.0003	0.0040
264	0.0042	0.0003	0.0040
265	0.0042	0.0002	0.0039
266	0.0041	0.0002	0.0039
267	0.0041	0.0002	0.0039
268	0.0041	0.0002	0.0038
269	0.0040	0.0002	0.0038
270	0.0040	0.0002	0.0038
271	0.0040	0.0002	0.0037
272	0.0039	0.0002	0.0037
273	0.0039	0.0002	0.0037
274	0.0038	0.0002	0.0036
275	0.0038	0.0002	0.0036
276	0.0038	0.0002	0.0036
277	0.0037	0.0002	0.0035
278	0.0037	0.0002	0.0035
279	0.0037	0.0002	0.0035
280	0.0037	0.0002	0.0034
281	0.0036	0.0002	0.0034
282	0.0036	0.0002	0.0034
283	0.0036	0.0002	0.0034
284	0.0035	0.0002	0.0033
285	0.0035	0.0002	0.0033
286	0.0035	0.0002	0.0033
287	0.0035	0.0002	0.0032
288	0.0034	0.0002	0.0032

Total soil rain loss = 0.15(In)
Total effective rainfall = 3.41(In)
Peak flow rate in flood hydrograph = 249.92(CFS)

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24 - H O U R S T O R M
R u n o f f H y d r o g r a p h

Hydrograph in 5 Minute intervals ((CFS))

```
Time(h+m) Volume Ac.Ft   Q(CFS)  0       75.0     150.0     225.0     300.0
-----------------------------------------------------------------------
  0+ 5       0.0007      0.10  Q         |         |         |         |
  0+10       0.0058      0.74  Q         |         |         |         |
  0+15       0.0165      1.57  Q         |         |         |         |
  0+20       0.0300      1.95  Q         |         |         |         |
  0+25       0.0449      2.17  Q         |         |         |         |
  0+30       0.0609      2.32  Q         |         |         |         |
  0+35       0.0777      2.43  Q         |         |         |         |
  0+40       0.0950      2.52  Q         |         |         |         |
  0+45       0.1128      2.58  Q         |         |         |         |
  0+50       0.1310      2.64  Q         |         |         |         |
  0+55       0.1494      2.68  Q         |         |         |         |
  1+ 0       0.1681      2.72  Q         |         |         |         |
```

1+ 5	0.1870	2.74	Q	|	|	|	|
1+10	0.2061	2.77	Q	|	|	|	|
1+15	0.2253	2.79	Q	|	|	|	|
1+20	0.2447	2.81	Q	|	|	|	|
1+25	0.2642	2.83	Q	|	|	|	|
1+30	0.2838	2.85	Q	|	|	|	|
1+35	0.3035	2.86	Q	|	|	|	|
1+40	0.3232	2.87	Q	|	|	|	|
1+45	0.3431	2.88	Q	|	|	|	|
1+50	0.3630	2.89	Q	|	|	|	|
1+55	0.3830	2.90	Q	|	|	|	|
2+ 0	0.4031	2.92	Q	|	|	|	|
2+ 5	0.4233	2.93	Q	|	|	|	|
2+10	0.4435	2.94	Q	|	|	|	|
2+15	0.4639	2.95	Q	|	|	|	|
2+20	0.4843	2.97	Q	|	|	|	|
2+25	0.5048	2.98	QV	|	|	|	|
2+30	0.5254	2.99	QV	|	|	|	|
2+35	0.5462	3.01	QV	|	|	|	|
2+40	0.5669	3.02	QV	|	|	|	|
2+45	0.5878	3.03	QV	|	|	|	|
2+50	0.6088	3.05	QV	|	|	|	|
2+55	0.6299	3.06	QV	|	|	|	|
3+ 0	0.6511	3.07	QV	|	|	|	|
3+ 5	0.6723	3.09	QV	|	|	|	|
3+10	0.6937	3.10	QV	|	|	|	|
3+15	0.7152	3.12	QV	|	|	|	|
3+20	0.7367	3.13	QV	|	|	|	|
3+25	0.7584	3.15	QV	|	|	|	|
3+30	0.7802	3.16	QV	|	|	|	|
3+35	0.8020	3.18	QV	|	|	|	|
3+40	0.8240	3.19	QV	|	|	|	|
3+45	0.8461	3.21	QV	|	|	|	|
3+50	0.8683	3.22	QV	|	|	|	|
3+55	0.8905	3.24	QV	|	|	|	|
4+ 0	0.9130	3.25	QV	|	|	|	|
4+ 5	0.9355	3.27	QV	|	|	|	|
4+10	0.9581	3.28	QV	|	|	|	|
4+15	0.9808	3.30	QV	|	|	|	|
4+20	1.0037	3.32	Q V	|	|	|	|
4+25	1.0266	3.33	Q V	|	|	|	|
4+30	1.0497	3.35	Q V	|	|	|	|
4+35	1.0729	3.37	Q V	|	|	|	|
4+40	1.0963	3.39	Q V	|	|	|	|
4+45	1.1197	3.40	Q V	|	|	|	|
4+50	1.1433	3.42	Q V	|	|	|	|
4+55	1.1670	3.44	Q V	|	|	|	|
5+ 0	1.1908	3.46	Q V	|	|	|	|
5+ 5	1.2147	3.48	Q V	|	|	|	|
5+10	1.2388	3.50	Q V	|	|	|	|
5+15	1.2630	3.51	Q V	|	|	|	|
5+20	1.2873	3.53	Q V	|	|	|	|
5+25	1.3118	3.55	Q V	|	|	|	|
5+30	1.3364	3.57	Q V	|	|	|	|
5+35	1.3612	3.59	Q V	|	|	|	|
5+40	1.3861	3.61	Q V	|	|	|	|
5+45	1.4111	3.63	Q V	|	|	|	|

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 5+50       1.4363      3.66  Q V       |          |          |          |
 5+55       1.4616      3.68  Q V       |          |          |          |
 6+ 0       1.4871      3.70  Q  V      |          |          |          |
 6+ 5       1.5127      3.72  Q  V      |          |          |          |
 6+10       1.5385      3.74  Q  V      |          |          |          |
 6+15       1.5644      3.76  Q  V      |          |          |          |
 6+20       1.5905      3.79  Q  V      |          |          |          |
 6+25       1.6167      3.81  Q  V      |          |          |          |
 6+30       1.6431      3.83  Q  V      |          |          |          |
 6+35       1.6697      3.86  Q  V      |          |          |          |
 6+40       1.6964      3.88  Q  V      |          |          |          |
 6+45       1.7233      3.91  Q  V      |          |          |          |
 6+50       1.7504      3.93  Q  V      |          |          |          |
 6+55       1.7776      3.96  Q  V      |          |          |          |
 7+ 0       1.8050      3.98  Q  V      |          |          |          |
 7+ 5       1.8326      4.01  Q  V      |          |          |          |
 7+10       1.8604      4.03  Q  V      |          |          |          |
 7+15       1.8884      4.06  Q  V      |          |          |          |
 7+20       1.9165      4.09  Q  V      |          |          |          |
 7+25       1.9449      4.12  Q  V      |          |          |          |
 7+30       1.9734      4.14  Q   V     |          |          |          |
 7+35       2.0021      4.17  Q   V     |          |          |          |
 7+40       2.0311      4.20  Q   V     |          |          |          |
 7+45       2.0602      4.23  Q   V     |          |          |          |
 7+50       2.0896      4.26  Q   V     |          |          |          |
 7+55       2.1191      4.29  Q   V     |          |          |          |
 8+ 0       2.1489      4.32  Q   V     |          |          |          |
 8+ 5       2.1789      4.35  Q   V     |          |          |          |
 8+10       2.2091      4.39  Q   V     |          |          |          |
 8+15       2.2395      4.42  Q   V     |          |          |          |
 8+20       2.2702      4.45  Q   V     |          |          |          |
 8+25       2.3011      4.49  Q   V     |          |          |          |
 8+30       2.3322      4.52  Q   V     |          |          |          |
 8+35       2.3636      4.56  Q   V     |          |          |          |
 8+40       2.3952      4.59  Q   V     |          |          |          |
 8+45       2.4271      4.63  Q   V     |          |          |          |
 8+50       2.4592      4.67  Q   V     |          |          |          |
 8+55       2.4916      4.70  Q    V    |          |          |          |
 9+ 0       2.5243      4.74  Q    V    |          |          |          |
 9+ 5       2.5572      4.78  Q    V    |          |          |          |
 9+10       2.5904      4.82  Q    V    |          |          |          |
 9+15       2.6239      4.86  Q    V    |          |          |          |
 9+20       2.6577      4.91  Q    V    |          |          |          |
 9+25       2.6918      4.95  Q    V    |          |          |          |
 9+30       2.7262      4.99  Q    V    |          |          |          |
 9+35       2.7609      5.04  Q    V    |          |          |          |
 9+40       2.7959      5.08  Q    V    |          |          |          |
 9+45       2.8312      5.13  Q    V    |          |          |          |
 9+50       2.8669      5.18  Q    V    |          |          |          |
 9+55       2.9029      5.23  Q    V    |          |          |          |
10+ 0       2.9392      5.28  Q    V    |          |          |          |
10+ 5       2.9759      5.33  Q     V   |          |          |          |
10+10       3.0129      5.38  Q     V   |          |          |          |
10+15       3.0503      5.43  Q     V   |          |          |          |
10+20       3.0881      5.49  Q     V   |          |          |          |
10+25       3.1263      5.54  Q     V   |          |          |          |
10+30       3.1649      5.60  Q     V   |          |          |          |
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10+35       3.2038      5.66  Q     V   |          |          |          |
10+40       3.2432      5.72  Q     V   |          |          |          |
10+45       3.2830      5.78  Q     V   |          |          |          |
10+50       3.3233      5.84  Q     V   |          |          |          |
10+55       3.3640      5.91  Q     V   |          |          |          |
11+ 0       3.4052      5.98  Q     V   |          |          |          |
11+ 5       3.4468      6.05  Q     V   |          |          |          |
11+10       3.4889      6.12  Q      V  |          |          |          |
11+15       3.5316      6.19  Q      V  |          |          |          |
11+20       3.5747      6.26  Q      V  |          |          |          |
11+25       3.6184      6.34  Q      V  |          |          |          |
11+30       3.6626      6.42  Q      V  |          |          |          |
11+35       3.7074      6.50  Q      V  |          |          |          |
11+40       3.7527      6.59  Q      V  |          |          |          |
11+45       3.7987      6.67  Q      V  |          |          |          |
11+50       3.8453      6.76  Q      V  |          |          |          |
11+55       3.8925      6.86  Q      V  |          |          |          |
12+ 0       3.9404      6.95  Q      V  |          |          |          |
12+ 5       3.9887      7.01  Q       V |          |          |          |
12+10       4.0360      6.87  Q       V |          |          |          |
12+15       4.0819      6.66  Q       V |          |          |          |
12+20       4.1274      6.62  Q       V |          |          |          |
12+25       4.1732      6.64  Q       V |          |          |          |
12+30       4.2193      6.70  Q       V |          |          |          |
12+35       4.2659      6.77  Q       V |          |          |          |
12+40       4.3132      6.86  Q       V |          |          |          |
12+45       4.3611      6.96  Q       V |          |          |          |
12+50       4.4098      7.07  Q       V |          |          |          |
12+55       4.4593      7.19  Q        V|          |          |          |
13+ 0       4.5097      7.32  Q        V|          |          |          |
13+ 5       4.5610      7.45  Q        V|          |          |          |
13+10       4.6133      7.60  |Q       V|          |          |          |
13+15       4.6667      7.75  |Q       V|          |          |          |
13+20       4.7212      7.91  |Q       V|          |          |          |
13+25       4.7769      8.08  |Q       V|          |          |          |
13+30       4.8338      8.26  |Q       V|          |          |          |
13+35       4.8920      8.46  |Q       V|          |          |          |
13+40       4.9517      8.66  |Q        V          |          |          |
13+45       5.0128      8.88  |Q        V          |          |          |
13+50       5.0755      9.10  |Q        V          |          |          |
13+55       5.1399      9.35  |Q        V          |          |          |
14+ 0       5.2060      9.60  |Q        V          |          |          |
14+ 5       5.2741      9.88  |Q        V          |          |          |
14+10       5.3443     10.20  |Q        V          |          |          |
14+15       5.4170     10.55  |Q        V          |          |          |
14+20       5.4921     10.90  |Q        |V         |          |          |
14+25       5.5697     11.28  |Q        |V         |          |          |
14+30       5.6502     11.68  |Q        |V         |          |          |
14+35       5.7336     12.12  |Q        |V         |          |          |
14+40       5.8203     12.59  |Q        |V         |          |          |
14+45       5.9106     13.11  |Q        |V         |          |          |
14+50       6.0048     13.68  |Q        | V        |          |          |
14+55       6.1034     14.31  |Q        | V        |          |          |
15+ 0       6.2068     15.01  | Q       | V        |          |          |
15+ 5       6.3156     15.81  | Q       | V        |          |          |
15+10       6.4307     16.70  | Q       |  V       |          |          |
15+15       6.5527     17.73  | Q       |  V       |          |          |
```

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15+20       6.6830     18.92  | Q       |  V      |         |         |
15+25       6.8245     20.54  | Q       |  V      |         |         |
15+30       6.9882     23.76  |  Q      |   V     |         |         |
15+35       7.1801     27.87  |  Q      |   V     |         |         |
15+40       7.3978     31.61  |   Q     |    V    |         |         |
15+45       7.6452     35.93  |   Q     |    V    |         |         |
15+50       7.9326     41.72  |    Q    |     V   |         |         |
15+55       8.2775     50.09  |     Q   |     V   |         |         |
16+ 0       8.7264     65.17  |       Q |      V  |         |         |
16+ 5       9.4630    106.95  |         |   Q    V|         |         |
16+10      10.9980    222.89  |         |         | V      Q|         |
16+15      12.7193    249.92  |         |         |    V    |  Q      |
16+20      13.7329    147.18  |         |        Q|      V  |         |
16+25      14.4371    102.24  |         |  Q      |        V|         |
16+30      14.9616     76.16  |         Q         |         V         |
16+35      15.3686     59.10  |      Q  |         |         |V        |
16+40      15.6909     46.80  |     Q   |         |         |V        |
16+45      15.9595     39.00  |    Q    |         |         | V       |
16+50      16.1839     32.59  |   Q     |         |         | V       |
16+55      16.3739     27.59  |  Q      |         |         |  V      |
17+ 0      16.5339     23.22  |  Q      |         |         |  V      |
17+ 5      16.6687     19.58  | Q       |         |         |  V      |
17+10      16.7926     17.99  | Q       |         |         |   V     |
17+15      16.9072     16.64  | Q       |         |         |   V     |
17+20      17.0063     14.39  |Q        |         |         |   V     |
17+25      17.0938     12.71  |Q        |         |         |   V     |
17+30      17.1645     10.26  |Q        |         |         |   V     |
17+35      17.2301      9.52  |Q        |         |         |   V     |
17+40      17.2917      8.95  |Q        |         |         |    V    |
17+45      17.3500      8.47  |Q        |         |         |    V    |
17+50      17.4056      8.07  |Q        |         |         |    V    |
17+55      17.4587      7.72  |Q        |         |         |    V    |
18+ 0      17.5097      7.40  Q         |         |         |    V    |
18+ 5      17.5589      7.15  Q         |         |         |    V    |
18+10      17.6080      7.13  Q         |         |         |    V    |
18+15      17.6576      7.20  Q         |         |         |    V    |
18+20      17.7066      7.11  Q         |         |         |    V    |
18+25      17.7546      6.98  Q         |         |         |     V   |
18+30      17.8017      6.83  Q         |         |         |     V   |
18+35      17.8477      6.68  Q         |         |         |     V   |
18+40      17.8926      6.53  Q         |         |         |     V   |
18+45      17.9366      6.38  Q         |         |         |     V   |
18+50      17.9795      6.24  Q         |         |         |     V   |
18+55      18.0216      6.10  Q         |         |         |     V   |
19+ 0      18.0627      5.97  Q         |         |         |     V   |
19+ 5      18.1030      5.84  Q         |         |         |     V   |
19+10      18.1424      5.72  Q         |         |         |     V   |
19+15      18.1810      5.61  Q         |         |         |     V   |
19+20      18.2188      5.50  Q         |         |         |     V   |
19+25      18.2560      5.39  Q         |         |         |      V  |
19+30      18.2924      5.29  Q         |         |         |      V  |
19+35      18.3281      5.19  Q         |         |         |      V  |
19+40      18.3632      5.09  Q         |         |         |      V  |
19+45      18.3976      5.00  Q         |         |         |      V  |
19+50      18.4314      4.91  Q         |         |         |      V  |
19+55      18.4647      4.83  Q         |         |         |      V  |
20+ 0      18.4974      4.75  Q         |         |         |      V  |
```

```
20+ 5      18.5296      4.67  Q          |          |          |       V  |
20+10      18.5612      4.60  Q          |          |          |       V  |
20+15      18.5924      4.53  Q          |          |          |       V  |
20+20      18.6231      4.46  Q          |          |          |       V  |
20+25      18.6533      4.39  Q          |          |          |       V  |
20+30      18.6831      4.33  Q          |          |          |       V  |
20+35      18.7125      4.26  Q          |          |          |       V  |
20+40      18.7415      4.20  Q          |          |          |        V |
20+45      18.7700      4.15  Q          |          |          |        V |
20+50      18.7982      4.09  Q          |          |          |        V |
20+55      18.8260      4.04  Q          |          |          |        V |
21+ 0      18.8534      3.98  Q          |          |          |        V |
21+ 5      18.8805      3.93  Q          |          |          |        V |
21+10      18.9073      3.88  Q          |          |          |        V |
21+15      18.9337      3.84  Q          |          |          |        V |
21+20      18.9598      3.79  Q          |          |          |        V |
21+25      18.9855      3.74  Q          |          |          |        V |
21+30      19.0110      3.70  Q          |          |          |        V |
21+35      19.0362      3.66  Q          |          |          |        V |
21+40      19.0611      3.62  Q          |          |          |        V |
21+45      19.0857      3.57  Q          |          |          |        V |
21+50      19.1101      3.54  Q          |          |          |        V |
21+55      19.1342      3.50  Q          |          |          |        V |
22+ 0      19.1580      3.46  Q          |          |          |        V |
22+ 5      19.1815      3.42  Q          |          |          |        V |
22+10      19.2049      3.39  Q          |          |          |        V |
22+15      19.2280      3.35  Q          |          |          |        V |
22+20      19.2508      3.32  Q          |          |          |         V|
22+25      19.2735      3.29  Q          |          |          |         V|
22+30      19.2959      3.25  Q          |          |          |         V|
22+35      19.3180      3.22  Q          |          |          |         V|
22+40      19.3400      3.19  Q          |          |          |         V|
22+45      19.3618      3.16  Q          |          |          |         V|
22+50      19.3834      3.13  Q          |          |          |         V|
22+55      19.4047      3.10  Q          |          |          |         V|
23+ 0      19.4259      3.07  Q          |          |          |         V|
23+ 5      19.4469      3.05  Q          |          |          |         V|
23+10      19.4677      3.02  Q          |          |          |         V|
23+15      19.4883      2.99  Q          |          |          |         V|
23+20      19.5087      2.97  Q          |          |          |         V|
23+25      19.5290      2.94  Q          |          |          |         V|
23+30      19.5491      2.92  Q          |          |          |         V|
23+35      19.5690      2.89  Q          |          |          |         V|
23+40      19.5888      2.87  Q          |          |          |         V|
23+45      19.6084      2.85  Q          |          |          |         V|
23+50      19.6278      2.82  Q          |          |          |         V|
23+55      19.6471      2.80  Q          |          |          |         V|
24+ 0      19.6662      2.78  Q          |          |          |         V|
24+ 5      19.6845      2.66  Q          |          |          |         V|
24+10      19.6983      2.00  Q          |          |          |         V|
24+15      19.7063      1.16  Q          |          |          |         V|
24+20      19.7116      0.78  Q          |          |          |         V|
24+25      19.7155      0.56  Q          |          |          |         V|
24+30      19.7183      0.41  Q          |          |          |         V|
24+35      19.7203      0.30  Q          |          |          |         V|
24+40      19.7219      0.23  Q          |          |          |         V|
24+45      19.7231      0.17  Q          |          |          |         V|
```

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   24+50      19.7239      0.12  Q         |         |         |        V|
   24+55      19.7245      0.09  Q         |         |         |        V|
   25+ 0      19.7249      0.06  Q         |         |         |        V|
   25+ 5      19.7253      0.05  Q         |         |         |        V|
   25+10      19.7255      0.03  Q         |         |         |        V|
   25+15      19.7256      0.02  Q         |         |         |        V|
   25+20      19.7257      0.01  Q         |         |         |         V
-----------------------------------------------------------------------
```

U n i t H y d r o g r a p h A n a l y s i s

Copyright (c) CIVILCADD/CIVILDESIGN, 1989 - 2012, Version 7.1

Study date 04/13/15

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San Bernardino County Synthetic Unit Hydrology Method
Manual date - August 1986

Program License Serial Number 6320

154166 - AMBOY - SAN BERNARDINO COUNTY
EXISTING CONDITIONS "B"
100-YEAR, 24-HOUR STORM
BY: JTS DATE: 04-13-15

Storm Event Year = 100

Antecedent Moisture Condition = 3

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

English Units used in output format

Area averaged rainfall intensity isohyetal data:

Sub-Area (Ac.)	Duration (hours)	Isohyetal (In)
Rainfall data for year 10		
91.36	1	0.86
Rainfall data for year 2		
91.36	6	0.75
Rainfall data for year 2		
91.36	24	1.07
Rainfall data for year 100		
91.36	1	1.59
Rainfall data for year 100		
91.36	6	2.43
Rainfall data for year 100		
91.36	24	3.56

```
-----------------------------------------------------------------
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

******** Area-averaged max loss rate, Fm ********


SCS curve  SCS curve     Area     Area     Fp(Fig C6)    Ap      Fm
No.(AMCII) NO.(AMC 3)    (Ac.)    Fraction     (In/Hr)  (dec.)   (In/Hr)
 91.0      98.2         91.36      1.000     0.036    1.000    0.036

Area-averaged adjusted loss rate Fm (In/Hr) =  0.036

********* Area-Averaged low loss rate fraction, Yb **********

Area       Area          SCS CN    SCS CN      S     Pervious
 (Ac.)      Fract         (AMC2)    (AMC3)           Yield Fr
    91.36   1.000         91.0      98.2       0.18     0.941

Area-averaged catchment yield fraction, Y =  0.941
Area-averaged low loss fraction, Yb =  0.059
User entry of time of concentration  =   0.230 (hours)
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Watershed area =      91.36(Ac.)
Catchment Lag time =   0.184 hours
Unit interval =   5.000 minutes
Unit interval percentage of lag time = 45.2899
Hydrograph baseflow =     0.00(CFS)
Average maximum watershed loss rate(Fm) =  0.036(In/Hr)
Average low loss rate fraction (Yb) = 0.059 (decimal)
DESERT S-Graph Selected
Computed peak 5-minute rainfall =  0.754(In)
Computed peak 30-minute rainfall =  1.291(In)
Specified peak 1-hour rainfall =  1.590(In)
Computed peak 3-hour rainfall =  2.062(In)
Specified peak 6-hour rainfall =  2.430(In)
Specified peak 24-hour rainfall =  3.560(In)


Rainfall depth area reduction factors:
Using a total area of      91.36(Ac.) (Ref: fig. E-4)

5-minute factor = 0.996     Adjusted rainfall =  0.751(In)
30-minute factor = 0.996    Adjusted rainfall =  1.286(In)
1-hour factor = 0.996       Adjusted rainfall =  1.583(In)
3-hour factor = 0.999       Adjusted rainfall =  2.061(In)
6-hour factor = 1.000       Adjusted rainfall =  2.429(In)
24-hour factor = 1.000      Adjusted rainfall =  3.560(In)
-------------------------------------------------------------------

                  U n i t  H y d r o g r a p h
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Interval          'S' Graph          Unit Hydrograph
Number            Mean values             ((CFS))
-------------------------------------------------------------------
            (K =      1104.88 (CFS))

  1                 3.365                   37.178
```

2	24.923	238.187
3	55.845	341.662
4	70.325	159.988
5	78.657	92.055
6	84.140	60.576
7	88.185	44.695
8	91.006	31.166
9	93.225	24.522
10	94.928	18.816
11	96.264	14.764
12	97.275	11.166
13	97.957	7.544
14	98.440	5.328
15	98.980	5.974
16	99.485	5.579
17	99.796	3.427
18	100.000	2.259

Peak Unit Number	Adjusted mass rainfall (In)	Unit rainfall (In)
1	0.7512	0.7512
2	0.9249	0.1736
3	1.0445	0.1196
4	1.1387	0.0942
5	1.2175	0.0788
6	1.2860	0.0684
7	1.3468	0.0609
8	1.4019	0.0550
9	1.4523	0.0504
10	1.4989	0.0466
11	1.5424	0.0435
12	1.5832	0.0408
13	1.6139	0.0307
14	1.6429	0.0290
15	1.6703	0.0274
16	1.6964	0.0261
17	1.7213	0.0249
18	1.7451	0.0238
19	1.7679	0.0228
20	1.7898	0.0219
21	1.8109	0.0211
22	1.8313	0.0203
23	1.8509	0.0197
24	1.8699	0.0190
25	1.8883	0.0184
26	1.9062	0.0179
27	1.9236	0.0174
28	1.9404	0.0169
29	1.9569	0.0164
30	1.9729	0.0160
31	1.9884	0.0156
32	2.0037	0.0152
33	2.0185	0.0149
34	2.0330	0.0145
35	2.0472	0.0142
36	2.0611	0.0139
37	2.0746	0.0134

38	2.0877	0.0132
39	2.1006	0.0129
40	2.1133	0.0126
41	2.1257	0.0124
42	2.1379	0.0122
43	2.1498	0.0120
44	2.1616	0.0118
45	2.1731	0.0115
46	2.1845	0.0114
47	2.1957	0.0112
48	2.2066	0.0110
49	2.2175	0.0108
50	2.2281	0.0106
51	2.2386	0.0105
52	2.2489	0.0103
53	2.2591	0.0102
54	2.2691	0.0100
55	2.2790	0.0099
56	2.2888	0.0098
57	2.2984	0.0096
58	2.3079	0.0095
59	2.3173	0.0094
60	2.3265	0.0093
61	2.3357	0.0091
62	2.3447	0.0090
63	2.3536	0.0089
64	2.3624	0.0088
65	2.3711	0.0087
66	2.3797	0.0086
67	2.3882	0.0085
68	2.3966	0.0084
69	2.4049	0.0083
70	2.4131	0.0082
71	2.4213	0.0081
72	2.4293	0.0080
73	2.4386	0.0093
74	2.4477	0.0092
75	2.4568	0.0091
76	2.4658	0.0090
77	2.4747	0.0089
78	2.4835	0.0088
79	2.4922	0.0087
80	2.5009	0.0087
81	2.5095	0.0086
82	2.5180	0.0085
83	2.5264	0.0084
84	2.5347	0.0084
85	2.5430	0.0083
86	2.5512	0.0082
87	2.5594	0.0081
88	2.5674	0.0081
89	2.5754	0.0080
90	2.5834	0.0079
91	2.5913	0.0079
92	2.5991	0.0078
93	2.6068	0.0078
94	2.6145	0.0077

95	2.6222	0.0076
96	2.6297	0.0076
97	2.6373	0.0075
98	2.6447	0.0075
99	2.6521	0.0074
100	2.6595	0.0074
101	2.6668	0.0073
102	2.6740	0.0073
103	2.6812	0.0072
104	2.6884	0.0071
105	2.6955	0.0071
106	2.7025	0.0071
107	2.7095	0.0070
108	2.7165	0.0070
109	2.7234	0.0069
110	2.7303	0.0069
111	2.7371	0.0068
112	2.7439	0.0068
113	2.7506	0.0067
114	2.7573	0.0067
115	2.7639	0.0066
116	2.7705	0.0066
117	2.7771	0.0066
118	2.7836	0.0065
119	2.7901	0.0065
120	2.7965	0.0064
121	2.8029	0.0064
122	2.8093	0.0064
123	2.8156	0.0063
124	2.8219	0.0063
125	2.8282	0.0063
126	2.8344	0.0062
127	2.8406	0.0062
128	2.8467	0.0061
129	2.8528	0.0061
130	2.8589	0.0061
131	2.8650	0.0060
132	2.8710	0.0060
133	2.8769	0.0060
134	2.8829	0.0059
135	2.8888	0.0059
136	2.8947	0.0059
137	2.9005	0.0059
138	2.9063	0.0058
139	2.9121	0.0058
140	2.9179	0.0058
141	2.9236	0.0057
142	2.9293	0.0057
143	2.9350	0.0057
144	2.9406	0.0056
145	2.9463	0.0056
146	2.9518	0.0056
147	2.9574	0.0056
148	2.9629	0.0055
149	2.9684	0.0055
150	2.9739	0.0055
151	2.9794	0.0055

152	2.9848	0.0054
153	2.9902	0.0054
154	2.9956	0.0054
155	3.0009	0.0053
156	3.0062	0.0053
157	3.0115	0.0053
158	3.0168	0.0053
159	3.0220	0.0052
160	3.0273	0.0052
161	3.0325	0.0052
162	3.0377	0.0052
163	3.0428	0.0052
164	3.0479	0.0051
165	3.0531	0.0051
166	3.0581	0.0051
167	3.0632	0.0051
168	3.0683	0.0050
169	3.0733	0.0050
170	3.0783	0.0050
171	3.0833	0.0050
172	3.0882	0.0050
173	3.0931	0.0049
174	3.0981	0.0049
175	3.1030	0.0049
176	3.1078	0.0049
177	3.1127	0.0049
178	3.1175	0.0048
179	3.1223	0.0048
180	3.1271	0.0048
181	3.1319	0.0048
182	3.1367	0.0048
183	3.1414	0.0047
184	3.1461	0.0047
185	3.1508	0.0047
186	3.1555	0.0047
187	3.1602	0.0047
188	3.1648	0.0046
189	3.1695	0.0046
190	3.1741	0.0046
191	3.1787	0.0046
192	3.1833	0.0046
193	3.1878	0.0046
194	3.1924	0.0045
195	3.1969	0.0045
196	3.2014	0.0045
197	3.2059	0.0045
198	3.2104	0.0045
199	3.2148	0.0045
200	3.2193	0.0044
201	3.2237	0.0044
202	3.2281	0.0044
203	3.2325	0.0044
204	3.2369	0.0044
205	3.2413	0.0044
206	3.2456	0.0043
207	3.2499	0.0043
208	3.2543	0.0043

209	3.2586	0.0043
210	3.2629	0.0043
211	3.2671	0.0043
212	3.2714	0.0043
213	3.2756	0.0042
214	3.2799	0.0042
215	3.2841	0.0042
216	3.2883	0.0042
217	3.2925	0.0042
218	3.2966	0.0042
219	3.3008	0.0042
220	3.3050	0.0041
221	3.3091	0.0041
222	3.3132	0.0041
223	3.3173	0.0041
224	3.3214	0.0041
225	3.3255	0.0041
226	3.3296	0.0041
227	3.3336	0.0041
228	3.3376	0.0040
229	3.3417	0.0040
230	3.3457	0.0040
231	3.3497	0.0040
232	3.3537	0.0040
233	3.3577	0.0040
234	3.3616	0.0040
235	3.3656	0.0040
236	3.3695	0.0039
237	3.3734	0.0039
238	3.3774	0.0039
239	3.3813	0.0039
240	3.3852	0.0039
241	3.3890	0.0039
242	3.3929	0.0039
243	3.3968	0.0039
244	3.4006	0.0038
245	3.4045	0.0038
246	3.4083	0.0038
247	3.4121	0.0038
248	3.4159	0.0038
249	3.4197	0.0038
250	3.4235	0.0038
251	3.4272	0.0038
252	3.4310	0.0038
253	3.4347	0.0037
254	3.4385	0.0037
255	3.4422	0.0037
256	3.4459	0.0037
257	3.4496	0.0037
258	3.4533	0.0037
259	3.4570	0.0037
260	3.4607	0.0037
261	3.4643	0.0037
262	3.4680	0.0037
263	3.4716	0.0036
264	3.4753	0.0036
265	3.4789	0.0036

266	3.4825	0.0036
267	3.4861	0.0036
268	3.4897	0.0036
269	3.4933	0.0036
270	3.4968	0.0036
271	3.5004	0.0036
272	3.5040	0.0036
273	3.5075	0.0035
274	3.5110	0.0035
275	3.5146	0.0035
276	3.5181	0.0035
277	3.5216	0.0035
278	3.5251	0.0035
279	3.5286	0.0035
280	3.5321	0.0035
281	3.5355	0.0035
282	3.5390	0.0035
283	3.5425	0.0035
284	3.5459	0.0034
285	3.5493	0.0034
286	3.5528	0.0034
287	3.5562	0.0034
288	3.5596	0.0034

Unit Period (number)	Unit Rainfall (In)	Unit Soil-Loss (In)	Effective Rainfall (In)
1	0.0034	0.0002	0.0032
2	0.0034	0.0002	0.0032
3	0.0034	0.0002	0.0032
4	0.0034	0.0002	0.0032
5	0.0035	0.0002	0.0033
6	0.0035	0.0002	0.0033
7	0.0035	0.0002	0.0033
8	0.0035	0.0002	0.0033
9	0.0035	0.0002	0.0033
10	0.0035	0.0002	0.0033
11	0.0035	0.0002	0.0033
12	0.0036	0.0002	0.0033
13	0.0036	0.0002	0.0034
14	0.0036	0.0002	0.0034
15	0.0036	0.0002	0.0034
16	0.0036	0.0002	0.0034
17	0.0036	0.0002	0.0034
18	0.0036	0.0002	0.0034
19	0.0037	0.0002	0.0034
20	0.0037	0.0002	0.0035
21	0.0037	0.0002	0.0035
22	0.0037	0.0002	0.0035
23	0.0037	0.0002	0.0035
24	0.0037	0.0002	0.0035
25	0.0038	0.0002	0.0035
26	0.0038	0.0002	0.0035
27	0.0038	0.0002	0.0036
28	0.0038	0.0002	0.0036
29	0.0038	0.0002	0.0036

30	0.0038	0.0002	0.0036
31	0.0039	0.0002	0.0036
32	0.0039	0.0002	0.0036
33	0.0039	0.0002	0.0037
34	0.0039	0.0002	0.0037
35	0.0039	0.0002	0.0037
36	0.0039	0.0002	0.0037
37	0.0040	0.0002	0.0037
38	0.0040	0.0002	0.0037
39	0.0040	0.0002	0.0038
40	0.0040	0.0002	0.0038
41	0.0040	0.0002	0.0038
42	0.0041	0.0002	0.0038
43	0.0041	0.0002	0.0038
44	0.0041	0.0002	0.0039
45	0.0041	0.0002	0.0039
46	0.0041	0.0002	0.0039
47	0.0042	0.0002	0.0039
48	0.0042	0.0002	0.0039
49	0.0042	0.0002	0.0040
50	0.0042	0.0002	0.0040
51	0.0042	0.0003	0.0040
52	0.0043	0.0003	0.0040
53	0.0043	0.0003	0.0040
54	0.0043	0.0003	0.0040
55	0.0043	0.0003	0.0041
56	0.0043	0.0003	0.0041
57	0.0044	0.0003	0.0041
58	0.0044	0.0003	0.0041
59	0.0044	0.0003	0.0042
60	0.0044	0.0003	0.0042
61	0.0045	0.0003	0.0042
62	0.0045	0.0003	0.0042
63	0.0045	0.0003	0.0043
64	0.0045	0.0003	0.0043
65	0.0046	0.0003	0.0043
66	0.0046	0.0003	0.0043
67	0.0046	0.0003	0.0044
68	0.0046	0.0003	0.0044
69	0.0047	0.0003	0.0044
70	0.0047	0.0003	0.0044
71	0.0047	0.0003	0.0045
72	0.0048	0.0003	0.0045
73	0.0048	0.0003	0.0045
74	0.0048	0.0003	0.0045
75	0.0049	0.0003	0.0046
76	0.0049	0.0003	0.0046
77	0.0049	0.0003	0.0046
78	0.0049	0.0003	0.0046
79	0.0050	0.0003	0.0047
80	0.0050	0.0003	0.0047
81	0.0050	0.0003	0.0047
82	0.0051	0.0003	0.0048
83	0.0051	0.0003	0.0048
84	0.0051	0.0003	0.0048
85	0.0052	0.0003	0.0049
86	0.0052	0.0003	0.0049

87	0.0052	0.0003	0.0049
88	0.0053	0.0003	0.0050
89	0.0053	0.0003	0.0050
90	0.0053	0.0003	0.0050
91	0.0054	0.0003	0.0051
92	0.0054	0.0003	0.0051
93	0.0055	0.0003	0.0052
94	0.0055	0.0003	0.0052
95	0.0056	0.0003	0.0052
96	0.0056	0.0003	0.0053
97	0.0056	0.0003	0.0053
98	0.0057	0.0003	0.0053
99	0.0057	0.0003	0.0054
100	0.0058	0.0003	0.0054
101	0.0058	0.0003	0.0055
102	0.0059	0.0003	0.0055
103	0.0059	0.0004	0.0056
104	0.0059	0.0004	0.0056
105	0.0060	0.0004	0.0057
106	0.0060	0.0004	0.0057
107	0.0061	0.0004	0.0057
108	0.0061	0.0004	0.0058
109	0.0062	0.0004	0.0058
110	0.0063	0.0004	0.0059
111	0.0063	0.0004	0.0060
112	0.0064	0.0004	0.0060
113	0.0064	0.0004	0.0061
114	0.0065	0.0004	0.0061
115	0.0066	0.0004	0.0062
116	0.0066	0.0004	0.0062
117	0.0067	0.0004	0.0063
118	0.0067	0.0004	0.0063
119	0.0068	0.0004	0.0064
120	0.0069	0.0004	0.0065
121	0.0070	0.0004	0.0065
122	0.0070	0.0004	0.0066
123	0.0071	0.0004	0.0067
124	0.0071	0.0004	0.0067
125	0.0073	0.0004	0.0068
126	0.0073	0.0004	0.0069
127	0.0074	0.0004	0.0070
128	0.0075	0.0004	0.0070
129	0.0076	0.0004	0.0071
130	0.0076	0.0005	0.0072
131	0.0078	0.0005	0.0073
132	0.0078	0.0005	0.0074
133	0.0079	0.0005	0.0075
134	0.0080	0.0005	0.0075
135	0.0081	0.0005	0.0077
136	0.0082	0.0005	0.0077
137	0.0084	0.0005	0.0079
138	0.0084	0.0005	0.0079
139	0.0086	0.0005	0.0081
140	0.0087	0.0005	0.0081
141	0.0088	0.0005	0.0083
142	0.0089	0.0005	0.0084
143	0.0091	0.0005	0.0085

144	0.0092	0.0005	0.0086
145	0.0080	0.0005	0.0076
146	0.0081	0.0005	0.0076
147	0.0083	0.0005	0.0078
148	0.0084	0.0005	0.0079
149	0.0086	0.0005	0.0081
150	0.0087	0.0005	0.0082
151	0.0089	0.0005	0.0084
152	0.0090	0.0005	0.0085
153	0.0093	0.0005	0.0087
154	0.0094	0.0006	0.0088
155	0.0096	0.0006	0.0091
156	0.0098	0.0006	0.0092
157	0.0100	0.0006	0.0094
158	0.0102	0.0006	0.0096
159	0.0105	0.0006	0.0099
160	0.0106	0.0006	0.0100
161	0.0110	0.0007	0.0103
162	0.0112	0.0007	0.0105
163	0.0115	0.0007	0.0109
164	0.0118	0.0007	0.0111
165	0.0122	0.0007	0.0115
166	0.0124	0.0007	0.0117
167	0.0129	0.0008	0.0121
168	0.0132	0.0008	0.0124
169	0.0139	0.0008	0.0131
170	0.0142	0.0008	0.0134
171	0.0149	0.0009	0.0140
172	0.0152	0.0009	0.0143
173	0.0160	0.0009	0.0150
174	0.0164	0.0010	0.0154
175	0.0174	0.0010	0.0163
176	0.0179	0.0011	0.0168
177	0.0190	0.0011	0.0179
178	0.0197	0.0012	0.0185
179	0.0211	0.0012	0.0198
180	0.0219	0.0013	0.0206
181	0.0238	0.0014	0.0224
182	0.0249	0.0015	0.0234
183	0.0274	0.0016	0.0258
184	0.0290	0.0017	0.0273
185	0.0408	0.0024	0.0384
186	0.0435	0.0026	0.0409
187	0.0504	0.0030	0.0474
188	0.0550	0.0030	0.0521
189	0.0684	0.0030	0.0655
190	0.0788	0.0030	0.0759
191	0.1196	0.0030	0.1167
192	0.1736	0.0030	0.1707
193	0.7512	0.0030	0.7483
194	0.0942	0.0030	0.0912
195	0.0609	0.0030	0.0579
196	0.0466	0.0028	0.0439
197	0.0307	0.0018	0.0289
198	0.0261	0.0015	0.0245
199	0.0228	0.0014	0.0215
200	0.0203	0.0012	0.0191

201	0.0184	0.0011	0.0173
202	0.0169	0.0010	0.0159
203	0.0156	0.0009	0.0147
204	0.0145	0.0009	0.0137
205	0.0134	0.0008	0.0126
206	0.0126	0.0007	0.0119
207	0.0120	0.0007	0.0113
208	0.0114	0.0007	0.0107
209	0.0108	0.0006	0.0102
210	0.0103	0.0006	0.0097
211	0.0099	0.0006	0.0093
212	0.0095	0.0006	0.0089
213	0.0091	0.0005	0.0086
214	0.0088	0.0005	0.0083
215	0.0085	0.0005	0.0080
216	0.0082	0.0005	0.0077
217	0.0093	0.0005	0.0087
218	0.0090	0.0005	0.0085
219	0.0087	0.0005	0.0082
220	0.0085	0.0005	0.0080
221	0.0083	0.0005	0.0078
222	0.0081	0.0005	0.0076
223	0.0079	0.0005	0.0074
224	0.0077	0.0005	0.0072
225	0.0075	0.0004	0.0071
226	0.0074	0.0004	0.0069
227	0.0072	0.0004	0.0068
228	0.0071	0.0004	0.0066
229	0.0069	0.0004	0.0065
230	0.0068	0.0004	0.0064
231	0.0066	0.0004	0.0063
232	0.0065	0.0004	0.0061
233	0.0064	0.0004	0.0060
234	0.0063	0.0004	0.0059
235	0.0062	0.0004	0.0058
236	0.0061	0.0004	0.0057
237	0.0060	0.0004	0.0056
238	0.0059	0.0003	0.0055
239	0.0058	0.0003	0.0054
240	0.0057	0.0003	0.0054
241	0.0056	0.0003	0.0053
242	0.0055	0.0003	0.0052
243	0.0055	0.0003	0.0051
244	0.0054	0.0003	0.0051
245	0.0053	0.0003	0.0050
246	0.0052	0.0003	0.0049
247	0.0052	0.0003	0.0049
248	0.0051	0.0003	0.0048
249	0.0050	0.0003	0.0047
250	0.0050	0.0003	0.0047
251	0.0049	0.0003	0.0046
252	0.0048	0.0003	0.0045
253	0.0048	0.0003	0.0045
254	0.0047	0.0003	0.0044
255	0.0047	0.0003	0.0044
256	0.0046	0.0003	0.0043
257	0.0046	0.0003	0.0043

258	0.0045	0.0003	0.0042
259	0.0045	0.0003	0.0042
260	0.0044	0.0003	0.0042
261	0.0044	0.0003	0.0041
262	0.0043	0.0003	0.0041
263	0.0043	0.0003	0.0040
264	0.0042	0.0003	0.0040
265	0.0042	0.0002	0.0039
266	0.0041	0.0002	0.0039
267	0.0041	0.0002	0.0039
268	0.0041	0.0002	0.0038
269	0.0040	0.0002	0.0038
270	0.0040	0.0002	0.0038
271	0.0040	0.0002	0.0037
272	0.0039	0.0002	0.0037
273	0.0039	0.0002	0.0037
274	0.0038	0.0002	0.0036
275	0.0038	0.0002	0.0036
276	0.0038	0.0002	0.0036
277	0.0037	0.0002	0.0035
278	0.0037	0.0002	0.0035
279	0.0037	0.0002	0.0035
280	0.0037	0.0002	0.0034
281	0.0036	0.0002	0.0034
282	0.0036	0.0002	0.0034
283	0.0036	0.0002	0.0034
284	0.0035	0.0002	0.0033
285	0.0035	0.0002	0.0033
286	0.0035	0.0002	0.0033
287	0.0035	0.0002	0.0032
288	0.0034	0.0002	0.0032

Total soil rain loss = 0.15(In)
Total effective rainfall = 3.41(In)
Peak flow rate in flood hydrograph = 330.19(CFS)

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24 - H O U R S T O R M
R u n o f f H y d r o g r a p h

Hydrograph in 5 Minute intervals ((CFS))

```
Time(h+m) Volume Ac.Ft   Q(CFS)  0      100.0     200.0     300.0     400.0
-----------------------------------------------------------------------
  0+ 5       0.0008      0.12  Q         |         |         |         |
  0+10       0.0069      0.88  Q         |         |         |         |
  0+15       0.0206      1.98  Q         |         |         |         |
  0+20       0.0378      2.50  Q         |         |         |         |
  0+25       0.0571      2.81  Q         |         |         |         |
  0+30       0.0779      3.01  Q         |         |         |         |
  0+35       0.0997      3.17  Q         |         |         |         |
  0+40       0.1223      3.28  Q         |         |         |         |
  0+45       0.1455      3.37  Q         |         |         |         |
  0+50       0.1692      3.44  Q         |         |         |         |
  0+55       0.1934      3.51  Q         |         |         |         |
```

1+ 0	0.2178	3.55	Q				
1+ 5	0.2426	3.59	Q				
1+10	0.2676	3.62	Q				
1+15	0.2927	3.66	Q				
1+20	0.3182	3.69	Q				
1+25	0.3438	3.72	Q				
1+30	0.3695	3.74	Q				
1+35	0.3954	3.75	Q				
1+40	0.4213	3.77	Q				
1+45	0.4474	3.79	Q				
1+50	0.4736	3.80	Q				
1+55	0.4999	3.82	Q				
2+ 0	0.5263	3.83	Q				
2+ 5	0.5528	3.85	Q				
2+10	0.5794	3.87	Q				
2+15	0.6061	3.88	Q				
2+20	0.6330	3.90	Q				
2+25	0.6600	3.92	QV				
2+30	0.6870	3.93	QV				
2+35	0.7142	3.95	QV				
2+40	0.7416	3.97	QV				
2+45	0.7690	3.99	QV				
2+50	0.7966	4.00	QV				
2+55	0.8243	4.02	QV				
3+ 0	0.8521	4.04	QV				
3+ 5	0.8800	4.06	QV				
3+10	0.9081	4.08	QV				
3+15	0.9363	4.10	QV				
3+20	0.9647	4.11	QV				
3+25	0.9931	4.13	QV				
3+30	1.0217	4.15	QV				
3+35	1.0505	4.17	QV				
3+40	1.0793	4.19	QV				
3+45	1.1083	4.21	QV				
3+50	1.1375	4.23	QV				
3+55	1.1668	4.25	QV				
4+ 0	1.1962	4.27	QV				
4+ 5	1.2258	4.30	QV				
4+10	1.2555	4.32	QV				
4+15	1.2854	4.34	QV				
4+20	1.3154	4.36	Q V				
4+25	1.3456	4.38	Q V				
4+30	1.3759	4.40	Q V				
4+35	1.4064	4.43	Q V				
4+40	1.4370	4.45	Q V				
4+45	1.4679	4.47	Q V				
4+50	1.4988	4.50	Q V				
4+55	1.5299	4.52	Q V				
5+ 0	1.5612	4.54	Q V				
5+ 5	1.5927	4.57	Q V				
5+10	1.6243	4.59	Q V				
5+15	1.6561	4.62	Q V				
5+20	1.6881	4.64	Q V				
5+25	1.7203	4.67	Q V				
5+30	1.7526	4.69	Q V				
5+35	1.7851	4.72	Q V				
5+40	1.8178	4.75	Q V				

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 5+45       1.8507      4.78  Q V       |          |          |          |
 5+50       1.8838      4.80  Q V       |          |          |          |
 5+55       1.9170      4.83  Q V       |          |          |          |
 6+ 0       1.9505      4.86  Q  V      |          |          |          |
 6+ 5       1.9842      4.89  Q  V      |          |          |          |
 6+10       2.0180      4.92  Q  V      |          |          |          |
 6+15       2.0521      4.95  Q  V      |          |          |          |
 6+20       2.0863      4.97  Q  V      |          |          |          |
 6+25       2.1208      5.01  Q  V      |          |          |          |
 6+30       2.1555      5.04  Q  V      |          |          |          |
 6+35       2.1904      5.07  Q  V      |          |          |          |
 6+40       2.2255      5.10  Q  V      |          |          |          |
 6+45       2.2608      5.13  Q  V      |          |          |          |
 6+50       2.2964      5.16  Q  V      |          |          |          |
 6+55       2.3322      5.20  Q  V      |          |          |          |
 7+ 0       2.3682      5.23  Q  V      |          |          |          |
 7+ 5       2.4045      5.26  Q  V      |          |          |          |
 7+10       2.4410      5.30  Q  V      |          |          |          |
 7+15       2.4777      5.33  Q  V      |          |          |          |
 7+20       2.5147      5.37  Q  V      |          |          |          |
 7+25       2.5519      5.41  Q  V      |          |          |          |
 7+30       2.5894      5.44  Q  V      |          |          |          |
 7+35       2.6271      5.48  Q   V     |          |          |          |
 7+40       2.6651      5.52  Q   V     |          |          |          |
 7+45       2.7034      5.56  Q   V     |          |          |          |
 7+50       2.7420      5.60  Q   V     |          |          |          |
 7+55       2.7808      5.64  Q   V     |          |          |          |
 8+ 0       2.8199      5.68  Q   V     |          |          |          |
 8+ 5       2.8593      5.72  Q   V     |          |          |          |
 8+10       2.8989      5.76  Q   V     |          |          |          |
 8+15       2.9389      5.80  Q   V     |          |          |          |
 8+20       2.9792      5.85  Q   V     |          |          |          |
 8+25       3.0198      5.89  Q   V     |          |          |          |
 8+30       3.0607      5.94  Q   V     |          |          |          |
 8+35       3.1019      5.98  Q   V     |          |          |          |
 8+40       3.1434      6.03  Q   V     |          |          |          |
 8+45       3.1853      6.08  Q   V     |          |          |          |
 8+50       3.2275      6.13  Q   V     |          |          |          |
 8+55       3.2701      6.18  Q    V    |          |          |          |
 9+ 0       3.3130      6.23  Q    V    |          |          |          |
 9+ 5       3.3562      6.28  Q    V    |          |          |          |
 9+10       3.3998      6.33  Q    V    |          |          |          |
 9+15       3.4438      6.39  Q    V    |          |          |          |
 9+20       3.4882      6.44  Q    V    |          |          |          |
 9+25       3.5329      6.50  Q    V    |          |          |          |
 9+30       3.5781      6.56  Q    V    |          |          |          |
 9+35       3.6236      6.61  Q    V    |          |          |          |
 9+40       3.6696      6.67  Q    V    |          |          |          |
 9+45       3.7160      6.74  Q    V    |          |          |          |
 9+50       3.7628      6.80  Q    V    |          |          |          |
 9+55       3.8101      6.86  Q    V    |          |          |          |
10+ 0       3.8578      6.93  Q    V    |          |          |          |
10+ 5       3.9060      6.99  Q     V   |          |          |          |
10+10       3.9546      7.06  Q     V   |          |          |          |
10+15       4.0037      7.13  Q     V   |          |          |          |
10+20       4.0533      7.20  Q     V   |          |          |          |
10+25       4.1035      7.28  Q     V   |          |          |          |
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10+30       4.1541      7.35  Q     V   |          |          |          |
10+35       4.2053      7.43  Q     V   |          |          |          |
10+40       4.2570      7.51  Q     V   |          |          |          |
10+45       4.3093      7.59  Q     V   |          |          |          |
10+50       4.3621      7.67  Q     V   |          |          |          |
10+55       4.4155      7.76  Q     V   |          |          |          |
11+ 0       4.4696      7.85  Q     V   |          |          |          |
11+ 5       4.5242      7.94  Q     V   |          |          |          |
11+10       4.5795      8.03  Q      V  |          |          |          |
11+15       4.6355      8.13  Q      V  |          |          |          |
11+20       4.6921      8.22  Q      V  |          |          |          |
11+25       4.7495      8.32  Q      V  |          |          |          |
11+30       4.8075      8.43  Q      V  |          |          |          |
11+35       4.8663      8.54  Q      V  |          |          |          |
11+40       4.9258      8.64  Q      V  |          |          |          |
11+45       4.9861      8.76  Q      V  |          |          |          |
11+50       5.0473      8.88  Q      V  |          |          |          |
11+55       5.1093      9.00  Q      V  |          |          |          |
12+ 0       5.1721      9.12  Q      V  |          |          |          |
12+ 5       5.2355      9.21  Q       V |          |          |          |
12+10       5.2978      9.05  Q       V |          |          |          |
12+15       5.3582      8.77  Q       V |          |          |          |
12+20       5.4181      8.71  Q       V |          |          |          |
12+25       5.4783      8.73  Q       V |          |          |          |
12+30       5.5389      8.80  Q       V |          |          |          |
12+35       5.6002      8.90  Q       V |          |          |          |
12+40       5.6622      9.01  Q       V |          |          |          |
12+45       5.7252      9.14  Q       V |          |          |          |
12+50       5.7891      9.28  Q       V |          |          |          |
12+55       5.8541      9.44  Q        V|          |          |          |
13+ 0       5.9202      9.60  Q        V|          |          |          |
13+ 5       5.9876      9.78  Q        V|          |          |          |
13+10       6.0563      9.97  Q        V|          |          |          |
13+15       6.1263     10.17  |Q       V|          |          |          |
13+20       6.1978     10.38  |Q       V|          |          |          |
13+25       6.2708     10.60  |Q       V|          |          |          |
13+30       6.3454     10.84  |Q       V|          |          |          |
13+35       6.4218     11.09  |Q       V|          |          |          |
13+40       6.5000     11.35  |Q        V          |          |          |
13+45       6.5802     11.64  |Q        V          |          |          |
13+50       6.6624     11.93  |Q        V          |          |          |
13+55       6.7467     12.25  |Q        V          |          |          |
14+ 0       6.8334     12.58  |Q        V          |          |          |
14+ 5       6.9226     12.95  |Q        V          |          |          |
14+10       7.0147     13.37  |Q        V          |          |          |
14+15       7.1100     13.84  |Q        V          |          |          |
14+20       7.2086     14.31  |Q        |V         |          |          |
14+25       7.3105     14.81  |Q        |V         |          |          |
14+30       7.4161     15.33  |Q        |V         |          |          |
14+35       7.5256     15.91  |Q        |V         |          |          |
14+40       7.6394     16.52  |Q        |V         |          |          |
14+45       7.7579     17.20  |Q        |V         |          |          |
14+50       7.8814     17.94  |Q        | V        |          |          |
14+55       8.0107     18.77  |Q        | V        |          |          |
15+ 0       8.1462     19.68  |Q        | V        |          |          |
15+ 5       8.2889     20.72  | Q       | V        |          |          |
15+10       8.4395     21.87  | Q       |  V       |          |          |
```

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15+15       8.5994     23.21  | Q       |  V      |         |         |
15+20       8.7698     24.74  | Q       |  V      |         |         |
15+25       8.9547     26.85  | Q       |  V      |         |         |
15+30       9.1669     30.81  |  Q      |   V     |         |         |
15+35       9.4159     36.16  |  Q      |   V     |         |         |
15+40       9.6982     40.99  |   Q     |   V     |         |         |
15+45      10.0191     46.58  |   Q     |    V    |         |         |
15+50      10.3906     53.94  |    Q    |     V   |         |         |
15+55      10.8361     64.69  |     Q   |     V   |         |         |
16+ 0      11.4113     83.53  |       Q |      V  |         |         |
16+ 5      12.3461    135.73  |         |  Q     V|         |         |
16+10      14.2497    276.39  |         |         |V     Q  |         |
16+15      16.5237    330.19  |         |         |    V    |  Q      |
16+20      17.8902    198.41  |         |        Q|      V  |         |
16+25      18.8356    137.27  |         |  Q      |        V|         |
16+30      19.5406    102.37  |         Q         |         V         |
16+35      20.0922     80.09  |       Q |         |         V         |
16+40      20.5279     63.26  |     Q   |         |         |V        |
16+45      20.8916     52.81  |    Q    |         |         | V       |
16+50      21.1968     44.33  |   Q     |         |         | V       |
16+55      21.4568     37.74  |  Q      |         |         |  V      |
17+ 0      21.6781     32.14  |  Q      |         |         |  V      |
17+ 5      21.8653     27.18  | Q       |         |         |  V      |
17+10      22.0285     23.70  | Q       |         |         |  V      |
17+15      22.1818     22.26  | Q       |         |         |   V     |
17+20      22.3217     20.33  | Q       |         |         |   V     |
17+25      22.4419     17.44  |Q        |         |         |   V     |
17+30      22.5474     15.33  |Q        |         |         |   V     |
17+35      22.6358     12.84  |Q        |         |         |   V     |
17+40      22.7183     11.97  |Q        |         |         |    V    |
17+45      22.7961     11.30  |Q        |         |         |    V    |
17+50      22.8700     10.73  |Q        |         |         |    V    |
17+55      22.9405     10.24  |Q        |         |         |    V    |
18+ 0      23.0081      9.81  Q        |         |         |    V    |
18+ 5      23.0733      9.47  Q        |         |         |    V    |
18+10      23.1381      9.41  Q        |         |         |    V    |
18+15      23.2035      9.50  Q        |         |         |    V    |
18+20      23.2681      9.38  Q        |         |         |    V    |
18+25      23.3315      9.21  Q        |         |         |    V    |
18+30      23.3936      9.01  Q        |         |         |     V   |
18+35      23.4542      8.81  Q        |         |         |     V   |
18+40      23.5135      8.61  Q        |         |         |     V   |
18+45      23.5715      8.42  Q        |         |         |     V   |
18+50      23.6282      8.23  Q        |         |         |     V   |
18+55      23.6836      8.05  Q        |         |         |     V   |
19+ 0      23.7379      7.88  Q        |         |         |     V   |
19+ 5      23.7910      7.71  Q        |         |         |     V   |
19+10      23.8429      7.55  Q        |         |         |     V   |
19+15      23.8939      7.39  Q        |         |         |     V   |
19+20      23.9438      7.25  Q        |         |         |     V   |
19+25      23.9927      7.11  Q        |         |         |      V  |
19+30      24.0407      6.97  Q        |         |         |      V  |
19+35      24.0878      6.84  Q        |         |         |      V  |
19+40      24.1341      6.71  Q        |         |         |      V  |
19+45      24.1795      6.59  Q        |         |         |      V  |
19+50      24.2241      6.48  Q        |         |         |      V  |
19+55      24.2680      6.37  Q        |         |         |      V  |
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20+ 0      24.3111      6.26  Q          |          |          |       V  |
20+ 5      24.3535      6.16  Q          |          |          |       V  |
20+10      24.3952      6.06  Q          |          |          |       V  |
20+15      24.4363      5.97  Q          |          |          |       V  |
20+20      24.4768      5.87  Q          |          |          |       V  |
20+25      24.5166      5.79  Q          |          |          |       V  |
20+30      24.5559      5.70  Q          |          |          |       V  |
20+35      24.5946      5.62  Q          |          |          |       V  |
20+40      24.6327      5.54  Q          |          |          |       V  |
20+45      24.6704      5.46  Q          |          |          |        V |
20+50      24.7075      5.39  Q          |          |          |        V |
20+55      24.7441      5.32  Q          |          |          |        V |
21+ 0      24.7803      5.25  Q          |          |          |        V |
21+ 5      24.8159      5.18  Q          |          |          |        V |
21+10      24.8512      5.12  Q          |          |          |        V |
21+15      24.8860      5.05  Q          |          |          |        V |
21+20      24.9203      4.99  Q          |          |          |        V |
21+25      24.9543      4.93  Q          |          |          |        V |
21+30      24.9879      4.87  Q          |          |          |        V |
21+35      25.0210      4.82  Q          |          |          |        V |
21+40      25.0538      4.76  Q          |          |          |        V |
21+45      25.0862      4.71  Q          |          |          |        V |
21+50      25.1183      4.66  Q          |          |          |        V |
21+55      25.1500      4.61  Q          |          |          |        V |
22+ 0      25.1814      4.56  Q          |          |          |        V |
22+ 5      25.2125      4.51  Q          |          |          |        V |
22+10      25.2432      4.46  Q          |          |          |        V |
22+15      25.2736      4.41  Q          |          |          |        V |
22+20      25.3037      4.37  Q          |          |          |         V|
22+25      25.3335      4.33  Q          |          |          |         V|
22+30      25.3630      4.28  Q          |          |          |         V|
22+35      25.3922      4.24  Q          |          |          |         V|
22+40      25.4211      4.20  Q          |          |          |         V|
22+45      25.4498      4.16  Q          |          |          |         V|
22+50      25.4782      4.12  Q          |          |          |         V|
22+55      25.5063      4.08  Q          |          |          |         V|
23+ 0      25.5342      4.05  Q          |          |          |         V|
23+ 5      25.5618      4.01  Q          |          |          |         V|
23+10      25.5892      3.98  Q          |          |          |         V|
23+15      25.6163      3.94  Q          |          |          |         V|
23+20      25.6433      3.91  Q          |          |          |         V|
23+25      25.6699      3.87  Q          |          |          |         V|
23+30      25.6964      3.84  Q          |          |          |         V|
23+35      25.7226      3.81  Q          |          |          |         V|
23+40      25.7486      3.78  Q          |          |          |         V|
23+45      25.7744      3.75  Q          |          |          |         V|
23+50      25.8000      3.72  Q          |          |          |         V|
23+55      25.8254      3.69  Q          |          |          |         V|
24+ 0      25.8506      3.66  Q          |          |          |         V|
24+ 5      25.8747      3.51  Q          |          |          |         V|
24+10      25.8935      2.72  Q          |          |          |         V|
24+15      25.9045      1.61  Q          |          |          |         V|
24+20      25.9120      1.08  Q          |          |          |         V|
24+25      25.9173      0.78  Q          |          |          |         V|
24+30      25.9213      0.58  Q          |          |          |         V|
24+35      25.9243      0.43  Q          |          |          |         V|
24+40      25.9265      0.33  Q          |          |          |         V|
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   24+45      25.9282      0.25  Q         |         |         |        V|
   24+50      25.9295      0.18  Q         |         |         |        V|
   24+55      25.9304      0.14  Q         |         |         |        V|
   25+ 0      25.9311      0.10  Q         |         |         |        V|
   25+ 5      25.9316      0.07  Q         |         |         |        V|
   25+10      25.9320      0.06  Q         |         |         |        V|
   25+15      25.9322      0.04  Q         |         |         |        V|
   25+20      25.9324      0.02  Q         |         |         |        V|
   25+25      25.9324      0.01  Q         |         |         |         V
-----------------------------------------------------------------------
```

ATTACHMENT 5

Reclamation Conditions
Rational Method Calculations
(20-Year, 1-Hour)
(100-Year, 1-Hour)

```
            San Bernardino County Rational Hydrology Program

                (Hydrology Manual Date - August 1986)

 CIVILCADD/CIVILDESIGN  Engineering Software, (c) 1989-2012 Version 7.2
      Rational Hydrology Study        Date: 04/09/15
----------------------------------------------------------------------
154166 - AMBOY - SAN BERNARDINO COUNTY
RECLAMATION CONDITION "A"
20-YEAR, 1-HOUR STORM
BY: JTS  DATE: 04-09-15
----------------------------------------------------------------------


Program License Serial Number 6320

----------------------------------------------------------------------
 *********   Hydrology Study Control Information **********

----------------------------------------------------------------------
Rational hydrology study storm event year is    20.0
   10 Year storm 1 hour rainfall  =      0.860(In.)
  100 Year storm 1 hour rainfall  =      1.590(In.)
Computed rainfall intensity:
Storm year =    20.00   1 hour rainfall =     1.080 (In.)
Slope used for rainfall intensity curve b =  0.7000
Soil antecedent moisture condition (AMC) = 1


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        1.000 to Point/Station        2.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Soil classification AP and SCS  values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2)  = 91.00
Adjusted SCS curve number for AMC 1 = 79.80
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.373(In/Hr)
Initial subarea data:
Initial area flow distance =  1000.000(Ft.)
Top (of initial area) elevation =  1922.000(Ft.)
Bottom (of initial area) elevation =  1580.000(Ft.)
Difference in elevation =   342.000(Ft.)
Slope =    0.34200  s(%)=      34.20
TC = k(0.465)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =    9.135 min.
Rainfall intensity =      4.032(In/Hr) for a    20.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.817
Subarea runoff =     31.680(CFS)
Total initial stream area =        9.620(Ac.)
Pervious area fraction = 1.000
Initial area Fm value =    0.373(In/Hr)


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Process from Point/Station        2.000 to Point/Station        3.000
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```
**** IMPROVED CHANNEL TRAVEL TIME ****
_____________________________________________________________________
Upstream point elevation =  1580.000(Ft.)
Downstream point elevation =  1475.000(Ft.)
Channel length thru subarea  =   394.200(Ft.)
Channel base width      =   10.000(Ft.)
Slope or 'Z' of left channel bank =   2.000
Slope or 'Z' of right channel bank =   2.000
Estimated mean flow rate at midpoint of channel =     49.357(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =   10.000(Ft.)
Flow(q) thru subarea =     49.357(CFS)
Depth of flow =   0.438(Ft.), Average velocity =  10.373(Ft/s)
Channel flow top width =   11.750(Ft.)
Flow Velocity =   10.37(Ft/s)
Travel time  =    0.63 min.
Time of concentration =    9.77 min.
Critical depth =      0.859(Ft.)
 Adding area flow to channel
Soil classification AP and SCS  values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2)  = 91.00
Adjusted SCS curve number for AMC 1 = 79.80
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.373(In/Hr)
Rainfall intensity =      3.847(In/Hr) for a    20.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.813
Subarea runoff =     35.295(CFS) for   11.800(Ac.)
Total runoff =     66.975(CFS)
Effective area this stream =       21.42(Ac.)
Total Study Area (Main Stream No. 1) =       21.42(Ac.)
Area averaged Fm value =    0.373(In/Hr)
Depth of flow =   0.524(Ft.), Average velocity =  11.572(Ft/s)
Critical depth =      1.039(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        3.000 to Point/Station        4.000
**** IMPROVED CHANNEL TRAVEL TIME ****
_____________________________________________________________________
Upstream point elevation =  1475.000(Ft.)
Downstream point elevation =  1090.000(Ft.)
Channel length thru subarea  =  2402.030(Ft.)
Channel base width      =   10.000(Ft.)
Slope or 'Z' of left channel bank =   2.000
Slope or 'Z' of right channel bank =   2.000
Estimated mean flow rate at midpoint of channel =    104.936(CFS)
Manning's 'N'    = 0.070
Maximum depth of channel  =   10.000(Ft.)
Flow(q) thru subarea =    104.936(CFS)
Depth of flow =   1.092(Ft.), Average velocity =   7.887(Ft/s)
Channel flow top width =   14.368(Ft.)
Flow Velocity =    7.89(Ft/s)
Travel time  =    5.08 min.
Time of concentration =   14.84 min.
Critical depth =      1.375(Ft.)
 Adding area flow to channel
```

```
Soil classification AP and SCS  values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2)  = 91.00
Adjusted SCS curve number for AMC 1 = 79.80
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.373(In/Hr)
Rainfall intensity =      2.870(In/Hr) for a    20.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.783
Subarea runoff =     75.830(CFS) for   42.120(Ac.)
Total runoff =    142.805(CFS)
Effective area this stream =       63.54(Ac.)
Total Study Area (Main Stream No. 1) =       63.54(Ac.)
Area averaged Fm value =    0.373(In/Hr)
Depth of flow =   1.301(Ft.), Average velocity =   8.706(Ft/s)
Critical depth =      1.656(Ft.)
End of computations, Total Study Area =           63.54 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.
Note: These figures do not consider reduced effective area
effects caused by confluences in the rational equation.

Area averaged pervious area fraction(Ap) = 1.000
Area averaged SCS curve number =  91.0
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            San Bernardino County Rational Hydrology Program

                (Hydrology Manual Date - August 1986)

 CIVILCADD/CIVILDESIGN  Engineering Software, (c) 1989-2012 Version 7.2
      Rational Hydrology Study        Date: 04/09/15
----------------------------------------------------------------------
154166 - AMBOY - SAN BERNARDINO COUNTY
RECLAMATION CONDITION "B"
20-YEAR, 1-HOUR STORM
BY: JTS  DATE: 04-09-15
----------------------------------------------------------------------


Program License Serial Number 6320

----------------------------------------------------------------------
 *********   Hydrology Study Control Information **********

----------------------------------------------------------------------
Rational hydrology study storm event year is    20.0
   10 Year storm 1 hour rainfall  =      0.860(In.)
  100 Year storm 1 hour rainfall  =      1.590(In.)
Computed rainfall intensity:
Storm year =    20.00   1 hour rainfall =     1.080 (In.)
Slope used for rainfall intensity curve b =  0.7000
Soil antecedent moisture condition (AMC) = 1


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        1.000 to Point/Station        2.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Soil classification AP and SCS  values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2)  = 91.00
Adjusted SCS curve number for AMC 1 = 79.80
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.373(In/Hr)
Initial subarea data:
Initial area flow distance =  1000.000(Ft.)
Top (of initial area) elevation =  1812.000(Ft.)
Bottom (of initial area) elevation =  1500.000(Ft.)
Difference in elevation =   312.000(Ft.)
Slope =    0.31200  s(%)=      31.20
TC = k(0.465)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =    9.304 min.
Rainfall intensity =      3.981(In/Hr) for a    20.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.816
Subarea runoff =     27.111(CFS)
Total initial stream area =        8.350(Ac.)
Pervious area fraction = 1.000
Initial area Fm value =    0.373(In/Hr)


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Process from Point/Station        2.000 to Point/Station        3.000
```

```
**** IMPROVED CHANNEL TRAVEL TIME ****
_____________________________________________________________________
Upstream point elevation =  1500.000(Ft.)
Downstream point elevation =  1020.000(Ft.)
Channel length thru subarea  =   669.840(Ft.)
Channel base width      =   50.000(Ft.)
Slope or 'Z' of left channel bank =   2.000
Slope or 'Z' of right channel bank =   2.000
Estimated mean flow rate at midpoint of channel =     81.896(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =   10.000(Ft.)
Flow(q) thru subarea =     81.896(CFS)
Depth of flow =   0.170(Ft.), Average velocity =   9.586(Ft/s)
Channel flow top width =   50.679(Ft.)
Flow Velocity =    9.59(Ft/s)
Travel time  =    1.16 min.
Time of concentration =   10.47 min.
Critical depth =      0.434(Ft.)
 Adding area flow to channel
Soil classification AP and SCS  values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2)  = 91.00
Adjusted SCS curve number for AMC 1 = 79.80
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.373(In/Hr)
Rainfall intensity =      3.665(In/Hr) for a    20.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.808
Subarea runoff =    109.509(CFS) for   37.760(Ac.)
Total runoff =    136.619(CFS)
Effective area this stream =       46.11(Ac.)
Total Study Area (Main Stream No. 1) =       46.11(Ac.)
Area averaged Fm value =    0.373(In/Hr)
Depth of flow =   0.231(Ft.), Average velocity =  11.739(Ft/s)
Critical depth =      0.609(Ft.)
End of computations, Total Study Area =           46.11 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.
Note: These figures do not consider reduced effective area
effects caused by confluences in the rational equation.

Area averaged pervious area fraction(Ap) = 1.000
Area averaged SCS curve number =  91.0
```

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            San Bernardino County Rational Hydrology Program

                (Hydrology Manual Date - August 1986)

 CIVILCADD/CIVILDESIGN  Engineering Software, (c) 1989-2012 Version 7.2
      Rational Hydrology Study        Date: 04/09/15
----------------------------------------------------------------------
154166 - AMBOY - SAN BERNARDINO COUNTY
RECLAMATION CONDITION "C"
20-YEAR, 1-HOUR STORM
BY: JTS  DATE: 04-09-15
----------------------------------------------------------------------


Program License Serial Number 6320

----------------------------------------------------------------------
 *********   Hydrology Study Control Information **********

----------------------------------------------------------------------
Rational hydrology study storm event year is    20.0
   10 Year storm 1 hour rainfall  =      0.860(In.)
  100 Year storm 1 hour rainfall  =      1.590(In.)
Computed rainfall intensity:
Storm year =    20.00   1 hour rainfall =     1.080 (In.)
Slope used for rainfall intensity curve b =  0.7000
Soil antecedent moisture condition (AMC) = 1


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        1.000 to Point/Station        2.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Soil classification AP and SCS  values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2)  = 91.00
Adjusted SCS curve number for AMC 1 = 79.80
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.373(In/Hr)
Initial subarea data:
Initial area flow distance =   823.720(Ft.)
Top (of initial area) elevation =  1470.000(Ft.)
Bottom (of initial area) elevation =  1331.000(Ft.)
Difference in elevation =   139.000(Ft.)
Slope =    0.16875  s(%)=      16.87
TC = k(0.465)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =    9.736 min.
Rainfall intensity =      3.856(In/Hr) for a    20.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.813
Subarea runoff =     29.844(CFS)
Total initial stream area =        9.520(Ac.)
Pervious area fraction = 1.000
Initial area Fm value =    0.373(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        2.000 to Point/Station        3.000
```

```
**** IMPROVED CHANNEL TRAVEL TIME ****
_____________________________________________________________________
Upstream point elevation =  1331.000(Ft.)
Downstream point elevation =  1129.000(Ft.)
Channel length thru subarea  =  1448.080(Ft.)
Channel base width      =   50.000(Ft.)
Slope or 'Z' of left channel bank =   2.000
Slope or 'Z' of right channel bank =   2.000
Estimated mean flow rate at midpoint of channel =     76.511(CFS)
Manning's 'N'    = 0.035
Maximum depth of channel  =   10.000(Ft.)
Flow(q) thru subarea =     76.511(CFS)
Depth of flow =   0.246(Ft.), Average velocity =   6.170(Ft/s)
Channel flow top width =   50.982(Ft.)
Flow Velocity =    6.17(Ft/s)
Travel time  =    3.91 min.
Time of concentration =   13.65 min.
Critical depth =      0.414(Ft.)
 Adding area flow to channel
Soil classification AP and SCS  values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2)  = 91.00
Adjusted SCS curve number for AMC 1 = 79.80
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.373(In/Hr)
Rainfall intensity =      3.044(In/Hr) for a    20.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.790
Subarea runoff =     93.267(CFS) for   41.690(Ac.)
Total runoff =    123.111(CFS)
Effective area this stream =       51.21(Ac.)
Total Study Area (Main Stream No. 1) =       51.21(Ac.)
Area averaged Fm value =    0.373(In/Hr)
Depth of flow =   0.327(Ft.), Average velocity =   7.442(Ft/s)
Critical depth =      0.570(Ft.)
End of computations, Total Study Area =           51.21 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.
Note: These figures do not consider reduced effective area
effects caused by confluences in the rational equation.

Area averaged pervious area fraction(Ap) = 1.000
Area averaged SCS curve number =  91.0
```

```
            San Bernardino County Rational Hydrology Program

                (Hydrology Manual Date - August 1986)

 CIVILCADD/CIVILDESIGN  Engineering Software, (c) 1989-2012 Version 7.2
      Rational Hydrology Study        Date: 04/09/15
----------------------------------------------------------------------
154166 - AMBOY - SAN BERNARDINO COUNTY
RECLAMATION CONDITION "A"
100-YEAR, 1-HOUR STORM
BY: JTS  DATE: 04-09-15
----------------------------------------------------------------------


Program License Serial Number 6320

----------------------------------------------------------------------
 *********   Hydrology Study Control Information **********

----------------------------------------------------------------------
Rational hydrology study storm event year is   100.0
   10 Year storm 1 hour rainfall  =      0.860(In.)
  100 Year storm 1 hour rainfall  =      1.590(In.)
Computed rainfall intensity:
Storm year =   100.00   1 hour rainfall =     1.590 (In.)
Slope used for rainfall intensity curve b =  0.7000
Soil antecedent moisture condition (AMC) = 3


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        1.000 to Point/Station        2.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Soil classification AP and SCS  values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2)  = 91.00
Adjusted SCS curve number for AMC 3 = 98.20
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.036(In/Hr)
Initial subarea data:
Initial area flow distance =  1000.000(Ft.)
Top (of initial area) elevation =  1922.000(Ft.)
Bottom (of initial area) elevation =  1580.000(Ft.)
Difference in elevation =   342.000(Ft.)
Slope =    0.34200  s(%)=      34.20
TC = k(0.465)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =    9.135 min.
Rainfall intensity =      5.938(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.895
Subarea runoff =     51.099(CFS)
Total initial stream area =        9.620(Ac.)
Pervious area fraction = 1.000
Initial area Fm value =    0.036(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        2.000 to Point/Station        3.000
```

```
**** IMPROVED CHANNEL TRAVEL TIME ****
_____________________________________________________________________
Upstream point elevation =  1580.000(Ft.)
Downstream point elevation =  1475.000(Ft.)
Channel length thru subarea  =   394.200(Ft.)
Channel base width      =   10.000(Ft.)
Slope or 'Z' of left channel bank =   2.000
Slope or 'Z' of right channel bank =   2.000
Estimated mean flow rate at midpoint of channel =     80.249(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =   10.000(Ft.)
Flow(q) thru subarea =     80.249(CFS)
Depth of flow =   0.583(Ft.), Average velocity =  12.336(Ft/s)
Channel flow top width =   12.331(Ft.)
Flow Velocity =   12.34(Ft/s)
Travel time  =    0.53 min.
Time of concentration =    9.67 min.
Critical depth =      1.156(Ft.)
 Adding area flow to channel
Soil classification AP and SCS  values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2)  = 91.00
Adjusted SCS curve number for AMC 3 = 98.20
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.036(In/Hr)
Rainfall intensity =      5.707(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.894
Subarea runoff =     58.227(CFS) for   11.800(Ac.)
Total runoff =    109.326(CFS)
Effective area this stream =       21.42(Ac.)
Total Study Area (Main Stream No. 1) =       21.42(Ac.)
Area averaged Fm value =    0.036(In/Hr)
Depth of flow =   0.698(Ft.), Average velocity =  13.737(Ft/s)
Critical depth =      1.406(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        3.000 to Point/Station        4.000
**** IMPROVED CHANNEL TRAVEL TIME ****
_____________________________________________________________________
Upstream point elevation =  1475.000(Ft.)
Downstream point elevation =  1090.000(Ft.)
Channel length thru subarea  =  2402.030(Ft.)
Channel base width      =   10.000(Ft.)
Slope or 'Z' of left channel bank =   2.000
Slope or 'Z' of right channel bank =   2.000
Estimated mean flow rate at midpoint of channel =    179.935(CFS)
Manning's 'N'    = 0.070
Maximum depth of channel  =   10.000(Ft.)
Flow(q) thru subarea =    179.935(CFS)
Depth of flow =   1.483(Ft.), Average velocity =   9.361(Ft/s)
Channel flow top width =   15.931(Ft.)
Flow Velocity =    9.36(Ft/s)
Travel time  =    4.28 min.
Time of concentration =   13.94 min.
Critical depth =      1.891(Ft.)
 Adding area flow to channel
```

```
Soil classification AP and SCS  values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2)  = 91.00
Adjusted SCS curve number for AMC 3 = 98.20
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.036(In/Hr)
Rainfall intensity =      4.416(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.893
Subarea runoff =    141.163(CFS) for   42.120(Ac.)
Total runoff =    250.489(CFS)
Effective area this stream =       63.54(Ac.)
Total Study Area (Main Stream No. 1) =       63.54(Ac.)
Area averaged Fm value =    0.036(In/Hr)
Depth of flow =   1.783(Ft.), Average velocity =  10.358(Ft/s)
Critical depth =      2.281(Ft.)
End of computations, Total Study Area =           63.54 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.
Note: These figures do not consider reduced effective area
effects caused by confluences in the rational equation.

Area averaged pervious area fraction(Ap) = 1.000
Area averaged SCS curve number =  91.0
```

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            San Bernardino County Rational Hydrology Program

                (Hydrology Manual Date - August 1986)

 CIVILCADD/CIVILDESIGN  Engineering Software, (c) 1989-2012 Version 7.2
      Rational Hydrology Study        Date: 04/09/15
----------------------------------------------------------------------
154166 - AMBOY - SAN BERNARDINO COUNTY
RECLAMATION CONDITION "B"
100-YEAR, 1-HOUR STORM
BY: JTS  DATE: 04-09-15
----------------------------------------------------------------------


Program License Serial Number 6320

----------------------------------------------------------------------
 *********   Hydrology Study Control Information **********

----------------------------------------------------------------------
Rational hydrology study storm event year is   100.0
   10 Year storm 1 hour rainfall  =      0.860(In.)
  100 Year storm 1 hour rainfall  =      1.590(In.)
Computed rainfall intensity:
Storm year =   100.00   1 hour rainfall =     1.590 (In.)
Slope used for rainfall intensity curve b =  0.7000
Soil antecedent moisture condition (AMC) = 3


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        1.000 to Point/Station        2.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Soil classification AP and SCS  values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2)  = 91.00
Adjusted SCS curve number for AMC 3 = 98.20
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.036(In/Hr)
Initial subarea data:
Initial area flow distance =  1000.000(Ft.)
Top (of initial area) elevation =  1812.000(Ft.)
Bottom (of initial area) elevation =  1500.000(Ft.)
Difference in elevation =   312.000(Ft.)
Slope =    0.31200  s(%)=      31.20
TC = k(0.465)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =    9.304 min.
Rainfall intensity =      5.862(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.895
Subarea runoff =     43.783(CFS)
Total initial stream area =        8.350(Ac.)
Pervious area fraction = 1.000
Initial area Fm value =    0.036(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        2.000 to Point/Station        3.000
```

```
**** IMPROVED CHANNEL TRAVEL TIME ****
_____________________________________________________________________
Upstream point elevation =  1500.000(Ft.)
Downstream point elevation =  1020.000(Ft.)
Channel length thru subarea  =   669.840(Ft.)
Channel base width      =   50.000(Ft.)
Slope or 'Z' of left channel bank =   2.000
Slope or 'Z' of right channel bank =   2.000
Estimated mean flow rate at midpoint of channel =    134.767(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =   10.000(Ft.)
Flow(q) thru subarea =    134.767(CFS)
Depth of flow =   0.229(Ft.), Average velocity =  11.676(Ft/s)
Channel flow top width =   50.915(Ft.)
Flow Velocity =   11.68(Ft/s)
Travel time  =    0.96 min.
Time of concentration =   10.26 min.
Critical depth =      0.602(Ft.)
 Adding area flow to channel
Soil classification AP and SCS  values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2)  = 91.00
Adjusted SCS curve number for AMC 3 = 98.20
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.036(In/Hr)
Rainfall intensity =      5.474(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.894
Subarea runoff =    181.894(CFS) for   37.760(Ac.)
Total runoff =    225.677(CFS)
Effective area this stream =       46.11(Ac.)
Total Study Area (Main Stream No. 1) =       46.11(Ac.)
Area averaged Fm value =    0.036(In/Hr)
Depth of flow =   0.312(Ft.), Average velocity =  14.308(Ft/s)
Critical depth =      0.844(Ft.)
End of computations, Total Study Area =           46.11 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.
Note: These figures do not consider reduced effective area
effects caused by confluences in the rational equation.

Area averaged pervious area fraction(Ap) = 1.000
Area averaged SCS curve number =  91.0
```

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            San Bernardino County Rational Hydrology Program

                (Hydrology Manual Date - August 1986)

 CIVILCADD/CIVILDESIGN  Engineering Software, (c) 1989-2012 Version 7.2
      Rational Hydrology Study        Date: 04/09/15
----------------------------------------------------------------------
154166 - AMBOY - SAN BERNARDINO COUNTY
RECLAMATION CONDITION "C"
100-YEAR, 1-HOUR- STORM
BY: JTS  DATE: 04-09-15
----------------------------------------------------------------------


Program License Serial Number 6320

----------------------------------------------------------------------
 *********   Hydrology Study Control Information **********

----------------------------------------------------------------------
Rational hydrology study storm event year is   100.0
   10 Year storm 1 hour rainfall  =      0.860(In.)
  100 Year storm 1 hour rainfall  =      1.590(In.)
Computed rainfall intensity:
Storm year =   100.00   1 hour rainfall =     1.590 (In.)
Slope used for rainfall intensity curve b =  0.7000
Soil antecedent moisture condition (AMC) = 3


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        1.000 to Point/Station        2.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Soil classification AP and SCS  values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2)  = 91.00
Adjusted SCS curve number for AMC 3 = 98.20
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.036(In/Hr)
Initial subarea data:
Initial area flow distance =   823.720(Ft.)
Top (of initial area) elevation =  1470.000(Ft.)
Bottom (of initial area) elevation =  1331.000(Ft.)
Difference in elevation =   139.000(Ft.)
Slope =    0.16875  s(%)=      16.87
TC = k(0.465)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =    9.736 min.
Rainfall intensity =      5.679(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.894
Subarea runoff =     48.349(CFS)
Total initial stream area =        9.520(Ac.)
Pervious area fraction = 1.000
Initial area Fm value =    0.036(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        2.000 to Point/Station        3.000
```

```
**** IMPROVED CHANNEL TRAVEL TIME ****
_____________________________________________________________________
Upstream point elevation =  1331.000(Ft.)
Downstream point elevation =  1129.000(Ft.)
Channel length thru subarea  =  1448.080(Ft.)
Channel base width      =   50.000(Ft.)
Slope or 'Z' of left channel bank =   2.000
Slope or 'Z' of right channel bank =   2.000
Estimated mean flow rate at midpoint of channel =    130.837(CFS)
Manning's 'N'    = 0.035
Maximum depth of channel  =   10.000(Ft.)
Flow(q) thru subarea =    130.837(CFS)
Depth of flow =   0.339(Ft.), Average velocity =   7.622(Ft/s)
Channel flow top width =   51.355(Ft.)
Flow Velocity =    7.62(Ft/s)
Travel time  =    3.17 min.
Time of concentration =   12.90 min.
Critical depth =      0.594(Ft.)
 Adding area flow to channel
Soil classification AP and SCS  values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2)  = 91.00
Adjusted SCS curve number for AMC 3 = 98.20
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.036(In/Hr)
Rainfall intensity =      4.663(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.893
Subarea runoff =    164.904(CFS) for   41.690(Ac.)
Total runoff =    213.252(CFS)
Effective area this stream =       51.21(Ac.)
Total Study Area (Main Stream No. 1) =       51.21(Ac.)
Area averaged Fm value =    0.036(In/Hr)
Depth of flow =   0.454(Ft.), Average velocity =   9.230(Ft/s)
Critical depth =      0.813(Ft.)
End of computations, Total Study Area =           51.21 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.
Note: These figures do not consider reduced effective area
effects caused by confluences in the rational equation.

Area averaged pervious area fraction(Ap) = 1.000
Area averaged SCS curve number =  91.0
```

ATTACHMENT 6

Reclamation Conditions
Hydrograph Calculations
(20-Year, 1-Hour)
(100-Year, 1-Hour)

U n i t H y d r o g r a p h A n a l y s i s

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Study date 04/09/15

++

San Bernardino County Synthetic Unit Hydrology Method
Manual date - August 1986

Program License Serial Number 6320

154166 - AMBOY - SAN BERNARDINO COUNTY
RECLAMATION CONDITION "A"
20-YEAR, 24-HOUR STORM
BY: JTS DATE: 04-09-15

Storm Event Year = 20

Antecedent Moisture Condition = 1

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

English Units used in output format

Area averaged rainfall intensity isohyetal data:

Sub-Area (Ac.)	Duration (hours)	Isohyetal (In)
Rainfall data for year 10		
63.54	1	0.86
Rainfall data for year 2		
63.54	6	0.75
Rainfall data for year 2		
63.54	24	1.07
Rainfall data for year 100		
63.54	1	1.59
Rainfall data for year 100		
63.54	6	2.43
Rainfall data for year 100		
63.54	24	3.56

```
-----------------------------------------------------------------
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

******** Area-averaged max loss rate, Fm ********


SCS curve  SCS curve     Area     Area     Fp(Fig C6)    Ap      Fm
No.(AMCII) NO.(AMC 1)    (Ac.)    Fraction     (In/Hr)  (dec.)   (In/Hr)
 91.0      79.8         63.54      1.000     0.373    1.000    0.373

Area-averaged adjusted loss rate Fm (In/Hr) =  0.373

********* Area-Averaged low loss rate fraction, Yb **********

Area       Area          SCS CN    SCS CN      S     Pervious
 (Ac.)      Fract         (AMC2)    (AMC1)           Yield Fr
    63.54   1.000         91.0      79.8       2.53     0.356

Area-averaged catchment yield fraction, Y =  0.356
Area-averaged low loss fraction, Yb =  0.644
User entry of time of concentration  =   0.230 (hours)
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Watershed area =      63.54(Ac.)
Catchment Lag time =   0.184 hours
Unit interval =   5.000 minutes
Unit interval percentage of lag time = 45.2899
Hydrograph baseflow =     0.00(CFS)
Average maximum watershed loss rate(Fm) =  0.373(In/Hr)
Average low loss rate fraction (Yb) = 0.644 (decimal)
DESERT S-Graph Selected
Computed peak 5-minute rainfall =  0.512(In)
Computed peak 30-minute rainfall =  0.877(In)
Specified peak 1-hour rainfall =  1.080(In)
Computed peak 3-hour rainfall =  1.446(In)
Specified peak 6-hour rainfall =  1.739(In)
Specified peak 24-hour rainfall =  2.536(In)


Rainfall depth area reduction factors:
Using a total area of      63.54(Ac.) (Ref: fig. E-4)

5-minute factor = 0.997     Adjusted rainfall =  0.511(In)
30-minute factor = 0.997    Adjusted rainfall =  0.874(In)
1-hour factor = 0.997       Adjusted rainfall =  1.077(In)
3-hour factor = 1.000       Adjusted rainfall =  1.446(In)
6-hour factor = 1.000       Adjusted rainfall =  1.738(In)
24-hour factor = 1.000      Adjusted rainfall =  2.535(In)
-------------------------------------------------------------------

                  U n i t  H y d r o g r a p h
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Interval          'S' Graph          Unit Hydrograph
Number            Mean values             ((CFS))
-------------------------------------------------------------------
            (K =       768.44 (CFS))

  1                3.365                  25.857
```

2	24.923	165.657
3	55.845	237.622
4	70.325	111.270
5	78.657	64.023
6	84.140	42.130
7	88.185	31.085
8	91.006	21.675
9	93.225	17.055
10	94.928	13.086
11	96.264	10.268
12	97.275	7.766
13	97.957	5.247
14	98.440	3.706
15	98.980	4.155
16	99.485	3.880
17	99.796	2.383
18	100.000	1.571

Peak Unit Number	Adjusted mass rainfall (In)	Unit rainfall (In)
1	0.5108	0.5108
2	0.6289	0.1181
3	0.7102	0.0813
4	0.7743	0.0640
5	0.8279	0.0536
6	0.8744	0.0465
7	0.9158	0.0414
8	0.9532	0.0374
9	0.9875	0.0343
10	1.0192	0.0317
11	1.0488	0.0296
12	1.0765	0.0277
13	1.0999	0.0234
14	1.1220	0.0221
15	1.1430	0.0210
16	1.1629	0.0200
17	1.1820	0.0191
18	1.2003	0.0183
19	1.2178	0.0175
20	1.2347	0.0169
21	1.2509	0.0163
22	1.2667	0.0157
23	1.2818	0.0152
24	1.2966	0.0147
25	1.3108	0.0143
26	1.3247	0.0139
27	1.3382	0.0135
28	1.3513	0.0131
29	1.3641	0.0128
30	1.3766	0.0125
31	1.3887	0.0122
32	1.4006	0.0119
33	1.4122	0.0116
34	1.4236	0.0114
35	1.4347	0.0111
36	1.4456	0.0109
37	1.4562	0.0106

38	1.4665	0.0104
39	1.4767	0.0102
40	1.4867	0.0100
41	1.4965	0.0098
42	1.5061	0.0096
43	1.5156	0.0095
44	1.5249	0.0093
45	1.5340	0.0091
46	1.5430	0.0090
47	1.5519	0.0089
48	1.5606	0.0087
49	1.5692	0.0086
50	1.5777	0.0085
51	1.5860	0.0083
52	1.5942	0.0082
53	1.6023	0.0081
54	1.6103	0.0080
55	1.6182	0.0079
56	1.6260	0.0078
57	1.6337	0.0077
58	1.6413	0.0076
59	1.6487	0.0075
60	1.6561	0.0074
61	1.6634	0.0073
62	1.6707	0.0072
63	1.6778	0.0071
64	1.6848	0.0070
65	1.6918	0.0070
66	1.6987	0.0069
67	1.7055	0.0068
68	1.7122	0.0067
69	1.7189	0.0067
70	1.7255	0.0066
71	1.7320	0.0065
72	1.7385	0.0065
73	1.7450	0.0065
74	1.7515	0.0065
75	1.7579	0.0064
76	1.7643	0.0063
77	1.7706	0.0063
78	1.7768	0.0062
79	1.7830	0.0062
80	1.7891	0.0061
81	1.7951	0.0061
82	1.8011	0.0060
83	1.8071	0.0060
84	1.8130	0.0059
85	1.8188	0.0058
86	1.8246	0.0058
87	1.8304	0.0058
88	1.8361	0.0057
89	1.8417	0.0057
90	1.8474	0.0056
91	1.8529	0.0056
92	1.8584	0.0055
93	1.8639	0.0055
94	1.8693	0.0054

95	1.8747	0.0054
96	1.8801	0.0054
97	1.8854	0.0053
98	1.8907	0.0053
99	1.8959	0.0052
100	1.9011	0.0052
101	1.9063	0.0052
102	1.9114	0.0051
103	1.9165	0.0051
104	1.9215	0.0050
105	1.9265	0.0050
106	1.9315	0.0050
107	1.9364	0.0049
108	1.9413	0.0049
109	1.9462	0.0049
110	1.9511	0.0048
111	1.9559	0.0048
112	1.9607	0.0048
113	1.9654	0.0047
114	1.9701	0.0047
115	1.9748	0.0047
116	1.9795	0.0047
117	1.9841	0.0046
118	1.9887	0.0046
119	1.9933	0.0046
120	1.9978	0.0045
121	2.0023	0.0045
122	2.0068	0.0045
123	2.0113	0.0045
124	2.0157	0.0044
125	2.0201	0.0044
126	2.0245	0.0044
127	2.0289	0.0044
128	2.0332	0.0043
129	2.0375	0.0043
130	2.0418	0.0043
131	2.0461	0.0043
132	2.0503	0.0042
133	2.0545	0.0042
134	2.0587	0.0042
135	2.0629	0.0042
136	2.0671	0.0041
137	2.0712	0.0041
138	2.0753	0.0041
139	2.0794	0.0041
140	2.0834	0.0041
141	2.0875	0.0040
142	2.0915	0.0040
143	2.0955	0.0040
144	2.0995	0.0040
145	2.1034	0.0040
146	2.1074	0.0039
147	2.1113	0.0039
148	2.1152	0.0039
149	2.1191	0.0039
150	2.1229	0.0039
151	2.1268	0.0038

152	2.1306	0.0038
153	2.1344	0.0038
154	2.1382	0.0038
155	2.1420	0.0038
156	2.1457	0.0038
157	2.1494	0.0037
158	2.1532	0.0037
159	2.1569	0.0037
160	2.1605	0.0037
161	2.1642	0.0037
162	2.1679	0.0037
163	2.1715	0.0036
164	2.1751	0.0036
165	2.1787	0.0036
166	2.1823	0.0036
167	2.1859	0.0036
168	2.1894	0.0036
169	2.1930	0.0035
170	2.1965	0.0035
171	2.2000	0.0035
172	2.2035	0.0035
173	2.2070	0.0035
174	2.2104	0.0035
175	2.2139	0.0035
176	2.2173	0.0034
177	2.2207	0.0034
178	2.2242	0.0034
179	2.2276	0.0034
180	2.2309	0.0034
181	2.2343	0.0034
182	2.2377	0.0034
183	2.2410	0.0033
184	2.2443	0.0033
185	2.2476	0.0033
186	2.2509	0.0033
187	2.2542	0.0033
188	2.2575	0.0033
189	2.2608	0.0033
190	2.2640	0.0032
191	2.2672	0.0032
192	2.2705	0.0032
193	2.2737	0.0032
194	2.2769	0.0032
195	2.2801	0.0032
196	2.2832	0.0032
197	2.2864	0.0032
198	2.2896	0.0032
199	2.2927	0.0031
200	2.2958	0.0031
201	2.2990	0.0031
202	2.3021	0.0031
203	2.3052	0.0031
204	2.3082	0.0031
205	2.3113	0.0031
206	2.3144	0.0031
207	2.3174	0.0031
208	2.3205	0.0030

209	2.3235	0.0030
210	2.3265	0.0030
211	2.3295	0.0030
212	2.3325	0.0030
213	2.3355	0.0030
214	2.3385	0.0030
215	2.3415	0.0030
216	2.3444	0.0030
217	2.3474	0.0029
218	2.3503	0.0029
219	2.3533	0.0029
220	2.3562	0.0029
221	2.3591	0.0029
222	2.3620	0.0029
223	2.3649	0.0029
224	2.3678	0.0029
225	2.3706	0.0029
226	2.3735	0.0029
227	2.3763	0.0029
228	2.3792	0.0028
229	2.3820	0.0028
230	2.3849	0.0028
231	2.3877	0.0028
232	2.3905	0.0028
233	2.3933	0.0028
234	2.3961	0.0028
235	2.3989	0.0028
236	2.4016	0.0028
237	2.4044	0.0028
238	2.4072	0.0028
239	2.4099	0.0027
240	2.4126	0.0027
241	2.4154	0.0027
242	2.4181	0.0027
243	2.4208	0.0027
244	2.4235	0.0027
245	2.4262	0.0027
246	2.4289	0.0027
247	2.4316	0.0027
248	2.4343	0.0027
249	2.4369	0.0027
250	2.4396	0.0027
251	2.4423	0.0027
252	2.4449	0.0026
253	2.4475	0.0026
254	2.4502	0.0026
255	2.4528	0.0026
256	2.4554	0.0026
257	2.4580	0.0026
258	2.4606	0.0026
259	2.4632	0.0026
260	2.4658	0.0026
261	2.4684	0.0026
262	2.4709	0.0026
263	2.4735	0.0026
264	2.4761	0.0026
265	2.4786	0.0025

266	2.4811	0.0025
267	2.4837	0.0025
268	2.4862	0.0025
269	2.4887	0.0025
270	2.4912	0.0025
271	2.4938	0.0025
272	2.4963	0.0025
273	2.4987	0.0025
274	2.5012	0.0025
275	2.5037	0.0025
276	2.5062	0.0025
277	2.5087	0.0025
278	2.5111	0.0025
279	2.5136	0.0025
280	2.5160	0.0024
281	2.5185	0.0024
282	2.5209	0.0024
283	2.5233	0.0024
284	2.5258	0.0024
285	2.5282	0.0024
286	2.5306	0.0024
287	2.5330	0.0024
288	2.5354	0.0024

Unit Period (number)	Unit Rainfall (In)	Unit Soil-Loss (In)	Effective Rainfall (In)
1	0.0024	0.0015	0.0009
2	0.0024	0.0015	0.0009
3	0.0024	0.0016	0.0009
4	0.0024	0.0016	0.0009
5	0.0024	0.0016	0.0009
6	0.0024	0.0016	0.0009
7	0.0025	0.0016	0.0009
8	0.0025	0.0016	0.0009
9	0.0025	0.0016	0.0009
10	0.0025	0.0016	0.0009
11	0.0025	0.0016	0.0009
12	0.0025	0.0016	0.0009
13	0.0025	0.0016	0.0009
14	0.0025	0.0016	0.0009
15	0.0025	0.0016	0.0009
16	0.0025	0.0016	0.0009
17	0.0026	0.0016	0.0009
18	0.0026	0.0017	0.0009
19	0.0026	0.0017	0.0009
20	0.0026	0.0017	0.0009
21	0.0026	0.0017	0.0009
22	0.0026	0.0017	0.0009
23	0.0026	0.0017	0.0009
24	0.0026	0.0017	0.0009
25	0.0026	0.0017	0.0009
26	0.0027	0.0017	0.0009
27	0.0027	0.0017	0.0010
28	0.0027	0.0017	0.0010
29	0.0027	0.0017	0.0010

30	0.0027	0.0017	0.0010
31	0.0027	0.0017	0.0010
32	0.0027	0.0018	0.0010
33	0.0027	0.0018	0.0010
34	0.0027	0.0018	0.0010
35	0.0028	0.0018	0.0010
36	0.0028	0.0018	0.0010
37	0.0028	0.0018	0.0010
38	0.0028	0.0018	0.0010
39	0.0028	0.0018	0.0010
40	0.0028	0.0018	0.0010
41	0.0028	0.0018	0.0010
42	0.0029	0.0018	0.0010
43	0.0029	0.0018	0.0010
44	0.0029	0.0019	0.0010
45	0.0029	0.0019	0.0010
46	0.0029	0.0019	0.0010
47	0.0029	0.0019	0.0010
48	0.0029	0.0019	0.0010
49	0.0030	0.0019	0.0011
50	0.0030	0.0019	0.0011
51	0.0030	0.0019	0.0011
52	0.0030	0.0019	0.0011
53	0.0030	0.0019	0.0011
54	0.0030	0.0020	0.0011
55	0.0031	0.0020	0.0011
56	0.0031	0.0020	0.0011
57	0.0031	0.0020	0.0011
58	0.0031	0.0020	0.0011
59	0.0031	0.0020	0.0011
60	0.0031	0.0020	0.0011
61	0.0032	0.0020	0.0011
62	0.0032	0.0020	0.0011
63	0.0032	0.0021	0.0011
64	0.0032	0.0021	0.0011
65	0.0032	0.0021	0.0011
66	0.0032	0.0021	0.0012
67	0.0033	0.0021	0.0012
68	0.0033	0.0021	0.0012
69	0.0033	0.0021	0.0012
70	0.0033	0.0021	0.0012
71	0.0033	0.0022	0.0012
72	0.0034	0.0022	0.0012
73	0.0034	0.0022	0.0012
74	0.0034	0.0022	0.0012
75	0.0034	0.0022	0.0012
76	0.0034	0.0022	0.0012
77	0.0035	0.0022	0.0012
78	0.0035	0.0022	0.0012
79	0.0035	0.0023	0.0012
80	0.0035	0.0023	0.0013
81	0.0036	0.0023	0.0013
82	0.0036	0.0023	0.0013
83	0.0036	0.0023	0.0013
84	0.0036	0.0023	0.0013
85	0.0037	0.0024	0.0013
86	0.0037	0.0024	0.0013

87	0.0037	0.0024	0.0013
88	0.0037	0.0024	0.0013
89	0.0038	0.0024	0.0013
90	0.0038	0.0024	0.0013
91	0.0038	0.0025	0.0014
92	0.0038	0.0025	0.0014
93	0.0039	0.0025	0.0014
94	0.0039	0.0025	0.0014
95	0.0039	0.0025	0.0014
96	0.0039	0.0025	0.0014
97	0.0040	0.0026	0.0014
98	0.0040	0.0026	0.0014
99	0.0040	0.0026	0.0014
100	0.0041	0.0026	0.0014
101	0.0041	0.0026	0.0015
102	0.0041	0.0027	0.0015
103	0.0042	0.0027	0.0015
104	0.0042	0.0027	0.0015
105	0.0042	0.0027	0.0015
106	0.0043	0.0027	0.0015
107	0.0043	0.0028	0.0015
108	0.0043	0.0028	0.0015
109	0.0044	0.0028	0.0016
110	0.0044	0.0028	0.0016
111	0.0045	0.0029	0.0016
112	0.0045	0.0029	0.0016
113	0.0045	0.0029	0.0016
114	0.0046	0.0029	0.0016
115	0.0046	0.0030	0.0016
116	0.0047	0.0030	0.0017
117	0.0047	0.0030	0.0017
118	0.0047	0.0031	0.0017
119	0.0048	0.0031	0.0017
120	0.0048	0.0031	0.0017
121	0.0049	0.0032	0.0017
122	0.0049	0.0032	0.0018
123	0.0050	0.0032	0.0018
124	0.0050	0.0032	0.0018
125	0.0051	0.0033	0.0018
126	0.0052	0.0033	0.0018
127	0.0052	0.0034	0.0019
128	0.0053	0.0034	0.0019
129	0.0054	0.0034	0.0019
130	0.0054	0.0035	0.0019
131	0.0055	0.0035	0.0020
132	0.0055	0.0036	0.0020
133	0.0056	0.0036	0.0020
134	0.0057	0.0036	0.0020
135	0.0058	0.0037	0.0020
136	0.0058	0.0037	0.0021
137	0.0059	0.0038	0.0021
138	0.0060	0.0038	0.0021
139	0.0061	0.0039	0.0022
140	0.0061	0.0039	0.0022
141	0.0062	0.0040	0.0022
142	0.0063	0.0040	0.0022
143	0.0064	0.0041	0.0023

144	0.0065	0.0042	0.0023
145	0.0065	0.0042	0.0023
146	0.0065	0.0042	0.0023
147	0.0067	0.0043	0.0024
148	0.0067	0.0043	0.0024
149	0.0069	0.0044	0.0025
150	0.0070	0.0045	0.0025
151	0.0071	0.0046	0.0025
152	0.0072	0.0046	0.0026
153	0.0074	0.0048	0.0026
154	0.0075	0.0048	0.0027
155	0.0077	0.0049	0.0027
156	0.0078	0.0050	0.0028
157	0.0080	0.0051	0.0028
158	0.0081	0.0052	0.0029
159	0.0083	0.0054	0.0030
160	0.0085	0.0054	0.0030
161	0.0087	0.0056	0.0031
162	0.0089	0.0057	0.0032
163	0.0091	0.0059	0.0033
164	0.0093	0.0060	0.0033
165	0.0096	0.0062	0.0034
166	0.0098	0.0063	0.0035
167	0.0102	0.0066	0.0036
168	0.0104	0.0067	0.0037
169	0.0109	0.0070	0.0039
170	0.0111	0.0072	0.0040
171	0.0116	0.0075	0.0041
172	0.0119	0.0076	0.0042
173	0.0125	0.0080	0.0044
174	0.0128	0.0082	0.0046
175	0.0135	0.0087	0.0048
176	0.0139	0.0089	0.0049
177	0.0147	0.0095	0.0052
178	0.0152	0.0098	0.0054
179	0.0163	0.0105	0.0058
180	0.0169	0.0109	0.0060
181	0.0183	0.0118	0.0065
182	0.0191	0.0123	0.0068
183	0.0210	0.0135	0.0075
184	0.0221	0.0142	0.0079
185	0.0277	0.0179	0.0099
186	0.0296	0.0190	0.0105
187	0.0343	0.0221	0.0122
188	0.0374	0.0241	0.0133
189	0.0465	0.0300	0.0166
190	0.0536	0.0311	0.0225
191	0.0813	0.0311	0.0502
192	0.1181	0.0311	0.0870
193	0.5108	0.0311	0.4797
194	0.0640	0.0311	0.0329
195	0.0414	0.0266	0.0147
196	0.0317	0.0204	0.0113
197	0.0234	0.0150	0.0083
198	0.0200	0.0129	0.0071
199	0.0175	0.0113	0.0062
200	0.0157	0.0101	0.0056

201	0.0143	0.0092	0.0051
202	0.0131	0.0084	0.0047
203	0.0122	0.0078	0.0043
204	0.0114	0.0073	0.0040
205	0.0106	0.0068	0.0038
206	0.0100	0.0064	0.0036
207	0.0095	0.0061	0.0034
208	0.0090	0.0058	0.0032
209	0.0086	0.0055	0.0031
210	0.0082	0.0053	0.0029
211	0.0079	0.0051	0.0028
212	0.0076	0.0049	0.0027
213	0.0073	0.0047	0.0026
214	0.0070	0.0045	0.0025
215	0.0068	0.0044	0.0024
216	0.0066	0.0042	0.0023
217	0.0065	0.0042	0.0023
218	0.0063	0.0041	0.0023
219	0.0062	0.0040	0.0022
220	0.0060	0.0039	0.0021
221	0.0058	0.0038	0.0021
222	0.0057	0.0037	0.0020
223	0.0056	0.0036	0.0020
224	0.0054	0.0035	0.0019
225	0.0053	0.0034	0.0019
226	0.0052	0.0033	0.0018
227	0.0051	0.0033	0.0018
228	0.0050	0.0032	0.0018
229	0.0049	0.0031	0.0017
230	0.0048	0.0031	0.0017
231	0.0047	0.0030	0.0017
232	0.0046	0.0030	0.0016
233	0.0045	0.0029	0.0016
234	0.0044	0.0029	0.0016
235	0.0044	0.0028	0.0016
236	0.0043	0.0028	0.0015
237	0.0042	0.0027	0.0015
238	0.0041	0.0027	0.0015
239	0.0041	0.0026	0.0015
240	0.0040	0.0026	0.0014
241	0.0040	0.0025	0.0014
242	0.0039	0.0025	0.0014
243	0.0038	0.0025	0.0014
244	0.0038	0.0024	0.0013
245	0.0037	0.0024	0.0013
246	0.0037	0.0024	0.0013
247	0.0036	0.0023	0.0013
248	0.0036	0.0023	0.0013
249	0.0035	0.0023	0.0013
250	0.0035	0.0022	0.0012
251	0.0035	0.0022	0.0012
252	0.0034	0.0022	0.0012
253	0.0034	0.0022	0.0012
254	0.0033	0.0021	0.0012
255	0.0033	0.0021	0.0012
256	0.0032	0.0021	0.0012
257	0.0032	0.0021	0.0011

258	0.0032	0.0020	0.0011
259	0.0031	0.0020	0.0011
260	0.0031	0.0020	0.0011
261	0.0031	0.0020	0.0011
262	0.0030	0.0020	0.0011
263	0.0030	0.0019	0.0011
264	0.0030	0.0019	0.0011
265	0.0029	0.0019	0.0011
266	0.0029	0.0019	0.0010
267	0.0029	0.0019	0.0010
268	0.0029	0.0018	0.0010
269	0.0028	0.0018	0.0010
270	0.0028	0.0018	0.0010
271	0.0028	0.0018	0.0010
272	0.0028	0.0018	0.0010
273	0.0027	0.0018	0.0010
274	0.0027	0.0017	0.0010
275	0.0027	0.0017	0.0010
276	0.0027	0.0017	0.0009
277	0.0026	0.0017	0.0009
278	0.0026	0.0017	0.0009
279	0.0026	0.0017	0.0009
280	0.0026	0.0017	0.0009
281	0.0025	0.0016	0.0009
282	0.0025	0.0016	0.0009
283	0.0025	0.0016	0.0009
284	0.0025	0.0016	0.0009
285	0.0025	0.0016	0.0009
286	0.0024	0.0016	0.0009
287	0.0024	0.0016	0.0009
288	0.0024	0.0016	0.0009

Total soil rain loss = 1.25(In)
Total effective rainfall = 1.28(In)
Peak flow rate in flood hydrograph = 135.12(CFS)

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24 - H O U R S T O R M
R u n o f f H y d r o g r a p h

Hydrograph in 5 Minute intervals ((CFS))

```
Time(h+m) Volume Ac.Ft   Q(CFS)  0       50.0     100.0     150.0     200.0
-----------------------------------------------------------------------
  0+ 5       0.0002      0.02  Q         |         |         |         |
  0+10       0.0013      0.16  Q         |         |         |         |
  0+15       0.0038      0.37  Q         |         |         |         |
  0+20       0.0070      0.46  Q         |         |         |         |
  0+25       0.0106      0.52  Q         |         |         |         |
  0+30       0.0144      0.56  Q         |         |         |         |
  0+35       0.0185      0.59  Q         |         |         |         |
  0+40       0.0226      0.61  Q         |         |         |         |
  0+45       0.0269      0.62  Q         |         |         |         |
  0+50       0.0313      0.64  Q         |         |         |         |
  0+55       0.0358      0.65  Q         |         |         |         |
```

1+ 0	0.0404	0.66	Q				
1+ 5	0.0449	0.67	Q				
1+10	0.0496	0.67	Q				
1+15	0.0542	0.68	Q				
1+20	0.0589	0.68	Q				
1+25	0.0637	0.69	Q				
1+30	0.0684	0.69	Q				
1+35	0.0732	0.70	Q				
1+40	0.0780	0.70	Q				
1+45	0.0829	0.70	Q				
1+50	0.0877	0.70	Q				
1+55	0.0926	0.71	Q				
2+ 0	0.0975	0.71	Q				
2+ 5	0.1024	0.71	Q				
2+10	0.1073	0.72	Q				
2+15	0.1123	0.72	Q				
2+20	0.1173	0.72	Q				
2+25	0.1223	0.73	Q				
2+30	0.1273	0.73	Q				
2+35	0.1323	0.73	Q				
2+40	0.1374	0.74	Q				
2+45	0.1425	0.74	Q				
2+50	0.1476	0.74	Q				
2+55	0.1527	0.75	Q				
3+ 0	0.1579	0.75	Q				
3+ 5	0.1630	0.75	Q				
3+10	0.1683	0.76	Q				
3+15	0.1735	0.76	QV				
3+20	0.1787	0.76	QV				
3+25	0.1840	0.77	QV				
3+30	0.1893	0.77	QV				
3+35	0.1946	0.77	QV				
3+40	0.2000	0.78	QV				
3+45	0.2054	0.78	QV				
3+50	0.2108	0.78	QV				
3+55	0.2162	0.79	QV				
4+ 0	0.2216	0.79	QV				
4+ 5	0.2271	0.80	QV				
4+10	0.2326	0.80	QV				
4+15	0.2382	0.80	QV				
4+20	0.2437	0.81	QV				
4+25	0.2493	0.81	QV				
4+30	0.2550	0.82	QV				
4+35	0.2606	0.82	QV				
4+40	0.2663	0.82	QV				
4+45	0.2720	0.83	QV				
4+50	0.2778	0.83	QV				
4+55	0.2835	0.84	QV				
5+ 0	0.2893	0.84	QV				
5+ 5	0.2952	0.85	QV				
5+10	0.3010	0.85	QV				
5+15	0.3069	0.86	QV				
5+20	0.3129	0.86	QV				
5+25	0.3188	0.87	QV				
5+30	0.3248	0.87	QV				
5+35	0.3308	0.88	QV				
5+40	0.3369	0.88	QV				

```
 5+45       0.3430      0.89  Q V       |          |          |          |
 5+50       0.3491      0.89  Q V       |          |          |          |
 5+55       0.3553      0.90  Q V       |          |          |          |
 6+ 0       0.3615      0.90  Q V       |          |          |          |
 6+ 5       0.3678      0.91  Q V       |          |          |          |
 6+10       0.3740      0.91  Q V       |          |          |          |
 6+15       0.3804      0.92  Q V       |          |          |          |
 6+20       0.3867      0.92  Q V       |          |          |          |
 6+25       0.3931      0.93  Q V       |          |          |          |
 6+30       0.3995      0.93  Q V       |          |          |          |
 6+35       0.4060      0.94  Q V       |          |          |          |
 6+40       0.4125      0.95  Q V       |          |          |          |
 6+45       0.4191      0.95  Q V       |          |          |          |
 6+50       0.4257      0.96  Q V       |          |          |          |
 6+55       0.4323      0.96  Q V       |          |          |          |
 7+ 0       0.4390      0.97  Q V       |          |          |          |
 7+ 5       0.4457      0.98  Q V       |          |          |          |
 7+10       0.4525      0.98  Q V       |          |          |          |
 7+15       0.4593      0.99  Q V       |          |          |          |
 7+20       0.4662      1.00  Q V       |          |          |          |
 7+25       0.4731      1.00  Q V       |          |          |          |
 7+30       0.4801      1.01  Q V       |          |          |          |
 7+35       0.4871      1.02  Q V       |          |          |          |
 7+40       0.4941      1.02  Q V       |          |          |          |
 7+45       0.5012      1.03  Q V       |          |          |          |
 7+50       0.5084      1.04  Q  V      |          |          |          |
 7+55       0.5156      1.05  Q  V      |          |          |          |
 8+ 0       0.5228      1.05  Q  V      |          |          |          |
 8+ 5       0.5302      1.06  Q  V      |          |          |          |
 8+10       0.5375      1.07  Q  V      |          |          |          |
 8+15       0.5449      1.08  Q  V      |          |          |          |
 8+20       0.5524      1.09  Q  V      |          |          |          |
 8+25       0.5600      1.09  Q  V      |          |          |          |
 8+30       0.5675      1.10  Q  V      |          |          |          |
 8+35       0.5752      1.11  Q  V      |          |          |          |
 8+40       0.5829      1.12  Q  V      |          |          |          |
 8+45       0.5907      1.13  Q  V      |          |          |          |
 8+50       0.5985      1.14  Q  V      |          |          |          |
 8+55       0.6064      1.15  Q  V      |          |          |          |
 9+ 0       0.6144      1.16  Q  V      |          |          |          |
 9+ 5       0.6224      1.17  Q  V      |          |          |          |
 9+10       0.6305      1.18  Q  V      |          |          |          |
 9+15       0.6387      1.19  Q  V      |          |          |          |
 9+20       0.6469      1.20  Q  V      |          |          |          |
 9+25       0.6552      1.21  Q  V      |          |          |          |
 9+30       0.6636      1.22  Q  V      |          |          |          |
 9+35       0.6721      1.23  Q  V      |          |          |          |
 9+40       0.6806      1.24  Q   V     |          |          |          |
 9+45       0.6892      1.25  Q   V     |          |          |          |
 9+50       0.6979      1.26  Q   V     |          |          |          |
 9+55       0.7067      1.27  Q   V     |          |          |          |
10+ 0       0.7156      1.29  Q   V     |          |          |          |
10+ 5       0.7245      1.30  Q   V     |          |          |          |
10+10       0.7336      1.31  Q   V     |          |          |          |
10+15       0.7427      1.33  Q   V     |          |          |          |
10+20       0.7519      1.34  Q   V     |          |          |          |
10+25       0.7612      1.35  Q   V     |          |          |          |
```

```
10+30       0.7707      1.37  Q   V     |          |          |          |
10+35       0.7802      1.38  Q   V     |          |          |          |
10+40       0.7898      1.40  Q   V     |          |          |          |
10+45       0.7995      1.41  Q   V     |          |          |          |
10+50       0.8093      1.43  Q   V     |          |          |          |
10+55       0.8192      1.44  Q   V     |          |          |          |
11+ 0       0.8293      1.46  Q   V     |          |          |          |
11+ 5       0.8395      1.48  Q   V     |          |          |          |
11+10       0.8497      1.49  Q    V    |          |          |          |
11+15       0.8601      1.51  Q    V    |          |          |          |
11+20       0.8707      1.53  Q    V    |          |          |          |
11+25       0.8813      1.55  Q    V    |          |          |          |
11+30       0.8921      1.57  Q    V    |          |          |          |
11+35       0.9031      1.59  Q    V    |          |          |          |
11+40       0.9141      1.61  Q    V    |          |          |          |
11+45       0.9254      1.63  Q    V    |          |          |          |
11+50       0.9367      1.65  Q    V    |          |          |          |
11+55       0.9483      1.67  Q    V    |          |          |          |
12+ 0       0.9599      1.70  Q    V    |          |          |          |
12+ 5       0.9718      1.72  Q    V    |          |          |          |
12+10       0.9837      1.74  Q    V    |          |          |          |
12+15       0.9958      1.75  Q    V    |          |          |          |
12+20       1.0080      1.77  Q    V    |          |          |          |
12+25       1.0204      1.80  Q     V   |          |          |          |
12+30       1.0329      1.82  Q     V   |          |          |          |
12+35       1.0457      1.85  Q     V   |          |          |          |
12+40       1.0586      1.88  Q     V   |          |          |          |
12+45       1.0718      1.91  Q     V   |          |          |          |
12+50       1.0851      1.94  Q     V   |          |          |          |
12+55       1.0988      1.98  Q     V   |          |          |          |
13+ 0       1.1126      2.01  Q     V   |          |          |          |
13+ 5       1.1268      2.05  Q     V   |          |          |          |
13+10       1.1412      2.09  Q     V   |          |          |          |
13+15       1.1559      2.13  Q     V   |          |          |          |
13+20       1.1708      2.18  Q     V   |          |          |          |
13+25       1.1861      2.22  Q      V  |          |          |          |
13+30       1.2018      2.27  Q      V  |          |          |          |
13+35       1.2177      2.32  Q      V  |          |          |          |
13+40       1.2341      2.37  Q      V  |          |          |          |
13+45       1.2508      2.43  Q      V  |          |          |          |
13+50       1.2680      2.49  Q      V  |          |          |          |
13+55       1.2856      2.55  Q      V  |          |          |          |
14+ 0       1.3036      2.62  Q      V  |          |          |          |
14+ 5       1.3221      2.69  Q      V  |          |          |          |
14+10       1.3412      2.77  Q      V  |          |          |          |
14+15       1.3610      2.86  Q       V |          |          |          |
14+20       1.3813      2.95  Q       V |          |          |          |
14+25       1.4023      3.05  Q       V |          |          |          |
14+30       1.4241      3.16  Q       V |          |          |          |
14+35       1.4466      3.27  Q       V |          |          |          |
14+40       1.4699      3.39  Q       V |          |          |          |
14+45       1.4942      3.52  Q       V |          |          |          |
14+50       1.5195      3.67  Q       V |          |          |          |
14+55       1.5459      3.83  Q        V|          |          |          |
15+ 0       1.5735      4.01  Q        V|          |          |          |
15+ 5       1.6025      4.21  Q        V|          |          |          |
15+10       1.6331      4.44  Q        V|          |          |          |
```

```
15+15       1.6655      4.70  Q        V|         |         |         |
15+20       1.6999      5.00  |Q        V         |         |         |
15+25       1.7370      5.38  |Q        V         |         |         |
15+30       1.7781      5.97  |Q        V         |         |         |
15+35       1.8245      6.73  |Q        V         |         |         |
15+40       1.8762      7.51  |Q        |V        |         |         |
15+45       1.9343      8.44  |Q        |V        |         |         |
15+50       2.0016      9.76  |Q        |V        |         |         |
15+55       2.0883     12.59  | Q       | V       |         |         |
16+ 0       2.2270     20.14  |   Q     |  V      |         |         |
16+ 5       2.5301     44.01  |       Q |   V     |         |         |
16+10       3.2875    109.97  |         |        V|Q        |         |
16+15       4.2181    135.12  |         |         |   V  Q  |         |
16+20       4.7236     73.40  |         |   Q     |      V  |         |
16+25       5.0439     46.51  |        Q|         |        V|         |
16+30       5.2712     33.01  |     Q   |         |         |V        |
16+35       5.4457     25.33  |    Q    |         |         | V       |
16+40       5.5785     19.29  |  Q      |         |         | V       |
16+45       5.6873     15.79  |  Q      |         |         |  V      |
16+50       5.7762     12.91  | Q       |         |         |   V     |
16+55       5.8500     10.72  | Q       |         |         |   V     |
17+ 0       5.9107      8.82  |Q        |         |         |   V     |
17+ 5       5.9598      7.12  |Q        |         |         |    V    |
17+10       6.0013      6.03  |Q        |         |         |    V    |
17+15       6.0415      5.83  |Q        |         |         |    V    |
17+20       6.0781      5.32  |Q        |         |         |    V    |
17+25       6.1076      4.29  Q         |         |         |     V   |
17+30       6.1323      3.58  Q         |         |         |     V   |
17+35       6.1506      2.67  Q         |         |         |     V   |
17+40       6.1678      2.49  Q         |         |         |     V   |
17+45       6.1840      2.36  Q         |         |         |     V   |
17+50       6.1995      2.24  Q         |         |         |     V   |
17+55       6.2142      2.15  Q         |         |         |     V   |
18+ 0       6.2284      2.06  Q         |         |         |     V   |
18+ 5       6.2421      1.98  Q         |         |         |     V   |
18+10       6.2553      1.92  Q         |         |         |     V   |
18+15       6.2682      1.87  Q         |         |         |     V   |
18+20       6.2807      1.81  Q         |         |         |      V  |
18+25       6.2928      1.76  Q         |         |         |      V  |
18+30       6.3046      1.71  Q         |         |         |      V  |
18+35       6.3161      1.67  Q         |         |         |      V  |
18+40       6.3273      1.62  Q         |         |         |      V  |
18+45       6.3382      1.58  Q         |         |         |      V  |
18+50       6.3488      1.54  Q         |         |         |      V  |
18+55       6.3592      1.51  Q         |         |         |      V  |
19+ 0       6.3693      1.47  Q         |         |         |      V  |
19+ 5       6.3792      1.44  Q         |         |         |      V  |
19+10       6.3889      1.41  Q         |         |         |      V  |
19+15       6.3983      1.38  Q         |         |         |      V  |
19+20       6.4076      1.35  Q         |         |         |      V  |
19+25       6.4167      1.32  Q         |         |         |      V  |
19+30       6.4257      1.30  Q         |         |         |      V  |
19+35       6.4344      1.27  Q         |         |         |      V  |
19+40       6.4430      1.25  Q         |         |         |       V |
19+45       6.4514      1.22  Q         |         |         |       V |
19+50       6.4597      1.20  Q         |         |         |       V |
19+55       6.4679      1.18  Q         |         |         |       V |
```

```
20+ 0       6.4759      1.16  Q          |          |          |        V |
20+ 5       6.4837      1.14  Q          |          |          |        V |
20+10       6.4915      1.13  Q          |          |          |        V |
20+15       6.4991      1.11  Q          |          |          |        V |
20+20       6.5066      1.09  Q          |          |          |        V |
20+25       6.5140      1.07  Q          |          |          |        V |
20+30       6.5213      1.06  Q          |          |          |        V |
20+35       6.5285      1.04  Q          |          |          |        V |
20+40       6.5356      1.03  Q          |          |          |        V |
20+45       6.5426      1.01  Q          |          |          |        V |
20+50       6.5495      1.00  Q          |          |          |        V |
20+55       6.5563      0.99  Q          |          |          |        V |
21+ 0       6.5630      0.97  Q          |          |          |        V |
21+ 5       6.5696      0.96  Q          |          |          |        V |
21+10       6.5761      0.95  Q          |          |          |        V |
21+15       6.5826      0.94  Q          |          |          |        V |
21+20       6.5889      0.93  Q          |          |          |        V |
21+25       6.5952      0.91  Q          |          |          |        V |
21+30       6.6015      0.90  Q          |          |          |        V |
21+35       6.6076      0.89  Q          |          |          |         V|
21+40       6.6137      0.88  Q          |          |          |         V|
21+45       6.6197      0.87  Q          |          |          |         V|
21+50       6.6257      0.86  Q          |          |          |         V|
21+55       6.6315      0.85  Q          |          |          |         V|
22+ 0       6.6374      0.84  Q          |          |          |         V|
22+ 5       6.6431      0.84  Q          |          |          |         V|
22+10       6.6488      0.83  Q          |          |          |         V|
22+15       6.6545      0.82  Q          |          |          |         V|
22+20       6.6600      0.81  Q          |          |          |         V|
22+25       6.6656      0.80  Q          |          |          |         V|
22+30       6.6710      0.79  Q          |          |          |         V|
22+35       6.6764      0.79  Q          |          |          |         V|
22+40       6.6818      0.78  Q          |          |          |         V|
22+45       6.6871      0.77  Q          |          |          |         V|
22+50       6.6924      0.76  Q          |          |          |         V|
22+55       6.6976      0.76  Q          |          |          |         V|
23+ 0       6.7028      0.75  Q          |          |          |         V|
23+ 5       6.7079      0.74  Q          |          |          |         V|
23+10       6.7130      0.74  Q          |          |          |         V|
23+15       6.7180      0.73  Q          |          |          |         V|
23+20       6.7230      0.72  Q          |          |          |         V|
23+25       6.7279      0.72  Q          |          |          |         V|
23+30       6.7328      0.71  Q          |          |          |         V|
23+35       6.7377      0.71  Q          |          |          |         V|
23+40       6.7425      0.70  Q          |          |          |         V|
23+45       6.7473      0.69  Q          |          |          |         V|
23+50       6.7520      0.69  Q          |          |          |         V|
23+55       6.7567      0.68  Q          |          |          |         V|
24+ 0       6.7614      0.68  Q          |          |          |         V|
24+ 5       6.7659      0.65  Q          |          |          |         V|
24+10       6.7693      0.50  Q          |          |          |         V|
24+15       6.7714      0.30  Q          |          |          |         V|
24+20       6.7728      0.20  Q          |          |          |         V|
24+25       6.7737      0.14  Q          |          |          |         V|
24+30       6.7745      0.11  Q          |          |          |         V|
24+35       6.7750      0.08  Q          |          |          |         V|
24+40       6.7755      0.06  Q          |          |          |         V|
```

```
   24+45       6.7758      0.05  Q         |         |         |        V|
   24+50       6.7760      0.03  Q         |         |         |        V|
   24+55       6.7762      0.03  Q         |         |         |        V|
   25+ 0       6.7763      0.02  Q         |         |         |        V|
   25+ 5       6.7764      0.01  Q         |         |         |        V|
   25+10       6.7765      0.01  Q         |         |         |        V|
   25+15       6.7765      0.01  Q         |         |         |        V|
   25+20       6.7765      0.00  Q         |         |         |        V|
   25+25       6.7765      0.00  Q         |         |         |         V
-----------------------------------------------------------------------
```

U n i t H y d r o g r a p h A n a l y s i s

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Study date 04/09/15

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San Bernardino County Synthetic Unit Hydrology Method
Manual date - August 1986

Program License Serial Number 6320

154166 - AMBOY - SAN BERNARDINO COUNTY
RECLAMATION CONDITION "B"
20-YEAR, 24-HOUR STORM
BY: JTS DATE: 04-09-15

Storm Event Year = 20

Antecedent Moisture Condition = 1

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

English Units used in output format

Area averaged rainfall intensity isohyetal data:

Sub-Area (Ac.)	Duration (hours)	Isohyetal (In)
Rainfall data for year 10		
46.11	1	0.86
Rainfall data for year 2		
46.11	6	0.75
Rainfall data for year 2		
46.11	24	1.07
Rainfall data for year 100		
0.00	1	1.59
46.11	1	1.59
Rainfall data for year 100		
46.11	6	2.43
Rainfall data for year 100		

```
          46.11           24           3.56
-------------------------------------------------------------------
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

******** Area-averaged max loss rate, Fm ********


SCS curve  SCS curve     Area     Area     Fp(Fig C6)    Ap      Fm
No.(AMCII) NO.(AMC 1)    (Ac.)    Fraction     (In/Hr)  (dec.)   (In/Hr)
 91.0      79.8         46.11      1.000     0.373    1.000    0.373

Area-averaged adjusted loss rate Fm (In/Hr) =  0.373

********* Area-Averaged low loss rate fraction, Yb **********

Area       Area          SCS CN    SCS CN      S     Pervious
 (Ac.)      Fract         (AMC2)    (AMC1)           Yield Fr
    46.11   1.000         91.0      79.8       2.53     0.356

Area-averaged catchment yield fraction, Y =  0.356
Area-averaged low loss fraction, Yb =  0.644
User entry of time of concentration  =   0.170 (hours)
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Watershed area =      46.11(Ac.)
Catchment Lag time =   0.136 hours
Unit interval =   5.000 minutes
Unit interval percentage of lag time = 61.2745
Hydrograph baseflow =     0.00(CFS)
Average maximum watershed loss rate(Fm) =  0.373(In/Hr)
Average low loss rate fraction (Yb) = 0.644 (decimal)
DESERT S-Graph Selected
Computed peak 5-minute rainfall =  0.512(In)
Computed peak 30-minute rainfall =  0.877(In)
Specified peak 1-hour rainfall =  1.080(In)
Computed peak 3-hour rainfall =  1.446(In)
Specified peak 6-hour rainfall =  1.739(In)
Specified peak 24-hour rainfall =  2.536(In)


Rainfall depth area reduction factors:
Using a total area of      46.11(Ac.) (Ref: fig. E-4)

5-minute factor = 0.998     Adjusted rainfall =  0.511(In)
30-minute factor = 0.998    Adjusted rainfall =  0.875(In)
1-hour factor = 0.998       Adjusted rainfall =  1.077(In)
3-hour factor = 1.000       Adjusted rainfall =  1.446(In)
6-hour factor = 1.000       Adjusted rainfall =  1.739(In)
24-hour factor = 1.000      Adjusted rainfall =  2.535(In)
-------------------------------------------------------------------

                  U n i t  H y d r o g r a p h
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Interval          'S' Graph          Unit Hydrograph
Number            Mean values             ((CFS))
-------------------------------------------------------------------
            (K =       557.64 (CFS))
```

1	5.829	32.506
2	42.748	205.874
3	68.862	145.626
4	80.052	62.398
5	86.633	36.699
6	90.841	23.464
7	93.754	16.247
8	95.820	11.516
9	97.269	8.081
10	98.124	4.769
11	98.821	3.886
12	99.497	3.774
13	100.000	2.803

Peak Unit Number	Adjusted mass rainfall (In)	Unit rainfall (In)
1	0.5112	0.5112
2	0.6294	0.1182
3	0.7108	0.0814
4	0.7749	0.0641
5	0.8286	0.0537
6	0.8751	0.0466
7	0.9166	0.0414
8	0.9540	0.0375
9	0.9883	0.0343
10	1.0201	0.0317
11	1.0497	0.0296
12	1.0774	0.0278
13	1.1007	0.0233
14	1.1228	0.0221
15	1.1437	0.0209
16	1.1637	0.0199
17	1.1827	0.0190
18	1.2009	0.0182
19	1.2184	0.0175
20	1.2353	0.0168
21	1.2515	0.0162
22	1.2672	0.0157
23	1.2824	0.0152
24	1.2970	0.0147
25	1.3113	0.0142
26	1.3251	0.0138
27	1.3386	0.0135
28	1.3517	0.0131
29	1.3644	0.0128
30	1.3769	0.0124
31	1.3890	0.0121
32	1.4009	0.0119
33	1.4124	0.0116
34	1.4238	0.0113
35	1.4349	0.0111
36	1.4457	0.0109
37	1.4563	0.0106
38	1.4667	0.0104
39	1.4769	0.0102
40	1.4868	0.0100
41	1.4966	0.0098

42	1.5063	0.0096
43	1.5157	0.0095
44	1.5250	0.0093
45	1.5342	0.0091
46	1.5432	0.0090
47	1.5520	0.0089
48	1.5608	0.0087
49	1.5693	0.0086
50	1.5778	0.0085
51	1.5861	0.0083
52	1.5944	0.0082
53	1.6025	0.0081
54	1.6104	0.0080
55	1.6183	0.0079
56	1.6261	0.0078
57	1.6338	0.0077
58	1.6414	0.0076
59	1.6489	0.0075
60	1.6562	0.0074
61	1.6635	0.0073
62	1.6708	0.0072
63	1.6779	0.0071
64	1.6849	0.0070
65	1.6919	0.0070
66	1.6988	0.0069
67	1.7056	0.0068
68	1.7123	0.0067
69	1.7190	0.0067
70	1.7256	0.0066
71	1.7321	0.0065
72	1.7386	0.0065
73	1.7451	0.0065
74	1.7516	0.0065
75	1.7580	0.0064
76	1.7644	0.0063
77	1.7706	0.0063
78	1.7769	0.0062
79	1.7830	0.0062
80	1.7892	0.0061
81	1.7952	0.0061
82	1.8012	0.0060
83	1.8072	0.0060
84	1.8131	0.0059
85	1.8189	0.0058
86	1.8247	0.0058
87	1.8305	0.0058
88	1.8362	0.0057
89	1.8418	0.0057
90	1.8474	0.0056
91	1.8530	0.0056
92	1.8585	0.0055
93	1.8640	0.0055
94	1.8694	0.0054
95	1.8748	0.0054
96	1.8802	0.0054
97	1.8855	0.0053
98	1.8908	0.0053

99	1.8960	0.0052
100	1.9012	0.0052
101	1.9063	0.0052
102	1.9115	0.0051
103	1.9165	0.0051
104	1.9216	0.0050
105	1.9266	0.0050
106	1.9316	0.0050
107	1.9365	0.0049
108	1.9414	0.0049
109	1.9463	0.0049
110	1.9511	0.0048
111	1.9560	0.0048
112	1.9607	0.0048
113	1.9655	0.0047
114	1.9702	0.0047
115	1.9749	0.0047
116	1.9796	0.0047
117	1.9842	0.0046
118	1.9888	0.0046
119	1.9934	0.0046
120	1.9979	0.0045
121	2.0024	0.0045
122	2.0069	0.0045
123	2.0114	0.0045
124	2.0158	0.0044
125	2.0202	0.0044
126	2.0246	0.0044
127	2.0290	0.0044
128	2.0333	0.0043
129	2.0376	0.0043
130	2.0419	0.0043
131	2.0462	0.0043
132	2.0504	0.0042
133	2.0546	0.0042
134	2.0588	0.0042
135	2.0630	0.0042
136	2.0671	0.0041
137	2.0713	0.0041
138	2.0754	0.0041
139	2.0794	0.0041
140	2.0835	0.0041
141	2.0875	0.0040
142	2.0916	0.0040
143	2.0956	0.0040
144	2.0995	0.0040
145	2.1035	0.0040
146	2.1074	0.0039
147	2.1114	0.0039
148	2.1153	0.0039
149	2.1191	0.0039
150	2.1230	0.0039
151	2.1268	0.0038
152	2.1307	0.0038
153	2.1345	0.0038
154	2.1383	0.0038
155	2.1420	0.0038

156	2.1458	0.0038
157	2.1495	0.0037
158	2.1532	0.0037
159	2.1569	0.0037
160	2.1606	0.0037
161	2.1643	0.0037
162	2.1679	0.0037
163	2.1716	0.0036
164	2.1752	0.0036
165	2.1788	0.0036
166	2.1824	0.0036
167	2.1859	0.0036
168	2.1895	0.0036
169	2.1930	0.0035
170	2.1966	0.0035
171	2.2001	0.0035
172	2.2036	0.0035
173	2.2070	0.0035
174	2.2105	0.0035
175	2.2140	0.0035
176	2.2174	0.0034
177	2.2208	0.0034
178	2.2242	0.0034
179	2.2276	0.0034
180	2.2310	0.0034
181	2.2344	0.0034
182	2.2377	0.0034
183	2.2411	0.0033
184	2.2444	0.0033
185	2.2477	0.0033
186	2.2510	0.0033
187	2.2543	0.0033
188	2.2576	0.0033
189	2.2608	0.0033
190	2.2641	0.0032
191	2.2673	0.0032
192	2.2705	0.0032
193	2.2738	0.0032
194	2.2770	0.0032
195	2.2801	0.0032
196	2.2833	0.0032
197	2.2865	0.0032
198	2.2896	0.0032
199	2.2928	0.0031
200	2.2959	0.0031
201	2.2990	0.0031
202	2.3021	0.0031
203	2.3052	0.0031
204	2.3083	0.0031
205	2.3114	0.0031
206	2.3145	0.0031
207	2.3175	0.0031
208	2.3205	0.0030
209	2.3236	0.0030
210	2.3266	0.0030
211	2.3296	0.0030
212	2.3326	0.0030

213	2.3356	0.0030
214	2.3386	0.0030
215	2.3415	0.0030
216	2.3445	0.0030
217	2.3475	0.0029
218	2.3504	0.0029
219	2.3533	0.0029
220	2.3562	0.0029
221	2.3592	0.0029
222	2.3621	0.0029
223	2.3649	0.0029
224	2.3678	0.0029
225	2.3707	0.0029
226	2.3736	0.0029
227	2.3764	0.0029
228	2.3793	0.0028
229	2.3821	0.0028
230	2.3849	0.0028
231	2.3877	0.0028
232	2.3905	0.0028
233	2.3933	0.0028
234	2.3961	0.0028
235	2.3989	0.0028
236	2.4017	0.0028
237	2.4045	0.0028
238	2.4072	0.0028
239	2.4100	0.0027
240	2.4127	0.0027
241	2.4154	0.0027
242	2.4182	0.0027
243	2.4209	0.0027
244	2.4236	0.0027
245	2.4263	0.0027
246	2.4290	0.0027
247	2.4317	0.0027
248	2.4343	0.0027
249	2.4370	0.0027
250	2.4397	0.0027
251	2.4423	0.0027
252	2.4450	0.0026
253	2.4476	0.0026
254	2.4502	0.0026
255	2.4528	0.0026
256	2.4555	0.0026
257	2.4581	0.0026
258	2.4607	0.0026
259	2.4633	0.0026
260	2.4658	0.0026
261	2.4684	0.0026
262	2.4710	0.0026
263	2.4736	0.0026
264	2.4761	0.0026
265	2.4787	0.0025
266	2.4812	0.0025
267	2.4837	0.0025
268	2.4863	0.0025
269	2.4888	0.0025

270	2.4913	0.0025
271	2.4938	0.0025
272	2.4963	0.0025
273	2.4988	0.0025
274	2.5013	0.0025
275	2.5038	0.0025
276	2.5062	0.0025
277	2.5087	0.0025
278	2.5112	0.0025
279	2.5136	0.0025
280	2.5161	0.0024
281	2.5185	0.0024
282	2.5210	0.0024
283	2.5234	0.0024
284	2.5258	0.0024
285	2.5282	0.0024
286	2.5306	0.0024
287	2.5330	0.0024
288	2.5354	0.0024

Unit Period (number)	Unit Rainfall (In)	Unit Soil-Loss (In)	Effective Rainfall (In)
1	0.0024	0.0015	0.0009
2	0.0024	0.0015	0.0009
3	0.0024	0.0016	0.0009
4	0.0024	0.0016	0.0009
5	0.0024	0.0016	0.0009
6	0.0024	0.0016	0.0009
7	0.0025	0.0016	0.0009
8	0.0025	0.0016	0.0009
9	0.0025	0.0016	0.0009
10	0.0025	0.0016	0.0009
11	0.0025	0.0016	0.0009
12	0.0025	0.0016	0.0009
13	0.0025	0.0016	0.0009
14	0.0025	0.0016	0.0009
15	0.0025	0.0016	0.0009
16	0.0025	0.0016	0.0009
17	0.0026	0.0016	0.0009
18	0.0026	0.0017	0.0009
19	0.0026	0.0017	0.0009
20	0.0026	0.0017	0.0009
21	0.0026	0.0017	0.0009
22	0.0026	0.0017	0.0009
23	0.0026	0.0017	0.0009
24	0.0026	0.0017	0.0009
25	0.0026	0.0017	0.0009
26	0.0027	0.0017	0.0009
27	0.0027	0.0017	0.0009
28	0.0027	0.0017	0.0010
29	0.0027	0.0017	0.0010
30	0.0027	0.0017	0.0010
31	0.0027	0.0017	0.0010
32	0.0027	0.0018	0.0010
33	0.0027	0.0018	0.0010

34	0.0027	0.0018	0.0010
35	0.0028	0.0018	0.0010
36	0.0028	0.0018	0.0010
37	0.0028	0.0018	0.0010
38	0.0028	0.0018	0.0010
39	0.0028	0.0018	0.0010
40	0.0028	0.0018	0.0010
41	0.0028	0.0018	0.0010
42	0.0029	0.0018	0.0010
43	0.0029	0.0018	0.0010
44	0.0029	0.0019	0.0010
45	0.0029	0.0019	0.0010
46	0.0029	0.0019	0.0010
47	0.0029	0.0019	0.0010
48	0.0029	0.0019	0.0010
49	0.0030	0.0019	0.0011
50	0.0030	0.0019	0.0011
51	0.0030	0.0019	0.0011
52	0.0030	0.0019	0.0011
53	0.0030	0.0019	0.0011
54	0.0030	0.0020	0.0011
55	0.0031	0.0020	0.0011
56	0.0031	0.0020	0.0011
57	0.0031	0.0020	0.0011
58	0.0031	0.0020	0.0011
59	0.0031	0.0020	0.0011
60	0.0031	0.0020	0.0011
61	0.0032	0.0020	0.0011
62	0.0032	0.0020	0.0011
63	0.0032	0.0021	0.0011
64	0.0032	0.0021	0.0011
65	0.0032	0.0021	0.0011
66	0.0032	0.0021	0.0012
67	0.0033	0.0021	0.0012
68	0.0033	0.0021	0.0012
69	0.0033	0.0021	0.0012
70	0.0033	0.0021	0.0012
71	0.0033	0.0022	0.0012
72	0.0034	0.0022	0.0012
73	0.0034	0.0022	0.0012
74	0.0034	0.0022	0.0012
75	0.0034	0.0022	0.0012
76	0.0034	0.0022	0.0012
77	0.0035	0.0022	0.0012
78	0.0035	0.0022	0.0012
79	0.0035	0.0023	0.0012
80	0.0035	0.0023	0.0013
81	0.0036	0.0023	0.0013
82	0.0036	0.0023	0.0013
83	0.0036	0.0023	0.0013
84	0.0036	0.0023	0.0013
85	0.0037	0.0024	0.0013
86	0.0037	0.0024	0.0013
87	0.0037	0.0024	0.0013
88	0.0037	0.0024	0.0013
89	0.0038	0.0024	0.0013
90	0.0038	0.0024	0.0013

91	0.0038	0.0025	0.0014
92	0.0038	0.0025	0.0014
93	0.0039	0.0025	0.0014
94	0.0039	0.0025	0.0014
95	0.0039	0.0025	0.0014
96	0.0039	0.0025	0.0014
97	0.0040	0.0026	0.0014
98	0.0040	0.0026	0.0014
99	0.0040	0.0026	0.0014
100	0.0041	0.0026	0.0014
101	0.0041	0.0026	0.0015
102	0.0041	0.0027	0.0015
103	0.0042	0.0027	0.0015
104	0.0042	0.0027	0.0015
105	0.0042	0.0027	0.0015
106	0.0043	0.0027	0.0015
107	0.0043	0.0028	0.0015
108	0.0043	0.0028	0.0015
109	0.0044	0.0028	0.0016
110	0.0044	0.0028	0.0016
111	0.0045	0.0029	0.0016
112	0.0045	0.0029	0.0016
113	0.0045	0.0029	0.0016
114	0.0046	0.0029	0.0016
115	0.0046	0.0030	0.0016
116	0.0047	0.0030	0.0017
117	0.0047	0.0030	0.0017
118	0.0047	0.0031	0.0017
119	0.0048	0.0031	0.0017
120	0.0048	0.0031	0.0017
121	0.0049	0.0032	0.0017
122	0.0049	0.0032	0.0018
123	0.0050	0.0032	0.0018
124	0.0050	0.0032	0.0018
125	0.0051	0.0033	0.0018
126	0.0052	0.0033	0.0018
127	0.0052	0.0034	0.0019
128	0.0053	0.0034	0.0019
129	0.0054	0.0034	0.0019
130	0.0054	0.0035	0.0019
131	0.0055	0.0035	0.0020
132	0.0055	0.0036	0.0020
133	0.0056	0.0036	0.0020
134	0.0057	0.0036	0.0020
135	0.0058	0.0037	0.0020
136	0.0058	0.0037	0.0021
137	0.0059	0.0038	0.0021
138	0.0060	0.0038	0.0021
139	0.0061	0.0039	0.0022
140	0.0061	0.0039	0.0022
141	0.0062	0.0040	0.0022
142	0.0063	0.0040	0.0022
143	0.0064	0.0041	0.0023
144	0.0065	0.0042	0.0023
145	0.0065	0.0042	0.0023
146	0.0065	0.0042	0.0023
147	0.0067	0.0043	0.0024

148	0.0067	0.0043	0.0024
149	0.0069	0.0044	0.0025
150	0.0070	0.0045	0.0025
151	0.0071	0.0046	0.0025
152	0.0072	0.0046	0.0026
153	0.0074	0.0048	0.0026
154	0.0075	0.0048	0.0027
155	0.0077	0.0049	0.0027
156	0.0078	0.0050	0.0028
157	0.0080	0.0051	0.0028
158	0.0081	0.0052	0.0029
159	0.0083	0.0054	0.0030
160	0.0085	0.0054	0.0030
161	0.0087	0.0056	0.0031
162	0.0089	0.0057	0.0032
163	0.0091	0.0059	0.0033
164	0.0093	0.0060	0.0033
165	0.0096	0.0062	0.0034
166	0.0098	0.0063	0.0035
167	0.0102	0.0066	0.0036
168	0.0104	0.0067	0.0037
169	0.0109	0.0070	0.0039
170	0.0111	0.0071	0.0039
171	0.0116	0.0075	0.0041
172	0.0119	0.0076	0.0042
173	0.0124	0.0080	0.0044
174	0.0128	0.0082	0.0045
175	0.0135	0.0087	0.0048
176	0.0138	0.0089	0.0049
177	0.0147	0.0095	0.0052
178	0.0152	0.0098	0.0054
179	0.0162	0.0105	0.0058
180	0.0168	0.0108	0.0060
181	0.0182	0.0117	0.0065
182	0.0190	0.0123	0.0068
183	0.0209	0.0135	0.0075
184	0.0221	0.0142	0.0079
185	0.0278	0.0179	0.0099
186	0.0296	0.0191	0.0105
187	0.0343	0.0221	0.0122
188	0.0375	0.0241	0.0133
189	0.0466	0.0300	0.0166
190	0.0537	0.0311	0.0226
191	0.0814	0.0311	0.0503
192	0.1182	0.0311	0.0871
193	0.5112	0.0311	0.4801
194	0.0641	0.0311	0.0330
195	0.0414	0.0267	0.0148
196	0.0317	0.0204	0.0113
197	0.0233	0.0150	0.0083
198	0.0199	0.0128	0.0071
199	0.0175	0.0113	0.0062
200	0.0157	0.0101	0.0056
201	0.0142	0.0092	0.0051
202	0.0131	0.0084	0.0047
203	0.0121	0.0078	0.0043
204	0.0113	0.0073	0.0040

205	0.0106	0.0068	0.0038
206	0.0100	0.0064	0.0036
207	0.0095	0.0061	0.0034
208	0.0090	0.0058	0.0032
209	0.0086	0.0055	0.0031
210	0.0082	0.0053	0.0029
211	0.0079	0.0051	0.0028
212	0.0076	0.0049	0.0027
213	0.0073	0.0047	0.0026
214	0.0070	0.0045	0.0025
215	0.0068	0.0044	0.0024
216	0.0066	0.0042	0.0023
217	0.0065	0.0042	0.0023
218	0.0063	0.0041	0.0023
219	0.0062	0.0040	0.0022
220	0.0060	0.0039	0.0021
221	0.0058	0.0038	0.0021
222	0.0057	0.0037	0.0020
223	0.0056	0.0036	0.0020
224	0.0054	0.0035	0.0019
225	0.0053	0.0034	0.0019
226	0.0052	0.0033	0.0018
227	0.0051	0.0033	0.0018
228	0.0050	0.0032	0.0018
229	0.0049	0.0031	0.0017
230	0.0048	0.0031	0.0017
231	0.0047	0.0030	0.0017
232	0.0046	0.0030	0.0016
233	0.0045	0.0029	0.0016
234	0.0044	0.0029	0.0016
235	0.0044	0.0028	0.0016
236	0.0043	0.0028	0.0015
237	0.0042	0.0027	0.0015
238	0.0041	0.0027	0.0015
239	0.0041	0.0026	0.0015
240	0.0040	0.0026	0.0014
241	0.0040	0.0025	0.0014
242	0.0039	0.0025	0.0014
243	0.0038	0.0025	0.0014
244	0.0038	0.0024	0.0013
245	0.0037	0.0024	0.0013
246	0.0037	0.0024	0.0013
247	0.0036	0.0023	0.0013
248	0.0036	0.0023	0.0013
249	0.0035	0.0023	0.0013
250	0.0035	0.0022	0.0012
251	0.0035	0.0022	0.0012
252	0.0034	0.0022	0.0012
253	0.0034	0.0022	0.0012
254	0.0033	0.0021	0.0012
255	0.0033	0.0021	0.0012
256	0.0032	0.0021	0.0012
257	0.0032	0.0021	0.0011
258	0.0032	0.0020	0.0011
259	0.0031	0.0020	0.0011
260	0.0031	0.0020	0.0011
261	0.0031	0.0020	0.0011

262	0.0030	0.0020	0.0011
263	0.0030	0.0019	0.0011
264	0.0030	0.0019	0.0011
265	0.0029	0.0019	0.0011
266	0.0029	0.0019	0.0010
267	0.0029	0.0019	0.0010
268	0.0029	0.0018	0.0010
269	0.0028	0.0018	0.0010
270	0.0028	0.0018	0.0010
271	0.0028	0.0018	0.0010
272	0.0028	0.0018	0.0010
273	0.0027	0.0018	0.0010
274	0.0027	0.0017	0.0010
275	0.0027	0.0017	0.0010
276	0.0027	0.0017	0.0009
277	0.0026	0.0017	0.0009
278	0.0026	0.0017	0.0009
279	0.0026	0.0017	0.0009
280	0.0026	0.0017	0.0009
281	0.0025	0.0016	0.0009
282	0.0025	0.0016	0.0009
283	0.0025	0.0016	0.0009
284	0.0025	0.0016	0.0009
285	0.0025	0.0016	0.0009
286	0.0024	0.0016	0.0009
287	0.0024	0.0016	0.0009
288	0.0024	0.0016	0.0009

Total soil rain loss = 1.25(In)
Total effective rainfall = 1.28(In)
Peak flow rate in flood hydrograph = 117.53(CFS)

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24 - H O U R S T O R M
R u n o f f H y d r o g r a p h

Hydrograph in 5 Minute intervals ((CFS))

```
Time(h+m) Volume Ac.Ft   Q(CFS)  0       50.0     100.0     150.0     200.0
-----------------------------------------------------------------------
  0+ 5       0.0002      0.03  Q         |         |         |         |
  0+10       0.0016      0.20  Q         |         |         |         |
  0+15       0.0039      0.33  Q         |         |         |         |
  0+20       0.0065      0.38  Q         |         |         |         |
  0+25       0.0094      0.42  Q         |         |         |         |
  0+30       0.0124      0.44  Q         |         |         |         |
  0+35       0.0155      0.45  Q         |         |         |         |
  0+40       0.0187      0.46  Q         |         |         |         |
  0+45       0.0220      0.47  Q         |         |         |         |
  0+50       0.0253      0.48  Q         |         |         |         |
  0+55       0.0286      0.48  Q         |         |         |         |
  1+ 0       0.0320      0.49  Q         |         |         |         |
  1+ 5       0.0354      0.49  Q         |         |         |         |
  1+10       0.0388      0.50  Q         |         |         |         |
  1+15       0.0422      0.50  Q         |         |         |         |
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1+20	0.0457	0.50	Q	|	|	|	|
1+25	0.0491	0.50	Q	|	|	|	|
1+30	0.0526	0.50	Q	|	|	|	|
1+35	0.0561	0.51	Q	|	|	|	|
1+40	0.0596	0.51	Q	|	|	|	|
1+45	0.0631	0.51	Q	|	|	|	|
1+50	0.0667	0.51	Q	|	|	|	|
1+55	0.0702	0.51	Q	|	|	|	|
2+ 0	0.0738	0.52	Q	|	|	|	|
2+ 5	0.0773	0.52	Q	|	|	|	|
2+10	0.0809	0.52	Q	|	|	|	|
2+15	0.0845	0.52	Q	|	|	|	|
2+20	0.0882	0.53	Q	|	|	|	|
2+25	0.0918	0.53	Q	|	|	|	|
2+30	0.0955	0.53	Q	|	|	|	|
2+35	0.0991	0.53	Q	|	|	|	|
2+40	0.1028	0.54	Q	|	|	|	|
2+45	0.1065	0.54	Q	|	|	|	|
2+50	0.1102	0.54	Q	|	|	|	|
2+55	0.1140	0.54	Q	|	|	|	|
3+ 0	0.1177	0.55	Q	|	|	|	|
3+ 5	0.1215	0.55	Q	|	|	|	|
3+10	0.1253	0.55	QV	|	|	|	|
3+15	0.1291	0.55	QV	|	|	|	|
3+20	0.1329	0.56	QV	|	|	|	|
3+25	0.1368	0.56	QV	|	|	|	|
3+30	0.1406	0.56	QV	|	|	|	|
3+35	0.1445	0.56	QV	|	|	|	|
3+40	0.1484	0.57	QV	|	|	|	|
3+45	0.1523	0.57	QV	|	|	|	|
3+50	0.1563	0.57	QV	|	|	|	|
3+55	0.1602	0.57	QV	|	|	|	|
4+ 0	0.1642	0.58	QV	|	|	|	|
4+ 5	0.1682	0.58	QV	|	|	|	|
4+10	0.1722	0.58	QV	|	|	|	|
4+15	0.1762	0.59	QV	|	|	|	|
4+20	0.1803	0.59	QV	|	|	|	|
4+25	0.1844	0.59	QV	|	|	|	|
4+30	0.1885	0.60	QV	|	|	|	|
4+35	0.1926	0.60	QV	|	|	|	|
4+40	0.1967	0.60	QV	|	|	|	|
4+45	0.2009	0.60	QV	|	|	|	|
4+50	0.2051	0.61	QV	|	|	|	|
4+55	0.2093	0.61	QV	|	|	|	|
5+ 0	0.2135	0.61	QV	|	|	|	|
5+ 5	0.2178	0.62	QV	|	|	|	|
5+10	0.2221	0.62	QV	|	|	|	|
5+15	0.2263	0.62	QV	|	|	|	|
5+20	0.2307	0.63	QV	|	|	|	|
5+25	0.2350	0.63	QV	|	|	|	|
5+30	0.2394	0.63	QV	|	|	|	|
5+35	0.2438	0.64	QV	|	|	|	|
5+40	0.2482	0.64	Q V	|	|	|	|
5+45	0.2527	0.65	Q V	|	|	|	|
5+50	0.2571	0.65	Q V	|	|	|	|
5+55	0.2616	0.65	Q V	|	|	|	|
6+ 0	0.2662	0.66	Q V	|	|	|	|

6+ 5	0.2707	0.66	Q V				
6+10	0.2753	0.67	Q V				
6+15	0.2799	0.67	Q V				
6+20	0.2845	0.67	Q V				
6+25	0.2892	0.68	Q V				
6+30	0.2939	0.68	Q V				
6+35	0.2986	0.69	Q V				
6+40	0.3034	0.69	Q V				
6+45	0.3081	0.69	Q V				
6+50	0.3130	0.70	Q V				
6+55	0.3178	0.70	Q V				
7+ 0	0.3227	0.71	Q V				
7+ 5	0.3276	0.71	Q V				
7+10	0.3325	0.72	Q V				
7+15	0.3375	0.72	Q V				
7+20	0.3425	0.73	Q V				
7+25	0.3476	0.73	Q V				
7+30	0.3526	0.74	Q V				
7+35	0.3577	0.74	Q V				
7+40	0.3629	0.75	Q V				
7+45	0.3681	0.75	Q V				
7+50	0.3733	0.76	Q V				
7+55	0.3786	0.76	Q V				
8+ 0	0.3839	0.77	Q V				
8+ 5	0.3892	0.77	Q V				
8+10	0.3946	0.78	Q V				
8+15	0.4000	0.79	Q V				
8+20	0.4055	0.79	Q V				
8+25	0.4110	0.80	Q V				
8+30	0.4165	0.81	Q V				
8+35	0.4221	0.81	Q V				
8+40	0.4277	0.82	Q V				
8+45	0.4334	0.82	Q V				
8+50	0.4391	0.83	Q V				
8+55	0.4449	0.84	Q V				
9+ 0	0.4507	0.85	Q V				
9+ 5	0.4566	0.85	Q V				
9+10	0.4625	0.86	Q V				
9+15	0.4685	0.87	Q V				
9+20	0.4745	0.87	Q V				
9+25	0.4806	0.88	Q V				
9+30	0.4867	0.89	Q V				
9+35	0.4929	0.90	Q V				
9+40	0.4991	0.91	Q V				
9+45	0.5054	0.91	Q V				
9+50	0.5118	0.92	Q V				
9+55	0.5182	0.93	Q V				
10+ 0	0.5247	0.94	Q V				
10+ 5	0.5312	0.95	Q V				
10+10	0.5379	0.96	Q V				
10+15	0.5445	0.97	Q V				
10+20	0.5513	0.98	Q V				
10+25	0.5581	0.99	Q V				
10+30	0.5650	1.00	Q V				
10+35	0.5719	1.01	Q V				
10+40	0.5790	1.02	Q V				
10+45	0.5861	1.03	Q V				

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10+50       0.5933      1.04  Q   V     |          |          |          |
10+55       0.6006      1.06  Q   V     |          |          |          |
11+ 0       0.6079      1.07  Q   V     |          |          |          |
11+ 5       0.6154      1.08  Q    V    |          |          |          |
11+10       0.6229      1.09  Q    V    |          |          |          |
11+15       0.6305      1.11  Q    V    |          |          |          |
11+20       0.6382      1.12  Q    V    |          |          |          |
11+25       0.6461      1.13  Q    V    |          |          |          |
11+30       0.6540      1.15  Q    V    |          |          |          |
11+35       0.6620      1.16  Q    V    |          |          |          |
11+40       0.6701      1.18  Q    V    |          |          |          |
11+45       0.6783      1.19  Q    V    |          |          |          |
11+50       0.6867      1.21  Q    V    |          |          |          |
11+55       0.6951      1.23  Q    V    |          |          |          |
12+ 0       0.7037      1.25  Q    V    |          |          |          |
12+ 5       0.7124      1.26  Q    V    |          |          |          |
12+10       0.7212      1.27  Q    V    |          |          |          |
12+15       0.7300      1.28  Q    V    |          |          |          |
12+20       0.7389      1.30  Q     V   |          |          |          |
12+25       0.7480      1.32  Q     V   |          |          |          |
12+30       0.7572      1.34  Q     V   |          |          |          |
12+35       0.7665      1.36  Q     V   |          |          |          |
12+40       0.7761      1.38  Q     V   |          |          |          |
12+45       0.7857      1.40  Q     V   |          |          |          |
12+50       0.7956      1.43  Q     V   |          |          |          |
12+55       0.8056      1.45  Q     V   |          |          |          |
13+ 0       0.8158      1.48  Q     V   |          |          |          |
13+ 5       0.8262      1.51  Q     V   |          |          |          |
13+10       0.8368      1.54  Q     V   |          |          |          |
13+15       0.8476      1.57  Q     V   |          |          |          |
13+20       0.8587      1.60  Q     V   |          |          |          |
13+25       0.8700      1.64  Q      V  |          |          |          |
13+30       0.8815      1.68  Q      V  |          |          |          |
13+35       0.8933      1.71  Q      V  |          |          |          |
13+40       0.9054      1.75  Q      V  |          |          |          |
13+45       0.9177      1.80  Q      V  |          |          |          |
13+50       0.9304      1.84  Q      V  |          |          |          |
13+55       0.9434      1.89  Q      V  |          |          |          |
14+ 0       0.9568      1.94  Q      V  |          |          |          |
14+ 5       0.9705      1.99  Q      V  |          |          |          |
14+10       0.9847      2.06  Q       V |          |          |          |
14+15       0.9993      2.12  Q       V |          |          |          |
14+20       1.0144      2.19  Q       V |          |          |          |
14+25       1.0300      2.26  Q       V |          |          |          |
14+30       1.0462      2.35  Q       V |          |          |          |
14+35       1.0629      2.43  Q       V |          |          |          |
14+40       1.0804      2.53  Q       V |          |          |          |
14+45       1.0984      2.63  Q       V |          |          |          |
14+50       1.1173      2.74  Q        V|          |          |          |
14+55       1.1371      2.86  Q        V|          |          |          |
15+ 0       1.1578      3.01  Q        V|          |          |          |
15+ 5       1.1796      3.16  Q        V|          |          |          |
15+10       1.2026      3.35  Q        V|          |          |          |
15+15       1.2270      3.54  Q        V|          |          |          |
15+20       1.2532      3.79  Q         V          |          |          |
15+25       1.2814      4.10  Q         V          |          |          |
15+30       1.3135      4.67  Q         V          |          |          |
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15+35       1.3495      5.23  |Q        V         |         |         |
15+40       1.3900      5.88  |Q        |V        |         |         |
15+45       1.4355      6.61  |Q        |V        |         |         |
15+50       1.4895      7.83  |Q        | V       |         |         |
15+55       1.5627     10.63  | Q       | V       |         |         |
16+ 0       1.6917     18.74  |  Q      |  V      |         |         |
16+ 5       1.9927     43.70  |       Q |     V   |         |         |
16+10       2.8021    117.53  |         |         | VQ      |         |
16+15       3.3920     85.66  |         |      Q  |      V  |         |
16+20       3.6907     43.37  |       Q |         |         V         |
16+25       3.8825     27.86  |    Q    |         |         |V        |
16+30       4.0159     19.37  |  Q      |         |         | V       |
16+35       4.1148     14.36  | Q       |         |         |  V      |
16+40       4.1904     10.97  | Q       |         |         |   V     |
16+45       4.2488      8.48  |Q        |         |         |   V     |
16+50       4.2925      6.35  |Q        |         |         |   V     |
16+55       4.3301      5.46  |Q        |         |         |    V    |
17+ 0       4.3641      4.92  Q         |         |         |    V    |
17+ 5       4.3918      4.02  Q         |         |         |    V    |
17+10       4.4089      2.49  Q         |         |         |    V    |
17+15       4.4245      2.26  Q         |         |         |    V    |
17+20       4.4389      2.10  Q         |         |         |     V   |
17+25       4.4525      1.97  Q         |         |         |     V   |
17+30       4.4653      1.86  Q         |         |         |     V   |
17+35       4.4775      1.77  Q         |         |         |     V   |
17+40       4.4891      1.69  Q         |         |         |     V   |
17+45       4.5002      1.61  Q         |         |         |     V   |
17+50       4.5109      1.55  Q         |         |         |     V   |
17+55       4.5211      1.49  Q         |         |         |     V   |
18+ 0       4.5310      1.43  Q         |         |         |     V   |
18+ 5       4.5405      1.38  Q         |         |         |     V   |
18+10       4.5498      1.35  Q         |         |         |     V   |
18+15       4.5589      1.31  Q         |         |         |      V  |
18+20       4.5677      1.28  Q         |         |         |      V  |
18+25       4.5762      1.24  Q         |         |         |      V  |
18+30       4.5845      1.21  Q         |         |         |      V  |
18+35       4.5927      1.18  Q         |         |         |      V  |
18+40       4.6006      1.15  Q         |         |         |      V  |
18+45       4.6083      1.12  Q         |         |         |      V  |
18+50       4.6158      1.09  Q         |         |         |      V  |
18+55       4.6232      1.07  Q         |         |         |      V  |
19+ 0       4.6303      1.04  Q         |         |         |      V  |
19+ 5       4.6374      1.02  Q         |         |         |      V  |
19+10       4.6443      1.00  Q         |         |         |      V  |
19+15       4.6510      0.98  Q         |         |         |      V  |
19+20       4.6576      0.96  Q         |         |         |      V  |
19+25       4.6641      0.94  Q         |         |         |      V  |
19+30       4.6704      0.92  Q         |         |         |      V  |
19+35       4.6767      0.91  Q         |         |         |       V |
19+40       4.6828      0.89  Q         |         |         |       V |
19+45       4.6888      0.87  Q         |         |         |       V |
19+50       4.6947      0.86  Q         |         |         |       V |
19+55       4.7006      0.84  Q         |         |         |       V |
20+ 0       4.7063      0.83  Q         |         |         |       V |
20+ 5       4.7119      0.82  Q         |         |         |       V |
20+10       4.7175      0.80  Q         |         |         |       V |
20+15       4.7229      0.79  Q         |         |         |       V |
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20+20       4.7283      0.78  Q          |          |          |        V |
20+25       4.7336      0.77  Q          |          |          |        V |
20+30       4.7388      0.76  Q          |          |          |        V |
20+35       4.7439      0.75  Q          |          |          |        V |
20+40       4.7490      0.74  Q          |          |          |        V |
20+45       4.7540      0.73  Q          |          |          |        V |
20+50       4.7590      0.72  Q          |          |          |        V |
20+55       4.7638      0.71  Q          |          |          |        V |
21+ 0       4.7686      0.70  Q          |          |          |        V |
21+ 5       4.7734      0.69  Q          |          |          |        V |
21+10       4.7781      0.68  Q          |          |          |        V |
21+15       4.7827      0.67  Q          |          |          |        V |
21+20       4.7873      0.66  Q          |          |          |        V |
21+25       4.7918      0.66  Q          |          |          |        V |
21+30       4.7963      0.65  Q          |          |          |        V |
21+35       4.8007      0.64  Q          |          |          |         V|
21+40       4.8051      0.63  Q          |          |          |         V|
21+45       4.8094      0.63  Q          |          |          |         V|
21+50       4.8136      0.62  Q          |          |          |         V|
21+55       4.8179      0.61  Q          |          |          |         V|
22+ 0       4.8221      0.61  Q          |          |          |         V|
22+ 5       4.8262      0.60  Q          |          |          |         V|
22+10       4.8303      0.59  Q          |          |          |         V|
22+15       4.8343      0.59  Q          |          |          |         V|
22+20       4.8384      0.58  Q          |          |          |         V|
22+25       4.8423      0.58  Q          |          |          |         V|
22+30       4.8463      0.57  Q          |          |          |         V|
22+35       4.8502      0.57  Q          |          |          |         V|
22+40       4.8540      0.56  Q          |          |          |         V|
22+45       4.8578      0.56  Q          |          |          |         V|
22+50       4.8616      0.55  Q          |          |          |         V|
22+55       4.8654      0.54  Q          |          |          |         V|
23+ 0       4.8691      0.54  Q          |          |          |         V|
23+ 5       4.8728      0.54  Q          |          |          |         V|
23+10       4.8764      0.53  Q          |          |          |         V|
23+15       4.8801      0.53  Q          |          |          |         V|
23+20       4.8836      0.52  Q          |          |          |         V|
23+25       4.8872      0.52  Q          |          |          |         V|
23+30       4.8907      0.51  Q          |          |          |         V|
23+35       4.8942      0.51  Q          |          |          |         V|
23+40       4.8977      0.50  Q          |          |          |         V|
23+45       4.9011      0.50  Q          |          |          |         V|
23+50       4.9046      0.50  Q          |          |          |         V|
23+55       4.9079      0.49  Q          |          |          |         V|
24+ 0       4.9113      0.49  Q          |          |          |         V|
24+ 5       4.9145      0.46  Q          |          |          |         V|
24+10       4.9164      0.28  Q          |          |          |         V|
24+15       4.9174      0.15  Q          |          |          |         V|
24+20       4.9181      0.10  Q          |          |          |         V|
24+25       4.9185      0.06  Q          |          |          |         V|
24+30       4.9188      0.04  Q          |          |          |         V|
24+35       4.9190      0.03  Q          |          |          |         V|
24+40       4.9192      0.02  Q          |          |          |         V|
24+45       4.9193      0.01  Q          |          |          |         V|
24+50       4.9193      0.01  Q          |          |          |         V|
24+55       4.9194      0.01  Q          |          |          |         V|
25+ 0       4.9194      0.00  Q          |          |          |         V|
```

U n i t H y d r o g r a p h A n a l y s i s

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Study date 04/09/15

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San Bernardino County Synthetic Unit Hydrology Method
Manual date - August 1986

Program License Serial Number 6320

154166 - AMBOY - SAN BERNARDINO COUNTY
RECLAMATION CONDITION "C"
20-YEAR, 24-HOUR STORM
BY: JTS DATE: 04-09-15

Storm Event Year = 20

Antecedent Moisture Condition = 1

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

English Units used in output format

Area averaged rainfall intensity isohyetal data:

Sub-Area (Ac.)	Duration (hours)	Isohyetal (In)
Rainfall data for year 10		
51.21	1	0.86
Rainfall data for year 2		
51.21	6	0.75
Rainfall data for year 2		
51.21	24	1.07
Rainfall data for year 100		
51.21	1	1.59
Rainfall data for year 100		
51.21	6	2.43
Rainfall data for year 100		
51.21	24	3.56

```
-----------------------------------------------------------------
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

******** Area-averaged max loss rate, Fm ********


SCS curve  SCS curve     Area     Area     Fp(Fig C6)    Ap      Fm
No.(AMCII) NO.(AMC 1)    (Ac.)    Fraction     (In/Hr)  (dec.)   (In/Hr)
 91.0      79.8         51.21      1.000     0.373    1.000    0.373

Area-averaged adjusted loss rate Fm (In/Hr) =  0.373

********* Area-Averaged low loss rate fraction, Yb **********

Area       Area          SCS CN    SCS CN      S     Pervious
 (Ac.)      Fract         (AMC2)    (AMC1)           Yield Fr
    51.21   1.000         91.0      79.8       2.53     0.356

Area-averaged catchment yield fraction, Y =  0.356
Area-averaged low loss fraction, Yb =  0.644
User entry of time of concentration  =   0.220 (hours)
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Watershed area =      51.21(Ac.)
Catchment Lag time =   0.176 hours
Unit interval =   5.000 minutes
Unit interval percentage of lag time = 47.3485
Hydrograph baseflow =     0.00(CFS)
Average maximum watershed loss rate(Fm) =  0.373(In/Hr)
Average low loss rate fraction (Yb) = 0.644 (decimal)
DESERT S-Graph Selected
Computed peak 5-minute rainfall =  0.512(In)
Computed peak 30-minute rainfall =  0.877(In)
Specified peak 1-hour rainfall =  1.080(In)
Computed peak 3-hour rainfall =  1.446(In)
Specified peak 6-hour rainfall =  1.739(In)
Specified peak 24-hour rainfall =  2.536(In)


Rainfall depth area reduction factors:
Using a total area of      51.21(Ac.) (Ref: fig. E-4)

5-minute factor = 0.998     Adjusted rainfall =  0.511(In)
30-minute factor = 0.998    Adjusted rainfall =  0.875(In)
1-hour factor = 0.998       Adjusted rainfall =  1.077(In)
3-hour factor = 1.000       Adjusted rainfall =  1.446(In)
6-hour factor = 1.000       Adjusted rainfall =  1.739(In)
24-hour factor = 1.000      Adjusted rainfall =  2.535(In)
-------------------------------------------------------------------

                  U n i t  H y d r o g r a p h
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Interval          'S' Graph          Unit Hydrograph
Number            Mean values             ((CFS))
-------------------------------------------------------------------
            (K =       619.32 (CFS))

  1                3.621                   22.428
```

2	27.374	147.107
3	58.032	189.872
4	71.898	85.875
5	79.947	49.849
6	85.264	32.926
7	89.111	23.825
8	91.816	16.753
9	93.936	13.132
10	95.547	9.976
11	96.789	7.695
12	97.673	5.473
13	98.224	3.409
14	98.770	3.386
15	99.332	3.480
16	99.712	2.351
17	100.000	1.784

Peak Unit Number	Adjusted mass rainfall (In)	Unit rainfall (In)
1	0.5111	0.5111
2	0.6293	0.1181
3	0.7107	0.0814
4	0.7747	0.0641
5	0.8284	0.0536
6	0.8749	0.0466
7	0.9163	0.0414
8	0.9538	0.0375
9	0.9881	0.0343
10	1.0198	0.0317
11	1.0494	0.0296
12	1.0772	0.0278
13	1.1005	0.0233
14	1.1226	0.0221
15	1.1435	0.0209
16	1.1634	0.0199
17	1.1825	0.0190
18	1.2007	0.0182
19	1.2182	0.0175
20	1.2351	0.0169
21	1.2513	0.0162
22	1.2670	0.0157
23	1.2822	0.0152
24	1.2969	0.0147
25	1.3112	0.0143
26	1.3250	0.0138
27	1.3385	0.0135
28	1.3516	0.0131
29	1.3643	0.0128
30	1.3768	0.0124
31	1.3889	0.0121
32	1.4008	0.0119
33	1.4124	0.0116
34	1.4237	0.0113
35	1.4348	0.0111
36	1.4457	0.0109
37	1.4563	0.0106
38	1.4666	0.0104

39	1.4768	0.0102
40	1.4868	0.0100
41	1.4966	0.0098
42	1.5062	0.0096
43	1.5157	0.0095
44	1.5250	0.0093
45	1.5341	0.0091
46	1.5431	0.0090
47	1.5520	0.0089
48	1.5607	0.0087
49	1.5693	0.0086
50	1.5778	0.0085
51	1.5861	0.0083
52	1.5943	0.0082
53	1.6024	0.0081
54	1.6104	0.0080
55	1.6183	0.0079
56	1.6261	0.0078
57	1.6338	0.0077
58	1.6413	0.0076
59	1.6488	0.0075
60	1.6562	0.0074
61	1.6635	0.0073
62	1.6707	0.0072
63	1.6779	0.0071
64	1.6849	0.0070
65	1.6919	0.0070
66	1.6988	0.0069
67	1.7056	0.0068
68	1.7123	0.0067
69	1.7190	0.0067
70	1.7256	0.0066
71	1.7321	0.0065
72	1.7386	0.0065
73	1.7451	0.0065
74	1.7516	0.0065
75	1.7580	0.0064
76	1.7643	0.0063
77	1.7706	0.0063
78	1.7768	0.0062
79	1.7830	0.0062
80	1.7891	0.0061
81	1.7952	0.0061
82	1.8012	0.0060
83	1.8071	0.0060
84	1.8130	0.0059
85	1.8189	0.0058
86	1.8247	0.0058
87	1.8304	0.0058
88	1.8362	0.0057
89	1.8418	0.0057
90	1.8474	0.0056
91	1.8530	0.0056
92	1.8585	0.0055
93	1.8640	0.0055
94	1.8694	0.0054
95	1.8748	0.0054

96	1.8802	0.0054
97	1.8855	0.0053
98	1.8907	0.0053
99	1.8960	0.0052
100	1.9012	0.0052
101	1.9063	0.0052
102	1.9114	0.0051
103	1.9165	0.0051
104	1.9216	0.0050
105	1.9266	0.0050
106	1.9316	0.0050
107	1.9365	0.0049
108	1.9414	0.0049
109	1.9463	0.0049
110	1.9511	0.0048
111	1.9559	0.0048
112	1.9607	0.0048
113	1.9655	0.0047
114	1.9702	0.0047
115	1.9749	0.0047
116	1.9795	0.0047
117	1.9842	0.0046
118	1.9888	0.0046
119	1.9933	0.0046
120	1.9979	0.0045
121	2.0024	0.0045
122	2.0069	0.0045
123	2.0114	0.0045
124	2.0158	0.0044
125	2.0202	0.0044
126	2.0246	0.0044
127	2.0289	0.0044
128	2.0333	0.0043
129	2.0376	0.0043
130	2.0419	0.0043
131	2.0461	0.0043
132	2.0504	0.0042
133	2.0546	0.0042
134	2.0588	0.0042
135	2.0630	0.0042
136	2.0671	0.0041
137	2.0712	0.0041
138	2.0753	0.0041
139	2.0794	0.0041
140	2.0835	0.0041
141	2.0875	0.0040
142	2.0915	0.0040
143	2.0955	0.0040
144	2.0995	0.0040
145	2.1035	0.0040
146	2.1074	0.0039
147	2.1113	0.0039
148	2.1152	0.0039
149	2.1191	0.0039
150	2.1230	0.0039
151	2.1268	0.0038
152	2.1306	0.0038

153	2.1345	0.0038
154	2.1382	0.0038
155	2.1420	0.0038
156	2.1458	0.0038
157	2.1495	0.0037
158	2.1532	0.0037
159	2.1569	0.0037
160	2.1606	0.0037
161	2.1643	0.0037
162	2.1679	0.0037
163	2.1716	0.0036
164	2.1752	0.0036
165	2.1788	0.0036
166	2.1824	0.0036
167	2.1859	0.0036
168	2.1895	0.0036
169	2.1930	0.0035
170	2.1965	0.0035
171	2.2001	0.0035
172	2.2035	0.0035
173	2.2070	0.0035
174	2.2105	0.0035
175	2.2139	0.0035
176	2.2174	0.0034
177	2.2208	0.0034
178	2.2242	0.0034
179	2.2276	0.0034
180	2.2310	0.0034
181	2.2344	0.0034
182	2.2377	0.0034
183	2.2410	0.0033
184	2.2444	0.0033
185	2.2477	0.0033
186	2.2510	0.0033
187	2.2543	0.0033
188	2.2575	0.0033
189	2.2608	0.0033
190	2.2641	0.0032
191	2.2673	0.0032
192	2.2705	0.0032
193	2.2737	0.0032
194	2.2769	0.0032
195	2.2801	0.0032
196	2.2833	0.0032
197	2.2865	0.0032
198	2.2896	0.0032
199	2.2928	0.0031
200	2.2959	0.0031
201	2.2990	0.0031
202	2.3021	0.0031
203	2.3052	0.0031
204	2.3083	0.0031
205	2.3114	0.0031
206	2.3144	0.0031
207	2.3175	0.0031
208	2.3205	0.0030
209	2.3236	0.0030

210	2.3266	0.0030
211	2.3296	0.0030
212	2.3326	0.0030
213	2.3356	0.0030
214	2.3386	0.0030
215	2.3415	0.0030
216	2.3445	0.0030
217	2.3474	0.0029
218	2.3504	0.0029
219	2.3533	0.0029
220	2.3562	0.0029
221	2.3591	0.0029
222	2.3620	0.0029
223	2.3649	0.0029
224	2.3678	0.0029
225	2.3707	0.0029
226	2.3735	0.0029
227	2.3764	0.0029
228	2.3792	0.0028
229	2.3821	0.0028
230	2.3849	0.0028
231	2.3877	0.0028
232	2.3905	0.0028
233	2.3933	0.0028
234	2.3961	0.0028
235	2.3989	0.0028
236	2.4017	0.0028
237	2.4044	0.0028
238	2.4072	0.0028
239	2.4099	0.0027
240	2.4127	0.0027
241	2.4154	0.0027
242	2.4181	0.0027
243	2.4209	0.0027
244	2.4236	0.0027
245	2.4263	0.0027
246	2.4290	0.0027
247	2.4316	0.0027
248	2.4343	0.0027
249	2.4370	0.0027
250	2.4396	0.0027
251	2.4423	0.0027
252	2.4449	0.0026
253	2.4476	0.0026
254	2.4502	0.0026
255	2.4528	0.0026
256	2.4554	0.0026
257	2.4580	0.0026
258	2.4606	0.0026
259	2.4632	0.0026
260	2.4658	0.0026
261	2.4684	0.0026
262	2.4710	0.0026
263	2.4735	0.0026
264	2.4761	0.0026
265	2.4786	0.0025
266	2.4812	0.0025

267	2.4837	0.0025
268	2.4862	0.0025
269	2.4888	0.0025
270	2.4913	0.0025
271	2.4938	0.0025
272	2.4963	0.0025
273	2.4988	0.0025
274	2.5013	0.0025
275	2.5038	0.0025
276	2.5062	0.0025
277	2.5087	0.0025
278	2.5112	0.0025
279	2.5136	0.0025
280	2.5161	0.0024
281	2.5185	0.0024
282	2.5209	0.0024
283	2.5234	0.0024
284	2.5258	0.0024
285	2.5282	0.0024
286	2.5306	0.0024
287	2.5330	0.0024
288	2.5354	0.0024

Unit Period (number)	Unit Rainfall (In)	Unit Soil-Loss (In)	Effective Rainfall (In)
1	0.0024	0.0015	0.0009
2	0.0024	0.0015	0.0009
3	0.0024	0.0016	0.0009
4	0.0024	0.0016	0.0009
5	0.0024	0.0016	0.0009
6	0.0024	0.0016	0.0009
7	0.0025	0.0016	0.0009
8	0.0025	0.0016	0.0009
9	0.0025	0.0016	0.0009
10	0.0025	0.0016	0.0009
11	0.0025	0.0016	0.0009
12	0.0025	0.0016	0.0009
13	0.0025	0.0016	0.0009
14	0.0025	0.0016	0.0009
15	0.0025	0.0016	0.0009
16	0.0025	0.0016	0.0009
17	0.0026	0.0016	0.0009
18	0.0026	0.0017	0.0009
19	0.0026	0.0017	0.0009
20	0.0026	0.0017	0.0009
21	0.0026	0.0017	0.0009
22	0.0026	0.0017	0.0009
23	0.0026	0.0017	0.0009
24	0.0026	0.0017	0.0009
25	0.0026	0.0017	0.0009
26	0.0027	0.0017	0.0009
27	0.0027	0.0017	0.0010
28	0.0027	0.0017	0.0010
29	0.0027	0.0017	0.0010
30	0.0027	0.0017	0.0010

31	0.0027	0.0017	0.0010
32	0.0027	0.0018	0.0010
33	0.0027	0.0018	0.0010
34	0.0027	0.0018	0.0010
35	0.0028	0.0018	0.0010
36	0.0028	0.0018	0.0010
37	0.0028	0.0018	0.0010
38	0.0028	0.0018	0.0010
39	0.0028	0.0018	0.0010
40	0.0028	0.0018	0.0010
41	0.0028	0.0018	0.0010
42	0.0029	0.0018	0.0010
43	0.0029	0.0018	0.0010
44	0.0029	0.0019	0.0010
45	0.0029	0.0019	0.0010
46	0.0029	0.0019	0.0010
47	0.0029	0.0019	0.0010
48	0.0029	0.0019	0.0010
49	0.0030	0.0019	0.0011
50	0.0030	0.0019	0.0011
51	0.0030	0.0019	0.0011
52	0.0030	0.0019	0.0011
53	0.0030	0.0019	0.0011
54	0.0030	0.0020	0.0011
55	0.0031	0.0020	0.0011
56	0.0031	0.0020	0.0011
57	0.0031	0.0020	0.0011
58	0.0031	0.0020	0.0011
59	0.0031	0.0020	0.0011
60	0.0031	0.0020	0.0011
61	0.0032	0.0020	0.0011
62	0.0032	0.0020	0.0011
63	0.0032	0.0021	0.0011
64	0.0032	0.0021	0.0011
65	0.0032	0.0021	0.0011
66	0.0032	0.0021	0.0012
67	0.0033	0.0021	0.0012
68	0.0033	0.0021	0.0012
69	0.0033	0.0021	0.0012
70	0.0033	0.0021	0.0012
71	0.0033	0.0022	0.0012
72	0.0034	0.0022	0.0012
73	0.0034	0.0022	0.0012
74	0.0034	0.0022	0.0012
75	0.0034	0.0022	0.0012
76	0.0034	0.0022	0.0012
77	0.0035	0.0022	0.0012
78	0.0035	0.0022	0.0012
79	0.0035	0.0023	0.0012
80	0.0035	0.0023	0.0013
81	0.0036	0.0023	0.0013
82	0.0036	0.0023	0.0013
83	0.0036	0.0023	0.0013
84	0.0036	0.0023	0.0013
85	0.0037	0.0024	0.0013
86	0.0037	0.0024	0.0013
87	0.0037	0.0024	0.0013

88	0.0037	0.0024	0.0013
89	0.0038	0.0024	0.0013
90	0.0038	0.0024	0.0013
91	0.0038	0.0025	0.0014
92	0.0038	0.0025	0.0014
93	0.0039	0.0025	0.0014
94	0.0039	0.0025	0.0014
95	0.0039	0.0025	0.0014
96	0.0039	0.0025	0.0014
97	0.0040	0.0026	0.0014
98	0.0040	0.0026	0.0014
99	0.0040	0.0026	0.0014
100	0.0041	0.0026	0.0014
101	0.0041	0.0026	0.0015
102	0.0041	0.0027	0.0015
103	0.0042	0.0027	0.0015
104	0.0042	0.0027	0.0015
105	0.0042	0.0027	0.0015
106	0.0043	0.0027	0.0015
107	0.0043	0.0028	0.0015
108	0.0043	0.0028	0.0015
109	0.0044	0.0028	0.0016
110	0.0044	0.0028	0.0016
111	0.0045	0.0029	0.0016
112	0.0045	0.0029	0.0016
113	0.0045	0.0029	0.0016
114	0.0046	0.0029	0.0016
115	0.0046	0.0030	0.0016
116	0.0047	0.0030	0.0017
117	0.0047	0.0030	0.0017
118	0.0047	0.0031	0.0017
119	0.0048	0.0031	0.0017
120	0.0048	0.0031	0.0017
121	0.0049	0.0032	0.0017
122	0.0049	0.0032	0.0018
123	0.0050	0.0032	0.0018
124	0.0050	0.0032	0.0018
125	0.0051	0.0033	0.0018
126	0.0052	0.0033	0.0018
127	0.0052	0.0034	0.0019
128	0.0053	0.0034	0.0019
129	0.0054	0.0034	0.0019
130	0.0054	0.0035	0.0019
131	0.0055	0.0035	0.0020
132	0.0055	0.0036	0.0020
133	0.0056	0.0036	0.0020
134	0.0057	0.0036	0.0020
135	0.0058	0.0037	0.0020
136	0.0058	0.0037	0.0021
137	0.0059	0.0038	0.0021
138	0.0060	0.0038	0.0021
139	0.0061	0.0039	0.0022
140	0.0061	0.0039	0.0022
141	0.0062	0.0040	0.0022
142	0.0063	0.0040	0.0022
143	0.0064	0.0041	0.0023
144	0.0065	0.0042	0.0023

145	0.0065	0.0042	0.0023
146	0.0065	0.0042	0.0023
147	0.0067	0.0043	0.0024
148	0.0067	0.0043	0.0024
149	0.0069	0.0044	0.0025
150	0.0070	0.0045	0.0025
151	0.0071	0.0046	0.0025
152	0.0072	0.0046	0.0026
153	0.0074	0.0048	0.0026
154	0.0075	0.0048	0.0027
155	0.0077	0.0049	0.0027
156	0.0078	0.0050	0.0028
157	0.0080	0.0051	0.0028
158	0.0081	0.0052	0.0029
159	0.0083	0.0054	0.0030
160	0.0085	0.0054	0.0030
161	0.0087	0.0056	0.0031
162	0.0089	0.0057	0.0032
163	0.0091	0.0059	0.0033
164	0.0093	0.0060	0.0033
165	0.0096	0.0062	0.0034
166	0.0098	0.0063	0.0035
167	0.0102	0.0066	0.0036
168	0.0104	0.0067	0.0037
169	0.0109	0.0070	0.0039
170	0.0111	0.0071	0.0040
171	0.0116	0.0075	0.0041
172	0.0119	0.0076	0.0042
173	0.0124	0.0080	0.0044
174	0.0128	0.0082	0.0045
175	0.0135	0.0087	0.0048
176	0.0138	0.0089	0.0049
177	0.0147	0.0095	0.0052
178	0.0152	0.0098	0.0054
179	0.0162	0.0105	0.0058
180	0.0169	0.0109	0.0060
181	0.0182	0.0117	0.0065
182	0.0190	0.0123	0.0068
183	0.0209	0.0135	0.0075
184	0.0221	0.0142	0.0079
185	0.0278	0.0179	0.0099
186	0.0296	0.0190	0.0105
187	0.0343	0.0221	0.0122
188	0.0375	0.0241	0.0133
189	0.0466	0.0300	0.0166
190	0.0536	0.0311	0.0225
191	0.0814	0.0311	0.0503
192	0.1181	0.0311	0.0870
193	0.5111	0.0311	0.4800
194	0.0641	0.0311	0.0330
195	0.0414	0.0267	0.0147
196	0.0317	0.0204	0.0113
197	0.0233	0.0150	0.0083
198	0.0199	0.0128	0.0071
199	0.0175	0.0113	0.0062
200	0.0157	0.0101	0.0056
201	0.0143	0.0092	0.0051

202	0.0131	0.0084	0.0047
203	0.0121	0.0078	0.0043
204	0.0113	0.0073	0.0040
205	0.0106	0.0068	0.0038
206	0.0100	0.0064	0.0036
207	0.0095	0.0061	0.0034
208	0.0090	0.0058	0.0032
209	0.0086	0.0055	0.0031
210	0.0082	0.0053	0.0029
211	0.0079	0.0051	0.0028
212	0.0076	0.0049	0.0027
213	0.0073	0.0047	0.0026
214	0.0070	0.0045	0.0025
215	0.0068	0.0044	0.0024
216	0.0066	0.0042	0.0023
217	0.0065	0.0042	0.0023
218	0.0063	0.0041	0.0023
219	0.0062	0.0040	0.0022
220	0.0060	0.0039	0.0021
221	0.0058	0.0038	0.0021
222	0.0057	0.0037	0.0020
223	0.0056	0.0036	0.0020
224	0.0054	0.0035	0.0019
225	0.0053	0.0034	0.0019
226	0.0052	0.0033	0.0018
227	0.0051	0.0033	0.0018
228	0.0050	0.0032	0.0018
229	0.0049	0.0031	0.0017
230	0.0048	0.0031	0.0017
231	0.0047	0.0030	0.0017
232	0.0046	0.0030	0.0016
233	0.0045	0.0029	0.0016
234	0.0044	0.0029	0.0016
235	0.0044	0.0028	0.0016
236	0.0043	0.0028	0.0015
237	0.0042	0.0027	0.0015
238	0.0041	0.0027	0.0015
239	0.0041	0.0026	0.0015
240	0.0040	0.0026	0.0014
241	0.0040	0.0025	0.0014
242	0.0039	0.0025	0.0014
243	0.0038	0.0025	0.0014
244	0.0038	0.0024	0.0013
245	0.0037	0.0024	0.0013
246	0.0037	0.0024	0.0013
247	0.0036	0.0023	0.0013
248	0.0036	0.0023	0.0013
249	0.0035	0.0023	0.0013
250	0.0035	0.0022	0.0012
251	0.0035	0.0022	0.0012
252	0.0034	0.0022	0.0012
253	0.0034	0.0022	0.0012
254	0.0033	0.0021	0.0012
255	0.0033	0.0021	0.0012
256	0.0032	0.0021	0.0012
257	0.0032	0.0021	0.0011
258	0.0032	0.0020	0.0011

259	0.0031	0.0020	0.0011
260	0.0031	0.0020	0.0011
261	0.0031	0.0020	0.0011
262	0.0030	0.0020	0.0011
263	0.0030	0.0019	0.0011
264	0.0030	0.0019	0.0011
265	0.0029	0.0019	0.0011
266	0.0029	0.0019	0.0010
267	0.0029	0.0019	0.0010
268	0.0029	0.0018	0.0010
269	0.0028	0.0018	0.0010
270	0.0028	0.0018	0.0010
271	0.0028	0.0018	0.0010
272	0.0028	0.0018	0.0010
273	0.0027	0.0018	0.0010
274	0.0027	0.0017	0.0010
275	0.0027	0.0017	0.0010
276	0.0027	0.0017	0.0009
277	0.0026	0.0017	0.0009
278	0.0026	0.0017	0.0009
279	0.0026	0.0017	0.0009
280	0.0026	0.0017	0.0009
281	0.0025	0.0016	0.0009
282	0.0025	0.0016	0.0009
283	0.0025	0.0016	0.0009
284	0.0025	0.0016	0.0009
285	0.0025	0.0016	0.0009
286	0.0024	0.0016	0.0009
287	0.0024	0.0016	0.0009
288	0.0024	0.0016	0.0009

Total soil rain loss = 1.25(In)
Total effective rainfall = 1.28(In)
Peak flow rate in flood hydrograph = 108.14(CFS)

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24 - H O U R S T O R M
R u n o f f H y d r o g r a p h

Hydrograph in 5 Minute intervals ((CFS))

```
Time(h+m) Volume Ac.Ft   Q(CFS)  0       50.0     100.0     150.0     200.0
-----------------------------------------------------------------------
  0+ 5       0.0001      0.02  Q         |         |         |         |
  0+10       0.0011      0.14  Q         |         |         |         |
  0+15       0.0032      0.31  Q         |         |         |         |
  0+20       0.0059      0.38  Q         |         |         |         |
  0+25       0.0088      0.43  Q         |         |         |         |
  0+30       0.0120      0.46  Q         |         |         |         |
  0+35       0.0152      0.48  Q         |         |         |         |
  0+40       0.0186      0.49  Q         |         |         |         |
  0+45       0.0221      0.51  Q         |         |         |         |
  0+50       0.0257      0.52  Q         |         |         |         |
  0+55       0.0293      0.53  Q         |         |         |         |
  1+ 0       0.0330      0.53  Q         |         |         |         |
```

1+ 5	0.0367	0.54	Q	|	|	|	|
1+10	0.0404	0.54	Q	|	|	|	|
1+15	0.0442	0.55	Q	|	|	|	|
1+20	0.0480	0.55	Q	|	|	|	|
1+25	0.0519	0.56	Q	|	|	|	|
1+30	0.0557	0.56	Q	|	|	|	|
1+35	0.0596	0.56	Q	|	|	|	|
1+40	0.0634	0.56	Q	|	|	|	|
1+45	0.0673	0.57	Q	|	|	|	|
1+50	0.0713	0.57	Q	|	|	|	|
1+55	0.0752	0.57	Q	|	|	|	|
2+ 0	0.0791	0.57	Q	|	|	|	|
2+ 5	0.0831	0.58	Q	|	|	|	|
2+10	0.0871	0.58	Q	|	|	|	|
2+15	0.0911	0.58	Q	|	|	|	|
2+20	0.0951	0.58	Q	|	|	|	|
2+25	0.0991	0.59	Q	|	|	|	|
2+30	0.1031	0.59	Q	|	|	|	|
2+35	0.1072	0.59	Q	|	|	|	|
2+40	0.1113	0.59	Q	|	|	|	|
2+45	0.1154	0.60	Q	|	|	|	|
2+50	0.1195	0.60	Q	|	|	|	|
2+55	0.1237	0.60	Q	|	|	|	|
3+ 0	0.1278	0.60	Q	|	|	|	|
3+ 5	0.1320	0.61	Q	|	|	|	|
3+10	0.1362	0.61	Q	|	|	|	|
3+15	0.1404	0.61	QV	|	|	|	|
3+20	0.1446	0.61	QV	|	|	|	|
3+25	0.1489	0.62	QV	|	|	|	|
3+30	0.1532	0.62	QV	|	|	|	|
3+35	0.1575	0.62	QV	|	|	|	|
3+40	0.1618	0.63	QV	|	|	|	|
3+45	0.1661	0.63	QV	|	|	|	|
3+50	0.1705	0.63	QV	|	|	|	|
3+55	0.1749	0.64	QV	|	|	|	|
4+ 0	0.1793	0.64	QV	|	|	|	|
4+ 5	0.1837	0.64	QV	|	|	|	|
4+10	0.1881	0.65	QV	|	|	|	|
4+15	0.1926	0.65	QV	|	|	|	|
4+20	0.1971	0.65	QV	|	|	|	|
4+25	0.2016	0.66	QV	|	|	|	|
4+30	0.2061	0.66	QV	|	|	|	|
4+35	0.2107	0.66	QV	|	|	|	|
4+40	0.2153	0.67	QV	|	|	|	|
4+45	0.2199	0.67	QV	|	|	|	|
4+50	0.2245	0.67	QV	|	|	|	|
4+55	0.2292	0.68	QV	|	|	|	|
5+ 0	0.2338	0.68	QV	|	|	|	|
5+ 5	0.2385	0.68	QV	|	|	|	|
5+10	0.2433	0.69	QV	|	|	|	|
5+15	0.2480	0.69	QV	|	|	|	|
5+20	0.2528	0.69	QV	|	|	|	|
5+25	0.2576	0.70	QV	|	|	|	|
5+30	0.2625	0.70	QV	|	|	|	|
5+35	0.2673	0.71	QV	|	|	|	|
5+40	0.2722	0.71	QV	|	|	|	|
5+45	0.2771	0.71	Q V	|	|	|	|

5+50	0.2821	0.72	Q V	|	|	|	|
5+55	0.2871	0.72	Q V	|	|	|	|
6+ 0	0.2921	0.73	Q V	|	|	|	|
6+ 5	0.2971	0.73	Q V	|	|	|	|
6+10	0.3022	0.74	Q V	|	|	|	|
6+15	0.3073	0.74	Q V	|	|	|	|
6+20	0.3124	0.74	Q V	|	|	|	|
6+25	0.3175	0.75	Q V	|	|	|	|
6+30	0.3227	0.75	Q V	|	|	|	|
6+35	0.3280	0.76	Q V	|	|	|	|
6+40	0.3332	0.76	Q V	|	|	|	|
6+45	0.3385	0.77	Q V	|	|	|	|
6+50	0.3438	0.77	Q V	|	|	|	|
6+55	0.3492	0.78	Q V	|	|	|	|
7+ 0	0.3546	0.78	Q V	|	|	|	|
7+ 5	0.3600	0.79	Q V	|	|	|	|
7+10	0.3655	0.79	Q V	|	|	|	|
7+15	0.3710	0.80	Q V	|	|	|	|
7+20	0.3765	0.80	Q V	|	|	|	|
7+25	0.3821	0.81	Q V	|	|	|	|
7+30	0.3877	0.81	Q V	|	|	|	|
7+35	0.3933	0.82	Q V	|	|	|	|
7+40	0.3990	0.83	Q V	|	|	|	|
7+45	0.4047	0.83	Q V	|	|	|	|
7+50	0.4105	0.84	Q V	|	|	|	|
7+55	0.4163	0.84	Q V	|	|	|	|
8+ 0	0.4222	0.85	Q V	|	|	|	|
8+ 5	0.4281	0.86	Q V	|	|	|	|
8+10	0.4340	0.86	Q V	|	|	|	|
8+15	0.4400	0.87	Q V	|	|	|	|
8+20	0.4460	0.88	Q V	|	|	|	|
8+25	0.4521	0.88	Q V	|	|	|	|
8+30	0.4583	0.89	Q V	|	|	|	|
8+35	0.4644	0.90	Q V	|	|	|	|
8+40	0.4706	0.90	Q V	|	|	|	|
8+45	0.4769	0.91	Q V	|	|	|	|
8+50	0.4832	0.92	Q V	|	|	|	|
8+55	0.4896	0.93	Q V	|	|	|	|
9+ 0	0.4960	0.93	Q V	|	|	|	|
9+ 5	0.5025	0.94	Q V	|	|	|	|
9+10	0.5091	0.95	Q V	|	|	|	|
9+15	0.5157	0.96	Q V	|	|	|	|
9+20	0.5223	0.97	Q V	|	|	|	|
9+25	0.5290	0.97	Q V	|	|	|	|
9+30	0.5358	0.98	Q V	|	|	|	|
9+35	0.5426	0.99	Q V	|	|	|	|
9+40	0.5495	1.00	Q V	|	|	|	|
9+45	0.5565	1.01	Q V	|	|	|	|
9+50	0.5635	1.02	Q V	|	|	|	|
9+55	0.5706	1.03	Q V	|	|	|	|
10+ 0	0.5777	1.04	Q V	|	|	|	|
10+ 5	0.5849	1.05	Q V	|	|	|	|
10+10	0.5922	1.06	Q V	|	|	|	|
10+15	0.5996	1.07	Q V	|	|	|	|
10+20	0.6070	1.08	Q V	|	|	|	|
10+25	0.6145	1.09	Q V	|	|	|	|
10+30	0.6221	1.10	Q V	|	|	|	|

```
10+35       0.6298      1.11  Q   V     |          |          |          |
10+40       0.6376      1.13  Q   V     |          |          |          |
10+45       0.6454      1.14  Q   V     |          |          |          |
10+50       0.6533      1.15  Q   V     |          |          |          |
10+55       0.6614      1.16  Q   V     |          |          |          |
11+ 0       0.6695      1.18  Q   V     |          |          |          |
11+ 5       0.6777      1.19  Q   V     |          |          |          |
11+10       0.6860      1.21  Q    V    |          |          |          |
11+15       0.6944      1.22  Q    V    |          |          |          |
11+20       0.7029      1.23  Q    V    |          |          |          |
11+25       0.7115      1.25  Q    V    |          |          |          |
11+30       0.7202      1.27  Q    V    |          |          |          |
11+35       0.7290      1.28  Q    V    |          |          |          |
11+40       0.7380      1.30  Q    V    |          |          |          |
11+45       0.7470      1.32  Q    V    |          |          |          |
11+50       0.7562      1.33  Q    V    |          |          |          |
11+55       0.7655      1.35  Q    V    |          |          |          |
12+ 0       0.7749      1.37  Q    V    |          |          |          |
12+ 5       0.7845      1.39  Q    V    |          |          |          |
12+10       0.7942      1.40  Q    V    |          |          |          |
12+15       0.8039      1.41  Q    V    |          |          |          |
12+20       0.8137      1.43  Q    V    |          |          |          |
12+25       0.8237      1.45  Q     V   |          |          |          |
12+30       0.8339      1.47  Q     V   |          |          |          |
12+35       0.8441      1.49  Q     V   |          |          |          |
12+40       0.8546      1.52  Q     V   |          |          |          |
12+45       0.8652      1.54  Q     V   |          |          |          |
12+50       0.8760      1.57  Q     V   |          |          |          |
12+55       0.8870      1.60  Q     V   |          |          |          |
13+ 0       0.8982      1.63  Q     V   |          |          |          |
13+ 5       0.9096      1.66  Q     V   |          |          |          |
13+10       0.9213      1.69  Q     V   |          |          |          |
13+15       0.9331      1.72  Q     V   |          |          |          |
13+20       0.9452      1.76  Q     V   |          |          |          |
13+25       0.9576      1.79  Q      V  |          |          |          |
13+30       0.9702      1.83  Q      V  |          |          |          |
13+35       0.9832      1.88  Q      V  |          |          |          |
13+40       0.9964      1.92  Q      V  |          |          |          |
13+45       1.0099      1.96  Q      V  |          |          |          |
13+50       1.0237      2.01  Q      V  |          |          |          |
13+55       1.0380      2.06  Q      V  |          |          |          |
14+ 0       1.0526      2.12  Q      V  |          |          |          |
14+ 5       1.0676      2.18  Q      V  |          |          |          |
14+10       1.0830      2.24  Q      V  |          |          |          |
14+15       1.0989      2.31  Q       V |          |          |          |
14+20       1.1154      2.39  Q       V |          |          |          |
14+25       1.1324      2.47  Q       V |          |          |          |
14+30       1.1499      2.55  Q       V |          |          |          |
14+35       1.1681      2.64  Q       V |          |          |          |
14+40       1.1870      2.74  Q       V |          |          |          |
14+45       1.2066      2.85  Q       V |          |          |          |
14+50       1.2271      2.97  Q       V |          |          |          |
14+55       1.2484      3.10  Q        V|          |          |          |
15+ 0       1.2708      3.25  Q        V|          |          |          |
15+ 5       1.2943      3.41  Q        V|          |          |          |
15+10       1.3191      3.60  Q        V|          |          |          |
15+15       1.3453      3.81  Q        V|          |          |          |
```

```
15+20       1.3732      4.05  Q         V         |         |         |
15+25       1.4033      4.37  Q         V         |         |         |
15+30       1.4368      4.86  Q         V         |         |         |
15+35       1.4746      5.49  |Q        V         |         |         |
15+40       1.5168      6.13  |Q        |V        |         |         |
15+45       1.5642      6.89  |Q        |V        |         |         |
15+50       1.6193      7.99  |Q        |V        |         |         |
15+55       1.6908     10.39  | Q       | V       |         |         |
16+ 0       1.8071     16.88  |  Q      |  V      |         |         |
16+ 5       2.0631     37.18  |      Q  |    V    |         |         |
16+10       2.7161     94.82  |         |       QV|         |         |
16+15       3.4609    108.14  |         |         |Q   V    |         |
16+20       3.8552     57.25  |         |Q        |       V |         |
16+25       4.1063     36.47  |      Q  |         |         V         |
16+30       4.2848     25.92  |    Q    |         |         |V        |
16+35       4.4203     19.68  |  Q      |         |         | V       |
16+40       4.5240     15.05  |  Q      |         |         |  V      |
16+45       4.6086     12.29  | Q       |         |         |  V      |
16+50       4.6774      9.99  |Q        |         |         |   V     |
16+55       4.7340      8.21  |Q        |         |         |   V     |
17+ 0       4.7796      6.63  |Q        |         |         |   V     |
17+ 5       4.8162      5.31  |Q        |         |         |    V    |
17+10       4.8503      4.95  Q         |         |         |    V    |
17+15       4.8823      4.65  Q         |         |         |    V    |
17+20       4.9087      3.83  Q         |         |         |    V    |
17+25       4.9310      3.25  Q         |         |         |     V   |
17+30       4.9466      2.26  Q         |         |         |     V   |
17+35       4.9610      2.09  Q         |         |         |     V   |
17+40       4.9746      1.97  Q         |         |         |     V   |
17+45       4.9875      1.88  Q         |         |         |     V   |
17+50       4.9998      1.79  Q         |         |         |     V   |
17+55       5.0116      1.72  Q         |         |         |     V   |
18+ 0       5.0230      1.65  Q         |         |         |     V   |
18+ 5       5.0339      1.59  Q         |         |         |     V   |
18+10       5.0445      1.54  Q         |         |         |     V   |
18+15       5.0548      1.50  Q         |         |         |      V  |
18+20       5.0649      1.45  Q         |         |         |      V  |
18+25       5.0746      1.41  Q         |         |         |      V  |
18+30       5.0840      1.37  Q         |         |         |      V  |
18+35       5.0933      1.34  Q         |         |         |      V  |
18+40       5.1022      1.30  Q         |         |         |      V  |
18+45       5.1110      1.27  Q         |         |         |      V  |
18+50       5.1195      1.24  Q         |         |         |      V  |
18+55       5.1278      1.21  Q         |         |         |      V  |
19+ 0       5.1359      1.18  Q         |         |         |      V  |
19+ 5       5.1439      1.15  Q         |         |         |      V  |
19+10       5.1517      1.13  Q         |         |         |      V  |
19+15       5.1593      1.11  Q         |         |         |      V  |
19+20       5.1667      1.08  Q         |         |         |      V  |
19+25       5.1740      1.06  Q         |         |         |      V  |
19+30       5.1812      1.04  Q         |         |         |      V  |
19+35       5.1882      1.02  Q         |         |         |      V  |
19+40       5.1951      1.00  Q         |         |         |       V |
19+45       5.2019      0.98  Q         |         |         |       V |
19+50       5.2086      0.97  Q         |         |         |       V |
19+55       5.2151      0.95  Q         |         |         |       V |
20+ 0       5.2216      0.93  Q         |         |         |       V |
```

```
20+ 5       5.2279      0.92  Q          |          |          |        V |
20+10       5.2341      0.90  Q          |          |          |        V |
20+15       5.2403      0.89  Q          |          |          |        V |
20+20       5.2463      0.88  Q          |          |          |        V |
20+25       5.2522      0.86  Q          |          |          |        V |
20+30       5.2581      0.85  Q          |          |          |        V |
20+35       5.2639      0.84  Q          |          |          |        V |
20+40       5.2696      0.83  Q          |          |          |        V |
20+45       5.2752      0.82  Q          |          |          |        V |
20+50       5.2807      0.80  Q          |          |          |        V |
20+55       5.2862      0.79  Q          |          |          |        V |
21+ 0       5.2916      0.78  Q          |          |          |        V |
21+ 5       5.2969      0.77  Q          |          |          |        V |
21+10       5.3022      0.76  Q          |          |          |        V |
21+15       5.3074      0.75  Q          |          |          |        V |
21+20       5.3125      0.74  Q          |          |          |        V |
21+25       5.3176      0.74  Q          |          |          |        V |
21+30       5.3226      0.73  Q          |          |          |        V |
21+35       5.3275      0.72  Q          |          |          |         V|
21+40       5.3324      0.71  Q          |          |          |         V|
21+45       5.3372      0.70  Q          |          |          |         V|
21+50       5.3420      0.69  Q          |          |          |         V|
21+55       5.3468      0.69  Q          |          |          |         V|
22+ 0       5.3514      0.68  Q          |          |          |         V|
22+ 5       5.3561      0.67  Q          |          |          |         V|
22+10       5.3607      0.67  Q          |          |          |         V|
22+15       5.3652      0.66  Q          |          |          |         V|
22+20       5.3697      0.65  Q          |          |          |         V|
22+25       5.3741      0.65  Q          |          |          |         V|
22+30       5.3785      0.64  Q          |          |          |         V|
22+35       5.3829      0.63  Q          |          |          |         V|
22+40       5.3872      0.63  Q          |          |          |         V|
22+45       5.3915      0.62  Q          |          |          |         V|
22+50       5.3957      0.61  Q          |          |          |         V|
22+55       5.3999      0.61  Q          |          |          |         V|
23+ 0       5.4041      0.60  Q          |          |          |         V|
23+ 5       5.4082      0.60  Q          |          |          |         V|
23+10       5.4123      0.59  Q          |          |          |         V|
23+15       5.4163      0.59  Q          |          |          |         V|
23+20       5.4203      0.58  Q          |          |          |         V|
23+25       5.4243      0.58  Q          |          |          |         V|
23+30       5.4283      0.57  Q          |          |          |         V|
23+35       5.4322      0.57  Q          |          |          |         V|
23+40       5.4361      0.56  Q          |          |          |         V|
23+45       5.4399      0.56  Q          |          |          |         V|
23+50       5.4437      0.55  Q          |          |          |         V|
23+55       5.4475      0.55  Q          |          |          |         V|
24+ 0       5.4513      0.55  Q          |          |          |         V|
24+ 5       5.4548      0.52  Q          |          |          |         V|
24+10       5.4576      0.39  Q          |          |          |         V|
24+15       5.4591      0.23  Q          |          |          |         V|
24+20       5.4602      0.15  Q          |          |          |         V|
24+25       5.4609      0.11  Q          |          |          |         V|
24+30       5.4615      0.08  Q          |          |          |         V|
24+35       5.4619      0.06  Q          |          |          |         V|
24+40       5.4622      0.04  Q          |          |          |         V|
24+45       5.4624      0.03  Q          |          |          |         V|
```

```
  24+50       5.4626      0.02  Q         |         |         |        V|
  24+55       5.4627      0.02  Q         |         |         |        V|
  25+ 0       5.4628      0.01  Q         |         |         |        V|
  25+ 5       5.4628      0.01  Q         |         |         |        V|
  25+10       5.4629      0.01  Q         |         |         |        V|
  25+15       5.4629      0.00  Q         |         |         |        V|
  25+20       5.4629      0.00  Q         |         |         |         V
-----------------------------------------------------------------------
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U n i t H y d r o g r a p h A n a l y s i s

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Study date 04/09/15

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San Bernardino County Synthetic Unit Hydrology Method
Manual date - August 1986

Program License Serial Number 6320

154166 - AMBOY - SAN BERNARDINO COUNTY
RECLAMATION CONDITION "A"
100-YEAR, 24-HOUR STORM
BY: JTS DATE: 04-09-15

Storm Event Year = 100

Antecedent Moisture Condition = 3

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

English Units used in output format

Area averaged rainfall intensity isohyetal data:

Sub-Area (Ac.)	Duration (hours)	Isohyetal (In)
Rainfall data for year 10		
63.54	1	0.86
Rainfall data for year 2		
63.54	6	0.75
Rainfall data for year 2		
63.54	24	1.07
Rainfall data for year 100		
63.54	1	1.59
Rainfall data for year 100		
63.54	6	2.43
Rainfall data for year 100		
63.54	24	3.56

```
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******** Area-averaged max loss rate, Fm ********


SCS curve  SCS curve     Area     Area     Fp(Fig C6)    Ap      Fm
No.(AMCII) NO.(AMC 3)    (Ac.)    Fraction     (In/Hr)  (dec.)   (In/Hr)
 91.0      98.2         63.54      1.000     0.036    1.000    0.036

Area-averaged adjusted loss rate Fm (In/Hr) =  0.036

********* Area-Averaged low loss rate fraction, Yb **********

Area       Area          SCS CN    SCS CN      S     Pervious
 (Ac.)      Fract         (AMC2)    (AMC3)           Yield Fr
    63.54   1.000         91.0      98.2       0.18     0.941

Area-averaged catchment yield fraction, Y =  0.941
Area-averaged low loss fraction, Yb =  0.059
User entry of time of concentration  =   0.230 (hours)
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Watershed area =      63.54(Ac.)
Catchment Lag time =   0.184 hours
Unit interval =   5.000 minutes
Unit interval percentage of lag time = 45.2899
Hydrograph baseflow =     0.00(CFS)
Average maximum watershed loss rate(Fm) =  0.036(In/Hr)
Average low loss rate fraction (Yb) = 0.059 (decimal)
DESERT S-Graph Selected
Computed peak 5-minute rainfall =  0.754(In)
Computed peak 30-minute rainfall =  1.291(In)
Specified peak 1-hour rainfall =  1.590(In)
Computed peak 3-hour rainfall =  2.062(In)
Specified peak 6-hour rainfall =  2.430(In)
Specified peak 24-hour rainfall =  3.560(In)


Rainfall depth area reduction factors:
Using a total area of      63.54(Ac.) (Ref: fig. E-4)

5-minute factor = 0.997     Adjusted rainfall =  0.752(In)
30-minute factor = 0.997    Adjusted rainfall =  1.288(In)
1-hour factor = 0.997       Adjusted rainfall =  1.585(In)
3-hour factor = 1.000       Adjusted rainfall =  2.061(In)
6-hour factor = 1.000       Adjusted rainfall =  2.430(In)
24-hour factor = 1.000      Adjusted rainfall =  3.560(In)
-------------------------------------------------------------------

                  U n i t  H y d r o g r a p h
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Interval          'S' Graph          Unit Hydrograph
Number            Mean values             ((CFS))
-------------------------------------------------------------------
            (K =       768.44 (CFS))

  1                3.365                  25.857
```

2	24.923	165.657
3	55.845	237.622
4	70.325	111.270
5	78.657	64.023
6	84.140	42.130
7	88.185	31.085
8	91.006	21.675
9	93.225	17.055
10	94.928	13.086
11	96.264	10.268
12	97.275	7.766
13	97.957	5.247
14	98.440	3.706
15	98.980	4.155
16	99.485	3.880
17	99.796	2.383
18	100.000	1.571

Peak Unit Number	Adjusted mass rainfall (In)	Unit rainfall (In)
1	0.7522	0.7522
2	0.9261	0.1739
3	1.0459	0.1198
4	1.1402	0.0943
5	1.2191	0.0789
6	1.2876	0.0685
7	1.3486	0.0609
8	1.4037	0.0551
9	1.4542	0.0505
10	1.5009	0.0467
11	1.5444	0.0435
12	1.5853	0.0408
13	1.6159	0.0306
14	1.6448	0.0289
15	1.6721	0.0274
16	1.6981	0.0260
17	1.7229	0.0248
18	1.7466	0.0237
19	1.7694	0.0227
20	1.7912	0.0218
21	1.8122	0.0210
22	1.8325	0.0203
23	1.8521	0.0196
24	1.8710	0.0189
25	1.8894	0.0184
26	1.9072	0.0178
27	1.9245	0.0173
28	1.9413	0.0168
29	1.9576	0.0164
30	1.9736	0.0159
31	1.9891	0.0155
32	2.0042	0.0152
33	2.0190	0.0148
34	2.0335	0.0145
35	2.0476	0.0141
36	2.0615	0.0138
37	2.0749	0.0134

38	2.0881	0.0132
39	2.1010	0.0129
40	2.1136	0.0126
41	2.1260	0.0124
42	2.1382	0.0122
43	2.1501	0.0120
44	2.1619	0.0117
45	2.1734	0.0115
46	2.1848	0.0114
47	2.1959	0.0112
48	2.2069	0.0110
49	2.2177	0.0108
50	2.2284	0.0106
51	2.2389	0.0105
52	2.2492	0.0103
53	2.2594	0.0102
54	2.2694	0.0100
55	2.2793	0.0099
56	2.2890	0.0098
57	2.2987	0.0096
58	2.3082	0.0095
59	2.3175	0.0094
60	2.3268	0.0092
61	2.3359	0.0091
62	2.3449	0.0090
63	2.3538	0.0089
64	2.3626	0.0088
65	2.3713	0.0087
66	2.3799	0.0086
67	2.3884	0.0085
68	2.3968	0.0084
69	2.4051	0.0083
70	2.4134	0.0082
71	2.4215	0.0081
72	2.4295	0.0080
73	2.4388	0.0093
74	2.4479	0.0092
75	2.4570	0.0091
76	2.4660	0.0090
77	2.4749	0.0089
78	2.4837	0.0088
79	2.4924	0.0087
80	2.5011	0.0087
81	2.5097	0.0086
82	2.5182	0.0085
83	2.5266	0.0084
84	2.5349	0.0084
85	2.5432	0.0083
86	2.5514	0.0082
87	2.5596	0.0081
88	2.5676	0.0081
89	2.5756	0.0080
90	2.5836	0.0079
91	2.5915	0.0079
92	2.5993	0.0078
93	2.6070	0.0078
94	2.6147	0.0077

95	2.6224	0.0076
96	2.6299	0.0076
97	2.6375	0.0075
98	2.6449	0.0075
99	2.6523	0.0074
100	2.6597	0.0074
101	2.6670	0.0073
102	2.6742	0.0073
103	2.6814	0.0072
104	2.6886	0.0071
105	2.6957	0.0071
106	2.7027	0.0070
107	2.7097	0.0070
108	2.7167	0.0070
109	2.7236	0.0069
110	2.7305	0.0069
111	2.7373	0.0068
112	2.7441	0.0068
113	2.7508	0.0067
114	2.7575	0.0067
115	2.7641	0.0066
116	2.7707	0.0066
117	2.7773	0.0066
118	2.7838	0.0065
119	2.7903	0.0065
120	2.7967	0.0064
121	2.8031	0.0064
122	2.8095	0.0064
123	2.8158	0.0063
124	2.8221	0.0063
125	2.8284	0.0063
126	2.8346	0.0062
127	2.8408	0.0062
128	2.8469	0.0061
129	2.8530	0.0061
130	2.8591	0.0061
131	2.8651	0.0060
132	2.8711	0.0060
133	2.8771	0.0060
134	2.8831	0.0059
135	2.8890	0.0059
136	2.8949	0.0059
137	2.9007	0.0058
138	2.9065	0.0058
139	2.9123	0.0058
140	2.9181	0.0058
141	2.9238	0.0057
142	2.9295	0.0057
143	2.9352	0.0057
144	2.9408	0.0056
145	2.9464	0.0056
146	2.9520	0.0056
147	2.9576	0.0056
148	2.9631	0.0055
149	2.9686	0.0055
150	2.9741	0.0055
151	2.9795	0.0055

152	2.9850	0.0054
153	2.9904	0.0054
154	2.9957	0.0054
155	3.0011	0.0053
156	3.0064	0.0053
157	3.0117	0.0053
158	3.0170	0.0053
159	3.0222	0.0052
160	3.0274	0.0052
161	3.0326	0.0052
162	3.0378	0.0052
163	3.0430	0.0052
164	3.0481	0.0051
165	3.0532	0.0051
166	3.0583	0.0051
167	3.0634	0.0051
168	3.0684	0.0050
169	3.0734	0.0050
170	3.0784	0.0050
171	3.0834	0.0050
172	3.0884	0.0050
173	3.0933	0.0049
174	3.0982	0.0049
175	3.1031	0.0049
176	3.1080	0.0049
177	3.1129	0.0049
178	3.1177	0.0048
179	3.1225	0.0048
180	3.1273	0.0048
181	3.1321	0.0048
182	3.1368	0.0048
183	3.1416	0.0047
184	3.1463	0.0047
185	3.1510	0.0047
186	3.1557	0.0047
187	3.1604	0.0047
188	3.1650	0.0046
189	3.1696	0.0046
190	3.1742	0.0046
191	3.1788	0.0046
192	3.1834	0.0046
193	3.1880	0.0046
194	3.1925	0.0045
195	3.1971	0.0045
196	3.2016	0.0045
197	3.2061	0.0045
198	3.2105	0.0045
199	3.2150	0.0045
200	3.2194	0.0044
201	3.2239	0.0044
202	3.2283	0.0044
203	3.2327	0.0044
204	3.2370	0.0044
205	3.2414	0.0044
206	3.2458	0.0043
207	3.2501	0.0043
208	3.2544	0.0043

209	3.2587	0.0043
210	3.2630	0.0043
211	3.2673	0.0043
212	3.2715	0.0043
213	3.2758	0.0042
214	3.2800	0.0042
215	3.2842	0.0042
216	3.2884	0.0042
217	3.2926	0.0042
218	3.2968	0.0042
219	3.3010	0.0042
220	3.3051	0.0041
221	3.3092	0.0041
222	3.3134	0.0041
223	3.3175	0.0041
224	3.3216	0.0041
225	3.3256	0.0041
226	3.3297	0.0041
227	3.3338	0.0041
228	3.3378	0.0040
229	3.3418	0.0040
230	3.3458	0.0040
231	3.3498	0.0040
232	3.3538	0.0040
233	3.3578	0.0040
234	3.3618	0.0040
235	3.3657	0.0040
236	3.3697	0.0039
237	3.3736	0.0039
238	3.3775	0.0039
239	3.3814	0.0039
240	3.3853	0.0039
241	3.3892	0.0039
242	3.3931	0.0039
243	3.3969	0.0039
244	3.4008	0.0038
245	3.4046	0.0038
246	3.4084	0.0038
247	3.4122	0.0038
248	3.4160	0.0038
249	3.4198	0.0038
250	3.4236	0.0038
251	3.4274	0.0038
252	3.4311	0.0038
253	3.4349	0.0037
254	3.4386	0.0037
255	3.4423	0.0037
256	3.4460	0.0037
257	3.4497	0.0037
258	3.4534	0.0037
259	3.4571	0.0037
260	3.4608	0.0037
261	3.4645	0.0037
262	3.4681	0.0037
263	3.4718	0.0036
264	3.4754	0.0036
265	3.4790	0.0036

266	3.4826	0.0036
267	3.4862	0.0036
268	3.4898	0.0036
269	3.4934	0.0036
270	3.4970	0.0036
271	3.5005	0.0036
272	3.5041	0.0036
273	3.5076	0.0035
274	3.5112	0.0035
275	3.5147	0.0035
276	3.5182	0.0035
277	3.5217	0.0035
278	3.5252	0.0035
279	3.5287	0.0035
280	3.5322	0.0035
281	3.5357	0.0035
282	3.5391	0.0035
283	3.5426	0.0035
284	3.5460	0.0034
285	3.5495	0.0034
286	3.5529	0.0034
287	3.5563	0.0034
288	3.5597	0.0034

Unit Period (number)	Unit Rainfall (In)	Unit Soil-Loss (In)	Effective Rainfall (In)
1	0.0034	0.0002	0.0032
2	0.0034	0.0002	0.0032
3	0.0034	0.0002	0.0032
4	0.0034	0.0002	0.0032
5	0.0035	0.0002	0.0033
6	0.0035	0.0002	0.0033
7	0.0035	0.0002	0.0033
8	0.0035	0.0002	0.0033
9	0.0035	0.0002	0.0033
10	0.0035	0.0002	0.0033
11	0.0035	0.0002	0.0033
12	0.0036	0.0002	0.0033
13	0.0036	0.0002	0.0034
14	0.0036	0.0002	0.0034
15	0.0036	0.0002	0.0034
16	0.0036	0.0002	0.0034
17	0.0036	0.0002	0.0034
18	0.0036	0.0002	0.0034
19	0.0037	0.0002	0.0034
20	0.0037	0.0002	0.0035
21	0.0037	0.0002	0.0035
22	0.0037	0.0002	0.0035
23	0.0037	0.0002	0.0035
24	0.0037	0.0002	0.0035
25	0.0038	0.0002	0.0035
26	0.0038	0.0002	0.0035
27	0.0038	0.0002	0.0036
28	0.0038	0.0002	0.0036
29	0.0038	0.0002	0.0036

30	0.0038	0.0002	0.0036
31	0.0039	0.0002	0.0036
32	0.0039	0.0002	0.0036
33	0.0039	0.0002	0.0037
34	0.0039	0.0002	0.0037
35	0.0039	0.0002	0.0037
36	0.0039	0.0002	0.0037
37	0.0040	0.0002	0.0037
38	0.0040	0.0002	0.0037
39	0.0040	0.0002	0.0038
40	0.0040	0.0002	0.0038
41	0.0040	0.0002	0.0038
42	0.0041	0.0002	0.0038
43	0.0041	0.0002	0.0038
44	0.0041	0.0002	0.0039
45	0.0041	0.0002	0.0039
46	0.0041	0.0002	0.0039
47	0.0042	0.0002	0.0039
48	0.0042	0.0002	0.0039
49	0.0042	0.0002	0.0040
50	0.0042	0.0002	0.0040
51	0.0042	0.0003	0.0040
52	0.0043	0.0003	0.0040
53	0.0043	0.0003	0.0040
54	0.0043	0.0003	0.0040
55	0.0043	0.0003	0.0041
56	0.0043	0.0003	0.0041
57	0.0044	0.0003	0.0041
58	0.0044	0.0003	0.0041
59	0.0044	0.0003	0.0042
60	0.0044	0.0003	0.0042
61	0.0045	0.0003	0.0042
62	0.0045	0.0003	0.0042
63	0.0045	0.0003	0.0043
64	0.0045	0.0003	0.0043
65	0.0046	0.0003	0.0043
66	0.0046	0.0003	0.0043
67	0.0046	0.0003	0.0044
68	0.0046	0.0003	0.0044
69	0.0047	0.0003	0.0044
70	0.0047	0.0003	0.0044
71	0.0047	0.0003	0.0045
72	0.0048	0.0003	0.0045
73	0.0048	0.0003	0.0045
74	0.0048	0.0003	0.0045
75	0.0049	0.0003	0.0046
76	0.0049	0.0003	0.0046
77	0.0049	0.0003	0.0046
78	0.0049	0.0003	0.0046
79	0.0050	0.0003	0.0047
80	0.0050	0.0003	0.0047
81	0.0050	0.0003	0.0047
82	0.0051	0.0003	0.0048
83	0.0051	0.0003	0.0048
84	0.0051	0.0003	0.0048
85	0.0052	0.0003	0.0049
86	0.0052	0.0003	0.0049

87	0.0052	0.0003	0.0049
88	0.0053	0.0003	0.0050
89	0.0053	0.0003	0.0050
90	0.0053	0.0003	0.0050
91	0.0054	0.0003	0.0051
92	0.0054	0.0003	0.0051
93	0.0055	0.0003	0.0052
94	0.0055	0.0003	0.0052
95	0.0056	0.0003	0.0052
96	0.0056	0.0003	0.0053
97	0.0056	0.0003	0.0053
98	0.0057	0.0003	0.0053
99	0.0057	0.0003	0.0054
100	0.0058	0.0003	0.0054
101	0.0058	0.0003	0.0055
102	0.0058	0.0003	0.0055
103	0.0059	0.0004	0.0056
104	0.0059	0.0004	0.0056
105	0.0060	0.0004	0.0057
106	0.0060	0.0004	0.0057
107	0.0061	0.0004	0.0057
108	0.0061	0.0004	0.0058
109	0.0062	0.0004	0.0058
110	0.0063	0.0004	0.0059
111	0.0063	0.0004	0.0060
112	0.0064	0.0004	0.0060
113	0.0064	0.0004	0.0061
114	0.0065	0.0004	0.0061
115	0.0066	0.0004	0.0062
116	0.0066	0.0004	0.0062
117	0.0067	0.0004	0.0063
118	0.0067	0.0004	0.0063
119	0.0068	0.0004	0.0064
120	0.0069	0.0004	0.0065
121	0.0070	0.0004	0.0065
122	0.0070	0.0004	0.0066
123	0.0071	0.0004	0.0067
124	0.0071	0.0004	0.0067
125	0.0073	0.0004	0.0068
126	0.0073	0.0004	0.0069
127	0.0074	0.0004	0.0070
128	0.0075	0.0004	0.0070
129	0.0076	0.0004	0.0071
130	0.0076	0.0005	0.0072
131	0.0078	0.0005	0.0073
132	0.0078	0.0005	0.0074
133	0.0079	0.0005	0.0075
134	0.0080	0.0005	0.0075
135	0.0081	0.0005	0.0077
136	0.0082	0.0005	0.0077
137	0.0084	0.0005	0.0079
138	0.0084	0.0005	0.0079
139	0.0086	0.0005	0.0081
140	0.0087	0.0005	0.0081
141	0.0088	0.0005	0.0083
142	0.0089	0.0005	0.0084
143	0.0091	0.0005	0.0085

144	0.0092	0.0005	0.0086
145	0.0080	0.0005	0.0076
146	0.0081	0.0005	0.0076
147	0.0083	0.0005	0.0078
148	0.0084	0.0005	0.0079
149	0.0086	0.0005	0.0081
150	0.0087	0.0005	0.0082
151	0.0089	0.0005	0.0084
152	0.0090	0.0005	0.0085
153	0.0092	0.0005	0.0087
154	0.0094	0.0006	0.0088
155	0.0096	0.0006	0.0091
156	0.0098	0.0006	0.0092
157	0.0100	0.0006	0.0094
158	0.0102	0.0006	0.0096
159	0.0105	0.0006	0.0099
160	0.0106	0.0006	0.0100
161	0.0110	0.0007	0.0103
162	0.0112	0.0007	0.0105
163	0.0115	0.0007	0.0109
164	0.0117	0.0007	0.0111
165	0.0122	0.0007	0.0115
166	0.0124	0.0007	0.0117
167	0.0129	0.0008	0.0121
168	0.0132	0.0008	0.0124
169	0.0138	0.0008	0.0130
170	0.0141	0.0008	0.0133
171	0.0148	0.0009	0.0139
172	0.0152	0.0009	0.0143
173	0.0159	0.0009	0.0150
174	0.0164	0.0010	0.0154
175	0.0173	0.0010	0.0163
176	0.0178	0.0011	0.0167
177	0.0189	0.0011	0.0178
178	0.0196	0.0012	0.0184
179	0.0210	0.0012	0.0198
180	0.0218	0.0013	0.0205
181	0.0237	0.0014	0.0223
182	0.0248	0.0015	0.0233
183	0.0274	0.0016	0.0257
184	0.0289	0.0017	0.0272
185	0.0408	0.0024	0.0384
186	0.0435	0.0026	0.0410
187	0.0505	0.0030	0.0475
188	0.0551	0.0030	0.0521
189	0.0685	0.0030	0.0656
190	0.0789	0.0030	0.0760
191	0.1198	0.0030	0.1168
192	0.1739	0.0030	0.1709
193	0.7522	0.0030	0.7492
194	0.0943	0.0030	0.0913
195	0.0609	0.0030	0.0580
196	0.0467	0.0028	0.0439
197	0.0306	0.0018	0.0288
198	0.0260	0.0015	0.0245
199	0.0227	0.0013	0.0214
200	0.0203	0.0012	0.0191

201	0.0184	0.0011	0.0173
202	0.0168	0.0010	0.0158
203	0.0155	0.0009	0.0146
204	0.0145	0.0009	0.0136
205	0.0134	0.0008	0.0126
206	0.0126	0.0007	0.0119
207	0.0120	0.0007	0.0112
208	0.0114	0.0007	0.0107
209	0.0108	0.0006	0.0102
210	0.0103	0.0006	0.0097
211	0.0099	0.0006	0.0093
212	0.0095	0.0006	0.0089
213	0.0091	0.0005	0.0086
214	0.0088	0.0005	0.0083
215	0.0085	0.0005	0.0080
216	0.0082	0.0005	0.0077
217	0.0093	0.0005	0.0087
218	0.0090	0.0005	0.0085
219	0.0087	0.0005	0.0082
220	0.0085	0.0005	0.0080
221	0.0083	0.0005	0.0078
222	0.0081	0.0005	0.0076
223	0.0079	0.0005	0.0074
224	0.0077	0.0005	0.0072
225	0.0075	0.0004	0.0071
226	0.0074	0.0004	0.0069
227	0.0072	0.0004	0.0068
228	0.0070	0.0004	0.0066
229	0.0069	0.0004	0.0065
230	0.0068	0.0004	0.0064
231	0.0066	0.0004	0.0063
232	0.0065	0.0004	0.0061
233	0.0064	0.0004	0.0060
234	0.0063	0.0004	0.0059
235	0.0062	0.0004	0.0058
236	0.0061	0.0004	0.0057
237	0.0060	0.0004	0.0056
238	0.0059	0.0003	0.0055
239	0.0058	0.0003	0.0054
240	0.0057	0.0003	0.0054
241	0.0056	0.0003	0.0053
242	0.0055	0.0003	0.0052
243	0.0055	0.0003	0.0051
244	0.0054	0.0003	0.0051
245	0.0053	0.0003	0.0050
246	0.0052	0.0003	0.0049
247	0.0052	0.0003	0.0049
248	0.0051	0.0003	0.0048
249	0.0050	0.0003	0.0047
250	0.0050	0.0003	0.0047
251	0.0049	0.0003	0.0046
252	0.0048	0.0003	0.0045
253	0.0048	0.0003	0.0045
254	0.0047	0.0003	0.0044
255	0.0047	0.0003	0.0044
256	0.0046	0.0003	0.0043
257	0.0046	0.0003	0.0043

258	0.0045	0.0003	0.0042
259	0.0045	0.0003	0.0042
260	0.0044	0.0003	0.0042
261	0.0044	0.0003	0.0041
262	0.0043	0.0003	0.0041
263	0.0043	0.0003	0.0040
264	0.0042	0.0003	0.0040
265	0.0042	0.0002	0.0039
266	0.0041	0.0002	0.0039
267	0.0041	0.0002	0.0039
268	0.0041	0.0002	0.0038
269	0.0040	0.0002	0.0038
270	0.0040	0.0002	0.0038
271	0.0040	0.0002	0.0037
272	0.0039	0.0002	0.0037
273	0.0039	0.0002	0.0037
274	0.0038	0.0002	0.0036
275	0.0038	0.0002	0.0036
276	0.0038	0.0002	0.0036
277	0.0037	0.0002	0.0035
278	0.0037	0.0002	0.0035
279	0.0037	0.0002	0.0035
280	0.0037	0.0002	0.0034
281	0.0036	0.0002	0.0034
282	0.0036	0.0002	0.0034
283	0.0036	0.0002	0.0034
284	0.0035	0.0002	0.0033
285	0.0035	0.0002	0.0033
286	0.0035	0.0002	0.0033
287	0.0035	0.0002	0.0032
288	0.0034	0.0002	0.0032

Total soil rain loss = 0.15(In)
Total effective rainfall = 3.41(In)
Peak flow rate in flood hydrograph = 229.94(CFS)

++

24 - H O U R S T O R M
R u n o f f H y d r o g r a p h

Hydrograph in 5 Minute intervals ((CFS))

```
Time(h+m) Volume Ac.Ft   Q(CFS)  0       75.0     150.0     225.0     300.0
-----------------------------------------------------------------------
  0+ 5       0.0006      0.08  Q         |         |         |         |
  0+10       0.0048      0.61  Q         |         |         |         |
  0+15       0.0143      1.38  Q         |         |         |         |
  0+20       0.0263      1.74  Q         |         |         |         |
  0+25       0.0397      1.95  Q         |         |         |         |
  0+30       0.0542      2.09  Q         |         |         |         |
  0+35       0.0693      2.20  Q         |         |         |         |
  0+40       0.0850      2.28  Q         |         |         |         |
  0+45       0.1012      2.34  Q         |         |         |         |
  0+50       0.1177      2.40  Q         |         |         |         |
  0+55       0.1345      2.44  Q         |         |         |         |
```

1+ 0	0.1515	2.47	Q				
1+ 5	0.1687	2.50	Q				
1+10	0.1861	2.52	Q				
1+15	0.2036	2.54	Q				
1+20	0.2213	2.57	Q				
1+25	0.2391	2.58	Q				
1+30	0.2570	2.60	Q				
1+35	0.2749	2.61	Q				
1+40	0.2930	2.62	Q				
1+45	0.3111	2.63	Q				
1+50	0.3293	2.64	Q				
1+55	0.3476	2.65	Q				
2+ 0	0.3660	2.67	Q				
2+ 5	0.3844	2.68	Q				
2+10	0.4029	2.69	Q				
2+15	0.4215	2.70	Q				
2+20	0.4402	2.71	Q				
2+25	0.4589	2.72	QV				
2+30	0.4778	2.73	QV				
2+35	0.4967	2.75	QV				
2+40	0.5157	2.76	QV				
2+45	0.5348	2.77	QV				
2+50	0.5540	2.78	QV				
2+55	0.5732	2.80	QV				
3+ 0	0.5926	2.81	QV				
3+ 5	0.6120	2.82	QV				
3+10	0.6315	2.83	QV				
3+15	0.6511	2.85	QV				
3+20	0.6708	2.86	QV				
3+25	0.6906	2.87	QV				
3+30	0.7105	2.89	QV				
3+35	0.7305	2.90	QV				
3+40	0.7506	2.92	QV				
3+45	0.7708	2.93	QV				
3+50	0.7910	2.94	QV				
3+55	0.8114	2.96	QV				
4+ 0	0.8319	2.97	QV				
4+ 5	0.8524	2.99	QV				
4+10	0.8731	3.00	QV				
4+15	0.8939	3.02	QV				
4+20	0.9148	3.03	Q V				
4+25	0.9358	3.05	Q V				
4+30	0.9568	3.06	Q V				
4+35	0.9780	3.08	Q V				
4+40	0.9994	3.09	Q V				
4+45	1.0208	3.11	Q V				
4+50	1.0423	3.13	Q V				
4+55	1.0640	3.14	Q V				
5+ 0	1.0857	3.16	Q V				
5+ 5	1.1076	3.18	Q V				
5+10	1.1296	3.19	Q V				
5+15	1.1517	3.21	Q V				
5+20	1.1740	3.23	Q V				
5+25	1.1963	3.25	Q V				
5+30	1.2188	3.26	Q V				
5+35	1.2414	3.28	Q V				
5+40	1.2642	3.30	Q V				

```
 5+45       1.2870      3.32  Q V       |          |          |          |
 5+50       1.3100      3.34  Q V       |          |          |          |
 5+55       1.3332      3.36  Q V       |          |          |          |
 6+ 0       1.3564      3.38  Q  V      |          |          |          |
 6+ 5       1.3798      3.40  Q  V      |          |          |          |
 6+10       1.4034      3.42  Q  V      |          |          |          |
 6+15       1.4271      3.44  Q  V      |          |          |          |
 6+20       1.4509      3.46  Q  V      |          |          |          |
 6+25       1.4749      3.48  Q  V      |          |          |          |
 6+30       1.4990      3.50  Q  V      |          |          |          |
 6+35       1.5233      3.52  Q  V      |          |          |          |
 6+40       1.5477      3.55  Q  V      |          |          |          |
 6+45       1.5722      3.57  Q  V      |          |          |          |
 6+50       1.5970      3.59  Q  V      |          |          |          |
 6+55       1.6219      3.61  Q  V      |          |          |          |
 7+ 0       1.6469      3.64  Q  V      |          |          |          |
 7+ 5       1.6721      3.66  Q  V      |          |          |          |
 7+10       1.6975      3.68  Q  V      |          |          |          |
 7+15       1.7231      3.71  Q  V      |          |          |          |
 7+20       1.7488      3.73  Q  V      |          |          |          |
 7+25       1.7747      3.76  Q  V      |          |          |          |
 7+30       1.8007      3.79  Q  V      |          |          |          |
 7+35       1.8270      3.81  Q   V     |          |          |          |
 7+40       1.8534      3.84  Q   V     |          |          |          |
 7+45       1.8800      3.86  Q   V     |          |          |          |
 7+50       1.9068      3.89  Q   V     |          |          |          |
 7+55       1.9338      3.92  Q   V     |          |          |          |
 8+ 0       1.9610      3.95  Q   V     |          |          |          |
 8+ 5       1.9884      3.98  Q   V     |          |          |          |
 8+10       2.0160      4.01  Q   V     |          |          |          |
 8+15       2.0438      4.04  Q   V     |          |          |          |
 8+20       2.0718      4.07  Q   V     |          |          |          |
 8+25       2.1000      4.10  Q   V     |          |          |          |
 8+30       2.1285      4.13  Q   V     |          |          |          |
 8+35       2.1571      4.16  Q   V     |          |          |          |
 8+40       2.1860      4.19  Q   V     |          |          |          |
 8+45       2.2152      4.23  Q   V     |          |          |          |
 8+50       2.2445      4.26  Q   V     |          |          |          |
 8+55       2.2741      4.30  Q    V    |          |          |          |
 9+ 0       2.3039      4.33  Q    V    |          |          |          |
 9+ 5       2.3340      4.37  Q    V    |          |          |          |
 9+10       2.3643      4.40  Q    V    |          |          |          |
 9+15       2.3949      4.44  Q    V    |          |          |          |
 9+20       2.4258      4.48  Q    V    |          |          |          |
 9+25       2.4569      4.52  Q    V    |          |          |          |
 9+30       2.4883      4.56  Q    V    |          |          |          |
 9+35       2.5200      4.60  Q    V    |          |          |          |
 9+40       2.5520      4.64  Q    V    |          |          |          |
 9+45       2.5842      4.68  Q    V    |          |          |          |
 9+50       2.6168      4.73  Q    V    |          |          |          |
 9+55       2.6496      4.77  Q    V    |          |          |          |
10+ 0       2.6828      4.82  Q    V    |          |          |          |
10+ 5       2.7163      4.86  Q     V   |          |          |          |
10+10       2.7501      4.91  Q     V   |          |          |          |
10+15       2.7843      4.96  Q     V   |          |          |          |
10+20       2.8188      5.01  Q     V   |          |          |          |
10+25       2.8537      5.06  Q     V   |          |          |          |
```

```
10+30       2.8889      5.11  Q     V   |          |          |          |
10+35       2.9245      5.17  Q     V   |          |          |          |
10+40       2.9604      5.22  Q     V   |          |          |          |
10+45       2.9968      5.28  Q     V   |          |          |          |
10+50       3.0335      5.34  Q     V   |          |          |          |
10+55       3.0707      5.40  Q     V   |          |          |          |
11+ 0       3.1083      5.46  Q     V   |          |          |          |
11+ 5       3.1463      5.52  Q     V   |          |          |          |
11+10       3.1848      5.58  Q      V  |          |          |          |
11+15       3.2237      5.65  Q      V  |          |          |          |
11+20       3.2631      5.72  Q      V  |          |          |          |
11+25       3.3029      5.79  Q      V  |          |          |          |
11+30       3.3433      5.86  Q      V  |          |          |          |
11+35       3.3842      5.94  Q      V  |          |          |          |
11+40       3.4256      6.01  Q      V  |          |          |          |
11+45       3.4675      6.09  Q      V  |          |          |          |
11+50       3.5101      6.17  Q      V  |          |          |          |
11+55       3.5532      6.26  Q      V  |          |          |          |
12+ 0       3.5968      6.34  Q      V  |          |          |          |
12+ 5       3.6410      6.40  Q       V |          |          |          |
12+10       3.6843      6.29  Q       V |          |          |          |
12+15       3.7263      6.10  Q       V |          |          |          |
12+20       3.7680      6.05  Q       V |          |          |          |
12+25       3.8098      6.07  Q       V |          |          |          |
12+30       3.8519      6.12  Q       V |          |          |          |
12+35       3.8945      6.18  Q       V |          |          |          |
12+40       3.9377      6.26  Q       V |          |          |          |
12+45       3.9814      6.35  Q       V |          |          |          |
12+50       4.0259      6.45  Q       V |          |          |          |
12+55       4.0711      6.56  Q        V|          |          |          |
13+ 0       4.1170      6.68  Q        V|          |          |          |
13+ 5       4.1639      6.80  Q        V|          |          |          |
13+10       4.2116      6.93  Q        V|          |          |          |
13+15       4.2603      7.07  Q        V|          |          |          |
13+20       4.3100      7.22  Q        V|          |          |          |
13+25       4.3608      7.37  Q        V|          |          |          |
13+30       4.4127      7.53  |Q       V|          |          |          |
13+35       4.4658      7.71  |Q       V|          |          |          |
13+40       4.5201      7.89  |Q        V          |          |          |
13+45       4.5759      8.09  |Q        V          |          |          |
13+50       4.6330      8.30  |Q        V          |          |          |
13+55       4.6917      8.52  |Q        V          |          |          |
14+ 0       4.7519      8.75  |Q        V          |          |          |
14+ 5       4.8139      9.00  |Q        V          |          |          |
14+10       4.8779      9.29  |Q        V          |          |          |
14+15       4.9440      9.60  |Q        V          |          |          |
14+20       5.0123      9.92  |Q        |V         |          |          |
14+25       5.0830     10.26  |Q        |V         |          |          |
14+30       5.1562     10.62  |Q        |V         |          |          |
14+35       5.2321     11.02  |Q        |V         |          |          |
14+40       5.3109     11.45  |Q        |V         |          |          |
14+45       5.3930     11.92  |Q        |V         |          |          |
14+50       5.4786     12.43  |Q        | V        |          |          |
14+55       5.5682     13.01  |Q        | V        |          |          |
15+ 0       5.6621     13.64  |Q        | V        |          |          |
15+ 5       5.7610     14.36  |Q        | V        |          |          |
15+10       5.8654     15.16  | Q       |  V       |          |          |
```

```
15+15       5.9762     16.09  | Q       |  V      |         |         |
15+20       6.0943     17.15  | Q       |  V      |         |         |
15+25       6.2225     18.61  | Q       |  V      |         |         |
15+30       6.3698     21.39  | Q       |   V     |         |         |
15+35       6.5430     25.14  |  Q      |   V     |         |         |
15+40       6.7394     28.52  |  Q      |   V     |         |         |
15+45       6.9627     32.43  |   Q     |    V    |         |         |
15+50       7.2214     37.55  |    Q    |     V   |         |         |
15+55       7.5316     45.04  |     Q   |     V   |         |         |
16+ 0       7.9321     58.16  |      Q  |      V  |         |         |
16+ 5       8.5831     94.52  |         | Q      V|         |         |
16+10       9.9087    192.48  |         |         |V   Q    |         |
16+15      11.4924    229.94  |         |         |    V    Q         |
16+20      12.4440    138.18  |         |       Q |      V  |         |
16+25      13.1023     95.59  |         | Q       |        V|         |
16+30      13.5932     71.27  |        Q|         |         V         |
16+35      13.9769     55.72  |      Q  |         |         V         |
16+40      14.2799     43.99  |    Q    |         |         |V        |
16+45      14.5328     36.72  |   Q     |         |         | V       |
16+50      14.7449     30.81  |   Q     |         |         | V       |
16+55      14.9255     26.22  |  Q      |         |         |  V      |
17+ 0      15.0792     22.32  | Q       |         |         |  V      |
17+ 5      15.2092     18.87  | Q       |         |         |  V      |
17+10      15.3225     16.45  | Q       |         |         |  V      |
17+15      15.4290     15.47  | Q       |         |         |   V     |
17+20      15.5263     14.13  |Q        |         |         |   V     |
17+25      15.6098     12.12  |Q        |         |         |   V     |
17+30      15.6832     10.65  |Q        |         |         |   V     |
17+35      15.7446      8.92  |Q        |         |         |   V     |
17+40      15.8019      8.32  |Q        |         |         |    V    |
17+45      15.8560      7.85  |Q        |         |         |    V    |
17+50      15.9073      7.46  Q         |         |         |    V    |
17+55      15.9564      7.12  Q         |         |         |    V    |
18+ 0      16.0033      6.82  Q         |         |         |    V    |
18+ 5      16.0487      6.58  Q         |         |         |    V    |
18+10      16.0937      6.54  Q         |         |         |    V    |
18+15      16.1392      6.60  Q         |         |         |    V    |
18+20      16.1841      6.52  Q         |         |         |    V    |
18+25      16.2282      6.40  Q         |         |         |    V    |
18+30      16.2713      6.26  Q         |         |         |     V   |
18+35      16.3135      6.13  Q         |         |         |     V   |
18+40      16.3548      5.99  Q         |         |         |     V   |
18+45      16.3951      5.85  Q         |         |         |     V   |
18+50      16.4345      5.72  Q         |         |         |     V   |
18+55      16.4731      5.60  Q         |         |         |     V   |
19+ 0      16.5108      5.48  Q         |         |         |     V   |
19+ 5      16.5477      5.36  Q         |         |         |     V   |
19+10      16.5839      5.25  Q         |         |         |     V   |
19+15      16.6193      5.14  Q         |         |         |     V   |
19+20      16.6540      5.04  Q         |         |         |     V   |
19+25      16.6880      4.94  Q         |         |         |      V  |
19+30      16.7214      4.85  Q         |         |         |      V  |
19+35      16.7542      4.76  Q         |         |         |      V  |
19+40      16.7863      4.67  Q         |         |         |      V  |
19+45      16.8179      4.59  Q         |         |         |      V  |
19+50      16.8490      4.50  Q         |         |         |      V  |
19+55      16.8794      4.43  Q         |         |         |      V  |
```

```
20+ 0      16.9094      4.35  Q          |          |          |       V  |
20+ 5      16.9389      4.28  Q          |          |          |       V  |
20+10      16.9680      4.21  Q          |          |          |       V  |
20+15      16.9965      4.15  Q          |          |          |       V  |
20+20      17.0247      4.09  Q          |          |          |       V  |
20+25      17.0524      4.02  Q          |          |          |       V  |
20+30      17.0797      3.96  Q          |          |          |       V  |
20+35      17.1066      3.91  Q          |          |          |       V  |
20+40      17.1331      3.85  Q          |          |          |       V  |
20+45      17.1593      3.80  Q          |          |          |        V |
20+50      17.1851      3.75  Q          |          |          |        V |
20+55      17.2106      3.70  Q          |          |          |        V |
21+ 0      17.2357      3.65  Q          |          |          |        V |
21+ 5      17.2605      3.60  Q          |          |          |        V |
21+10      17.2850      3.56  Q          |          |          |        V |
21+15      17.3092      3.51  Q          |          |          |        V |
21+20      17.3331      3.47  Q          |          |          |        V |
21+25      17.3567      3.43  Q          |          |          |        V |
21+30      17.3801      3.39  Q          |          |          |        V |
21+35      17.4032      3.35  Q          |          |          |        V |
21+40      17.4260      3.31  Q          |          |          |        V |
21+45      17.4485      3.27  Q          |          |          |        V |
21+50      17.4708      3.24  Q          |          |          |        V |
21+55      17.4929      3.20  Q          |          |          |        V |
22+ 0      17.5147      3.17  Q          |          |          |        V |
22+ 5      17.5363      3.13  Q          |          |          |        V |
22+10      17.5576      3.10  Q          |          |          |        V |
22+15      17.5788      3.07  Q          |          |          |        V |
22+20      17.5997      3.04  Q          |          |          |         V|
22+25      17.6204      3.01  Q          |          |          |         V|
22+30      17.6410      2.98  Q          |          |          |         V|
22+35      17.6613      2.95  Q          |          |          |         V|
22+40      17.6814      2.92  Q          |          |          |         V|
22+45      17.7013      2.89  Q          |          |          |         V|
22+50      17.7211      2.87  Q          |          |          |         V|
22+55      17.7406      2.84  Q          |          |          |         V|
23+ 0      17.7600      2.81  Q          |          |          |         V|
23+ 5      17.7792      2.79  Q          |          |          |         V|
23+10      17.7983      2.76  Q          |          |          |         V|
23+15      17.8172      2.74  Q          |          |          |         V|
23+20      17.8359      2.72  Q          |          |          |         V|
23+25      17.8544      2.69  Q          |          |          |         V|
23+30      17.8728      2.67  Q          |          |          |         V|
23+35      17.8911      2.65  Q          |          |          |         V|
23+40      17.9091      2.63  Q          |          |          |         V|
23+45      17.9271      2.60  Q          |          |          |         V|
23+50      17.9449      2.58  Q          |          |          |         V|
23+55      17.9625      2.56  Q          |          |          |         V|
24+ 0      17.9800      2.54  Q          |          |          |         V|
24+ 5      17.9968      2.44  Q          |          |          |         V|
24+10      18.0099      1.89  Q          |          |          |         V|
24+15      18.0176      1.12  Q          |          |          |         V|
24+20      18.0227      0.75  Q          |          |          |         V|
24+25      18.0265      0.54  Q          |          |          |         V|
24+30      18.0292      0.40  Q          |          |          |         V|
24+35      18.0313      0.30  Q          |          |          |         V|
24+40      18.0329      0.23  Q          |          |          |         V|
```

```
   24+45      18.0340      0.17  Q         |         |         |        V|
   24+50      18.0349      0.13  Q         |         |         |        V|
   24+55      18.0356      0.09  Q         |         |         |        V|
   25+ 0      18.0360      0.07  Q         |         |         |        V|
   25+ 5      18.0364      0.05  Q         |         |         |        V|
   25+10      18.0367      0.04  Q         |         |         |        V|
   25+15      18.0368      0.03  Q         |         |         |        V|
   25+20      18.0369      0.01  Q         |         |         |        V|
   25+25      18.0370      0.01  Q         |         |         |        V|
-----------------------------------------------------------------------
```

U n i t H y d r o g r a p h A n a l y s i s

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Study date 04/09/15

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San Bernardino County Synthetic Unit Hydrology Method
Manual date - August 1986

Program License Serial Number 6320

154166 - AMBOY - SAN BERNARDINO COUNTY
RECLAMATION CONDITION "B"
20-YEAR, 24-HOUR STORM
BY: JTS DATE: 04-09-15

Storm Event Year = 100

Antecedent Moisture Condition = 3

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

English Units used in output format

Area averaged rainfall intensity isohyetal data:

Sub-Area (Ac.)	Duration (hours)	Isohyetal (In)
Rainfall data for year 10		
46.11	1	0.86
Rainfall data for year 2		
46.11	6	0.75
Rainfall data for year 2		
46.11	24	1.07
Rainfall data for year 100		
0.00	1	1.59
46.11	1	1.59
Rainfall data for year 100		
46.11	6	2.43
Rainfall data for year 100		

```
          46.11           24           3.56
-------------------------------------------------------------------
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

******** Area-averaged max loss rate, Fm ********


SCS curve  SCS curve     Area     Area     Fp(Fig C6)    Ap      Fm
No.(AMCII) NO.(AMC 3)    (Ac.)    Fraction     (In/Hr)  (dec.)   (In/Hr)
 91.0      98.2         46.11      1.000     0.036    1.000    0.036

Area-averaged adjusted loss rate Fm (In/Hr) =  0.036

********* Area-Averaged low loss rate fraction, Yb **********

Area       Area          SCS CN    SCS CN      S     Pervious
 (Ac.)      Fract         (AMC2)    (AMC3)           Yield Fr
    46.11   1.000         91.0      98.2       0.18     0.941

Area-averaged catchment yield fraction, Y =  0.941
Area-averaged low loss fraction, Yb =  0.059
User entry of time of concentration  =   0.170 (hours)
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Watershed area =      46.11(Ac.)
Catchment Lag time =   0.136 hours
Unit interval =   5.000 minutes
Unit interval percentage of lag time = 61.2745
Hydrograph baseflow =     0.00(CFS)
Average maximum watershed loss rate(Fm) =  0.036(In/Hr)
Average low loss rate fraction (Yb) = 0.059 (decimal)
DESERT S-Graph Selected
Computed peak 5-minute rainfall =  0.754(In)
Computed peak 30-minute rainfall =  1.291(In)
Specified peak 1-hour rainfall =  1.590(In)
Computed peak 3-hour rainfall =  2.062(In)
Specified peak 6-hour rainfall =  2.430(In)
Specified peak 24-hour rainfall =  3.560(In)


Rainfall depth area reduction factors:
Using a total area of      46.11(Ac.) (Ref: fig. E-4)

5-minute factor = 0.998     Adjusted rainfall =  0.753(In)
30-minute factor = 0.998    Adjusted rainfall =  1.289(In)
1-hour factor = 0.998       Adjusted rainfall =  1.587(In)
3-hour factor = 1.000       Adjusted rainfall =  2.062(In)
6-hour factor = 1.000       Adjusted rainfall =  2.430(In)
24-hour factor = 1.000      Adjusted rainfall =  3.560(In)
-------------------------------------------------------------------

                  U n i t  H y d r o g r a p h
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Interval          'S' Graph          Unit Hydrograph
Number            Mean values             ((CFS))
-------------------------------------------------------------------
            (K =       557.64 (CFS))
```

1	5.829	32.506
2	42.748	205.874
3	68.862	145.626
4	80.052	62.398
5	86.633	36.699
6	90.841	23.464
7	93.754	16.247
8	95.820	11.516
9	97.269	8.081
10	98.124	4.769
11	98.821	3.886
12	99.497	3.774
13	100.000	2.803

Peak Unit Number	Adjusted mass rainfall (In)	Unit rainfall (In)
1	0.7528	0.7528
2	0.9269	0.1740
3	1.0467	0.1199
4	1.1411	0.0944
5	1.2201	0.0790
6	1.2887	0.0686
7	1.3497	0.0610
8	1.4049	0.0552
9	1.4554	0.0505
10	1.5021	0.0467
11	1.5457	0.0436
12	1.5866	0.0409
13	1.6171	0.0306
14	1.6460	0.0288
15	1.6733	0.0273
16	1.6992	0.0259
17	1.7240	0.0247
18	1.7476	0.0237
19	1.7703	0.0227
20	1.7921	0.0218
21	1.8130	0.0210
22	1.8333	0.0202
23	1.8528	0.0195
24	1.8717	0.0189
25	1.8900	0.0183
26	1.9078	0.0178
27	1.9250	0.0172
28	1.9418	0.0168
29	1.9581	0.0163
30	1.9740	0.0159
31	1.9895	0.0155
32	2.0046	0.0151
33	2.0194	0.0148
34	2.0338	0.0144
35	2.0479	0.0141
36	2.0617	0.0138
37	2.0751	0.0134
38	2.0883	0.0132
39	2.1012	0.0129
40	2.1138	0.0126
41	2.1262	0.0124

42	2.1384	0.0122
43	2.1503	0.0120
44	2.1621	0.0117
45	2.1736	0.0115
46	2.1850	0.0113
47	2.1961	0.0112
48	2.2071	0.0110
49	2.2179	0.0108
50	2.2286	0.0106
51	2.2390	0.0105
52	2.2494	0.0103
53	2.2595	0.0102
54	2.2696	0.0100
55	2.2795	0.0099
56	2.2892	0.0098
57	2.2988	0.0096
58	2.3083	0.0095
59	2.3177	0.0094
60	2.3269	0.0092
61	2.3361	0.0091
62	2.3451	0.0090
63	2.3540	0.0089
64	2.3628	0.0088
65	2.3715	0.0087
66	2.3801	0.0086
67	2.3886	0.0085
68	2.3970	0.0084
69	2.4053	0.0083
70	2.4135	0.0082
71	2.4216	0.0081
72	2.4296	0.0080
73	2.4389	0.0093
74	2.4481	0.0092
75	2.4571	0.0091
76	2.4661	0.0090
77	2.4750	0.0089
78	2.4838	0.0088
79	2.4926	0.0087
80	2.5012	0.0087
81	2.5098	0.0086
82	2.5183	0.0085
83	2.5267	0.0084
84	2.5351	0.0084
85	2.5433	0.0083
86	2.5516	0.0082
87	2.5597	0.0081
88	2.5678	0.0081
89	2.5758	0.0080
90	2.5837	0.0079
91	2.5916	0.0079
92	2.5994	0.0078
93	2.6072	0.0078
94	2.6149	0.0077
95	2.6225	0.0076
96	2.6301	0.0076
97	2.6376	0.0075
98	2.6451	0.0075

99	2.6525	0.0074
100	2.6598	0.0074
101	2.6671	0.0073
102	2.6744	0.0072
103	2.6816	0.0072
104	2.6887	0.0071
105	2.6958	0.0071
106	2.7029	0.0070
107	2.7099	0.0070
108	2.7168	0.0070
109	2.7237	0.0069
110	2.7306	0.0069
111	2.7374	0.0068
112	2.7442	0.0068
113	2.7509	0.0067
114	2.7576	0.0067
115	2.7642	0.0066
116	2.7708	0.0066
117	2.7774	0.0066
118	2.7839	0.0065
119	2.7904	0.0065
120	2.7968	0.0064
121	2.8032	0.0064
122	2.8096	0.0064
123	2.8159	0.0063
124	2.8222	0.0063
125	2.8285	0.0063
126	2.8347	0.0062
127	2.8409	0.0062
128	2.8470	0.0061
129	2.8531	0.0061
130	2.8592	0.0061
131	2.8653	0.0060
132	2.8713	0.0060
133	2.8772	0.0060
134	2.8832	0.0059
135	2.8891	0.0059
136	2.8950	0.0059
137	2.9008	0.0058
138	2.9066	0.0058
139	2.9124	0.0058
140	2.9182	0.0058
141	2.9239	0.0057
142	2.9296	0.0057
143	2.9353	0.0057
144	2.9409	0.0056
145	2.9465	0.0056
146	2.9521	0.0056
147	2.9577	0.0056
148	2.9632	0.0055
149	2.9687	0.0055
150	2.9742	0.0055
151	2.9796	0.0054
152	2.9851	0.0054
153	2.9905	0.0054
154	2.9958	0.0054
155	3.0012	0.0053

156	3.0065	0.0053
157	3.0118	0.0053
158	3.0171	0.0053
159	3.0223	0.0052
160	3.0276	0.0052
161	3.0328	0.0052
162	3.0379	0.0052
163	3.0431	0.0052
164	3.0482	0.0051
165	3.0533	0.0051
166	3.0584	0.0051
167	3.0635	0.0051
168	3.0685	0.0050
169	3.0735	0.0050
170	3.0785	0.0050
171	3.0835	0.0050
172	3.0885	0.0050
173	3.0934	0.0049
174	3.0983	0.0049
175	3.1032	0.0049
176	3.1081	0.0049
177	3.1130	0.0049
178	3.1178	0.0048
179	3.1226	0.0048
180	3.1274	0.0048
181	3.1322	0.0048
182	3.1369	0.0048
183	3.1417	0.0047
184	3.1464	0.0047
185	3.1511	0.0047
186	3.1558	0.0047
187	3.1605	0.0047
188	3.1651	0.0046
189	3.1697	0.0046
190	3.1744	0.0046
191	3.1789	0.0046
192	3.1835	0.0046
193	3.1881	0.0046
194	3.1926	0.0045
195	3.1971	0.0045
196	3.2017	0.0045
197	3.2062	0.0045
198	3.2106	0.0045
199	3.2151	0.0045
200	3.2195	0.0044
201	3.2240	0.0044
202	3.2284	0.0044
203	3.2328	0.0044
204	3.2371	0.0044
205	3.2415	0.0044
206	3.2459	0.0043
207	3.2502	0.0043
208	3.2545	0.0043
209	3.2588	0.0043
210	3.2631	0.0043
211	3.2674	0.0043
212	3.2716	0.0043

213	3.2759	0.0042
214	3.2801	0.0042
215	3.2843	0.0042
216	3.2885	0.0042
217	3.2927	0.0042
218	3.2969	0.0042
219	3.3010	0.0042
220	3.3052	0.0041
221	3.3093	0.0041
222	3.3134	0.0041
223	3.3176	0.0041
224	3.3216	0.0041
225	3.3257	0.0041
226	3.3298	0.0041
227	3.3338	0.0041
228	3.3379	0.0040
229	3.3419	0.0040
230	3.3459	0.0040
231	3.3499	0.0040
232	3.3539	0.0040
233	3.3579	0.0040
234	3.3619	0.0040
235	3.3658	0.0040
236	3.3697	0.0039
237	3.3737	0.0039
238	3.3776	0.0039
239	3.3815	0.0039
240	3.3854	0.0039
241	3.3893	0.0039
242	3.3931	0.0039
243	3.3970	0.0039
244	3.4008	0.0038
245	3.4047	0.0038
246	3.4085	0.0038
247	3.4123	0.0038
248	3.4161	0.0038
249	3.4199	0.0038
250	3.4237	0.0038
251	3.4274	0.0038
252	3.4312	0.0038
253	3.4350	0.0037
254	3.4387	0.0037
255	3.4424	0.0037
256	3.4461	0.0037
257	3.4498	0.0037
258	3.4535	0.0037
259	3.4572	0.0037
260	3.4609	0.0037
261	3.4645	0.0037
262	3.4682	0.0037
263	3.4718	0.0036
264	3.4755	0.0036
265	3.4791	0.0036
266	3.4827	0.0036
267	3.4863	0.0036
268	3.4899	0.0036
269	3.4935	0.0036

270	3.4971	0.0036
271	3.5006	0.0036
272	3.5042	0.0036
273	3.5077	0.0035
274	3.5113	0.0035
275	3.5148	0.0035
276	3.5183	0.0035
277	3.5218	0.0035
278	3.5253	0.0035
279	3.5288	0.0035
280	3.5323	0.0035
281	3.5357	0.0035
282	3.5392	0.0035
283	3.5427	0.0035
284	3.5461	0.0034
285	3.5495	0.0034
286	3.5530	0.0034
287	3.5564	0.0034
288	3.5598	0.0034

Unit Period (number)	Unit Rainfall (In)	Unit Soil-Loss (In)	Effective Rainfall (In)
1	0.0034	0.0002	0.0032
2	0.0034	0.0002	0.0032
3	0.0034	0.0002	0.0032
4	0.0034	0.0002	0.0032
5	0.0035	0.0002	0.0033
6	0.0035	0.0002	0.0033
7	0.0035	0.0002	0.0033
8	0.0035	0.0002	0.0033
9	0.0035	0.0002	0.0033
10	0.0035	0.0002	0.0033
11	0.0035	0.0002	0.0033
12	0.0036	0.0002	0.0033
13	0.0036	0.0002	0.0034
14	0.0036	0.0002	0.0034
15	0.0036	0.0002	0.0034
16	0.0036	0.0002	0.0034
17	0.0036	0.0002	0.0034
18	0.0036	0.0002	0.0034
19	0.0037	0.0002	0.0034
20	0.0037	0.0002	0.0035
21	0.0037	0.0002	0.0035
22	0.0037	0.0002	0.0035
23	0.0037	0.0002	0.0035
24	0.0037	0.0002	0.0035
25	0.0038	0.0002	0.0035
26	0.0038	0.0002	0.0035
27	0.0038	0.0002	0.0036
28	0.0038	0.0002	0.0036
29	0.0038	0.0002	0.0036
30	0.0038	0.0002	0.0036
31	0.0039	0.0002	0.0036
32	0.0039	0.0002	0.0036
33	0.0039	0.0002	0.0037

34	0.0039	0.0002	0.0037
35	0.0039	0.0002	0.0037
36	0.0039	0.0002	0.0037
37	0.0040	0.0002	0.0037
38	0.0040	0.0002	0.0037
39	0.0040	0.0002	0.0038
40	0.0040	0.0002	0.0038
41	0.0040	0.0002	0.0038
42	0.0041	0.0002	0.0038
43	0.0041	0.0002	0.0038
44	0.0041	0.0002	0.0038
45	0.0041	0.0002	0.0039
46	0.0041	0.0002	0.0039
47	0.0042	0.0002	0.0039
48	0.0042	0.0002	0.0039
49	0.0042	0.0002	0.0040
50	0.0042	0.0002	0.0040
51	0.0042	0.0003	0.0040
52	0.0043	0.0003	0.0040
53	0.0043	0.0003	0.0040
54	0.0043	0.0003	0.0040
55	0.0043	0.0003	0.0041
56	0.0043	0.0003	0.0041
57	0.0044	0.0003	0.0041
58	0.0044	0.0003	0.0041
59	0.0044	0.0003	0.0042
60	0.0044	0.0003	0.0042
61	0.0045	0.0003	0.0042
62	0.0045	0.0003	0.0042
63	0.0045	0.0003	0.0043
64	0.0045	0.0003	0.0043
65	0.0046	0.0003	0.0043
66	0.0046	0.0003	0.0043
67	0.0046	0.0003	0.0044
68	0.0046	0.0003	0.0044
69	0.0047	0.0003	0.0044
70	0.0047	0.0003	0.0044
71	0.0047	0.0003	0.0045
72	0.0048	0.0003	0.0045
73	0.0048	0.0003	0.0045
74	0.0048	0.0003	0.0045
75	0.0049	0.0003	0.0046
76	0.0049	0.0003	0.0046
77	0.0049	0.0003	0.0046
78	0.0049	0.0003	0.0046
79	0.0050	0.0003	0.0047
80	0.0050	0.0003	0.0047
81	0.0050	0.0003	0.0047
82	0.0051	0.0003	0.0048
83	0.0051	0.0003	0.0048
84	0.0051	0.0003	0.0048
85	0.0052	0.0003	0.0049
86	0.0052	0.0003	0.0049
87	0.0052	0.0003	0.0049
88	0.0053	0.0003	0.0050
89	0.0053	0.0003	0.0050
90	0.0053	0.0003	0.0050

91	0.0054	0.0003	0.0051
92	0.0054	0.0003	0.0051
93	0.0055	0.0003	0.0052
94	0.0055	0.0003	0.0052
95	0.0056	0.0003	0.0052
96	0.0056	0.0003	0.0053
97	0.0056	0.0003	0.0053
98	0.0057	0.0003	0.0053
99	0.0057	0.0003	0.0054
100	0.0058	0.0003	0.0054
101	0.0058	0.0003	0.0055
102	0.0058	0.0003	0.0055
103	0.0059	0.0004	0.0056
104	0.0059	0.0004	0.0056
105	0.0060	0.0004	0.0057
106	0.0060	0.0004	0.0057
107	0.0061	0.0004	0.0057
108	0.0061	0.0004	0.0058
109	0.0062	0.0004	0.0058
110	0.0063	0.0004	0.0059
111	0.0063	0.0004	0.0060
112	0.0064	0.0004	0.0060
113	0.0064	0.0004	0.0061
114	0.0065	0.0004	0.0061
115	0.0066	0.0004	0.0062
116	0.0066	0.0004	0.0062
117	0.0067	0.0004	0.0063
118	0.0067	0.0004	0.0063
119	0.0068	0.0004	0.0064
120	0.0069	0.0004	0.0065
121	0.0070	0.0004	0.0065
122	0.0070	0.0004	0.0066
123	0.0071	0.0004	0.0067
124	0.0071	0.0004	0.0067
125	0.0072	0.0004	0.0068
126	0.0073	0.0004	0.0069
127	0.0074	0.0004	0.0070
128	0.0075	0.0004	0.0070
129	0.0076	0.0004	0.0071
130	0.0076	0.0005	0.0072
131	0.0078	0.0005	0.0073
132	0.0078	0.0005	0.0074
133	0.0079	0.0005	0.0075
134	0.0080	0.0005	0.0075
135	0.0081	0.0005	0.0077
136	0.0082	0.0005	0.0077
137	0.0084	0.0005	0.0079
138	0.0084	0.0005	0.0079
139	0.0086	0.0005	0.0081
140	0.0087	0.0005	0.0081
141	0.0088	0.0005	0.0083
142	0.0089	0.0005	0.0084
143	0.0091	0.0005	0.0085
144	0.0092	0.0005	0.0086
145	0.0080	0.0005	0.0076
146	0.0081	0.0005	0.0076
147	0.0083	0.0005	0.0078

148	0.0084	0.0005	0.0079
149	0.0086	0.0005	0.0081
150	0.0087	0.0005	0.0082
151	0.0089	0.0005	0.0084
152	0.0090	0.0005	0.0085
153	0.0092	0.0005	0.0087
154	0.0094	0.0006	0.0088
155	0.0096	0.0006	0.0090
156	0.0098	0.0006	0.0092
157	0.0100	0.0006	0.0094
158	0.0102	0.0006	0.0096
159	0.0105	0.0006	0.0099
160	0.0106	0.0006	0.0100
161	0.0110	0.0007	0.0103
162	0.0112	0.0007	0.0105
163	0.0115	0.0007	0.0109
164	0.0117	0.0007	0.0110
165	0.0122	0.0007	0.0115
166	0.0124	0.0007	0.0117
167	0.0129	0.0008	0.0121
168	0.0132	0.0008	0.0124
169	0.0138	0.0008	0.0130
170	0.0141	0.0008	0.0133
171	0.0148	0.0009	0.0139
172	0.0151	0.0009	0.0142
173	0.0159	0.0009	0.0150
174	0.0163	0.0010	0.0153
175	0.0172	0.0010	0.0162
176	0.0178	0.0011	0.0167
177	0.0189	0.0011	0.0178
178	0.0195	0.0012	0.0184
179	0.0210	0.0012	0.0197
180	0.0218	0.0013	0.0205
181	0.0237	0.0014	0.0223
182	0.0247	0.0015	0.0233
183	0.0273	0.0016	0.0257
184	0.0288	0.0017	0.0271
185	0.0409	0.0024	0.0385
186	0.0436	0.0026	0.0410
187	0.0505	0.0030	0.0475
188	0.0552	0.0030	0.0522
189	0.0686	0.0030	0.0656
190	0.0790	0.0030	0.0760
191	0.1199	0.0030	0.1169
192	0.1740	0.0030	0.1710
193	0.7528	0.0030	0.7499
194	0.0944	0.0030	0.0914
195	0.0610	0.0030	0.0580
196	0.0467	0.0028	0.0440
197	0.0306	0.0018	0.0288
198	0.0259	0.0015	0.0244
199	0.0227	0.0013	0.0213
200	0.0202	0.0012	0.0190
201	0.0183	0.0011	0.0172
202	0.0168	0.0010	0.0158
203	0.0155	0.0009	0.0146
204	0.0144	0.0009	0.0136

205	0.0134	0.0008	0.0126
206	0.0126	0.0007	0.0119
207	0.0120	0.0007	0.0112
208	0.0113	0.0007	0.0107
209	0.0108	0.0006	0.0102
210	0.0103	0.0006	0.0097
211	0.0099	0.0006	0.0093
212	0.0095	0.0006	0.0089
213	0.0091	0.0005	0.0086
214	0.0088	0.0005	0.0083
215	0.0085	0.0005	0.0080
216	0.0082	0.0005	0.0077
217	0.0093	0.0005	0.0087
218	0.0090	0.0005	0.0085
219	0.0087	0.0005	0.0082
220	0.0085	0.0005	0.0080
221	0.0083	0.0005	0.0078
222	0.0081	0.0005	0.0076
223	0.0079	0.0005	0.0074
224	0.0077	0.0005	0.0072
225	0.0075	0.0004	0.0071
226	0.0074	0.0004	0.0069
227	0.0072	0.0004	0.0068
228	0.0070	0.0004	0.0066
229	0.0069	0.0004	0.0065
230	0.0068	0.0004	0.0064
231	0.0066	0.0004	0.0063
232	0.0065	0.0004	0.0061
233	0.0064	0.0004	0.0060
234	0.0063	0.0004	0.0059
235	0.0062	0.0004	0.0058
236	0.0061	0.0004	0.0057
237	0.0060	0.0004	0.0056
238	0.0059	0.0003	0.0055
239	0.0058	0.0003	0.0054
240	0.0057	0.0003	0.0054
241	0.0056	0.0003	0.0053
242	0.0055	0.0003	0.0052
243	0.0054	0.0003	0.0051
244	0.0054	0.0003	0.0051
245	0.0053	0.0003	0.0050
246	0.0052	0.0003	0.0049
247	0.0052	0.0003	0.0048
248	0.0051	0.0003	0.0048
249	0.0050	0.0003	0.0047
250	0.0050	0.0003	0.0047
251	0.0049	0.0003	0.0046
252	0.0048	0.0003	0.0045
253	0.0048	0.0003	0.0045
254	0.0047	0.0003	0.0044
255	0.0047	0.0003	0.0044
256	0.0046	0.0003	0.0043
257	0.0046	0.0003	0.0043
258	0.0045	0.0003	0.0042
259	0.0045	0.0003	0.0042
260	0.0044	0.0003	0.0042
261	0.0044	0.0003	0.0041

262	0.0043	0.0003	0.0041
263	0.0043	0.0003	0.0040
264	0.0042	0.0003	0.0040
265	0.0042	0.0002	0.0039
266	0.0041	0.0002	0.0039
267	0.0041	0.0002	0.0039
268	0.0041	0.0002	0.0038
269	0.0040	0.0002	0.0038
270	0.0040	0.0002	0.0038
271	0.0040	0.0002	0.0037
272	0.0039	0.0002	0.0037
273	0.0039	0.0002	0.0037
274	0.0038	0.0002	0.0036
275	0.0038	0.0002	0.0036
276	0.0038	0.0002	0.0036
277	0.0037	0.0002	0.0035
278	0.0037	0.0002	0.0035
279	0.0037	0.0002	0.0035
280	0.0037	0.0002	0.0034
281	0.0036	0.0002	0.0034
282	0.0036	0.0002	0.0034
283	0.0036	0.0002	0.0034
284	0.0035	0.0002	0.0033
285	0.0035	0.0002	0.0033
286	0.0035	0.0002	0.0033
287	0.0035	0.0002	0.0032
288	0.0034	0.0002	0.0032

Total soil rain loss = 0.15(In)
Total effective rainfall = 3.41(In)
Peak flow rate in flood hydrograph = 196.06(CFS)

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24 - H O U R S T O R M
R u n o f f H y d r o g r a p h

Hydrograph in 5 Minute intervals ((CFS))

Time(h+m)	Volume Ac.Ft	Q(CFS)	0	50.0	100.0	150.0	200.0
0+ 5	0.0007	0.10	Q	|	|	|	|
0+10	0.0060	0.76	Q	|	|	|	|
0+15	0.0145	1.23	Q	|	|	|	|
0+20	0.0244	1.44	Q	|	|	|	|
0+25	0.0352	1.56	Q	|	|	|	|
0+30	0.0465	1.64	Q	|	|	|	|
0+35	0.0582	1.70	Q	|	|	|	|
0+40	0.0702	1.75	Q	|	|	|	|
0+45	0.0825	1.78	Q	|	|	|	|
0+50	0.0949	1.80	Q	|	|	|	|
0+55	0.1074	1.82	Q	|	|	|	|
1+ 0	0.1201	1.84	Q	|	|	|	|
1+ 5	0.1328	1.86	Q	|	|	|	|
1+10	0.1457	1.86	Q	|	|	|	|
1+15	0.1586	1.87	Q	|	|	|	|

1+20	0.1715	1.88	Q	|	|	|	|
1+25	0.1845	1.89	Q	|	|	|	|
1+30	0.1975	1.89	Q	|	|	|	|
1+35	0.2106	1.90	Q	|	|	|	|
1+40	0.2238	1.91	Q	|	|	|	|
1+45	0.2370	1.92	Q	|	|	|	|
1+50	0.2502	1.93	Q	|	|	|	|
1+55	0.2635	1.93	Q	|	|	|	|
2+ 0	0.2769	1.94	Q	|	|	|	|
2+ 5	0.2903	1.95	Q	|	|	|	|
2+10	0.3038	1.96	Q	|	|	|	|
2+15	0.3173	1.97	Q	|	|	|	|
2+20	0.3309	1.97	QV	|	|	|	|
2+25	0.3446	1.98	QV	|	|	|	|
2+30	0.3583	1.99	QV	|	|	|	|
2+35	0.3721	2.00	QV	|	|	|	|
2+40	0.3859	2.01	QV	|	|	|	|
2+45	0.3998	2.02	QV	|	|	|	|
2+50	0.4138	2.03	QV	|	|	|	|
2+55	0.4278	2.04	QV	|	|	|	|
3+ 0	0.4419	2.05	QV	|	|	|	|
3+ 5	0.4561	2.06	QV	|	|	|	|
3+10	0.4703	2.07	QV	|	|	|	|
3+15	0.4846	2.07	QV	|	|	|	|
3+20	0.4989	2.08	QV	|	|	|	|
3+25	0.5134	2.09	QV	|	|	|	|
3+30	0.5278	2.10	QV	|	|	|	|
3+35	0.5424	2.11	QV	|	|	|	|
3+40	0.5570	2.12	QV	|	|	|	|
3+45	0.5717	2.13	QV	|	|	|	|
3+50	0.5865	2.14	QV	|	|	|	|
3+55	0.6013	2.15	QV	|	|	|	|
4+ 0	0.6163	2.17	QV	|	|	|	|
4+ 5	0.6312	2.18	QV	|	|	|	|
4+10	0.6463	2.19	QV	|	|	|	|
4+15	0.6614	2.20	Q V	|	|	|	|
4+20	0.6767	2.21	Q V	|	|	|	|
4+25	0.6920	2.22	Q V	|	|	|	|
4+30	0.7073	2.23	Q V	|	|	|	|
4+35	0.7228	2.24	Q V	|	|	|	|
4+40	0.7383	2.26	Q V	|	|	|	|
4+45	0.7539	2.27	Q V	|	|	|	|
4+50	0.7696	2.28	Q V	|	|	|	|
4+55	0.7854	2.29	Q V	|	|	|	|
5+ 0	0.8013	2.30	Q V	|	|	|	|
5+ 5	0.8172	2.32	Q V	|	|	|	|
5+10	0.8332	2.33	Q V	|	|	|	|
5+15	0.8494	2.34	Q V	|	|	|	|
5+20	0.8656	2.35	Q V	|	|	|	|
5+25	0.8819	2.37	Q V	|	|	|	|
5+30	0.8983	2.38	Q V	|	|	|	|
5+35	0.9147	2.39	Q V	|	|	|	|
5+40	0.9313	2.41	Q V	|	|	|	|
5+45	0.9480	2.42	Q V	|	|	|	|
5+50	0.9648	2.44	Q V	|	|	|	|
5+55	0.9816	2.45	Q V	|	|	|	|
6+ 0	0.9986	2.46	Q V	|	|	|	|

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 6+ 5       1.0157      2.48  Q  V      |          |          |          |
 6+10       1.0328      2.49  Q  V      |          |          |          |
 6+15       1.0501      2.51  Q  V      |          |          |          |
 6+20       1.0675      2.52  Q  V      |          |          |          |
 6+25       1.0850      2.54  Q  V      |          |          |          |
 6+30       1.1026      2.55  Q  V      |          |          |          |
 6+35       1.1203      2.57  Q  V      |          |          |          |
 6+40       1.1381      2.59  Q  V      |          |          |          |
 6+45       1.1560      2.60  Q  V      |          |          |          |
 6+50       1.1741      2.62  Q  V      |          |          |          |
 6+55       1.1922      2.64  Q  V      |          |          |          |
 7+ 0       1.2105      2.65  Q  V      |          |          |          |
 7+ 5       1.2289      2.67  Q  V      |          |          |          |
 7+10       1.2474      2.69  Q  V      |          |          |          |
 7+15       1.2660      2.71  Q  V      |          |          |          |
 7+20       1.2848      2.73  Q  V      |          |          |          |
 7+25       1.3037      2.74  Q  V      |          |          |          |
 7+30       1.3227      2.76  Q   V     |          |          |          |
 7+35       1.3419      2.78  Q   V     |          |          |          |
 7+40       1.3612      2.80  Q   V     |          |          |          |
 7+45       1.3806      2.82  Q   V     |          |          |          |
 7+50       1.4002      2.84  Q   V     |          |          |          |
 7+55       1.4199      2.86  Q   V     |          |          |          |
 8+ 0       1.4397      2.88  Q   V     |          |          |          |
 8+ 5       1.4597      2.90  Q   V     |          |          |          |
 8+10       1.4799      2.93  Q   V     |          |          |          |
 8+15       1.5002      2.95  Q   V     |          |          |          |
 8+20       1.5206      2.97  Q   V     |          |          |          |
 8+25       1.5412      2.99  Q   V     |          |          |          |
 8+30       1.5620      3.02  Q   V     |          |          |          |
 8+35       1.5829      3.04  Q   V     |          |          |          |
 8+40       1.6040      3.06  Q   V     |          |          |          |
 8+45       1.6253      3.09  Q   V     |          |          |          |
 8+50       1.6467      3.11  Q    V    |          |          |          |
 8+55       1.6684      3.14  Q    V    |          |          |          |
 9+ 0       1.6902      3.17  Q    V    |          |          |          |
 9+ 5       1.7121      3.19  Q    V    |          |          |          |
 9+10       1.7343      3.22  Q    V    |          |          |          |
 9+15       1.7566      3.25  Q    V    |          |          |          |
 9+20       1.7792      3.27  Q    V    |          |          |          |
 9+25       1.8019      3.30  Q    V    |          |          |          |
 9+30       1.8249      3.33  Q    V    |          |          |          |
 9+35       1.8481      3.36  Q    V    |          |          |          |
 9+40       1.8714      3.39  Q    V    |          |          |          |
 9+45       1.8950      3.42  Q    V    |          |          |          |
 9+50       1.9188      3.46  Q    V    |          |          |          |
 9+55       1.9429      3.49  Q    V    |          |          |          |
10+ 0       1.9671      3.52  Q     V   |          |          |          |
10+ 5       1.9916      3.56  Q     V   |          |          |          |
10+10       2.0164      3.59  Q     V   |          |          |          |
10+15       2.0414      3.63  Q     V   |          |          |          |
10+20       2.0666      3.67  Q     V   |          |          |          |
10+25       2.0921      3.70  Q     V   |          |          |          |
10+30       2.1179      3.74  Q     V   |          |          |          |
10+35       2.1439      3.78  Q     V   |          |          |          |
10+40       2.1703      3.82  Q     V   |          |          |          |
10+45       2.1969      3.86  Q     V   |          |          |          |
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10+50       2.2238      3.91  Q     V   |          |          |          |
10+55       2.2510      3.95  Q     V   |          |          |          |
11+ 0       2.2785      4.00  Q     V   |          |          |          |
11+ 5       2.3064      4.04  Q      V  |          |          |          |
11+10       2.3345      4.09  Q      V  |          |          |          |
11+15       2.3631      4.14  Q      V  |          |          |          |
11+20       2.3919      4.19  Q      V  |          |          |          |
11+25       2.4211      4.24  Q      V  |          |          |          |
11+30       2.4507      4.30  Q      V  |          |          |          |
11+35       2.4807      4.35  Q      V  |          |          |          |
11+40       2.5111      4.41  Q      V  |          |          |          |
11+45       2.5418      4.47  Q      V  |          |          |          |
11+50       2.5730      4.53  Q      V  |          |          |          |
11+55       2.6046      4.59  Q      V  |          |          |          |
12+ 0       2.6367      4.66  Q       V |          |          |          |
12+ 5       2.6690      4.68  Q       V |          |          |          |
12+10       2.7000      4.50  Q       V |          |          |          |
12+15       2.7302      4.39  Q       V |          |          |          |
12+20       2.7604      4.38  Q       V |          |          |          |
12+25       2.7907      4.41  Q       V |          |          |          |
12+30       2.8214      4.46  Q       V |          |          |          |
12+35       2.8525      4.51  Q       V |          |          |          |
12+40       2.8840      4.58  Q       V |          |          |          |
12+45       2.9160      4.65  Q       V |          |          |          |
12+50       2.9486      4.73  Q        V|          |          |          |
12+55       2.9817      4.81  Q        V|          |          |          |
13+ 0       3.0155      4.90  Q        V|          |          |          |
13+ 5       3.0499      5.00  Q        V|          |          |          |
13+10       3.0850      5.10  |Q       V|          |          |          |
13+15       3.1209      5.20  |Q       V|          |          |          |
13+20       3.1576      5.32  |Q       V|          |          |          |
13+25       3.1950      5.44  |Q       V|          |          |          |
13+30       3.2333      5.57  |Q       V|          |          |          |
13+35       3.2725      5.69  |Q        V          |          |          |
13+40       3.3128      5.84  |Q        V          |          |          |
13+45       3.3540      5.98  |Q        V          |          |          |
13+50       3.3963      6.14  |Q        V          |          |          |
13+55       3.4397      6.30  |Q        V          |          |          |
14+ 0       3.4844      6.49  |Q        V          |          |          |
14+ 5       3.5303      6.67  |Q        V          |          |          |
14+10       3.5779      6.90  |Q        V          |          |          |
14+15       3.6269      7.12  |Q        |V         |          |          |
14+20       3.6777      7.37  |Q        |V         |          |          |
14+25       3.7302      7.62  |Q        |V         |          |          |
14+30       3.7846      7.91  |Q        |V         |          |          |
14+35       3.8411      8.20  |Q        |V         |          |          |
14+40       3.8999      8.54  |Q        |V         |          |          |
14+45       3.9611      8.89  |Q        | V        |          |          |
14+50       4.0252      9.30  |Q        | V        |          |          |
14+55       4.0922      9.73  |Q        | V        |          |          |
15+ 0       4.1627     10.25  | Q       | V        |          |          |
15+ 5       4.2369     10.78  | Q       | V        |          |          |
15+10       4.3157     11.44  | Q       |  V       |          |          |
15+15       4.3993     12.14  | Q       |  V       |          |          |
15+20       4.4891     13.03  | Q       |  V       |          |          |
15+25       4.5872     14.24  | Q       |   V      |          |          |
15+30       4.7053     17.14  |  Q      |   V      |          |          |
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15+35       4.8415     19.79  |  Q      |   V     |         |         |
15+40       4.9967     22.53  |   Q     |    V    |         |         |
15+45       5.1728     25.57  |    Q    |    V    |         |         |
15+50       5.3807     30.19  |     Q   |     V   |         |         |
15+55       5.6317     36.44  |      Q  |      V  |         |         |
16+ 0       5.9726     49.51  |        Q|       V |         |         |
16+ 5       6.5713     86.92  |         |      Q  V         |         |
16+10       7.9215    196.06  |         |         |   V     |        Q|
16+15       8.9492    149.21  |         |         |      V Q|         |
16+20       9.5381     85.51  |         |      Q  |        V|         |
16+25       9.9490     59.67  |         |Q        |         V         |
16+30      10.2468     43.24  |       Q |         |         |V        |
16+35      10.4739     32.97  |     Q   |         |         | V       |
16+40      10.6535     26.08  |    Q    |         |         | V       |
16+45      10.7980     20.99  |   Q     |         |         | V       |
16+50      10.9134     16.75  |  Q      |         |         |  V      |
16+55      11.0135     14.54  | Q       |         |         |  V      |
17+ 0      11.1033     13.04  | Q       |         |         |  V      |
17+ 5      11.1800     11.13  | Q       |         |         |   V     |
17+10      11.2377      8.39  |Q        |         |         |   V     |
17+15      11.2903      7.63  |Q        |         |         |   V     |
17+20      11.3389      7.06  |Q        |         |         |   V     |
17+25      11.3843      6.59  |Q        |         |         |   V     |
17+30      11.4272      6.22  |Q        |         |         |   V     |
17+35      11.4678      5.89  |Q        |         |         |    V    |
17+40      11.5064      5.61  |Q        |         |         |    V    |
17+45      11.5432      5.35  |Q        |         |         |    V    |
17+50      11.5785      5.12  |Q        |         |         |    V    |
17+55      11.6124      4.92  Q         |         |         |    V    |
18+ 0      11.6450      4.73  Q         |         |         |    V    |
18+ 5      11.6767      4.60  Q         |         |         |    V    |
18+10      11.7090      4.69  Q         |         |         |    V    |
18+15      11.7415      4.72  Q         |         |         |    V    |
18+20      11.7735      4.65  Q         |         |         |    V    |
18+25      11.8049      4.56  Q         |         |         |     V   |
18+30      11.8357      4.46  Q         |         |         |     V   |
18+35      11.8657      4.37  Q         |         |         |     V   |
18+40      11.8951      4.27  Q         |         |         |     V   |
18+45      11.9239      4.17  Q         |         |         |     V   |
18+50      11.9519      4.08  Q         |         |         |     V   |
18+55      11.9794      3.99  Q         |         |         |     V   |
19+ 0      12.0063      3.90  Q         |         |         |     V   |
19+ 5      12.0326      3.82  Q         |         |         |     V   |
19+10      12.0583      3.74  Q         |         |         |     V   |
19+15      12.0836      3.66  Q         |         |         |     V   |
19+20      12.1083      3.59  Q         |         |         |      V  |
19+25      12.1326      3.52  Q         |         |         |      V  |
19+30      12.1564      3.45  Q         |         |         |      V  |
19+35      12.1797      3.39  Q         |         |         |      V  |
19+40      12.2026      3.33  Q         |         |         |      V  |
19+45      12.2252      3.27  Q         |         |         |      V  |
19+50      12.2473      3.22  Q         |         |         |      V  |
19+55      12.2691      3.16  Q         |         |         |      V  |
20+ 0      12.2905      3.11  Q         |         |         |      V  |
20+ 5      12.3116      3.06  Q         |         |         |      V  |
20+10      12.3324      3.01  Q         |         |         |      V  |
20+15      12.3528      2.97  Q         |         |         |      V  |
```

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20+20      12.3729      2.92  Q          |          |          |       V  |
20+25      12.3928      2.88  Q          |          |          |       V  |
20+30      12.4123      2.84  Q          |          |          |       V  |
20+35      12.4316      2.80  Q          |          |          |       V  |
20+40      12.4506      2.76  Q          |          |          |        V |
20+45      12.4694      2.72  Q          |          |          |        V |
20+50      12.4879      2.69  Q          |          |          |        V |
20+55      12.5061      2.65  Q          |          |          |        V |
21+ 0      12.5241      2.62  Q          |          |          |        V |
21+ 5      12.5419      2.58  Q          |          |          |        V |
21+10      12.5595      2.55  Q          |          |          |        V |
21+15      12.5769      2.52  Q          |          |          |        V |
21+20      12.5940      2.49  Q          |          |          |        V |
21+25      12.6110      2.46  Q          |          |          |        V |
21+30      12.6277      2.43  Q          |          |          |        V |
21+35      12.6443      2.41  Q          |          |          |        V |
21+40      12.6607      2.38  Q          |          |          |        V |
21+45      12.6769      2.35  Q          |          |          |        V |
21+50      12.6929      2.33  Q          |          |          |        V |
21+55      12.7088      2.30  Q          |          |          |        V |
22+ 0      12.7244      2.28  Q          |          |          |        V |
22+ 5      12.7400      2.25  Q          |          |          |        V |
22+10      12.7553      2.23  Q          |          |          |        V |
22+15      12.7705      2.21  Q          |          |          |         V|
22+20      12.7856      2.19  Q          |          |          |         V|
22+25      12.8005      2.16  Q          |          |          |         V|
22+30      12.8152      2.14  Q          |          |          |         V|
22+35      12.8298      2.12  Q          |          |          |         V|
22+40      12.8443      2.10  Q          |          |          |         V|
22+45      12.8587      2.08  Q          |          |          |         V|
22+50      12.8729      2.06  Q          |          |          |         V|
22+55      12.8870      2.04  Q          |          |          |         V|
23+ 0      12.9009      2.03  Q          |          |          |         V|
23+ 5      12.9147      2.01  Q          |          |          |         V|
23+10      12.9284      1.99  Q          |          |          |         V|
23+15      12.9420      1.97  Q          |          |          |         V|
23+20      12.9555      1.96  Q          |          |          |         V|
23+25      12.9689      1.94  Q          |          |          |         V|
23+30      12.9821      1.92  Q          |          |          |         V|
23+35      12.9953      1.91  Q          |          |          |         V|
23+40      13.0083      1.89  Q          |          |          |         V|
23+45      13.0212      1.88  Q          |          |          |         V|
23+50      13.0340      1.86  Q          |          |          |         V|
23+55      13.0467      1.85  Q          |          |          |         V|
24+ 0      13.0594      1.83  Q          |          |          |         V|
24+ 5      13.0712      1.71  Q          |          |          |         V|
24+10      13.0783      1.04  Q          |          |          |         V|
24+15      13.0823      0.57  Q          |          |          |         V|
24+20      13.0848      0.36  Q          |          |          |         V|
24+25      13.0865      0.24  Q          |          |          |         V|
24+30      13.0876      0.17  Q          |          |          |         V|
24+35      13.0884      0.11  Q          |          |          |         V|
24+40      13.0889      0.08  Q          |          |          |         V|
24+45      13.0893      0.05  Q          |          |          |         V|
24+50      13.0895      0.03  Q          |          |          |         V|
24+55      13.0896      0.02  Q          |          |          |         V|
25+ 0      13.0897      0.01  Q          |          |          |          V
```

U n i t H y d r o g r a p h A n a l y s i s

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Study date 04/09/15

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San Bernardino County Synthetic Unit Hydrology Method
Manual date - August 1986

Program License Serial Number 6320

154166 - AMBOY - SAN BERNARDINO COUNTY
RECLAMATION CONDITION "C"
100-YEAR, 24-HOUR STORM
BY: JTS DATE: 04-09-15

Storm Event Year = 100

Antecedent Moisture Condition = 3

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

English Units used in output format

Area averaged rainfall intensity isohyetal data:

Sub-Area (Ac.)	Duration (hours)	Isohyetal (In)
Rainfall data for year 10		
51.21	1	0.86
Rainfall data for year 2		
51.21	6	0.75
Rainfall data for year 2		
51.21	24	1.07
Rainfall data for year 100		
51.21	1	1.59
Rainfall data for year 100		
51.21	6	2.43
Rainfall data for year 100		
51.21	24	3.56

```
-----------------------------------------------------------------------
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

******** Area-averaged max loss rate, Fm ********


SCS curve  SCS curve     Area     Area     Fp(Fig C6)    Ap      Fm
No.(AMCII) NO.(AMC 3)    (Ac.)    Fraction     (In/Hr)  (dec.)   (In/Hr)
 91.0      98.2         51.21      1.000     0.036    1.000    0.036

Area-averaged adjusted loss rate Fm (In/Hr) =  0.036

********* Area-Averaged low loss rate fraction, Yb **********

Area       Area          SCS CN    SCS CN      S     Pervious
 (Ac.)      Fract         (AMC2)    (AMC3)           Yield Fr
    51.21   1.000         91.0      98.2       0.18     0.941

Area-averaged catchment yield fraction, Y =  0.941
Area-averaged low loss fraction, Yb =  0.059
User entry of time of concentration  =   0.220 (hours)
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Watershed area =      51.21(Ac.)
Catchment Lag time =   0.176 hours
Unit interval =   5.000 minutes
Unit interval percentage of lag time = 47.3485
Hydrograph baseflow =     0.00(CFS)
Average maximum watershed loss rate(Fm) =  0.036(In/Hr)
Average low loss rate fraction (Yb) = 0.059 (decimal)
DESERT S-Graph Selected
Computed peak 5-minute rainfall =  0.754(In)
Computed peak 30-minute rainfall =  1.291(In)
Specified peak 1-hour rainfall =  1.590(In)
Computed peak 3-hour rainfall =  2.062(In)
Specified peak 6-hour rainfall =  2.430(In)
Specified peak 24-hour rainfall =  3.560(In)


Rainfall depth area reduction factors:
Using a total area of      51.21(Ac.) (Ref: fig. E-4)

5-minute factor = 0.998     Adjusted rainfall =  0.753(In)
30-minute factor = 0.998    Adjusted rainfall =  1.288(In)
1-hour factor = 0.998       Adjusted rainfall =  1.586(In)
3-hour factor = 1.000       Adjusted rainfall =  2.062(In)
6-hour factor = 1.000       Adjusted rainfall =  2.430(In)
24-hour factor = 1.000      Adjusted rainfall =  3.560(In)
-----------------------------------------------------------------------

                  U n i t  H y d r o g r a p h
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Interval          'S' Graph          Unit Hydrograph
Number            Mean values             ((CFS))
-----------------------------------------------------------------------
            (K =       619.32 (CFS))

  1                3.621                   22.428
```

2	27.374	147.107
3	58.032	189.872
4	71.898	85.875
5	79.947	49.849
6	85.264	32.926
7	89.111	23.825
8	91.816	16.753
9	93.936	13.132
10	95.547	9.976
11	96.789	7.695
12	97.673	5.473
13	98.224	3.409
14	98.770	3.386
15	99.332	3.480
16	99.712	2.351
17	100.000	1.784

Peak Unit Number	Adjusted mass rainfall (In)	Unit rainfall (In)
1	0.7527	0.7527
2	0.9266	0.1740
3	1.0465	0.1199
4	1.1408	0.0943
5	1.2198	0.0790
6	1.2884	0.0686
7	1.3494	0.0610
8	1.4045	0.0552
9	1.4550	0.0505
10	1.5018	0.0467
11	1.5453	0.0436
12	1.5862	0.0409
13	1.6168	0.0306
14	1.6456	0.0288
15	1.6729	0.0273
16	1.6989	0.0260
17	1.7237	0.0248
18	1.7473	0.0237
19	1.7700	0.0227
20	1.7918	0.0218
21	1.8128	0.0210
22	1.8330	0.0202
23	1.8526	0.0195
24	1.8715	0.0189
25	1.8898	0.0183
26	1.9076	0.0178
27	1.9249	0.0173
28	1.9416	0.0168
29	1.9580	0.0163
30	1.9739	0.0159
31	1.9894	0.0155
32	2.0045	0.0151
33	2.0193	0.0148
34	2.0337	0.0144
35	2.0478	0.0141
36	2.0616	0.0138
37	2.0751	0.0134
38	2.0882	0.0132

39	2.1011	0.0129
40	2.1138	0.0126
41	2.1262	0.0124
42	2.1383	0.0122
43	2.1503	0.0120
44	2.1620	0.0117
45	2.1736	0.0115
46	2.1849	0.0113
47	2.1961	0.0112
48	2.2071	0.0110
49	2.2179	0.0108
50	2.2285	0.0106
51	2.2390	0.0105
52	2.2493	0.0103
53	2.2595	0.0102
54	2.2695	0.0100
55	2.2794	0.0099
56	2.2892	0.0098
57	2.2988	0.0096
58	2.3083	0.0095
59	2.3176	0.0094
60	2.3269	0.0092
61	2.3360	0.0091
62	2.3450	0.0090
63	2.3539	0.0089
64	2.3627	0.0088
65	2.3714	0.0087
66	2.3800	0.0086
67	2.3885	0.0085
68	2.3969	0.0084
69	2.4052	0.0083
70	2.4134	0.0082
71	2.4216	0.0081
72	2.4296	0.0080
73	2.4389	0.0093
74	2.4480	0.0092
75	2.4571	0.0091
76	2.4661	0.0090
77	2.4750	0.0089
78	2.4838	0.0088
79	2.4925	0.0087
80	2.5012	0.0087
81	2.5098	0.0086
82	2.5183	0.0085
83	2.5267	0.0084
84	2.5350	0.0084
85	2.5433	0.0083
86	2.5515	0.0082
87	2.5597	0.0081
88	2.5677	0.0081
89	2.5757	0.0080
90	2.5837	0.0079
91	2.5916	0.0079
92	2.5994	0.0078
93	2.6071	0.0078
94	2.6148	0.0077
95	2.6225	0.0076

96	2.6300	0.0076
97	2.6376	0.0075
98	2.6450	0.0075
99	2.6524	0.0074
100	2.6598	0.0074
101	2.6671	0.0073
102	2.6743	0.0072
103	2.6815	0.0072
104	2.6887	0.0071
105	2.6958	0.0071
106	2.7028	0.0070
107	2.7098	0.0070
108	2.7168	0.0070
109	2.7237	0.0069
110	2.7306	0.0069
111	2.7374	0.0068
112	2.7441	0.0068
113	2.7509	0.0067
114	2.7576	0.0067
115	2.7642	0.0066
116	2.7708	0.0066
117	2.7774	0.0066
118	2.7839	0.0065
119	2.7904	0.0065
120	2.7968	0.0064
121	2.8032	0.0064
122	2.8096	0.0064
123	2.8159	0.0063
124	2.8222	0.0063
125	2.8284	0.0063
126	2.8347	0.0062
127	2.8408	0.0062
128	2.8470	0.0061
129	2.8531	0.0061
130	2.8592	0.0061
131	2.8652	0.0060
132	2.8712	0.0060
133	2.8772	0.0060
134	2.8831	0.0059
135	2.8891	0.0059
136	2.8949	0.0059
137	2.9008	0.0058
138	2.9066	0.0058
139	2.9124	0.0058
140	2.9182	0.0058
141	2.9239	0.0057
142	2.9296	0.0057
143	2.9353	0.0057
144	2.9409	0.0056
145	2.9465	0.0056
146	2.9521	0.0056
147	2.9577	0.0056
148	2.9632	0.0055
149	2.9687	0.0055
150	2.9742	0.0055
151	2.9796	0.0054
152	2.9850	0.0054

153	2.9904	0.0054
154	2.9958	0.0054
155	3.0012	0.0053
156	3.0065	0.0053
157	3.0118	0.0053
158	3.0170	0.0053
159	3.0223	0.0052
160	3.0275	0.0052
161	3.0327	0.0052
162	3.0379	0.0052
163	3.0431	0.0052
164	3.0482	0.0051
165	3.0533	0.0051
166	3.0584	0.0051
167	3.0635	0.0051
168	3.0685	0.0050
169	3.0735	0.0050
170	3.0785	0.0050
171	3.0835	0.0050
172	3.0885	0.0050
173	3.0934	0.0049
174	3.0983	0.0049
175	3.1032	0.0049
176	3.1081	0.0049
177	3.1129	0.0049
178	3.1178	0.0048
179	3.1226	0.0048
180	3.1274	0.0048
181	3.1322	0.0048
182	3.1369	0.0048
183	3.1417	0.0047
184	3.1464	0.0047
185	3.1511	0.0047
186	3.1558	0.0047
187	3.1604	0.0047
188	3.1651	0.0046
189	3.1697	0.0046
190	3.1743	0.0046
191	3.1789	0.0046
192	3.1835	0.0046
193	3.1881	0.0046
194	3.1926	0.0045
195	3.1971	0.0045
196	3.2016	0.0045
197	3.2061	0.0045
198	3.2106	0.0045
199	3.2151	0.0045
200	3.2195	0.0044
201	3.2239	0.0044
202	3.2283	0.0044
203	3.2327	0.0044
204	3.2371	0.0044
205	3.2415	0.0044
206	3.2458	0.0043
207	3.2502	0.0043
208	3.2545	0.0043
209	3.2588	0.0043

210	3.2631	0.0043
211	3.2673	0.0043
212	3.2716	0.0043
213	3.2759	0.0042
214	3.2801	0.0042
215	3.2843	0.0042
216	3.2885	0.0042
217	3.2927	0.0042
218	3.2969	0.0042
219	3.3010	0.0042
220	3.3052	0.0041
221	3.3093	0.0041
222	3.3134	0.0041
223	3.3175	0.0041
224	3.3216	0.0041
225	3.3257	0.0041
226	3.3298	0.0041
227	3.3338	0.0041
228	3.3379	0.0040
229	3.3419	0.0040
230	3.3459	0.0040
231	3.3499	0.0040
232	3.3539	0.0040
233	3.3579	0.0040
234	3.3618	0.0040
235	3.3658	0.0040
236	3.3697	0.0039
237	3.3737	0.0039
238	3.3776	0.0039
239	3.3815	0.0039
240	3.3854	0.0039
241	3.3892	0.0039
242	3.3931	0.0039
243	3.3970	0.0039
244	3.4008	0.0038
245	3.4047	0.0038
246	3.4085	0.0038
247	3.4123	0.0038
248	3.4161	0.0038
249	3.4199	0.0038
250	3.4237	0.0038
251	3.4274	0.0038
252	3.4312	0.0038
253	3.4349	0.0037
254	3.4387	0.0037
255	3.4424	0.0037
256	3.4461	0.0037
257	3.4498	0.0037
258	3.4535	0.0037
259	3.4572	0.0037
260	3.4609	0.0037
261	3.4645	0.0037
262	3.4682	0.0037
263	3.4718	0.0036
264	3.4754	0.0036
265	3.4791	0.0036
266	3.4827	0.0036

267	3.4863	0.0036
268	3.4899	0.0036
269	3.4935	0.0036
270	3.4970	0.0036
271	3.5006	0.0036
272	3.5041	0.0036
273	3.5077	0.0035
274	3.5112	0.0035
275	3.5148	0.0035
276	3.5183	0.0035
277	3.5218	0.0035
278	3.5253	0.0035
279	3.5288	0.0035
280	3.5322	0.0035
281	3.5357	0.0035
282	3.5392	0.0035
283	3.5426	0.0035
284	3.5461	0.0034
285	3.5495	0.0034
286	3.5529	0.0034
287	3.5564	0.0034
288	3.5598	0.0034

Unit Period (number)	Unit Rainfall (In)	Unit Soil-Loss (In)	Effective Rainfall (In)
1	0.0034	0.0002	0.0032
2	0.0034	0.0002	0.0032
3	0.0034	0.0002	0.0032
4	0.0034	0.0002	0.0032
5	0.0035	0.0002	0.0033
6	0.0035	0.0002	0.0033
7	0.0035	0.0002	0.0033
8	0.0035	0.0002	0.0033
9	0.0035	0.0002	0.0033
10	0.0035	0.0002	0.0033
11	0.0035	0.0002	0.0033
12	0.0036	0.0002	0.0033
13	0.0036	0.0002	0.0034
14	0.0036	0.0002	0.0034
15	0.0036	0.0002	0.0034
16	0.0036	0.0002	0.0034
17	0.0036	0.0002	0.0034
18	0.0036	0.0002	0.0034
19	0.0037	0.0002	0.0034
20	0.0037	0.0002	0.0035
21	0.0037	0.0002	0.0035
22	0.0037	0.0002	0.0035
23	0.0037	0.0002	0.0035
24	0.0037	0.0002	0.0035
25	0.0038	0.0002	0.0035
26	0.0038	0.0002	0.0035
27	0.0038	0.0002	0.0036
28	0.0038	0.0002	0.0036
29	0.0038	0.0002	0.0036
30	0.0038	0.0002	0.0036

31	0.0039	0.0002	0.0036
32	0.0039	0.0002	0.0036
33	0.0039	0.0002	0.0037
34	0.0039	0.0002	0.0037
35	0.0039	0.0002	0.0037
36	0.0039	0.0002	0.0037
37	0.0040	0.0002	0.0037
38	0.0040	0.0002	0.0037
39	0.0040	0.0002	0.0038
40	0.0040	0.0002	0.0038
41	0.0040	0.0002	0.0038
42	0.0041	0.0002	0.0038
43	0.0041	0.0002	0.0038
44	0.0041	0.0002	0.0038
45	0.0041	0.0002	0.0039
46	0.0041	0.0002	0.0039
47	0.0042	0.0002	0.0039
48	0.0042	0.0002	0.0039
49	0.0042	0.0002	0.0040
50	0.0042	0.0002	0.0040
51	0.0042	0.0003	0.0040
52	0.0043	0.0003	0.0040
53	0.0043	0.0003	0.0040
54	0.0043	0.0003	0.0040
55	0.0043	0.0003	0.0041
56	0.0043	0.0003	0.0041
57	0.0044	0.0003	0.0041
58	0.0044	0.0003	0.0041
59	0.0044	0.0003	0.0042
60	0.0044	0.0003	0.0042
61	0.0045	0.0003	0.0042
62	0.0045	0.0003	0.0042
63	0.0045	0.0003	0.0043
64	0.0045	0.0003	0.0043
65	0.0046	0.0003	0.0043
66	0.0046	0.0003	0.0043
67	0.0046	0.0003	0.0044
68	0.0046	0.0003	0.0044
69	0.0047	0.0003	0.0044
70	0.0047	0.0003	0.0044
71	0.0047	0.0003	0.0045
72	0.0048	0.0003	0.0045
73	0.0048	0.0003	0.0045
74	0.0048	0.0003	0.0045
75	0.0049	0.0003	0.0046
76	0.0049	0.0003	0.0046
77	0.0049	0.0003	0.0046
78	0.0049	0.0003	0.0046
79	0.0050	0.0003	0.0047
80	0.0050	0.0003	0.0047
81	0.0050	0.0003	0.0047
82	0.0051	0.0003	0.0048
83	0.0051	0.0003	0.0048
84	0.0051	0.0003	0.0048
85	0.0052	0.0003	0.0049
86	0.0052	0.0003	0.0049
87	0.0052	0.0003	0.0049

88	0.0053	0.0003	0.0050
89	0.0053	0.0003	0.0050
90	0.0053	0.0003	0.0050
91	0.0054	0.0003	0.0051
92	0.0054	0.0003	0.0051
93	0.0055	0.0003	0.0052
94	0.0055	0.0003	0.0052
95	0.0056	0.0003	0.0052
96	0.0056	0.0003	0.0053
97	0.0056	0.0003	0.0053
98	0.0057	0.0003	0.0053
99	0.0057	0.0003	0.0054
100	0.0058	0.0003	0.0054
101	0.0058	0.0003	0.0055
102	0.0058	0.0003	0.0055
103	0.0059	0.0004	0.0056
104	0.0059	0.0004	0.0056
105	0.0060	0.0004	0.0057
106	0.0060	0.0004	0.0057
107	0.0061	0.0004	0.0057
108	0.0061	0.0004	0.0058
109	0.0062	0.0004	0.0058
110	0.0063	0.0004	0.0059
111	0.0063	0.0004	0.0060
112	0.0064	0.0004	0.0060
113	0.0064	0.0004	0.0061
114	0.0065	0.0004	0.0061
115	0.0066	0.0004	0.0062
116	0.0066	0.0004	0.0062
117	0.0067	0.0004	0.0063
118	0.0067	0.0004	0.0063
119	0.0068	0.0004	0.0064
120	0.0069	0.0004	0.0065
121	0.0070	0.0004	0.0065
122	0.0070	0.0004	0.0066
123	0.0071	0.0004	0.0067
124	0.0071	0.0004	0.0067
125	0.0072	0.0004	0.0068
126	0.0073	0.0004	0.0069
127	0.0074	0.0004	0.0070
128	0.0075	0.0004	0.0070
129	0.0076	0.0004	0.0071
130	0.0076	0.0005	0.0072
131	0.0078	0.0005	0.0073
132	0.0078	0.0005	0.0074
133	0.0079	0.0005	0.0075
134	0.0080	0.0005	0.0075
135	0.0081	0.0005	0.0077
136	0.0082	0.0005	0.0077
137	0.0084	0.0005	0.0079
138	0.0084	0.0005	0.0079
139	0.0086	0.0005	0.0081
140	0.0087	0.0005	0.0081
141	0.0088	0.0005	0.0083
142	0.0089	0.0005	0.0084
143	0.0091	0.0005	0.0085
144	0.0092	0.0005	0.0086

145	0.0080	0.0005	0.0076
146	0.0081	0.0005	0.0076
147	0.0083	0.0005	0.0078
148	0.0084	0.0005	0.0079
149	0.0086	0.0005	0.0081
150	0.0087	0.0005	0.0082
151	0.0089	0.0005	0.0084
152	0.0090	0.0005	0.0085
153	0.0092	0.0005	0.0087
154	0.0094	0.0006	0.0088
155	0.0096	0.0006	0.0091
156	0.0098	0.0006	0.0092
157	0.0100	0.0006	0.0094
158	0.0102	0.0006	0.0096
159	0.0105	0.0006	0.0099
160	0.0106	0.0006	0.0100
161	0.0110	0.0007	0.0103
162	0.0112	0.0007	0.0105
163	0.0115	0.0007	0.0109
164	0.0117	0.0007	0.0110
165	0.0122	0.0007	0.0115
166	0.0124	0.0007	0.0117
167	0.0129	0.0008	0.0121
168	0.0132	0.0008	0.0124
169	0.0138	0.0008	0.0130
170	0.0141	0.0008	0.0133
171	0.0148	0.0009	0.0139
172	0.0151	0.0009	0.0142
173	0.0159	0.0009	0.0150
174	0.0163	0.0010	0.0154
175	0.0173	0.0010	0.0162
176	0.0178	0.0011	0.0167
177	0.0189	0.0011	0.0178
178	0.0195	0.0012	0.0184
179	0.0210	0.0012	0.0197
180	0.0218	0.0013	0.0205
181	0.0237	0.0014	0.0223
182	0.0248	0.0015	0.0233
183	0.0273	0.0016	0.0257
184	0.0288	0.0017	0.0271
185	0.0409	0.0024	0.0384
186	0.0436	0.0026	0.0410
187	0.0505	0.0030	0.0475
188	0.0552	0.0030	0.0522
189	0.0686	0.0030	0.0656
190	0.0790	0.0030	0.0760
191	0.1199	0.0030	0.1169
192	0.1740	0.0030	0.1710
193	0.7527	0.0030	0.7497
194	0.0943	0.0030	0.0913
195	0.0610	0.0030	0.0580
196	0.0467	0.0028	0.0440
197	0.0306	0.0018	0.0288
198	0.0260	0.0015	0.0244
199	0.0227	0.0013	0.0213
200	0.0202	0.0012	0.0190
201	0.0183	0.0011	0.0172

202	0.0168	0.0010	0.0158
203	0.0155	0.0009	0.0146
204	0.0144	0.0009	0.0136
205	0.0134	0.0008	0.0126
206	0.0126	0.0007	0.0119
207	0.0120	0.0007	0.0112
208	0.0113	0.0007	0.0107
209	0.0108	0.0006	0.0102
210	0.0103	0.0006	0.0097
211	0.0099	0.0006	0.0093
212	0.0095	0.0006	0.0089
213	0.0091	0.0005	0.0086
214	0.0088	0.0005	0.0083
215	0.0085	0.0005	0.0080
216	0.0082	0.0005	0.0077
217	0.0093	0.0005	0.0087
218	0.0090	0.0005	0.0085
219	0.0087	0.0005	0.0082
220	0.0085	0.0005	0.0080
221	0.0083	0.0005	0.0078
222	0.0081	0.0005	0.0076
223	0.0079	0.0005	0.0074
224	0.0077	0.0005	0.0072
225	0.0075	0.0004	0.0071
226	0.0074	0.0004	0.0069
227	0.0072	0.0004	0.0068
228	0.0070	0.0004	0.0066
229	0.0069	0.0004	0.0065
230	0.0068	0.0004	0.0064
231	0.0066	0.0004	0.0063
232	0.0065	0.0004	0.0061
233	0.0064	0.0004	0.0060
234	0.0063	0.0004	0.0059
235	0.0062	0.0004	0.0058
236	0.0061	0.0004	0.0057
237	0.0060	0.0004	0.0056
238	0.0059	0.0003	0.0055
239	0.0058	0.0003	0.0054
240	0.0057	0.0003	0.0054
241	0.0056	0.0003	0.0053
242	0.0055	0.0003	0.0052
243	0.0054	0.0003	0.0051
244	0.0054	0.0003	0.0051
245	0.0053	0.0003	0.0050
246	0.0052	0.0003	0.0049
247	0.0052	0.0003	0.0048
248	0.0051	0.0003	0.0048
249	0.0050	0.0003	0.0047
250	0.0050	0.0003	0.0047
251	0.0049	0.0003	0.0046
252	0.0048	0.0003	0.0045
253	0.0048	0.0003	0.0045
254	0.0047	0.0003	0.0044
255	0.0047	0.0003	0.0044
256	0.0046	0.0003	0.0043
257	0.0046	0.0003	0.0043
258	0.0045	0.0003	0.0042

259	0.0045	0.0003	0.0042
260	0.0044	0.0003	0.0042
261	0.0044	0.0003	0.0041
262	0.0043	0.0003	0.0041
263	0.0043	0.0003	0.0040
264	0.0042	0.0003	0.0040
265	0.0042	0.0002	0.0039
266	0.0041	0.0002	0.0039
267	0.0041	0.0002	0.0039
268	0.0041	0.0002	0.0038
269	0.0040	0.0002	0.0038
270	0.0040	0.0002	0.0038
271	0.0040	0.0002	0.0037
272	0.0039	0.0002	0.0037
273	0.0039	0.0002	0.0037
274	0.0038	0.0002	0.0036
275	0.0038	0.0002	0.0036
276	0.0038	0.0002	0.0036
277	0.0037	0.0002	0.0035
278	0.0037	0.0002	0.0035
279	0.0037	0.0002	0.0035
280	0.0037	0.0002	0.0034
281	0.0036	0.0002	0.0034
282	0.0036	0.0002	0.0034
283	0.0036	0.0002	0.0034
284	0.0035	0.0002	0.0033
285	0.0035	0.0002	0.0033
286	0.0035	0.0002	0.0033
287	0.0035	0.0002	0.0032
288	0.0034	0.0002	0.0032

Total soil rain loss = 0.15(In)
Total effective rainfall = 3.41(In)
Peak flow rate in flood hydrograph = 184.34(CFS)

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24 - H O U R S T O R M
R u n o f f H y d r o g r a p h

Hydrograph in 5 Minute intervals ((CFS))

```
Time(h+m) Volume Ac.Ft   Q(CFS)  0       50.0     100.0     150.0     200.0
-----------------------------------------------------------------------
  0+ 5       0.0005      0.07  Q         |         |         |         |
  0+10       0.0042      0.54  Q         |         |         |         |
  0+15       0.0122      1.15  Q         |         |         |         |
  0+20       0.0221      1.43  Q         |         |         |         |
  0+25       0.0331      1.60  Q         |         |         |         |
  0+30       0.0449      1.71  Q         |         |         |         |
  0+35       0.0572      1.79  Q         |         |         |         |
  0+40       0.0700      1.85  Q         |         |         |         |
  0+45       0.0831      1.90  Q         |         |         |         |
  0+50       0.0965      1.94  Q         |         |         |         |
  0+55       0.1101      1.98  Q         |         |         |         |
  1+ 0       0.1239      2.00  Q         |         |         |         |
```

1+ 5	0.1378	2.02	Q	|	|	|	|
1+10	0.1519	2.04	Q	|	|	|	|
1+15	0.1660	2.06	Q	|	|	|	|
1+20	0.1803	2.07	Q	|	|	|	|
1+25	0.1947	2.09	Q	|	|	|	|
1+30	0.2091	2.10	Q	|	|	|	|
1+35	0.2236	2.11	Q	|	|	|	|
1+40	0.2382	2.11	Q	|	|	|	|
1+45	0.2528	2.12	Q	|	|	|	|
1+50	0.2675	2.13	Q	|	|	|	|
1+55	0.2822	2.14	Q	|	|	|	|
2+ 0	0.2970	2.15	Q	|	|	|	|
2+ 5	0.3119	2.16	Q	|	|	|	|
2+10	0.3268	2.17	Q	|	|	|	|
2+15	0.3418	2.18	Q	|	|	|	|
2+20	0.3569	2.19	Q	|	|	|	|
2+25	0.3720	2.20	QV	|	|	|	|
2+30	0.3872	2.21	QV	|	|	|	|
2+35	0.4025	2.22	QV	|	|	|	|
2+40	0.4178	2.22	QV	|	|	|	|
2+45	0.4332	2.23	QV	|	|	|	|
2+50	0.4486	2.24	QV	|	|	|	|
2+55	0.4642	2.26	QV	|	|	|	|
3+ 0	0.4798	2.27	QV	|	|	|	|
3+ 5	0.4954	2.28	QV	|	|	|	|
3+10	0.5112	2.29	QV	|	|	|	|
3+15	0.5270	2.30	QV	|	|	|	|
3+20	0.5429	2.31	QV	|	|	|	|
3+25	0.5588	2.32	QV	|	|	|	|
3+30	0.5749	2.33	QV	|	|	|	|
3+35	0.5910	2.34	QV	|	|	|	|
3+40	0.6072	2.35	QV	|	|	|	|
3+45	0.6235	2.36	QV	|	|	|	|
3+50	0.6398	2.37	QV	|	|	|	|
3+55	0.6562	2.39	QV	|	|	|	|
4+ 0	0.6727	2.40	QV	|	|	|	|
4+ 5	0.6893	2.41	QV	|	|	|	|
4+10	0.7060	2.42	QV	|	|	|	|
4+15	0.7228	2.43	QV	|	|	|	|
4+20	0.7396	2.45	Q V	|	|	|	|
4+25	0.7565	2.46	Q V	|	|	|	|
4+30	0.7735	2.47	Q V	|	|	|	|
4+35	0.7906	2.48	Q V	|	|	|	|
4+40	0.8078	2.50	Q V	|	|	|	|
4+45	0.8251	2.51	Q V	|	|	|	|
4+50	0.8425	2.52	Q V	|	|	|	|
4+55	0.8599	2.54	Q V	|	|	|	|
5+ 0	0.8775	2.55	Q V	|	|	|	|
5+ 5	0.8951	2.56	Q V	|	|	|	|
5+10	0.9129	2.58	Q V	|	|	|	|
5+15	0.9307	2.59	Q V	|	|	|	|
5+20	0.9486	2.60	Q V	|	|	|	|
5+25	0.9667	2.62	Q V	|	|	|	|
5+30	0.9848	2.63	Q V	|	|	|	|
5+35	1.0030	2.65	Q V	|	|	|	|
5+40	1.0214	2.66	Q V	|	|	|	|
5+45	1.0398	2.68	Q V	|	|	|	|

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 5+50       1.0584      2.69  Q V       |          |          |          |
 5+55       1.0770      2.71  Q V       |          |          |          |
 6+ 0       1.0958      2.73  Q  V      |          |          |          |
 6+ 5       1.1147      2.74  Q  V      |          |          |          |
 6+10       1.1337      2.76  Q  V      |          |          |          |
 6+15       1.1528      2.77  Q  V      |          |          |          |
 6+20       1.1720      2.79  Q  V      |          |          |          |
 6+25       1.1913      2.81  Q  V      |          |          |          |
 6+30       1.2108      2.82  Q  V      |          |          |          |
 6+35       1.2304      2.84  Q  V      |          |          |          |
 6+40       1.2501      2.86  Q  V      |          |          |          |
 6+45       1.2699      2.88  Q  V      |          |          |          |
 6+50       1.2898      2.90  Q  V      |          |          |          |
 6+55       1.3099      2.92  Q  V      |          |          |          |
 7+ 0       1.3301      2.93  Q  V      |          |          |          |
 7+ 5       1.3505      2.95  Q  V      |          |          |          |
 7+10       1.3709      2.97  Q  V      |          |          |          |
 7+15       1.3915      2.99  Q  V      |          |          |          |
 7+20       1.4123      3.01  Q  V      |          |          |          |
 7+25       1.4332      3.03  Q  V      |          |          |          |
 7+30       1.4542      3.05  Q   V     |          |          |          |
 7+35       1.4754      3.07  Q   V     |          |          |          |
 7+40       1.4967      3.10  Q   V     |          |          |          |
 7+45       1.5182      3.12  Q   V     |          |          |          |
 7+50       1.5398      3.14  Q   V     |          |          |          |
 7+55       1.5616      3.16  Q   V     |          |          |          |
 8+ 0       1.5835      3.19  Q   V     |          |          |          |
 8+ 5       1.6056      3.21  Q   V     |          |          |          |
 8+10       1.6279      3.23  Q   V     |          |          |          |
 8+15       1.6503      3.26  Q   V     |          |          |          |
 8+20       1.6729      3.28  Q   V     |          |          |          |
 8+25       1.6957      3.31  Q   V     |          |          |          |
 8+30       1.7186      3.33  Q   V     |          |          |          |
 8+35       1.7417      3.36  Q   V     |          |          |          |
 8+40       1.7650      3.38  Q   V     |          |          |          |
 8+45       1.7885      3.41  Q   V     |          |          |          |
 8+50       1.8122      3.44  Q   V     |          |          |          |
 8+55       1.8361      3.47  Q    V    |          |          |          |
 9+ 0       1.8602      3.49  Q    V    |          |          |          |
 9+ 5       1.8844      3.52  Q    V    |          |          |          |
 9+10       1.9089      3.55  Q    V    |          |          |          |
 9+15       1.9336      3.58  Q    V    |          |          |          |
 9+20       1.9585      3.61  Q    V    |          |          |          |
 9+25       1.9836      3.65  Q    V    |          |          |          |
 9+30       2.0089      3.68  Q    V    |          |          |          |
 9+35       2.0345      3.71  Q    V    |          |          |          |
 9+40       2.0603      3.75  Q    V    |          |          |          |
 9+45       2.0863      3.78  Q    V    |          |          |          |
 9+50       2.1126      3.81  Q    V    |          |          |          |
 9+55       2.1391      3.85  Q    V    |          |          |          |
10+ 0       2.1659      3.89  Q    V    |          |          |          |
10+ 5       2.1929      3.93  Q     V   |          |          |          |
10+10       2.2202      3.96  Q     V   |          |          |          |
10+15       2.2478      4.00  Q     V   |          |          |          |
10+20       2.2756      4.04  Q     V   |          |          |          |
10+25       2.3038      4.08  Q     V   |          |          |          |
10+30       2.3322      4.13  Q     V   |          |          |          |
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10+35       2.3609      4.17  Q     V   |          |          |          |
10+40       2.3899      4.21  Q     V   |          |          |          |
10+45       2.4193      4.26  Q     V   |          |          |          |
10+50       2.4489      4.31  Q     V   |          |          |          |
10+55       2.4789      4.36  Q     V   |          |          |          |
11+ 0       2.5093      4.40  Q     V   |          |          |          |
11+ 5       2.5400      4.46  Q     V   |          |          |          |
11+10       2.5710      4.51  Q      V  |          |          |          |
11+15       2.6024      4.56  Q      V  |          |          |          |
11+20       2.6342      4.62  Q      V  |          |          |          |
11+25       2.6664      4.67  Q      V  |          |          |          |
11+30       2.6990      4.73  Q      V  |          |          |          |
11+35       2.7320      4.79  Q      V  |          |          |          |
11+40       2.7654      4.85  Q      V  |          |          |          |
11+45       2.7993      4.92  Q      V  |          |          |          |
11+50       2.8336      4.98  Q      V  |          |          |          |
11+55       2.8684      5.05  |Q     V  |          |          |          |
12+ 0       2.9037      5.12  |Q     V  |          |          |          |
12+ 5       2.9393      5.17  |Q      V |          |          |          |
12+10       2.9741      5.06  |Q      V |          |          |          |
12+15       3.0079      4.91  Q       V |          |          |          |
12+20       3.0415      4.88  Q       V |          |          |          |
12+25       3.0752      4.89  Q       V |          |          |          |
12+30       3.1092      4.93  Q       V |          |          |          |
12+35       3.1435      4.99  Q       V |          |          |          |
12+40       3.1784      5.05  |Q      V |          |          |          |
12+45       3.2137      5.13  |Q      V |          |          |          |
12+50       3.2495      5.21  |Q      V |          |          |          |
12+55       3.2860      5.30  |Q       V|          |          |          |
13+ 0       3.3231      5.39  |Q       V|          |          |          |
13+ 5       3.3609      5.49  |Q       V|          |          |          |
13+10       3.3995      5.60  |Q       V|          |          |          |
13+15       3.4388      5.71  |Q       V|          |          |          |
13+20       3.4790      5.83  |Q       V|          |          |          |
13+25       3.5200      5.96  |Q       V|          |          |          |
13+30       3.5619      6.09  |Q       V|          |          |          |
13+35       3.6048      6.23  |Q       V|          |          |          |
13+40       3.6488      6.38  |Q        V          |          |          |
13+45       3.6938      6.54  |Q        V          |          |          |
13+50       3.7400      6.71  |Q        V          |          |          |
13+55       3.7875      6.89  |Q        V          |          |          |
14+ 0       3.8362      7.08  |Q        V          |          |          |
14+ 5       3.8863      7.28  |Q        V          |          |          |
14+10       3.9380      7.51  |Q        V          |          |          |
14+15       3.9915      7.76  |Q        V          |          |          |
14+20       4.0467      8.02  |Q        |V         |          |          |
14+25       4.1038      8.29  |Q        |V         |          |          |
14+30       4.1630      8.59  |Q        |V         |          |          |
14+35       4.2243      8.91  |Q        |V         |          |          |
14+40       4.2881      9.26  |Q        |V         |          |          |
14+45       4.3544      9.64  |Q        |V         |          |          |
14+50       4.4237     10.06  | Q       | V        |          |          |
14+55       4.4961     10.52  | Q       | V        |          |          |
15+ 0       4.5721     11.04  | Q       | V        |          |          |
15+ 5       4.6522     11.62  | Q       | V        |          |          |
15+10       4.7367     12.28  | Q       |  V       |          |          |
15+15       4.8265     13.03  | Q       |  V       |          |          |
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15+20       4.9223     13.91  | Q       |  V      |         |         |
15+25       5.0263     15.11  |  Q      |  V      |         |         |
15+30       5.1468     17.49  |  Q      |   V     |         |         |
15+35       5.2883     20.54  |   Q     |   V     |         |         |
15+40       5.4488     23.30  |   Q     |   V     |         |         |
15+45       5.6312     26.49  |    Q    |    V    |         |         |
15+50       5.8431     30.77  |     Q   |     V   |         |         |
15+55       6.0975     36.94  |      Q  |     V   |         |         |
16+ 0       6.4285     48.07  |        Q|      V  |         |         |
16+ 5       6.9718     78.88  |         |    Q   V|         |         |
16+10       8.1041    164.40  |         |         | V       | Q       |
16+15       9.3736    184.34  |         |         |    V    |     Q   |
16+20      10.1212    108.56  |         |         |Q     V  |         |
16+25      10.6406     75.41  |         |    Q    |        V|         |
16+30      11.0273     56.16  |         |Q        |         V         |
16+35      11.3274     43.56  |       Q |         |         |V        |
16+40      11.5649     34.49  |     Q   |         |         |V        |
16+45      11.7627     28.73  |    Q    |         |         | V       |
16+50      11.9281     24.00  |   Q     |         |         | V       |
16+55      12.0680     20.32  |   Q     |         |         |  V      |
17+ 0      12.1857     17.10  |  Q      |         |         |  V      |
17+ 5      12.2850     14.41  | Q       |         |         |  V      |
17+10      12.3762     13.24  | Q       |         |         |   V     |
17+15      12.4606     12.26  | Q       |         |         |   V     |
17+20      12.5335     10.60  | Q       |         |         |   V     |
17+25      12.5980      9.36  |Q        |         |         |   V     |
17+30      12.6501      7.56  |Q        |         |         |   V     |
17+35      12.6984      7.01  |Q        |         |         |   V     |
17+40      12.7438      6.59  |Q        |         |         |    V    |
17+45      12.7867      6.24  |Q        |         |         |    V    |
17+50      12.8277      5.94  |Q        |         |         |    V    |
17+55      12.8668      5.68  |Q        |         |         |    V    |
18+ 0      12.9043      5.45  |Q        |         |         |    V    |
18+ 5      12.9406      5.27  |Q        |         |         |    V    |
18+10      12.9768      5.25  |Q        |         |         |    V    |
18+15      13.0133      5.31  |Q        |         |         |    V    |
18+20      13.0494      5.24  |Q        |         |         |    V    |
18+25      13.0848      5.14  |Q        |         |         |     V   |
18+30      13.1195      5.03  |Q        |         |         |     V   |
18+35      13.1534      4.92  Q         |         |         |     V   |
18+40      13.1865      4.81  Q         |         |         |     V   |
18+45      13.2189      4.70  Q         |         |         |     V   |
18+50      13.2506      4.60  Q         |         |         |     V   |
18+55      13.2815      4.50  Q         |         |         |     V   |
19+ 0      13.3118      4.40  Q         |         |         |     V   |
19+ 5      13.3415      4.31  Q         |         |         |     V   |
19+10      13.3705      4.22  Q         |         |         |     V   |
19+15      13.3990      4.13  Q         |         |         |     V   |
19+20      13.4269      4.05  Q         |         |         |     V   |
19+25      13.4543      3.97  Q         |         |         |      V  |
19+30      13.4811      3.90  Q         |         |         |      V  |
19+35      13.5074      3.82  Q         |         |         |      V  |
19+40      13.5333      3.75  Q         |         |         |      V  |
19+45      13.5586      3.68  Q         |         |         |      V  |
19+50      13.5836      3.62  Q         |         |         |      V  |
19+55      13.6081      3.56  Q         |         |         |      V  |
20+ 0      13.6322      3.50  Q         |         |         |      V  |
```

```
20+ 5      13.6559      3.44  Q          |          |          |       V  |
20+10      13.6792      3.39  Q          |          |          |       V  |
20+15      13.7022      3.34  Q          |          |          |       V  |
20+20      13.7248      3.28  Q          |          |          |       V  |
20+25      13.7471      3.24  Q          |          |          |       V  |
20+30      13.7690      3.19  Q          |          |          |       V  |
20+35      13.7907      3.14  Q          |          |          |       V  |
20+40      13.8120      3.10  Q          |          |          |        V |
20+45      13.8331      3.06  Q          |          |          |        V |
20+50      13.8538      3.01  Q          |          |          |        V |
20+55      13.8743      2.97  Q          |          |          |        V |
21+ 0      13.8945      2.94  Q          |          |          |        V |
21+ 5      13.9145      2.90  Q          |          |          |        V |
21+10      13.9342      2.86  Q          |          |          |        V |
21+15      13.9537      2.83  Q          |          |          |        V |
21+20      13.9729      2.79  Q          |          |          |        V |
21+25      13.9919      2.76  Q          |          |          |        V |
21+30      14.0107      2.73  Q          |          |          |        V |
21+35      14.0292      2.69  Q          |          |          |        V |
21+40      14.0476      2.66  Q          |          |          |        V |
21+45      14.0657      2.63  Q          |          |          |        V |
21+50      14.0837      2.61  Q          |          |          |        V |
21+55      14.1014      2.58  Q          |          |          |        V |
22+ 0      14.1190      2.55  Q          |          |          |        V |
22+ 5      14.1363      2.52  Q          |          |          |        V |
22+10      14.1535      2.50  Q          |          |          |        V |
22+15      14.1705      2.47  Q          |          |          |        V |
22+20      14.1874      2.45  Q          |          |          |         V|
22+25      14.2041      2.42  Q          |          |          |         V|
22+30      14.2206      2.40  Q          |          |          |         V|
22+35      14.2369      2.37  Q          |          |          |         V|
22+40      14.2531      2.35  Q          |          |          |         V|
22+45      14.2691      2.33  Q          |          |          |         V|
22+50      14.2850      2.31  Q          |          |          |         V|
22+55      14.3008      2.29  Q          |          |          |         V|
23+ 0      14.3164      2.27  Q          |          |          |         V|
23+ 5      14.3319      2.25  Q          |          |          |         V|
23+10      14.3472      2.23  Q          |          |          |         V|
23+15      14.3624      2.21  Q          |          |          |         V|
23+20      14.3774      2.19  Q          |          |          |         V|
23+25      14.3924      2.17  Q          |          |          |         V|
23+30      14.4072      2.15  Q          |          |          |         V|
23+35      14.4218      2.13  Q          |          |          |         V|
23+40      14.4364      2.11  Q          |          |          |         V|
23+45      14.4508      2.10  Q          |          |          |         V|
23+50      14.4652      2.08  Q          |          |          |         V|
23+55      14.4794      2.06  Q          |          |          |         V|
24+ 0      14.4935      2.05  Q          |          |          |         V|
24+ 5      14.5070      1.96  Q          |          |          |         V|
24+10      14.5171      1.47  Q          |          |          |         V|
24+15      14.5230      0.85  Q          |          |          |         V|
24+20      14.5269      0.57  Q          |          |          |         V|
24+25      14.5298      0.41  Q          |          |          |         V|
24+30      14.5318      0.30  Q          |          |          |         V|
24+35      14.5334      0.22  Q          |          |          |         V|
24+40      14.5345      0.17  Q          |          |          |         V|
24+45      14.5354      0.12  Q          |          |          |         V|
```

```
   24+50      14.5360      0.09  Q         |         |         |        V|
   24+55      14.5364      0.07  Q         |         |         |        V|
   25+ 0      14.5368      0.05  Q         |         |         |        V|
   25+ 5      14.5370      0.04  Q         |         |         |        V|
   25+10      14.5372      0.02  Q         |         |         |        V|
   25+15      14.5373      0.01  Q         |         |         |        V|
   25+20      14.5373      0.01  Q         |         |         |         V
----------------------------------------------------------------------
```

ATTACHMENT 7

Reclamation Conditions
AREA “B”
5-Day Hydrograph Calculations
(100-Year, 1-Hour)

U n i t H y d r o g r a p h A n a l y s i s

Copyright (c) CIVILCADD/CIVILDESIGN, 1989 - 2012, Version 7.1

Study date 04/09/15

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San Bernardino County Synthetic Unit Hydrology Method
Manual date - August 1986

Program License Serial Number 6320

154166 - AMBOY - SAN BERNARDINO COUNTY
RECLAMATION CONDITION "B"
100-YEAR, 5-DAY STORM
BY: JTS DATE: 04-09-15

Storm Event Year = 100

Antecedent Moisture Condition = 3

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

English Units used in output format

Area averaged rainfall intensity isohyetal data:

Sub-Area (Ac.)	Duration (hours)	Isohyetal (In)
Rainfall data for year 10		
46.11	1	0.86
Rainfall data for year 2		
46.11	6	0.75
Rainfall data for year 2		
46.11	24	1.07
Rainfall data for year 100		
0.00	1	1.59
46.11	1	1.59
Rainfall data for year 100		
46.11	6	2.43
Rainfall data for year 100		

```
          46.11           24           3.56
-------------------------------------------------------------------
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

******** Area-averaged max loss rate, Fm ********


SCS curve  SCS curve     Area     Area     Fp(Fig C6)    Ap      Fm
No.(AMCII) NO.(AMC 3)    (Ac.)    Fraction     (In/Hr)  (dec.)   (In/Hr)
 91.0      98.2         46.11      1.000     0.036    1.000    0.036

Area-averaged adjusted loss rate Fm (In/Hr) =  0.036

********* Area-Averaged low loss rate fraction, Yb **********

Area       Area          SCS CN    SCS CN      S     Pervious
 (Ac.)      Fract         (AMC2)    (AMC3)           Yield Fr
    46.11   1.000         91.0      98.2       0.18     0.941

Area-averaged catchment yield fraction, Y =  0.941
Area-averaged low loss fraction, Yb =  0.059
User entry of time of concentration  =   0.170 (hours)
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Watershed area =      46.11(Ac.)
Catchment Lag time =   0.136 hours
Unit interval =   5.000 minutes
Unit interval percentage of lag time = 61.2745
Hydrograph baseflow =     0.00(CFS)
Average maximum watershed loss rate(Fm) =  0.036(In/Hr)
Average low loss rate fraction (Yb) = 0.059 (decimal)
DESERT S-Graph Selected
Computed peak 5-minute rainfall =  0.754(In)
Computed peak 30-minute rainfall =  1.291(In)
Specified peak 1-hour rainfall =  1.590(In)
Computed peak 3-hour rainfall =  2.062(In)
Specified peak 6-hour rainfall =  2.430(In)
Specified peak 24-hour rainfall =  3.560(In)


Rainfall depth area reduction factors:
Using a total area of      46.11(Ac.) (Ref: fig. E-4)

5-minute factor = 0.998     Adjusted rainfall =  0.753(In)
30-minute factor = 0.998    Adjusted rainfall =  1.289(In)
1-hour factor = 0.998       Adjusted rainfall =  1.587(In)
3-hour factor = 1.000       Adjusted rainfall =  2.062(In)
6-hour factor = 1.000       Adjusted rainfall =  2.430(In)
24-hour factor = 1.000      Adjusted rainfall =  3.560(In)
-------------------------------------------------------------------

                  U n i t  H y d r o g r a p h
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Interval          'S' Graph          Unit Hydrograph
Number            Mean values             ((CFS))
-------------------------------------------------------------------
            (K =       557.64 (CFS))
```

1	5.829	32.506
2	42.748	205.874
3	68.862	145.626
4	80.052	62.398
5	86.633	36.699
6	90.841	23.464
7	93.754	16.247
8	95.820	11.516
9	97.269	8.081
10	98.124	4.769
11	98.821	3.886
12	99.497	3.774
13	100.000	2.803

Mday RAINFALL MASS RATIOS

Rainfall Duration	Ratio To Peak 24 Hours
PEAK 24 HOURS	1
PEAK 48 TO 24 HOURS	0.360
PEAK 72 TO 48 HOURS	0.190
PEAK 96 TO 72 HOURS	0.150
PEAK 120 TO 96 HOURS	0.100

STORM DAY 1 Ratio to Peak 24 Hours: 0.100

STORM DAY 1 Total Rainfall = 0.3560 (In)

Peak Unit Number	Adjusted mass rainfall (In)	Unit rainfall (In)
1	0.0753	0.0753
2	0.0927	0.0174
3	0.1047	0.0120
4	0.1141	0.0094
5	0.1220	0.0079
6	0.1289	0.0069
7	0.1350	0.0061
8	0.1405	0.0055
9	0.1455	0.0051
10	0.1502	0.0047
11	0.1546	0.0044
12	0.1587	0.0041
13	0.1617	0.0031
14	0.1646	0.0029
15	0.1673	0.0027
16	0.1699	0.0026
17	0.1724	0.0025
18	0.1748	0.0024
19	0.1770	0.0023
20	0.1792	0.0022
21	0.1813	0.0021
22	0.1833	0.0020
23	0.1853	0.0020
24	0.1872	0.0019
25	0.1890	0.0018
26	0.1908	0.0018
27	0.1925	0.0017
28	0.1942	0.0017
29	0.1958	0.0016
30	0.1974	0.0016
31	0.1989	0.0015

32	0.2005	0.0015
33	0.2019	0.0015
34	0.2034	0.0014
35	0.2048	0.0014
36	0.2062	0.0014
37	0.2075	0.0013
38	0.2088	0.0013
39	0.2101	0.0013
40	0.2114	0.0013
41	0.2126	0.0012
42	0.2138	0.0012
43	0.2150	0.0012
44	0.2162	0.0012
45	0.2174	0.0012
46	0.2185	0.0011
47	0.2196	0.0011
48	0.2207	0.0011
49	0.2218	0.0011
50	0.2229	0.0011
51	0.2239	0.0010
52	0.2249	0.0010
53	0.2260	0.0010
54	0.2270	0.0010
55	0.2279	0.0010
56	0.2289	0.0010
57	0.2299	0.0010
58	0.2308	0.0009
59	0.2318	0.0009
60	0.2327	0.0009
61	0.2336	0.0009
62	0.2345	0.0009
63	0.2354	0.0009
64	0.2363	0.0009
65	0.2371	0.0009
66	0.2380	0.0009
67	0.2389	0.0008
68	0.2397	0.0008
69	0.2405	0.0008
70	0.2413	0.0008
71	0.2422	0.0008
72	0.2430	0.0008
73	0.2439	0.0009
74	0.2448	0.0009
75	0.2457	0.0009
76	0.2466	0.0009
77	0.2475	0.0009
78	0.2484	0.0009
79	0.2493	0.0009
80	0.2501	0.0009
81	0.2510	0.0009
82	0.2518	0.0008
83	0.2527	0.0008
84	0.2535	0.0008
85	0.2543	0.0008
86	0.2552	0.0008
87	0.2560	0.0008
88	0.2568	0.0008

89	0.2576	0.0008
90	0.2584	0.0008
91	0.2592	0.0008
92	0.2599	0.0008
93	0.2607	0.0008
94	0.2615	0.0008
95	0.2622	0.0008
96	0.2630	0.0008
97	0.2638	0.0008
98	0.2645	0.0007
99	0.2652	0.0007
100	0.2660	0.0007
101	0.2667	0.0007
102	0.2674	0.0007
103	0.2682	0.0007
104	0.2689	0.0007
105	0.2696	0.0007
106	0.2703	0.0007
107	0.2710	0.0007
108	0.2717	0.0007
109	0.2724	0.0007
110	0.2731	0.0007
111	0.2737	0.0007
112	0.2744	0.0007
113	0.2751	0.0007
114	0.2758	0.0007
115	0.2764	0.0007
116	0.2771	0.0007
117	0.2777	0.0007
118	0.2784	0.0007
119	0.2790	0.0006
120	0.2797	0.0006
121	0.2803	0.0006
122	0.2810	0.0006
123	0.2816	0.0006
124	0.2822	0.0006
125	0.2828	0.0006
126	0.2835	0.0006
127	0.2841	0.0006
128	0.2847	0.0006
129	0.2853	0.0006
130	0.2859	0.0006
131	0.2865	0.0006
132	0.2871	0.0006
133	0.2877	0.0006
134	0.2883	0.0006
135	0.2889	0.0006
136	0.2895	0.0006
137	0.2901	0.0006
138	0.2907	0.0006
139	0.2912	0.0006
140	0.2918	0.0006
141	0.2924	0.0006
142	0.2930	0.0006
143	0.2935	0.0006
144	0.2941	0.0006
145	0.2947	0.0006

146	0.2952	0.0006
147	0.2958	0.0006
148	0.2963	0.0006
149	0.2969	0.0006
150	0.2974	0.0005
151	0.2980	0.0005
152	0.2985	0.0005
153	0.2990	0.0005
154	0.2996	0.0005
155	0.3001	0.0005
156	0.3007	0.0005
157	0.3012	0.0005
158	0.3017	0.0005
159	0.3022	0.0005
160	0.3028	0.0005
161	0.3033	0.0005
162	0.3038	0.0005
163	0.3043	0.0005
164	0.3048	0.0005
165	0.3053	0.0005
166	0.3058	0.0005
167	0.3063	0.0005
168	0.3069	0.0005
169	0.3074	0.0005
170	0.3079	0.0005
171	0.3084	0.0005
172	0.3088	0.0005
173	0.3093	0.0005
174	0.3098	0.0005
175	0.3103	0.0005
176	0.3108	0.0005
177	0.3113	0.0005
178	0.3118	0.0005
179	0.3123	0.0005
180	0.3127	0.0005
181	0.3132	0.0005
182	0.3137	0.0005
183	0.3142	0.0005
184	0.3146	0.0005
185	0.3151	0.0005
186	0.3156	0.0005
187	0.3160	0.0005
188	0.3165	0.0005
189	0.3170	0.0005
190	0.3174	0.0005
191	0.3179	0.0005
192	0.3184	0.0005
193	0.3188	0.0005
194	0.3193	0.0005
195	0.3197	0.0005
196	0.3202	0.0005
197	0.3206	0.0004
198	0.3211	0.0004
199	0.3215	0.0004
200	0.3220	0.0004
201	0.3224	0.0004
202	0.3228	0.0004

203	0.3233	0.0004
204	0.3237	0.0004
205	0.3242	0.0004
206	0.3246	0.0004
207	0.3250	0.0004
208	0.3255	0.0004
209	0.3259	0.0004
210	0.3263	0.0004
211	0.3267	0.0004
212	0.3272	0.0004
213	0.3276	0.0004
214	0.3280	0.0004
215	0.3284	0.0004
216	0.3289	0.0004
217	0.3293	0.0004
218	0.3297	0.0004
219	0.3301	0.0004
220	0.3305	0.0004
221	0.3309	0.0004
222	0.3313	0.0004
223	0.3318	0.0004
224	0.3322	0.0004
225	0.3326	0.0004
226	0.3330	0.0004
227	0.3334	0.0004
228	0.3338	0.0004
229	0.3342	0.0004
230	0.3346	0.0004
231	0.3350	0.0004
232	0.3354	0.0004
233	0.3358	0.0004
234	0.3362	0.0004
235	0.3366	0.0004
236	0.3370	0.0004
237	0.3374	0.0004
238	0.3378	0.0004
239	0.3381	0.0004
240	0.3385	0.0004
241	0.3389	0.0004
242	0.3393	0.0004
243	0.3397	0.0004
244	0.3401	0.0004
245	0.3405	0.0004
246	0.3409	0.0004
247	0.3412	0.0004
248	0.3416	0.0004
249	0.3420	0.0004
250	0.3424	0.0004
251	0.3427	0.0004
252	0.3431	0.0004
253	0.3435	0.0004
254	0.3439	0.0004
255	0.3442	0.0004
256	0.3446	0.0004
257	0.3450	0.0004
258	0.3454	0.0004
259	0.3457	0.0004

260	0.3461	0.0004
261	0.3465	0.0004
262	0.3468	0.0004
263	0.3472	0.0004
264	0.3475	0.0004
265	0.3479	0.0004
266	0.3483	0.0004
267	0.3486	0.0004
268	0.3490	0.0004
269	0.3493	0.0004
270	0.3497	0.0004
271	0.3501	0.0004
272	0.3504	0.0004
273	0.3508	0.0004
274	0.3511	0.0004
275	0.3515	0.0004
276	0.3518	0.0004
277	0.3522	0.0004
278	0.3525	0.0003
279	0.3529	0.0003
280	0.3532	0.0003
281	0.3536	0.0003
282	0.3539	0.0003
283	0.3543	0.0003
284	0.3546	0.0003
285	0.3550	0.0003
286	0.3553	0.0003
287	0.3556	0.0003
288	0.3560	0.0003

STORM DAY 2 Ratio to Peak 24 Hours: 0.150
STORM DAY 2 Total Rainfall = 0.5340 (In)

1	0.1129	0.1129
2	0.1390	0.0261
3	0.1570	0.0180
4	0.1712	0.0142
5	0.1830	0.0119
6	0.1933	0.0103
7	0.2025	0.0091
8	0.2107	0.0083
9	0.2183	0.0076
10	0.2253	0.0070
11	0.2319	0.0065
12	0.2380	0.0061
13	0.2426	0.0046
14	0.2469	0.0043
15	0.2510	0.0041
16	0.2549	0.0039
17	0.2586	0.0037
18	0.2621	0.0035
19	0.2655	0.0034
20	0.2688	0.0033
21	0.2720	0.0031
22	0.2750	0.0030
23	0.2779	0.0029
24	0.2808	0.0028
25	0.2835	0.0027
26	0.2862	0.0027

27	0.2888	0.0026
28	0.2913	0.0025
29	0.2937	0.0024
30	0.2961	0.0024
31	0.2984	0.0023
32	0.3007	0.0023
33	0.3029	0.0022
34	0.3051	0.0022
35	0.3072	0.0021
36	0.3093	0.0021
37	0.3113	0.0020
38	0.3132	0.0020
39	0.3152	0.0019
40	0.3171	0.0019
41	0.3189	0.0019
42	0.3208	0.0018
43	0.3226	0.0018
44	0.3243	0.0018
45	0.3260	0.0017
46	0.3277	0.0017
47	0.3294	0.0017
48	0.3311	0.0016
49	0.3327	0.0016
50	0.3343	0.0016
51	0.3359	0.0016
52	0.3374	0.0015
53	0.3389	0.0015
54	0.3404	0.0015
55	0.3419	0.0015
56	0.3434	0.0015
57	0.3448	0.0014
58	0.3462	0.0014
59	0.3477	0.0014
60	0.3490	0.0014
61	0.3504	0.0014
62	0.3518	0.0014
63	0.3531	0.0013
64	0.3544	0.0013
65	0.3557	0.0013
66	0.3570	0.0013
67	0.3583	0.0013
68	0.3595	0.0013
69	0.3608	0.0012
70	0.3620	0.0012
71	0.3632	0.0012
72	0.3644	0.0012
73	0.3658	0.0014
74	0.3672	0.0014
75	0.3686	0.0014
76	0.3699	0.0013
77	0.3713	0.0013
78	0.3726	0.0013
79	0.3739	0.0013
80	0.3752	0.0013
81	0.3765	0.0013
82	0.3777	0.0013
83	0.3790	0.0013

84	0.3803	0.0013
85	0.3815	0.0012
86	0.3827	0.0012
87	0.3840	0.0012
88	0.3852	0.0012
89	0.3864	0.0012
90	0.3876	0.0012
91	0.3887	0.0012
92	0.3899	0.0012
93	0.3911	0.0012
94	0.3922	0.0012
95	0.3934	0.0011
96	0.3945	0.0011
97	0.3956	0.0011
98	0.3968	0.0011
99	0.3979	0.0011
100	0.3990	0.0011
101	0.4001	0.0011
102	0.4012	0.0011
103	0.4022	0.0011
104	0.4033	0.0011
105	0.4044	0.0011
106	0.4054	0.0011
107	0.4065	0.0011
108	0.4075	0.0010
109	0.4086	0.0010
110	0.4096	0.0010
111	0.4106	0.0010
112	0.4116	0.0010
113	0.4126	0.0010
114	0.4136	0.0010
115	0.4146	0.0010
116	0.4156	0.0010
117	0.4166	0.0010
118	0.4176	0.0010
119	0.4186	0.0010
120	0.4195	0.0010
121	0.4205	0.0010
122	0.4214	0.0010
123	0.4224	0.0009
124	0.4233	0.0009
125	0.4243	0.0009
126	0.4252	0.0009
127	0.4261	0.0009
128	0.4271	0.0009
129	0.4280	0.0009
130	0.4289	0.0009
131	0.4298	0.0009
132	0.4307	0.0009
133	0.4316	0.0009
134	0.4325	0.0009
135	0.4334	0.0009
136	0.4342	0.0009
137	0.4351	0.0009
138	0.4360	0.0009
139	0.4369	0.0009
140	0.4377	0.0009

141	0.4386	0.0009
142	0.4394	0.0009
143	0.4403	0.0009
144	0.4411	0.0008
145	0.4420	0.0008
146	0.4428	0.0008
147	0.4437	0.0008
148	0.4445	0.0008
149	0.4453	0.0008
150	0.4461	0.0008
151	0.4469	0.0008
152	0.4478	0.0008
153	0.4486	0.0008
154	0.4494	0.0008
155	0.4502	0.0008
156	0.4510	0.0008
157	0.4518	0.0008
158	0.4526	0.0008
159	0.4533	0.0008
160	0.4541	0.0008
161	0.4549	0.0008
162	0.4557	0.0008
163	0.4565	0.0008
164	0.4572	0.0008
165	0.4580	0.0008
166	0.4588	0.0008
167	0.4595	0.0008
168	0.4603	0.0008
169	0.4610	0.0008
170	0.4618	0.0008
171	0.4625	0.0007
172	0.4633	0.0007
173	0.4640	0.0007
174	0.4648	0.0007
175	0.4655	0.0007
176	0.4662	0.0007
177	0.4669	0.0007
178	0.4677	0.0007
179	0.4684	0.0007
180	0.4691	0.0007
181	0.4698	0.0007
182	0.4705	0.0007
183	0.4713	0.0007
184	0.4720	0.0007
185	0.4727	0.0007
186	0.4734	0.0007
187	0.4741	0.0007
188	0.4748	0.0007
189	0.4755	0.0007
190	0.4762	0.0007
191	0.4768	0.0007
192	0.4775	0.0007
193	0.4782	0.0007
194	0.4789	0.0007
195	0.4796	0.0007
196	0.4802	0.0007
197	0.4809	0.0007

198	0.4816	0.0007
199	0.4823	0.0007
200	0.4829	0.0007
201	0.4836	0.0007
202	0.4843	0.0007
203	0.4849	0.0007
204	0.4856	0.0007
205	0.4862	0.0007
206	0.4869	0.0007
207	0.4875	0.0007
208	0.4882	0.0006
209	0.4888	0.0006
210	0.4895	0.0006
211	0.4901	0.0006
212	0.4907	0.0006
213	0.4914	0.0006
214	0.4920	0.0006
215	0.4926	0.0006
216	0.4933	0.0006
217	0.4939	0.0006
218	0.4945	0.0006
219	0.4952	0.0006
220	0.4958	0.0006
221	0.4964	0.0006
222	0.4970	0.0006
223	0.4976	0.0006
224	0.4982	0.0006
225	0.4989	0.0006
226	0.4995	0.0006
227	0.5001	0.0006
228	0.5007	0.0006
229	0.5013	0.0006
230	0.5019	0.0006
231	0.5025	0.0006
232	0.5031	0.0006
233	0.5037	0.0006
234	0.5043	0.0006
235	0.5049	0.0006
236	0.5055	0.0006
237	0.5061	0.0006
238	0.5066	0.0006
239	0.5072	0.0006
240	0.5078	0.0006
241	0.5084	0.0006
242	0.5090	0.0006
243	0.5095	0.0006
244	0.5101	0.0006
245	0.5107	0.0006
246	0.5113	0.0006
247	0.5118	0.0006
248	0.5124	0.0006
249	0.5130	0.0006
250	0.5136	0.0006
251	0.5141	0.0006
252	0.5147	0.0006
253	0.5152	0.0006
254	0.5158	0.0006

255	0.5164	0.0006
256	0.5169	0.0006
257	0.5175	0.0006
258	0.5180	0.0006
259	0.5186	0.0006
260	0.5191	0.0006
261	0.5197	0.0005
262	0.5202	0.0005
263	0.5208	0.0005
264	0.5213	0.0005
265	0.5219	0.0005
266	0.5224	0.0005
267	0.5229	0.0005
268	0.5235	0.0005
269	0.5240	0.0005
270	0.5246	0.0005
271	0.5251	0.0005
272	0.5256	0.0005
273	0.5262	0.0005
274	0.5267	0.0005
275	0.5272	0.0005
276	0.5277	0.0005
277	0.5283	0.0005
278	0.5288	0.0005
279	0.5293	0.0005
280	0.5298	0.0005
281	0.5304	0.0005
282	0.5309	0.0005
283	0.5314	0.0005
284	0.5319	0.0005
285	0.5324	0.0005
286	0.5329	0.0005
287	0.5335	0.0005
288	0.5340	0.0005

STORM DAY 3 Ratio to Peak 24 Hours: 0.190
STORM DAY 3 Total Rainfall = 0.6764 (In)

1	0.1430	0.1430
2	0.1761	0.0331
3	0.1989	0.0228
4	0.2168	0.0179
5	0.2318	0.0150
6	0.2449	0.0130
7	0.2564	0.0116
8	0.2669	0.0105
9	0.2765	0.0096
10	0.2854	0.0089
11	0.2937	0.0083
12	0.3014	0.0078
13	0.3073	0.0058
14	0.3127	0.0055
15	0.3179	0.0052
16	0.3229	0.0049
17	0.3276	0.0047
18	0.3320	0.0045
19	0.3364	0.0043
20	0.3405	0.0041
21	0.3445	0.0040

22	0.3483	0.0038
23	0.3520	0.0037
24	0.3556	0.0036
25	0.3591	0.0035
26	0.3625	0.0034
27	0.3658	0.0033
28	0.3689	0.0032
29	0.3720	0.0031
30	0.3751	0.0030
31	0.3780	0.0029
32	0.3809	0.0029
33	0.3837	0.0028
34	0.3864	0.0027
35	0.3891	0.0027
36	0.3917	0.0026
37	0.3943	0.0026
38	0.3968	0.0025
39	0.3992	0.0024
40	0.4016	0.0024
41	0.4040	0.0024
42	0.4063	0.0023
43	0.4086	0.0023
44	0.4108	0.0022
45	0.4130	0.0022
46	0.4151	0.0022
47	0.4173	0.0021
48	0.4194	0.0021
49	0.4214	0.0021
50	0.4234	0.0020
51	0.4254	0.0020
52	0.4274	0.0020
53	0.4293	0.0019
54	0.4312	0.0019
55	0.4331	0.0019
56	0.4350	0.0019
57	0.4368	0.0018
58	0.4386	0.0018
59	0.4404	0.0018
60	0.4421	0.0018
61	0.4439	0.0017
62	0.4456	0.0017
63	0.4473	0.0017
64	0.4489	0.0017
65	0.4506	0.0017
66	0.4522	0.0016
67	0.4538	0.0016
68	0.4554	0.0016
69	0.4570	0.0016
70	0.4586	0.0016
71	0.4601	0.0015
72	0.4616	0.0015
73	0.4634	0.0018
74	0.4651	0.0017
75	0.4669	0.0017
76	0.4686	0.0017
77	0.4703	0.0017
78	0.4719	0.0017

79	0.4736	0.0017
80	0.4752	0.0016
81	0.4769	0.0016
82	0.4785	0.0016
83	0.4801	0.0016
84	0.4817	0.0016
85	0.4832	0.0016
86	0.4848	0.0016
87	0.4863	0.0015
88	0.4879	0.0015
89	0.4894	0.0015
90	0.4909	0.0015
91	0.4924	0.0015
92	0.4939	0.0015
93	0.4954	0.0015
94	0.4968	0.0015
95	0.4983	0.0015
96	0.4997	0.0014
97	0.5011	0.0014
98	0.5026	0.0014
99	0.5040	0.0014
100	0.5054	0.0014
101	0.5068	0.0014
102	0.5081	0.0014
103	0.5095	0.0014
104	0.5109	0.0014
105	0.5122	0.0013
106	0.5135	0.0013
107	0.5149	0.0013
108	0.5162	0.0013
109	0.5175	0.0013
110	0.5188	0.0013
111	0.5201	0.0013
112	0.5214	0.0013
113	0.5227	0.0013
114	0.5239	0.0013
115	0.5252	0.0013
116	0.5265	0.0013
117	0.5277	0.0012
118	0.5289	0.0012
119	0.5302	0.0012
120	0.5314	0.0012
121	0.5326	0.0012
122	0.5338	0.0012
123	0.5350	0.0012
124	0.5362	0.0012
125	0.5374	0.0012
126	0.5386	0.0012
127	0.5398	0.0012
128	0.5409	0.0012
129	0.5421	0.0012
130	0.5432	0.0012
131	0.5444	0.0011
132	0.5455	0.0011
133	0.5467	0.0011
134	0.5478	0.0011
135	0.5489	0.0011

136	0.5500	0.0011
137	0.5512	0.0011
138	0.5523	0.0011
139	0.5534	0.0011
140	0.5545	0.0011
141	0.5555	0.0011
142	0.5566	0.0011
143	0.5577	0.0011
144	0.5588	0.0011
145	0.5598	0.0011
146	0.5609	0.0011
147	0.5620	0.0011
148	0.5630	0.0011
149	0.5641	0.0010
150	0.5651	0.0010
151	0.5661	0.0010
152	0.5672	0.0010
153	0.5682	0.0010
154	0.5692	0.0010
155	0.5702	0.0010
156	0.5712	0.0010
157	0.5722	0.0010
158	0.5732	0.0010
159	0.5742	0.0010
160	0.5752	0.0010
161	0.5762	0.0010
162	0.5772	0.0010
163	0.5782	0.0010
164	0.5792	0.0010
165	0.5801	0.0010
166	0.5811	0.0010
167	0.5821	0.0010
168	0.5830	0.0010
169	0.5840	0.0010
170	0.5849	0.0010
171	0.5859	0.0009
172	0.5868	0.0009
173	0.5877	0.0009
174	0.5887	0.0009
175	0.5896	0.0009
176	0.5905	0.0009
177	0.5915	0.0009
178	0.5924	0.0009
179	0.5933	0.0009
180	0.5942	0.0009
181	0.5951	0.0009
182	0.5960	0.0009
183	0.5969	0.0009
184	0.5978	0.0009
185	0.5987	0.0009
186	0.5996	0.0009
187	0.6005	0.0009
188	0.6014	0.0009
189	0.6023	0.0009
190	0.6031	0.0009
191	0.6040	0.0009
192	0.6049	0.0009

193	0.6057	0.0009
194	0.6066	0.0009
195	0.6075	0.0009
196	0.6083	0.0009
197	0.6092	0.0009
198	0.6100	0.0009
199	0.6109	0.0008
200	0.6117	0.0008
201	0.6126	0.0008
202	0.6134	0.0008
203	0.6142	0.0008
204	0.6151	0.0008
205	0.6159	0.0008
206	0.6167	0.0008
207	0.6175	0.0008
208	0.6184	0.0008
209	0.6192	0.0008
210	0.6200	0.0008
211	0.6208	0.0008
212	0.6216	0.0008
213	0.6224	0.0008
214	0.6232	0.0008
215	0.6240	0.0008
216	0.6248	0.0008
217	0.6256	0.0008
218	0.6264	0.0008
219	0.6272	0.0008
220	0.6280	0.0008
221	0.6288	0.0008
222	0.6296	0.0008
223	0.6303	0.0008
224	0.6311	0.0008
225	0.6319	0.0008
226	0.6327	0.0008
227	0.6334	0.0008
228	0.6342	0.0008
229	0.6350	0.0008
230	0.6357	0.0008
231	0.6365	0.0008
232	0.6372	0.0008
233	0.6380	0.0008
234	0.6388	0.0008
235	0.6395	0.0008
236	0.6403	0.0007
237	0.6410	0.0007
238	0.6417	0.0007
239	0.6425	0.0007
240	0.6432	0.0007
241	0.6440	0.0007
242	0.6447	0.0007
243	0.6454	0.0007
244	0.6462	0.0007
245	0.6469	0.0007
246	0.6476	0.0007
247	0.6483	0.0007
248	0.6491	0.0007
249	0.6498	0.0007

250	0.6505	0.0007
251	0.6512	0.0007
252	0.6519	0.0007
253	0.6526	0.0007
254	0.6534	0.0007
255	0.6541	0.0007
256	0.6548	0.0007
257	0.6555	0.0007
258	0.6562	0.0007
259	0.6569	0.0007
260	0.6576	0.0007
261	0.6583	0.0007
262	0.6590	0.0007
263	0.6596	0.0007
264	0.6603	0.0007
265	0.6610	0.0007
266	0.6617	0.0007
267	0.6624	0.0007
268	0.6631	0.0007
269	0.6638	0.0007
270	0.6644	0.0007
271	0.6651	0.0007
272	0.6658	0.0007
273	0.6665	0.0007
274	0.6671	0.0007
275	0.6678	0.0007
276	0.6685	0.0007
277	0.6691	0.0007
278	0.6698	0.0007
279	0.6705	0.0007
280	0.6711	0.0007
281	0.6718	0.0007
282	0.6724	0.0007
283	0.6731	0.0007
284	0.6738	0.0007
285	0.6744	0.0007
286	0.6751	0.0007
287	0.6757	0.0006
288	0.6764	0.0006

STORM DAY 4 Ratio to Peak 24 Hours: 0.360
STORM DAY 4 Total Rainfall = 1.2815 (In)

1	0.2710	0.2710
2	0.3337	0.0626
3	0.3768	0.0432
4	0.4108	0.0340
5	0.4392	0.0284
6	0.4639	0.0247
7	0.4859	0.0220
8	0.5057	0.0199
9	0.5239	0.0182
10	0.5408	0.0168
11	0.5564	0.0157
12	0.5712	0.0147
13	0.5822	0.0110
14	0.5925	0.0104
15	0.6024	0.0098
16	0.6117	0.0093

17	0.6206	0.0089
18	0.6291	0.0085
19	0.6373	0.0082
20	0.6451	0.0078
21	0.6527	0.0075
22	0.6600	0.0073
23	0.6670	0.0070
24	0.6738	0.0068
25	0.6804	0.0066
26	0.6868	0.0064
27	0.6930	0.0062
28	0.6990	0.0060
29	0.7049	0.0059
30	0.7106	0.0057
31	0.7162	0.0056
32	0.7217	0.0054
33	0.7270	0.0053
34	0.7322	0.0052
35	0.7372	0.0051
36	0.7422	0.0050
37	0.7470	0.0048
38	0.7518	0.0047
39	0.7564	0.0046
40	0.7610	0.0046
41	0.7654	0.0045
42	0.7698	0.0044
43	0.7741	0.0043
44	0.7784	0.0042
45	0.7825	0.0042
46	0.7866	0.0041
47	0.7906	0.0040
48	0.7946	0.0040
49	0.7985	0.0039
50	0.8023	0.0038
51	0.8061	0.0038
52	0.8098	0.0037
53	0.8134	0.0037
54	0.8170	0.0036
55	0.8206	0.0036
56	0.8241	0.0035
57	0.8276	0.0035
58	0.8310	0.0034
59	0.8344	0.0034
60	0.8377	0.0033
61	0.8410	0.0033
62	0.8442	0.0032
63	0.8474	0.0032
64	0.8506	0.0032
65	0.8537	0.0031
66	0.8568	0.0031
67	0.8599	0.0031
68	0.8629	0.0030
69	0.8659	0.0030
70	0.8689	0.0030
71	0.8718	0.0029
72	0.8747	0.0029
73	0.8780	0.0033

74	0.8813	0.0033
75	0.8846	0.0033
76	0.8878	0.0032
77	0.8910	0.0032
78	0.8942	0.0032
79	0.8973	0.0031
80	0.9004	0.0031
81	0.9035	0.0031
82	0.9066	0.0031
83	0.9096	0.0030
84	0.9126	0.0030
85	0.9156	0.0030
86	0.9186	0.0030
87	0.9215	0.0029
88	0.9244	0.0029
89	0.9273	0.0029
90	0.9301	0.0029
91	0.9330	0.0028
92	0.9358	0.0028
93	0.9386	0.0028
94	0.9413	0.0028
95	0.9441	0.0027
96	0.9468	0.0027
97	0.9495	0.0027
98	0.9522	0.0027
99	0.9549	0.0027
100	0.9575	0.0026
101	0.9602	0.0026
102	0.9628	0.0026
103	0.9654	0.0026
104	0.9679	0.0026
105	0.9705	0.0026
106	0.9730	0.0025
107	0.9756	0.0025
108	0.9781	0.0025
109	0.9805	0.0025
110	0.9830	0.0025
111	0.9855	0.0025
112	0.9879	0.0024
113	0.9903	0.0024
114	0.9927	0.0024
115	0.9951	0.0024
116	0.9975	0.0024
117	0.9999	0.0024
118	1.0022	0.0023
119	1.0045	0.0023
120	1.0069	0.0023
121	1.0092	0.0023
122	1.0115	0.0023
123	1.0137	0.0023
124	1.0160	0.0023
125	1.0183	0.0023
126	1.0205	0.0022
127	1.0227	0.0022
128	1.0249	0.0022
129	1.0271	0.0022
130	1.0293	0.0022

131	1.0315	0.0022
132	1.0337	0.0022
133	1.0358	0.0022
134	1.0379	0.0021
135	1.0401	0.0021
136	1.0422	0.0021
137	1.0443	0.0021
138	1.0464	0.0021
139	1.0485	0.0021
140	1.0505	0.0021
141	1.0526	0.0021
142	1.0547	0.0021
143	1.0567	0.0020
144	1.0587	0.0020
145	1.0608	0.0020
146	1.0628	0.0020
147	1.0648	0.0020
148	1.0668	0.0020
149	1.0687	0.0020
150	1.0707	0.0020
151	1.0727	0.0020
152	1.0746	0.0020
153	1.0766	0.0019
154	1.0785	0.0019
155	1.0804	0.0019
156	1.0823	0.0019
157	1.0842	0.0019
158	1.0861	0.0019
159	1.0880	0.0019
160	1.0899	0.0019
161	1.0918	0.0019
162	1.0937	0.0019
163	1.0955	0.0019
164	1.0974	0.0018
165	1.0992	0.0018
166	1.1010	0.0018
167	1.1029	0.0018
168	1.1047	0.0018
169	1.1065	0.0018
170	1.1083	0.0018
171	1.1101	0.0018
172	1.1119	0.0018
173	1.1136	0.0018
174	1.1154	0.0018
175	1.1172	0.0018
176	1.1189	0.0018
177	1.1207	0.0017
178	1.1224	0.0017
179	1.1241	0.0017
180	1.1259	0.0017
181	1.1276	0.0017
182	1.1293	0.0017
183	1.1310	0.0017
184	1.1327	0.0017
185	1.1344	0.0017
186	1.1361	0.0017
187	1.1378	0.0017

188	1.1394	0.0017
189	1.1411	0.0017
190	1.1428	0.0017
191	1.1444	0.0017
192	1.1461	0.0016
193	1.1477	0.0016
194	1.1493	0.0016
195	1.1510	0.0016
196	1.1526	0.0016
197	1.1542	0.0016
198	1.1558	0.0016
199	1.1574	0.0016
200	1.1590	0.0016
201	1.1606	0.0016
202	1.1622	0.0016
203	1.1638	0.0016
204	1.1654	0.0016
205	1.1669	0.0016
206	1.1685	0.0016
207	1.1701	0.0016
208	1.1716	0.0016
209	1.1732	0.0015
210	1.1747	0.0015
211	1.1763	0.0015
212	1.1778	0.0015
213	1.1793	0.0015
214	1.1808	0.0015
215	1.1824	0.0015
216	1.1839	0.0015
217	1.1854	0.0015
218	1.1869	0.0015
219	1.1884	0.0015
220	1.1899	0.0015
221	1.1914	0.0015
222	1.1928	0.0015
223	1.1943	0.0015
224	1.1958	0.0015
225	1.1973	0.0015
226	1.1987	0.0015
227	1.2002	0.0015
228	1.2016	0.0015
229	1.2031	0.0014
230	1.2045	0.0014
231	1.2060	0.0014
232	1.2074	0.0014
233	1.2088	0.0014
234	1.2103	0.0014
235	1.2117	0.0014
236	1.2131	0.0014
237	1.2145	0.0014
238	1.2159	0.0014
239	1.2173	0.0014
240	1.2187	0.0014
241	1.2201	0.0014
242	1.2215	0.0014
243	1.2229	0.0014
244	1.2243	0.0014

245	1.2257	0.0014
246	1.2271	0.0014
247	1.2284	0.0014
248	1.2298	0.0014
249	1.2312	0.0014
250	1.2325	0.0014
251	1.2339	0.0014
252	1.2352	0.0014
253	1.2366	0.0013
254	1.2379	0.0013
255	1.2393	0.0013
256	1.2406	0.0013
257	1.2419	0.0013
258	1.2433	0.0013
259	1.2446	0.0013
260	1.2459	0.0013
261	1.2472	0.0013
262	1.2485	0.0013
263	1.2499	0.0013
264	1.2512	0.0013
265	1.2525	0.0013
266	1.2538	0.0013
267	1.2551	0.0013
268	1.2564	0.0013
269	1.2577	0.0013
270	1.2589	0.0013
271	1.2602	0.0013
272	1.2615	0.0013
273	1.2628	0.0013
274	1.2641	0.0013
275	1.2653	0.0013
276	1.2666	0.0013
277	1.2678	0.0013
278	1.2691	0.0013
279	1.2704	0.0013
280	1.2716	0.0013
281	1.2729	0.0012
282	1.2741	0.0012
283	1.2754	0.0012
284	1.2766	0.0012
285	1.2778	0.0012
286	1.2791	0.0012
287	1.2803	0.0012
288	1.2815	0.0012

STORM DAY 5 Ratio to Peak 24 Hours: 1.000
STORM DAY 5 Total Rainfall = 3.5598 (In)

1	0.7528	0.7528
2	0.9269	0.1740
3	1.0467	0.1199
4	1.1411	0.0944
5	1.2201	0.0790
6	1.2887	0.0686
7	1.3497	0.0610
8	1.4049	0.0552
9	1.4554	0.0505
10	1.5021	0.0467
11	1.5457	0.0436

12	1.5866	0.0409
13	1.6171	0.0306
14	1.6460	0.0288
15	1.6733	0.0273
16	1.6992	0.0259
17	1.7240	0.0247
18	1.7476	0.0237
19	1.7703	0.0227
20	1.7921	0.0218
21	1.8130	0.0210
22	1.8333	0.0202
23	1.8528	0.0195
24	1.8717	0.0189
25	1.8900	0.0183
26	1.9078	0.0178
27	1.9250	0.0172
28	1.9418	0.0168
29	1.9581	0.0163
30	1.9740	0.0159
31	1.9895	0.0155
32	2.0046	0.0151
33	2.0194	0.0148
34	2.0338	0.0144
35	2.0479	0.0141
36	2.0617	0.0138
37	2.0751	0.0134
38	2.0883	0.0132
39	2.1012	0.0129
40	2.1138	0.0126
41	2.1262	0.0124
42	2.1384	0.0122
43	2.1503	0.0120
44	2.1621	0.0117
45	2.1736	0.0115
46	2.1850	0.0113
47	2.1961	0.0112
48	2.2071	0.0110
49	2.2179	0.0108
50	2.2286	0.0106
51	2.2390	0.0105
52	2.2494	0.0103
53	2.2595	0.0102
54	2.2696	0.0100
55	2.2795	0.0099
56	2.2892	0.0098
57	2.2988	0.0096
58	2.3083	0.0095
59	2.3177	0.0094
60	2.3269	0.0092
61	2.3361	0.0091
62	2.3451	0.0090
63	2.3540	0.0089
64	2.3628	0.0088
65	2.3715	0.0087
66	2.3801	0.0086
67	2.3886	0.0085
68	2.3970	0.0084

69	2.4053	0.0083
70	2.4135	0.0082
71	2.4216	0.0081
72	2.4296	0.0080
73	2.4389	0.0093
74	2.4481	0.0092
75	2.4571	0.0091
76	2.4661	0.0090
77	2.4750	0.0089
78	2.4838	0.0088
79	2.4926	0.0087
80	2.5012	0.0087
81	2.5098	0.0086
82	2.5183	0.0085
83	2.5267	0.0084
84	2.5351	0.0084
85	2.5433	0.0083
86	2.5516	0.0082
87	2.5597	0.0081
88	2.5678	0.0081
89	2.5758	0.0080
90	2.5837	0.0079
91	2.5916	0.0079
92	2.5994	0.0078
93	2.6072	0.0078
94	2.6149	0.0077
95	2.6225	0.0076
96	2.6301	0.0076
97	2.6376	0.0075
98	2.6451	0.0075
99	2.6525	0.0074
100	2.6598	0.0074
101	2.6671	0.0073
102	2.6744	0.0072
103	2.6816	0.0072
104	2.6887	0.0071
105	2.6958	0.0071
106	2.7029	0.0070
107	2.7099	0.0070
108	2.7168	0.0070
109	2.7237	0.0069
110	2.7306	0.0069
111	2.7374	0.0068
112	2.7442	0.0068
113	2.7509	0.0067
114	2.7576	0.0067
115	2.7642	0.0066
116	2.7708	0.0066
117	2.7774	0.0066
118	2.7839	0.0065
119	2.7904	0.0065
120	2.7968	0.0064
121	2.8032	0.0064
122	2.8096	0.0064
123	2.8159	0.0063
124	2.8222	0.0063
125	2.8285	0.0063

126	2.8347	0.0062
127	2.8409	0.0062
128	2.8470	0.0061
129	2.8531	0.0061
130	2.8592	0.0061
131	2.8653	0.0060
132	2.8713	0.0060
133	2.8772	0.0060
134	2.8832	0.0059
135	2.8891	0.0059
136	2.8950	0.0059
137	2.9008	0.0058
138	2.9066	0.0058
139	2.9124	0.0058
140	2.9182	0.0058
141	2.9239	0.0057
142	2.9296	0.0057
143	2.9353	0.0057
144	2.9409	0.0056
145	2.9465	0.0056
146	2.9521	0.0056
147	2.9577	0.0056
148	2.9632	0.0055
149	2.9687	0.0055
150	2.9742	0.0055
151	2.9796	0.0054
152	2.9851	0.0054
153	2.9905	0.0054
154	2.9958	0.0054
155	3.0012	0.0053
156	3.0065	0.0053
157	3.0118	0.0053
158	3.0171	0.0053
159	3.0223	0.0052
160	3.0276	0.0052
161	3.0328	0.0052
162	3.0379	0.0052
163	3.0431	0.0052
164	3.0482	0.0051
165	3.0533	0.0051
166	3.0584	0.0051
167	3.0635	0.0051
168	3.0685	0.0050
169	3.0735	0.0050
170	3.0785	0.0050
171	3.0835	0.0050
172	3.0885	0.0050
173	3.0934	0.0049
174	3.0983	0.0049
175	3.1032	0.0049
176	3.1081	0.0049
177	3.1130	0.0049
178	3.1178	0.0048
179	3.1226	0.0048
180	3.1274	0.0048
181	3.1322	0.0048
182	3.1369	0.0048

183	3.1417	0.0047
184	3.1464	0.0047
185	3.1511	0.0047
186	3.1558	0.0047
187	3.1605	0.0047
188	3.1651	0.0046
189	3.1697	0.0046
190	3.1744	0.0046
191	3.1789	0.0046
192	3.1835	0.0046
193	3.1881	0.0046
194	3.1926	0.0045
195	3.1971	0.0045
196	3.2017	0.0045
197	3.2062	0.0045
198	3.2106	0.0045
199	3.2151	0.0045
200	3.2195	0.0044
201	3.2240	0.0044
202	3.2284	0.0044
203	3.2328	0.0044
204	3.2371	0.0044
205	3.2415	0.0044
206	3.2459	0.0043
207	3.2502	0.0043
208	3.2545	0.0043
209	3.2588	0.0043
210	3.2631	0.0043
211	3.2674	0.0043
212	3.2716	0.0043
213	3.2759	0.0042
214	3.2801	0.0042
215	3.2843	0.0042
216	3.2885	0.0042
217	3.2927	0.0042
218	3.2969	0.0042
219	3.3010	0.0042
220	3.3052	0.0041
221	3.3093	0.0041
222	3.3134	0.0041
223	3.3176	0.0041
224	3.3216	0.0041
225	3.3257	0.0041
226	3.3298	0.0041
227	3.3338	0.0041
228	3.3379	0.0040
229	3.3419	0.0040
230	3.3459	0.0040
231	3.3499	0.0040
232	3.3539	0.0040
233	3.3579	0.0040
234	3.3619	0.0040
235	3.3658	0.0040
236	3.3697	0.0039
237	3.3737	0.0039
238	3.3776	0.0039
239	3.3815	0.0039

240	3.3854	0.0039
241	3.3893	0.0039
242	3.3931	0.0039
243	3.3970	0.0039
244	3.4008	0.0038
245	3.4047	0.0038
246	3.4085	0.0038
247	3.4123	0.0038
248	3.4161	0.0038
249	3.4199	0.0038
250	3.4237	0.0038
251	3.4274	0.0038
252	3.4312	0.0038
253	3.4350	0.0037
254	3.4387	0.0037
255	3.4424	0.0037
256	3.4461	0.0037
257	3.4498	0.0037
258	3.4535	0.0037
259	3.4572	0.0037
260	3.4609	0.0037
261	3.4645	0.0037
262	3.4682	0.0037
263	3.4718	0.0036
264	3.4755	0.0036
265	3.4791	0.0036
266	3.4827	0.0036
267	3.4863	0.0036
268	3.4899	0.0036
269	3.4935	0.0036
270	3.4971	0.0036
271	3.5006	0.0036
272	3.5042	0.0036
273	3.5077	0.0035
274	3.5113	0.0035
275	3.5148	0.0035
276	3.5183	0.0035
277	3.5218	0.0035
278	3.5253	0.0035
279	3.5288	0.0035
280	3.5323	0.0035
281	3.5357	0.0035
282	3.5392	0.0035
283	3.5427	0.0035
284	3.5461	0.0034
285	3.5495	0.0034
286	3.5530	0.0034
287	3.5564	0.0034
288	3.5598	0.0034

Unit Period (number)	Unit Rainfall (In)	Unit Soil-Loss (In)	Effective Rainfall (In)
STORM DAY 1			
1	0.0003	0.0000	0.0003
2	0.0003	0.0000	0.0003

3	0.0003	0.0000	0.0003
4	0.0003	0.0000	0.0003
5	0.0003	0.0000	0.0003
6	0.0003	0.0000	0.0003
7	0.0003	0.0000	0.0003
8	0.0003	0.0000	0.0003
9	0.0004	0.0000	0.0003
10	0.0004	0.0000	0.0003
11	0.0004	0.0000	0.0003
12	0.0004	0.0000	0.0003
13	0.0004	0.0000	0.0003
14	0.0004	0.0000	0.0003
15	0.0004	0.0000	0.0003
16	0.0004	0.0000	0.0003
17	0.0004	0.0000	0.0003
18	0.0004	0.0000	0.0003
19	0.0004	0.0000	0.0003
20	0.0004	0.0000	0.0003
21	0.0004	0.0000	0.0003
22	0.0004	0.0000	0.0003
23	0.0004	0.0000	0.0004
24	0.0004	0.0000	0.0004
25	0.0004	0.0000	0.0004
26	0.0004	0.0000	0.0004
27	0.0004	0.0000	0.0004
28	0.0004	0.0000	0.0004
29	0.0004	0.0000	0.0004
30	0.0004	0.0000	0.0004
31	0.0004	0.0000	0.0004
32	0.0004	0.0000	0.0004
33	0.0004	0.0000	0.0004
34	0.0004	0.0000	0.0004
35	0.0004	0.0000	0.0004
36	0.0004	0.0000	0.0004
37	0.0004	0.0000	0.0004
38	0.0004	0.0000	0.0004
39	0.0004	0.0000	0.0004
40	0.0004	0.0000	0.0004
41	0.0004	0.0000	0.0004
42	0.0004	0.0000	0.0004
43	0.0004	0.0000	0.0004
44	0.0004	0.0000	0.0004
45	0.0004	0.0000	0.0004
46	0.0004	0.0000	0.0004
47	0.0004	0.0000	0.0004
48	0.0004	0.0000	0.0004
49	0.0004	0.0000	0.0004
50	0.0004	0.0000	0.0004
51	0.0004	0.0000	0.0004
52	0.0004	0.0000	0.0004
53	0.0004	0.0000	0.0004
54	0.0004	0.0000	0.0004
55	0.0004	0.0000	0.0004
56	0.0004	0.0000	0.0004
57	0.0004	0.0000	0.0004
58	0.0004	0.0000	0.0004
59	0.0004	0.0000	0.0004

60	0.0004	0.0000	0.0004
61	0.0004	0.0000	0.0004
62	0.0004	0.0000	0.0004
63	0.0005	0.0000	0.0004
64	0.0005	0.0000	0.0004
65	0.0005	0.0000	0.0004
66	0.0005	0.0000	0.0004
67	0.0005	0.0000	0.0004
68	0.0005	0.0000	0.0004
69	0.0005	0.0000	0.0004
70	0.0005	0.0000	0.0004
71	0.0005	0.0000	0.0004
72	0.0005	0.0000	0.0004
73	0.0005	0.0000	0.0005
74	0.0005	0.0000	0.0005
75	0.0005	0.0000	0.0005
76	0.0005	0.0000	0.0005
77	0.0005	0.0000	0.0005
78	0.0005	0.0000	0.0005
79	0.0005	0.0000	0.0005
80	0.0005	0.0000	0.0005
81	0.0005	0.0000	0.0005
82	0.0005	0.0000	0.0005
83	0.0005	0.0000	0.0005
84	0.0005	0.0000	0.0005
85	0.0005	0.0000	0.0005
86	0.0005	0.0000	0.0005
87	0.0005	0.0000	0.0005
88	0.0005	0.0000	0.0005
89	0.0005	0.0000	0.0005
90	0.0005	0.0000	0.0005
91	0.0005	0.0000	0.0005
92	0.0005	0.0000	0.0005
93	0.0005	0.0000	0.0005
94	0.0006	0.0000	0.0005
95	0.0006	0.0000	0.0005
96	0.0006	0.0000	0.0005
97	0.0006	0.0000	0.0005
98	0.0006	0.0000	0.0005
99	0.0006	0.0000	0.0005
100	0.0006	0.0000	0.0005
101	0.0006	0.0000	0.0005
102	0.0006	0.0000	0.0006
103	0.0006	0.0000	0.0006
104	0.0006	0.0000	0.0006
105	0.0006	0.0000	0.0006
106	0.0006	0.0000	0.0006
107	0.0006	0.0000	0.0006
108	0.0006	0.0000	0.0006
109	0.0006	0.0000	0.0006
110	0.0006	0.0000	0.0006
111	0.0006	0.0000	0.0006
112	0.0006	0.0000	0.0006
113	0.0006	0.0000	0.0006
114	0.0006	0.0000	0.0006
115	0.0007	0.0000	0.0006
116	0.0007	0.0000	0.0006

117	0.0007	0.0000	0.0006
118	0.0007	0.0000	0.0006
119	0.0007	0.0000	0.0006
120	0.0007	0.0000	0.0006
121	0.0007	0.0000	0.0007
122	0.0007	0.0000	0.0007
123	0.0007	0.0000	0.0007
124	0.0007	0.0000	0.0007
125	0.0007	0.0000	0.0007
126	0.0007	0.0000	0.0007
127	0.0007	0.0000	0.0007
128	0.0007	0.0000	0.0007
129	0.0008	0.0000	0.0007
130	0.0008	0.0000	0.0007
131	0.0008	0.0000	0.0007
132	0.0008	0.0000	0.0007
133	0.0008	0.0000	0.0007
134	0.0008	0.0000	0.0008
135	0.0008	0.0000	0.0008
136	0.0008	0.0000	0.0008
137	0.0008	0.0000	0.0008
138	0.0008	0.0000	0.0008
139	0.0009	0.0001	0.0008
140	0.0009	0.0001	0.0008
141	0.0009	0.0001	0.0008
142	0.0009	0.0001	0.0008
143	0.0009	0.0001	0.0009
144	0.0009	0.0001	0.0009
145	0.0008	0.0000	0.0008
146	0.0008	0.0000	0.0008
147	0.0008	0.0000	0.0008
148	0.0008	0.0000	0.0008
149	0.0009	0.0001	0.0008
150	0.0009	0.0001	0.0008
151	0.0009	0.0001	0.0008
152	0.0009	0.0001	0.0008
153	0.0009	0.0001	0.0009
154	0.0009	0.0001	0.0009
155	0.0010	0.0001	0.0009
156	0.0010	0.0001	0.0009
157	0.0010	0.0001	0.0009
158	0.0010	0.0001	0.0010
159	0.0010	0.0001	0.0010
160	0.0011	0.0001	0.0010
161	0.0011	0.0001	0.0010
162	0.0011	0.0001	0.0010
163	0.0012	0.0001	0.0011
164	0.0012	0.0001	0.0011
165	0.0012	0.0001	0.0011
166	0.0012	0.0001	0.0012
167	0.0013	0.0001	0.0012
168	0.0013	0.0001	0.0012
169	0.0014	0.0001	0.0013
170	0.0014	0.0001	0.0013
171	0.0015	0.0001	0.0014
172	0.0015	0.0001	0.0014
173	0.0016	0.0001	0.0015

174	0.0016	0.0001	0.0015
175	0.0017	0.0001	0.0016
176	0.0018	0.0001	0.0017
177	0.0019	0.0001	0.0018
178	0.0020	0.0001	0.0018
179	0.0021	0.0001	0.0020
180	0.0022	0.0001	0.0020
181	0.0024	0.0001	0.0022
182	0.0025	0.0001	0.0023
183	0.0027	0.0002	0.0026
184	0.0029	0.0002	0.0027
185	0.0041	0.0002	0.0038
186	0.0044	0.0003	0.0041
187	0.0051	0.0003	0.0048
188	0.0055	0.0003	0.0052
189	0.0069	0.0004	0.0065
190	0.0079	0.0005	0.0074
191	0.0120	0.0007	0.0113
192	0.0174	0.0010	0.0164
193	0.0753	0.0030	0.0723
194	0.0094	0.0006	0.0089
195	0.0061	0.0004	0.0057
196	0.0047	0.0003	0.0044
197	0.0031	0.0002	0.0029
198	0.0026	0.0002	0.0024
199	0.0023	0.0001	0.0021
200	0.0020	0.0001	0.0019
201	0.0018	0.0001	0.0017
202	0.0017	0.0001	0.0016
203	0.0015	0.0001	0.0015
204	0.0014	0.0001	0.0014
205	0.0013	0.0001	0.0013
206	0.0013	0.0001	0.0012
207	0.0012	0.0001	0.0011
208	0.0011	0.0001	0.0011
209	0.0011	0.0001	0.0010
210	0.0010	0.0001	0.0010
211	0.0010	0.0001	0.0009
212	0.0009	0.0001	0.0009
213	0.0009	0.0001	0.0009
214	0.0009	0.0001	0.0008
215	0.0008	0.0001	0.0008
216	0.0008	0.0000	0.0008
217	0.0009	0.0001	0.0009
218	0.0009	0.0001	0.0008
219	0.0009	0.0001	0.0008
220	0.0008	0.0001	0.0008
221	0.0008	0.0000	0.0008
222	0.0008	0.0000	0.0008
223	0.0008	0.0000	0.0007
224	0.0008	0.0000	0.0007
225	0.0008	0.0000	0.0007
226	0.0007	0.0000	0.0007
227	0.0007	0.0000	0.0007
228	0.0007	0.0000	0.0007
229	0.0007	0.0000	0.0006
230	0.0007	0.0000	0.0006

231	0.0007	0.0000	0.0006
232	0.0007	0.0000	0.0006
233	0.0006	0.0000	0.0006
234	0.0006	0.0000	0.0006
235	0.0006	0.0000	0.0006
236	0.0006	0.0000	0.0006
237	0.0006	0.0000	0.0006
238	0.0006	0.0000	0.0006
239	0.0006	0.0000	0.0005
240	0.0006	0.0000	0.0005
241	0.0006	0.0000	0.0005
242	0.0006	0.0000	0.0005
243	0.0005	0.0000	0.0005
244	0.0005	0.0000	0.0005
245	0.0005	0.0000	0.0005
246	0.0005	0.0000	0.0005
247	0.0005	0.0000	0.0005
248	0.0005	0.0000	0.0005
249	0.0005	0.0000	0.0005
250	0.0005	0.0000	0.0005
251	0.0005	0.0000	0.0005
252	0.0005	0.0000	0.0005
253	0.0005	0.0000	0.0004
254	0.0005	0.0000	0.0004
255	0.0005	0.0000	0.0004
256	0.0005	0.0000	0.0004
257	0.0005	0.0000	0.0004
258	0.0005	0.0000	0.0004
259	0.0004	0.0000	0.0004
260	0.0004	0.0000	0.0004
261	0.0004	0.0000	0.0004
262	0.0004	0.0000	0.0004
263	0.0004	0.0000	0.0004
264	0.0004	0.0000	0.0004
265	0.0004	0.0000	0.0004
266	0.0004	0.0000	0.0004
267	0.0004	0.0000	0.0004
268	0.0004	0.0000	0.0004
269	0.0004	0.0000	0.0004
270	0.0004	0.0000	0.0004
271	0.0004	0.0000	0.0004
272	0.0004	0.0000	0.0004
273	0.0004	0.0000	0.0004
274	0.0004	0.0000	0.0004
275	0.0004	0.0000	0.0004
276	0.0004	0.0000	0.0004
277	0.0004	0.0000	0.0004
278	0.0004	0.0000	0.0003
279	0.0004	0.0000	0.0003
280	0.0004	0.0000	0.0003
281	0.0004	0.0000	0.0003
282	0.0004	0.0000	0.0003
283	0.0004	0.0000	0.0003
284	0.0004	0.0000	0.0003
285	0.0004	0.0000	0.0003
286	0.0003	0.0000	0.0003
287	0.0003	0.0000	0.0003

288	0.0003	0.0000	0.0003
STORM DAY 2			
289	0.0005	0.0000	0.0005
290	0.0005	0.0000	0.0005
291	0.0005	0.0000	0.0005
292	0.0005	0.0000	0.0005
293	0.0005	0.0000	0.0005
294	0.0005	0.0000	0.0005
295	0.0005	0.0000	0.0005
296	0.0005	0.0000	0.0005
297	0.0005	0.0000	0.0005
298	0.0005	0.0000	0.0005
299	0.0005	0.0000	0.0005
300	0.0005	0.0000	0.0005
301	0.0005	0.0000	0.0005
302	0.0005	0.0000	0.0005
303	0.0005	0.0000	0.0005
304	0.0005	0.0000	0.0005
305	0.0005	0.0000	0.0005
306	0.0005	0.0000	0.0005
307	0.0005	0.0000	0.0005
308	0.0006	0.0000	0.0005
309	0.0006	0.0000	0.0005
310	0.0006	0.0000	0.0005
311	0.0006	0.0000	0.0005
312	0.0006	0.0000	0.0005
313	0.0006	0.0000	0.0005
314	0.0006	0.0000	0.0005
315	0.0006	0.0000	0.0005
316	0.0006	0.0000	0.0005
317	0.0006	0.0000	0.0005
318	0.0006	0.0000	0.0005
319	0.0006	0.0000	0.0005
320	0.0006	0.0000	0.0005
321	0.0006	0.0000	0.0005
322	0.0006	0.0000	0.0006
323	0.0006	0.0000	0.0006
324	0.0006	0.0000	0.0006
325	0.0006	0.0000	0.0006
326	0.0006	0.0000	0.0006
327	0.0006	0.0000	0.0006
328	0.0006	0.0000	0.0006
329	0.0006	0.0000	0.0006
330	0.0006	0.0000	0.0006
331	0.0006	0.0000	0.0006
332	0.0006	0.0000	0.0006
333	0.0006	0.0000	0.0006
334	0.0006	0.0000	0.0006
335	0.0006	0.0000	0.0006
336	0.0006	0.0000	0.0006
337	0.0006	0.0000	0.0006
338	0.0006	0.0000	0.0006
339	0.0006	0.0000	0.0006
340	0.0006	0.0000	0.0006
341	0.0006	0.0000	0.0006
342	0.0006	0.0000	0.0006
343	0.0007	0.0000	0.0006

344	0.0007	0.0000	0.0006
345	0.0007	0.0000	0.0006
346	0.0007	0.0000	0.0006
347	0.0007	0.0000	0.0006
348	0.0007	0.0000	0.0006
349	0.0007	0.0000	0.0006
350	0.0007	0.0000	0.0006
351	0.0007	0.0000	0.0006
352	0.0007	0.0000	0.0006
353	0.0007	0.0000	0.0006
354	0.0007	0.0000	0.0006
355	0.0007	0.0000	0.0007
356	0.0007	0.0000	0.0007
357	0.0007	0.0000	0.0007
358	0.0007	0.0000	0.0007
359	0.0007	0.0000	0.0007
360	0.0007	0.0000	0.0007
361	0.0007	0.0000	0.0007
362	0.0007	0.0000	0.0007
363	0.0007	0.0000	0.0007
364	0.0007	0.0000	0.0007
365	0.0007	0.0000	0.0007
366	0.0007	0.0000	0.0007
367	0.0007	0.0000	0.0007
368	0.0008	0.0000	0.0007
369	0.0008	0.0000	0.0007
370	0.0008	0.0000	0.0007
371	0.0008	0.0000	0.0007
372	0.0008	0.0000	0.0007
373	0.0008	0.0000	0.0007
374	0.0008	0.0000	0.0007
375	0.0008	0.0000	0.0007
376	0.0008	0.0000	0.0007
377	0.0008	0.0000	0.0008
378	0.0008	0.0000	0.0008
379	0.0008	0.0000	0.0008
380	0.0008	0.0000	0.0008
381	0.0008	0.0000	0.0008
382	0.0008	0.0000	0.0008
383	0.0008	0.0000	0.0008
384	0.0008	0.0000	0.0008
385	0.0008	0.0001	0.0008
386	0.0009	0.0001	0.0008
387	0.0009	0.0001	0.0008
388	0.0009	0.0001	0.0008
389	0.0009	0.0001	0.0008
390	0.0009	0.0001	0.0008
391	0.0009	0.0001	0.0008
392	0.0009	0.0001	0.0008
393	0.0009	0.0001	0.0008
394	0.0009	0.0001	0.0009
395	0.0009	0.0001	0.0009
396	0.0009	0.0001	0.0009
397	0.0009	0.0001	0.0009
398	0.0009	0.0001	0.0009
399	0.0009	0.0001	0.0009
400	0.0010	0.0001	0.0009

401	0.0010	0.0001	0.0009
402	0.0010	0.0001	0.0009
403	0.0010	0.0001	0.0009
404	0.0010	0.0001	0.0009
405	0.0010	0.0001	0.0009
406	0.0010	0.0001	0.0009
407	0.0010	0.0001	0.0010
408	0.0010	0.0001	0.0010
409	0.0010	0.0001	0.0010
410	0.0011	0.0001	0.0010
411	0.0011	0.0001	0.0010
412	0.0011	0.0001	0.0010
413	0.0011	0.0001	0.0010
414	0.0011	0.0001	0.0010
415	0.0011	0.0001	0.0010
416	0.0011	0.0001	0.0011
417	0.0011	0.0001	0.0011
418	0.0011	0.0001	0.0011
419	0.0012	0.0001	0.0011
420	0.0012	0.0001	0.0011
421	0.0012	0.0001	0.0011
422	0.0012	0.0001	0.0011
423	0.0012	0.0001	0.0011
424	0.0012	0.0001	0.0012
425	0.0013	0.0001	0.0012
426	0.0013	0.0001	0.0012
427	0.0013	0.0001	0.0012
428	0.0013	0.0001	0.0012
429	0.0013	0.0001	0.0012
430	0.0013	0.0001	0.0013
431	0.0014	0.0001	0.0013
432	0.0014	0.0001	0.0013
433	0.0012	0.0001	0.0011
434	0.0012	0.0001	0.0011
435	0.0012	0.0001	0.0012
436	0.0013	0.0001	0.0012
437	0.0013	0.0001	0.0012
438	0.0013	0.0001	0.0012
439	0.0013	0.0001	0.0013
440	0.0014	0.0001	0.0013
441	0.0014	0.0001	0.0013
442	0.0014	0.0001	0.0013
443	0.0014	0.0001	0.0014
444	0.0015	0.0001	0.0014
445	0.0015	0.0001	0.0014
446	0.0015	0.0001	0.0014
447	0.0016	0.0001	0.0015
448	0.0016	0.0001	0.0015
449	0.0016	0.0001	0.0015
450	0.0017	0.0001	0.0016
451	0.0017	0.0001	0.0016
452	0.0018	0.0001	0.0017
453	0.0018	0.0001	0.0017
454	0.0019	0.0001	0.0018
455	0.0019	0.0001	0.0018
456	0.0020	0.0001	0.0019
457	0.0021	0.0001	0.0019

458	0.0021	0.0001	0.0020
459	0.0022	0.0001	0.0021
460	0.0023	0.0001	0.0021
461	0.0024	0.0001	0.0022
462	0.0024	0.0001	0.0023
463	0.0026	0.0002	0.0024
464	0.0027	0.0002	0.0025
465	0.0028	0.0002	0.0027
466	0.0029	0.0002	0.0028
467	0.0031	0.0002	0.0030
468	0.0033	0.0002	0.0031
469	0.0035	0.0002	0.0033
470	0.0037	0.0002	0.0035
471	0.0041	0.0002	0.0039
472	0.0043	0.0003	0.0041
473	0.0061	0.0004	0.0058
474	0.0065	0.0004	0.0061
475	0.0076	0.0004	0.0071
476	0.0083	0.0005	0.0078
477	0.0103	0.0006	0.0097
478	0.0119	0.0007	0.0111
479	0.0180	0.0011	0.0169
480	0.0261	0.0015	0.0246
481	0.1129	0.0030	0.1099
482	0.0142	0.0008	0.0133
483	0.0091	0.0005	0.0086
484	0.0070	0.0004	0.0066
485	0.0046	0.0003	0.0043
486	0.0039	0.0002	0.0037
487	0.0034	0.0002	0.0032
488	0.0030	0.0002	0.0029
489	0.0027	0.0002	0.0026
490	0.0025	0.0001	0.0024
491	0.0023	0.0001	0.0022
492	0.0022	0.0001	0.0020
493	0.0020	0.0001	0.0019
494	0.0019	0.0001	0.0018
495	0.0018	0.0001	0.0017
496	0.0017	0.0001	0.0016
497	0.0016	0.0001	0.0015
498	0.0015	0.0001	0.0015
499	0.0015	0.0001	0.0014
500	0.0014	0.0001	0.0013
501	0.0014	0.0001	0.0013
502	0.0013	0.0001	0.0012
503	0.0013	0.0001	0.0012
504	0.0012	0.0001	0.0012
505	0.0014	0.0001	0.0013
506	0.0013	0.0001	0.0013
507	0.0013	0.0001	0.0012
508	0.0013	0.0001	0.0012
509	0.0012	0.0001	0.0012
510	0.0012	0.0001	0.0011
511	0.0012	0.0001	0.0011
512	0.0012	0.0001	0.0011
513	0.0011	0.0001	0.0011
514	0.0011	0.0001	0.0010

515	0.0011	0.0001	0.0010
516	0.0011	0.0001	0.0010
517	0.0010	0.0001	0.0010
518	0.0010	0.0001	0.0010
519	0.0010	0.0001	0.0009
520	0.0010	0.0001	0.0009
521	0.0010	0.0001	0.0009
522	0.0009	0.0001	0.0009
523	0.0009	0.0001	0.0009
524	0.0009	0.0001	0.0009
525	0.0009	0.0001	0.0008
526	0.0009	0.0001	0.0008
527	0.0009	0.0001	0.0008
528	0.0009	0.0001	0.0008
529	0.0008	0.0000	0.0008
530	0.0008	0.0000	0.0008
531	0.0008	0.0000	0.0008
532	0.0008	0.0000	0.0008
533	0.0008	0.0000	0.0007
534	0.0008	0.0000	0.0007
535	0.0008	0.0000	0.0007
536	0.0008	0.0000	0.0007
537	0.0008	0.0000	0.0007
538	0.0007	0.0000	0.0007
539	0.0007	0.0000	0.0007
540	0.0007	0.0000	0.0007
541	0.0007	0.0000	0.0007
542	0.0007	0.0000	0.0007
543	0.0007	0.0000	0.0007
544	0.0007	0.0000	0.0007
545	0.0007	0.0000	0.0006
546	0.0007	0.0000	0.0006
547	0.0007	0.0000	0.0006
548	0.0007	0.0000	0.0006
549	0.0007	0.0000	0.0006
550	0.0006	0.0000	0.0006
551	0.0006	0.0000	0.0006
552	0.0006	0.0000	0.0006
553	0.0006	0.0000	0.0006
554	0.0006	0.0000	0.0006
555	0.0006	0.0000	0.0006
556	0.0006	0.0000	0.0006
557	0.0006	0.0000	0.0006
558	0.0006	0.0000	0.0006
559	0.0006	0.0000	0.0006
560	0.0006	0.0000	0.0006
561	0.0006	0.0000	0.0005
562	0.0006	0.0000	0.0005
563	0.0006	0.0000	0.0005
564	0.0006	0.0000	0.0005
565	0.0006	0.0000	0.0005
566	0.0006	0.0000	0.0005
567	0.0006	0.0000	0.0005
568	0.0005	0.0000	0.0005
569	0.0005	0.0000	0.0005
570	0.0005	0.0000	0.0005
571	0.0005	0.0000	0.0005

572	0.0005	0.0000	0.0005
573	0.0005	0.0000	0.0005
574	0.0005	0.0000	0.0005
575	0.0005	0.0000	0.0005
576	0.0005	0.0000	0.0005
STORM DAY 3			
577	0.0006	0.0000	0.0006
578	0.0006	0.0000	0.0006
579	0.0007	0.0000	0.0006
580	0.0007	0.0000	0.0006
581	0.0007	0.0000	0.0006
582	0.0007	0.0000	0.0006
583	0.0007	0.0000	0.0006
584	0.0007	0.0000	0.0006
585	0.0007	0.0000	0.0006
586	0.0007	0.0000	0.0006
587	0.0007	0.0000	0.0006
588	0.0007	0.0000	0.0006
589	0.0007	0.0000	0.0006
590	0.0007	0.0000	0.0006
591	0.0007	0.0000	0.0006
592	0.0007	0.0000	0.0006
593	0.0007	0.0000	0.0006
594	0.0007	0.0000	0.0007
595	0.0007	0.0000	0.0007
596	0.0007	0.0000	0.0007
597	0.0007	0.0000	0.0007
598	0.0007	0.0000	0.0007
599	0.0007	0.0000	0.0007
600	0.0007	0.0000	0.0007
601	0.0007	0.0000	0.0007
602	0.0007	0.0000	0.0007
603	0.0007	0.0000	0.0007
604	0.0007	0.0000	0.0007
605	0.0007	0.0000	0.0007
606	0.0007	0.0000	0.0007
607	0.0007	0.0000	0.0007
608	0.0007	0.0000	0.0007
609	0.0007	0.0000	0.0007
610	0.0007	0.0000	0.0007
611	0.0007	0.0000	0.0007
612	0.0007	0.0000	0.0007
613	0.0008	0.0000	0.0007
614	0.0008	0.0000	0.0007
615	0.0008	0.0000	0.0007
616	0.0008	0.0000	0.0007
617	0.0008	0.0000	0.0007
618	0.0008	0.0000	0.0007
619	0.0008	0.0000	0.0007
620	0.0008	0.0000	0.0007
621	0.0008	0.0000	0.0007
622	0.0008	0.0000	0.0007
623	0.0008	0.0000	0.0007
624	0.0008	0.0000	0.0007
625	0.0008	0.0000	0.0008
626	0.0008	0.0000	0.0008
627	0.0008	0.0000	0.0008

628	0.0008	0.0000	0.0008
629	0.0008	0.0000	0.0008
630	0.0008	0.0000	0.0008
631	0.0008	0.0000	0.0008
632	0.0008	0.0000	0.0008
633	0.0008	0.0000	0.0008
634	0.0008	0.0000	0.0008
635	0.0008	0.0000	0.0008
636	0.0008	0.0001	0.0008
637	0.0009	0.0001	0.0008
638	0.0009	0.0001	0.0008
639	0.0009	0.0001	0.0008
640	0.0009	0.0001	0.0008
641	0.0009	0.0001	0.0008
642	0.0009	0.0001	0.0008
643	0.0009	0.0001	0.0008
644	0.0009	0.0001	0.0008
645	0.0009	0.0001	0.0008
646	0.0009	0.0001	0.0008
647	0.0009	0.0001	0.0008
648	0.0009	0.0001	0.0009
649	0.0009	0.0001	0.0009
650	0.0009	0.0001	0.0009
651	0.0009	0.0001	0.0009
652	0.0009	0.0001	0.0009
653	0.0009	0.0001	0.0009
654	0.0009	0.0001	0.0009
655	0.0009	0.0001	0.0009
656	0.0010	0.0001	0.0009
657	0.0010	0.0001	0.0009
658	0.0010	0.0001	0.0009
659	0.0010	0.0001	0.0009
660	0.0010	0.0001	0.0009
661	0.0010	0.0001	0.0009
662	0.0010	0.0001	0.0009
663	0.0010	0.0001	0.0009
664	0.0010	0.0001	0.0009
665	0.0010	0.0001	0.0010
666	0.0010	0.0001	0.0010
667	0.0010	0.0001	0.0010
668	0.0010	0.0001	0.0010
669	0.0010	0.0001	0.0010
670	0.0010	0.0001	0.0010
671	0.0011	0.0001	0.0010
672	0.0011	0.0001	0.0010
673	0.0011	0.0001	0.0010
674	0.0011	0.0001	0.0010
675	0.0011	0.0001	0.0010
676	0.0011	0.0001	0.0010
677	0.0011	0.0001	0.0010
678	0.0011	0.0001	0.0010
679	0.0011	0.0001	0.0011
680	0.0011	0.0001	0.0011
681	0.0011	0.0001	0.0011
682	0.0011	0.0001	0.0011
683	0.0012	0.0001	0.0011
684	0.0012	0.0001	0.0011

685	0.0012	0.0001	0.0011
686	0.0012	0.0001	0.0011
687	0.0012	0.0001	0.0011
688	0.0012	0.0001	0.0011
689	0.0012	0.0001	0.0012
690	0.0012	0.0001	0.0012
691	0.0012	0.0001	0.0012
692	0.0013	0.0001	0.0012
693	0.0013	0.0001	0.0012
694	0.0013	0.0001	0.0012
695	0.0013	0.0001	0.0012
696	0.0013	0.0001	0.0012
697	0.0013	0.0001	0.0012
698	0.0013	0.0001	0.0013
699	0.0013	0.0001	0.0013
700	0.0014	0.0001	0.0013
701	0.0014	0.0001	0.0013
702	0.0014	0.0001	0.0013
703	0.0014	0.0001	0.0013
704	0.0014	0.0001	0.0013
705	0.0014	0.0001	0.0014
706	0.0015	0.0001	0.0014
707	0.0015	0.0001	0.0014
708	0.0015	0.0001	0.0014
709	0.0015	0.0001	0.0014
710	0.0015	0.0001	0.0014
711	0.0015	0.0001	0.0015
712	0.0016	0.0001	0.0015
713	0.0016	0.0001	0.0015
714	0.0016	0.0001	0.0015
715	0.0016	0.0001	0.0015
716	0.0016	0.0001	0.0015
717	0.0017	0.0001	0.0016
718	0.0017	0.0001	0.0016
719	0.0017	0.0001	0.0016
720	0.0017	0.0001	0.0016
721	0.0015	0.0001	0.0014
722	0.0015	0.0001	0.0015
723	0.0016	0.0001	0.0015
724	0.0016	0.0001	0.0015
725	0.0016	0.0001	0.0015
726	0.0017	0.0001	0.0016
727	0.0017	0.0001	0.0016
728	0.0017	0.0001	0.0016
729	0.0018	0.0001	0.0017
730	0.0018	0.0001	0.0017
731	0.0018	0.0001	0.0017
732	0.0019	0.0001	0.0017
733	0.0019	0.0001	0.0018
734	0.0019	0.0001	0.0018
735	0.0020	0.0001	0.0019
736	0.0020	0.0001	0.0019
737	0.0021	0.0001	0.0020
738	0.0021	0.0001	0.0020
739	0.0022	0.0001	0.0021
740	0.0022	0.0001	0.0021
741	0.0023	0.0001	0.0022

742	0.0024	0.0001	0.0022
743	0.0024	0.0001	0.0023
744	0.0025	0.0001	0.0024
745	0.0026	0.0002	0.0025
746	0.0027	0.0002	0.0025
747	0.0028	0.0002	0.0026
748	0.0029	0.0002	0.0027
749	0.0030	0.0002	0.0028
750	0.0031	0.0002	0.0029
751	0.0033	0.0002	0.0031
752	0.0034	0.0002	0.0032
753	0.0036	0.0002	0.0034
754	0.0037	0.0002	0.0035
755	0.0040	0.0002	0.0037
756	0.0041	0.0002	0.0039
757	0.0045	0.0003	0.0042
758	0.0047	0.0003	0.0044
759	0.0052	0.0003	0.0049
760	0.0055	0.0003	0.0052
761	0.0078	0.0005	0.0073
762	0.0083	0.0005	0.0078
763	0.0096	0.0006	0.0090
764	0.0105	0.0006	0.0099
765	0.0130	0.0008	0.0123
766	0.0150	0.0009	0.0141
767	0.0228	0.0013	0.0214
768	0.0331	0.0020	0.0311
769	0.1430	0.0030	0.1401
770	0.0179	0.0011	0.0169
771	0.0116	0.0007	0.0109
772	0.0089	0.0005	0.0084
773	0.0058	0.0003	0.0055
774	0.0049	0.0003	0.0046
775	0.0043	0.0003	0.0041
776	0.0038	0.0002	0.0036
777	0.0035	0.0002	0.0033
778	0.0032	0.0002	0.0030
779	0.0029	0.0002	0.0028
780	0.0027	0.0002	0.0026
781	0.0026	0.0002	0.0024
782	0.0024	0.0001	0.0023
783	0.0023	0.0001	0.0021
784	0.0022	0.0001	0.0020
785	0.0021	0.0001	0.0019
786	0.0020	0.0001	0.0018
787	0.0019	0.0001	0.0018
788	0.0018	0.0001	0.0017
789	0.0017	0.0001	0.0016
790	0.0017	0.0001	0.0016
791	0.0016	0.0001	0.0015
792	0.0016	0.0001	0.0015
793	0.0018	0.0001	0.0017
794	0.0017	0.0001	0.0016
795	0.0017	0.0001	0.0016
796	0.0016	0.0001	0.0015
797	0.0016	0.0001	0.0015
798	0.0015	0.0001	0.0014

799	0.0015	0.0001	0.0014
800	0.0015	0.0001	0.0014
801	0.0014	0.0001	0.0013
802	0.0014	0.0001	0.0013
803	0.0014	0.0001	0.0013
804	0.0013	0.0001	0.0013
805	0.0013	0.0001	0.0012
806	0.0013	0.0001	0.0012
807	0.0013	0.0001	0.0012
808	0.0012	0.0001	0.0012
809	0.0012	0.0001	0.0011
810	0.0012	0.0001	0.0011
811	0.0012	0.0001	0.0011
812	0.0012	0.0001	0.0011
813	0.0011	0.0001	0.0011
814	0.0011	0.0001	0.0011
815	0.0011	0.0001	0.0010
816	0.0011	0.0001	0.0010
817	0.0011	0.0001	0.0010
818	0.0011	0.0001	0.0010
819	0.0010	0.0001	0.0010
820	0.0010	0.0001	0.0010
821	0.0010	0.0001	0.0009
822	0.0010	0.0001	0.0009
823	0.0010	0.0001	0.0009
824	0.0010	0.0001	0.0009
825	0.0010	0.0001	0.0009
826	0.0009	0.0001	0.0009
827	0.0009	0.0001	0.0009
828	0.0009	0.0001	0.0009
829	0.0009	0.0001	0.0009
830	0.0009	0.0001	0.0008
831	0.0009	0.0001	0.0008
832	0.0009	0.0001	0.0008
833	0.0009	0.0001	0.0008
834	0.0009	0.0001	0.0008
835	0.0008	0.0001	0.0008
836	0.0008	0.0000	0.0008
837	0.0008	0.0000	0.0008
838	0.0008	0.0000	0.0008
839	0.0008	0.0000	0.0008
840	0.0008	0.0000	0.0008
841	0.0008	0.0000	0.0007
842	0.0008	0.0000	0.0007
843	0.0008	0.0000	0.0007
844	0.0008	0.0000	0.0007
845	0.0008	0.0000	0.0007
846	0.0008	0.0000	0.0007
847	0.0008	0.0000	0.0007
848	0.0007	0.0000	0.0007
849	0.0007	0.0000	0.0007
850	0.0007	0.0000	0.0007
851	0.0007	0.0000	0.0007
852	0.0007	0.0000	0.0007
853	0.0007	0.0000	0.0007
854	0.0007	0.0000	0.0007
855	0.0007	0.0000	0.0007

856	0.0007	0.0000	0.0007
857	0.0007	0.0000	0.0006
858	0.0007	0.0000	0.0006
859	0.0007	0.0000	0.0006
860	0.0007	0.0000	0.0006
861	0.0007	0.0000	0.0006
862	0.0007	0.0000	0.0006
863	0.0007	0.0000	0.0006
864	0.0007	0.0000	0.0006
STORM DAY 4			
865	0.0012	0.0001	0.0012
866	0.0012	0.0001	0.0012
867	0.0012	0.0001	0.0012
868	0.0012	0.0001	0.0012
869	0.0012	0.0001	0.0012
870	0.0012	0.0001	0.0012
871	0.0013	0.0001	0.0012
872	0.0013	0.0001	0.0012
873	0.0013	0.0001	0.0012
874	0.0013	0.0001	0.0012
875	0.0013	0.0001	0.0012
876	0.0013	0.0001	0.0012
877	0.0013	0.0001	0.0012
878	0.0013	0.0001	0.0012
879	0.0013	0.0001	0.0012
880	0.0013	0.0001	0.0012
881	0.0013	0.0001	0.0012
882	0.0013	0.0001	0.0012
883	0.0013	0.0001	0.0012
884	0.0013	0.0001	0.0012
885	0.0013	0.0001	0.0013
886	0.0013	0.0001	0.0013
887	0.0013	0.0001	0.0013
888	0.0013	0.0001	0.0013
889	0.0014	0.0001	0.0013
890	0.0014	0.0001	0.0013
891	0.0014	0.0001	0.0013
892	0.0014	0.0001	0.0013
893	0.0014	0.0001	0.0013
894	0.0014	0.0001	0.0013
895	0.0014	0.0001	0.0013
896	0.0014	0.0001	0.0013
897	0.0014	0.0001	0.0013
898	0.0014	0.0001	0.0013
899	0.0014	0.0001	0.0013
900	0.0014	0.0001	0.0013
901	0.0014	0.0001	0.0013
902	0.0014	0.0001	0.0013
903	0.0014	0.0001	0.0014
904	0.0014	0.0001	0.0014
905	0.0015	0.0001	0.0014
906	0.0015	0.0001	0.0014
907	0.0015	0.0001	0.0014
908	0.0015	0.0001	0.0014
909	0.0015	0.0001	0.0014
910	0.0015	0.0001	0.0014
911	0.0015	0.0001	0.0014

912	0.0015	0.0001	0.0014
913	0.0015	0.0001	0.0014
914	0.0015	0.0001	0.0014
915	0.0015	0.0001	0.0014
916	0.0015	0.0001	0.0014
917	0.0015	0.0001	0.0015
918	0.0015	0.0001	0.0015
919	0.0016	0.0001	0.0015
920	0.0016	0.0001	0.0015
921	0.0016	0.0001	0.0015
922	0.0016	0.0001	0.0015
923	0.0016	0.0001	0.0015
924	0.0016	0.0001	0.0015
925	0.0016	0.0001	0.0015
926	0.0016	0.0001	0.0015
927	0.0016	0.0001	0.0015
928	0.0016	0.0001	0.0015
929	0.0016	0.0001	0.0016
930	0.0017	0.0001	0.0016
931	0.0017	0.0001	0.0016
932	0.0017	0.0001	0.0016
933	0.0017	0.0001	0.0016
934	0.0017	0.0001	0.0016
935	0.0017	0.0001	0.0016
936	0.0017	0.0001	0.0016
937	0.0017	0.0001	0.0016
938	0.0017	0.0001	0.0016
939	0.0017	0.0001	0.0016
940	0.0018	0.0001	0.0017
941	0.0018	0.0001	0.0017
942	0.0018	0.0001	0.0017
943	0.0018	0.0001	0.0017
944	0.0018	0.0001	0.0017
945	0.0018	0.0001	0.0017
946	0.0018	0.0001	0.0017
947	0.0018	0.0001	0.0017
948	0.0018	0.0001	0.0017
949	0.0019	0.0001	0.0018
950	0.0019	0.0001	0.0018
951	0.0019	0.0001	0.0018
952	0.0019	0.0001	0.0018
953	0.0019	0.0001	0.0018
954	0.0019	0.0001	0.0018
955	0.0019	0.0001	0.0018
956	0.0020	0.0001	0.0018
957	0.0020	0.0001	0.0019
958	0.0020	0.0001	0.0019
959	0.0020	0.0001	0.0019
960	0.0020	0.0001	0.0019
961	0.0020	0.0001	0.0019
962	0.0020	0.0001	0.0019
963	0.0021	0.0001	0.0019
964	0.0021	0.0001	0.0020
965	0.0021	0.0001	0.0020
966	0.0021	0.0001	0.0020
967	0.0021	0.0001	0.0020
968	0.0021	0.0001	0.0020

969	0.0022	0.0001	0.0020
970	0.0022	0.0001	0.0020
971	0.0022	0.0001	0.0021
972	0.0022	0.0001	0.0021
973	0.0022	0.0001	0.0021
974	0.0023	0.0001	0.0021
975	0.0023	0.0001	0.0021
976	0.0023	0.0001	0.0022
977	0.0023	0.0001	0.0022
978	0.0023	0.0001	0.0022
979	0.0024	0.0001	0.0022
980	0.0024	0.0001	0.0022
981	0.0024	0.0001	0.0023
982	0.0024	0.0001	0.0023
983	0.0025	0.0001	0.0023
984	0.0025	0.0001	0.0023
985	0.0025	0.0001	0.0024
986	0.0025	0.0001	0.0024
987	0.0026	0.0002	0.0024
988	0.0026	0.0002	0.0024
989	0.0026	0.0002	0.0025
990	0.0026	0.0002	0.0025
991	0.0027	0.0002	0.0025
992	0.0027	0.0002	0.0025
993	0.0027	0.0002	0.0026
994	0.0027	0.0002	0.0026
995	0.0028	0.0002	0.0026
996	0.0028	0.0002	0.0026
997	0.0029	0.0002	0.0027
998	0.0029	0.0002	0.0027
999	0.0029	0.0002	0.0028
1000	0.0030	0.0002	0.0028
1001	0.0030	0.0002	0.0028
1002	0.0030	0.0002	0.0029
1003	0.0031	0.0002	0.0029
1004	0.0031	0.0002	0.0029
1005	0.0032	0.0002	0.0030
1006	0.0032	0.0002	0.0030
1007	0.0033	0.0002	0.0031
1008	0.0033	0.0002	0.0031
1009	0.0029	0.0002	0.0027
1010	0.0029	0.0002	0.0028
1011	0.0030	0.0002	0.0028
1012	0.0030	0.0002	0.0028
1013	0.0031	0.0002	0.0029
1014	0.0031	0.0002	0.0029
1015	0.0032	0.0002	0.0030
1016	0.0032	0.0002	0.0031
1017	0.0033	0.0002	0.0031
1018	0.0034	0.0002	0.0032
1019	0.0035	0.0002	0.0033
1020	0.0035	0.0002	0.0033
1021	0.0036	0.0002	0.0034
1022	0.0037	0.0002	0.0034
1023	0.0038	0.0002	0.0035
1024	0.0038	0.0002	0.0036
1025	0.0040	0.0002	0.0037

1026	0.0040	0.0002	0.0038
1027	0.0042	0.0002	0.0039
1028	0.0042	0.0003	0.0040
1029	0.0044	0.0003	0.0041
1030	0.0045	0.0003	0.0042
1031	0.0046	0.0003	0.0044
1032	0.0047	0.0003	0.0045
1033	0.0050	0.0003	0.0047
1034	0.0051	0.0003	0.0048
1035	0.0053	0.0003	0.0050
1036	0.0054	0.0003	0.0051
1037	0.0057	0.0003	0.0054
1038	0.0059	0.0003	0.0055
1039	0.0062	0.0004	0.0058
1040	0.0064	0.0004	0.0060
1041	0.0068	0.0004	0.0064
1042	0.0070	0.0004	0.0066
1043	0.0075	0.0004	0.0071
1044	0.0078	0.0005	0.0074
1045	0.0085	0.0005	0.0080
1046	0.0089	0.0005	0.0084
1047	0.0098	0.0006	0.0092
1048	0.0104	0.0006	0.0098
1049	0.0147	0.0009	0.0138
1050	0.0157	0.0009	0.0148
1051	0.0182	0.0011	0.0171
1052	0.0199	0.0012	0.0187
1053	0.0247	0.0015	0.0232
1054	0.0284	0.0017	0.0268
1055	0.0432	0.0026	0.0406
1056	0.0626	0.0030	0.0597
1057	0.2710	0.0030	0.2680
1058	0.0340	0.0020	0.0320
1059	0.0220	0.0013	0.0207
1060	0.0168	0.0010	0.0158
1061	0.0110	0.0007	0.0104
1062	0.0093	0.0006	0.0088
1063	0.0082	0.0005	0.0077
1064	0.0073	0.0004	0.0068
1065	0.0066	0.0004	0.0062
1066	0.0060	0.0004	0.0057
1067	0.0056	0.0003	0.0052
1068	0.0052	0.0003	0.0049
1069	0.0048	0.0003	0.0045
1070	0.0046	0.0003	0.0043
1071	0.0043	0.0003	0.0040
1072	0.0041	0.0002	0.0038
1073	0.0039	0.0002	0.0037
1074	0.0037	0.0002	0.0035
1075	0.0036	0.0002	0.0033
1076	0.0034	0.0002	0.0032
1077	0.0033	0.0002	0.0031
1078	0.0032	0.0002	0.0030
1079	0.0031	0.0002	0.0029
1080	0.0030	0.0002	0.0028
1081	0.0033	0.0002	0.0031
1082	0.0032	0.0002	0.0030

1083	0.0031	0.0002	0.0030
1084	0.0031	0.0002	0.0029
1085	0.0030	0.0002	0.0028
1086	0.0029	0.0002	0.0027
1087	0.0028	0.0002	0.0027
1088	0.0028	0.0002	0.0026
1089	0.0027	0.0002	0.0025
1090	0.0026	0.0002	0.0025
1091	0.0026	0.0002	0.0024
1092	0.0025	0.0002	0.0024
1093	0.0025	0.0001	0.0023
1094	0.0024	0.0001	0.0023
1095	0.0024	0.0001	0.0023
1096	0.0023	0.0001	0.0022
1097	0.0023	0.0001	0.0022
1098	0.0023	0.0001	0.0021
1099	0.0022	0.0001	0.0021
1100	0.0022	0.0001	0.0021
1101	0.0022	0.0001	0.0020
1102	0.0021	0.0001	0.0020
1103	0.0021	0.0001	0.0020
1104	0.0021	0.0001	0.0019
1105	0.0020	0.0001	0.0019
1106	0.0020	0.0001	0.0019
1107	0.0020	0.0001	0.0018
1108	0.0019	0.0001	0.0018
1109	0.0019	0.0001	0.0018
1110	0.0019	0.0001	0.0018
1111	0.0019	0.0001	0.0017
1112	0.0018	0.0001	0.0017
1113	0.0018	0.0001	0.0017
1114	0.0018	0.0001	0.0017
1115	0.0018	0.0001	0.0017
1116	0.0017	0.0001	0.0016
1117	0.0017	0.0001	0.0016
1118	0.0017	0.0001	0.0016
1119	0.0017	0.0001	0.0016
1120	0.0017	0.0001	0.0016
1121	0.0016	0.0001	0.0015
1122	0.0016	0.0001	0.0015
1123	0.0016	0.0001	0.0015
1124	0.0016	0.0001	0.0015
1125	0.0016	0.0001	0.0015
1126	0.0016	0.0001	0.0015
1127	0.0015	0.0001	0.0014
1128	0.0015	0.0001	0.0014
1129	0.0015	0.0001	0.0014
1130	0.0015	0.0001	0.0014
1131	0.0015	0.0001	0.0014
1132	0.0015	0.0001	0.0014
1133	0.0014	0.0001	0.0014
1134	0.0014	0.0001	0.0014
1135	0.0014	0.0001	0.0013
1136	0.0014	0.0001	0.0013
1137	0.0014	0.0001	0.0013
1138	0.0014	0.0001	0.0013
1139	0.0014	0.0001	0.0013

1140	0.0014	0.0001	0.0013
1141	0.0013	0.0001	0.0013
1142	0.0013	0.0001	0.0013
1143	0.0013	0.0001	0.0012
1144	0.0013	0.0001	0.0012
1145	0.0013	0.0001	0.0012
1146	0.0013	0.0001	0.0012
1147	0.0013	0.0001	0.0012
1148	0.0013	0.0001	0.0012
1149	0.0013	0.0001	0.0012
1150	0.0013	0.0001	0.0012
1151	0.0012	0.0001	0.0012
1152	0.0012	0.0001	0.0012
STORM DAY 5			
1153	0.0034	0.0002	0.0032
1154	0.0034	0.0002	0.0032
1155	0.0034	0.0002	0.0032
1156	0.0034	0.0002	0.0032
1157	0.0035	0.0002	0.0033
1158	0.0035	0.0002	0.0033
1159	0.0035	0.0002	0.0033
1160	0.0035	0.0002	0.0033
1161	0.0035	0.0002	0.0033
1162	0.0035	0.0002	0.0033
1163	0.0035	0.0002	0.0033
1164	0.0036	0.0002	0.0033
1165	0.0036	0.0002	0.0034
1166	0.0036	0.0002	0.0034
1167	0.0036	0.0002	0.0034
1168	0.0036	0.0002	0.0034
1169	0.0036	0.0002	0.0034
1170	0.0036	0.0002	0.0034
1171	0.0037	0.0002	0.0034
1172	0.0037	0.0002	0.0035
1173	0.0037	0.0002	0.0035
1174	0.0037	0.0002	0.0035
1175	0.0037	0.0002	0.0035
1176	0.0037	0.0002	0.0035
1177	0.0038	0.0002	0.0035
1178	0.0038	0.0002	0.0035
1179	0.0038	0.0002	0.0036
1180	0.0038	0.0002	0.0036
1181	0.0038	0.0002	0.0036
1182	0.0038	0.0002	0.0036
1183	0.0039	0.0002	0.0036
1184	0.0039	0.0002	0.0036
1185	0.0039	0.0002	0.0037
1186	0.0039	0.0002	0.0037
1187	0.0039	0.0002	0.0037
1188	0.0039	0.0002	0.0037
1189	0.0040	0.0002	0.0037
1190	0.0040	0.0002	0.0037
1191	0.0040	0.0002	0.0038
1192	0.0040	0.0002	0.0038
1193	0.0040	0.0002	0.0038
1194	0.0041	0.0002	0.0038
1195	0.0041	0.0002	0.0038

1196	0.0041	0.0002	0.0038
1197	0.0041	0.0002	0.0039
1198	0.0041	0.0002	0.0039
1199	0.0042	0.0002	0.0039
1200	0.0042	0.0002	0.0039
1201	0.0042	0.0002	0.0040
1202	0.0042	0.0002	0.0040
1203	0.0042	0.0003	0.0040
1204	0.0043	0.0003	0.0040
1205	0.0043	0.0003	0.0040
1206	0.0043	0.0003	0.0040
1207	0.0043	0.0003	0.0041
1208	0.0043	0.0003	0.0041
1209	0.0044	0.0003	0.0041
1210	0.0044	0.0003	0.0041
1211	0.0044	0.0003	0.0042
1212	0.0044	0.0003	0.0042
1213	0.0045	0.0003	0.0042
1214	0.0045	0.0003	0.0042
1215	0.0045	0.0003	0.0043
1216	0.0045	0.0003	0.0043
1217	0.0046	0.0003	0.0043
1218	0.0046	0.0003	0.0043
1219	0.0046	0.0003	0.0044
1220	0.0046	0.0003	0.0044
1221	0.0047	0.0003	0.0044
1222	0.0047	0.0003	0.0044
1223	0.0047	0.0003	0.0045
1224	0.0048	0.0003	0.0045
1225	0.0048	0.0003	0.0045
1226	0.0048	0.0003	0.0045
1227	0.0049	0.0003	0.0046
1228	0.0049	0.0003	0.0046
1229	0.0049	0.0003	0.0046
1230	0.0049	0.0003	0.0046
1231	0.0050	0.0003	0.0047
1232	0.0050	0.0003	0.0047
1233	0.0050	0.0003	0.0047
1234	0.0051	0.0003	0.0048
1235	0.0051	0.0003	0.0048
1236	0.0051	0.0003	0.0048
1237	0.0052	0.0003	0.0049
1238	0.0052	0.0003	0.0049
1239	0.0052	0.0003	0.0049
1240	0.0053	0.0003	0.0050
1241	0.0053	0.0003	0.0050
1242	0.0053	0.0003	0.0050
1243	0.0054	0.0003	0.0051
1244	0.0054	0.0003	0.0051
1245	0.0055	0.0003	0.0052
1246	0.0055	0.0003	0.0052
1247	0.0056	0.0003	0.0052
1248	0.0056	0.0003	0.0053
1249	0.0056	0.0003	0.0053
1250	0.0057	0.0003	0.0053
1251	0.0057	0.0003	0.0054
1252	0.0058	0.0003	0.0054

1253	0.0058	0.0003	0.0055
1254	0.0058	0.0003	0.0055
1255	0.0059	0.0004	0.0056
1256	0.0059	0.0004	0.0056
1257	0.0060	0.0004	0.0057
1258	0.0060	0.0004	0.0057
1259	0.0061	0.0004	0.0057
1260	0.0061	0.0004	0.0058
1261	0.0062	0.0004	0.0058
1262	0.0063	0.0004	0.0059
1263	0.0063	0.0004	0.0060
1264	0.0064	0.0004	0.0060
1265	0.0064	0.0004	0.0061
1266	0.0065	0.0004	0.0061
1267	0.0066	0.0004	0.0062
1268	0.0066	0.0004	0.0062
1269	0.0067	0.0004	0.0063
1270	0.0067	0.0004	0.0063
1271	0.0068	0.0004	0.0064
1272	0.0069	0.0004	0.0065
1273	0.0070	0.0004	0.0065
1274	0.0070	0.0004	0.0066
1275	0.0071	0.0004	0.0067
1276	0.0071	0.0004	0.0067
1277	0.0072	0.0004	0.0068
1278	0.0073	0.0004	0.0069
1279	0.0074	0.0004	0.0070
1280	0.0075	0.0004	0.0070
1281	0.0076	0.0004	0.0071
1282	0.0076	0.0005	0.0072
1283	0.0078	0.0005	0.0073
1284	0.0078	0.0005	0.0074
1285	0.0079	0.0005	0.0075
1286	0.0080	0.0005	0.0075
1287	0.0081	0.0005	0.0077
1288	0.0082	0.0005	0.0077
1289	0.0084	0.0005	0.0079
1290	0.0084	0.0005	0.0079
1291	0.0086	0.0005	0.0081
1292	0.0087	0.0005	0.0081
1293	0.0088	0.0005	0.0083
1294	0.0089	0.0005	0.0084
1295	0.0091	0.0005	0.0085
1296	0.0092	0.0005	0.0086
1297	0.0080	0.0005	0.0076
1298	0.0081	0.0005	0.0076
1299	0.0083	0.0005	0.0078
1300	0.0084	0.0005	0.0079
1301	0.0086	0.0005	0.0081
1302	0.0087	0.0005	0.0082
1303	0.0089	0.0005	0.0084
1304	0.0090	0.0005	0.0085
1305	0.0092	0.0005	0.0087
1306	0.0094	0.0006	0.0088
1307	0.0096	0.0006	0.0090
1308	0.0098	0.0006	0.0092
1309	0.0100	0.0006	0.0094

1310	0.0102	0.0006	0.0096
1311	0.0105	0.0006	0.0099
1312	0.0106	0.0006	0.0100
1313	0.0110	0.0007	0.0103
1314	0.0112	0.0007	0.0105
1315	0.0115	0.0007	0.0109
1316	0.0117	0.0007	0.0110
1317	0.0122	0.0007	0.0115
1318	0.0124	0.0007	0.0117
1319	0.0129	0.0008	0.0121
1320	0.0132	0.0008	0.0124
1321	0.0138	0.0008	0.0130
1322	0.0141	0.0008	0.0133
1323	0.0148	0.0009	0.0139
1324	0.0151	0.0009	0.0142
1325	0.0159	0.0009	0.0150
1326	0.0163	0.0010	0.0153
1327	0.0172	0.0010	0.0162
1328	0.0178	0.0011	0.0167
1329	0.0189	0.0011	0.0178
1330	0.0195	0.0012	0.0184
1331	0.0210	0.0012	0.0197
1332	0.0218	0.0013	0.0205
1333	0.0237	0.0014	0.0223
1334	0.0247	0.0015	0.0233
1335	0.0273	0.0016	0.0257
1336	0.0288	0.0017	0.0271
1337	0.0409	0.0024	0.0385
1338	0.0436	0.0026	0.0410
1339	0.0505	0.0030	0.0475
1340	0.0552	0.0030	0.0522
1341	0.0686	0.0030	0.0656
1342	0.0790	0.0030	0.0760
1343	0.1199	0.0030	0.1169
1344	0.1740	0.0030	0.1710
1345	0.7528	0.0030	0.7499
1346	0.0944	0.0030	0.0914
1347	0.0610	0.0030	0.0580
1348	0.0467	0.0028	0.0440
1349	0.0306	0.0018	0.0288
1350	0.0259	0.0015	0.0244
1351	0.0227	0.0013	0.0213
1352	0.0202	0.0012	0.0190
1353	0.0183	0.0011	0.0172
1354	0.0168	0.0010	0.0158
1355	0.0155	0.0009	0.0146
1356	0.0144	0.0009	0.0136
1357	0.0134	0.0008	0.0126
1358	0.0126	0.0007	0.0119
1359	0.0120	0.0007	0.0112
1360	0.0113	0.0007	0.0107
1361	0.0108	0.0006	0.0102
1362	0.0103	0.0006	0.0097
1363	0.0099	0.0006	0.0093
1364	0.0095	0.0006	0.0089
1365	0.0091	0.0005	0.0086
1366	0.0088	0.0005	0.0083

1367	0.0085	0.0005	0.0080
1368	0.0082	0.0005	0.0077
1369	0.0093	0.0005	0.0087
1370	0.0090	0.0005	0.0085
1371	0.0087	0.0005	0.0082
1372	0.0085	0.0005	0.0080
1373	0.0083	0.0005	0.0078
1374	0.0081	0.0005	0.0076
1375	0.0079	0.0005	0.0074
1376	0.0077	0.0005	0.0072
1377	0.0075	0.0004	0.0071
1378	0.0074	0.0004	0.0069
1379	0.0072	0.0004	0.0068
1380	0.0070	0.0004	0.0066
1381	0.0069	0.0004	0.0065
1382	0.0068	0.0004	0.0064
1383	0.0066	0.0004	0.0063
1384	0.0065	0.0004	0.0061
1385	0.0064	0.0004	0.0060
1386	0.0063	0.0004	0.0059
1387	0.0062	0.0004	0.0058
1388	0.0061	0.0004	0.0057
1389	0.0060	0.0004	0.0056
1390	0.0059	0.0003	0.0055
1391	0.0058	0.0003	0.0054
1392	0.0057	0.0003	0.0054
1393	0.0056	0.0003	0.0053
1394	0.0055	0.0003	0.0052
1395	0.0054	0.0003	0.0051
1396	0.0054	0.0003	0.0051
1397	0.0053	0.0003	0.0050
1398	0.0052	0.0003	0.0049
1399	0.0052	0.0003	0.0048
1400	0.0051	0.0003	0.0048
1401	0.0050	0.0003	0.0047
1402	0.0050	0.0003	0.0047
1403	0.0049	0.0003	0.0046
1404	0.0048	0.0003	0.0045
1405	0.0048	0.0003	0.0045
1406	0.0047	0.0003	0.0044
1407	0.0047	0.0003	0.0044
1408	0.0046	0.0003	0.0043
1409	0.0046	0.0003	0.0043
1410	0.0045	0.0003	0.0042
1411	0.0045	0.0003	0.0042
1412	0.0044	0.0003	0.0042
1413	0.0044	0.0003	0.0041
1414	0.0043	0.0003	0.0041
1415	0.0043	0.0003	0.0040
1416	0.0042	0.0003	0.0040
1417	0.0042	0.0002	0.0039
1418	0.0041	0.0002	0.0039
1419	0.0041	0.0002	0.0039
1420	0.0041	0.0002	0.0038
1421	0.0040	0.0002	0.0038
1422	0.0040	0.0002	0.0038
1423	0.0040	0.0002	0.0037

1424	0.0039	0.0002	0.0037
1425	0.0039	0.0002	0.0037
1426	0.0038	0.0002	0.0036
1427	0.0038	0.0002	0.0036
1428	0.0038	0.0002	0.0036
1429	0.0037	0.0002	0.0035
1430	0.0037	0.0002	0.0035
1431	0.0037	0.0002	0.0035
1432	0.0037	0.0002	0.0034
1433	0.0036	0.0002	0.0034
1434	0.0036	0.0002	0.0034
1435	0.0036	0.0002	0.0034
1436	0.0035	0.0002	0.0033
1437	0.0035	0.0002	0.0033
1438	0.0035	0.0002	0.0033
1439	0.0035	0.0002	0.0032
1440	0.0034	0.0002	0.0032

Total soil rain loss = 0.30(In)
Total effective rainfall = 6.11(In)
Peak flow rate in flood hydrograph = 196.06(CFS)

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120 - H O U R S T O R M
R u n o f f H y d r o g r a p h

Hydrograph in 5 Minute intervals ((CFS))

```
Time(h+m) Volume Ac.Ft   Q(CFS)  0       50.0     100.0     150.0     200.0
-----------------------------------------------------------------------
  0+ 5       0.0001      0.01  Q         |         |         |         |
  0+10       0.0006      0.08  Q         |         |         |         |
  0+15       0.0014      0.12  Q         |         |         |         |
  0+20       0.0024      0.14  Q         |         |         |         |
  0+25       0.0035      0.16  Q         |         |         |         |
  0+30       0.0046      0.16  Q         |         |         |         |
  0+35       0.0058      0.17  Q         |         |         |         |
  0+40       0.0070      0.17  Q         |         |         |         |
  0+45       0.0082      0.18  Q         |         |         |         |
  0+50       0.0095      0.18  Q         |         |         |         |
  0+55       0.0107      0.18  Q         |         |         |         |
  1+ 0       0.0120      0.18  Q         |         |         |         |
  1+ 5       0.0133      0.19  Q         |         |         |         |
  1+10       0.0146      0.19  Q         |         |         |         |
  1+15       0.0159      0.19  Q         |         |         |         |
  1+20       0.0171      0.19  Q         |         |         |         |
  1+25       0.0184      0.19  Q         |         |         |         |
  1+30       0.0198      0.19  Q         |         |         |         |
  1+35       0.0211      0.19  Q         |         |         |         |
  1+40       0.0224      0.19  Q         |         |         |         |
  1+45       0.0237      0.19  Q         |         |         |         |
  1+50       0.0250      0.19  Q         |         |         |         |
  1+55       0.0264      0.19  Q         |         |         |         |
  2+ 0       0.0277      0.19  Q         |         |         |         |
  2+ 5       0.0290      0.19  Q         |         |         |         |
```

2+10	0.0304	0.20	Q				
2+15	0.0317	0.20	Q				
2+20	0.0331	0.20	Q				
2+25	0.0345	0.20	Q				
2+30	0.0358	0.20	Q				
2+35	0.0372	0.20	Q				
2+40	0.0386	0.20	Q				
2+45	0.0400	0.20	Q				
2+50	0.0414	0.20	Q				
2+55	0.0428	0.20	Q				
3+ 0	0.0442	0.20	Q				
3+ 5	0.0456	0.21	Q				
3+10	0.0470	0.21	Q				
3+15	0.0485	0.21	Q				
3+20	0.0499	0.21	Q				
3+25	0.0513	0.21	Q				
3+30	0.0528	0.21	Q				
3+35	0.0542	0.21	Q				
3+40	0.0557	0.21	Q				
3+45	0.0572	0.21	Q				
3+50	0.0587	0.21	Q				
3+55	0.0601	0.22	Q				
4+ 0	0.0616	0.22	Q				
4+ 5	0.0631	0.22	Q				
4+10	0.0646	0.22	Q				
4+15	0.0661	0.22	Q				
4+20	0.0677	0.22	Q				
4+25	0.0692	0.22	Q				
4+30	0.0707	0.22	Q				
4+35	0.0723	0.22	Q				
4+40	0.0738	0.23	Q				
4+45	0.0754	0.23	Q				
4+50	0.0770	0.23	Q				
4+55	0.0785	0.23	Q				
5+ 0	0.0801	0.23	Q				
5+ 5	0.0817	0.23	Q				
5+10	0.0833	0.23	Q				
5+15	0.0849	0.23	Q				
5+20	0.0866	0.24	Q				
5+25	0.0882	0.24	Q				
5+30	0.0898	0.24	Q				
5+35	0.0915	0.24	Q				
5+40	0.0931	0.24	Q				
5+45	0.0948	0.24	Q				
5+50	0.0965	0.24	Q				
5+55	0.0982	0.24	Q				
6+ 0	0.0999	0.25	Q				
6+ 5	0.1016	0.25	Q				
6+10	0.1033	0.25	Q				
6+15	0.1050	0.25	Q				
6+20	0.1067	0.25	Q				
6+25	0.1085	0.25	Q				
6+30	0.1103	0.26	Q				
6+35	0.1120	0.26	Q				
6+40	0.1138	0.26	Q				
6+45	0.1156	0.26	Q				
6+50	0.1174	0.26	Q				

6+55	0.1192	0.26	Q	|	|	|	|
7+ 0	0.1210	0.27	Q	|	|	|	|
7+ 5	0.1229	0.27	Q	|	|	|	|
7+10	0.1247	0.27	Q	|	|	|	|
7+15	0.1266	0.27	Q	|	|	|	|
7+20	0.1285	0.27	Q	|	|	|	|
7+25	0.1304	0.27	Q	|	|	|	|
7+30	0.1323	0.28	Q	|	|	|	|
7+35	0.1342	0.28	Q	|	|	|	|
7+40	0.1361	0.28	Q	|	|	|	|
7+45	0.1381	0.28	Q	|	|	|	|
7+50	0.1400	0.28	Q	|	|	|	|
7+55	0.1420	0.29	Q	|	|	|	|
8+ 0	0.1440	0.29	Q	|	|	|	|
8+ 5	0.1460	0.29	Q	|	|	|	|
8+10	0.1480	0.29	Q	|	|	|	|
8+15	0.1500	0.29	Q	|	|	|	|
8+20	0.1521	0.30	Q	|	|	|	|
8+25	0.1541	0.30	Q	|	|	|	|
8+30	0.1562	0.30	Q	|	|	|	|
8+35	0.1583	0.30	Q	|	|	|	|
8+40	0.1604	0.31	Q	|	|	|	|
8+45	0.1625	0.31	Q	|	|	|	|
8+50	0.1647	0.31	Q	|	|	|	|
8+55	0.1668	0.31	Q	|	|	|	|
9+ 0	0.1690	0.32	Q	|	|	|	|
9+ 5	0.1712	0.32	Q	|	|	|	|
9+10	0.1734	0.32	Q	|	|	|	|
9+15	0.1757	0.32	Q	|	|	|	|
9+20	0.1779	0.33	Q	|	|	|	|
9+25	0.1802	0.33	Q	|	|	|	|
9+30	0.1825	0.33	Q	|	|	|	|
9+35	0.1848	0.34	Q	|	|	|	|
9+40	0.1871	0.34	Q	|	|	|	|
9+45	0.1895	0.34	Q	|	|	|	|
9+50	0.1919	0.35	Q	|	|	|	|
9+55	0.1943	0.35	Q	|	|	|	|
10+ 0	0.1967	0.35	Q	|	|	|	|
10+ 5	0.1992	0.36	Q	|	|	|	|
10+10	0.2016	0.36	Q	|	|	|	|
10+15	0.2041	0.36	Q	|	|	|	|
10+20	0.2067	0.37	Q	|	|	|	|
10+25	0.2092	0.37	Q	|	|	|	|
10+30	0.2118	0.37	Q	|	|	|	|
10+35	0.2144	0.38	Q	|	|	|	|
10+40	0.2170	0.38	Q	|	|	|	|
10+45	0.2197	0.39	Q	|	|	|	|
10+50	0.2224	0.39	Q	|	|	|	|
10+55	0.2251	0.40	Q	|	|	|	|
11+ 0	0.2279	0.40	Q	|	|	|	|
11+ 5	0.2306	0.40	Q	|	|	|	|
11+10	0.2335	0.41	Q	|	|	|	|
11+15	0.2363	0.41	Q	|	|	|	|
11+20	0.2392	0.42	Q	|	|	|	|
11+25	0.2421	0.42	Q	|	|	|	|
11+30	0.2451	0.43	Q	|	|	|	|
11+35	0.2481	0.44	Q	|	|	|	|

11+40	0.2511	0.44	Q	|	|	|	|
11+45	0.2542	0.45	Q	|	|	|	|
11+50	0.2573	0.45	Q	|	|	|	|
11+55	0.2605	0.46	Q	|	|	|	|
12+ 0	0.2637	0.47	Q	|	|	|	|
12+ 5	0.2669	0.47	Q	|	|	|	|
12+10	0.2700	0.45	Q	|	|	|	|
12+15	0.2730	0.44	Q	|	|	|	|
12+20	0.2760	0.44	Q	|	|	|	|
12+25	0.2791	0.44	Q	|	|	|	|
12+30	0.2821	0.45	Q	|	|	|	|
12+35	0.2852	0.45	Q	|	|	|	|
12+40	0.2884	0.46	Q	|	|	|	|
12+45	0.2916	0.46	Q	|	|	|	|
12+50	0.2949	0.47	Q	|	|	|	|
12+55	0.2982	0.48	Q	|	|	|	|
13+ 0	0.3016	0.49	Q	|	|	|	|
13+ 5	0.3050	0.50	Q	|	|	|	|
13+10	0.3085	0.51	Q	|	|	|	|
13+15	0.3121	0.52	Q	|	|	|	|
13+20	0.3158	0.53	Q	|	|	|	|
13+25	0.3195	0.54	Q	|	|	|	|
13+30	0.3233	0.56	Q	|	|	|	|
13+35	0.3273	0.57	Q	|	|	|	|
13+40	0.3313	0.58	Q	|	|	|	|
13+45	0.3354	0.60	Q	|	|	|	|
13+50	0.3396	0.61	Q	|	|	|	|
13+55	0.3440	0.63	Q	|	|	|	|
14+ 0	0.3484	0.65	Q	|	|	|	|
14+ 5	0.3530	0.67	Q	|	|	|	|
14+10	0.3578	0.69	Q	|	|	|	|
14+15	0.3627	0.71	Q	|	|	|	|
14+20	0.3678	0.74	Q	|	|	|	|
14+25	0.3730	0.76	Q	|	|	|	|
14+30	0.3785	0.79	Q	|	|	|	|
14+35	0.3841	0.82	Q	|	|	|	|
14+40	0.3900	0.85	Q	|	|	|	|
14+45	0.3961	0.89	Q	|	|	|	|
14+50	0.4025	0.93	Q	|	|	|	|
14+55	0.4092	0.97	Q	|	|	|	|
15+ 0	0.4163	1.02	Q	|	|	|	|
15+ 5	0.4237	1.08	Q	|	|	|	|
15+10	0.4316	1.14	Q	|	|	|	|
15+15	0.4399	1.21	Q	|	|	|	|
15+20	0.4489	1.30	Q	|	|	|	|
15+25	0.4587	1.42	Q	|	|	|	|
15+30	0.4705	1.71	Q	|	|	|	|
15+35	0.4842	1.98	Q	|	|	|	|
15+40	0.4997	2.25	Q	|	|	|	|
15+45	0.5172	2.55	Q	|	|	|	|
15+50	0.5378	2.99	Q	|	|	|	|
15+55	0.5624	3.58	Q	|	|	|	|
16+ 0	0.5955	4.81	QV	|	|	|	|
16+ 5	0.6532	8.38	|Q	|	|	|	|
16+10	0.7834	18.90	|V Q	|	|	|	|
16+15	0.8827	14.41	|VQ	|	|	|	|
16+20	0.9398	8.29	|Q	|	|	|	|

16+25	0.9798	5.82	|Q	|	|	|	|
16+30	1.0089	4.23	QV	|	|	|	|
16+35	1.0312	3.23	QV	|	|	|	|
16+40	1.0489	2.56	QV	|	|	|	|
16+45	1.0631	2.07	QV	|	|	|	|
16+50	1.0745	1.65	QV	|	|	|	|
16+55	1.0844	1.44	QV	|	|	|	|
17+ 0	1.0933	1.29	QV	|	|	|	|
17+ 5	1.1009	1.10	QV	|	|	|	|
17+10	1.1066	0.84	QV	|	|	|	|
17+15	1.1119	0.76	QV	|	|	|	|
17+20	1.1168	0.71	QV	|	|	|	|
17+25	1.1213	0.66	QV	|	|	|	|
17+30	1.1256	0.62	QV	|	|	|	|
17+35	1.1296	0.59	QV	|	|	|	|
17+40	1.1335	0.56	QV	|	|	|	|
17+45	1.1372	0.54	QV	|	|	|	|
17+50	1.1407	0.51	QV	|	|	|	|
17+55	1.1441	0.49	QV	|	|	|	|
18+ 0	1.1474	0.47	QV	|	|	|	|
18+ 5	1.1505	0.46	QV	|	|	|	|
18+10	1.1538	0.47	QV	|	|	|	|
18+15	1.1570	0.47	QV	|	|	|	|
18+20	1.1602	0.47	QV	|	|	|	|
18+25	1.1634	0.46	QV	|	|	|	|
18+30	1.1664	0.45	QV	|	|	|	|
18+35	1.1694	0.44	QV	|	|	|	|
18+40	1.1724	0.43	QV	|	|	|	|
18+45	1.1753	0.42	Q V	|	|	|	|
18+50	1.1781	0.41	Q V	|	|	|	|
18+55	1.1808	0.40	Q V	|	|	|	|
19+ 0	1.1835	0.39	Q V	|	|	|	|
19+ 5	1.1861	0.38	Q V	|	|	|	|
19+10	1.1887	0.37	Q V	|	|	|	|
19+15	1.1912	0.37	Q V	|	|	|	|
19+20	1.1937	0.36	Q V	|	|	|	|
19+25	1.1961	0.35	Q V	|	|	|	|
19+30	1.1985	0.35	Q V	|	|	|	|
19+35	1.2008	0.34	Q V	|	|	|	|
19+40	1.2031	0.33	Q V	|	|	|	|
19+45	1.2054	0.33	Q V	|	|	|	|
19+50	1.2076	0.32	Q V	|	|	|	|
19+55	1.2098	0.32	Q V	|	|	|	|
20+ 0	1.2119	0.31	Q V	|	|	|	|
20+ 5	1.2140	0.31	Q V	|	|	|	|
20+10	1.2161	0.30	Q V	|	|	|	|
20+15	1.2182	0.30	Q V	|	|	|	|
20+20	1.2202	0.29	Q V	|	|	|	|
20+25	1.2221	0.29	Q V	|	|	|	|
20+30	1.2241	0.28	Q V	|	|	|	|
20+35	1.2260	0.28	Q V	|	|	|	|
20+40	1.2279	0.28	Q V	|	|	|	|
20+45	1.2298	0.27	Q V	|	|	|	|
20+50	1.2317	0.27	Q V	|	|	|	|
20+55	1.2335	0.27	Q V	|	|	|	|
21+ 0	1.2353	0.26	Q V	|	|	|	|
21+ 5	1.2371	0.26	Q V	|	|	|	|

21+10	1.2388	0.26	Q V				
21+15	1.2406	0.25	Q V				
21+20	1.2423	0.25	Q V				
21+25	1.2440	0.25	Q V				
21+30	1.2456	0.24	Q V				
21+35	1.2473	0.24	Q V				
21+40	1.2489	0.24	Q V				
21+45	1.2506	0.24	Q V				
21+50	1.2522	0.23	Q V				
21+55	1.2537	0.23	Q V				
22+ 0	1.2553	0.23	Q V				
22+ 5	1.2569	0.23	Q V				
22+10	1.2584	0.22	Q V				
22+15	1.2599	0.22	Q V				
22+20	1.2614	0.22	Q V				
22+25	1.2629	0.22	Q V				
22+30	1.2644	0.21	Q V				
22+35	1.2659	0.21	Q V				
22+40	1.2673	0.21	Q V				
22+45	1.2687	0.21	Q V				
22+50	1.2702	0.21	Q V				
22+55	1.2716	0.20	Q V				
23+ 0	1.2730	0.20	Q V				
23+ 5	1.2743	0.20	Q V				
23+10	1.2757	0.20	Q V				
23+15	1.2771	0.20	Q V				
23+20	1.2784	0.20	Q V				
23+25	1.2798	0.19	Q V				
23+30	1.2811	0.19	Q V				
23+35	1.2824	0.19	Q V				
23+40	1.2837	0.19	Q V				
23+45	1.2850	0.19	Q V				
23+50	1.2863	0.19	Q V				
23+55	1.2875	0.18	Q V				
24+ 0	1.2888	0.18	Q V				
24+ 5	1.2889	0.02	Q V				
24+10	1.2897	0.11	Q V				
24+15	1.2910	0.19	Q V				
24+20	1.2925	0.22	Q V				
24+25	1.2941	0.23	Q V				
24+30	1.2958	0.25	Q V				
24+35	1.2975	0.26	Q V				
24+40	1.2993	0.26	Q V				
24+45	1.3012	0.27	Q V				
24+50	1.3030	0.27	Q V				
24+55	1.3049	0.27	Q V				
25+ 0	1.3068	0.28	Q V				
25+ 5	1.3087	0.28	Q V				
25+10	1.3107	0.28	Q V				
25+15	1.3126	0.28	Q V				
25+20	1.3145	0.28	Q V				
25+25	1.3165	0.28	Q V				
25+30	1.3184	0.28	Q V				
25+35	1.3204	0.29	Q V				
25+40	1.3224	0.29	Q V				
25+45	1.3244	0.29	Q V				
25+50	1.3263	0.29	Q V				

25+55	1.3283	0.29	Q V				
26+ 0	1.3303	0.29	Q V				
26+ 5	1.3324	0.29	Q V				
26+10	1.3344	0.29	Q V				
26+15	1.3364	0.29	Q V				
26+20	1.3385	0.30	Q V				
26+25	1.3405	0.30	Q V				
26+30	1.3426	0.30	Q V				
26+35	1.3446	0.30	Q V				
26+40	1.3467	0.30	Q V				
26+45	1.3488	0.30	Q V				
26+50	1.3509	0.30	Q V				
26+55	1.3530	0.31	Q V				
27+ 0	1.3551	0.31	Q V				
27+ 5	1.3572	0.31	Q V				
27+10	1.3594	0.31	Q V				
27+15	1.3615	0.31	Q V				
27+20	1.3636	0.31	Q V				
27+25	1.3658	0.31	Q V				
27+30	1.3680	0.32	Q V				
27+35	1.3702	0.32	Q V				
27+40	1.3724	0.32	Q V				
27+45	1.3746	0.32	Q V				
27+50	1.3768	0.32	Q V				
27+55	1.3790	0.32	Q V				
28+ 0	1.3812	0.32	Q V				
28+ 5	1.3835	0.33	Q V				
28+10	1.3858	0.33	Q V				
28+15	1.3880	0.33	Q V				
28+20	1.3903	0.33	Q V				
28+25	1.3926	0.33	Q V				
28+30	1.3949	0.33	Q V				
28+35	1.3972	0.34	Q V				
28+40	1.3996	0.34	Q V				
28+45	1.4019	0.34	Q V				
28+50	1.4043	0.34	Q V				
28+55	1.4066	0.34	Q V				
29+ 0	1.4090	0.35	Q V				
29+ 5	1.4114	0.35	Q V				
29+10	1.4138	0.35	Q V				
29+15	1.4162	0.35	Q V				
29+20	1.4186	0.35	Q V				
29+25	1.4211	0.36	Q V				
29+30	1.4235	0.36	Q V				
29+35	1.4260	0.36	Q V				
29+40	1.4285	0.36	Q V				
29+45	1.4310	0.36	Q V				
29+50	1.4335	0.37	Q V				
29+55	1.4361	0.37	Q V				
30+ 0	1.4386	0.37	Q V				
30+ 5	1.4412	0.37	Q V				
30+10	1.4437	0.37	Q V				
30+15	1.4463	0.38	Q V				
30+20	1.4489	0.38	Q V				
30+25	1.4516	0.38	Q V				
30+30	1.4542	0.38	Q V				
30+35	1.4568	0.39	Q V				

30+40	1.4595	0.39	Q V				
30+45	1.4622	0.39	Q V				
30+50	1.4649	0.39	Q V				
30+55	1.4676	0.40	Q V				
31+ 0	1.4704	0.40	Q V				
31+ 5	1.4731	0.40	Q V				
31+10	1.4759	0.40	Q V				
31+15	1.4787	0.41	Q V				
31+20	1.4815	0.41	Q V				
31+25	1.4844	0.41	Q V				
31+30	1.4872	0.41	Q V				
31+35	1.4901	0.42	Q V				
31+40	1.4930	0.42	Q V				
31+45	1.4959	0.42	Q V				
31+50	1.4988	0.43	Q V				
31+55	1.5018	0.43	Q V				
32+ 0	1.5048	0.43	Q V				
32+ 5	1.5078	0.44	Q V				
32+10	1.5108	0.44	Q V				
32+15	1.5138	0.44	Q V				
32+20	1.5169	0.45	Q V				
32+25	1.5200	0.45	Q V				
32+30	1.5231	0.45	Q V				
32+35	1.5262	0.46	Q V				
32+40	1.5294	0.46	Q V				
32+45	1.5326	0.46	Q V				
32+50	1.5358	0.47	Q V				
32+55	1.5391	0.47	Q V				
33+ 0	1.5423	0.47	Q V				
33+ 5	1.5456	0.48	Q V				
33+10	1.5490	0.48	Q V				
33+15	1.5523	0.49	Q V				
33+20	1.5557	0.49	Q V				
33+25	1.5591	0.50	Q V				
33+30	1.5625	0.50	Q V				
33+35	1.5660	0.50	Q V				
33+40	1.5695	0.51	Q V				
33+45	1.5731	0.51	Q V				
33+50	1.5766	0.52	Q V				
33+55	1.5802	0.52	Q V				
34+ 0	1.5839	0.53	Q V				
34+ 5	1.5876	0.53	Q V				
34+10	1.5913	0.54	Q V				
34+15	1.5950	0.54	Q V				
34+20	1.5988	0.55	Q V				
34+25	1.6026	0.56	Q V				
34+30	1.6065	0.56	Q V				
34+35	1.6104	0.57	Q V				
34+40	1.6143	0.57	Q V				
34+45	1.6183	0.58	Q V				
34+50	1.6224	0.59	Q V				
34+55	1.6265	0.59	Q V				
35+ 0	1.6306	0.60	Q V				
35+ 5	1.6348	0.61	Q V				
35+10	1.6390	0.61	Q V				
35+15	1.6433	0.62	Q V				
35+20	1.6476	0.63	Q V				

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35+25       1.6520      0.64  Q V       |          |          |          |
35+30       1.6564      0.64  Q V       |          |          |          |
35+35       1.6609      0.65  Q V       |          |          |          |
35+40       1.6655      0.66  Q V       |          |          |          |
35+45       1.6701      0.67  Q V       |          |          |          |
35+50       1.6748      0.68  Q V       |          |          |          |
35+55       1.6795      0.69  Q V       |          |          |          |
36+ 0       1.6843      0.70  Q V       |          |          |          |
36+ 5       1.6892      0.70  Q V       |          |          |          |
36+10       1.6938      0.68  Q V       |          |          |          |
36+15       1.6983      0.66  Q V       |          |          |          |
36+20       1.7029      0.66  Q V       |          |          |          |
36+25       1.7074      0.66  Q V       |          |          |          |
36+30       1.7120      0.67  Q V       |          |          |          |
36+35       1.7167      0.68  Q V       |          |          |          |
36+40       1.7214      0.69  Q V       |          |          |          |
36+45       1.7262      0.70  Q V       |          |          |          |
36+50       1.7311      0.71  Q V       |          |          |          |
36+55       1.7361      0.72  Q V       |          |          |          |
37+ 0       1.7411      0.74  Q V       |          |          |          |
37+ 5       1.7463      0.75  Q V       |          |          |          |
37+10       1.7516      0.77  Q V       |          |          |          |
37+15       1.7569      0.78  Q V       |          |          |          |
37+20       1.7624      0.80  Q  V      |          |          |          |
37+25       1.7681      0.82  Q  V      |          |          |          |
37+30       1.7738      0.84  Q  V      |          |          |          |
37+35       1.7797      0.85  Q  V      |          |          |          |
37+40       1.7857      0.88  Q  V      |          |          |          |
37+45       1.7919      0.90  Q  V      |          |          |          |
37+50       1.7982      0.92  Q  V      |          |          |          |
37+55       1.8048      0.95  Q  V      |          |          |          |
38+ 0       1.8115      0.97  Q  V      |          |          |          |
38+ 5       1.8184      1.00  Q  V      |          |          |          |
38+10       1.8255      1.04  Q  V      |          |          |          |
38+15       1.8328      1.07  Q  V      |          |          |          |
38+20       1.8405      1.11  Q  V      |          |          |          |
38+25       1.8483      1.14  Q  V      |          |          |          |
38+30       1.8565      1.19  Q  V      |          |          |          |
38+35       1.8650      1.23  Q  V      |          |          |          |
38+40       1.8738      1.28  Q  V      |          |          |          |
38+45       1.8830      1.33  Q  V      |          |          |          |
38+50       1.8926      1.40  Q  V      |          |          |          |
38+55       1.9026      1.46  Q  V      |          |          |          |
39+ 0       1.9132      1.54  Q  V      |          |          |          |
39+ 5       1.9243      1.62  Q  V      |          |          |          |
39+10       1.9362      1.72  Q  V      |          |          |          |
39+15       1.9487      1.82  Q  V      |          |          |          |
39+20       1.9622      1.96  Q  V      |          |          |          |
39+25       1.9769      2.14  Q  V      |          |          |          |
39+30       1.9946      2.57  Q  V      |          |          |          |
39+35       2.0150      2.97  Q  V      |          |          |          |
39+40       2.0383      3.38  Q  V      |          |          |          |
39+45       2.0646      3.82  Q  V      |          |          |          |
39+50       2.0955      4.48  Q  V      |          |          |          |
39+55       2.1324      5.37  |Q V       |          |          |          |
40+ 0       2.1821      7.21  |Q V       |          |          |          |
40+ 5       2.2690     12.62  | QV       |          |          |          |
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40+10       2.4664     28.66  |   VQ    |         |         |         |
40+15       2.6167     21.83  |   Q     |         |         |         |
40+20       2.7030     12.53  | Q V     |         |         |         |
40+25       2.7635      8.78  |Q  V     |         |         |         |
40+30       2.8074      6.38  |Q  V     |         |         |         |
40+35       2.8410      4.87  Q   V     |         |         |         |
40+40       2.8676      3.86  Q   V     |         |         |         |
40+45       2.8890      3.11  Q   V     |         |         |         |
40+50       2.9061      2.49  Q   V     |         |         |         |
40+55       2.9210      2.16  Q   V     |         |         |         |
41+ 0       2.9344      1.94  Q    V    |         |         |         |
41+ 5       2.9458      1.66  Q    V    |         |         |         |
41+10       2.9545      1.26  Q    V    |         |         |         |
41+15       2.9624      1.14  Q    V    |         |         |         |
41+20       2.9697      1.06  Q    V    |         |         |         |
41+25       2.9765      0.99  Q    V    |         |         |         |
41+30       2.9829      0.93  Q    V    |         |         |         |
41+35       2.9890      0.88  Q    V    |         |         |         |
41+40       2.9948      0.84  Q    V    |         |         |         |
41+45       3.0003      0.80  Q    V    |         |         |         |
41+50       3.0056      0.77  Q    V    |         |         |         |
41+55       3.0107      0.74  Q    V    |         |         |         |
42+ 0       3.0156      0.71  Q    V    |         |         |         |
42+ 5       3.0203      0.69  Q    V    |         |         |         |
42+10       3.0252      0.70  Q    V    |         |         |         |
42+15       3.0301      0.71  Q    V    |         |         |         |
42+20       3.0349      0.70  Q    V    |         |         |         |
42+25       3.0396      0.68  Q    V    |         |         |         |
42+30       3.0442      0.67  Q    V    |         |         |         |
42+35       3.0487      0.65  Q    V    |         |         |         |
42+40       3.0531      0.64  Q    V    |         |         |         |
42+45       3.0574      0.63  Q    V    |         |         |         |
42+50       3.0616      0.61  Q    V    |         |         |         |
42+55       3.0657      0.60  Q    V    |         |         |         |
43+ 0       3.0698      0.59  Q    V    |         |         |         |
43+ 5       3.0737      0.57  Q    V    |         |         |         |
43+10       3.0776      0.56  Q    V    |         |         |         |
43+15       3.0814      0.55  Q    V    |         |         |         |
43+20       3.0851      0.54  Q    V    |         |         |         |
43+25       3.0887      0.53  Q    V    |         |         |         |
43+30       3.0923      0.52  Q    V    |         |         |         |
43+35       3.0958      0.51  Q    V    |         |         |         |
43+40       3.0992      0.50  Q    V    |         |         |         |
43+45       3.1026      0.49  Q    V    |         |         |         |
43+50       3.1059      0.48  Q    V    |         |         |         |
43+55       3.1092      0.47  Q    V    |         |         |         |
44+ 0       3.1124      0.47  Q    V    |         |         |         |
44+ 5       3.1156      0.46  Q    V    |         |         |         |
44+10       3.1187      0.45  Q    V    |         |         |         |
44+15       3.1218      0.45  Q    V    |         |         |         |
44+20       3.1248      0.44  Q    V    |         |         |         |
44+25       3.1278      0.43  Q    V    |         |         |         |
44+30       3.1307      0.43  Q    V    |         |         |         |
44+35       3.1336      0.42  Q    V    |         |         |         |
44+40       3.1364      0.41  Q    V    |         |         |         |
44+45       3.1392      0.41  Q    V    |         |         |         |
44+50       3.1420      0.40  Q    V    |         |         |         |
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44+55	3.1448	0.40	Q	V				
45+ 0	3.1475	0.39	Q	V				
45+ 5	3.1501	0.39	Q	V				
45+10	3.1528	0.38	Q	V				
45+15	3.1554	0.38	Q	V				
45+20	3.1579	0.37	Q	V				
45+25	3.1605	0.37	Q	V				
45+30	3.1630	0.36	Q	V				
45+35	3.1655	0.36	Q	V				
45+40	3.1679	0.36	Q	V				
45+45	3.1704	0.35	Q	V				
45+50	3.1728	0.35	Q	V				
45+55	3.1752	0.35	Q	V				
46+ 0	3.1775	0.34	Q	V				
46+ 5	3.1798	0.34	Q	V				
46+10	3.1821	0.33	Q	V				
46+15	3.1844	0.33	Q	V				
46+20	3.1867	0.33	Q	V				
46+25	3.1889	0.32	Q	V				
46+30	3.1911	0.32	Q	V				
46+35	3.1933	0.32	Q	V				
46+40	3.1955	0.32	Q	V				
46+45	3.1976	0.31	Q	V				
46+50	3.1998	0.31	Q	V				
46+55	3.2019	0.31	Q	V				
47+ 0	3.2040	0.30	Q	V				
47+ 5	3.2060	0.30	Q	V				
47+10	3.2081	0.30	Q	V				
47+15	3.2101	0.30	Q	V				
47+20	3.2122	0.29	Q	V				
47+25	3.2142	0.29	Q	V				
47+30	3.2162	0.29	Q	V				
47+35	3.2181	0.29	Q	V				
47+40	3.2201	0.28	Q	V				
47+45	3.2220	0.28	Q	V				
47+50	3.2239	0.28	Q	V				
47+55	3.2258	0.28	Q	V				
48+ 0	3.2277	0.27	Q	V				
48+ 5	3.2279	0.02	Q	V				
48+10	3.2289	0.15	Q	V				
48+15	3.2305	0.23	Q	V				
48+20	3.2324	0.27	Q	V				
48+25	3.2344	0.30	Q	V				
48+30	3.2366	0.31	Q	V				
48+35	3.2388	0.32	Q	V				
48+40	3.2411	0.33	Q	V				
48+45	3.2434	0.34	Q	V				
48+50	3.2458	0.34	Q	V				
48+55	3.2481	0.35	Q	V				
49+ 0	3.2506	0.35	Q	V				
49+ 5	3.2530	0.35	Q	V				
49+10	3.2554	0.35	Q	V				
49+15	3.2579	0.36	Q	V				
49+20	3.2603	0.36	Q	V				
49+25	3.2628	0.36	Q	V				
49+30	3.2653	0.36	Q	V				
49+35	3.2678	0.36	Q	V				

49+40	3.2703	0.36	Q	V				
49+45	3.2728	0.36	Q	V				
49+50	3.2753	0.37	Q	V				
49+55	3.2778	0.37	Q	V				
50+ 0	3.2804	0.37	Q	V				
50+ 5	3.2829	0.37	Q	V				
50+10	3.2855	0.37	Q	V				
50+15	3.2880	0.37	Q	V				
50+20	3.2906	0.38	Q	V				
50+25	3.2932	0.38	Q	V				
50+30	3.2958	0.38	Q	V				
50+35	3.2984	0.38	Q	V				
50+40	3.3011	0.38	Q	V				
50+45	3.3037	0.38	Q	V				
50+50	3.3064	0.39	Q	V				
50+55	3.3090	0.39	Q	V				
51+ 0	3.3117	0.39	Q	V				
51+ 5	3.3144	0.39	Q	V				
51+10	3.3171	0.39	Q	V				
51+15	3.3198	0.39	Q	V				
51+20	3.3225	0.40	Q	V				
51+25	3.3253	0.40	Q	V				
51+30	3.3280	0.40	Q	V				
51+35	3.3308	0.40	Q	V				
51+40	3.3336	0.40	Q	V				
51+45	3.3364	0.41	Q	V				
51+50	3.3392	0.41	Q	V				
51+55	3.3420	0.41	Q	V				
52+ 0	3.3448	0.41	Q	V				
52+ 5	3.3477	0.41	Q	V				
52+10	3.3505	0.42	Q	V				
52+15	3.3534	0.42	Q	V				
52+20	3.3563	0.42	Q	V				
52+25	3.3592	0.42	Q	V				
52+30	3.3621	0.42	Q	V				
52+35	3.3651	0.43	Q	V				
52+40	3.3680	0.43	Q	V				
52+45	3.3710	0.43	Q	V				
52+50	3.3740	0.43	Q	V				
52+55	3.3770	0.44	Q	V				
53+ 0	3.3800	0.44	Q	V				
53+ 5	3.3830	0.44	Q	V				
53+10	3.3861	0.44	Q	V				
53+15	3.3891	0.44	Q	V				
53+20	3.3922	0.45	Q	V				
53+25	3.3953	0.45	Q	V				
53+30	3.3984	0.45	Q	V				
53+35	3.4015	0.45	Q	V				
53+40	3.4047	0.46	Q	V				
53+45	3.4079	0.46	Q	V				
53+50	3.4110	0.46	Q	V				
53+55	3.4143	0.47	Q	V				
54+ 0	3.4175	0.47	Q	V				
54+ 5	3.4207	0.47	Q	V				
54+10	3.4240	0.47	Q	V				
54+15	3.4273	0.48	Q	V				
54+20	3.4306	0.48	Q	V				

54+25	3.4339	0.48	Q	V				
54+30	3.4372	0.49	Q	V				
54+35	3.4406	0.49	Q	V				
54+40	3.4440	0.49	Q	V				
54+45	3.4474	0.49	Q	V				
54+50	3.4508	0.50	Q	V				
54+55	3.4543	0.50	Q	V				
55+ 0	3.4577	0.50	Q	V				
55+ 5	3.4612	0.51	Q	V				
55+10	3.4647	0.51	Q	V				
55+15	3.4683	0.51	Q	V				
55+20	3.4719	0.52	Q	V				
55+25	3.4754	0.52	Q	V				
55+30	3.4791	0.52	Q	V				
55+35	3.4827	0.53	Q	V				
55+40	3.4864	0.53	Q	V				
55+45	3.4901	0.54	Q	V				
55+50	3.4938	0.54	Q	V				
55+55	3.4975	0.54	Q	V				
56+ 0	3.5013	0.55	Q	V				
56+ 5	3.5051	0.55	Q	V				
56+10	3.5089	0.56	Q	V				
56+15	3.5128	0.56	Q	V				
56+20	3.5167	0.56	Q	V				
56+25	3.5206	0.57	Q	V				
56+30	3.5245	0.57	Q	V				
56+35	3.5285	0.58	Q	V				
56+40	3.5325	0.58	Q	V				
56+45	3.5365	0.59	Q	V				
56+50	3.5406	0.59	Q	V				
56+55	3.5447	0.60	Q	V				
57+ 0	3.5489	0.60	Q	V				
57+ 5	3.5530	0.61	Q	V				
57+10	3.5573	0.61	Q	V				
57+15	3.5615	0.62	Q	V				
57+20	3.5658	0.62	Q	V				
57+25	3.5701	0.63	Q	V				
57+30	3.5745	0.63	Q	V				
57+35	3.5789	0.64	Q	V				
57+40	3.5833	0.64	Q	V				
57+45	3.5878	0.65	Q	V				
57+50	3.5923	0.66	Q	V				
57+55	3.5969	0.66	Q	V				
58+ 0	3.6015	0.67	Q	V				
58+ 5	3.6062	0.68	Q	V				
58+10	3.6109	0.68	Q	V				
58+15	3.6156	0.69	Q	V				
58+20	3.6204	0.70	Q	V				
58+25	3.6252	0.70	Q	V				
58+30	3.6301	0.71	Q	V				
58+35	3.6351	0.72	Q	V				
58+40	3.6401	0.73	Q	V				
58+45	3.6451	0.73	Q	V				
58+50	3.6503	0.74	Q	V				
58+55	3.6554	0.75	Q	V				
59+ 0	3.6607	0.76	Q	V				
59+ 5	3.6660	0.77	Q	V				

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59+10       3.6713      0.78  Q     V   |          |          |          |
59+15       3.6767      0.79  Q     V   |          |          |          |
59+20       3.6822      0.80  Q     V   |          |          |          |
59+25       3.6878      0.81  Q     V   |          |          |          |
59+30       3.6934      0.82  Q     V   |          |          |          |
59+35       3.6991      0.83  Q     V   |          |          |          |
59+40       3.7048      0.84  Q     V   |          |          |          |
59+45       3.7107      0.85  Q     V   |          |          |          |
59+50       3.7166      0.86  Q     V   |          |          |          |
59+55       3.7226      0.87  Q     V   |          |          |          |
60+ 0       3.7287      0.88  Q     V   |          |          |          |
60+ 5       3.7348      0.89  Q     V   |          |          |          |
60+10       3.7407      0.86  Q     V   |          |          |          |
60+15       3.7465      0.83  Q     V   |          |          |          |
60+20       3.7522      0.83  Q     V   |          |          |          |
60+25       3.7580      0.84  Q     V   |          |          |          |
60+30       3.7638      0.85  Q     V   |          |          |          |
60+35       3.7697      0.86  Q     V   |          |          |          |
60+40       3.7757      0.87  Q     V   |          |          |          |
60+45       3.7818      0.88  Q     V   |          |          |          |
60+50       3.7880      0.90  Q     V   |          |          |          |
60+55       3.7943      0.91  Q     V   |          |          |          |
61+ 0       3.8007      0.93  Q     V   |          |          |          |
61+ 5       3.8072      0.95  Q     V   |          |          |          |
61+10       3.8139      0.97  Q     V   |          |          |          |
61+15       3.8207      0.99  Q     V   |          |          |          |
61+20       3.8277      1.01  Q     V   |          |          |          |
61+25       3.8348      1.03  Q     V   |          |          |          |
61+30       3.8421      1.06  Q     V   |          |          |          |
61+35       3.8495      1.08  Q     V   |          |          |          |
61+40       3.8572      1.11  Q     V   |          |          |          |
61+45       3.8650      1.14  Q     V   |          |          |          |
61+50       3.8730      1.17  Q     V   |          |          |          |
61+55       3.8813      1.20  Q     V   |          |          |          |
62+ 0       3.8898      1.23  Q     V   |          |          |          |
62+ 5       3.8985      1.27  Q     V   |          |          |          |
62+10       3.9075      1.31  Q     V   |          |          |          |
62+15       3.9169      1.35  Q     V   |          |          |          |
62+20       3.9265      1.40  Q     V   |          |          |          |
62+25       3.9365      1.45  Q     V   |          |          |          |
62+30       3.9468      1.50  Q     V   |          |          |          |
62+35       3.9575      1.56  Q     V   |          |          |          |
62+40       3.9687      1.62  Q     V   |          |          |          |
62+45       3.9804      1.69  Q     V   |          |          |          |
62+50       3.9925      1.77  Q     V   |          |          |          |
62+55       4.0053      1.85  Q     V   |          |          |          |
63+ 0       4.0187      1.95  Q     V   |          |          |          |
63+ 5       4.0328      2.05  Q     V   |          |          |          |
63+10       4.0477      2.17  Q     V   |          |          |          |
63+15       4.0636      2.31  Q     V   |          |          |          |
63+20       4.0807      2.48  Q     V   |          |          |          |
63+25       4.0993      2.71  Q     V   |          |          |          |
63+30       4.1217      3.26  Q      V  |          |          |          |
63+35       4.1476      3.76  Q      V  |          |          |          |
63+40       4.1771      4.28  Q      V  |          |          |          |
63+45       4.2104      4.84  Q      V  |          |          |          |
63+50       4.2495      5.67  |Q     V  |          |          |          |
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63+55       4.2963      6.80  |Q     V  |          |          |          |
64+ 0       4.3593      9.14  |Q     V  |          |          |          |
64+ 5       4.4695     16.01  |  Q   V  |          |          |          |
64+10       4.7207     36.47  |       QV |          |          |          |
64+15       4.9119     27.77  |    Q  V |          |          |          |
64+20       5.0215     15.92  |  Q    V |          |          |          |
64+25       5.0983     11.15  | Q     V |          |          |          |
64+30       5.1541      8.10  |Q      V |          |          |          |
64+35       5.1967      6.18  |Q      V |          |          |          |
64+40       5.2304      4.90  Q       V |          |          |          |
64+45       5.2576      3.95  Q       V |          |          |          |
64+50       5.2794      3.16  Q        V|          |          |          |
64+55       5.2982      2.74  Q        V|          |          |          |
65+ 0       5.3152      2.46  Q        V|          |          |          |
65+ 5       5.3297      2.11  Q        V|          |          |          |
65+10       5.3407      1.59  Q        V|          |          |          |
65+15       5.3507      1.45  Q        V|          |          |          |
65+20       5.3599      1.34  Q        V|          |          |          |
65+25       5.3685      1.25  Q        V|          |          |          |
65+30       5.3767      1.18  Q        V|          |          |          |
65+35       5.3844      1.12  Q        V|          |          |          |
65+40       5.3917      1.07  Q        V|          |          |          |
65+45       5.3987      1.02  Q        V|          |          |          |
65+50       5.4054      0.97  Q        V|          |          |          |
65+55       5.4119      0.93  Q        V|          |          |          |
66+ 0       5.4180      0.90  Q        V|          |          |          |
66+ 5       5.4241      0.87  Q        V|          |          |          |
66+10       5.4302      0.89  Q        V|          |          |          |
66+15       5.4364      0.90  Q        V|          |          |          |
66+20       5.4425      0.88  Q        V|          |          |          |
66+25       5.4484      0.87  Q        V|          |          |          |
66+30       5.4543      0.85  Q        V|          |          |          |
66+35       5.4600      0.83  Q        V|          |          |          |
66+40       5.4656      0.81  Q        V|          |          |          |
66+45       5.4710      0.79  Q        V|          |          |          |
66+50       5.4764      0.77  Q        V|          |          |          |
66+55       5.4816      0.76  Q        V|          |          |          |
67+ 0       5.4867      0.74  Q        V|          |          |          |
67+ 5       5.4917      0.73  Q        V|          |          |          |
67+10       5.4966      0.71  Q        V|          |          |          |
67+15       5.5014      0.70  Q        V|          |          |          |
67+20       5.5061      0.68  Q        V|          |          |          |
67+25       5.5107      0.67  Q        V|          |          |          |
67+30       5.5152      0.66  Q        V|          |          |          |
67+35       5.5196      0.64  Q        V|          |          |          |
67+40       5.5240      0.63  Q        V|          |          |          |
67+45       5.5283      0.62  Q        V|          |          |          |
67+50       5.5325      0.61  Q        V|          |          |          |
67+55       5.5366      0.60  Q        V|          |          |          |
68+ 0       5.5407      0.59  Q        V|          |          |          |
68+ 5       5.5447      0.58  Q        V|          |          |          |
68+10       5.5486      0.57  Q        V|          |          |          |
68+15       5.5525      0.56  Q        V|          |          |          |
68+20       5.5564      0.56  Q        V|          |          |          |
68+25       5.5601      0.55  Q        V|          |          |          |
68+30       5.5638      0.54  Q        V|          |          |          |
68+35       5.5675      0.53  Q        V|          |          |          |
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68+40	5.5711	0.52	Q	V			
68+45	5.5747	0.52	Q	V			
68+50	5.5782	0.51	Q	V			
68+55	5.5817	0.50	Q	V			
69+ 0	5.5851	0.50	Q	V			
69+ 5	5.5885	0.49	Q	V			
69+10	5.5918	0.48	Q	V			
69+15	5.5951	0.48	Q	V			
69+20	5.5984	0.47	Q	V			
69+25	5.6016	0.47	Q	V			
69+30	5.6048	0.46	Q	V			
69+35	5.6079	0.46	Q	V			
69+40	5.6110	0.45	Q	V			
69+45	5.6141	0.45	Q	V			
69+50	5.6171	0.44	Q	V			
69+55	5.6202	0.44	Q	V			
70+ 0	5.6231	0.43	Q	V			
70+ 5	5.6261	0.43	Q	V			
70+10	5.6290	0.42	Q	V			
70+15	5.6319	0.42	Q	V			
70+20	5.6348	0.42	Q	V			
70+25	5.6376	0.41	Q	V			
70+30	5.6404	0.41	Q	V			
70+35	5.6432	0.40	Q	V			
70+40	5.6459	0.40	Q	V			
70+45	5.6486	0.40	Q	V			
70+50	5.6513	0.39	Q	V			
70+55	5.6540	0.39	Q	V			
71+ 0	5.6567	0.38	Q	V			
71+ 5	5.6593	0.38	Q	V			
71+10	5.6619	0.38	Q	V			
71+15	5.6645	0.37	Q	V			
71+20	5.6670	0.37	Q	V			
71+25	5.6696	0.37	Q	V			
71+30	5.6721	0.37	Q	V			
71+35	5.6746	0.36	Q	V			
71+40	5.6771	0.36	Q	V			
71+45	5.6795	0.36	Q	V			
71+50	5.6820	0.35	Q	V			
71+55	5.6844	0.35	Q	V			
72+ 0	5.6868	0.35	Q	V			
72+ 5	5.6870	0.04	Q	V			
72+10	5.6889	0.28	Q	V			
72+15	5.6920	0.44	Q	V			
72+20	5.6956	0.52	Q	V			
72+25	5.6994	0.56	Q	V			
72+30	5.7035	0.59	Q	V			
72+35	5.7077	0.61	Q	V			
72+40	5.7121	0.63	Q	V			
72+45	5.7165	0.64	Q	V			
72+50	5.7209	0.65	Q	V			
72+55	5.7254	0.66	Q	V			
73+ 0	5.7300	0.66	Q	V			
73+ 5	5.7346	0.67	Q	V			
73+10	5.7392	0.67	Q	V			
73+15	5.7439	0.67	Q	V			
73+20	5.7485	0.68	Q	V			

73+25	5.7532	0.68	Q	V|	|	|	|
73+30	5.7579	0.68	Q	V|	|	|	|
73+35	5.7626	0.68	Q	V|	|	|	|
73+40	5.7673	0.69	Q	V|	|	|	|
73+45	5.7721	0.69	Q	V|	|	|	|
73+50	5.7769	0.69	Q	V|	|	|	|
73+55	5.7816	0.70	Q	V|	|	|	|
74+ 0	5.7865	0.70	Q	V|	|	|	|
74+ 5	5.7913	0.70	Q	V|	|	|	|
74+10	5.7961	0.70	Q	V|	|	|	|
74+15	5.8010	0.71	Q	V|	|	|	|
74+20	5.8059	0.71	Q	V|	|	|	|
74+25	5.8108	0.71	Q	V|	|	|	|
74+30	5.8158	0.72	Q	V|	|	|	|
74+35	5.8207	0.72	Q	V|	|	|	|
74+40	5.8257	0.72	Q	V|	|	|	|
74+45	5.8307	0.73	Q	V|	|	|	|
74+50	5.8357	0.73	Q	V|	|	|	|
74+55	5.8408	0.73	Q	V|	|	|	|
75+ 0	5.8459	0.74	Q	V|	|	|	|
75+ 5	5.8510	0.74	Q	V|	|	|	|
75+10	5.8561	0.74	Q	V|	|	|	|
75+15	5.8612	0.75	Q	V|	|	|	|
75+20	5.8664	0.75	Q	V	|	|	|
75+25	5.8716	0.75	Q	V	|	|	|
75+30	5.8768	0.76	Q	V	|	|	|
75+35	5.8820	0.76	Q	V	|	|	|
75+40	5.8873	0.76	Q	V	|	|	|
75+45	5.8926	0.77	Q	V	|	|	|
75+50	5.8979	0.77	Q	V	|	|	|
75+55	5.9033	0.78	Q	V	|	|	|
76+ 0	5.9086	0.78	Q	V	|	|	|
76+ 5	5.9140	0.78	Q	V	|	|	|
76+10	5.9194	0.79	Q	V	|	|	|
76+15	5.9249	0.79	Q	V	|	|	|
76+20	5.9304	0.80	Q	V	|	|	|
76+25	5.9359	0.80	Q	V	|	|	|
76+30	5.9414	0.80	Q	V	|	|	|
76+35	5.9470	0.81	Q	V	|	|	|
76+40	5.9526	0.81	Q	V	|	|	|
76+45	5.9582	0.82	Q	V	|	|	|
76+50	5.9638	0.82	Q	V	|	|	|
76+55	5.9695	0.82	Q	V	|	|	|
77+ 0	5.9752	0.83	Q	V	|	|	|
77+ 5	5.9810	0.83	Q	V	|	|	|
77+10	5.9867	0.84	Q	V	|	|	|
77+15	5.9925	0.84	Q	V	|	|	|
77+20	5.9984	0.85	Q	V	|	|	|
77+25	6.0042	0.85	Q	V	|	|	|
77+30	6.0102	0.86	Q	V	|	|	|
77+35	6.0161	0.86	Q	V	|	|	|
77+40	6.0221	0.87	Q	V	|	|	|
77+45	6.0281	0.87	Q	V	|	|	|
77+50	6.0341	0.88	Q	V	|	|	|
77+55	6.0402	0.88	Q	V	|	|	|
78+ 0	6.0463	0.89	Q	V	|	|	|
78+ 5	6.0524	0.89	Q	V	|	|	|

78+10	6.0586	0.90	Q	V	|	|	|
78+15	6.0648	0.90	Q	V	|	|	|
78+20	6.0711	0.91	Q	V	|	|	|
78+25	6.0774	0.91	Q	V	|	|	|
78+30	6.0837	0.92	Q	V	|	|	|
78+35	6.0901	0.93	Q	V	|	|	|
78+40	6.0965	0.93	Q	V	|	|	|
78+45	6.1029	0.94	Q	V	|	|	|
78+50	6.1094	0.94	Q	V	|	|	|
78+55	6.1160	0.95	Q	V	|	|	|
79+ 0	6.1226	0.96	Q	V	|	|	|
79+ 5	6.1292	0.96	Q	V	|	|	|
79+10	6.1358	0.97	Q	V	|	|	|
79+15	6.1425	0.97	Q	V	|	|	|
79+20	6.1493	0.98	Q	V	|	|	|
79+25	6.1561	0.99	Q	V	|	|	|
79+30	6.1630	0.99	Q	V	|	|	|
79+35	6.1699	1.00	Q	V	|	|	|
79+40	6.1768	1.01	Q	V	|	|	|
79+45	6.1838	1.02	Q	V	|	|	|
79+50	6.1908	1.02	Q	V	|	|	|
79+55	6.1979	1.03	Q	V	|	|	|
80+ 0	6.2051	1.04	Q	V	|	|	|
80+ 5	6.2123	1.05	Q	V	|	|	|
80+10	6.2195	1.05	Q	V	|	|	|
80+15	6.2268	1.06	Q	V	|	|	|
80+20	6.2342	1.07	Q	V	|	|	|
80+25	6.2416	1.08	Q	V	|	|	|
80+30	6.2491	1.09	Q	V	|	|	|
80+35	6.2566	1.09	Q	V	|	|	|
80+40	6.2642	1.10	Q	V	|	|	|
80+45	6.2719	1.11	Q	V	|	|	|
80+50	6.2796	1.12	Q	V	|	|	|
80+55	6.2874	1.13	Q	V	|	|	|
81+ 0	6.2952	1.14	Q	V	|	|	|
81+ 5	6.3031	1.15	Q	V	|	|	|
81+10	6.3111	1.16	Q	V	|	|	|
81+15	6.3192	1.17	Q	V	|	|	|
81+20	6.3273	1.18	Q	V	|	|	|
81+25	6.3355	1.19	Q	V	|	|	|
81+30	6.3437	1.20	Q	V	|	|	|
81+35	6.3521	1.21	Q	V	|	|	|
81+40	6.3605	1.22	Q	V	|	|	|
81+45	6.3690	1.23	Q	V	|	|	|
81+50	6.3776	1.24	Q	V	|	|	|
81+55	6.3862	1.26	Q	V	|	|	|
82+ 0	6.3949	1.27	Q	V	|	|	|
82+ 5	6.4038	1.28	Q	V	|	|	|
82+10	6.4127	1.29	Q	V	|	|	|
82+15	6.4217	1.31	Q	V	|	|	|
82+20	6.4308	1.32	Q	V	|	|	|
82+25	6.4399	1.33	Q	V	|	|	|
82+30	6.4492	1.35	Q	|V	|	|	|
82+35	6.4586	1.36	Q	|V	|	|	|
82+40	6.4681	1.38	Q	|V	|	|	|
82+45	6.4776	1.39	Q	|V	|	|	|
82+50	6.4873	1.41	Q	|V	|	|	|

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82+55       6.4971      1.42  Q          |V         |          |          |
83+ 0       6.5070      1.44  Q          |V         |          |          |
83+ 5       6.5171      1.46  Q          |V         |          |          |
83+10       6.5272      1.47  Q          |V         |          |          |
83+15       6.5375      1.49  Q          |V         |          |          |
83+20       6.5479      1.51  Q          |V         |          |          |
83+25       6.5584      1.53  Q          |V         |          |          |
83+30       6.5690      1.55  Q          |V         |          |          |
83+35       6.5798      1.57  Q          |V         |          |          |
83+40       6.5908      1.59  Q          |V         |          |          |
83+45       6.6018      1.61  Q          |V         |          |          |
83+50       6.6131      1.63  Q          |V         |          |          |
83+55       6.6244      1.65  Q          |V         |          |          |
84+ 0       6.6360      1.68  Q          |V         |          |          |
84+ 5       6.6476      1.69  Q          |V         |          |          |
84+10       6.6588      1.62  Q          |V         |          |          |
84+15       6.6696      1.58  Q          |V         |          |          |
84+20       6.6805      1.58  Q          |V         |          |          |
84+25       6.6914      1.59  Q          |V         |          |          |
84+30       6.7025      1.60  Q          |V         |          |          |
84+35       6.7137      1.62  Q          |V         |          |          |
84+40       6.7250      1.65  Q          |V         |          |          |
84+45       6.7365      1.67  Q          |V         |          |          |
84+50       6.7483      1.70  Q          |V         |          |          |
84+55       6.7602      1.73  Q          |V         |          |          |
85+ 0       6.7724      1.77  Q          |V         |          |          |
85+ 5       6.7847      1.80  Q          |V         |          |          |
85+10       6.7974      1.84  Q          |V         |          |          |
85+15       6.8103      1.87  Q          |V         |          |          |
85+20       6.8235      1.92  Q          |V         |          |          |
85+25       6.8370      1.96  Q          |V         |          |          |
85+30       6.8508      2.00  Q          |V         |          |          |
85+35       6.8649      2.05  Q          |V         |          |          |
85+40       6.8794      2.10  Q          |V         |          |          |
85+45       6.8942      2.15  Q          |V         |          |          |
85+50       6.9094      2.21  Q          |V         |          |          |
85+55       6.9251      2.27  Q          |V         |          |          |
86+ 0       6.9411      2.34  Q          |V         |          |          |
86+ 5       6.9577      2.40  Q          |V         |          |          |
86+10       6.9748      2.48  Q          |V         |          |          |
86+15       6.9925      2.56  Q          |V         |          |          |
86+20       7.0107      2.65  Q          |V         |          |          |
86+25       7.0296      2.74  Q          |V         |          |          |
86+30       7.0492      2.85  Q          | V        |          |          |
86+35       7.0696      2.95  Q          | V        |          |          |
86+40       7.0907      3.08  Q          | V        |          |          |
86+45       7.1128      3.20  Q          | V        |          |          |
86+50       7.1358      3.35  Q          | V        |          |          |
86+55       7.1600      3.50  Q          | V        |          |          |
87+ 0       7.1854      3.69  Q          | V        |          |          |
87+ 5       7.2121      3.88  Q          | V        |          |          |
87+10       7.2404      4.12  Q          | V        |          |          |
87+15       7.2705      4.37  Q          | V        |          |          |
87+20       7.3029      4.69  Q          | V        |          |          |
87+25       7.3382      5.13  |Q         | V        |          |          |
87+30       7.3807      6.17  |Q         | V        |          |          |
87+35       7.4297      7.12  |Q         | V        |          |          |
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87+40       7.4856      8.11  |Q         | V       |         |         |
87+45       7.5487      9.17  |Q         | V       |         |         |
87+50       7.6228     10.75  | Q        |  V      |         |         |
87+55       7.7115     12.88  | Q        |  V      |         |         |
88+ 0       7.8309     17.34  |  Q       |  V      |         |         |
88+ 5       8.0414     30.57  |     Q    |  V      |         |         |
88+10       8.5218     69.75  |          |  QV     |         |         |
88+15       8.8871     53.04  |          Q    V   |         |         |
88+20       9.0962     30.36  |     Q    |    V    |         |         |
88+25       9.2425     21.24  |   Q      |    V    |         |         |
88+30       9.3486     15.42  |  Q       |    V    |         |         |
88+35       9.4297     11.77  | Q        |     V   |         |         |
88+40       9.4939      9.32  |Q         |     V   |         |         |
88+45       9.5456      7.51  |Q         |     V   |         |         |
88+50       9.5869      5.99  |Q         |     V   |         |         |
88+55       9.6228      5.21  |Q         |     V   |         |         |
89+ 0       9.6550      4.68  Q          |     V   |         |         |
89+ 5       9.6825      4.00  Q          |     V   |         |         |
89+10       9.7033      3.02  Q          |     V   |         |         |
89+15       9.7222      2.75  Q          |     V   |         |         |
89+20       9.7397      2.54  Q          |     V   |         |         |
89+25       9.7560      2.37  Q          |     V   |         |         |
89+30       9.7715      2.24  Q          |     V   |         |         |
89+35       9.7861      2.12  Q          |     V   |         |         |
89+40       9.8000      2.02  Q          |     V   |         |         |
89+45       9.8132      1.93  Q          |     V   |         |         |
89+50       9.8259      1.84  Q          |     V   |         |         |
89+55       9.8381      1.77  Q          |     V   |         |         |
90+ 0       9.8499      1.70  Q          |     V   |         |         |
90+ 5       9.8613      1.66  Q          |     V   |         |         |
90+10       9.8729      1.69  Q          |     V   |         |         |
90+15       9.8846      1.70  Q          |     V   |         |         |
90+20       9.8961      1.67  Q          |     V   |         |         |
90+25       9.9075      1.64  Q          |     V   |         |         |
90+30       9.9185      1.61  Q          |     V   |         |         |
90+35       9.9293      1.57  Q          |     V   |         |         |
90+40       9.9399      1.54  Q          |     V   |         |         |
90+45       9.9503      1.50  Q          |     V   |         |         |
90+50       9.9604      1.47  Q          |     V   |         |         |
90+55       9.9703      1.44  Q          |      V  |         |         |
91+ 0       9.9799      1.40  Q          |      V  |         |         |
91+ 5       9.9894      1.38  Q          |      V  |         |         |
91+10       9.9987      1.35  Q          |      V  |         |         |
91+15      10.0078      1.32  Q          |      V  |         |         |
91+20      10.0167      1.29  Q          |      V  |         |         |
91+25      10.0254      1.27  Q          |      V  |         |         |
91+30      10.0340      1.24  Q          |      V  |         |         |
91+35      10.0424      1.22  Q          |      V  |         |         |
91+40      10.0506      1.20  Q          |      V  |         |         |
91+45      10.0587      1.18  Q          |      V  |         |         |
91+50      10.0667      1.16  Q          |      V  |         |         |
91+55      10.0746      1.14  Q          |      V  |         |         |
92+ 0      10.0823      1.12  Q          |      V  |         |         |
92+ 5      10.0899      1.10  Q          |      V  |         |         |
92+10      10.0973      1.08  Q          |      V  |         |         |
92+15      10.1047      1.07  Q          |      V  |         |         |
92+20      10.1119      1.05  Q          |      V  |         |         |
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92+25	10.1191	1.04	Q	|	V	|	|
92+30	10.1261	1.02	Q	|	V	|	|
92+35	10.1330	1.01	Q	|	V	|	|
92+40	10.1399	0.99	Q	|	V	|	|
92+45	10.1466	0.98	Q	|	V	|	|
92+50	10.1533	0.97	Q	|	V	|	|
92+55	10.1599	0.95	Q	|	V	|	|
93+ 0	10.1664	0.94	Q	|	V	|	|
93+ 5	10.1728	0.93	Q	|	V	|	|
93+10	10.1791	0.92	Q	|	V	|	|
93+15	10.1854	0.91	Q	|	V	|	|
93+20	10.1915	0.90	Q	|	V	|	|
93+25	10.1976	0.89	Q	|	V	|	|
93+30	10.2037	0.88	Q	|	V	|	|
93+35	10.2096	0.87	Q	|	V	|	|
93+40	10.2155	0.86	Q	|	V	|	|
93+45	10.2214	0.85	Q	|	V	|	|
93+50	10.2271	0.84	Q	|	V	|	|
93+55	10.2328	0.83	Q	|	V	|	|
94+ 0	10.2385	0.82	Q	|	V	|	|
94+ 5	10.2441	0.81	Q	|	V	|	|
94+10	10.2496	0.80	Q	|	V	|	|
94+15	10.2551	0.79	Q	|	V	|	|
94+20	10.2605	0.79	Q	|	V	|	|
94+25	10.2658	0.78	Q	|	V	|	|
94+30	10.2712	0.77	Q	|	V	|	|
94+35	10.2764	0.76	Q	|	V	|	|
94+40	10.2816	0.76	Q	|	V	|	|
94+45	10.2868	0.75	Q	|	V	|	|
94+50	10.2919	0.74	Q	|	V	|	|
94+55	10.2970	0.74	Q	|	V	|	|
95+ 0	10.3020	0.73	Q	|	V	|	|
95+ 5	10.3070	0.72	Q	|	V	|	|
95+10	10.3119	0.72	Q	|	V	|	|
95+15	10.3168	0.71	Q	|	V	|	|
95+20	10.3217	0.70	Q	|	V	|	|
95+25	10.3265	0.70	Q	|	V	|	|
95+30	10.3312	0.69	Q	|	V	|	|
95+35	10.3360	0.69	Q	|	V	|	|
95+40	10.3407	0.68	Q	|	V	|	|
95+45	10.3453	0.68	Q	|	V	|	|
95+50	10.3499	0.67	Q	|	V	|	|
95+55	10.3545	0.66	Q	|	V	|	|
96+ 0	10.3590	0.66	Q	|	V	|	|
96+ 5	10.3598	0.10	Q	|	V	|	|
96+10	10.3650	0.76	Q	|	V	|	|
96+15	10.3735	1.23	Q	|	V	|	|
96+20	10.3834	1.44	Q	|	V	|	|
96+25	10.3942	1.56	Q	|	V	|	|
96+30	10.4055	1.64	Q	|	V	|	|
96+35	10.4172	1.70	Q	|	V	|	|
96+40	10.4293	1.75	Q	|	V	|	|
96+45	10.4415	1.78	Q	|	V	|	|
96+50	10.4539	1.80	Q	|	V	|	|
96+55	10.4664	1.82	Q	|	V	|	|
97+ 0	10.4791	1.84	Q	|	V	|	|
97+ 5	10.4919	1.86	Q	|	V	|	|

97+10	10.5047	1.86	Q	|	V |	|	|
97+15	10.5176	1.87	Q	|	V |	|	|
97+20	10.5305	1.88	Q	|	V |	|	|
97+25	10.5435	1.89	Q	|	V |	|	|
97+30	10.5566	1.89	Q	|	V |	|	|
97+35	10.5697	1.90	Q	|	V |	|	|
97+40	10.5828	1.91	Q	|	V |	|	|
97+45	10.5960	1.92	Q	|	V |	|	|
97+50	10.6093	1.93	Q	|	V |	|	|
97+55	10.6226	1.93	Q	|	V |	|	|
98+ 0	10.6359	1.94	Q	|	V |	|	|
98+ 5	10.6494	1.95	Q	|	V |	|	|
98+10	10.6628	1.96	Q	|	V |	|	|
98+15	10.6764	1.97	Q	|	V |	|	|
98+20	10.6900	1.97	Q	|	V |	|	|
98+25	10.7036	1.98	Q	|	V |	|	|
98+30	10.7174	1.99	Q	|	V |	|	|
98+35	10.7311	2.00	Q	|	V |	|	|
98+40	10.7450	2.01	Q	|	V |	|	|
98+45	10.7589	2.02	Q	|	V |	|	|
98+50	10.7729	2.03	Q	|	V |	|	|
98+55	10.7869	2.04	Q	|	V |	|	|
99+ 0	10.8010	2.05	Q	|	V |	|	|
99+ 5	10.8151	2.06	Q	|	V |	|	|
99+10	10.8293	2.07	Q	|	V |	|	|
99+15	10.8436	2.07	Q	|	V |	|	|
99+20	10.8580	2.08	Q	|	V |	|	|
99+25	10.8724	2.09	Q	|	V |	|	|
99+30	10.8869	2.10	Q	|	V |	|	|
99+35	10.9015	2.11	Q	|	V |	|	|
99+40	10.9161	2.12	Q	|	V |	|	|
99+45	10.9308	2.13	Q	|	V |	|	|
99+50	10.9455	2.14	Q	|	V |	|	|
99+55	10.9604	2.15	Q	|	V |	|	|
100+ 0	10.9753	2.17	Q	|	V |	|	|
100+ 5	10.9903	2.18	Q	|	V |	|	|
100+10	11.0054	2.19	Q	|	V |	|	|
100+15	11.0205	2.20	Q	|	V |	|	|
100+20	11.0357	2.21	Q	|	V |	|	|
100+25	11.0510	2.22	Q	|	V |	|	|
100+30	11.0664	2.23	Q	|	V |	|	|
100+35	11.0818	2.24	Q	|	V |	|	|
100+40	11.0974	2.26	Q	|	V |	|	|
100+45	11.1130	2.27	Q	|	V |	|	|
100+50	11.1287	2.28	Q	|	V |	|	|
100+55	11.1444	2.29	Q	|	V|	|	|
101+ 0	11.1603	2.30	Q	|	V|	|	|
101+ 5	11.1762	2.32	Q	|	V|	|	|
101+10	11.1923	2.33	Q	|	V|	|	|
101+15	11.2084	2.34	Q	|	V|	|	|
101+20	11.2246	2.35	Q	|	V|	|	|
101+25	11.2409	2.37	Q	|	V|	|	|
101+30	11.2573	2.38	Q	|	V|	|	|
101+35	11.2738	2.39	Q	|	V|	|	|
101+40	11.2904	2.41	Q	|	V|	|	|
101+45	11.3070	2.42	Q	|	V|	|	|
101+50	11.3238	2.44	Q	|	V|	|	|

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101+55      11.3407      2.45  Q          |         V|          |          |
102+ 0      11.3577      2.46  Q          |         V|          |          |
102+ 5      11.3747      2.48  Q          |         V|          |          |
102+10      11.3919      2.49  Q          |         V|          |          |
102+15      11.4092      2.51  Q          |         V|          |          |
102+20      11.4265      2.52  Q          |         V|          |          |
102+25      11.4440      2.54  Q          |         V|          |          |
102+30      11.4616      2.55  Q          |         V|          |          |
102+35      11.4793      2.57  Q          |         V|          |          |
102+40      11.4971      2.59  Q          |         V|          |          |
102+45      11.5151      2.60  Q          |         V|          |          |
102+50      11.5331      2.62  Q          |         V|          |          |
102+55      11.5513      2.64  Q          |         V|          |          |
103+ 0      11.5695      2.65  Q          |         V|          |          |
103+ 5      11.5879      2.67  Q          |         V|          |          |
103+10      11.6064      2.69  Q          |         V|          |          |
103+15      11.6251      2.71  Q          |         V|          |          |
103+20      11.6439      2.73  Q          |         V|          |          |
103+25      11.6627      2.74  Q          |         V|          |          |
103+30      11.6818      2.76  Q          |         V|          |          |
103+35      11.7009      2.78  Q          |         V|          |          |
103+40      11.7202      2.80  Q          |         V|          |          |
103+45      11.7396      2.82  Q          |          V          |          |
103+50      11.7592      2.84  Q          |          V          |          |
103+55      11.7789      2.86  Q          |          V          |          |
104+ 0      11.7988      2.88  Q          |          V          |          |
104+ 5      11.8188      2.90  Q          |          V          |          |
104+10      11.8389      2.93  Q          |          V          |          |
104+15      11.8592      2.95  Q          |          V          |          |
104+20      11.8797      2.97  Q          |          V          |          |
104+25      11.9003      2.99  Q          |          V          |          |
104+30      11.9210      3.02  Q          |          V          |          |
104+35      11.9420      3.04  Q          |          V          |          |
104+40      11.9631      3.06  Q          |          V          |          |
104+45      11.9843      3.09  Q          |          V          |          |
104+50      12.0058      3.11  Q          |          V          |          |
104+55      12.0274      3.14  Q          |          V          |          |
105+ 0      12.0492      3.17  Q          |          V          |          |
105+ 5      12.0712      3.19  Q          |          V          |          |
105+10      12.0933      3.22  Q          |          V          |          |
105+15      12.1157      3.25  Q          |          V          |          |
105+20      12.1382      3.27  Q          |          V          |          |
105+25      12.1610      3.30  Q          |          V          |          |
105+30      12.1839      3.33  Q          |          V          |          |
105+35      12.2071      3.36  Q          |          V          |          |
105+40      12.2305      3.39  Q          |          V          |          |
105+45      12.2541      3.42  Q          |          V          |          |
105+50      12.2779      3.46  Q          |          V          |          |
105+55      12.3019      3.49  Q          |          V          |          |
106+ 0      12.3262      3.52  Q          |          |V         |          |
106+ 5      12.3507      3.56  Q          |          |V         |          |
106+10      12.3754      3.59  Q          |          |V         |          |
106+15      12.4004      3.63  Q          |          |V         |          |
106+20      12.4257      3.67  Q          |          |V         |          |
106+25      12.4512      3.70  Q          |          |V         |          |
106+30      12.4769      3.74  Q          |          |V         |          |
106+35      12.5030      3.78  Q          |          |V         |          |
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106+40      12.5293      3.82  Q          |          |V         |          |
106+45      12.5559      3.86  Q          |          |V         |          |
106+50      12.5828      3.91  Q          |          |V         |          |
106+55      12.6100      3.95  Q          |          |V         |          |
107+ 0      12.6376      4.00  Q          |          |V         |          |
107+ 5      12.6654      4.04  Q          |          |V         |          |
107+10      12.6936      4.09  Q          |          |V         |          |
107+15      12.7221      4.14  Q          |          |V         |          |
107+20      12.7510      4.19  Q          |          |V         |          |
107+25      12.7802      4.24  Q          |          |V         |          |
107+30      12.8098      4.30  Q          |          |V         |          |
107+35      12.8397      4.35  Q          |          |V         |          |
107+40      12.8701      4.41  Q          |          |V         |          |
107+45      12.9009      4.47  Q          |          | V        |          |
107+50      12.9321      4.53  Q          |          | V        |          |
107+55      12.9637      4.59  Q          |          | V        |          |
108+ 0      12.9958      4.66  Q          |          | V        |          |
108+ 5      13.0280      4.68  Q          |          | V        |          |
108+10      13.0590      4.50  Q          |          | V        |          |
108+15      13.0892      4.39  Q          |          | V        |          |
108+20      13.1194      4.38  Q          |          | V        |          |
108+25      13.1498      4.41  Q          |          | V        |          |
108+30      13.1805      4.46  Q          |          | V        |          |
108+35      13.2115      4.51  Q          |          | V        |          |
108+40      13.2431      4.58  Q          |          | V        |          |
108+45      13.2751      4.65  Q          |          | V        |          |
108+50      13.3076      4.73  Q          |          | V        |          |
108+55      13.3408      4.81  Q          |          | V        |          |
109+ 0      13.3746      4.90  Q          |          | V        |          |
109+ 5      13.4090      5.00  Q          |          | V        |          |
109+10      13.4441      5.10  |Q         |          | V        |          |
109+15      13.4799      5.20  |Q         |          | V        |          |
109+20      13.5166      5.32  |Q         |          |  V       |          |
109+25      13.5540      5.44  |Q         |          |  V       |          |
109+30      13.5924      5.57  |Q         |          |  V       |          |
109+35      13.6316      5.69  |Q         |          |  V       |          |
109+40      13.6718      5.84  |Q         |          |  V       |          |
109+45      13.7130      5.98  |Q         |          |  V       |          |
109+50      13.7553      6.14  |Q         |          |  V       |          |
109+55      13.7987      6.30  |Q         |          |  V       |          |
110+ 0      13.8434      6.49  |Q         |          |  V       |          |
110+ 5      13.8894      6.67  |Q         |          |  V       |          |
110+10      13.9369      6.90  |Q         |          |  V       |          |
110+15      13.9859      7.12  |Q         |          |  V       |          |
110+20      14.0367      7.37  |Q         |          |  V       |          |
110+25      14.0892      7.62  |Q         |          |   V      |          |
110+30      14.1437      7.91  |Q         |          |   V      |          |
110+35      14.2001      8.20  |Q         |          |   V      |          |
110+40      14.2590      8.54  |Q         |          |   V      |          |
110+45      14.3201      8.89  |Q         |          |   V      |          |
110+50      14.3842      9.30  |Q         |          |   V      |          |
110+55      14.4512      9.73  |Q         |          |   V      |          |
111+ 0      14.5218     10.25  | Q        |          |   V      |          |
111+ 5      14.5960     10.78  | Q        |          |   V      |          |
111+10      14.6748     11.44  | Q        |          |    V     |          |
111+15      14.7584     12.14  | Q        |          |    V     |          |
111+20      14.8482     13.03  | Q        |          |    V     |          |
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111+25      14.9462     14.24  | Q       |         |    V    |         |
111+30      15.0643     17.14  |  Q      |         |    V    |         |
111+35      15.2006     19.79  |  Q      |         |    V    |         |
111+40      15.3558     22.53  |   Q     |         |     V   |         |
111+45      15.5318     25.57  |    Q    |         |     V   |         |
111+50      15.7397     30.19  |     Q   |         |     V   |         |
111+55      15.9907     36.44  |      Q  |         |      V  |         |
112+ 0      16.3317     49.51  |        Q|         |      V  |         |
112+ 5      16.9303     86.92  |         |      Q  |       V |         |
112+10      18.2806    196.06  |         |         |         |V       Q|
112+15      19.3082    149.21  |         |         |        Q| V       |
112+20      19.8971     85.51  |         |      Q  |         |  V      |
112+25      20.3081     59.67  |         |Q        |         |   V     |
112+30      20.6058     43.24  |       Q |         |         |    V    |
112+35      20.8329     32.97  |     Q   |         |         |    V    |
112+40      21.0125     26.08  |    Q    |         |         |    V    |
112+45      21.1571     20.99  |   Q     |         |         |     V   |
112+50      21.2724     16.75  |  Q      |         |         |     V   |
112+55      21.3725     14.54  | Q       |         |         |     V   |
113+ 0      21.4623     13.04  | Q       |         |         |     V   |
113+ 5      21.5390     11.13  | Q       |         |         |     V   |
113+10      21.5968      8.39  |Q        |         |         |     V   |
113+15      21.6494      7.63  |Q        |         |         |     V   |
113+20      21.6980      7.06  |Q        |         |         |      V  |
113+25      21.7434      6.59  |Q        |         |         |      V  |
113+30      21.7862      6.22  |Q        |         |         |      V  |
113+35      21.8268      5.89  |Q        |         |         |      V  |
113+40      21.8654      5.61  |Q        |         |         |      V  |
113+45      21.9023      5.35  |Q        |         |         |      V  |
113+50      21.9376      5.12  |Q        |         |         |      V  |
113+55      21.9715      4.92  Q         |         |         |      V  |
114+ 0      22.0040      4.73  Q         |         |         |      V  |
114+ 5      22.0357      4.60  Q         |         |         |      V  |
114+10      22.0680      4.69  Q         |         |         |      V  |
114+15      22.1005      4.72  Q         |         |         |      V  |
114+20      22.1326      4.65  Q         |         |         |      V  |
114+25      22.1640      4.56  Q         |         |         |      V  |
114+30      22.1947      4.46  Q         |         |         |      V  |
114+35      22.2248      4.37  Q         |         |         |      V  |
114+40      22.2542      4.27  Q         |         |         |      V  |
114+45      22.2829      4.17  Q         |         |         |       V |
114+50      22.3110      4.08  Q         |         |         |       V |
114+55      22.3384      3.99  Q         |         |         |       V |
115+ 0      22.3653      3.90  Q         |         |         |       V |
115+ 5      22.3916      3.82  Q         |         |         |       V |
115+10      22.4174      3.74  Q         |         |         |       V |
115+15      22.4426      3.66  Q         |         |         |       V |
115+20      22.4674      3.59  Q         |         |         |       V |
115+25      22.4916      3.52  Q         |         |         |       V |
115+30      22.5154      3.45  Q         |         |         |       V |
115+35      22.5388      3.39  Q         |         |         |       V |
115+40      22.5617      3.33  Q         |         |         |       V |
115+45      22.5842      3.27  Q         |         |         |       V |
115+50      22.6064      3.22  Q         |         |         |       V |
115+55      22.6282      3.16  Q         |         |         |       V |
116+ 0      22.6496      3.11  Q         |         |         |       V |
116+ 5      22.6707      3.06  Q         |         |         |       V |
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116+10	22.6914	3.01	Q	|	|	|	V |
116+15	22.7119	2.97	Q	|	|	|	V |
116+20	22.7320	2.92	Q	|	|	|	V |
116+25	22.7518	2.88	Q	|	|	|	V |
116+30	22.7714	2.84	Q	|	|	|	V |
116+35	22.7906	2.80	Q	|	|	|	V |
116+40	22.8096	2.76	Q	|	|	|	V |
116+45	22.8284	2.72	Q	|	|	|	V |
116+50	22.8469	2.69	Q	|	|	|	V |
116+55	22.8652	2.65	Q	|	|	|	V|
117+ 0	22.8832	2.62	Q	|	|	|	V|
117+ 5	22.9010	2.58	Q	|	|	|	V|
117+10	22.9186	2.55	Q	|	|	|	V|
117+15	22.9359	2.52	Q	|	|	|	V|
117+20	22.9531	2.49	Q	|	|	|	V|
117+25	22.9700	2.46	Q	|	|	|	V|
117+30	22.9868	2.43	Q	|	|	|	V|
117+35	23.0034	2.41	Q	|	|	|	V|
117+40	23.0197	2.38	Q	|	|	|	V|
117+45	23.0359	2.35	Q	|	|	|	V|
117+50	23.0520	2.33	Q	|	|	|	V|
117+55	23.0678	2.30	Q	|	|	|	V|
118+ 0	23.0835	2.28	Q	|	|	|	V|
118+ 5	23.0990	2.25	Q	|	|	|	V|
118+10	23.1144	2.23	Q	|	|	|	V|
118+15	23.1296	2.21	Q	|	|	|	V|
118+20	23.1446	2.19	Q	|	|	|	V|
118+25	23.1595	2.16	Q	|	|	|	V|
118+30	23.1743	2.14	Q	|	|	|	V|
118+35	23.1889	2.12	Q	|	|	|	V|
118+40	23.2034	2.10	Q	|	|	|	V|
118+45	23.2177	2.08	Q	|	|	|	V|
118+50	23.2319	2.06	Q	|	|	|	V|
118+55	23.2460	2.04	Q	|	|	|	V|
119+ 0	23.2600	2.03	Q	|	|	|	V|
119+ 5	23.2738	2.01	Q	|	|	|	V|
119+10	23.2875	1.99	Q	|	|	|	V|
119+15	23.3011	1.97	Q	|	|	|	V|
119+20	23.3146	1.96	Q	|	|	|	V|
119+25	23.3279	1.94	Q	|	|	|	V|
119+30	23.3412	1.92	Q	|	|	|	V|
119+35	23.3543	1.91	Q	|	|	|	V|
119+40	23.3673	1.89	Q	|	|	|	V|
119+45	23.3803	1.88	Q	|	|	|	V|
119+50	23.3931	1.86	Q	|	|	|	V|
119+55	23.4058	1.85	Q	|	|	|	V|
120+ 0	23.4184	1.83	Q	|	|	|	V|
120+ 5	23.4302	1.71	Q	|	|	|	V|
120+10	23.4374	1.04	Q	|	|	|	V|
120+15	23.4413	0.57	Q	|	|	|	V|
120+20	23.4438	0.36	Q	|	|	|	V|
120+25	23.4455	0.24	Q	|	|	|	V|
120+30	23.4467	0.17	Q	|	|	|	V|
120+35	23.4474	0.11	Q	|	|	|	V|
120+40	23.4480	0.08	Q	|	|	|	V|
120+45	23.4483	0.05	Q	|	|	|	V|
120+50	23.4485	0.03	Q	|	|	|	V|

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  120+55      23.4487      0.02  Q         |         |         |        V|
  121+ 0      23.4487      0.01  Q         |         |         |        V|
----------------------------------------------------------------------
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ATTACHMENT 8

Existing Conditions
Hydrograph Calculations
(10-Year, 6-Hour),
Spillway Sizing Calculations,
USGS “Sediment Yield and Runoff
Frequency of Small Drainage Basins in the
Mojave Desert, California and Nevada”
Fact Sheet 2006-3007
&
California Stormwater Quality Association
(CASQA)
Best Management Handbook
Sediment Control Handouts

U n i t H y d r o g r a p h A n a l y s i s

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Study date 09/02/15

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San Bernardino County Synthetic Unit Hydrology Method
Manual date - August 1986

Program License Serial Number 6320

154166 - AMBOY - SAN BERNARDINO COUNTY
EXISTING CONDITION "A"
10-YEAR, 6-HOUR STORM
BY: JTS DATE: 04-10-15

Storm Event Year = 10

Antecedent Moisture Condition = 1

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

English Units used in output format

Area averaged rainfall intensity isohyetal data:

Sub-Area (Ac.)	Duration (hours)	Isohyetal (In)
Rainfall data for year 10		
69.49	1	0.86
Rainfall data for year 2		
69.49	6	0.75
Rainfall data for year 2		
69.49	24	1.07
Rainfall data for year 100		
69.49	1	1.59
Rainfall data for year 100		
69.49	6	2.43
Rainfall data for year 100		
69.49	24	3.56

++

******** Area-averaged max loss rate, Fm ********

SCS curve No.(AMCII)	SCS curve NO.(AMC 1)	Area (Ac.)	Area Fraction	Fp(Fig C6) (In/Hr)	Ap (dec.)	Fm (In/Hr)
91.0	79.8	69.49	1.000	0.373	1.000	0.373

Area-averaged adjusted loss rate Fm (In/Hr) = 0.373

********* Area-Averaged low loss rate fraction, Yb **********

Area (Ac.)	Area Fract	SCS CN (AMC2)	SCS CN (AMC1)	S	Pervious Yield Fr
69.49	1.000	91.0	79.8	2.53	0.292

Area-averaged catchment yield fraction, Y = 0.292
Area-averaged low loss fraction, Yb = 0.708
User entry of time of concentration = 0.220 (hours)
++
Watershed area = 69.49(Ac.)
Catchment Lag time = 0.176 hours
Unit interval = 5.000 minutes
Unit interval percentage of lag time = 47.3485
Hydrograph baseflow = 0.00(CFS)
Average maximum watershed loss rate(Fm) = 0.373(In/Hr)
Average low loss rate fraction (Yb) = 0.708 (decimal)
DESERT S-Graph Selected
Computed peak 5-minute rainfall = 0.408(In)
Computed peak 30-minute rainfall = 0.699(In)
Specified peak 1-hour rainfall = 0.860(In)
Computed peak 3-hour rainfall = 1.180(In)
Specified peak 6-hour rainfall = 1.441(In)
Specified peak 24-hour rainfall = 2.094(In)

Rainfall depth area reduction factors:
Using a total area of 69.49(Ac.) (Ref: fig. E-4)

5-minute factor = 0.997 Adjusted rainfall = 0.407(In)
30-minute factor = 0.997 Adjusted rainfall = 0.696(In)
1-hour factor = 0.997 Adjusted rainfall = 0.857(In)
3-hour factor = 1.000 Adjusted rainfall = 1.180(In)
6-hour factor = 1.000 Adjusted rainfall = 1.441(In)
24-hour factor = 1.000 Adjusted rainfall = 2.094(In)

U n i t H y d r o g r a p h
++

Interval Number	'S' Graph Mean values	Unit Hydrograph ((CFS))
	(K = 840.39 (CFS))	
1	3.621	30.434
2	27.374	199.619
3	58.032	257.648
4	71.898	116.529
5	79.947	67.643
6	85.264	44.679
7	89.111	32.329
8	91.816	22.733
9	93.936	17.820
10	95.547	13.537
11	96.789	10.442
12	97.673	7.427
13	98.224	4.626

14	98.770	4.595
15	99.332	4.722
16	99.712	3.190
17	100.000	2.421

Peak Unit Number	Adjusted mass rainfall (In)	Unit rainfall (In)
1	0.4067	0.4067
2	0.5008	0.0940
3	0.5655	0.0648
4	0.6165	0.0510
5	0.6592	0.0427
6	0.6963	0.0371
7	0.7292	0.0330
8	0.7590	0.0298
9	0.7863	0.0273
10	0.8116	0.0253
11	0.8351	0.0235
12	0.8572	0.0221
13	0.8774	0.0202
14	0.8965	0.0191
15	0.9147	0.0182
16	0.9320	0.0173
17	0.9485	0.0166
18	0.9644	0.0159
19	0.9797	0.0153
20	0.9944	0.0147
21	1.0087	0.0142
22	1.0224	0.0137
23	1.0357	0.0133
24	1.0486	0.0129
25	1.0611	0.0125
26	1.0733	0.0122
27	1.0851	0.0118
28	1.0966	0.0115
29	1.1079	0.0112
30	1.1189	0.0110
31	1.1296	0.0107
32	1.1401	0.0105
33	1.1503	0.0102
34	1.1603	0.0100
35	1.1701	0.0098
36	1.1798	0.0096
37	1.1891	0.0094
38	1.1983	0.0092
39	1.2073	0.0090
40	1.2162	0.0088
41	1.2249	0.0087
42	1.2334	0.0085
43	1.2418	0.0084
44	1.2501	0.0083
45	1.2582	0.0081
46	1.2662	0.0080
47	1.2741	0.0079
48	1.2818	0.0078
49	1.2895	0.0076
50	1.2970	0.0075
51	1.3044	0.0074
52	1.3118	0.0073
53	1.3190	0.0072
54	1.3261	0.0071
55	1.3332	0.0070
56	1.3401	0.0069

57	1.3470	0.0069
58	1.3537	0.0068
59	1.3604	0.0067
60	1.3670	0.0066
61	1.3736	0.0065
62	1.3800	0.0065
63	1.3864	0.0064
64	1.3927	0.0063
65	1.3990	0.0062
66	1.4051	0.0062
67	1.4113	0.0061
68	1.4173	0.0060
69	1.4233	0.0060
70	1.4292	0.0059
71	1.4351	0.0059
72	1.4409	0.0058

Unit Period (number)	Unit Rainfall (In)	Unit Soil-Loss (In)	Effective Rainfall (In)
1	0.0058	0.0041	0.0017
2	0.0059	0.0041	0.0017
3	0.0060	0.0042	0.0017
4	0.0060	0.0043	0.0018
5	0.0062	0.0044	0.0018
6	0.0062	0.0044	0.0018
7	0.0064	0.0045	0.0019
8	0.0065	0.0046	0.0019
9	0.0066	0.0047	0.0019
10	0.0067	0.0047	0.0020
11	0.0069	0.0049	0.0020
12	0.0069	0.0049	0.0020
13	0.0071	0.0050	0.0021
14	0.0072	0.0051	0.0021
15	0.0074	0.0053	0.0022
16	0.0075	0.0053	0.0022
17	0.0078	0.0055	0.0023
18	0.0079	0.0056	0.0023
19	0.0081	0.0058	0.0024
20	0.0083	0.0058	0.0024
21	0.0085	0.0060	0.0025
22	0.0087	0.0062	0.0025
23	0.0090	0.0064	0.0026
24	0.0092	0.0065	0.0027
25	0.0096	0.0068	0.0028
26	0.0098	0.0069	0.0029
27	0.0102	0.0073	0.0030
28	0.0105	0.0074	0.0031
29	0.0110	0.0078	0.0032
30	0.0112	0.0080	0.0033
31	0.0118	0.0084	0.0035
32	0.0122	0.0086	0.0036
33	0.0129	0.0091	0.0038
34	0.0133	0.0094	0.0039
35	0.0142	0.0101	0.0042
36	0.0147	0.0104	0.0043
37	0.0159	0.0112	0.0046
38	0.0166	0.0117	0.0048
39	0.0182	0.0129	0.0053
40	0.0191	0.0135	0.0056
41	0.0221	0.0156	0.0065
42	0.0235	0.0167	0.0069

43	0.0273	0.0193	0.0080
44	0.0298	0.0211	0.0087
45	0.0371	0.0262	0.0108
46	0.0427	0.0302	0.0125
47	0.0648	0.0311	0.0337
48	0.0940	0.0311	0.0629
49	0.4067	0.0311	0.3757
50	0.0510	0.0311	0.0199
51	0.0330	0.0233	0.0096
52	0.0253	0.0179	0.0074
53	0.0202	0.0143	0.0059
54	0.0173	0.0123	0.0051
55	0.0153	0.0108	0.0045
56	0.0137	0.0097	0.0040
57	0.0125	0.0089	0.0037
58	0.0115	0.0082	0.0034
59	0.0107	0.0076	0.0031
60	0.0100	0.0071	0.0029
61	0.0094	0.0066	0.0027
62	0.0088	0.0063	0.0026
63	0.0084	0.0059	0.0025
64	0.0080	0.0057	0.0023
65	0.0076	0.0054	0.0022
66	0.0073	0.0052	0.0021
67	0.0070	0.0050	0.0021
68	0.0068	0.0048	0.0020
69	0.0065	0.0046	0.0019
70	0.0063	0.0045	0.0018
71	0.0061	0.0043	0.0018
72	0.0059	0.0042	0.0017

Total soil rain loss = 0.71(In)
Total effective rainfall = 0.73(In)
Peak flow rate in flood hydrograph = 112.20(CFS)

++

6 - H O U R S T O R M
R u n o f f H y d r o g r a p h

Hydrograph in 5 Minute intervals ((CFS))

```
Time(h+m) Volume Ac.Ft   Q(CFS)  0       50.0     100.0     150.0     200.0
-------------------------------------------------------------------------
  0+ 5       0.0004      0.05  Q         |         |         |         |
  0+10       0.0030      0.39  Q         |         |         |         |
  0+15       0.0088      0.83  Q         |         |         |         |
  0+20       0.0159      1.04  Q         |         |         |         |
  0+25       0.0240      1.17  Q         |         |         |         |
  0+30       0.0327      1.27  Q         |         |         |         |
  0+35       0.0420      1.34  Q         |         |         |         |
  0+40       0.0516      1.40  Q         |         |         |         |
  0+45       0.0617      1.46  Q         |         |         |         |
  0+50       0.0720      1.50  Q         |         |         |         |
  0+55       0.0827      1.55  Q         |         |         |         |
  1+ 0       0.0936      1.59  Q         |         |         |         |
  1+ 5       0.1048      1.63  Q         |         |         |         |
  1+10       0.1163      1.66  QV        |         |         |         |
  1+15       0.1280      1.70  QV        |         |         |         |
  1+20       0.1400      1.74  QV        |         |         |         |
  1+25       0.1523      1.78  QV        |         |         |         |
  1+30       0.1648      1.82  QV        |         |         |         |
```

```
1+35        0.1776       1.86  QV         |          |          |          |
1+40        0.1907       1.90  QV         |          |          |          |
1+45        0.2041       1.95  QV         |          |          |          |
1+50        0.2178       1.99  Q V        |          |          |          |
1+55        0.2319       2.04  Q V        |          |          |          |
2+ 0        0.2463       2.09  Q V        |          |          |          |
2+ 5        0.2611       2.15  Q V        |          |          |          |
2+10        0.2764       2.21  Q V        |          |          |          |
2+15        0.2921       2.28  Q V        |          |          |          |
2+20        0.3083       2.35  Q V        |          |          |          |
2+25        0.3250       2.43  Q  V       |          |          |          |
2+30        0.3423       2.51  Q  V       |          |          |          |
2+35        0.3602       2.60  Q  V       |          |          |          |
2+40        0.3788       2.69  Q  V       |          |          |          |
2+45        0.3980       2.80  Q  V       |          |          |          |
2+50        0.4180       2.91  Q  V       |          |          |          |
2+55        0.4389       3.03  Q   V      |          |          |          |
3+ 0        0.4608       3.17  Q   V      |          |          |          |
3+ 5        0.4837       3.33  Q   V      |          |          |          |
3+10        0.5078       3.50  Q   V      |          |          |          |
3+15        0.5333       3.70  Q    V     |          |          |          |
3+20        0.5604       3.93  Q    V     |          |          |          |
3+25        0.5894       4.21  Q    V     |          |          |          |
3+30        0.6208       4.57  Q    V     |          |          |          |
3+35        0.6554       5.01  |Q    V     |          |          |          |
3+40        0.6934       5.53  |Q    V     |          |          |          |
3+45        0.7360       6.18  |Q    V     |          |          |          |
3+50        0.7846       7.07  |Q     V    |          |          |          |
3+55        0.8454       8.82  |Q     V    |          |          |          |
4+ 0        0.9471      14.76  | Q     V   |          |          |          |
4+ 5        1.1952      36.02  |       Q   |V         |          |          |
4+10        1.8695      97.91  |           |      V Q|          |          |
4+15        2.6422     112.20  |           |          | Q V      |          |
4+20        3.0412      57.94  |           |Q         |        V |          |
4+25        3.2933      36.60  |       Q   |          |          |V         |
4+30        3.4718      25.92  |     Q     |          |          | V        |
4+35        3.6076      19.72  |   Q       |          |          |   V      |
4+40        3.7112      15.05  |   Q       |          |          |   V      |
4+45        3.7960      12.30  | Q         |          |          |    V     |
4+50        3.8647       9.99  |Q          |          |          |     V    |
4+55        3.9213       8.21  |Q          |          |          |     V    |
5+ 0        3.9667       6.60  |Q          |          |          |      V   |
5+ 5        4.0030       5.26  |Q          |          |          |      V   |
5+10        4.0370       4.94  Q           |          |          |       V  |
5+15        4.0691       4.67  Q           |          |          |       V  |
5+20        4.0955       3.83  Q           |          |          |       V  |
5+25        4.1178       3.25  Q           |          |          |       V  |
5+30        4.1331       2.21  Q           |          |          |       V  |
5+35        4.1473       2.06  Q           |          |          |        V|
5+40        4.1607       1.95  Q           |          |          |        V|
5+45        4.1735       1.86  Q           |          |          |        V|
5+50        4.1858       1.78  Q           |          |          |        V|
5+55        4.1975       1.71  Q           |          |          |        V|
6+ 0        4.2088       1.64  Q           |          |          |        V|
6+ 5        4.2194       1.53  Q           |          |          |        V|
6+10        4.2272       1.14  Q           |          |          |        V|
6+15        4.2319       0.67  Q           |          |          |        V|
6+20        4.2350       0.45  Q           |          |          |        V|
6+25        4.2372       0.32  Q           |          |          |        V|
6+30        4.2388       0.24  Q           |          |          |        V|
6+35        4.2400       0.17  Q           |          |          |        V|
6+40        4.2409       0.13  Q           |          |          |        V|
6+45        4.2416       0.10  Q           |          |          |        V|
```

```
    6+50       4.2421      0.07  Q          |          |          |         V|
    6+55       4.2424      0.05  Q          |          |          |         V|
    7+ 0       4.2427      0.04  Q          |          |          |         V|
    7+ 5       4.2428      0.03  Q          |          |          |         V|
    7+10       4.2430      0.02  Q          |          |          |         V|
    7+15       4.2430      0.01  Q          |          |          |         V|
    7+20       4.2431      0.00  Q          |          |          |          V
-----------------------------------------------------------------------
```

U n i t H y d r o g r a p h A n a l y s i s

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Study date 09/02/15

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San Bernardino County Synthetic Unit Hydrology Method
Manual date - August 1986

Program License Serial Number 6320

154166 - AMBOY - SAN BERNARDINO COUNTY
EXISTING CONDITIONS "B"
10-YEAR, 6-HOUR STORM
BY: JTS DATE: 04-13-15

Storm Event Year = 10

Antecedent Moisture Condition = 1

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

English Units used in output format

Area averaged rainfall intensity isohyetal data:

Sub-Area (Ac.)	Duration (hours)	Isohyetal (In)
Rainfall data for year 10		
91.36	1	0.86
Rainfall data for year 2		
91.36	6	0.75
Rainfall data for year 2		
91.36	24	1.07
Rainfall data for year 100		
91.36	1	1.59
Rainfall data for year 100		
91.36	6	2.43
Rainfall data for year 100		
91.36	24	3.56

++

******** Area-averaged max loss rate, Fm ********

SCS curve No.(AMCII)	SCS curve NO.(AMC 1)	Area (Ac.)	Area Fraction	Fp(Fig C6) (In/Hr)	Ap (dec.)	Fm (In/Hr)
91.0	79.8	91.36	1.000	0.373	1.000	0.373

Area-averaged adjusted loss rate Fm (In/Hr) = 0.373

********* Area-Averaged low loss rate fraction, Yb **********

Area (Ac.)	Area Fract	SCS CN (AMC2)	SCS CN (AMC1)	S	Pervious Yield Fr
91.36	1.000	91.0	79.8	2.53	0.292

Area-averaged catchment yield fraction, Y = 0.292
Area-averaged low loss fraction, Yb = 0.708
User entry of time of concentration = 0.230 (hours)
++
Watershed area = 91.36(Ac.)
Catchment Lag time = 0.184 hours
Unit interval = 5.000 minutes
Unit interval percentage of lag time = 45.2899
Hydrograph baseflow = 0.00(CFS)
Average maximum watershed loss rate(Fm) = 0.373(In/Hr)
Average low loss rate fraction (Yb) = 0.708 (decimal)
DESERT S-Graph Selected
Computed peak 5-minute rainfall = 0.408(In)
Computed peak 30-minute rainfall = 0.699(In)
Specified peak 1-hour rainfall = 0.860(In)
Computed peak 3-hour rainfall = 1.180(In)
Specified peak 6-hour rainfall = 1.441(In)
Specified peak 24-hour rainfall = 2.094(In)

Rainfall depth area reduction factors:
Using a total area of 91.36(Ac.) (Ref: fig. E-4)

5-minute factor = 0.996 Adjusted rainfall = 0.406(In)
30-minute factor = 0.996 Adjusted rainfall = 0.696(In)
1-hour factor = 0.996 Adjusted rainfall = 0.856(In)
3-hour factor = 0.999 Adjusted rainfall = 1.180(In)
6-hour factor = 1.000 Adjusted rainfall = 1.441(In)
24-hour factor = 1.000 Adjusted rainfall = 2.094(In)

U n i t H y d r o g r a p h
++

Interval Number	'S' Graph Mean values	Unit Hydrograph ((CFS))
	(K = 1104.88 (CFS))	
1	3.365	37.178
2	24.923	238.187
3	55.845	341.662
4	70.325	159.988
5	78.657	92.055
6	84.140	60.576
7	88.185	44.695
8	91.006	31.166
9	93.225	24.522
10	94.928	18.816
11	96.264	14.764
12	97.275	11.166
13	97.957	7.544

14	98.440	5.328
15	98.980	5.974
16	99.485	5.579
17	99.796	3.427
18	100.000	2.259

Peak Unit Number	Adjusted mass rainfall (In)	Unit rainfall (In)
1	0.4063	0.4063
2	0.5003	0.0939
3	0.5650	0.0647
4	0.6159	0.0509
5	0.6585	0.0426
6	0.6955	0.0370
7	0.7285	0.0329
8	0.7582	0.0298
9	0.7855	0.0273
10	0.8107	0.0252
11	0.8343	0.0235
12	0.8563	0.0221
13	0.8765	0.0202
14	0.8957	0.0191
15	0.9139	0.0182
16	0.9312	0.0174
17	0.9478	0.0166
18	0.9638	0.0159
19	0.9791	0.0153
20	0.9938	0.0148
21	1.0081	0.0142
22	1.0218	0.0138
23	1.0352	0.0133
24	1.0481	0.0129
25	1.0606	0.0125
26	1.0728	0.0122
27	1.0847	0.0119
28	1.0963	0.0116
29	1.1075	0.0113
30	1.1185	0.0110
31	1.1293	0.0107
32	1.1398	0.0105
33	1.1501	0.0103
34	1.1601	0.0101
35	1.1700	0.0098
36	1.1796	0.0096
37	1.1890	0.0094
38	1.1982	0.0092
39	1.2072	0.0090
40	1.2160	0.0088
41	1.2247	0.0087
42	1.2333	0.0085
43	1.2417	0.0084
44	1.2499	0.0083
45	1.2581	0.0081
46	1.2661	0.0080
47	1.2739	0.0079
48	1.2817	0.0078
49	1.2893	0.0076
50	1.2969	0.0075
51	1.3043	0.0074
52	1.3116	0.0073
53	1.3189	0.0072
54	1.3260	0.0071
55	1.3330	0.0070

56	1.3400	0.0069
57	1.3468	0.0069
58	1.3536	0.0068
59	1.3603	0.0067
60	1.3669	0.0066
61	1.3735	0.0065
62	1.3799	0.0065
63	1.3863	0.0064
64	1.3926	0.0063
65	1.3989	0.0062
66	1.4050	0.0062
67	1.4111	0.0061
68	1.4172	0.0060
69	1.4232	0.0060
70	1.4291	0.0059
71	1.4350	0.0059
72	1.4408	0.0058

Unit Period (number)	Unit Rainfall (In)	Unit Soil-Loss (In)	Effective Rainfall (In)
1	0.0058	0.0041	0.0017
2	0.0059	0.0041	0.0017
3	0.0060	0.0042	0.0017
4	0.0060	0.0043	0.0018
5	0.0062	0.0044	0.0018
6	0.0062	0.0044	0.0018
7	0.0064	0.0045	0.0019
8	0.0065	0.0046	0.0019
9	0.0066	0.0047	0.0019
10	0.0067	0.0047	0.0020
11	0.0069	0.0049	0.0020
12	0.0069	0.0049	0.0020
13	0.0071	0.0050	0.0021
14	0.0072	0.0051	0.0021
15	0.0074	0.0053	0.0022
16	0.0075	0.0053	0.0022
17	0.0078	0.0055	0.0023
18	0.0079	0.0056	0.0023
19	0.0081	0.0058	0.0024
20	0.0083	0.0058	0.0024
21	0.0085	0.0060	0.0025
22	0.0087	0.0062	0.0025
23	0.0090	0.0064	0.0026
24	0.0092	0.0065	0.0027
25	0.0096	0.0068	0.0028
26	0.0098	0.0070	0.0029
27	0.0103	0.0073	0.0030
28	0.0105	0.0074	0.0031
29	0.0110	0.0078	0.0032
30	0.0113	0.0080	0.0033
31	0.0119	0.0084	0.0035
32	0.0122	0.0086	0.0036
33	0.0129	0.0091	0.0038
34	0.0133	0.0094	0.0039
35	0.0142	0.0101	0.0042
36	0.0148	0.0104	0.0043
37	0.0159	0.0113	0.0047
38	0.0166	0.0118	0.0049
39	0.0182	0.0129	0.0053
40	0.0191	0.0135	0.0056
41	0.0221	0.0156	0.0064

42	0.0235	0.0166	0.0069
43	0.0273	0.0193	0.0080
44	0.0298	0.0211	0.0087
45	0.0370	0.0262	0.0108
46	0.0426	0.0302	0.0125
47	0.0647	0.0311	0.0336
48	0.0939	0.0311	0.0628
49	0.4063	0.0311	0.3752
50	0.0509	0.0311	0.0198
51	0.0329	0.0233	0.0096
52	0.0252	0.0179	0.0074
53	0.0202	0.0143	0.0059
54	0.0174	0.0123	0.0051
55	0.0153	0.0108	0.0045
56	0.0138	0.0097	0.0040
57	0.0125	0.0089	0.0037
58	0.0116	0.0082	0.0034
59	0.0107	0.0076	0.0031
60	0.0101	0.0071	0.0029
61	0.0094	0.0066	0.0027
62	0.0088	0.0063	0.0026
63	0.0084	0.0059	0.0025
64	0.0080	0.0057	0.0023
65	0.0076	0.0054	0.0022
66	0.0073	0.0052	0.0021
67	0.0070	0.0050	0.0021
68	0.0068	0.0048	0.0020
69	0.0065	0.0046	0.0019
70	0.0063	0.0045	0.0018
71	0.0061	0.0043	0.0018
72	0.0059	0.0042	0.0017

Total soil rain loss = 0.71(In)
Total effective rainfall = 0.73(In)
Peak flow rate in flood hydrograph = 148.56(CFS)

++

6 - H O U R S T O R M
R u n o f f H y d r o g r a p h

Hydrograph in 5 Minute intervals ((CFS))

```
Time(h+m) Volume Ac.Ft   Q(CFS)  0       50.0     100.0     150.0     200.0
-------------------------------------------------------------------------
  0+ 5       0.0004      0.06  Q         |         |         |         |
  0+10       0.0037      0.47  Q         |         |         |         |
  0+15       0.0109      1.05  Q         |         |         |         |
  0+20       0.0201      1.34  Q         |         |         |         |
  0+25       0.0306      1.52  Q         |         |         |         |
  0+30       0.0419      1.64  Q         |         |         |         |
  0+35       0.0539      1.74  Q         |         |         |         |
  0+40       0.0665      1.83  Q         |         |         |         |
  0+45       0.0795      1.90  Q         |         |         |         |
  0+50       0.0930      1.96  Q         |         |         |         |
  0+55       0.1070      2.02  Q         |         |         |         |
  1+ 0       0.1212      2.08  Q         |         |         |         |
  1+ 5       0.1359      2.13  Q         |         |         |         |
  1+10       0.1509      2.18  QV        |         |         |         |
  1+15       0.1662      2.23  QV        |         |         |         |
  1+20       0.1819      2.28  QV        |         |         |         |
  1+25       0.1980      2.33  QV        |         |         |         |
```

```
1+30        0.2145       2.39  QV         |          |          |          |
1+35        0.2313       2.44  QV         |          |          |          |
1+40        0.2484       2.49  QV         |          |          |          |
1+45        0.2660       2.55  QV         |          |          |          |
1+50        0.2840       2.61  Q V        |          |          |          |
1+55        0.3024       2.68  Q V        |          |          |          |
2+ 0        0.3213       2.74  Q V        |          |          |          |
2+ 5        0.3407       2.82  Q V        |          |          |          |
2+10        0.3607       2.90  Q V        |          |          |          |
2+15        0.3814       3.00  Q V        |          |          |          |
2+20        0.4026       3.09  Q V        |          |          |          |
2+25        0.4246       3.19  Q  V       |          |          |          |
2+30        0.4473       3.29  Q  V       |          |          |          |
2+35        0.4708       3.41  Q  V       |          |          |          |
2+40        0.4951       3.53  Q  V       |          |          |          |
2+45        0.5203       3.67  Q  V       |          |          |          |
2+50        0.5466       3.81  Q  V       |          |          |          |
2+55        0.5740       3.98  Q   V      |          |          |          |
3+ 0        0.6026       4.16  Q   V      |          |          |          |
3+ 5        0.6326       4.36  Q   V      |          |          |          |
3+10        0.6642       4.59  Q   V      |          |          |          |
3+15        0.6976       4.85  Q    V     |          |          |          |
3+20        0.7330       5.14  |Q   V     |          |          |          |
3+25        0.7709       5.50  |Q   V     |          |          |          |
3+30        0.8120       5.96  |Q   V     |          |          |          |
3+35        0.8569       6.53  |Q    V    |          |          |          |
3+40        0.9064       7.19  |Q    V    |          |          |          |
3+45        0.9617       8.03  |Q    V    |          |          |          |
3+50        1.0247       9.16  |Q     V   |          |          |          |
3+55        1.1031      11.37  | Q    V   |          |          |          |
4+ 0        1.2312      18.60  |  Q    V  |          |          |          |
4+ 5        1.5412      45.01  |         Q|V         |          |          |
4+10        2.3673     119.96  |          |     V    |  Q       |          |
4+15        3.3905     148.56  |          |          |   V    Q|          |
4+20        3.9330      78.77  |          |    Q     |        V |          |
4+25        4.2736      49.46  |         Q|          |          V          |
4+30        4.5144      34.97  |      Q   |          |          | V        |
4+35        4.6997      26.90  |    Q     |          |          |  V       |
4+40        4.8404      20.43  |   Q      |          |          |   V      |
4+45        4.9557      16.74  |  Q       |          |          |    V     |
4+50        5.0500      13.68  | Q        |          |          |     V    |
4+55        5.1282      11.36  | Q        |          |          |     V    |
5+ 0        5.1925       9.33  |Q         |          |          |      V   |
5+ 5        5.2441       7.49  |Q         |          |          |      V   |
5+10        5.2877       6.34  |Q         |          |          |      V   |
5+15        5.3303       6.18  |Q         |          |          |       V  |
5+20        5.3693       5.65  |Q         |          |          |       V  |
5+25        5.4005       4.54  Q          |          |          |       V  |
5+30        5.4265       3.78  Q          |          |          |       V  |
5+35        5.4457       2.78  Q          |          |          |        V|
5+40        5.4636       2.60  Q          |          |          |        V|
5+45        5.4806       2.47  Q          |          |          |        V|
5+50        5.4969       2.36  Q          |          |          |        V|
5+55        5.5125       2.26  Q          |          |          |        V|
6+ 0        5.5275       2.17  Q          |          |          |        V|
6+ 5        5.5415       2.03  Q          |          |          |        V|
6+10        5.5522       1.56  Q          |          |          |        V|
6+15        5.5586       0.93  Q          |          |          |        V|
6+20        5.5630       0.63  Q          |          |          |        V|
6+25        5.5661       0.46  Q          |          |          |        V|
6+30        5.5684       0.34  Q          |          |          |        V|
6+35        5.5702       0.25  Q          |          |          |        V|
6+40        5.5715       0.19  Q          |          |          |        V|
```

```
    6+45       5.5724      0.14  Q          |          |          |         V|
    6+50       5.5732      0.11  Q          |          |          |         V|
    6+55       5.5737      0.08  Q          |          |          |         V|
    7+ 0       5.5741      0.06  Q          |          |          |         V|
    7+ 5       5.5744      0.04  Q          |          |          |         V|
    7+10       5.5746      0.03  Q          |          |          |         V|
    7+15       5.5747      0.02  Q          |          |          |         V|
    7+20       5.5748      0.01  Q          |          |          |         V|
    7+25       5.5748      0.00  Q          |          |          |         V|
-----------------------------------------------------------------------
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Joseph E. Bonadiman & Assoc., Inc.
Consulting Engineers
234 N. Arrowhead Ave.
San Bernardino, California 92408
(909)885-3806

SPILLWAY "B"

```
     |<-----------------------( 38.14')------------------------>|
******- - - - - - - - -Channel Depth (  3.29')- - - - - - - - - ******
     ***                                                        ***
       ***                                                    ***
         ***                                                ***
           *** |<-------------( 30.14')-------------->| ***
             ***^^^^^^^^ Water Depth (  1.29')^^^^^^^^***
               ***                                 ***
                 ***                             ***
                   ***                         ***
                     ***|<-----( 25.00')---->|***
                       ***********************
                         ********************
```

Trapezoidal Channel

Flowrate	445.760	CFS
Velocity	12.570	fps
Depth of Flow	1.286	feet
Critical Depth	2.026	feet
Freeboard	2.000	feet
Total Depth	3.286	feet
Width at Water Surface	30.145	feet
Top Width	38.145	feet
Slope of Channel	1.000	%
Left Side Slope	2.000	: 1
Right Side Slope	2.000	: 1
Base Width	25.000	feet
X-Sectional Area	35.462	sq. ft.
Wetted Perimeter	30.752	feet
AR^(2/3)	38.996	
Mannings 'n'	0.013	

Sediment yield and runoff frequency of small drainage basins in the Mojave Desert, California and Nevada

Peter G. Griffiths, Richard Hereford, and Robert H. Webb

The Mojave Desert

The Mojave Desert spreads across eastern California, southern Nevada, southwest Utah and northwest Arizona (Fig. 1). Since the 1950s, the population in and around the Mojave Desert has dramatically increased, and with it recreational, grazing, mining, military, and other activities. The federal agencies that serve as caretakers are often faced with difficult decisions as they work to ensure that the diverse and fragile ecosystem survives in the face of increasing land use. The first step in making sound management decisions is to understand the desert's ecological systems, including the processes that shape the geomorphology, or surface features, of the desert landscape.

Figure 1. The study area (Figure 3, outlined in green) is within the Mojave Desert (outlined in red), which covers 25,000 square miles. Elevation in the Mojave Desert ranges from below sea level in Death Valley to over 1,600 m. Precipitation is between 65 and 190 mm annually, most of which falls during the winter season.

Figure 2. Aerial view of the former Tonopah and Tidewater Railroad in Valjean Valley. Several small reservoirs appear as light-colored areas upslope (to the left) of the railroad bed. Photograph by M.P. Collier.

Sediment Yield

One measure of geomorphic activity is sediment yield, which is defined as the amount of sediment per unit area removed from a watershed by flowing water during a specified period of time. Changes in sediment yield can signal changes in many elements of the desert ecosystem, including rates of weathering and erosion, climate, and human activity. Sediment yield affects rates of soil development and influences the recovery of disturbed surfaces downslope from source areas in desert landscapes. Sediment yield is strongly affected by surficial materials, topography, rainfall seasonality, and vegetation cover and can be increased by soil disturbance, which often occurs as the result of land use. Sediment yield from small arid basins, particularly in the Mojave Desert, is largely unknown owing to the ephemeral nature of desert streams and the long time intervals between flow events.

Numerous railroads built in the early twentieth century to serve mining camps in the Mojave Desert provide a unique opportunity to measure recent rates of sediment yield. These railroads cross thousands of washes, but only the most prominent watersheds were given adequate drainage. In some cases, the railbed dammed small watersheds to create artificial reservoirs (Fig. 2). We identified numerous small reservoirs of this type (Fig. 3), where all sediment eroded from the upstream watershed has been trapped behind the railbed. Most of these railroads were built between 1906 and 1910, and sediment in them preserves nearly a century of sediment-yield history in the Mojave Desert.

Figure 3. Small reservoirs examined for sediment yield and runoff frequency history plotted along abandoned railroad beds.

Calculation of sediment yield requires measures of the area drained, the volume (or mass) of sediment removed, and the time interval over which deposition has occurred. Drainage area was calculated by integrating GPS coordinates collected along the boundary of each drainage basin. The volume of sediment captured in each reservoir was calculated by sampling the depth of the deposit with a soil augur at 1- to 2-meter intervals and integrating the results across the area of the reservoir. The time interval of deposition was defined by the date of railway construction and either 1993, when some basins breached during regional flooding, or 2000-2001, when the stratigraphic analyses were performed.

Runoff Frequency

Another useful measure of geomorphic activity is runoff frequency, defined as the number of streamflow events that occur in a watershed over a given time interval. This measure is often expressed as a recurrence interval (RI), the average number of years that occur between flood events. Runoff frequency is closely associated with the pattern of local precipitation, and changes in frequency can reflect changes in vegetation, land use, or climate. Runoff frequency can also be a major determinant of sediment yield. Runoff events were evaluated in 18 reservoirs by examining the stratigraphy and sedimentology of the deposits exposed in the walls of small pits (Fig. 4). In most of the reservoirs, individual flood deposits were distinguishable as couplets of sediment grading upward from silty-sand to silty-clay. Couplets as thin as 2 mm were identified (Fig. 5). The recurrence interval of sediment-depositing floods for each reservoir was calculated by dividing the lifespan of the reservoir by the number of distinct flood strata. The sediment record can be considered censored data in that it records only those streamflow floods of sufficient magnitude to deposit sediment in the reservoir. The smallest runoff events are not recorded.

^{137}Cs Dating

In order to evaluate changes in flood frequency over the last century, the span of time represented by the reservoir deposits must be broken into shorter time intervals. This additional control on the age of deposits was obtained by sampling and analyzing reservoir strata for the presence of cesium-137 (^{137}Cs) which is an anthropogenic isotope created as a by-product of nuclear fission. Introduction of ^{137}Cs to the global environment as fallout began in 1952 when large amounts of ^{137}Cs were injected into the stratosphere by the above-ground testing of high-yield nuclear weapons. Virtually all sediment exposed to fallout after 1952 contains detectable amounts of ^{137}Cs, even if the sediment has been subsequently eroded,

Figure 4. The small reservoir at the Eagle Mountain (EM) site, along the Tonopah and Tidewater Railroad. The abandoned railbed is on the right.

transported, and redeposited. ^{137}Cs has been used extensively as a temporal marker in very young stream and lake deposits. Based on the absence or presence of ^{137}Cs, individual reservoir strata were separated into pre- and post-1952 periods, respectively, and flood frequency measures were calculated for each period (Fig. 6).

Results

Streamflow recurrence intervals were calculated for 14 reservoirs and ranged from 2.6 to 7.3 yrs with an average of 4.7 yrs. Comparing pre-and post-1952 deposits, the average RI increased from 4.6 to 6.4 yrs, reflecting a decrease in the frequency of sediment-depositing floods in the second half of the 20th century. The decrease in runoff frequency may be related to concurrent changes observed by Hereford et al. (2004) in the regional precipitation regime: a shift from a wet period (1905 through 1941) to a dry period (1942 to 1978) known as the mid-century drought. This change was characterized by a reduction in the frequency of high-intensity precipitation (Fig. 7). Storm intensity is likely a good indicator of sediment deposition because of the censored nature of the preserved deposits. Although the frequency of storms and flow events may not have decreased, the reduced storm intensity probably reduced the frequency of higher magnitude floods, which are more likely to deposit sediment in the reservoirs.

Sediment yield at 15 reservoirs for the entire period of record averaged 28 metric tons km^{-2} yr^{-1}, an order of magnitude smaller than sediment yields calculated for other regions (Fig. 8). This is not explained by variation in levels of precipitation; a similarly-sized, extremely arid watershed in the southern Negev Desert of Israel generates much more sediment (Fig. 8). The difference may be the result of storm types. Precipitation in the Negev is often generated by intense, localized thunderstorms, while most of the Mojave's precipitation results from lower-intensity winter storms that are likely less erosive. Sediment yield from the Mojave basins may also be limited by the gentle gradient of the sampled watersheds, as well as the presence of coarse particles or desert pavements that protect most of the watershed surfaces and limit erosion.

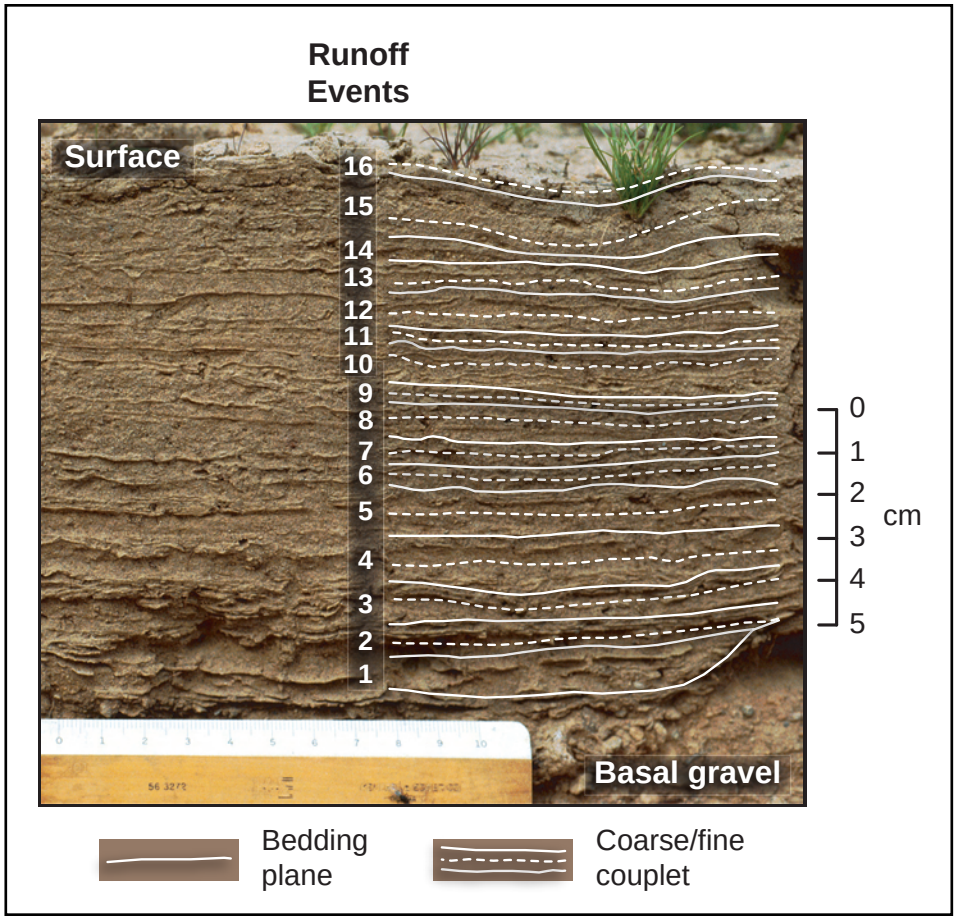

Figure 5. Stratigraphic section of reservoir deposits at the Silurian 3 (SIL) site showing runoff events represented by 16 coarse-fine couplets.

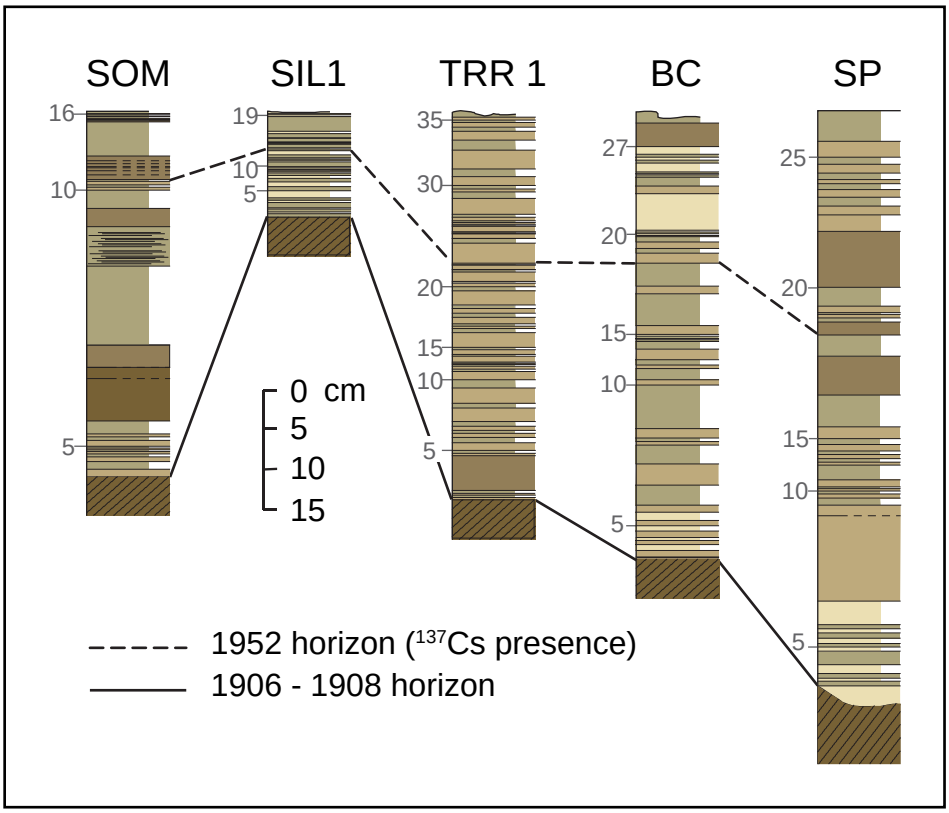

Figure 6. Stratigraphic cross section showing sedimentology and correlation of reservoir alluvium along a 284-km north-south transect. ^{137}Cs is present in strata deposited after 1952. Cumulative number of runoff events is indicated to the left of each column.

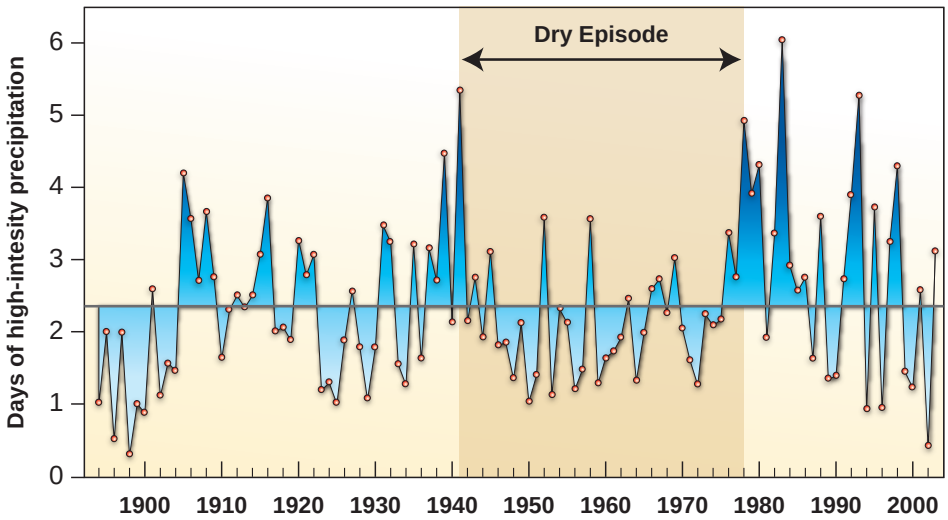

Figure 7. The average frequency of precipitation events on days of high-intensity precipitation shows a dry episode from 1942 to 1978. (High intensity is defined as precipitation > 90th percentile of all measurable daily precipitation at a station. Analysis is based on data from 52 weather stations.)

In general, sediment yield from the Mojave basins decreased as drainage area increased, a trend typical of larger drainage basins in a variety of climatic and geologic settings (Fig. 8). Small drainage basins are usually topographically simple, and moving sediment the short distance required to exit the basin is a straightforward process. Sediment yield from small basins is typically supply-limited, meaning it is limited primarily by the supply of sediment, and sediment yield increases as a function of drainage basin area. As drainage basins increase in area and become more topographically complex, sediment yield often becomes transport-limited, meaning that sediment yield is restricted by the increasingly complex process of moving sediment out of the basin. For example, sediment eroded from steep headwaters can become trapped in flat bottomlands and increasingly complex drainage networks, which tend to grow more quickly than the headwaters as drainage area increases. Sediment trapping can also occur as water percolates out of the channel network and down into the basin substrate, a process known as transmission loss. Transmission losses will result in reduced streamflow and a decreased ability to transport sediment.

The inverse relation between sediment yield and drainage area exhibited by the Mojave basins suggests that, like larger drainage basins elsewhere, these basins are transport-limited. Sediment-transport limitations such as channel storage and transmission losses may be enhanced by the low slope and coarse substrate of these particular alluvial fans. These limitations would also have a strong effect on the low-discharge, long-duration flood events generated from the low-intensity winter storms that characterize the Mojave Desert precipitation regime.

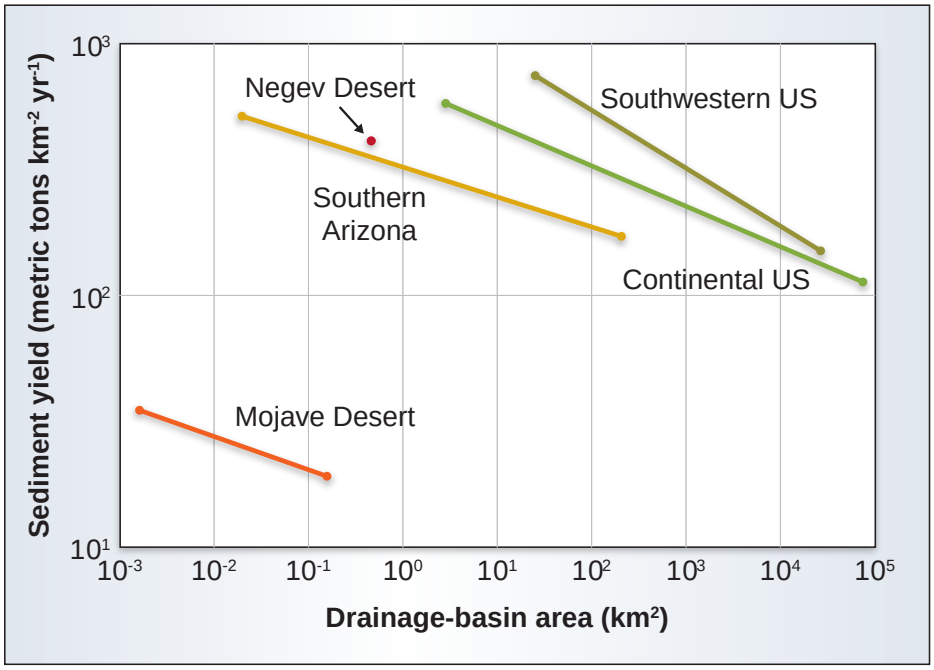

Figure 8. Graph showing the relation between sediment yield and drainage area for drainage basins in five different locations. Note that the Mojave Desert drainage basins generate an order of magnitude less sediment per unit area than basins elsewhere.

Acknowledgements

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For a full bibliography, see:

Griffiths, P.G., Hereford, R., and Webb, R.H., In press, Sediment yield and runoff frequency of small drainage basins in the Mojave Desert, U.S.A.: Geomorphology.

Hereford, R. Webb, R.H., and Longpré, C.I., 2004, Precipitation history of the Mojave Desert region: U.S. Geological Survey Fact Sheet 117-03, 4 p.

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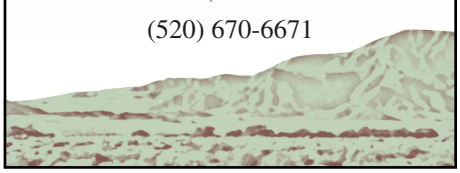
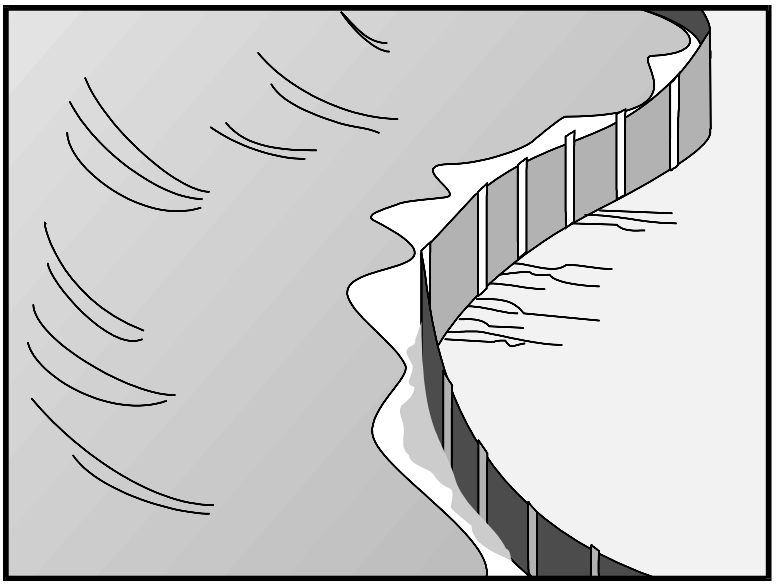


Graphic design by Tina Kister

Silt Fence SE-1



Categories

EC	Erosion Control	
SE	Sediment Control	☑
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Description and Purpose

A silt fence is made of a woven geotextile that has been entrenched, attached to supporting poles, and sometimes backed by a plastic or wire mesh for support. The silt fence detains water, promoting sedimentation of coarse sediment behind the fence. Silt fence does not retain soil fine particles like clays or silts.

Suitable Applications

Silt fences are suitable for perimeter control, placed below areas where sheet flows discharge from the site. They could also be used as interior controls below disturbed areas where runoff may occur in the form of sheet and rill erosion and around inlets within disturbed areas (SE-10). Silt fences should not be used in locations where the flow is concentrated. Silt fences should always be used in combination with erosion controls. Suitable applications include:

- At perimeter of a project.
- Below the toe or down slope of exposed and erodible slopes.
- Along streams and channels.
- Around temporary spoil areas and stockpiles.
- Around inlets.
- Below other small cleared areas.

Targeted Constituents

Sediment (coarse sediment)	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-5 Fiber Rolls

SE-6 Gravel Bag Berm SE-12 Manufactured Linear Sediment Controls

SE-13 Compost Socks and Berms

SE-14 Biofilter Bags

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Limitations

- Do not use in streams, channels, drain inlets, or anywhere flow is concentrated.
- Do not use in locations where ponded water may cause a flooding hazard.
- Do not use silt fence to divert water flows or place across any contour line.
- Improperly installed fences are subject to failure from undercutting, overtopping, or collapsing.
- Must be trenched and keyed in.
- Not intended for use as a substitute for Fiber Rolls (SE-5), when fiber rolls are being used as a slope interruption device.
- Do not use on slopes subject to creeping, slumping, or landslides.

Implementation

General

A silt fence is a temporary sediment barrier consisting of woven geotextile stretched across and attached to supporting posts, trenched-in, and, depending upon the strength of fabric used, supported with plastic or wire mesh fence. Silt fences trap coarse sediment by intercepting and detaining sediment-laden runoff from disturbed areas in order to promote sedimentation behind the fence.

The following layout and installation guidance can improve performance and should be followed:

- Silt fence should be used in combination with erosion controls up-slope in order to provide the most effective sediment control.
- Silt fence alone is not effective at reducing turbidity. (Barrett and Malina, 2004)
- Designers should consider diverting sediment laden water to a temporary sediment basin or trap. (EPA, 2012)
- Use principally in areas where sheet flow occurs.
- Install along a level contour, so water does not pond more than 1.5 ft at any point along the silt fence.
- Provide sufficient room for runoff to pond behind the fence and to allow sediment removal equipment to pass between the silt fence and toes of slopes or other obstructions. About 1200 ft^2 of ponding area should be provided for every acre draining to the fence.
- Efficiency of silt fences is primarily dependent on the detention time of the runoff behind the control. (Barrett and Malina, 2004)
- The drainage area above any fence should not exceed a quarter of an acre. (Rule of Thumb-100-feet of silt fence per 10,000 square feet of disturbed area.) (EPA 2012)

- The maximum length of slope draining to any point along the silt fence should be 100 ft per foot of silt fence.
- Turn the ends of the filter fence uphill to prevent stormwater from flowing around the fence.
- Leave an undisturbed or stabilized area immediately down slope from the fence where feasible.
- Silt fences should remain in place until the disturbed area draining to the silt fence is permanently stabilized, after which, the silt fence fabric and posts should be removed and properly disposed.
- J-Hooks, which have ends turning up the slope to break up long runs of fence and provide multiple storage areas that work like mini-retention areas, may be used to increase the effectiveness of silt fence.
- Be aware of local regulations regarding the type and installation requirements of silt fence, which may differ from those presented in this fact sheet.

Design and Layout

In areas where high winds are anticipated the fence should be supported by a plastic or wire mesh. The geotextile fabric of the silt fence should contain ultraviolet inhibitors and stabilizers to provide longevity equivalent to the project life or replacement schedule.

- Layout in accordance with the attached figures.
- For slopes that contain a high number of rocks or large dirt clods that tend to dislodge, it may be necessary to protect silt fence from rocks (e.g., rockfall netting) ensure the integrity of the silt fence installation.

Standard vs. Heavy Duty Silt Fence

Standard Silt Fence

- Generally applicable in cases where the area draining to fence produces moderate sediment loads.

Heavy Duty Silt Fence

- Heavy duty silt fence usually has 1 or more of the following characteristics, not possessed by standard silt fence.
  - Fabric is reinforced with wire backing or additional support.
  - Posts are spaced closer than pre-manufactured, standard silt fence products.
- Use is generally limited to areas affected by high winds.
- Area draining to fence produces moderate sediment loads.

Materials

Standard Silt Fence

- Silt fence material should be woven geotextile with a minimum width of 36 in. The fabric should conform to the requirements in ASTM designation D6461.
- Wooden stakes should be commercial quality lumber of the size and shape shown on the plans. Each stake should be free from decay, splits or cracks longer than the

thickness of the stake or other defects that would weaken the stakes and cause the stakes to be structurally unsuitable.

- Staples used to fasten the fence fabric to the stakes should be not less than 1.75 in. long and should be fabricated from 15 gauge or heavier wire. The wire used to fasten the tops of the stakes together when joining two sections of fence should be 9 gauge or heavier wire. Galvanizing of the fastening wire will not be required.

Heavy-Duty Silt Fence

- Some silt fence has a wire backing to provide additional support, and there are products that may use prefabricated plastic holders for the silt fence and use metal posts instead of wood stakes.

Installation Guidelines – Traditional Method

Silt fences are to be constructed on a level contour. Sufficient area should exist behind the fence for ponding to occur without flooding or overtopping the fence.

- A trench should be excavated approximately 6 in. wide and 6 in. deep along the line of the proposed silt fence (trenches should not be excavated wider or deeper than necessary for proper silt fence installation).
- Bottom of the silt fence should be keyed-in a minimum of 12 in.
- Posts should be spaced a maximum of 6 ft apart and driven securely into the ground a minimum of 18 in. or 12 in. below the bottom of the trench.
- When standard strength geotextile is used, a plastic or wire mesh support fence should be fastened securely to the upslope side of posts using heavy–duty wire staples at least 1 in. long. The mesh should extend into the trench.
- When extra-strength geotextile and closer post spacing are used, the mesh support fence may be eliminated.
- Woven geotextile should be purchased in a long roll, then cut to the length of the barrier. When joints are necessary, geotextile should be spliced together only at a support post, with a minimum 6 in. overlap and both ends securely fastened to the post.
- The trench should be backfilled with native material and compacted.
- Construct the length of each reach so that the change in base elevation along the reach does not exceed 1/3 the height of the barrier; in no case should the reach exceed 500 ft.
- Cross barriers should be a minimum of 1/3 and a maximum of ½ the height of the linear barrier.
- See typical installation details at the end of this fact sheet.

Installation Guidelines - Static Slicing Method

- Static Slicing is defined as insertion of a narrow blade pulled behind a tractor, similar to a plow blade, at least 10 inches into the soil while at the same time pulling silt geotextile fabric into the ground through the opening created by the blade to the depth of the blade. Once the geotextile is installed, the soil is compacted using tractor tires.
- This method will not work with pre-fabricated, wire backed silt fence.
- Benefits:
    - Ease of installation (most often done with a 2 person crew).
    - Minimal soil disturbance.
    - Better level of compaction along fence, less susceptible to undercutting
    - Uniform installation.
- Limitations:
    - Does not work in shallow or rocky soils.
    - Complete removal of geotextile material after use is difficult.
    - Be cautious when digging near potential underground utilities.

Costs

- It should be noted that costs vary greatly across regions due to available supplies and labor costs.
- Average annual cost for installation using the traditional silt fence installation method (assumes 6 month useful life) is $7 per linear foot based on vendor research. Range of cost is $3.50 - $9.10 per linear foot.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Repair undercut silt fences.
- Repair or replace split, torn, slumping, or weathered fabric. The lifespan of silt fence fabric is generally 5 to 8 months.
- Silt fences that are damaged and become unsuitable for the intended purpose should be removed from the site of work, disposed, and replaced with new silt fence barriers.
- Sediment that accumulates in the BMP should be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches 1/3 of the barrier height.
- Silt fences should be left in place until the upgradient area is permanently stabilized. Until then, the silt fence should be inspected and maintained regularly.

- Remove silt fence when upgradient areas are stabilized. Fill and compact post holes and anchor trench, remove sediment accumulation, grade fence alignment to blend with adjacent ground, and stabilize disturbed area.

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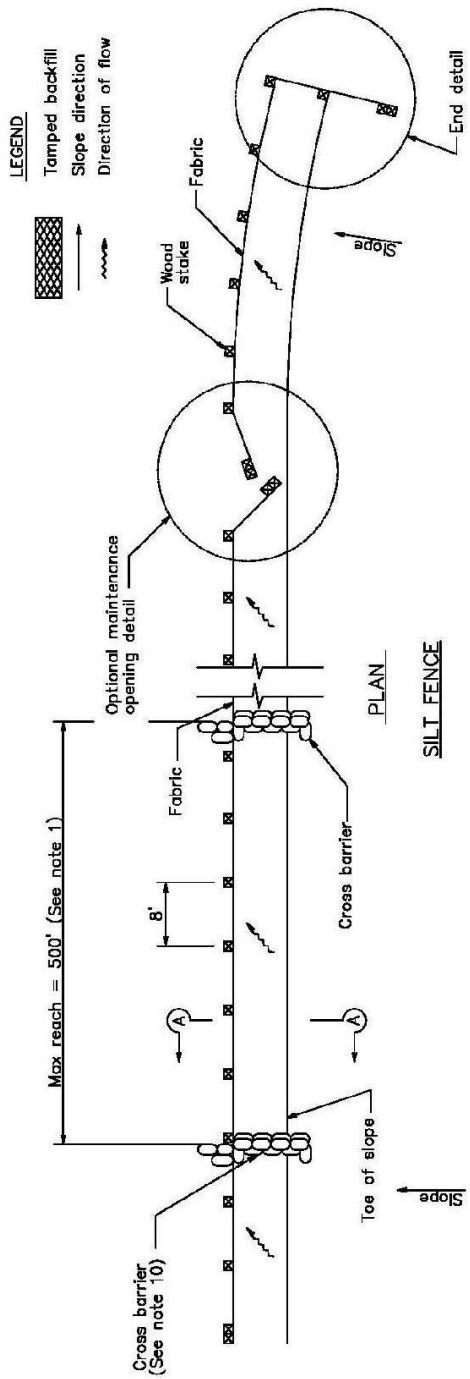
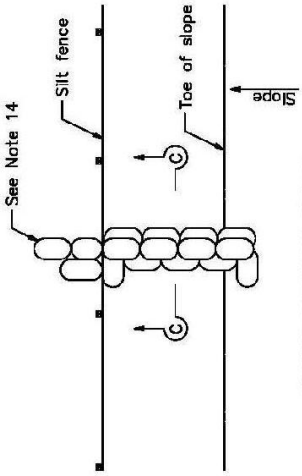
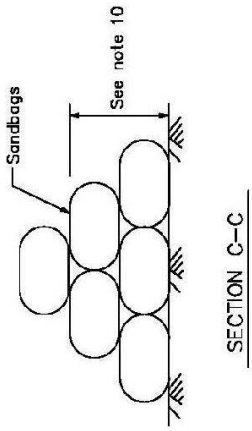
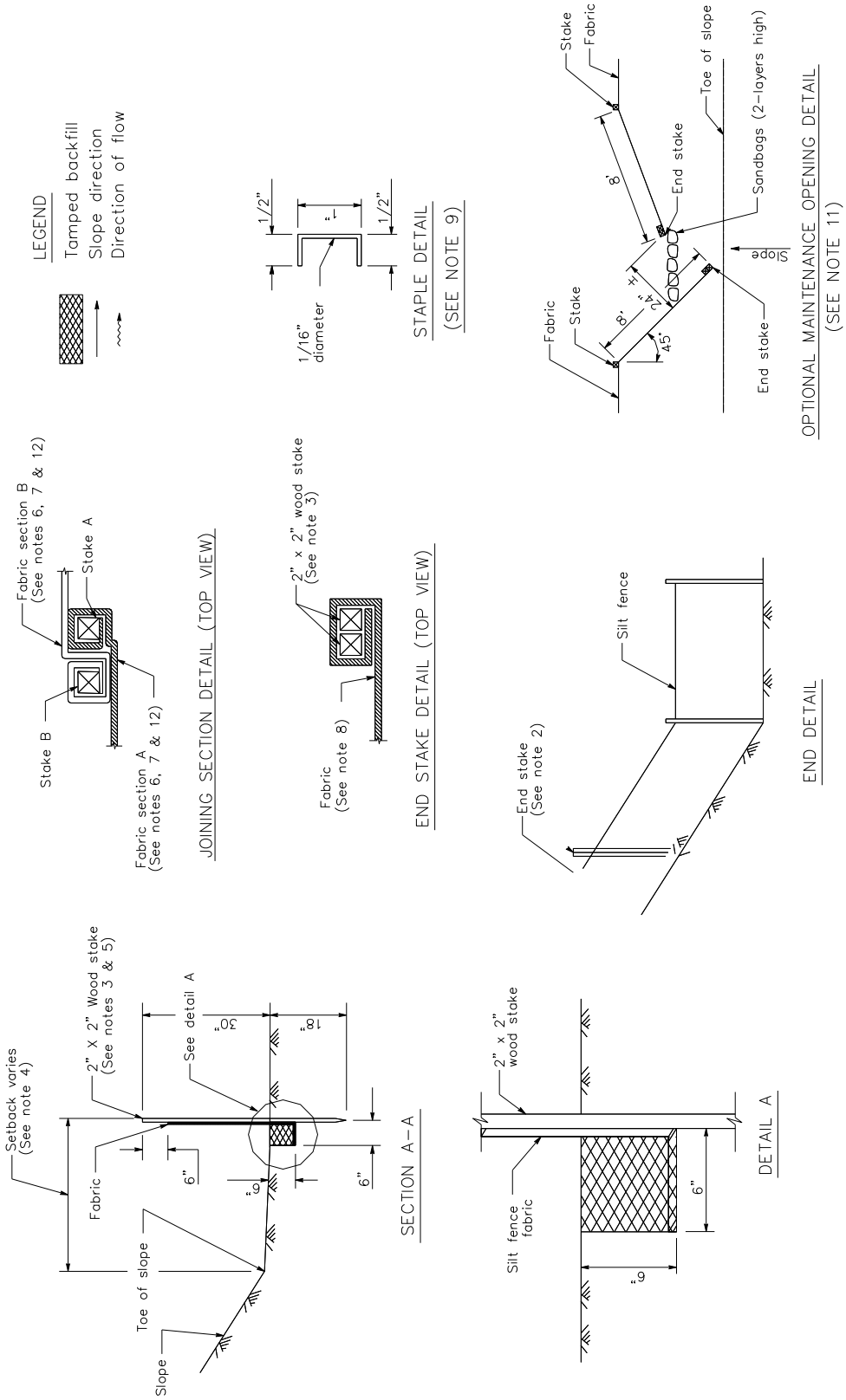


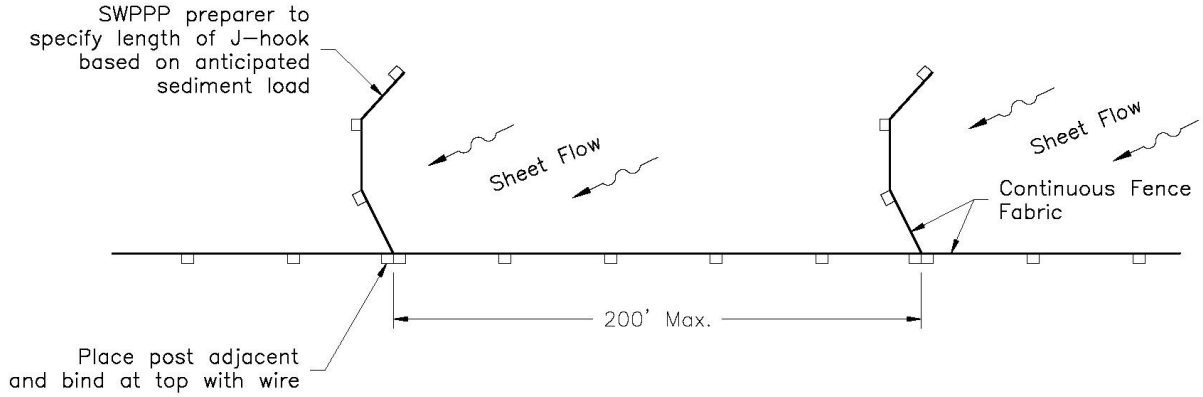




NOTES

1. Construct the length of each reach so that the change in base elevation along the reach does not exceed 1/3 the height of the linear barrier, in no case shall the reach length exceed 500'.
2. The last 8'–0" of fence shall be turned up slope.
3. Stake dimensions are nominal.
4. Dimension may vary to fit field condition.
5. Stakes shall be spaced at 8'–0" maximum and shall be positioned on downstream side of fence.
6. Stakes to overlap and fence fabric to fold around each stake one full turn. Secure fabric to stake with 4 staples.
7. Stakes shall be driven tightly together to prevent potential flow–through of sediment at joint. The tops of the stakes shall be secured with wire.
8. For end stake, fence fabric shall be folded around two stakes one full turn and secured with 4 staples.
9. Minimum 4 staples per stake. Dimensions shown are typical.
10. Cross barriers shall be a minimum of 1/3 and a maximum of 1/2 the height of the linear barrier.
11. Maintenance openings shall be constructed in a manner to ensure sediment remains behind silt fence.
12. Joining sections shall not be placed at sump locations.
13. Sandbag rows and layers shall be offset to eliminate gaps.
14. Add 3–4 bags to cross barrier on downgradient side of silt fence as needed to prevent bypass or undermining and as allowable based on site limits of disturbance.

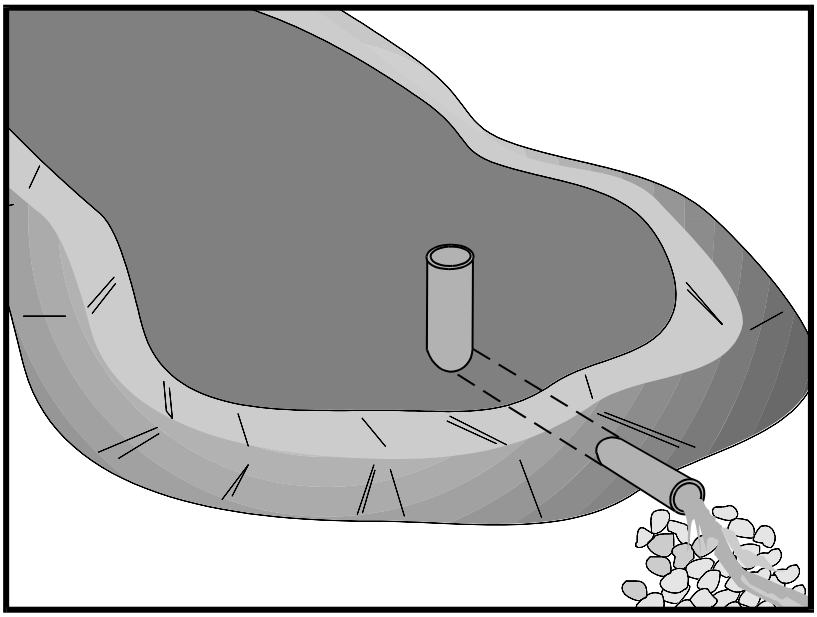

LEGEND
Tamped backfill
Slope direction
Direction of flow
1/2"
1"
1/2"
1/16" diameter
STAPLE DETAIL
(SEE NOTE 9)
Stake
Fabric
Toe of slope
Sandbags (2-layers high)
End stake
8'
4'
2'
8'
45°
Fabric
Stake
End stake
Slope
OPTIONAL MAINTENANCE OPENING DETAIL
(SEE NOTE 11)
Fabric section B
(See notes 6, 7 & 12)
Stake A
Stake B
Fabric section A
(See notes 6, 7 & 12)
JOINING SECTION DETAIL (TOP VIEW)
2" x 2" wood stake
(See note 3)
Fabric
(See note 8)
END STAKE DETAIL (TOP VIEW)
Silt fence
End stake
(See note 2)
END DETAIL
Setback varies
(See note 4)
2" X 2" Wood stake
(See notes 3 & 5)
See detail A
30"
18"
Fabric
6"
6"
6"
Toe of slope
Slope
SECTION A-A
2" x 2"
wood stake
Silt fence
fabric
6"
6"
DETAIL A


SWPPP preparer to specify length of J–hook based on anticipated sediment load
Sheet Flow
Sheet Flow
Continuous Fence Fabric
200' Max.
Place post adjacent and bind at top with wire

Plan

J–HOOK

Sediment Basin SE-2



Categories		
EC	Erosion Control	
SE	Sediment Control	☑
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents	
Sediment	☑
Nutrients	
Trash	☑
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-3 Sediment Trap (for smaller areas)

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Description and Purpose

A sediment basin is a temporary basin formed by excavation or by constructing an embankment so that sediment-laden runoff is temporarily detained under quiescent conditions, allowing sediment to settle out before the runoff is released.

Sediment basin design guidance presented in this fact sheet is intended to provide options, methods, and techniques to optimize temporary sediment basin performance and basin sediment removal. Basin design guidance provided in this fact sheet is not intended to guarantee basin effluent compliance with numeric discharge limits (numeric action levels or numeric effluent limits for turbidity). Compliance with discharge limits requires a thoughtful approach to comprehensive BMP planning, implementation, and maintenance. Therefore, optimally designed and maintained sediment basins should be used in conjunction with a comprehensive system of BMPs that includes:

- Diverting runoff from undisturbed areas away from the basin
- Erosion control practices to minimize disturbed areas on-site and to provide temporary stabilization and interim sediment controls (e.g., stockpile perimeter control, check dams, perimeter controls around individual lots) to reduce the basin's influent sediment concentration.

At some sites, sediment basin design enhancements may be required to adequately remove sediment. Traditional

(a.k.a. "physical") enhancements such as alternative outlet configurations or flow deflection baffles increase detention time and other techniques such as outlet skimmers preferentially drain flows with lower sediment concentrations. These "physical" enhancement techniques are described in this fact sheet. To further enhance sediment removal particularly at sites with fine soils or turbidity sensitive receiving waters, some projects may need to consider implementing Active Treatment Systems (ATS) whereby coagulants and flocculants are used to enhance settling and removal of suspended sediments. Guidance on implementing ATS is provided in SE-11.

Suitable Applications

Sediment basins may be suitable for use on larger projects with sufficient space for constructing the basin. Sediment basins should be considered for use:

- Where sediment-laden water may enter the drainage system or watercourses
- On construction projects with disturbed areas during the rainy season
- At the outlet of disturbed watersheds between 5 acres and 75 acres and evaluated on a site by site basis
- Where post construction detention basins are required
- In association with dikes, temporary channels, and pipes used to convey runoff from disturbed areas

Limitations

Sediment basins must be installed only within the property limits and where failure of the structure will not result in loss of life, damage to homes or buildings, or interruption of use or service of public roads or utilities. In addition, sediment basins are attractive to children and can be very dangerous. Local ordinances regarding health and safety must be adhered to. If fencing of the basin is required, the type of fence and its location should be shown in the SWPPP and in the construction specifications.

- As a general guideline, sediment basins are suitable for drainage areas of 5 acres or more, but not appropriate for drainage areas greater than 75 acres. However, the tributary area should be evaluated on a site by site basis.
- Sediment basins may become an "attractive nuisance" and care must be taken to adhere to all safety practices. If safety is a concern, basin may require protective fencing.
- Sediment basins designed according to this fact sheet are only effective in removing sediment down to about the silt size fraction. Sediment-laden runoff with smaller size fractions (fine silt and clay) may not be adequately treated unless chemical (or other appropriate method) treatment is used in addition to the sediment basin.
- Basins with a height of 25 ft or more or an impounding capacity of 50 ac-ft or more must obtain approval from California Department of Water Resources Division of Safety of Dams (http://www.water.ca.gov/damsafety/).

- Water that stands in sediment basins longer than 96 hours may become a source of mosquitoes (and midges), particularly along perimeter edges, in shallow zones, in scour or below-grade pools, around inlet pipes, along low-flow channels, and among protected habitats created by emergent or floating vegetation (e.g. cattails, water hyacinth), algal mats, riprap, etc.

- Basins require large surface areas to permit settling of sediment. Size may be limited by the available area.

Implementation

General

A sediment basin is a controlled stormwater release structure formed by excavation or by construction of an embankment of compacted soil across a drainage way, or other suitable location. It is intended to trap sediment before it leaves the construction site. The basin is a temporary measure expected to be used during active construction in most cases and is to be maintained until the site area is permanently protected against erosion or a permanent detention basin is constructed.

Sediment basins are suitable for nearly all types of construction projects. Whenever possible, construct the sediment basins before clearing and grading work begins. Basins should be located at the stormwater outlet from the site but not in any natural or undisturbed stream. A typical application would include temporary dikes, pipes, and/or channels to convey runoff to the basin inlet.

Many development projects in California are required by local ordinances to provide a stormwater detention basin for post-construction flood control, desilting, or stormwater pollution control. A temporary sediment basin may be constructed by rough grading the post-construction control basins early in the project.

Sediment basins if properly designed and maintained can trap a significant amount of the sediment that flows into them. However, traditional basins do not remove all inflowing sediment. Therefore, they should be used in conjunction with erosion control practices such as temporary seeding, mulching, diversion dikes, etc., to reduce the amount of sediment flowing into the basin.

Planning

To improve the effectiveness of the basin, it should be located to intercept runoff from the largest possible amount of disturbed area. Locations best suited for a sediment basin are generally in lower elevation areas of the site (or basin tributary area) where site drainage would not require significant diversion or other means to direct water to the basin but outside jurisdictional waterways. However, as necessary, drainage into the basin can be improved by the use of earth dikes and drainage swales (see BMP EC-9). . The basin should not be located where its failure would result in the loss of life or interruption of the use or service of public utilities or roads.

Construct before clearing and grading work begins when feasible.

- Do not locate the basin in a jurisdictional stream.

- Basin sites should be located where failure of the structure will not cause loss of life, damage to homes or buildings, or interruption of use or service of public roads or utilities.
- Basins with a height of 25 ft or more or an impounding capacity of 50 ac-ft must obtain approval from the Division of Dam Safety. Local dam safety requirements may be more stringent.
- Limit the contributing area to the sediment basin to only the runoff from the disturbed soil areas. Use temporary concentrated flow conveyance controls to divert runoff from undisturbed areas away from the sediment basin.
- The basin should be located: (1) by excavating a suitable area or where a low embankment can be constructed across a swale, (2) where post-construction (permanent) detention basins will be constructed, and (3) where the basins can be maintained on a year-round basis to provide access for maintenance, including sediment removal and sediment stockpiling in a protected area, and to maintain the basin to provide the required capacity.

Design

When designing a sediment basin, designers should evaluate the site constraints that could affect the efficiency of the BMP. Some of these constraints include: the relationship between basin capacity, anticipated sediment load, and freeboard, available footprint for the basin, maintenance frequency and access, and hydraulic capacity and efficiency of the temporary outlet infrastructure. Sediment basins should be designed to maximize sediment removal and to consider sediment load retained by the basin as it affects basin performance.

Three Basin Design Options (Part A) are presented below along with a Typical Sediment/Detention Basin Design Methodology (Part B). Regardless of the design option that is selected, designers also need to evaluate the sediment basin capacity with respect to sediment accumulation (See "*Step 3. Evaluate the Capacity of the Sediment Basin"),* and should incorporate approaches identified in "*Step 4. Other Design Considerations*" to enhance basin performance.

A) Basin Design Options:

Option 1:

Design sediment basin(s) using the standard equation:

$$A_s = \frac{1.2Q}{V_s} \qquad \text{(Eq. 1)}$$

Where:

A_s = Minimum surface area for trapping soil particles of a certain size

V_s = Settling velocity of the design particle size chosen (V_s = 0.00028 ft/s for a design particle size of 0.01 mm at 68°F)

1.2 = Factor of safety recommended by USEPA to account for the reduction in basin efficiency caused due to turbulence and other non ideal conditions.

$Q = CIA$ (Eq.2)

Where

Q = Peak basin influent flow rate measured in cubic feet per second (ft^3/s)

C = Runoff coefficient (unitless)

I = Peak rainfall intensity for the 10-year, 6-hour rain event (in/hr)

A = Area draining into the sediment basin in acres

The design particle size should be the smallest soil grain size determined by wet sieve analysis, or the fine silt sized (0.01 mm [or 0.0004 in.]) particle, and the Vs used should be 100 percent of the calculated settling velocity.

This sizing basin method is dependent on the outlet structure design or the total basin length with an appropriate outlet. If the designer chooses to utilize the outlet structure to control the flow duration in the basin, the basin length (distance between the inlet and the outlet) should be a minimum of twice the basin width; the depth should not be less than 3 ft nor greater than 5 ft for safety reasons and for maximum efficiency (2 ft of sediment storage, 2 ft of capacity). If the designer chooses to utilize the basin length (with appropriate basin outlet) to control the flow duration in the basin, the basin length (distance between the inlet and the outlet) should be a specifically designed to capture 100% of the design particle size; the depth should not be less than 3 ft nor greater than 5 ft for safety reasons and for maximum efficiency (2 ft of sediment storage, 2 ft of capacity).

Basin design guidance provided herein assumes standard water properties (e.g., estimated average water temperature, kinematic viscosity, etc.) as a basis of the design. Designers can use an alternative design (Option 3) with site specific water properties as long as the design is as protective as Option 1.

The design guidance uses the peak influent flow rate to size sediment basins. Designers can use an alternative design (Option 3) with site specific average flow rates as long as the design is as protective as Option 1.

The basin should be located on the site where it can be maintained on a year-round basis and should be maintained on a schedule to retain the 2 ft of capacity.

Option 2:

Design pursuant to local ordinance for sediment basin design and maintenance, provided that the design efficiency is as protective or more protective of water quality than Option 1.

Option 3:

The use of an equivalent surface area design or equation provided that the design efficiency is as protective or more protective of water quality than Option 1.

B) Typical Sediment/Detention Basin Design Methodology:

Design of a sediment basin requires the designer to have an understanding of the site constraints, knowledge of the local soil (e.g., particle size distribution of potentially contributing soils), drainage area of the basin, and local hydrology. Designers should not assume that a sediment basin for location A is applicable to location B. Therefore, designers can use this factsheet as guidance but will need to apply professional judgment and knowledge of the site to design an effective and efficient sediment basin. The following provides a general overview of typical design methodologies:

Step 1. Hydrologic Design

- Evaluate the site constraints and assess the drainage area for the sediment basin. Designers should consider on- and off-site flows as well as changes in the drainage area associated with site construction/disturbance. To minimize additional construction during the course of the project, the designer should consider identifying the maximum drainage area when calculating the basin dimensions.

- If a local hydrology manual is not available it is recommended to follow standard rational method procedures to estimate the flow rate. The references section of this factsheet provides a reference to standard hydrology textbooks that can provide standard methodologies. If local rainfall depths are not available, values can be obtained from standard precipitation frequency maps from NOAA (downloaded from http://www.wrcc.dri.edu/pcpnfreq.html).

Step 2. Hydraulic Design

- Calculate the surface area required for the sediment basin using Equation 1. In which the flow rate is estimated for a 10-yr 6-hr event using rational method procedure listed in local hydrology manual and Vs is estimated using Stokes Law presented in Equation 3.

$$V_s = 2.81d^2 \qquad \text{(Eq.3)}$$

Where

V_s = Settling velocity in feet per second at 68˚F

d = diameter of sediment particle in millimeters (smallest soil grain size determined by wet sieve analysis or fine silt (0.01 mm [or 0.0004 in.])

- In general the basin outlet design requires an iterative trial and error approach that considered the maximum water surface elevation, the elevation versus volume (stage-storage) relationship, the elevation verses basin outflow (a.k.a.-discharge) relationship, and the estimated inflow hydrograph. To adequately design the basins to settle sediment, the outlet configuration and associated outflow rates can be estimated by numerous methodologies. The following provides some guidance for design the basin outlet:

  - An outlet should have more than one orifice.

  - An outlet design typically utilizes multiple horizontal rows of orifices (approximately 3 or more) with at least 2 orifices per row (see Figures 1 and 2 at the end of this fact sheet).

- Orifices can vary in shape.
- Select the appropriate orifice diameter and number of perforations per row with the objective of minimizing the number of rows while maximizing the detention time.
- The diameter of each orifice is typically a maximum of 3-4 inches and a minimum of 0.25-0.5 inches.
- If a rectangular orifice is used, it is recommended to have minimum height of 0.5 inches and a maximum height of 6 inches.
- Rows are typically spaced at three times the diameter center to center vertically with a minimum distance of approximately 4 inches on center and a maximum distance of 1 foot on center.
- To estimate the outflow rate, each row is calculated separately based on the flow through a single orifice then multiplied by the number of orifices in the row. This step is repeated for each of the rows. Once all of the orifices are estimated, the total outflow rate versus elevation (stage-discharge curve) is developed to evaluate the detention time within the basin.
- Flow through a single orifice can be estimated using an Equation 4:

$$Q = BC' A(2gH)^{0.5} \qquad \text{(Eq.4)}$$

Where
Q = Outflow rate in ft^3/s
C´ = Orifice coefficient (unitless)
A = Area of the orifice (ft^2)
g = acceleration due to gravity (ft^3/s)
H = Head above the orifice (ft)
B = Anticipated Blockage or clogging factor (unitless), It is dependent on anticipated sediment and debris load, trash rack configuration etc, so the value is dependent on design engineers professional judgment and/or local requirements (B is never greater than 1 and a value of 0.5 is generally used)

  - Care must be taken in the selection of orifice coefficient ("C´"); 0.60 is most often recommended and used. However, based on actual tests, Young and Graziano (1989), "Outlet Hydraulics of Extended Detention Facilities for Northern Virginia Planning District Commission", recommends the following:
    - C´ = 0.66 for thin materials; where the thickness is equal to or less than the orifice diameter, or
    - C´ = 0.80 when the material is thicker than the orifice diameter
- If different sizes of orifices are used along the riser then they have to be sized such that not more than 50 percent of the design storm event drains in one-third of the drawdown time (to provide adequate settling time for events smaller than the design storm event)

and the entire volume drains within 96 hours or as regulated by the local vector control agency. If a basin fails to drain within 96 hours, the basin must be pumped dry.

- Because basins are not maintained for infiltration, water loss by infiltration should be disregarded when designing the hydraulic capacity of the outlet structure.

- Floating Outlet Skimmer: The floating skimmer (see Figure 3 at the end of this fact sheet is an alternative outlet configuration (patented) that drains water from upper portion of the water column. This configuration has been used for temporary and permanent basins and can improve basin performance by eliminating bottom orifices which have the potential of discharging solids. Some design considerations for this alternative outlet device includes the addition of a sand filter or perforated under drain at the low point in the basin and near the floating skimmer. These secondary drains allow the basin to fully drain. More detailed guidelines for sizing the skimmer can be downloaded from http://www.fairclothskimmer.com/.

- Hold and Release Valve: An ideal sediment/detention basin would hold all flows to the design storm level for sufficient time to settle solids, and then slowly release the storm water. Implementing a reliable valve system for releasing detention basins is critical to eliminate the potential for flooding in such a system. Some variations of hold and release valves include manual valves, bladder devices or electrically operated valves. When a precipitation event is forecast, the valve would be close for the duration of the storm and appropriate settling time. When the settling duration is met (approximately 24 or 48 hours), the valve would be opened and allow the stormwater to be released at a rate that does not resuspend settled solids and in a non-erosive manner. If this type of system is used the valve should be designed to empty the entire basin within 96 hours or as stipulated by local vector control regulations.

Step 3. Evaluate the Capacity of the Sediment Basin

- Typically, sediment basins do not perform as designed when they are not properly maintained or the sediment yield to the basin is larger than expected. As part of a good sediment basin design, designers should consider maintenance cycles, estimated soil loss and/or sediment yield, and basin sediment storage volume. The two equations below can be used to quantify the amount of soil entering the basin.

- The Revised Universal Soil Loss Equation (RUSLE, Eq.5) can be used to estimate annual soil loss and the Modified Universal Soil Equation (MUSLE, Eq.6) can be used to estimate sediment yield from a single storm event.

$$A = R \times K \times LS \times C \times P \qquad \text{(Eq.5)}$$

$$Y = 95\left(Q \times q_p\right)^{0.56} \times K \times LS \times C \times P \qquad \text{(Eq.6)}$$

Where:

A = annual soil loss, tons/acre-year

R = rainfall erosion index, in 100 ft.tons/acre.in/hr

K = soil erodibility factor, tons/acre per unit of R

LS = slope length and steepness factor (unitless)

C = vegetative cover factor (unitless)

P = erosion control practice factor (unitless)

Y = single storm sediment yield in tons

Q = runoff volume in acre-feet

q_p = peak flow in cfs

- Detailed descriptions and methodologies for estimating the soil loss can be obtained from standard hydrology text books (See References section).
- Determination of the appropriate equation should consider construction duration and local environmental factors (soils, hydrology, etc.). For example, if a basin is planned for a project duration of 1 year and the designer specifies one maintenance cycle, RUSLE could be used to estimate the soil loss and thereby the designer could indicate that the sediment storage volume would be half of the soil loss value estimated. As an example for use of MUSLE, a project may have a short construction duration thereby requiring fewer maintenance cycles and a reduced sediment storage volume. MUSLE would be used to estimate the anticipated soil loss based on a specific storm event to evaluate the sediment storage volume and appropriate maintenance frequency.
- The soil loss estimates are an essential step in the design and it is essential that the designer provide construction contractors with enough information to understand maintenance frequency and/or depths within the basin that would trigger maintenance. Providing maintenance methods, frequency and specification should be included in design bid documents such as the SWPPP Site Map.
- Once the designer has quantified the amount of soil entering the basin, the depth required for sediment storage can be determined by dividing the estimated sediment loss by the surface area of the basin.

Step 4. Other Design Considerations

- Consider designing the volume of the settling zone for the total storm volume associated with the 2-year event or other appropriate design storms specified by the local agency. This volume can be used as a guide for sizing the basin without iterative routing calculations. The depth of the settling zone can be estimated by dividing the estimated 2-yr storm volume by the surface area of the basin.
- The basin volume consists of two zones:
  - A sediment storage zone at least 1 ft deep.
  - A settling zone at least 2 ft deep.

- The basin depth must be no less than 3 ft (not including freeboard).

- Proper hydraulic design of the outlet is critical to achieving the desired performance of the basin. The outlet should be designed to drain the basin within 24 to 96 hours (also referred to as "drawdown time"). The 24-hour limit is specified to provide adequate settling time; the 96-hour limit is specified to mitigate vector control concerns.

- Confirmation of the basin performance can be evaluated by routing the design storm (10-yr 6-hr, or as directed by local regulations) through the basin based on the basin volume (stage-storage curve) and the outlet design (stage-discharge curve based on the orifice configuration or equivalent outlet design).

- Sediment basins, regardless of size and storage volume, should include features to accommodate overflow or bypass flows that exceed the design storm event.

  - Include an emergency spillway to accommodate flows not carried by the principal spillway. The spillway should consist of an open channel (earthen or vegetated) over undisturbed material (not fill) or constructed of a non-erodible riprap (or equivalent protection) on fill slopes.

  - The spillway control section, which is a level portion of the spillway channel at the highest elevation in the channel, should be a minimum of 20 ft in length.

- Rock, vegetation or appropriate erosion control should be used to protect the basin inlet, outlet, and slopes against erosion.

- The total depth of the sediment basin should include the depth required for sediment storage, depth required for settling zone and freeboard of at least 1 foot or as regulated by local flood control agency for a flood event specified by the local agency.

- The basin alignment should be designed such that the length of the basin is more than twice the width of the basin; the length should be determined by measuring the distance between the inlet and the outlet. If the site topography does not allow for this configuration baffles should be installed so that the ratio is satisfied. If a basin has more than one inflow point, any inflow point that conveys more than 30 percent of the total peak inflow rate has to meet the required length to width ratio.

- An alternative basin sizing method proposed by Fifield (2004) can be consulted to estimate an alternative length to width ratio and basin configuration. These methods can be considered as part of Option 3 which allows for alternative designs that are protective or more protective of water quality.

- Baffles (see Figure 4 at the end of this fact sheet) can be considered at project sites where the existing topography or site constraints limit the length to width ratio. Baffles should be constructed of earthen berms or other structural material within the basin to divert flow in the basin, thus increasing the effective flow length from the basin inlet to the outlet riser. Baffles also reduce the change of short circuiting and allows for settling throughout the basin.

- Baffles are typically constructed from the invert of the basin to the crest of the emergency spillway (i.e., design event flows are meant to flow around the baffles and flows greater than the design event would flow over the baffles to the emergency spillway).
- Use of other materials for construction of basin baffles (such as silt fence) may not be appropriate based on the material specifications and will require frequent maintenance (maintain after every storm event). Maintenance may not be feasible when required due to flooded conditions resulting from frequent (i.e., back to back) storm events. Use of alternative baffle materials should not deviate from the intended purpose of the material, as described by the manufacturer.
- Sediment basins are best used in conjunction with erosion controls.
- Basins with an impounding levee greater than 4.5 ft tall, measured from the lowest point to the impounding area to the highest point of the levee, and basins capable of impounding more than 35,000 ft^3, should be designed by a Registered Civil Engineer. The design should include maintenance requirements, including sediment and vegetation removal, to ensure continuous function of the basin outlet and bypass structures.
- A forebay, constructed upstream of the basin, may be provided to remove debris and larger particles.
- The outflow from the sediment basin should be provided with velocity dissipation devices (see BMP EC-10) to prevent erosion and scouring of the embankment and channel.
- The principal outlet should consist of a corrugated metal, high density polyethylene (HDPE), or reinforced concrete riser pipe with dewatering holes and an anti-vortex device and trash rack attached to the top of the riser, to prevent floating debris from flowing out of the basin or obstructing the system. This principal structure should be designed to accommodate the inflow design storm.
- A rock pile or rock-filled gabions can serve as alternatives to the debris screen, although the designer should be aware of the potential for extra maintenance involved should the pore spaces in the rock pile clog.
- The outlet structure should be placed on a firm, smooth foundation with the base securely anchored with concrete or other means to prevent floatation.
- Attach riser pipe (watertight connection) to a horizontal pipe (barrel). Provide anti-seep collars on the barrel.
- Cleanout level should be clearly marked on the riser pipe.

Installation

- Securely anchor and install an anti-seep collar on the outlet pipe/riser and provide an emergency spillway for passing major floods (see local flood control agency).
- Areas under embankments must be cleared and stripped of vegetation.

- Chain link fencing should be provided around each sediment basin to prevent unauthorized entry to the basin or if safety is a concern.

Costs

The cost of a sediment basin is highly variable and is dependent of the site configuration. To decrease basin construction costs, designers should consider using existing site features such as berms or depressed area to site the sediment basin. Designers should also consider potential savings associated with designing the basin to minimize the number of maintenance cycles and siting the basin in a location where a permanent BMP (e.g., extended detention basin) is required for the project site.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level and as required by local requirements. It is recommended that at a minimum, basins be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Examine basin banks for seepage and structural soundness.
- Check inlet and outlet structures and spillway for any damage or obstructions. Repair damage and remove obstructions as needed.
- Check inlet and outlet area for erosion and stabilize if required.
- Check fencing for damage and repair as needed.
- Sediment that accumulates in the basin must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when sediment accumulation reaches one-half the designated sediment storage volume. Sediment removed during maintenance should be managed properly. The sediment should be appropriately evaluated and used or disposed of accordingly. Options include: incorporating sediment into earthwork on the site (only if there is no risk that sediment is contaminated); or off-site export/disposal at an appropriate location (e.g., sediment characterization and disposal to an appropriate landfill).
- Remove standing water from basin within 96 hours after accumulation.
- If the basin does not drain adequately (e.g., due to storms that are more frequent or larger than the design storm or other unforeseen site conditions), dewatering should be conducted in accordance with appropriate dewatering BMPs (see NS-2) and in accordance with local permits as applicable.
- To minimize vector production:
  - Remove accumulation of live and dead floating vegetation in basins during every inspection.
  - Remove excessive emergent and perimeter vegetation as needed or as advised by local or state vector control agencies.

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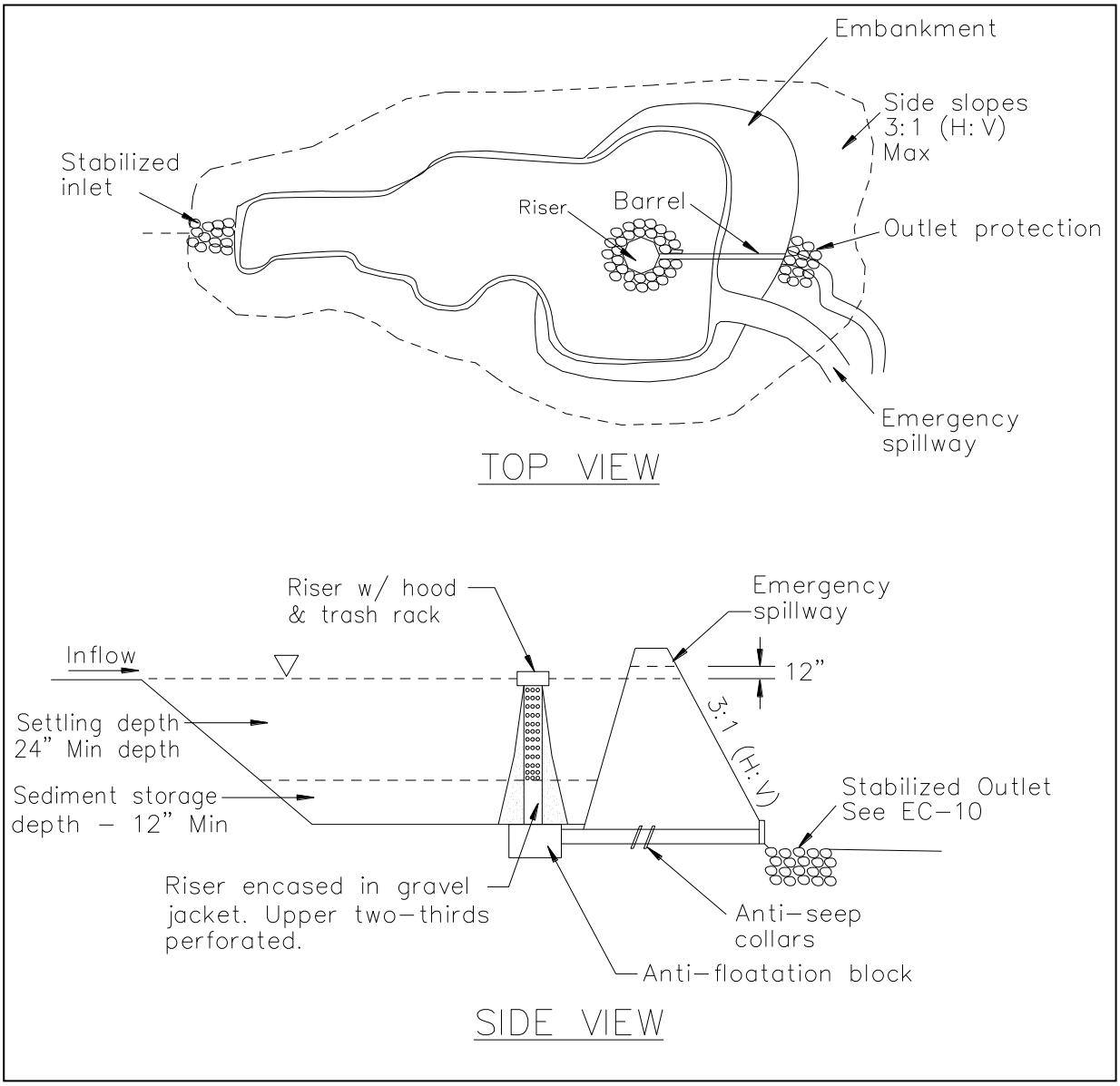


FIGURE 1: TYPICAL TEMPORARY SEDIMENT BASIN
MULTIPLE ORIFICE DESIGN
NOT TO SCALE

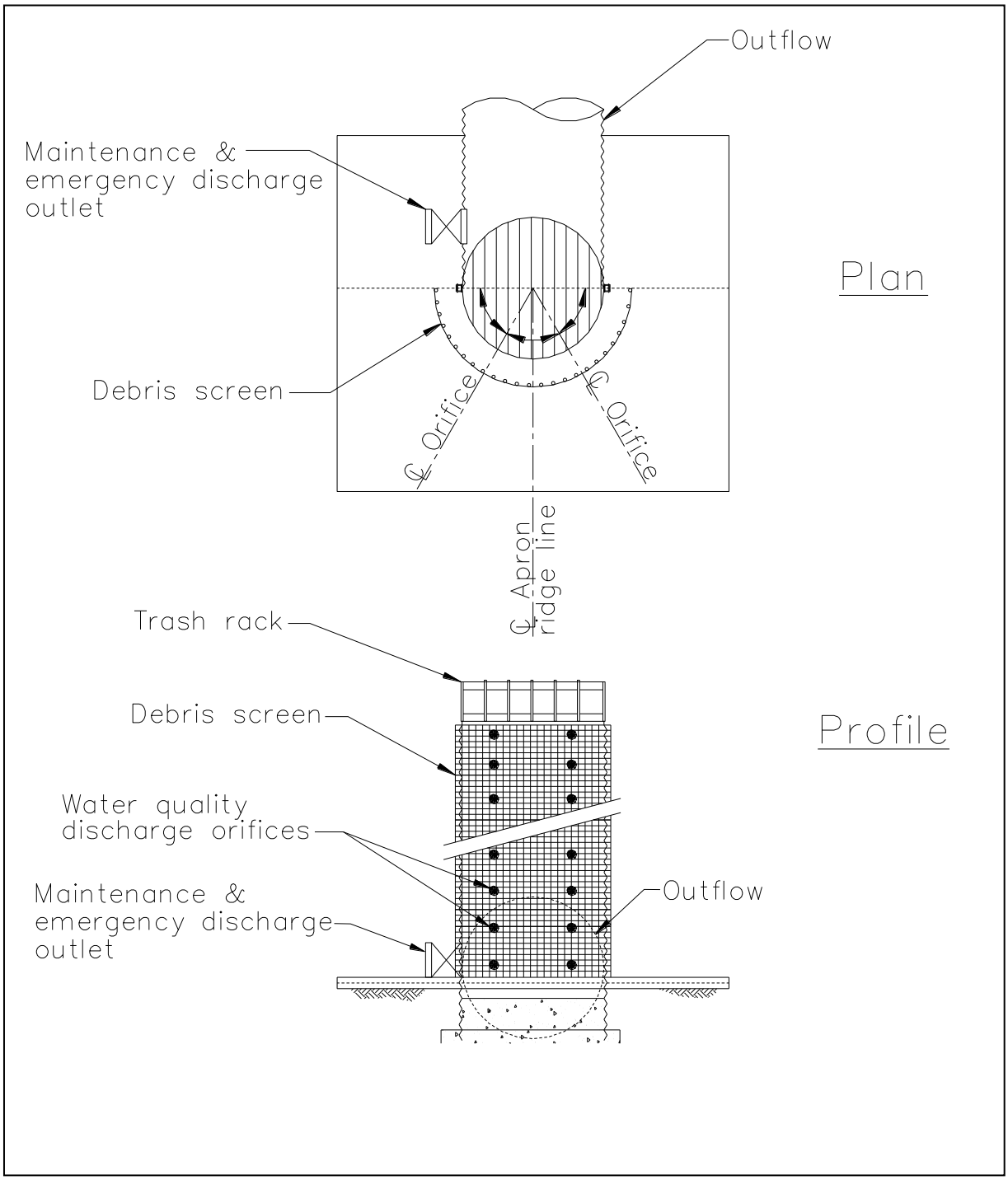


FIGURE 2: MULTIPLE ORIFICE OUTLET RISER

NOT TO SCALE

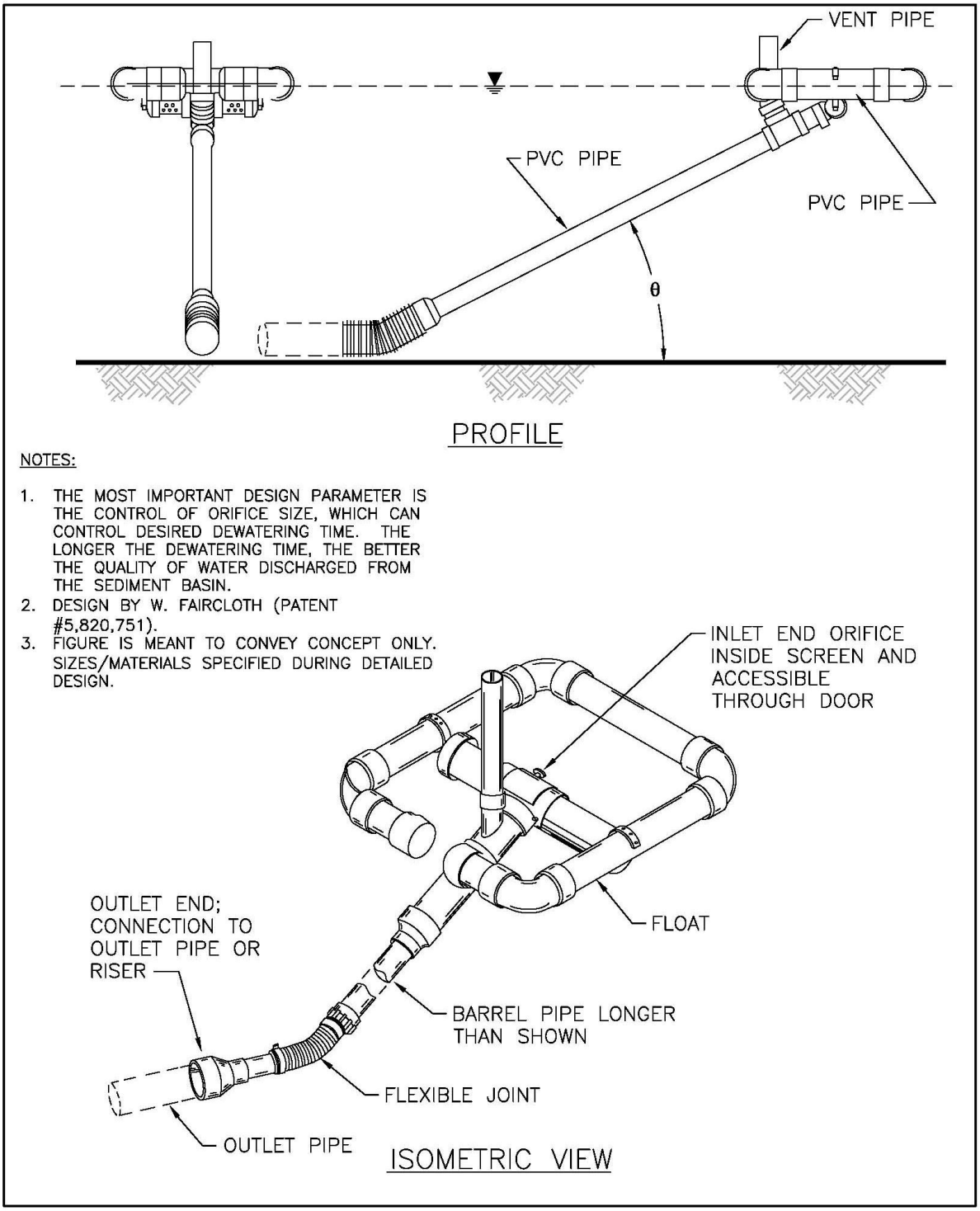


FIGURE 3: TYPICAL SKIMMER

NOT TO SCALE

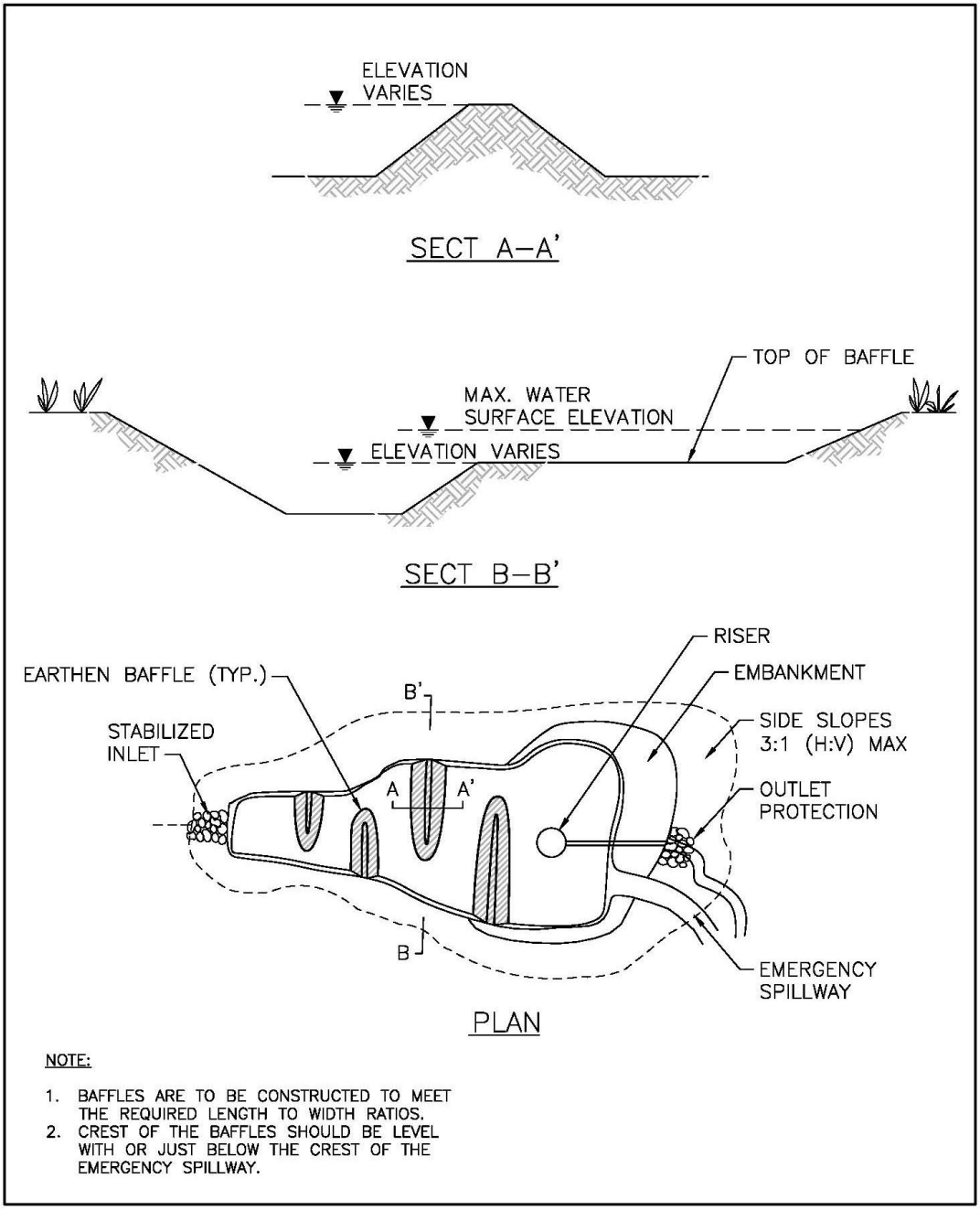
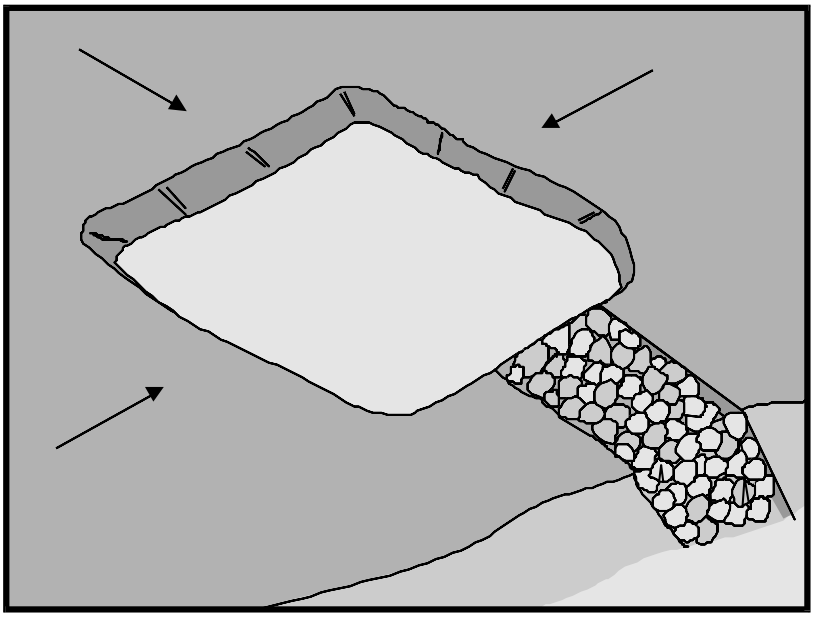


FIGURE 4: TYPICAL TEMPORARY SEDIMENT BASIN WITH BAFFLES

NOT TO SCALE

Sediment Trap SE-3



Categories

EC	Erosion Control	
SE	Sediment Control	☑
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	☑
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-2 Sediment Basin (for larger areas)

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Description and Purpose

A sediment trap is a containment area where sediment-laden runoff is temporarily detained under quiescent conditions, allowing sediment to settle out or before the runoff is discharged by gravity flow. Sediment traps are formed by excavating or constructing an earthen embankment across a waterway or low drainage area.

Trap design guidance provided in this fact sheet is not intended to guarantee compliance with numeric discharge limits (numeric action levels or numeric effluent limits for turbidity). Compliance with discharge limits requires a thoughtful approach to comprehensive BMP planning, implementation, and maintenance. Therefore, optimally designed and maintained sediment traps should be used in conjunction with a comprehensive system of BMPs.

Suitable Applications

Sediment traps should be considered for use:

- At the perimeter of the site at locations where sediment-laden runoff is discharged offsite.
- At multiple locations within the project site where sediment control is needed.
- Around or upslope from storm drain inlet protection measures.
- Sediment traps may be used on construction projects where the drainage area is less than 5 acres. Traps would be

placed where sediment-laden stormwater may enter a storm drain or watercourse. SE-2, Sediment Basins, must be used for drainage areas greater than 5 acres.

- As a supplemental control, sediment traps provide additional protection for a water body or for reducing sediment before it enters a drainage system.

Limitations

- Requires large surface areas to permit infiltration and settling of sediment.
- Not appropriate for drainage areas greater than 5 acres.
- Only removes large and medium sized particles and requires upstream erosion control.
- Attractive and dangerous to children, requiring protective fencing.
- Conducive to vector production.
- Should not be located in live streams.

Implementation

Design

A sediment trap is a small temporary ponding area, usually with a gravel outlet, formed by excavation or by construction of an earthen embankment. Its purpose is to collect and store sediment from sites cleared or graded during construction. It is intended for use on small drainage areas with no unusual drainage features and projected for a quick build-out time. It should help in removing coarse sediment from runoff. The trap is a temporary measure with a design life of approximately six months to one year and is to be maintained until the site area is permanently protected against erosion by vegetation and/or structures.

Sediment traps should be used only for small drainage areas. If the contributing drainage area is greater than 5 acres, refer to SE-2, Sediment Basins, or subdivide the catchment area into smaller drainage basins.

Sediment usually must be removed from the trap after each rainfall event. The SWPPP should detail how this sediment is to be disposed, such as in fill areas onsite, or removal to an approved offsite dump. Sediment traps used as perimeter controls should be installed before any land disturbance takes place in the drainage area.

Sediment traps are usually small enough that a failure of the structure would not result in a loss of life, damage to home or buildings, or interruption in the use of public roads or utilities. However, sediment traps are attractive to children and can be dangerous. The following recommendations should be implemented to reduce risks:

- Install continuous fencing around the sediment trap or pond. Consult local ordinances regarding requirements for maintaining health and safety.
- Restrict basin side slopes to 3:1 or flatter.

Sediment trap size depends on the type of soil, size of the drainage area, and desired sediment removal efficiency (see SE-2, Sediment Basin). As a rule of thumb, the larger the basin volume

the greater the sediment removal efficiency. Sizing criteria are typically established under the local grading ordinance or equivalent. The runoff volume from a 2-year storm is a common design criteria for a sediment trap. The sizing criteria below assume that this runoff volume is 0.042 acre-ft/acre (0.5 in. of runoff). While the climatic, topographic, and soil type extremes make it difficult to establish a statewide standard, the following criteria should trap moderate to high amounts of sediment in most areas of California:

- Locate sediment traps as near as practical to areas producing the sediment.
- Trap should be situated according to the following criteria: (1) by excavating a suitable area or where a low embankment can be constructed across a swale, (2) where failure would not cause loss of life or property damage, and (3) to provide access for maintenance, including sediment removal and sediment stockpiling in a protected area.
- Trap should be sized to accommodate a settling zone and sediment storage zone with recommended minimum volumes of 67 yd^3/acre and 33 yd^3/acre of contributing drainage area, respectively, based on 0.5 in. of runoff volume over a 24-hour period. In many cases, the size of an individual trap is limited by available space. Multiple traps or additional volume may be required to accommodate specific rainfall, soil, and site conditions.
- Traps with an impounding levee greater than 4.5 ft tall, measured from the lowest point to the impounding area to the highest point of the levee, and traps capable of impounding more than 35,000 ft^3, should be designed by a Registered Civil Engineer. The design should include maintenance requirements, including sediment and vegetation removal, to ensure continuous function of the trap outlet and bypass structures.
- The outlet pipe or open spillway must be designed to convey anticipated peak flows.
- Use rock or vegetation to protect the trap outlets against erosion.
- Fencing should be provided to prevent unauthorized entry.

Installation

Sediment traps can be constructed by excavating a depression in the ground or creating an impoundment with a small embankment. Sediment traps should be installed outside the area being graded and should be built prior to the start of the grading activities or removal of vegetation. To minimize the area disturbed by them, sediment traps should be installed in natural depressions or in small swales or drainage ways. The following steps must be followed during installation:

- The area under the embankment must be cleared, grubbed, and stripped of any vegetation and root mat. The pool area should be cleared.
- The fill material for the embankment must be free of roots or other woody vegetation as well as oversized stones, rocks, organic material, or other objectionable material. The embankment may be compacted by traversing with equipment while it is being constructed.
- All cut-and-fill slopes should be 3:1 or flatter.
- When a riser is used, all pipe joints must be watertight.

- When a riser is used, at least the top two-thirds of the riser should be perforated with 0.5 in. diameter holes spaced 8 in. vertically and 10 to 12 in. horizontally. See SE-2, Sediment Basin.
- When an earth or stone outlet is used, the outlet crest elevation should be at least 1 ft below the top of the embankment.
- When crushed stone outlet is used, the crushed stone used in the outlet should meet AASHTO M43, size No. 2 or 24, or its equivalent such as MSHA No. 2. Gravel meeting the above gradation may be used if crushed stone is not available.

Costs

Average annual cost per installation and maintenance (18 month useful life) is $0.73 per ft^3 ($1,300 per drainage acre). Maintenance costs are approximately 20% of installation costs.

Inspection and Maintenance

- Inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Inspect outlet area for erosion and stabilize if required.
- Inspect trap banks for seepage and structural soundness, repair as needed.
- Inspect outlet structure and spillway for any damage or obstructions. Repair damage and remove obstructions as needed.
- Inspect fencing for damage and repair as needed.
- Inspect the sediment trap for area of standing water during every visit. Corrective measures should be taken if the BMP does not dewater completely in 96 hours or less to prevent vector production.
- Sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the trap capacity. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed of at an appropriate location.
- Remove vegetation from the sediment trap when first detected to prevent pools of standing water and subsequent vector production.
- BMPs that require dewatering shall be continuously attended while dewatering takes place. Dewatering BMPs per NS-2 shall be implemented at all times during dewatering activities.

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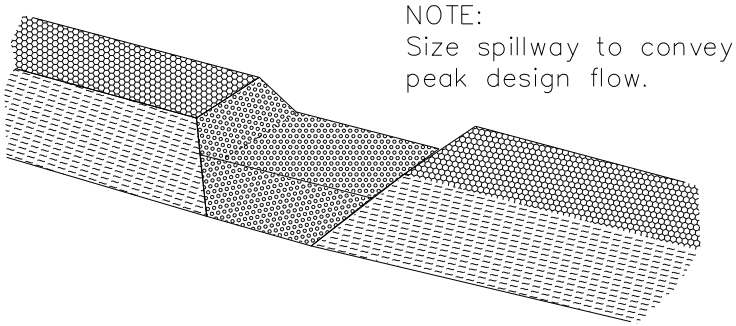
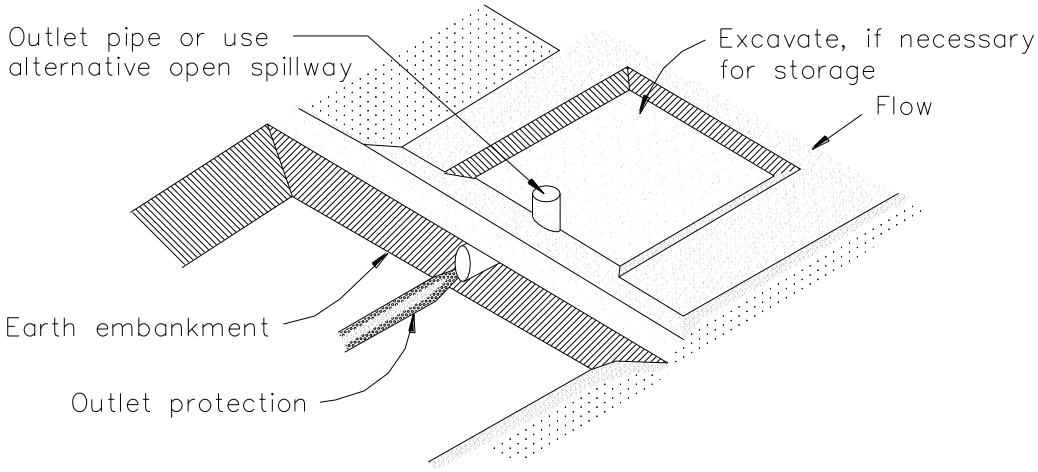
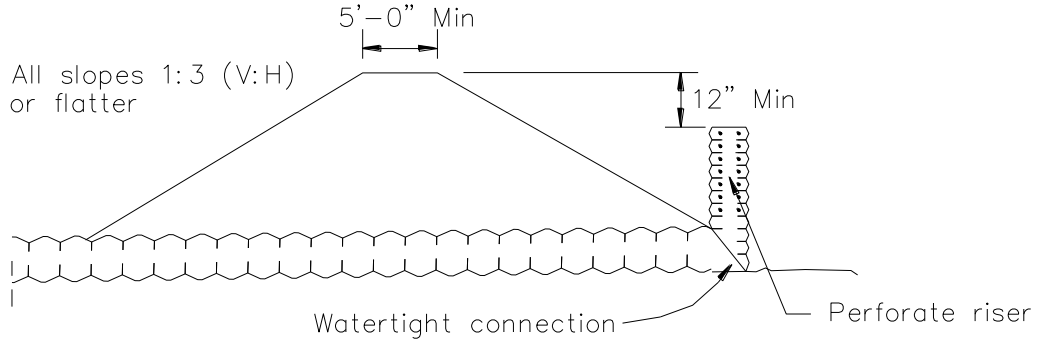


TYPICAL OPEN SPILLWAY

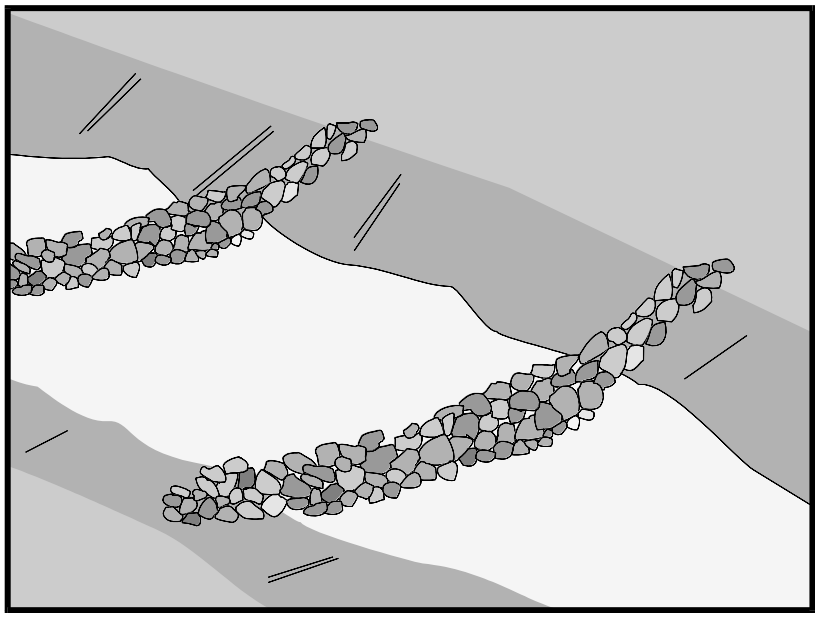




EMBANKMENT SECTION THRU RISER

TYPICAL SEDIMENT TRAP
NOT TO SCALE

Check Dams SE-4



Categories

EC	Erosion Control	☒
SE	Sediment Control	☑
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-5 Fiber Rolls

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

SE-12 Manufactured Linear Sediment Controls

SE-14 Biofilter Bags

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Description and Purpose

A check dam is a small barrier constructed of rock, gravel bags, sandbags, fiber rolls, or other proprietary products, placed across a constructed swale or drainage ditch. Check dams reduce the effective slope of the channel, thereby reducing scour and channel erosion by reducing flow velocity and increasing residence time within the channel, allowing sediment to settle.

Suitable Applications

Check dams may be appropriate in the following situations:

- To promote sedimentation behind the dam.
- To prevent erosion by reducing the velocity of channel flow in small intermittent channels and temporary swales.
- In small open channels that drain 10 acres or less.
- In steep channels where stormwater runoff velocities exceed 5 ft/s.
- During the establishment of grass linings in drainage ditches or channels.
- In temporary ditches where the short length of service does not warrant establishment of erosion-resistant linings.
- To act as a grade control structure.

Limitations

- Not to be used in live streams or in channels with extended base flows.
- Not appropriate in channels that drain areas greater than 10 acres.
- Not appropriate in channels that are already grass-lined unless erosion potential or sediment-laden flow is expected, as installation may damage vegetation.
- Require extensive maintenance following high velocity flows.
- Promotes sediment trapping which can be re-suspended during subsequent storms or removal of the check dam.
- Do not construct check dams with straw bales or silt fence.
- Water suitable for mosquito production may stand behind check dams, particularly if subjected to daily non-stormwater discharges.

Implementation

General

Check dams reduce the effective slope and create small pools in swales and ditches that drain 10 acres or less. Using check dams to reduce channel slope reduces the velocity of stormwater flows, thus reducing erosion of the swale or ditch and promoting sedimentation. Thus, check dams are dual-purpose and serve an important role as erosion controls as well as as sediment controls. Note that use of 1-2 isolated check dams for sedimentation will likely result in little net removal of sediment because of the small detention time and probable scour during longer storms. Using a series of check dams will generally increase their effectiveness. A sediment trap (SE-3) may be placed immediately upstream of the check dam to increase sediment removal efficiency.

Design and Layout

Check dams work by decreasing the effective slope in ditches and swales. An important consequence of the reduced slope is a reduction in capacity of the ditch or swale. This reduction in capacity should be considered when using this BMP, as reduced capacity can result in overtopping of the ditch or swale and resultant consequences. In some cases, such as a "permanent" ditch or swale being constructed early and used as a "temporary" conveyance for construction flows, the ditch or swale may have sufficient capacity such that the temporary reduction in capacity due to check dams is acceptable. When check dams reduce capacities beyond acceptable limits, either:

- Don't use check dams. Consider alternative BMPs, or.
- Increase the size of the ditch or swale to restore capacity.

Maximum slope and velocity reduction is achieved when the toe of the upstream dam is at the same elevation as the top of the downstream dam (see "Spacing Between Check Dams" detail at the end of this fact sheet). The center section of the dam should be lower than the edge sections (at least 6 inches), acting as a spillway, so that the check dam will direct flows to the center of

the ditch or swale (see "Typical Rock Check Dam" detail at the end of this fact sheet). Bypass or side-cutting can occur if a sufficient spillway is not provided in the center of the dam.

Check dams are usually constructed of rock, gravel bags, sandbags, and fiber rolls. A number of products can also be used as check dams (e.g. HDPE check dams, temporary silt dikes (SE-12)), and some of these products can be removed and reused. Check dams can also be constructed of logs or lumber, and have the advantage of a longer lifespan when compared to gravel bags, sandbags, and fiber rolls. Check dams should not be constructed from straw bales or silt fences, since concentrated flows quickly wash out these materials.

Rock check dams are usually constructed of 8 to 12 in. rock. The rock is placed either by hand or mechanically, but never just dumped into the channel. The dam should completely span the ditch or swale to prevent washout. The rock used should be large enough to stay in place given the expected design flow through the channel. It is recommended that abutments be extended 18 in. into the channel bank. Rock can be graded such that smaller diameter rock (e.g. 2-4 in) is located on the upstream side of larger rock (holding the smaller rock in place); increasing residence time.

Log check dams are usually constructed of 4 to 6 in. diameter logs, installed vertically. The logs should be embedded into the soil at least 18 in. Logs can be bolted or wired to vertical support logs that have been driven or buried into the soil.

See fiber rolls, SE-5, for installation of fiber roll check dams.

Gravel bag and sand bag check dams are constructed by stacking bags across the ditch or swale, shaped as shown in the drawings at the end of this fact sheet (see "Gravel Bag Check Dam" detail at the end of this fact sheet).

Manufactured products, such as temporary silt dikes (SE-12), should be installed in accordance with the manufacturer's instructions. Installation typically requires anchoring or trenching of products, as well as regular maintenance to remove accumulated sediment and debris.

If grass is planted to stabilize the ditch or swale, the check dam should be removed when the grass has matured (unless the slope of the swales is greater than 4%).

The following guidance should be followed for the design and layout of check dams:

- Install the first check dam approximately 16 ft from the outfall device and at regular intervals based on slope gradient and soil type.
- Check dams should be placed at a distance and height to allow small pools to form between each check dam.
- For multiple check dam installation, backwater from a downstream check dam should reach the toes of the upstream check dam.
- A sediment trap provided immediately upstream of the check dam will help capture sediment. Due to the potential for this sediment to be resuspended in subsequent storms, the sediment trap should be cleaned following each storm event.

- High flows (typically a 2-year storm or larger) should safely flow over the check dam without an increase in upstream flooding or damage to the check dam.
- Where grass is used to line ditches, check dams should be removed when grass has matured sufficiently to protect the ditch or swale.

Materials

- Rock used for check dams should typically be 8-12 in rock and be sufficiently sized to stay in place given expected design flows in the channel. Smaller diameter rock (e.g. 2 to 4 in) can be placed on the upstream side of larger rock to increase residence time.
- Gravel bags used for check dams should conform to the requirements of SE-6, Gravel Bag Berms.
- Sandbags used for check dams should conform to SE-8, Sandbag Barrier.
- Fiber rolls used for check dams should conform to SE-5, Fiber Rolls.
- Temporary silt dikes used for check dams should conform to SE-12, Temporary Silt Dikes.

Installation

- Rock should be placed individually by hand or by mechanical methods (no dumping of rock) to achieve complete ditch or swale coverage.
- Tightly abut bags and stack according to detail shown in the figure at the end of this section (pyramid approach). Gravel bags and sandbags should not be stacked any higher than 3 ft.
- Upper rows or gravel and sand bags shall overlap joints in lower rows.
- Fiber rolls should be trenched in, backfilled, and firmly staked in place.
- Install along a level contour.
- HDPE check dams, temporary silt dikes, and other manufactured products should be used and installed per manufacturer specifications.

Costs

Cost consists of labor costs if materials are readily available (such as gravel on-site). If material must be imported, costs will increase. For other material and installation costs, see SE-5, SE-6, SE-8, SE-12, and SE-14.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Replace missing rock, bags, rolls, etc. Replace bags or rolls that have degraded or have become damaged.

- If the check dam is used as a sediment capture device, sediment that accumulates behind the BMP should be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height.
- If the check dam is used as a grade control structure, sediment removal is not required as long as the system continues to control the grade.
- Inspect areas behind check dams for pools of standing water, especially if subjected to daily non-stormwater discharges.
- Remove accumulated sediment prior to permanent seeding or soil stabilization.
- Remove check dam and accumulated sediment when check dams are no longer needed.

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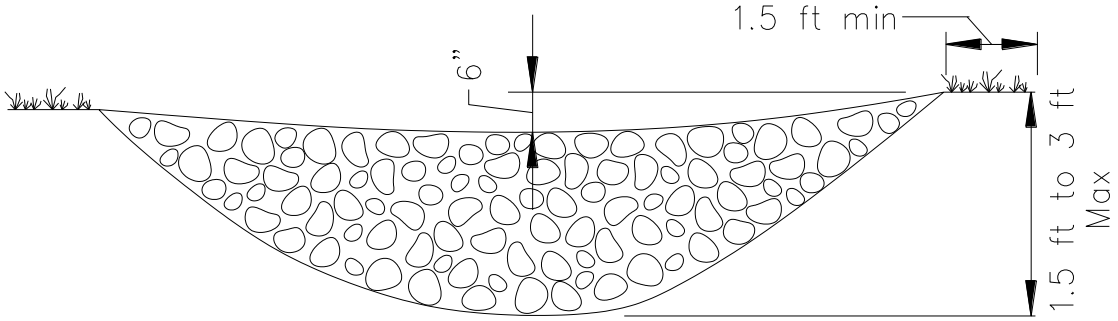
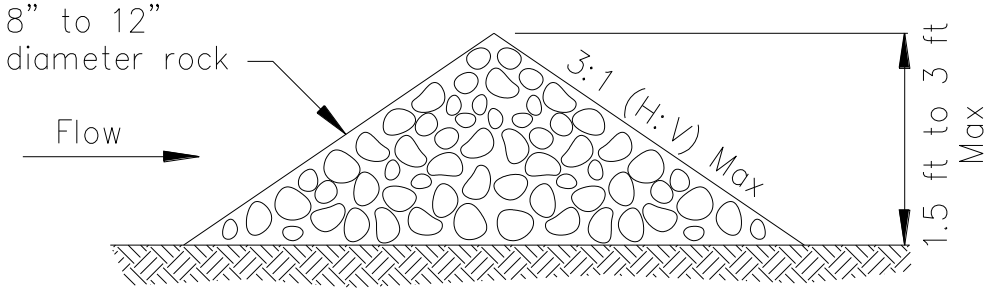
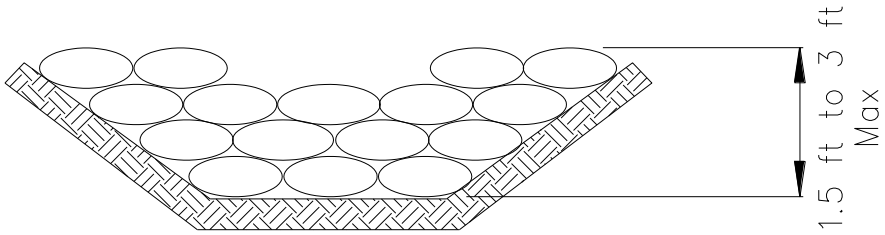


ELEVATION

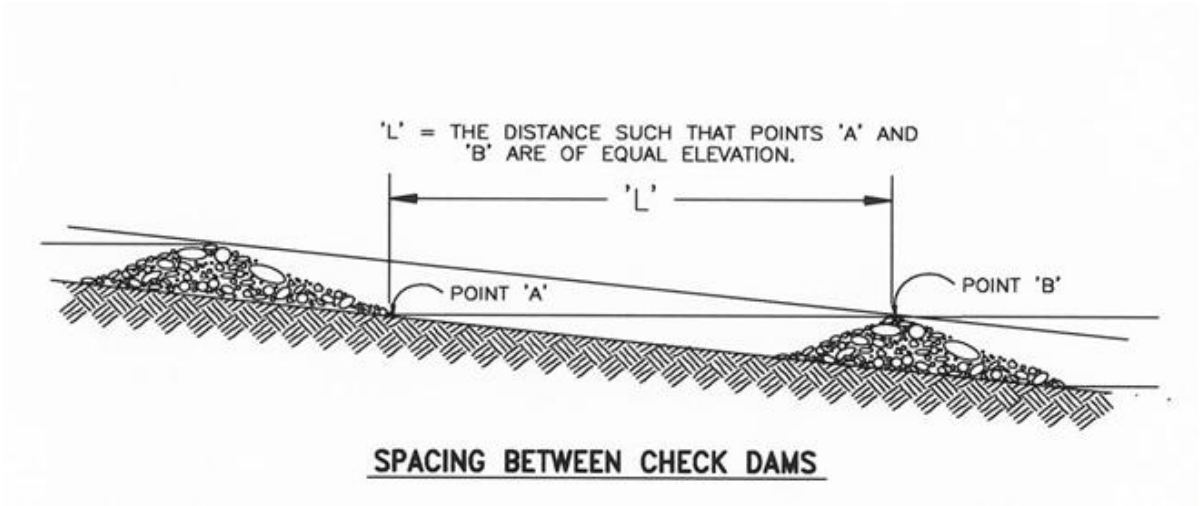


TYPICAL ROCK CHECK DAM SECTION

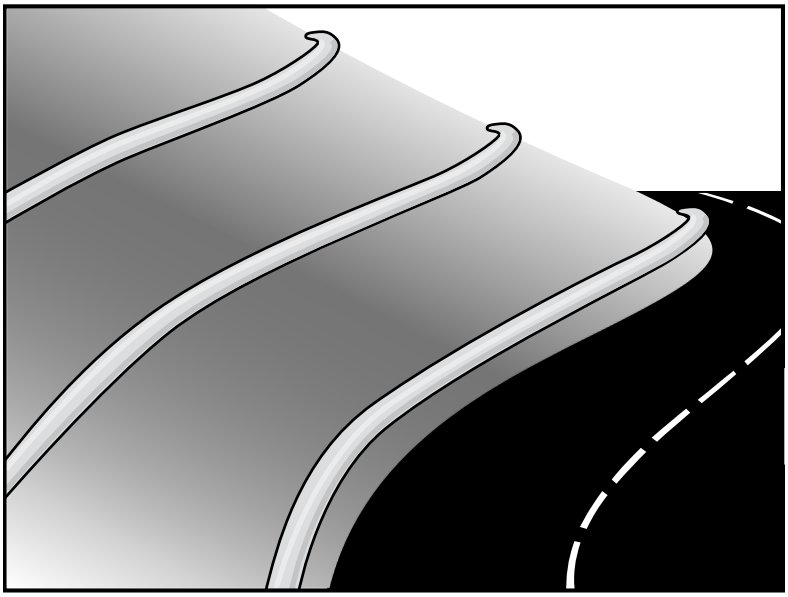
ROCK CHECK DAM
NOT TO SCALE



GRAVEL BAG CHECK DAM ELEVATION
NOT TO SCALE


'L' = THE DISTANCE SUCH THAT POINTS 'A' AND 'B' ARE OF EQUAL ELEVATION.
'L'
POINT 'A'
POINT 'B'
SPACING BETWEEN CHECK DAMS

Fiber Rolls SE-5



Categories

EC	Erosion Control	☒
SE	Sediment Control	☑
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Description and Purpose

A fiber roll consists of straw, coir, or other biodegradable materials bound into a tight tubular roll wrapped by netting, which can be photodegradable or natural. Additionally, gravel core fiber rolls are available, which contain an imbedded ballast material such as gravel or sand for additional weight when staking the rolls are not feasible (such as use as inlet protection). When fiber rolls are placed at the toe and on the face of slopes along the contours, they intercept runoff, reduce its flow velocity, release the runoff as sheet flow, and provide removal of sediment from the runoff (through sedimentation). By interrupting the length of a slope, fiber rolls can also reduce sheet and rill erosion until vegetation is established.

Suitable Applications

Fiber rolls may be suitable:

- Along the toe, top, face, and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow.
- At the end of a downward slope where it transitions to a steeper slope.
- Along the perimeter of a project.
- As check dams in unlined ditches with minimal grade.
- Down-slope of exposed soil areas.
- At operational storm drains as a form of inlet protection.

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-1 Silt Fence

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

SE-12 Manufactured Linear Sediment Controls

SE-14 Biofilter Bags

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- Around temporary stockpiles.

Limitations

- Fiber rolls are not effective unless trenched in and staked.
- Not intended for use in high flow situations.
- Difficult to move once saturated.
- If not properly staked and trenched in, fiber rolls could be transported by high flows.
- Fiber rolls have a very limited sediment capture zone.
- Fiber rolls should not be used on slopes subject to creep, slumping, or landslide.
- Rolls typically function for 12-24 months depending upon local conditions.

Implementation

Fiber Roll Materials

- Fiber rolls should be prefabricated.
- Fiber rolls may come manufactured containing polyacrylamide (PAM), a flocculating agent within the roll. Fiber rolls impregnated with PAM provide additional sediment removal capabilities and should be used in areas with fine, clayey or silty soils to provide additional sediment removal capabilities. Monitoring may be required for these installations.
- Fiber rolls are made from weed free rice straw, flax, or a similar agricultural material bound into a tight tubular roll by netting.
- Typical fiber rolls vary in diameter from 9 in. to 20 in. Larger diameter rolls are available as well.

Installation

- Locate fiber rolls on level contours spaced as follows:
  - Slope inclination of 4:1 (H:V) or flatter: Fiber rolls should be placed at a maximum interval of 20 ft.
  - Slope inclination between 4:1 and 2:1 (H:V): Fiber Rolls should be placed at a maximum interval of 15 ft. (a closer spacing is more effective).
  - Slope inclination 2:1 (H:V) or greater: Fiber Rolls should be placed at a maximum interval of 10 ft. (a closer spacing is more effective).
- Prepare the slope before beginning installation.
- Dig small trenches across the slope on the contour. The trench depth should be ¼ to 1/3 of the thickness of the roll, and the width should equal the roll diameter, in order to provide area to backfill the trench.

- It is critical that rolls are installed perpendicular to water movement, and parallel to the slope contour.
- Start building trenches and installing rolls from the bottom of the slope and work up.
- It is recommended that pilot holes be driven through the fiber roll. Use a straight bar to drive holes through the roll and into the soil for the wooden stakes.
- Turn the ends of the fiber roll up slope to prevent runoff from going around the roll.
- Stake fiber rolls into the trench.
  - Drive stakes at the end of each fiber roll and spaced 4 ft maximum on center.
  - Use wood stakes with a nominal classification of 0.75 by 0.75 in. and minimum length of 24 in.
- If more than one fiber roll is placed in a row, the rolls should be overlapped, not abutted.
- See typical fiber roll installation details at the end of this fact sheet.

Removal

- Fiber rolls can be left in place or removed depending on the type of fiber roll and application (temporary vs. permanent installation). Typically, fiber rolls encased with plastic netting are used for a temporary application because the netting does not biodegrade. Fiber rolls used in a permanent application are typically encased with a biodegradeable material and are left in place. Removal of a fiber roll used in a permanent application can result in greater disturbance.
- Temporary installations should only be removed when up gradient areas are stabilized per General Permit requirements, and/or pollutant sources no longer present a hazard. But, they should also be removed before vegetation becomes too mature so that the removal process does not disturb more soil and vegetation than is necessary.

Costs

Material costs for regular fiber rolls range from $20 - $30 per 25 ft roll.

Material costs for PAM impregnated fiber rolls range between 7.00-$9.00 per linear foot, based upon vendor research.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Repair or replace split, torn, unraveling, or slumping fiber rolls.
- If the fiber roll is used as a sediment capture device, or as an erosion control device to maintain sheet flows, sediment that accumulates in the BMP should be periodically removed

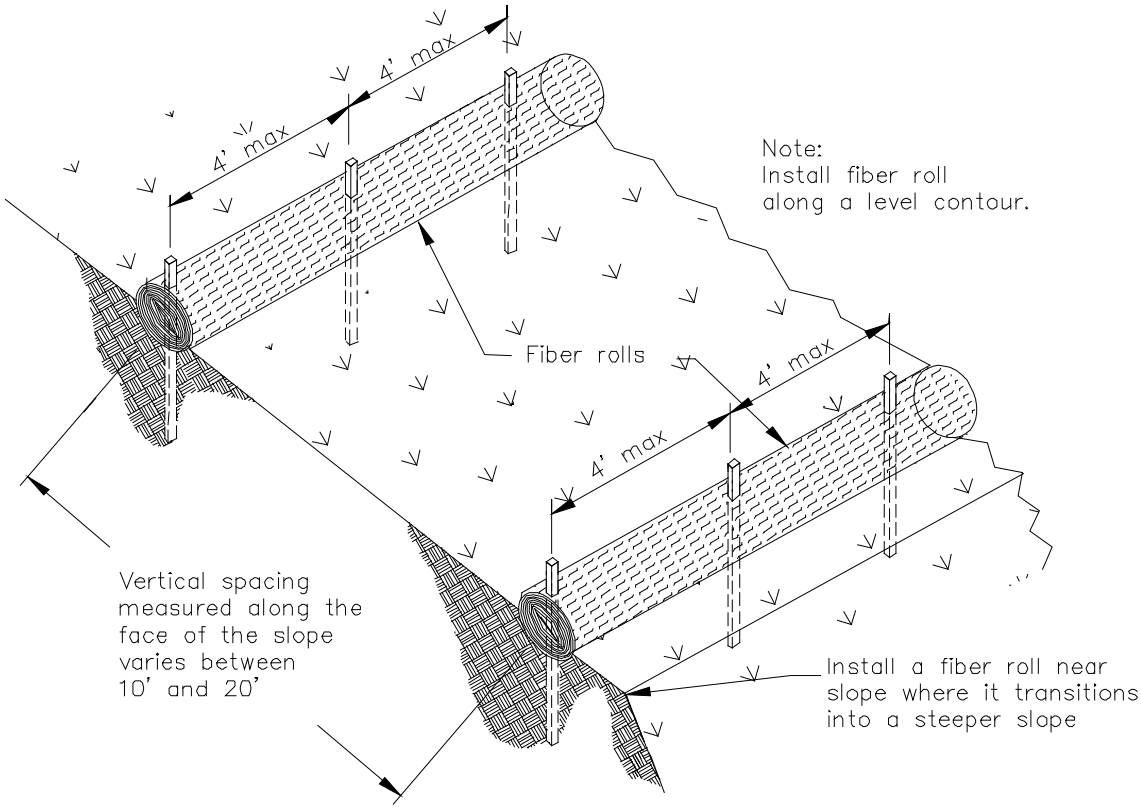
in order to maintain BMP effectiveness. Sediment should be removed when sediment accumulation reaches one-third the designated sediment storage depth.

- If fiber rolls are used for erosion control, such as in a check dam, sediment removal should not be required as long as the system continues to control the grade. Sediment control BMPs will likely be required in conjunction with this type of application.
- Repair any rills or gullies promptly.

References

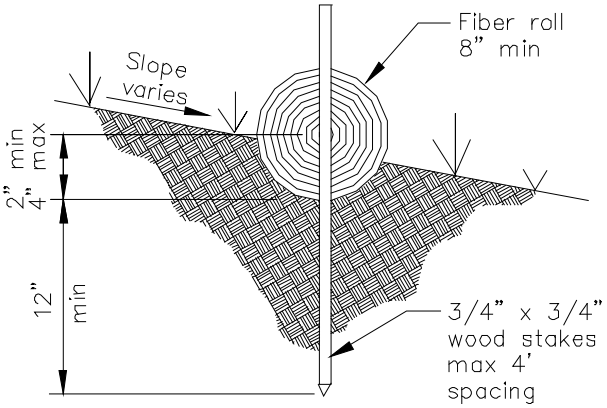
Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.



TYPICAL FIBER ROLL INSTALLATION

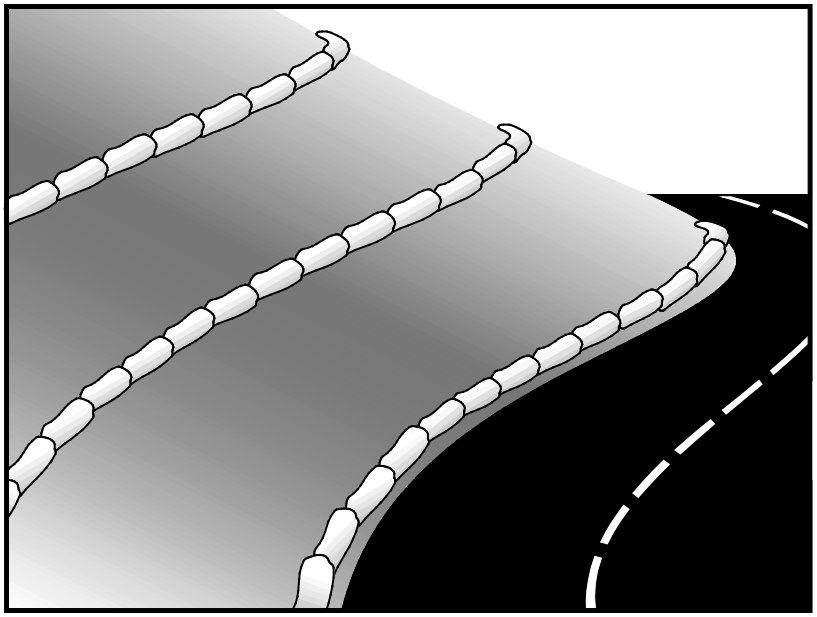
N.T.S.



ENTRENCHMENT DETAIL

N.T.S.

Gravel Bag Berm SE-6



Description and Purpose

A gravel bag berm is a series of gravel-filled bags placed on a level contour to intercept sheet flows. Gravel bags pond sheet flow runoff, allowing sediment to settle out, and release runoff slowly as sheet flow, preventing erosion.

Suitable Applications

Gravel bag berms may be suitable:

- As a linear sediment control measure:
  - Below the toe of slopes and erodible slopes
  - As sediment traps at culvert/pipe outlets
  - Below other small cleared areas
  - Along the perimeter of a site
  - Down slope of exposed soil areas
  - Around temporary stockpiles and spoil areas
  - Parallel to a roadway to keep sediment off paved areas
  - Along streams and channels
- As a linear erosion control measure:
  - Along the face and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow.

Categories

EC	Erosion Control	☒
SE	Sediment Control	☑
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-1 Silt Fence

SE-5 Fiber Roll

SE-8 Sandbag Barrier

SE-12 Temporary Silt Dike

SE-14 Biofilter Bags

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- At the top of slopes to divert runoff away from disturbed slopes.
- As chevrons (small check dams) across mildly sloped construction roads. For use check dam use in channels, see SE-4, Check Dams.

Limitations

- Gravel berms may be difficult to remove.
- Removal problems limit their usefulness in landscaped areas.
- Gravel bag berm may not be appropriate for drainage areas greater than 5 acres.
- Runoff will pond upstream of the berm, possibly causing flooding if sufficient space does not exist.
- Degraded gravel bags may rupture when removed, spilling contents.
- Installation can be labor intensive.
- Durability of gravel bags is somewhat limited and bags may need to be replaced when installation is required for longer than 6 months.
- Easily damaged by construction equipment.
- When used to detain concentrated flows, maintenance requirements increase.

Implementation

General

A gravel bag berm consists of a row of open graded gravel-filled bags placed on a level contour. When appropriately placed, a gravel bag berm intercepts and slows sheet flow runoff, causing temporary ponding. The temporary ponding allows sediment to settle. The open graded gravel in the bags is porous, which allows the ponded runoff to flow slowly through the bags, releasing the runoff as sheet flows. Gravel bag berms also interrupt the slope length and thereby reduce erosion by reducing the tendency of sheet flows to concentrate into rivulets, which erode rills, and ultimately gullies, into disturbed, sloped soils. Gravel bag berms are similar to sand bag barriers, but are more porous. Generally, gravel bag berms should be used in conjunction with temporary soil stabilization controls up slope to provide effective erosion and sediment control.

Design and Layout

- Locate gravel bag berms on level contours.
- When used for slope interruption, the following slope/sheet flow length combinations apply:
  - Slope inclination of 4:1 (H:V) or flatter: Gravel bags should be placed at a maximum interval of 20 ft, with the first row near the slope toe.
  - Slope inclination between 4:1 and 2:1 (H:V): Gravel bags should be placed at a maximum interval of 15 ft. (a closer spacing is more effective), with the first row near the slope toe.

Slope inclination 2:1 (H:V) or greater: Gravel bags should be placed at a maximum interval of 10 ft. (a closer spacing is more effective), with the first row near the slope toe.

- Turn the ends of the gravel bag barriers up slope to prevent runoff from going around the berm.
- Allow sufficient space up slope from the gravel bag berm to allow ponding, and to provide room for sediment storage.
- For installation near the toe of the slope, gravel bag barriers should be set back from the slope toe to facilitate cleaning. Where specific site conditions do not allow for a set-back, the gravel bag barrier may be constructed on the toe of the slope. To prevent flows behind the barrier, bags can be placed perpendicular to a berm to serve as cross barriers.
- Drainage area should not exceed 5 acres.
- In Non-Traffic Areas:
  - Height = 18 in. maximum
  - Top width = 24 in. minimum for three or more layer construction
  - Top width = 12 in. minimum for one or two layer construction
  - Side slopes = 2:1 (H:V) or flatter
- In Construction Traffic Areas:
  - Height = 12 in. maximum
  - Top width = 24 in. minimum for three or more layer construction.
  - Top width = 12 in. minimum for one or two layer construction.
  - Side slopes = 2:1 (H:V) or flatter.
- Butt ends of bags tightly.
- On multiple row, or multiple layer construction, overlap butt joints of adjacent row and row beneath.
- Use a pyramid approach when stacking bags.

Materials

- ***Bag Material:*** Bags should be woven polypropylene, polyethylene or polyamide fabric or burlap, minimum unit weight of 4 ounces/yd^2, Mullen burst strength exceeding 300 lb/in^2 in conformance with the requirements in ASTM designation D3786, and ultraviolet stability exceeding 70% in conformance with the requirements in ASTM designation D4355.

- ***Bag Size:*** Each gravel-filled bag should have a length of 18 in., width of 12 in., thickness of 3 in., and mass of approximately 33 lbs. Bag dimensions are nominal, and may vary based on locally available materials.

- ***Fill Material:*** Fill material should be 0.5 to 1 in. crushed rock, clean and free from clay, organic matter, and other deleterious material, or other suitable open graded, non-cohesive, porous gravel.

Costs

Material costs for gravel bags are average and are dependent upon material availability. $2.50-3.00 per filled gravel bag is standard based upon vendor research.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.

- Gravel bags exposed to sunlight will need to be replaced every two to three months due to degrading of the bags.

- Reshape or replace gravel bags as needed.

- Repair washouts or other damage as needed.

- Sediment that accumulates in the BMP should be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height.

- Remove gravel bag berms when no longer needed and recycle gravel fill whenever possible and properly dispose of bag material. Remove sediment accumulation and clean, re-grade, and stabilize the area.

References

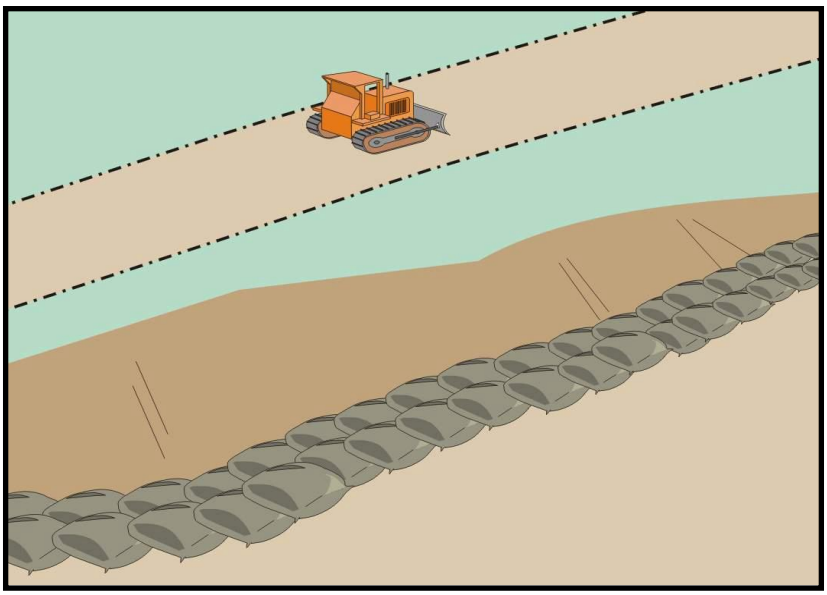
Handbook of Steel Drainage and Highway Construction, American Iron and Steel Institute, 1983.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Stormwater Pollution Plan Handbook, First Edition, State of California, Department of Transportation Division of New Technology, Materials and Research, October 1992.

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.

Sandbag Barrier SE-8



Categories

EC	Erosion Control	☒
SE	Sediment Control	☑
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-1 Silt Fence

SE-5 Fiber Rolls

SE-6 Gravel Bag Berm

SE-12 Manufactured Linear Sediment Controls

SE-14 Biofilter Bags

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Description and Purpose

A sandbag barrier is a series of sand-filled bags placed on a level contour to intercept or to divert sheet flows. Sandbag barriers placed on a level contour pond sheet flow runoff, allowing sediment to settle out.

Suitable Applications

Sandbag barriers may be a suitable control measure for the applications described below. It is important to consider that sand bags are less porous than gravel bags and ponding or flooding can occur behind the barrier. Also, sand is easily transported by runoff if bags are damaged or ruptured. The SWPPP Preparer should select the location of a sandbag barrier with respect to the potential for flooding, damage, and the ability to maintain the BMP.

- As a linear sediment control measure:
  - Below the toe of slopes and erodible slopes.
  - As sediment traps at culvert/pipe outlets.
  - Below other small cleared areas.
  - Along the perimeter of a site.
  - Down slope of exposed soil areas.
  - Around temporary stockpiles and spoil areas.
  - Parallel to a roadway to keep sediment off paved areas.
  - Along streams and channels.

- As linear erosion control measure:
  - Along the face and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow.
  - At the top of slopes to divert runoff away from disturbed slopes.
  - As check dams across mildly sloped construction roads.

Limitations

- It is necessary to limit the drainage area upstream of the barrier to 5 acres.
- Sandbags are not intended to be used as filtration devices.
- Easily damaged by construction equipment.
- Degraded sandbags may rupture when removed, spilling sand.
- Installation can be labor intensive.
- Durability of sandbags is somewhat limited and bags will need to be replaced when there are signs of damage or wear.
- Burlap should not be used for sandbags.

Implementation

General

A sandbag barrier consists of a row of sand-filled bags placed on a level contour. When appropriately placed, a sandbag barrier intercepts and slows sheet flow runoff, causing temporary ponding. The temporary ponding allows sediment to settle. Sand-filled bags have limited porosity, which is further limited as the fine sand tends to quickly plug with sediment, limiting or completely blocking the rate of flow through the barrier. If a porous barrier is desired, consider SE-1, Silt Fence, SE-5, Fiber Rolls, SE-6, Gravel Bag Berms or SE-14, Biofilter Bags. Sandbag barriers also interrupt the slope length and thereby reduce erosion by reducing the tendency of sheet flows to concentrate into rivulets which erode rills, and ultimately gullies, into disturbed, sloped soils. Sandbag barriers are similar to gravel bag berms, but less porous. Generally, sandbag barriers should be used in conjunction with temporary soil stabilization controls up slope to provide effective erosion and sediment control.

Design and Layout

- Locate sandbag barriers on a level contour.
- When used for slope interruption, the following slope/sheet flow length combinations apply:
  - Slope inclination of 4:1 (H:V) or flatter: Sandbags should be placed at a maximum interval of 20 ft, with the first row near the slope toe.
  - Slope inclination between 4:1 and 2:1 (H:V): Sandbags should be placed at a maximum interval of 15 ft. (a closer spacing is more effective), with the first row near the slope toe.

- Slope inclination 2:1 (H:V) or greater: Sandbags should be placed at a maximum interval of 10 ft. (a closer spacing is more effective), with the first row near the slope toe.

- Turn the ends of the sandbag barrier up slope to prevent runoff from going around the barrier.
- Allow sufficient space up slope from the barrier to allow ponding, and to provide room for sediment storage.
- For installation near the toe of the slope, sand bag barriers should be set back from the slope toe to facilitate cleaning. Where specific site conditions do not allow for a set-back, the sand bag barrier may be constructed on the toe of the slope. To prevent flows behind the barrier, bags can be placed perpendicular to a berm to serve as cross barriers.
- Drainage area should not exceed 5 acres.
- Butt ends of bags tightly.
- Overlap butt joints of row beneath with each successive row.
- Use a pyramid approach when stacking bags.
- In non-traffic areas
  - Height = 18 in. maximum
  - Top width = 24 in. minimum for three or more layer construction
  - Side slope = 2:1 (H:V) or flatter
- In construction traffic areas
  - Height = 12 in. maximum
  - Top width = 24 in. minimum for three or more layer construction.
  - Side slopes = 2:1 (H:V) or flatter.
- See typical sandbag barrier installation details at the end of this fact sheet.

Materials

- ***Sandbag Material:*** Sandbag should be woven polypropylene, polyethylene or polyamide fabric, minimum unit weight of 4 ounces/yd^2, Mullen burst strength exceeding 300 lb/in^2 in conformance with the requirements in ASTM designation D3786, and ultraviolet stability exceeding 70% in conformance with the requirements in ASTM designation D4355. Use of burlap is not an acceptable substitute, as sand can more easily mobilize out of burlap.
- ***Sandbag Size:*** Each sand-filled bag should have a length of 18 in., width of 12 in., thickness of 3 in., and mass of approximately 33 lbs. Bag dimensions are nominal, and may vary based on locally available materials.

- ***Fill Material:*** All sandbag fill material should be non-cohesive, Class 3 (Caltrans Standard Specification, Section 25) or similar permeable material free from clay and deleterious material, such as recycled concrete or asphalt.

Costs

Empty sandbags cost $0.25 - $0.75. Average cost of fill material is $8 per yd^3. Additional labor is required to fill the bags. Pre-filled sandbags are more expensive at $1.50 - $2.00 per bag. These costs are based upon vendor research.

Inspection and Maintenance

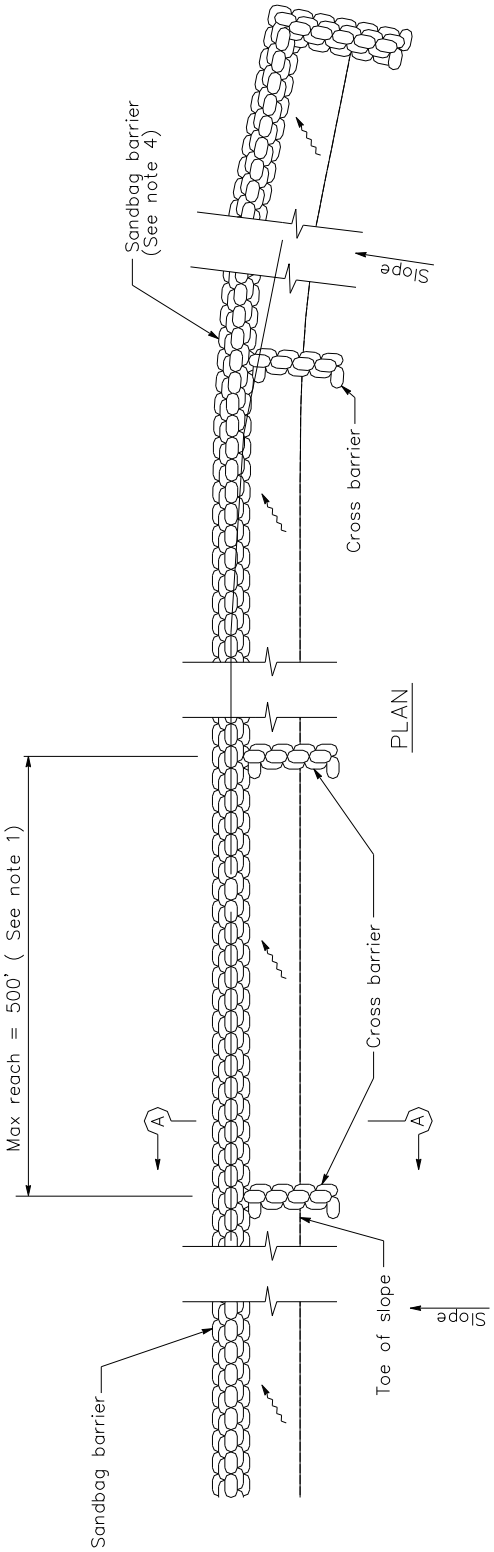
- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Sandbags exposed to sunlight will need to be replaced every two to three months due to degradation of the bags.
- Reshape or replace sandbags as needed.
- Repair washouts or other damage as needed.
- Sediment that accumulates behind the BMP should be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height.
- Remove sandbags when no longer needed and recycle sand fill whenever possible and properly dispose of bag material. Remove sediment accumulation, and clean, re-grade, and stabilize the area.

References

Standard Specifications for Construction of Local Streets and Roads, California Department of Transportation (Caltrans), July 2002.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

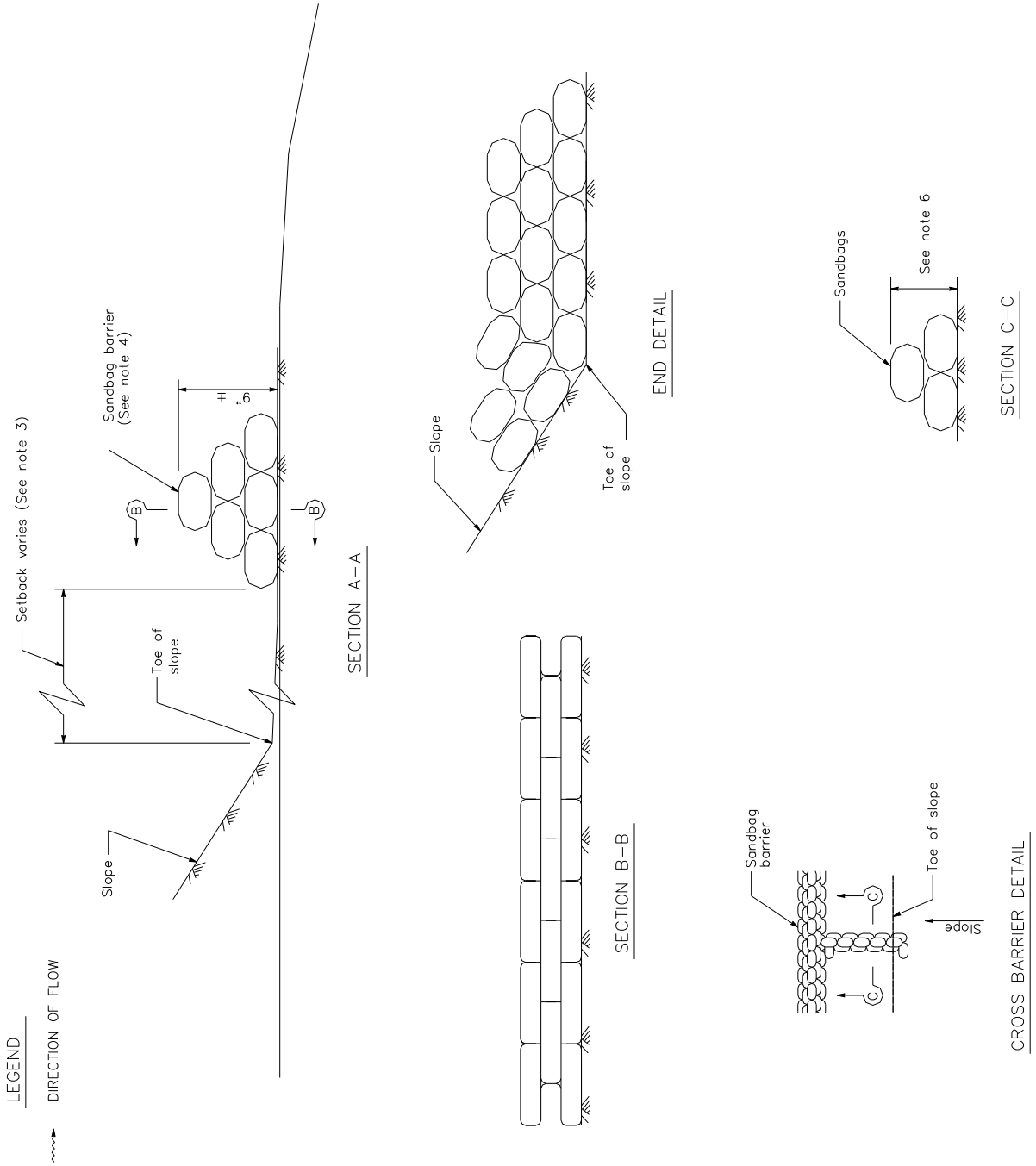
Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.



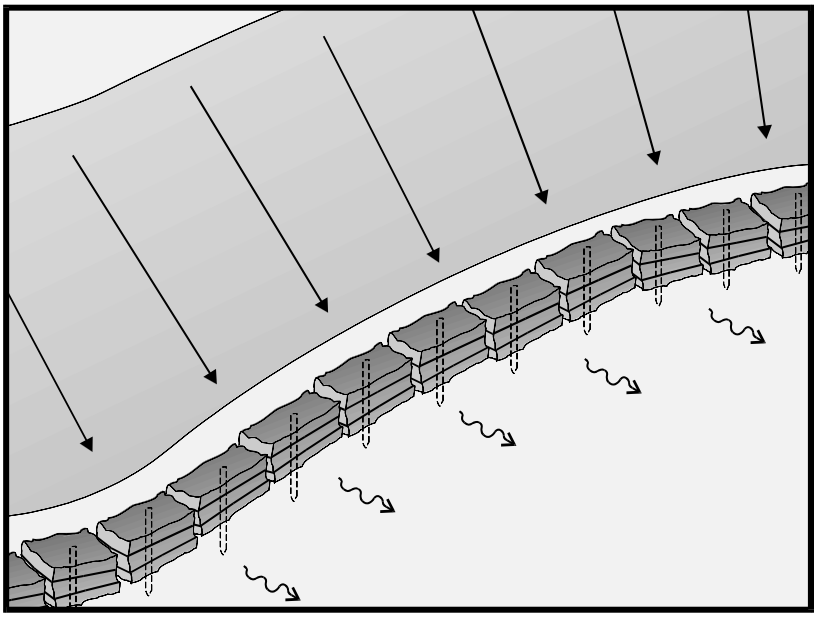
SANDBAG BARRIER

NOTES

1. Construct the length of each reach so that the change in base elevation along the reach does not exceed 1/2 the height of the linear barrier. In no case shall the reach length exceed 500'.
2. Place sandbags tightly.
3. Dimension may vary to fit field condition.
4. Sandbag barrier shall be a minimum of 3 bags high.
5. The end of the barrier shall be turned up slope.
6. Cross barriers shall be a min of 1/2 and a max of 2/3 the height of the linear barrier.
7. Sandbag rows and layers shall be staggered to eliminate gaps.


LEGEND
DIRECTION OF FLOW
Setback varies (See note 3)
Sandbag barrier
(See note 4)
9"
H
B
B
Toe of
slope
Slope
SECTION A–A
Slope
Toe of
slope
END DETAIL
SECTION B–B
Sandbags
See note 6
SECTION C–C
Sandbag
barrier
C
C
Toe of slope
Slope
CROSS BARRIER DETAIL

Straw Bale Barrier SE-9



Description and Purpose

A straw bale barrier is a series of straw bales placed on a level contour to intercept sheet flows. Straw bale barriers pond sheet-flow runoff, allowing sediment to settle out.

Suitable Applications

Straw bale barriers may be suitable:

- As a linear sediment control measure:
  - Below the toe of slopes and erodible slopes
  - As sediment traps at culvert/pipe outlets
  - Below other small cleared areas
  - Along the perimeter of a site
  - Down slope of exposed soil areas
  - Around temporary stockpiles and spoil areas
  - Parallel to a roadway to keep sediment off paved areas
  - Along streams and channels
- As linear erosion control measure:
  - Along the face and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow

Categories

EC	Erosion Control	☒
SE	Sediment Control	☑
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-1 Silt Fence

SE-5 Fiber Rolls

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

SE-12 Temporary Silt Dike

SE-14 Biofilter Bags

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- At the top of slopes to divert runoff away from disturbed slopes
- As check dams across mildly sloped construction roads

Limitations

Straw bale barriers:

- Are not to be used for extended periods of time because they tend to rot and fall apart
- Are suitable only for sheet flow on slopes of 10 % or flatter
- Are not appropriate for large drainage areas, limit to one acre or less
- May require constant maintenance due to rotting
- Are not recommended for concentrated flow, inlet protection, channel flow, and live streams
- Cannot be made of bale bindings of jute or cotton
- Require labor-intensive installation and maintenance
- Cannot be used on paved surfaces
- Should not to be used for drain inlet protection
- Should not be used on lined ditches
- May introduce undesirable non-native plants to the area

Implementation

General

A straw bale barrier consists of a row of straw bales placed on a level contour. When appropriately placed, a straw bale barrier intercepts and slows sheet flow runoff, causing temporary ponding. The temporary ponding provides quiescent conditions allowing sediment to settle. Straw bale barriers also interrupt the slope length and thereby reduce erosion by reducing the tendency of sheet flows to concentrate into rivulets, which erode rills, and ultimately gullies, into disturbed, sloped soils.

Straw bale barriers have not been as effective as expected due to improper use. These barriers have been placed in streams and drainage ways where runoff volumes and velocities have caused the barriers to wash out. In addition, failure to stake and entrench the straw bale has allowed undercutting and end flow. Use of straw bale barriers in accordance with this BMP should produce acceptable results.

Design and Layout

- Locate straw bale barriers on a level contour.
  - Slopes up to 10:1 (H:V): Straw bales should be placed at a maximum interval of 50 ft (a closer spacing is more effective), with the first row near the toe of slope.
  - Slopes greater than 10:1 (H:V): Not recommended.

- Turn the ends of the straw bale barrier up slope to prevent runoff from going around the barrier.
- Allow sufficient space up slope from the barrier to allow ponding, and to provide room for sediment storage.
- For installation near the toe of the slope, consider moving the barrier away from the slope toe to facilitate cleaning. To prevent flow behind the barrier, sand bags can be placed perpendicular to the barrier to serve as cross barriers.
- Drainage area should not exceed 1 acre, or 0.25 acre per 100 ft of barrier.
- Maximum flow path to the barrier should be limited to 100 ft.
- Straw bale barriers should consist of two parallel rows.
  - Butt ends of bales tightly
  - Stagger butt joints between front and back row
  - Each row of bales must be trenched in and firmly staked
- Straw bale barriers are limited in height to one bale laid on its side.
- Anchor bales with either two wood stakes or four bars driven through the bale and into the soil. Drive the first stake towards the butt joint with the adjacent bale to force the bales together.
- See attached figure for installation details.

Materials

- ***Straw Bale Size:*** Each straw bale should be a minimum of 14 in. wide, 18 in. in height, 36 in. in length and should have a minimum mass of 50 lbs. The straw bale should be composed entirely of vegetative matter, except for the binding material.
- ***Bale Bindings:*** Bales should be bound by steel wire, nylon or polypropylene string placed horizontally. Jute and cotton binding should not be used. Baling wire should be a minimum diameter of 14 gauge. Nylon or polypropylene string should be approximately 12 gauge in diameter with a breaking strength of 80 lbs force.
- ***Stakes:*** Wood stakes should be commercial quality lumber of the size and shape shown on the plans. Each stake should be free from decay, splits or cracks longer than the thickness of the stake, or other defects that would weaken the stakes and cause the stakes to be structurally unsuitable. Steel bar reinforcement should be equal to a #4 designation or greater. End protection should be provided for any exposed bar reinforcement.

Costs

Straw bales cost $5 - $7 each. Adequate labor should be budgeted for installation and maintenance.

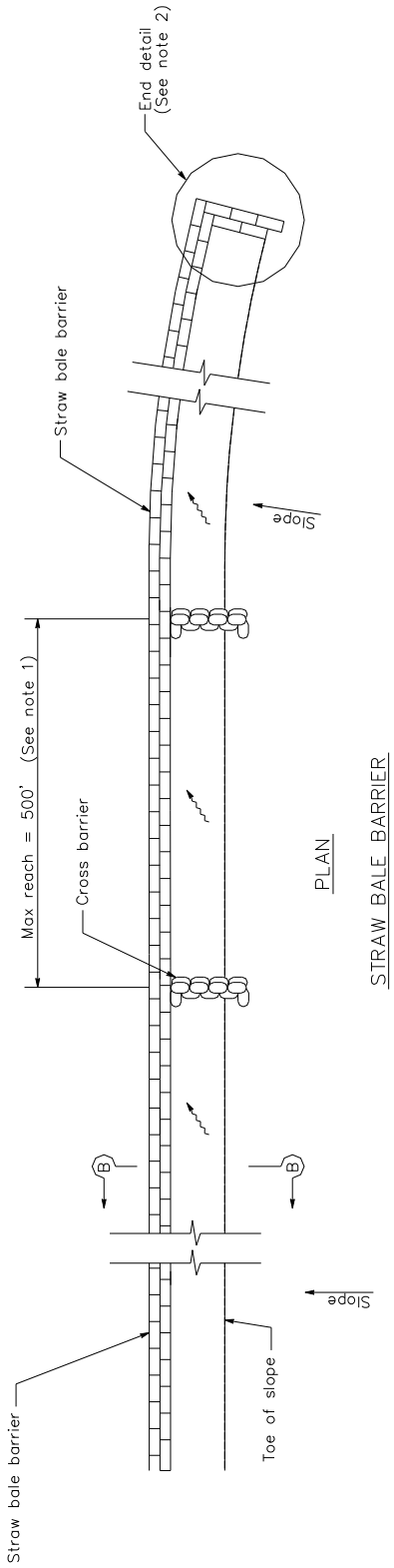
Inspection and Maintenance

Maintenance

- Inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Straw bales degrade, especially when exposed to moisture. Rotting bales will need to be replaced on a regular basis.
- Replace or repair damaged bales as needed.
- Repair washouts or other damages as needed.
- Sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed at an appropriate location.
- Remove straw bales when no longer needed. Remove sediment accumulation, and clean, re-grade, and stabilize the area. Removed sediment should be incorporated in the project or disposed of.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.



PLAN

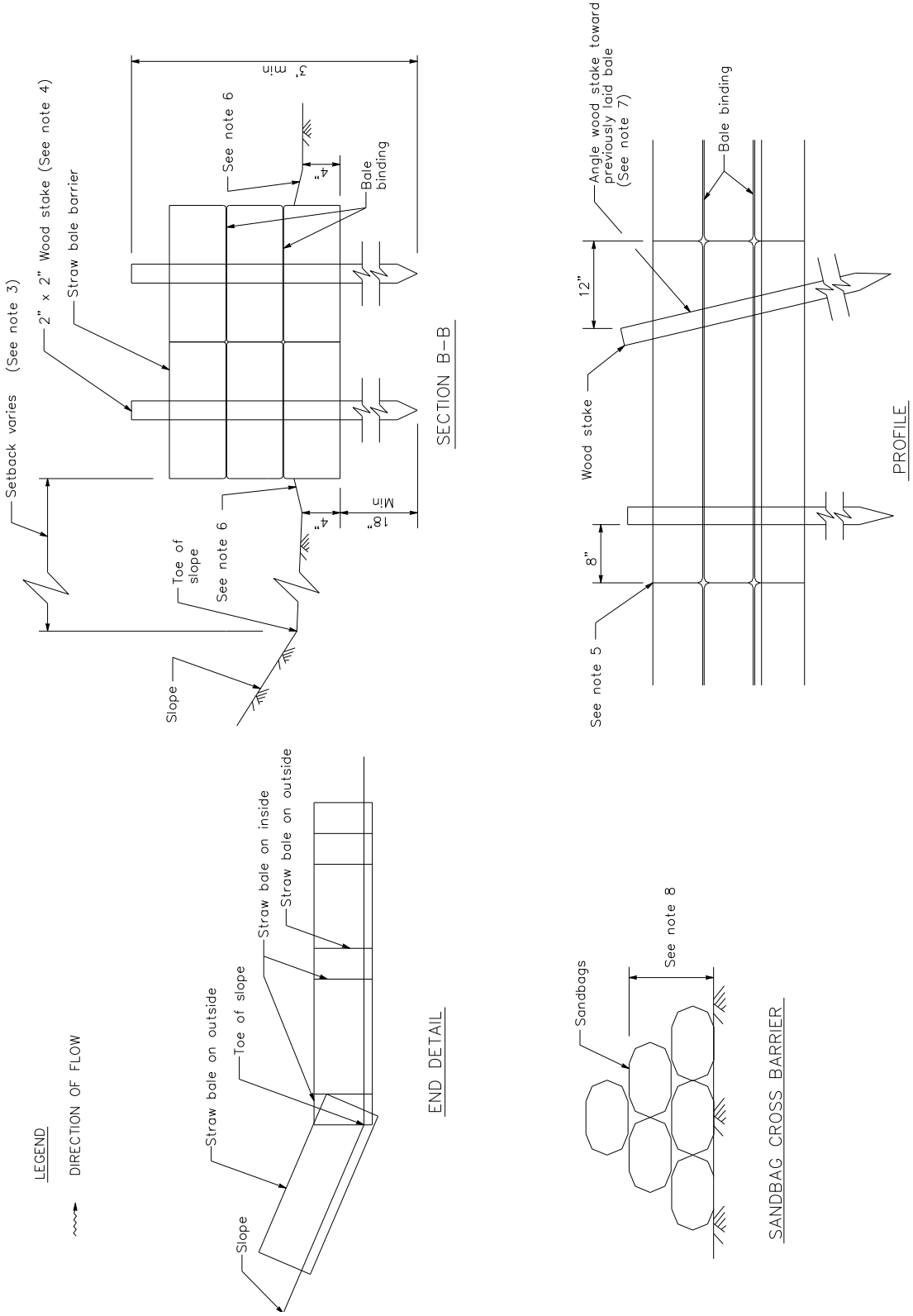
STRAW BALE BARRIER

LEGEND

DIRECTION OF FLOW

NOTES

1. Construct the length of each reach so that the change in base elevation along the reach does not exceed 1/2 the height of the linear barrier. In no case shall the reach length exceed 500'.
2. The end of barrier shall be turned up slope.
3. Dimension may vary to fit field condition.
4. Stake dimensions are nominal.
5. Place straw bales tightly together.
6. Tamp embedment spoils against sides of installed bales.
7. Drive angled wood stake before vertical stake to ensure tight abutment to adjacent bale.
8. Sandbag cross barriers should be a min of 1/2 and a max of 2/3 the height of the linear barrier.
9. Sandbag rows and layers should be offset to eliminate gaps.


Setback varies (See note 3)
2" x 2" Wood stake (See note 4)
Straw bale barrier
See note 6
Min 5'
4"
Bale binding
Toe of slope
See note 6
4"
Min 18"
Slope
SECTION B–B
Angle wood stake toward previously laid bale (See note 7)
Bale binding
12"
Wood stake
8"
See note 5
PROFILE
LEGEND
DIRECTION OF FLOW
Straw bale on inside
Straw bale on outside
Straw bale on outside
Toe of slope
Slope
END DETAIL
Sandbags
See note 8
SANDBAG CROSS BARRIER

APPENDIX G

U.S. Army Corps of Engineers, Streambed Alteration Agreement, December 19, 1996

WEBBER AND WEBBER
MINING CONSULTANTS, INC.

December 19, 1996

Mr. Howard Brown
Pluess-Staufer (California), Inc.
P.O. Box 825
Lucerne Valley, CA 92356

Re: **Amboy Limestone Quarry**

Subject: **Fish and Game Fees**

Dear Howard:

Please find enclosed the original Department of Fish and Game Environmental Filing Fee Cash Receipt for your files.

If you have any questions or comments, please do not hesitate to contact me at (909) 793-3416.

Sincerely,

George A. Webber

1323 WEST COLTON AVENUE, SUITE 217 • REDLANDS, CALIFORNIA 92374 • (909) 793-3416

STATE OF CALIFORNIA-THE RESOURCES AGENCY
DEPARTMENT OF FISH AND GAME

ENVIRONMENTAL FILING FEE CASH RECEIPT

DFG 753.5a (6-91)

OPXCBD9990

39869

Lead Agency: County of San Bernardino/Planning Date: 12/19/96

County/State Agency of Filing: County of San Bernardino Document No.:

Project Title: SAMR/95-0066/DN913-181N

Project Applicant Name: Pluess-Staufer, Inc. Phone Number: 909-387-4105

Project Applicant Address: P. O. Box 825, Lucerne Vly, CA 92356

Project Applicant *(check appropriate box)*: Local Public Agency ☐ School District ☐ Other Special District ☐ State Agency ☐ Private Entity ☒

CHECK APPLICABLE FEES:

( )	Environmental Impact Report	Check No. 5523 (Pluess Staufer)	$850.00	$
(X)	Negative Declaration	Check No. 2691 (Webber)	$1,250.00	$ 1,250.00
( )	Application Fee Water Diversion *(State Water Resources Control Board Only)*		$850.00	$
( )	Projects Subject to Certified Regulatory Programs		$850.00	$
(X)	County Administrative Fee		$25.00	$ 35.00
( )	Project that is exempt from fees			
		TOTAL RECEIVED		$ 1,285.00

Signature and title of person receiving payment: Laura Hewitt Deputy Clerk

FIRST COPY-PROJECT APPLICANT SECOND COPY-DFG/FASB THIRD COPY-LEAD AGENCY FOURTH COPY-COUNTY/STATE AGENCY OF FILING

26. Adequate provisions shall be made to intercept and conduct the off-site tributary drainage flow around or through the site in a manner which will not adversely affect adjacent or downstream properties.

27. All conditions of this Conditional Use Permit are continuing conditions. Failure of the applicant and/or operator to comply with any or all of said conditions at any time may result in the revocation of the permit granted to use the property.

28. The applicant/owner shall pay a fee of $1,250.00 (one thousand two hundred fifty dollars) to the Department of Fish and Game, pursuant to California State Assembly Bill 3158. This fee shall be submitted to the Clerk of the Board of Supervisors within five (5) days after the date of conditional approval along with a $35.00 administrative handling fee required by the Clerk. The Planning Department shall then file the Notice of Determination within five (5) days after the effective date of conditional approval. The applicant should be aware that Section 21089(b) of the Public Resources code provides that any project approved under CEQA is not operative, vested or final until the required fee is paid. Proof of fee payment may be required prior to issuance of building permits or final

*29. An adequate number of portable toilets shall be provided and maintained so as not to create a public nuisance and shall be maintained by a DEHS permitted pumper. Portable unit shall provide hand washing capacity. Units shall be serviced at least weekly while in use. Submit copy of service contract from approved pumper to DEHS. For information, call DEHS/Wastewater Section at (909) 387-4666.

30. Water purveyor shall be EHS approved.

31. No landfilling of wastes shall occur on-site without an approved Solid Waste Facilities Permit. Refuse collection service shall be provided by a DEHS permitted waste hauler. Frequency of pick up shall be sufficient to avoid a public nuisance. Submit copy of service to DEHS Land Use Section. For information, contact the Local Enforcement Agency at (909) 387-4655.

32. Noise level shall be maintained at or below County Standards, Development Code Section 87.0905(b). For information, call DEHS at (909) 387-4666.

WEBBER AND WEBBER
MINING CONSULTANTS, INC.

October 30, 1996

Department of Fish and Game
330 Golden Shore, Suite 50
Long Beach, CA 90802

Re: **Pluess-Staufer (CA), Inc.**
Amboy Limestone Quarry Project

Subject: **Streambed Alteration**

Please find enclosed a completed 1603 Permit Application and pursuant to 7b, the following mine project documents:

- Proposed Mitigated Negative Declaration Document
- Biological Assessment
- Project Mining/Reclamation Plan Maps

San Bernardino County Mining Conditional Use Permit conditions of approval will require the Applicant, Pluess-Staufer (CA), INC., to obtain a 1603 Permit or waiver from your department if the permit is not required. Please review the enclosed documents to determine if the permit is required or a waiver is applicable.

Please direct any questions or requests to the undersigned at (909) 793-3416. Thank you for your timely processing of this application.

Respectfully,

George A.. Webber
Project Representative

Enclosures

cc: H. Brown, Pluess-Staufer

1323 WEST COLTON AVENUE, SUITE 217 • REDLANDS, CALIFORNIA 92374 • (909) 793-3416

The department has 30 days from date of receipt of a completed application in which to make its recommendations. This time period does not begin until the department receives the appropriate fee (see attached for schedule).

T.H.P. No. _____

Notification No. _____ Received _____

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF FISH AND GAME

NOTIFICATION OF REMOVAL OF MATERIALS AND/OR ALTERATION OF LAKE, RIVER, OR STREAMBED BOTTOM, OR MARGIN

A. APPLICANT Pursuant to Sections 1601–1607 of the California Fish and Game Code

I, George A. Webber (Applicant's Rep) (Name of Applicant) of 1323 W. Colton A., #217, Redlands, CA 92374 (Mailing Address), Webber & Webber Mining Consultants

Representing APPLICANT--Pluess-Staufer (CA), INC., P.O. Box 825, Lucerne Valley, CA 92356 (Name and address of Individual, Agency, Company, etc. owning property or doing work.)

Hereby notify the California Department of Fish and Game of operations to be carried out by or for me

from Jan 1, 1997 (Starting Date) to Jan 1, 2061 (Ending Date) on or affecting

Two No Name Intermittent Bluelines (Name of Stream, River, or Lake) of San Bernardino County, tributary to Bristol Dry Lake (Major Water Body)

Located 5 miles northeasterly of Amboy within Section 30 (Distance and Direction to Landmarks)

Section 30 Township 6 North Range 13 East

USGS Map Amboy, CA Co. Assessor's Parcel No. 558-151-10 & 11

Property owners name and address (if different from applicant) _____

Mr. James Reddy, President (Name of Person to Be Contacted at Site During Operations) is responsible for operations at the site.

He/she can be reached at P.O. Box 825, Lucerne Valley, CA. 92356 (Mailing Address) (619-248-7306) (Telephone)

B. Description of operation 1. The nature of said operations will be as follows:
Check all squares which apply.

- [x] Soil, sand, gravel, and/or boulder removal or displacement
- [x] Water diversion or impoundment
- [x] Mining—other than aggregate removal
- [ ] Road or bridge construction
- [ ] Levee or channel construction
- [ ] Timber harvesting or any related activity required for harvesting timber
- [ ] Temporary, recreational or irrigation dam
- [x] Fill or spoil in bed, bank, or channel
- [x] Other—Describe below (See Mining/Reclamation Plan Maps)

2. Type of material removed, displaced or added [x] Soil [x] Sand [x] Gravel [x] Boulders x Bedrock
Volume 10,000,000 Yards++
3. Equipment to be used in the described site Dozers, Loaders, Drills, Haul Trucks, and Crushers
4. Use of water (i.e., domestic, irrigation, gravel, washing, etc.) None Available Quantity N/A
5. Describe type and density of vegetation to be affected, and estimate area involved.
Mojave Creosote Bush Scrub sparsely covering 19 acres of streambed area
6. What actions are proposed to protect fish and wildlife resources and/or mitigate for project impacts?
See enclosed Proposed Mitigated Negative Declaration Document

7a. Does project have a local or state lead agency or require other permits? [x] Yes [ ] No

7b. If 7a answer is yes, please attach or identify any available environmental document.

7c. For state-designated wild and scenic rivers, a determination of the project's consistency with the California Wild and Scenic Rivers Act must be made by the Secretary for Resources. Until the Secretary determines the project is consistent with the Act, the Department cannot issue a valid agreement. A tentative agreement will be issued, conditioned upon a finding of consistency by the Resources Secretary.

7d. THIS AGREEMENT IS NOT INTENDED AS AN APPROVAL OF A PROJECT OR OF SPECIFIC PROJECT FEATURES BY THE DEPARTMENT OF FISH AND GAME. INDEPENDENT REVIEW AND RECOMMENDATIONS WILL BE PROVIDED BY THE DEPARTMENT AS APPROPRIATE ON THOSE PROJECTS WHERE LOCAL, STATE, OR FEDERAL PERMITS OR OTHER ENVIRONMENTAL REPORTS ARE REQUIRED.

8. Briefly describe proposed construction methods. Attach diagram or sketch of the location of your operation to clearly indicate the stream or other water and access and distance from named public road. Indicate locked gates with an "X". Show existing features with a solid line (————) and proposed features with a broken line (- - - - - - -). Show compass direction. Attach larger scale map if necessary.

Signature of Applicant _____ Date 10/29/96

NO CARBON NEEDED

CALIFORNIA DEPARTMENT OF FISH AND GAME
330 Golden Shore, Suite 50
Long Beach, California 90802

Notification No. 5-443-96
Page 1 of 5

AGREEMENT REGARDING PROPOSED STREAM OR LAKE ALTERATION

THIS AGREEMENT, entered into between the State of California, Department of Fish and Game, hereinafter called the Department, and James Reddy of Pluess-Staufer Inc. State of California, hereinafter called the Operator, is as follows:

WHEREAS, pursuant to Section 1602 of California Fish and Game Code, the Operator, on the 12th day of November, 1996, notified the Department that they intend to divert or obstruct the natural flow of, or change the bed, channel, or bank of, or use material from the streambed(s) of, the following water(s): unnamed wash to Bristol Dry Lake, **San Bernardino** County, California, Section 30 Township 6N Range 13E.

WHEREAS, the Department (represented by Rebecca Jones) has determined that such operations may substantially adversely affect existing fish and wildlife resources including: prairie falcon, Death Valley sage, chuckwalla, Nelson's bighorn sheep, desert tortoise, bats, aquatic resources and wildlife in the area.

THEREFORE, the Department hereby proposes measures to protect fish and wildlife resources during the Operator's work. The Operator hereby agrees to accept the following measures/conditions as part of the proposed work.

If the Operator's work changes from that stated in the notification specified above, this Agreement is no longer valid and a new notification shall be submitted to the Department of Fish and Game. Failure to comply with the provisions of this Agreement and with other pertinent code sections, including but not limited to Fish and Game Code sections 5650, 5652, 5937, and 5948, may result in prosecution.

Nothing in this Agreement authorizes the Operator to trespass on any land or property, nor does it relieve the Operator of responsibility for compliance with applicable federal, state, or local laws or ordinances. A consummated Agreement does not constitute Department of Fish and Game endorsement of the proposed operation, or assure the Department's concurrence with permits required from other agencies.

This Agreement becomes effective the date of Department's signature and terminates 5 year from date of Department's signature for project construction only. This Agreement shall remain in effect for that time necessary to satisfy the terms/conditions of this Agreement.

STREAMBED ALTERATION CONDITIONS FOR NOTIFICATION NUMBER: 5-443-96

1. The following provisions constitute the limit of activities agreed to and resolved by this Agreement. The signing of this Agreement does not imply that the Operator is precluded from doing other activities at the site. However, activities not specifically agreed to and resolved by this Agreement shall be subject to separate notification pursuant to Fish and Game Code Sections 1600 et seq.

2. The Operator proposes to alter the streambed to conduct mining activities on 73 acres, 19 acres are within wash areas. The project live is expected to be approximately 55 years, with 6.4 million tons extracted during that time. The site will be left as open space once the project is completed.

3. The agreed work includes activities associated with No. 2 above. The project area is located **approximately 0.5 mile west of Kelbaker Road, 1.5 miles north of National Trails highway and 6 miles northeast of Amboy** in **San Bernardino** County. Specific work areas and mitigation measures are described on/in the plans and documents submitted by the Operator and shall be implemented as proposed unless directed differently by this agreement.

4. The Operator shall request an extension of this agreement prior to its termination. Extensions may be granted for up to 5 years from the date of termination of the agreement and are subject to Departmental approval. The extension request and fees shall be submitted to the Department's Region 5 Office at the above address. If the Operator fails to request the extension prior to the agreement's termination then the Operator shall submit a new notification with fees and required information to the Department. Any activities conducted under an expired agreement is a violation of Fish and Game Code Section 1600 et. seq. The Operator may request up to a maximum of 11 extensions of this agreement.

5. Equipment shall not be operated in wetted areas (including but not limited to ponded, flowing, or wetland areas).

6.If a stream channel has been altered during the operations, its low flow channel shall be returned as nearly as possible to pre-project conditions without creating a possible future bank erosion problem, or a flat wide channel or sluice-like area. The alignment of the streambed shall be restored as depicted in the aproved mine reclamation plan.

7. Structures and associated materials not designed to withstand high seasonal flows shall be removed to areas above the high water mark before such flows occur.

8. The perimeter of the work site shall be adequately flagged or fenced to prevent damage to adjacent habitat.

9. Mitigation for big horn sheep shall be as follows: (a) If any open water ponds will be present on the project location, the Operator shall install an 8 ft. high chain-link fence around any and all open water ponds. That fence shall remain locked unless it is currently being accessed; and (b) Operator shall maintain a written log documenting the observation of the following animals: deer, mountain sheep, badger, kit fox and bobcat. They will submit a annual summary report of those observations to the Department. The observation log will contain sighting information on both live and dead animals.

10. A copy of the Revegetation/Habitat Restoration Plan for reclamation shall be submitted to the Department for review and approval when complete. If the survival and cover requirements have not been met, as per the reclamation plan, the Operator is responsible for replacement planting to achieve these requirements. Replacement plants shall be monitored with the same survival and growth requirement.

11. The Operator shall have a qualified biologist resurvey the site prior to start of construction activities to insure no tortoises have wandered on to the site. If desert tortoise is found, or could be impacted by the work proposed, this agreement shall not be valid until the Operator obtains the required state and federal threatened and endangered species permits.

12. If a tortoise is found on the work site or access road, all work shall cease until the tortoise has left the construction area and the Department shall be notified. No tortoise shall be handled.

13. All construction and maintenance workers shall participate in a desert tortoise education program. The Operator shall develop this program prior to initial construction activities or shall modify an existing program to suit the needs of this project. The program shall include the following topics: occurrence of desert tortoise within the affected area, sensitivity of the species to human activities, legal protection for desert tortoise, penalties for violations of Federal and State laws, general activity patterns, reporting requirements, and project measures designed to reduce impacts to the desert tortoise. Employees shall be forewarned that tortoises seeking shade may crawl beneath parked vehicles or equipment, and that to avoid crushing tortoises, the ground beneath all parked vehicles shall be checked prior to moving vehicles or equipment. A fact sheet conveying this information will also be prepared for distribution to all employees. Upon completion of the orientation, employees shall

sign a form stating that they attended the program and understand all protection measures.

14. Prior to ground disturbance, a qualified biologist shall determine if prairie falcons are currently using the nest site. If falcons are nesting, no mining will be allowed from April 1 through August 15. If nest must be disturbed out side of this time, the Operator shall construct additional nesting/roosting sites. Location and construction methods shall be determined by a qualified biologist.

15. The Operator shall have a qualified biologist survey for bat roosts prior to disturbance of site. If roosts exist, they shall not be disturbed during hibernation or roosting time. Artificial roost shall be constructed to replace roosts that have been disturbed.

16. No debris, soil, silt, sand, bark, slash, sawdust, rubbish, cement or concrete or washings thereof, asphalt, oil or petroleum products or other organic or earthen material from any logging, construction, or associated activity of whatever nature shall be allowed to enter into or placed where it may be washed by rainfall or runoff into, waters of the State. When operations are completed, any excess materials or debris shall be removed from the work area. No rubbish shall be deposited within 150 feet of the high water mark of any stream or lake.

17. The Operator shall comply with all litter and pollution laws. All contractors, subcontractors and employees shall also obey these laws and it shall be the responsibility of the operator to ensure compliance.

18. No equipment maintenance shall be done within or near any stream channel or lake margin where petroleum products or other pollutants from the equipment may enter these areas under any flow.

19. The Operator shall **provide a copy of this** Agreement **to all contractors, subcontractors, and the Operator's project supervisors. Copies of the** Agreement **shall be readily available at work sites at all times during periods of active work** and must be presented to any Department personnel, or personnel from another agency upon demand.

20. The Department reserves the right to enter the project site at any time to ensure compliance with terms/conditions of this Agreement.

21. The Department reserves the right to cancel this Agreement, after giving notice to the Operator, if the Department determines that the Operator has breached any of the terms or conditions of the Agreement.

22. The Department reserves the right to suspend or cancel this Agreement for other reasons, including but are not limited to, the following:

a. The Department determines the information provided by the Operator in support of the Agreement/Notification is incomplete or inaccurate;
b. The Department obtains new information that was not known to it in preparing the terms and conditions of the Agreement;
c. The conditions of or affecting fish and wildlife resources change; or
d. The Department determines project activities will result in a substantial adverse effect on the environment.

CONCURRENCE

(Operator's name)

12-19-96

(signature) (date)

PRESIDENT - PLUESS-STAUFFER (CA) INC.

(title)

California Dept. of Fish and Game

James Jones for Rebecca Jones 1/3/97

(signature) (date)

Rebecca Jones
Environmental Specialist III
(title)

CALIFORNIA DEPARTMENT OF FISH AND GAME
330 Golden Shore, Suite 50
Long Beach, California 90802

Notification No. 5-443-96
Page 1 of 5

AGREEMENT REGARDING PROPOSED STREAM OR LAKE ALTERATION

THIS AGREEMENT, entered into between the State of California, Department of Fish and Game, hereinafter called the Department, and James Reddy of Pluess-Staufer Inc., State of California, hereinafter called the Operator, is as follows:

WHEREAS, pursuant to Section 1603 of California Fish and Game Code, the Operator, on the 12th day of November, 1996, notified the Department that they intend to divert or obstruct the natural flow of, or change the bed, channel, or bank of, or use material from the streambed(s) of, the following water(s): [illegible] wash to Bristol Dry Lake, San Bernardino County, California, Section 30 Township 6N Range 13E.

Revise

WHEREAS, the Department (represented by Rebecca [illegible]) has determined that such operations may substantially adversely affect existing fish and wildlife resources including: [illegible] falcon, Death Valley sage, chuckwalla, Nelson's bighorn sheep, desert tortoise, bats, aquatic resources and wildlife [illegible].

THEREFORE, the Department hereby proposes measures to protect fish and wildlife resources during the Operator's work. The Operator hereby agrees to accept the following [illegible] conditions as part of the proposed work.

If the Operator's work changes from that stated in the notification specified above, this Agreement is no longer valid and a new notification shall be submitted to the Department of Fish and Game. Failure to comply with the provisions of this Agreement and with other pertinent code sections, including but not limited to Fish and Game Code Sections 5650, [illegible], [illegible], and 5948, may result in prosecution.

Nothing in this Agreement authorizes the Operator to trespass on any land or property, nor does it relieve the Operator of responsibility for compliance with applicable federal, state, or local laws or ordinances. A consummated Agreement does not constitute Department of Fish and Game endorsement of the proposed operation, or assure the Department's concurrence with permits required from other agencies.

This Agreement becomes effective the date of Department signature and terminates 5 year from date of Department signature for project construction only. This Agreement shall remain in effect for that time necessary to satisfy the terms/conditions of this Agreement.

STREAMBED ALTERATION CONDITIONS FOR NOTIFICATION NUMBER: 5-443-96

1. The following provisions constitute the limit of activities agreed to and resolved by this Agreement. The signing of this Agreement does not imply that the Operator is precluded from doing other activities at the site. However, activities not specifically agreed to and resolved by this Agreement shall be subject to separate notification pursuant to Fish and Game Code Sections 1600 et seq.

2. The Operator proposes to alter the streambed to conduct mining activities on 73 acres, 19 acres are within wash areas. The project live is expected to be approximately 55 years, with 6.4 million tons extracted during that time. The site will be left as open space once the project is completed.

3. The agreed work includes activities associated with No. 2 above. The project area is located **approximately 0.5 miles west of Kelbaker Road, 1.5 miles north of National Trails Highway and 5 miles northeast of Amboy in San Bernardino** County. Specific work areas and mitigation measures are described on/in the plans and documents submitted by the Operator and shall be implemented as proposed unless directed differently by this agreement.

4. The Operator shall request an extension of this agreement prior to its termination. Extensions may be granted for up to 5 years from the date of termination of the agreement and are subject to Departmental approval. The extension request and fees shall be submitted to the Department's Region 5 Office at the above address. If the Operator fails to request the extension prior to the agreement's termination then the Operator shall submit a new notification with fees and required information to the Department. Any activities conducted under an expired agreement is a violation of Fish and Game Code Section 1600 et. seq. The Operator may request up to a maximum of [illegible] extensions of this agreement.

5. Equipment shall not be operated in wetted areas including but not limited to ponded, flowing, or wetland areas.

6. If a stream channel has been altered during the operations, its low flow channel shall be returned as nearly as practicable to pre-project conditions without creating a potential future bank erosion problem, or a flat wide channel or sluice-like area. The gradient of the streambed shall be returned to [illegible] grade unless such operation is part of a restoration [illegible] in which case, the change in grade must be approved by the Department prior to project commencement.

NEEDS APPROVAL

RECLAMATION ?

7. Structures and associated materials not designed to withstand high seasonal flows shall be removed to areas above the high water mark before such flows occur.

8. The perimeter of the work site shall be adequately flagged or fenced to prevent damage to adjacent habitat.

9. Mitigation for big horn sheep shall be as follows: (a) If any open water ponds will be present on the project location, the Operator shall install an 8 ft. high chain-link fence around any and all open water ponds. That fence shall remain locked unless it is currently being accessed; and (b) Operator shall maintain a written log documenting the observation of the following animals: deer, mountain sheep, badger, kit fox and bobcat. They will submit a annual summary report of those observations to the Department. The observation log will contain sighting information on both live and dead animals.

ok

10. A copy of the Revegetation/Habitat Restoration Plan for reclamation shall be submitted to the Department for review and approval when complete. If the survival and cover requirements have not been met, as per the reclamation plan, the Operator is responsible for replacement planting to achieve these requirements. Replacement plants shall be monitored with the same survival and growth requirement.

?

11. The Operator shall have a qualified biologist survey the site prior to start of construction activities to insure no tortoises have wandered on to the site. If desert tortoise is found, or could be impacted by the work proposed, this agreement shall not be valid until the Operator obtains the required state and federal threatened and endangered species permits.

ok

12. If a tortoise is found on the work site or within road, all work shall cease until the tortoise has left the construction area and the Department shall be notified. No tortoise shall be handled.

ok

13. All construction and maintenance workers shall participate in a desert tortoise education program. The Operator shall develop this program prior to initial construction activities or shall modify an existing program to suit the needs of this project. The program shall include the following topics: occurrence of desert tortoise within the affected area, sensitivity of the species to human activities, legal protection for desert tortoise, penalties for violations of Federal and State laws, general activity patterns, reporting requirements, and project measures designed to reduce impacts to the desert tortoise. Employees shall be forewarned that tortoises seeking shade may crawl beneath parked vehicles or equipment, and that to avoid crushing tortoises, the ground beneath all parked vehicles shall be checked prior to moving vehicles or equipment. [illegible] conveying this information will also be provided in [illegible] to all employees. Upon completion of the orientation, employees shall

ok

sign a form stating that they attended the program and understand all protection measures.

14. Prior to ground disturbance, a qualified biologist shall determine if prairie falcons are currently using the nest site. If falcons are nesting, no mining will be allowed from April 1 through August 15. If nest must be disturbed out side of this time, the Operator shall construct additional nesting/roosting sites. Location and construction methods shall be determined by a qualified biologist.

15. The Operator shall have a qualified biologist survey for bat roosts prior to disturbance of site. If roosts exist, they shall not be disturbed during hibernation or roosting time. Artificial roost shall be constructed to replace roosts that have been disturbed.

16. No debris, soil, silt, sand, bark, slash, sawdust, rubbish, cement or concrete or washings thereof, asphalt, oil or petroleum products or other organic or earthen material from any logging, construction, or associated activity of whatever nature shall be allowed to enter into or placed where it may be washed by rainfall or runoff into, waters of the State. When operations are completed, any excess materials or debris shall be removed from the work area. No rubbish shall be deposited within 150 feet of the high water mark of any stream or lake.

17. The Operator shall comply with all litter and pollution laws. All contractors, subcontractors and employees shall also obey these laws and it shall be the responsibility of the operator to ensure compliance.

18. No equipment maintenance shall be done within or near any stream channel or lake margin where petroleum products or other pollutants from the equipment may enter these areas under any flow.

19. The Operator shall provide a copy of this Agreement to all contractors, subcontractors, and the Operator's project supervisors. Copies of the Agreement shall be readily available at work sites at all times during periods of active work and must be presented to any Department personnel, or personnel from another agency upon demand.

20. The Department reserves the right to enter the project site at any time to ensure compliance with terms/conditions of this Agreement.

21. The Department reserves the right to cancel this Agreement after giving notice to the Operator, if the Department determines that the Operator has breached any of the terms or conditions of this Agreement.

22. The Department reserves the right to suspend or cancel this Agreement for other reasons, including but are not limited to, the following:

 #5-443-96

a. The Department determines the information provided by the Operator in support of the Agreement/Notification is incomplete or inaccurate;
b. The Department obtains new information that was not known to it in preparing the terms and conditions of the Agreement;
c. The conditions of or affecting fish and wildlife resources change; or
d. The Department determines project activities will result in a substantial adverse effect on the environment.

CONCURRENCE

(Operator's name)	California Dept. of Fish and Game
(signature) (date)	(signature) (date)
(title)	Rebecca Jones Environmental Specialist III (title)

APPENDIX H

U.S. Army Corps of Engineers Letter
December 3, 1996

DEPARTMENT OF THE ARMY
LOS ANGELES DISTRICT, CORPS OF ENGINEERS
SEVEN OAKS DAM RESIDENT OFFICE
32330 SANTA ANA CANYON ROAD
HIGHLAND, CALIFORNIA 92346

REPLY TO
ATTENTION OF:

DEC - 3 1997

Office of the Chief
Regulatory Branch

Mr. George A. Webber
Webber & Webber Mining Consultants, Inc.
1323 Colton Ave., Suite 217
Redlands, California 92374

Dear Mr. Webber:

Reference is made to your application (No. 97-30008-AJS) dated November 5, 1996 for a Department of the Army Permit to establish a 73-acre limestone quarry near Amboy, San Bernardino County, California. The application was submitted on behalf of Pluess-Staufer (California), Inc.

Based on the information furnished in your application and a site visit with our staff, we have determined that your proposed project does not discharge dredged or fill material into a water of the United States or an adjacent wetland. Therefore, the project is not subject to our jurisdiction under Section 404 of the Clean Water Act and a Section 404 permit is not required from our office.

The receipt of your application is appreciated. If you have any questions, please contact Antal Szijj of my staff at (909) 794-7704.

Sincerely,

Mark Durham

Mark Durham
Chief, South Coast Section
Regulatory Branch

APPENDIX I

Slope Stability Investigation
January 2015

CHJ Consultants
1355 E. Cooley Drive, Suite C, Colton, CA 92324 ◆ Phone (909) 824-7311 ◆ Fax (909) 503-1136
15345 Anacapa Road, Suite D, Victorville, CA 92392 ◆ Phone (760) 243-0506 ◆ Fax (760) 243-1225
77-564A Country Club Drive, Suite 122, Palm Desert, CA 92211 ◆ Phone (760) 772-8234 ◆ Fax (909) 503-1136

January 27, 2015

Omya California
A Division of Omya, Incorporated
7225 Crystal Creek Road
Lucerne Valley, California 92356
Attention: Mr. James Rogers

Job No. 14814-8

Dear Mr. Rogers:

Attached herewith is the Slope Stability Investigation report, prepared for the proposed Amboy Mine Reclamation project, located in San Bernardino County, California.

We appreciate this opportunity to provide geotechnical services for this project. If you have questions or comments concerning this report, please contact us at your convenience.

Respectfully submitted,
CHJ CONSULTANTS

John S. McKeown

John S. McKeown, E.G.
Project Geologist

JSM:lb

Distribution: Omya California (2)

SLOPE STABILITY INVESTIGATION
PROPOSED RECLAMATION PLAN
AMBOY MINE
SAN BERNARDINO COUNTY, CALIFORNIA
PREPARED FOR
OMYA CALIFORNIA
A DIVISION OF OMYA, INCORPORATED
JOB NO. 14814-8

CHJ Consultants
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January 27, 2015

Omya California
A Division of Omya, Incorporated
7225 Crystal Creek Road
Lucerne Valley, California 92356
Attention: Mr. James Rogers

Job No. 14814-8

Dear Mr. Rogers:

Attached herewith is the Slope Stability Investigation report, prepared for the proposed Amboy Mine Reclamation project, located in San Bernardino County, California.

This report was based upon a scope of services generally outlined in our proposal dated November 14, 2014, and other written and verbal communications.

We appreciate this opportunity to provide geotechnical services for this project. If you have questions or comments concerning this report, please contact this firm at your convenience.

Respectfully submitted,
CHJ CONSULTANTS

John S. McKeown

John S. McKeown, E.G.
Project Geologist

JSM/lb

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SLOPE STABILITY INVESTIGATION
PROPOSED RECLAMATION PLAN
AMBOY MINE
SAN BERNARDINO COUNTY, CALIFORNIA
PREPARED FOR
OMYA CALIFORNIA
A DIVISION OF OMYA, INCORPORATED
JOB NO. 14814-8

INTRODUCTION

During December 2014, a slope stability investigation for the proposed Amboy Mine Reclamation Plan was performed by this firm. The purposes of this study were to explore and evaluate the geotechnical/geological engineering conditions at the subject mine and to provide slope stability evaluation for existing and future cut slopes and overburden embankments.

To orient our investigation, several documents and maps were provided for our use. These include the following:

- Permitting quarry design map, dated October 30, 2014.
- Topographic map with 2-foot contours on ortho-photographic base, dated October 2, 2013.
- Quarry map, dated 2009 indicating the area of prior mining.
- Excerpt from a Condition of Approval (COA) letter dated December 19, 2006.
- Report by Gary S. Rasmussen and Associates, Inc. (GSRA), dated April 19, 1996. The report by GSRA forms the basis of the slope stability recommendations with regard to final slope configurations for quarry slopes.
- Excerpt from U.S. Geological Survey Open-File Report 81-503, Stratigraphy and Structure of a Portion of the Bristol Mountains, San Bernardino County, California by Howard Brown, March 10, 1980.
- Bristol Mountains Marble Deposit – drill hole and cross section location map, undated, Brown, H. J., includes color geologic map and cross sections.

Previously recommended slope configurations consist of:

- Cut slopes no steeper than 2(h) to 1(v) in alluvium, colluvium and landslide debris up to 15 feet in maximum height.
- Cut slopes in rock to a maximum height of 400 feet with 40-foot-high walls and 25-foot-wide benches, resulting in a 3/4(h) to 1(v) bench slope ratio (approximately 53 degrees) and an overall 1(h):1(v) slope ratio (when haul roads are included).

As specified in the COA letter, overburden stockpile slopes are to be no steeper than 2(h) to 1(v) at the time of final reclamation.

Based on the 2009 quarry map, mining has occurred at the north end of the quarry in a bedrock cut approximately 60 feet high that includes benches. The cut extends roughly east-west for a distance of approximately 650 feet. Overburden stockpiles are located southeast of the quarry area. Based on aerial imagery, additional north-south trending quarry walls are present locally.

According to the Permitting Design Map, a northwest-southeast oriented, elongate quarry pit is planned in the northern mine area. Overburden stockpiles are to be located adjacent to the mine pit to the west-southwest and northeast. A pad area is planned in the southeast portion of the mine area.

The approximate location of the site is shown on the attached Location Map (Enclosure A-1).

The results of our slope stability investigation, together with our conclusions and recommendations, are presented in this report.

SCOPE OF SERVICES

The scope of services provided during this investigation included the following:

- Review of published and unpublished literature and maps including geologic mapping by Mr. Howard Brown
- Examination of aerial imagery dated 1995, 2003, 2005, 2009, 2012, 2013 and 2014
- Examination of Omya California mine plans
- Review of previous studies by GSRA
- Structural geologic mapping of the quarry areas
- Geologic (kinematic) evaluation of the proposed rock slopes
- Slope stability calculations (limit equilibrium) for the proposed rock and fill slopes under static and seismic conditions
- Evaluation of geologic hazards to the project including seismic shaking hazard

PROJECT CONSIDERATIONS

This study was performed in order to evaluate the slope stability of the proposed excavated mine slopes and overburden embankments for the mine reclamation project.

According to the Permitting Quarry Design Map, maximum anticipated relief in the pit area is approximately 615 feet measured from the top of an existing cut at the north end of the mine area (elevation 1,635) to the proposed pit bottom at elevation 1,020 feet. This slope would have an apparent angle (dip) of approximately 44 degrees. The maximum height of rock (limestone) slopes in the pit area measured perpendicular to the wall face and extending from the pit rim to the pit bottom will be approximately 480 feet high and inclined with an overall slope of approximately 52 degrees to 55 degrees. The Design Map indicated approximately 60-foot-high inter-bench slope faces inclined

at 88 degrees with an intervening bench approximately 40 feet wide. This configuration results in an average slope angle of approximately 56 degrees. The occurrence of back break and kinematic influence of face angles may result in flatter inter-bench slope angles. Also, the presence of haul roads across some slope profiles may yield an approximate 50- to 53-degree overall slope angle. Our slope stability calculations for the proposed rock slopes are based on slope configurations consistent with anticipated final reclamation conditions. It is anticipated that the footwall contact between the Sultan limestone and overlying ore will guide the west side of the pit excavation.

Overburden (OB) stockpiles are planned to the northeast and west of the future mine pit. The west OB stockpile is planned as several 100-foot-high, 2(h) to 1(v) slopes separated by 25-foot-wide benches to a total height of approximately 350 feet. Inclusion of benches in this configuration results in overall slopes angles of approximately 24 degrees. The northeast OB stockpile is planned as a continuous 150-foot-high, 2(h) to 1(v) fill-over-native slope with fill thickness of about 55 feet or less. These configurations were utilized in evaluating, by calculation, the stability of reclaimed stockpile configurations.

SITE DESCRIPTION

The Amboy Limestone quarry produces high-purity limestone used for numerous commercial and industrial applications. The high-purity limestone deposits required for these applications are typically white in color and very high-purity calcium carbonate. The quarry is located in the southern Bristol Mountains in San Bernardino County, northeast of Amboy, California. The Bristol Mountains expose a series of Paleozoic age sedimentary rocks overlying a Precambrian basement in the central Mojave Desert. The limestone ore occurs in the Paleozoic section. Access to the quarry is by a haul road extending westerly from Kelbaker Road.

The quarry occupies a north-south trending ridgeline bounded by drainages on the east and west. Natural topography is locally steep with some near-vertical cliffs existing in limestone slopes.

Natural slope ratios typically range from 2(h) to 1(v) to 1.5(h) to 1(v). Relief on the order of 300 feet from ridgetop to drainage occurs in natural terrain locally.

Existing mine slopes include cuts with near 1(h) to 1(v) ratios up to approximately 50 feet in height. The "amphitheater" area includes an approximately 80-foot-high slope inclined at about 60 degrees with locally steeper sections. Talus and fill are present on some natural and mine slopes.

The proposed mining and reclaimed configuration of the subject quarry is depicted on Enclosure A-3.

Vegetation at the quarries consists of a sparse growth of desert shrubs in undisturbed areas. Vegetation is generally absent on the mine slopes.

FIELD INVESTIGATION

A certified engineering geologist conducted geologic mapping of the existing mines slopes in the quarry on December 8, 2014. Geologic structure was measured, including bedding/foliation, joint and fault orientations and geometry using a Brunton compass and clinometer. Structure mapping areas are identified by number on the Mine Map (Enclosure A-2.1) and data are summarized in tabular format in Appendix B. Our focus in the field was on continuous features that might affect kinematic stability of local slope faces and condition of existing slopes relative to geologic structure. Detailed field mapping of named geologic units was not within the scope of our investigation; therefore, we utilized prior mapping by Brown provided for our use. Mr. James Rogers, geologist of Omya California, identified major and minor structural features of the subject quarries and provided an overview of the various geologic units in the field. A Geologic Map based on mapping by Brown is provided as Enclosure A-4. Geology by Brown was mapped prior to mining; therefore, dipping features or contacts may appear shifted from their current locations.

SITE GEOLOGY

The Amboy Limestone quarry is located in the southern Bristol Mountains in San Bernardino County, northeast of Amboy, California. The Bristol Mountains expose a series of Paleozoic age sedimentary rocks overlying a Precambrian basement in the central Mojave Desert. Paleozoic units include Cambrian, Devonian, Carboniferous and Permian age units. Ordovician and Silurian units are not present in the Bristol Mountains Paleozoic section. According to Brown (2003), the limestone ore occurs in the Bullion Member of the Mississippian age Monte Cristo Limestone forming a unit up to 300 feet thick. The deposit trends north-south and dips east at approximately 45 degrees. Underlying (footwall) rocks include lower members of the Monte Cristo Limestone and Devonian age Sultan Limestone. Intrusive syenite units truncate the ore body to the north and west. Locally, diabase dikes have metamorphosed cherty limestone to opaque wollastonite marble (Appendix D – photos 13 and 14). A Geologic Map based on mapping by Brown is provided as Enclosure A-4. Paleozoic rocks of the Bristol Mountains are correlatable with the regional Paleozoic section defined for the greater Mojave Desert region.

Bedding in the Monte Cristo Limestone (ore body) is generally suggested by gray color bands that dip eastward at moderate angles. Brown (undated map) defined a foliation within the metamorphosed limestones that dips east at angles from 38 to 60 degrees with values between 40 and 47 degrees being typical. Wollastonite "beds" in the amphitheater and south mine area follow this moderately east-dipping "bedding" structure. Brown's foliation is defined as bedding in Table B-1 – Structural Data presented in Appendix B. The lithologic units at the Amboy Limestone quarry consist of sedimentary rocks that have been subjected to high-grade metamorphism. While bedding is generally well preserved in these materials, no potentially weak primary clay or silt beds were observed. Slope stability is anticipated to be influenced primarily by foliation, joint fabric near intrusive contacts and joint systems orthogonal to bedding/foliation.

Brown (2003) described several high-angle faults that cut the limestone and shift contacts a few tens of feet without large displacement. Brown (2003 and undated maps) also identified a compound

west-dipping normal fault that places Pennsylvanian Bird Spring Formation on top of the Monte Cristo Limestone at the mine ridgetop. A major contact between limestone of the Bird Spring and Monte Cristo units and syenite is present along the northern mine boundary. Contact between the limestone units and syenite is shown as intrusive in all maps and sections (Appendix D – photo 8). A well-developed joint system is present in the syenite near the intrusive contact as observed at the north end of the existing quarry at Location 2 (Appendix D – photo 4). This joint system, and possibly anastomosing high-angle faults, influences a system of compound south- and southwest-dipping shear surfaces that form slip planes in several wedge failures and a block glide slope failure (Appendix D – photos 2 through 7). A northwest-trending, down-to-the-northeast normal fault is also mapped between the Bird Spring and Monte Cristo limestone units along the northern ore boundary. Brown indicates southwest dips from 60 to 80 degrees on this structure. A high-angle fault system, coincident with a fault mapped by Brown as dipping southwest at 78 degrees (undated maps) between Bird Spring and Monte Cristo limestone units, is present along the north wall of the "amphitheater" area (Appendix D – photos 15-17). This fault forms a steep south-facing dip surface with abundant slickensides and clay/gouge infill.

A bedding-plane landslide formed in Monte Cristo limestone is present to the northwest of the mine area across the west drainage (Enclosure A-2). This feature is identified by an accumulation of colluvium on the head of the slide mass and deflection of the drainage at the toe and appears to be an ancient feature. The mechanism of movement is interpreted as translation along east-dipping bedding/foliation planes based on the conformance of the slip surface with bedding in nearby outcrops. This feature was mapped by Brown as in-place Anchor Member of the Monte Cristo Limestone and noted by Rasmussen (1996) as a landslide. The eastward-directed movement and bedding geometry suggests a potential for bedding-controlled slip surfaces in the mine area. This landslide mass will be partially concealed by the west OB stockpile. Based on the age, geometry and location of the slide, placement of OB material against the slide will not destabilize or otherwise cause an unstable condition in native or overburden slopes.

Fill observed at the site is associated with berms and stockpiles in the area of quarrying, as well as with roadways and general processing areas. Since this investigation is focused on rock and overburden stockpile slopes, specific locations of fill are not included on the Geologic Map (Enclosure A-4).

SITE SEISMICITY AND DESIGN

The Amboy Limestone quarry generally lies east of the more seismically active portion of the Mojave Desert that includes the Eastern California Shear Zone (ECSZ). The ECSZ is a regional area of distributed dextral shear that forms a system of predominantly northwest-trending, strike-slip faults traversing the Mojave Desert. The ECSZ accommodates strain between the Pacific-North American Plate boundary across a zone approximately 65 miles wide and is thought to transfer as much as 15 percent of the total plate boundary shear into the Great Basin area (Shermer and others, 1996). Several ECSZ faults ruptured in combination during the 1992 Landers earthquake. The closest fault of the ECSZ is the Pisgah-Bullion fault located about 31 miles southwest of the site. The Hector Mine earthquake of 1999 occurred along the Lavic Lake fault located approximately 34 miles west of the site and included rupture along the central portion of the Bullion fault. Other regional seismic sources include the North Frontal fault zone located along the northern flank of the San Bernardino Mountains approximately 70 miles to the west and the San Andreas fault zone located approximately 60 miles to the southwest.

Evidence of active faulting traversing the mine area was not indicated in published and unpublished literature and maps or during the field mapping. Ground rupture due to primary fault slip in the mine area is not anticipated.

The one-sigma value for a deterministic earthquake event occurring 30 miles (48 kilometers) from the site is 0.20g using "next-generation" attenuation equations by Abrahamson and Silva (2008), Boore and Atkinson (2008) and Campbell and Borzognia (2008).

The 2013 California Building Code (CBC) design acceleration parameters for structures were determined from latitude/longitude coordinates N34.5808, W115.6603 using the web-based U.S. Geologic Survey application, http://earthquake.usgs.gov/hazards/designmaps/javacalc.php. The corresponding value of peak ground acceleration (PGA) from the design acceleration spectrum according to the 2010 CBC is 0.29g.

The Uniform Hazard Response Spectrum (UHRS) value for PGA from the MCE-level (2% in 50-year probability of exceedance) earthquake was determined as 0.26g using the web-based U.S. Geologic Survey application, http://geohazards.usgs.gov/hazardtool/application.php.

Bray and Travasarou (2007) recommend one-half the value of PGA for use in slope analysis for habitable structures. For large slopes, Seed suggested Kh = 0.15 for sites near faults capable of generating magnitude 8.5 earthquakes. The seismic potential near the site is significantly less than this. Based on the method of Seed (1979) and the seismic setting of the site, our selection of Kh = 0.15 is conservative and appropriate for evaluation of existing site slopes. Therefore, a horizontal seismic coefficient of Kh = 0.15 was utilized based on the PGA values obtained for the site.

GROUNDWATER

No evidence for springs or perched groundwater conditions was observed at the site during the geologic mapping or on the aerial photographs examined. The mine occupies an elevated position on a mountain ridge relative to alluvial plains abutting the Bristol Mountains. The lowest planned feature of the mine is the final pit bottom at elevation 1,020 feet above mean sea level (amsl). The toe of the west overburden stockpile is at elevation 1,090 feet amsl. Groundwater elevations ranging from 577 to 565 feet amsl are reported for a well located approximately 2 miles west-southwest (California Department of Water Resources, 2015). The mine is located in an arid region; therefore, static groundwater or long-term seepage is not anticipated to affect the mine pit walls.

Groundwater was not encountered in exploratory borings drilled to approximately 200 feet below ground surface along the east drainage (Howard Brown, personal communication). Based on the planned excavation depths, the depth to groundwater in regional wells and the presence of non-liquefiable bedrock, the potential for liquefaction and other shallow groundwater-related hazards at the site is considered to be very low.

SLOPE STABILITY

The term "landslide", as used in this report, refers to deep-seated slope failures that involve pit-scale features that have the potential to reduce the long-term stability of finished quarry reclamation slopes. Landslides in rock are typically related to the structure in the parent material. Surficial failures refer to shallow failures that affect limited inter-bench zones and may result in localized raveling of rock material. No evidence for deep-seated landsliding with the potential to affect the future mine pit or overburden stockpile slopes was observed within the mine area or on the aerial photographs examined.

Minor surficial failures, typically involving small rock falls or talus accumulations, were observed in the quarry walls. These surficial failures are considered a mining management/maintenance issue mitigated by inclusion of safety benches in final slopes.

The susceptibility of a geologic unit to landsliding is dependent upon various factors, primarily: 1) the presence and orientation of weak structures, such as fractures, faults or clay beds; 2) the height and steepness of the natural or cut slope; 3) the presence and quantity of groundwater and 4) the occurrence of strong seismic shaking. Groundwater and seismic shaking are not considered significant factors in the stability of mine slopes for the Amboy Limestone quarry. Primary influences on the stability of final mine slopes is anticipated to be interaction between slope geometry and structures including foliation/bedding and faults along the pit margin.

GEOLOGIC STRUCTURE:

Geologic structural mapping included measurement of the orientation of bedrock structures in the quarry exposures that influence kinematic rock slope stability. We also included faults and contacts from the geologic map by Mr. Howard Brown. The orientation of joints, bedding/foliation, dikes and shear zones were mapped and recorded in tabular format (Appendix B - Table B-1). Observations of potential failure modes for each mapping area were noted. Structural data were grouped into map areas that exhibit similar structural characteristics. Eight map areas were defined and are presented in Enclosure A-2.

Location 2

Location 2 includes a roughly east-west trending cut slope formed by mining near the syenite/limestone contact at the north end of the mine area. Photographs 2 and 3 (Appendix D) show an overview of this location. The slope along Location 2 exposure several anastomosing, polished surfaces that form steeply-dipping faces, wedge failures, and a block glide mass that appears potentially unstable by examination. The block glide is identified by displacement of berm materials several feet down to the south and open fissures along the east side. Native outcrops of syenite exposed in the slope above the block glide exhibit well-developed, closely-spaced joints that dip steeply toward the south-southwest. We anticipate this joint system, developed along the syenite/limestone contact, to influence stability of the north and northeast quarry slopes. Removal of talus debris from the toe of the block glide may trigger further movement of the displaced block.

Two wedge structures are present in the slope face along Location 2 (photo 6 – Appendix D). These are formed by intersection of the east-west shear planes and orthogonal joints. An accumulation of large blocks is present at the toe of the eastern wedge feature.

Location 5

Foliation as defined by Brown (undated map) included as bedding in kinematic mapping (Table B-1) was observed at Location 5, which consists of a bench cut above the amphitheater area. Closely spaced color bands and wollastonite interbeds in marble are exposed at Location 5 (Photo 14 –

Appendix D). Foliation/bedding dips eastward at angles from about 40 to 75 degrees. It is anticipated the foliation/bedding will be the primary influence on stability of northeast- and east-facing slopes.

Location 8 – Amphitheater Area

The amphitheater area included the tallest existing slopes in the ore body at the time of our investigation and exposed a slickensided/sheared fault surface along its north side (Appendix D – photos 15-17). These faults form an anastomosing system of steeply south-southwest-dipping surfaces coincident with a high-angle fault system mapped by Brown as dipping southwest at 78 degrees between Bird Spring and Monte Cristo limestone units. It is anticipated the fault contact, if exposed in the mine wall, will be the primary influence on stability of south-west-facing slopes.

Due to the purity of the limestone and dolomite, no significant clay or silt layers are expected to be exposed in the proposed cut slopes and the whole rock condition is considered relatively strong. Fracturing/jointing is typical, and fault/shear planes are locally significant and may reduce the effective cohesion of individual blocks of rock in proposed slopes. However, the closely spaced and random jointing also effectively limits the depth and areal extent of any slope failures that could occur. Based on these data and the results of our investigation, deep-seated landsliding is not anticipated in the proposed slopes. Further analyses of the proposed slopes are presented in the following section as kinematic analysis and slope stability calculations.

SLOPE STABILITY EVALUATION

We evaluated the kinematic (geometrically feasible failure modes) and global slope stability of the proposed reclamation slopes for representative material types. Structural data were plotted and evaluated using stereonet plotting software. Rock strength properties for global stability calculations were modeled using Hoek Brown criteria and the ultimate mining depths (highest slopes) anticipated in the mine pit. Direct shear tests were performed on representative overburden stockpile materials

for use in evaluation of stockpile slopes. Discussion and summary of these analyses are presented below. Slope stability data and calculations are presented in Appendices B and C.

GLOBAL STABILITY CALCULATIONS:

The global stability of proposed mining slopes and proposed reclamation stockpiles, as depicted in the Permitting Quarry Design Map, was analyzed using Spencer's method under both static and seismic conditions for rotational and composite failure surfaces using the SLIDE computer program, version 6.032 (Rocscience, Inc., 2014). Selection of the slope configurations for the analysis of excavated slopes and stockpiles, which depicts the tallest anticipated continuous excavated or stockpile slopes proposed, is based on a most-conservative analysis approach. The whole rock strength of the Syenite unit exceeds that of the limestone unit; therefore, the models used the limestone strength values for global stability.

Representative slope sections of the excavated rock slopes and overburden stockpiles derived from the Permitting Design Map were modeled as follows:

- 447-foot-high benched cut slope (Section A – west wall)
- 467-foot-high native-over-cut slope (Section A – east wall)
- 563-foot-high limestone cut and upper native slope extended east from Section A
- 322-foot-high fill-over-native slope (Section A – stockpile)
- 148-foot-high fill over 370-foot high cut slope (Section B)
- 45-foot-thick/120-foot-high fill over 80-foot high native slope (Section C)

The seismic stability calculations were performed using a lateral pseudostatic coefficient "k" of 0.15, consistent with the seismic conditions of the site region. Groundwater was not considered in the global stability evaluation due to the lack of seepage or groundwater anticipated in the generally arid site environment.

Laboratory tests of rock samples collected from the mine included Unconfined Compressive Strength (UCS) and density. The results are summarized below. The rock strength was modeled utilizing the Generalized Hoek-Brown criteria (Hoek, 2000 and Hoek, Carranza-Torres & Corkum, 2002) and the program's built-in parameter calculator with the following input values:

Table 1.1: Amboy Quarry - Syenite Unit
Rock Strength Parameters

	Value	**Description**
Unit Weight (pcf*)	164	Measured
Intact UCS[1] (psf**)	3.09×10^6	Measured by UCS test
Geological Strength Index	40	Very blocky with fair surface conditions
Intact Rock Constant (mi***)	28	Gneiss
Disturbance Factor	1	Production blasting

Table 1.2: Amboy Quarry - Limestone Units Rock Strength Parameters		
	Value	**Description**
Unit Weight (pcf*)	167	Measured
Intact UCS[1] (psf**)	1.75×10^6	Measured by UCS test
Geological Strength Index	53	Blocky with fair surface conditions
Intact Rock Constant (mi***)	12	Crystalline limestone
Disturbance Factor	1	Production blasting

[1] Uniaxial Compressive Strength test result
* pcf = pounds per cubic foot
** psf = pounds per square foot
*** mi = unitless constant

Strength properties of overburden material are based on large-scale direct shear tests performed on samples remolded to 145 pounds per cubic feet (pcf), 3 percent water content, and loaded according to anticipated fill thickness. Test results are included in Appendix C and are summarized below in Table 1.3.

Table 1.3: Amboy Quarry – Overburden Material Strength Parameters			
Sample		**OB-1**	**OB-2**
Friction Angle	**Peak**	41	44
	Residual	40	44
Cohesion (psf)*		460	1,180
Unit Weight (pcf)		145	

*lesser of measured values

The results of our global slope stability analyses are summarized below in Table 2. Details of stability calculations including material type boundaries, strength parameters utilized and the minimum factor of safety and critical slip surface are included in Enclosures C-1.1 through C-3.2.

Table 2: Summary of Slope Stability Results – Amboy Quarry Mine and Stockpile Slopes

Cross Section	Slope Configuration	Static F.S.	Seismic F.S. (Kh=0.15)
Section A – east wall	Native above benched cut	1.97	1.62
Section A – east wall extended	Native above benched cut	1.95	1.57
Section A – west wall	Benched cut	1.94	1.59
Section A – stockpile	Fill over native	2.27	1.65
Section B	Fill above benched cut	2.18	1.63
Section C	Fill over native	2.32	1.69

As indicated by calculation, sufficient static factors of safety in excess of 1.5 and seismic factors of safety in excess of 1.1 were indicated for the modeled proposed rock and overburden slope configurations and satisfy Office of Mine Reclamation (OMR) criteria. The global rock and overburden slope configurations appear suitably stable for reclamation of the Amboy Mine slopes according to regulatory requirements.

KINEMATIC ANALYSIS:

Kinematic analysis involves the evaluation of geometrically feasible failure modes in bedrock based on the orientation of structural discontinuities including joints, faults, shear zones, bedding and foliations. Kinematic analysis does not consider mass or force as in a limit-equilibrium analysis.

Structurally controlled kinematic failure modes include planar, wedge and topple failures. Topple failure was not evident in the native or mine slopes; therefore, kinematic analysis of this mode was not included. Circular failure of highly fractured rock masses is considered in a global stability analysis (as presented previously).

Planar sliding requires a release surface—a joint or tension crack—to allow sliding to occur. Kinematic analysis does not consider the geometry of releasing surfaces or the presence of bonded contacts along the sliding plane. The field data include many measurements of planar joints between rock blocks that have not undergone sliding movement; therefore, the potential for sliding or wedge failure suggested by stereonet analysis should be considered a conservative estimate of probability subject to mitigation by mining practices such as scaling and adjustment of slope face angles to the geometry and conditions encountered during mining.

Stereonet analysis (Rocscience, 2013) for selected representative rock slopes was performed utilizing the data from mapped geologic structures within the site (Appendix B - Table B-1). Rock slopes for the Amboy quarry configuration were evaluated for slope dip azimuths oriented at 15 degrees, 48 degrees, 55 degrees, 195 degrees, 235 degrees and 270 degrees representing the suite of proposed slope aspects. Figure A-3 depicts the slope aspect zones considered in this evaluation. A slope face angle of 70 degrees and friction angle of 35 degrees were used based on typical slope finished angles for limestone mining (to account for back break) and roughness/cohesion along planar contacts. Planar analysis considers dip vectors of data points measured in the field. Wedge analysis considers the intersections of all field data points; therefore, wedge analysis generates a large number of vectors to evaluate. The stereonet data plots are presented in Appendix B. Locations of geologic structural mapping areas (domains) are indicated on the Mine Map (Enclosure A-2). Table 3 summarized the results of kinematic evaluation.

Table 3: Summary of Kinematic Evaluation			
Aspect	**Percentage Critical Points**		**Pit Area**
	Planar	**Wedge**	
015	2.6	15.4	South portion of west wall
048	1.6	8.3	North portion of west wall
055	17.9	22.5	Central portion of west wall
195	20.6	35.4	North portion of east wall
235	13.6	30.9	Central portion of east wall
270	5.1	26.7	South portion of east wall

The stereonet evaluation provides results as a percentage of points in a data set with a geometrically feasible orientation to undergo a particular failure mode. In general, the percentage value relates to probability of a particular failure mode. Probabilities below 5 percent suggest low failure potential, 5 percent to 20 percent a low to moderate potential, and values above 20 percent a moderate or higher potential.

The higher probabilities for planar failure are suggested for the central west wall, north east wall and central east wall. The presence of foliation/bedding in east-facing exposures with moderate dips is the primary structure controlling planar features in the west wall. Faults are the primary structure influencing planar features in the east wall.

With the exception of the north portion of the west wall, a moderate to high potential for wedge failure is suggested for all slope aspects. The potential for interaction of fault planes and joints is interpreted to be the primary influence in wedge failure potential for the north portion of the east wall, which showed the highest wedge potential. This is evident in existing exposures as discussed previously for Location 2. The length (continuity) of joints controls the size of wedge blocks. The

majority of existing wedge structures are smaller than bench face scale and therefore can be mitigated by typical mining practice such as inclusion of safety benches and scaling after blasting. However, the north and central portion of the east wall may be subject to larger wedge failures and planar slides where joints orthogonal to the fault surface exposed near Location 2 interact with the fault. The block glide documented in Appendix D, photo 7 can be considered a planar or broad wedge feature.

Future excavation practice and slope design for the north east wall should address the potential for wedge or planar failure along the steeply southwest-dipping, continuous, sheared rock surfaces. Visual monitoring during excavation activities along the north-northeast wall during mining should be included in the operational plan. Preparation of the final benched slope faces should include careful scaling to ensure removal of loose or potentially unstable blocks. If raveling or instability is evident, the bench width should be increased to provide a suitable buffer to daylighted or unstable features and a sufficient area to mitigate rockfall. The existing block glide should be stabilized—possibly by adding material to the toe of the slope—or removed by carefully scaling the block material without exposure of personnel or equipment to sudden sliding or movement. Removal of this mass may result in movement of additional material upslope from the existing face. The bench at Location 2 may be widened to provide a buffer to future movements of material in this zone. Based on the dip angle of planar and wedge structures exposed along the northeast cuts, it is anticipated that these features will be mitigated by the proposed benching scheme as mining proceeds to lower elevations, provided that adjustments are made to prevent daylighted slip planes or unstable wedges.

With the exception of the north and central portions of the east wall and central portion of the west wall, which may require additional monitoring, scaling or adjustment of bench widths, the kinematic stability for the proposed mine slope configurations appears consistent with typical limestone bodies that are configured with similar overall slope angles, bench face heights and bench widths.

CONCLUSIONS

On the basis of our field investigation and slope stability analyses, it is the opinion of this firm that the proposed mine excavation, stockpile placement and reclamation of the Amboy Limestone quarry are feasible from geotechnical engineering and engineering geologic standpoints, provided the recommendations contained in this report are implemented during mining.

In general, it appears that past quarry operations have resulted in formation of grossly stable slopes and that the whole rock strength of ore and overburden rock is sufficient to accommodate the proposed overall slope angles.

Based upon our analyses, the proposed overall approximate 50- to 55-degree mine cut-slopes up to approximately 560 feet in height are suitably stable against gross failure for the anticipated long-term conditions, including the effects of seismic shaking. The proposed approximately 2(h):1(v) OB fill slopes meet the factor of safety criteria for static and seismic conditions.

Placement of OB material against the existing ancient landslide mass in the west drainage will not result in unstable native or overburden slopes.

Subsequent to blasting of the final rock slope walls, quarry operations may include the use of a scaling chain or mechanical equipment to assist in removal of loose or precarious blocks during removal of the ore. Adherence to the slope benching plan and consideration of newly exposed adverse structural features (if present) during future quarry work can result in stable slopes after completion of quarry reclamation.

No evidence of active faulting was observed on the site during this investigation. Several inactive faults traverse the mine area. The potential for liquefaction and other shallow groundwater hazards within the reclamation area is considered to be remote.

Moderate seismic shaking of the site can be expected to occur during the lifetime of the proposed mining and reclamation. This potential has been considered in our analyses and evaluation of slope stability.

Raveling processes during and after quarry operation, with time, will result in deposition of talus on benches. Talus left on the benches can facilitate revegetation and lend a more natural appearance to the reclaimed slopes. It is anticipated that boulders will be angular and relatively resistant to rolling.

RECOMMENDATIONS

The existing wedge and block glide features at the north cut area indicate a potential for exposure of unstable rock masses at the northeast wall. Future excavation practice and slope design for the northeast wall should address the potential for wedge or planar failure along the steeply southwest-dipping, continuous, sheared rock surfaces. Visual monitoring during excavation activities along the north-northeast wall during mining should be included in the operational plan. Preparation of the final benched slope faces should include careful scaling to ensure removal of loose or potentially unstable blocks. If raveling or instability is evident, the bench width should be increased to provide a suitable buffer to daylighted or unstable features and a sufficient area to mitigate rockfall. The existing block glide should be stabilized, possibly by adding material to the toe of the slope, or removed by carefully scaling the block material without exposure of personnel or equipment to sudden sliding or movement. Removal of this mass may result in movement of additional material upslope from the existing face. The bench at Location 2 may be widened to provide a buffer to future movements of material in this zone. Based on the dip angle of planar and wedge structures exposed along the northeast cuts, it is anticipated that these features will be mitigated by the proposed benching scheme as mining proceeds to lower elevations, provided that adjustments are made to prevent daylighted slip planes or unstable wedges.

Overall final cut slopes in the rock materials should be no steeper than design angles up to the maximum proposed height. It is anticipated that the contact between the ore body and underlying

Sultan limestone will influence the angle of the west pit wall. This contact is depicted as dipping approximately 45 degrees eastward; therefore, overall pit slopes steeper than the design angles are not anticipated.

Natural raveling processes will result in accumulation of talus on the excavated benches. The talus may help to facilitate revegetation and to lend the reclaimed slopes a relatively natural appearance. It is anticipated that any resulting boulders will be angular and relatively resistant to rolling. Any large, unstable, rounded boulders on slopes steeper than approximately 2(h) to 1(v) should be removed or stabilized where accessible. Areas below loose rock, if left in place, should be restricted and indicated by means of signage or fencing.

Geotechnical evaluation and design, management of mine bench geometry based on encountered conditions, or use of mechanical support systems can enhance the safety of or mitigate hazards in mining; however, monitoring of slope conditions for failure warning signs is the most important means for protecting mine workers (Girard and McHugh, 2000) as it can prevent exposure of personnel to potentially hazardous conditions. As is typical for any surface mining location, we recommend that the ongoing practice of periodic observation of mine benches above working areas for indications of potential instability continue during mine operations.

Final reclaimed fill slopes composed of overburden materials should be no steeper than 2(h):1(v) to the maximum proposed heights.

Slopes should be protected with berms and/or levees as necessary to prevent slope erosion in the areas where natural slopes drain onto the reclaimed slopes.

LIMITATIONS

CHJ Consultants has striven to perform our services within the limits prescribed by our client, and in a manner consistent with the usual thoroughness and competence of reputable geotechnical engineers

and engineering geologists practicing under similar circumstances. No other representation, express or implied, and no warranty or guarantee is included or intended by virtue of the services performed or reports, opinion, documents, or otherwise supplied.

This report reflects the testing conducted on the site as the site existed during the study, which is the subject of this report. However, changes in the conditions of a property can occur with the passage of time, due to natural processes or the works of man on this or adjacent properties. Changes in applicable or appropriate standards may also occur whether as a result of legislation, application, or the broadening of knowledge. Therefore, this report is indicative of only those conditions tested at the time of the subject study, and the findings of this report may be invalidated fully or partially by changes outside of the control of CHJ Consultants. This report is therefore subject to review and should not be relied upon after a period of one year.

The conclusions and recommendations in this report are based upon observations performed and data collected at separate locations, and interpolation between these locations, carried out for the project and the scope of services described. It is assumed and expected that the conditions between locations observed and/or sampled are similar to those encountered at the individual locations where observation and sampling was performed. However, conditions between these locations may vary significantly. Should conditions that appear different than those described herein be encountered in the field by the client, any firm performing services for the client or the client's assign, this firm should be contacted immediately in order that we might evaluate their effect.

If this report or portions thereof are provided to contractors or included in specifications, it should be understood by all parties that they are provided for information only and should be used as such.

The report and its contents resulting from this study are not intended or represented to be suitable for reuse on extensions or modifications of the project, or for use on any other project.

CLOSURE

We appreciate this opportunity to be of service and trust this report provides the information desired at this time. Should questions arise, please do not hesitate to contact this office.

Respectfully submitted,

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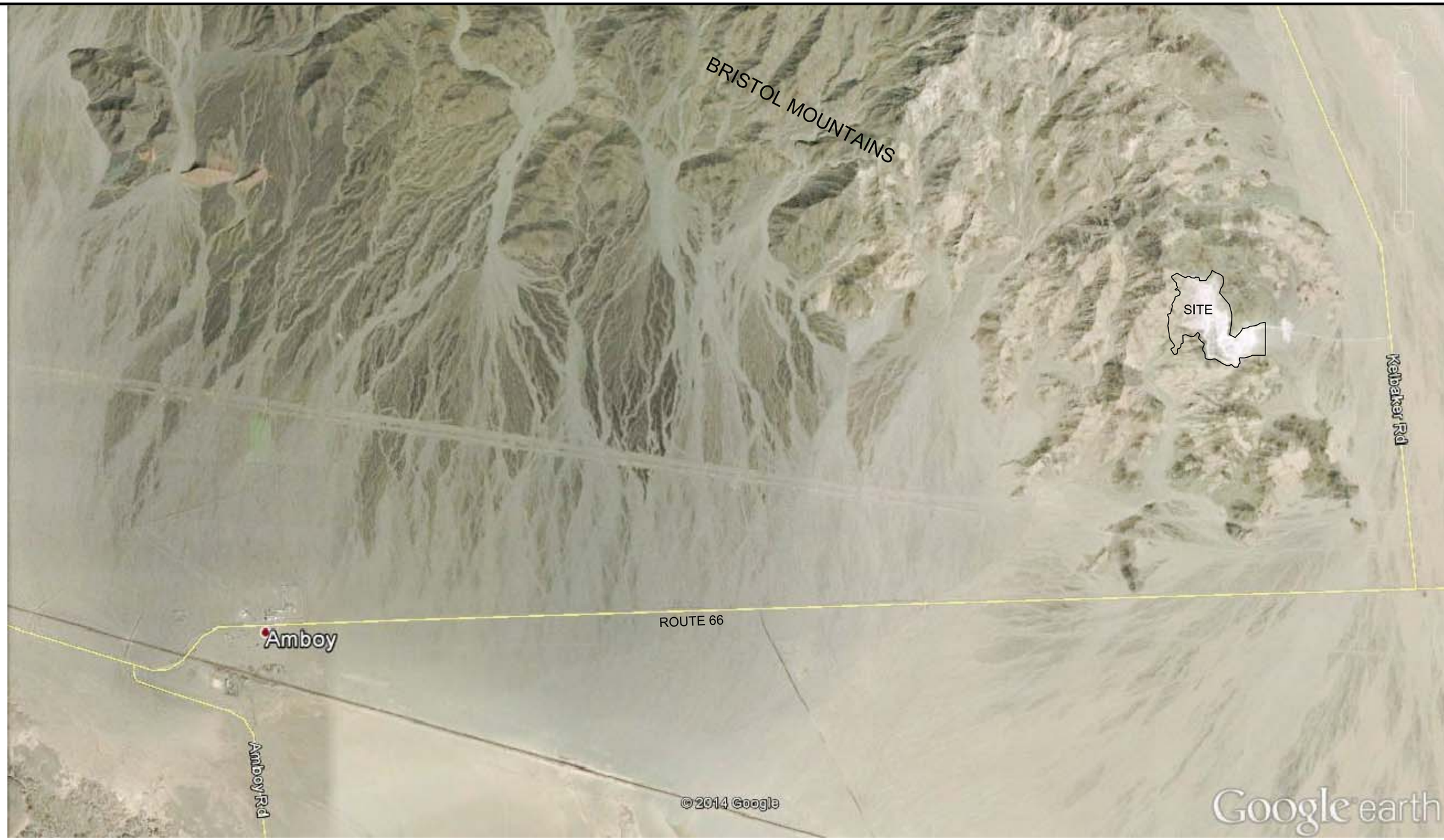
AERIAL PHOTOGRAPHS EXAMINED

Google Earth software application, 2014, aerial photographs dated September 27, 1995; February 16, 2003; July 4, 2003; December 30, 2005; June 5, 2009; May 27, 2012; March 9, 2013; and March 29, 2014.

APPENDIX A

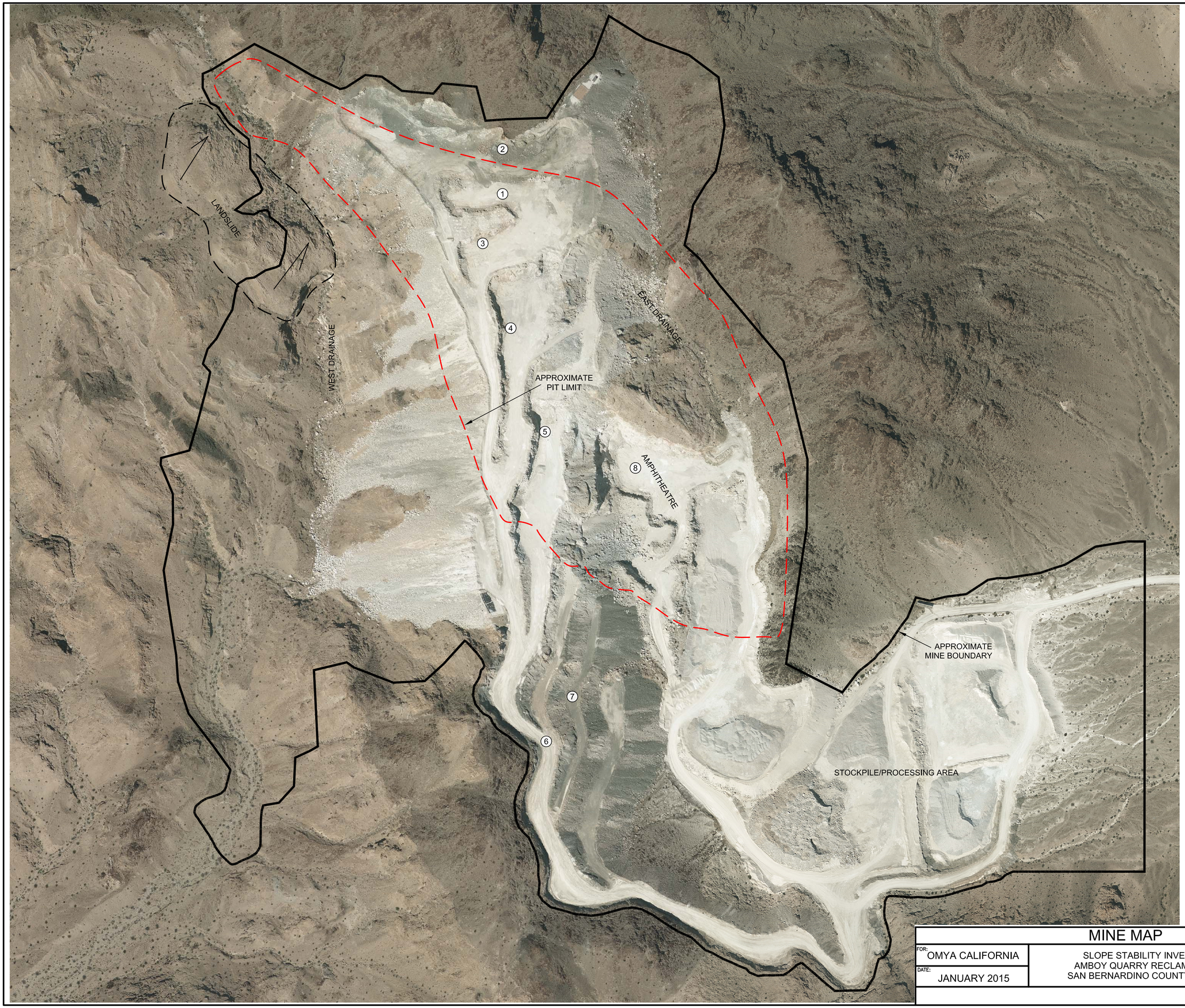
GEOLOGIC MAPS



N

SCALE: 1" = APPROX. 2,500'

LOCATION MAP		
FOR: OMYA CALIFORNIA	SLOPE STABILITY INVESTIGATION AMBOY QUARRY RECLAMATION PLAN SAN BERNARDINO COUNTY, CALIFORNIA	ENCLOSURE "A-1"
DATE: DECEMBER 2014		JOB NUMBER 14814-8
		CHJ Consultants



N

SCALE: 1" = APPROX. 150'

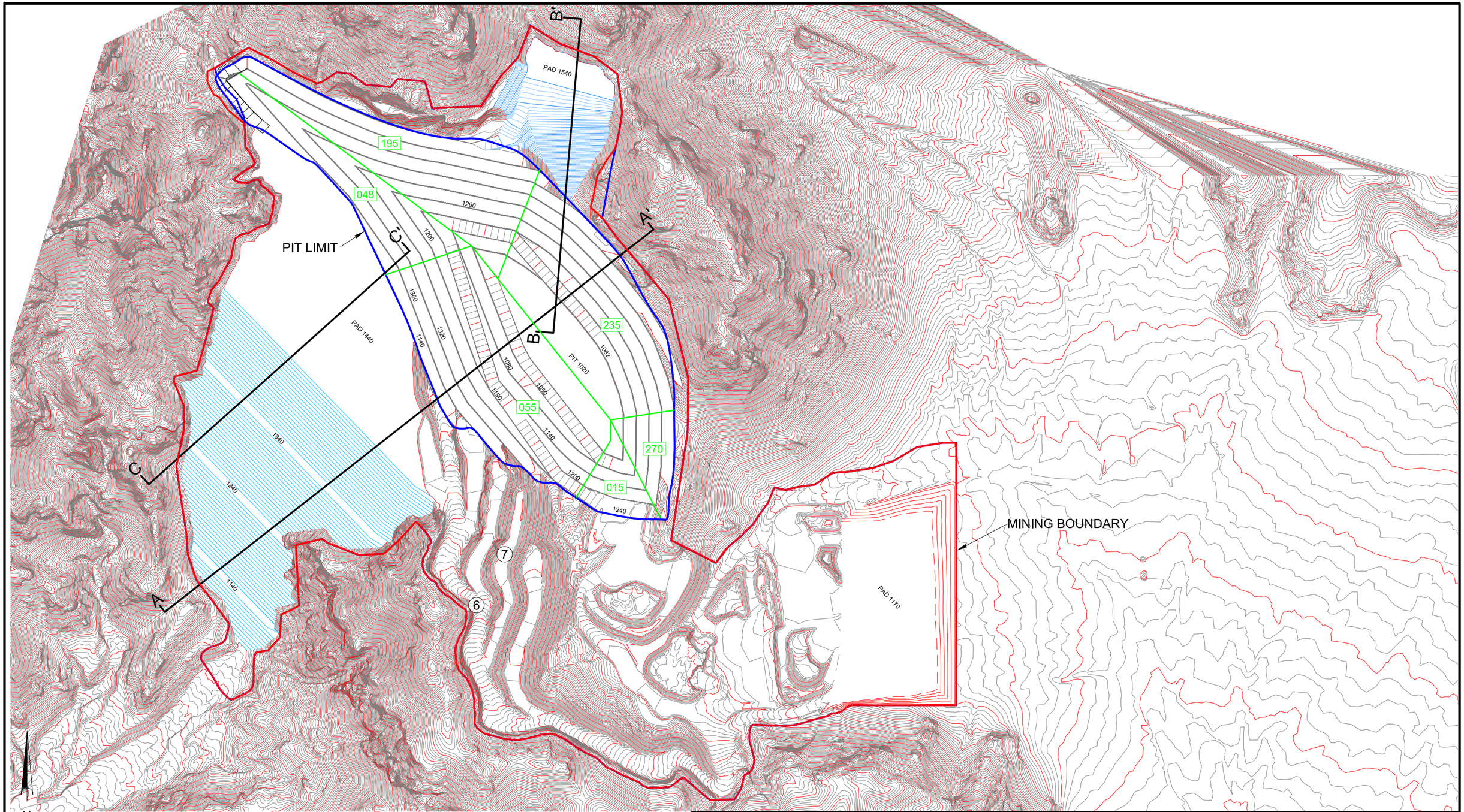
LEGEND:

8 NUMBER CORRESPONDING TO STRUCTURE DATA

MINE MAP

FOR: OMYA CALIFORNIA	SLOPE STABILITY INVESTIGATION AMBOY QUARRY RECLAMATION PLAN SAN BERNARDINO COUNTY, CALIFORNIA	ENCLOSURE "A-2"
DATE: JANUARY 2015		JOB NUMBER 14814-8

CHJ Consultants



LEGEND:

7 NUMBER CORRESPONDING TO STRUCTURE DATA

270 SLOPE ASPECT ZONE

C C' GEOLOGIC SECTION

PERMITTING QUARRY DESIGN MAP

FOR: OMYA CALIFORNIA

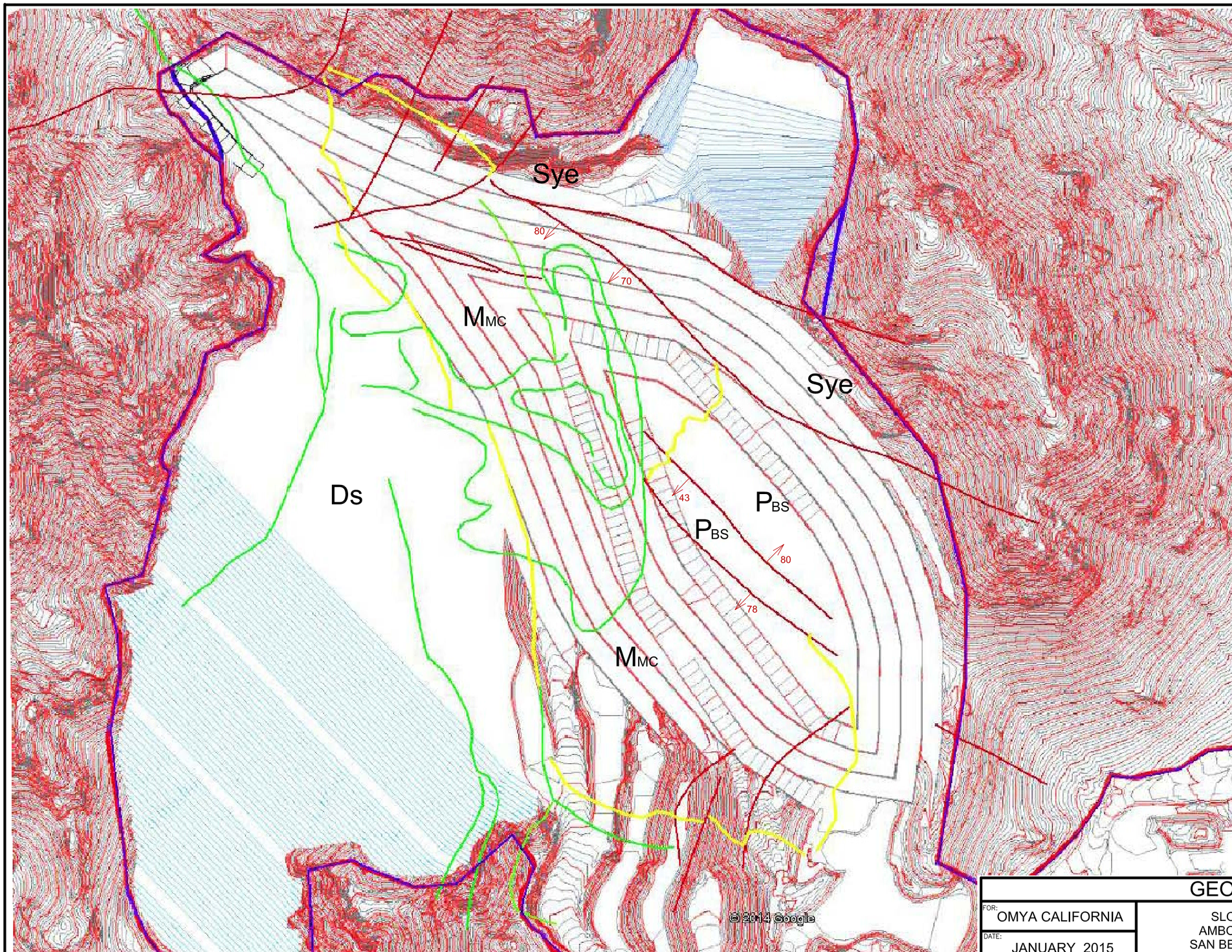
DATE: JANUARY 2015

SLOPE STABILITY INVESTIGATION
AMBOY QUARRY RECLAMATION PLAN
SAN BERNARDINO COUNTY, CALIFORNIA

ENCLOSURE "A-3"

JOB NUMBER 14814-8

CHJ Consultants



GEOLOGIC UNITS:

Sye - Syenite -medium-to coars-grained syenite and monzonite
PBS - Bird Spring Formation -marble and dolomite
MMC - Monte Cristo Limestone -includes Bullion, Anchor and Dawn members
Ds - Sultan Limestone and older rocks - includes several marker units and members

Geologic Contact

Fault, arrow indicates dip direction and value

80

Thrust and low angle gravity thrusts

Note: Geology generalized from maps and sections by Howard Brown. Mapping conducted prior to mining: therefore features may appear in different location than existing exposure.

N

SCALE: 1" = 200'

GEOLOGIC MAP

FOR: OMYA CALIFORNIA	SLOPE STABILITY INVESTIGATION AMBOY QUARRY RECLAMATION PLAN SAN BERNARDINO COUNTY, CALIFORNIA	ENCLOSURE "A-4"
DATE: JANUARY 2015		JOB NUMBER 14814-8

CHJ Consultants

APPENDIX B

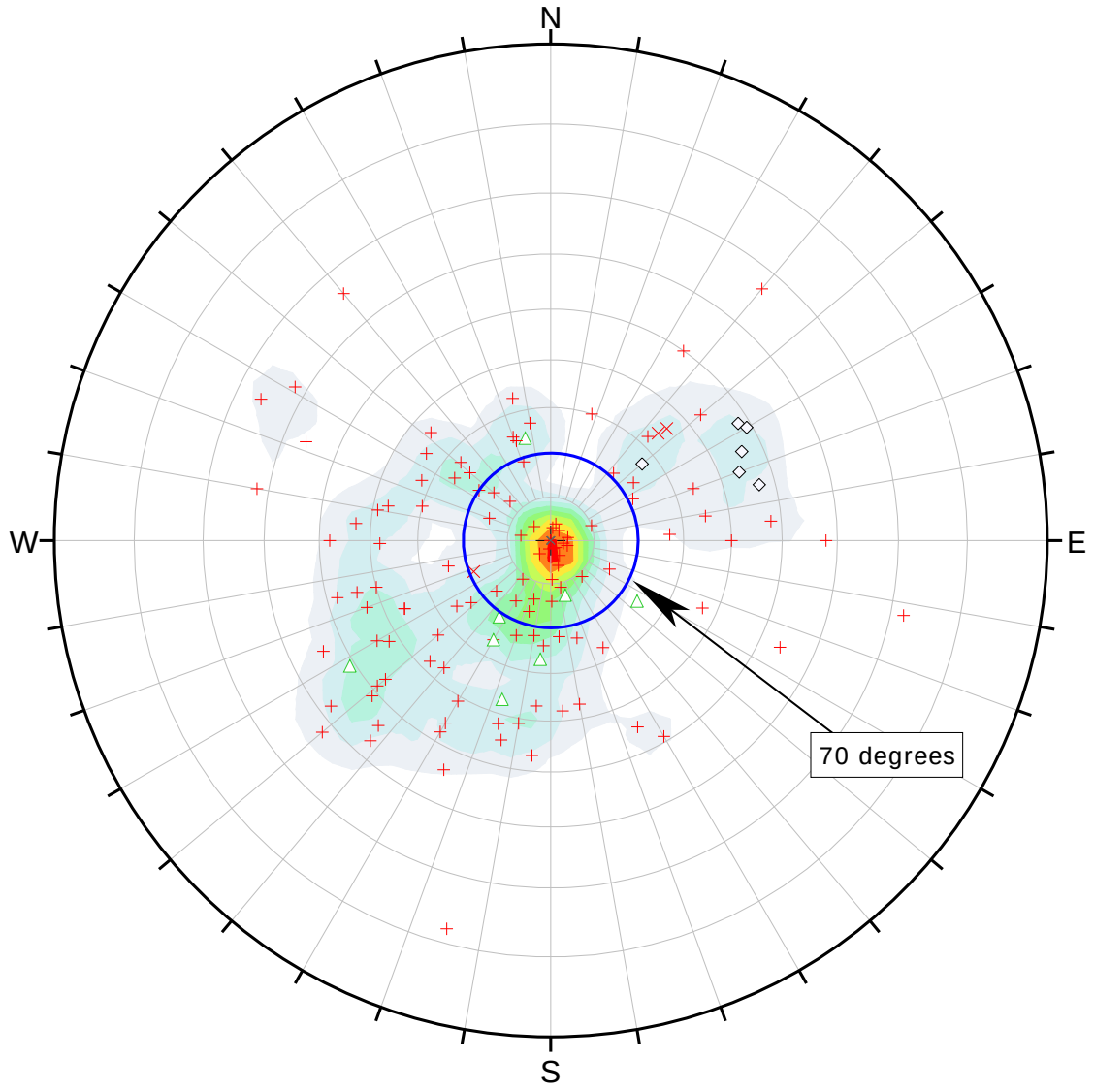
KINEMATIC EVALUATION

B-1: Structural Data - Amboy							
Dip	**Dip Direction**	**Type**	**Continuity**	**Roughness**	**Geologic Unit**	**Location**	**Notes**
85	310	J	1	3	ore	1	6" spacing, parallel, blocky
75	290	J	1	4	ore	1	
67	200	J	3	5	ore	1	12" spacing
66	346	F	5	1	ore	1	48" crush zone, polished, slicks
77	314	J	4	2	sye	1	4-8" spacing
63	185	F	5	1	sye	2	anastomosing, polished, joint/shear surfaces; form large faces and wedges where ortho intersections
60	285	J	4	2	sye	2	
53	197	F	4	1	sye	2	conjugate to face
42	85	J	3	3	sye	2	ortho to face
53	114	J	1	3	sye	2	ortho to face
47	275	J	4	4	sye	2	ortho to face
24	320	J	4	3	sye	2	ortho to face
53	282	J	3	4	sye	2	
79	216	J	2	4	sye	2	
49	190	J	5	2	sye	2	native dip slope on joint system
73	197	J	5	2	sye	2	wedge plane
51	280	J	3	4	sye	2	wedge plane
75	116	J	3	3	sye	2	wedge
24	296	J	5	2	sye	2	low angle, neutral to face
76	196	J	5	2	sye	2	face
68	190	J	3	2	sye	2	face set
60	18	J	3	2	sye	2	
87	102	J	3	3	sye	2	ortho to face
43	185	J	4	1	sye	2	
79	168	J	5	2	sye	2	face
66	256	J	3	2	sye	2	wedge plane ortho to face
53	185	J	3	3	ore	3	mineralized joint
50	90	J	1	3	ore	3	
32	233	J	3	2	ore	3	
64	210	J	1	2	ore	3	
90	140	J	1	2	ore	3	
54	245	J	3	3	ore	3	3-6" spacing
42	255	J	3	2	ore	3	12-36" spacing
45	155	J	3	3	ore	3	
53	220	J	3	4	ore	4	mineralized face on east wall
36	223	J	3	3	ore	4	
86	107	J	1	5	ore	4	

Dip	Dip Direction	Type	Continuity	Roughness	Geologic Unit	Location	Notes
36	115	J	3	4	ore	4	
46	255	J	2	2	ore	4	
73	310	J	2	2	ore	4	
50	255	J	4	2	ore	4	6-36" spacing, parallel
23	40	J	1	3	ore	4	
54	312	J	1	2	ore	4	
43	230	J	4	2	ore	4	
57	345	J	4	3	ore	4	6-8' spacing
90	164	J	1	2	ore	4	
66	310	J	3	3	ore	4	4-6" spacing, parallel
32	90	J	3	3	ore	4	
67	232	J	2	2	ore	4	mineralized
54	245	J	3	2	ore	4	overhang on west wall
64	210	F	4	1	ore	4	3/4" thick gouge
55	81	J	3	2	ore	4	face
48	238	J	4	2	ore	4	6-36" spacing, parallel
84	163	J	2	4	ore	4	
77	165	F	4	3	ore	4	3" thick crush zone
28	280	J	3	2	ore	4	12-24" spacing
34	292	J	5	3	ore	4	
74	210	J	3	2	ore	4	
36	205	J	3	1	ore	4	
86	80	J	3	3	ore	4	
67	165	J	3	3	ore	4	12-36" spacing
88	145	J	2	3	ore	4	
41	150	J	2	3	ore	4	
42	58	B	3	5	ore	4	
43	75	B	5	4	ore	5	dark gray bands, 4-6" spacing
44	65	B	5	5	ore	5	controls joints
64	303	J	4	4	ore	5	
41	230	J	2	4	ore	5	
88	190	J	3	3	ore	5	
86	220	J	3	3	ore	5	
83	280	J	3	3	ore	5	overhang
47	250	J	1	3	ore	5	
73	227	J	4	3	ore	5	
63	311	J	3	4	ore	5	
52	225	J	2	4	ore	5	
56	45	D	5	3	dike	5	green/gray mafic 10-12' thick; sub-parallel

							to B
Dip	**Dip Direction**	**Type**	**Continuity**	**Roughness**	**Geologic Unit**	**Location**	**Notes**
63	154	J	4	2	ore	5	
81	178	J	4	2	ore	5	12-50" spacing
45	194	J	4	2	ore	5	
41	60	B	5	5	ore	5	
44	210	J	2	3	ore	5	
71	248	D	4	3	ore	5	8-14" thick; offset by joint
49	210	J	2	3	ore	5	
67	55	J	2	3	ore	5	wedge 1
53	170	J	2	3	ore	5	wedge 2
57	230	J	2	2	ore	5	6-24" spacing; topple
36	244	J	5	3	ore	5	
80	70	J	3	5	ore	5	
56	70	J	4	3	ore	5	
18	102	J	4	2	ore	5	
39	238	F	4	1	ore	5	
66	125	F	5	2	sye	6	face
69	43	J	3	3	sye	6	wedge
54	46	D	4	3	sye	6	mafic, 50' thick; below ore contact
47	50	J	3	3	sye	6	dike
28	301	J	4	2	sye	6	joints in dike
63	87	J	5	3	sye	6	block glide face
64	235	J	3	2	ore	7	
56	305	J	3	2	ore	7	
46	70	B	5	3	ore	7	
69	63	J	3	4	ore	7	face
69	214	F	5	1	ore	8	fault/face ore v. sye contact
52	269	J	2	3	ore	8	
88	160	J	5	2	ore	8	
33	222	J	5	1	ore	8	
40	35	J	2	3	ore	8	
28	230	J	4	2	ore	8	
86	17	J	3	3	ore	8	
70	305	J	5	3	ore	8	
63	50	B	5	5	ore	8	
42	270	J	2	2	ore	8	
87	39	J	5	2	ore	8	60" spacing
58	295	J	2	2	ore	8	
39	229	J	3	2	ore	8	6-18" spacing, undulatory

Dip	Dip Direction	Type	Continuity	Roughness	Geologic Unit	Location	Notes
86	150	J	3	3	ore	8	
66	184	J	2	2	ore	8	
79	139	J	1	3	ore	8	
76	179	J	1	3	ore	8	
68	175	J	2	2	ore	8	
12	195	J	4	4	ore	8	
87	9	J	1	5	ore	8	
66	341	J	4	4	ore	8	
46	240	J	3	2	ore	8	
58	43	J	3	2	ore	8	
63	350	J	2	2	ore	8	'hanging' block
52	176	J	2	2	ore	8	'hanging' block
71	341	J	4	3	ore	8	
42	210	J	3	2	ore	8	
65	340	J	4	3	ore	8	8-12" spacing
48	196	J	3	1	ore	8	



Symbol	TYPE	Quantity
◇	B	6
×	D	3
△	F	8
+	J	113

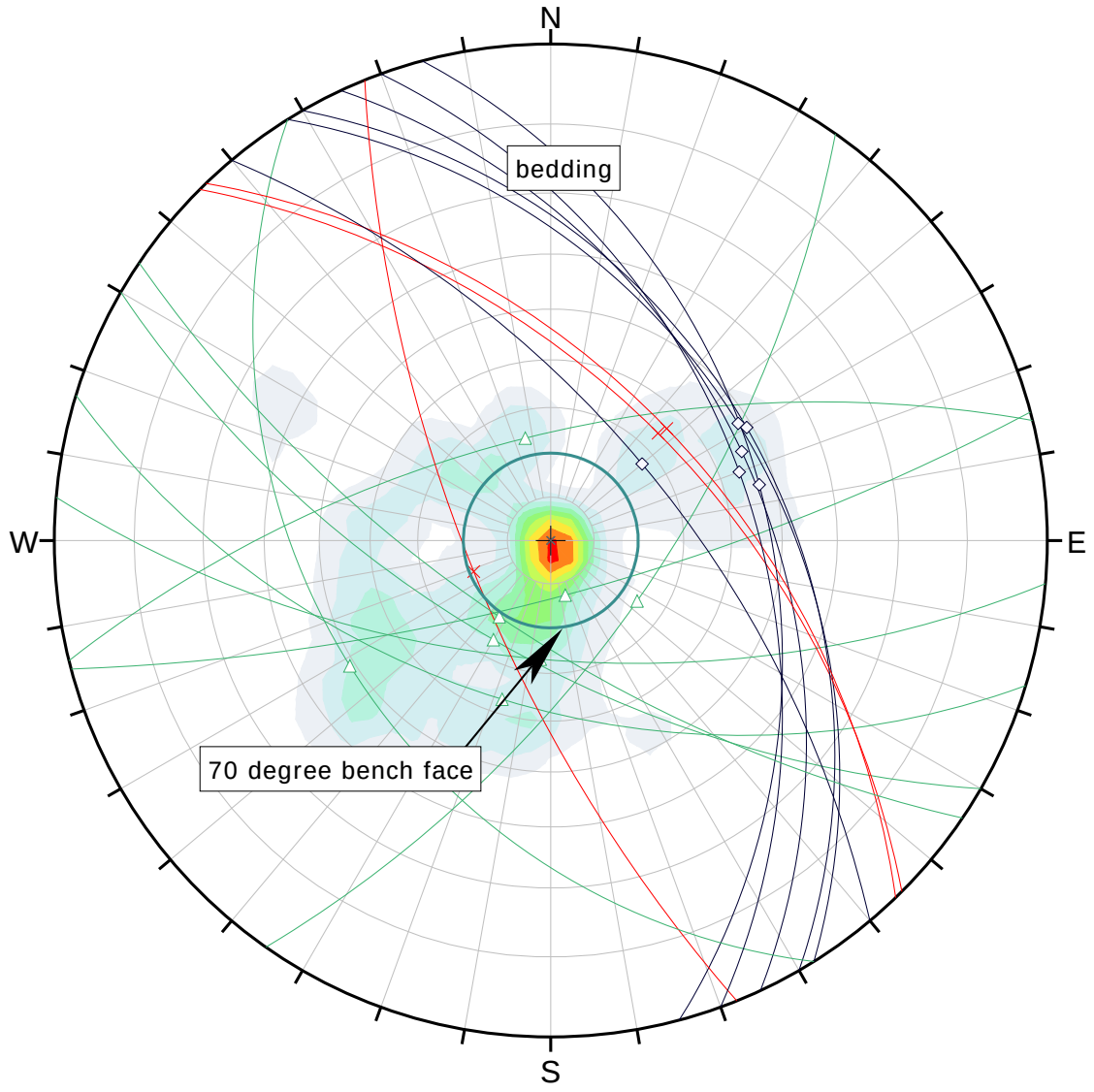
Color	Density Concentrations
	0.00 - 1.30
	1.30 - 2.60
	2.60 - 3.90
	3.90 - 5.20
	5.20 - 6.50
	6.50 - 7.80
	7.80 - 9.10
	9.10 - 10.40
	10.40 - 11.70
	11.70 - 13.00

Maximum Density	12.12%
Contour Data	Dip Vectors
Contour Distribution	Fisher
Counting Circle Size	1.0%

Plot Mode	Dip Vectors
Vector Count	130 (130 Entries)
Hemisphere	Lower
Projection	Equal Angle

Project	Amboy		
Analysis Description	Global Data, Dip Vector Plot		
Drawn By	CHJ	*Author*	JMc
File Name	Global_Amboy Data.dips6	*Date*	12/17/2014
		Enclosure	B-2.1

DIPS 6.008



Symbol	TYPE	Quantity
◇	B	6
×	D	3
△	F	8
	Others	113

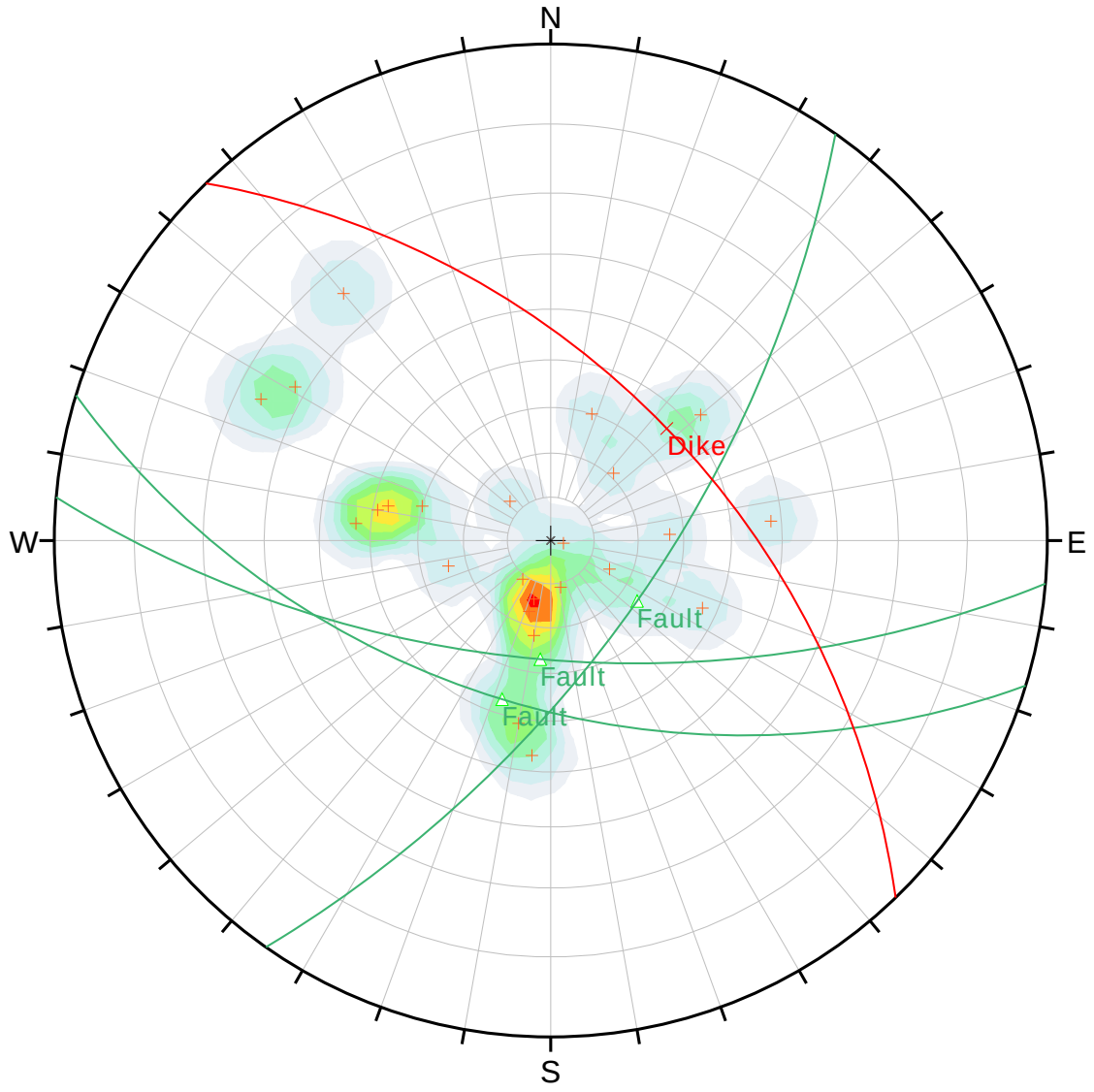
Color	Density Concentrations
	0.00 - 1.30
	1.30 - 2.60
	2.60 - 3.90
	3.90 - 5.20
	5.20 - 6.50
	6.50 - 7.80
	7.80 - 9.10
	9.10 - 10.40
	10.40 - 11.70
	11.70 - 13.00

Maximum Density	12.12%
Contour Data	Dip Vectors
Contour Distribution	Fisher
Counting Circle Size	1.0%

Plot Mode	Dip Vectors
Vector Count	130 (130 Entries)
Hemisphere	Lower
Projection	Equal Angle

Project	Amboy		
Analysis Description	Major Structures, Dip Vector Plot		
Drawn By	CHJ	*Author*	JMc
File Name	Dikes_Faults_Amboy Data.dips6	*Date*	12/17/2014
		Enclosure	B-2.2

DIPS 6.008



Symbol	TYPE	Quantity
×	D	1
△	F	3
+	J	24

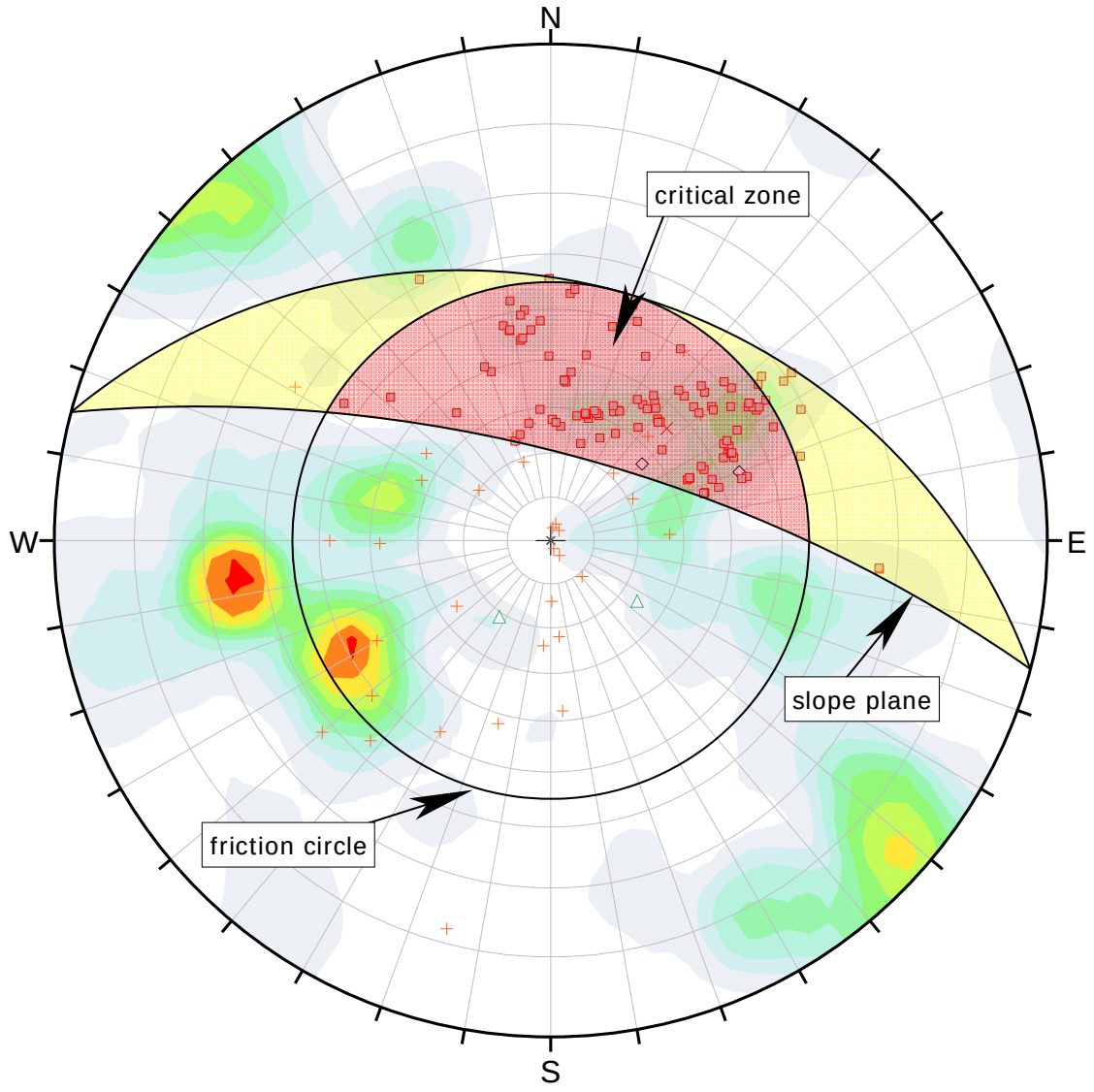
Color	Density Concentrations
	0.00 - 1.50
	1.50 - 3.00
	3.00 - 4.50
	4.50 - 6.00
	6.00 - 7.50
	7.50 - 9.00
	9.00 - 10.50
	10.50 - 12.00
	12.00 - 13.50
	13.50 - 15.00

Maximum Density	14.19%
Contour Data	Dip Vectors
Contour Distribution	Fisher
Counting Circle Size	1.0%

Plot Mode	Dip Vectors
Vector Count	28 (28 Entries)
Hemisphere	Lower
Projection	Equal Angle

Project	Amboy		
Analysis Description	Structures, Syenite Unit, Dip Vector Plot		
Drawn By	CHJ	*Author*	JMc
File Name	SyeniteData.dips6	*Date* 12/17/2014	*Enclosure* B-2.3

DIPS 6.008



Symbol	TYPE	Quantity
◇	B	2
×	D	1
△	F	2
+	J	34

Symbol	Feature
■	Critical Intersection

Color	Density Concentrations
	0.00 - 0.60
	0.60 - 1.20
	1.20 - 1.80
	1.80 - 2.40
	2.40 - 3.00
	3.00 - 3.60
	3.60 - 4.20
	4.20 - 4.80
	4.80 - 5.40
	5.40 - 6.00

Maximum Density	5.58%
Contour Data	Intersections
Contour Distribution	Fisher
Counting Circle Size	1.0%

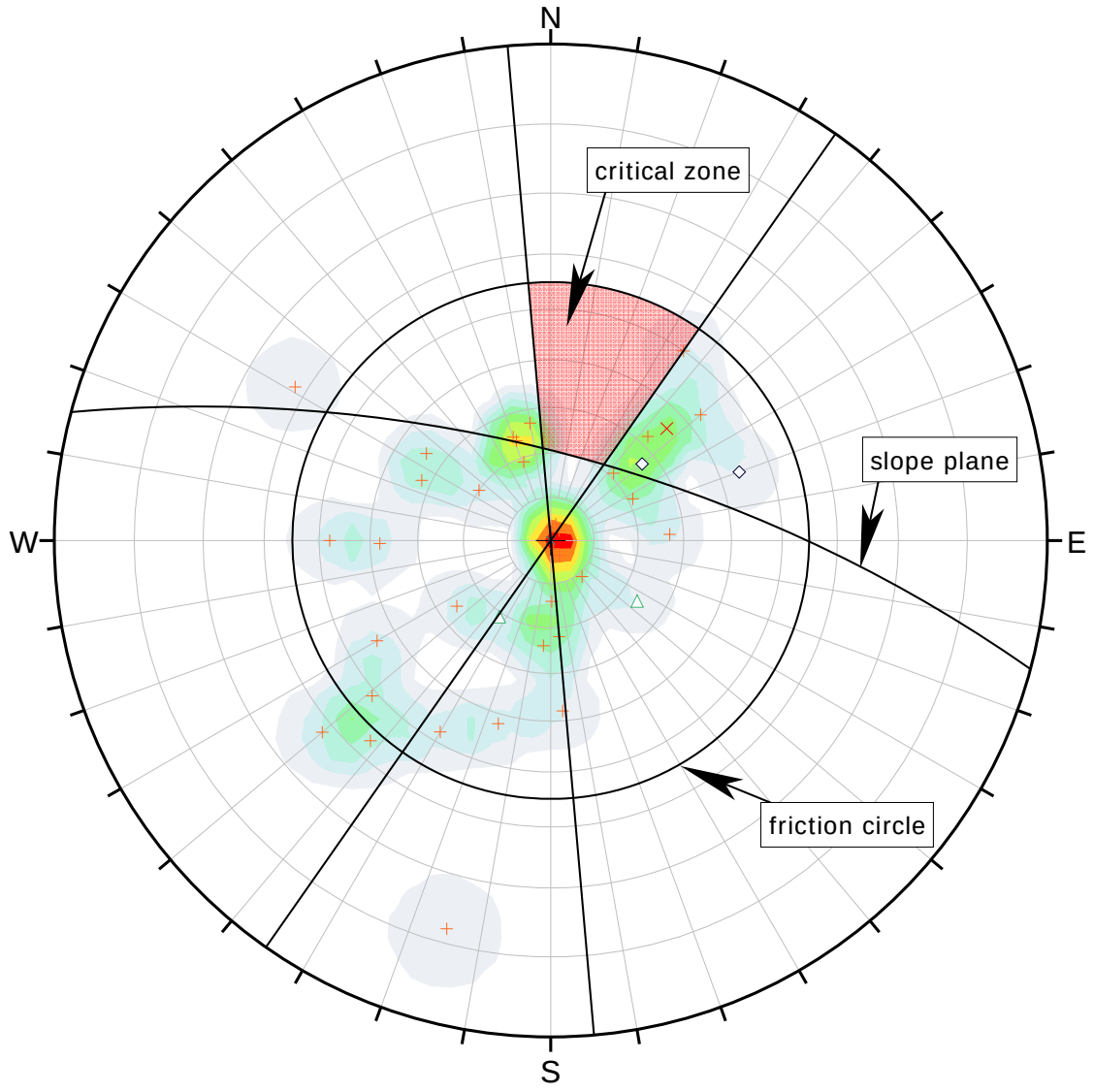
Kinematic Analysis	Wedge Sliding
Slope Dip	70
Slope Dip Direction	15
Friction Angle	35°

	Critical	Total	%
Wedge Sliding	114	741	15.38%

Plot Mode	Dip Vectors
Vector Count	39 (39 Entries)
Intersection Mode	Grid Data Planes
Intersections Count	741
Hemisphere	Lower
Projection	Equal Angle

DIPS 6.008

Project	Amboy		
Analysis Description	Aspect 015, Wedge Analysis, Dip Vector Plot		
Drawn By	CHJ	*Author*	JMc
File Name	Amboy 015_6 7 8 wedge.dips6	*Date*	12/17/2014
Enclosure	B-3.1		



Symbol	TYPE	Quantity
◇	B	2
×	D	1
△	F	2
+	J	34

Color	Density Concentrations
	0.00 - 1.30
	1.30 - 2.60
	2.60 - 3.90
	3.90 - 5.20
	5.20 - 6.50
	6.50 - 7.80
	7.80 - 9.10
	9.10 - 10.40
	10.40 - 11.70
	11.70 - 13.00

Maximum Density	12.48%
Contour Data	Dip Vectors
Contour Distribution	Fisher
Counting Circle Size	1.0%

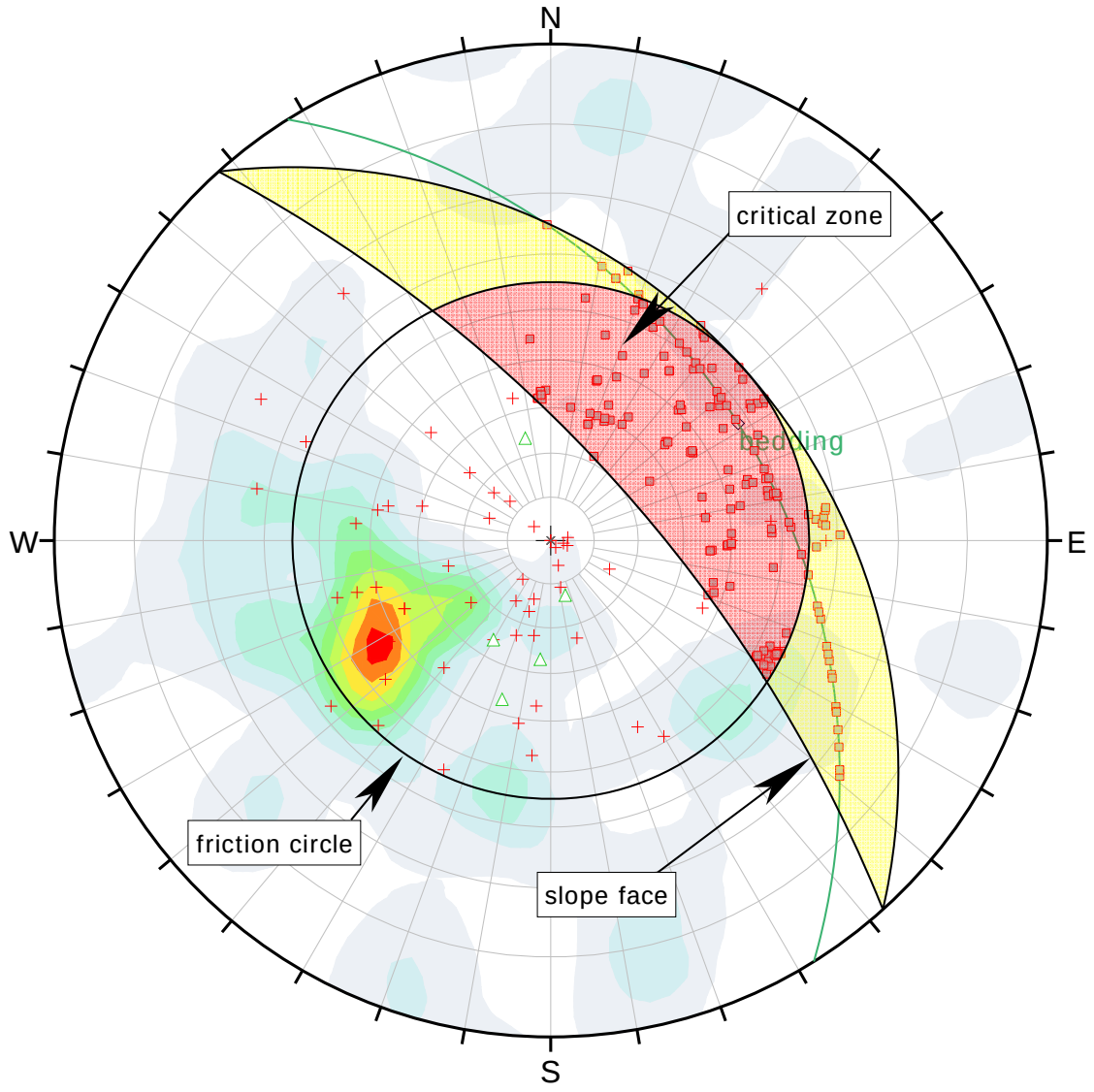
Kinematic Analysis	Planar Sliding
Slope Dip	70
Slope Dip Direction	15
Friction Angle	35°
Lateral Limits	20°

	Critical	Total	%
Planar Sliding (All)	1	39	2.56%

Plot Mode	Dip Vectors
Vector Count	39 (39 Entries)
Hemisphere	Lower
Projection	Equal Angle

DIPS 6.008

Project	Amboy		
Analysis Description	Aspect 015, Plane Analysis, Dip Vector Plot		
Drawn By	CHJ	*Author*	JMc
File Name	Amboy 015_6 7 8 wedge.dips6	*Date*	12/17/2014
Enclosure	B-3.2		



Symbol	TYPE	Quantity
◇	B	1
△	F	5
+	J	58
Symbol	**Feature**	
■	Critical Intersection	

Color	Density Concentrations
	0.00 - 0.75
	0.75 - 1.50
	1.50 - 2.25
	2.25 - 3.00
	3.00 - 3.75
	3.75 - 4.50
	4.50 - 5.25
	5.25 - 6.00
	6.00 - 6.75
	6.75 - 7.50

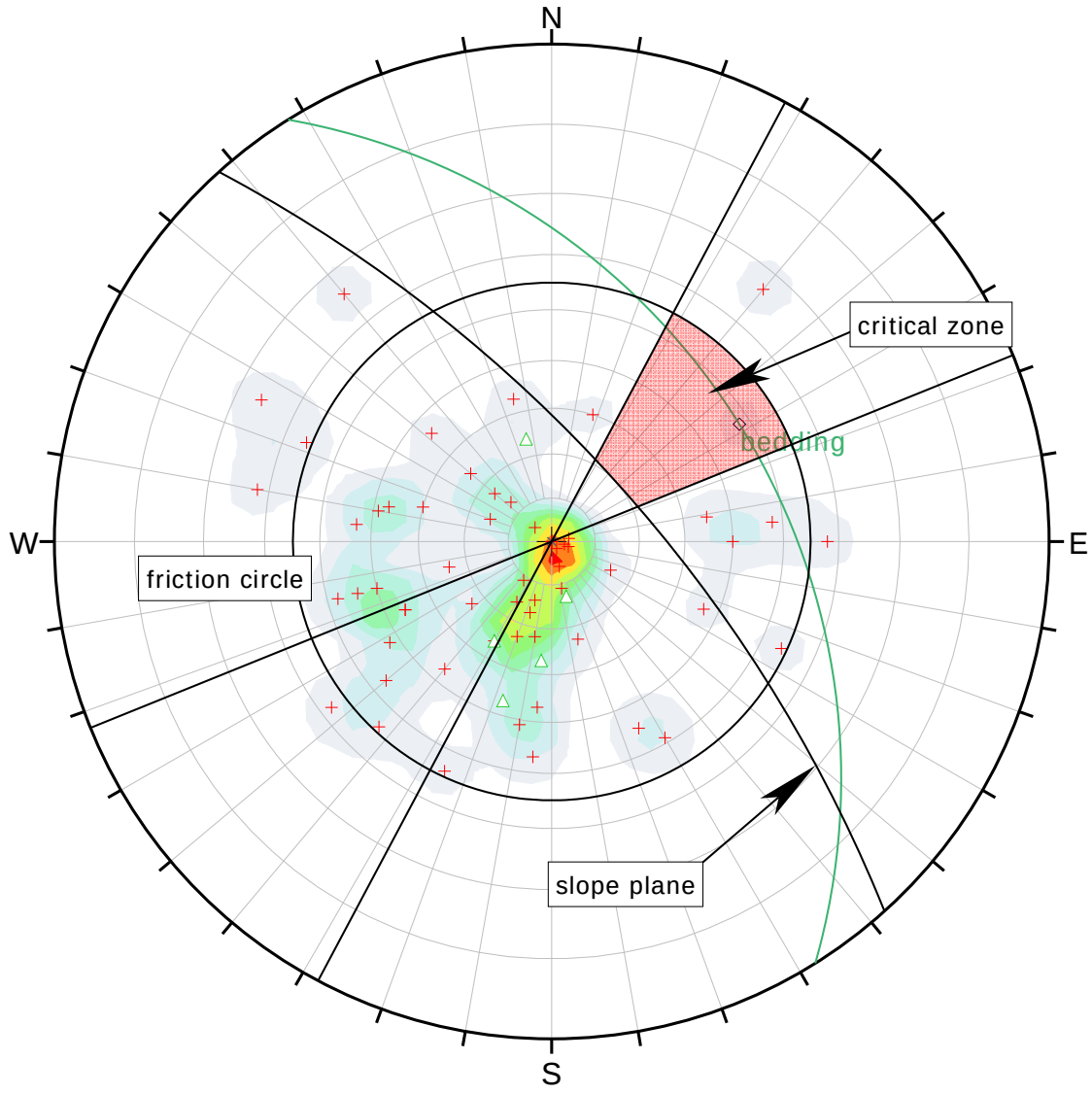
Maximum Density	7.08%
Contour Data	Intersections
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Wedge Sliding
Slope Dip	70
Slope Dip Direction	48
Friction Angle	35°

	Critical	Total	%
Wedge Sliding	168	2014	8.34%

Plot Mode	Dip Vectors
Vector Count	64 (64 Entries)
Intersection Mode	Grid Data Planes
Intersections Count	2014
Hemisphere	Lower
Projection	Equal Angle

DIPS 6.008	*Project* Amboy		
	Analysis Description Aspect 048, Wedge Analysis, Dip Vector Plot		
	Drawn By CHJ	*Author* JMc	
	File Name Amboy 048_1 2 3 4 wedge.dips6	*Date* 12/17/2014	*Enclosure* B-3.3



Symbol	TYPE	Quantity
◇	B	1
△	F	5
+	J	58

Color	Density Concentrations
	0.00 - 1.40
	1.40 - 2.80
	2.80 - 4.20
	4.20 - 5.60
	5.60 - 7.00
	7.00 - 8.40
	8.40 - 9.80
	9.80 - 11.20
	11.20 - 12.60
	12.60 - 14.00

Maximum Density	13.15%
Contour Data	Dip Vectors
Contour Distribution	Fisher
Counting Circle Size	1.0%

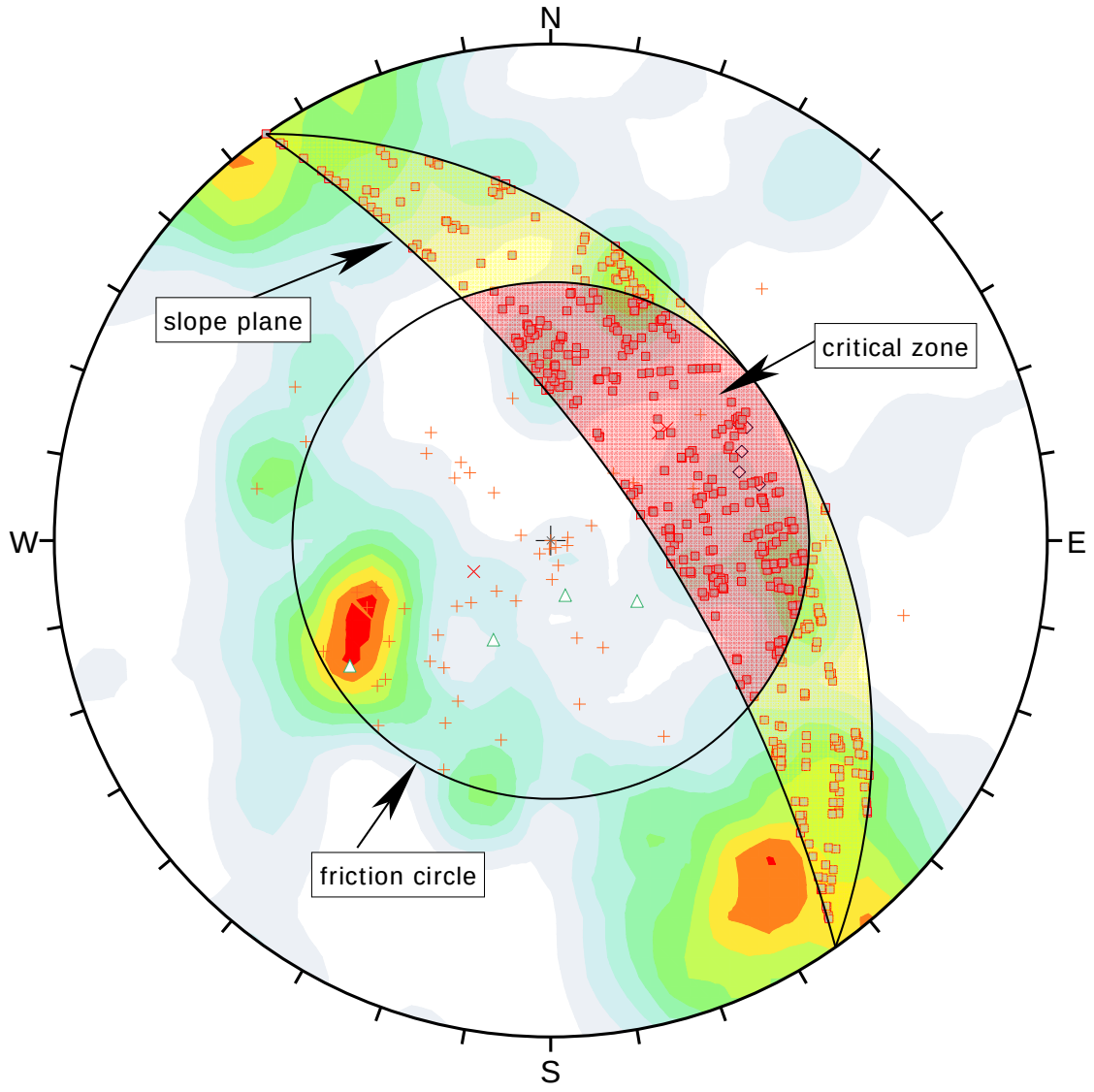
Kinematic Analysis	Planar Sliding
Slope Dip	70
Slope Dip Direction	48
Friction Angle	35°
Lateral Limits	20°

	Critical	Total	%
Planar Sliding (All)	1	64	1.56%

Plot Mode	Dip Vectors
Vector Count	64 (64 Entries)
Hemisphere	Lower
Projection	Equal Angle

DIPS 6.008

Project	Amboy		
Analysis Description	Aspect 048 Plane Analysis, Dip Vector Plot		
Drawn By	CHJ	*Author*	JMc
File Name	Amboy 048_1 2 3 4 plane.dips6	*Date*	12/17/2014
Enclosure	B-3.4		



Symbol	TYPE	Quantity
◇	B	5
×	D	3
△	F	4
+	J	55

Symbol	Feature
■	Critical Intersection

Color	Density Concentrations
	0.00 - 0.45
	0.45 - 0.90
	0.90 - 1.35
	1.35 - 1.80
	1.80 - 2.25
	2.25 - 2.70
	2.70 - 3.15
	3.15 - 3.60
	3.60 - 4.05
	4.05 - 4.50

Maximum Density	4.27%
Contour Data	Intersections
Contour Distribution	Fisher
Counting Circle Size	1.0%

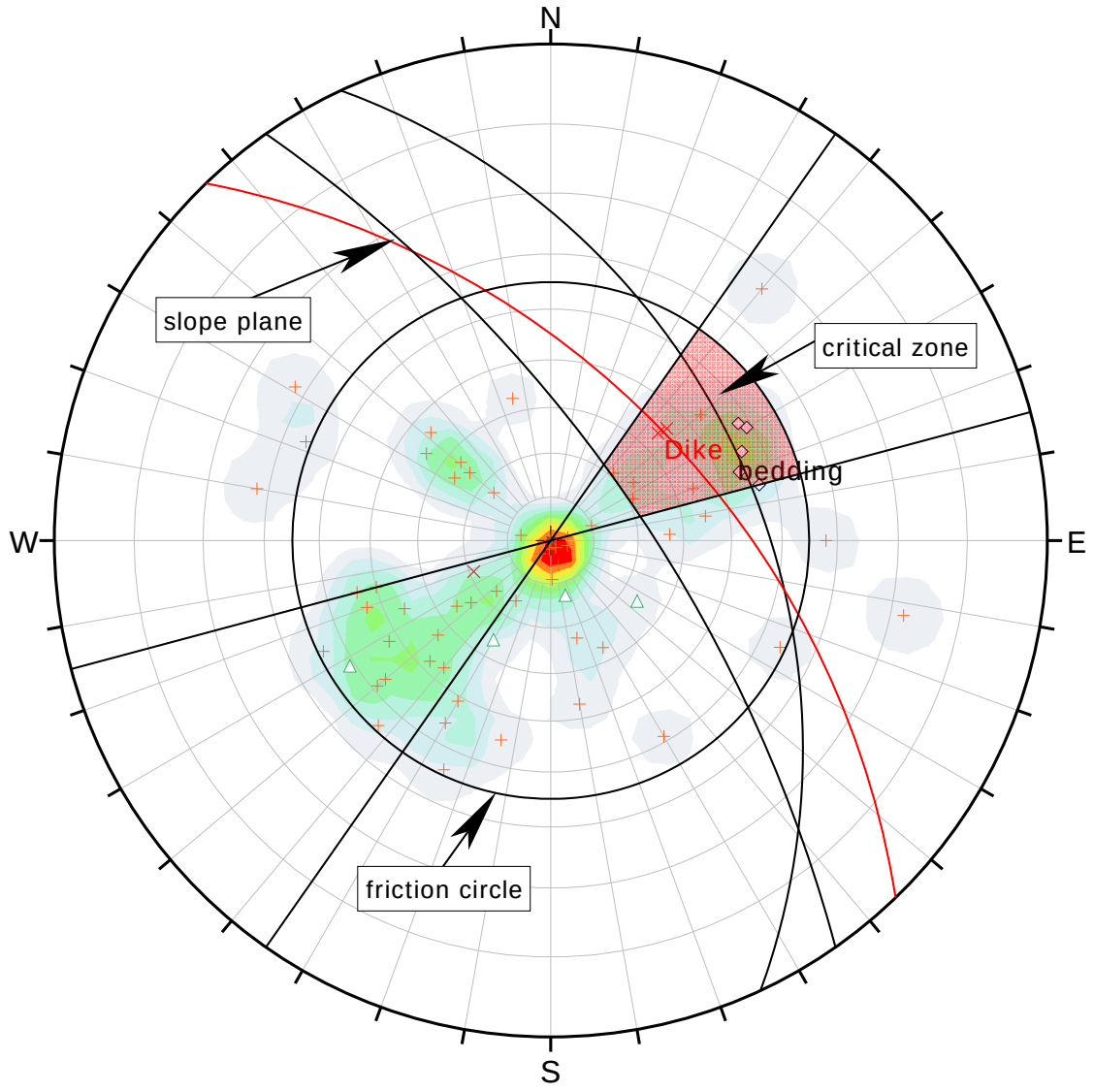
Kinematic Analysis	Wedge Sliding
Slope Dip	70
Slope Dip Direction	55
Friction Angle	35°

	Critical	Total	%
Wedge Sliding	498	2211	22.52%

Plot Mode	Dip Vectors
Vector Count	67 (67 Entries)
Intersection Mode	Grid Data Planes
Intersections Count	2211
Hemisphere	Lower
Projection	Equal Angle

DIPS 6.008

Project	Amboy		
Analysis Description	Aspect 055, Wedge Analysis, Dip Vector Plot		
Drawn By	CHJ	*Author*	JMc
File Name	Amboy 055_4 5 6 7 wedge.dips6	*Date*	12/17/2014
Enclosure	B-3.5		



Symbol	TYPE	Quantity
◇	B	5
×	D	3
△	F	4
+	J	55

Color	Density Concentrations
	0.00 - 1.20
	1.20 - 2.40
	2.40 - 3.60
	3.60 - 4.80
	4.80 - 6.00
	6.00 - 7.20
	7.20 - 8.40
	8.40 - 9.60
	9.60 - 10.80
	10.80 - 12.00

Maximum Density	11.88%
Contour Data	Dip Vectors
Contour Distribution	Fisher
Counting Circle Size	1.0%

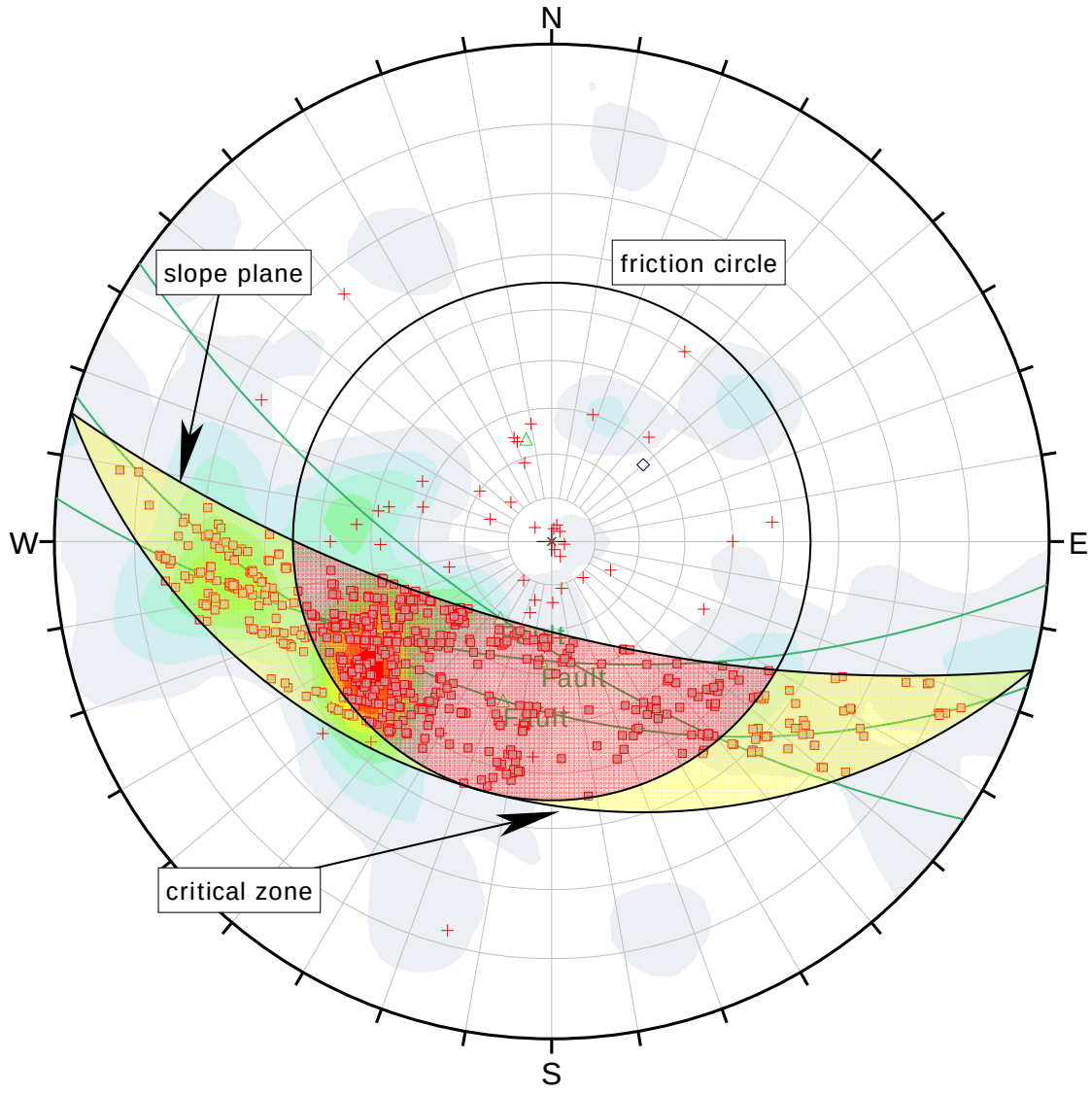
Kinematic Analysis	Planar Sliding
Slope Dip	70
Slope Dip Direction	55
Friction Angle	35°
Lateral Limits	20°

	Critical	Total	%
Planar Sliding (All)	12	67	17.91%

Plot Mode	Dip Vectors
Vector Count	67 (67 Entries)
Hemisphere	Lower
Projection	Equal Angle

DIPS 6.008

Project	Amboy		
Analysis Description	Aspect 055, Plane Analysis, Dip Vector Plot		
Drawn By	CHJ	*Author*	JMc
File Name	Amboy 055_4 5 6 7 plane.dips6	*Date*	12/17/2014
Enclosure	B-3.6		



Symbol	TYPE	Quantity
◇	B	1
△	F	4
+	J	58
Symbol	**Feature**	
■	Critical Intersection	

Color	Density Concentrations
	0.00 - 0.80
	0.80 - 1.60
	1.60 - 2.40
	2.40 - 3.20
	3.20 - 4.00
	4.00 - 4.80
	4.80 - 5.60
	5.60 - 6.40
	6.40 - 7.20
	7.20 - 8.00

Maximum Density	7.81%
Contour Data	Intersections
Contour Distribution	Fisher
Counting Circle Size	1.0%

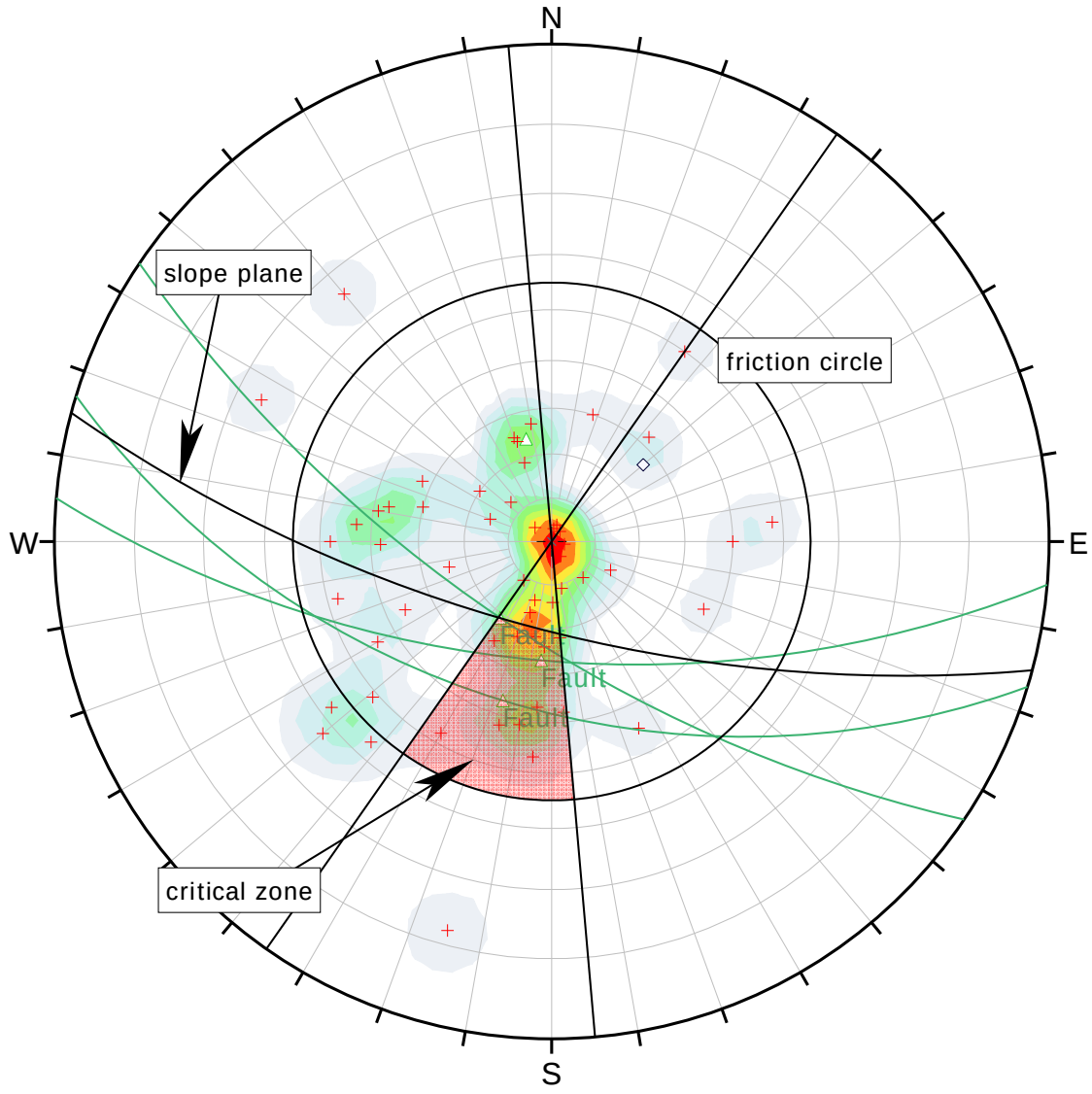
Kinematic Analysis	Wedge Sliding
Slope Dip	70
Slope Dip Direction	195
Friction Angle	35°

	Critical	Total	%
Wedge Sliding	692	1953	35.43%

Plot Mode	Dip Vectors
Vector Count	63 (63 Entries)
Intersection Mode	Grid Data Planes
Intersections Count	1953
Hemisphere	Lower
Projection	Equal Angle

DIPS 6.008

Project	Amboy		
Analysis Description	Aspect 195, Wedge Analysis, Dip Vector Plot		
Drawn By	CHJ	*Author*	JMc
File Name	Amboy 195_1 2 3 8 wedge.dips6	*Date*	12/17/2014
Enclosure	B-3.7		



Symbol	TYPE	Quantity
◇	B	1
△	F	4
+	J	58

Color	Density Concentrations
	0.00 - 1.30
	1.30 - 2.60
	2.60 - 3.90
	3.90 - 5.20
	5.20 - 6.50
	6.50 - 7.80
	7.80 - 9.10
	9.10 - 10.40
	10.40 - 11.70
	11.70 - 13.00

Maximum Density	12.53%
Contour Data	Dip Vectors
Contour Distribution	Fisher
Counting Circle Size	1.0%

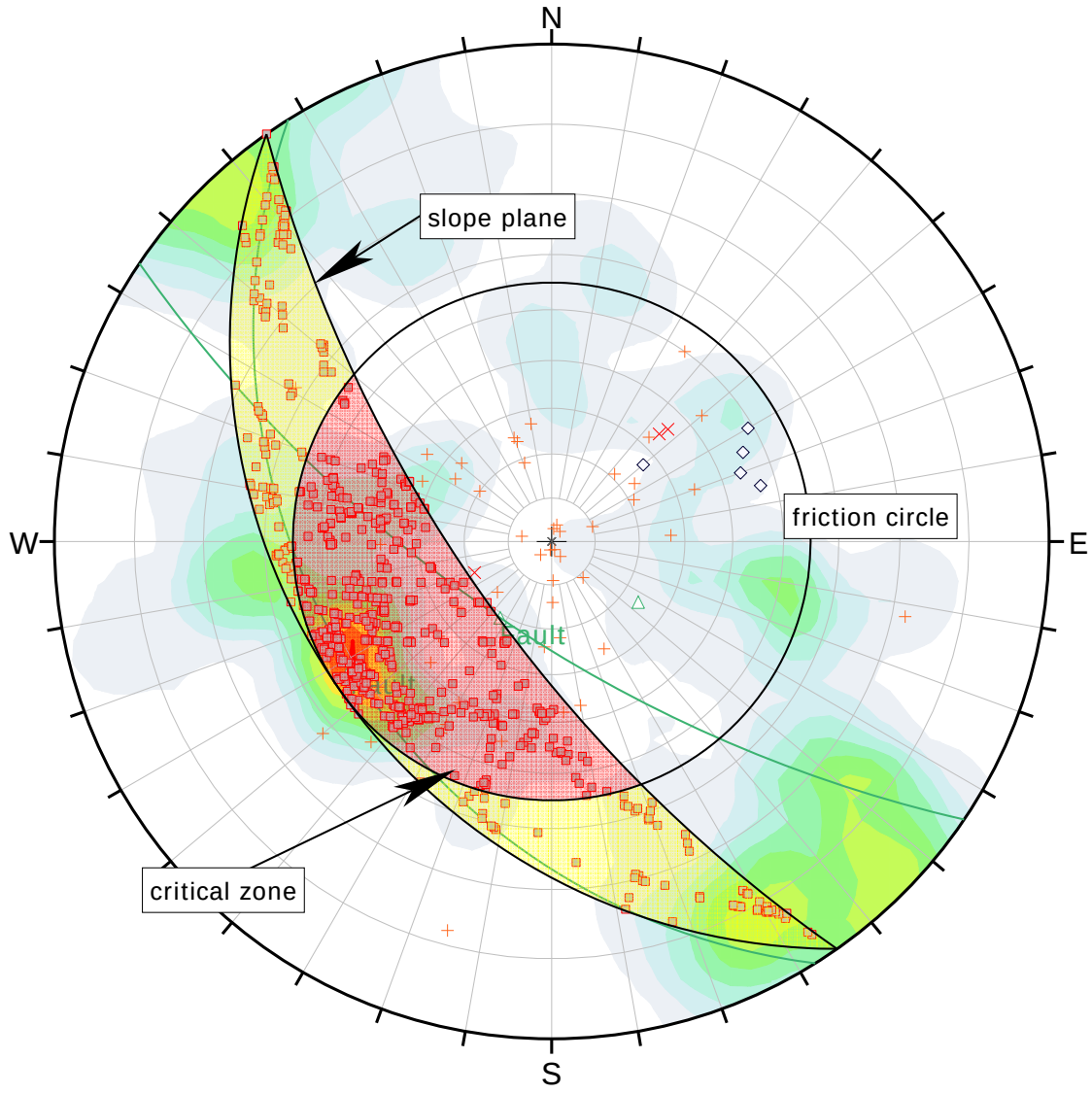
Kinematic Analysis	Planar Sliding
Slope Dip	70
Slope Dip Direction	195
Friction Angle	35°
Lateral Limits	20°

	Critical	Total	%
Planar Sliding (All)	13	63	20.63%

Plot Mode	Dip Vectors
Vector Count	63 (63 Entries)
Hemisphere	Lower
Projection	Equal Angle

DIPS 6.008

Project	Amboy		
Analysis Description	Aspect 195, Plane Analysis, Dip Vector Plot		
Drawn By	CHJ	*Author*	JMc
File Name	Amboy 195_1 2 3 8 plane.dips6	*Date*	12/17/2014
Enclosure	B-3.8		



Symbol	TYPE	Quantity
◇	B	5
×	D	3
△	F	3
+	J	55

Symbol	Feature
■	Critical Intersection

Color	Density Concentrations
	0.00 - 0.60
	0.60 - 1.20
	1.20 - 1.80
	1.80 - 2.40
	2.40 - 3.00
	3.00 - 3.60
	3.60 - 4.20
	4.20 - 4.80
	4.80 - 5.40
	5.40 - 6.00

Maximum Density	5.51%
Contour Data	Intersections
Contour Distribution	Fisher
Counting Circle Size	1.0%

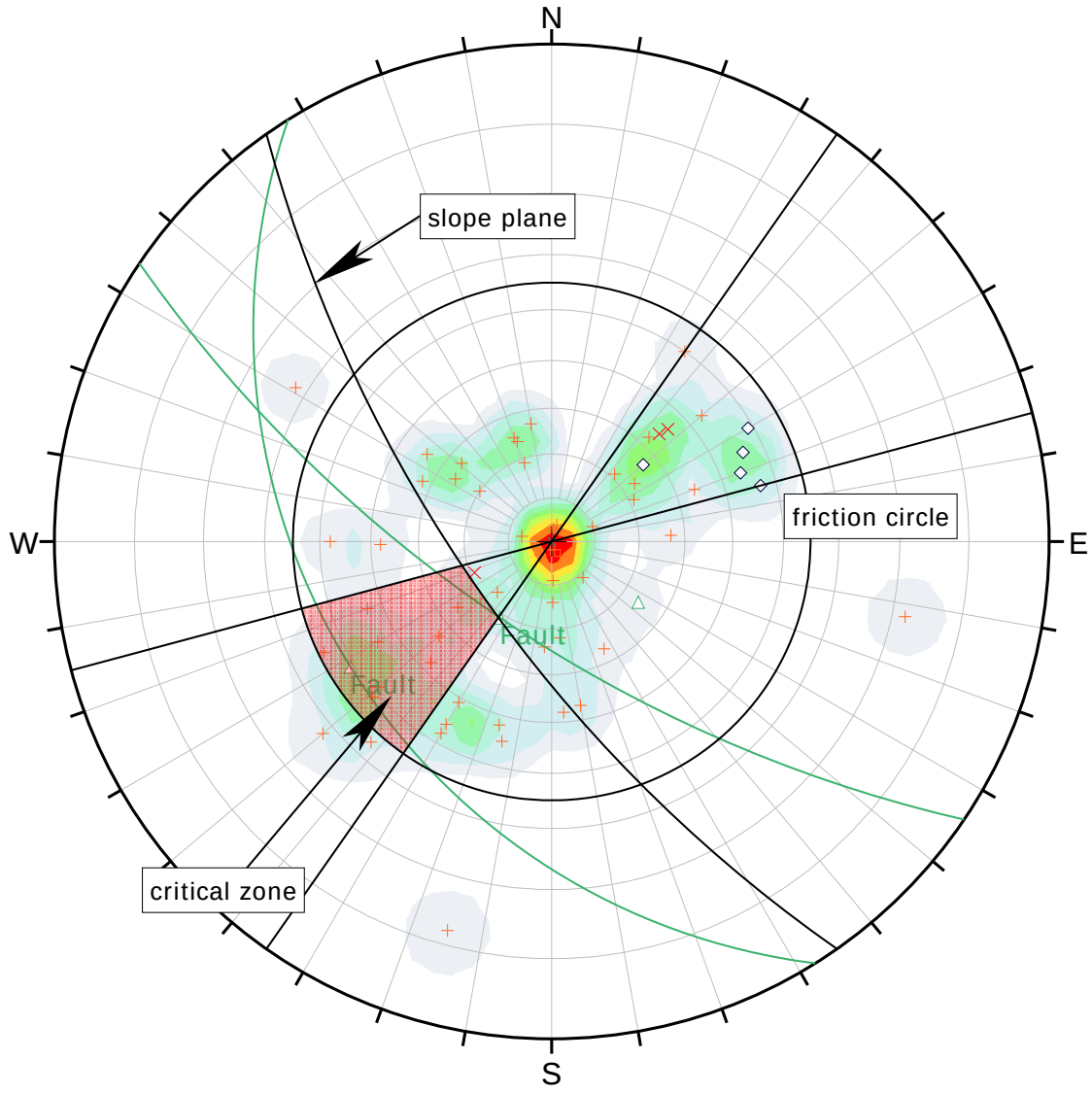
Kinematic Analysis	Wedge Sliding
Slope Dip	70
Slope Dip Direction	235
Friction Angle	35°

	Critical	Total	%
Wedge Sliding	662	2145	30.86%

Plot Mode	Dip Vectors
Vector Count	66 (66 Entries)
Intersection Mode	Grid Data Planes
Intersections Count	2145
Hemisphere	Lower
Projection	Equal Angle

Project	Amboy		
Analysis Description	Aspect 235, Wedge Analysis, Dip Vector Plot		
Drawn By	CHJ	*Author*	JMc
File Name	Amboy 235_5 6 7 8 wedge.dips6	*Date*	12/17/2014
		Enclosure	B-3.9

DIPS 6.008



Symbol	TYPE	Quantity
◇	B	5
×	D	3
△	F	3
+	J	55

Color	Density Concentrations
	0.00 - 1.20
	1.20 - 2.40
	2.40 - 3.60
	3.60 - 4.80
	4.80 - 6.00
	6.00 - 7.20
	7.20 - 8.40
	8.40 - 9.60
	9.60 - 10.80
	10.80 - 12.00

Maximum Density	11.92%
Contour Data	Dip Vectors
Contour Distribution	Fisher
Counting Circle Size	1.0%

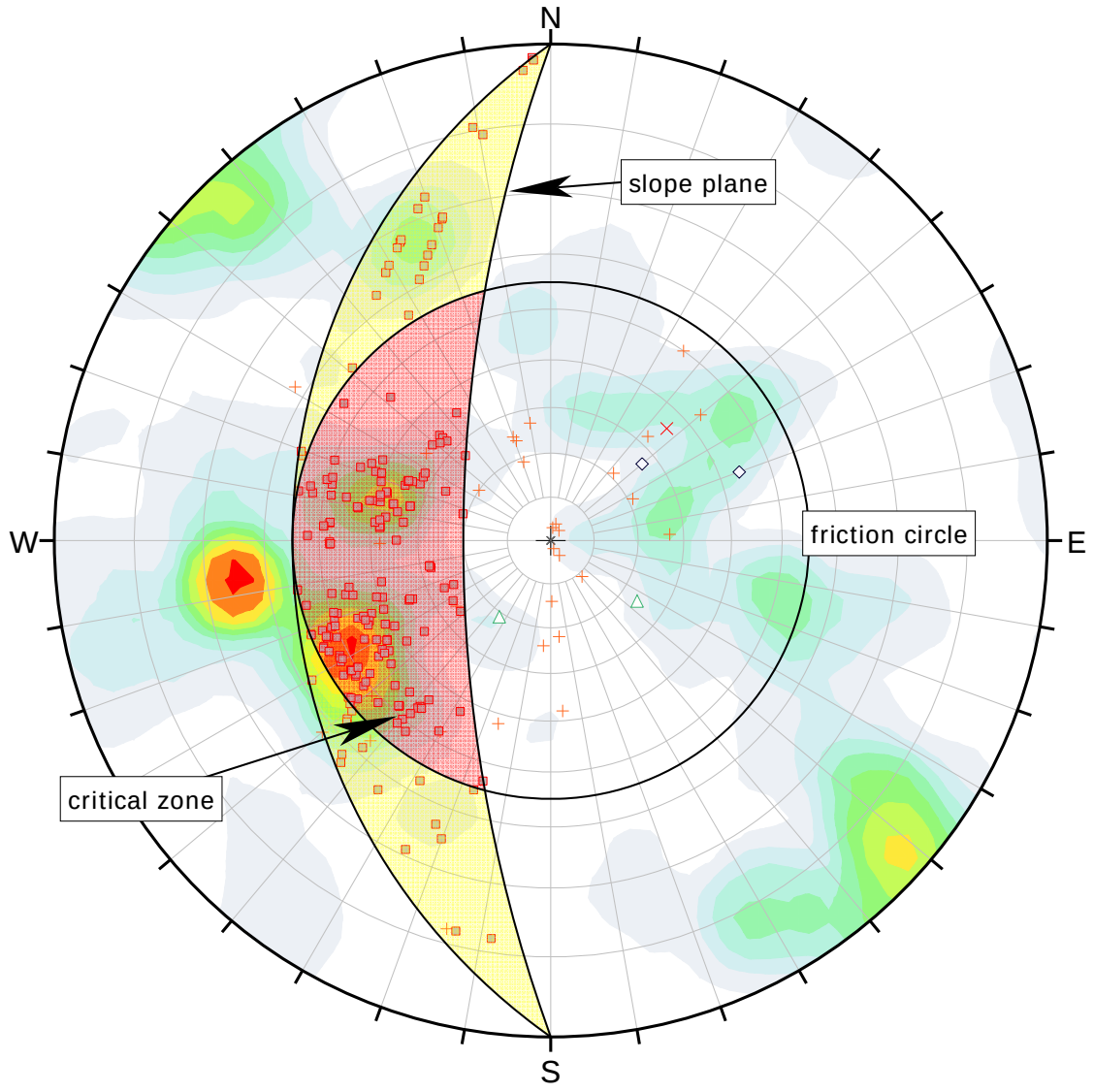
Kinematic Analysis	Planar Sliding
Slope Dip	70
Slope Dip Direction	235
Friction Angle	35°
Lateral Limits	20°

	Critical	Total	%
Planar Sliding (All)	9	66	13.64%

Plot Mode	Dip Vectors
Vector Count	66 (66 Entries)
Hemisphere	Lower
Projection	Equal Angle

DIPS 6.008

Project	Amboy		
Analysis Description	Aspect 235, Plane Analysis, Dip Vector Plot		
Drawn By	CHJ	*Author*	JMc
File Name	Amboy 235_5 6 7 8 plane.dips6	*Date*	12/17/2014
Enclosure	B-3.10		



Symbol	TYPE	Quantity
◇	B	2
×	D	1
△	F	2
+	J	34

Symbol	Feature
■	Critical Intersection

Color	Density Concentrations
	0.00 - 0.60
	0.60 - 1.20
	1.20 - 1.80
	1.80 - 2.40
	2.40 - 3.00
	3.00 - 3.60
	3.60 - 4.20
	4.20 - 4.80
	4.80 - 5.40
	5.40 - 6.00

Maximum Density	5.58%
Contour Data	Intersections
Contour Distribution	Fisher
Counting Circle Size	1.0%

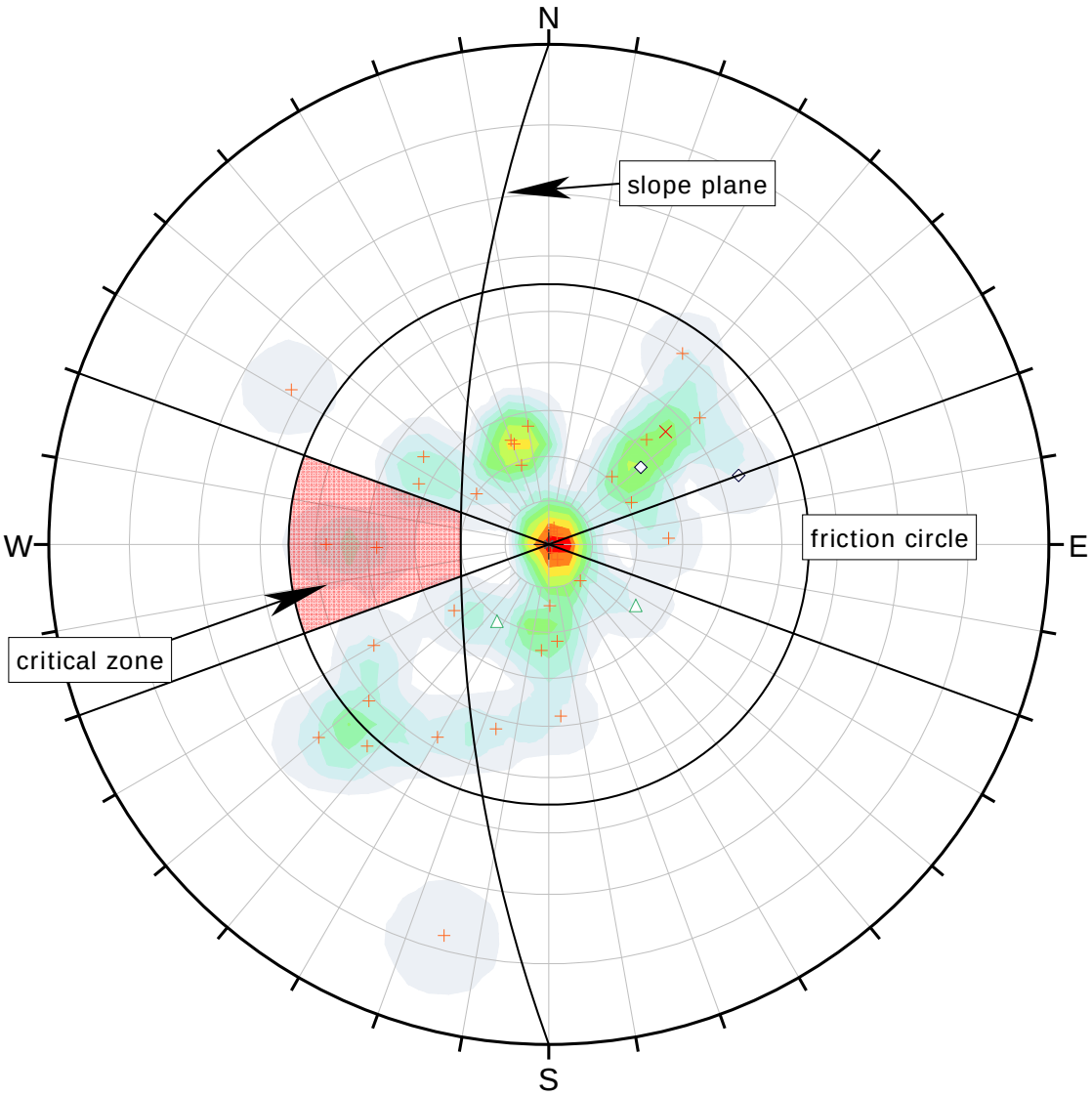
Kinematic Analysis	Wedge Sliding
Slope Dip	70
Slope Dip Direction	270
Friction Angle	35°

	Critical	Total	%
Wedge Sliding	198	741	26.72%

Plot Mode	Dip Vectors
Vector Count	39 (39 Entries)
Intersection Mode	Grid Data Planes
Intersections Count	741
Hemisphere	Lower
Projection	Equal Angle

DIPS 6.008

Project	Amboy		
Analysis Description	Aspect 270, Wedge Analysis, Dip Vector Plot		
Drawn By	CHJ	*Author*	JMc
File Name	Amboy 270_6 7 8 wedge.dips6	*Date*	12/17/2014
Enclosure	B-3.11		



Symbol	TYPE	Quantity
◇	B	2
×	D	1
△	F	2
+	J	34

Color	Density Concentrations
	0.00 - 1.30
	1.30 - 2.60
	2.60 - 3.90
	3.90 - 5.20
	5.20 - 6.50
	6.50 - 7.80
	7.80 - 9.10
	9.10 - 10.40
	10.40 - 11.70
	11.70 - 13.00

Maximum Density	12.48%
Contour Data	Dip Vectors
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Planar Sliding
Slope Dip	70
Slope Dip Direction	270
Friction Angle	35°
Lateral Limits	20°

	Critical	Total	%
Planar Sliding (All)	2	39	5.13%

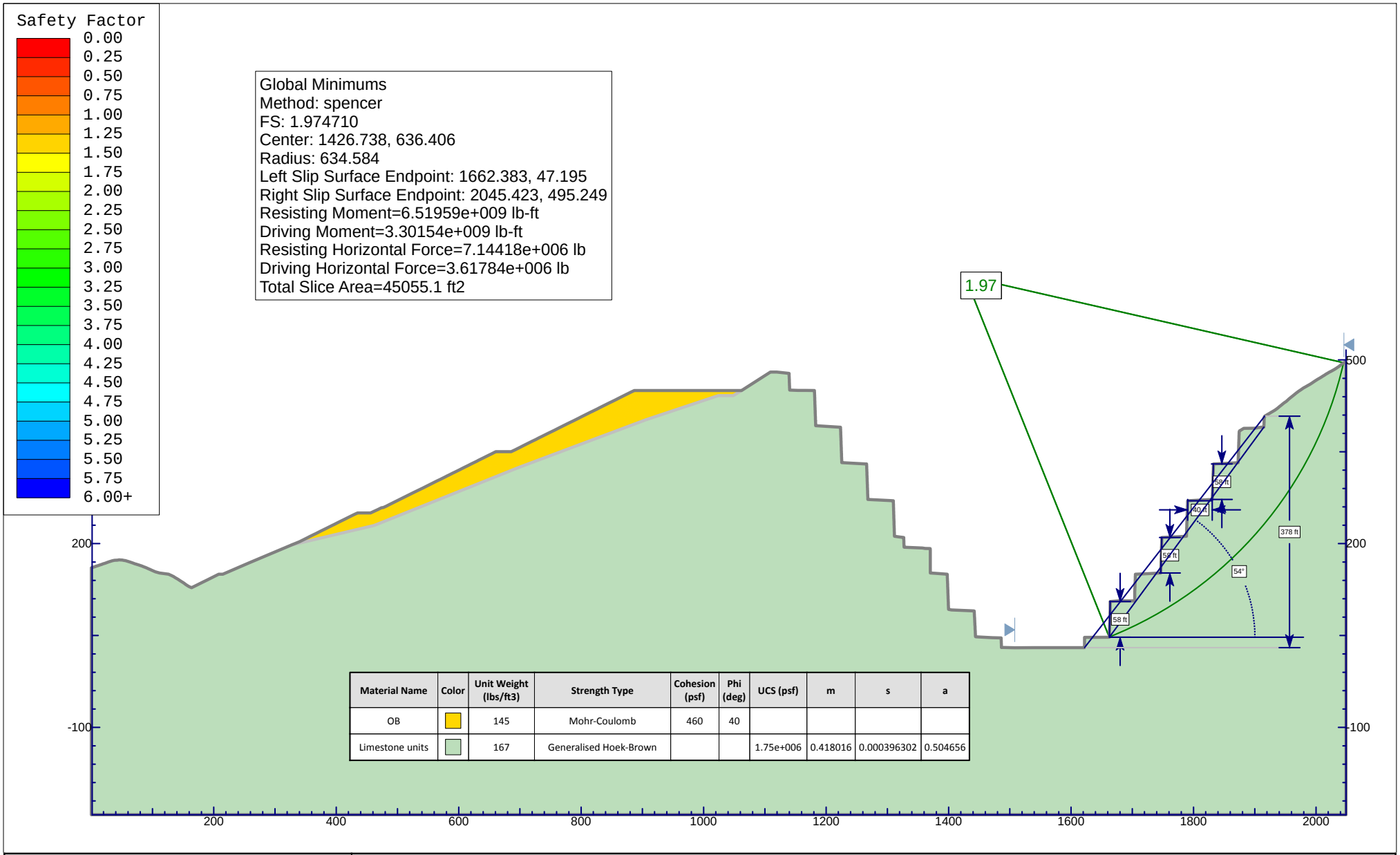
Plot Mode	Dip Vectors
Vector Count	39 (39 Entries)
Hemisphere	Lower
Projection	Equal Angle

DIPS 6.008

Project	Amboy		
Analysis Description	Aspect 270, Plane Analysis, Dip Vector Plot		
Drawn By	CHJ	*Author*	JMc
File Name	Amboy 270_6 7 8 plane.dips6	*Date*	12/17/2014
Enclosure	B-3.12		

APPENDIX C

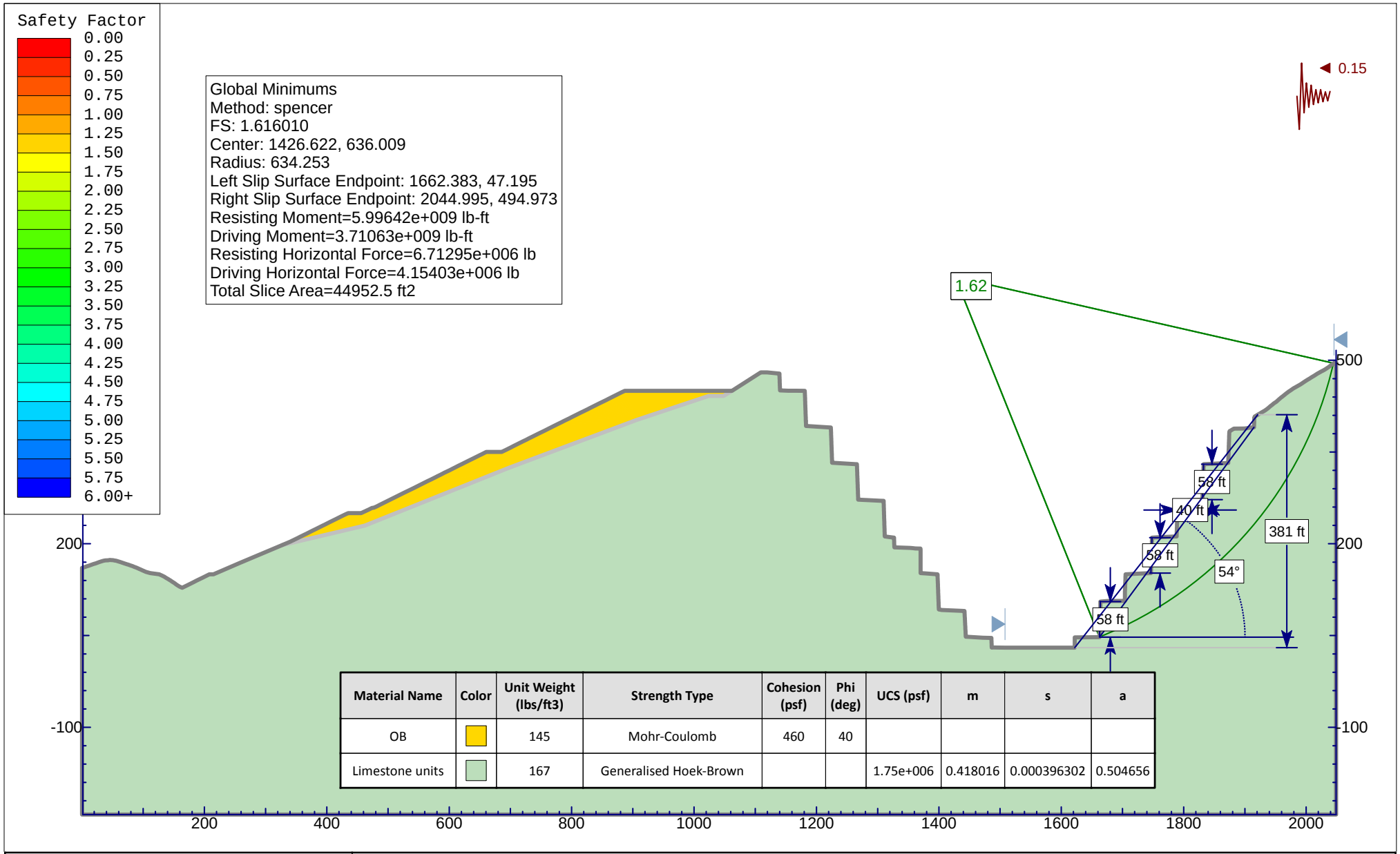
SLOPE STABILITY CALCULATIONS



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	UCS (psf)	m	s	a
OB		145	Mohr-Coulomb	460	40				
Limestone units		167	Generalised Hoek-Brown			1.75e+006	0.418016	0.000396302	0.504656

SLIDEINTERPRET 6.032

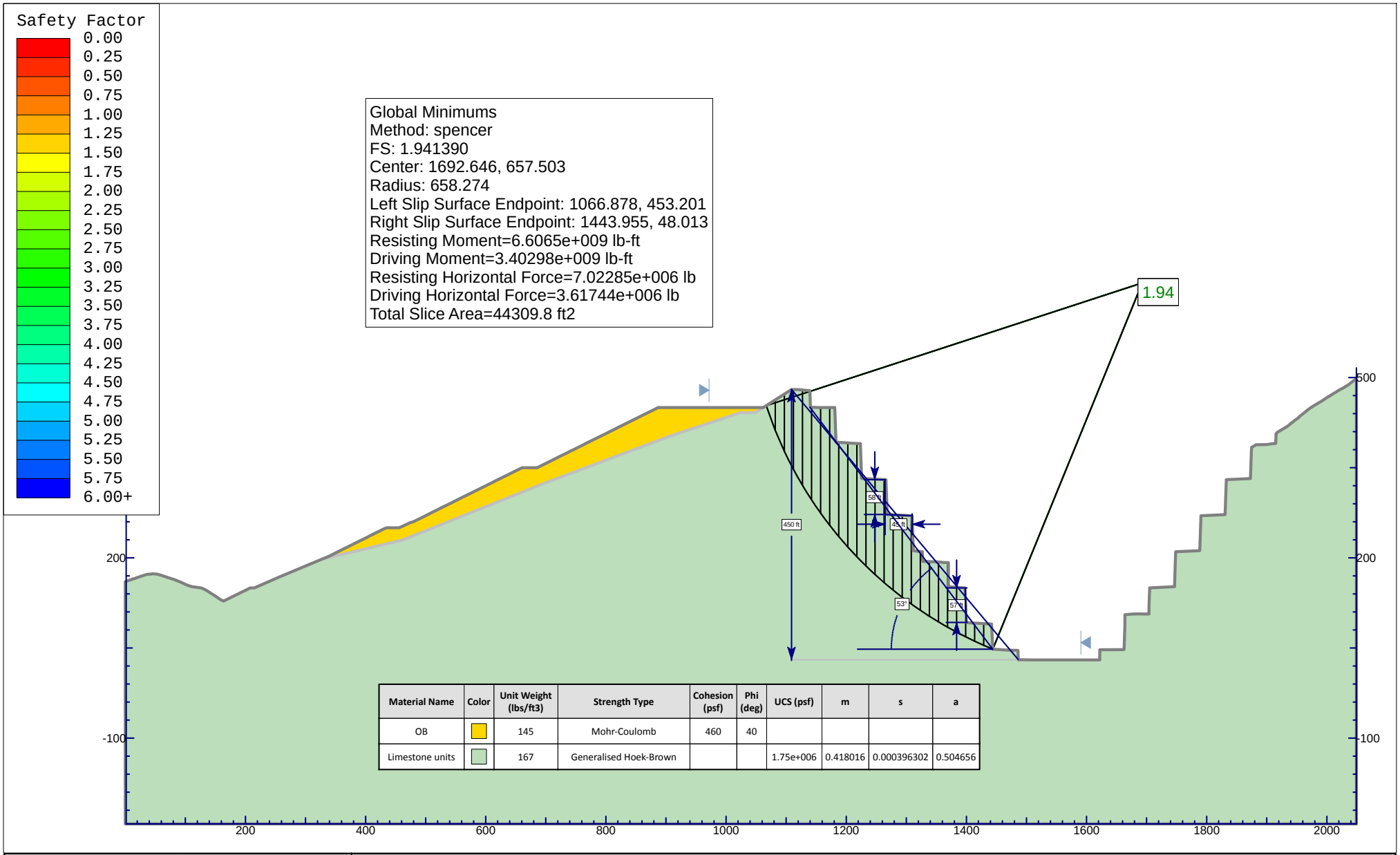
Project	Amboy Limestone Quarry		
Analysis Description	Section A - east wall		
Drawn By	CHJ	*Author* JMc	*Scale* 1:2600
File Name	Sect A east wall.slim	*Date* December 2014	*Enclosure* C-1.1



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	UCS (psf)	m	s	a
OB		145	Mohr-Coulomb	460	40				
Limestone units		167	Generalised Hoek-Brown			1.75e+006	0.418016	0.000396302	0.504656

SLIDEINTERPRET 6.032

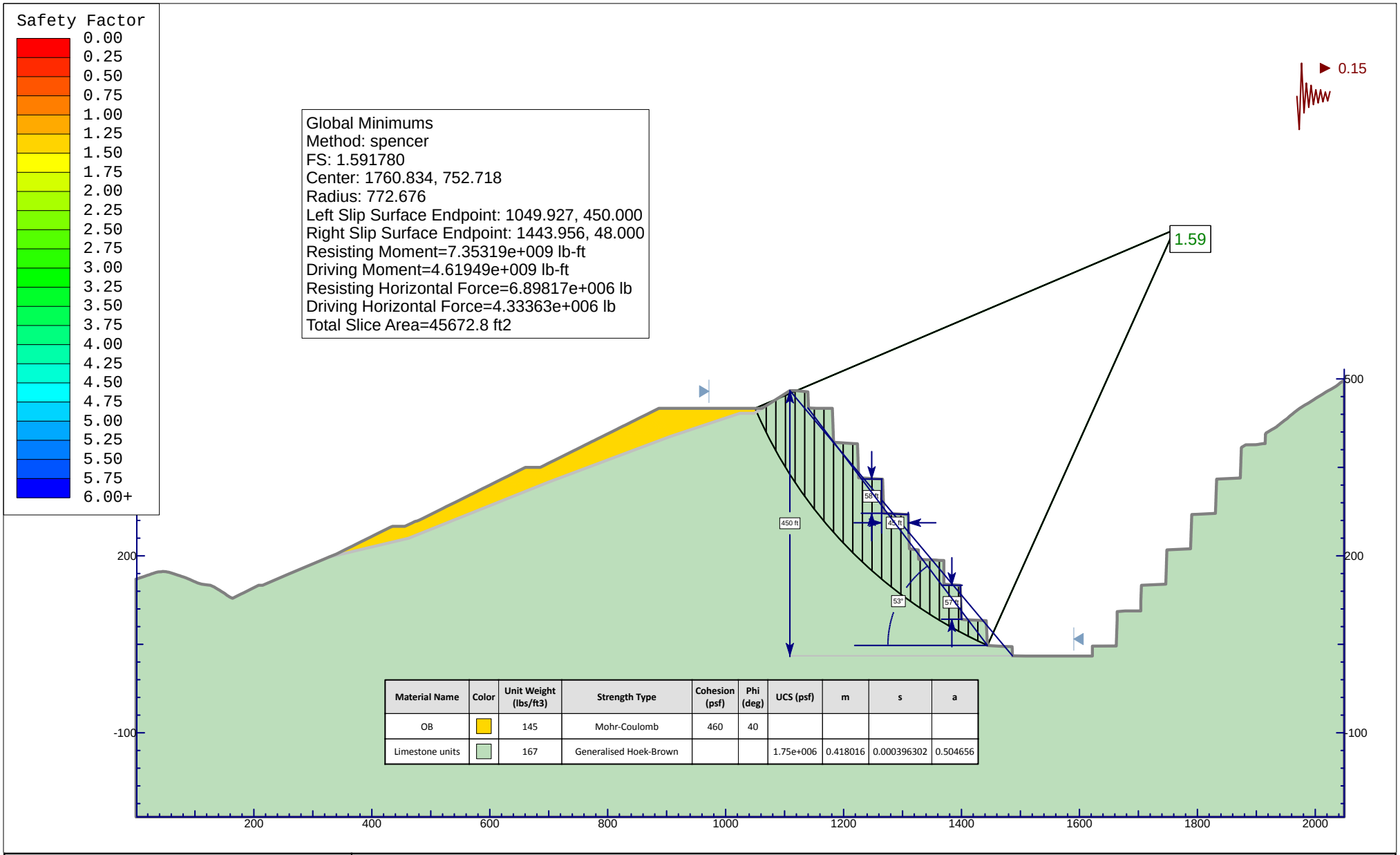
Project	Amboy Limestone Quarry		
Analysis Description	Section A - east wall		
Drawn By	CHJ	*Author* JMc	*Scale* 1:2600
File Name	Sect A east wall seis.slim	*Date* December 2014	*Enclosure* C-1.2



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	UCS (psf)	m	s	a
OB		145	Mohr-Coulomb	460	40				
Limestone units		167	Generalised Hoek-Brown			1.75e+006	0.418016	0.000396302	0.504656

SLIDEINTERPRET 6.032

Project	Amboy Limestone Quarry		
Analysis Description	Section A - west wall		
Drawn By	CHJ	*Author* JMc	*Scale* 1:2650
File Name	Sect A west wall.slim	*Date* December 2014	*Enclosure* C-1.3



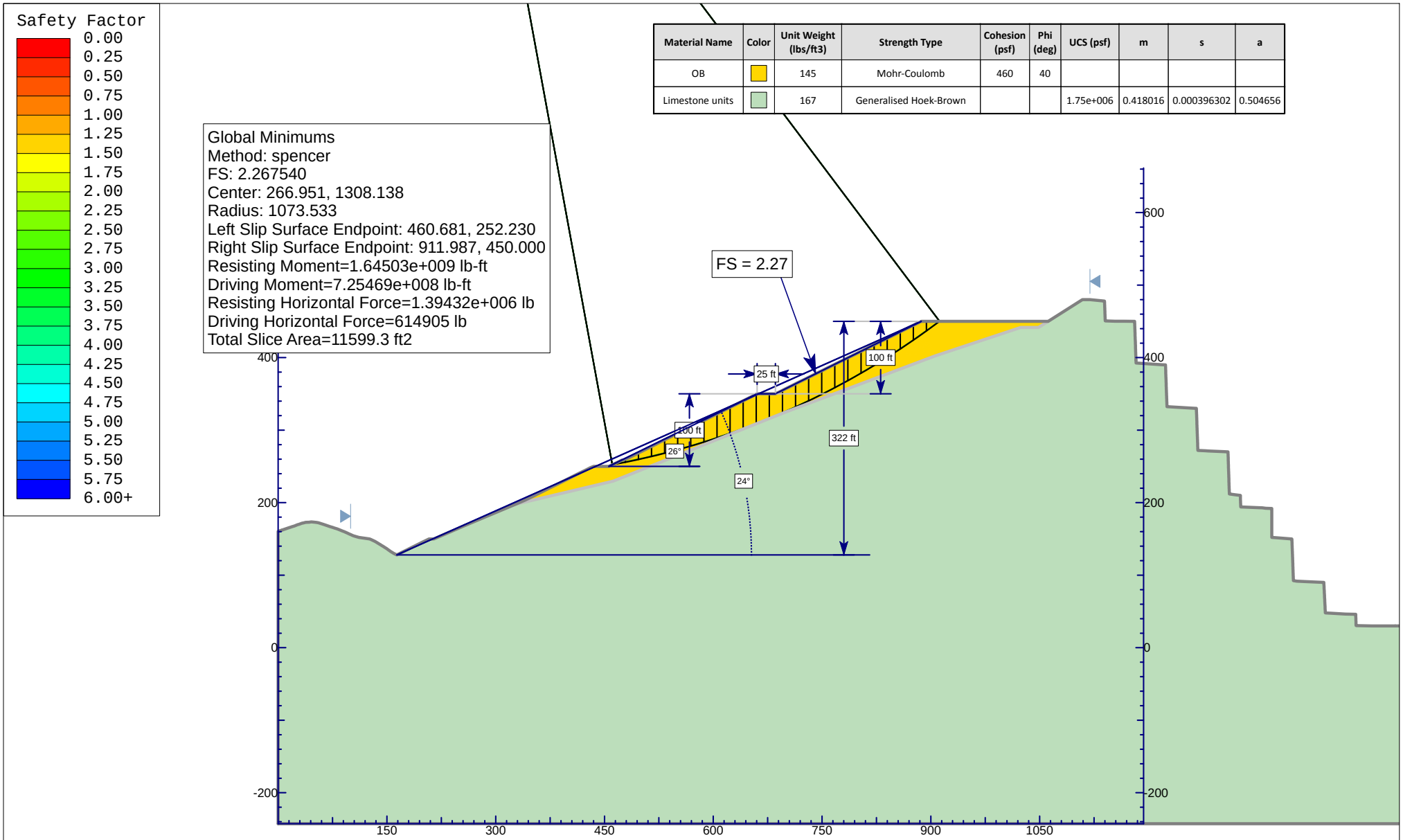
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	UCS (psf)	m	s	a
OB		145	Mohr-Coulomb	460	40				
Limestone units		167	Generalised Hoek-Brown			1.75e+006	0.418016	0.000396302	0.504656

SLIDEINTERPRET 6.032

Project	Amboy Limestone Quarry		
Analysis Description	Section A - west wall		
Drawn By	CHJ	*Author* JMc	*Scale* 1:2700
File Name	Sect A west wall seis.slim	*Date* December 2014	*Enclosure* C-1.4

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	UCS (psf)	m	s	a
OB		145	Mohr-Coulomb	460	40				
Limestone units		167	Generalised Hoek-Brown			1.75e+006	0.418016	0.000396302	0.504656

Global Minimums
Method: spencer
FS: 2.267540
Center: 266.951, 1308.138
Radius: 1073.533
Left Slip Surface Endpoint: 460.681, 252.230
Right Slip Surface Endpoint: 911.987, 450.000
Resisting Moment=1.64503e+009 lb-ft
Driving Moment=7.25469e+008 lb-ft
Resisting Horizontal Force=1.39432e+006 lb
Driving Horizontal Force=614905 lb
Total Slice Area=11599.3 ft2



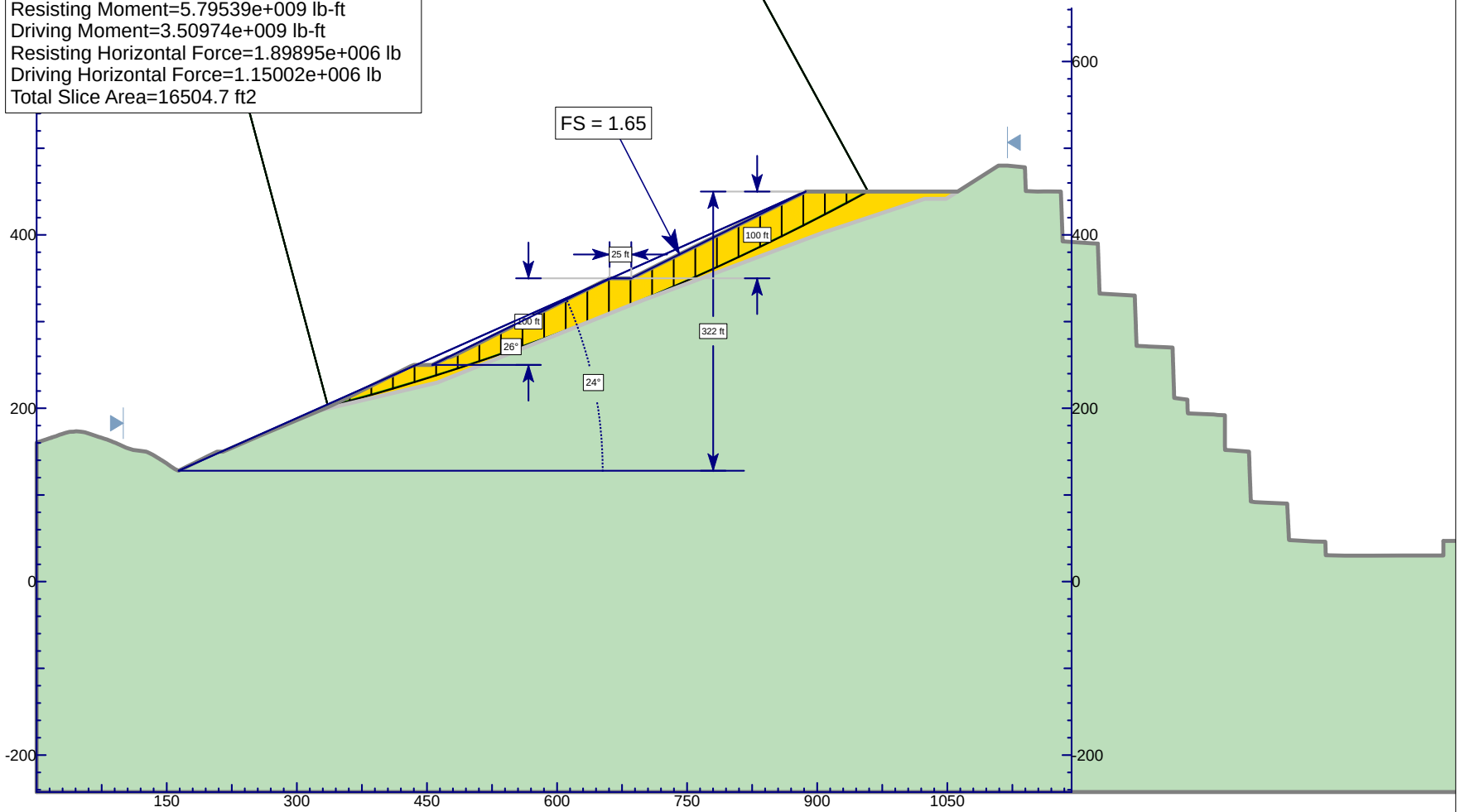
Project	Amboy Limestone Quarry		
Analysis Description	Section A - stockpile		
Drawn By	CHJ	Author JMc	Scale 1:2200
File Name	Sect A stockpile.slim	Date December 2014	Enclosure C-1.5

SLIDEINTERPRET 6.032

Safety Factor
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
4.00
4.25
4.50
4.75
5.00
5.25
5.50
5.75
6.00+

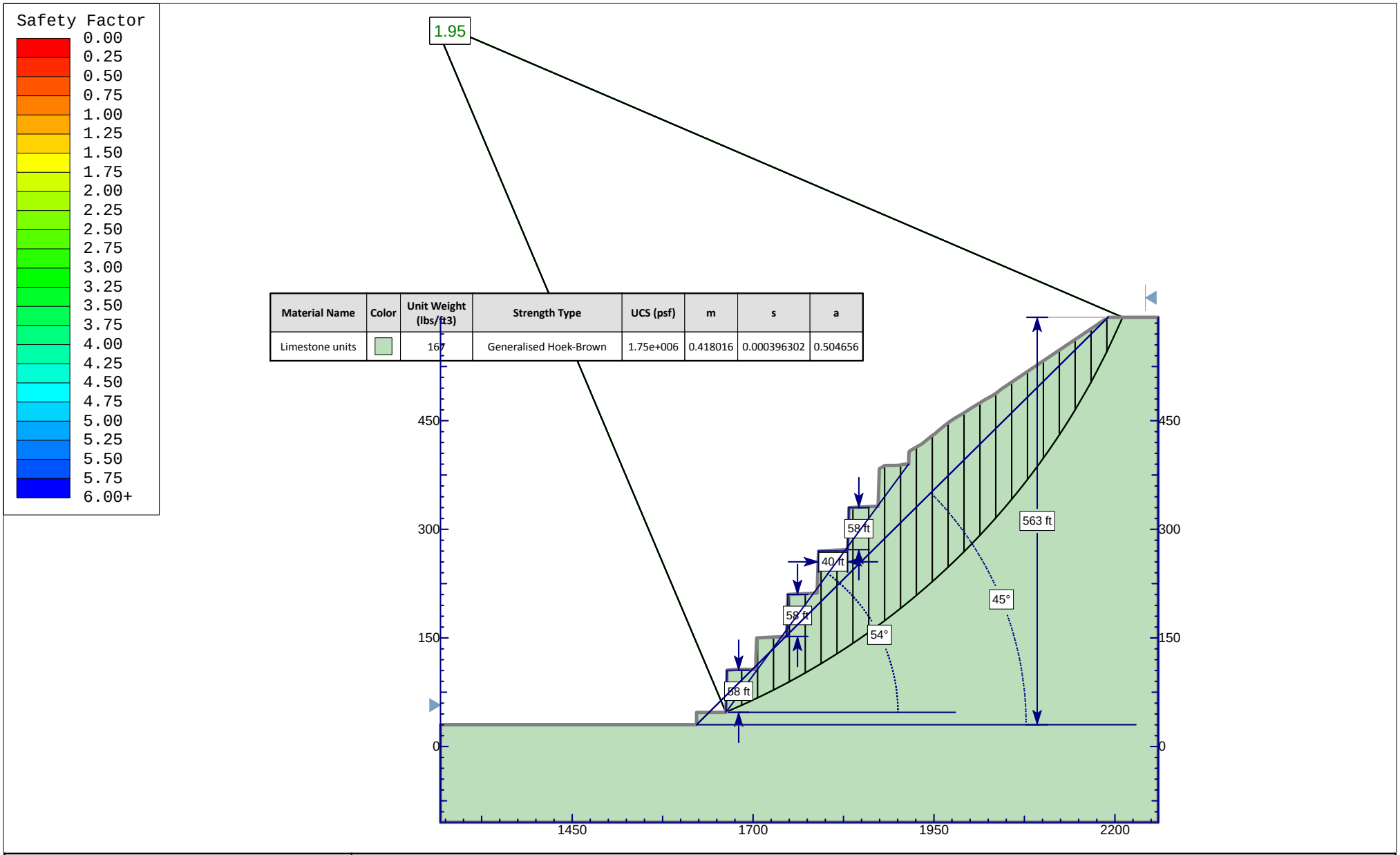
Global Minimums
Method: spencer
FS: 1.651230
Center: -390.885, 2926.648
Radius: 2820.437
Left Slip Surface Endpoint: 336.116, 201.517
Right Slip Surface Endpoint: 958.589, 450.000
Resisting Moment=5.79539e+009 lb-ft
Driving Moment=3.50974e+009 lb-ft
Resisting Horizontal Force=1.89895e+006 lb
Driving Horizontal Force=1.15002e+006 lb
Total Slice Area=16504.7 ft2

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	UCS (psf)	m	s	a
OB		145	Mohr-Coulomb	460	40				
Limestone units		167	Generalised Hoek-Brown			1.75e+006	0.418016	0.000396302	0.504656



Project	Amboy Limestone Quarry		
Analysis Description	Section A - stockpile		
Drawn By	CHJ	Author JMc	Scale 1:2200
File Name	Sect A stockpile seis.slim	Date December 2014	Enclosure C-1.6

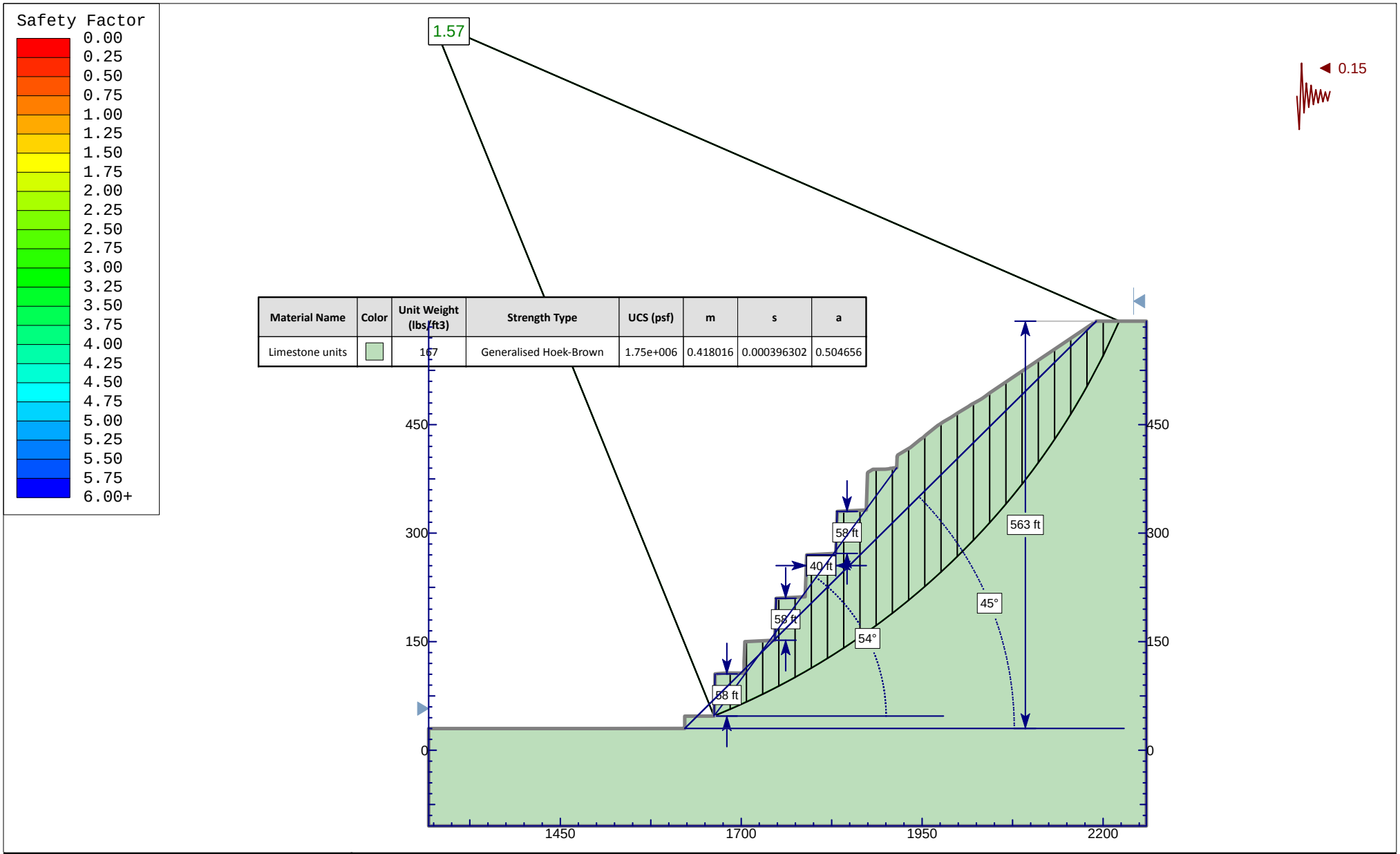
SLIDEINTERPRET 6.032



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	UCS (psf)	m	s	a
Limestone units		167	Generalised Hoek-Brown	1.75e+006	0.418016	0.000396302	0.504656

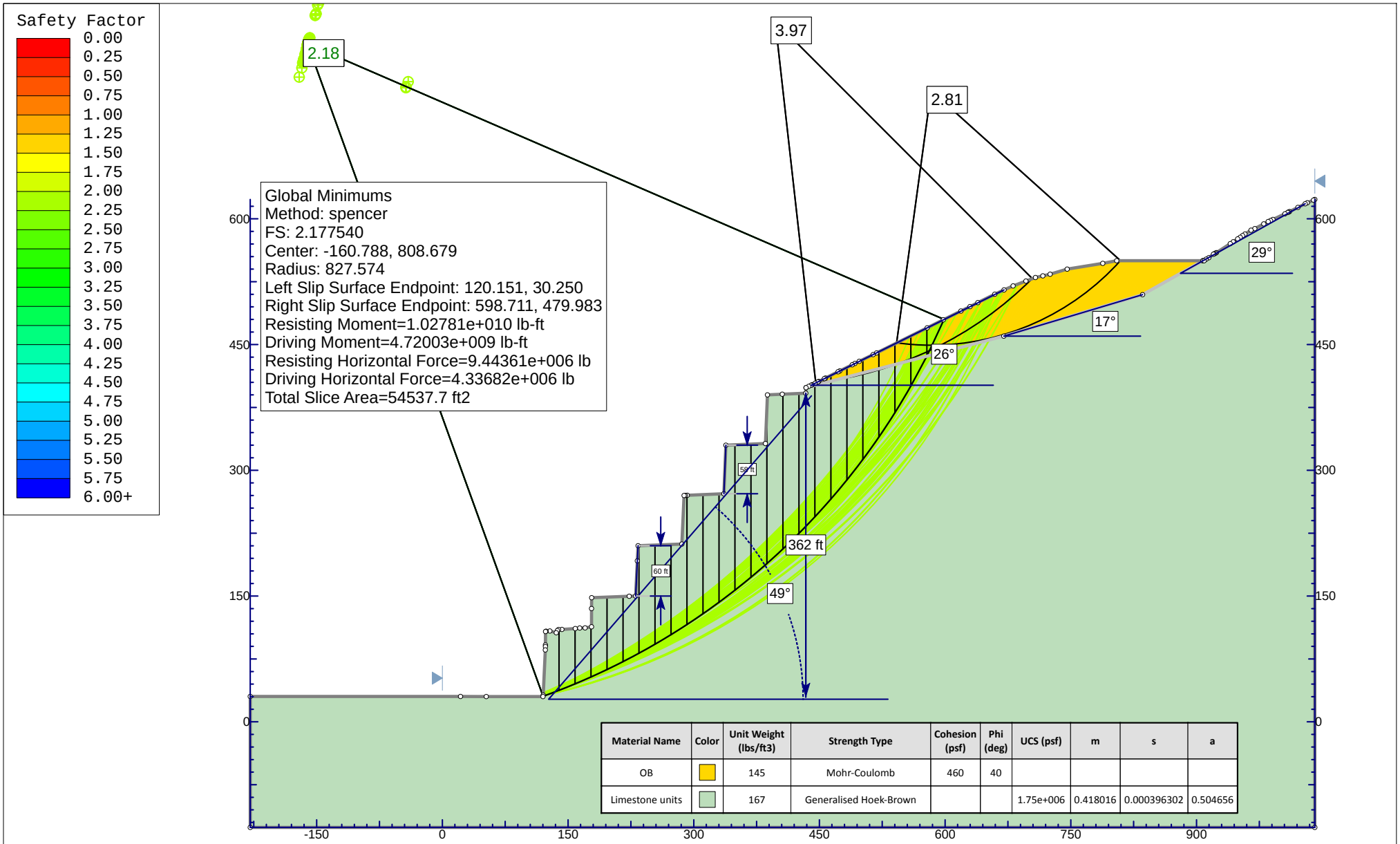
Project	Amboy Limestone Quarry		
Analysis Description	Section A - east wall (extended)		
Drawn By CHJ	*Author* JMc	*Scale* 1:2200	
File Name Sect A model extended.slim	*Date* December 2014	*Enclosure* C-1.7	

SLIDEINTERPRET 6.032



Project	Amboy Limestone Quarry		
Analysis Description	Section A - east wall (extended)		
Drawn By	CHJ	Author JMc	Scale 1:2200
File Name	Sect A model seis extended.slim	Date December 2014	Enclosure C-1.8

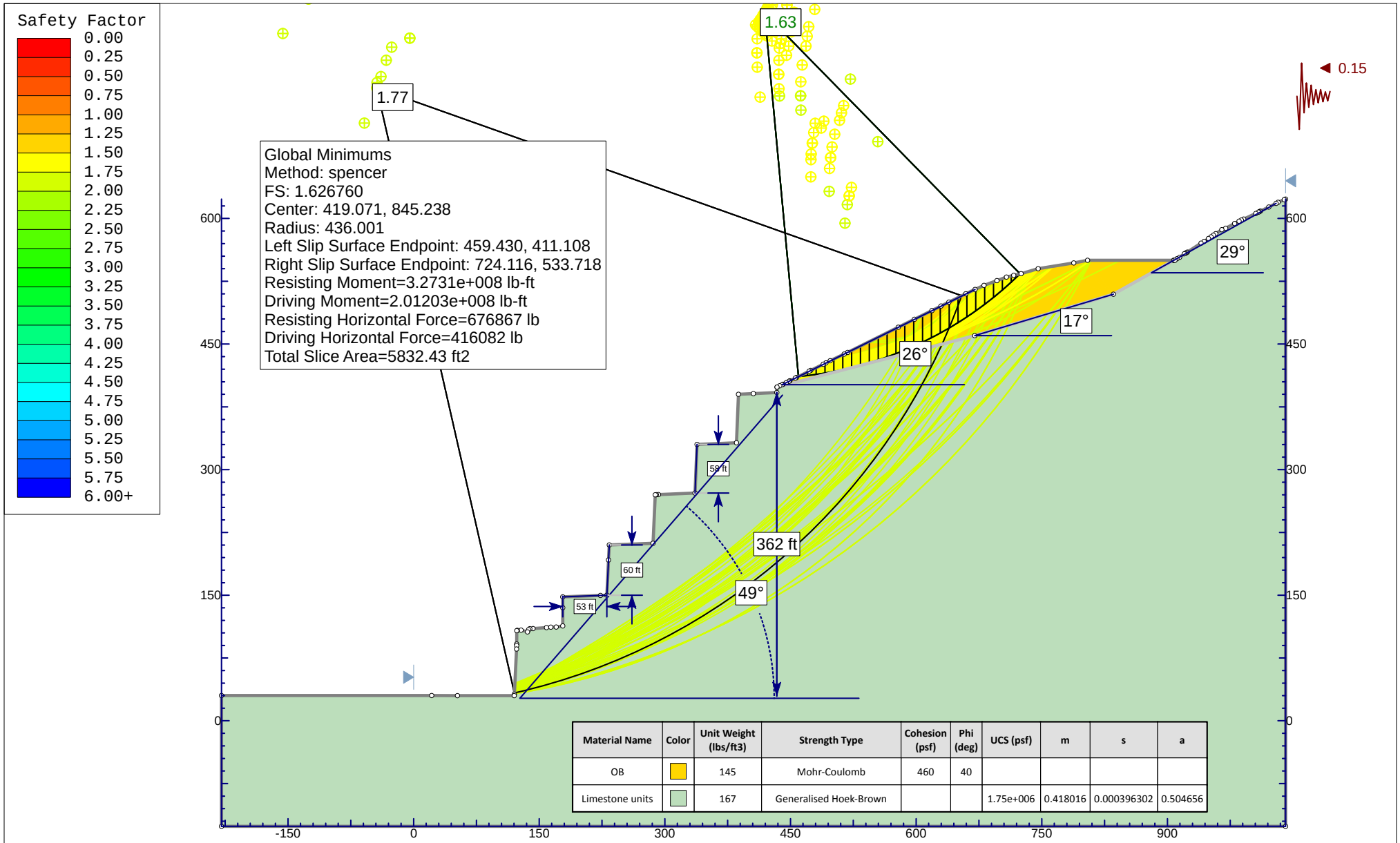
SLIDEINTERPRET 6.032



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	UCS (psf)	m	s	a
OB		145	Mohr-Coulomb	460	40				
Limestone units		167	Generalised Hoek-Brown			1.75e+006	0.418016	0.000396302	0.504656

SLIDEINTERPRET 6.032

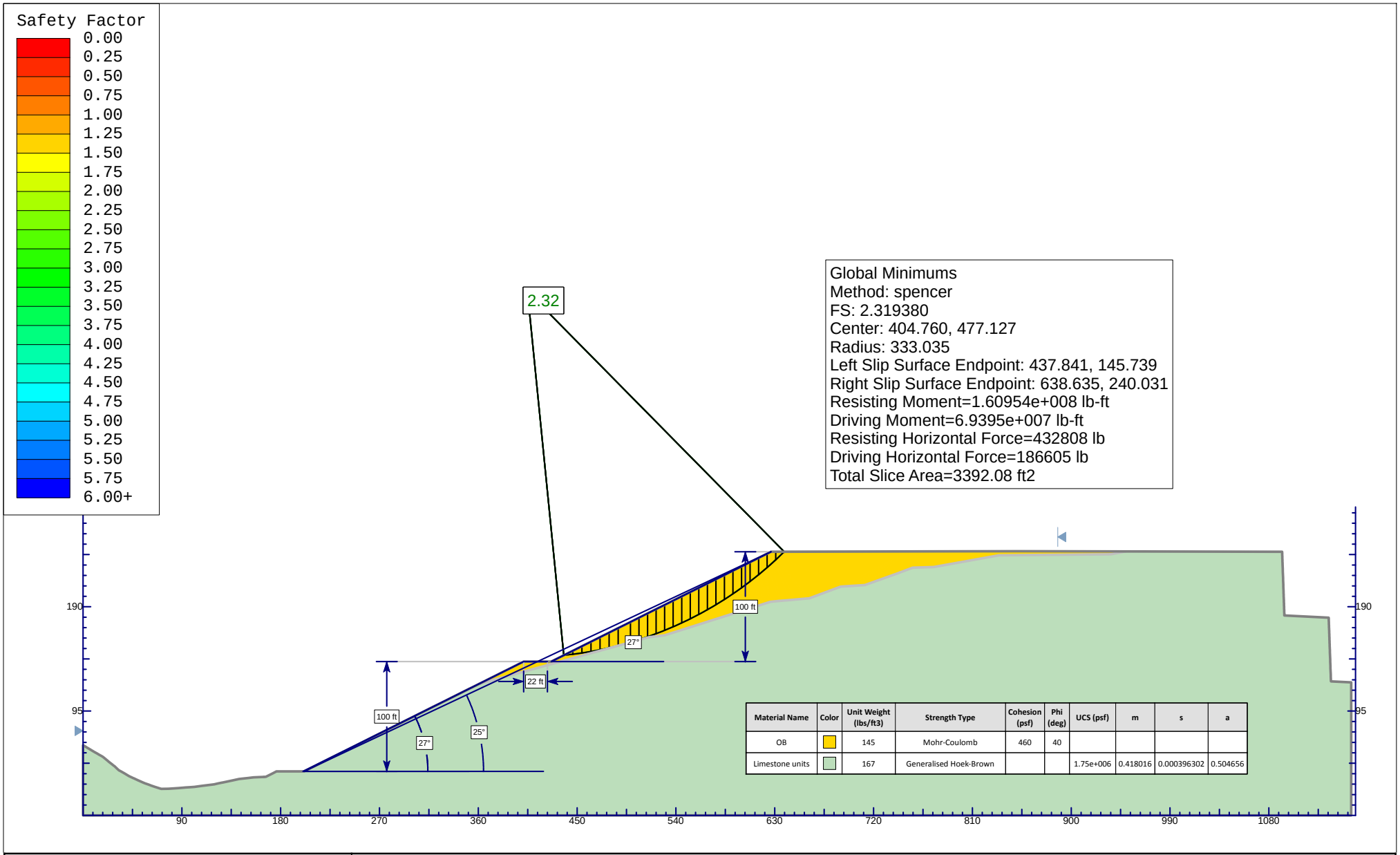
Project	Amboy Limestone Quarry		
Analysis Description	Section B		
Drawn By	CHJ	*Author* JMc	*Scale* 1:1900
File Name	Sect B model.slim	*Date* December 2014	*Enclosure* C-2.1



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	UCS (psf)	m	s	a
OB		145	Mohr-Coulomb	460	40				
Limestone units		167	Generalised Hoek-Brown			1.75e+006	0.418016	0.000396302	0.504656

SLIDEINTERPRET 6.032

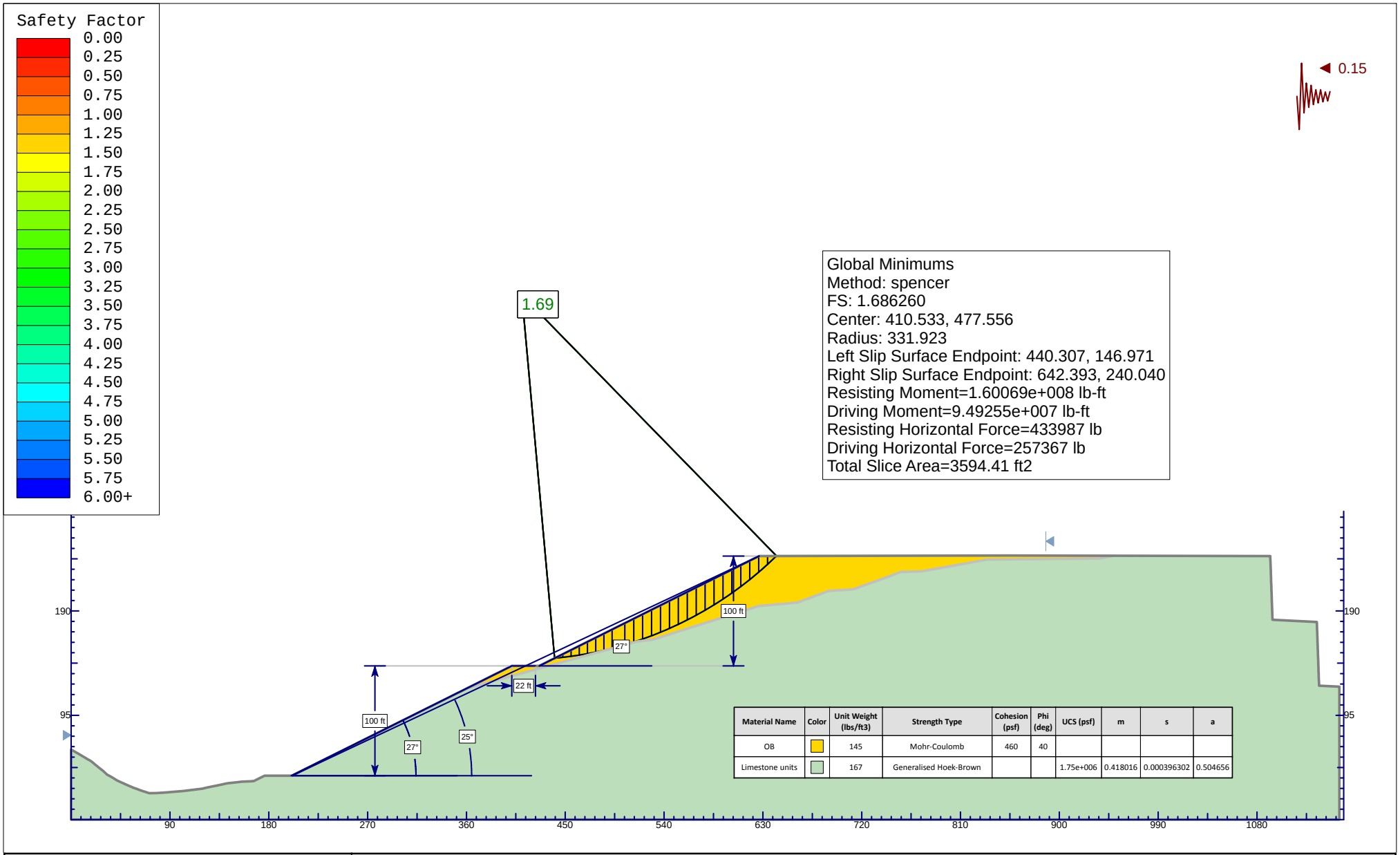
Project	Amboy Limestone Quarry		
Analysis Description	Section B		
Drawn By CHJ	*Author* JMc	*Scale* 1:1900	
File Name Sect B seis.slim	*Date* December 2014	*Enclosure* C-2.2	



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	UCS (psf)	m	s	a
OB		145	Mohr-Coulomb	460	40				
Limestone units		167	Generalised Hoek-Brown			1.75e+006	0.418016	0.000396302	0.504656

SLIDEINTERPRET 6.032

Project	Amboy Limestone Quarry		
Analysis Description	Section C		
Drawn By	CHJ	*Author* JMc	*Scale* 1:1450
File Name	Sect C stat.slim	*Date* December 2014	*Enclosure* C-3.1



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	UCS (psf)	m	s	a
OB		145	Mohr-Coulomb	460	40				
Limestone units		167	Generalised Hoek-Brown			1.75e+006	0.418016	0.000396302	0.504656

SLIDEINTERPRET 6.032

Project	Amboy Limestone Quarry		
Analysis Description	Section C		
Drawn By	CHJ	*Author* JMc	*Scale* 1:1450
File Name	Sect C seis.slim	*Date* December 2014	*Enclosure* C-3.2

LARGE SCALE DIRECT SHEAR REPORT

Internal Shear

Geo-Logic ASSOCIATES

Report Date: January 5, 2015

Client / Project Name: CHJ CONSULTANTS / PROJECT # 14814-8-8

Project No: 2014.A140.100

Superstrate: ⇦ Spacer

Material 1: ⇦ OB-1, Gray Silty Gravel w/ Sand — LSN: 3838A — Remolded

Material 2: ⇨ OB-1, Gray Silty Gravel w/ Sand — LSN: 3838A — Remolded

Substrate: ⇨ Spacer

PEAK STRENGTH

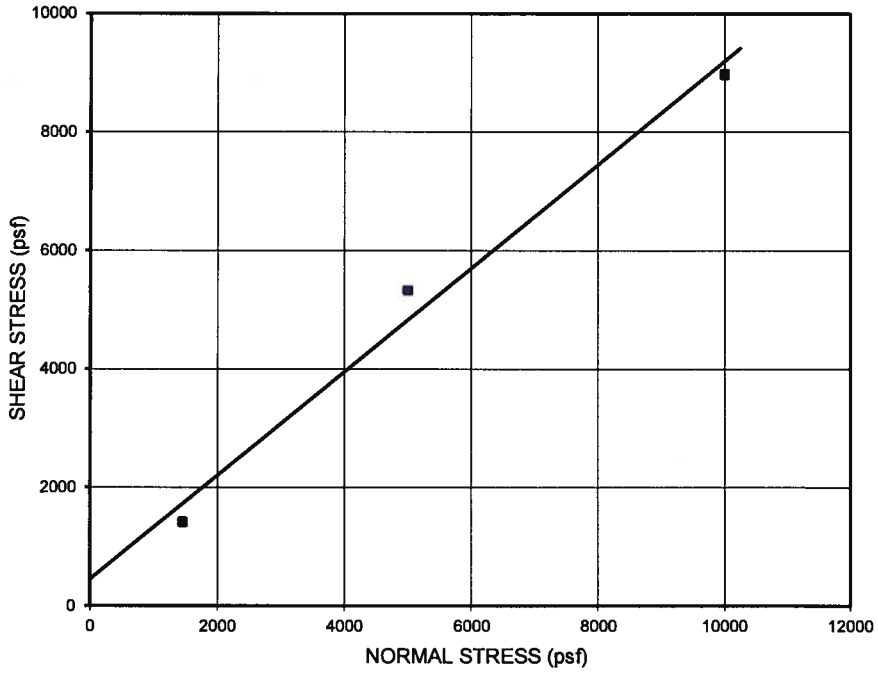
Test Point	Normal Stress psi	Normal Stress psf	Shear Stress psf	Secant Friction Angle
1.	10.1	1450	1430	45
2.	34.7	5000	5330	47
3.	69.4	10000	8980	42

Adhesion: 460 psf

Friction Angle: 41 degrees

Coefficient of Friction: 0.87

NOTE: GRAPH NOT TO SCALE



STRENGTH ENVELOPE

(at 3.0 in. displacement)

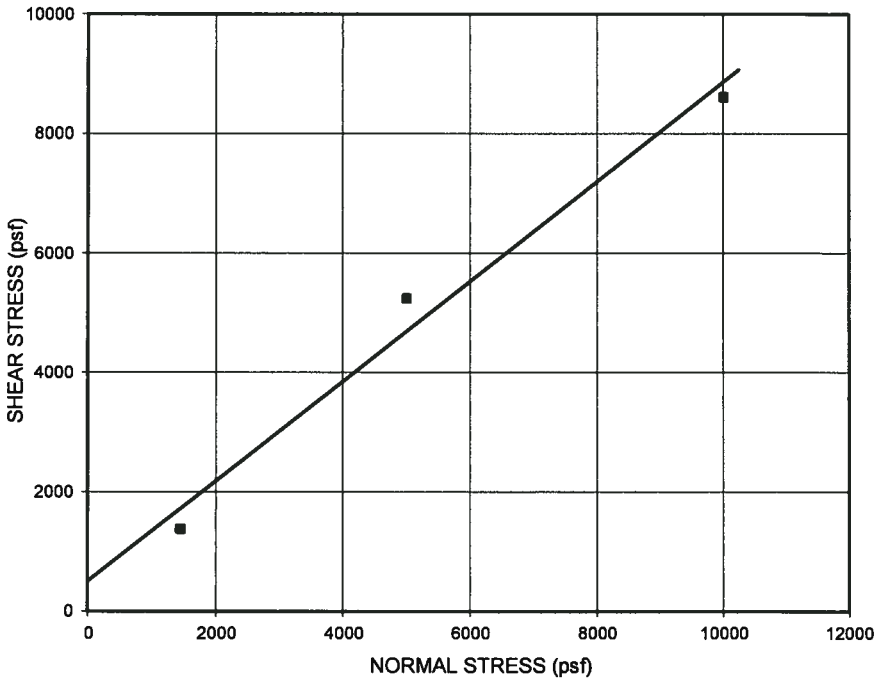
Test Point	Normal Stress psi	Normal Stress psf	Shear Stress psf	Secant Friction Angle
1.	10.1	1450	1390	44
2.	34.7	5000	5250	46
3.	69.4	10000	8620	41

Adhesion: 510 psf

Friction Angle: 40 degrees

Coefficient of Friction: 0.83

NOTE: GRAPH NOT TO SCALE



This testing is based upon accepted industry practice as well as the test method listed. These results apply only to the samples supplied and tested for the above referenced job.

LARGE SCALE DIRECT SHEAR REPORT

Internal Shear

Geo-Logic ASSOCIATES

Report Date: January 5, 2015

Client / Project Name: CHJ CONSULTANTS / PROJECT # 14814-8-8

Project No: 2014.A140.100

Superstrate: ⇦ Spacer

Material 1: ⇦ OB-1, Gray Silty Gravel w/ Sand LSN: 3838A Remolded

Material 2: ⇨ OB-1, Gray Silty Gravel w/ Sand LSN: 3838A Remolded

Substrate: ⇨ Spacer

DISPLACEMENT vs. SHEAR STRESS

Test Point	Normal Stress psi	Normal Stress psf
1.	10.1	1450
2.	34.7	5000
3.	69.4	10000

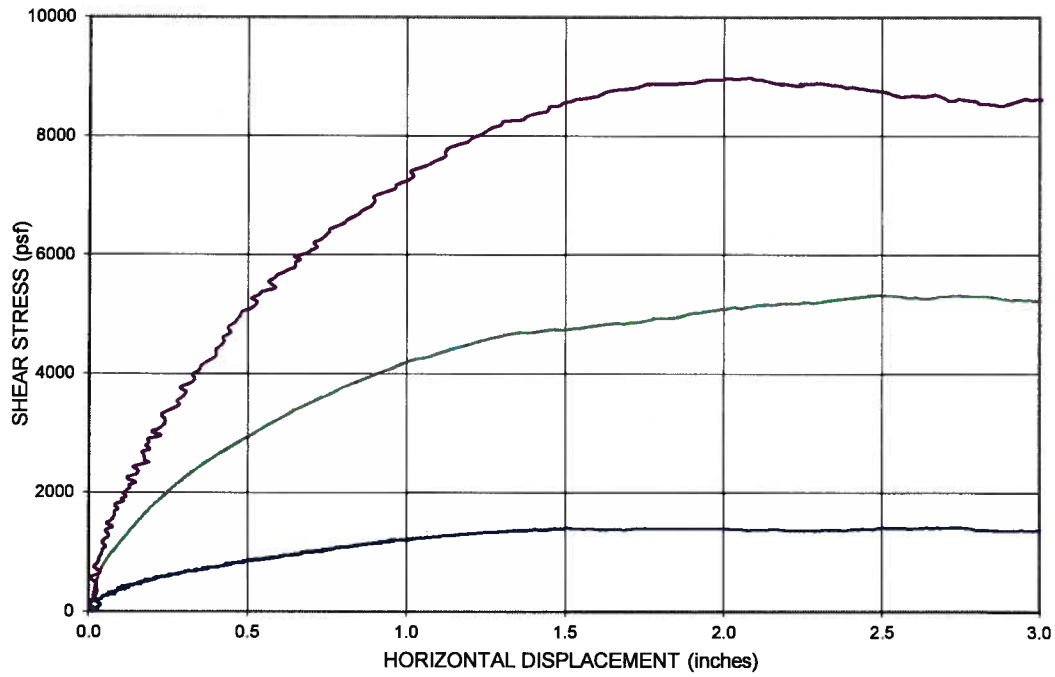
MOISTURE DATA:

(Gravel)

Initial Water Content: 3%

Initial Dry Density: 145 pcf

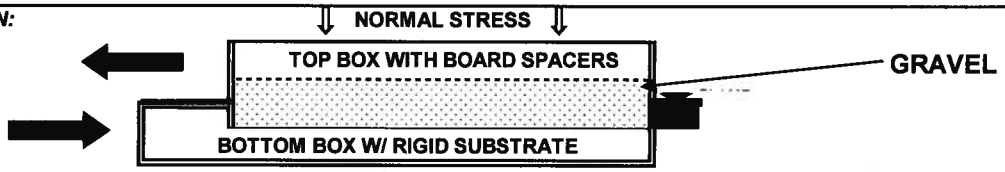
Final Water Content:(%)
1) 11.2 2) 9.1 3) 9



STANDARD CONDITIONS: **SHEAR DISPLACEMENT RATE: 0.04 in/min**

1. The "gap" between shear boxes was set at 80 mil (2.0 mm)
2. The test specimens were flooded during testing unless otherwise noted.
3. High Normal Stresses, >5psi (35 kPa) was applied using air pressure.
4. Low Normal Stresses, <5psi (35 kPa) was applied using dead weights.
5. The tests were terminated after 3.0"(75 mm) of displacement unless otherwise noted.
6. Tests were performed in general accordance with ASTM procedure D-3080 using a Brainard-Killman LG-112 direct shear machine with an effective area of 12" x 12" (300 x300 mm).

TEST ORIENTATION:



SPECIAL TEST NOTES:

1. The test method was modified to measure the internal shear characteristics of the gravel.
2. The gravel was remolded into both the upper and lower box to the specified dry density and water content.
3. Each test point was consolidated under specified normal stress for approximately 2 hours, then sheared.
4. The test was performed in a "wet" or "flooded" condition.
5. Shearing occurred internally within the gravel.
6. The Friction Angle and Adhesion (or Cohesion) results given here are based on a mathematically determined best fit line.
7. Further interpretation should be conducted by a qualified professional experienced in geosynthetic and geotechnical engineering.

This testing is based upon accepted industry practice as well as the test method listed. These results apply only to the samples supplied and tested for the above referenced job.

Geo-Logic Associates
143E Spring Hill Drive
Grass Valley, CA 95945
USA
T+1 530 272 2448
F+1 530 272 8533
www.geo-logic.com

DATE: January 5, 2015

TO: John McKeown
CHJ Consultants
1355 E.Cooley Dr.
Colton, CA 92392

e-mail: JMcKeown@chjconsultants.com

JOB NO: 2014.A140.100
LAB LOG: 3838.0

RE: **Lab Report: Project # 14814-8-8**

Enclosed are results for: Samples Received - December 29, 2014

Code	Item	Quantity
1650	Direct Shear CD /pt, ASTM D-3080, 2.5 - 4"	6
1750	Large Box, 12' x 12" add / pt	6

Thank you for consulting Geo-Logic Associates for your material testing requirements. We look forward to working with you again. If you have any questions or require any additional information, please call us at 1-530-272-2448. This testing is based upon accepted industry practice as well as the for the test method listed. These results apply only to the samples supplied and tested for the above referenced job. This report shall not be reproduced except in full without written approval of Geo-Logic Associates.

Sincerely,

Prepared By: Kindra Hillman
Laboratory Manager

Reviewed By: Kenneth R. Criley
Technical Director

LARGE SCALE DIRECT SHEAR REPORT

Internal Shear

Geo-Logic ASSOCIATES

Report Date: January 5, 2015

Client / Project Name: CHJ CONSULTANTS / PROJECT # 14814-8-8

Project No: 2014.A140.100

Superstrate: ⇦ Spacer

Material 1: ⇦ OB-2, White Silty Gravel w/ Sand — LSN: 3838B — Remolded

Material 2: ⇨ OB-2, White Silty Gravel w/ Sand — LSN: 3838B — Remolded

Substrate: ⇨ Spacer

PEAK STRENGTH

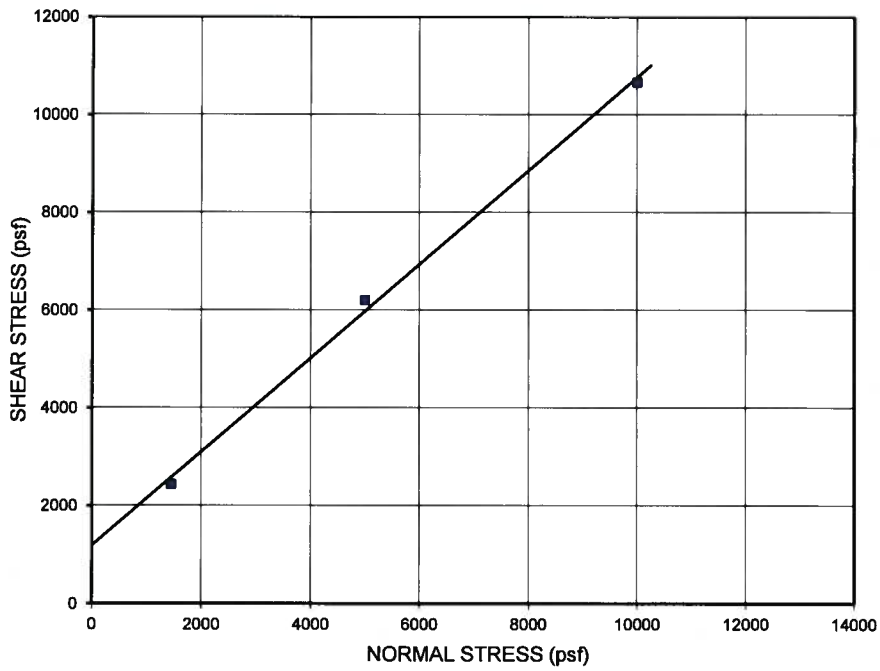
Test Point	Normal Stress psi	Normal Stress psf	Shear Stress psf	Secant Friction Angle
1.	10.1	1450	2430	59
2.	34.7	5000	6210	51
3.	69.4	10000	10660	47

Adhesion: 1180 psf

Friction Angle: 44 degrees

Coefficient of Friction: 0.96

NOTE: GRAPH NOT TO SCALE



STRENGTH ENVELOPE
(at 3.0 in. displacement)

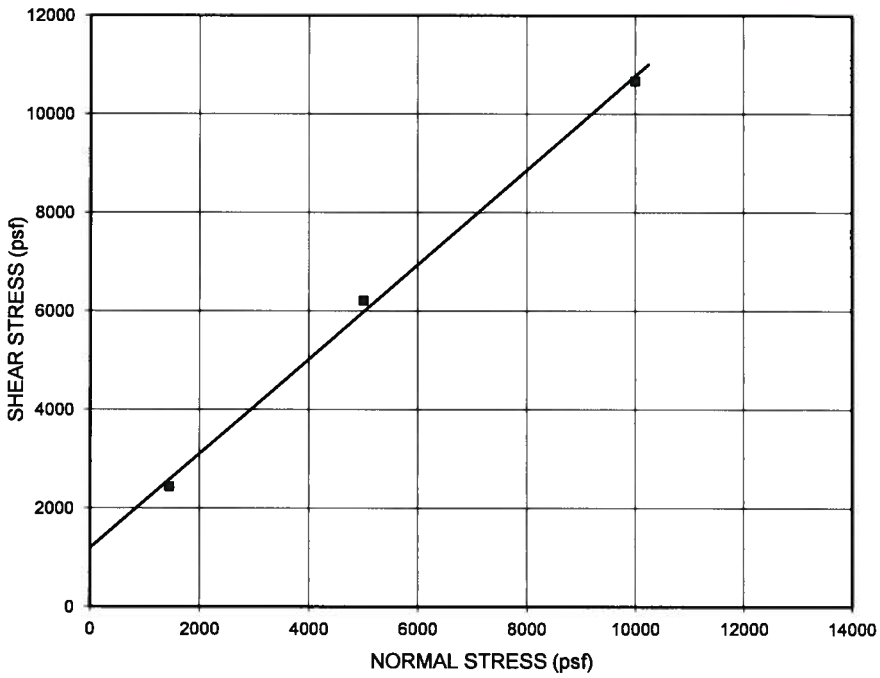
Test Point	Normal Stress psi	Normal Stress psf	Shear Stress psf	Secant Friction Angle
1.	10.1	1450	2430	59
2.	34.7	5000	6210	51
3.	69.4	10000	10660	47

Adhesion: 1180 psf

Friction Angle: 44 degrees

Coefficient of Friction: 0.96

NOTE: GRAPH NOT TO SCALE



This testing is based upon accepted industry practice as well as the test method listed. These results apply only to the samples supplied and tested for the above referenced job.

LARGE SCALE DIRECT SHEAR REPORT

Internal Shear

Geo-Logic ASSOCIATES

Report Date: January 5, 2015
Project No: 2014.A140.100

Client / Project Name: CHJ CONSULTANTS / PROJECT # 14814-8-8

Superstrate: ⇦ Spacer

Material 1: ⇦ OB-2, White Silty Gravel w/ Sand — LSN: 3838B — Remolded

Material 2: ⇨ OB-2, White Silty Gravel w/ Sand — LSN: 3838B — Remolded

Substrate: ⇨ Spacer

DISPLACEMENT vs. SHEAR STRESS

Test Point	Normal Stress psi	Normal Stress psf
1.	10.1	1450
2.	34.7	5000
3.	69.4	10000

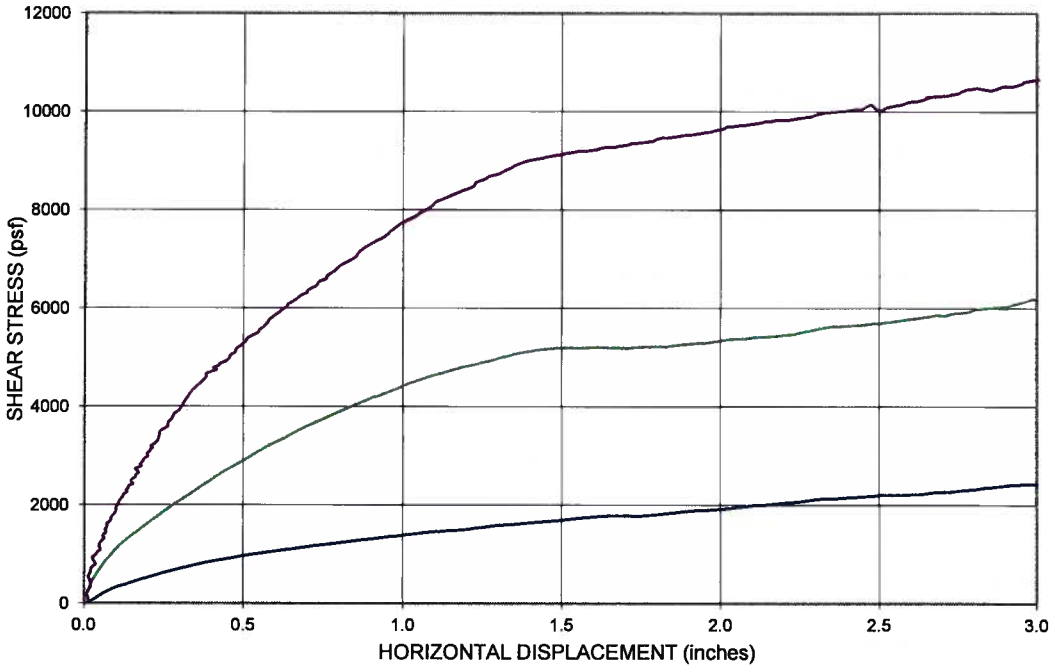
MOISTURE DATA:

(Gravel)

Initial Water Content: 3%

Initial Dry Density: 145 pcf

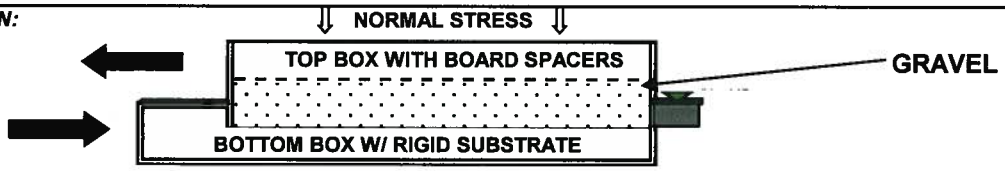
Final Water Content:(%)
1) 8.8 2) 6.8 3) 6.1



STANDARD CONDITIONS: **SHEAR DISPLACEMENT RATE: 0.04 in/min**

1. The "gap" between shear boxes was set at 80 mil (2.0 mm)
2. The test specimens were flooded during testing unless otherwise noted.
3. High Normal Stresses, >5psi (35 kPa) was applied using air pressure.
4. Low Normal Stresses, <5psi (35 kPa) was applied using dead weights.
5. The tests were terminated after 3.0"(75 mm) of displacement unless otherwise noted.
6. Tests were performed in general accordance with ASTM procedure D-3080 using a Brainard-Killman LG-112 direct shear machine with an effective area of 12" x 12" (300 x300 mm).

TEST ORIENTATION:



SPECIAL TEST NOTES:

1. The test method was modified to measure the internal shear characteristics of the gravel.
2. The gravel was remolded into both the upper and lower box to the specified dry density and water content.
3. Each test point was consolidated under specified normal stress for approximately 2 hours, then sheared.
4. The test was performed in a "wet" or "flooded" condition.
5. Shearing occurred internally within the gravel.
6. The Friction Angle and Adhesion (or Cohesion) results given here are based on a mathematically determined best fit line.
7. Further interpretation should be conducted by a qualified professional experienced in geosynthetic and geotechnical engineering.

This testing is based upon accepted industry practice as well as the test method listed. These results apply only to the samples supplied and tested for the above referenced job.

APPENDIX D

SITE PHOTOGRAPHS

Photo 1: Overview of mine area looking south from Location 2.

Photo 2: Overview of west end Location 2 looking north. Note wedge structure with debris at toe of slope.

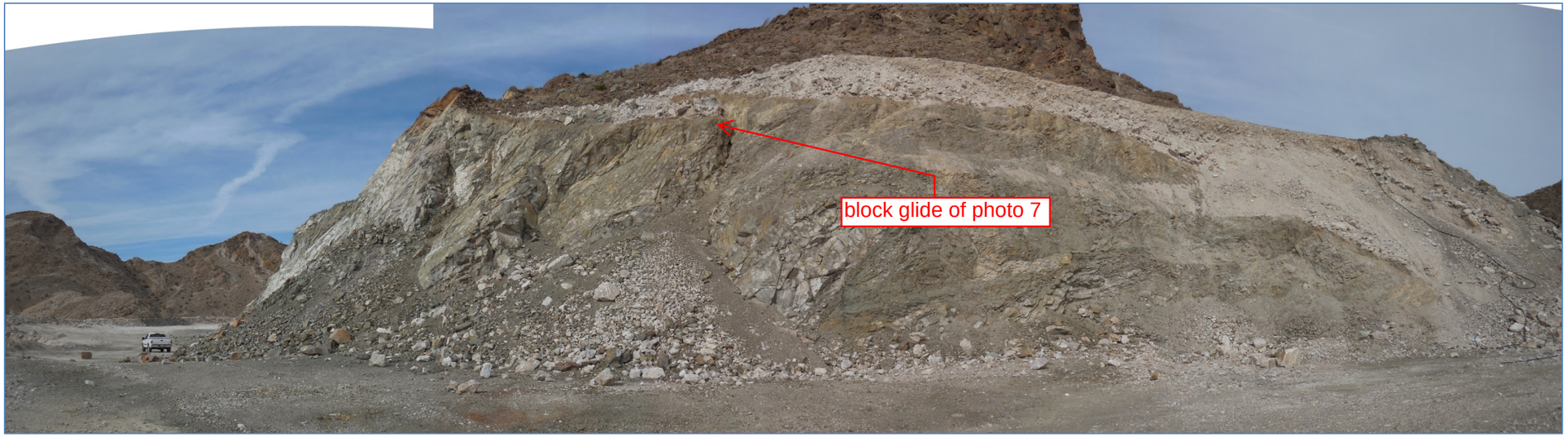


Photo 3: Overview of east end of Location 2. Note block glide scarp at top center and planar faces as dip slopes.

Photo 4: Native outcrop with south-dipping joints systems above Location 2.

Photo 5: Wedge failure at Location 2. Structure includes face forming joint and orthogonal joint.

Photo 6: Wedge structures at Location 2.

Photo 7: Block glide (planar failure) forming scarp in berm materials above Location 2. Feature at east end of Location 2.

Photo 8: Contact of ore and syenite – west end of Location 2.

Photo 9: ore exposure near Location 6 – color contrast of fresh (left) and weathered (right) exposure.

Photo 10: East dipping bedding in native outcrops west of mine.

Photo 11: Landslide formed along bedding – west of mine.

Photo 12: wedge structure formed by planar joint (left) and stepped fractures (right).

Dike appears as dark band.

Photo 13: Wollastonite as altered chert beds.

Photo 14: East dipping beds (foliation) forming closely-spaced planar surfaces at Location 5.

Photo 15: 'Amphitheater' area overview. Note bedding at upper right in native outcrop. Note fault surface as brown/white coatings on face at right.

Photo: 16: Coatings/fillings of fault at north end of Amphitheatre.

Photo 17: surface of Ampitheatre fault.

Photo 18: coarse-grained crystallization in marble.

APPENDIX J

U.S Department of the Interior, BLM, Decision Record
February 5, 2013

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Needles Field Office
1303 South U.S. Highway 95
Needles, CA 92363
www.ca.blm.gov/needles

February 5, 2013

In Reply Refer To:
3809(P)
CACA-035437
CAD090.24

CERTIFIED MAIL NO. 7010 2780 0003 2622 9672
RETURN RECEIPT REQUESTED

Christine Granquist
Manager of Environmental and Regulatory Compliance
Omya California Inc.
7225 Crystal Creek Road
Lucerne Valley, CA 92356

Dear Ms. Granquist:

Enclosed is the Decision Record with attendant Conditions of Approval for your Amboy Limestone Quarry Plan Modification (DOI-BLM-CA-D090-2012-0012-EA). Thank you for providing the detailed information necessary to process this plan modification. Please review this document carefully. The Decision Record with Conditions of Approval must be in your staff's possession whenever you or they are conducting any operations at the project site.

If you have any questions please contact Ken Downing, staff geologist, at (760) 326-7017.

Sincerely,

Raymond C. Lee
Field Manager

Enclosure:
Decision Record with Conditions of Approval (DOI-BLM-CA-D090-2012-0012-EA)

UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
NEEDLES RESOURCE AREA

DECISION RECORD

Omya California Amboy Limestone Quarry Plan Modification

In accordance with 30 United States Code (U.S.C.) 22 and 43 U.S.C. 1201 and 1701, it is my decision to approve Omya California (Calif.), Inc.'s proposed plan modification to enlarge the area of mining activity as reviewed in Environmental Assessment DOI-BLM-CA-D090-2012-0012-EA and described below. Conditioned through mitigation measures, I find that this action will not result in significant impacts on the human environment and that an Environmental Impact Statement is not required. I further find this action in conformance with applicable land use plans and that it will not cause unnecessary or undue degradation. Measures mitigating project impacts are formulated into the attached conditions of approval, incorporated by reference as the decision of the Bureau of Land Management regarding this action. A copy of this Decision Record and attendant stipulations shall be attached to the previously authorized plan of operations and both shall be in the possession of the on site operator during all approved undertakings.

Specifically, this approval action consists of the enlargement of the area of disturbance in five (5) areas as shown on Figure 1, and Amboy Limestone Quarry, sheets 1 and 2 dated 11/26/2011, attached. This expansion will result in additional disturbances of 1.5 Ac. on Public Lands and 9.3 Ac. on Fee Land for a total of 10.8 Acres. No other modifications are proposed for any other aspects of the approved Plan of Operations. The areas of proposed new disturbance enlarge current activities and do not introduce new mining functions. Area 1 will be an enlargement of the quarry wall for more stability of benches. Area 2 will be an enlargement of the overburden waste pile. Area 3, 4, and 5 are enlargements of the ore stock pile areas. A major portion of Area 1, all of Area 3, approximately half of Area 4, and all of Area 5 are on Fee land. A small portion of Area 1, all of Area 2, and approximately half of Area 4 are on Public Lands.

An appeal from this decision may be taken to the State Director, California State Office, Bureau of Land Management in accordance with the provisions in Title 43 Code of Federal Regulations 3809. If an appeal is taken, the notice of appeal must be filed with the Needles Resource Area Office, 1303 South US Highway 95, Needles, California 92363 within thirty (30) days from receipt of this decision. Do not send the notice of appeal to the State Director. The appeal and the case history will be sent to the State Director by the Resource Area Office. The appeal to the State Director must contain: 1. The name and mailing address of the appellant; 2. Where applicable, the name of the mining claim(s) and serial number(s) assigned to the mining claim(s) recorded pursuant to Part 3833 of this title which are subject to appeal; and 3. A statement of reasons for

appeal and any arguments the appellant wishes to present which would justify reversal or modification of the decision. To avoid summary dismissal of the appeal, there must be strict compliance with the regulations.

During the appeal to the State Director, all decisions from which the appeal is taken shall be effective during the pendency of the appeal.

If no appeal is taken, this decision constitutes final administrative action of this Department as it affects the mining claim(s). No appeal, protest or petition for reconsideration will be entertained from this decision after the appeal period has expired.

Approved by:

Field Manager, Needles Field Office

February 5, 2013
Date

CONDITIONS OF APPROVAL AND ADVISORY:

CONTROL NUMBER: DOI-BLM-CA-D090-2012-0012-EA
PROJECT: Omya California Amboy Limestone Quarry Plan Modification

Conditions of Approval

1 The operator will comply with all stipulations contained in this authorization unless otherwise approved in writing by the Authorized Officer. Non-compliance with these stipulations by the operator or any of his agents may at the option of the Authorized Officer result in the issuance of a Notice of Noncompliance and suspension of the authorization or other adverse action against the operator.

2. The operator shall comply with applicable federal and state laws and regulations issued thereunder, existing or hereafter enacted or promulgated (Grandfathered Rights excepted), affecting in any manner construction, operation, maintenance or termination of the right-of-way grant, permit, authorization.

3. The operator shall confine all activities within the area specifically defined in the authorization.

4. When all development and rehabilitation have been completed, a joint compliance check of the project area will be made. The operator and the Authorized Officer shall hold a joint inspection of the project area to determine if compliance with the terms and conditions of this authorization have been completed. The operator shall perform at their own expense any required modifications or additional reclamation work needed to comply with the terms of this authorization as conclusively determined by the Authorized Officer.

5. The operator will immediately bring to the attention of the Authorized Officer any archaeological resources encountered during operations and maintain the integrity of such resources pending subsequent investigation.

6. Releases of any material not authorized shall be reported immediately to the Federal Interagency Communications Center (FICC) at (909) 383-5652. An Initial Report shall be faxed to the authorized officer within 24 hours of the incident's discovery (760) 326-7099. Incidents which occur during non-office hours must be faxed to the FICC concurrently at (909) 383-5587. A comprehensive follow-up report must be received by the Authorized Officer within 14 calendar days of the incident's discovery.

7. The operator shall meet all Federal and State Air Quality standards and regulations, and be in possession of all necessary permits. The operator is required to supply the Bureau of Land Management (BLM) with copies of these permits before operations begin.

8. Operations which generate fugitive dust emissions shall be curtailed when sustained wind speeds exceed 30 MPH.

9. Additional mitigation measures shall be implemented if fugitive dust emissions exceed the Mojave Desert Air Quality Management District (MDAQMD) standards or California Health and Safety Code Section 41700 and 41701.

10. MDAQMD permits shall be kept current.

11. Dust control measures will consist of the following:

Source Category	Control Measures
unpaved road	improve road surface vehicular traffic speed at 25 mph apply biodegradable dust suppressants (i.e., no petroleum or petroleum by products)
open storage piles (only if silt content is 5 or more percent)	use wind screens use enclosures around piles apply biodegradable dust suppressants
disturbed surface area	use fences/barriers vegetate apply biodegradable dust suppressants cover with gravel compact surface

12. All surface disturbance will be performed in such a manner as to prevent unnecessary or undue degradation to lands and vegetation.

13. A tarpaulin, plastic, or other protective device will be required to prevent oil and other fluids leaking from equipment from contaminating soils.

14. The operator shall obtain a Section 1603 permit from the California Department of Fish and Game before altering any stream channels.

15. Reclamation activities will include control of slopes on cuts and fills, plus revegetation, to control surface erosion.

16. The operator shall comply with the approved Revegetation Plan for the Amboy Limestone Quarry prepared by Biological Resource Specialists dated January 4, 1998, which is made a part of this document by reference. This Revegetation Plan was prepared to comply with the California State Mining and Reclamation Act (SMARA) performance standards for revegetation (PRC Section 3705). This Revegetation Plan inventories the baseline data; describes site preparation, and general revegetation; stipulates seed collection, limited irrigation, fertilization, cactus

salvage, weed control, specific seeding methods and re-vegetation scheduling; finally provides for annual monitoring and success criteria based on the overall quality of the revegetation results compared to the recorded baseline vegetation data.

17. Baseline vegetation measurements will be completed as part of revegetation research program prior to surface disturbing activities.

18. The operator will annually provide to the BLM a detailed description of the experiments performed and results achieved in connection with its revegetation research program and will further describe the progress of all re-vegetated areas.

    a. As a result of its review of the information provided by these reports, the County or BLM may adjust the revegetation standards.

    b. If the BLM determines that such adjustment is warranted, it will provide notice.

19. The operator will provide to the BLM a copy of the required annual Mitigation Monitoring Report as stipulated in the Section 4.0 of the Revegetation Plan prepared by Biological Resource Specialists dated January 4, 1998. The annual report documents the revegetation effort and assesses the results of the ongoing re-vegetation on completed re-vegetated areas, areas being cleared, and areas where revegetation is being planned. Re-vegetated areas will be assessed utilizing success criteria, with successful methods being implemented for future revegetation.

20. All disturbed surfaces shall be re-contoured to resemble the surrounding terrain, to the degrees as stated in 4.12 and 4.13 of the Plan of Operations and Reclamation Plan, Amboy Limestone Quarry, San Bernardino County, California - April 7, 1996 (Plan of Operations 4/7/96).

21. At the conclusion of mining, overburden shall be backfilled into the pit as described in the Plan of Operations 4/7/96 for the Amboy Limestone Quarry.

22. Any newly disturbed areas on public land not required for operation of the site as specified in the Plan of Operations 4/7/96 shall be reclaimed in a manner subject to approval of the BLM Authorized Officer.

23. Upon completion of operations, rock exposures along new access roads on public land shall be stained in such a manner as to blend with the adjacent landscape. Staining materials must be approved by BLM.

24. The Bureau of Land Management, Needles Field Office, will be named as a designee on all reclamation bonds or other financial assurance documents as may be required by San Bernardino County. All reclamation bonds or other financial assurance instruments must be approved by the Authorized Officer. Within 90 days

from the authorization date of the Decision Record all reclamation bonds or other financial assurance instruments must comply with regulations at 43 CFR 3809, as revised, and which became effective March 31, 1997.

Advisory:

1. Actions other than those explicitly approved by the Bureau of Land Management which result in impacts upon archaeological resources, shall be subject to the judicial proceedings of the Archaeological Resources Protection Act of 1979, as amended, and the Federal Land Policy and Management Act of 1976. As property of the United States, no person may, without authorization, excavate, remove, damage, or otherwise alter or deface any historic or prehistoric site, artifact, or object of antiquity located on public lands.

UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
NEEDLES RESOURCE AREA

ENVIRONMENTAL ASSESSMENT
DOI-BLM-CA-D090-2012-0012-EA

PROJECT: Omya California Amboy Limestone Quarry Plan Modification

Lead	Kenneth M Downing
Air Quality	Kenneth M Downing
Cultural Resources	Ruth Z Q
Ecologically Critical Area;	
Environmental Justice;	
Hazardous and Solid Materials; and	
Health and Safety	Geo. T. Macdonald
Invasive, Nonnative Species	
Land Use Conflicts	
Law Enforcement	2/8/12
Range Conservation	
Recreation	
Soils and Minerals	Kenneth M Downing
Water Quality	Kenneth M Downing
Wetlands and Riparian Areas	
Wild, Free-Roaming Burros	
Wilderness Characteristics ADDED	
Wildlife	Geo. T. Macdonald for L. LaPre (P.O.) 5/15/13
Recreation Staff Chief	
Multi-Resources Staff Chief	Kenneth M Downing

UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
NEEDLES RESOURCE AREA

ENVIRONMENTAL ASSESSMENT

1. **CONTROL NUMBER:**

   DOI-BLM-CA-D090-2012-0012-EA

2. **CASE FILE / SERIAL NUMBER:**

   CACA 35437

3. **PROPONENT:**

   Omya California, Inc.

4. **PROJECT:**

   Omya California Amboy Limestone Quarry Plan Modification

5. **LOCATION:**

   Section 30, T. 3 N., R. 13 E., SBBM

6. **AFFECTED ACREAGE:**

   Approved: 16 Ac. Public Lands and 57 Ac. Fee Lands
   Proposed additional disturbance: 1.5 Ac Public 9.3 Ac Fee
   Total disturbance: 17.5 Ac. Public lands 66.3 Ac. Fee Lands

7. **7.5' QUADRANGLE:**

   Amboy

8. **MULTIPLE-USE CLASS:**

   Limited

9. **LAW ENFORCEMENT SECTOR:**

93

10. LAND STATUS:

Public Lands, Fee Lands

11. SPECIAL DESIGNATION AREA:

California Desert Conservation Area

12. AUTHORITY:

30 U.S.C. 22; 43 U.S.C. 1201 and 1701

13. LAND USE PLAN CONFORMANCE:

The proposed action is subject to and in conformance with the *California Desert Conservation Area Management Plan* (CDCA) 1980 *et seqq*. The plan's Geology, Energy and Mineral Resources Element provides for continued recognition of access to and the availability of as much public land as possible for mineral exploration and development. Locatable mineral actions located within Multiple-Use Class L (Limited) are to be subject to Title 43 CFR 3809 Regulations and applicable State and local law. Plans of operations are to be reviewed for potential impacts on sensitive resources identified on lands in this class. Mitigation, subject to technical and economic feasibility, would be required.

14. NEED FOR PROPOSED ACTION:

After *The 1872 Mining Law*, the public has the statutory right to secure claim to mineral deposits located on open public lands, consistent with the *Federal Land Policy and Management Act of 1976*, applicable Federal and State environmental statutes and County ordinances. The proponent has filed a modification to an approved plan of operations with the Bureau, conforming with Title 43 Code of Federal Regulations 3809, seeking approval to enlarge mining operations on the subject lands claimed.

15. Background

Pluess-Staufer (California) Inc. submitted a plan of operations consisting of four phases for the Amboy Limestone Quarry to BLM on March 10, 1995, and to San Bernardino County Planning Department (SBCPD) on April 7, 1996. Environmental Analysis was completed under EA7-21. Phases 1 and 2 of the plan of operations and reclamation plan submitted April 7, 1996 to SBCPD was approved by SBCPD on December 19, 1996, and by BLM on March 19, 1997. Ownership of the mine was subsequently transferred to Omya California, Inc.(Omya). Phases 3 and 4, required consultation with the State Historic Preservation Office (SHPO) pursuant to Section 106 of the National Historic Preservation Act. Consultation with SHPO was completed

July 1, 1997, and Phases 3 and 4 were approved by BLM April 23, 2001. See CA-690-DNA01-21.

The following is a generalized description of the approved Plan of Operations all four phases of which were previously approved on April 23, 2001. Additional details are discussed in the Pleuss-Staufer (California) Inc., Plan of Operations and Reclamation Plan, Amboy Limestone Quarry, San Bernardino County, California, dated April 7, 1996, which is made part of this document by reference. Current operations are in Phase 2.

The site of the OMYA limestone quarry is located approximately 0.5 mile west of Kelbaker Road, 1.5 miles north of National Trails Highway (old Route 66) and six (6) miles northeast of the community of Amboy in the central desert region of San Bernardino County. Access to the quarry site is via a 1.5 mile road situated on private property and a patented claim. This road has been improved to accommodate highway legal haulage trucks.

The project has been developed as a crystalline food grade limestone quarry (known as the Amboy Quarry) with mine development occurring in four (4) phases. The existing and future quarry area is located on a 210 acre site which includes a patented 160 acre claim (fee land owned by OMYA) and 50 acres of mill sites and placer claims located on Bureau of Land Management (BLM) administered public land (see Map Attachment 1). Approximately 3 acres of public land has been disturbed for purposes of haulage and access roads and growth media storage area during approved Phase 1. During Phase 2 an additional 13 acres of public land has been previously authorized to be disturbed for the purpose of overburden storage and quarry development.

The previously approved portion of Phase 1 encompassed the first five (5) years of the new project and resulted in approximately 5 acres of quarry development on private land in addition to establishment of necessary access roads on public land. The approved remaining portion of Phase 1 as previously authorized encompasses 10 years of the project life resulting in no further disturbance of public lands, other than the 13 acres noted above. During this time, 25,000 tons of crushed rock extraction has been authorized for each year. Mining operations in Phase 1 will occur for approximately 4 months each year.

The previously approved Phase 2 encompasses the next 20 years after Phase 1 is completed. Quarry and overburden of Phase 2 development as previously authorized will disturb 13 acres of public land. No further disturbance of public lands has been authorized to occur after completion of Phase 2.

During Phase 2 up to 100,000 tons per year of limestone ore production has been previously authorized.

Phases 3 and 4 encompass the final 20 years of the project life and completes the previously authorized development of the quarry. No disturbance of additional public land has previously been authorized to occur during these final Phases. During Phase 3 and 4 up to 200,000 tons of limestone ore production per year has been previously authorized.

Mining at the Amboy Quarry utilizes standard drill and blast techniques to accomplish initial ore extraction in benches 30 to 40 feet high. Ultimately more than 10 benches will be developed over a vertical interval of 400 feet. As previously authorized, current pit design calls for mining the deposit down to an elevation of 1080 feet above sea level (ASL) from 1580 ASL. Blasted rock is loaded with wheel loaders into haul trucks and transported to the crusher or overburden placement sites. Ore is crushed on site, then the crushed ore is stockpiled and transported to the existing OMYA plant for processing on a year round basis. A temporary portable crusher is brought to the site for crushing and stockpiling of the ore for 2 months per year during Phase 1, and then removed. During middle and later phases, the crusher is utilized for 3 to 6 months per year and then removed. The applicant has been authorized to construct a stationary crusher setup when the quarry reaches the 100,000 tons per year extraction rate, and install a more permanent fuel storage site. Also at that time, rail haulage may be evaluated as an alternative for transport of crushed ore to Lucerne Valley with appropriate environmental assessment.

Mobile equipment used on site consists of one or two Cat 966 (or equivalent) loaders, one Cat D9 dozer for excavations, one Cat 16G grader (used approximately once per month for road blading), one 4,000 gallon water truck, one track drill, and one 50 ton off-road haul truck.

Operations are conducted primarily during the winter and spring months of each year due to extremely hot temperatures (in excess of 120 degrees F) which occur on site in the summer season. The operation employs approximately five (5) people during Phase 1 and up to 8 people during Phase 2. During Phase 3 and 4 up to 12 people may be required if rail haulage is utilized. Rail haulage as an alternate form of ore transport would require appropriate environmental assessment and a right of way grant across public lands. Rail haulage has specifically <u>not</u> been previously approved nor would it be authorized as part of this decision.

As described in the approved Plan of Operations 4/7/96, the final Reclamation Plan prepared for this project will leave the site as open space once the mining operation life is concluded. Cactus salvage and growth media salvage will occur to the degree possible during the life of the operation as set forth in the approved Reclamation Plan. Most of the reclamation can only occur once the final mining limits have been reached, and will include site cleanup, public safety measures, drainage controls, slope reduction of overburden site, some back filling of the quarry, visibility reduction, re-contouring and ripping, prioritized placement of growth media islands, revegetation with native species (including salvaged cactus), monitoring of reclamation and at least five (5) years of maintenance. Financial assurances in the form of performance bonds will be adequate to cover the cost of implementing the reclamation plans. Post mining uses will be compatible with State of California Surface Mining And Reclamation Act (SMARA) and San Bernardino County land use directives, and include open space and wildlife habitat.

In accordance with Title 43 Code of Federal Regulations (CFR) 3809.0-6, assurance of adequate and responsible measures to prevent unnecessary or undue degradation of the Federal lands and to provide for reasonable reclamation is required of the proponent, after but not limited to 3809.0-5(k) and 3809.1-3(d). After 43 CFR 3809.1-5(c)(5), reclamation of all

areas of disturbance will be completed to the following standards, and reasonable measures will be taken to prevent unnecessary and undue degradation of the Federal lands during operations, in accordance with 43 CFR 3809.0-5(k):

Access routes will be planned for only the minimum width needed for operations and will follow natural contours, where practicable to minimize cut and fill. All tailings, dumps, deleterious materials or substances, and other waste produced by the operations will be disposed of so as to prevent unnecessary or undue degradation and in accordance with applicable with Federal and State laws.

At the earliest feasible time, the operator will reclaim the area disturbed, except to the extent necessary to preserve evidence of mineralization, by taking reasonable measures to prevent or control on-site damage to Federal lands.

Reclamation will include, but not be limited to:

Saving of topsoil for final application after reshaping of disturbed areas have been completed;

Measures to control erosion, landslides, and water runoff;

Measures to isolate, remove, or control toxic materials;

Reshaping the area disturbed, application of the topsoil, and revegetation of disturbed areas, where reasonably practicable; and

Rehabilitation of fisheries and wildlife habitat.

Pursuant to Title 43 Code of Federal Regulations (CFR) 3809.0-6, during operations and upon cessation of mining activities, OMYA (CA), Inc. is responsible for assuring adequate and responsible measures to prevent unnecessary or undue degradation of the Federal lands and in providing for reasonable reclamation, after but no limited to CFR 3809.0-5(k) and 3809.1-3(d).

16. PROPOSED ACTION AND ALTERNATIVES:

16.1 Proposed Action:

Omya has submitted a modification to the approved plan of operations that enlarge the area of disturbance by a total of 10.8 acres (1.5 Ac. Public Lands and 9.3 ac. Fee Land).

The proposed action would enlarge the area of disturbance in five (5) areas as shown on Figure 1, attached. The proposed expansion would result in additional disturbances of 1.5 Ac. on Public Lands and 9.3 Ac. on Fee Land for a total of 10.8 Acres. No other modifications are proposed for any other aspects of the approved Plan of Operations. The areas of proposed

new disturbance enlarge current activities and do not introduce new mining functions. Area 1 would be an enlargement of the quarry wall for more stability of benches. Area 2 would be an enlargement of the overburden waste pile. Area 3, 4, and 5 are enlargements of the ore stock pile areas. A major portion of Area 1, all of Area 3, approximately half of Area 4, and all of Area 5 are on Fee land. A small portion of Area 1, all of Area 2, and approximately half of Area 4 are on Public Lands.

16.2 Alternatives Considered But Not Analyzed Further:

None

16.3 No Action Alternative:

The Proposed Action would not be undertaken as proposed. The subject area would continue to be managed within the framework of a program of multiple use and sustained yield, and the maintenance of environmental quality [43 U.S.C. 1781 (b)] in conformance with applicable statutes, regulations, policy and land use plans. A finding of unnecessary or undue degradation conditions the No Action Alternative decision, pursuant to Title 43 CFR 3809.0-3(b).

17.1ENVIRONMENTAL CONSEQUENCES: Proposed Action

The following elements of the human environment, subject to review specified in statute, regulation or executive order, are not located within the project area: Ecologically Critical Area, Floodplains, Prime or Unique Farm Lands, Wetlands and Riparian Zones, Wild and Scenic Rivers, and Wilderness.

Air Quality

The Mohave Desert Air Quality Management District (MDAQMD) has state air quality jurisdiction over the project area. The MDAQMD has rules that apply to this project along with permitting requirements. Much of the time, air quality throughout the project area is generally good. There are, however, times that the area does not meet air quality standards due to locally generated and/or wind transported pollutants. The vicinity in which the proposed expansion is located is currently classified as a federal non-attainment area for ozone and PM-10 under national standards. The proposed project area is within the Mojave Desert PM-10 Planning Area and the South East Desert Ozone non-attainment area. The State Implementation Plan (SIP) identifies sources of PM-10 emissions and control measures to reduce emissions. The SIP emphasizes controls and management. As a minimum, the Environmental Protection Act (EPA) requires the application of reasonable available control technology (RACT) to stationary emission sources and reasonable available control measures (RACM) to mobile sources and new source review and permitting.

An increase in fugitive dust during wind storms would occur due to the soil disturbance as a result of the proposed action. Vehicle use on the access road would generate PM-10

emissions throughout the project. The operation of the processing plant would generate PM-10 emissions. The operation of engines to power the operation would generate unknown levels of particulate and other emissions. No control measures are incorporated into the proposed action to reduce emissions from the activities associated with the proposed project but the proposed actions should not be allowed to exceed the maximum emission levels.

After mitigation the proposed action would not exceed deminimus emission levels and no further conformity determination is necessary. No impacts are anticipated regarding air quality for the proposed action.

Cultural Resources and Native American Religious Values

No cultural resources potentially eligible for inclusion in the National Register of Historic Places Occur within the project's area of potential effect. Review of the Native American Sacred Lands Inventory, no traditional or sacred lands occur within or proximal to the project area.

Environmental Justice

No minority communities or low income communities are located within or adjacent to the proposed project areas. The proposed action would not impact distinct Native American cultural practices or result in disproportionately high or adverse human health or environmental effects on minority communities.

Hazardous and Solid Wastes

The proposed action sufficiently addresses potential project solid and hazardous waste related impacts as addressed In the Plan of Operations and Reclamation Plan, Amboy Limestone Quarry, San Bernardino County, California, dated April 7, 1996.

Health and Safety

The proposed action sufficiently addresses potential project health and safety related impacts. The proposed activity will be supported by the *Omya Health and Safety Plan*. The plan addresses The Amboy Site-Specific Hazard Awareness Training, required of all employees, General Safety Rules and procedures, Emergency Communication and Evacuation Procedures, and Mine Safety and Health Administration (MSHA) required training plans. As addressed in the Plan of Operations and Reclamation Plan, Amboy Limestone Quarry, San Bernardino County, California, dated April 7, 1996, mining operations comply with all Federal, State, and local mine safety regulations. Public access to the area is restricted by locked gates.

Soils:

During the operation the B soil horizon (surface layer) would be excavated. The subsurface soils would become disturbed by heavy equipment use, and the very small particles of silt/clay

would be susceptible to wind erosion. Soil contamination by hydraulic fluids, oils, or other lubricants is strictly forbidden. Spillage of these fluids requires that the contaminated soil be treated as a hazardous waste according to the Environmental Protection Agency (EPA) regulations. All costs associated with this cleanup should be borne by the proponent. The soil losses due to the proposed action are irreversible and irretrievable.

Surface and Ground Water Quality

Surface Water: No Impacts are anticipated

Ground Water: No Impacts are anticipated

Sensitive Species and Unique Plant Assemblages

The inventory conducted for the environmental assessment for the master Plan of operations (CA069-EA7-18) found no sensitive species or unique plant assemblages in the area of the mining operations.

Threatened and Endangered Species

Two surveys conducted for the master Plan of Operations (CA069-EA7-18) found no signs (scat, tracks, shell fragments, etc.) and resulted in a finding of no affect. The area is not in desert tortoise critical habitat nor a Designated Wildlife Management Area (DWMA).

Visual Resources

The proposed action under consideration here occurs on lands assigned to VRM Class III according to predetermined criteria. The objective of this class is to partially retain the existing character of the landscape. The level of change should be moderate. Management activities may attract attention but should not dominate the view of the casual observer. Any changes should repeat the basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape.

The effect of the proposed action on visual resources would be notable to the visibility of the casual observer due to the close proximity of the site to National Trails Highway (Route 66) and Kelbaker Road (a major connector to Route 66.) The proposed mine site is clearly visible by the naked eye five miles west, five miles east, and five miles north of the intersection of Route 66 and Kelbaker Roads. When seen from the key viewing points, the area does conform to VRM Class 3 standards, that is, the resultant visual impacts are such that the site can be seen, but it does not substantially attract attention. This is in large part due to the similarity in color between the surface and subsurface materials. New access roads to the open pit should not represent as great a visual impact as might be expected for an operation of its life expectancy (55 years). At present, the integrity of visual resources in the vicinity of the proposed action are compromised by the existing communications structures atop Bristol Mountains, and to the south of the site.

Wilderness / Wild Lands

Wilderness Characteristics

The Wilderness Act of 1964 defines an area of wilderness as "an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions and which (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; (3) has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition; and (4) may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value."

The proposed Omya California Amboy Limestone Quarry Plan Modification Project is located within an area evaluated during the BLM California Desert Conservation Area Wilderness Inventory of 1979. Area CDCA 258A – SW Bristol Mountains, is generally located directly north of the town of Amboy and contains approximately 43,709 acres. The area, which includes the southern terminus of the Bristol Mountains, is bordered on the east by Kelbaker Road and its associated spur; on the north, by the gas pipeline right-of-way; on the west, by a maintained road from Bagdad to the northern pipeline; and on the south, by another gas pipeline right-of-way.

According to the Wilderness Inventory site description, "this area with the exception of the southeastern portion [proposed project area], and a road from Amboy to prospects in section 17, Township 6 North, Range 12 East, this area's primitive, undeveloped state has been retained. Man's works are substantially unnoticeable, and it is primarily affected by the forces of nature. No roads penetrate the northern portion of the area. In the southeastern portion many mines are present, with roads and ways leading to them. A radio repeater station is also present, along with its access road. Many off-road vehicle scars are present on this portion unsuitable due to permanent improvements and the extent to which the area has been disturbed by man. This impacted portion was omitted from further wilderness consideration.

Outstanding opportunities for solitude exist throughout the northern portions. The distance from the base of the mountains across the bajada to the Old National Trails Highway/Route 66 actually enhances the feeling of solitude and freedom of movement. The ruggedness of the mountains tends to topographically screen visitors from one another. Primitive and unconfined recreation are well-suited to this area."

Today, unit 258A continues to exist as it did in 1979 with minimal changes. Access to the radio repeater has improved, and mining operations have consistently grown. Lands to the north are encircled by a series of vehicle routes as designated within

NECO. The Mojave Adventure Routes trail system which were an outstanding network of legally designated 4x4 vehicle backcountry touring routes for motorized recreation is a shared-use trail system which provides recreational opportunities for all persons, hikers, bicyclists, equestrians and those who use non-street-legal (Green Sticker) vehicles, and allows for back country opportunity for non-traditional trail users such as persons with disabilities, senior citizens, and families with small children. These routes were mapped and developed for the purpose of traveling to areas not often seen by many people. Some areas offer hiking and dispersed camping opportunities as well. Easier access along these routes has not diminished the overall wilderness characteristic of the northern portion of the unit.

The proposed increased mining disturbance in five areas, and the expansion of approximately 11 acres of land in the southeastern section of Unit 258A will not change the past inventory review of the southeastern corner of the unit or decrease the wilderness characteristics of the northern section where the values are still intact. Therefore, since no wilderness, wilderness study areas or areas with wilderness characteristics would be impacted by the current project, no mitigation for wilderness resources will be proposed.

Wildlife

Due to the extremely barren, arid, and hot environment, wildlife in the area is sparse. A few varieties of lizards, birds, mammal, and insects inhabit the area.

17.2 MITIGATION MEASURES

Air Quality:

1. The proponent should meet all Federal and State Air Quality standards and regulations, and be in possession of all necessary permits. The proponent would be required to supply the BLM with copies of these permits before operations begin.

2. Operations which generate fugitive dust emissions should be curtailed when wind speeds exceed 30 MPH.

3. Additional mitigation measures should be implemented if fugitive dust emissions exceed the Mojave Desert Air Quality Management District (MDAQMD) standards or California Health and Safety Code Section 41700 and 41701.

4. MDAQMD permits should be kept current.

5. Dust control measures should consist of the following:

Source Category	Control Measure
unpaved road	improve road surface
	vehicular traffic speed at 25mph

apply biodegradable dust suppressants (i.e., no petroleum or petroleum byproducts)

open storage piles (only if silt content is 5 or more percent)	use wind screens use enclosures around piles apply biodegradable dust suppressants
disturbed surface area	use fences/barriers vegetate apply biodegradable dust suppressants cover with gravel compact surface

Hazardous and Solid Wastes

If spillage of fuel, oil, antifreeze or other fluids occurs in association with vehicle breakdowns or accidents, all costs associated with this cleanup should be borne by the permittee.

Releases of any material not authorized will be reported immediately to the Federal Interagency Communications Center (FICC) at (909) 383-5652. An initial Report will be faxed to the authorized officer within 24 hours of the incident's discovery (760) 326-7099. Incidents which occur during non-office hours must be faxed to the FICC concurrently at (909) 383-5587. A comprehensive follow-up report must be received by the authorized officer within 14 calendar days of the incident's discovery.

Soils

1. All surface disturbance should be performed in such a manner as to prevent unnecessary or undue degradation to lands and vegetation.

2. A tarpaulin, plastic, or other protective device should be required to prevent oil and other fluids leaking from equipment from contaminating soils.

Visual Resources:

1. Any newly disturbed areas not required for operation of the site should be reclaimed in a manner subject to approval of the BLM Authorized Officer.

2. All disturbed surfaces should be recontoured to resemble the surrounding terrain, to the degrees as stated in 4.12 and 4.13 of the Omya California (California) Inc., Plan of Operations and Reclamation Plan, Amboy Limestone Quarry, San Bernardino County, California (April 7, 1996), and revegetated to reduce the visual contrast.

3. Upon completion of operations, rock exposures along new access roads should be stained in such a manner as to blend with the adjacent landscape. Staining materials should

be approved by BLM.

17.3 RESIDUAL IMPACTS

Visual Resources

Upon completion of reclamation activities, the visual impacts will be lessened to some degree, although the effects of vegetative loss will exist for many years to come.

17.4 CUMULATIVE IMPACTS

Cumulative impacts are those impacts on the environment which result "from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions." (40 CFR 1508.7). In this case, past and presently on-going actions and activities in the project vicinity include: the current OMYA mining activity, Route 66 National Trails Highway, Santa Fe Railroad, salt brine production on Bristol Dry Lake, the towns of Amboy and Chambless, and Cadiz Farm. A groundwater production field and pipeline has been proposed for the area.

The proposed action would contribute an additional 10.8 acres of disturbance to the mine area and would affect visual resources. The general area would retaln the rural setting. The proposed action is not anticipated to lead to increased use of the area's transportation systems beyond current use.

In consideration of the existing environment associated with the assessed resources, ecosystems and human communities of concem, conditions are not approaching the point where additional stresses associated with the proposed action and the future foreseeable actions would have consequential cumulative effects.

17.5 ENVIRONMENTAL CONSEQUENCES: No Action Alternative

The no action alternative would deny only the enlarged area of disturbance and all impacts resulting from the previously approved would continue under this alternative.

Minerals:

Under the No Action Altemative a portion of reserves would not be allowed to be mined and certain portions of mine facilities (overburden pile, growth medium stockplle, and haul roads) would not be enlarged. This could place added financial burden on the operator and reduce his profit. Operations on private lands have been permitted by San Bernardino County and those operations would continue. The small amount of reserves remaining un-mined would be replaced in the market by other sources. Little if any socio-economic impact to the local area would result. Cost to BLM would result if the proponent appealed BLM's selection of this altemative.

18. NOTIFICATION

Notification of the proposed action and analysis has been posted on the Field Office NEPA Lister web page during the environmental review process. No comments were received in association of the project's posting.

19. DOCUMENT REVIEW

Planning and Environmental Coordinator

Date 1/25/13

APPENDIX K

Best Management Practices (BMP) Manual

SESPE CONSULTING, INC.

374 Poli Street, Suite 200 • Ventura, California 93001

STORM WATER BEST MANAGEMENT PRACTICE (BMP) MANUAL

Amboy Limestone Quarry
Omya California, Inc.
San Bernardino, CA

CA Mine ID #91-36-0140

September 2015

Prepared for: Omya, Inc.
7225 Crystal Creek Road
Lucerne Valley, California 92365
(760) 248-5200

Prepared by: Sespe Consulting, Inc.
374 Poli Street, Suite 200
Ventura, California 93001
(805) 275-1515

STORM WATER BMP MANUAL

Amboy Limestone Quarry
San Bernardino, CA

September 2015

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STORM WATER BMP MANUAL

Amboy Limestone Quarry
San Bernardino, CA

September 2015

1.0 EXECUTIVE SUMMARY

This Storm Water Best Management Practice (BMP) Manual has been prepared for Omya, Inc.'s Amboy Limestone Quarry site, located in the central Mojave Desert approximately six (6) miles east of Amboy, and one (1) mile north of Highway 66.

The undisturbed native limestone in the area is very resistant to erosion, and not highly fractured.[1] During the mining operations, the fractured and crushed limestone is stockpiled, and these stockpiles are subject to erosion, windblown dust, and sediment transport issues. Therefore, Best Management Practices (BMPs) and erosion control measures are necessary to minimize adverse environmental effects associated with mining activities.

In the stockpile area and lower portions of the site, BMPs described in this Manual will be implemented to reduce the adverse effects of the mining operation during active mining.

Once all phases of mining have been completed, the quarry pit will act as a storage basin capable of capturing the full extent of a 100-year storm event eliminating storm water runoff from that area of the mine. In the area of the overburden placement sites, storm water is expected to permeate the rock and cobble conditions and follow the natural drainage course of the gulleys where they are located; resulting in a low risk of sediment transport and no significant impacts to downstream areas.[2]

Post-operational BMPs and drainage control measures may include regrading / recontouring to promote and direct surface runoff, construction of berms in overburden placement areas and the crusher site to minimize runoff and erosion on outslopes, and construction of localized drainage controls including: ditches, berms, water bars, and placement of erosion control materials. Given the variations in physical characteristics within the quarry site area, one or a combination of several drainage control measures may be used to optimize stability and erosion protection and minimize off-site sediment transport.

[1] *Amended Reclamation Plan, Amboy Limestone Quarry* (Sespe Consulting, 2015)
[2] *Hydrology Study & Drainage Analysis* (Bonadiman, 2015)

2.0 BACKGROUND

The white limestone deposit at the Amboy Quarry was originally identified in the 1930's. Mining of the limestone material had commenced by 1956. The mining operation at the Amboy Quarry is being conducted in four phases. The life of the mine is currently estimated at 65 years.

2.1 Climate

Climate in the area is extremely harsh and is characterized by exceedingly hot summers, and mild warm winters. The Amboy area (particularly the area of the limestone deposit) is one of the hottest places in the country. Precipitation of any type is uncommon, and rarely exceeds 1.5 inches per year.[3]

2.2 Offsite Run On

Due to the mountainous location of the site, some storm water run on is expected. Generally, storm water flows from off-site are directed around industrial areas and are not commingled with storm water runoff from the industrial areas. However, storm water run on cannot always be redirected around the site and will, in some cases, be commingled with storm water from the Facility. Although the run on will be from undisturbed, non-industrial areas, heavy flows may contain high levels of sediment.

[3] *General Biological Resource Assessment Report, Omya Amboy Limestone Quarry* (Himes Consulting, 2014)

3.0 BEST MANAGEMENT PRACTICES (BMPs)

BMPs are defined as the "scheduling of activities, prohibitions of practices, maintenance procedures, and other management practices to reduce or prevent the discharge of pollutants… includ[ing] treatment requirements, operating procedures, and practices to control site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage."[4] The BMPs presented in the following sections should be implemented on-site, to the extent feasible, to reduce the impact of Facility operations on storm water discharges.

It is important to note that due to the nature of the operations conducted at the site (surface mining), the BMPs specified in this section are relatively generic. Surface mining covers large areas and includes constantly changing landscapes and elevations, frequent movement of stockpiles, and variance in location of materials. Therefore, specific BMP implementation may change frequently throughout the course of the mining operation. The BMPs presented in this section should be considered a toolbox for the operator to use in order to reduce or eliminate potential pollutants from storm water discharges.

Table 1 provides a complete list of BMPs, control category, and on-site implementation. BMP fact sheets that provide information about specific BMPs are included in Appendix 2.

3.1 Good Housekeeping

The following good housekeeping measures will be implemented at the site:

- Observe areas associated with industrial activity, including: storm water discharge locations, drainage areas, conveyance systems, waste handling / disposal areas, and perimeter areas impacted by off-facility materials or storm water run-on to determine housekeeping needs. Any identified debris, waste, spills, tracked materials, or leaked materials should be cleaned and disposed of properly;
- Minimize dust generated from industrial materials or activities;
- Ensure that all facility areas impacted by rinse / wash waters are cleaned as soon as possible;
- Cover stored industrial materials that can be readily mobilized by contact with storm water, as applicable; and
- Prevent disposal of any rinse / wash waters or industrial materials into the storm water conveyance system.

Applicable BMPs to be implemented on-site are summarized in Table 1.

3.2 Preventive Maintenance

The following preventative maintenance measures will be implemented at the site:

- Identify all equipment and systems used outdoors that may spill or leak pollutants;
- Observe the identified equipment and systems to detect leaks, or identify conditions that may result in the development of leaks;
- Establish an appropriate schedule for maintenance of identified equipment and systems; and
- Establish procedures for prompt maintenance and repair of equipment, and maintenance of systems when conditions exist that may result in the development of spills or leaks.

Applicable BMPs to be implemented on-site are summarized in Table 1.

[4] 40 C.F.R. § 122.2

3.3 Spill and Leak Prevention and Response

The following spill and leak prevention and response measures will be implemented at the site:

- Establish procedures and/or controls to minimize spills and leaks;
- Develop and implement spill and leak response procedures to prevent industrial materials from discharging through the storm water conveyance system. Spilled or leaked industrial materials will be cleaned promptly and disposed of properly;
- Identify and describe all necessary and appropriate spill and leak response equipment, location(s) of spill and leak response equipment, and spill or leak response equipment maintenance procedures; and
- Identify and train appropriate spill and leak response personnel.

Applicable BMPs to be implemented on-site are summarized in Table 1.

3.4 Material Handling and Waste Management

The following material handling and waste management measures will be implemented at the site:

- Prevent or minimize handling of industrial materials or wastes that can be readily mobilized by contact with storm water during a storm event;
- Cover waste disposal containers and industrial material storage containers that contain industrial materials when not in use;
- Divert run-on and storm water generated from within the facility away from stockpiled materials when possible;
- Clean spills of industrial materials or wastes that occur during handling in accordance with the spill response procedures (see Section 3.3); and
- Observe and clean as appropriate, any outdoor material or waste handling equipment or containers that can be contaminated by contact with industrial materials or wastes.

Applicable BMPs to be implemented on-site are summarized in Table 1.

3.5 Erosion and Sediment Controls

The following erosion and sediment control measures will be implemented at the site:

- Implement effective wind erosion controls;
- Provide effective stabilization for disturbed and other erodible areas prior to a forecasted storm event;
- When possible, divert run-on and storm water generated from within the facility away from erodible materials; and
- Maintain sediment basins in good condition (see Section 3.8).

Applicable BMPs to be implemented on-site are summarized in Table 1.

3.6 Employee Training Program

An employee training program will be implemented at the site:

- Ensure that all team members implementing the BMPs outlined in this manual are properly trained in topics including but not limited to: BMP implementation, BMP effectiveness evaluations, and visual observations;
- Prepare or acquire appropriate training manuals or training materials; and

- Identify which personnel need to be trained, their responsibilities, and the type of training they will receive.

To promote storm water management awareness specific for this facility, refresher training will be provided as needed. Task specific training for all employees engaged in activities that have the potential to cause storm water pollution will be conducted when new employees are hired and refresher training will be provided as needed.

3.7 Exposure Minimization

Storm resistant shelters (either permanent or temporary) that prevent the contact of storm water with industrial materials will be utilized. Typically these shelters may consist of portable trailers, sea cargo containers, or mobile office buildings.

Applicable BMPs to be implemented on-site are summarized in Table 1.

3.8 Storm Water Containment and Discharge Reduction

Storm water containment and discharge reduction BMPs include BMPs that divert, reuse, contain, or reduce the volume of storm water runoff. Site specific containment and discharge reduction BMPs include:

- The entire site is unpaved and pervious. This allows storm water that falls on the site to infiltrate.
- This site contains a series of sediment basins that collect storm water. These basins are unlined, allowing storm water to infiltrate, and limits the frequency and volume of storm water discharges from the site.
- The mining area is maintained as a pit. This allows storm water to infiltrate and limit the frequency and volume of storm water discharges from the site.

Applicable BMPs to be implemented on-site are summarized in Table 1.

Table 1: BMP Implementation Tracking

CASQA Fact Sheet Number	CASQA BMP Fact Sheet Name	Implemented On-site?	BMP Category						
			Good Housekeeping	Preventive Maintenance	Spill and Leak Prevention and Response	Material Handling and Waste Management	Erosion and Sediment Control	Exposure Minimization	Storm Water Containment and Discharge Reduction
EC-01	Scheduling	✓					✓		
EC-02	Preservation of Existing Vegetation	✓					✓		
EC-03	Hydraulic Mulch	✓					✓		
EC-04	Hydroseed	✓					✓		
EC-05	Soil Binders						✓		
EC-06	Straw Mulch						✓		
EC-07	Geotextiles and Mats						✓		
EC-08	Wood Mulching						✓		
EC-09	Earth Dike and Drainage Swales						✓		
EC-10	Velocity Dissipation Devices	✓					✓		
EC-11	Slope Drains	✓					✓		
EC-12	Stream Bank Stabilization						✓		
EC-14	Compost Blankets						✓		
EC-15	Soil Preparation-Roughening						✓		
EC-16	Non-Vegetated Stabilization	✓					✓		
MP-20	Biotreatment								
MP-40	Storm Water Filter								
MP-50	Wet Vault								
MP-51	Gravity Separator								
MP-52	Drain Inlet Insert						✓		
NS-01	Water Conservation Practices	✓	✓				✓		
NS-02	Dewatering Operation								

CASQA Fact Sheet Number	CASQA BMP Fact Sheet Name	Implemented On-site?	BMP Category						
			Good Housekeeping	Preventive Maintenance	Spill and Leak Prevention and Response	Material Handling and Waste Management	Erosion and Sediment Control	Exposure Minimization	Storm Water Containment and Discharge Reduction
NS-03	Paving and Grinding Operation					✓			
NS-04	Temporary Stream Crossing								
NS-05	Clear Water Diversion								
NS-06	Illicit Connection- Illegal Discharge Connection								
NS-07	Potable Water Irrigation Discharge Detection								
NS-08	Vehicle and Equipment Cleaning	✓	✓						
NS-09	Vehicle and Equipment Fueling	✓	✓						
NS-10	Vehicle and Equipment Maintenance	✓	✓						
NS-11	Pile Driving Operation								
NS-12	Concrete Curing					✓			
NS-13	Concrete Finishing					✓			
NS-14	Material and Equipment Use Over Water								
NS-15	Demolition Removal Adjacent to Water								
NS-16	Temporary Batch Plants								
SC-10	Non-Storm Water Discharges	✓	✓		✓				
SC-11	Spill Prevention, Control, and Cleanup	✓			✓				
SC-20	Vehicle and Equipment Fueling	✓	✓	✓	✓	✓			

CASQA Fact Sheet Number	CASQA BMP Fact Sheet Name	Implemented On-site?	BMP Category						
			Good Housekeeping	Preventive Maintenance	Spill and Leak Prevention and Response	Material Handling and Waste Management	Erosion and Sediment Control	Exposure Minimization	Storm Water Containment and Discharge Reduction
SC-21	Vehicle and Equipment Cleaning	✓	✓	✓	✓	✓			
SC-22	Vehicle and Equipment Maintenance and Repair	✓	✓	✓	✓	✓			
SC-30	Outdoor Loading and Unloading	✓	✓		✓	✓			
SC-31	Outdoor Liquid Container Storage	✓	✓	✓	✓	✓			
SC-32	Outdoor Equipment Operations	✓	✓	✓	✓	✓			
SC-33	Outdoor Storage of Raw Materials	✓	✓	✓	✓		✓		
SC-34	Waste Handling and Disposal	✓	✓	✓	✓	✓			
SC-35	Safer Alternative Products								
SC-40	Contaminated or Erodible Surfaces	✓					✓		
SC-41	Building and Grounds Maintenance	✓	✓		✓	✓			
SC-42	Building Repair, Remodeling, and Construction	✓	✓		✓	✓	✓		
SC-43	Parking Area Maintenance	✓	✓	✓	✓				
SC-44	Drainage System Maintenance	✓	✓	✓	✓				
SE-01	Silt Fence	✓					✓		
SE-02	Sediment Basin	✓					✓		✓
SE-03	Sediment Trap	✓					✓		✓
SE-04	Check Dams	✓					✓		

CASQA Fact Sheet Number	CASQA BMP Fact Sheet Name	Implemented On-site?	BMP Category						
			Good Housekeeping	Preventive Maintenance	Spill and Leak Prevention and Response	Material Handling and Waste Management	Erosion and Sediment Control	Exposure Minimization	Storm Water Containment and Discharge Reduction
SE-05	Fiber Rolls	✓					✓		
SE-06	Gravel Bag Berm	✓					✓		
SE-07	Street Sweeping						✓		
SE-08	Sandbag Barrier	✓					✓		
SE-09	Straw Bale Barrier	✓					✓		
SE-10	Storm Drain Inlet Protection						✓		
SE-11	ATS						✓		
SE-12	Manufactured Linear Sediment Control	✓					✓		
SE-13	Compost Sock and Berm						✓		
SE-14	Biofilter Bags						✓		
TC-01	Stabilized Construction Entrance and Exit						✓		
TC-02	Stabilized Construction Roadway						✓		
TC-03	Entrance Outlet Tire Wash						✓		
TC-10	Infiltration Trench	✓					✓		✓
TC-11	Infiltration Basin	✓					✓		✓
TC-12	Harvest and Reuse	✓							✓
TC-20	Wet Pond						✓		✓
TC-21	Constructed Wetland						✓		✓
TC-22	Extended Detention Basin	✓					✓		✓
TC-30	Vegetated Swale						✓		✓
TC-31	Vegetated Buffer Strip						✓		
TC-32	Bioretention						✓		✓
TC-40	Media Filter						✓		

CASQA Fact Sheet Number	CASQA BMP Fact Sheet Name	Implemented On-site?	BMP Category						
			Good Housekeeping	Preventive Maintenance	Spill and Leak Prevention and Response	Material Handling and Waste Management	Erosion and Sediment Control	Exposure Minimization	Storm Water Containment and Discharge Reduction
TC-50	Water Quality Inlet						✓		
TC-60	Multiple Systems						✓		
WE-01	Wind Erosion Control	✓					✓		
WM-01	Material Delivery and Storage	✓	✓			✓			
WM-02	Material Use	✓	✓			✓			
WM-03	Stockpile Management	✓	✓			✓			
WM-04	Spill Prevention and Control	✓			✓	✓			
WM-05	Solid Waste Management	✓	✓			✓			
WM-06	Hazardous Waste Management	✓	✓		✓	✓			
WM-07	Contaminated Soil Management	✓	✓			✓			
WM-08	Concrete Waste Management		✓			✓			
WM-09	Sanitary-Septic Waste Management	✓	✓		✓	✓			
WM-10	Liquid Waste Management		✓		✓	✓			

4.0 SITE SPECIFIC BMPs

This section provides site specific BMPs for areas of primary concern at the site in addition to the generic BMPs listed in the previous section.

4.1 Long Runs

Long, sloped runs typically include haul roads and unfinished slopes. The Slope Stability Investigation recommends that slopes be protected with berms and/or levees as necessary to prevent slope erosion in the areas where natural slopes drain onto the reclaimed slopes.

The haul roads are designed to direct storm runoff into the quarry pit or off the roads where water will evaporate. Roads are designed with sediment catchments, rock lined drains, hay bales or other filters, to direct runoff off the roads, and prevent sediment from being transported off-site.

The overburden placement sites consist primarily of rock and cobbles which are highly permeable. Storm water is expected to permeate the fill and follow the natural drainage course of the gulley resulting in a low risk of sediment transportation. Overburden Placement Site 1 is located to the west of the quarry and will abut against the opposite canyon wall. This will allow for the formation of a stable, surface compacted, buttressed fill pad. Overburden Placement Site 2 is located to the north of the quarry. As the overburden placement sites are built rip rap will be placed at the toe of the slopes. The rip rap will prevent undue off-site sediment transport of material from the overburden placement sites. Final configuration of the site will not block drainage.

Specific BMPs include:

- EC-10 Velocity Dissipation Devices: Rock, grouted riprap, or concrete rubble installed at outlets of pipes, drains, culverts, slope drains, diversion ditches, swales, conduits, channels, or points where lined conveyances discharge to unlined conveyances.
- SC-40 Contaminated or Erodible Areas: Non-vegetative stabilization BMPs for bare areas subject to soil erosion.
- SC-44 Drainage System Maintenance: Specifies storm channel maintenance, modifications, and improvements.
- SE-03 Sediment Trap: Small containment area where sediment-laden runoff is temporarily detained, allowing sediment to settle out before the runoff is discharged.
- SE-04 Check Dams: Small barrier constructed of rock, gravel bags, sandbags, fiber rolls, or other proprietary products, placed across a constructed swale or drainage ditch.
- TC-10 Infiltration Trench: A gravel-filled trench that promotes storm water infiltration, reduces discharge of storm water to receiving waters, and provides pollutant removal.

4.2 Sediment Basins

The site contains several sediment basins (SE-02, TC-11, TC-22) that collect storm water. These basins are unlined, allowing storm water to infiltrate, and limits the frequency and volume of storm water discharges from the site.

Generally, basins should be maintained in good condition. This includes removal of accumulated sediment and regular inspections.

The Hydrology Study & Drainage Analysis includes specific design criteria for the sediment basin installed on the eastern portion of the site to control sedimentation from mining activities. Specifically, the sediment basin will be:

- Equipped with at least two (2) outlet pipes each with a valve that is to remain closed.
- Drained after each storm events when the sediment has had sufficient time to settle, typically 24 hours.
- Equipped with a spillway constructed of concrete or other non-erosive design.

Refer to the complete Hydrology Study & Drainage Analysis for full design criteria and maintenance.

4.3 Stockpiles

The crusher fines and ore stockpiles are located to the south of the quarry. Due to the nature of operations conducted at the site, stockpile management will vary throughout the life of the operation.

Typical stockpile BMPs (SC-33, WM-03) implemented on-site include: watering; placement of overburden for dust and erosion control; and use of fiber rolls, gravel bags, sand bag barriers, and/or straw bale barriers for runoff and sediment transport control.

4.4 Hazardous Materials

The use of hazardous materials during mining activities consists of fuels, lubricants, fluids associated with vehicles and equipment, and blasting materials. Hazardous materials will be stored in accordance with regulatory requirements and Spill and Leak Prevention and Response BMP specified in the previous sections to protect water quality.

During the early phases of mining activity, fuel is and will be stored in a mobile fuel truck. During later phases, fuel will be stored in an approved bermed above ground storage tank (AST) containing up to 10,000 gallons.

Routine equipment maintenance occurs on-site at the crusher site. Waste oil generated is collected and transported for off-site disposal by approved methods and properly trained personnel. No processing chemicals are used at the site.

4.5 Windblown Dust

Windblown dust is specifically a concern for vehicle travel over paved roads, mining, processing, and stockpiling operations. The undisturbed native limestone in the area is very resistant to erosion, and not highly fractured; therefore the primary locations of concern for dust are the stockpile area and lower portions of the site.

Dust control on-site (WE-01) will be achieved through the use of the following methods:

- A foam dust suppression system, spray bars, or other dust suppression system will be used on the crushing system and processing equipment;
- A water truck will be used to water unpaved roads and mining areas during blasting activities; and
- Stockpiled fines will be covered by overburden to minimize windblown dust.

APPENDIX 1

FIGURES

LEGEND

- ACCESS ROADS
- OMYA CONTROLLED PROPERTY BOUNDARY PROPOSED SEPTEMBER 2015 RECLAMATION AREA
- PROPOSED DISTURBANCE AREA
- ADDITIONAL DISTURBANCE AREA (ROAD)
- APPROXIMATE SURFACE DRAINAGE DIRECTION. FOR DETAILS SEE HYDROLOGY REPORT.

BEST MANAGEMENT PRACTICES

ABBREVIATION	CATEGORY	EXAMPLE CASQA BMP
ESC	EROSION & SEDIMENT CONTROL	EC-10, SC-40, SC-44, SE-03, SE-04, TC-10, ETC.
DET	CONTAINMENT AND DISCHARGE REDUCTION	SE-02, TC-11, TC-22
STP	STOCKPILES	SC-33, WM-03
DST	WINDBLOWN DUST	WE-01

APN: 558-151-11

PLACER CLAIM

MILL SITE CLAIM

OVERBURDEN PLACEMENT SITE

PLACER CLAIM

PATENTED CLAIM

OVERBURDEN PLACEMENT SITE

APN: 558-151-10

APN: 558-151-24

BERM

ESC, DST

EXIST. ROAD

BASIN W/ CULVERT SPILLWAY

DET

STATIONARY CRUSHER AREA

STOCKPILE AREA

ESC, DST

EXIST. ROAD

TWIN 24" CULVERTS UNDER ROAD

CRUSHED ORE CRUSHED FINES STORAGE

STP, DST

STP, DST

STP, DST

DST

GROWTH MEDIA STORAGE

DET

DET

DETENTION BASIN W/ CULVERT SPILLWAY

DET

ESC, DST

EXIST. ROAD

25' WIDE ACCESS ROAD

EQUIPMENT STAGING PARKING AREA

EQUIPMENT STAGING AREA

MILL SITE CLAIM

MILL SITE CLAIM

MILL SITE CLAIM

MILL SITE CLAIM

120 0 120 240

SCALE OF FEET

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AMBOY QUARRY

BMP IMPLEMENTATION

SCALE: HORI.: AS SHO.: N VERT.: AS SHO.: N

DRA.: N BY: G.CAMUS

CHECKED BY: APS

FIGURE NUMBER 1

SEPTEMBER 2015

Plot Scale(X,Y): 1,1

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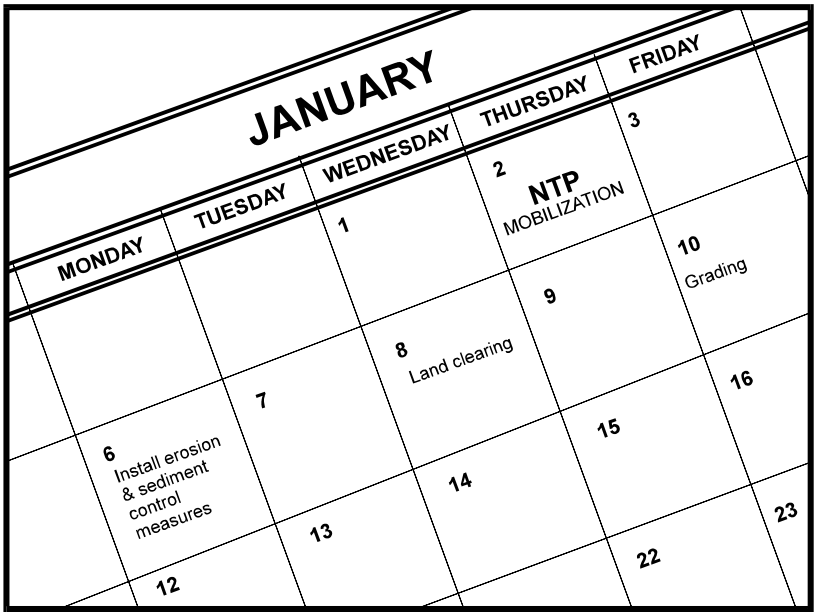
APPENDIX 2

CASQA BMP FACT SHEETS

Scheduling EC-1



Description and Purpose

Scheduling is the development of a written plan that includes sequencing of construction activities and the implementation of BMPs such as erosion control and sediment control while taking local climate (rainfall, wind, etc.) into consideration. The purpose is to reduce the amount and duration of soil exposed to erosion by wind, rain, runoff, and vehicle tracking, and to perform the construction activities and control practices in accordance with the planned schedule.

Suitable Applications

Proper sequencing of construction activities to reduce erosion potential should be incorporated into the schedule of every construction project especially during rainy season. Use of other, more costly yet less effective, erosion and sediment control BMPs may often be reduced through proper construction sequencing.

Limitations

- Environmental constraints such as nesting season prohibitions reduce the full capabilities of this BMP.

Implementation

- Avoid rainy periods. Schedule major grading operations during dry months when practical. Allow enough time before rainfall begins to stabilize the soil with vegetation or physical means or to install sediment trapping devices.

- Plan the project and develop a schedule showing each phase of construction. Clearly show how the rainy season relates

Categories

EC	Erosion Control	☑
SE	Sediment Control	☒
TC	Tracking Control	☒
WE	Wind Erosion Control	☒
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

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to soil disturbing and re-stabilization activities. Incorporate the construction schedule into the SWPPP.

- Include on the schedule, details on the rainy season implementation and deployment of:
  - Erosion control BMPs
  - Sediment control BMPs
  - Tracking control BMPs
  - Wind erosion control BMPs
  - Non-stormwater BMPs
  - Waste management and materials pollution control BMPs
- Include dates for activities that may require non-stormwater discharges such as dewatering, sawcutting, grinding, drilling, boring, crushing, blasting, painting, hydro-demolition, mortar mixing, pavement cleaning, etc.
- Work out the sequencing and timetable for the start and completion of each item such as site clearing and grubbing, grading, excavation, paving, foundation pouring utilities installation, etc., to minimize the active construction area during the rainy season.
  - Sequence trenching activities so that most open portions are closed before new trenching begins.
  - Incorporate staged seeding and re-vegetation of graded slopes as work progresses.
  - Schedule establishment of permanent vegetation during appropriate planting time for specified vegetation.
- Non-active areas should be stabilized as soon as practical after the cessation of soil disturbing activities or one day prior to the onset of precipitation.
- Monitor the weather forecast for rainfall.
- When rainfall is predicted, adjust the construction schedule to allow the implementation of soil stabilization and sediment treatment controls on all disturbed areas prior to the onset of rain.
- Be prepared year round to deploy erosion control and sediment control BMPs. Erosion may be caused during dry seasons by un-seasonal rainfall, wind, and vehicle tracking. Keep the site stabilized year round, and retain and maintain rainy season sediment trapping devices in operational condition.
- Apply permanent erosion control to areas deemed substantially complete during the project's defined seeding window.

Costs

Construction scheduling to reduce erosion may increase other construction costs due to reduced economies of scale in performing site grading. The cost effectiveness of scheduling techniques should be compared with the other less effective erosion and sedimentation controls to achieve a cost effective balance.

Inspection and Maintenance

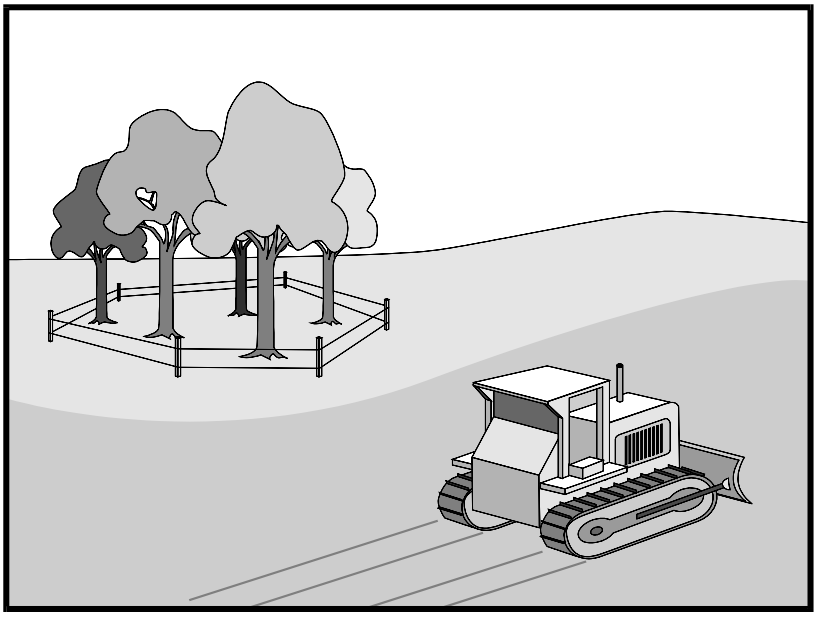
- Verify that work is progressing in accordance with the schedule. If progress deviates, take corrective actions.
- Amend the schedule when changes are warranted.
- Amend the schedule prior to the rainy season to show updated information on the deployment and implementation of construction site BMPs.

References

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities Developing Pollution Prevention Plans and Best Management Practices (EPA 832-R-92-005), U.S. Environmental Protection Agency, Office of Water, September 1992.

Preservation Of Existing Vegetation EC-2



Categories

EC	Erosion Control	☑
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

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Description and Purpose

Carefully planned preservation of existing vegetation minimizes the potential of removing or injuring existing trees, vines, shrubs, and grasses that protect soil from erosion.

Suitable Applications

Preservation of existing vegetation is suitable for use on most projects. Large project sites often provide the greatest opportunity for use of this BMP. Suitable applications include the following:

- Areas within the site where no construction activity occurs, or occurs at a later date. This BMP is especially suitable to multi year projects where grading can be phased.
- Areas where natural vegetation exists and is designated for preservation. Such areas often include steep slopes, watercourse, and building sites in wooded areas.
- Areas where local, state, and federal government require preservation, such as vernal pools, wetlands, marshes, certain oak trees, etc. These areas are usually designated on the plans, or in the specifications, permits, or environmental documents.
- Where vegetation designated for ultimate removal can be temporarily preserved and be utilized for erosion control and sediment control.

Limitations

- Requires forward planning by the owner/developer, contractor, and design staff.
- Limited opportunities for use when project plans do not incorporate existing vegetation into the site design.
- For sites with diverse topography, it is often difficult and expensive to save existing trees while grading the site satisfactory for the planned development.

Implementation

The best way to prevent erosion is to not disturb the land. In order to reduce the impacts of new development and redevelopment, projects may be designed to avoid disturbing land in sensitive areas of the site (e.g., natural watercourses, steep slopes), and to incorporate unique or desirable existing vegetation into the site's landscaping plan. Clearly marking and leaving a buffer area around these unique areas during construction will help to preserve these areas as well as take advantage of natural erosion prevention and sediment trapping.

Existing vegetation to be preserved on the site must be protected from mechanical and other injury while the land is being developed. The purpose of protecting existing vegetation is to ensure the survival of desirable vegetation for shade, beautification, and erosion control. Mature vegetation has extensive root systems that help to hold soil in place, thus reducing erosion. In addition, vegetation helps keep soil from drying rapidly and becoming susceptible to erosion. To effectively save existing vegetation, no disturbances of any kind should be allowed within a defined area around the vegetation. For trees, no construction activity should occur within the drip line of the tree.

Timing

- Provide for preservation of existing vegetation prior to the commencement of clearing and grubbing operations or other soil disturbing activities in areas where no construction activity is planned or will occur at a later date.

Design and Layout

- Mark areas to be preserved with temporary fencing. Include sufficient setback to protect roots.
  - Orange colored plastic mesh fencing works well.
  - Use appropriate fence posts and adequate post spacing and depth to completely support the fence in an upright position.
- Locate temporary roadways, stockpiles, and layout areas to avoid stands of trees, shrubs, and grass.
- Consider the impact of grade changes to existing vegetation and the root zone.
- Maintain existing irrigation systems where feasible. Temporary irrigation may be required.
- Instruct employees and subcontractors to honor protective devices. Prohibit heavy equipment, vehicular traffic, or storage of construction materials within the protected area.

Costs

There is little cost associated with preserving existing vegetation if properly planned during the project design, and these costs may be offset by aesthetic benefits that enhance property values. During construction, the cost for preserving existing vegetation will likely be less than the cost of applying erosion and sediment controls to the disturbed area. Replacing vegetation inadvertently destroyed during construction can be extremely expensive, sometimes in excess of $10,000 per tree.

Inspection and Maintenance

During construction, the limits of disturbance should remain clearly marked at all times. Irrigation or maintenance of existing vegetation should be described in the landscaping plan. If damage to protected trees still occurs, maintenance guidelines described below should be followed:

- Verify that protective measures remain in place. Restore damaged protection measures immediately.
- Serious tree injuries shall be attended to by an arborist.
- Damage to the crown, trunk, or root system of a retained tree shall be repaired immediately.
- Trench as far from tree trunks as possible, usually outside of the tree drip line or canopy. Curve trenches around trees to avoid large roots or root concentrations. If roots are encountered, consider tunneling under them. When trenching or tunneling near or under trees to be retained, place tunnels at least 18 in. below the ground surface, and not below the tree center to minimize impact on the roots.
- Do not leave tree roots exposed to air. Cover exposed roots with soil as soon as possible. If soil covering is not practical, protect exposed roots with wet burlap or peat moss until the tunnel or trench is ready for backfill.
- Cleanly remove the ends of damaged roots with a smooth cut.
- Fill trenches and tunnels as soon as possible. Careful filling and tamping will eliminate air spaces in the soil, which can damage roots.
- If bark damage occurs, cut back all loosened bark into the undamaged area, with the cut tapered at the top and bottom and drainage provided at the base of the wood. Limit cutting the undamaged area as much as possible.
- Aerate soil that has been compacted over a trees root zone by punching holes 12 in. deep with an iron bar, and moving the bar back and forth until the soil is loosened. Place holes 18 in. apart throughout the area of compacted soil under the tree crown.
- Fertilization
  - Fertilize stressed or damaged broadleaf trees to aid recovery.
  - Fertilize trees in the late fall or early spring.

- Apply fertilizer to the soil over the feeder roots and in accordance with label instructions, but never closer than 3 ft to the trunk. Increase the fertilized area by one-fourth of the crown area for conifers that have extended root systems.

- Retain protective measures until all other construction activity is complete to avoid damage during site cleanup and stabilization.

References

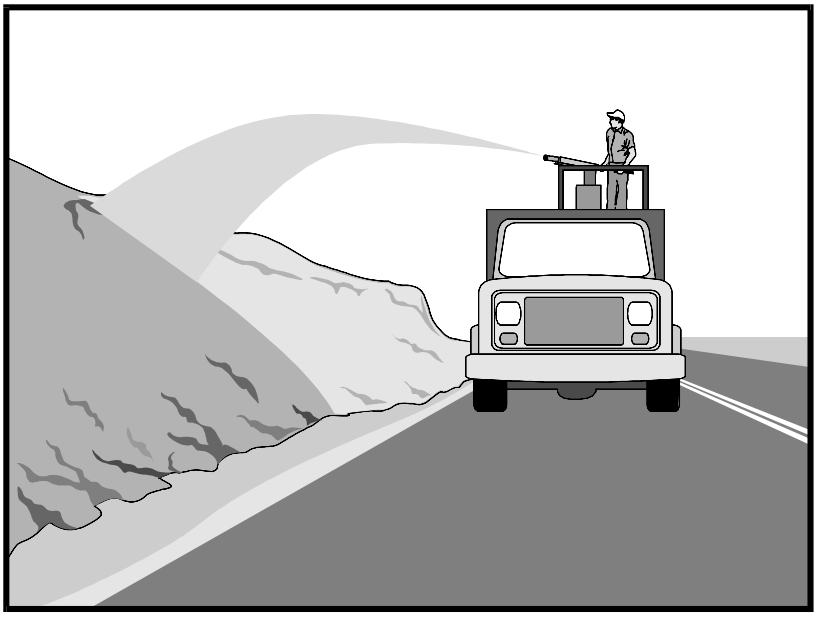
County of Sacramento Tree Preservation Ordinance, September 1981.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Water Quality Management Plan for The Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.

Hydraulic Mulch EC-3



Categories

EC	Erosion Control	☑
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	☒
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-4 Hydroseeding

EC-5 Soil Binders

EC-6 Straw Mulch

EC-7 Geotextiles and Mats

EC-8 Wood Mulching

EC-14 Compost Blanket

EC-16 Non-Vegetative Stabilization

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Description and Purpose

Hydraulic Mulch consists of various types of fibrous materials mixed with water and sprayed onto the soil surface in slurry form to provide a layer of temporary protection from wind and water erosion.

Suitable Applications

Hydraulic mulch as a temporary, stand alone, erosion control BMP is suitable for disturbed areas that require temporary protection from wind and water erosion until permanent soil stabilization activities commence. Examples include:

- Rough-graded areas that will remain inactive for longer than permit-required thresholds (e.g., 14 days) or otherwise require stabilization to minimize erosion or prevent sediment discharges.
- Soil stockpiles.
- Slopes with exposed soil between existing vegetation such as trees or shrubs.
- Slopes planted with live, container-grown vegetation or plugs.
- Slopes burned by wildfire.

Hydraulic mulch can also be applied to augment other erosion control BMPs such as:

- In conjunction with straw mulch (see EC-6 Straw Mulch) where the rate of hydraulic mulch is reduced to 100-500 lbs per acre and the slurry is applied over the straw as a tackifying agent to hold the straw in place.

- Supplemental application of soil amendments, such as fertilizer, lime, gypsum, soil bio-stimulants or compost.

Limitations

In general, hydraulic mulch is not limited by slope length, gradient or soil type. However, the following limitations typically apply:

- Most hydraulic mulch applications, particularly bonded fiber matrices (BFMs), require at least 24 hours to dry before rainfall occurs.

- Temporary applications (i.e., without a vegetative component) may require a second application in order to remain effective for an entire rainy season.

- Treatment areas must be accessible to hydraulic mulching equipment.

- Availability of water sources in remote areas for mixing and application.

- As a stand-alone temporary BMP, hydraulic mulches may need to be re-applied to maintain their erosion control effectiveness, typically after 6-12 months depending on the type of mulch used.

- Availability of hydraulic mulching equipment may be limited just prior to the rainy season and prior to storms due to high demand.

- Cellulose fiber mulches alone may not perform well on steep slopes or in course soils.

- This BMP consists of a mixture of several constituents (e.g., fibers/mulches, tackifiers, and other chemical constituents), some of which may be proprietary and may come pre-mixed by the manufacturer. The water quality impacts of these constituents are relatively unknown and some may have water quality impacts due to their chemical makeup. Refer to specific chemical properties identified in the product Material Safety Data Sheet; products should be evaluated for project-specific implementation by the SWPPP Preparer. Refer to factsheet EC-05 for further guidance on selecting soil binders.

Implementation

- Where feasible, it is preferable to prepare soil surfaces prior to application by roughening embankments and fill areas with a crimping or punching type roller or by track walking.

- The majority of hydraulic mulch applications do not necessarily require surface/soil preparation (See EC-15 Soil Preparation) although in almost every case where re-vegetation is included as part of the practice, soil preparation can be beneficial. One of the advantages of hydraulic mulch over other erosion control methods is that it can be applied in areas where soil preparation is precluded by site conditions, such as steep slopes, rocky soils, or inaccessibility.

- Avoid mulch over spray onto roads, sidewalks, drainage channels, existing vegetation, etc.
- Hydraulic mulching is generally performed utilizing specialized machines that have a large water-holding/mixing tank and some form of mechanical agitation or other recirculation method to keep water, mulch and soil amendments in suspension. The mixed hydraulic slurry can be applied from a tower sprayer on top of the machine or by extending a hose to areas remote from the machine.
- Where possible apply hydraulic mulch from multiple directions to adequately cover the soil. Application from a single direction can result in shadowing, uneven coverage and failure of the BMP.
- Hydraulic mulch can also include a vegetative component, such as seed, rhizomes, or stolons (see EC-4 Hydraulic Seed).
- Typical hydraulic mulch application rates range from 2,000 pounds per acre for standard mulches (SMs) to 3,500 pounds per acre for BFMs. However, the required amount of hydraulic mulch to provide adequate coverage of exposed topsoil may appear to exceed the standard rates when the roughness of the soil surface is changed due to soil preparation methods (see EC-15 Soil Preparation) or by slope gradient.
- Other factors such as existing soil moisture and soil texture can have a profound effect on the amount of hydraulic mulch required (i.e. application rate) applied to achieve an erosion-resistant covering.
- Avoid use of mulch without a tackifier component, especially on slopes.
- Mulches used in the hydraulic mulch slurry can include:
  - Cellulose fiber
  - Thermally-processed wood fibers
  - Cotton
  - Synthetics
  - Compost (see EC-14, Compost Blanket)
- Additional guidance on the comparison and selection of temporary slope stabilization methods is provided in Appendix F of the Handbook.

Categories of Hydraulic Mulches

Standard Hydraulic Mulch (SM)

Standard hydraulic mulches are generally applied at a rate of 2,000 pounds per acre and are manufactured containing around 5% tackifier (i.e. soil binder), usually a plant-derived guar or psyllium type. Most standard mulches are green in color derived from food-color based dyes.

Hydraulic Matrices (HM) and Stabilized Fiber Matrices (SFM)

Hydraulic matrices and stabilized fiber matrices are slurries which contain increased levels of tackifiers/soil binders; usually 10% or more by weight. HMs and SFMs have improved performance compared to a standard hydraulic mulch (SM) because of the additional percentage of tackifier and because of their higher application rates, typically 2,500 – 4,000 pounds per acre. Hydraulic matrices can include a mixture of fibers, for example, a 50/50 blend of paper and wood fiber. In the case of an SFM, the tackifier/soil binder is specified as a polyacrylamide (PAM).

Bonded Fiber Matrix (BFM)

Bonded fiber matrices (BFMs) are hydraulically-applied systems of fibers, adhesives (typically guar based) and chemical cross-links. Upon drying, the slurry forms an erosion-resistant blanket that prevents soil erosion and promotes vegetation establishment. The cross-linked adhesive in the BFM should be biodegradable and should not dissolve or disperse upon re-wetting. BFMs are typically applied at rates from 3,000 to 4,000 lbs/acre based on the manufacturer's recommendation. BFMs should not be applied immediately before, during or immediately after rainfall or if the soil is saturated. Depending on the product, BFMs typically require 12 to 24 hours to dry and become effective.

Mechanically-Bonded Fiber Matrices (MBFM)

Mechanically-bonded fiber matrices (MBFMs) are hydraulically applied systems similar to BFM that use crimped synthetic fibers and PAM and are typically applied to a slope at a higher application rate than a standard BFM.

Hydraulic Compost Matrix (HCM)

Hydraulic compost matrix (HCM) is a field-derived practice whereby finely graded or sifted compost is introduced into the hydraulic mulch slurry. A guar-type tackifier can be added for steeper slope applications as well as any specified seed mixtures. A HCM can help to accelerate seed germination and growth. HCMs are particularly useful as an in-fill for three-dimensional re-vegetation geocomposites, such as turf reinforcement mats (TRM) (see EC-7 Geotextiles and Mats).

Costs

Average installed costs for hydraulic mulch categories are is provided in Table 1, below.

Table 1
HYDRAULIC MULCH BMPs
INSTALLED COSTS

BMP	Installed Cost/Acre
Standard Hydraulic Mulching (SM)	$1,700 - $3,600 per acre
Hydraulic Matrices (HM) and Stabilized Fiber Matrices	
Guar-based	$2,000 - $4,000 per acre
PAM-based	$2,500 - $5,610 per acre
Bonded Fiber Matrix (BFM)	$3,900 - $6,900 per acre
Mechanically Bonded Fiber Matrix (MBFM)	$4,500 - $6,000 per acre
Hydraulic Compost Matrix (HCM)	$3,000 - $3,500 per acre

Source: Cost information received from individual product manufacturers solicited by Geosyntec Consultants (2004)

Inspection and Maintenance

- Maintain an unbroken, temporary mulched ground cover throughout the period of construction when the soils are not being reworked.
- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Areas where erosion is evident should be repaired and BMPs re-applied as soon as possible. Care should be exercised to minimize the damage to protected areas while making repairs, as any area damaged will require re-application of BMPs.
- Compare the number of bags or weight of applied mulch to the area treated to determine actual application rates and compliance with specifications.

References

Soil Stabilization BMP Research for Erosion and Sediment Controls: Cost Survey Technical Memorandum, State of California Department of Transportation (Caltrans), July 2007.

Controlling Erosion of Construction Sites, Agricultural Information #347, U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) (formerly Soil Conservation Service – SCS).

Guides for Erosion and Sediment Control in California, USDA Soils Conservation Service, January 1991.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

Sedimentation and Erosion Control, An Inventory of Current Practices Draft, US EPA, April 1990.

Soil Erosion by Water, Agriculture Information Bulletin #513, U.S. Department of Agriculture, Soil Conservation Service.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

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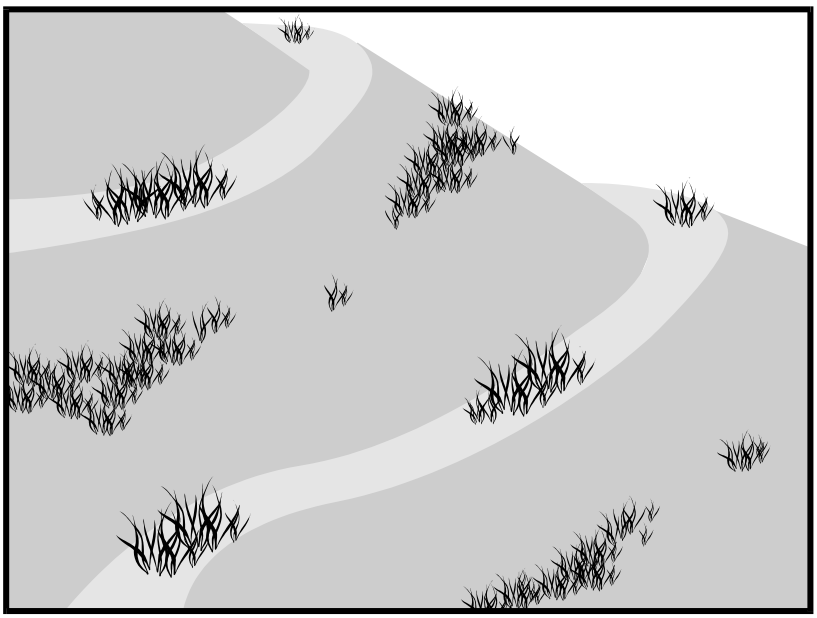
Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.

Hydroseeding EC-4



Description and Purpose

Hydroseeding typically consists of applying a mixture of a hydraulic mulch, seed, fertilizer, and stabilizing emulsion with a hydraulic mulcher, to temporarily protect exposed soils from erosion by water and wind. Hydraulic seeding, or hydroseeding, is simply the method by which temporary or permanent seed is applied to the soil surface.

Suitable Applications

Hydroseeding is suitable for disturbed areas requiring temporary protection until permanent stabilization is established, for disturbed areas that will be re-disturbed following an extended period of inactivity, or to apply permanent stabilization measures. Hydroseeding without mulch or other cover (e.g. EC-7, Erosion Control Blanket) is not a stand-alone erosion control BMP and should be combined with additional measures until vegetation establishment.

Typical applications for hydroseeding include:

- Disturbed soil/graded areas where permanent stabilization or continued earthwork is not anticipated prior to seed germination.
- Cleared and graded areas exposed to seasonal rains or temporary irrigation.
- Areas not subject to heavy wear by construction equipment or high traffic.

Categories

EC	Erosion Control	☑
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	☒
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-3 Hydraulic Mulch

EC-5 Soil Binders

EC-6 Straw Mulch

EC-7 Geotextiles and Mats

EC-8 Wood Mulching

EC-14 Compost Blanket

EC-16 Non-Vegetative Stabilization

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Limitations

- Availability of hydroseeding equipment may be limited just prior to the rainy season and prior to storms due to high demand.
- Hydraulic seed should be applied with hydraulic mulch or a stand-alone hydroseed application should be followed by one of the following:
  - Straw mulch (see Straw Mulch EC-6)
  - Rolled erosion control products (see Geotextiles and Mats EC-7)
  - Application of Compost Blanket (see Compost Blanket EC-14)

  Hydraulic seed may be used alone only on small flat surfaces when there is sufficient time in the season to ensure adequate vegetation establishment and coverage to provide adequate erosion control.
- Hydraulic seed without mulch does not provide immediate erosion control.
- Temporary seeding may not be appropriate for steep slopes (i.e., slopes readily prone to rill erosion or without sufficient topsoil).
- Temporary seeding may not be appropriate in dry periods without supplemental irrigation.
- Temporary vegetation may have to be removed before permanent vegetation is applied.
- Temporary vegetation may not be appropriate for short term inactivity (i.e. less than 3-6 months).
- This BMP consists of a mixture of several constituents (e.g., fibers/mulches, tackifiers, and other chemical constituents), some of which may be proprietary and may come pre-mixed by the manufacturer. The water quality impacts of these constituents are relatively unknown and some may have water quality impacts due to their chemical makeup. Additionally these constituents may require non-visible pollutant monitoring. Refer to specific chemical properties identified in the product Material Safety Data Sheet; products should be evaluated for project-specific implementation by the SWPPP Preparer. Refer to factsheet EC-05 for further guidance on selecting soil binders.

Implementation

In order to select appropriate hydraulic seed mixtures, an evaluation of site conditions should be performed with respect to:

- Soil conditions
- Site topography and exposure (sun/wind)
- Season and climate
- Vegetation types
- Maintenance requirements
- Sensitive adjacent areas
- Water availability
- Plans for permanent vegetation

The local office of the U.S.D.A. Natural Resources Conservation Service (NRCS), Resource Conservation Districts and Agricultural Extension Service can provide information on appropriate seed mixes.

The following steps should be followed for implementation:

- Where appropriate or feasible, soil should be prepared to receive the seed by disking or otherwise scarifying (See EC-15, Soil Preparation) the surface to eliminate crust, improve air and water infiltration and create a more favorable environment for germination and growth.
- Avoid use of hydraulic seed in areas where the BMP would be incompatible with future earthwork activities.
- Hydraulic seed can be applied using a multiple step or one step process.
  - In a multiple step process, hydraulic seed is applied first, followed by mulch or a Rolled Erosion Control Product (RECP).
  - In the one step process, hydraulic seed is applied with hydraulic mulch in a hydraulic matrix. When the one step process is used to apply the mixture of fiber, seed, etc., the seed rate should be increased to compensate for all seeds not having direct contact with the soil.
- All hydraulically seeded areas should have mulch, or alternate erosion control cover to keep seeds in place and to moderate soil moisture and temperature until the seeds germinate and grow.
- All seeds should be in conformance with the California State Seed Law of the Department of Agriculture. Each seed bag should be delivered to the site sealed and clearly marked as to species, purity, percent germination, dealer's guarantee, and dates of test. The container should be labeled to clearly reflect the amount of Pure Live Seed (PLS) contained. All legume seed should be pellet inoculated. Inoculant sources should be species specific and should be applied at a rate of 2 lb of inoculant per 100 lb seed.
- Commercial fertilizer should conform to the requirements of the California Food and Agricultural Code, which can be found at http://www.leginfo.ca.gov/.html/fac_table_of_contents.html. Fertilizer should be pelleted or granular form.
- Follow up applications should be made as needed to cover areas of poor coverage or germination/vegetation establishment and to maintain adequate soil protection.
- Avoid over spray onto roads, sidewalks, drainage channels, existing vegetation, etc.
- Additional guidance on the comparison and selection of temporary slope stabilization methods is provided in Appendix F of the Handbook.

Costs

Average cost for installation and maintenance may vary from as low as $1,900 per acre for flat slopes and stable soils, to $4,000 per acre for moderate to steep slopes and/or erosive soils. Cost of seed mixtures vary based on types of required vegetation.

BMP	Installed Cost per Acre
Hydraulic Seed	$1,900-$4,000

Source: Cost information received from individual product manufacturers solicited by Geosyntec Consultants (2004).

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Areas where erosion is evident should be repaired and BMPs re-applied as soon as possible. Care should be exercised to minimize the damage to protected areas while making repairs, as any area damaged will require re-application of BMPs.
- Where seeds fail to germinate, or they germinate and die, the area must be re-seeded, fertilized, and mulched within the planting season, using not less than half the original application rates.
- Irrigation systems, if applicable, should be inspected daily while in use to identify system malfunctions and line breaks. When line breaks are detected, the system must be shut down immediately and breaks repaired before the system is put back into operation.
- Irrigation systems should be inspected for complete coverage and adjusted as needed to maintain complete coverage.

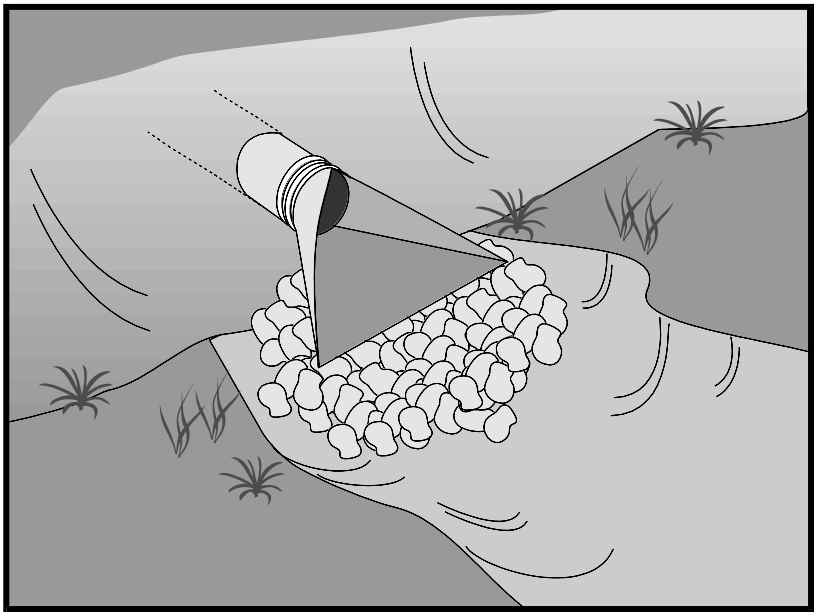
References

Soil Stabilization BMP Research for Erosion and Sediment Controls: Cost Survey Technical Memorandum, State of California Department of Transportation (Caltrans), July 2007.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Guidance Document: Soil Stabilization for Temporary Slopes, State of California Department of Transportation (Caltrans), November 1999.

Velocity Dissipation Devices EC-10



Categories

EC	Erosion Control	☑
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

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Description and Purpose

Outlet protection is a physical device composed of rock, grouted riprap, or concrete rubble, which is placed at the outlet of a pipe or channel to prevent scour of the soil caused by concentrated, high velocity flows.

Suitable Applications

Whenever discharge velocities and energies at the outlets of culverts, conduits, or channels are sufficient to erode the next downstream reach. This includes temporary diversion structures to divert runon during construction.

- These devices may be used at the following locations:
  - Outlets of pipes, drains, culverts, slope drains, diversion ditches, swales, conduits, or channels.
  - Outlets located at the bottom of mild to steep slopes.
  - Discharge outlets that carry continuous flows of water.
  - Outlets subject to short, intense flows of water, such as flash floods.
  - Points where lined conveyances discharge to unlined conveyances

Limitations

- Large storms or high flows can wash away the rock outlet protection and leave the area susceptible to erosion.

- Sediment captured by the rock outlet protection may be difficult to remove without removing the rock.
- Outlet protection may negatively impact the channel habitat.
- Grouted riprap may break up in areas of freeze and thaw.
- If there is not adequate drainage, and water builds up behind grouted riprap, it may cause the grouted riprap to break up due to the resulting hydrostatic pressure.
- Sediment accumulation, scour depressions, and/or persistent non-stormwater discharges can result in areas of standing water suitable for mosquito production in velocity dissipation devices.

Implementation

General

Outlet protection is needed where discharge velocities and energies at the outlets of culverts, conduits or channels are sufficient to erode the immediate downstream reach. This practice protects the outlet from developing small eroded pools (plange pools), and protects against gully erosion resulting from scouring at a culvert mouth.

Design and Layout

As with most channel design projects, depth of flow, roughness, gradient, side slopes, discharge rate, and velocity should be considered in the outlet design. Compliance to local and state regulations should also be considered while working in environmentally sensitive streambeds. General recommendations for rock size and length of outlet protection mat are shown in the rock outlet protection figure in this BMP and should be considered minimums. The apron length and rock size gradation are determined using a combination of the discharge pipe diameter and estimate discharge rate: Select the longest apron length and largest rock size suggested by the pipe size and discharge rate. Where flows are conveyed in open channels such as ditches and swales, use the estimated discharge rate for selecting the apron length and rock size. Flows should be same as the culvert or channel design flow but never the less than the peak 5 year flow for temporary structures planned for one rainy season, or the 10 year peak flow for temporary structures planned for two or three rainy seasons.

- There are many types of energy dissipaters, with rock being the one that is represented in the attached figure.
- Best results are obtained when sound, durable, and angular rock is used.
- Install riprap, grouted riprap, or concrete apron at selected outlet. Riprap aprons are best suited for temporary use during construction. Grouted or wired tied rock riprap can minimize maintenance requirements.
- Rock outlet protection is usually less expensive and easier to install than concrete aprons or energy dissipaters. It also serves to trap sediment and reduce flow velocities.
- Carefully place riprap to avoid damaging the filter fabric.

- Stone 4 in. to 6 in. may be carefully dumped onto filter fabric from a height not to exceed 12 in.

- Stone 8 in. to 12 in. must be hand placed onto filter fabric, or the filter fabric may be covered with 4 in. of gravel and the 8 in. to 12 in. rock may be dumped from a height not to exceed 16 in.

- Stone greater than 12 in. shall only be dumped onto filter fabric protected with a layer of gravel with a thickness equal to one half the D_{50} rock size, and the dump height limited to twice the depth of the gravel protection layer thickness.

- For proper operation of apron: Align apron with receiving stream and keep straight throughout its length. If a curve is needed to fit site conditions, place it in upper section of apron.

- Outlets on slopes steeper than 10 percent should have additional protection.

Costs

Costs are low if material is readily available. If material is imported, costs will be higher. Average installed cost is $150 per device.

Inspection and Maintenance

- Inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.

- Inspect BMPs subjected to non-stormwater discharges daily while non-stormwater discharges occur. Minimize areas of standing water by removing sediment blockages and filling scour depressions.

- Inspect apron for displacement of the riprap and damage to the underlying fabric. Repair fabric and replace riprap that has washed away. If riprap continues to wash away, consider using larger material.

- Inspect for scour beneath the riprap and around the outlet. Repair damage to slopes or underlying filter fabric immediately.

- Temporary devices should be completely removed as soon as the surrounding drainage area has been stabilized or at the completion of construction.

References

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Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

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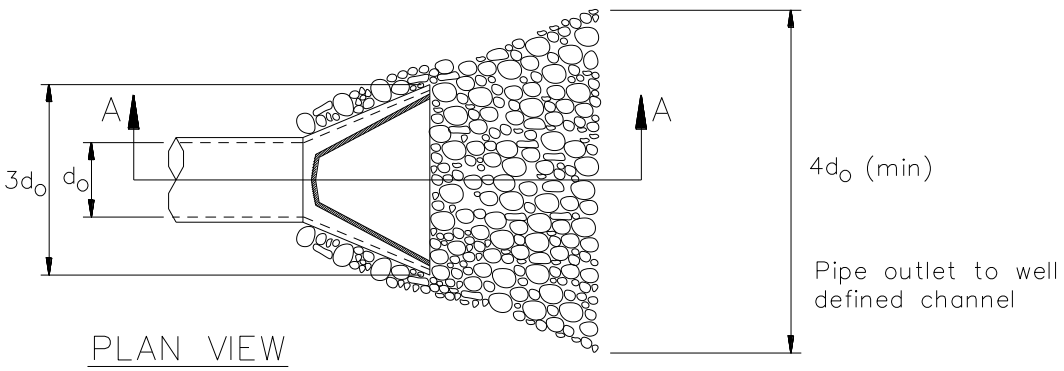
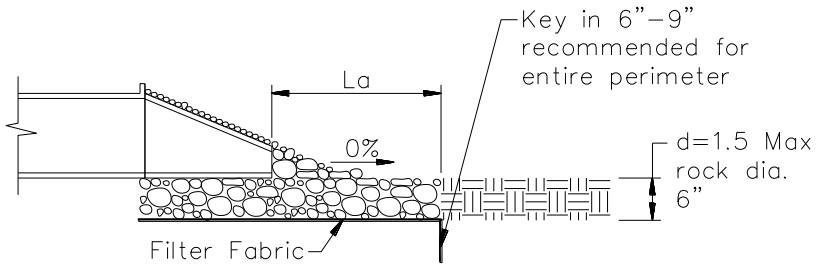
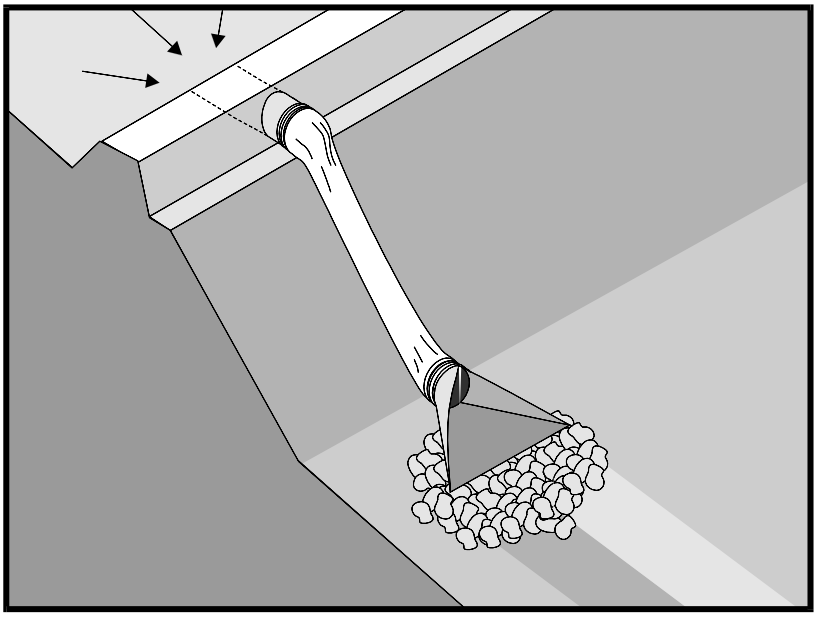




Pipe Diameter inches	Discharge ft³/s	Apron Length, La ft	Rip Rap D_{50} Diameter Min inches
12	5	10	4
	10	13	6
18	10	10	6
	20	16	8
	30	23	12
	40	26	16
24	30	16	8
	40	26	8
	50	26	12
	60	30	16

For larger or higher flows consult a Registered Civil Engineer
Source: USDA - SCS

Slope Drains EC-11



Categories

EC	Erosion Control	☑
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-9 Earth Dike, Drainage Swales

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Description and Purpose

A slope drain is a pipe used to intercept and direct surface runoff or groundwater into a stabilized watercourse, trapping device, or stabilized area. Slope drains are used with earth dikes and drainage ditches to intercept and direct surface flow away from slope areas to protect cut or fill slopes.

Suitable Applications

- Where concentrated flow of surface runoff must be conveyed down a slope in order to prevent erosion.
- Drainage for top of slope diversion dikes or swales.
- Drainage for top of cut and fill slopes where water can accumulate.
- Emergency spillway for a sediment basin.

Limitations

Installation is critical for effective use of the pipe slope drain to minimize potential gully erosion.

- Maximum drainage area per slope drain is 10 acres. (For large areas use a paved chute, rock lined channel, or additional pipes.)
- Severe erosion may result when slope drains fail by overtopping, piping, or pipe separation.

- During large storms, pipe slope drains may become clogged or over charged, forcing water around the pipe and causing extreme slope erosion.
- If the sectional downdrain is not sized correctly, the runoff can spill over the drain sides causing gully erosion and potential failure of the structure.

- Dissipation of high flow velocities at the pipe outlet is required to avoid downstream erosion.
- Sediment accumulation, scour depressions, and/or persistent non-stormwater discharges can result in areas of standing water suitable for mosquito production in energy dissipaters associated with slope drain outlets.

Implementation

General

The slope drain is applicable for any construction site where concentrated surface runoff can accumulate and must be conveyed down the slope in order to prevent erosion. The slope drain is effective because it prevents the stormwater from flowing directly down the slope by confining all the runoff into an enclosed pipe or channel. Due to the time lag between grading slopes and installation of permanent stormwater collection systems and slope stabilization measures, temporary provisions to intercept runoff are sometimes necessary. Particularly in steep terrain, slope drains can protect unstabilized areas from erosion.

Installation

The slope drain may be a rigid pipe, such as corrugated metal, a flexible conduit, or a lined terrace drain with the inlet placed on the top of a slope and the outlet at the bottom of the slope. This BMP typically is used in combination with a diversion control, such as an earth dike or drainage swale at the top of the slope.

The following criteria must be considered when siting slope drains.

- Permanent structures included in the project plans can often serve as construction BMPs if implemented early. However, the permanent structure must meet or exceed the criteria for the temporary structure.
- Inlet structures must be securely entrenched and compacted to avoid severe gully erosion.
- Slope drains must be securely anchored to the slope and must be adequately sized to carry the capacity of the design storm and associated forces.
- Outlets must be stabilized with riprap, concrete or other type of energy dissipator, or directed into a stable sediment trap or basin. See EC-10, Velocity Dissipation Devices.
- Debris racks are recommended at the inlet. Debris racks located several feet upstream of the inlet can usually be larger than racks at the inlet, and thus provide enhanced debris protection and less plugging.
- Safety racks are also recommended at the inlet and outlet of pipes where children or animals could become entrapped.
- Secure inlet and surround with dikes to prevent gully erosion and anchor pipe to slope.

- When using slope drains, limit drainage area to 10 acres per pipe. For larger areas, use a rock lined channel or a series of pipes.
- Size to convey at least the peak flow of a 10-year storm. The design storm is conservative due to the potential impact of system failures.
- Maximum slope generally limited to 2:1 (H:V) as energy dissipation below steeper slopes is difficult.
- Direct surface runoff to slope drains with interceptor dikes. See BMP EC-9, Earth Dikes and Drainage Swales. Top of interceptor dikes should be 12 in. higher than the top of the slope drain.
- Slope drains can be placed on or buried underneath the slope surface.
- Recommended materials include both metal and plastic pipe, either corrugated or smooth wall. Concrete pipe can also be used.
- When installing slope drains:
  - Install slope drains perpendicular to slope contours.
  - Compact soil around and under entrance, outlet, and along length of pipe.
  - Securely anchor and stabilize pipe and appurtenances into soil.
  - Check to ensure that pipe connections are watertight.
  - Protect area around inlet with filter cloth. Protect outlet with riprap or other energy dissipation device. For high energy discharges, reinforce riprap with concrete or use reinforced concrete device.
  - Protect outlet of slope drains using a flared end section when outlet discharges to a flexible energy dissipation device.
  - A flared end section installed at the inlet will improve flow into the slope drain and prevent erosion at the pipe entrance. Use a flared end section with a 6 in. minimum toe plate to help prevent undercutting. The flared section should slope towards the pipe inlet.

Design and Layout

The capacity for temporary drains should be sufficient to convey at least the peak runoff from a 10-year rainfall event. The pipe size may be computed using the Rational Method or a method established by the local municipality. Higher flows must be safely stored or routed to prevent any offsite concentration of flow and any erosion of the slope. The design storm is purposely conservative due to the potential impacts associated with system failures.

As a guide, temporary pipe slope drains should not be sized smaller than shown in the following table:

Minimum Pipe Diameter (Inches)	Maximum Drainage Area (Acres)
12	1.0
18	3.0
21	5.0
24	7.0
30	10.0

Larger drainage areas can be treated if the area can be subdivided into areas of 10 acres or less and each area is treated as a separate drainage. Drainage areas exceeding 10 acres must be designed by a Registered Civil Engineer and approved by the agency that issued the grading permit.

Materials:

Soil type, rainfall patterns, construction schedule, local requirements, and available supply are some of the factors to be considered when selecting materials. The following types of slope drains are commonly used:

- **Rigid Pipe:** This type of slope drain is also known as a pipe drop. The pipe usually consists of corrugated metal pipe or rigid plastic pipe. The pipe is placed on undisturbed or compacted soil and secured onto the slope surface or buried in a trench. Concrete thrust blocks must be used when warranted by the calculated thrust forces. Collars should be properly installed and secured with metal strappings or watertight collars.

- **Flexible Pipe**: The flexible pipe slope drain consists of a flexible tube of heavy duty plastic, rubber, or composite material. The tube material is securely anchored onto the slope surface. The tube should be securely fastened to the metal inlet and outlet conduit sections with metal strappings or watertight collars.

- **Section Downdrains**: The section downdrain consists of pre-fabricated, section conduit of half round or third round material. The sectional downdrain performs similar to a flume or chute. The pipe must be placed on undisturbed or compacted soil and secured into the slope.

- **Concrete-lined Terrace Drain:** This is a concrete channel for draining water from a terrace on a slope to the next level. These drains are typically specified as permanent structures and if installed early, can serve as slope drains during construction, which should be designed according to local drainage design criteria.

Costs

- Cost varies based on pipe selection and selected outlet protection.

Corrugated Steel Pipes, Per Foot	
Size	Supplied and Installed Cost (No Trenching Included)
12”	$19.60 per LF
15”	$22.00
18”	$26.00
24”	$32.00
30”	$50.00
PVC Pipes, Per Foot	
Size	Supplied and Installed Cost (No Trenching Included)
12”	$24.50
14”	$49.00
16”	$51.00
18”	$54.00
20”	$66.00
24”	$93.00
30”	$130.00

Inspection and Maintenance

- Inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Inspect BMPs subjected to non-stormwater discharges daily while non-stormwater discharges occur. Minimize areas of standing water by removing sediment blockages and filling scour depressions.
- Inspect outlet for erosion and downstream scour. If eroded, repair damage and install additional energy dissipation measures. If downstream scour is occurring, it may be necessary to reduce flows being discharged into the channel unless other preventative measures are implemented.
- Insert inlet for clogging or undercutting. Remove debris from inlet to maintain flows. Repair undercutting at inlet and if needed, install flared section or rip rap around the inlet to prevent further undercutting.
- Inspect pipes for leakage. Repair leaks and restore damaged slopes.
- Inspect slope drainage for accumulations of debris and sediment.

- Remove built up sediment from entrances and outlets as required. Flush drains if necessary; capture and settle out sediment from discharge.
- Make sure water is not ponding onto inappropriate areas (e.g., active traffic lanes, material storage areas, etc.).
- Pipe anchors must be checked to ensure that the pipe remains anchored to the slope. Install additional anchors if pipe movement is detected.

References

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National Management Measures to Control Nonpoint Source Pollution from Urban Areas, United States Environmental Protection Agency, 2002.

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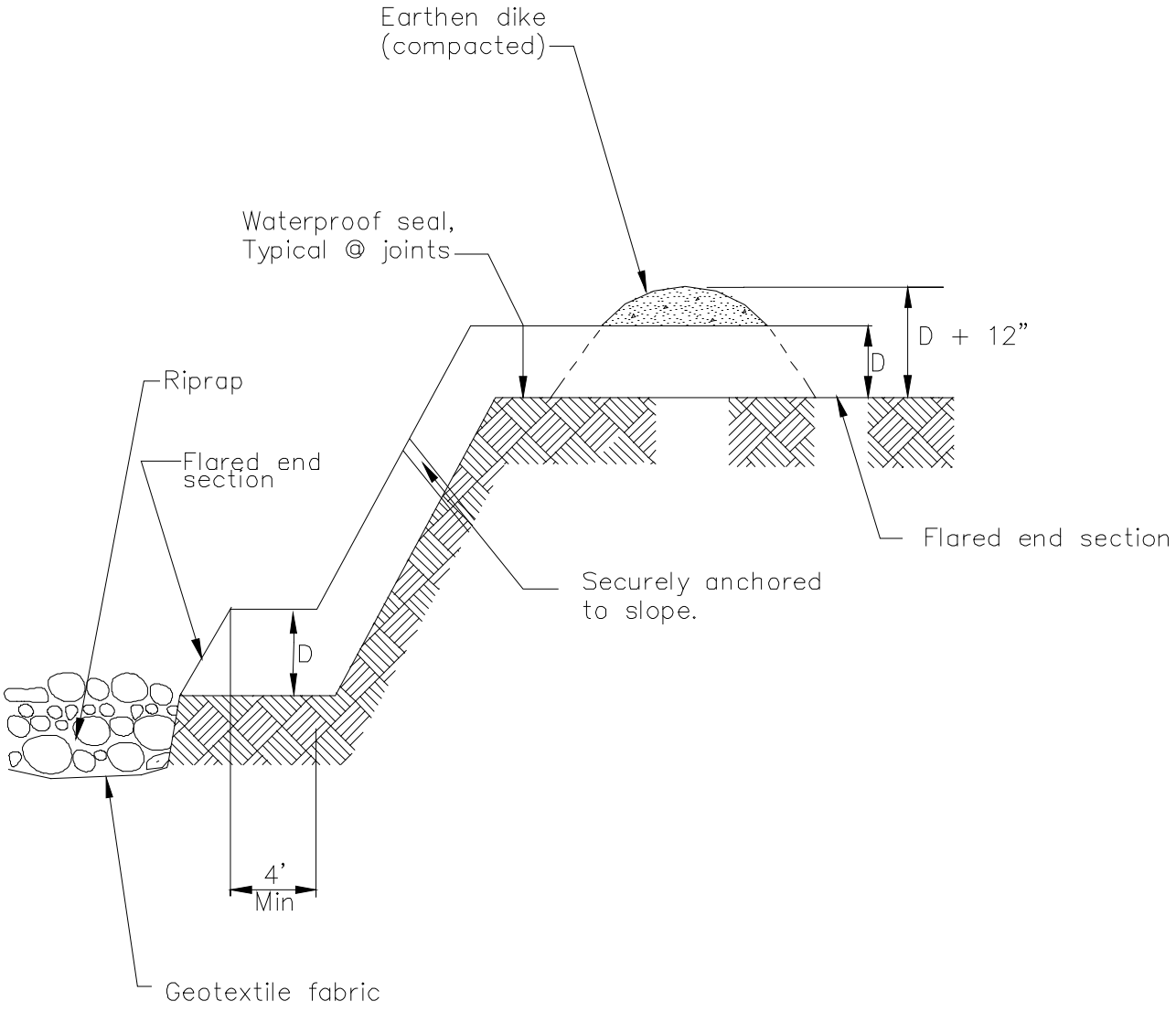

TYPICAL SLOPE DRAIN
NOT TO SCALE

Non-Vegetative Stabilization EC-16

Description and Purpose

Non-vegetative stabilization methods are used for temporary or permanent stabilization of areas prone to erosion and should be used only where vegetative options are not feasible; examples include:

- Areas of vehicular or pedestrian traffic such as roads or paths;
- Arid environments where vegetation would not provide timely ground coverage, or would require excessive irrigation;
- Rocky substrate, infertile or droughty soils where vegetation would be difficult to establish; and
- Areas where vegetation will not grow adequately within the construction time frame.

There are several non-vegetative stabilization methods and selection should be based on site-specific conditions.

Decomposed Granite (DG) is a permanent erosion protection method that consists of a layer of stabilized decomposed granite placed over an erodible surface.

Degradable Mulches of various types (see EC-3, EC-6, EC-8) can be used for temporary non-vegetative stabilization; examples include straw mulch, compost, wood chips or hydraulic mulch.

Geotextiles and Mats can be used for temporary non-vegetative stabilization (see EC-7). These BMPs are typically manufactured from degradable or synthetic materials and are

Categories

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SE	Sediment Control	☒
TR	Tracking Control	
WE	Wind Erosion Control	☒
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

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designed and specified based on their functional longevity, i.e., how long they will persist and provide erosion protection. All geotextiles and mats should be replaced when they exceed their functional longevity or when permanent stabilization methods are instituted.

Gravel Mulch is a non-degradable erosion control product that is composed of washed and screened coarse to very coarse gravel, 16 mm to 64 mm (0.6" - 2.5"), similar to an AASHTO No. 3 coarse aggregate.

Rock Slope Protection consists of utilizing large rock or rip-rap (4"- 24") to stabilize slopes with a high erosion potential and those subject to scour along waterways.

Soil Binders can be used for temporary non-vegetative stabilization (see EC-5). The key to their use is functional longevity. In most cases, the soil binder will need to be routinely monitored and re-applied to maintain an erosion-resistant coverage.

Suitable Applications

Non-vegetated stabilization methods are suitable for use on disturbed soil areas and on material stockpiles that need to be temporarily or permanently protected from erosion by water and wind. Non-vegetated stabilization should only be utilized when vegetation cannot be established in the required timeframe, due to soil or climactic conditions, or where vegetation may be a potential fire hazard.

Decomposed Granite (DG) and Gravel Mulch are suitable for use in areas where vegetation establishment is difficult, on flat surfaces, trails and pathways, and when used in conjunction with a stabilizer or tackifier, on shallow slopes (i.e., 10:1 [H:V]). DG and gravel can also be used on shallow rocky slopes where vegetation cannot be established for permanent erosion control.

Degradable Mulches can be used to cover and protect soil surfaces from erosion both in temporary and permanent applications. In many cases, the use of mulches by themselves requires routine inspection and re-application. See EC-3 Hydraulic Mulch, EC-6 Straw Mulch, EC-8 Wood Mulch, or EC-14 Compost Blankets for more information.

Geotextiles and Mats can be used as a temporary stand-alone soil stabilization method. Depending on material selection, geotextiles and mats can be a short-term (3 mos – 1 year) or long-term (1-2 years) temporary stabilization method. For more information on geotextiles and mats see EC-7 Geotextiles and Mats.

Rock Slope Protection can be used when the slopes are subject to scour or have a high erosion potential, such as slopes adjacent to flowing waterways or slopes subject to overflow from detention facilities (spillways).

Soil Binders can be used for temporary stabilization of stockpiles and disturbed areas not subject to heavy traffic. See EC-5 Soil Binders for more information.

Limitations

General

- Refer to EC-3, EC-6, EC-8, and EC-14 for limitations on use of mulches. Refer to EC-7 for limitations on use of geotextiles and mats. Refer to EC-5 for limitations on use of Soil Binders.

Decomposed Granite

- Not available in some geographic regions.
- If not tackified, material may be susceptible to erosion even on slight slopes (e.g., 30:1 [H:V]).
- Installed costs may be more expensive than vegetative stabilization methods.

Gravel Mulch

- Availability is limited in some geographic regions.
- If not properly screened and washed, can contain fine material that can erode and/or create dust problems.
- If inadequately sized, material may be susceptible to erosion on sloped areas.
- Pore spaces fill with dirt and debris over time; may provide a growing medium for weeds.

Rock Slope Protection

- Installation is labor intensive.
- Installed costs can be significantly higher than vegetative stabilization methods.
- Rounded stones may not be used on slopes greater than 2:1 [H:V].

Implementation

General

Non-vegetated stabilization should be used in accordance with the following general guidance:

- Should be used in conjunction with other BMPs, including drainage, erosion controls and sediment controls.
- Refer to EC-3, EC-6, EC-8, and EC-14 for implementation details for mulches. Refer to EC-7 for implementation details for geotextiles and mats. Refer to EC-5 for implementation details for soil binders.
- Non-vegetated stabilization measures should be implemented as soon as the disturbance in the areas they are intended to protect has ceased.
- Additional guidance on the comparison and selection of temporary slope stabilization methods is provided in Appendix F of the Handbook.

Decomposed Granite Stabilization

- If used for a road or path should be installed on a prepared base.
- Should be mixed with a stabilizer if used for roads or pathways, or on slope applications.
- Though porous it is recommended to prevent standing water on or next to a decomposed granite road or pathway.

Gravel Mulch

- Should be sized based on slope, rainfall, and upgradient run-on conditions. Stone size should be increased as potential for erosion increases (steeper slopes, high intensity rainfall).
- If permanent, a weed control fabric should be placed prior to installation.
- Should be installed at a minimum 2" depth.
- Should completely cover all exposed surfaces.

Rock Slope Protection

- Rock slope protection installation should follow Caltrans Standard Specification 72-2: Rock Slope Protection. Refer to the specification for rock conformity requirements and installation methods.
- When using rock slope protection, rock size and installation method should be specified by an Engineer.
- A geotextile fabric should be placed prior to installation.

Costs

- Costs are highly variable depending not only on technique chosen, but also on materials chosen within specific techniques. In addition, availability of certain materials will vary by region/location, which will also affect the cost. Costs of mulches, geotextiles and mats, and soil binders are presented in their respective fact sheets. Costs for decomposed granite, gravel mulch stabilization and rock slope protection may be higher depending on location and availability of materials. Caltrans has provided an estimate for gravel mulch of \$10 - \$15/yd^2 in flat areas and \$11 - \$23/yd^2 on side slopes.

Inspection and Maintenance

General

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- For permanent installation, require inspection periodically and after major storm events to look for signs of erosion or damage to the stabilization.
- All damage should be repaired immediately.
- Refer to EC-3, EC-6, EC-8, and EC-14 for inspection and maintenance requirements for mulches. Refer to EC-7 for inspection and maintenance requirements for geotextiles and mats. Refer to EC-5 for inspection and maintenance requirements for soil binders.

Decomposed Granite and Gravel Mulch Stabilization

- Rake out and add decomposed granite or gravel as needed to areas subject to rill erosion. Inspect upgradient drainage controls and repair/modify as necessary.

- Should remain stable under loose surface material. Any significant problem areas should be repaired to restore uniformity to the installation.

References

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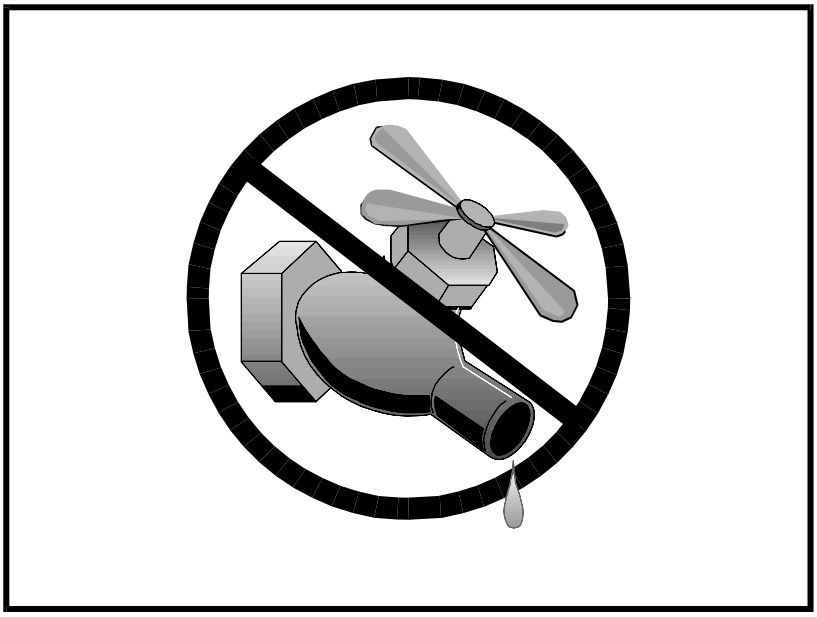
Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Water Conservation Practices NS-1



Categories		
EC	Erosion Control	☒
SE	Sediment Control	☒
TC	Tracking Control	
WE	Wind Erosion Control	
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Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents	
Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

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Description and Purpose

Water conservation practices are activities that use water during the construction of a project in a manner that avoids causing erosion and the transport of pollutants offsite. These practices can reduce or eliminate non-stormwater discharges.

Suitable Applications

Water conservation practices are suitable for all construction sites where water is used, including piped water, metered water, trucked water, and water from a reservoir.

Limitations

- None identified.

Implementation

- Keep water equipment in good working condition.
- Stabilize water truck filling area.
- Repair water leaks promptly.
- Washing of vehicles and equipment on the construction site is discouraged.
- Avoid using water to clean construction areas. If water must be used for cleaning or surface preparation, surface should be swept and vacuumed first to remove dirt. This will minimize amount of water required.

- Direct construction water runoff to areas where it can soak into the ground or be collected and reused.
- Authorized non-stormwater discharges to the storm drain system, channels, or receiving waters are acceptable with the implementation of appropriate BMPs.
- Lock water tank valves to prevent unauthorized use.

Costs

The cost is small to none compared to the benefits of conserving water.

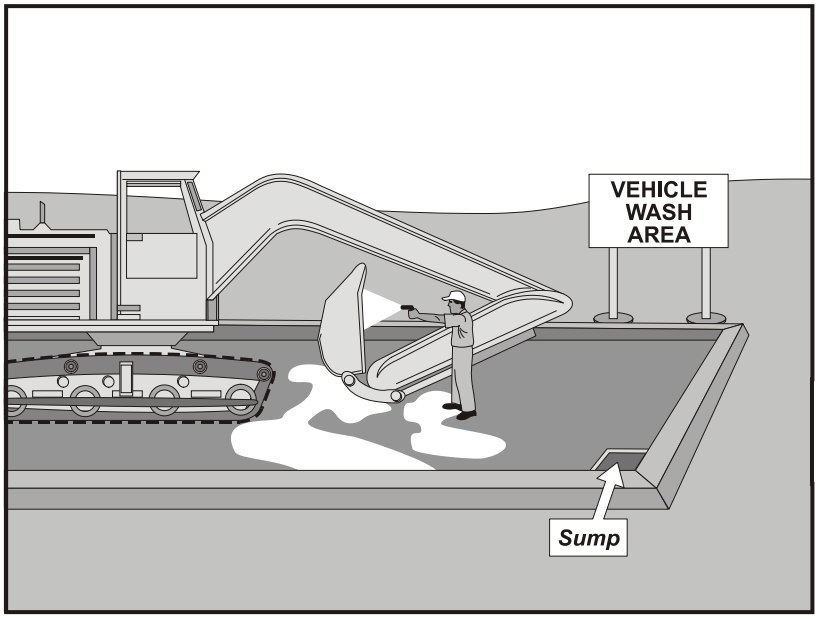
Inspection and Maintenance

- Inspect and verify that activity based BMPs are in place prior to the commencement of authorized non-stormwater discharges.
- Inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges are occuring.
- Repair water equipment as needed to prevent unintended discharges.
  - Water trucks
  - Water reservoirs (water buffalos)
  - Irrigation systems
  - Hydrant connections

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Vehicle and Equipment Cleaning NS-8



Categories

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Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	
Metals	
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

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Description and Purpose

Vehicle and equipment cleaning procedures and practices eliminate or reduce the discharge of pollutants to stormwater from vehicle and equipment cleaning operations. Procedures and practices include but are not limited to: using offsite facilities; washing in designated, contained areas only; eliminating discharges to the storm drain by infiltrating the wash water; and training employees and subcontractors in proper cleaning procedures.

Suitable Applications

These procedures are suitable on all construction sites where vehicle and equipment cleaning is performed.

Limitations

Even phosphate-free, biodegradable soaps have been shown to be toxic to fish before the soap degrades. Sending vehicles/equipment offsite should be done in conjunction with TC-1, Stabilized Construction Entrance/Exit.

Implementation

Other options to washing equipment onsite include contracting with either an offsite or mobile commercial washing business. These businesses may be better equipped to handle and dispose of the wash waters properly. Performing this work offsite can also be economical by eliminating the need for a separate washing operation onsite.

If washing operations are to take place onsite, then:

- Use phosphate-free, biodegradable soaps.
- Educate employees and subcontractors on pollution prevention measures.
- Do not permit steam cleaning onsite. Steam cleaning can generate significant pollutant concentrates.
- Cleaning of vehicles and equipment with soap, solvents or steam should not occur on the project site unless resulting wastes are fully contained and disposed of. Resulting wastes should not be discharged or buried, and must be captured and recycled or disposed according to the requirements of WM-10, Liquid Waste Management or WM-6, Hazardous Waste Management, depending on the waste characteristics. Minimize use of solvents. Use of diesel for vehicle and equipment cleaning is prohibited.
- All vehicles and equipment that regularly enter and leave the construction site must be cleaned offsite.
- When vehicle and equipment washing and cleaning must occur onsite, and the operation cannot be located within a structure or building equipped with appropriate disposal facilities, the outside cleaning area should have the following characteristics:
  - Located away from storm drain inlets, drainage facilities, or watercourses
  - Paved with concrete or asphalt and bermed to contain wash waters and to prevent runon and runoff
  - Configured with a sump to allow collection and disposal of wash water
  - No discharge of wash waters to storm drains or watercourses
  - Used only when necessary
- When cleaning vehicles and equipment with water:
  - Use as little water as possible. High-pressure sprayers may use less water than a hose and should be considered
  - Use positive shutoff valve to minimize water usage
  - Facility wash racks should discharge to a sanitary sewer, recycle system or other approved discharge system and must not discharge to the storm drainage system, watercourses, or to groundwater

Costs

Cleaning vehicles and equipment at an offsite facility may reduce overall costs for vehicle and equipment cleaning by eliminating the need to provide similar services onsite. When onsite cleaning is needed, the cost to establish appropriate facilities is relatively low on larger, long-duration projects, and moderate to high on small, short-duration projects.

Inspection and Maintenance

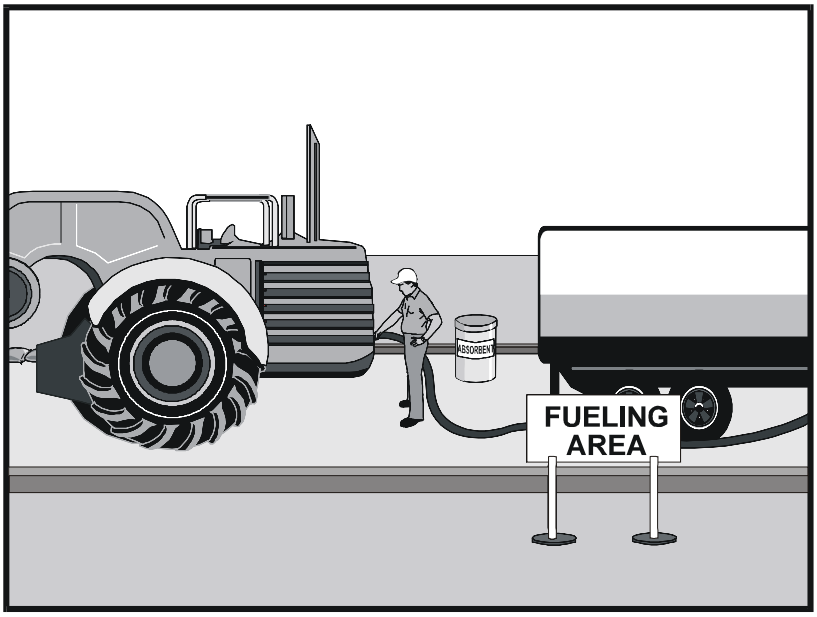
- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Inspection and maintenance is minimal, although some berm repair may be necessary.
- Monitor employees and subcontractors throughout the duration of the construction project to ensure appropriate practices are being implemented.
- Inspect sump regularly and remove liquids and sediment as needed.
- Prohibit employees and subcontractors from washing personal vehicles and equipment on the construction site.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Swisher, R.D. Surfactant Biodegradation, Marcel Decker Corporation, 1987.

Vehicle and Equipment Fueling NS-9



Categories

EC	Erosion Control	
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WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	☑
Organics	

Potential Alternatives

None

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Description and Purpose

Vehicle equipment fueling procedures and practices are designed to prevent fuel spills and leaks, and reduce or eliminate contamination of stormwater. This can be accomplished by using offsite facilities, fueling in designated areas only, enclosing or covering stored fuel, implementing spill controls, and training employees and subcontractors in proper fueling procedures.

Suitable Applications

These procedures are suitable on all construction sites where vehicle and equipment fueling takes place.

Limitations

Onsite vehicle and equipment fueling should only be used where it is impractical to send vehicles and equipment offsite for fueling. Sending vehicles and equipment offsite should be done in conjunction with TC-1, Stabilized Construction Entrance/ Exit.

Implementation

- Use offsite fueling stations as much as possible. These businesses are better equipped to handle fuel and spills properly. Performing this work offsite can also be economical by eliminating the need for a separate fueling area at a site.
- Discourage “topping-off” of fuel tanks.

- Absorbent spill cleanup materials and spill kits should be available in fueling areas and on fueling trucks, and should be disposed of properly after use.
- Drip pans or absorbent pads should be used during vehicle and equipment fueling, unless the fueling is performed over an impermeable surface in a dedicated fueling area.
- Use absorbent materials on small spills. Do not hose down or bury the spill. Remove the adsorbent materials promptly and dispose of properly.
- Avoid mobile fueling of mobile construction equipment around the site; rather, transport the equipment to designated fueling areas. With the exception of tracked equipment such as bulldozers and large excavators, most vehicles should be able to travel to a designated area with little lost time.
- Train employees and subcontractors in proper fueling and cleanup procedures.
- When fueling must take place onsite, designate an area away from drainage courses to be used. Fueling areas should be identified in the SWPPP.
- Dedicated fueling areas should be protected from stormwater runon and runoff, and should be located at least 50 ft away from downstream drainage facilities and watercourses. Fueling must be performed on level-grade areas.
- Protect fueling areas with berms and dikes to prevent runon, runoff, and to contain spills.
- Nozzles used in vehicle and equipment fueling should be equipped with an automatic shutoff to control drips. Fueling operations should not be left unattended.
- Use vapor recovery nozzles to help control drips as well as air pollution where required by Air Quality Management Districts (AQMD).
- Federal, state, and local requirements should be observed for any stationary above ground storage tanks.

Costs

- All of the above measures are low cost except for the capital costs of above ground tanks that meet all local environmental, zoning, and fire codes.

Inspection and Maintenance

- Inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Vehicles and equipment should be inspected each day of use for leaks. Leaks should be repaired immediately or problem vehicles or equipment should be removed from the project site.
- Keep ample supplies of spill cleanup materials onsite.

- Immediately clean up spills and properly dispose of contaminated soil and cleanup materials.

References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance, Working Group Working Paper; USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

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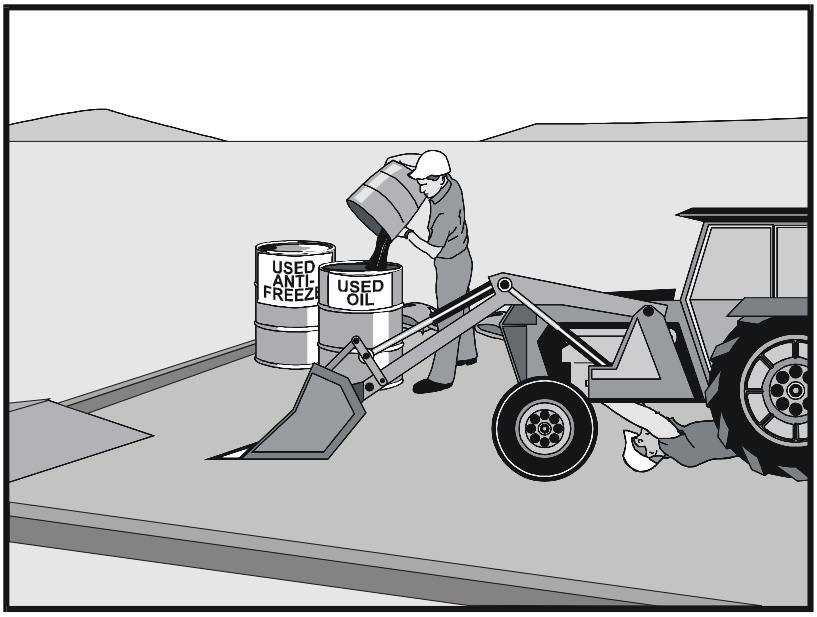
Vehicle & Equipment Maintenance NS-10



Categories		
EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	

Legend:
☑ **Primary Objective**
☒ **Secondary Objective**

Targeted Constituents	
Sediment	
Nutrients	☑
Trash	☑
Metals	
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

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Description and Purpose

Prevent or reduce the contamination of stormwater resulting from vehicle and equipment maintenance by running a "dry and clean site". The best option would be to perform maintenance activities at an offsite facility. If this option is not available then work should be performed in designated areas only, while providing cover for materials stored outside, checking for leaks and spills, and containing and cleaning up spills immediately. Employees and subcontractors must be trained in proper procedures.

Suitable Applications

These procedures are suitable on all construction projects where an onsite yard area is necessary for storage and maintenance of heavy equipment and vehicles.

Limitations

Onsite vehicle and equipment maintenance should only be used where it is impractical to send vehicles and equipment offsite for maintenance and repair. Sending vehicles/equipment offsite should be done in conjunction with TC-1, Stabilized Construction Entrance/Exit.

Outdoor vehicle or equipment maintenance is a potentially significant source of stormwater pollution. Activities that can contaminate stormwater include engine repair and service, changing or replacement of fluids, and outdoor equipment storage and parking (engine fluid leaks). For further information on vehicle or equipment servicing, see NS-8,

Vehicle and Equipment Cleaning, and NS-9, Vehicle and Equipment Fueling.

Implementation

- Use offsite repair shops as much as possible. These businesses are better equipped to handle vehicle fluids and spills properly. Performing this work offsite can also be economical by eliminating the need for a separate maintenance area.
- If maintenance must occur onsite, use designated areas, located away from drainage courses. Dedicated maintenance areas should be protected from stormwater runon and runoff, and should be located at least 50 ft from downstream drainage facilities and watercourses.
- Drip pans or absorbent pads should be used during vehicle and equipment maintenance work that involves fluids, unless the maintenance work is performed over an impermeable surface in a dedicated maintenance area.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- All fueling trucks and fueling areas are required to have spill kits and/or use other spill protection devices.
- Use adsorbent materials on small spills. Remove the absorbent materials promptly and dispose of properly.
- Inspect onsite vehicles and equipment daily at startup for leaks, and repair immediately.
- Keep vehicles and equipment clean; do not allow excessive build-up of oil and grease.
- Segregate and recycle wastes, such as greases, used oil or oil filters, antifreeze, cleaning solutions, automotive batteries, hydraulic and transmission fluids. Provide secondary containment and covers for these materials if stored onsite.
- Train employees and subcontractors in proper maintenance and spill cleanup procedures.
- Drip pans or plastic sheeting should be placed under all vehicles and equipment placed on docks, barges, or other structures over water bodies when the vehicle or equipment is planned to be idle for more than 1 hour.
- For long-term projects, consider using portable tents or covers over maintenance areas if maintenance cannot be performed offsite.
- Consider use of new, alternative greases and lubricants, such as adhesive greases, for chassis lubrication and fifth-wheel lubrication.
- Properly dispose of used oils, fluids, lubricants, and spill cleanup materials.
- Do not place used oil in a dumpster or pour into a storm drain or watercourse.
- Properly dispose of or recycle used batteries.
- Do not bury used tires.

- Repair leaks of fluids and oil immediately.

Listed below is further information if you must perform vehicle or equipment maintenance onsite.

Safer Alternative Products

- Consider products that are less toxic or hazardous than regular products. These products are often sold under an "environmentally friendly" label.
- Consider use of grease substitutes for lubrication of truck fifth-wheels. Follow manufacturers label for details on specific uses.
- Consider use of plastic friction plates on truck fifth-wheels in lieu of grease. Follow manufacturers label for details on specific uses.

Waste Reduction

Parts are often cleaned using solvents such as trichloroethylene, trichloroethane, or methylene chloride. Many of these cleaners are listed in California Toxic Rule as priority pollutants. These materials are harmful and must not contaminate stormwater. They must be disposed of as a hazardous waste. Reducing the number of solvents makes recycling easier and reduces hazardous waste management costs. Often, one solvent can perform a job as well as two different solvents. Also, if possible, eliminate or reduce the amount of hazardous materials and waste by substituting non-hazardous or less hazardous materials. For example, replace chlorinated organic solvents with non-chlorinated solvents. Non-chlorinated solvents like kerosene or mineral spirits are less toxic and less expensive to dispose of properly. Check the list of active ingredients to see whether it contains chlorinated solvents. The "chlor" term indicates that the solvent is chlorinated. Also, try substituting a wire brush for solvents to clean parts.

Recycling and Disposal

Separating wastes allows for easier recycling and may reduce disposal costs. Keep hazardous wastes separate, do not mix used oil solvents, and keep chlorinated solvents (like,-trichloroethane) separate from non-chlorinated solvents (like kerosene and mineral spirits). Promptly transfer used fluids to the proper waste or recycling drums. Don't leave full drip pans or other open containers lying around. Provide cover and secondary containment until these materials can be removed from the site.

Oil filters can be recycled. Ask your oil supplier or recycler about recycling oil filters.

Do not dispose of extra paints and coatings by dumping liquid onto the ground or throwing it into dumpsters. Allow coatings to dry or harden before disposal into covered dumpsters.

Store cracked batteries in a non-leaking secondary container. Do this with all cracked batteries, even if you think all the acid has drained out. If you drop a battery, treat it as if it is cracked. Put it into the containment area until you are sure it is not leaking.

Costs

All of the above are low cost measures. Higher costs are incurred to setup and maintain onsite maintenance areas.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Keep ample supplies of spill cleanup materials onsite.
- Maintain waste fluid containers in leak proof condition.
- Vehicles and equipment should be inspected on each day of use. Leaks should be repaired immediately or the problem vehicle(s) or equipment should be removed from the project site.
- Inspect equipment for damaged hoses and leaky gaskets routinely. Repair or replace as needed.

References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Coastal Nonpoint Pollution Control Program; Program Development and Approval Guidance, Working Group, Working Paper; USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Non-Stormwater Discharges SC-10

Description

Non-stormwater discharges (NSWDs) are flows that do not consist entirely of stormwater. Some non-stormwater discharges do not include pollutants and may be discharged to the storm drain if local regulations allow. These include uncontaminated groundwater and natural springs. There are also some non-stormwater discharges that typically do not contain pollutants and may be discharged to the storm drain with conditions. These include: potable water sources, fire hydrant flushing, air conditioner condensate, landscape irrigation drainage and landscape watering, emergency firefighting, etc. as discussed in Section 2.

However there are certain non-stormwater discharges that pose an environmental concern. These discharges may originate from illegal dumping of industrial material or wastes and illegal connections such as internal floor drains, appliances, industrial processes, sinks, and toilets that are illegally connected to the nearby storm drainage system through on-site drainage and piping. These unauthorized discharges (examples of which may include: process waste waters, cooling waters, wash waters, and sanitary wastewater) can carry substances such as paint, oil, fuel and other automotive fluids, chemicals and other pollutants into storm drains.

Non-stormwater discharges will need to be addressed through a combination of detection and elimination. The ultimate goal is to effectively eliminate unauthorized non-stormwater discharges to the stormwater drainage system through implementation of measures to detect, correct, and enforce against illicit connections and illegal discharges of

Objectives
■ *Cover*
■ *Contain*
■ *Educate*
■ *Reduce/Minimize*
■ *Product Substitution*

Targeted Constituents	
Sediment	
Nutrients	✓
Trash	
Metals	✓
Bacteria	✓
Oil and Grease	✓
Organics	✓

Minimum BMPs Covered	
Good Housekeeping	✓
Preventative Maintenance	
Spill and Leak Prevention and Response	✓
Material Handling & Waste Management	
Erosion and Sediment Controls	
Employee Training Program	✓
Quality Assurance Record Keeping	✓

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pollutants on streets and into the storm drain system and downstream water bodies.

Approach

Initially the Discharger must make an assessment of non-stormwater discharges to determine which types must be eliminated or addressed through BMPs. The focus of the following approach is the elimination of unauthorized non-stormwater discharges. See other BMP Fact Sheets for activity-specific pollution prevention procedures.

General Pollution Prevention Protocols

- Implement waste management controls described in SC-34 Waste Handling and Disposal.
- Develop clear protocols and lines of communication for effectively prohibiting non-stormwater discharges, especially those that are not classified as hazardous. These are often not responded to as effectively as they need to be.
- Stencil or demarcate storm drains, where applicable, to prevent illegal disposal of pollutants. Storm drain inlets should have messages such as "Dump No Waste Drains to Stream" or similar stenciled or demarcated next to them to warn against ignorant or unintentional dumping of pollutants into the storm drainage system.
- Manage and control sources of water such as hose bibs, faucets, wash racks, irrigation heads, etc. Identify hoses and faucets in the SWPPP, and post signage for appropriate use.

Non-Stormwater Discharge Investigation Protocols

Identifying the sources of non-stormwater discharges requires the Discharger to conduct an investigation of the facility at regular intervals. There are several categories of non-stormwater discharges:

- Visible, easily identifiable discharges, typically generated as surface runoff, such as uncontained surface runoff from vehicle or equipment washing; and
- Non-visible, (e.g., subsurface) discharges into the site drainage system through a variety of pathways that are not obvious.

The approach to detecting and eliminating non-stormwater discharges will vary considerably, as discussed below:

Visible and identifiable discharges

- Conduct routine inspections of the facilities and of each major activity area and identify visible evidence of unauthorized non-stormwater discharges. This may include:
  - ✓ Visual observations of actual discharges occurring;

- ✓ Evidence of surface staining, discoloring etc. that indicates that discharges have occurred;
- ✓ Pools of water in low lying areas when a rain event has not occurred; and
- ✓ Discussions with operations personnel to understand practices that may lead to unauthorized discharges.

- ☐ If evidence of non-stormwater discharges is discovered:
  - ✓ Document the location and circumstances using Worksheets 5 and 6 (Section 2 of the manual), including digital photos;
  - ✓ Identify and implement any quick remedy or corrective action (e.g., moving uncovered containers inside or to a proper location); and
  - ✓ Develop a plan to eliminate the discharge. Consult the appropriate activity-specific BMP Fact Sheet for alternative approaches to manage and eliminate the discharge.
- ☐ Consult the appropriate activity-specific BMP Fact Sheet for alternative approaches to manage and eliminate the discharge. Make sure the facility SWPPP is up-to-date and includes applicable BMPs to address the non-stormwater discharge.

Other Illegal Discharges (Non visible)

Illicit Connections

- ☐ Locate discharges from the industrial storm drainage system to the municipal storm drain system through review of "as-built" piping schematics.
- ☐ Isolate problem areas and plug illicit discharge points.
- ☐ Locate and evaluate discharges to the storm drain system.
- ☐ Visual Inspection and Inventory:
  - ✓ Inventory and inspect each discharge point during dry weather.
  - ✓ Keep in mind that drainage from a storm event can continue for a day or two following the end of a storm and groundwater may infiltrate the underground stormwater collection system.
  - ✓ Non-stormwater discharges are often intermittent and may require periodic inspections.

Review Infield Piping

- ☐ A review of the "as-built" piping schematic is a way to determine if there are any connections to the stormwater collection system.

- Inspect the path of loading/unloading area drain inlets and floor drains in older buildings.

- Never assume storm drains are connected to the sanitary sewer system.

Monitoring for investigation/detection of illegal discharges

- If a suspected illegal or unknown discharge is detected, monitoring of the discharge may help identify the content and/or suggest the source. This may be done with a field screening analysis, flow meter measurements, or by collecting a sample for laboratory analysis. Section 5 and Appendix D describe the necessary field equipment and procedures for field investigations.

- Investigative monitoring may be conducted over time. For example if, a discharge is intermittent, then monitoring might be conducted to determine the timing of the discharge to determine the source.

- Investigative monitoring may be conducted over a spatial area. For example, if a discharge is observed in a pipe, then monitoring might be conducted at accessible upstream locations in order to pinpoint the source of the discharge.

- Generally, investigative monitoring requiring collection of samples and submittal for lab analysis requires proper planning and specially trained staff.

Smoke Testing

Smoke testing of wastewater and stormwater collection systems is used to detect connections between the two piping systems. Smoke testing is generally performed at a downstream location and the smoke is forced upstream using blowers to create positive pressure. The advantage to smoke testing is that it can potentially identify multiple potential discharge sources at once.

- Smoke testing uses a harmless, non-toxic smoke cartridges developed specifically for this purpose.

- Smoke testing requires specialized equipment (e.g., cartridges, blowers) and is generally only appropriate for specially trained staff.

- A Standard Operating Procedure (SOP) for smoke testing is highly desirable. The SOP should address the following elements:

  - ✓ Proper planning and notification of nearby residents and emergency services is necessary since introducing smoke into the system may result in false alarms;

  - ✓ During dry weather, the stormwater collection system is filled with smoke and then traced back to sources;

- ✓ Temporary isolation of segments of pipe using sand bags is often needed to force the smoke into leaking pipes; and
- ✓ The appearance of smoke in a waste vent pipe, at a sewer manhole, or even the base of a toilet indicates that there may be a connection between the sanitary and storm water systems.

- ☐ Most municipal wastewater agencies will have necessary staff and equipment to conduct smoke testing and they should be contacted if cross connections with the sanitary sewer are suspected. See SC-44 Drainage System Maintenance for more information.

Dye Testing

- ☐ Dye testing is typically performed when there is a suspected specific pollutant source and location (i.e., leaking sanitary sewer) and there is evidence of dry weather flows in the stormwater collection system.
- ☐ Dye is released at a probable upstream source location, either the facility's sanitary or process wastewater system. The dye must be released with a sufficient volume of water to flush the system.
- ☐ Operators then visually examine the downstream discharge points from the stormwater collection system for the presence of the dye.
- ☐ Dye testing can be performed informally using commercially available products in order to conduct an initial investigation for fairly obvious cross-connections.
- ☐ More detailed dye testing should be performed by properly trained staff and follow SOPs. Specialized equipment such as fluorometers may be necessary to detect low concentrations of dye.
- ☐ Most municipal wastewater agencies will have necessary staff and equipment to conduct dye testing and they should be contacted if cross connections with the sanitary sewer are suspected.

TV Inspection of Drainage System

- ☐ Closed Circuit Television (CCTV) can be employed to visually identify illicit connections to the industrial storm drainage system. Two types of CCTV systems are available: (1) a small specially designed camera that can be manually pushed on a stiff cable through storm drains to observe the interior of the piping, or (2) a larger remote operated video camera on treads or wheels that can be guided through storm drains to view the interior of the pipe.
- ☐ CCTV systems often include a high-pressure water jet and camera on a flexible cable. The water jet cleans debris and biofilm off the inside of pipes so the camera can take video images of the pipe condition.

- CCTV units can detect large cracks and other defects such as offsets in pipe ends caused by root intrusions or shifting substrate.
- CCTV can also be used to detect dye introduced into the sanitary sewer.
- CCTV inspections require specialized equipment and properly trained staff and are generally best left to specialized contractors or municipal public works staff.

Illegal Dumping

- Substances illegally dumped on streets and into the storm drain systems and creeks may include paints, used oil and other automotive fluids, construction debris, chemicals, fresh concrete, leaves, grass clippings, and pet wastes. These wastes can cause stormwater and receiving water quality problems as well as clog the storm drain system itself.
- Establish a system for tracking incidents. The system should be designed to identify the following:
  - ✓ Illegal dumping hot spots;
  - ✓ Types and quantities (in some cases) of wastes;
  - ✓ Patterns in time of occurrence (time of day/night, month, or year);
  - ✓ Mode of dumping (abandoned containers, "midnight dumping" from moving vehicles, direct dumping of materials, accidents/spills);
  - ✓ An anonymous tip/reporting mechanism; and
  - ✓ Evidence of responsible parties (e.g., tagging, encampments, etc.).
- One of the keys to success of reducing or eliminating illegal dumping is increasing the number of people at the facility who are aware of the problem and who have the tools to at least identify the incident, if not correct it. Therefore, train field staff to recognize and report the incidents.

Once a site has been cleaned:

- Post "No Dumping" signs with a phone number for reporting dumping and disposal.
- Landscaping and beautification efforts of hot spots may also discourage future dumping, as well as provide open space and increase property values.
- Lighting or barriers may also be needed to discourage future dumping.
- See fact sheet SC-11 Spill Prevention, Control, and Cleanup.

Inspection

- Regularly inspect and clean up hot spots and other storm drainage areas where illegal dumping and disposal occurs.
- Conduct field investigations of the industrial storm drain system for potential sources of non-stormwater discharges.
- Pro-actively conduct investigations of high priority areas. Based on historical data, prioritize specific geographic areas and/or incident type for pro-active investigations.

Spill and Leak Prevention and Response

- On paved surfaces, clean up spills with as little water as possible. Use a rag for small spills, a damp mop for general cleanup, and absorbent material for larger spills. If the spilled material is hazardous, then the used cleanup materials are also hazardous and must be sent to a certified laundry (rags) or disposed of as hazardous waste.
- Never hose down or bury dry material spills. Sweep up the material and dispose of properly.
- Use adsorbent materials on small spills rather than hosing down the spill. Remove the adsorbent materials promptly and dispose of properly.
- For larger spills, a private spill cleanup company or Hazmat team may be necessary.
- See SC-11 Spill Prevention Control and Cleanup.

Employee Training Program

- Training of technical staff in identifying and documenting illegal dumping incidents is required. The frequency of training must be presented in the SWPPP, and depends on site-specific industrial materials and activities.
- Consider posting a quick reference table near storm drains to reinforce training.
- Train employees to identify non-stormwater discharges and report discharges to the appropriate departments.
- Educate employees about spill prevention and cleanup.
- Well-trained employees can reduce human errors that lead to accidental releases or spills. The employee should have the tools and knowledge to immediately begin cleaning up a spill should one occur. Employees should be familiar with the Spill Prevention Control and Countermeasure Plan. Employees should be able to identify work/jobs with high potential for spills and suggest methods to reduce possibility.
- Determine and implement appropriate outreach efforts to reduce non-permissible non-stormwater discharges.

- Conduct spill response drills annually (if no events occurred) in order to evaluate the effectiveness of the plan.
- When a responsible party is identified, educate the party on the impacts of his or her actions.

Quality Assurance and Record Keeping

Performance Evaluation

- Annually review internal investigation results; assess whether goals were met and what changes or improvements are necessary.
- Obtain feedback from personnel assigned to respond to, or inspect for, illicit connections and illegal dumping incidents.
- Develop document and data management procedures.
- A database is useful for defining and tracking the magnitude and location of the problem.
- Report prohibited non-stormwater discharges observed during the course of normal daily activities so they can be investigated, contained, and cleaned up or eliminated.
- Document that non-stormwater discharges have been eliminated by recording tests performed, methods used, dates of testing, and any on-site drainage points observed.
- Annually document and report the results of the program.
- Maintain documentation of illicit connection and illegal dumping incidents, including significant conditionally exempt discharges that are not properly managed.
- Document training activities.

Potential Limitations and Work-Arounds

Some facilities may have space constraints, limited staffing and time limitations that may preclude implementation of BMPs. Provided below are typical limitations and recommended "work-arounds."

- Many facilities do not have accurate, up-to-date 'as-built' plans or drawings which may be necessary in order to conduct non-stormwater discharge assessments.
  - ✓ Online tools such as Google Earth™ can provide an aerial view of the facility and may be useful in understanding drainage patterns and potential sources of non-stormwater discharges
  - ✓ Local municipal jurisdictions may have useful drainage systems maps.

- Video surveillance cameras are commonly used to secure the perimeter of industrial facilities against break-ins and theft. These surveillance systems may also be useful for capturing illegal dumping activities. Minor, temporary adjustments to the field of view of existing surveillance camera systems to target known or suspected problem areas may be a cost-effective way of capturing illegal dumping activities and identifying the perpetrators.

Potential Capital Facility Costs and Operation & Maintenance Requirements

Facilities

- Capital facility cost requirements may be minimal unless cross-connections to storm drains are detected.
- Indoor floor drains may require re-plumbing if cross-connections are detected.
- Leaky sanitary sewers will require repair or replacement which can have significant costs depending on the size and industrial activity at the facility.

Maintenance (including administrative and staffing)

- The primary effort is for staff time and depends on how aggressively a program is implemented.
- Costs for containment, and disposal of any leak or discharge is borne by the Discharger.
- Illicit connections can be difficult to locate especially if there is groundwater infiltration.
- Illegal dumping and illicit connection violations requires technical staff to detect and investigate them.

Supplemental Information

Permit Requirements

The IGP authorizes certain Non-Storm Water Discharges (NSWDs) provided BMPs are included in the SWPPP and implemented to:

- Reduce or prevent the contact of authorized NSWDs with materials or equipment that are potential sources of pollutants;
- Reduce, to the extent practicable, the flow or volume of authorized NSWDs;
- Ensure that authorized NSWDs do not contain quantities of pollutants that cause or contribute to an exceedance of a water quality standards (WQS); and,

- Reduce or prevent discharges of pollutants in authorized NSWDs in a manner that reflects best industry practice considering technological availability and economic practicability and achievability."

References and Resources

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Spill Prevention, Control & Cleanup SC-11

Description

Many activities that occur at an industrial or commercial site have the potential to cause accidental spills. Preparation for accidental spills, with proper training and reporting systems implemented, can minimize the discharge of pollutants to the environment.

Spills and leaks are one of the largest contributors of stormwater pollutants. Spill prevention and control plans are applicable to any site at which hazardous materials are stored or used. An effective plan should have spill prevention and response procedures that identify hazardous material storage areas, specify material handling procedures, describe spill response procedures, and provide locations of spill clean-up equipment and materials. The plan should take steps to identify and characterize potential spills, eliminate and reduce spill potential, respond to spills when they occur in an effort to prevent pollutants from entering the stormwater drainage system, and train personnel to prevent and control future spills. An adequate supply of spill clean-up materials must be maintained onsite.

Objectives
■ *Cover*
■ *Contain*
■ *Educate*
■ *Reduce/Minimize*
■ *Product Substitution*

Targeted Constituents	
Sediment	
Nutrients	
Trash	
Metals	✓
Bacteria	
Oil and Grease	✓
Organics	✓

Minimum BMPs Covered	
Good Housekeeping	
Preventative Maintenance	
Spill and Leak Prevention and Response	✓
Material Handling & Waste Management	
Erosion and Sediment Controls	
Employee Training Program	✓
Quality Assurance Record Keeping	✓

Approach

General Pollution Prevention Protocols

- ☐ Develop procedures to prevent/mitigate spills to storm drain systems.
- ☐ Develop and standardize reporting procedures, containment, storage, and disposal activities, documentation, and follow-up procedures.
- ☐ Establish procedures and/or controls to minimize spills and leaks. The procedures should address:
  - ✓ Description of the facility, owner and address, activities, chemicals, and quantities present;

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- ✓ Facility map of the locations of industrial materials;
- ✓ Notification and evacuation procedures;
- ✓ Cleanup instructions;
- ✓ Identification of responsible departments; and
- ✓ Identify key spill response personnel.

- ☐ Recycle, reclaim, or reuse materials whenever possible. This will reduce the amount of process materials that are brought into the facility.

Spill and Leak Prevention and Response

Spill Prevention

- ☐ Develop procedures to prevent/mitigate spills to storm drain systems. Develop and standardize reporting procedures, containment, storage, and disposal activities, documentation, and follow-up procedures.

- ☐ If illegal dumping is observed at the facility:
  - ✓ Post "No Dumping" signs with a phone number for reporting illegal dumping and disposal. Signs should also indicate fines and penalties applicable for illegal dumping.
  - ✓ Landscaping and beautification efforts may also discourage illegal dumping.
  - ✓ Bright lighting and/or entrance barriers may also be needed to discourage illegal dumping.

- ☐ Store and contain liquid materials in such a manner that if the container is ruptured, the contents will not discharge, flow, or be washed into the storm drainage system, surface waters, or groundwater.

- ☐ If the liquid is oil, gas, or other material that separates from and floats on water, install a spill control device (such as a tee section) in the catch basins that collects runoff from the storage tank area.

Preventative Maintenance

- ☐ Place drip pans or absorbent materials beneath all mounted taps, and at all potential drip and spill locations during filling and unloading of tanks. Any collected liquids or soiled absorbent materials must be reused/recycled or properly disposed.

- ☐ Store and maintain appropriate spill cleanup materials in a location known to all near the tank storage area; and ensure that employees are familiar with the site's spill control plan and/or proper spill cleanup procedures.

- ☐ Sweep and clean the storage area monthly if it is paved, *do not hose down the area to a storm drain.*
- ☐ Check tanks (and any containment sumps) daily for leaks and spills. Replace tanks that are leaking, corroded, or otherwise deteriorating with tanks in good condition. Collect all spilled liquids and properly dispose of them.
- ☐ Label all containers according to their contents (e.g., solvent, gasoline).
- ☐ Label hazardous substances regarding the potential hazard (corrosive, radioactive, flammable, explosive, poisonous).
- ☐ Prominently display required labels on transported hazardous and toxic materials (per US DOT regulations).
- ☐ Identify key spill response personnel.

Spill Response

- ☐ Clean up leaks and spills immediately.
- ☐ Place a stockpile of spill cleanup materials where it will be readily accessible (e.g., near storage and maintenance areas).
- ☐ On paved surfaces, clean up spills with as little water as possible.
  - ✓ Use a rag for small spills, a damp mop for general cleanup, and absorbent material for larger spills.
  - ✓ If the spilled material is hazardous, then the used cleanup materials are also hazardous and must be sent to a certified laundry (rags) or disposed of as hazardous waste.
  - ✓ If possible use physical methods for the cleanup of dry chemicals (e.g., brooms, shovels, sweepers, or vacuums).
- ☐ Never hose down or bury dry material spills. Sweep up the material and dispose of properly.
- ☐ Chemical cleanups of material can be achieved with the use of adsorbents, gels, and foams. Use adsorbent materials on small spills rather than hosing down the spill. Remove the adsorbent materials promptly and dispose of properly.
- ☐ For larger spills, a private spill cleanup company or Hazmat team may be necessary.

Reporting

- Report spills that pose an immediate threat to human health or the environment to the Regional Water Quality Control Board or local authority as location regulations dictate.
- Federal regulations require that any oil spill into a water body or onto an adjoining shoreline be reported to the National Response Center (NRC) at 800-424-8802 (24 hour).
- Report spills to 911 for dispatch and clean-up assistance when needed. Do not contact fire agencies directly.
- Establish a system for tracking incidents. The system should be designed to identify the following:
  - ✓ Types and quantities (in some cases) of wastes;
  - ✓ Patterns in time of occurrence (time of day/night, month, or year);
  - ✓ Mode of dumping (abandoned containers, "midnight dumping" from moving vehicles, direct dumping of materials, accidents/spills);
  - ✓ Clean-up procedures; and
  - ✓ Responsible parties.

Employee Training Program

- Educate employees about spill prevention and cleanup.
- Well-trained employees can reduce human errors that lead to accidental releases or spills:
  - ✓ The employee should have the tools and knowledge to immediately begin cleaning up a spill should one occur; and
  - ✓ Employees should be familiar with the Spill Prevention Control and Countermeasure Plan.
- Employees should be educated about aboveground storage tank requirements. Employees responsible for aboveground storage tanks and liquid transfers should be thoroughly familiar with the Spill Prevention Control and Countermeasure Plan and the plan should be readily available.
- Train employees to recognize and report illegal dumping incidents.

Other Considerations (Limitations and Regulations)

- State regulations exist for facilities with a storage capacity of 10,000 gallons or more of petroleum to prepare a Spill Prevention Control and Countermeasure (SPCC) Plan (Health & Safety Code Chapter 6.67).
- State regulations also exist for storage of hazardous materials (Health & Safety Code Chapter 6.95), including the preparation of area and business plans for emergency response to the releases or threatened releases.
- Consider requiring smaller secondary containment areas (less than 200 sq. ft.) to be connected to the sanitary sewer, prohibiting any hard connections to the storm drain.

Requirements

Costs (including capital and operation & maintenance)

- Will vary depending on the size of the facility and the necessary controls.
- Prevention of leaks and spills is inexpensive. Treatment and/or disposal of contaminated soil or water can be quite expensive.

Maintenance (including administrative and staffing)

- Develop spill prevention and control plan, provide and document training, conduct inspections of material storage areas, and supply spill kits.
- Extra time is needed to properly handle and dispose of spills, which results in increased labor costs.

Supplemental Information

Further Detail of the BMP

Reporting

Record keeping and internal reporting represent good operating practices because they can increase the efficiency of the facility and the effectiveness of BMPs. A good record keeping system helps the facility minimize incident recurrence, correctly respond with appropriate cleanup activities, and comply with legal requirements. A record keeping and reporting system should be set up for documenting spills, leaks, and other discharges, including discharges of hazardous substances in reportable quantities. Incident records describe the quality and quantity of non-stormwater discharges to the storm sewer. These records should contain the following information:

- Date and time of the incident;
- Weather conditions;
- Duration of the spill/leak/discharge;

- Cause of the spill/leak/discharge;
- Response procedures implemented;
- Persons notified; and
- Environmental problems associated with the spill/leak/discharge.

Separate record keeping systems should be established to document housekeeping and preventive maintenance inspections, and training activities. All housekeeping and preventive maintenance inspections should be documented. Inspection documentation should contain the following information:

- Date and time the inspection was performed;
- Name of the inspector;
- Items inspected;
- Problems noted;
- Corrective action required; and
- Date corrective action was taken.

Other means to document and record inspection results are field notes, timed and dated photographs, videotapes, and drawings and maps.

Aboveground Tank Leak and Spill Control

Accidental releases of materials from aboveground liquid storage tanks present the potential for contaminating stormwater with many different pollutants. Materials spilled, leaked, or lost from tanks may accumulate in soils or on impervious surfaces and be carried away by stormwater runoff.

The most common causes of unintentional releases are:

- Installation problems;
- Failure of piping systems (pipes, pumps, flanges, couplings, hoses, and valves);
- External corrosion and structural failure;
- Spills and overfills due to operator error; and
- Leaks during pumping of liquids or gases from truck or rail car to a storage tank or vice versa.

Storage of reactive, ignitable, or flammable liquids should comply with the Uniform Fire Code and the National Electric Code. Practices listed below should be employed to enhance the code requirements:

- Tanks should be placed in a designated area.
- Tanks located in areas where firearms are discharged should be encapsulated in concrete or the equivalent.
- Designated areas should be impervious and paved with Portland cement concrete, free of cracks and gaps, in order to contain leaks and spills.
- Liquid materials should be stored in UL approved double walled tanks or surrounded by a curb or dike to provide the volume to contain 10 percent of the volume of all of the containers or 110 percent of the volume of the largest container, whichever is greater. The area inside the curb should slope to a drain.
- For used oil or dangerous waste, a dead-end sump should be installed in the drain.
- All other liquids should be drained to the sanitary sewer if available. The drain must have a positive control such as a lock, valve, or plug to prevent release of contaminated liquids.
- Accumulated stormwater in petroleum storage areas should be passed through an oil/water separator.

Maintenance is critical to preventing leaks and spills. Conduct routine inspections and:

- Check for external corrosion and structural failure.
- Check for spills and overfills due to operator error.
- Check for failure of piping system (pipes, pumps, flanges, coupling, hoses, and valves).
- Check for leaks or spills during pumping of liquids or gases from truck or rail car to a storage facility or vice versa.
- Visually inspect new tank or container installation for loose fittings, poor welding, and improper or poorly fitted gaskets.
- Inspect tank foundations, connections, coatings, and tank walls and piping system. Look for corrosion, leaks, cracks, scratches, and other physical damage that may weaken the tank or container system.
- Frequently relocate accumulated stormwater during the wet season.

- Periodically conduct integrity testing by a qualified professional.

Vehicle Leak and Spill Control

Major spills on roadways and other public areas are generally handled by highly trained Hazmat teams from local fire departments or environmental health departments. The measures listed below pertain to leaks and smaller spills at vehicle maintenance shops.

In addition to implementing the spill prevention, control, and clean up practices above, use the following measures related to specific activities:

Vehicle and Equipment Maintenance

- Perform all vehicle fluid removal or changing inside or under cover to prevent the run-on of stormwater and the runoff of spills.
- Regularly inspect vehicles and equipment for leaks, and repair immediately.
- Check incoming vehicles and equipment (including delivery trucks, and employee and subcontractor vehicles) for leaking oil and fluids. Do not allow leaking vehicles or equipment onsite.
- Always use secondary containment, such as a drain pan or drop cloth, to catch spills or leaks when removing or changing fluids.
- Immediately drain all fluids from wrecked vehicles.
- Store wrecked vehicles or damaged equipment under cover.
- Place drip pans or absorbent materials under heavy equipment when not in use.
- Use absorbent materials on small spills rather than hosing down the spill.
- Remove the adsorbent materials promptly and dispose of properly.
- Promptly transfer used fluids to the proper waste or recycling drums. Don't leave full drip pans or other open containers lying around.
- Oil filters disposed of in trashcans or dumpsters can leak oil and contaminate stormwater. Place the oil filter in a funnel over a waste oil recycling drum to drain excess oil before disposal. Oil filters can also be recycled. Ask your oil supplier or recycler about recycling oil filters.
- Store cracked batteries in a non-leaking secondary container. Do this with all cracked batteries, even if you think all the acid has drained out. If you drop a battery, treat it as if it is cracked. Put it into the containment area until you are sure it is not leaking.

Vehicle and Equipment Fueling

- Design the fueling area to prevent the run-on of stormwater and the runoff of spills:

  Cover fueling area if possible.

  Use a perimeter drain or slope pavement inward with drainage to a sump.

  Pave fueling area with concrete rather than asphalt.

- If dead-end sump is not used to collect spills, install an oil/water separator.
- Install vapor recovery nozzles to help control drips as well as air pollution.
- Discourage "topping-off' of fuel tanks.
- Use secondary containment when transferring fuel from the tank truck to the fuel tank.
- Use absorbent materials on small spills and general cleaning rather than hosing down the area. Remove the absorbent materials promptly.
- Carry out all Federal and State requirements regarding underground storage tanks, or install above ground tanks.
- Do not use mobile fueling of mobile industrial equipment around the facility; rather, transport the equipment to designated fueling areas.
- Keep your Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date.
- Train employees in proper fueling and cleanup procedures.

Industrial Spill Prevention Response

For the purposes of developing a spill prevention and response program to meet the stormwater regulations, facility managers should use information provided in this fact sheet and the spill prevention/response portions of the fact sheets in this handbook, for specific activities.

The program should:

- Integrate with existing emergency response/hazardous materials programs (e.g., Fire Department).
- Develop procedures to prevent/mitigate spills to storm drain systems.
- Identify responsible departments.

- Develop and standardize reporting procedures, containment, storage, and disposal activities, documentation, and follow-up procedures.
- Address spills at municipal facilities, as well as public areas.
- Provide training concerning spill prevention, response and cleanup to all appropriate personnel.

References and Resources

California's Nonpoint Source Program Plan. http://www.swrcb.ca.gov/nps/index.html.

Clark County Storm Water Pollution Control Manual. Available online at: http://www.co.clark.wa.us/pubworks/bmpman.pdf.

King County Storm Water Pollution Control Manual. Available online at: http://dnr.metrokc.gov/wlr/dss/spcm.htm.

Orange County Stormwater Program, Best Management Practices for Industrial/Commercial Business Activities. Available online at: http://ocwatersheds.com/documents/bmp/industrialcommercialbusinessesactivities

Santa Clara Valley Urban Runoff Pollution Prevention Program. http://www.scvurppp.org.

The Stormwater Managers Resource Center. http://www.stormwatercenter.net/.

Vehicle and Equipment Fueling SC-20

Description

Spills and leaks that occur during vehicle and equipment fueling can contribute hydrocarbons, oil and grease, as well as heavy metals, to stormwater runoff. Implementing the following management practices can help prevent fuel spills and leaks.

Approach

- Reduce potential for pollutant discharge through source control pollution prevention and BMP implementation. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives.

General Pollution Prevention Protocols

- Use properly maintained off-site fueling stations whenever possible. These businesses are better equipped to handle fuel and spills properly.
- Focus pollution prevention activities on containment of spills and leaks, most of which may occur during liquid transfers.

Good Housekeeping

- "Spot clean" leaks and drips routinely. Leaks are not cleaned up until the absorbent is picked up and disposed of properly.
- Manage materials and waste properly (see Material Handling and Waste Management) to reduce adverse impacts on stormwater quality.
- Paint signs on storm drain inlets to indicate that they are not to receive liquid or solid wastes.
- Post signs at sinks to remind employees not to pour wastes down drains.

Objectives
Cover
Contain
Educate
Reduce/Minimize
Product Substitution

Targeted Constituents	
Sediment	
Nutrients	
Trash	✓
Metals	✓
Bacteria	
Oil and Grease	✓
Organics	✓

Minimum BMPs Covered	
Good Housekeeping	✓
Preventative Maintenance	✓
Spill and Leak Prevention and Response	✓
Material Handling & Waste Management	✓
Erosion and Sediment Controls	
Employee Training Program	✓
Quality Assurance Record Keeping	✓

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- ☐ Clean yard storm drain inlets(s) regularly and especially after large storms.
- ☐ Do not pour materials down storm drains.
- ☐ Build a shed or temporary roof over fueling area to limit exposure to rain.
- ☐ Post signs to remind employees and customers not to top off the fuel tank when filling and signs that ban customers and employees from changing engine oil or other fluids at that location.
- ☐ Report leaking vehicles to fleet maintenance.
- ☐ Ensure the following safeguards are in place:
  - ✓ Overflow protection devices on tank systems to warn the operator or automatically shut down transfer pumps when the tank reaches full capacity.
  - ✓ Protective guards around tanks and piping to prevent vehicle or forklift damage.
  - ✓ Clear tagging or labeling of all valves to reduce human error.
  - ✓ Emergency shut-off and emergency phone number.

Preventative Maintenance

Fuel Dispensing Areas

- ☐ Inspect vehicles and equipment for leaks regularly and repair immediately.
- ☐ Sweep the fueling area weekly, if it is paved, to collect loose particles, and wipe up spills with rags and other absorbent material immediately. Do not hose down the area to a storm drain.
- ☐ Fit underground storage tanks with spill containment and overfill prevention systems meeting the requirements of Section 2635(b) of Title 23 of the California Code of Regulations.
- ☐ Fit fuel dispensing nozzles with "hold-open latches" (automatic shutoffs) except where prohibited by local fire departments.
- ☐ Post signs at the fuel dispenser or fuel island warning vehicle owners/operators against "topping off" of vehicle fuel tanks.
- ☐ Design fueling area to prevent stormwater runoff and spills. Use a perimeter drain or slope pavement inward with drainage to sump; regularly remove materials accumulated in sump.
- ☐ Pave area with concrete rather than asphalt.

- Cover fueling area with an overhanging roof structure or canopy so that precipitation cannot come in contact with the fueling area. Where covering is not feasible and the fuel island is surrounded by pavement, apply a suitable sealant that protects the asphalt from spilled fuels.

- Install vapor recovery nozzles to help control drips as well as air pollution.

- Use secondary containment when transferring fuel from the tank truck to the fuel tank. Cover storm drains in the vicinity during transfer.

Air/Water Supply Area

- Minimize the possibility of stormwater pollution from air/water supply areas by doing at least one of the following:

  - ✓ Spot clean leaks and drips routinely to prevent runoff of spillage.

  - ✓ Grade and pave the air/water supply area to prevent run-on of stormwater.

  - ✓ Install a roof over the air/water supply area.

  - ✓ Install a low containment berm around the air/water supply area.

Inspection

- Aboveground Tank Leak and Spill Control:

  - ✓ Check for external corrosion and structural failure.

  - ✓ Check for spills and overfills due to operator error.

  - ✓ Check for failure of piping system.

  - ✓ Check for leaks or spills during pumping of liquids or gases from truck or rail car to a storage facility or vice versa.

  - ✓ Visually inspect new tank or container installation for loose fittings, poor welding, and improper or poorly fitted gaskets.

  - ✓ Inspect tank foundations, connections, coatings, and tank walls and piping system. Look for corrosion, leaks, cracks, scratches, and other physical damage that may weaken the tank or container system.

  - ✓ Conduct integrity testing periodically by a qualified professional.

- Inspect and clean, if necessary, storm drain inlets and catch basins within the facility boundary before October 1 each year.

Spill Response and Prevention Procedures

- ☐ Keep your spill prevention and control plan up-to-date.
- ☐ Maintain an adequate stockpile of spill cleanup materials at locations where it will be readily accessible.
- ☐ Clean leaks, drips, and other spills with as little water as possible.
  - ✓ Use rags for small spills,
  - ✓ Use a damp mop for general cleanup,
  - ✓ Use dry absorbent material for larger spills.
- ☐ Use the following three-step method for cleaning floors:
  - ✓ Clean spills with rags or other absorbent materials
  - ✓ Sweep floor using dry absorbent material
  - ✓ Mop the floor. Mop water may be discharged to the sanitary sewer via a toilet or sink.
- ☐ Remove the adsorbent materials promptly and dispose of properly when using absorbent materials on small spills.
- ☐ Store portable absorbent booms (long flexible shafts or barriers made of absorbent material) in unbermed fueling areas.
- ☐ Report spills promptly.
- ☐ If a dead-end sump is not used to collect spills, install an oil/water separator.

Material Handling and Waste Management

- ☐ Do not pour liquid wastes into floor drains, sinks, outdoor storm drain inlets, or other storm drains or sewer connections.
- ☐ Do not put used or leftover cleaning solutions, solvents, and automotive fluids in the sanitary sewer.
- ☐ Collect leaking or dripping fluids in drip pans or containers. Fluids are easier to recycle if kept separate.
- ☐ Promptly transfer used fluids to the proper waste or recycling drums. Do not leave drip pans or other open containers lying around.

- Minimize the possibility of stormwater pollution from outside waste receptacles by doing at least one of the following:
  - ✓ Use only watertight waste receptacle(s) and keep the lid(s) closed.
  - ✓ Grade and pave the waste receptacle area to prevent run-on of stormwater.
  - ✓ Install a roof over the waste receptacle area.
  - ✓ Install a low containment berm around the waste receptacle area.
  - ✓ Use and maintain drip pans under waste receptacles.
- Post "no littering" signs.

Employee Training Program

- Educate employees about facility-wide pollution prevention measures and goals.
- Train designated employees (e.g., those involved with the handling or management of fuels) on proper fueling and cleanup procedures.
- Train designated employees upon hiring and annually thereafter on proper methods for handling and disposing of waste. Make sure that all employees understand stormwater discharge prohibitions, wastewater discharge requirements, and these best management practices.
- Ensure that employees are familiar with the site's spill control plan and/or proper spill cleanup procedures.
- Use a training log or similar method to document training. The training log should include entries for:
  - ✓ Training topic,
  - ✓ Trainer,
  - ✓ Attendees,
  - ✓ Frequency,
  - ✓ Comments,
  - ✓ Target date for completion of training, and
  - ✓ Date completed.

Quality Assurance and Record Keeping

- Keep accurate maintenance logs that document minimum BMP activities performed for vehicle and equipment fueling, quantities of materials removed, and improvement actions.
- Keep accurate logs of spill response actions that document what types of liquids were spilled, how it was cleaned up, and how the waste was disposed.
- Establish procedures to complete logs and file them in the central office.

Potential Capital Facility Costs and Operation & Maintenance Requirements

Facilities

- The retrofitting of existing fueling areas to minimize stormwater exposure or spill runoff can be expensive. Good design must occur during the initial installation. Extruded curb along the "upstream" side of the fueling area to prevent stormwater run-on is of modest cost.
- Capital investments will likely be required at some sites if adequate cover and containment facilities do not exist and can vary significantly depending upon site conditions.

Maintenance

- Most of the operations and maintenance activities associated with implementing this BMP are integrally linked to routine operations as previously described. Therefore additional O&M is not required.
- For facilities responsible for pre-treating their wastewater prior to discharging, the proper functioning of structural treatment system is an important maintenance consideration.
- Routine cleanout of sumps and oil/water separators is required for the devices to maintain their effectiveness, usually at least once a month. During periods of heavy rainfall, cleanout is required more often to ensure pollutants are not washed through the system. Sediment removal is also required on a regular basis to keep the device working efficiently.

Supplemental Information

Designing New Installations

The elements listed below should be included in the design and construction of new or substantially remodeled facilities.

Fuel Dispensing Areas

- Fuel dispensing areas must be paved with Portland cement concrete (or, equivalent smooth impervious surface), with a 2 to 4% slope to prevent ponding, and must be

separated from the rest of the site by a grade break that prevents run-on of stormwater to the extent practicable. The fuel dispensing area is defined as extending 6.5 feet from the corner of each fuel dispenser or the length at which the hose and nozzle assembly may be operated plus 1 foot, whichever is less. The paving around the fuel dispensing area may exceed the minimum dimensions of the "fuel dispensing area" stated above.

- The fuel dispensing area must be covered, and the cover's minimum dimensions must be equal to or greater than the area within the grade break or the fuel dispensing area, as defined above. The cover must not drain onto the fuel dispensing area.

- If necessary, install and maintain an oil control device in the appropriate catch basin(s) to treat runoff from the fueling area.

Outdoor Waste Receptacle Area

- Grade and pave the outdoor waste receptacle area to prevent run-on of stormwater to the extent practicable.

Air/Water Supply Area

- Grade and pave the air/water supply area to prevent run-on of stormwater to the extent practicable.

Designated Fueling Area

- If your facility has large numbers of mobile equipment working throughout the site and you currently fuel them with a mobile fuel truck, consider establishing a designated fueling area. With the exception of tracked equipment such as bulldozers and perhaps small forklifts, most vehicles should be able to travel to a designated area with little lost time. Place temporary "caps" over nearby catch basins or manhole covers so that if a spill occurs it is prevented from entering the storm drain.

Examples

The Spill Prevention Control and Countermeasure (SPCC) Plan, which is required by law for some facilities, is an effective program to reduce the number of accidental spills and minimize contamination of stormwater runoff.

The City of Palo Alto has an effective program for commercial vehicle service facilities. Many of the program's elements, including specific BMP guidance and lists of equipment suppliers, are also applicable to industrial facilities.

References and Resources

Orange County Stormwater Program, Best Management Practices for Industrial/Commercial Business Activities. Available online at: http://ocwatersheds.com/documents/bmp/industrialcommercialbusinessesactivities.

Oregon Department of Environmental Quality, 2013. *Industrial Stormwater Best Management Practices Manual- BMP 8 Vehicle, Pavement and Building Washing*. Available online at: http://www.deq.state.or.us/wq/wqpermit/docs/IndBMP021413.pdf

Sacramento Stormwater Management Program. *Best Management Practices for Industrial Storm Water Pollution Control.* Available online at: http://www.msa.saccounty.net/sactostormwater/documents/guides/industrial-BMP-manual.pdf.

Sacramento County Environmental Management Stormwater Program: Best Management Practices –Vehicle Washing. Available online at: http://www.emd.saccounty.net/EnvHealth/Stormwater/Stormwater-BMPs.html.

Santa Clara Valley Urban Runoff Pollution Prevention Program. http://www.scvurppp-w2k.com/.

US EPA. National Pollutant Discharge Elimination System – Stormwater Menu of BMPs - Municipal Vehicle and Equipment Washing, Available online at: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=132.

Washington State Department of Ecology, 2012. *Vehicle and Equipment Washwater Discharges Best Management Practices Manual.* Publication no. WQ-R-95-056. Available online at: https://fortress.wa.gov/ecy/publications/publications/95056.pdf.

Vehicle and Equipment Cleaning SC-21

Description

Wash water from vehicle and equipment cleaning activities performed outdoors or in areas where wash water flows onto the ground can contribute toxic hydrocarbons and other organic compounds, oils and greases, nutrients, phosphates, heavy metals, and suspended solids to stormwater runoff. Use of the procedures outlined below can prevent or reduce the discharge of pollutants to stormwater during vehicle and equipment cleaning.

Approach

Reduce potential for pollutant discharge through source control pollution prevention and BMP implementation. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives

General Pollution Prevention Protocols

- ☐ If possible, use properly maintained off-site commercial washing and steam cleaning businesses whenever possible. These businesses are better equipped to handle and properly dispose of the wash waters.
- ☐ Use dry cleaning methods to remove debris and sweep area; avoid washing with water when possible.
- ☐ Good housekeeping practices can minimize the risk of contamination from wash water discharges.
- ☐ Use biodegradable, phosphate-free detergents for washing vehicles as appropriate
- ☐ Emphasize the connection between the storm drain system and runoff, help reinforce that vehicle and equipment washing activities affect local water quality through storm drain stenciling programs.

Objectives
■ *Cover*
■ *Contain*
■ *Educate*
■ *Reduce/Minimize*
■ *Product Substitution*

Targeted Constituents	
Sediment	✓
Nutrients	✓
Trash	
Metals	✓
Bacteria	
Oil and Grease	✓
Organics	✓

Minimum BMPs Addressed	
Good Housekeeping	✓
Preventative Maintenance	✓
Spill and Leak Prevention and Response	✓
Material Handling & Waste Management	✓
Erosion and Sediment Controls	
Employee Training Program	✓
Quality Assurance Record Keeping	✓

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- ☐ Map on-site storm drain locations to avoid discharges to the storm drain system.
- ☐ Designate specific wash area with clarifier or place wash areas away from storm drain connections.

Good Housekeeping

- ☐ Mark the area clearly as a wash area by:
  - ✓ Posting signs stating that only washing is allowed in wash area; and
  - ✓ Providing information on how washing is to be done.
- ☐ Provide trash containers in wash area.
- ☐ Have all vehicle and equipment washing done in areas designed to collect and hold the wash and rinse water or effluent generated. Recycle, collect or treat wash water effluent prior to discharge to the sanitary sewer system.
- ☐ If washing/cleaning must occur on-site, consider washing vehicles and equipment inside the building or on an impervious surface to control the targeted constituents by directing them to the sanitary sewer.
- ☐ If washing must occur on-site and outdoor:
  - ✓ Use designated paved wash areas. This area must be covered or bermed to collect the wash water and graded to direct the wash water to a treatment or disposal facility.
  - ✓ Do not conduct oil changes and other engine maintenance in the designated washing area. Perform these activities in a place designated for oil change and maintenance activities.
  - ✓ Cover the wash area when not in use to prevent contact with rain water.
- ☐ Do not permit steam cleaning wash water to enter the storm drain system.
- ☐ If possible, conduct pressure and steam cleaning at appropriate off-site areas to avoid generating runoff with high pollutant concentrations.

Preventative Maintenance

- ☐ Install sumps or drain lines to collect wash water for treatment.
- ☐ Use hoses with nozzles that automatically turn off when left unattended.
- ☐ Perform routine inspections of drain lines, holding tanks, and hoses and repair leaks immediately.

- Perform routine inspection and maintenance of wash water recycling and treatment systems.

Spill Response and Prevention Procedures

- Keep the spill prevention and control plan up-to-date.
- Have an emergency plan, equipment, and trained personnel ready at all times to deal immediately with major spills.
- Collect all spilled liquids and properly dispose of them.
- Store and maintain appropriate spill cleanup materials in a location known to all near the designated wash area.

Material Handling and Waste Management

- Collect all wash water from vehicle and equipment cleaning operations. Consider treating and reusing or discharging wash waters to a sanitary sewer system.
- Large quantities of wash waters may require treatment at the facility. Treatment using a process treatment system (e.g., holding tank, filtration system, and related appurtenances) will require engineering and capital expenditures.
- Collect and treat small amounts of wash water at the facility and either recycle or discharge to the sanitary sewer system or collect and dispose of as an industrial waste.
- Discharge wash waters into sanitary sewer only after contacting local sewer authority to find out if pretreatment is required.

Employee Training Program

- Train employees on proper cleaning and wash water disposal procedures and conduct “refresher” courses on a regular basis.
- Train staff on proper maintenance measures for the wash area.
- Train employees and contractors on proper spill containment and cleanup. The employee should have the tools and knowledge to immediately begin cleaning up a spill should one occur.
- Use a training log or similar method to document training.

Quality Assurance and Record Keeping

- Keep accurate maintenance/inspection logs that document the minimum BMP activities performed for vehicle and equipment cleaning activities and improvement actions.

- Keep accurate logs of spill response actions that document what was spilled, how it was cleaned up, and how the waste was disposed.
- Establish procedures to complete logs and file them in the central office.

Other Facility-Specific Considerations

- Some municipalities may require pretreatment and monitoring of wash water discharges to the sanitary sewer.
- Steam cleaning can generate significant pollutant concentrations requiring that careful consideration be given to the environmental impacts and compliance issues related to the condensate wastewater generated.

Potential Limitations and Work-Arounds

Some facilities may have space constraints, limited staffing and time limitations that may preclude implementation of certain BMPs. Provided below are typical limitations and recommended "work-arounds":

- Most car washing best management practices are inexpensive, and rely more on good housekeeping practices (where vehicles are washed, planning for the collection of wash water) than on expensive technology. However, the construction of a specialized area for vehicle washing can be expensive. Also, for facilities that cannot recycle their wash water, the cost of pre-treating wash water through either structural practices or planning for collection and hauling of contaminated water to sewage treatment plants can be cost-prohibitive.
- A potential work-around is to use properly maintained off-site commercial washing and steam cleaning businesses whenever possible.

Potential Capital Facility Costs and Operation & Maintenance Requirements

Facilities

- Many facilities will already have indoor covered areas where vehicle and equipment cleaning takes place and will require no additional capital expenditures for providing cover.
- Capital investments will be required at some sites if systems to collect and recycle/treat and properly discharge wash water are not in place. The cost associated with these investments will vary depending on the size of the washing facility and local regulations regarding effluent wash water.

Maintenance

- Perform wash and collection system inspections and repair.
- Sweep washing areas frequently to remove solid debris.

- Repair berms and dikes as necessary.
- Inspect and maintain sumps, oil/water separators, and on-site treatment/recycling units.

Supplemental Information

Designated Cleaning Areas

- Washing operations outside should be conducted in a designated wash area having the following characteristics:
  - ✓ Paved with Portland cement concrete
  - ✓ Covered and bermed to prevent contact with stormwater and contain wash water
  - ✓ Sloped for wash water collections
  - ✓ Drainage system for wash water to the sanitary or recycle treatment process waste sewer, or to a dead-end sump equipped with an oil/water separator if necessary.

References and Resources

Orange County Stormwater Program, Best Management Practices for Industrial/Commercial Business Activities. Available online at: http://ocwatersheds.com/documents/bmp/industrialcommercialbusinessesactivities.

Oregon Department of Environmental Quality, 2013. *Industrial Stormwater Best Management Practices Manual- BMP 8 Vehicle, Pavement and Building Washing*. Available online at: http://www.deq.state.or.us/wq/wqpermit/docs/IndBMP021413.pdf.

Sacramento Stormwater Management Program. *Best Management Practices for Industrial Storm Water Pollution Control*. Available online at: http://www.msa.saccounty.net/sactostormwater/documents/guides/industrial-BMP-manual.pdf.

Sacramento County Environmental Management Stormwater Program: Best Management Practices –Vehicle Washing. Available online at: http://www.emd.saccounty.net/EnvHealth/Stormwater/Stormwater-BMPs.html.

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Washington State Department of Ecology, 2012 .*Vehicle and Equipment Washwater Discharges Best Management Practices Manual.* Publication no. WQ-R-95-056. Available online at: https://fortress.wa.gov/ecy/publications/publications/95056.pdf.

Vehicle and Equipment Repair SC-22

Description

Vehicle or equipment maintenance and repair are potentially significant sources of stormwater pollution, due to use of harmful materials and wastes during maintenance and repair processes. Engine repair and service (e.g., parts cleaning), replacement of fluids (e.g., oil change), and outdoor equipment storage and parking (leaking vehicles) can impact water quality if stormwater runoff from areas with these activities becomes polluted by a variety of contaminants. Implementation of the following activities must be done where applicable to prevent or reduce the discharge of pollutants to stormwater from vehicle and equipment maintenance and repair activities.

Approach

The BMP approach is to reduce the potential for pollutant discharges through source control pollution prevention and BMP implementation. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives. General pollution prevention protocols are presented followed by applicable minimum BMPs as required by the Industrial General Permit.

General Pollution Prevention Protocols

- ☐ Designate a vehicle maintenance area designed to prevent stormwater pollution.
- ☐ Minimize contact of stormwater with outside operations through berming and appropriate drainage routing.
- ☐ Keep accurate maintenance logs to evaluate materials removed and improvements made.
- ☐ Switch to non-toxic chemicals for maintenance when possible.
- ☐ Choose cleaning agents that can be recycled.
- ☐ Use drop cloths and drip pans.

Objectives
■ *Cover*
■ *Contain*
■ *Educate*
■ *Reduce/Minimize*
■ *Product Substitution*

Targeted Constituents	
Sediment	
Nutrients	
Trash	
Metals	✓
Bacteria	
Oil and Grease	✓
Organics	✓

Minimum BMPs Covered	
Good Housekeeping	✓
Preventative Maintenance	✓
Spill and Leak Prevention and Response	✓
Material Handling & Waste Management	✓
Erosion and Sediment Controls	
Employee Training Program	✓
Quality Assurance Record Keeping	✓

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- Minimize use of solvents. Clean parts without using solvents whenever possible, or use water-based solvents for cleaning.
- Recycle used motor oil, diesel oil, and other vehicle fluids and parts whenever possible.

Operational Protocols

General

- Move maintenance and repair activities indoors whenever feasible.
- Place curbs around the immediate boundaries of process equipment.

Good Housekeeping

- Store idle equipment under cover
- Use a vehicle maintenance area designed to prevent stormwater pollution - minimize contact of stormwater with outside operations through berming and appropriate drainage routing.
- Avoid hosing down your work areas. If work areas are washed, collect and direct wash water to sanitary sewer. Use dry sweeping if possible.
- Paint signs on storm drain inlets to indicate that they are not to receive liquid or solid wastes.
- Post signs at sinks to remind employees not to pour wastes down drains.
- Clean yard storm drain inlets(s) regularly and especially after large storms.
- Do not pour materials down storm drains.
- Cover the work area to limit exposure to rain.
- Place curbs around the immediate boundaries of process equipment.
- Build a shed or temporary roof over areas where parked cars await repair or salvage, especially wrecked vehicles. Build a roof over vehicles kept for parts.

Preventive Maintenance and Repair Activities

- Provide a designated area for vehicle maintenance.
- Inspect vehicles and equipment for leaks regularly and repair immediately.
- Make sure incoming vehicles are checked for leaking oil and fluids. Do not allow leaking vehicles or equipment on-site without correcting the source of the leak and cleaning up any spill.
- Keep equipment clean; don't allow excessive build-up of oil and grease.

- Perform all vehicle fluid removal or changing inside or under cover if possible to prevent the run-on of stormwater and the runoff of spills.

- Use a tarp, ground cloth, or drip pans beneath the vehicle or equipment to capture all spills and drips if temporary work is being conducted outside. Collected drips and spills must be disposed, reused, or recycled properly.

- It is important to sweep the maintenance area weekly, if it is paved, to collect loose particles, and wipe up spills with rags and other absorbent material immediately. Do not hose down the area to a storm drain.

- Establish standard procedures to prevent spillage/leakage of fluids including:

  - ✓ Keep a drip pan under the vehicle while you unclip hoses, unscrew filters, or remove other parts. Use a drip pan under any vehicle that might leak while working on it to keep splatters or drips off the shop floor.

  - ✓ Promptly transfer used fluids to the proper waste or recycling drums. Do not leave drip pans or other open containers lying around.

  - ✓ Keep drip pans or containers under vehicles or equipment that may drip during repairs.

  - ✓ Do not change motor oil or perform equipment maintenance in non-appropriate areas.

- Drain oil and other fluids first if the vehicle or equipment is to be stored outdoors. Elevate and tarp stored vehicles and equipment.

- Monitor parked vehicles closely for leaks. Pans should be placed under any leaks to collect the fluids for proper disposal or recycling.

- Mechanics should clean vehicle parts without using liquid cleaners wherever possible to reduce waste.

- Steam cleaning and pressure washing may be used instead of solvent parts cleaning. The wastewater generated from steam cleaning must be discharged to an on-site oil water separator that is connected to a sanitary sewer or blind sump. Non-caustic detergents should be used instead of caustic cleaning agents, detergent-based or water-based cleaning systems in place of organic solvent degreasers, and non-chlorinated solvent in place of chlorinated organic solvents for parts cleaning. Refer to SC21 for more information on steam cleaning.

- Fifth-wheel bearings on trucks require routine lubrication. Typically chassis grease is applied to the fifth-wheel bearing at rates that result in grease dripping off of the bearing into the environment. To address this concern the following options are available:

  - ✓ Use specialized lubricants with good adhesion (e.g., stay in place) properties. Carefully follow manufacturer's label regarding the use of adhesive lubricant for

truck fifth-wheels. Typically this means applying no more than 8 oz. of grease. No visible extrusion of lubricant from the fifth-wheel bearing when truck and trailer are connected should be present.

- ✓ Use on-board truck or on-board trailer automatic lubrication systems. If these systems apply lube thinner than National Grease Lubrication Institute #2, equipment for collection of used lubricant is needed to prevent excess lubricant from dripping off the truck.
- ✓ Use plastic or Teflon plates instead of grease or other lubricants. Carefully follow manufacturer's instructions for installation and operation.

- ☐ Use one of the following for lubricating vehicle-trailer coupling:
  - ✓ Specialized adhesive lubricants;
  - ✓ Grease-free fifth wheel slip plates (e.g., plastic or Teflon coatings); and
  - ✓ On-Board automatic lubricating systems.

Spill and Leak Prevention and Response Procedures

- ☐ Keep your spill prevention and control plan up-to-date.
- ☐ Place an adequate stockpile of spill cleanup materials where it will be readily accessible.
- ☐ Clean leaks, drips, and other spills with as little water as possible. Use rags for small spills, a damp mop for general cleanup, and dry absorbent material for larger spills. Use the following three-step method for cleaning floors:
  - ✓ Clean spills with rags or other absorbent materials;
  - ✓ Sweep floor using dry absorbent material; and
  - ✓ Mop the floor.

  Mop water may be discharged to the sanitary sewer via a toilet or sink.
- ☐ Remove the adsorbent materials promptly and dispose of properly when using adsorbent materials on small spills.

Material Handling and Waste Management

- ☐ Designate a special area to drain and replace motor oil, coolant, and other fluids, where there are no connections to the storm drain or the sanitary sewer, and drips and spills can be easily cleaned up.
- ☐ Drain all fluids immediately from wrecked vehicles. Ensure that the drain pan or drip pan is large enough to contain drained fluids (e.g., larger pans are needed to contain antifreeze, which may gush from some vehicles).

- Do not pour liquid waste to floor drains, sinks, outdoor storm drain inlets, or other storm drains or sewer connections.
- Do not put used or leftover cleaning solutions, solvents, and automotive fluids and in the sanitary sewer.
- Collect leaking or dripping fluids in drip pans or containers. Fluids are easier to recycle if kept separate.
- Promptly transfer used fluids to the proper waste or recycling drums. Do not leave drip pans or other open containers lying around.
- Place oil filter in a funnel over a waste oil recycling drum to drain excess oil before disposal since municipalities prohibit or discourage disposal of these items in solid waste facilities.
- Oil filters can also be recycled. Ask your oil supplier or recycler about recycling oil filters. Oil filters disposed of in trashcans or dumpsters can leak oil and contaminate stormwater.
- Store cracked batteries in a non-leaking secondary container and dispose of properly at recycling or household hazardous waste facilities.

Employee Training Program

- Train employees and contractors in the proper handling and disposal of engine fluids and waste materials.
- Employees should have the tools and knowledge to immediately begin cleaning up a spill should one occur.
- Conduct annual training to ensure that employees are familiar with the facility's spill control plan and/or proper spill cleanup procedures (You can use reusable cloth rags to clean up small drips and spills instead of disposables; these can be washed by a permitted industrial laundry. Do not clean them at home or at a coin-operated laundry business).
- Use a training log or similar method to document training.

Quality Assurance and Recordkeeping

- Keep accurate maintenance logs to evaluate materials removed and improvements made.
- Establish procedures to collect and file maintenance logs in the central office.

Other Facility-Specific Considerations

Parts Cleaning

Vehicle and equipment maintenance facilities often must clean parts as a part of day-today operations. The following activities should be considered:

- Clean vehicle parts without using liquid cleaners wherever possible to reduce waste.
- Steam cleaning and pressure washing may be used instead of solvent parts cleaning.
- Wastewater generated from steam cleaning must be discharged to an on-site oil water separator that is connected to a sanitary sewer or blind sump.
- Use non-caustic detergents instead of caustic cleaning agents, detergent-based or water-based cleaning systems in place of organic solvent degreasers, and non-chlorinated solvent in place of chlorinated organic solvents for parts cleaning. Refer to SC21 for more information on steam cleaning.

Potential Limitations and Work-Arounds

- Some facilities may have space constraints and time limitations that may preclude all work from being conducted indoors.
  - ✓ Designate specific areas for outdoor activities.
  - ✓ Require employees to understand and follow preventive maintenance and spill and leak prevention BMPs.
- It may not be possible to contain and clean up spills from vehicles/equipment brought on-site after working hours.
  - ✓ Provide a designated area for afterhours deliveries.
  - ✓ Install spill kits.
- Drain pans (usually 1 ft. x 1 ft.) are generally too small to contain antifreeze
  - ✓ Purchase or fabricate large drip pans (3 ft. x 3 ft.) with sufficient volume to contain expected quantities of liquids based on equipment/vehicle specifications.
- Dry floor cleaning methods may not be sufficient for some spills.
  - ✓ Use three-step method instead.
- Identification of engine leaks may require some use of solvents.
  - ✓ Minimize the use of solvents and use drip pans to collect spills and leaks.
- Prices for recycled materials and fluids may be higher than those of non-recycled materials.

- Some facilities may be limited by a lack of providers of recycled materials, and by the absence of businesses to provide services such as hazardous waste removal, structural treatment practice maintenance, or solvent equipment and solvent recycling.

Potential Facilities and Maintenance Requirements

Facilities Requirements

- For facilities that already have covered areas where maintenance takes place, have berms or other means to retain spills and leaks, and/ have other appropriate constructed systems for containment, there may not need to be any significant new capital investment. Capital costs will likely be required at some sites if adequate cover and containment facilities do not exist and can vary significantly depending upon site conditions.

Maintenance Requirements

- Most of the operations and maintenance activity associated with implementing this BMP are integrally linked to routine operations as previously described. Therefore, significant additional operations and maintenance efforts are not likely to be required.

- For facilities responsible for pre-treating their wastewater prior to discharging, the proper functioning of structural treatment system is an important maintenance consideration. Routine cleanout of oil and grease is required for the devices to maintain their effectiveness, usually at least once a month. During periods of heavy rainfall, cleanout is required more often to ensure pollutants are not washed through the trap. Sediment removal is also required on a regular basis to keep the device working efficiently.

- It is important to sweep the maintenance area weekly, if it is paved, to collect loose particles, and wipe up spills with rags and other absorbent material immediately. Do not hose down the area to a storm drain.

Supplemental Information

Waste Reduction

Parts are often cleaned using solvents such as trichloroethylene, 1,1,1-trichloroethane or methylene chloride. Many of these cleaners are harmful and must be disposed of as a hazardous waste. Cleaning without using liquid cleaners (e.g., wire brush) whenever possible reduces waste. Prevent spills and drips of solvents and cleansers to the shop floor. Do all liquid cleaning at a centralized station so the solvents and residues stay in one area. Locate drip pans, drain boards, and drying racks to direct drips back into a solvent sink or fluid holding tank for reuse. Reducing the number of solvents makes recycling easier and reduces hazardous waste management costs. Often, one solvent can perform a job as well as two different solvents.

- Clean parts without using liquid cleaners whenever possible to reduce waste.

- Prevent spills and drips of solvents and cleansers to the shop floor.

- Do all liquid cleaning at a centralized station so the solvents and residues stay in one area.
- Locate drip pans, drain boards, and drying racks to direct drips back into a solvent sink or fluid holding tank for reuse.

Recycling

Separating wastes allows for easier recycling and may reduce treatment costs. Keep hazardous and non-hazardous wastes separate, do not mix used oil and solvents, and keep chlorinated solvents (e.g., 1,1,1-trichloroethane) separate from non-chlorinated solvents (e.g., kerosene and mineral spirits).

Many products made of recycled (i.e., refined or purified) materials are available. Engine oil, transmission fluid, antifreeze, and hydraulic fluid are available in recycled form. Buying recycled products supports the market for recycled materials.

- Recycling is always preferable to disposal of unwanted materials.
- Separate wastes for easier recycling. Keep hazardous and non-hazardous wastes separate, do not mix used oil and solvents, and keep chlorinated solvents separate from non-chlorinated solvents.
- Label and track the recycling of waste material (e.g., used oil, spent solvents, batteries).
- Purchase recycled products to support the market for recycled materials.

Safer Alternatives

If possible, eliminate or reduce the amount of hazardous materials and waste by substituting non-hazardous or less hazardous material:

- Use non-caustic detergents instead of caustic cleaning for parts cleaning.
- Use detergent-based or water-based cleaning systems in place of organic solvent degreasers. Wash water may require treatment before it can be discharged to the sewer.
- Replace chlorinated organic solvents with non-chlorinated solvents. Non-chlorinated solvents like kerosene or mineral spirits are less toxic and less expensive to dispose of properly. Check list of active ingredients to see whether it contains chlorinated solvents.
- Choose cleaning agents that can be recycled.

References and Resources

Orange County Stormwater Program, Best Management Practices for Industrial/Commercial Business Activities. Available online at: http://ocwatersheds.com/documents/bmp/industrialcommercialbusinessesactivities.

Oregon Department of Environmental Quality, 2013. *Industrial Stormwater Best Management Practices Manual- BMP 8 Vehicle, Pavement and Building Washing*. Available online at: http://www.deq.state.or.us/wq/wqpermit/docs/IndBMP021413.pdf.

Sacramento Stormwater Management Program. *Best Management Practices for Industrial Storm Water Pollution Control*. Available online at: http://www.msa.saccounty.net/sactostormwater/documents/guides/industrial-BMP-manual.pdf.

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Santa Clara Valley Urban Runoff Pollution Prevention Program http://www.scvurppp-w2k.com/.

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Washington State Department of Ecology, 2012. *Vehicle and Equipment Washwater Discharges Best Management Practices Manual*. Publication no. WQ-R-95-056. Available online at: https://fortress.wa.gov/ecy/publications/publications/95056.pdf.

Outdoor Loading/Unloading SC-30

Description

The loading/unloading of materials usually takes place outside on docks or terminals; therefore, materials spilled, leaked, or lost during loading/unloading may collect in the soil or on other surfaces and have the potential to be carried away by wind, stormwater runoff or when the area is cleaned. Additionally, rainfall may wash pollutants from machinery used to unload or move materials. Implementation of the following protocols will prevent or reduce the discharge of pollutants to stormwater from outdoor loading/unloading of materials.

Approach

Reduce potential for pollutant discharge through source control pollution prevention and BMP implementation. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives.

General Pollution Prevention Protocols

- ☐ Park tank trucks or delivery vehicles in designated areas so that spills or leaks can be contained.
- ☐ Limit exposure of material to rainfall whenever possible.
- ☐ Prevent stormwater run-on.
- ☐ Check equipment regularly for leaks.

Good Housekeeping

- ☐ Develop an operations plan that describes procedures for loading and/or unloading.
- ☐ Conduct loading and unloading in dry weather if possible.

Objectives
■ *Cover*
■ *Contain*
■ *Educate*
■ *Reduce/Minimize*
■ *Product Substitution*

Targeted Constituents	
Sediment	✓
Nutrients	✓
Trash	
Metals	✓
Bacteria	
Oil and Grease	✓
Organics	✓

Minimum BMPs Covered	
Good Housekeeping	✓
Preventative Maintenance	
Spill and Leak Prevention and Response	✓
Material Handling & Waste Management	✓
Erosion and Sediment Controls	
Employee Training Program	✓
Quality Assurance Record Keeping	✓

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- Cover designated loading/unloading areas to reduce exposure of materials to rain.
- Consider placing a seal or door skirt between delivery vehicles and building to prevent exposure to rain.
- Design loading/unloading area to prevent stormwater run-on, which would include grading or berming the area, and position roof downspouts so they direct stormwater away from the loading/unloading areas.
- Have employees load and unload all materials and equipment in covered areas such as building overhangs at loading docks if feasible.
- Load/unload only at designated loading areas.
- Use drip pans underneath hose and pipe connections and other leak-prone spots during liquid transfer operations, and when making and breaking connections. Several drip pans should be stored in a covered location near the liquid transfer area so that they are always available, yet protected from precipitation when not in use. Drip pans can be made specifically for railroad tracks. Drip pans must be cleaned periodically, and drip collected materials must be disposed of properly.
- Pave loading areas with concrete instead of asphalt.
- Avoid placing storm drains inlets in the area.
- Grade and/or berm the loading/unloading area with drainage to sump; regularly remove materials accumulated in sump.

Spill Response and Prevention Procedures

- Keep your spill prevention and control plan up-to-date or have an emergency spill cleanup plan readily available, as applicable.
- Contain leaks during transfer.
- Store and maintain appropriate spill cleanup materials in a location that is readily accessible and known to all employees.
- Ensure that employees are familiar with the site's spill control plan and proper spill cleanup procedures.
- Use drip pans or comparable devices when transferring oils, solvents, and paints.

Material Handling and Waste Management

- Spot clean leaks and drips routinely to prevent runoff of spillage.
- Do not pour liquid wastes into floor drains, sinks, outdoor storm drain inlets, or other storm drains or sewer connections.

- Do not put used or leftover cleaning solutions, solvents, and automotive fluids in the storm drain or sanitary sewer.
- Collect leaking or dripping fluids in drip pans or containers. Fluids are easier to recycle if kept separate.
- Promptly transfer used fluids to the proper waste or recycling drums. Do not leave drip pans or other open containers lying around.
- Minimize the possibility of stormwater pollution from outside waste receptacles by doing at least one of the following:
  - ✓ Use only watertight waste receptacle(s) and keep the lid(s) closed.
  - ✓ Grade and pave the waste receptacle area to prevent run-on of stormwater.
  - ✓ Install a roof over the waste receptacle area.
  - ✓ Install a low containment berm around the waste receptacle area.
  - ✓ Use and maintain drip pans under waste receptacles.
- Post "no littering" signs.
- Perform work area clean-up and dry sweep after daily operations.

Employee Training Program

- Train employees (e.g., fork lift operators) and contractors on proper spill containment and cleanup.
- Have employees trained in spill containment and cleanup present during loading/unloading.
- Train employees in proper handling techniques during liquid transfers to avoid spills.
- Make sure forklift operators are properly trained on loading and unloading procedures.

Quality Assurance and Record Keeping

- Keep accurate maintenance logs that document activities performed, quantities of materials removed, and improvement actions.
- Keep accurate logs of spill response actions that document what was spilled, how it was cleaned up, and how the waste was disposed.
- Establish procedures to complete logs and file them in the central office.
- Keep accurate logs of daily clean-up operations.

Potential Limitations and Work-Arounds

Some facilities may have space constraints, limited staffing and time limitations that may preclude implementation of BMPs. Provided below are typical limitations and recommended "work-arounds."

- Space and time limitations may preclude all transfers from being performed indoors or under cover.
  - ✓ Designate specific areas for outdoor loading and unloading.
  - ✓ Require employees to understand and follow spill and leak prevention BMPs.
- It may not be possible to conduct transfers only during dry weather.
  - ✓ Limit materials and equipment rainfall exposure to all extents practicable.
  - ✓ Require employees to understand and follow spill and leak prevention BMPs.

Potential Capital Facility Costs and Operation & Maintenance Requirements

Facilities

Many facilities will already have indoor or covered areas where loading/unloading takes place and will require no additional capital expenditures.

If outdoor activities are required, construction of berms or other means to retain spills and leaks may require appropriate constructed systems for containment. These containment areas may require significant new capital investment.

Capital investments will likely be required at some sites if adequate cover and containment facilities do not exist and can vary significantly depending upon site conditions.

Maintenance

Most of the operations and maintenance activities associated with implementing this BMP are integrally linked to routine operations as previously described. Therefore additional O&M is not required.

- Conduct regular inspections and make repairs and improvements as necessary.
- Check loading and unloading equipment regularly for leaks.
- Conduct regular broom dry-sweeping of area. Do not wash with water.

Supplemental Information

Loading and Unloading of Liquids

- Loading or unloading of liquids should occur in the manufacturing building so that any spills that are not completely retained can be discharged to the sanitary sewer,

treatment plant, or treated in a manner consistent with local sewer authorities and permit requirements.

- For loading and unloading tank trucks to above and below ground storage tanks, the following procedures should be used:
  - ✓ The area where the transfer takes place should be paved. If the liquid is reactive with the asphalt, Portland cement should be used to pave the area.
  - ✓ The transfer area should be designed to prevent run-on of stormwater from adjacent areas. Sloping the pad and using a curb, like a speed bump, around the uphill side of the transfer area should reduce run-on.
  - ✓ The transfer area should be designed to prevent runoff of spilled liquids from the area. Sloping the area to a drain should prevent runoff. The drain should be connected to a dead-end sump or to the sanitary sewer. A positive control valve should be installed on the drain.
- For transfer from rail cars to storage tanks that must occur outside, use the following procedures:
  - ✓ Drip pans should be placed at locations where spillage may occur, such as hose connections, hose reels, and filler nozzles. Use drip pans when making and breaking connections.
  - ✓ Drip pan systems should be installed between the rails to collect spillage from tank cars.

References and Resources

Minnesota Pollution Control Agency, *Industrial Stormwater Best Management Practices Guidebook BMP 26 Fueling and Liquid Loading/Unloading Operations*. Available online at: http://www.pca.state.mn.us/index.php/view-document.html?gid=10557.

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Santa Clara Valley Urban Runoff Pollution Prevention Program. http://www.scvurppp-w2k.com/.

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Outdoor Liquid Container Storage SC-31

Description

Accidental releases of materials from above ground liquid storage tanks, drums, and dumpsters present the potential for contaminating stormwater with many different pollutants. Tanks may store many potential stormwater runoff pollutants, such as gasoline, aviation gas, diesel fuel, kerosene, oils, greases, lubricants and other distilled, blended and refined products derived from crude petroleum. Materials spilled, leaked, or lost from storage tanks may accumulate in soils or on other surfaces and be carried away by rainfall runoff. These source controls apply to containers located outside of a building used to temporarily store liquid materials and include installing safeguards against accidental releases, installing secondary containment, conducting regular inspections, and training employees in standard operating procedures and spill cleanup techniques.

Approach

General Pollution Prevention Protocols

- ☐ Educate employees about pollution prevention measures and goals.
- ☐ Keep an accurate, up-to-date inventory of the materials delivered and stored on-site.
- ☐ Try to keep chemicals in their original containers, and keep them well labeled.
- ☐ Develop an operations plan that describes procedures for loading and/or unloading. Refer to SC-30 Outdoor Loading/Unloading of Materials for more detailed BMP information pertaining to loading and unloading of liquids.
- ☐ Protect materials from rainfall, run-on, runoff, and wind dispersal:
  - ✓ Cover the storage area with a roof.

Objectives
■ *Cover*
■ *Contain*
■ *Educate*
■ *Reduce/Minimize*

Targeted Constituents	
Sediment	
Nutrients	✓
Trash	
Metals	✓
Bacteria	
Oil and Grease	✓
Organics	✓

Minimum BMPs Covered	
Good Housekeeping	
Preventative Maintenance	✓
Spill and Leak Prevention and Response	✓
Material Handling & Waste Management	✓
Erosion and Sediment Controls	
Employee Training Program	✓
Quality Assurance Record Keeping	✓

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- ✓ Minimize stormwater run-on by enclosing the area or building a berm around it.
- ✓ Use a walled structure for storage of liquid containers.
- ✓ Use only watertight containers and keep the lids closed.

- ☐ Employ safeguards against accidental releases:
  - ✓ Provide overflow protection devices to warn operator or automatic shutdown transfer pumps.
  - ✓ Provide protection guards (bollards) around tanks and piping to prevent damage from a vehicle or forklift.
  - ✓ Provide clear tagging or labeling, and restrict access to valves to reduce human error.
  - ✓ Berm or surround tank or container with secondary containment system, including dikes, liners, vaults, or double walled tanks.
  - ✓ Be aware and ready to address the fact that some municipalities require secondary containment areas to be connected to the sanitary sewer, prohibiting any hard connections to the storm drain.
  - ✓ Contact the appropriate regulatory agency regarding environmental compliance for facilities with "spill ponds" designed to intercept, treat, and/or divert spills.
  - ✓ Have registered and specifically trained professional engineers identify and correct potential problems such as loose fittings, poor welding, and improper or poorly fitted gaskets for newly installed tank systems.
- ☐ Use MSDSs to ID hazardous components and keep incompatible products apart and to list/have available appropriate PPE and clean-up products.

Good Housekeeping

- ☐ Provide storage tank piping located below product level with a shut-off valve at the tank; ideally this valve should be an automatic shear valve with the shut-off located inside the tank.
- ☐ Provide barriers such as posts or guardrails, where tanks are exposed, to prevent collision damage with vehicles.
- ☐ Provide secure storage to prevent vandalism-caused contamination.
- ☐ Place tight-fitting lids on containers.

- Enclose or cover the containers where they are stored.
- Raise the containers off the ground by use of pallet or similar method, with provisions for spill control.
- Do not store liquid containers near the storm drainage system or surface waters.
- Sweep and clean the storage area regularly if it is paved, do not hose down the area to a storm drain.

Preventative Maintenance

- Inspect storage areas regularly for leaks or spills.
- Conduct routine inspections and check for external corrosion of material containers. Also check for structural failure, spills and overfills due to operator error, failure of piping system.
- Check for leaks or spills during pumping of liquids or gases from truck or rail car to a storage facility or vice versa.
- Visually inspect new tank or container installations for loose fittings, poor welding, and improper or poorly fitted gaskets.
- Inspect tank foundations, connections, coatings, and tank walls and piping system. Look for corrosion, leaks, cracks, scratches, and other physical damage that may weaken the tank or container system.
- Replace containers that are leaking, corroded, or otherwise deteriorating with ones in good condition. If the liquid chemicals are corrosive, containers made of compatible materials must be used instead of metal drums.
- New or secondary containers must be labeled with the product name and hazards.

Spill Response and Prevention Procedures

- Keep your spill prevention and control plan up-to-date.
- Maintain an adequate stockpile of spill cleanup materials at locations where it will be readily accessible.
- Have an emergency plan, equipment, and trained personnel ready at all times to deal immediately with major spills.
- Collect spilled liquids and properly dispose of them.
- Remove the adsorbent materials promptly and dispose of properly when using adsorbent materials on small spills.
- Have employees trained in emergency spill cleanup procedures present when dangerous waste, liquid chemicals, or other wastes are delivered.

- Prevent operator errors by using engineering safeguards and thus reducing accidental releases of pollutants.

Material Handling and Waste Management

- Contain the material in such a manner that if the container leaks or spills, the contents will not discharge, flow, or be washed into the storm drainage system, surface waters or groundwater.
- Place drip pans or absorbent materials beneath mounted container taps, and at potential drip and spill locations during filling and unloading of containers. Any collected liquids or soiled absorbent materials must be reused/recycled or properly disposed.
- Ensure that any underground or aboveground storage tanks are designed and managed in accordance with applicable regulations, identified as a potential pollution source, and have secondary containment such as a berm or dike with an impervious surface.
- Do not pour liquids into floor drains, sinks, outdoor storm drain inlets, or other storm drains or sewer connections.
- Collect leaking or dripping fluids in drip pans or containers. Fluids are easier to recycle if kept separate.
- Promptly transfer used fluids to the proper waste or recycling drums. Do not leave drip pans or other open containers lying around.

Employee Training Program

- Train employee (e.g., fork lift operators) and contractors in proper spill containment and cleanup. The employee should have the tools and knowledge to immediately begin cleaning up a spill if one should occur.
- Train employees in proper spill response and prevention, materials handling, and waste management.
- Use a training log or similar method to document training.

Quality Assurance and Record Keeping

- Keep accurate maintenance/inspection logs that document minimum BMP activities performed for liquid container storage and improvement actions.
- Keep accurate logs of spill response actions that document what was spilled, how it was cleaned up, and how the waste was disposed.
- Establish procedures to complete logs and file them in the central office.

Other Facility-Specific Considerations

- Storage sheds often must meet building and fire code requirements.

- The local fire district must be consulted for limitations on clearance of roof covers over containers used to store flammable materials.
- All specific standards set by Federal and State laws concerning the storage of oil and hazardous materials must be met.
- Storage of reactive, ignitable, or flammable liquids should comply with the Uniform Fire Code and the National Electric Code.
- Storage of oil and hazardous materials must meet specific Federal and State standards including:
  - ✓ Spill Prevention Control and Countermeasure Plan (SPCC) Plan;
  - ✓ Secondary containment;
  - ✓ Integrity and leak detection monitoring; and
  - ✓ Emergency preparedness plans.

Potential Capital Facility Costs and Operation & Maintenance Requirements

Facilities

- Capital investments such as sheds, covers, dikes, and curbs will likely be required at some sites if adequate cover and containment facilities do not exist and can vary significantly depending upon site conditions.

Maintenance

- Most of the operations and maintenance activities associated with implementing this BMP are integrally linked to routine operations as previously described. Therefore additional O&M is not required.
- Conduct regular inspections and make repairs and improvements as necessary.
- Conduct regular broom dry-sweeping of area. Do not wash with water.

Supplemental Information

The most common causes of unintentional releases are:

- Installation problems;
- Failure of piping systems (pipes, pumps, flanges, couplings, hoses, and valves);
- External corrosion and structural failure;
- Spills and overfills due to operator error; and
- Leaks during pumping of liquids or gases from truck or rail car to a storage tank or vice versa.

Aboveground Tank Leak and Spill Control

Storage of reactive, ignitable, or flammable liquids should comply with the Uniform Fire Code and the National Electric Code. Practices listed below should be employed to enhance the code requirements:

- Tanks should be placed in a designated area.
- Tanks located in areas where firearms are discharged should be encapsulated in concrete or the equivalent.
- Designated areas should be paved with Portland cement concrete, free of cracks and gaps, and impervious in order to contain leaks and spills.
- Liquid materials should be stored in UL approved double walled tanks or surrounded by a curb or dike to provide the volume to contain 10% of the volume of the containers or 110% of the volume of the largest container, whichever is greater. The area inside the curb should slope to a drain.
- For used oil or dangerous waste, a dead-end sump should be installed in the drain.
- Other liquids should be drained to the sanitary sewer if available. The drain must have a positive control such as a lock, valve, or plug to prevent release of contaminated liquids.
- Accumulated stormwater in petroleum storage areas should be passed through an oil/water separator.

Maintenance is critical to preventing leaks and spills. Conduct routine weekly inspections and:

- Check for external corrosion and structural failure.
- Check for spills and overfills due to operator error.
- Check for failure of piping system (pipes, pumps, flanger, coupling, hoses, and valves).
- Check for leaks or spills during pumping of liquids or gases from truck or rail car to a storage facility or vice versa.
- Inspect new tank or container installation visually for loose fittings, poor welding, and improper or poorly fitted gaskets.
- Inspect tank foundations, connections, coatings, and tank walls and piping system. Look for corrosion, leaks, cracks, scratches, and other physical damage that may weaken the tank or container system.
- Frequently release accumulated stormwater during the wet season.
- Have periodic integrity testing conducted by a qualified professional.

Dikes

One of the best protective measures against contamination of stormwater is the use of dikes. Containment dikes are berms or retaining walls that are designed to hold spills. Use of dikes is an effective pollution prevention measure for above ground storage tanks and railcar or tank truck loading and unloading areas. The dike surrounds the area of concern and holds the spill, keeping spill materials separated from the stormwater side of the dike area. Diking can be used in any industrial or municipal facility, but it is most commonly used for controlling large spills or releases from liquid storage areas and liquid transfer areas.

- For single-wall tanks, containment dikes should be large enough to hold the contents of the storage tank for the facility plus rain water.
- For trucks, diked areas should be capable of holding an amount equal to the volume of the tank truck compartment. Diked construction material should be strong enough to safely hold spilled materials.
- Dike materials can consist of earth, concrete, synthetic materials, metal, or other impervious materials.
- Strong acids or bases may react with metal containers, concrete, and some plastics.
- Where strong acids or bases or stored, alternative dike materials should be considered. More active organic chemicals may need certain special liners for dikes.
- Dikes may also be designed with impermeable materials to increase containment capabilities.
- Dikes should be inspected during or after significant storms or spills to check for washouts or overflows.
- Regular checks of containment dikes to insure the dikes are capable of holding spills should be conducted.
- Inability of a structure to retain stormwater, dike erosion, soggy areas, or changes in vegetation indicate problems with dike structures. Damaged areas should be patched and stabilized immediately.
- Earthen dikes may require special maintenance of vegetation such as mulching and irrigation.
- Remove accumulated stormwater after precipitation events and dispose of according to local regulations.

Curbing

Curbing is a barrier that surrounds an area of concern. Curbing is similar to containment diking in the way that it prevents spills and leaks from being released into the environment. Curbing is usually small scaled and does not contain large spills to the degree that dikes can. Curbing is common at many facilities in small areas where

handling and transfer of liquid materials occur. Curbing can redirect contaminated stormwater away from the storage area. It is useful in areas where liquid materials are transferred from one container to another. Asphalt is a common material used for curbing; however, curbing materials can include earth, concrete, synthetic materials, metal, or other impenetrable materials.

- Spilled materials should be removed immediately from curbed areas to allow space for future spills.
- Curbs should have manually-controlled pump systems rather than common drainage systems for collection of spilled materials.
- The curbed area should be inspected regularly to clear clogging debris.
- Maintenance should also be conducted frequently to prevent overflow of any spilled materials as curbed areas are designed only for smaller spills.
- Remove accumulated stormwater after precipitation events and dispose of according to local regulations.
- Curbing has the following advantages:
  - ✓ Excellent run-on control;
  - ✓ Inexpensive;
  - ✓ Ease of installment;
  - ✓ Provides option to recycle materials spilled in curb areas; and
  - ✓ Common industry practice.

References and Resources

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Outdoor Equipment Operations SC-32

Description

Outside process equipment operations and maintenance can contaminate stormwater runoff. Activities, such as grinding, painting, coating, sanding, degreasing or parts cleaning, landfills and waste piles, and solid waste treatment and disposal are examples of process operations that can lead to contamination of stormwater runoff. The targeted constituents will vary for each site depending on the operation being performed.

Approach

Implement source control BMPs to limit exposure of outdoor equipment to direct precipitation and stormwater run-on. Refer to SC-22 Vehicle and Equipment Repair for additional information.

General Pollution Prevention Protocols

- ☐ Perform the activity during dry periods whenever possible.
- ☐ Install secondary containment measures where leaks and spills may occur.
- ☐ Use non-toxic chemicals for maintenance and minimize or eliminate the use of solvents.
- ☐ Connect process equipment area to public sanitary sewer or facility wastewater treatment system when possible. Some jurisdictions require that secondary containment areas be connected to the sanitary sewer, prohibiting any hard connections to the storm drain.

Good Housekeeping

- ☐ Manage materials and waste properly (see Material Handling and Waste Management) to reduce adverse impacts on stormwater quality.

Objectives
■ *Cover*
■ *Contain*
■ *Educate*
■ *Reduce/Minimize*

Targeted Constituents	
Sediment	✓
Nutrients	✓
Trash	✓
Metals	✓
Bacteria	✓
Oil and Grease	✓
Organics	✓

Minimum BMPs Covered	
Good Housekeeping	✓
Preventative Maintenance	✓
Spill and Leak Prevention and Response	✓
Material Handling & Waste Management	✓
Erosion and Sediment Controls	
Employee Training Program	✓
Quality Assurance Record Keeping	✓

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- Cover the work area with a permanent roof if possible.
- Use drop cloths for sanding and painting operations.
- Use a vacuum for fine particle clean-up in pavement cracks and crevices.
- Minimize contact of stormwater with outside process equipment operations through berming and drainage routing (run-on prevention).
- "Spot clean" leaks and drips routinely. Leaks are not cleaned up until the absorbent is picked up and disposed of properly.
- Paint signs on storm drain inlets to indicate that they are not to receive liquid or solid wastes.
- Use roll down or permanent walls when windy/breezy to prevent wind transport of particulates/pollutants.

Preventative Maintenance

- Design outdoor equipment areas to prevent stormwater runoff and spills. Use a perimeter drain or slope pavement inward with drainage to sump.
- Dry clean the work area regularly. Do not wash outdoor equipment with water if there is a direct connection to the storm drain.
- Pave area with concrete rather than asphalt.
- Inspect outdoor equipment regularly for leaks or spills. Also check for structural failure, spills and overfills due to operator error, and/or failure of piping system.
- Inspect and clean, if necessary, storm drain inlets and catch basins within the outdoor equipment area before October 1 each year.

Spill Response and Prevention Procedures

- Keep your Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date.
- Have employees trained in emergency spill cleanup procedures present when dangerous waste, liquid chemicals, or other wastes are delivered.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- Prevent operator errors by using engineering safe guards and thus reducing accidental releases of pollutant.

Material Handling and Waste Management

- Do not pour liquid wastes into floor drains, sinks, outdoor storm drain inlets, or other storm drain or sewer connections.
- Collect leaking or dripping fluids in drip pans or containers. Fluids are easier to recycle if kept separate.
- Promptly transfer used fluids to the proper waste or recycling drums. Do not leave drip pans or other open containers lying around.
- Minimize the possibility of stormwater pollution from outside waste receptacles by doing at least one of the following:
  - ✓ Use only watertight waste receptacle(s) and keep the lid(s) closed.
  - ✓ Grade and pave the waste receptacle area to prevent run-on of stormwater.
  - ✓ Install a roof over the waste receptacle area.

Employee Training Program

- Educate employees about pollution prevention measures and goals.
- Train employees on proper equipment operation and maintenance procedures.
- Train all employees upon hiring and annually thereafter on proper methods for handling and disposing of waste. Ensure that all employees understand stormwater discharge prohibitions, wastewater discharge requirements, and these best management practices.
- Use a training log or similar method to document training.
- Ensure that employees are familiar with the site's spill control plan and/or proper spill cleanup procedures.

Quality Assurance and Record Keeping

- Keep accurate maintenance logs that document minimum BMP activities performed for outdoor equipment, types and quantities of materials removed and disposed of, and any improvement actions.
- Keep accurate logs of spill response actions that document what was spilled, how it was cleaned up, and how the waste was disposed.
- Establish procedures to complete logs and file them in the central office.

Potential Limitations and Work-Arounds

Some facilities may have space constraints, limited staffing and time limitations that may preclude implementation of BMPs. Provided below are typical limitations and recommended "work-arounds."

- Providing cover over outdoor equipment may be impractical or cost-prohibitive.
  - ✓ Operate outdoor equipment only during periods of dry weather.
- Regular operations and time limitations may require outdoor activities during wet weather.
  - ✓ Designate specific areas for outdoor activities.
  - ✓ Allow time for work area clean-up after each shift.
  - ✓ Require employees to understand and follow preventive maintenance and spill and leak prevention BMPs.
  - ✓ Design and install secondary containment and good housekeeping BMPs for outdoor equipment area.
- Storage sheds often must meet building and fire code requirements.

Potential Capital Facility Costs and Operation & Maintenance Requirements

Facilities

- Many facilities will already have indoor covered areas where vehicle and equipment repairs take place and will require no additional capital expenditures.
- If outdoor activities are required, construction of berms or other means to retain spills and leaks may require appropriate constructed systems for containment. These containment areas may require significant new capital investment.
- Capital investments will likely be required at some sites if adequate cover and containment facilities do not exist and can vary significantly depending upon site conditions.

Maintenance

- Most of the operations and maintenance activities associated with implementing this BMP are integrally linked to routine operations as previously described. Therefore additional O&M is not required.
- For facilities responsible for pre-treating their wastewater prior to discharging, the proper functioning of structural treatment system is an important maintenance consideration.
- Routine cleanout of oil and grease is required for the devices to maintain their effectiveness, usually at least once a month. During periods of heavy rainfall, cleanout is required more often to ensure pollutants are not washed through the trap. Sediment removal is also required on a regular basis to keep the device working efficiently.

References and Resources

Minnesota Pollution Control Agency. *Industrial Stormwater Best Management Practices Guidebook BMP 26 Fueling and Liquid Loading/Unloading Operations*. Available online at: http://www.pca.state.mn.us/index.php/view-document.html?gid=10557.

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Sacramento County Environmental Management Stormwater Program: Best Management Practices. Available online at: http://www.emd.saccounty.net/EnvHealth/Stormwater/Stormwater-BMPs.html.

Santa Clara Valley Urban Runoff Pollution Prevention Program. http://www.scvurppp-w2k.com/

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Outdoor Storage of Raw Materials SC-33

Description

Stockpiles of raw materials, by-products, and finished products exposed to rain and/or runoff can pollute stormwater. Stormwater can become contaminated when materials wash off or dissolve into water due to improper storage and containment. To prevent or reduce the discharge of pollutants to stormwater from raw material delivery and storage, pollution prevention and source control measures must be implemented, such as minimizing the storage of hazardous materials on-site, enclosing or covering materials, storing materials in a designated area, installing secondary containment, conducting regular inspections, preventing stormwater run-on and runoff, and training employees and subcontractors. This fact sheet focuses on source control BMPs for stockpiles of solid materials; if the raw material, by-product, or product is a liquid, more information for outside storage of liquids can be found under SC-31 Outdoor Liquid Container Storage.

Approach

Reduce potential for pollutant discharge through source control pollution prevention and BMP implementation. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives.

General Pollution Prevention Protocols

- ☐ Emphasize employee education for successful BMP implementation.
- ☐ Store materials that could contaminate stormwater inside or under permanent cover. If this is not feasible, then all outside storage areas should be covered with a roof and bermed or enclosed to prevent stormwater contact.
- ☐ Elevate and tarp solid materials such as beams, metal, etc.
- ☐ Minimize the inventory of raw materials kept outside.

Objectives
■ *Cover*
■ *Contain*
■ *Educate*
■ *Reduce/Minimize*

Targeted Constituents	
Sediment	✓
Nutrients	✓
Trash	
Metals	✓
Bacteria	
Oil and Grease	✓
Organics	✓

Minimum BMPs Covered	
Good Housekeeping	✓
Preventative Maintenance	✓
Spill and Leak Prevention and Response	✓
Material Handling & Waste Management	
Erosion and Sediment Controls	✓
Employee Training Program	✓
Quality Assurance Record Keeping	✓

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- Keep an accurate, up-to-date inventory of the materials delivered and stored on-site.
- Stormwater runoff that could potentially be contaminated by materials stored outdoors should be drained to the sanitary sewer if available. The drain must have a positive control such as a lock, valve, or plug to prevent release of contaminated liquids.

Good Housekeeping

- If raw materials cannot all be stored inside or under permanent cover, prevent exposure to direct precipitation and stormwater run-on by installing a storm- resistant waterproof covering made of polyethylene, polypropylene or hypalon over all materials stored outside. The covers must be in place at all times when work with the stockpiles is not occurring (Applicable to small stockpiles only).
- Implement erosion control practices at the perimeter of the facilty site and at any catch basins to prevent erosion of the stockpiled material off-site, if the stockpiles are so large that they cannot feasibly be covered and contained.
- Minimize stormwater run-on by enclosing the area or building a berm around it.
- Keep storage areas clean and dry.
- Slope paved areas in a manner that minimizes pooling of water on the site, particularly with materials that may leach pollutants into stormwater and/or groundwater, such as compost, logs, and wood chips. A minimum slope of 1.5% is recommended.
- Secure drums stored in an area where unauthorized persons may not gain access to prevent accidental spillage, pilferage, or any unauthorized use.
- Install curbing or berms along the perimeter of the area to prevent the run-on of uncontaminated stormwater from adjacent areas as well as runoff of stormwater from the stockpile areas.
- Slope the area inside the curb or berm to a drain with sump. The sump should be equipped with an oil and water separator if applicable for materials stored onsite.
- Do not store materials on top of or directly adjacent to storm drain inlets.
- Cover wood products treated with chromated copper arsenate, ammonical copper zinc arsenate, creosote, or pentachlorophenol with properly secured tarps or store indoors.

Preventative Maintenance

- Maintain outdoor storage containers in good condition. Replace leaky or otherwise inadequate containers as necessary.
- Maintain outdoor waterproof covers (e.g., tarps) in good condition and properly secure them to be storm resistant. Replace tarps damaged by UV exposure or wear and tear on a regular basis.

- Perform routine inspection of storm drains and sumps and regularly remove accumulated materials.
- Dry clean the work area regularly. Do not wash outdoor material storage areas with water if there is a direct connection to the storm drain.
- Pave outdoor storage areas for liquids such as solvents with concrete rather than asphalt.
- Conduct regular inspections of storage areas so that leaks and spills are detected as soon as possible.
- Routinely inspect berms, curbing, containment, and sediment controls for proper function and repair as necessary.

Spill and Leak Prevention and Response

- Keep the facility spill prevention and control plan up-to-date.
- Place a stockpile of spill cleanup materials, such as brooms, dustpans, and vacuum sweepers (if desired) near the storage area where it will be readily accessible.
- Have employees trained in spill containment and cleanup present during the loading/unloading of hazardous or otherwise dangerous materials.

Erosion and Sediment Controls

- Keep materials covered to prevent erosion of stockpiles. This may not be feasible for large stockpiles.
- Install sediment controls such as fiber rolls around the perimeter of stockpiles to prevent transport of raw materials to the storm drain.
- Install drain inlet protection around all inlets to prevent raw materials from entering storm drain.
- Install sediment controls such as silt fence around the perimeter of the site to prevent transport of raw materials to the storm drain or offsite surface waters.

Employee Training Program

- Educate employees about pollution prevention measures and goals.
- Train employees how to properly store outdoor raw materials using the source control BMPs described above.
- Use a training log or similar method to document training.
- Ensure that employees are familiar with the site's spill control plan and/or proper spill cleanup procedures.

Quality Assurance and Record Keeping

- Keep accurate maintenance logs that document minimum BMP activities performed for outdoor storage of raw materials, types and quantities of materials removed and disposed of, and any improvement actions.
- Keep accurate logs of spill response actions that document what was spilled, how it was cleaned up, and how the waste was disposed.
- Establish procedures to complete logs and file them in the central office.

Other Facility-Specific Considerations

- Storage sheds often must meet building and fire code requirements. Storage of reactive, ignitable, or flammable liquids must comply with the Uniform Fire Code and the National Electric Code.
- Some municipalities require that secondary containment areas (regardless of size) be connected to the sanitary sewer, prohibiting any hard connections to the storm drain.
- The local fire district must be consulted for limitations on clearance of roof covers over containers used to store flammable materials.

Potential Limitations and Work-Arounds

Some facilities may have space constraints, limited staffing and time limitations that may preclude implementation of BMPs. Provided below are typical limitations and recommended "work-arounds"

- Space limitations may preclude storing all materials indoors.
  - ✓ Implement good housekeeping, preventative maintenance, and erosion and sediment controls as described above.

Potential Capital Facility Costs and Operation & Maintenance Requirements

Facilities

- Many facilities will already have indoor covered areas where raw materials will be stored and will require no additional capital expenditures.
- If outdoor storage of materials is required, construction of berms or other means to prevent stormwater run-on and runoff may require appropriate constructed systems for containment. These containment areas may require significant new capital investment.
- Purchase and installation of erosion and sediment controls will require additional capital investments, and this amount will vary depending on site characteristics.
- Capital investments will likely be required at some sites if adequate cover and containment facilities do not exist and can vary significantly depending upon site conditions.

Maintenance

- Accurate and up-to-date inventories should be kept of all stored materials.
- Berms and curbs may require periodic repair and patching.
- Parking lots or other surfaces near bulk materials storage areas should be swept periodically to remove debris blown or washed from storage areas.
- Sweep paved storage areas regularly for collection and disposal of loose solid materials, do not hose down the area to a storm drain or conveyance ditch.
- Erosion and sediment controls require regular inspection and periodic replacement or reinstallation.

Supplemental Information

Raw Material Containment

Paved areas should be sloped in a manner that minimizes pooling of water on the site, particularly with materials that may leach pollutants into stormwater and/or groundwater, such as compost, logs, and wood chips. A minimum slope of 1.5% is recommended.

- Curbing or berms should be placed along the perimeter of the area to prevent the run-on of uncontaminated stormwater from adjacent areas as well as runoff of stormwater from stockpile areas.
- The storm drainage system should be designed to minimize use of catch basins in the interior of the area as they tend to rapidly fill with manufacturing material.

The area should be sloped to drain stormwater to the perimeter where it can be collected or to internal drainage alleyways where material is not stockpiled.

The “doghouse” design has been used to store small liquid containers. The roof and flooring design prevent contact with direct rain or runoff. The doghouse has two solid structural walls and two canvas covered walls. The flooring is wire mesh about secondary containment.

References and Resources

Minnesota Pollution Control Agency, *Industrial Stormwater Best Management Practices Guidebook*. Available online at: http://www.pca.state.mn.us/index.php/view-document.html?gid=10557.

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US EPA. National Pollutant Discharge Elimination System – Industrial Fact Sheet Series for Activities Covered by EPA's Multi Sector General Permit. Available online at: http://cfpub.epa.gov/npdes/stormwater/swsectors.cfm.

Waste Handling & Disposal SC-34

Description

Improper storage and handling of solid wastes can allow toxic compounds, oils and greases, heavy metals, nutrients, suspended solids, and other pollutants to enter stormwater runoff. The discharge of pollutants to stormwater from waste handling and disposal can be prevented and reduced by tracking waste generation, storage, and disposal; reducing waste generation and disposal through source reduction, reuse, and recycling; and preventing run-on and runoff.

Approach

Reduce potential for pollutant discharge through source control pollution prevention and BMP implementation. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives.

General Pollution Prevention Protocols

- ☐ Accomplish reduction in the amount of waste generated using the following source controls:
  - ✓ Production planning and sequencing;
  - ✓ Process or equipment modification;
  - ✓ Raw material substitution or elimination;
  - ✓ Loss prevention and housekeeping;
  - ✓ Waste segregation and separation; and
  - ✓ Close loop recycling.
- ☐ Establish a material tracking system to increase awareness about material usage. This may reduce spills and minimize contamination, thus reducing the amount of waste produced.
- ☐ Recycle materials whenever possible.

Objectives
■ *Cover*
■ *Contain*
■ *Educate*
■ *Reduce/Minimize*
■ *Product Substitution*

Targeted Constituents	
Sediment	
Nutrients	
Trash	
Metals	✓
Bacteria	✓
Oil and Grease	✓
Organics	✓

Minimum BMPs Covered	
Good Housekeeping	✓
Preventative Maintenance	✓
Spill and Leak Prevention and Response	✓
Material Handling & Waste Management	✓
Erosion and Sediment Controls	
Employee Training Program	✓
Quality Assurance Record Keeping	✓

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- Use the entire product before disposing of the container.
- To the extent possible, store wastes under cover or indoors after ensuring all safety concerns such as fire hazard and ventilation are addressed.
- Provide containers for each waste stream at each work station. Allow time after shift to clean area.

Good Housekeeping

- Cover storage containers with leak proof lids or some other means. If waste is not in containers, cover all waste piles (plastic tarps are acceptable coverage) and prevent stormwater run-on and runoff with a berm. The waste containers or piles must be covered except when in use.
- Use drip pans or absorbent materials whenever grease containers are emptied by vacuum trucks or other means. Grease cannot be left on the ground. Collected grease must be properly disposed of as garbage.
- Dispose of rinse and wash water from cleaning waste containers into a sanitary sewer if allowed by the local sewer authority. Do not discharge wash water to the street or storm drain. Clean in a designated wash area that drains to a clarifier.
- Transfer waste from damaged containers into safe containers.
- Take special care when loading or unloading wastes to minimize losses. Loading systems can be used to minimize spills and fugitive emission losses such as dust or mist. Vacuum transfer systems can minimize waste loss.
- Keep the waste management area clean at all times by sweeping and cleaning up spills immediately.
- Use dry methods when possible (e.g., sweeping, use of absorbents) when cleaning around restaurant/food handling dumpster areas. If water must be used after sweeping/using absorbents, collect water and discharge through grease interceptor to the sewer.
- Stencil or demarcate storm drains on the facility's property with prohibitive message regarding waste disposal.
- Cover waste piles with temporary covering material such as reinforced tarpaulin, polyethylene, polyurethane, polypropylene or hypalon.
- If possible, move the activity indoor after ensuring all safety concerns such as fire hazard and ventilation are addressed.

Preventative Maintenance

- Prevent stormwater run-on from entering the waste management area by enclosing the area or building a berm around the area.
- Prevent waste materials from directly contacting rain.

- Cover waste piles with temporary covering material such as reinforced tarpaulin, polyethylene, polyurethane, polypropylene or hypalon.
- Cover the area with a permanent roof if feasible.
- Cover dumpsters to prevent rain from washing waste out of holes or cracks in the bottom of the dumpster.
- Check waste containers weekly for leaks and to ensure that lids are on tightly. Replace any that are leaking, corroded, or otherwise deteriorating.
- Sweep and clean the waste management area regularly. Use dry methods when possible (e.g., sweeping, vacuuming, use of absorbents) when cleaning around restaurant/food handling dumpster areas. If water must be used after sweeping/using absorbents, collect water and discharge through grease interceptor to the sewer.
- Inspect and replace faulty pumps or hoses regularly to minimize the potential of releases and spills.
- Repair leaking equipment including valves, lines, seals, or pumps promptly.

Spill Response and Prevention Procedures

- Keep your spill prevention and plan up-to-date.
- Have an emergency plan, equipment and trained personnel ready at all times to deal immediately with major spills.
- Collect all spilled liquids and properly dispose of them.
- Store and maintain appropriate spill cleanup materials in a location known to all near the designated wash area.
- Ensure that vehicles transporting waste have spill prevention equipment that can prevent spills during transport. Spill prevention equipment includes:
  - ✓ Vehicles equipped with baffles for liquid waste; and
  - ✓ Trucks with sealed gates and spill guards for solid waste.

Material Handling and Waste Management

Litter Control

- Post “No Littering” signs and enforce anti-litter laws.
- Provide a sufficient number of litter receptacles for the facility.
- Clean out and cover litter receptacles frequently to prevent spillage.

Waste Collection

- Keep waste collection areas clean.

- Inspect solid waste containers for structural damage regularly. Repair or replace damaged containers as necessary.
- Secure solid waste containers; containers must be closed tightly when not in use.
- Do not fill waste containers with washout water or any other liquid.
- Ensure that only appropriate solid wastes are added to the solid waste container. Certain wastes such as hazardous wastes, appliances, fluorescent lamps, pesticides, etc., may not be disposed of in solid waste containers (see chemical/ hazardous waste collection section below).
- Do not mix wastes; this can cause chemical reactions, make recycling impossible, and complicate disposal. Affix labels to all waste containers.

Chemical/Hazardous Wastes

- Select designated hazardous waste collection areas on-site.
- Store hazardous materials and wastes in covered containers and protect them from vandalism.
- Place hazardous waste containers in secondary containment.
- Make sure that hazardous waste is collected, removed, and disposed of only at authorized disposal areas.
- Hazardous waste cannot be reused or recycled; it must be disposed of by a licensed hazardous waste hauler.

Employee Training Program

- Educate employees about pollution prevention measures and goals.
- Train employees how to properly handle and dispose of waste using the source control BMPs described above.
- Train employees and subcontractors in proper hazardous waste management.
- Use a training log or similar method to document training.
- Ensure that employees are familiar with the site's spill control plan and/or proper spill cleanup procedures.

Quality Assurance and Record Keeping

- Keep accurate maintenance logs that document minimum BMP activities performed for waste handling and disposal, types and quantities of waste disposed of, and any improvement actions.
- Keep accurate logs of spill response actions that document what was spilled, how it was cleaned up, and how the waste was disposed.

- Establish procedures to complete logs and file them in the central office.

Potential Capital Facility Costs and Operation & Maintenance Requirements

Facilities

- Capital costs will vary substantially depending on the size of the facility and the types of waste handled. Significant capital costs may be associated with reducing wastes by modifying processes or implementing closed-loop recycling.
- Many facilities will already have indoor covered areas where waste materials will be stored and will require no additional capital expenditures for providing cover.
- If outdoor storage of wastes is required, construction of berms or other means to prevent stormwater run-on and runoff may require appropriate constructed systems for containment.
- Capital investments will likely be required at some sites if adequate cover and containment facilities do not exist and can vary significantly depending upon site conditions.

Maintenance

- Check waste containers weekly for leaks and to ensure that lids are on tightly. Replace any that are leaking, corroded, or otherwise deteriorating.
- Sweep and clean the waste management area regularly. Use dry methods when possible (e.g., sweeping, use of absorbents) when cleaning around restaurant/food handling dumpster areas. If water must be used after sweeping/using absorbents, collect water and discharge through grease interceptor to the sewer.
- Inspect and replace faulty pumps or hoses regularly to minimize the potential of releases and spills.
- Repair leaking equipment including valves, lines, seals, or pumps promptly.

References and Resources

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Contaminated or Erodible Areas SC-40

Description

Areas within an industrial site that are bare of vegetation or are subject to activities that promote the suppression of vegetation are often subject to erosion. In addition, they may or may not be contaminated from past or current activities. If the area is temporarily bare because of construction, see SC-42 Building Repair, Remodeling, and Construction. Sites with excessive erosion or the potential for excessive erosion should consider employing the soil erosion BMPs identified in the Construction BMP Handbook. Note that this fact sheet addresses soils that do not exceed hazardous waste criteria (see Title 22 California Code of Regulations for Hazardous Waste Criteria).

Approach

Reduce potential for pollutant discharge through source control pollution prevention and BMP implementation. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives.

General Pollution Prevention Protocols

Implement erosion and sediment control BMPs to stabilize soils and reduce pollutant discharges from contaminated or erodible surfaces.

Erosion and Sediment Controls

- ☐ Preserve natural vegetation whenever possible. See also EC-2 Preservation of Existing Vegetation, in the Construction BMP Handbook.
- ☐ Analyze soil conditions.
- ☐ Remove contaminated soil and dispose of properly.
- ☐ Stabilize loose soils by re-vegetating whenever possible. See also EC-4 Hydroseeding, in the Construction BMP Handbook.

Objectives
■ *Cover*
■ *Contain*
■ *Educate*
■ *Reduce/Minimize*
■ *Product Substitution*

Targeted Constituents	
Sediment	✓
Nutrients	✓
Trash	
Metals	✓
Bacteria	✓
Oil and Grease	✓
Organics	✓

Minimum BMPs Covered	
Good Housekeeping	
Preventative Maintenance	
Spill and Leak Prevention and	
Material Handling & Waste Management	
Erosion and Sediment Controls	✓
Employee Training Program	✓
Quality Assurance Record Keeping	✓

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- Utilize non-vegetative stabilization methods for areas prone to erosion where vegetative options are not feasible. Examples include:
  - ✓ Areas of vehicular or pedestrian traffic such as roads or paths;
  - ✓ Arid environments where vegetation would not provide timely ground coverage, or would require excessive irrigation;
  - ✓ Rocky substrate, infertile or droughty soils where vegetation would be difficult to establish; and
  - ✓ Areas where vegetation will not grow adequately within the construction time frame.

  There are several non-vegetative stabilization methods and selection should be based on site-specific conditions. See also EC-16 Non-Vegetative Stabilization, in the Construction BMP Handbook.
- Utilize chemical stabilization when needed. See also EC-5 Soil Binders, in the Construction BMP Handbook.
- Use geosynthetic membranes to control erosion if feasible. See also EC-7 Geotextiles and Mats, in the Construction BMP Handbook.
- Stabilize all roadways, entrances, and exits to sufficiently control discharges of erodible materials from discharging or being tracked off the site. See also TC 1-3 Tracking Control, in the Construction BMP Handbook.
- Implement wind erosion control measures as necessary. See also WE-1 Wind Erosion Control, in the Construction BMP Handbook.

Employee Training Program

- Educate employees about pollution prevention measures and goals.
- Train employees how to properly install and maintain the erosion and sediment source control BMPs described above. Detailed information is provided in the Construction BMP Handbook.
- Use a training log or similar method to document training.

Quality Assurance and Record Keeping

- Keep accurate logs that document actions taken to maintain and improve the effectiveness of the erosion and sediment control BMPs described above.
- Keep accurate logs of spill response actions that document what was spilled, how it was cleaned up, and how the waste was disposed.
- Establish procedures to complete logs and file them in the central office.

Potential Capital Facility Costs and Operation & Maintenance Requirements

Facilities

- Many facilities do not have contaminated or erodible areas and will require no additional capital expenditures.
- For sites with contaminated or erodible areas, purchase and installation of erosion and sediment controls will require additional capital investments, and this amount will vary depending on site characteristics and the types of BMPs being implemented.
- Minimize costs by maintaining existing vegetation and limiting site operations on bare soils.

Maintenance

- The erosion and sediment control BMPs described above require periodic inspection and maintenance to remain effective. The cost of these actions will vary depending on site characteristics and the types of BMPs being implemented.
- Irrigation costs may be required to establish and maintain vegetation.

Supplemental Information

Stabilization of Erodible Areas

Preserving stabilized areas minimizes erosion potential, protects water quality, and provides aesthetic benefits. The most effective way to control erosion is to preserve existing vegetation. Preservation of natural vegetation provides a natural buffer zone and an opportunity for infiltration of stormwater and capture of pollutants in the soil matrix. This practice can be used as a permanent source control measure.

Vegetation preservation should be incorporated into the site. Preservation requires good site management to minimize operations on bare soils where vegetation exists. Proper maintenance is important to ensure healthy vegetation that can control erosion. Different species, soil types, and climatic conditions will require different maintenance activities such as mulching, fertilizing, liming, irrigation, pruning and weed and pest control.

The preferred approach is to leave as much native vegetation on-site as possible, thereby reducing or eliminating any erosion problem. However, assuming the site already has contaminated or erodible surface areas, there are four possible courses of action which can be taken:

- The area can be revegetated if it is not in use and therefore not subject to damage from site activities. In as much as the area is already devoid of vegetation, special measures are likely necessary. Lack of vegetation may be due to the lack of water and/or poor soils. The latter can perhaps be solved with fertilization, or the ground may simply be too compacted from prior use. Improving soil conditions may be sufficient to support the recovery of vegetation. Use process wastewater for irrigation if possible, and see the Construction BMP Handbook for further procedures on establishing vegetation.

- Watering trucks to prevent dust.
- Chemical stabilization can be used as an alternate method in areas where temporary seeding practices cannot be used because of season or climate. It can provide immediate, effective, and inexpensive erosion control. Application rates and procedures recommended by the manufacturer should be followed as closely as possible to prevent the products from forming ponds and creating large areas where moisture cannot penetrate the soil. See also EC-5, Soil Binders, in the Construction BMP Handbook for more information. Advantages of chemical stabilization include:
  - ✓ Applied easily to the surface;
  - ✓ Stabilizes areas effectively; and
  - ✓ Provides immediate protection to soils that are in danger of erosion.
- Contaminated soils should be cleaned up or removed. This requires determination of the level and extent of the contamination. Removal must comply with State and Federal regulations; permits must be acquired and fees paid.
- Non-vegetated stabilization methods are suitable for permanently protecting from erosion by water and wind. Non-vegetated stabilization should only be utilized when vegetation cannot be established due to soil or climactic conditions, or where vegetation may be a potential fire hazard.

  Examples of non-vegetative stabilization BMPs are provided below:
  - ✓ ***Decomposed Granite (DG) and Gravel Mulch*** are suitable for use in areas where vegetation establishment is difficult, on flat surfaces, trails and pathways, and when used in conjunction with a stabilizer or tackifier, on shallow slopes (i.e., 10:1 [H:V]). DG and gravel can also be used on shallow rocky slopes where vegetation cannot be established for permanent erosion control.
  - ✓ ***Degradable Mulches*** can be used to cover and protect soil surfaces from erosion both in temporary and permanent applications. In many cases, the use of mulches by themselves requires routine inspection and re-application. See EC-3 Hydraulic Mulch, EC-6 Straw Mulch, EC-8 Wood Mulch, or EC-14 Compost Blankets of the Construction BMP Handbook for more information.
  - ✓ ***Geotextiles and Mats*** can be used as a temporary stand-alone soil stabilization method. Depending on material selection, geotextiles and mats can be a short-term (3 months – 1 year) or long-term (1-2 years) temporary stabilization method. For more information on geotextiles and mats see EC-7 Geotextiles and Mats of the Construction BMP Handbook.
  - ✓ ***Rock Slope Protection*** can be used when the slopes are subject to scour or have a high erosion potential, such as slopes adjacent to flowing waterways or slopes subject to overflow from detention facilities (spillways).

- ✓ ***Soil Binders*** can be used for temporary stabilization of stockpiles and disturbed areas not subject to heavy traffic. See EC-5 Soil Binders for more information. References and Resources.

References and Resources

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Building & Grounds Maintenance SC-41

Description

Stormwater runoff from building and grounds maintenance activities can be contaminated with toxic hydrocarbons in solvents, fertilizers and pesticides, suspended solids, heavy metals, abnormal pH, and oils and greases. Utilizing the protocols in this fact sheet will prevent or reduce the discharge of pollutants to stormwater from building and grounds maintenance activities by washing and cleaning up with as little water as possible, following good landscape management practices, preventing and cleaning up spills immediately, keeping debris from entering the storm drains, and maintaining the stormwater collection system.

Approach

Reduce potential for pollutant discharge through source control pollution prevention and BMP implementation. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives.

General Pollution Prevention Protocols

- ☐ Switch to non-toxic chemicals for maintenance to the maximum extent possible.
- ☐ Choose cleaning agents that can be recycled.
- ☐ Encourage proper lawn management and landscaping, including use of native vegetation.
- ☐ Encourage use of Integrated Pest Management techniques for pest control.
- ☐ Encourage proper onsite recycling of yard trimmings.
- ☐ Recycle residual paints, solvents, lumber, and other material as much as possible.

Objectives
■ *Cover*
■ *Contain*
■ *Educate*
■ *Reduce/Minimize*
■ *Product Substitution*

Targeted Constituents	
Sediment	✓
Nutrients	✓
Trash	
Metals	✓
Bacteria	✓
Oil and Grease	
Organics	

Minimum BMPs Covered	
Good Housekeeping	✓
Preventative Maintenance	
Spill and Leak Prevention and Response	✓
Material Handling & Waste Management	✓
Erosion and Sediment Controls	
Employee Training Program	✓
Quality Assurance Record Keeping	✓

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- Clean work areas at the end of each work shift using dry cleaning methods such as sweeping and vacuuming.

Good Housekeeping

Pressure Washing of Buildings, Rooftops, and Other Large Objects

- In situations where soaps or detergents are used and the surrounding area is paved, pressure washers must use a water collection device that enables collection of wash water and associated solids. A sump pump, wet vacuum or similarly effective device must be used to collect the runoff and loose materials. The collected runoff and solids must be disposed of properly.

- If soaps or detergents are not used, and the surrounding area is paved, wash runoff does not have to be collected but must be screened. Pressure washers must use filter fabric or some other type of screen on the ground and/or in the catch basin to trap the particles in wash water runoff.

- If you are pressure washing on a grassed area (with or without soap), runoff must be dispersed as sheet flow as much as possible, rather than as a concentrated stream. The wash runoff must remain on the grass and not drain to pavement.

Landscaping Activities

- Dispose of grass clippings, leaves, sticks, or other collected vegetation as garbage, or by composting. Do not dispose of collected vegetation into waterways or storm drainage systems.

- Use mulch or other erosion control measures on exposed soils. See also SC-40, Contaminated and Erodible Areas, for more information.

Building Repair, Remodeling, and Construction

- Do not dump any toxic substance or liquid waste on the pavement, the ground, or toward a storm drain.

- Use ground or drop cloths underneath outdoor painting, scraping, and sandblasting work, and properly dispose of collected material daily.

- Use a ground cloth or oversized tub for activities such as paint mixing and tool cleaning.

- Clean paintbrushes and tools covered with water-based paints in sinks connected to sanitary sewers or in portable containers that can be dumped into a sanitary sewer drain. Brushes and tools covered with non-water-based paints, finishes, or other materials must be cleaned in a manner that enables collection of used solvents (e.g., paint thinner, turpentine, etc.) for recycling or proper disposal.

- Use a storm drain cover, filter fabric, or similarly effective runoff control mechanism if dust, grit, wash water, or other pollutants may escape the work area and enter a catch basin. This is particularly necessary on rainy days. The containment device(s) must be in place at the beginning of the work day, and accumulated dirty runoff and

solids must be collected and disposed of before removing the containment device(s) at the end of the work day.

- If you need to de-water an excavation site, you may need to filter the water before discharging to a catch basin or off-site. If directed off-site, you should direct the water through hay bales and filter fabric or use other sediment filters or traps.
- Store toxic material under cover during precipitation events and when not in use. A cover would include tarps or other temporary cover material.

Mowing, Trimming, and Planting

- Dispose of leaves, sticks, or other collected vegetation as garbage, by composting or at a permitted landfill. Do not dispose of collected vegetation into waterways or storm drainage systems.
- Use mulch or other erosion control measures when soils are exposed.
- Place temporarily stockpiled material away from watercourses and drain inlets, and berm or cover stockpiles to prevent material releases to the storm drain system.
- Consider an alternative approach when bailing out muddy water: do not put it in the storm drain; pour over landscaped areas.
- Use hand weeding where practical.

Fertilizer and Pesticide Management

- Do not use pesticides if rain is expected.
- Do not mix or prepare pesticides for application near storm drains.
- Use the minimum amount needed for the job.
- Calibrate fertilizer distributors to avoid excessive application.
- Employ techniques to minimize off-target application (e.g., spray drift) of pesticides, including consideration of alternative application techniques.
- Apply pesticides only when wind speeds are low.
- Fertilizers should be worked into the soil rather than dumped or broadcast onto the surface.
- Irrigate slowly to prevent runoff and then only as much as is needed.
- Clean pavement and sidewalk if fertilizer is spilled on these surfaces before applying irrigation water.

Inspection

- Inspect irrigation system periodically to ensure that the right amount of water is being applied and that excessive runoff is not occurring. Minimize excess watering and repair leaks in the irrigation system as soon as they are observed.

Building & Grounds Maintenance SC-41

Spill Response and Prevention Procedures

- Keep your Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date.
- Place a stockpile of spill cleanup materials, such as brooms, dustpans, and vacuum sweepers (if desired) near the storage area where it will be readily accessible.
- Have employees trained in spill containment and cleanup present during the loading/unloading of dangerous wastes, liquid chemicals, or other materials.
- Familiarize employees with the Spill Prevention Control and Countermeasure Plan.
- Clean up spills immediately.

Material Handling and Waste Management

- Follow all federal, state, and local laws and regulations governing the use, storage, and disposal of fertilizers and pesticides and training of applicators and pest control advisors.
- Use less toxic pesticides that will do the job when applicable. Avoid use of copper-based pesticides if possible.
- Dispose of empty pesticide containers according to the instructions on the container label.
- Use up the pesticides. Rinse containers, and use rinse water as product. Dispose of unused pesticide as hazardous waste.
- Implement storage requirements for pesticide products with guidance from the local fire department and County Agricultural Commissioner. Provide secondary containment for pesticides.

Employee Training Program

- Educate and train employees on pesticide use and in pesticide application techniques to prevent pollution.
- Train employees and contractors in proper techniques for spill containment and cleanup.
- Be sure the frequency of training takes into account the complexity of the operations and the needs of individual staff.

Quality Assurance and Record Keeping

- Keep accurate logs that document maintenance activities performed and minimum BMP measures implemented.
- Keep accurate logs of spill response actions that document what was spilled, how it was cleaned up, and how the waste was disposed.
- Establish procedures to complete logs and file them in the central office.

Potential Capital Facility Costs and Operation & Maintenance Requirements

Facilities

- Additional capital costs are not anticipated for building and grounds maintenance. Implementation of the minimum BMPs described above should be conducted as part of regular site operations.

Maintenance

- Maintenance activities for the BMPs described above will be minimal, and no additional cost is anticipated.

Supplemental Information

Fire Sprinkler Line Flushing

Site fire sprinkler line flushing may be a source of non-stormwater runoff pollution. The water entering the system is usually potable water, though in some areas it may be non-potable reclaimed wastewater. There are subsequent factors that may drastically reduce the quality of the water in such systems. Black iron pipe is usually used since it is cheaper than potable piping, but it is subject to rusting and results in lower quality water. Initially, the black iron pipe has an oil coating to protect it from rusting between manufacture and installation; this will contaminate the water from the first flush but not from subsequent flushes. Nitrates, poly-phosphates and other corrosion inhibitors, as well as fire suppressants and antifreeze may be added to the sprinkler water system. Water generally remains in the sprinkler system a long time (typically a year) and between flushes may accumulate iron, manganese, lead, copper, nickel, and zinc. The water generally becomes anoxic and contains living and dead bacteria and breakdown products from chlorination. This may result in a significant BOD problem and the water often smells. Consequently dispose fire sprinkler line flush water into the sanitary sewer. Do not allow discharge to storm drain or infiltration due to potential high levels of pollutants in fire sprinkler line water.

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Building Repair and Construction SC-42

Description

Site modifications are common, particularly at large industrial sites. The activity may vary from minor and normal building repair to major remodeling, or the construction of new facilities. These activities can generate pollutants including solvents, paints, paint and varnish removers, finishing residues, spent thinners, soap cleaners, kerosene, asphalt and concrete materials, adhesive residues, and old asbestos installation. Protocols in this fact sheet are intended to prevent or reduce the discharge of pollutants to stormwater from building repair, remodeling, and minor construction by using soil erosion controls, enclosing or covering building material storage areas, using good housekeeping practices, using safer alternative products, and training employees.

This fact sheet is intended to be used for minor repairs and construction. If major construction is required, the guidelines in the Construction BMP Handbook should be followed.

Approach

The BMP approach is to reduce potential for pollutant discharges through source control pollution prevention and BMP implementation. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives.

General Pollution Prevention Protocols

- ☐ Recycle residual paints, solvents, lumber, and other materials to the maximum extent practicable.
- ☐ Avoid outdoor repairs and construction during periods of wet weather.
- ☐ Use safer alternative products to the maximum extent practicable. See also SC-35 Safer Alternative Products for more information.

Objectives
■ *Cover*
■ *Contain*
■ *Educate*
■ *Reduce/Minimize*
■ *Product Substitution*

Targeted Constituents	
Sediment	✓
Nutrients	
Trash	✓
Metals	✓
Bacteria	
Oil and Grease	✓
Organics	✓

Minimum BMPs Covered	
Good Housekeeping	✓
Preventative Maintenance	
Spill and Leak Prevention and Response	✓
Material Handling & Waste Management	✓
Erosion and Sediment Controls	✓
Employee Training Program	✓
Quality Assurance Record Keeping	✓

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- Buy recycled products to the maximum extent practicable.
- Inform on-site contractors of company policy on these matters and include appropriate provisions in their contract to ensure certain proper housekeeping and disposal practices are implemented.
- Make sure that nearby storm drains are well marked to minimize the chance of inadvertent disposal of residual paints and other liquids.

Good Housekeeping

Repair & Remodeling

- Keep the work site clean and orderly. Remove debris in a timely fashion. Sweep and vacuum the area regularly to remove sediments and small debris.
- Cover raw materials of particular concern that must be left outside, particularly during the rainy season. See also SC-33 Outdoor Storage of Raw Materials for more information.
- Use equipment and tools such as bag sanders to reduce accumulation of debris.
- Limit/prohibit work on windy days; implement roll-down walls or other measures to reduce wind transport of pollutants.
- Do not dump waste liquids down the storm drain.
- Dispose of wash water, sweepings, and sediments properly.
- Store liquid materials properly that are normally used in repair and remodeling such as paints and solvents. See also SC-31 Outdoor Liquid Container Storage for more information.
- Sweep out rain gutters or wash the gutter and trap the particles at the outlet of the downspout. A sock or geofabric placed over the outlet may effectively trap the materials. If the downspout is tight lined, place a temporary plug at the first convenient point in the storm drain and pump out the water with a vactor truck, and clean the catch basin sump where you placed the plug.
- Clean the storm drain system in the immediate vicinity of the construction activity after it is completed. See also SC-44 Drainage System Maintenance for more information.

Painting

- Enclose painting operations consistent with local air quality regulations and OSHA.
- Local air pollution regulations may, in many areas of the state, specify painting procedures which if properly carried out are usually sufficient to protect water quality.
- Develop paint handling procedures for proper use, storage, and disposal of paints.

- Transport paint and materials to and from job sites in containers with secure lids and tied down to the transport vehicle.
- Test and inspect spray equipment prior to starting to paint. Tighten all hoses and connections and do not overfill paint containers.
- Mix paint indoors before using so that any spill will not be exposed to rain. Do so even during dry weather because cleanup of a spill will never be 100 percent effective.
- Transfer and load paint and hot thermoplastic away from storm drain inlets.
- Do not transfer or load paint near storm drain inlets.
- Plug nearby storm drain inlets prior to starting painting and remove plugs when job is complete when there is risk of a spill reaching storm drains.
- Cover nearby storm drain inlets prior to starting work if sand blasting is used to remove paint.
- Use a ground cloth to collect the chips if painting requires scraping or sand blasting of the existing surface. Dispose of the residue properly.
- Cover or enclose painting operations properly to avoid drift.
- Clean the application equipment in a sink that is connected to the sanitary sewer if using water based paints.
- Capture all cleanup-water and dispose of properly.
- Dispose of paints containing lead or tributyl tin and considered a hazardous waste properly.
- Store leftover paints if they are to be kept for the next job properly, or dispose properly.
- Recycle paint when possible. Dispose of paint at an appropriate household hazardous waste facility.

Spill Response and Prevention Procedures

- Keep your spill prevention and control plan up-to-date.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- Clean up spills immediately.
- Excavate and remove the contaminated (stained) soil if a spill occurs on dirt.

Material Handling and Waste Management

- Post “No Littering” signs and enforce anti-litter laws.

- Provide a sufficient number of litter receptacles for the facility.
- Clean out and cover litter receptacles frequently to prevent spillage.
- Keep waste collection areas clean.
- Inspect solid waste containers for structural damage regularly. Repair or replace damaged containers as necessary.
- Secure solid waste containers; containers must be closed tightly when not in use.
- Do not fill waste containers with washout water or any other liquid.
- Ensure that only appropriate solid wastes are added to the solid waste container. Certain wastes such as hazardous wastes, appliances, fluorescent lamps, pesticides, etc., may not be disposed of in solid waste containers (see chemical/ hazardous waste collection section below).
- Do not mix wastes; this can cause chemical reactions, make recycling impossible, and complicate disposal. Affix labels to all waste containers.
- Make sure that hazardous waste is collected, removed, and disposed of properly. See also SC-34, Waste Handling and Disposal for more information.

Sediment and Erosion Controls

- Limit disturbance to bare soils and preserve natural vegetation whenever possible. See also EC-2, Preservation of Existing Vegetation, in the Construction BMP Handbook.
- Stabilize loose soils by re-vegetating whenever possible. See also EC-4 Hydroseeding, in the Construction BMP Handbook.
- Utilize non-vegetative stabilization methods for areas prone to erosion where vegetative options are not feasible. Examples include:
  - ✓ Areas of vehicular or pedestrian traffic such as roads or paths;
  - ✓ Arid environments where vegetation would not provide timely ground coverage, or would require excessive irrigation;
  - ✓ Rocky substrate, infertile or droughty soils where vegetation would be difficult to establish; and
  - ✓ Areas where vegetation will not grow adequately within the construction time frame.

  There are several non-vegetative stabilization methods and selection should be based on site-specific conditions. See also EC-16 Non-Vegetative Stabilization, in the Construction BMP Handbook.

- Utilize chemical stabilization when needed. See also EC-5 Soil Binders, in the Construction BMP Handbook.
- Use geosynthetic membranes to control erosion if feasible. See also EC-7 Geotextiles and Mats, in the Construction BMP Handbook.
- Stabilize all roadways, entrances, and exits to sufficiently control discharges of erodible materials from discharging or being tracked off the site. See also TC 1-3 Tracking Control, in the Construction BMP Handbook.
- Refer to the supplemental information provided below for projects that involve more extensive soil disturbance activities.

Employee Training Program

- Educate employees about pollution prevention measures and goals.
- Train employees how to properly implement the source control BMPs described above. Detailed information for Sediment and Erosion Control BMPs is provided in the Construction BMP Handbook.
- Proper education of off-site contractors is often overlooked. The conscientious efforts of well trained employees can be lost by unknowing off-site contractors, so make sure they are well informed about pollutant source control responsibilities.
- Use a training log or similar method to document training.

Quality Assurance and Record Keeping

- Keep accurate maintenance logs that document minimum BMP activities performed for building repair and construction, types and quantities of waste disposed of, and any improvement actions.
- Keep accurate logs of spill response actions that document what was spilled, how it was cleaned up, and how the waste was disposed.
- Establish procedures to complete logs and file them in the central office.

Potential Limitations and Work-Arounds

Some facilities may have space constraints, limited staffing and time limitations that may preclude implementation of BMPs. Provided below are typical limitations and recommended "work-arounds."

- This BMP is for minor construction only. The State's General Construction Activity Stormwater Permit has more extensive requirements for larger projects that would disturb one or more acres of surface.
  - ✓ Refer to the companion "Construction Best Management Practice Handbook" which contains specific guidance and best management practices for larger-scale projects.

- Time constraints may require some outdoor repairs and construction during wet weather.
  - ✓ Require employees to understand and follow good housekeeping and spill and leak prevention BMPs.
  - ✓ Inspect sediment and erosion control BMPs daily during periods of wet weather and repair or improve BMP implementation as necessary.
- Hazardous waste that cannot be reused or recycled must be disposed of by a licensed hazardous waste hauler.
  - ✓ Minimize use of hazardous materials to the maximum extent practicable.
- Be certain that actions to help stormwater quality are consistent with Cal- and Fed-OSHA and air quality regulations.
- Prices for recycled/safer alternative materials and fluids may be higher than those of conventional materials.

Potential Capital Facility Costs and Operation & Maintenance Requirements

Facilities

- Limited capital investments may be required at some sites if adequate cover and containment facilities do not exist for construction materials and wastes.
- Purchase and installation of erosion and sediment controls, if needed will require additional capital investments, and this amount will vary depending on site characteristics and the types of BMPs being implemented.
- Minimize costs by maintaining existing vegetation and limiting construction operations on bare soils.

Maintenance

- The erosion and sediment control BMPs described above require periodic inspection and maintenance to remain effective. The cost of these actions will vary depending on site characteristics and the types of BMPs being implemented.
- Irrigation costs may be required to establish and maintain vegetation.

Supplemental Information

Soil/Erosion Control

If the work involves exposing large areas of soil, employ the appropriate soil erosion and control techniques. See the Construction Best Management Practice Handbook. If old buildings are being torn down and not replaced in the near future, stabilize the site using measures described in SC-40 Contaminated or Erodible Areas.

If a building is to be placed over an open area with a storm drainage system, make sure the storm inlets within the building are covered or removed, or the storm line is connected to the sanitary sewer. If because of the remodeling a new drainage system is to be installed or the existing system is to be modified, consider installing catch basins as they serve as effective "in-line" treatment devices. Include in the catch basin a "turn-down" elbow or similar device to trap floatables.

References and Resources

City of Seattle, Seattle Public Utilities Department of Planning and Development, 2009. *Stormwater Manual Vol. 1 Source Control Technical Requirements Manual*.

California Stormwater Quality Association, 2012. *Construction Stormwater Best Management Practice Handbook*. Available at http://www.casqa.org.

Kennedy/Jenks Consultants, 2007. *The Truckee Meadows Industrial and Commercial Storm Water Best Management Practices Handbook*. Available online at: http://www.cityofsparks.us/sites/default/files/assets/documents/env-control/construction/TM-I-C_BMP_Handbook_2-07-final.pdf.

Sacramento Stormwater Management Program. *Best Management Practices for Industrial Storm Water Pollution Control*. Available online at: http://www.msa.saccounty.net/sactostormwater/documents/guides/industrial-BMP-manual.pdf.

US EPA. *Construction Site Stormwater Runoff Control*. Available online at: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=min_measure&min_measure_id=4.

Parking Area Maintenance SC-43

Description

Parking lots can contribute a number of substances, such as trash, suspended solids, hydrocarbons, oil and grease, and heavy metals that can enter receiving waters through stormwater runoff or non-stormwater discharges. The protocols in this fact sheet are intended to prevent or reduce the discharge of pollutants from parking areas and include using good housekeeping practices, following appropriate cleaning BMPs, and training employees.

BMPs for other outdoor areas on site (loading/unloading, material storage, and equipment operations) are described in SC-30 through SC-33.

Approach

The goal of this program is to ensure stormwater pollution prevention practices are considered when conducting activities on or around parking areas to reduce potential for pollutant discharge to receiving waters. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives.

General Pollution Prevention Protocols

- ☐ Encourage advanced designs and maintenance strategies for impervious parking lots. Refer to the treatment control BMP fact sheets in this manual for additional information.
- ☐ Keep accurate maintenance logs to evaluate BMP implementation.

Good Housekeeping

- ☐ Keep all parking areas clean and orderly. Remove debris, litter, and sediments in a timely fashion.
- ☐ Post "No Littering" signs and enforce anti-litter laws.

Objectives
■ *Cover*
■ *Contain*
■ *Educate*
■ *Reduce/Minimize*
■ *Product Substitution*

Targeted Constituents	
Sediment	✓
Nutrients	
Trash	✓
Metals	✓
Bacteria	
Oil and Grease	✓
Organics	✓

Minimum BMPs Covered	
Good Housekeeping	✓
Preventative Maintenance	✓
Spill and Leak Prevention and Response	✓
Material Handling & Waste Management	
Erosion and Sediment Controls	
Employee Training Program	✓
Quality Assurance Record Keeping	✓

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- ☐ Provide an adequate number of litter receptacles.
- ☐ Clean out and cover litter receptacles frequently to prevent spillage.

Preventative Maintenance

Inspection

Have designated personnel conduct inspections of parking facilities and stormwater conveyance systems associated with parking facilities on a regular basis.

- ☐ Inspect cleaning equipment/sweepers for leaks on a regular basis.

Surface Cleaning

- ☐ Use dry cleaning methods (e.g., sweeping, vacuuming) to prevent the discharge of pollutants into the stormwater conveyance system if possible.
- ☐ Establish frequency of public parking lot sweeping based on usage and field observations of waste accumulation.
- ☐ Sweep all parking lots at least once before the onset of the wet season.
- ☐ Dispose of parking lot sweeping debris and dirt at a landfill.
- ☐ Follow the procedures below if water is used to clean surfaces:
  - ✓ Block the storm drain or contain runoff.
  - ✓ Collect and pump wash water to the sanitary sewer or discharge to a pervious surface. Do not allow wash water to enter storm drains.
- ☐ Follow the procedures below when cleaning heavy oily deposits:
  - ✓ Clean oily spots with absorbent materials.
  - ✓ Use a screen or filter fabric over inlet, then wash surfaces.
  - ✓ Do not allow discharges to the storm drain.
  - ✓ Vacuum/pump discharges to a tank or discharge to sanitary sewer.
  - ✓ Dispose of spilled materials and absorbents appropriately.

Surface Repair

- ☐ Check local ordinance for SUSMP/LID ordinance.
- ☐ Preheat, transfer or load hot bituminous material away from storm drain inlets.
- ☐ Apply concrete, asphalt, and seal coat during dry weather to prevent contamination from contacting stormwater runoff.
- ☐ Cover and seal nearby storm drain inlets where applicable (with waterproof material or mesh) and manholes before applying seal coat, slurry seal, etc. Leave covers in

place until job is complete and all water from emulsified oil sealants has drained or evaporated. Clean any debris from these covered manholes and drains for proper disposal.

- Use only as much water as necessary for dust control during sweeping to avoid runoff.
- Catch drips from paving equipment that is not in use with pans or absorbent material placed under the machines. Dispose of collected material and absorbents properly.

Spill Response and Prevention Procedures

- Keep your Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date.
- Place a stockpile of spill cleanup materials where it will be readily accessible or at a central location.
- Clean up fluid spills immediately with absorbent rags or material.
- Dispose of spilled material and absorbents properly.

Employee Training Program

- Provide regular training to field employees and/or contractors regarding cleaning of paved areas and proper operation of equipment.
- Train employees and contractors in proper techniques for spill containment and cleanup.
- Use a training log or similar method to document training.

Quality Assurance and Record Keeping

- Keep accurate maintenance logs that document minimum BMP activities performed for parking area maintenance, types and quantities of waste disposed of, and any improvement actions.
- Keep accurate logs of spill response actions that document what was spilled, how it was cleaned up, and how the waste was disposed.
- Establish procedures to complete logs and file them in the central office.

Potential Capital Facility Costs and Operation & Maintenance Requirements

Facilities

- Capital investments may be required at some sites to purchase sweeping equipment, train sweeper operators, install oil/water/sand separators, or implement advanced BMPs. These costs can vary significantly depending upon site conditions and the amount of BMPs required.

Maintenance

- Sweep and clean parking lots regularly to minimize pollutant transport into storm drains from stormwater runoff.
- Clean out oil/water/sand separators regularly, especially after heavy storms.
- Maintain advanced BMPs such as vegetated swales, infiltration trenches, or detention basins as appropriate. Refer to the treatment control fact sheets for more information.

Supplemental Information

Advanced BMPs

Some parking areas may require advanced BMPs to further reduce pollutants in stormwater runoff, and a few examples are listed below. Refer to the Treatment Control Fact Sheets and the New Development and Redevelopment Manual for more information.

- When possible, direct sheet runoff to flow into biofilters (vegetated strip and swale) and/or infiltration devices.
- Utilize sand filters or oleophilic collectors for oily waste in low quantities.
- Arrange rooftop drains to prevent drainage directly onto paved surfaces.
- Design lot to include semi-permeable hardscape.

References and Resources

City of Seattle, Seattle Public Utilities Department of Planning and Development, 2009. *Stormwater Manual Vol. 1 Source Control Technical Requirements Manual*.

California Stormwater Quality Association, 2003. *New Development and Redevelopment Stormwater Best Management Practice Handbook*. Available online at: https://www.casqa.org/resources/bmp-handbooks/new-development-redevelopment-bmp-handbook.

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The Storm Water Managers Resource Center, http://www.stormwatercenter.net.

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Drainage System Maintenance SC-44

Description

As a consequence of its function, the stormwater drainage facilities on site convey stormwater that may contain certain pollutants either to the offsite conveyance system that collects and transports urban runoff and stormwater, or directly to receiving waters. The protocols in this fact sheet are intended to reduce pollutants leaving the site to the offsite drainage infrastructure or to receiving waters through proper on-site conveyance system operation and maintenance. The targeted constituents will vary depending on site characteristics and operations.

Approach

Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives.

General Pollution Prevention Protocols

- ☐ Maintain catch basins, stormwater inlets, and other stormwater conveyance structures on a regular basis to remove pollutants, reduce high pollutant concentrations during the first flush of storms, prevent clogging of the downstream conveyance system, restore catch basins' sediment trapping capacity, and ensure the system functions properly hydraulically to avoid flooding.
- ☐ Develop and follow a site specific drainage system maintenance plan that describes maintenance locations, methods, required equipment, water sources, sediment collection areas, disposal requirements, and any other pertinent information.

Good Housekeeping

Illicit Connections and Discharges

- ☐ Look for evidence of illegal discharges or illicit connections during routine maintenance of conveyance system and drainage structures:

Objectives
■ *Cover*
■ *Contain*
■ *Educate*
■ *Reduce/Minimize*

Targeted Constituents	
Sediment	✓
Nutrients	✓
Trash	✓
Metals	✓
Bacteria	✓
Oil and Grease	✓
Organics	✓

Minimum BMPs Covered	
Good Housekeeping	✓
Preventative Maintenance	✓
Spill and Leak Prevention and Response	✓
Material Handling & Waste Management	
Erosion and Sediment Controls	
Employee Training Program	✓
Quality Assurance Record Keeping	✓

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- ✓ Identify evidence of spills such as paints, discoloring, odors, etc.
- ✓ Record locations of apparent illegal discharges/illicit connections.
- ✓ Track flows back to potential discharges and conduct aboveground inspections. This can be done through visual inspection of upgradient manholes or alternate techniques including zinc chloride smoke testing, fluorometric dye testing, physical inspection testing, or television camera inspection.
- ✓ Eliminate the discharge once the origin of flow is established.

- ☐ Stencil or demarcate storm drains, where applicable, to prevent illegal disposal of pollutants. Storm drain inlets should have messages such as "Dump No Waste Drains to Stream" or similar stenciled next to them to warn against ignorant or intentional dumping of pollutants into the storm drainage system.
- ☐ Refer to fact sheet SC-10 Non-Stormwater Discharges for additional information.

Illegal Dumping

- ☐ Inspect and clean up hot spots and other storm drainage areas regularly where illegal dumping and disposal occurs.
- ☐ Establish a system for tracking incidents. The system should be designed to identify the following:
  - ✓ Illegal dumping hot spots;
  - ✓ Types and quantities (in some cases) of wastes;
  - ✓ Patterns in time of occurrence (time of day/night, month, or year);
  - ✓ Mode of dumping (abandoned containers, "midnight dumping" from moving vehicles, direct dumping of materials, accidents/spills); and
  - ✓ Responsible parties.
- ☐ Post "No Dumping" signs in problem areas with a phone number for reporting dumping and disposal. Signs should also indicate fines and penalties for illegal dumping.
- ☐ Refer to fact sheet SC-10 Non-Stormwater Discharges for additional information.

Preventative Maintenance

Catch Basins/Inlet Structures

- ☐ Staff should regularly inspect facilities to ensure compliance with the following:
  - ✓ Immediate repair of any deterioration threatening structural integrity.
  - ✓ Cleaning before the sump is 40% full. Catch basins should be cleaned as frequently as needed to meet this standard.

- Clean catch basins, storm drain inlets, and other conveyance structures before the wet season to remove sediments and debris accumulated during the summer.
- Conduct inspections more frequently during the wet season for problem areas where sediment or trash accumulates more often. Prioritize storm drain inlets; clean and repair as needed.
- Keep accurate logs of the number of catch basins cleaned.
- Store wastes collected from cleaning activities of the drainage system in appropriate containers or temporary storage sites in a manner that prevents discharge to the storm drain.
- Dewater the wastes if necessary with outflow into the sanitary sewer if permitted. Water should be treated with an appropriate filtering device prior to discharge to the sanitary sewer. If discharge to the sanitary sewer is not allowed, water should be pumped or vacuumed to a tank and properly disposed. Do not dewater near a storm drain or stream.

Storm Drain Conveyance System

- Locate reaches of storm drain with deposit problems and develop a flushing schedule that keeps the pipe clear of excessive buildup.
- Collect and pump flushed effluent to the sanitary sewer for treatment whenever possible.

Pump Stations

- Clean all storm drain pump stations prior to the wet season to remove silt and trash.
- Do not allow discharge to reach the storm drain system when cleaning a storm drain pump station or other facility.
- Conduct routine maintenance at each pump station.
- Inspect, clean, and repair as necessary all outlet structures prior to the wet season.

Open Channel

- Modify storm channel characteristics to improve channel hydraulics, increase pollutant removals, and enhance channel/creek aesthetic and habitat value.
- Conduct channel modification/improvement in accordance with existing laws. Any person, government agency, or public utility proposing an activity that will change the natural state of any river, stream, or lake in California, must enter into a Steam or Lake Alteration Agreement with the Department of Fish and Wildlife. The developer-applicant should also contact local governments (city, county, special districts), other state agencies (SWRCB, RWQCB, Department of Forestry, Department of Water Resources), and Army Corps of Engineers and USFWS.

Spill Response and Prevention Procedures

- Keep your spill prevention control plan up-to-date.

- Investigate all reports of spills, leaks, and/or illegal dumping promptly.
- Place a stockpile of spill cleanup materials where it will be readily accessible or at a central location.
- Clean up all spills and leaks using "dry" methods (with absorbent materials and/or rags) or dig up, remove, and properly dispose of contaminated soil.

Employee Training Program

- Educate employees about pollution prevention measures and goals.
- Train employees how to properly handle and dispose of waste using the source control BMPs described above.
- Train employees and subcontractors in proper hazardous waste management.
- Use a training log or similar method to document training.
- Ensure that employees are familiar with the site's spill control plan and/or proper spill cleanup procedures.
- Have staff involved in detection and removal of illicit connections trained in the following:
  - ✓ OSHA-required Health and Safety Training (29 CFR 1910.120) plus annual refresher training (as needed).
  - ✓ OSHA Confined Space Entry training (Cal-OSHA Confined Space, Title 8 and Federal OSHA 29 CFR 1910.146).
  - ✓ Procedural training (field screening, sampling, smoke/dye testing, TV inspection).

Quality Assurance and Record Keeping

- Keep accurate maintenance logs that document minimum BMP activities performed for drainage system maintenance, types and quantities of waste disposed of, and any improvement actions.
- Keep accurate logs of spill response actions that document what was spilled, how it was cleaned up, and how the waste was disposed.
- Keep accurate logs of illicit connections, illicit discharges, and illegal dumping into the storm drain system including how wastes were cleaned up and disposed.
- Establish procedures to complete logs and file them in the central office.

Potential Limitations and Work-Arounds

Provided below are typical limitations and recommended "work-arounds" for drainage system maintenance:

- Clean-up activities may create a slight disturbance for local aquatic species. Access to items and material on private property may be limited. Trade-offs may exist between channel hydraulics and water quality/riparian habitat. If storm channels or basins are recognized as wetlands, many activities, including maintenance, may be subject to regulation and permitting.
  - ✓ Perform all maintenance onsite and do not flush accumulated material downstream to private property or riparian habitats.
- Storm drain flushing is most effective in small diameter pipes (36-inch diameter pipe or less, depending on water supply and sediment collection capacity). Other considerations associated with storm drain flushing may include the availability of a water source, finding a downstream area to collect sediments, and liquid/sediment disposal.
  - ✓ Develop and follow a site specific drainage system maintenance plan that describes maintenance locations, methods, required equipment, water sources, sediment collection areas, disposal requirements, and any other pertinent information.
- Regulations may include adoption of substantial penalties for illegal dumping and disposal.
  - ✓ Do not dump illegal materials anywhere onsite.
  - ✓ Identify illicit connections, illicit discharge, and illegal dumping.
  - ✓ Cleanup spills immediately and properly dispose of wastes.
- Local municipal codes may include sections prohibiting discharge of soil, debris, refuse, hazardous wastes, and other pollutants into the sanitary sewer system.
  - ✓ Collect all materials and pollutants accumulated in drainage system and dispose of according to local regulations.
  - ✓ Install debris excluders in areas with a trash TMDL.

Potential Capital Facility Costs and Operation & Maintenance Requirements

Facilities

- Capital costs will vary substantially depending on the size of the facility and characteristics of the drainage system. Significant capital costs may be associated with purchasing water trucks, vacuum trucks, and any other necessary cleaning equipment or improving the drainage infrastructure to reduce the potential .
- Developing and implementing a site specific drainage system maintenance plan will require additional capital if a similar program is not already in place.

Maintenance

- Two-person teams may be required to clean catch basins with vactor trucks.
- Teams of at least two people plus administrative personnel are required to identify illicit discharges, depending on the complexity of the storm sewer system.
- Arrangements must be made for proper disposal of collected wastes.
- Technical staff are required to detect and investigate illegal dumping violations.
- Methods used for illicit connection detection (smoke testing, dye testing, visual inspection, and flow monitoring) can be costly and time-consuming. Site-specific factors, such as the level of impervious area, the density and ages of buildings, and type of land use will determine the level of investigation necessary.

Supplemental Information

Storm Drain Flushing

Flushing is a common maintenance activity used to improve pipe hydraulics and to remove pollutants in storm drainage systems. Flushing may be designed to hydraulically convey accumulated material to strategic locations, such as an open channel, another point where flushing will be initiated, or the sanitary sewer and the treatment facilities, thus preventing re-suspension and overflow of a portion of the solids during storm events. Flushing prevents "plug flow" discharges of concentrated pollutant loadings and sediments. Deposits can hinder the designed conveyance capacity of the storm drain system and potentially cause backwater conditions in severe cases of clogging.

Storm drain flushing usually takes place along segments of pipe with grades that are too flat to maintain adequate velocity to keep particles in suspension. An upstream manhole is selected to place an inflatable device that temporarily plugs the pipe. Further upstream, water is pumped into the line to create a flushing wave. When the upstream reach of pipe is sufficiently full to cause a flushing wave, the inflated device is rapidly deflated with the assistance of a vacuum pump, thereby releasing the backed up water and resulting in the cleaning of the storm drain segment.

To further reduce impacts of stormwater pollution, a second inflatable device placed well downstream may be used to recollect the water after the force of the flushing wave has dissipated. A pump may then be used to transfer the water and accumulated material to the sanitary sewer for treatment. In some cases, an interceptor structure may be more practical or required to recollect the flushed waters.

It has been found that cleansing efficiency of periodic flush waves is dependent upon flush volume, flush discharge rate, sewer slope, sewer length, sewer flow rate, sewer diameter, and population density. As a rule of thumb, the length of line to be flushed should not exceed 700 feet. At this maximum recommended length, the percent removal efficiency ranges between 65-75% for organics and 55-65% for dry weather grit/inorganic material. The percent removal efficiency drops rapidly beyond that. Water is commonly supplied by a water truck, but fire hydrants can also supply water. To make the best use of water, it is recommended that reclaimed water be used if allowed or that fire hydrant line flushing coincide with storm sewer flushing.

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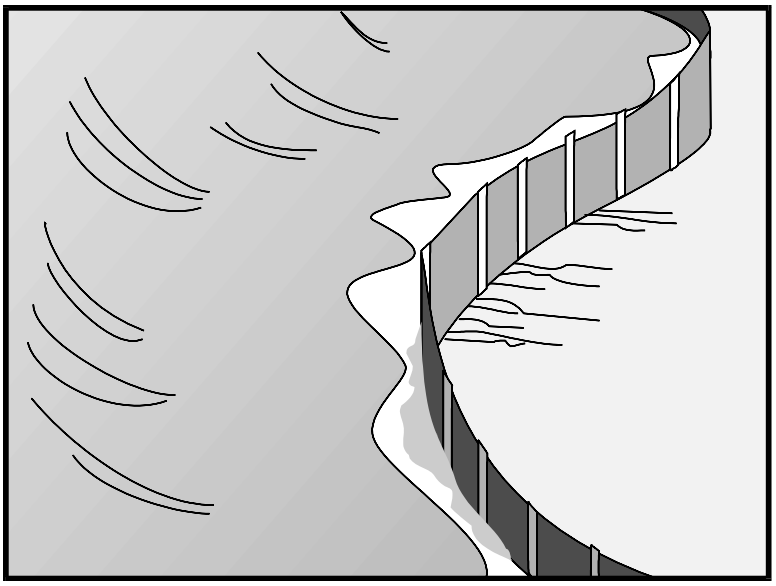
Silt Fence SE-1



Categories

EC	Erosion Control	
SE	Sediment Control	☑
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Description and Purpose

A silt fence is made of a woven geotextile that has been entrenched, attached to supporting poles, and sometimes backed by a plastic or wire mesh for support. The silt fence detains water, promoting sedimentation of coarse sediment behind the fence. Silt fence does not retain soil fine particles like clays or silts.

Suitable Applications

Silt fences are suitable for perimeter control, placed below areas where sheet flows discharge from the site. They could also be used as interior controls below disturbed areas where runoff may occur in the form of sheet and rill erosion and around inlets within disturbed areas (SE-10). Silt fences should not be used in locations where the flow is concentrated. Silt fences should always be used in combination with erosion controls. Suitable applications include:

- At perimeter of a project.
- Below the toe or down slope of exposed and erodible slopes.
- Along streams and channels.
- Around temporary spoil areas and stockpiles.
- Around inlets.
- Below other small cleared areas.

Targeted Constituents

Sediment (coarse sediment)	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-5 Fiber Rolls

SE-6 Gravel Bag Berm SE-12 Manufactured Linear Sediment Controls

SE-13 Compost Socks and Berms

SE-14 Biofilter Bags

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Limitations

- Do not use in streams, channels, drain inlets, or anywhere flow is concentrated.
- Do not use in locations where ponded water may cause a flooding hazard.
- Do not use silt fence to divert water flows or place across any contour line.
- Improperly installed fences are subject to failure from undercutting, overtopping, or collapsing.
- Must be trenched and keyed in.
- Not intended for use as a substitute for Fiber Rolls (SE-5), when fiber rolls are being used as a slope interruption device.
- Do not use on slopes subject to creeping, slumping, or landslides.

Implementation

General

A silt fence is a temporary sediment barrier consisting of woven geotextile stretched across and attached to supporting posts, trenched-in, and, depending upon the strength of fabric used, supported with plastic or wire mesh fence. Silt fences trap coarse sediment by intercepting and detaining sediment-laden runoff from disturbed areas in order to promote sedimentation behind the fence.

The following layout and installation guidance can improve performance and should be followed:

- Silt fence should be used in combination with erosion controls up-slope in order to provide the most effective sediment control.
- Silt fence alone is not effective at reducing turbidity. (Barrett and Malina, 2004)
- Designers should consider diverting sediment laden water to a temporary sediment basin or trap. (EPA, 2012)
- Use principally in areas where sheet flow occurs.
- Install along a level contour, so water does not pond more than 1.5 ft at any point along the silt fence.
- Provide sufficient room for runoff to pond behind the fence and to allow sediment removal equipment to pass between the silt fence and toes of slopes or other obstructions. About 1200 ft^2 of ponding area should be provided for every acre draining to the fence.
- Efficiency of silt fences is primarily dependent on the detention time of the runoff behind the control. (Barrett and Malina, 2004)
- The drainage area above any fence should not exceed a quarter of an acre. (Rule of Thumb-100-feet of silt fence per 10,000 square feet of disturbed area.) (EPA 2012)

- The maximum length of slope draining to any point along the silt fence should be 100 ft per foot of silt fence.
- Turn the ends of the filter fence uphill to prevent stormwater from flowing around the fence.
- Leave an undisturbed or stabilized area immediately down slope from the fence where feasible.
- Silt fences should remain in place until the disturbed area draining to the silt fence is permanently stabilized, after which, the silt fence fabric and posts should be removed and properly disposed.
- J-Hooks, which have ends turning up the slope to break up long runs of fence and provide multiple storage areas that work like mini-retention areas, may be used to increase the effectiveness of silt fence.
- Be aware of local regulations regarding the type and installation requirements of silt fence, which may differ from those presented in this fact sheet.

Design and Layout

In areas where high winds are anticipated the fence should be supported by a plastic or wire mesh. The geotextile fabric of the silt fence should contain ultraviolet inhibitors and stabilizers to provide longevity equivalent to the project life or replacement schedule.

- Layout in accordance with the attached figures.
- For slopes that contain a high number of rocks or large dirt clods that tend to dislodge, it may be necessary to protect silt fence from rocks (e.g., rockfall netting) ensure the integrity of the silt fence installation.

Standard vs. Heavy Duty Silt Fence

Standard Silt Fence

- Generally applicable in cases where the area draining to fence produces moderate sediment loads.

Heavy Duty Silt Fence

- Heavy duty silt fence usually has 1 or more of the following characteristics, not possessed by standard silt fence.
  - Fabric is reinforced with wire backing or additional support.
  - Posts are spaced closer than pre-manufactured, standard silt fence products.
- Use is generally limited to areas affected by high winds.
- Area draining to fence produces moderate sediment loads.

Materials

Standard Silt Fence

- Silt fence material should be woven geotextile with a minimum width of 36 in. The fabric should conform to the requirements in ASTM designation D6461.
- Wooden stakes should be commercial quality lumber of the size and shape shown on the plans. Each stake should be free from decay, splits or cracks longer than the

thickness of the stake or other defects that would weaken the stakes and cause the stakes to be structurally unsuitable.

- Staples used to fasten the fence fabric to the stakes should be not less than 1.75 in. long and should be fabricated from 15 gauge or heavier wire. The wire used to fasten the tops of the stakes together when joining two sections of fence should be 9 gauge or heavier wire. Galvanizing of the fastening wire will not be required.

Heavy-Duty Silt Fence

- Some silt fence has a wire backing to provide additional support, and there are products that may use prefabricated plastic holders for the silt fence and use metal posts instead of wood stakes.

Installation Guidelines – Traditional Method

Silt fences are to be constructed on a level contour. Sufficient area should exist behind the fence for ponding to occur without flooding or overtopping the fence.

- A trench should be excavated approximately 6 in. wide and 6 in. deep along the line of the proposed silt fence (trenches should not be excavated wider or deeper than necessary for proper silt fence installation).
- Bottom of the silt fence should be keyed-in a minimum of 12 in.
- Posts should be spaced a maximum of 6 ft apart and driven securely into the ground a minimum of 18 in. or 12 in. below the bottom of the trench.
- When standard strength geotextile is used, a plastic or wire mesh support fence should be fastened securely to the upslope side of posts using heavy–duty wire staples at least 1 in. long. The mesh should extend into the trench.
- When extra-strength geotextile and closer post spacing are used, the mesh support fence may be eliminated.
- Woven geotextile should be purchased in a long roll, then cut to the length of the barrier. When joints are necessary, geotextile should be spliced together only at a support post, with a minimum 6 in. overlap and both ends securely fastened to the post.
- The trench should be backfilled with native material and compacted.
- Construct the length of each reach so that the change in base elevation along the reach does not exceed 1/3 the height of the barrier; in no case should the reach exceed 500 ft.
- Cross barriers should be a minimum of 1/3 and a maximum of ½ the height of the linear barrier.
- See typical installation details at the end of this fact sheet.

Installation Guidelines - Static Slicing Method

- Static Slicing is defined as insertion of a narrow blade pulled behind a tractor, similar to a plow blade, at least 10 inches into the soil while at the same time pulling silt geotextile fabric into the ground through the opening created by the blade to the depth of the blade. Once the geotextile is installed, the soil is compacted using tractor tires.
- This method will not work with pre-fabricated, wire backed silt fence.
- Benefits:
    - Ease of installation (most often done with a 2 person crew).
    - Minimal soil disturbance.
    - Better level of compaction along fence, less susceptible to undercutting
    - Uniform installation.
- Limitations:
    - Does not work in shallow or rocky soils.
    - Complete removal of geotextile material after use is difficult.
    - Be cautious when digging near potential underground utilities.

Costs

- It should be noted that costs vary greatly across regions due to available supplies and labor costs.
- Average annual cost for installation using the traditional silt fence installation method (assumes 6 month useful life) is $7 per linear foot based on vendor research. Range of cost is $3.50 - $9.10 per linear foot.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Repair undercut silt fences.
- Repair or replace split, torn, slumping, or weathered fabric. The lifespan of silt fence fabric is generally 5 to 8 months.
- Silt fences that are damaged and become unsuitable for the intended purpose should be removed from the site of work, disposed, and replaced with new silt fence barriers.
- Sediment that accumulates in the BMP should be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches 1/3 of the barrier height.
- Silt fences should be left in place until the upgradient area is permanently stabilized. Until then, the silt fence should be inspected and maintained regularly.

- Remove silt fence when upgradient areas are stabilized. Fill and compact post holes and anchor trench, remove sediment accumulation, grade fence alignment to blend with adjacent ground, and stabilize disturbed area.

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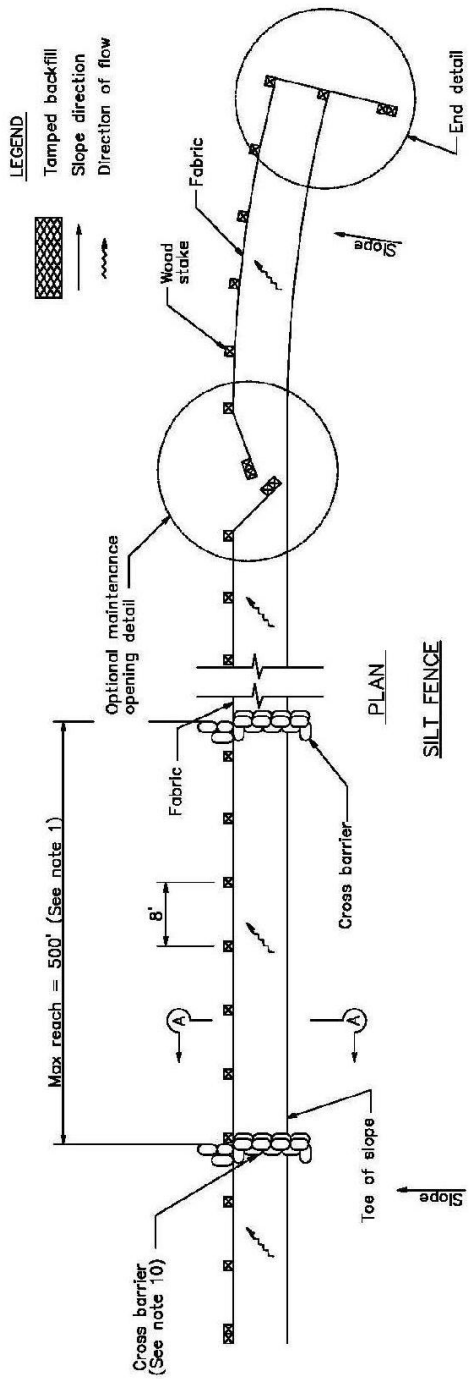
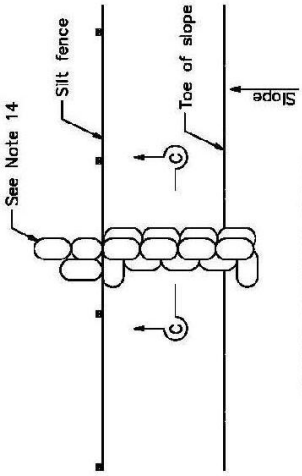
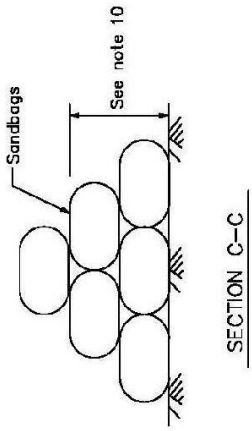
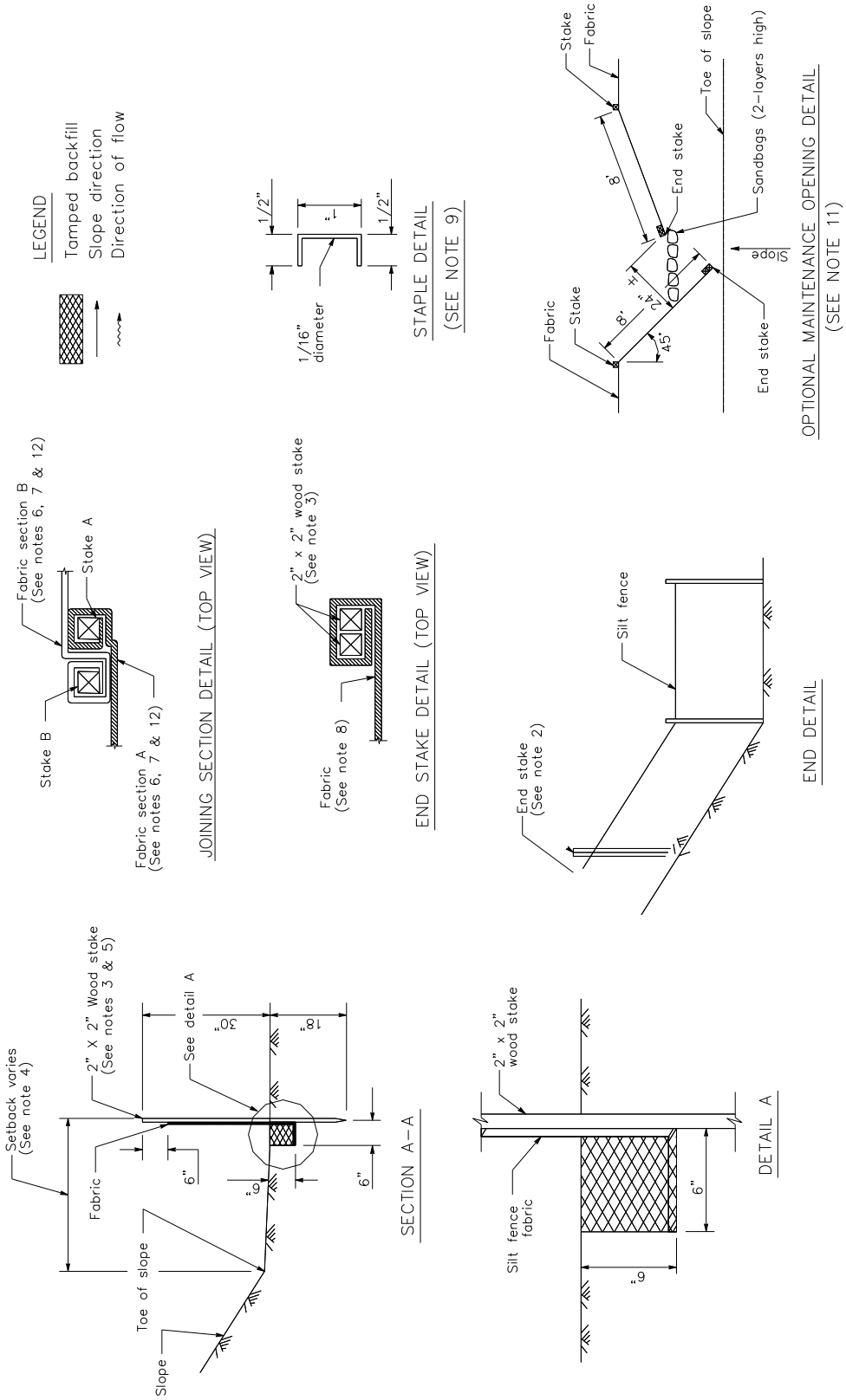


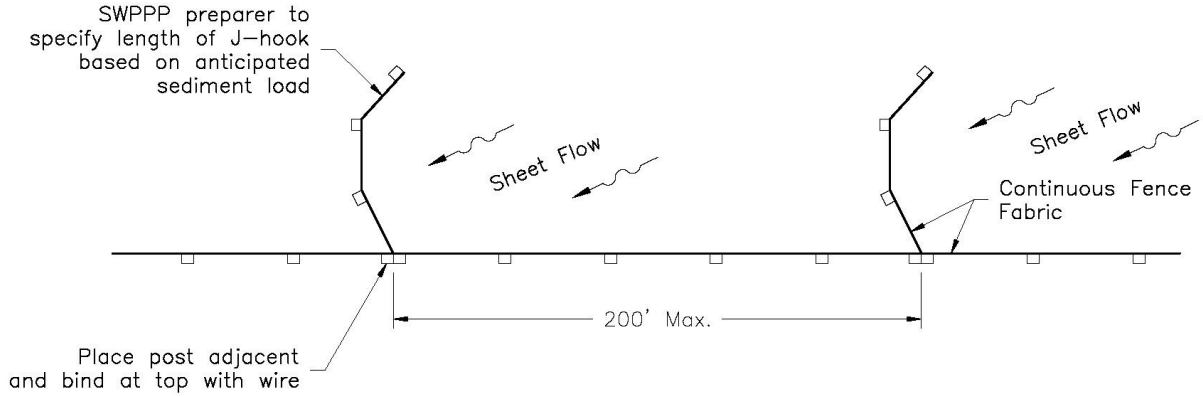




NOTES

1. Construct the length of each reach so that the change in base elevation along the reach does not exceed 1/3 the height of the linear barrier, in no case shall the reach length exceed 500'.
2. The last 8'–0" of fence shall be turned up slope.
3. Stake dimensions are nominal.
4. Dimension may vary to fit field condition.
5. Stakes shall be spaced at 8'–0" maximum and shall be positioned on downstream side of fence.
6. Stakes to overlap and fence fabric to fold around each stake one full turn. Secure fabric to stake with 4 staples.
7. Stakes shall be driven tightly together to prevent potential flow–through of sediment at joint. The tops of the stakes shall be secured with wire.
8. For end stake, fence fabric shall be folded around two stakes one full turn and secured with 4 staples.
9. Minimum 4 staples per stake. Dimensions shown are typical.
10. Cross barriers shall be a minimum of 1/3 and a maximum of 1/2 the height of the linear barrier.
11. Maintenance openings shall be constructed in a manner to ensure sediment remains behind silt fence.
12. Joining sections shall not be placed at sump locations.
13. Sandbag rows and layers shall be offset to eliminate gaps.
14. Add 3–4 bags to cross barrier on downgradient side of silt fence as needed to prevent bypass or undermining and as allowable based on site limits of disturbance.

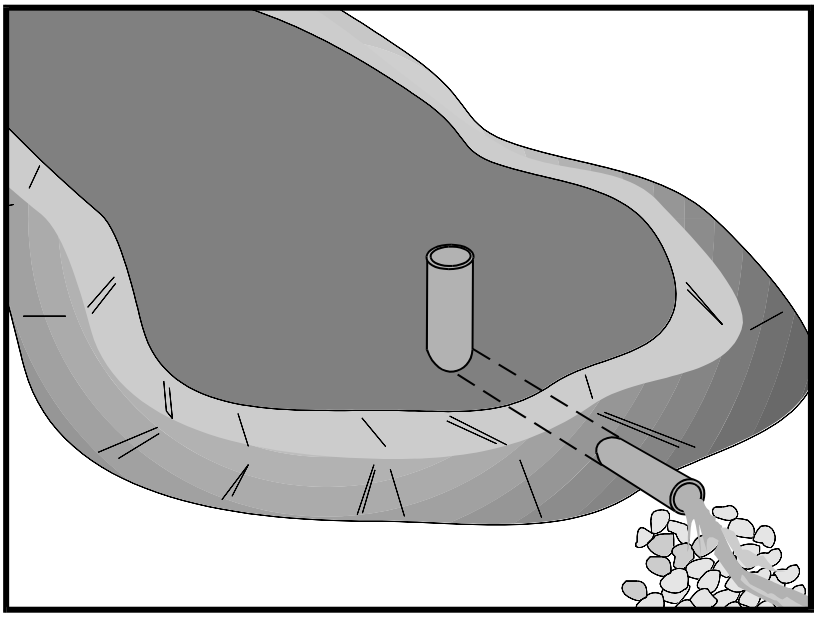

LEGEND
Tamped backfill
Slope direction
Direction of flow
1/2"
1"
1/2"
1/16" diameter
STAPLE DETAIL
(SEE NOTE 9)
Stake
Fabric
Toe of slope
Sandbags (2-layers high)
End stake
8'
4'
2'
8'
45°
Fabric
Stake
End stake
Slope
OPTIONAL MAINTENANCE OPENING DETAIL
(SEE NOTE 11)
Fabric section B
(See notes 6, 7 & 12)
Stake A
Stake B
Fabric section A
(See notes 6, 7 & 12)
JOINING SECTION DETAIL (TOP VIEW)
2" x 2" wood stake
(See note 3)
Fabric
(See note 8)
END STAKE DETAIL (TOP VIEW)
Silt fence
End stake
(See note 2)
END DETAIL
Setback varies
(See note 4)
2" X 2" Wood stake
(See notes 3 & 5)
See detail A
30"
18"
Fabric
6"
6"
6"
Toe of slope
Slope
SECTION A-A
2" x 2"
wood stake
Silt fence
fabric
6"
6"
DETAIL A


SWPPP preparer to specify length of J–hook based on anticipated sediment load
Sheet Flow
Sheet Flow
Continuous Fence Fabric
200' Max.
Place post adjacent and bind at top with wire

Plan

J–HOOK

Sediment Basin SE-2



Categories		
EC	Erosion Control	
SE	Sediment Control	☑
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents	
Sediment	☑
Nutrients	
Trash	☑
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-3 Sediment Trap (for smaller areas)

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Description and Purpose

A sediment basin is a temporary basin formed by excavation or by constructing an embankment so that sediment-laden runoff is temporarily detained under quiescent conditions, allowing sediment to settle out before the runoff is released.

Sediment basin design guidance presented in this fact sheet is intended to provide options, methods, and techniques to optimize temporary sediment basin performance and basin sediment removal. Basin design guidance provided in this fact sheet is not intended to guarantee basin effluent compliance with numeric discharge limits (numeric action levels or numeric effluent limits for turbidity). Compliance with discharge limits requires a thoughtful approach to comprehensive BMP planning, implementation, and maintenance. Therefore, optimally designed and maintained sediment basins should be used in conjunction with a comprehensive system of BMPs that includes:

- Diverting runoff from undisturbed areas away from the basin
- Erosion control practices to minimize disturbed areas on-site and to provide temporary stabilization and interim sediment controls (e.g., stockpile perimeter control, check dams, perimeter controls around individual lots) to reduce the basin's influent sediment concentration.

At some sites, sediment basin design enhancements may be required to adequately remove sediment. Traditional

(a.k.a. "physical") enhancements such as alternative outlet configurations or flow deflection baffles increase detention time and other techniques such as outlet skimmers preferentially drain flows with lower sediment concentrations. These "physical" enhancement techniques are described in this fact sheet. To further enhance sediment removal particularly at sites with fine soils or turbidity sensitive receiving waters, some projects may need to consider implementing Active Treatment Systems (ATS) whereby coagulants and flocculants are used to enhance settling and removal of suspended sediments. Guidance on implementing ATS is provided in SE-11.

Suitable Applications

Sediment basins may be suitable for use on larger projects with sufficient space for constructing the basin. Sediment basins should be considered for use:

- Where sediment-laden water may enter the drainage system or watercourses
- On construction projects with disturbed areas during the rainy season
- At the outlet of disturbed watersheds between 5 acres and 75 acres and evaluated on a site by site basis
- Where post construction detention basins are required
- In association with dikes, temporary channels, and pipes used to convey runoff from disturbed areas

Limitations

Sediment basins must be installed only within the property limits and where failure of the structure will not result in loss of life, damage to homes or buildings, or interruption of use or service of public roads or utilities. In addition, sediment basins are attractive to children and can be very dangerous. Local ordinances regarding health and safety must be adhered to. If fencing of the basin is required, the type of fence and its location should be shown in the SWPPP and in the construction specifications.

- As a general guideline, sediment basins are suitable for drainage areas of 5 acres or more, but not appropriate for drainage areas greater than 75 acres. However, the tributary area should be evaluated on a site by site basis.
- Sediment basins may become an "attractive nuisance" and care must be taken to adhere to all safety practices. If safety is a concern, basin may require protective fencing.
- Sediment basins designed according to this fact sheet are only effective in removing sediment down to about the silt size fraction. Sediment-laden runoff with smaller size fractions (fine silt and clay) may not be adequately treated unless chemical (or other appropriate method) treatment is used in addition to the sediment basin.
- Basins with a height of 25 ft or more or an impounding capacity of 50 ac-ft or more must obtain approval from California Department of Water Resources Division of Safety of Dams (http://www.water.ca.gov/damsafety/).

- Water that stands in sediment basins longer than 96 hours may become a source of mosquitoes (and midges), particularly along perimeter edges, in shallow zones, in scour or below-grade pools, around inlet pipes, along low-flow channels, and among protected habitats created by emergent or floating vegetation (e.g. cattails, water hyacinth), algal mats, riprap, etc.

- Basins require large surface areas to permit settling of sediment. Size may be limited by the available area.

Implementation

General

A sediment basin is a controlled stormwater release structure formed by excavation or by construction of an embankment of compacted soil across a drainage way, or other suitable location. It is intended to trap sediment before it leaves the construction site. The basin is a temporary measure expected to be used during active construction in most cases and is to be maintained until the site area is permanently protected against erosion or a permanent detention basin is constructed.

Sediment basins are suitable for nearly all types of construction projects. Whenever possible, construct the sediment basins before clearing and grading work begins. Basins should be located at the stormwater outlet from the site but not in any natural or undisturbed stream. A typical application would include temporary dikes, pipes, and/or channels to convey runoff to the basin inlet.

Many development projects in California are required by local ordinances to provide a stormwater detention basin for post-construction flood control, desilting, or stormwater pollution control. A temporary sediment basin may be constructed by rough grading the post-construction control basins early in the project.

Sediment basins if properly designed and maintained can trap a significant amount of the sediment that flows into them. However, traditional basins do not remove all inflowing sediment. Therefore, they should be used in conjunction with erosion control practices such as temporary seeding, mulching, diversion dikes, etc., to reduce the amount of sediment flowing into the basin.

Planning

To improve the effectiveness of the basin, it should be located to intercept runoff from the largest possible amount of disturbed area. Locations best suited for a sediment basin are generally in lower elevation areas of the site (or basin tributary area) where site drainage would not require significant diversion or other means to direct water to the basin but outside jurisdictional waterways. However, as necessary, drainage into the basin can be improved by the use of earth dikes and drainage swales (see BMP EC-9). . The basin should not be located where its failure would result in the loss of life or interruption of the use or service of public utilities or roads.

Construct before clearing and grading work begins when feasible.

- Do not locate the basin in a jurisdictional stream.

- Basin sites should be located where failure of the structure will not cause loss of life, damage to homes or buildings, or interruption of use or service of public roads or utilities.
- Basins with a height of 25 ft or more or an impounding capacity of 50 ac-ft must obtain approval from the Division of Dam Safety. Local dam safety requirements may be more stringent.
- Limit the contributing area to the sediment basin to only the runoff from the disturbed soil areas. Use temporary concentrated flow conveyance controls to divert runoff from undisturbed areas away from the sediment basin.
- The basin should be located: (1) by excavating a suitable area or where a low embankment can be constructed across a swale, (2) where post-construction (permanent) detention basins will be constructed, and (3) where the basins can be maintained on a year-round basis to provide access for maintenance, including sediment removal and sediment stockpiling in a protected area, and to maintain the basin to provide the required capacity.

Design

When designing a sediment basin, designers should evaluate the site constraints that could affect the efficiency of the BMP. Some of these constraints include: the relationship between basin capacity, anticipated sediment load, and freeboard, available footprint for the basin, maintenance frequency and access, and hydraulic capacity and efficiency of the temporary outlet infrastructure. Sediment basins should be designed to maximize sediment removal and to consider sediment load retained by the basin as it affects basin performance.

Three Basin Design Options (Part A) are presented below along with a Typical Sediment/Detention Basin Design Methodology (Part B). Regardless of the design option that is selected, designers also need to evaluate the sediment basin capacity with respect to sediment accumulation (See "*Step 3. Evaluate the Capacity of the Sediment Basin"),* and should incorporate approaches identified in "*Step 4. Other Design Considerations*" to enhance basin performance.

A) Basin Design Options:

Option 1:

Design sediment basin(s) using the standard equation:

$$A_s = \frac{1.2Q}{V_s} \qquad \text{(Eq. 1)}$$

Where:

A_s = Minimum surface area for trapping soil particles of a certain size

V_s = Settling velocity of the design particle size chosen (V_s = 0.00028 ft/s for a design particle size of 0.01 mm at 68°F)

1.2 = Factor of safety recommended by USEPA to account for the reduction in basin efficiency caused due to turbulence and other non ideal conditions.

$Q = CIA$ (Eq.2)

Where

Q = Peak basin influent flow rate measured in cubic feet per second (ft^3/s)

C = Runoff coefficient (unitless)

I = Peak rainfall intensity for the 10-year, 6-hour rain event (in/hr)

A = Area draining into the sediment basin in acres

The design particle size should be the smallest soil grain size determined by wet sieve analysis, or the fine silt sized (0.01 mm [or 0.0004 in.]) particle, and the Vs used should be 100 percent of the calculated settling velocity.

This sizing basin method is dependent on the outlet structure design or the total basin length with an appropriate outlet. If the designer chooses to utilize the outlet structure to control the flow duration in the basin, the basin length (distance between the inlet and the outlet) should be a minimum of twice the basin width; the depth should not be less than 3 ft nor greater than 5 ft for safety reasons and for maximum efficiency (2 ft of sediment storage, 2 ft of capacity). If the designer chooses to utilize the basin length (with appropriate basin outlet) to control the flow duration in the basin, the basin length (distance between the inlet and the outlet) should be a specifically designed to capture 100% of the design particle size; the depth should not be less than 3 ft nor greater than 5 ft for safety reasons and for maximum efficiency (2 ft of sediment storage, 2 ft of capacity).

Basin design guidance provided herein assumes standard water properties (e.g., estimated average water temperature, kinematic viscosity, etc.) as a basis of the design. Designers can use an alternative design (Option 3) with site specific water properties as long as the design is as protective as Option 1.

The design guidance uses the peak influent flow rate to size sediment basins. Designers can use an alternative design (Option 3) with site specific average flow rates as long as the design is as protective as Option 1.

The basin should be located on the site where it can be maintained on a year-round basis and should be maintained on a schedule to retain the 2 ft of capacity.

Option 2:

Design pursuant to local ordinance for sediment basin design and maintenance, provided that the design efficiency is as protective or more protective of water quality than Option 1.

Option 3:

The use of an equivalent surface area design or equation provided that the design efficiency is as protective or more protective of water quality than Option 1.

B) Typical Sediment/Detention Basin Design Methodology:

Design of a sediment basin requires the designer to have an understanding of the site constraints, knowledge of the local soil (e.g., particle size distribution of potentially contributing soils), drainage area of the basin, and local hydrology. Designers should not assume that a sediment basin for location A is applicable to location B. Therefore, designers can use this factsheet as guidance but will need to apply professional judgment and knowledge of the site to design an effective and efficient sediment basin. The following provides a general overview of typical design methodologies:

Step 1. Hydrologic Design

- Evaluate the site constraints and assess the drainage area for the sediment basin. Designers should consider on- and off-site flows as well as changes in the drainage area associated with site construction/disturbance. To minimize additional construction during the course of the project, the designer should consider identifying the maximum drainage area when calculating the basin dimensions.

- If a local hydrology manual is not available it is recommended to follow standard rational method procedures to estimate the flow rate. The references section of this factsheet provides a reference to standard hydrology textbooks that can provide standard methodologies. If local rainfall depths are not available, values can be obtained from standard precipitation frequency maps from NOAA (downloaded from http://www.wrcc.dri.edu/pcpnfreq.html).

Step 2. Hydraulic Design

- Calculate the surface area required for the sediment basin using Equation 1. In which the flow rate is estimated for a 10-yr 6-hr event using rational method procedure listed in local hydrology manual and Vs is estimated using Stokes Law presented in Equation 3.

$$V_s = 2.81d^2 \qquad \text{(Eq.3)}$$

Where

V_s = Settling velocity in feet per second at 68˚F

d = diameter of sediment particle in millimeters (smallest soil grain size determined by wet sieve analysis or fine silt (0.01 mm [or 0.0004 in.])

- In general the basin outlet design requires an iterative trial and error approach that considered the maximum water surface elevation, the elevation versus volume (stage-storage) relationship, the elevation verses basin outflow (a.k.a.-discharge) relationship, and the estimated inflow hydrograph. To adequately design the basins to settle sediment, the outlet configuration and associated outflow rates can be estimated by numerous methodologies. The following provides some guidance for design the basin outlet:

  - An outlet should have more than one orifice.

  - An outlet design typically utilizes multiple horizontal rows of orifices (approximately 3 or more) with at least 2 orifices per row (see Figures 1 and 2 at the end of this fact sheet).

- Orifices can vary in shape.
- Select the appropriate orifice diameter and number of perforations per row with the objective of minimizing the number of rows while maximizing the detention time.
- The diameter of each orifice is typically a maximum of 3-4 inches and a minimum of 0.25-0.5 inches.
- If a rectangular orifice is used, it is recommended to have minimum height of 0.5 inches and a maximum height of 6 inches.
- Rows are typically spaced at three times the diameter center to center vertically with a minimum distance of approximately 4 inches on center and a maximum distance of 1 foot on center.
- To estimate the outflow rate, each row is calculated separately based on the flow through a single orifice then multiplied by the number of orifices in the row. This step is repeated for each of the rows. Once all of the orifices are estimated, the total outflow rate versus elevation (stage-discharge curve) is developed to evaluate the detention time within the basin.
- Flow through a single orifice can be estimated using an Equation 4:

$$Q = BC' A(2gH)^{0.5} \qquad \text{(Eq.4)}$$

Where
Q = Outflow rate in ft^3/s
C´ = Orifice coefficient (unitless)
A = Area of the orifice (ft^2)
g = acceleration due to gravity (ft^3/s)
H = Head above the orifice (ft)
B = Anticipated Blockage or clogging factor (unitless), It is dependent on anticipated sediment and debris load, trash rack configuration etc, so the value is dependent on design engineers professional judgment and/or local requirements (B is never greater than 1 and a value of 0.5 is generally used)

  - Care must be taken in the selection of orifice coefficient ("C´"); 0.60 is most often recommended and used. However, based on actual tests, Young and Graziano (1989), "Outlet Hydraulics of Extended Detention Facilities for Northern Virginia Planning District Commission", recommends the following:
    - C´ = 0.66 for thin materials; where the thickness is equal to or less than the orifice diameter, or
    - C´ = 0.80 when the material is thicker than the orifice diameter
- If different sizes of orifices are used along the riser then they have to be sized such that not more than 50 percent of the design storm event drains in one-third of the drawdown time (to provide adequate settling time for events smaller than the design storm event)

and the entire volume drains within 96 hours or as regulated by the local vector control agency. If a basin fails to drain within 96 hours, the basin must be pumped dry.

- Because basins are not maintained for infiltration, water loss by infiltration should be disregarded when designing the hydraulic capacity of the outlet structure.

- Floating Outlet Skimmer: The floating skimmer (see Figure 3 at the end of this fact sheet is an alternative outlet configuration (patented) that drains water from upper portion of the water column. This configuration has been used for temporary and permanent basins and can improve basin performance by eliminating bottom orifices which have the potential of discharging solids. Some design considerations for this alternative outlet device includes the addition of a sand filter or perforated under drain at the low point in the basin and near the floating skimmer. These secondary drains allow the basin to fully drain. More detailed guidelines for sizing the skimmer can be downloaded from http://www.fairclothskimmer.com/.

- Hold and Release Valve: An ideal sediment/detention basin would hold all flows to the design storm level for sufficient time to settle solids, and then slowly release the storm water. Implementing a reliable valve system for releasing detention basins is critical to eliminate the potential for flooding in such a system. Some variations of hold and release valves include manual valves, bladder devices or electrically operated valves. When a precipitation event is forecast, the valve would be close for the duration of the storm and appropriate settling time. When the settling duration is met (approximately 24 or 48 hours), the valve would be opened and allow the stormwater to be released at a rate that does not resuspend settled solids and in a non-erosive manner. If this type of system is used the valve should be designed to empty the entire basin within 96 hours or as stipulated by local vector control regulations.

Step 3. Evaluate the Capacity of the Sediment Basin

- Typically, sediment basins do not perform as designed when they are not properly maintained or the sediment yield to the basin is larger than expected. As part of a good sediment basin design, designers should consider maintenance cycles, estimated soil loss and/or sediment yield, and basin sediment storage volume. The two equations below can be used to quantify the amount of soil entering the basin.

- The Revised Universal Soil Loss Equation (RUSLE, Eq.5) can be used to estimate annual soil loss and the Modified Universal Soil Equation (MUSLE, Eq.6) can be used to estimate sediment yield from a single storm event.

$$A = R \times K \times LS \times C \times P \qquad \text{(Eq.5)}$$

$$Y = 95\left(Q \times q_p\right)^{0.56} \times K \times LS \times C \times P \qquad \text{(Eq.6)}$$

Where:

A = annual soil loss, tons/acre-year

R = rainfall erosion index, in 100 ft.tons/acre.in/hr

K = soil erodibility factor, tons/acre per unit of R

LS = slope length and steepness factor (unitless)

C = vegetative cover factor (unitless)

P = erosion control practice factor (unitless)

Y = single storm sediment yield in tons

Q = runoff volume in acre-feet

q_p = peak flow in cfs

- Detailed descriptions and methodologies for estimating the soil loss can be obtained from standard hydrology text books (See References section).
- Determination of the appropriate equation should consider construction duration and local environmental factors (soils, hydrology, etc.). For example, if a basin is planned for a project duration of 1 year and the designer specifies one maintenance cycle, RUSLE could be used to estimate the soil loss and thereby the designer could indicate that the sediment storage volume would be half of the soil loss value estimated. As an example for use of MUSLE, a project may have a short construction duration thereby requiring fewer maintenance cycles and a reduced sediment storage volume. MUSLE would be used to estimate the anticipated soil loss based on a specific storm event to evaluate the sediment storage volume and appropriate maintenance frequency.
- The soil loss estimates are an essential step in the design and it is essential that the designer provide construction contractors with enough information to understand maintenance frequency and/or depths within the basin that would trigger maintenance. Providing maintenance methods, frequency and specification should be included in design bid documents such as the SWPPP Site Map.
- Once the designer has quantified the amount of soil entering the basin, the depth required for sediment storage can be determined by dividing the estimated sediment loss by the surface area of the basin.

Step 4. Other Design Considerations

- Consider designing the volume of the settling zone for the total storm volume associated with the 2-year event or other appropriate design storms specified by the local agency. This volume can be used as a guide for sizing the basin without iterative routing calculations. The depth of the settling zone can be estimated by dividing the estimated 2-yr storm volume by the surface area of the basin.
- The basin volume consists of two zones:
  - A sediment storage zone at least 1 ft deep.
  - A settling zone at least 2 ft deep.

- The basin depth must be no less than 3 ft (not including freeboard).

- Proper hydraulic design of the outlet is critical to achieving the desired performance of the basin. The outlet should be designed to drain the basin within 24 to 96 hours (also referred to as "drawdown time"). The 24-hour limit is specified to provide adequate settling time; the 96-hour limit is specified to mitigate vector control concerns.

- Confirmation of the basin performance can be evaluated by routing the design storm (10-yr 6-hr, or as directed by local regulations) through the basin based on the basin volume (stage-storage curve) and the outlet design (stage-discharge curve based on the orifice configuration or equivalent outlet design).

- Sediment basins, regardless of size and storage volume, should include features to accommodate overflow or bypass flows that exceed the design storm event.

  - Include an emergency spillway to accommodate flows not carried by the principal spillway. The spillway should consist of an open channel (earthen or vegetated) over undisturbed material (not fill) or constructed of a non-erodible riprap (or equivalent protection) on fill slopes.

  - The spillway control section, which is a level portion of the spillway channel at the highest elevation in the channel, should be a minimum of 20 ft in length.

- Rock, vegetation or appropriate erosion control should be used to protect the basin inlet, outlet, and slopes against erosion.

- The total depth of the sediment basin should include the depth required for sediment storage, depth required for settling zone and freeboard of at least 1 foot or as regulated by local flood control agency for a flood event specified by the local agency.

- The basin alignment should be designed such that the length of the basin is more than twice the width of the basin; the length should be determined by measuring the distance between the inlet and the outlet. If the site topography does not allow for this configuration baffles should be installed so that the ratio is satisfied. If a basin has more than one inflow point, any inflow point that conveys more than 30 percent of the total peak inflow rate has to meet the required length to width ratio.

- An alternative basin sizing method proposed by Fifield (2004) can be consulted to estimate an alternative length to width ratio and basin configuration. These methods can be considered as part of Option 3 which allows for alternative designs that are protective or more protective of water quality.

- Baffles (see Figure 4 at the end of this fact sheet) can be considered at project sites where the existing topography or site constraints limit the length to width ratio. Baffles should be constructed of earthen berms or other structural material within the basin to divert flow in the basin, thus increasing the effective flow length from the basin inlet to the outlet riser. Baffles also reduce the change of short circuiting and allows for settling throughout the basin.

- Baffles are typically constructed from the invert of the basin to the crest of the emergency spillway (i.e., design event flows are meant to flow around the baffles and flows greater than the design event would flow over the baffles to the emergency spillway).
- Use of other materials for construction of basin baffles (such as silt fence) may not be appropriate based on the material specifications and will require frequent maintenance (maintain after every storm event). Maintenance may not be feasible when required due to flooded conditions resulting from frequent (i.e., back to back) storm events. Use of alternative baffle materials should not deviate from the intended purpose of the material, as described by the manufacturer.
- Sediment basins are best used in conjunction with erosion controls.
- Basins with an impounding levee greater than 4.5 ft tall, measured from the lowest point to the impounding area to the highest point of the levee, and basins capable of impounding more than 35,000 ft^3, should be designed by a Registered Civil Engineer. The design should include maintenance requirements, including sediment and vegetation removal, to ensure continuous function of the basin outlet and bypass structures.
- A forebay, constructed upstream of the basin, may be provided to remove debris and larger particles.
- The outflow from the sediment basin should be provided with velocity dissipation devices (see BMP EC-10) to prevent erosion and scouring of the embankment and channel.
- The principal outlet should consist of a corrugated metal, high density polyethylene (HDPE), or reinforced concrete riser pipe with dewatering holes and an anti-vortex device and trash rack attached to the top of the riser, to prevent floating debris from flowing out of the basin or obstructing the system. This principal structure should be designed to accommodate the inflow design storm.
- A rock pile or rock-filled gabions can serve as alternatives to the debris screen, although the designer should be aware of the potential for extra maintenance involved should the pore spaces in the rock pile clog.
- The outlet structure should be placed on a firm, smooth foundation with the base securely anchored with concrete or other means to prevent floatation.
- Attach riser pipe (watertight connection) to a horizontal pipe (barrel). Provide anti-seep collars on the barrel.
- Cleanout level should be clearly marked on the riser pipe.

Installation

- Securely anchor and install an anti-seep collar on the outlet pipe/riser and provide an emergency spillway for passing major floods (see local flood control agency).
- Areas under embankments must be cleared and stripped of vegetation.

- Chain link fencing should be provided around each sediment basin to prevent unauthorized entry to the basin or if safety is a concern.

Costs

The cost of a sediment basin is highly variable and is dependent of the site configuration. To decrease basin construction costs, designers should consider using existing site features such as berms or depressed area to site the sediment basin. Designers should also consider potential savings associated with designing the basin to minimize the number of maintenance cycles and siting the basin in a location where a permanent BMP (e.g., extended detention basin) is required for the project site.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level and as required by local requirements. It is recommended that at a minimum, basins be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Examine basin banks for seepage and structural soundness.
- Check inlet and outlet structures and spillway for any damage or obstructions. Repair damage and remove obstructions as needed.
- Check inlet and outlet area for erosion and stabilize if required.
- Check fencing for damage and repair as needed.
- Sediment that accumulates in the basin must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when sediment accumulation reaches one-half the designated sediment storage volume. Sediment removed during maintenance should be managed properly. The sediment should be appropriately evaluated and used or disposed of accordingly. Options include: incorporating sediment into earthwork on the site (only if there is no risk that sediment is contaminated); or off-site export/disposal at an appropriate location (e.g., sediment characterization and disposal to an appropriate landfill).
- Remove standing water from basin within 96 hours after accumulation.
- If the basin does not drain adequately (e.g., due to storms that are more frequent or larger than the design storm or other unforeseen site conditions), dewatering should be conducted in accordance with appropriate dewatering BMPs (see NS-2) and in accordance with local permits as applicable.
- To minimize vector production:
  - Remove accumulation of live and dead floating vegetation in basins during every inspection.
  - Remove excessive emergent and perimeter vegetation as needed or as advised by local or state vector control agencies.

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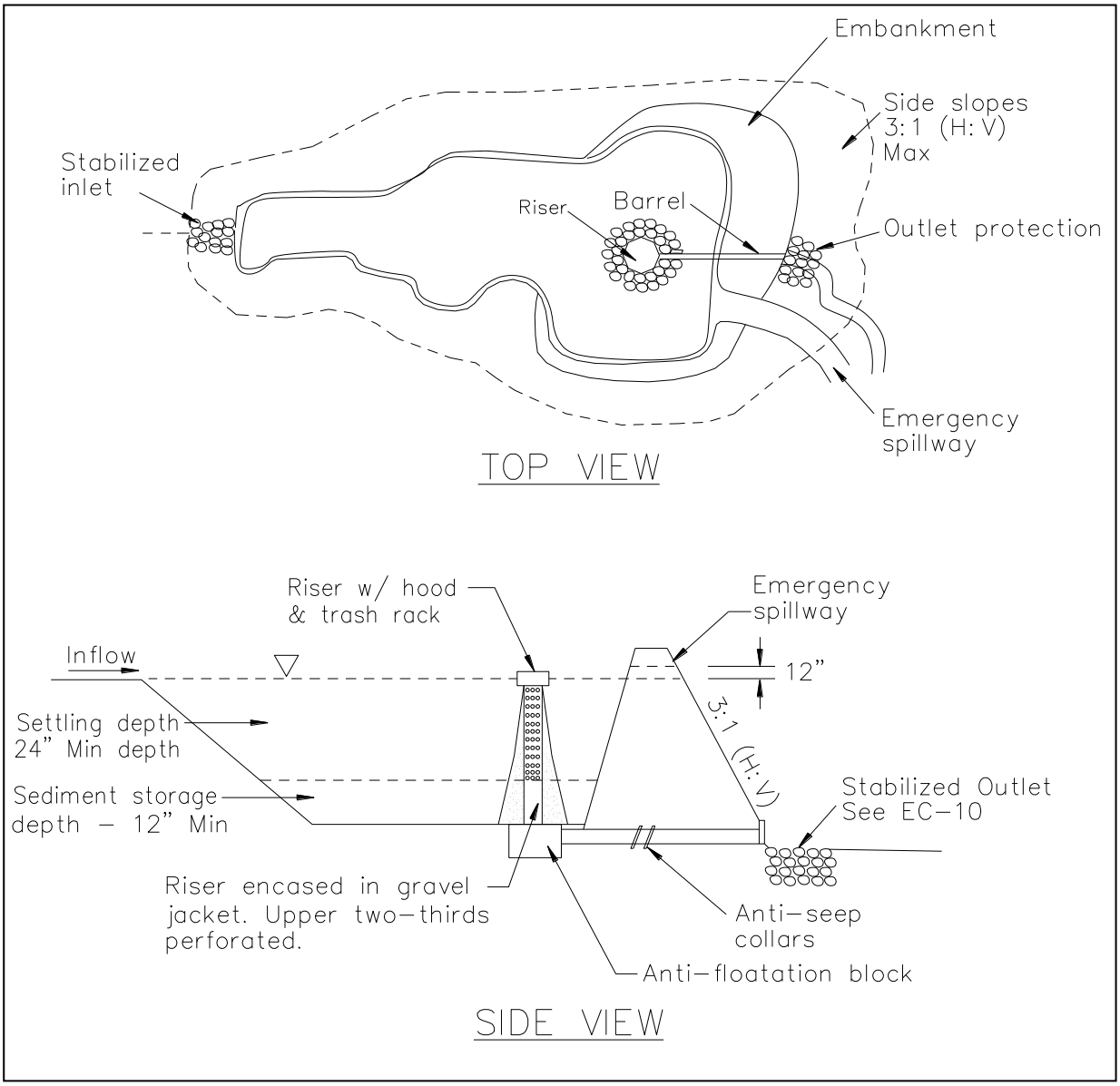


FIGURE 1: TYPICAL TEMPORARY SEDIMENT BASIN
MULTIPLE ORIFICE DESIGN
NOT TO SCALE

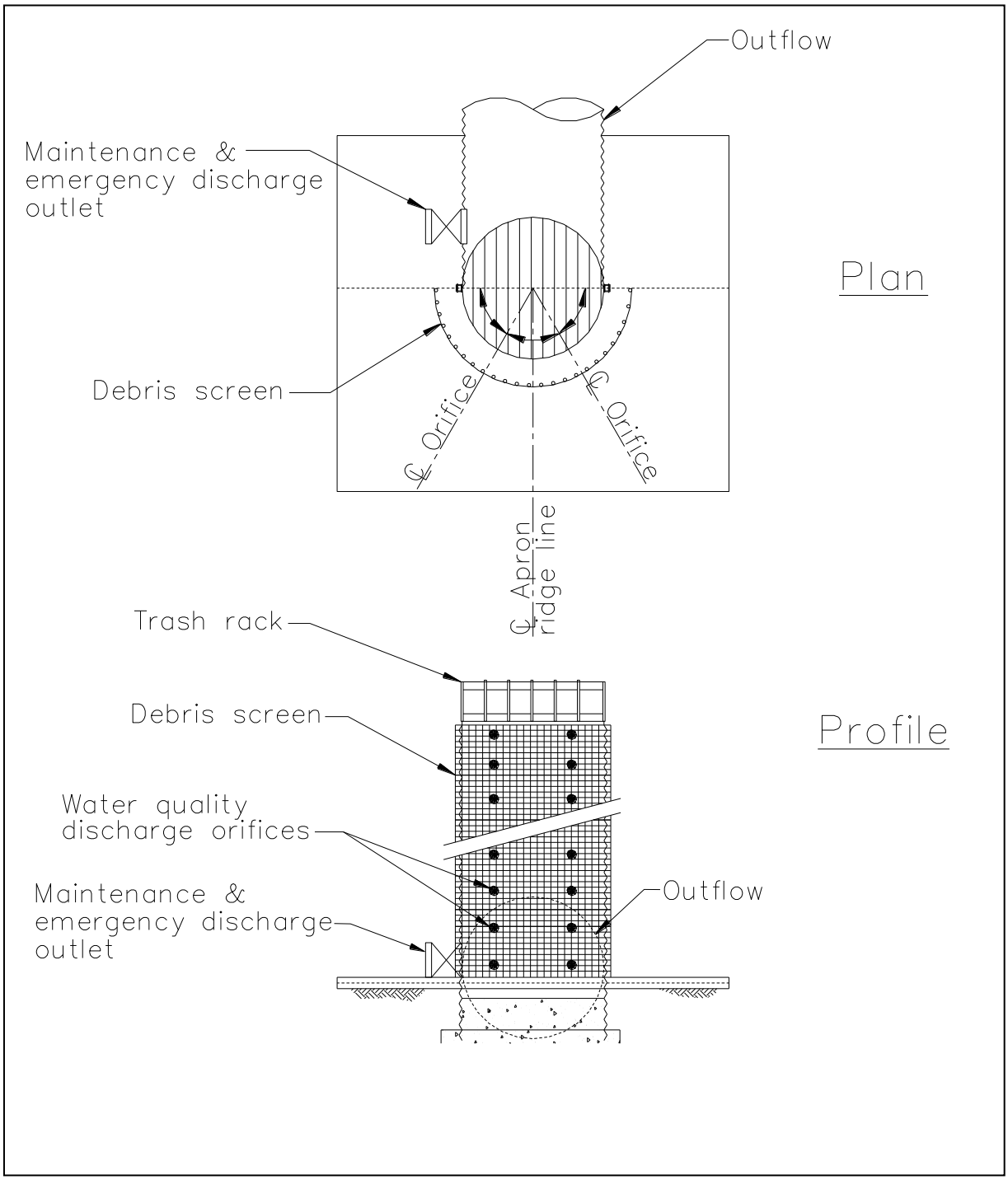


FIGURE 2: MULTIPLE ORIFICE OUTLET RISER

NOT TO SCALE

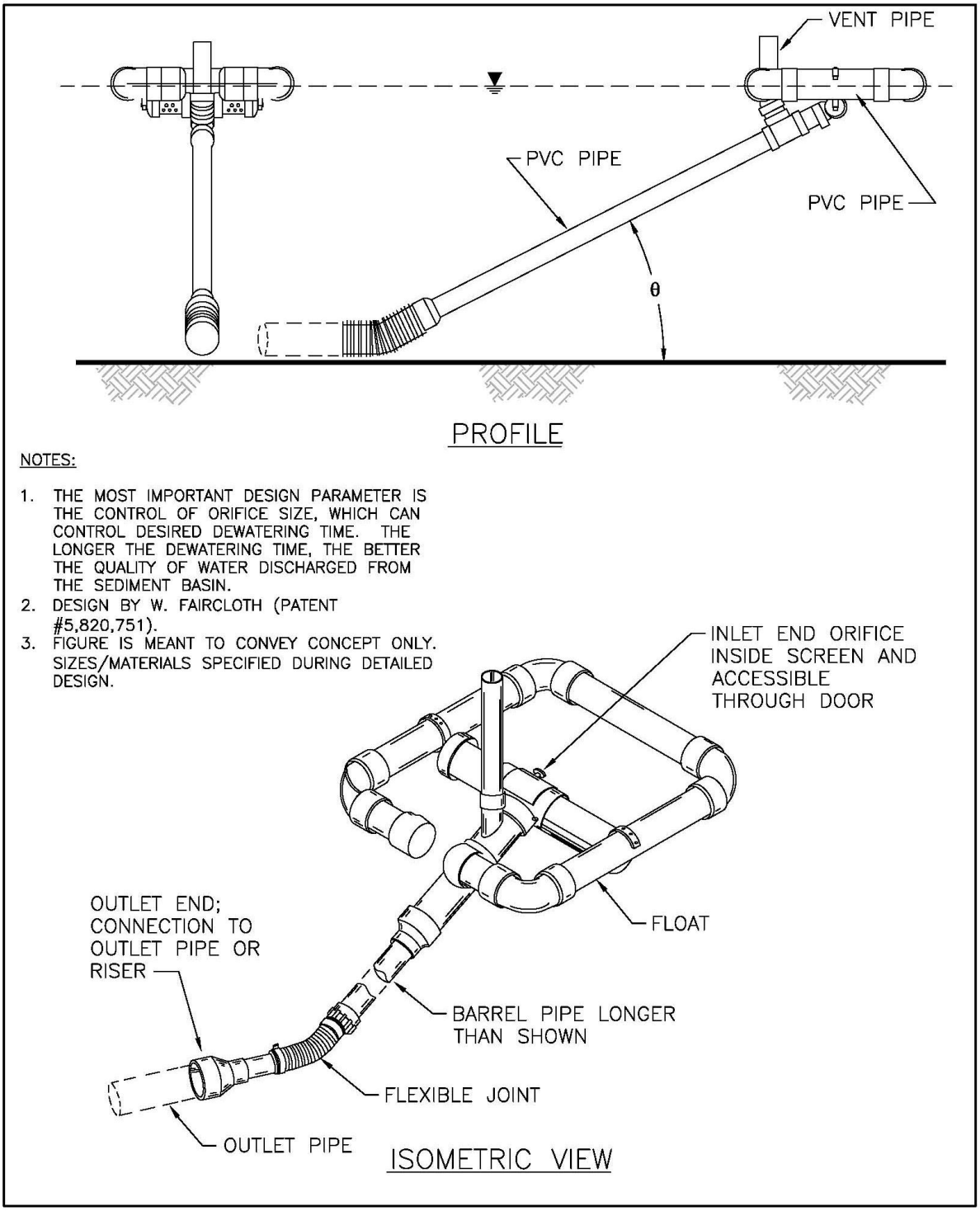


FIGURE 3: TYPICAL SKIMMER

NOT TO SCALE

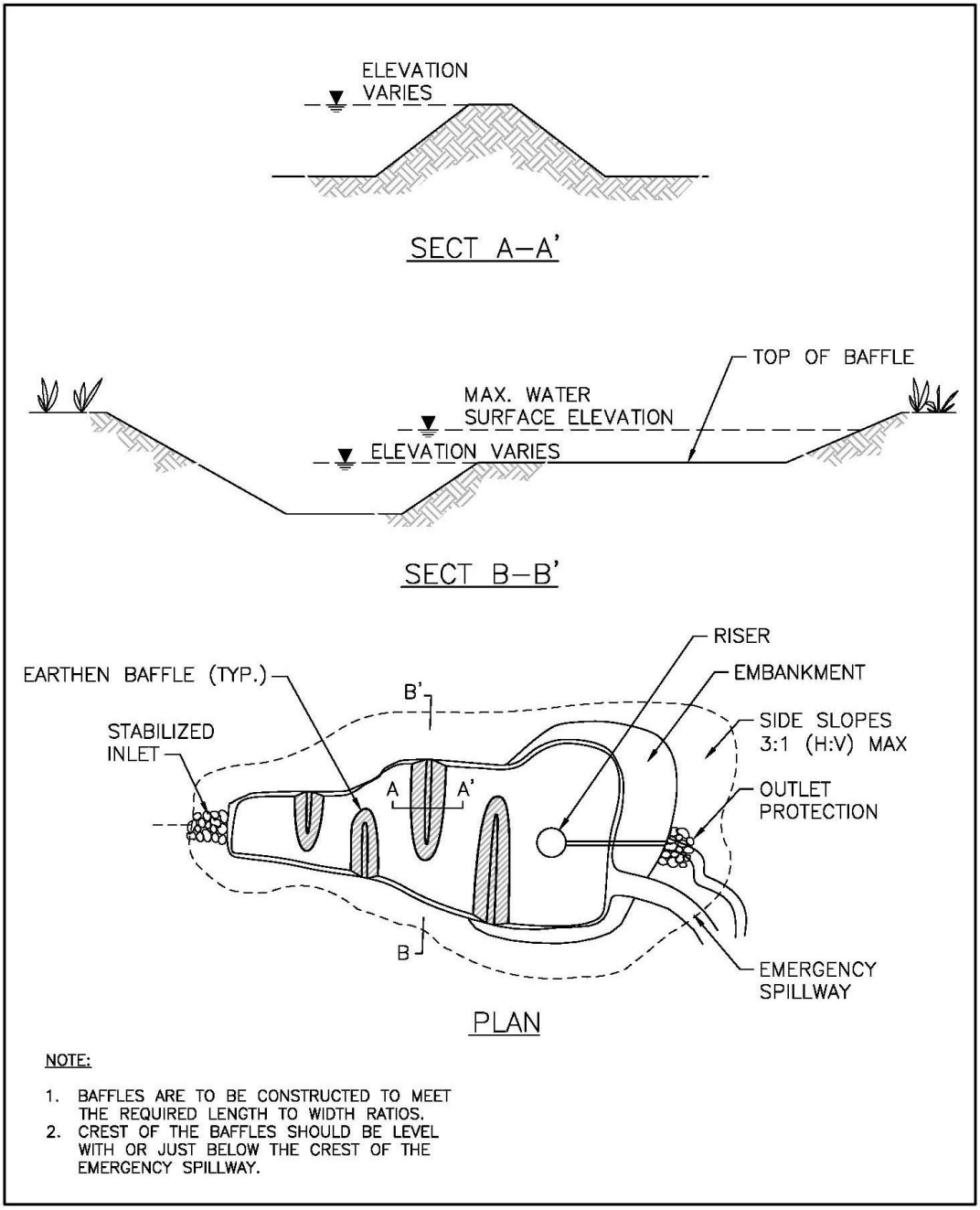
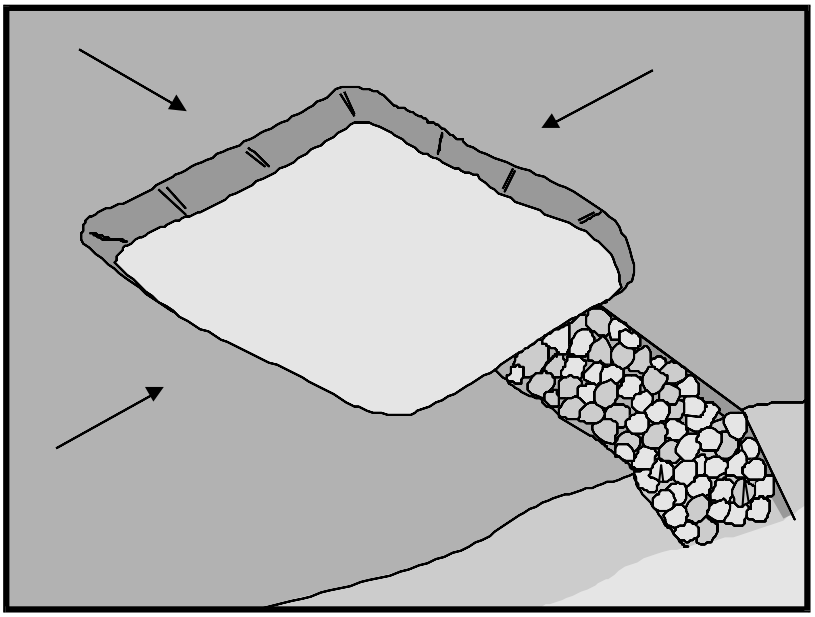


FIGURE 4: TYPICAL TEMPORARY SEDIMENT BASIN WITH BAFFLES

NOT TO SCALE

Sediment Trap SE-3



Categories

EC	Erosion Control	
SE	Sediment Control	☑
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	☑
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-2 Sediment Basin (for larger areas)

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Description and Purpose

A sediment trap is a containment area where sediment-laden runoff is temporarily detained under quiescent conditions, allowing sediment to settle out or before the runoff is discharged by gravity flow. Sediment traps are formed by excavating or constructing an earthen embankment across a waterway or low drainage area.

Trap design guidance provided in this fact sheet is not intended to guarantee compliance with numeric discharge limits (numeric action levels or numeric effluent limits for turbidity). Compliance with discharge limits requires a thoughtful approach to comprehensive BMP planning, implementation, and maintenance. Therefore, optimally designed and maintained sediment traps should be used in conjunction with a comprehensive system of BMPs.

Suitable Applications

Sediment traps should be considered for use:

- At the perimeter of the site at locations where sediment-laden runoff is discharged offsite.
- At multiple locations within the project site where sediment control is needed.
- Around or upslope from storm drain inlet protection measures.
- Sediment traps may be used on construction projects where the drainage area is less than 5 acres. Traps would be

placed where sediment-laden stormwater may enter a storm drain or watercourse. SE-2, Sediment Basins, must be used for drainage areas greater than 5 acres.

- As a supplemental control, sediment traps provide additional protection for a water body or for reducing sediment before it enters a drainage system.

Limitations

- Requires large surface areas to permit infiltration and settling of sediment.
- Not appropriate for drainage areas greater than 5 acres.
- Only removes large and medium sized particles and requires upstream erosion control.
- Attractive and dangerous to children, requiring protective fencing.
- Conducive to vector production.
- Should not be located in live streams.

Implementation

Design

A sediment trap is a small temporary ponding area, usually with a gravel outlet, formed by excavation or by construction of an earthen embankment. Its purpose is to collect and store sediment from sites cleared or graded during construction. It is intended for use on small drainage areas with no unusual drainage features and projected for a quick build-out time. It should help in removing coarse sediment from runoff. The trap is a temporary measure with a design life of approximately six months to one year and is to be maintained until the site area is permanently protected against erosion by vegetation and/or structures.

Sediment traps should be used only for small drainage areas. If the contributing drainage area is greater than 5 acres, refer to SE-2, Sediment Basins, or subdivide the catchment area into smaller drainage basins.

Sediment usually must be removed from the trap after each rainfall event. The SWPPP should detail how this sediment is to be disposed, such as in fill areas onsite, or removal to an approved offsite dump. Sediment traps used as perimeter controls should be installed before any land disturbance takes place in the drainage area.

Sediment traps are usually small enough that a failure of the structure would not result in a loss of life, damage to home or buildings, or interruption in the use of public roads or utilities. However, sediment traps are attractive to children and can be dangerous. The following recommendations should be implemented to reduce risks:

- Install continuous fencing around the sediment trap or pond. Consult local ordinances regarding requirements for maintaining health and safety.
- Restrict basin side slopes to 3:1 or flatter.

Sediment trap size depends on the type of soil, size of the drainage area, and desired sediment removal efficiency (see SE-2, Sediment Basin). As a rule of thumb, the larger the basin volume

the greater the sediment removal efficiency. Sizing criteria are typically established under the local grading ordinance or equivalent. The runoff volume from a 2-year storm is a common design criteria for a sediment trap. The sizing criteria below assume that this runoff volume is 0.042 acre-ft/acre (0.5 in. of runoff). While the climatic, topographic, and soil type extremes make it difficult to establish a statewide standard, the following criteria should trap moderate to high amounts of sediment in most areas of California:

- Locate sediment traps as near as practical to areas producing the sediment.
- Trap should be situated according to the following criteria: (1) by excavating a suitable area or where a low embankment can be constructed across a swale, (2) where failure would not cause loss of life or property damage, and (3) to provide access for maintenance, including sediment removal and sediment stockpiling in a protected area.
- Trap should be sized to accommodate a settling zone and sediment storage zone with recommended minimum volumes of 67 yd^3/acre and 33 yd^3/acre of contributing drainage area, respectively, based on 0.5 in. of runoff volume over a 24-hour period. In many cases, the size of an individual trap is limited by available space. Multiple traps or additional volume may be required to accommodate specific rainfall, soil, and site conditions.
- Traps with an impounding levee greater than 4.5 ft tall, measured from the lowest point to the impounding area to the highest point of the levee, and traps capable of impounding more than 35,000 ft^3, should be designed by a Registered Civil Engineer. The design should include maintenance requirements, including sediment and vegetation removal, to ensure continuous function of the trap outlet and bypass structures.
- The outlet pipe or open spillway must be designed to convey anticipated peak flows.
- Use rock or vegetation to protect the trap outlets against erosion.
- Fencing should be provided to prevent unauthorized entry.

Installation

Sediment traps can be constructed by excavating a depression in the ground or creating an impoundment with a small embankment. Sediment traps should be installed outside the area being graded and should be built prior to the start of the grading activities or removal of vegetation. To minimize the area disturbed by them, sediment traps should be installed in natural depressions or in small swales or drainage ways. The following steps must be followed during installation:

- The area under the embankment must be cleared, grubbed, and stripped of any vegetation and root mat. The pool area should be cleared.
- The fill material for the embankment must be free of roots or other woody vegetation as well as oversized stones, rocks, organic material, or other objectionable material. The embankment may be compacted by traversing with equipment while it is being constructed.
- All cut-and-fill slopes should be 3:1 or flatter.
- When a riser is used, all pipe joints must be watertight.

- When a riser is used, at least the top two-thirds of the riser should be perforated with 0.5 in. diameter holes spaced 8 in. vertically and 10 to 12 in. horizontally. See SE-2, Sediment Basin.
- When an earth or stone outlet is used, the outlet crest elevation should be at least 1 ft below the top of the embankment.
- When crushed stone outlet is used, the crushed stone used in the outlet should meet AASHTO M43, size No. 2 or 24, or its equivalent such as MSHA No. 2. Gravel meeting the above gradation may be used if crushed stone is not available.

Costs

Average annual cost per installation and maintenance (18 month useful life) is $0.73 per ft^3 ($1,300 per drainage acre). Maintenance costs are approximately 20% of installation costs.

Inspection and Maintenance

- Inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Inspect outlet area for erosion and stabilize if required.
- Inspect trap banks for seepage and structural soundness, repair as needed.
- Inspect outlet structure and spillway for any damage or obstructions. Repair damage and remove obstructions as needed.
- Inspect fencing for damage and repair as needed.
- Inspect the sediment trap for area of standing water during every visit. Corrective measures should be taken if the BMP does not dewater completely in 96 hours or less to prevent vector production.
- Sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the trap capacity. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed of at an appropriate location.
- Remove vegetation from the sediment trap when first detected to prevent pools of standing water and subsequent vector production.
- BMPs that require dewatering shall be continuously attended while dewatering takes place. Dewatering BMPs per NS-2 shall be implemented at all times during dewatering activities.

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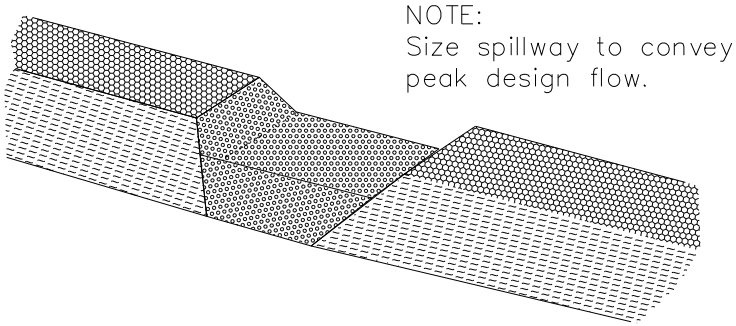
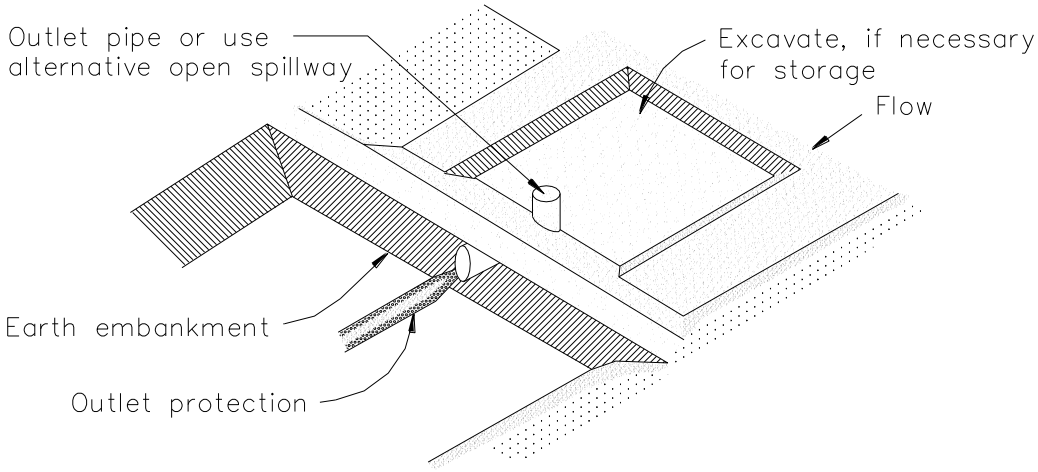
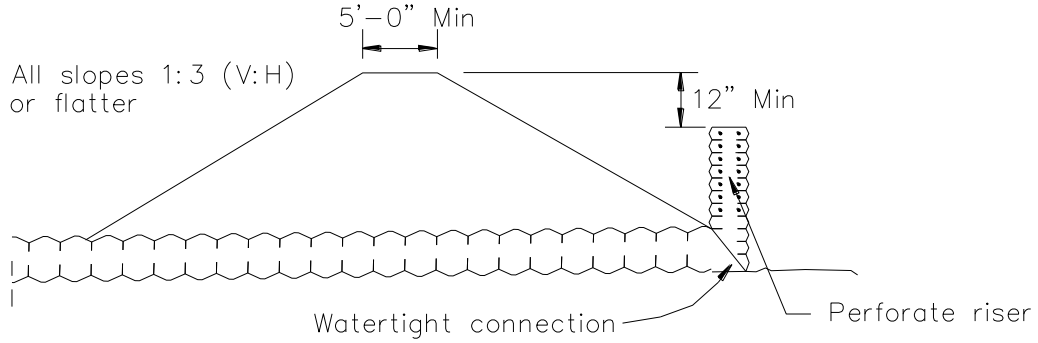


TYPICAL OPEN SPILLWAY

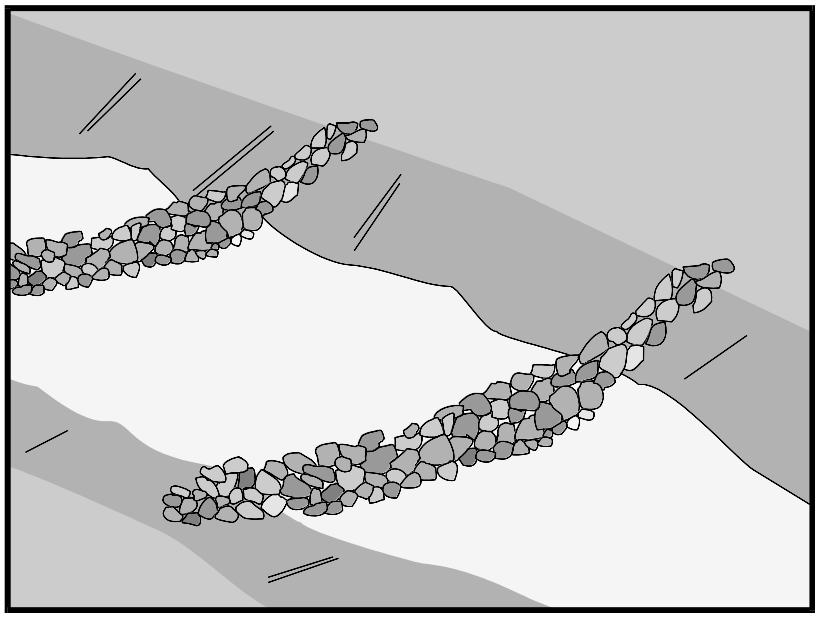




EMBANKMENT SECTION THRU RISER

TYPICAL SEDIMENT TRAP
NOT TO SCALE

Check Dams SE-4



Categories

EC	Erosion Control	☒
SE	Sediment Control	☑
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-5 Fiber Rolls

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

SE-12 Manufactured Linear Sediment Controls

SE-14 Biofilter Bags

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Description and Purpose

A check dam is a small barrier constructed of rock, gravel bags, sandbags, fiber rolls, or other proprietary products, placed across a constructed swale or drainage ditch. Check dams reduce the effective slope of the channel, thereby reducing scour and channel erosion by reducing flow velocity and increasing residence time within the channel, allowing sediment to settle.

Suitable Applications

Check dams may be appropriate in the following situations:

- To promote sedimentation behind the dam.
- To prevent erosion by reducing the velocity of channel flow in small intermittent channels and temporary swales.
- In small open channels that drain 10 acres or less.
- In steep channels where stormwater runoff velocities exceed 5 ft/s.
- During the establishment of grass linings in drainage ditches or channels.
- In temporary ditches where the short length of service does not warrant establishment of erosion-resistant linings.
- To act as a grade control structure.

Limitations

- Not to be used in live streams or in channels with extended base flows.
- Not appropriate in channels that drain areas greater than 10 acres.
- Not appropriate in channels that are already grass-lined unless erosion potential or sediment-laden flow is expected, as installation may damage vegetation.
- Require extensive maintenance following high velocity flows.
- Promotes sediment trapping which can be re-suspended during subsequent storms or removal of the check dam.
- Do not construct check dams with straw bales or silt fence.
- Water suitable for mosquito production may stand behind check dams, particularly if subjected to daily non-stormwater discharges.

Implementation

General

Check dams reduce the effective slope and create small pools in swales and ditches that drain 10 acres or less. Using check dams to reduce channel slope reduces the velocity of stormwater flows, thus reducing erosion of the swale or ditch and promoting sedimentation. Thus, check dams are dual-purpose and serve an important role as erosion controls as well as as sediment controls. Note that use of 1-2 isolated check dams for sedimentation will likely result in little net removal of sediment because of the small detention time and probable scour during longer storms. Using a series of check dams will generally increase their effectiveness. A sediment trap (SE-3) may be placed immediately upstream of the check dam to increase sediment removal efficiency.

Design and Layout

Check dams work by decreasing the effective slope in ditches and swales. An important consequence of the reduced slope is a reduction in capacity of the ditch or swale. This reduction in capacity should be considered when using this BMP, as reduced capacity can result in overtopping of the ditch or swale and resultant consequences. In some cases, such as a "permanent" ditch or swale being constructed early and used as a "temporary" conveyance for construction flows, the ditch or swale may have sufficient capacity such that the temporary reduction in capacity due to check dams is acceptable. When check dams reduce capacities beyond acceptable limits, either:

- Don't use check dams. Consider alternative BMPs, or.
- Increase the size of the ditch or swale to restore capacity.

Maximum slope and velocity reduction is achieved when the toe of the upstream dam is at the same elevation as the top of the downstream dam (see "Spacing Between Check Dams" detail at the end of this fact sheet). The center section of the dam should be lower than the edge sections (at least 6 inches), acting as a spillway, so that the check dam will direct flows to the center of

the ditch or swale (see "Typical Rock Check Dam" detail at the end of this fact sheet). Bypass or side-cutting can occur if a sufficient spillway is not provided in the center of the dam.

Check dams are usually constructed of rock, gravel bags, sandbags, and fiber rolls. A number of products can also be used as check dams (e.g. HDPE check dams, temporary silt dikes (SE-12)), and some of these products can be removed and reused. Check dams can also be constructed of logs or lumber, and have the advantage of a longer lifespan when compared to gravel bags, sandbags, and fiber rolls. Check dams should not be constructed from straw bales or silt fences, since concentrated flows quickly wash out these materials.

Rock check dams are usually constructed of 8 to 12 in. rock. The rock is placed either by hand or mechanically, but never just dumped into the channel. The dam should completely span the ditch or swale to prevent washout. The rock used should be large enough to stay in place given the expected design flow through the channel. It is recommended that abutments be extended 18 in. into the channel bank. Rock can be graded such that smaller diameter rock (e.g. 2-4 in) is located on the upstream side of larger rock (holding the smaller rock in place); increasing residence time.

Log check dams are usually constructed of 4 to 6 in. diameter logs, installed vertically. The logs should be embedded into the soil at least 18 in. Logs can be bolted or wired to vertical support logs that have been driven or buried into the soil.

See fiber rolls, SE-5, for installation of fiber roll check dams.

Gravel bag and sand bag check dams are constructed by stacking bags across the ditch or swale, shaped as shown in the drawings at the end of this fact sheet (see "Gravel Bag Check Dam" detail at the end of this fact sheet).

Manufactured products, such as temporary silt dikes (SE-12), should be installed in accordance with the manufacturer's instructions. Installation typically requires anchoring or trenching of products, as well as regular maintenance to remove accumulated sediment and debris.

If grass is planted to stabilize the ditch or swale, the check dam should be removed when the grass has matured (unless the slope of the swales is greater than 4%).

The following guidance should be followed for the design and layout of check dams:

- Install the first check dam approximately 16 ft from the outfall device and at regular intervals based on slope gradient and soil type.
- Check dams should be placed at a distance and height to allow small pools to form between each check dam.
- For multiple check dam installation, backwater from a downstream check dam should reach the toes of the upstream check dam.
- A sediment trap provided immediately upstream of the check dam will help capture sediment. Due to the potential for this sediment to be resuspended in subsequent storms, the sediment trap should be cleaned following each storm event.

- High flows (typically a 2-year storm or larger) should safely flow over the check dam without an increase in upstream flooding or damage to the check dam.
- Where grass is used to line ditches, check dams should be removed when grass has matured sufficiently to protect the ditch or swale.

Materials

- Rock used for check dams should typically be 8-12 in rock and be sufficiently sized to stay in place given expected design flows in the channel. Smaller diameter rock (e.g. 2 to 4 in) can be placed on the upstream side of larger rock to increase residence time.
- Gravel bags used for check dams should conform to the requirements of SE-6, Gravel Bag Berms.
- Sandbags used for check dams should conform to SE-8, Sandbag Barrier.
- Fiber rolls used for check dams should conform to SE-5, Fiber Rolls.
- Temporary silt dikes used for check dams should conform to SE-12, Temporary Silt Dikes.

Installation

- Rock should be placed individually by hand or by mechanical methods (no dumping of rock) to achieve complete ditch or swale coverage.
- Tightly abut bags and stack according to detail shown in the figure at the end of this section (pyramid approach). Gravel bags and sandbags should not be stacked any higher than 3 ft.
- Upper rows or gravel and sand bags shall overlap joints in lower rows.
- Fiber rolls should be trenched in, backfilled, and firmly staked in place.
- Install along a level contour.
- HDPE check dams, temporary silt dikes, and other manufactured products should be used and installed per manufacturer specifications.

Costs

Cost consists of labor costs if materials are readily available (such as gravel on-site). If material must be imported, costs will increase. For other material and installation costs, see SE-5, SE-6, SE-8, SE-12, and SE-14.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Replace missing rock, bags, rolls, etc. Replace bags or rolls that have degraded or have become damaged.

- If the check dam is used as a sediment capture device, sediment that accumulates behind the BMP should be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height.
- If the check dam is used as a grade control structure, sediment removal is not required as long as the system continues to control the grade.
- Inspect areas behind check dams for pools of standing water, especially if subjected to daily non-stormwater discharges.
- Remove accumulated sediment prior to permanent seeding or soil stabilization.
- Remove check dam and accumulated sediment when check dams are no longer needed.

References

Draft – Sedimentation and Erosion Control, and Inventory of Current Practices, USEPA, April 1990.

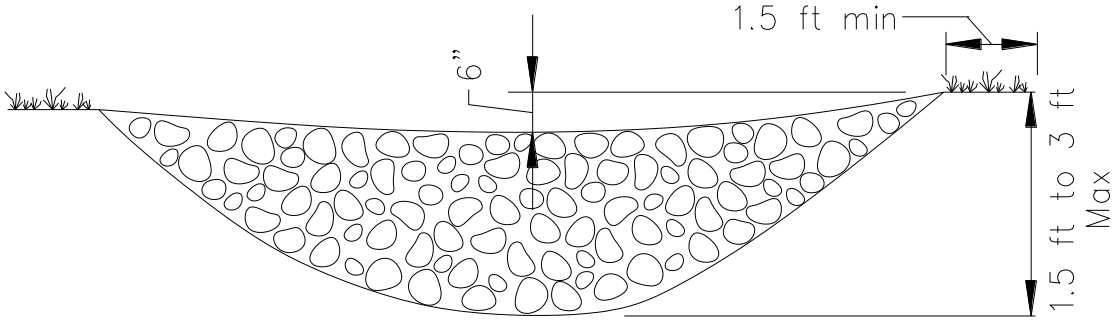
Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

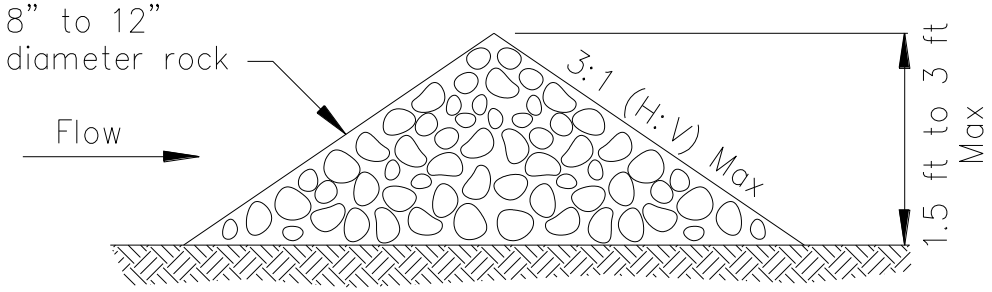
Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.

Metzger, M.E. 2004. Managing mosquitoes in stormwater treatment devices. University of California Division of Agriculture and Natural Resources, Publication 8125. On-line: http://anrcatalog.ucdavis.edu/pdf/8125.pdf

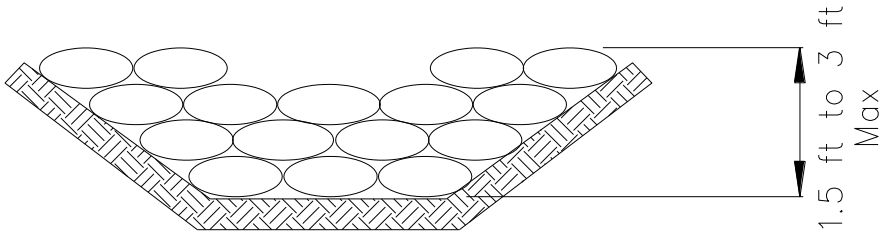


ELEVATION

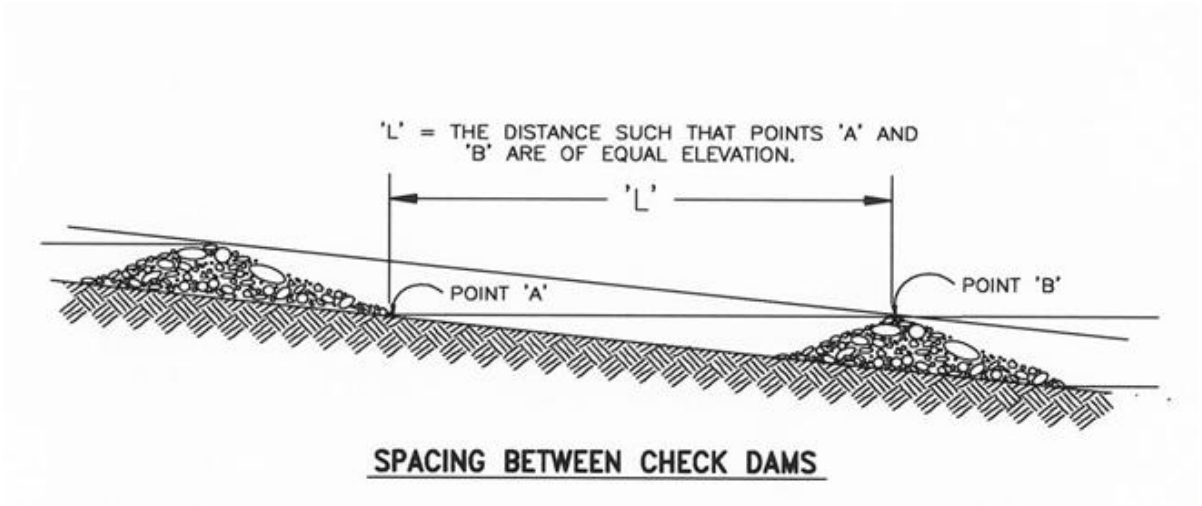


TYPICAL ROCK CHECK DAM SECTION

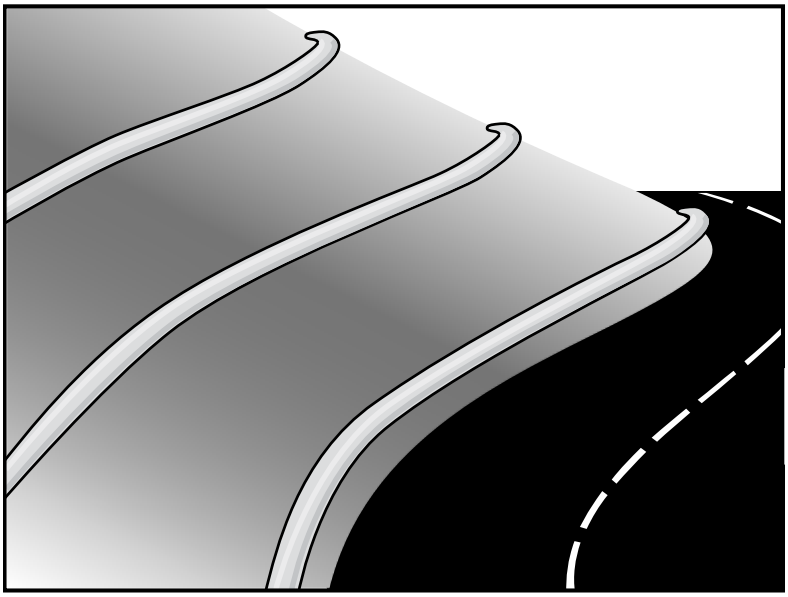
ROCK CHECK DAM
NOT TO SCALE



GRAVEL BAG CHECK DAM ELEVATION
NOT TO SCALE


'L' = THE DISTANCE SUCH THAT POINTS 'A' AND 'B' ARE OF EQUAL ELEVATION.
'L'
POINT 'A'
POINT 'B'
SPACING BETWEEN CHECK DAMS

Fiber Rolls SE-5



Categories

EC	Erosion Control	☒
SE	Sediment Control	☑
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Description and Purpose

A fiber roll consists of straw, coir, or other biodegradable materials bound into a tight tubular roll wrapped by netting, which can be photodegradable or natural. Additionally, gravel core fiber rolls are available, which contain an imbedded ballast material such as gravel or sand for additional weight when staking the rolls are not feasible (such as use as inlet protection). When fiber rolls are placed at the toe and on the face of slopes along the contours, they intercept runoff, reduce its flow velocity, release the runoff as sheet flow, and provide removal of sediment from the runoff (through sedimentation). By interrupting the length of a slope, fiber rolls can also reduce sheet and rill erosion until vegetation is established.

Suitable Applications

Fiber rolls may be suitable:

- Along the toe, top, face, and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow.
- At the end of a downward slope where it transitions to a steeper slope.
- Along the perimeter of a project.
- As check dams in unlined ditches with minimal grade.
- Down-slope of exposed soil areas.
- At operational storm drains as a form of inlet protection.

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-1 Silt Fence

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

SE-12 Manufactured Linear Sediment Controls

SE-14 Biofilter Bags

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- Around temporary stockpiles.

Limitations

- Fiber rolls are not effective unless trenched in and staked.
- Not intended for use in high flow situations.
- Difficult to move once saturated.
- If not properly staked and trenched in, fiber rolls could be transported by high flows.
- Fiber rolls have a very limited sediment capture zone.
- Fiber rolls should not be used on slopes subject to creep, slumping, or landslide.
- Rolls typically function for 12-24 months depending upon local conditions.

Implementation

Fiber Roll Materials

- Fiber rolls should be prefabricated.
- Fiber rolls may come manufactured containing polyacrylamide (PAM), a flocculating agent within the roll. Fiber rolls impregnated with PAM provide additional sediment removal capabilities and should be used in areas with fine, clayey or silty soils to provide additional sediment removal capabilities. Monitoring may be required for these installations.
- Fiber rolls are made from weed free rice straw, flax, or a similar agricultural material bound into a tight tubular roll by netting.
- Typical fiber rolls vary in diameter from 9 in. to 20 in. Larger diameter rolls are available as well.

Installation

- Locate fiber rolls on level contours spaced as follows:
  - Slope inclination of 4:1 (H:V) or flatter: Fiber rolls should be placed at a maximum interval of 20 ft.
  - Slope inclination between 4:1 and 2:1 (H:V): Fiber Rolls should be placed at a maximum interval of 15 ft. (a closer spacing is more effective).
  - Slope inclination 2:1 (H:V) or greater: Fiber Rolls should be placed at a maximum interval of 10 ft. (a closer spacing is more effective).
- Prepare the slope before beginning installation.
- Dig small trenches across the slope on the contour. The trench depth should be ¼ to 1/3 of the thickness of the roll, and the width should equal the roll diameter, in order to provide area to backfill the trench.

- It is critical that rolls are installed perpendicular to water movement, and parallel to the slope contour.
- Start building trenches and installing rolls from the bottom of the slope and work up.
- It is recommended that pilot holes be driven through the fiber roll. Use a straight bar to drive holes through the roll and into the soil for the wooden stakes.
- Turn the ends of the fiber roll up slope to prevent runoff from going around the roll.
- Stake fiber rolls into the trench.
  - Drive stakes at the end of each fiber roll and spaced 4 ft maximum on center.
  - Use wood stakes with a nominal classification of 0.75 by 0.75 in. and minimum length of 24 in.
- If more than one fiber roll is placed in a row, the rolls should be overlapped, not abutted.
- See typical fiber roll installation details at the end of this fact sheet.

Removal

- Fiber rolls can be left in place or removed depending on the type of fiber roll and application (temporary vs. permanent installation). Typically, fiber rolls encased with plastic netting are used for a temporary application because the netting does not biodegrade. Fiber rolls used in a permanent application are typically encased with a biodegradeable material and are left in place. Removal of a fiber roll used in a permanent application can result in greater disturbance.
- Temporary installations should only be removed when up gradient areas are stabilized per General Permit requirements, and/or pollutant sources no longer present a hazard. But, they should also be removed before vegetation becomes too mature so that the removal process does not disturb more soil and vegetation than is necessary.

Costs

Material costs for regular fiber rolls range from $20 - $30 per 25 ft roll.

Material costs for PAM impregnated fiber rolls range between 7.00-$9.00 per linear foot, based upon vendor research.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Repair or replace split, torn, unraveling, or slumping fiber rolls.
- If the fiber roll is used as a sediment capture device, or as an erosion control device to maintain sheet flows, sediment that accumulates in the BMP should be periodically removed

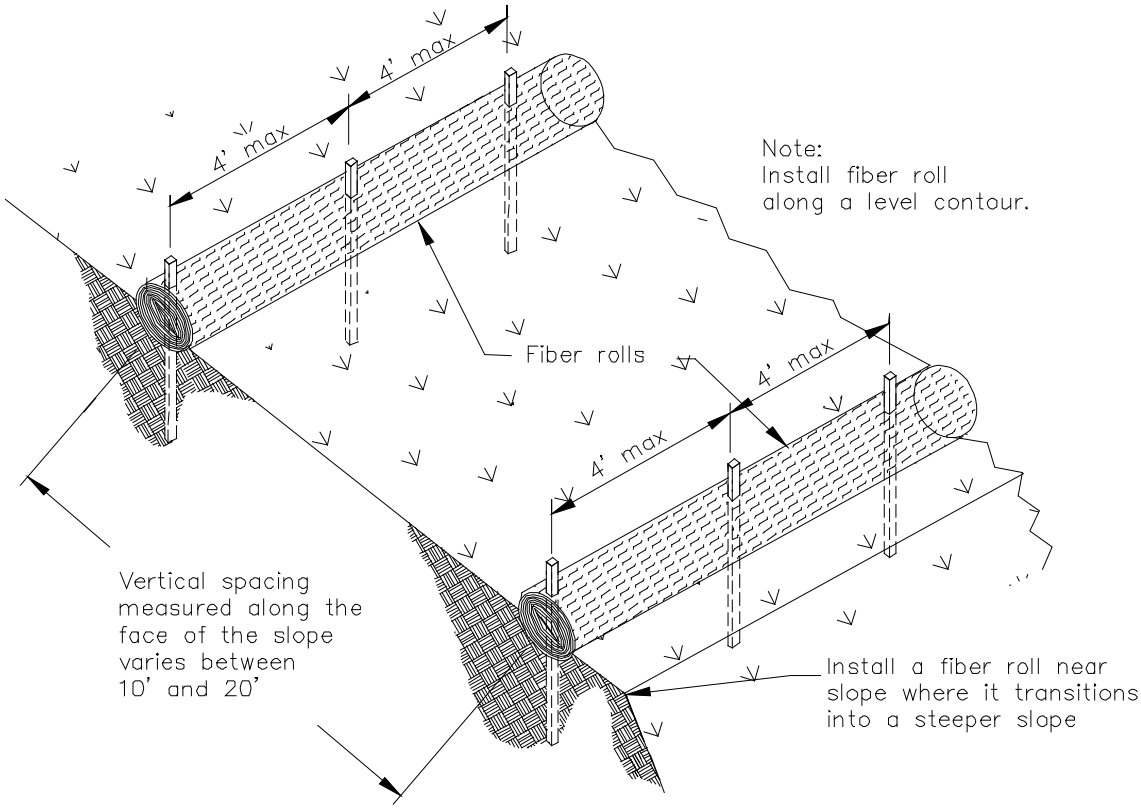
in order to maintain BMP effectiveness. Sediment should be removed when sediment accumulation reaches one-third the designated sediment storage depth.

- If fiber rolls are used for erosion control, such as in a check dam, sediment removal should not be required as long as the system continues to control the grade. Sediment control BMPs will likely be required in conjunction with this type of application.
- Repair any rills or gullies promptly.

References

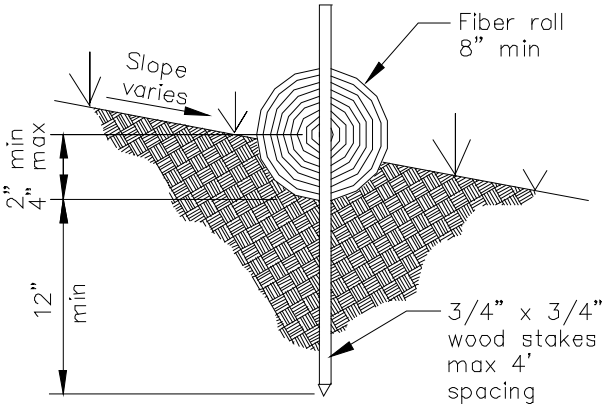
Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.



TYPICAL FIBER ROLL INSTALLATION

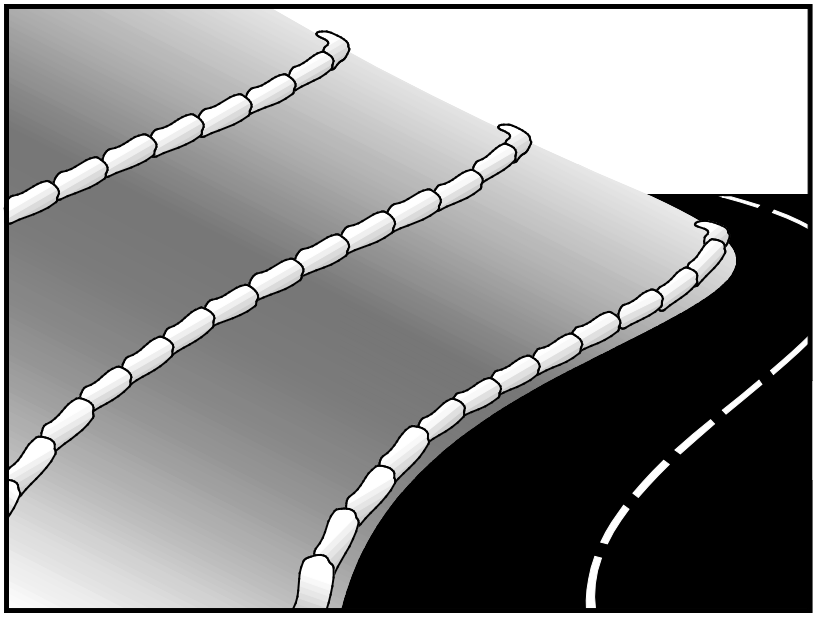
N.T.S.



ENTRENCHMENT DETAIL

N.T.S.

Gravel Bag Berm SE-6



Description and Purpose

A gravel bag berm is a series of gravel-filled bags placed on a level contour to intercept sheet flows. Gravel bags pond sheet flow runoff, allowing sediment to settle out, and release runoff slowly as sheet flow, preventing erosion.

Suitable Applications

Gravel bag berms may be suitable:

- As a linear sediment control measure:
  - Below the toe of slopes and erodible slopes
  - As sediment traps at culvert/pipe outlets
  - Below other small cleared areas
  - Along the perimeter of a site
  - Down slope of exposed soil areas
  - Around temporary stockpiles and spoil areas
  - Parallel to a roadway to keep sediment off paved areas
  - Along streams and channels
- As a linear erosion control measure:
  - Along the face and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow.

Categories

EC	Erosion Control	☒
SE	Sediment Control	☑
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-1 Silt Fence

SE-5 Fiber Roll

SE-8 Sandbag Barrier

SE-12 Temporary Silt Dike

SE-14 Biofilter Bags

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- At the top of slopes to divert runoff away from disturbed slopes.
- As chevrons (small check dams) across mildly sloped construction roads. For use check dam use in channels, see SE-4, Check Dams.

Limitations

- Gravel berms may be difficult to remove.
- Removal problems limit their usefulness in landscaped areas.
- Gravel bag berm may not be appropriate for drainage areas greater than 5 acres.
- Runoff will pond upstream of the berm, possibly causing flooding if sufficient space does not exist.
- Degraded gravel bags may rupture when removed, spilling contents.
- Installation can be labor intensive.
- Durability of gravel bags is somewhat limited and bags may need to be replaced when installation is required for longer than 6 months.
- Easily damaged by construction equipment.
- When used to detain concentrated flows, maintenance requirements increase.

Implementation

General

A gravel bag berm consists of a row of open graded gravel-filled bags placed on a level contour. When appropriately placed, a gravel bag berm intercepts and slows sheet flow runoff, causing temporary ponding. The temporary ponding allows sediment to settle. The open graded gravel in the bags is porous, which allows the ponded runoff to flow slowly through the bags, releasing the runoff as sheet flows. Gravel bag berms also interrupt the slope length and thereby reduce erosion by reducing the tendency of sheet flows to concentrate into rivulets, which erode rills, and ultimately gullies, into disturbed, sloped soils. Gravel bag berms are similar to sand bag barriers, but are more porous. Generally, gravel bag berms should be used in conjunction with temporary soil stabilization controls up slope to provide effective erosion and sediment control.

Design and Layout

- Locate gravel bag berms on level contours.
- When used for slope interruption, the following slope/sheet flow length combinations apply:
  - Slope inclination of 4:1 (H:V) or flatter: Gravel bags should be placed at a maximum interval of 20 ft, with the first row near the slope toe.
  - Slope inclination between 4:1 and 2:1 (H:V): Gravel bags should be placed at a maximum interval of 15 ft. (a closer spacing is more effective), with the first row near the slope toe.

Slope inclination 2:1 (H:V) or greater: Gravel bags should be placed at a maximum interval of 10 ft. (a closer spacing is more effective), with the first row near the slope toe.

- Turn the ends of the gravel bag barriers up slope to prevent runoff from going around the berm.
- Allow sufficient space up slope from the gravel bag berm to allow ponding, and to provide room for sediment storage.
- For installation near the toe of the slope, gravel bag barriers should be set back from the slope toe to facilitate cleaning. Where specific site conditions do not allow for a set-back, the gravel bag barrier may be constructed on the toe of the slope. To prevent flows behind the barrier, bags can be placed perpendicular to a berm to serve as cross barriers.
- Drainage area should not exceed 5 acres.
- In Non-Traffic Areas:
  - Height = 18 in. maximum
  - Top width = 24 in. minimum for three or more layer construction
  - Top width = 12 in. minimum for one or two layer construction
  - Side slopes = 2:1 (H:V) or flatter
- In Construction Traffic Areas:
  - Height = 12 in. maximum
  - Top width = 24 in. minimum for three or more layer construction.
  - Top width = 12 in. minimum for one or two layer construction.
  - Side slopes = 2:1 (H:V) or flatter.
- Butt ends of bags tightly.
- On multiple row, or multiple layer construction, overlap butt joints of adjacent row and row beneath.
- Use a pyramid approach when stacking bags.

Materials

- ***Bag Material:*** Bags should be woven polypropylene, polyethylene or polyamide fabric or burlap, minimum unit weight of 4 ounces/yd^2, Mullen burst strength exceeding 300 lb/in^2 in conformance with the requirements in ASTM designation D3786, and ultraviolet stability exceeding 70% in conformance with the requirements in ASTM designation D4355.

- ***Bag Size:*** Each gravel-filled bag should have a length of 18 in., width of 12 in., thickness of 3 in., and mass of approximately 33 lbs. Bag dimensions are nominal, and may vary based on locally available materials.

- ***Fill Material:*** Fill material should be 0.5 to 1 in. crushed rock, clean and free from clay, organic matter, and other deleterious material, or other suitable open graded, non-cohesive, porous gravel.

Costs

Material costs for gravel bags are average and are dependent upon material availability. $2.50-3.00 per filled gravel bag is standard based upon vendor research.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.

- Gravel bags exposed to sunlight will need to be replaced every two to three months due to degrading of the bags.

- Reshape or replace gravel bags as needed.

- Repair washouts or other damage as needed.

- Sediment that accumulates in the BMP should be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height.

- Remove gravel bag berms when no longer needed and recycle gravel fill whenever possible and properly dispose of bag material. Remove sediment accumulation and clean, re-grade, and stabilize the area.

References

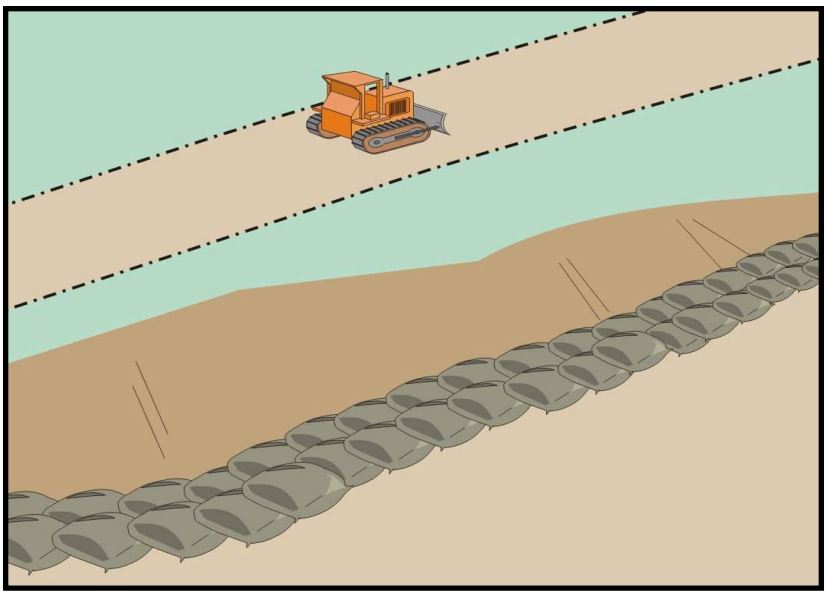
Handbook of Steel Drainage and Highway Construction, American Iron and Steel Institute, 1983.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Stormwater Pollution Plan Handbook, First Edition, State of California, Department of Transportation Division of New Technology, Materials and Research, October 1992.

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.

Sandbag Barrier SE-8



Categories

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Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-1 Silt Fence

SE-5 Fiber Rolls

SE-6 Gravel Bag Berm

SE-12 Manufactured Linear Sediment Controls

SE-14 Biofilter Bags

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Description and Purpose

A sandbag barrier is a series of sand-filled bags placed on a level contour to intercept or to divert sheet flows. Sandbag barriers placed on a level contour pond sheet flow runoff, allowing sediment to settle out.

Suitable Applications

Sandbag barriers may be a suitable control measure for the applications described below. It is important to consider that sand bags are less porous than gravel bags and ponding or flooding can occur behind the barrier. Also, sand is easily transported by runoff if bags are damaged or ruptured. The SWPPP Preparer should select the location of a sandbag barrier with respect to the potential for flooding, damage, and the ability to maintain the BMP.

- As a linear sediment control measure:
  - Below the toe of slopes and erodible slopes.
  - As sediment traps at culvert/pipe outlets.
  - Below other small cleared areas.
  - Along the perimeter of a site.
  - Down slope of exposed soil areas.
  - Around temporary stockpiles and spoil areas.
  - Parallel to a roadway to keep sediment off paved areas.
  - Along streams and channels.

- As linear erosion control measure:
  - Along the face and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow.
  - At the top of slopes to divert runoff away from disturbed slopes.
  - As check dams across mildly sloped construction roads.

Limitations

- It is necessary to limit the drainage area upstream of the barrier to 5 acres.
- Sandbags are not intended to be used as filtration devices.
- Easily damaged by construction equipment.
- Degraded sandbags may rupture when removed, spilling sand.
- Installation can be labor intensive.
- Durability of sandbags is somewhat limited and bags will need to be replaced when there are signs of damage or wear.
- Burlap should not be used for sandbags.

Implementation

General

A sandbag barrier consists of a row of sand-filled bags placed on a level contour. When appropriately placed, a sandbag barrier intercepts and slows sheet flow runoff, causing temporary ponding. The temporary ponding allows sediment to settle. Sand-filled bags have limited porosity, which is further limited as the fine sand tends to quickly plug with sediment, limiting or completely blocking the rate of flow through the barrier. If a porous barrier is desired, consider SE-1, Silt Fence, SE-5, Fiber Rolls, SE-6, Gravel Bag Berms or SE-14, Biofilter Bags. Sandbag barriers also interrupt the slope length and thereby reduce erosion by reducing the tendency of sheet flows to concentrate into rivulets which erode rills, and ultimately gullies, into disturbed, sloped soils. Sandbag barriers are similar to gravel bag berms, but less porous. Generally, sandbag barriers should be used in conjunction with temporary soil stabilization controls up slope to provide effective erosion and sediment control.

Design and Layout

- Locate sandbag barriers on a level contour.
- When used for slope interruption, the following slope/sheet flow length combinations apply:
  - Slope inclination of 4:1 (H:V) or flatter: Sandbags should be placed at a maximum interval of 20 ft, with the first row near the slope toe.
  - Slope inclination between 4:1 and 2:1 (H:V): Sandbags should be placed at a maximum interval of 15 ft. (a closer spacing is more effective), with the first row near the slope toe.

- Slope inclination 2:1 (H:V) or greater: Sandbags should be placed at a maximum interval of 10 ft. (a closer spacing is more effective), with the first row near the slope toe.

- Turn the ends of the sandbag barrier up slope to prevent runoff from going around the barrier.
- Allow sufficient space up slope from the barrier to allow ponding, and to provide room for sediment storage.
- For installation near the toe of the slope, sand bag barriers should be set back from the slope toe to facilitate cleaning. Where specific site conditions do not allow for a set-back, the sand bag barrier may be constructed on the toe of the slope. To prevent flows behind the barrier, bags can be placed perpendicular to a berm to serve as cross barriers.
- Drainage area should not exceed 5 acres.
- Butt ends of bags tightly.
- Overlap butt joints of row beneath with each successive row.
- Use a pyramid approach when stacking bags.
- In non-traffic areas
  - Height = 18 in. maximum
  - Top width = 24 in. minimum for three or more layer construction
  - Side slope = 2:1 (H:V) or flatter
- In construction traffic areas
  - Height = 12 in. maximum
  - Top width = 24 in. minimum for three or more layer construction.
  - Side slopes = 2:1 (H:V) or flatter.
- See typical sandbag barrier installation details at the end of this fact sheet.

Materials

- ***Sandbag Material:*** Sandbag should be woven polypropylene, polyethylene or polyamide fabric, minimum unit weight of 4 ounces/yd^2, Mullen burst strength exceeding 300 lb/in^2 in conformance with the requirements in ASTM designation D3786, and ultraviolet stability exceeding 70% in conformance with the requirements in ASTM designation D4355. Use of burlap is not an acceptable substitute, as sand can more easily mobilize out of burlap.
- ***Sandbag Size:*** Each sand-filled bag should have a length of 18 in., width of 12 in., thickness of 3 in., and mass of approximately 33 lbs. Bag dimensions are nominal, and may vary based on locally available materials.

- ***Fill Material:*** All sandbag fill material should be non-cohesive, Class 3 (Caltrans Standard Specification, Section 25) or similar permeable material free from clay and deleterious material, such as recycled concrete or asphalt.

Costs

Empty sandbags cost $0.25 - $0.75. Average cost of fill material is $8 per yd^3. Additional labor is required to fill the bags. Pre-filled sandbags are more expensive at $1.50 - $2.00 per bag. These costs are based upon vendor research.

Inspection and Maintenance

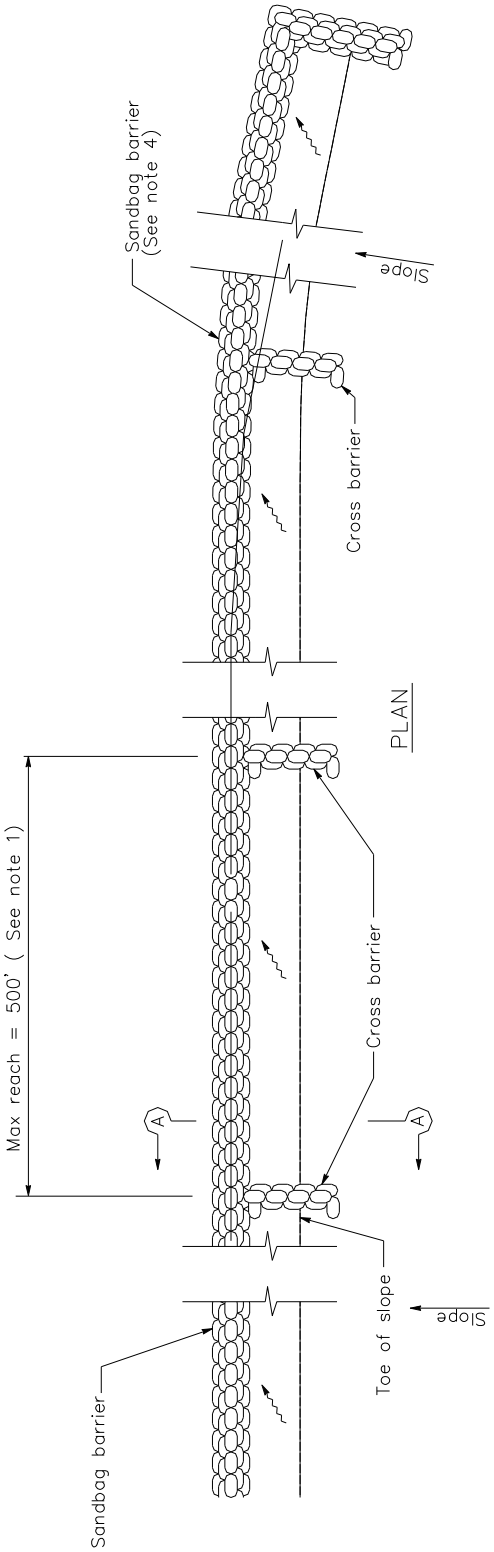
- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Sandbags exposed to sunlight will need to be replaced every two to three months due to degradation of the bags.
- Reshape or replace sandbags as needed.
- Repair washouts or other damage as needed.
- Sediment that accumulates behind the BMP should be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height.
- Remove sandbags when no longer needed and recycle sand fill whenever possible and properly dispose of bag material. Remove sediment accumulation, and clean, re-grade, and stabilize the area.

References

Standard Specifications for Construction of Local Streets and Roads, California Department of Transportation (Caltrans), July 2002.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

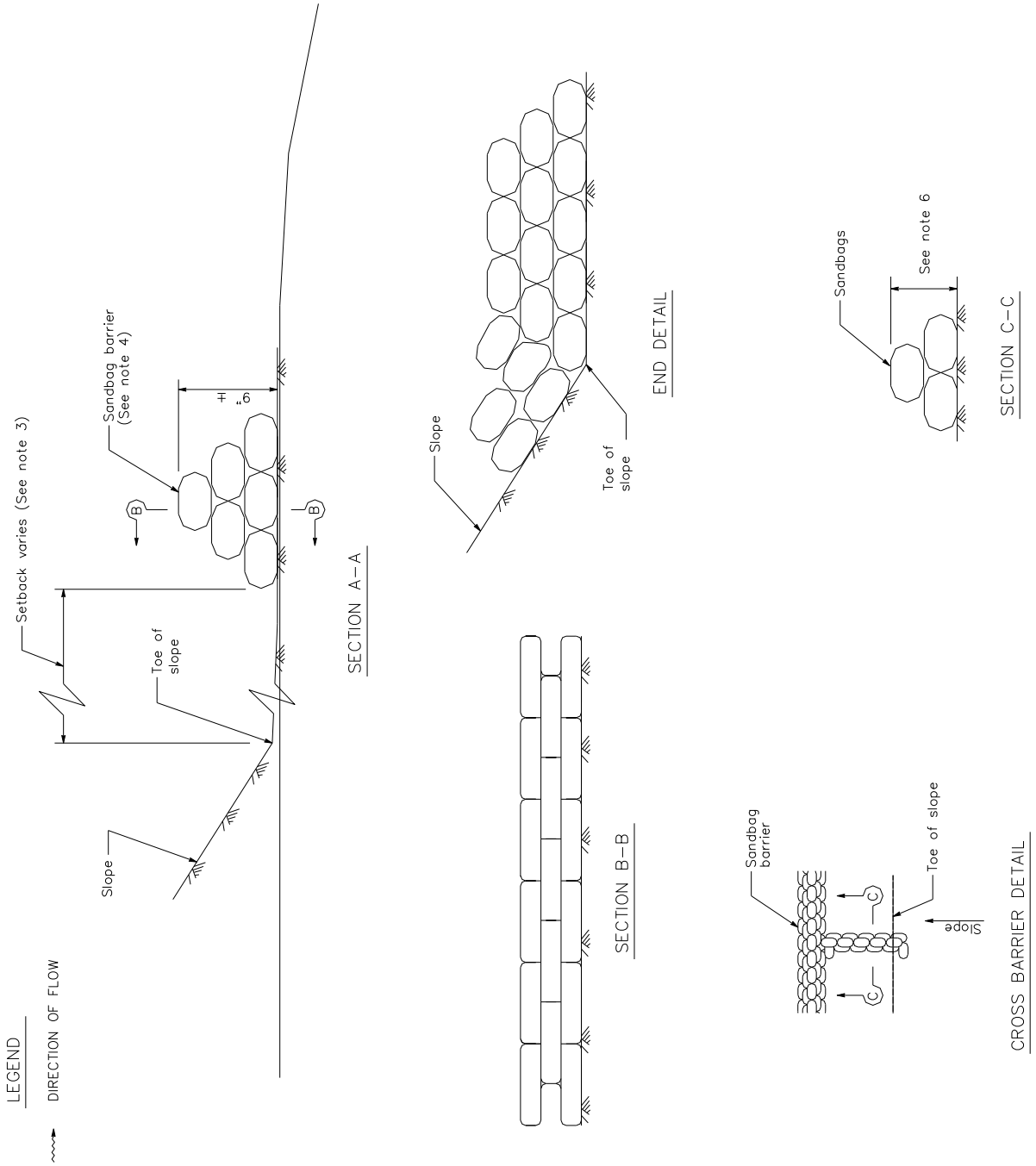
Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.



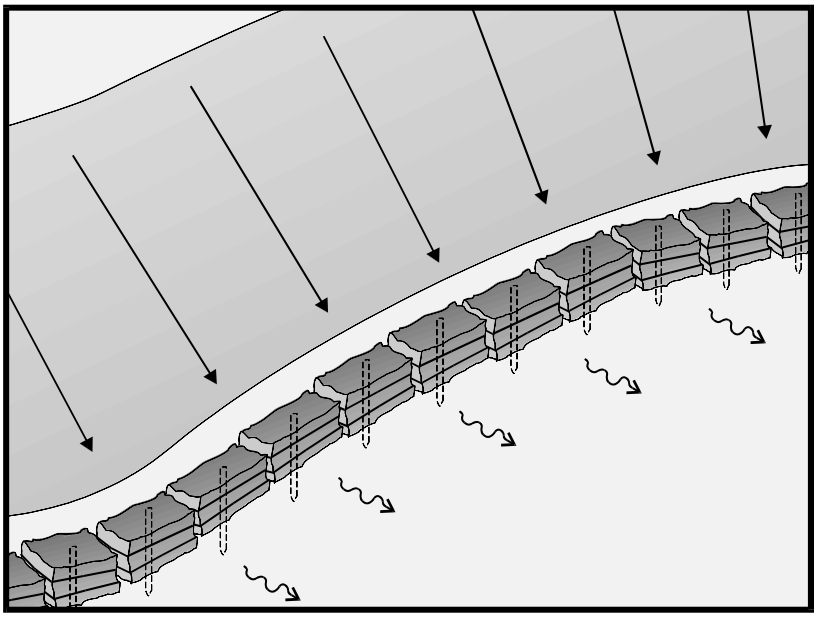
SANDBAG BARRIER

NOTES

1. Construct the length of each reach so that the change in base elevation along the reach does not exceed 1/2 the height of the linear barrier. In no case shall the reach length exceed 500'.
2. Place sandbags tightly.
3. Dimension may vary to fit field condition.
4. Sandbag barrier shall be a minimum of 3 bags high.
5. The end of the barrier shall be turned up slope.
6. Cross barriers shall be a min of 1/2 and a max of 2/3 the height of the linear barrier.
7. Sandbag rows and layers shall be staggered to eliminate gaps.


LEGEND
DIRECTION OF FLOW
Setback varies (See note 3)
Sandbag barrier
(See note 4)
9"
H
B
B
Toe of
slope
Slope
SECTION A–A
Slope
Toe of
slope
END DETAIL
SECTION B–B
Sandbags
See note 6
SECTION C–C
Sandbag
barrier
C
C
Toe of slope
Slope
CROSS BARRIER DETAIL

Straw Bale Barrier SE-9



Description and Purpose

A straw bale barrier is a series of straw bales placed on a level contour to intercept sheet flows. Straw bale barriers pond sheet-flow runoff, allowing sediment to settle out.

Suitable Applications

Straw bale barriers may be suitable:

- As a linear sediment control measure:
  - Below the toe of slopes and erodible slopes
  - As sediment traps at culvert/pipe outlets
  - Below other small cleared areas
  - Along the perimeter of a site
  - Down slope of exposed soil areas
  - Around temporary stockpiles and spoil areas
  - Parallel to a roadway to keep sediment off paved areas
  - Along streams and channels
- As linear erosion control measure:
  - Along the face and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow

Categories

EC	Erosion Control	☒
SE	Sediment Control	☑
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-1 Silt Fence

SE-5 Fiber Rolls

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

SE-12 Temporary Silt Dike

SE-14 Biofilter Bags

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- At the top of slopes to divert runoff away from disturbed slopes
- As check dams across mildly sloped construction roads

Limitations

Straw bale barriers:

- Are not to be used for extended periods of time because they tend to rot and fall apart
- Are suitable only for sheet flow on slopes of 10 % or flatter
- Are not appropriate for large drainage areas, limit to one acre or less
- May require constant maintenance due to rotting
- Are not recommended for concentrated flow, inlet protection, channel flow, and live streams
- Cannot be made of bale bindings of jute or cotton
- Require labor-intensive installation and maintenance
- Cannot be used on paved surfaces
- Should not to be used for drain inlet protection
- Should not be used on lined ditches
- May introduce undesirable non-native plants to the area

Implementation

General

A straw bale barrier consists of a row of straw bales placed on a level contour. When appropriately placed, a straw bale barrier intercepts and slows sheet flow runoff, causing temporary ponding. The temporary ponding provides quiescent conditions allowing sediment to settle. Straw bale barriers also interrupt the slope length and thereby reduce erosion by reducing the tendency of sheet flows to concentrate into rivulets, which erode rills, and ultimately gullies, into disturbed, sloped soils.

Straw bale barriers have not been as effective as expected due to improper use. These barriers have been placed in streams and drainage ways where runoff volumes and velocities have caused the barriers to wash out. In addition, failure to stake and entrench the straw bale has allowed undercutting and end flow. Use of straw bale barriers in accordance with this BMP should produce acceptable results.

Design and Layout

- Locate straw bale barriers on a level contour.
  - Slopes up to 10:1 (H:V): Straw bales should be placed at a maximum interval of 50 ft (a closer spacing is more effective), with the first row near the toe of slope.
  - Slopes greater than 10:1 (H:V): Not recommended.

- Turn the ends of the straw bale barrier up slope to prevent runoff from going around the barrier.
- Allow sufficient space up slope from the barrier to allow ponding, and to provide room for sediment storage.
- For installation near the toe of the slope, consider moving the barrier away from the slope toe to facilitate cleaning. To prevent flow behind the barrier, sand bags can be placed perpendicular to the barrier to serve as cross barriers.
- Drainage area should not exceed 1 acre, or 0.25 acre per 100 ft of barrier.
- Maximum flow path to the barrier should be limited to 100 ft.
- Straw bale barriers should consist of two parallel rows.
  - Butt ends of bales tightly
  - Stagger butt joints between front and back row
  - Each row of bales must be trenched in and firmly staked
- Straw bale barriers are limited in height to one bale laid on its side.
- Anchor bales with either two wood stakes or four bars driven through the bale and into the soil. Drive the first stake towards the butt joint with the adjacent bale to force the bales together.
- See attached figure for installation details.

Materials

- ***Straw Bale Size:*** Each straw bale should be a minimum of 14 in. wide, 18 in. in height, 36 in. in length and should have a minimum mass of 50 lbs. The straw bale should be composed entirely of vegetative matter, except for the binding material.
- ***Bale Bindings:*** Bales should be bound by steel wire, nylon or polypropylene string placed horizontally. Jute and cotton binding should not be used. Baling wire should be a minimum diameter of 14 gauge. Nylon or polypropylene string should be approximately 12 gauge in diameter with a breaking strength of 80 lbs force.
- ***Stakes:*** Wood stakes should be commercial quality lumber of the size and shape shown on the plans. Each stake should be free from decay, splits or cracks longer than the thickness of the stake, or other defects that would weaken the stakes and cause the stakes to be structurally unsuitable. Steel bar reinforcement should be equal to a #4 designation or greater. End protection should be provided for any exposed bar reinforcement.

Costs

Straw bales cost $5 - $7 each. Adequate labor should be budgeted for installation and maintenance.

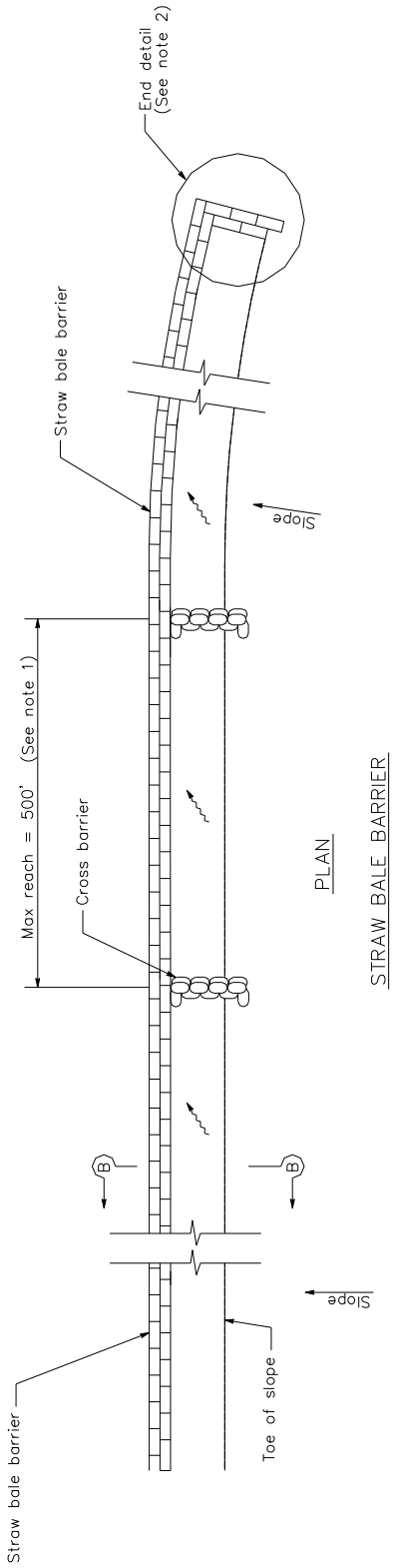
Inspection and Maintenance

Maintenance

- Inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Straw bales degrade, especially when exposed to moisture. Rotting bales will need to be replaced on a regular basis.
- Replace or repair damaged bales as needed.
- Repair washouts or other damages as needed.
- Sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed at an appropriate location.
- Remove straw bales when no longer needed. Remove sediment accumulation, and clean, re-grade, and stabilize the area. Removed sediment should be incorporated in the project or disposed of.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.



PLAN

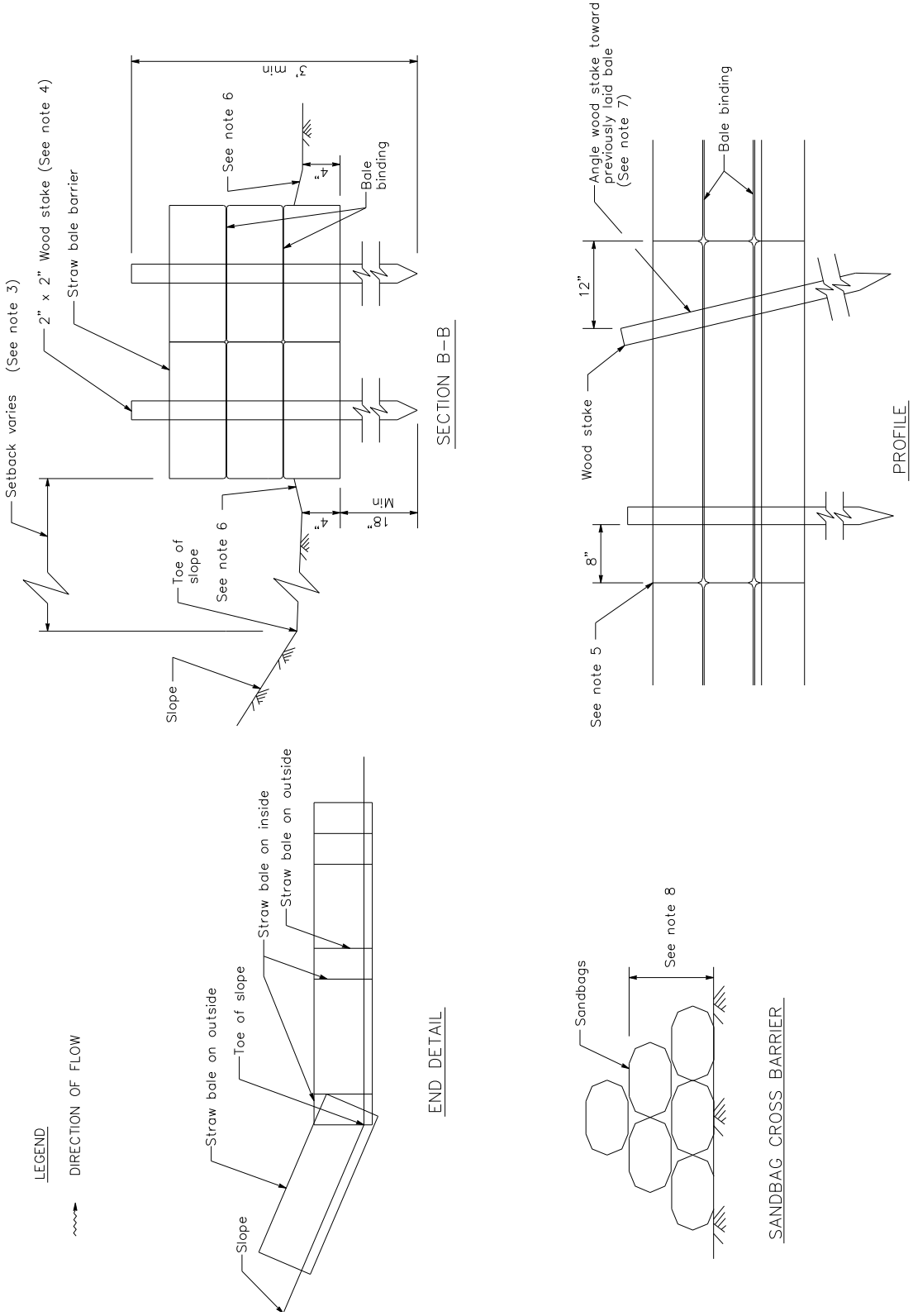
STRAW BALE BARRIER

LEGEND

DIRECTION OF FLOW

NOTES

1. Construct the length of each reach so that the change in base elevation along the reach does not exceed 1/2 the height of the linear barrier. In no case shall the reach length exceed 500'.
2. The end of barrier shall be turned up slope.
3. Dimension may vary to fit field condition.
4. Stake dimensions are nominal.
5. Place straw bales tightly together.
6. Tamp embedment spoils against sides of installed bales.
7. Drive angled wood stake before vertical stake to ensure tight abutment to adjacent bale.
8. Sandbag cross barriers should be a min of 1/2 and a max of 2/3 the height of the linear barrier.
9. Sandbag rows and layers should be offset to eliminate gaps.


Setback varies (See note 3)
2" x 2" Wood stake (See note 4)
Straw bale barrier
See note 6
Min 5'
4"
Bale binding
Toe of slope
See note 6
4"
Min 18"
Slope
SECTION B–B
Angle wood stake toward previously laid bale (See note 7)
Bale binding
12"
Wood stake
8"
See note 5
PROFILE
LEGEND
DIRECTION OF FLOW
Straw bale on inside
Straw bale on outside
Straw bale on outside
Toe of slope
Slope
END DETAIL
Sandbags
See note 8
SANDBAG CROSS BARRIER

Manufactured Linear Sediment Controls (MLSC) SE-12

Categories

EC	Erosion Control	☒
SE	Sediment Control	☑
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	☒
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-1 Silt Fence

SE-5 Fiber Roll

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

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Description and Purpose

Manufactured linear sediment controls (MLSC) are pre-manufactured devices that are typically specified and installed for drainage and sediment control on the perimeter of disturbed sites or stockpiles and as check dams within channels. Typically, MLSCs can be reused.

This fact sheet is intended to provide guidance on BMP selection and implementation of proprietary or vendor-supplied products, for sediment control. Products should be evaluated for project-specific implementation and used if determined to be appropriate by the SWPPP Preparer.

Suitable Applications

MLSCs are generally used in areas as a substitute for fiber rolls and silt fences in sediment control applications to slow down runoff water, divert drainage or contain fines and sediment. MLSCs are a linear control and application suitability varies based on the specific product type. They may be suitable:

- On paved surfaces for perimeter protection.
- As check structures in channels.
- Along the perimeter of disturbed sites in lieu of silt fence.

- At operational storm drains as a form of inlet protection.
- Around temporary stockpiles or material/equipment storage areas.
- At the interface between graveled driveways and pavement.
- Along the toe of exposed and erodible slopes.

Limitations

- Limitations vary by product. Product manufacturer's printed product use instructions should be reviewed by the SWPPP Preparer to determine the project-specific applicability of MLSCs.

Implementation

General

When appropriately placed, MLSCs intercept and slow sheet flow runoff, causing temporary ponding. The temporary ponding provides quiescent conditions allowing sediment to settle. The device is porous, which allows the ponded runoff to flow slowly through the device, releasing the runoff as sheet flows. Generally, MLSCs should be used in conjunction with temporary soil stabilization controls up-slope to provide an effective combination of erosion and sediment control.

Design and Layout

- MLSCs used on soil should be trenched or attached to the ground per manufacturer specifications in a manner that precludes runoff or ponded water from flowing around or under the device.
- MLSCs designed for use on asphalt or concrete may be attached using a variety of methods, including nailing the device to the pavement, or using a high strength adhesive.
- Follow manufacturer written specifications when installing MLSCs.
- Allow sufficient space up-slope from the silt dike to allow ponding, and to provide room for sediment storage.
- For installation near the toe of the slope, MLSCs should be set back 3 feet from the slope toe to facilitate cleaning. Where site conditions do not allow set back, the sediment control may be constructed on the toe of the slope. To prevent flows behind the barrier, sand or gravel bags can be placed perpendicular and between the sediment control and slope to serve as a barrier to parallel flow.
- Drainage area should not exceed 5 acres.

Materials

- Several manufactured products are available. The following search terms or combination of terms can be used with an internet search engine to find manufactured linear sediment controls:

- "silt barrier"
- "reusable silt fence"
- "silt fence alternative" or
- "perimeter sediment control"

Costs

Manufacturers should be contacted directly for current pricing.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Reshape or replace sections of damaged MLSCs as needed.
- Repair washouts or other damage as needed.
- Sediment that accumulates behind the BMP should be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height.
- Remove MLSCs when no longer needed. Remove sediment accumulation and clean, re-grade, and stabilize the area. Removed sediment should be incorporated in the project or disposed of properly.

References

City of Elko Construction Site Best Management Practices Handbook, December 2005.

Construction Site Best Management Practices Handbook, June 2008 Update, Truckee Meadows Regional Stormwater Quality Management Program, June 2008.

Complying with the Edwards Aquifer Rules Technical Guidance on Best Management Practices, Texas Commission on Environmental Quality, Revised July 2005, Addendum Sheet, January26, 2011.

Stormwater Management Manual for Western Washington Volume II, Construction Stormwater Pollution Prevention, Washington State Department of Ecology, February 2005.

Infiltration Trench TC-10

General Description

An infiltration trench is a gravel-filled trench that receives stormwater runoff. Runoff is stored in the void space between the stones and infiltrates through the bottom and sides of the trench into the soil matrix. Infiltration trenches promote stormwater infiltration, reduce discharge of stormwater to receiving waters and provide pollutant removal. Pretreatment using buffer strips, swales, or detention basins is important for limiting amounts of sediment, oil & grease, and trash and debris entering the trench which can clog and render the trench ineffective.

Inspection/Maintenance Considerations

Frequency of clogging is dependent on effectiveness of pretreatment, such as vegetated buffer strips (see TC-31), vegetated swales (see TC-30), and detention basins (see TC-22) at removing sediments. Generally, clogging is occurring if the trench shows signs of long surface ponding. Clogging often occurs within the surface layer and removing and replacing the top 2-3 inches of the surface media may improve performance. If the clogging is subsurface, as determined by observing an inspection well, then completely removing the media and rehabbing the trench is needed. Clogged infiltration trenches with surface standing water can become a nuisance due to mosquito breeding. Maintenance efforts associated with infiltration trenches should include frequent inspections to ensure that water infiltrates into the subsurface completely at a recommended infiltration rate of 96 hours or less to prevent creating mosquito and other vector habitats.

Advanced BMPs Covered

Maintenance Concerns

- *Accumulation of metals*
- *Clogged soil or outlet structures*
- *Vegetation/landscape maintenance*

Targeted Constituents

Sediment	■✱
Nutrients	■
Trash	■✱
Metals	■
Bacteria	■
Oil and Grease	■✱
Organics	■

Legend ***(Removal Effectiveness)***

● Low ■ High ▲ Medium
✱ Requires Pretreatment

Note: The removal effectiveness ratings shown in the table are for properly designed, sited, and maintained BMPs; some configurations will have variations in pollutant effectiveness.

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Inspection Activities	Suggested Frequency
☐ Inspect after major storms for the first few months to ensure proper functioning. Drain times should be observed to confirm that the designed drain time has been achieved. ☐ Inspect for upslope or adjacent contributing sediment sources and ensure that pretreatment systems are in place.	After construction and semi-annually (beginning and end of rainy season)
☐ Inspect facility for signs of wetness or damage to structures, signs of petroleum hydrocarbon contamination, standing water, trash and debris, sediment accumulation, slope stability, standing water, and material buildup. ☐ Check for standing water or, if available, check observation wells following 3 days of dry weather to ensure proper drain time. ☐ Inspect pretreatment devices and diversion structures for damage, sediment buildup, and structural damage.	Semi-annual and after major storm events
☐ Trenches with filter fabric should be inspected for sediment deposits by removing a small section of the top layer. If inspection indicates that the trench is partially or completely clogged, it should be restored to its design condition.	Annual
Maintenance Activities	**Suggested Frequency**
☐ Repair undercut and eroded areas at inflow and outflow structures. ☐ Remove sediment, debris, and oil/grease from pretreatment devices, forebays, inlet/outlet structures, overflow spillway, and trenches as necessary.	Standard maintenance (as needed)
☐ Remove trash, debris, grass clippings, trees, and other large vegetation from the trench perimeter and dispose of properly. ☐ Mow and trim vegetation to prevent establishment of woody vegetation, and for aesthetic and vector reasons.	Semi-annual, more often as needed
☐ Remove accumulated sediment from the surface of the trench. Replace first layer of aggregate and filter fabric if clogging appears only to be at the surface. ☐ Clean trench when loss of infiltrative capacity is observed. If drawdown time is observed to have increased significantly over the design drawdown time, removal of sediment may be necessary. This is an expensive maintenance activity and the need for it can be minimized through prevention of upstream erosion.	Annual
☐ Monitor ongoing effectiveness and determine if another BMP type or additional pretreatment could improve long-term performance. A qualified designer with knowledge of local soils and BMP design should be consulted in order to make this determination.	Every 5 years

☐ Total rehabilitation of the trench should be conducted to maintain storage capacity within 2/3 of the design treatment volume and 96-hour exfiltration rate limit. ☐ Rehabilitation of the trench should be performed under the direction of a qualified designer with knowledge of local soils and BMP design. General steps for trench rehabilitation include: ✓ Trench walls should be excavated to expose clean soil. ✓ All of the stone aggregate must be removed. Filter fabric may need to be removed from the sides and bottom ✓ Accumulated sediment should be stripped from the trench bottom. At this point the bottom may be scarified or tilled to help induce infiltration. New fabric and clean stone aggregate should be refilled.	Upon reaching target thresholds

Most of the maintenance should be concentrated on the pretreatment practices, such as buffer strips and swales upstream of the trench to limit the amount of sediment that reaches the infiltration trench. Regular inspection should determine if the sediment removal structures require routine maintenance. Infiltration trenches should not be put into operation until the upstream tributary area is stabilized.

Additional Information

Infiltration practices have historically had a high rate of failure compared to other stormwater management practices. One study conducted in Prince George's County, Maryland (Galli, 1992), revealed that less than half of the infiltration trenches investigated (of about 50) were still functioning properly, and less than one-third still functioned properly after 5 years. Many of these practices, however, did not incorporate advanced pretreatment. By carefully selecting the location and improving the design features of infiltration practices, their performance should improve.

It is absolutely critical that settleable particles and floatable materials be removed from runoff water before it enters the infiltration trench. The trench will clog and become nonfunctional if excessive particulate matter is allowed to enter the trench.

Special considerations are required for infiltration trenches to be effective in cold climates – refer to the Stormwater Managers Resource Center for more information.

References

California Department of Transportation. *Treatment BMP Technology Report (CTSW-RT-09-239.06),* 2010. Available online at: http://www.dot.ca.gov/hq/env/stormwater/pdf/CTSW-RT-09-239-06.pdf.

California Stormwater Quality Association. *Stormwater Best Management Practice Handbook, New Development and Redevelopment,* 2003. Available online at: https://www.casqa.org/resources/bmp-handbooks/new-development-redevelopment-bmp-handbook.

City of Los Angeles. "*Development Best Management Practices Handbook, Part B Planning Activities, 4th edition*, 2011. Available online at: http://www.lastormwater.org/wp-content/files_mf/lidhandbookfinal62212.pdf.

Galli, J., 1992. *Analysis of Urban BMP Performance and Longevity in Prince George's County, Maryland*. Metropolitan Washington Council of Governments, Washington, D.C.

Minnesota Pollution Control Agency. Operation and Maintenance of Infiltration Trench, 2013. Available online at: http://stormwater.pca.state.mn.us/index.php/Operation_and_maintenance_of_Infiltration_trench.

Riverside County Flood Control and Water Conservation District. *Riverside County Design Handbook for Low Impact Development Best Management Practices,* 2011, Available online at: http://rcflood.org/downloads/NPDES/Documents/LIDManual/LID_BMP_Design_Handbook.pdf.

San Francisco Public Utilities Commission, et al. San Francisco Stormwater Design Guidelines. Appendix A, Stormwater BMP Fact Sheets, 2010. Available online at: http://www.sfwater.org/modules/showdocument.aspx?documentid=2778.

Stormwater Managers Resource Center. Available online at: http://www.stormwatercenter.net.

Stormwater Mangers Resource Center, Stormwater Practices for Cold Climates. Available online at: http://www.stormwatercenter.net/Cold%20Climates/cold-climates.htm.

Tahoe Regional Planning Agency. Best Management Practices Handbook, 2012. http://www.tahoebmp.org/Documents/2012%20BMP%20Handbook.pdf.

U.S. Environmental Protection Agency, Post-Construction Stormwater Management in New Development and Redevelopment, BMP Fact Sheets. Available online at: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=min_measure&min_measure_id=5.

Ventura Countywide Stormwater Quality Management Program. *Technical Guidance Manual for Stormwater Quality Control Measures*, 2010. Available online at: http://www.vcstormwater.org/documents/workproducts/technicalguidancemanual/2010revisions/Ventura%20Technical%20Guidance%20Document_5-6-10.pdf.

Watershed Management Institute, Inc. *Operation, Maintenance, and Management of Stormwater Management Systems*. August, 1997. Available online at: http://www.stormwater.ucf.edu/research/stormwaterOMM/stormwateromm.pdf.

Infiltration Basin TC-11

General Description

An infiltration basin is a shallow impoundment that is designed to infiltrate stormwater. Infiltration basins store stormwater runoff until it gradually exfiltrates into the underlying soil. Pollutant removal occurs through the infiltration of runoff and the adsorption of pollutants into the soil and vegetation. Additional benefits include:

- Reduced runoff volume and attenuation of peak flows, and
- Facilitated groundwater recharge thus helping to maintain low flows in stream systems.

Inspection/Maintenance Considerations

The use and regular maintenance of pretreatment BMPs will significantly minimize maintenance requirements for the basin. Installing vegetated swales or a sediment forebay upstream from the infiltration basin can provide effective pretreatment and reduce maintenance.

Spill response procedures and controls should be implemented to prevent spills from reaching the infiltration system. This BMP may require groundwater monitoring, and basins cannot be put into operation until the upstream tributary area is stabilized.

Advanced BMPs Covered

Maintenance Concerns

- *Vector Control*
- *Clogged soil or outlet structures*
- *Vegetation/Landscape Maintenance*
- *Groundwater contamination*
- *Accumulation of metals*
- *Aesthetics*

Targeted Constituents

Sediment	■
Nutrients	■
Trash	■
Metals	■
Bacteria	■
Oil and Grease	■
Organics	■

Legend (Removal Effectiveness)

● Low ▲ Medium ■ High

✱ Requires Pretreatment

Note: The removal effectiveness ratings shown in the table are for properly designed, sited, and maintained BMPs; some configurations will have variations in pollutant effectiveness.

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Inspection Activities	Suggested Frequency
☐ Observe drain time for a storm after completion or modification of the facility to confirm that the desired drain time has been obtained. ☐ Newly established vegetation should be inspected several times to determine if any landscape maintenance (reseeding, irrigation, etc.) is necessary. ☐ Inspect for upslope or adjacent contributing sediment sources and ensure that pretreatment systems are in place.	Post construction and semi-annually (beginning and end of rainy season)
☐ Inspect for the following issues: differential accumulation of sediment, signs of wetness or damage to structures, erosion of the basin floor, dead or dying grass on the bottom, condition of riprap, drain time, signs of petroleum hydrocarbon contamination, standing water, trash and debris, sediment accumulation, slope stability, pretreatment device condition	Semi-annually and after extreme events

Maintenance Activities	Suggested Frequency
☐ Factors responsible for clogging should be repaired immediately.	Immediately
☐ Remove invasive weeds once monthly during the first two growing seasons.	Monthly during growing season
☐ Stabilize eroded banks with erosion control mat or mulch and revegetate. ☐ Repair undercut and eroded areas at inflow and outflow structures. ☐ Maintain access to the basin for regular maintenance activities. ☐ Mow as appropriate for vegetative cover species. ☐ Monitor health of vegetation and replace as necessary. ☐ Control mosquitoes as necessary. ☐ Remove litter and debris from infiltration basin area as required. ☐ Trim vegetation to prevent establishment of woody vegetation that decreases storage volume.	Standard maintenance (as needed)
☐ Mow and remove grass clippings, litter, and debris. ☐ Replant eroded or barren spots to prevent erosion and accumulation of sediment.	Semi-annual
☐ Scrape bottom and remove sediment when accumulated sediment reduces original infiltration rate by 25-50%. Restore original cross-section and infiltration rate. Properly dispose of sediment. ☐ Seed or sod to restore ground cover. ☐ Disc or otherwise aerate bottom. ☐ Dethatch basin bottom.	3-5 year maintenance

If there are actual signs of clogging or significant loss of infiltrative capacity the following maintenance activities should be considered:

- ☐ Mechanically de-thatching and/or aerating the top soils along the sides and bottom of the basin.
- ☐ Tilling or dicing to scarify the bottom of the basin

These activities should be on an "as-needed" rather than on a routine basis. Always remove deposited sediments before scarification, and use a hand-guided rotary tiller, if possible, or a disc harrow pulled by a light tractor.

Clogged infiltration basins with surface standing water can become a breeding area for mosquitoes and midges. Maintenance efforts associated with infiltration basins should include frequent inspections to ensure that water infiltrates into the subsurface completely (recommended infiltration rate of 96 hours or less) and that vegetation is carefully managed to prevent creating mosquito and other vector habitats.

Additional Information

In most cases, surface sediment removed from an infiltration basin during periodic maintenance to restore capacity does not contain toxic materials (e/g metals, oil and grease, or organics) at levels posing a hazardous concern. Studies to date indicate that pond sediments are generally below toxicity limits and can be safely landfilled or disposed onsite. Onsite sediment disposal is always preferable (if local authorities permit) as long as the sediments are deposited away from the perimeter to prevent their reentry into the basin. Sediments should be tested for toxic materials in compliance with current landfill requirements and disposed of properly.

Maintenance activities should use lightweight equipment (e.g. bobcat), which will not compact the underlying soil to remove the top layer of sediment. The remaining soil should be tilled and revegetated as soon as possible.

Sediment removal within the basin should be performed when the sediment is dry enough so that it is cracked and readily separates from the basin floor. This minimizes intermixing of the finer sediment with underlying coarser material on the basin floor.

Special maintenance considerations are required maintain infiltration basins effectiveness in cold climates. Treating runoff containing salt-based deicers in an infiltration basin may reduce soil fertility cause vegetation to fail. Incorporating mulch into the soil can help to mitigate this problem. Infiltration basins should not be used to store snow plowed from highways or parking lots. The sand in this snow can clog the basin. In addition, the chlorides and other pollutants can contaminate the groundwater.

References

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Harvest and Reuse TC-12

General Description

Harvest and reuse refers to the capture of stormwater runoff in a holding pond or vault and subsequent use of the captured volume for irrigation of landscape or natural pervious areas. This technology is very effective as a stormwater quality practice in that, for the captured water quality volume, it provides virtually no discharge to receiving waters thereby greatly reducing pollutant loads from industrial sources.

This technology mimics natural undeveloped watershed conditions wherein the vast majority of the rainfall volume during smaller rainfall events is infiltrated through the soil profile. Their main advantage over other infiltration technologies is the use of an irrigation system to spread the runoff over a larger area for infiltration and/or to satisfy evapotranspiration demands of vegetation including ornamental vegetation on the site. This allows them to be used in areas with low permeability soils.

Stormwater harvesting typically utilizes rain barrels or cisterns.

- Rain barrels are small containers, typically ranging from 50 to 100 gallons installed adjacent to individual downspouts to capture rainwater runoff from roofs. The stored water can be used for irrigation, vehicle washing, or other non-potable applications. Rain barrels are inexpensive, easy to install and maintain, and well suited to small-scale sites.
- Cisterns are typically much larger than rain barrels, ranging from 1,000 gallons for small installations to millions of gallons beneath large facilities. They can be installed above or below ground, or even on the roof, depending upon site conditions.

Advanced BMPs Covered

Stormwater Containment and Discharge Reduction

Maintenance Concerns

- *Sediment Accumulation*
- *Mechanical malfunction*
- *Vector Control*

Targeted Constituents

Sediment	■✱
Nutrients	■✱
Trash	■✱
Metals	■✱
Bacteria	■✱
Oil and Grease	■✱
Organics	■✱

Legend (Removal Effectiveness)

● Low ■ High ▲ Medium

✱ Requires Pretreatment

Note: The removal effectiveness ratings shown in the table are for properly designed, sited, and maintained BMPs; some configurations will have variations in pollutant effectiveness.

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The use of harvested rainwater for irrigation may utilize a simple gravity system for small systems or use pumps for larger systems. The pump and wet well should be automated with a rainfall sensor to provide irrigation only during periods when required infiltration rates can be realized.

Inspection Activities	Suggested Frequency
☐ The irrigation system should be inspected and tested (or observed while in operation) to verify proper operation regularly during periods of use. ☐ Any leaks, broken spray heads, or other malfunctions with the irrigation system should be repaired immediately.	Frequently (3-6 times per year)
☐ Inspect gutter systems, pipes, and storage facilities for accumulated sediment and debris and remove as necessary. ☐ Inspect rain barrels, cisterns, and other water storage containers to ensure they remain mosquito-proof. Repair damaged or missing screens or other mosquito-preventive measures. Contact the local mosquito and vector control agency if mosquito breeding is observed or suspected.	Semi-annually (beginning and end of rainy season)
Maintenance Activities	**Suggested Frequency**
☐ The upper stage, side slopes, and bottom of a retention basin should be mowed regularly to control weeds and discourage woody growth that reduces storage volumes.	Standard maintenance (as needed)
☐ Sediment must be removed from inlet structure/sediment forebay, and from around the sump area at least 2 times annually or when depth reaches 3 inches. When sediment in other areas of the basin fills the volume allocated for sediment accumulation, all sediment should be removed and disposed of properly. ☐ Grass areas in and around basins must be mowed at least twice annually to limit vegetation height to 18 inches. More frequent mowing to maintain aesthetic appeal may be necessary in landscaped areas. When mowing is performed, a mulching mower should be used, or grass clippings should be caught and removed. ☐ Debris and litter will accumulate near the basin pump and should be removed during regular mowing operations and inspections. Particular attention should be paid to floating debris that can eventually clog the irrigation system. ☐ For underground cisterns, ensure that manhole is accessible, operational, and secure.	Semi-annual
☐ The pond side slopes and embankment may periodically suffer from slumping and erosion, although this should not occur often if the soils are properly compacted during construction. Re-grading and re-vegetation may be required to correct the problems.	Infrequently

Inspection/Maintenance Considerations

Pollutant removal rates are estimated to be nearly 100% for all pollutants in the captured and irrigated stormwater volume. However, relatively frequent inspection and maintenance is necessary to verify proper operation of these facilities and to prevent accumulated sediment and debris from clogging conveyance lines. Some maintenance concerns are specific to the type of irrigation system or practice used.

Additional Information

Rain barrels, cisterns, sumps, and vaults that store water can become a nuisance due to mosquito and other vector breeding. Preventing mosquito access to standing water in rain barrels and above-ground cisterns can often be achieved by sealing openings with stainless steel wire mesh (1/16" openings or less). Sealing below-ground storage systems against mosquitoes can be more difficult depending on the design and the number of potential entry points. Open storage structures such as ponds and retention basins (see appropriate fact sheets) will require routine preventative maintenance plans to minimize mosquito production. Certain systems may require routine inspection and treatment by local mosquito and vector control agencies.

Special considerations are required for harvest and reuse to be effective in cold climates. Underground or indoor systems are more appropriate for year-round use, but these systems are more difficult to design, construct, and maintain.

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Extended Detention Basin TC-22

General Description

Dry extended detention ponds (a.k.a. dry ponds, extended detention basins, detention ponds, extended detention ponds) are basins whose outlets have been designed to draw down the stormwater runoff from a water quality design storm for some minimum time (e.g., 48 hours) to allow particles and associated pollutants to settle. Unlike wet ponds, these facilities do not have a large permanent pool. They can also be used to provide flood control by including additional flood detention storage. Considerable stormwater volume reduction can also occur, depending on the infiltration capacity of the subsoil.

Inspection/Maintenance Considerations

Inspections should be conducted semi-annually and after significant storm events to identify potential problems early. Most maintenance efforts will need to be directed toward vegetation management and vector control, which may focus on basic housekeeping practices such as removal of debris accumulations and vegetation management to ensure that the basin dewaters completely (recommended 48 hour residence time or less) to prevent creating mosquito and other vector habitats.

If infiltration is desired for stormwater reduction, the following additional maintenance may be required to maintain infiltrative capacity:

- Mechanically de-thatching and/or aerating the top soils along the sides and bottom of the basin;
- Tilling or dicing to scarify the bottom of the basin; and
- Maintaining adequate vegetative cover.

Advanced BMPs Covered

Maintenance Concerns

- *Accumulation of Metals and Toxics*
- *Clogged Soil Outlet Structures*
- *Vegetation/Landscape Maintenance*
- *Erosion*
- *Vector Control*

Targeted Constituents

Sediment	▲
Nutrients	●
Trash	■
Metals	▲
Bacteria	▲
Oil and Grease	▲
Organics	▲

Legend (Removal Effectiveness)

● Low ■ High ▲ Medium

✱ Requires Pretreatment

Note: The removal effectiveness ratings shown in the table are for properly designed, sited, and maintained BMPs; some configurations will have variations in pollutant effectiveness.

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Refer to TC-11 Infiltration Basin for further information.

Inspection Activities	Suggested Frequency
☐ Inspect after several storm events for bank stability, vegetation growth, and to determine if the desired residence time has been achieved. ☐ Inspect outlet structure for evidence of clogging or outflow release velocities that are greater than design flow.	Post construction
☐ Inspect for the following issues: differential settlement, cracking, erosion of pond banks or bottom, leakage, tree growth on the embankment, the condition of the riprap in the inlet, clogging of outlet and pilot channels, standing water, slope stability, presence of burrows, sediment accumulation in the basin, forebay, and outlet structures, trash and debris, and the vigor and density of vegetation on the basin side slopes and floor.	Semi-annual, after significant storms, or more frequent
☐ Inspect for the following issues: subsidence, damage to the emergency spillway, inadequacy of the inlet/outlet channel erosion control measures, changes in the condition of the pilot channel, accumulated sediment volume, and semi-annual inspection items.	Annual
☐ During inspections, changes to the extended storage pond or the contributing watershed should be noted, as these may affect basin performance.	Annual inspection
Maintenance Activities	**Suggested Frequency**
☐ If necessary, modify the outlet orifice to achieve design values if inspection indicates modifications are necessary. ☐ Repair undercut or eroded areas. ☐ Mow side slopes for aesthetics and to remove woody debris that reduces storage volume. ☐ Maintain vegetation in and around basin to prevent any erosion and minimize aesthetic concerns. Minimize use of fertilizers and pesticides. Reseed if necessary. ☐ Remove litter and debris. ☐ Make structural changes or repairs as needed to eliminate pools of water that stand longer than 96 hrs to prevent mosquito production, particularly during the warmer months of the year. Identify and eliminate sources of non-stormwater runoff that feed standing water pools. Coordinate with the local mosquito and vector control agency to control mosquitoes, if necessary.	Standard Maintenance (As needed)
☐ Remove accumulated trash and debris from the basin, around the riser pipe, side slopes, embankment, emergency spillway, and outflow trash racks. The frequency of this activity may be altered to meet specific site conditions. ☐ Trim vegetation at the beginning and end of the wet season to prevent establishment of woody vegetation and for aesthetic and vector reasons.	Semi-annual, or more frequent, as needed
☐ Seed or sod to restore dead or damaged ground cover. ☐ Repair erosion to banks and bottom as required.	Annual maintenance (as needed)
☐ Supplement vegetation if a significant portion have not been established (at least 50% of the surface area). ☐ Remove nuisance plant species.	Annual maintenance (if needed)
☐ Remove sediment from the forebay to reduce frequency of main basin cleaning.	3- to 5-year

☐ Remove sediment from the basin bottom and thatch, aerate, or scarify soils to maintain infiltrative capacity.	maintenance
☐ Monitor sediment accumulation and remove accumulated sediment and regrade about every 10 years or when the accumulated sediment volume exceeds 10-20% of the basin volume, or when accumulation reaches 6 inches or if resuspension is observed. Clean in early spring so vegetation damaged during cleaning has time to re-establish.	Every 10-25 years

Additional Information

In most cases, surface sediment removed from an extended detention basin during periodic maintenance to restore capacity does not contain toxic materials (e/g metals, oil and grease, or organics) at levels posing a hazardous concern. Studies to date indicate that pond sediments are generally below toxicity limits and can be safely landfilled or disposed onsite. Onsite sediment disposal is always preferable (if local authorities permit) as long as the sediments are deposited away from the perimeter to prevent their reentry into the basin. Sediments should be tested for toxic materials in compliance with current landfill requirements and disposed of properly.

Special considerations are required for extended detention basins to be effective in cold climates. Refer to the Stormwater Managers Resource Center for more information.

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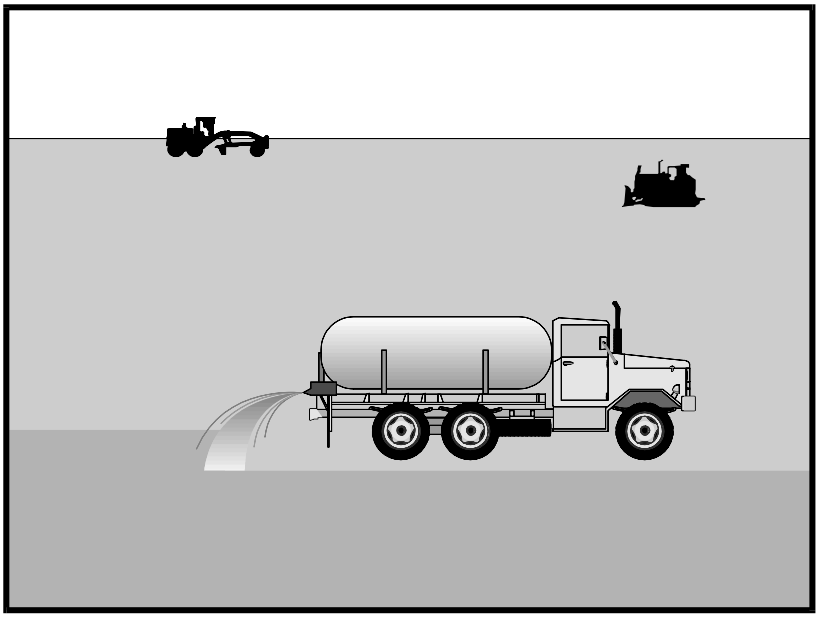
Wind Erosion Control WE-1



Categories

EC	Erosion Control	
SE	Sediment Control	☒
TC	Tracking Control	
WE	Wind Erosion Control	☑
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-5 Soil Binders

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Description and Purpose

Wind erosion or dust control consists of applying water or other chemical dust suppressants as necessary to prevent or alleviate dust nuisance generated by construction activities. Covering small stockpiles or areas is an alternative to applying water or other dust palliatives.

California's Mediterranean climate, with a short "wet" season and a typically long, hot "dry" season, allows the soils to thoroughly dry out. During the dry season, construction activities are at their peak, and disturbed and exposed areas are increasingly subject to wind erosion, sediment tracking and dust generated by construction equipment. Site conditions and climate can make dust control more of an erosion problem than water based erosion. Additionally, many local agencies, including Air Quality Management Districts, require dust control and/or dust control permits in order to comply with local nuisance laws, opacity laws (visibility impairment) and the requirements of the Clean Air Act. Wind erosion control is required to be implemented at all construction sites greater than 1 acre by the General Permit.

Suitable Applications

Most BMPs that provide protection against water-based erosion will also protect against wind-based erosion and dust control requirements required by other agencies will generally meet wind erosion control requirements for water quality protection. Wind erosion control BMPs are suitable during the following construction activities:

- Construction vehicle traffic on unpaved roads
- Drilling and blasting activities
- Soils and debris storage piles
- Batch drop from front-end loaders
- Areas with unstabilized soil
- Final grading/site stabilization

Limitations

- Watering prevents dust only for a short period (generally less than a few hours) and should be applied daily (or more often) to be effective.
- Over watering may cause erosion and track-out.
- Oil or oil-treated subgrade should not be used for dust control because the oil may migrate into drainageways and/or seep into the soil.
- Chemical dust suppression agents may have potential environmental impacts. Selected chemical dust control agents should be environmentally benign.
- Effectiveness of controls depends on soil, temperature, humidity, wind velocity and traffic.
- Chemical dust suppression agents should not be used within 100 feet of wetlands or water bodies.
- Chemically treated subgrades may make the soil water repellant, interfering with long-term infiltration and the vegetation/re-vegetation of the site. Some chemical dust suppressants may be subject to freezing and may contain solvents and should be handled properly.
- In compacted areas, watering and other liquid dust control measures may wash sediment or other constituents into the drainage system.
- If the soil surface has minimal natural moisture, the affected area may need to be pre-wetted so that chemical dust control agents can uniformly penetrate the soil surface.

Implementation

Dust Control Practices

Dust control BMPs generally stabilize exposed surfaces and minimize activities that suspend or track dust particles. The following table presents dust control practices that can be applied to varying site conditions that could potentially cause dust. For heavily traveled and disturbed areas, wet suppression (watering), chemical dust suppression, gravel asphalt surfacing, temporary gravel construction entrances, equipment wash-out areas, and haul truck covers can be employed as dust control applications. Permanent or temporary vegetation and mulching can be employed for areas of occasional or no construction traffic. Preventive measures include minimizing surface areas to be disturbed, limiting onsite vehicle traffic to 15 mph or less, and controlling the number and activity of vehicles on a site at any given time.

Chemical dust suppressants include: mulch and fiber based dust palliatives (e.g. paper mulch with gypsum binder), salts and brines (e.g. calcium chloride, magnesium chloride), non-petroleum based organics (e.g. vegetable oil, lignosulfonate), petroleum based organics (e.g. asphalt emulsion, dust oils, petroleum resins), synthetic polymers (e.g. polyvinyl acetate, vinyls, acrylic), clay additives (e.g. bentonite, montimorillonite) and electrochemical products (e.g. enzymes, ionic products).

Site Condition	Dust Control Practices							
	Permanent Vegetation	Mulching	Wet Suppression (Watering)	Chemical Dust Suppression	Gravel or Asphalt	Temporary Gravel Construction Entrances/Equipment Wash Down	Synthetic Covers	Minimize Extent of Disturbed Area
Disturbed Areas not Subject to Traffic	X	X	X	X	X			X
Disturbed Areas Subject to Traffic			X	X	X	X		X
Material Stockpiles		X	X	X			X	X
Demolition			X			X	X	
Clearing/ Excavation			X	X				X
Truck Traffic on Unpaved Roads			X	X	X	X	X	
Tracking					X	X		

Additional preventive measures include:

- Schedule construction activities to minimize exposed area (see EC-1, Scheduling).
- Quickly treat exposed soils using water, mulching, chemical dust suppressants, or stone/gravel layering.
- Identify and stabilize key access points prior to commencement of construction.
- Minimize the impact of dust by anticipating the direction of prevailing winds.
- Restrict construction traffic to stabilized roadways within the project site, as practicable.
- Water should be applied by means of pressure-type distributors or pipelines equipped with a spray system or hoses and nozzles that will ensure even distribution.
- All distribution equipment should be equipped with a positive means of shutoff.
- Unless water is applied by means of pipelines, at least one mobile unit should be available at all times to apply water or dust palliative to the project.
- If reclaimed waste water is used, the sources and discharge must meet California Department of Health Services water reclamation criteria and the Regional Water Quality

Control Board (RWQCB) requirements. Non-potable water should not be conveyed in tanks or drain pipes that will be used to convey potable water and there should be no connection between potable and non-potable supplies. Non-potable tanks, pipes, and other conveyances should be marked, "NON-POTABLE WATER - DO NOT DRINK."

- Pave or chemically stabilize access points where unpaved traffic surfaces adjoin paved roads.
- Provide covers for haul trucks transporting materials that contribute to dust.
- Provide for rapid clean up of sediments deposited on paved roads. Furnish stabilized construction road entrances and wheel wash areas.
- Stabilize inactive areas of construction sites using temporary vegetation or chemical stabilization methods.

For chemical stabilization, there are many products available for chemically stabilizing gravel roadways and stockpiles. If chemical stabilization is used, the chemicals should not create any adverse effects on stormwater, plant life, or groundwater and should meet all applicable regulatory requirements.

Costs

Installation costs for water and chemical dust suppression vary based on the method used and the length of effectiveness. Annual costs may be high since some of these measures are effective for only a few hours to a few days.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities.
- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Check areas protected to ensure coverage.
- Most water-based dust control measures require frequent application, often daily or even multiple times per day. Obtain vendor or independent information on longevity of chemical dust suppressants.

References

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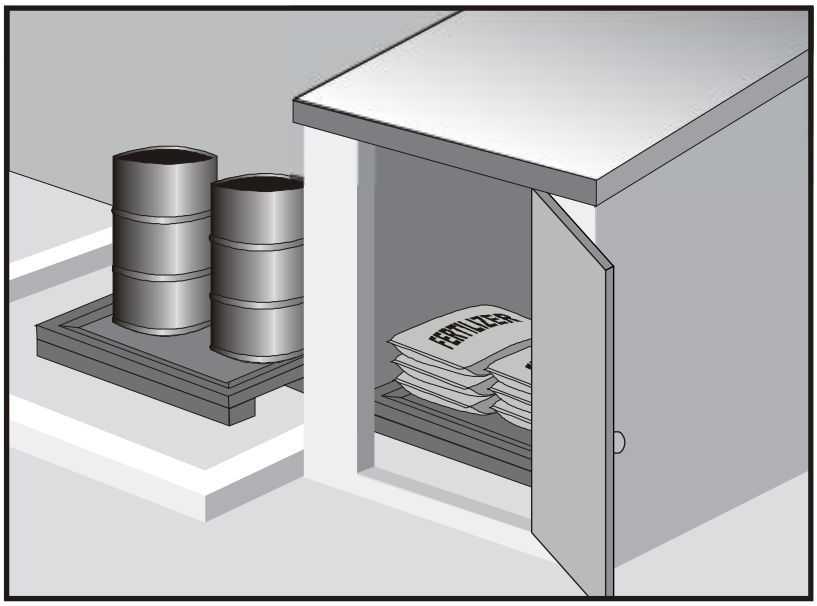
Material Delivery and Storage WM-1



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Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

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Description and Purpose

Prevent, reduce, or eliminate the discharge of pollutants from material delivery and storage to the stormwater system or watercourses by minimizing the storage of hazardous materials onsite, storing materials in watertight containers and/or a completely enclosed designated area, installing secondary containment, conducting regular inspections, and training employees and subcontractors.

This best management practice covers only material delivery and storage. For other information on materials, see WM-2, Material Use, or WM-4, Spill Prevention and Control. For information on wastes, see the waste management BMPs in this section.

Suitable Applications

These procedures are suitable for use at all construction sites with delivery and storage of the following materials:

- Soil stabilizers and binders
- Pesticides and herbicides
- Fertilizers
- Detergents
- Plaster
- Petroleum products such as fuel, oil, and grease

- Asphalt and concrete components
- Hazardous chemicals such as acids, lime, glues, adhesives, paints, solvents, and curing compounds
- Concrete compounds
- Other materials that may be detrimental if released to the environment

Limitations

- Space limitation may preclude indoor storage.
- Storage sheds often must meet building and fire code requirements.

Implementation

The following steps should be taken to minimize risk:

- Chemicals must be stored in water tight containers with appropriate secondary containment or in a storage shed.
- When a material storage area is located on bare soil, the area should be lined and bermed.
- Use containment pallets or other practical and available solutions, such as storing materials within newly constructed buildings or garages, to meet material storage requirements.
- Stack erodible landscape material on pallets and cover when not in use.
- Contain all fertilizers and other landscape materials when not in use.
- Temporary storage areas should be located away from vehicular traffic.
- Material Safety Data Sheets (MSDS) should be available on-site for all materials stored that have the potential to effect water quality.
- Construction site areas should be designated for material delivery and storage.
- Material delivery and storage areas should be located away from waterways, if possible.
  - Avoid transport near drainage paths or waterways.
  - Surround with earth berms or other appropriate containment BMP. See EC-9, Earth Dikes and Drainage Swales.
  - Place in an area that will be paved.
- Storage of reactive, ignitable, or flammable liquids must comply with the fire codes of your area. Contact the local Fire Marshal to review site materials, quantities, and proposed storage area to determine specific requirements. See the Flammable and Combustible Liquid Code, NFPA30.
- An up to date inventory of materials delivered and stored onsite should be kept.

- Hazardous materials storage onsite should be minimized.
- Hazardous materials should be handled as infrequently as possible.
- Keep ample spill cleanup supplies appropriate for the materials being stored. Ensure that cleanup supplies are in a conspicuous, labeled area.
- Employees and subcontractors should be trained on the proper material delivery and storage practices.
- Employees trained in emergency spill cleanup procedures must be present when dangerous materials or liquid chemicals are unloaded.
- If significant residual materials remain on the ground after construction is complete, properly remove and dispose of materials and any contaminated soil. See WM-7, Contaminated Soil Management. If the area is to be paved, pave as soon as materials are removed to stabilize the soil.

Material Storage Areas and Practices

- Liquids, petroleum products, and substances listed in 40 CFR Parts 110, 117, or 302 should be stored in approved containers and drums and should not be overfilled. Containers and drums should be placed in temporary containment facilities for storage.
- A temporary containment facility should provide for a spill containment volume able to contain precipitation from a 25 year storm event, plus the greater of 10% of the aggregate volume of all containers or 100% of the capacity of the largest container within its boundary, whichever is greater.
- A temporary containment facility should be impervious to the materials stored therein for a minimum contact time of 72 hours.
- A temporary containment facility should be maintained free of accumulated rainwater and spills. In the event of spills or leaks, accumulated rainwater and spills should be collected and placed into drums. These liquids should be handled as a hazardous waste unless testing determines them to be non-hazardous. All collected liquids or non-hazardous liquids should be sent to an approved disposal site.
- Sufficient separation should be provided between stored containers to allow for spill cleanup and emergency response access.
- Incompatible materials, such as chlorine and ammonia, should not be stored in the same temporary containment facility.
- Materials should be covered prior to, and during rain events.
- Materials should be stored in their original containers and the original product labels should be maintained in place in a legible condition. Damaged or otherwise illegible labels should be replaced immediately.

- Bagged and boxed materials should be stored on pallets and should not be allowed to accumulate on the ground. To provide protection from wind and rain throughout the rainy season, bagged and boxed materials should be covered during non-working days and prior to and during rain events.
- Stockpiles should be protected in accordance with WM-3, Stockpile Management.
- Materials should be stored indoors within existing structures or completely enclosed storage sheds when available.
- Proper storage instructions should be posted at all times in an open and conspicuous location.
- An ample supply of appropriate spill clean up material should be kept near storage areas.
- Also see WM-6, Hazardous Waste Management, for storing of hazardous wastes.

Material Delivery Practices

- Keep an accurate, up-to-date inventory of material delivered and stored onsite.
- Arrange for employees trained in emergency spill cleanup procedures to be present when dangerous materials or liquid chemicals are unloaded.

Spill Cleanup

- Contain and clean up any spill immediately.
- Properly remove and dispose of any hazardous materials or contaminated soil if significant residual materials remain on the ground after construction is complete. See WM-7, Contaminated Soil Management.
- See WM-4, Spill Prevention and Control, for spills of chemicals and/or hazardous materials.
- If spills or leaks of materials occur that are not contained and could discharge to surface waters, non-visible sampling of site discharge may be required. Refer to the General Permit or to your project specific Construction Site Monitoring Plan to determine if and where sampling is required.

Cost

- The largest cost of implementation may be in the construction of a materials storage area that is covered and provides secondary containment.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Keep storage areas clean and well organized, including a current list of all materials onsite.
- Inspect labels on containers for legibility and accuracy.

- Repair or replace perimeter controls, containment structures, covers, and liners as needed to maintain proper function.

References

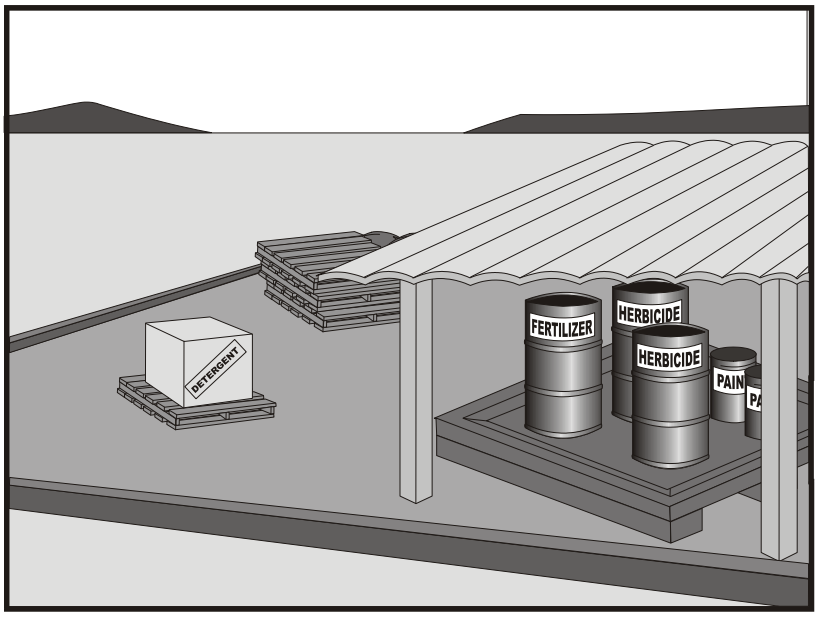
Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance, Working Group Working Paper; USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Material Use WM-2



Categories

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

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Description and Purpose

Prevent or reduce the discharge of pollutants to the storm drain system or watercourses from material use by using alternative products, minimizing hazardous material use onsite, and training employees and subcontractors.

Suitable Applications

This BMP is suitable for use at all construction projects. These procedures apply when the following materials are used or prepared onsite:

- Pesticides and herbicides
- Fertilizers
- Detergents
- Petroleum products such as fuel, oil, and grease
- Asphalt and other concrete components
- Other hazardous chemicals such as acids, lime, glues, adhesives, paints, solvents, and curing compounds
- Other materials that may be detrimental if released to the environment

Limitations

Safer alternative building and construction products may not be available or suitable in every instance.

Implementation

The following steps should be taken to minimize risk:

- Minimize use of hazardous materials onsite.
- Follow manufacturer instructions regarding uses, protective equipment, ventilation, flammability, and mixing of chemicals.
- Train personnel who use pesticides. The California Department of Pesticide Regulation and county agricultural commissioners license pesticide dealers, certify pesticide applicators, and conduct onsite inspections.
- The preferred method of termiticide application is soil injection near the existing or proposed structure foundation/slab; however, if not feasible, soil drench application of termiticides should follow EPA label guidelines and the following recommendations (most of which are applicable to most pesticide applications):
  - Do not treat soil that is water-saturated or frozen.
  - Application shall not commence within 24-hours of a predicted precipitation event with a 40% or greater probability. Weather tracking must be performed on a daily basis prior to termiticide application and during the period of termiticide application.
  - Do not allow treatment chemicals to runoff from the target area. Apply proper quantity to prevent excess runoff. Provide containment for and divert stormwater from application areas using berms or diversion ditches during application.
  - Dry season: Do not apply within 10 feet of storm drains. Do not apply within 25 feet of aquatic habitats (such as, but not limited to, lakes; reservoirs; rivers; permanent streams; marshes or ponds; estuaries; and commercial fish farm ponds).
  - Wet season: Do not apply within 50 feet of storm drains or aquatic habitats (such as, but not limited to, lakes; reservoirs; rivers; permanent streams; marshes or ponds; estuaries; and commercial fish farm ponds) unless a vegetative buffer is present (if so, refer to dry season requirements).
  - Do not make on-grade applications when sustained wind speeds are above 10 mph (at application site) at nozzle end height.
  - Cover treatment site prior to a rain event in order to prevent run-off of the pesticide into non-target areas. The treated area should be limited to a size that can be backfilled and/or covered by the end of the work shift. Backfilling or covering of the treated area shall be done by the end of the same work shift in which the application is made.
  - The applicator must either cover the soil him/herself or provide written notification of the above requirement to the contractor on site and to the person commissioning the

application (if different than the contractor). If notice is provided to the contractor or the person commissioning the application, then they are responsible under the Federal Insecticide Fungicide, and Rodenticide Act (FIFRA) to ensure that: 1) if the concrete slab cannot be poured over the treated soil within 24 hours of application, the treated soil is covered with a waterproof covering (such as polyethylene sheeting), and 2) the treated soil is covered if precipitation is predicted to occur before the concrete slab is scheduled to be poured.

- Do not over-apply fertilizers, herbicides, and pesticides. Prepare only the amount needed. Follow the recommended usage instructions. Over-application is expensive and environmentally harmful. Unless on steep slopes, till fertilizers into the soil rather than hydraulic application. Apply surface dressings in several smaller applications, as opposed to one large application, to allow time for infiltration and to avoid excess material being carried offsite by runoff. Do not apply these chemicals before predicted rainfall.
- Train employees and subcontractors in proper material use.
- Supply Material Safety Data Sheets (MSDS) for all materials.
- Dispose of latex paint and paint cans, used brushes, rags, absorbent materials, and drop cloths, when thoroughly dry and are no longer hazardous, with other construction debris.
- Do not remove the original product label; it contains important safety and disposal information. Use the entire product before disposing of the container.
- Mix paint indoors or in a containment area. Never clean paintbrushes or rinse paint containers into a street, gutter, storm drain, or watercourse. Dispose of any paint thinners, residue, and sludge(s) that cannot be recycled, as hazardous waste.
- For water-based paint, clean brushes to the extent practicable, and rinse to a drain leading to a sanitary sewer where permitted, or contain for proper disposal off site. For oil-based paints, clean brushes to the extent practicable, and filter and reuse thinners and solvents.
- Use recycled and less hazardous products when practical. Recycle residual paints, solvents, non-treated lumber, and other materials.
- Use materials only where and when needed to complete the construction activity. Use safer alternative materials as much as possible. Reduce or eliminate use of hazardous materials onsite when practical.
- Document the location, time, chemicals applied, and applicator's name and qualifications.
- Keep an ample supply of spill clean up material near use areas. Train employees in spill clean up procedures.
- Avoid exposing applied materials to rainfall and runoff unless sufficient time has been allowed for them to dry.
- Discontinue use of erodible landscape material within 2 days prior to a forecasted rain event and materials should be covered and/or bermed.

- Provide containment for material use areas such as masons' areas or paint mixing/preparation areas to prevent materials/pollutants from entering stormwater.

Costs

All of the above are low cost measures.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities.
- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Ensure employees and subcontractors throughout the job are using appropriate practices.

References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

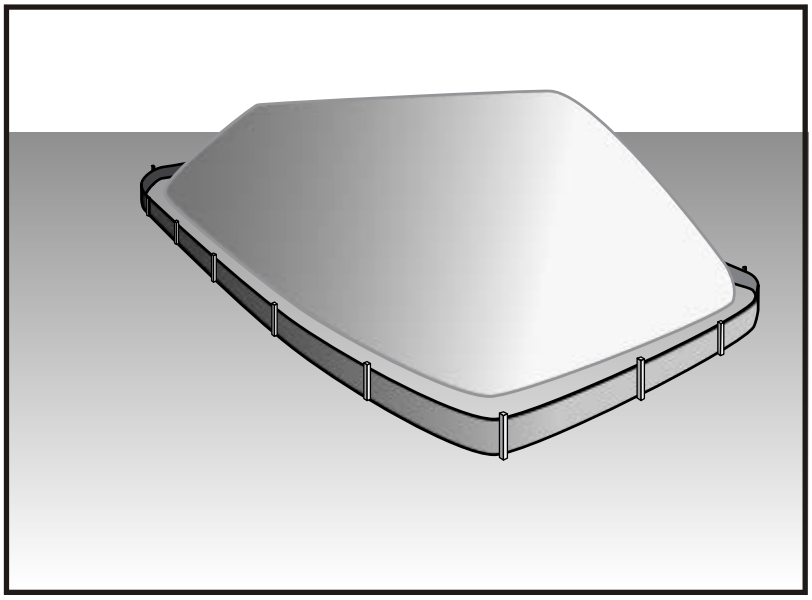
Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance, Working Group Working Paper; USEPA, April 1992.

Comments on Risk Assessments Risk Reduction Options for Cypermethrin: Docket No. OPP–2005–0293; California Stormwater Quality Association (CASQA) letter to USEPA, 2006.Environmental Hazard and General Labeling for Pyrethroid Non-Agricultural Outdoor Products, EPA-HQ-OPP-2008-0331-0021; USEPA, 2008.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Stockpile Management WM-3



Categories		
EC	Erosion Control	
SE	Sediment Control	☒
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☒
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents	
Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Stockpile management procedures and practices are designed to reduce or eliminate air and stormwater pollution from stockpiles of soil, soil amendments, sand, paving materials such as portland cement concrete (PCC) rubble, asphalt concrete (AC), asphalt concrete rubble, aggregate base, aggregate sub base or pre-mixed aggregate, asphalt minder (so called "cold mix" asphalt), and pressure treated wood.

Suitable Applications

Implement in all projects that stockpile soil and other loose materials.

Limitations

- Plastic sheeting as a stockpile protection is temporary and hard to manage in windy conditions. Where plastic is used, consider use of plastic tarps with nylon reinforcement which may be more durable than standard sheeting.
- Plastic sheeting can increase runoff volume due to lack of infiltration and potentially cause perimeter control failure.
- Plastic sheeting breaks down faster in sunlight.
- The use of Plastic materials and photodegradable plastics should be avoided.

Implementation

Protection of stockpiles is a year-round requirement. To properly manage stockpiles:

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- On larger sites, a minimum of 50 ft separation from concentrated flows of stormwater, drainage courses, and inlets is recommended.
- After 14 days of inactivity, a stockpile is non-active and requires further protection described below. All stockpiles are required to be protected as non-active stockpiles immediately if they are not scheduled to be used within 14 days.
- Protect all stockpiles from stormwater runon using temporary perimeter sediment barriers such as compost berms (SE-13), temporary silt dikes (SE-12), fiber rolls (SE-5), silt fences (SE-1), sandbags (SE-8), gravel bags (SE-6), or biofilter bags (SE-14). Refer to the individual fact sheet for each of these controls for installation information.
- Implement wind erosion control practices as appropriate on all stockpiled material. For specific information, see WE-1, Wind Erosion Control.
- Manage stockpiles of contaminated soil in accordance with WM-7, Contaminated Soil Management.
- Place bagged materials on pallets and under cover.
- Ensure that stockpile coverings are installed securely to protect from wind and rain.
- Some plastic covers withstand weather and sunlight better than others. Select cover materials or methods based on anticipated duration of use.

Protection of Non-Active Stockpiles

A stockpile is considered non-active if it either is not used for 14 days or if it is scheduled not to be used for 14 days or more. Stockpiles need to be protected immediately if they are not scheduled to be used within 14 days. Non-active stockpiles of the identified materials should be protected as follows:

Soil stockpiles

- Soil stockpiles should be covered or protected with soil stabilization measures and a temporary perimeter sediment barrier at all times.
- Temporary vegetation should be considered for topsoil piles that will be stockpiled for extended periods.

Stockpiles of Portland cement concrete rubble, asphalt concrete, asphalt concrete rubble, aggregate base, or aggregate sub base

- Stockpiles should be covered and protected with a temporary perimeter sediment barrier at all times.

Stockpiles of "cold mix"

- Cold mix stockpiles should be placed on and covered with plastic sheeting or comparable material at all times and surrounded by a berm.

Stockpiles of fly ash, stucco, hydrated lime

- Stockpiles of materials that may raise the pH of runoff (i.e., basic materials) should be covered with plastic and surrounded by a berm.

Stockpiles/Storage of wood (Pressure treated with chromated copper arsenate or ammoniacal copper zinc arsenate

- Treated wood should be covered with plastic sheeting or comparable material at all times and surrounded by a berm.

Protection of Active Stockpiles

A stockpile is active when it is being used or is scheduled to be used within 14 days of the previous use. Active stockpiles of the identified materials should be protected as follows:

- All stockpiles should be covered and protected with a temporary linear sediment barrier prior to the onset of precipitation.

- Stockpiles of "cold mix" and treated wood, and basic materials should be placed on and covered with plastic sheeting or comparable material and surrounded by a berm prior to the onset of precipitation.

- The downstream perimeter of an active stockpile should be protected with a linear sediment barrier or berm and runoff should be diverted around or away from the stockpile on the upstream perimeter.

Costs

For cost information associated with stockpile protection refer to the individual erosion or sediment control BMP fact sheet considered for implementation (For example, refer to SE-1 Silt Fence for installation of silt fence around the perimeter of a stockpile.)

Inspection and Maintenance

- Stockpiles must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.

- It may be necessary to inspect stockpiles covered with plastic sheeting more frequently during certain conditions (for example, high winds or extreme heat).

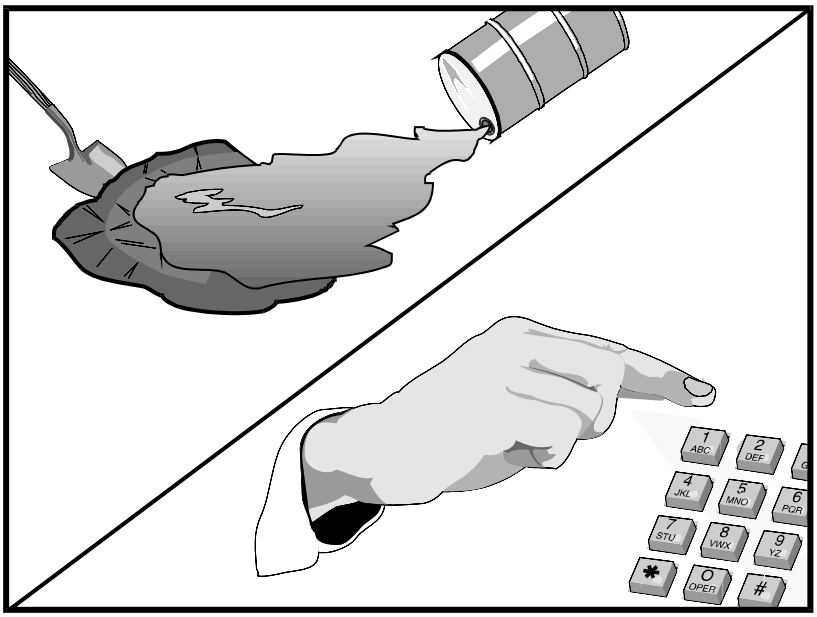
- Repair and/or replace perimeter controls and covers as needed to keep them functioning properly.

- Sediment shall be removed when it reaches one-third of the barrier height.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Spill Prevention and Control WM-4



Categories

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

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Description and Purpose

Prevent or reduce the discharge of pollutants to drainage systems or watercourses from leaks and spills by reducing the chance for spills, stopping the source of spills, containing and cleaning up spills, properly disposing of spill materials, and training employees.

This best management practice covers only spill prevention and control. However, WM-1, Materials Delivery and Storage, and WM-2, Material Use, also contain useful information, particularly on spill prevention. For information on wastes, see the waste management BMPs in this section.

Suitable Applications

This BMP is suitable for all construction projects. Spill control procedures are implemented anytime chemicals or hazardous substances are stored on the construction site, including the following materials:

- Soil stabilizers/binders
- Dust palliatives
- Herbicides
- Growth inhibitors
- Fertilizers
- Deicing/anti-icing chemicals

- Fuels
- Lubricants
- Other petroleum distillates

Limitations

- In some cases it may be necessary to use a private spill cleanup company.
- This BMP applies to spills caused by the contractor and subcontractors.
- Procedures and practices presented in this BMP are general. Contractor should identify appropriate practices for the specific materials used or stored onsite

Implementation

The following steps will help reduce the stormwater impacts of leaks and spills:

Education

- Be aware that different materials pollute in different amounts. Make sure that each employee knows what a "significant spill" is for each material they use, and what is the appropriate response for "significant" and "insignificant" spills.
- Educate employees and subcontractors on potential dangers to humans and the environment from spills and leaks.
- Hold regular meetings to discuss and reinforce appropriate disposal procedures (incorporate into regular safety meetings).
- Establish a continuing education program to indoctrinate new employees.
- Have contractor's superintendent or representative oversee and enforce proper spill prevention and control measures.

General Measures

- To the extent that the work can be accomplished safely, spills of oil, petroleum products, substances listed under 40 CFR parts 110,117, and 302, and sanitary and septic wastes should be contained and cleaned up immediately.
- Store hazardous materials and wastes in covered containers and protect from vandalism.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- Train employees in spill prevention and cleanup.
- Designate responsible individuals to oversee and enforce control measures.
- Spills should be covered and protected from stormwater runon during rainfall to the extent that it doesn't compromise clean up activities.
- Do not bury or wash spills with water.

- Store and dispose of used clean up materials, contaminated materials, and recovered spill material that is no longer suitable for the intended purpose in conformance with the provisions in applicable BMPs.
- Do not allow water used for cleaning and decontamination to enter storm drains or watercourses. Collect and dispose of contaminated water in accordance with WM-10, Liquid Waste Management.
- Contain water overflow or minor water spillage and do not allow it to discharge into drainage facilities or watercourses.
- Place proper storage, cleanup, and spill reporting instructions for hazardous materials stored or used on the project site in an open, conspicuous, and accessible location.
- Keep waste storage areas clean, well organized, and equipped with ample cleanup supplies as appropriate for the materials being stored. Perimeter controls, containment structures, covers, and liners should be repaired or replaced as needed to maintain proper function.

Cleanup

- Clean up leaks and spills immediately.
- Use a rag for small spills on paved surfaces, a damp mop for general cleanup, and absorbent material for larger spills. If the spilled material is hazardous, then the used cleanup materials are also hazardous and must be sent to either a certified laundry (rags) or disposed of as hazardous waste.
- Never hose down or bury dry material spills. Clean up as much of the material as possible and dispose of properly. See the waste management BMPs in this section for specific information.

Minor Spills

- Minor spills typically involve small quantities of oil, gasoline, paint, etc. which can be controlled by the first responder at the discovery of the spill.
- Use absorbent materials on small spills rather than hosing down or burying the spill.
- Absorbent materials should be promptly removed and disposed of properly.
- Follow the practice below for a minor spill:
  - Contain the spread of the spill.
  - Recover spilled materials.
  - Clean the contaminated area and properly dispose of contaminated materials.

Semi-Significant Spills

- Semi-significant spills still can be controlled by the first responder along with the aid of other personnel such as laborers and the foreman, etc. This response may require the cessation of all other activities.

- Spills should be cleaned up immediately:
  - Contain spread of the spill.
  - Notify the project foreman immediately.
  - If the spill occurs on paved or impermeable surfaces, clean up using "dry" methods (absorbent materials, cat litter and/or rags). Contain the spill by encircling with absorbent materials and do not let the spill spread widely.
  - If the spill occurs in dirt areas, immediately contain the spill by constructing an earthen dike. Dig up and properly dispose of contaminated soil.
  - If the spill occurs during rain, cover spill with tarps or other material to prevent contaminating runoff.

Significant/Hazardous Spills

- For significant or hazardous spills that cannot be controlled by personnel in the immediate vicinity, the following steps should be taken:
  - Notify the local emergency response by dialing 911. In addition to 911, the contractor will notify the proper county officials. It is the contractor's responsibility to have all emergency phone numbers at the construction site.
  - Notify the Governor's Office of Emergency Services Warning Center, (916) 845-8911.
  - For spills of federal reportable quantities, in conformance with the requirements in 40 CFR parts 110,119, and 302, the contractor should notify the National Response Center at (800) 424-8802.
  - Notification should first be made by telephone and followed up with a written report.
  - The services of a spills contractor or a Haz-Mat team should be obtained immediately. Construction personnel should not attempt to clean up until the appropriate and qualified staffs have arrived at the job site.
  - Other agencies which may need to be consulted include, but are not limited to, the Fire Department, the Public Works Department, the Coast Guard, the Highway Patrol, the City/County Police Department, Department of Toxic Substances, California Division of Oil and Gas, Cal/OSHA, etc.

Reporting

- Report significant spills to local agencies, such as the Fire Department; they can assist in cleanup.
- Federal regulations require that any significant oil spill into a water body or onto an adjoining shoreline be reported to the National Response Center (NRC) at 800-424-8802 (24 hours).

Use the following measures related to specific activities:

Vehicle and Equipment Maintenance

- If maintenance must occur onsite, use a designated area and a secondary containment, located away from drainage courses, to prevent the runon of stormwater and the runoff of spills.
- Regularly inspect onsite vehicles and equipment for leaks and repair immediately
- Check incoming vehicles and equipment (including delivery trucks, and employee and subcontractor vehicles) for leaking oil and fluids. Do not allow leaking vehicles or equipment onsite.
- Always use secondary containment, such as a drain pan or drop cloth, to catch spills or leaks when removing or changing fluids.
- Place drip pans or absorbent materials under paving equipment when not in use.
- Use absorbent materials on small spills rather than hosing down or burying the spill. Remove the absorbent materials promptly and dispose of properly.
- Promptly transfer used fluids to the proper waste or recycling drums. Don't leave full drip pans or other open containers lying around
- Oil filters disposed of in trashcans or dumpsters can leak oil and pollute stormwater. Place the oil filter in a funnel over a waste oil-recycling drum to drain excess oil before disposal. Oil filters can also be recycled. Ask the oil supplier or recycler about recycling oil filters.
- Store cracked batteries in a non-leaking secondary container. Do this with all cracked batteries even if you think all the acid has drained out. If you drop a battery, treat it as if it is cracked. Put it into the containment area until you are sure it is not leaking.

Vehicle and Equipment Fueling

- If fueling must occur onsite, use designate areas, located away from drainage courses, to prevent the runon of stormwater and the runoff of spills.
- Discourage "topping off" of fuel tanks.
- Always use secondary containment, such as a drain pan, when fueling to catch spills/ leaks.

Costs

Prevention of leaks and spills is inexpensive. Treatment and/ or disposal of contaminated soil or water can be quite expensive.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.

- Inspect BMPs subject to non-stormwater discharge daily while non-stormwater discharges occur.
- Keep ample supplies of spill control and cleanup materials onsite, near storage, unloading, and maintenance areas.
- Update your spill prevention and control plan and stock cleanup materials as changes occur in the types of chemicals onsite.

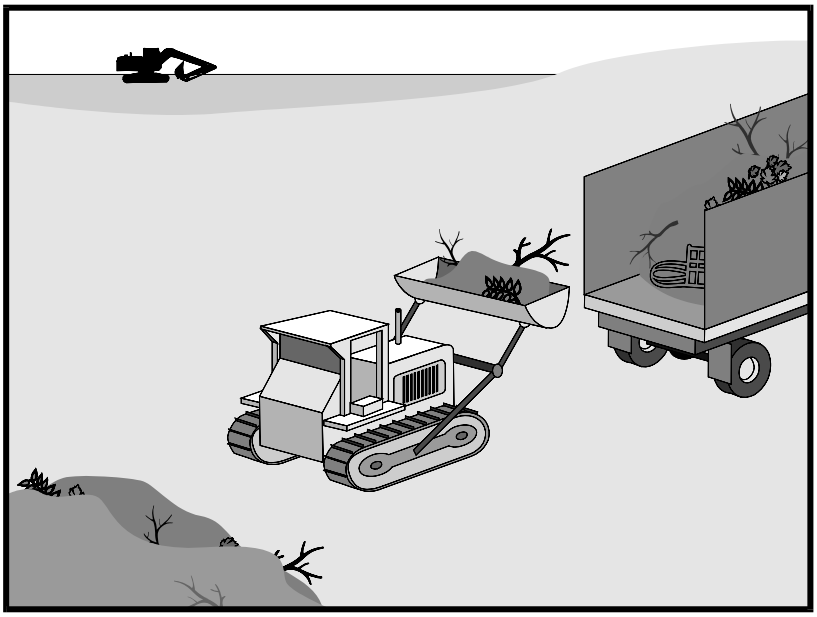
References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Solid Waste Management WM-5



Categories		
EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents	
Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

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Description and Purpose

Solid waste management procedures and practices are designed to prevent or reduce the discharge of pollutants to stormwater from solid or construction waste by providing designated waste collection areas and containers, arranging for regular disposal, and training employees and subcontractors.

Suitable Applications

This BMP is suitable for construction sites where the following wastes are generated or stored:

- Solid waste generated from trees and shrubs removed during land clearing, demolition of existing structures (rubble), and building construction
- Packaging materials including wood, paper, and plastic
- Scrap or surplus building materials including scrap metals, rubber, plastic, glass pieces, and masonry products
- Domestic wastes including food containers such as beverage cans, coffee cups, paper bags, plastic wrappers, and cigarettes
- Construction wastes including brick, mortar, timber, steel and metal scraps, pipe and electrical cuttings, non-hazardous equipment parts, styrofoam and other materials used to transport and package construction materials

- Highway planting wastes, including vegetative material, plant containers, and packaging materials

Limitations

Temporary stockpiling of certain construction wastes may not necessitate stringent drainage related controls during the non-rainy season or in desert areas with low rainfall.

Implementation

The following steps will help keep a clean site and reduce stormwater pollution:

- Select designated waste collection areas onsite.
- Inform trash-hauling contractors that you will accept only watertight dumpsters for onsite use. Inspect dumpsters for leaks and repair any dumpster that is not watertight.
- Locate containers in a covered area or in a secondary containment.
- Provide an adequate number of containers with lids or covers that can be placed over the container to keep rain out or to prevent loss of wastes when it is windy.
- Cover waste containers at the end of each work day and when it is raining.
- Plan for additional containers and more frequent pickup during the demolition phase of construction.
- Collect site trash daily, especially during rainy and windy conditions.
- Remove this solid waste promptly since erosion and sediment control devices tend to collect litter.
- Make sure that toxic liquid wastes (used oils, solvents, and paints) and chemicals (acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris.
- Do not hose out dumpsters on the construction site. Leave dumpster cleaning to the trash hauling contractor.
- Arrange for regular waste collection before containers overflow.
- Clean up immediately if a container does spill.
- Make sure that construction waste is collected, removed, and disposed of only at authorized disposal areas.

Education

- Have the contractor's superintendent or representative oversee and enforce proper solid waste management procedures and practices.
- Instruct employees and subcontractors on identification of solid waste and hazardous waste.
- Educate employees and subcontractors on solid waste storage and disposal procedures.

- Hold regular meetings to discuss and reinforce disposal procedures (incorporate into regular safety meetings).
- Require that employees and subcontractors follow solid waste handling and storage procedures.
- Prohibit littering by employees, subcontractors, and visitors.
- Minimize production of solid waste materials wherever possible.

Collection, Storage, and Disposal

- Littering on the project site should be prohibited.
- To prevent clogging of the storm drainage system, litter and debris removal from drainage grates, trash racks, and ditch lines should be a priority.
- Trash receptacles should be provided in the contractor's yard, field trailer areas, and at locations where workers congregate for lunch and break periods.
- Litter from work areas within the construction limits of the project site should be collected and placed in watertight dumpsters at least weekly, regardless of whether the litter was generated by the contractor, the public, or others. Collected litter and debris should not be placed in or next to drain inlets, stormwater drainage systems, or watercourses.
- Dumpsters of sufficient size and number should be provided to contain the solid waste generated by the project.
- Full dumpsters should be removed from the project site and the contents should be disposed of by the trash hauling contractor.
- Construction debris and waste should be removed from the site biweekly or more frequently as needed.
- Construction material visible to the public should be stored or stacked in an orderly manner.
- Stormwater runon should be prevented from contacting stored solid waste through the use of berms, dikes, or other temporary diversion structures or through the use of measures to elevate waste from site surfaces.
- Solid waste storage areas should be located at least 50 ft from drainage facilities and watercourses and should not be located in areas prone to flooding or ponding.
- Except during fair weather, construction and highway planting waste not stored in watertight dumpsters should be securely covered from wind and rain by covering the waste with tarps or plastic.
- Segregate potentially hazardous waste from non-hazardous construction site waste.
- Make sure that toxic liquid wastes (used oils, solvents, and paints) and chemicals (acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris.

- For disposal of hazardous waste, see WM-6, Hazardous Waste Management. Have hazardous waste hauled to an appropriate disposal and/or recycling facility.

- Salvage or recycle useful vegetation debris, packaging and surplus building materials when practical. For example, trees and shrubs from land clearing can be used as a brush barrier, or converted into wood chips, then used as mulch on graded areas. Wood pallets, cardboard boxes, and construction scraps can also be recycled.

Costs

All of the above are low cost measures.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.

- Inspect BMPs subject to non-stormwater discharge daily while non-stormwater discharges occur

- Inspect construction waste area regularly.

- Arrange for regular waste collection.

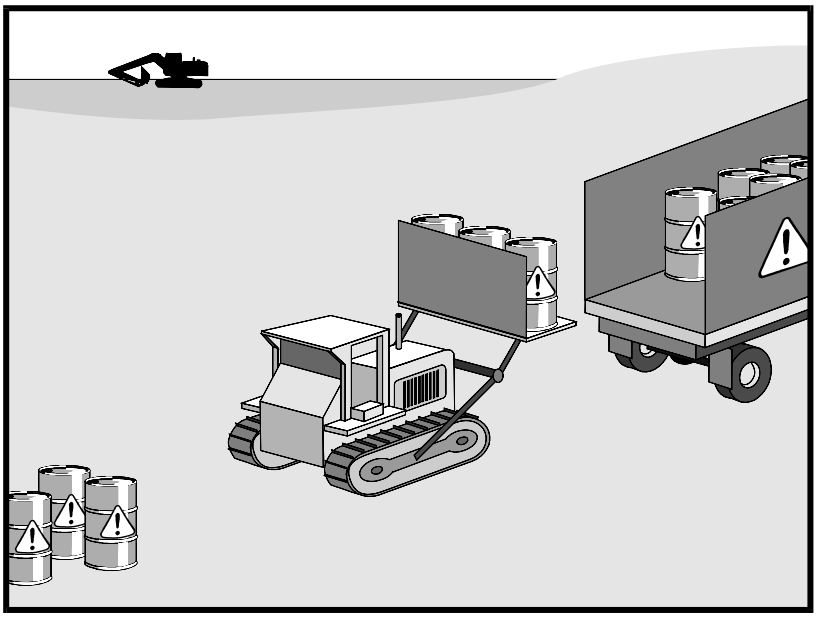
References

Processes, Procedures and Methods to Control Pollution Resulting from All Construction Activity, 430/9-73-007, USEPA, 1973.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Hazardous Waste Management WM-6



Categories

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	☑
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

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Description and Purpose

Prevent or reduce the discharge of pollutants to stormwater from hazardous waste through proper material use, waste disposal, and training of employees and subcontractors.

Suitable Applications

This best management practice (BMP) applies to all construction projects. Hazardous waste management practices are implemented on construction projects that generate waste from the use of:

- Petroleum Products
- Concrete Curing Compounds
- Palliatives
- Septic Wastes
- Stains
- Wood Preservatives
- Asphalt Products
- Pesticides
- Acids
- Paints
- Solvents
- Roofing Tar
- Any materials deemed a hazardous waste in California, Title 22 Division 4.5, or listed in 40 CFR Parts 110, 117, 261, or 302

In addition, sites with existing structures may contain wastes, which must be disposed of in accordance with federal, state, and local regulations. These wastes include:

- Sandblasting grit mixed with lead-, cadmium-, or chromium-based paints
- Asbestos
- PCBs (particularly in older transformers)

Limitations

- Hazardous waste that cannot be reused or recycled must be disposed of by a licensed hazardous waste hauler.
- Nothing in this BMP relieves the contractor from responsibility for compliance with federal, state, and local laws regarding storage, handling, transportation, and disposal of hazardous wastes.
- This BMP does not cover aerially deposited lead (ADL) soils. For ADL soils refer to WM-7, Contaminated Soil Management.

Implementation

The following steps will help reduce stormwater pollution from hazardous wastes:

Material Use

- Wastes should be stored in sealed containers constructed of a suitable material and should be labeled as required by Title 22 CCR, Division 4.5 and 49 CFR Parts 172, 173, 178, and 179.
- All hazardous waste should be stored, transported, and disposed as required in Title 22 CCR, Division 4.5 and 49 CFR 261-263.
- Waste containers should be stored in temporary containment facilities that should comply with the following requirements:
  - Temporary containment facility should provide for a spill containment volume equal to 1.5 times the volume of all containers able to contain precipitation from a 25 year storm event, plus the greater of 10% of the aggregate volume of all containers or 100% of the capacity of the largest tank within its boundary, whichever is greater.
  - Temporary containment facility should be impervious to the materials stored there for a minimum contact time of 72 hours.
  - Temporary containment facilities should be maintained free of accumulated rainwater and spills. In the event of spills or leaks, accumulated rainwater and spills should be placed into drums after each rainfall. These liquids should be handled as a hazardous waste unless testing determines them to be non-hazardous. Non-hazardous liquids should be sent to an approved disposal site.
  - Sufficient separation should be provided between stored containers to allow for spill cleanup and emergency response access.

- Incompatible materials, such as chlorine and ammonia, should not be stored in the same temporary containment facility.
- Throughout the rainy season, temporary containment facilities should be covered during non-working days, and prior to rain events. Covered facilities may include use of plastic tarps for small facilities or constructed roofs with overhangs.

- Drums should not be overfilled and wastes should not be mixed.
- Unless watertight, containers of dry waste should be stored on pallets.
- Do not over-apply herbicides and pesticides. Prepare only the amount needed. Follow the recommended usage instructions. Over application is expensive and environmentally harmful. Apply surface dressings in several smaller applications, as opposed to one large application. Allow time for infiltration and avoid excess material being carried offsite by runoff. Do not apply these chemicals just before it rains. People applying pesticides must be certified in accordance with federal and state regulations.
- Paint brushes and equipment for water and oil based paints should be cleaned within a contained area and should not be allowed to contaminate site soils, watercourses, or drainage systems. Waste paints, thinners, solvents, residues, and sludges that cannot be recycled or reused should be disposed of as hazardous waste. When thoroughly dry, latex paint and paint cans, used brushes, rags, absorbent materials, and drop cloths should be disposed of as solid waste.
- Do not clean out brushes or rinse paint containers into the dirt, street, gutter, storm drain, or stream. “Paint out” brushes as much as possible. Rinse water-based paints to the sanitary sewer. Filter and reuse thinners and solvents. Dispose of excess oil-based paints and sludge as hazardous waste.
- The following actions should be taken with respect to temporary contaminant:
  - Ensure that adequate hazardous waste storage volume is available.
  - Ensure that hazardous waste collection containers are conveniently located.
  - Designate hazardous waste storage areas onsite away from storm drains or watercourses and away from moving vehicles and equipment to prevent accidental spills.
  - Minimize production or generation of hazardous materials and hazardous waste on the job site.
  - Use containment berms in fueling and maintenance areas and where the potential for spills is high.
  - Segregate potentially hazardous waste from non-hazardous construction site debris.
  - Keep liquid or semi-liquid hazardous waste in appropriate containers (closed drums or similar) and under cover.

- Clearly label all hazardous waste containers with the waste being stored and the date of accumulation.
- Place hazardous waste containers in secondary containment.
- Do not allow potentially hazardous waste materials to accumulate on the ground.
- Do not mix wastes.
- Use all of the product before disposing of the container.
- Do not remove the original product label; it contains important safety and disposal information.

Waste Recycling Disposal

- Select designated hazardous waste collection areas onsite.
- Hazardous materials and wastes should be stored in covered containers and protected from vandalism.
- Place hazardous waste containers in secondary containment.
- Do not mix wastes, this can cause chemical reactions, making recycling impossible and complicating disposal.
- Recycle any useful materials such as used oil or water-based paint.
- Make sure that toxic liquid wastes (used oils, solvents, and paints) and chemicals (acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris.
- Arrange for regular waste collection before containers overflow.
- Make sure that hazardous waste (e.g., excess oil-based paint and sludge) is collected, removed, and disposed of only at authorized disposal areas.

Disposal Procedures

- Waste should be disposed of by a licensed hazardous waste transporter at an authorized and licensed disposal facility or recycling facility utilizing properly completed Uniform Hazardous Waste Manifest forms.
- A Department of Health Services certified laboratory should sample waste to determine the appropriate disposal facility.
- Properly dispose of rainwater in secondary containment that may have mixed with hazardous waste.
- Attention is directed to "Hazardous Material", "Contaminated Material", and "Aerially Deposited Lead" of the contract documents regarding the handling and disposal of hazardous materials.

Education

- Educate employees and subcontractors on hazardous waste storage and disposal procedures.
- Educate employees and subcontractors on potential dangers to humans and the environment from hazardous wastes.
- Instruct employees and subcontractors on safety procedures for common construction site hazardous wastes.
- Instruct employees and subcontractors in identification of hazardous and solid waste.
- Hold regular meetings to discuss and reinforce hazardous waste management procedures (incorporate into regular safety meetings).
- The contractor's superintendent or representative should oversee and enforce proper hazardous waste management procedures and practices.
- Make sure that hazardous waste is collected, removed, and disposed of only at authorized disposal areas.
- Warning signs should be placed in areas recently treated with chemicals.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- If a container does spill, clean up immediately.

Costs

All of the above are low cost measures.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events..
- Inspect BMPs subject to non-stormwater discharge daily while non-stormwater discharges occur
- Hazardous waste should be regularly collected.
- A foreman or construction supervisor should monitor onsite hazardous waste storage and disposal procedures.
- Waste storage areas should be kept clean, well organized, and equipped with ample cleanup supplies as appropriate for the materials being stored.
- Perimeter controls, containment structures, covers, and liners should be repaired or replaced as needed to maintain proper function.

- Hazardous spills should be cleaned up and reported in conformance with the applicable Material Safety Data Sheet (MSDS) and the instructions posted at the project site.
- The National Response Center, at (800) 424-8802, should be notified of spills of federal reportable quantities in conformance with the requirements in 40 CFR parts 110, 117, and 302. Also notify the Governors Office of Emergency Services Warning Center at (916) 845-8911.
- A copy of the hazardous waste manifests should be provided.

References

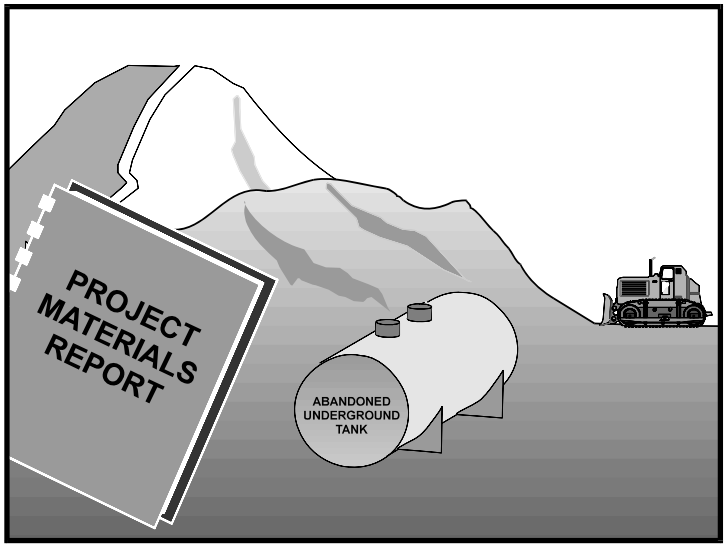
Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Processes, Procedures and Methods to Control Pollution Resulting from All Construction Activity, 430/9-73-007, USEPA, 1973.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Contaminated Soil Management WM-7



Categories		
EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:
☑ **Primary Objective**
☒ **Secondary Objective**

Targeted Constituents	
Sediment	
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	☑
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Prevent or reduce the discharge of pollutants to stormwater from contaminated soil and highly acidic or alkaline soils by conducting pre-construction surveys, inspecting excavations regularly, and remediating contaminated soil promptly.

Suitable Applications

Contaminated soil management is implemented on construction projects in highly urbanized or industrial areas where soil contamination may have occurred due to spills, illicit discharges, aerial deposition, past use and leaks from underground storage tanks.

Limitations

Contaminated soils that cannot be treated onsite must be disposed of offsite by a licensed hazardous waste hauler. The presence of contaminated soil may indicate contaminated water as well. See NS-2, Dewatering Operations, for more information.

The procedures and practices presented in this BMP are general. The contractor should identify appropriate practices and procedures for the specific contaminants known to exist or discovered onsite.

Implementation

Most owners and developers conduct pre-construction environmental assessments as a matter of routine. Contaminated soils are often identified during project planning and development with known locations identified in the plans, specifications and in the SWPPP. The contractor should review applicable reports and investigate appropriate call-outs in the

plans, specifications, and SWPPP. Recent court rulings holding contractors liable for cleanup costs when they unknowingly move contaminated soil highlight the need for contractors to confirm a site assessment is completed before earth moving begins.

The following steps will help reduce stormwater pollution from contaminated soil:

- Conduct thorough, pre-construction inspections of the site and review documents related to the site. If inspection or reviews indicated presence of contaminated soils, develop a plan before starting work.
- Look for contaminated soil as evidenced by discoloration, odors, differences in soil properties, abandoned underground tanks or pipes, or buried debris.
- Prevent leaks and spills. Contaminated soil can be expensive to treat and dispose of properly. However, addressing the problem before construction is much less expensive than after the structures are in place.
- The contractor may further identify contaminated soils by investigating:
  - Past site uses and activities
  - Detected or undetected spills and leaks
  - Acid or alkaline solutions from exposed soil or rock formations high in acid or alkaline forming elements
  - Contaminated soil as evidenced by discoloration, odors, differences in soil properties, abandoned underground tanks or pipes, or buried debris.
  - Suspected soils should be tested at a certified laboratory.

Education

- Have employees and subcontractors complete a safety training program which meets 29 CFR 1910.120 and 8 CCR 5192 covering the potential hazards as identified, prior to performing any excavation work at the locations containing material classified as hazardous.
- Educate employees and subcontractors in identification of contaminated soil and on contaminated soil handling and disposal procedures.
- Hold regular meetings to discuss and reinforce disposal procedures (incorporate into regular safety meetings).

Handling Procedures for Material with Aerially Deposited Lead (ADL)

- Materials from areas designated as containing (ADL) may, if allowed by the contract special provisions, be excavated, transported, and used in the construction of embankments and/or backfill.
- Excavation, transportation, and placement operations should result in no visible dust.
- Caution should be exercised to prevent spillage of lead containing material during transport.

- Quality should be monitored during excavation of soils contaminated with lead.

Handling Procedures for Contaminated Soils

- Minimize onsite storage. Contaminated soil should be disposed of properly in accordance with all applicable regulations. All hazardous waste storage will comply with the requirements in Title 22, CCR, Sections 66265.250 to 66265.260.
- Test suspected soils at an approved certified laboratory.
- Work with the local regulatory agencies to develop options for treatment or disposal if the soil is contaminated.
- Avoid temporary stockpiling of contaminated soils or hazardous material.
- Take the following precautions if temporary stockpiling is necessary:
  - Cover the stockpile with plastic sheeting or tarps.
  - Install a berm around the stockpile to prevent runoff from leaving the area.
  - Do not stockpile in or near storm drains or watercourses.
- Remove contaminated material and hazardous material on exteriors of transport vehicles and place either into the current transport vehicle or into the excavation prior to the vehicle leaving the exclusion zone.
- Monitor the air quality continuously during excavation operations at all locations containing hazardous material.
- Procure all permits and licenses, pay all charges and fees, and give all notices necessary and incident to the due and lawful prosecution of the work, including registration for transporting vehicles carrying the contaminated material and the hazardous material.
- Collect water from decontamination procedures and treat or dispose of it at an appropriate disposal site.
- Collect non-reusable protective equipment, once used by any personnel, and dispose of at an appropriate disposal site.
- Install temporary security fence to surround and secure the exclusion zone. Remove fencing when no longer needed.
- Excavate, transport, and dispose of contaminated material and hazardous material in accordance with the rules and regulations of the following agencies (the specifications of these agencies supersede the procedures outlined in this BMP):
  - United States Department of Transportation (USDOT)
  - United States Environmental Protection Agency (USEPA)
  - California Environmental Protection Agency (CAL-EPA)

- California Division of Occupation Safety and Health Administration (CAL-OSHA)
- Local regulatory agencies

Procedures for Underground Storage Tank Removals

- Prior to commencing tank removal operations, obtain the required underground storage tank removal permits and approval from the federal, state, and local agencies that have jurisdiction over such work.
- To determine if it contains hazardous substances, arrange to have tested, any liquid or sludge found in the underground tank prior to its removal.
- Following the tank removal, take soil samples beneath the excavated tank and perform analysis as required by the local agency representative(s).
- The underground storage tank, any liquid or sludge found within the tank, and all contaminated substances and hazardous substances removed during the tank removal and transported to disposal facilities permitted to accept such waste.

Water Control

- All necessary precautions and preventive measures should be taken to prevent the flow of water, including ground water, from mixing with hazardous substances or underground storage tank excavations. Such preventative measures may consist of, but are not limited to, berms, cofferdams, grout curtains, freeze walls, and seal course concrete or any combination thereof.
- If water does enter an excavation and becomes contaminated, such water, when necessary to proceed with the work, should be discharged to clean, closed top, watertight transportable holding tanks, treated, and disposed of in accordance with federal, state, and local laws.

Costs

Prevention of leaks and spills is inexpensive. Treatment or disposal of contaminated soil can be quite expensive.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Arrange for contractor's Water Pollution Control Manager, foreman, and/or construction supervisor to monitor onsite contaminated soil storage and disposal procedures.
- Monitor air quality continuously during excavation operations at all locations containing hazardous material.
- Coordinate contaminated soils and hazardous substances/waste management with the appropriate federal, state, and local agencies.

- Implement WM-4, Spill Prevention and Control, to prevent leaks and spills as much as possible.

References

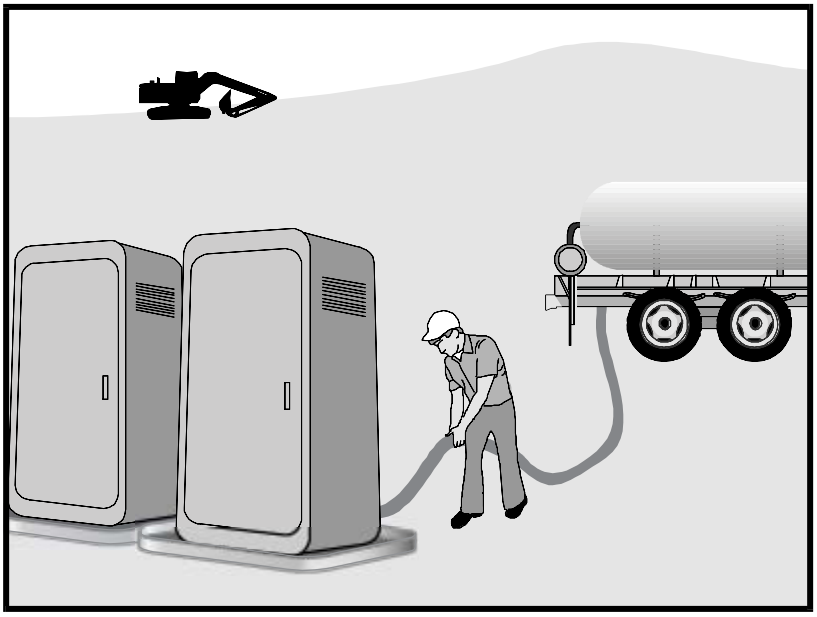
Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Processes, Procedures and Methods to Control Pollution Resulting from All Construction Activity, 430/9-73-007, USEPA, 1973.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Sanitary/Septic Waste Management WM-9



Description and Purpose

Proper sanitary and septic waste management prevent the discharge of pollutants to stormwater from sanitary and septic waste by providing convenient, well-maintained facilities, and arranging for regular service and disposal.

Suitable Applications

Sanitary septic waste management practices are suitable for use at all construction sites that use temporary or portable sanitary and septic waste systems.

Limitations

None identified.

Implementation

Sanitary or septic wastes should be treated or disposed of in accordance with state and local requirements. In many cases, one contract with a local facility supplier will be all that it takes to make sure sanitary wastes are properly disposed.

Storage and Disposal Procedures

- Temporary sanitary facilities should be located away from drainage facilities, watercourses, and from traffic circulation. If site conditions allow, place portable facilities a minimum of 50 feet from drainage conveyances and traffic areas. When subjected to high winds or risk of high winds, temporary sanitary facilities should be secured to prevent overturning.

Categories

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	
Nutrients	☑
Trash	☑
Metals	
Bacteria	☑
Oil and Grease	
Organics	☑

Potential Alternatives

None

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- Temporary sanitary facilities must be equipped with containment to prevent discharge of pollutants to the stormwater drainage system of the receiving water.
- Consider safety as well as environmental implications before placing temporary sanitary facilities.
- Wastewater should not be discharged or buried within the project site.
- Sanitary and septic systems that discharge directly into sanitary sewer systems, where permissible, should comply with the local health agency, city, county, and sewer district requirements.
- Only reputable, licensed sanitary and septic waste haulers should be used.
- Sanitary facilities should be located in a convenient location.
- Temporary septic systems should treat wastes to appropriate levels before discharging.
- If using an onsite disposal system (OSDS), such as a septic system, local health agency requirements must be followed.
- Temporary sanitary facilities that discharge to the sanitary sewer system should be properly connected to avoid illicit discharges.
- Sanitary and septic facilities should be maintained in good working order by a licensed service.
- Regular waste collection by a licensed hauler should be arranged before facilities overflow.
- If a spill does occur from a temporary sanitary facility, follow federal, state and local regulations for containment and clean-up.

Education

- Educate employees, subcontractors, and suppliers on sanitary and septic waste storage and disposal procedures.
- Educate employees, subcontractors, and suppliers of potential dangers to humans and the environment from sanitary and septic wastes.
- Instruct employees, subcontractors, and suppliers in identification of sanitary and septic waste.
- Hold regular meetings to discuss and reinforce the use of sanitary facilities (incorporate into regular safety meetings).
- Establish a continuing education program to indoctrinate new employees.

Costs

All of the above are low cost measures.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Arrange for regular waste collection.
- If high winds are expected, portable sanitary facilities must be secured with spikes or weighed down to prevent over turning.
- If spills or leaks from sanitary or septic facilities occur that are not contained and discharge from the site, non-visible sampling of site discharge may be required. Refer to the General Permit or to your project specific Construction Site Monitoring Plan to determine if and where sampling is required.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

APPENDIX 3

REFERENCES

REFERENCE DOCUMENTS

Amboy Limestone Quarry
San Bernardino, CA

- *Amended Reclamation Plan, Amboy Limestone Quarry*, May 2015, Sespe Consulting

- *General Biological Resource Assessment Report, Omya Amboy Limestone Quarry*, June 2014, Himes Consulting, L.L.C

- *Hydrology Study & Drainage Analysis (Preliminary)*, September 2015, Joseph E. Bonadiman & Associates, Inc.

- *Jurisdictional Delineation Report, Omya Arizona Inc., Amboy Limestone Quarry*, July 2014, Himes Consulting, L.L.C.

- *National Pollutant Discharge Elimination System (NPDES) General Permit for Storm Water Discharges Associated with Industrial Activities, Order NPDES No. CAS000001*, April 1, 2014, State Water Resources Control Board (State Water Board)

- *Slope Stability Investigation, proposed Reclamation Plan, Amboy Mine*, January 27, 2015, CHJ Consultants

- *Stormwater Best Management Practice Handbook Portal: Construction*, 2010, California Stormwater Quality Association (CASQA)

APPENDIX L

Notice of Non-Applicability (NONA)

SESPE
CONSULTING, INC.
5920 Friars Road, Suite 103 • San Diego, CA 92108
Office (619) 894-8669 • Fax (805) 667-8104

No Impact Technical Report
Omya Amboy Quarry

April 1, 2015

A Jurisdictional Delineation Report was prepared by Himes Consulting, LLC (Attachment 1) which states:

> "Surface water from the site flows downstream towards Bristol Lake, a dry lakebed south of the project site. As these waters collect and evaporate at Bristol Lake, they are considered isolated and do not connect to downstream navigable waters. Therefore these washes are not subject to federal jurisdiction under Section 404 of the Clean Water Act. A letter from the US Army Corps of Engineers dated December 3, 1996, confirms that the original project did not discharge into waters of the U.S." (Page 9, Attachment 1).

The US Army Corps of Engineers letter is provided in Attachment 2.

Based on information presented above and attached, the Omya Amboy facility is located in basins or other physical locations that are not hydrologically connected to waters of the United States. Therefore, as provided for by the Industrial General Permit (2014-0057-DWQ) Section XX.C, a Notice of Non-Applicability (NONA) has been filed with the State Water Resources Control Board.

Scott D. Cohen
California Professional Engineer (M30545)

JURISDICTIONAL DELINEATION REPORT

OMYA ARIZONA INC.
AMBOY LIMESTONE QUARRY

SAN BERNARDINO COUNTY, CALIFORNIA

Prepared for:

OMYA, Inc.
9987 Carver Road, Suite 300
Cincinnati, OH 45242
(513) 387-4696

Prepared by:

Himes Consulting, L.L.C.
3301 West Genoa Way
Chandler, AZ 85226
(480) 899-5708 ph.
(602) 499-9253 mobile

Project Number 14-08

July 2014

INTRODUCTION

The Amboy Limestone Quarry, operated by OMYA, Inc. (OMYA) is located approximately 6 miles northeast of Amboy in San Bernardino County, California. OMYA is in the process of amending their existing Mine Reclamation Plan to expand the permitted boundary and to include a buffer area around their existing limestone quarry operations. Himes Consulting, L.L.C. conducted a survey of potential jurisdictional waters on May 26-27, 2014.

A Streambed Alteration Agreement (No. 5-443-96) was received on January 9, 1997 for the original quarry operations. This agreement was renewed and extended until 2012. Under this agreement, approximately 0.2 acres have already been disturbed.

PROJECT DESCRIPTION AND LOCATION

Project Location. The Amboy Limestone Quarry has been mined by OMYA since 1996. The site is located approximately 6 miles northeast of the town of Amboy, approximately 10 miles south of Interstate 40, 3 miles north of Route 66 (National Trails Highway), and just west of Kelbaker Road (Figures 1 and 2). The project site is located in Section 30, Township 6 North, Range 13 East (San Bernardino Baseline and Meridian). Orange Blossom Wash lies approximately 3 miles to the northeast of the intersection of Kelbaker Road and the mine access road. The quarry lies at the southern tip of the Bristol Mountains, to the west of the Marble Mountains, and north of Bristol Lake.

Project Description. OMYA currently quarries a limestone deposit of exceptionally pure crystalline limestone, suitable for food grade products and supplements. Current disturbance within their property boundary is approximately 69 acres. Future disturbances include continuation of use of the overburden was pile (within original permit boundaries), expansion of the existing quarry to the northeast, and expansion of the eastern stockpile area. Total future disturbances are 11 acres. OMYA proposes to include a buffer area around their existing limestone quarry operations for a total of approximately 200 acres.

ENVIRONMENTAL SETTING

Existing Conditions. The quarry is located at the southern tip of the southern Bristol Mountains. Terrain at the project site contains large areas of very steep, nearly vertical, and rugged rock outcrops with little vegetation. Lower elevations within the property consist of large expanses of desert pavement and creosote bush flats interspersed with ephemeral drainages. Elevations within the property range from approximately 1,900

feet (ft) above mean sea level (msl) in the northwest portion of the property to approximately 350 ft above msl at Kelbaker Road.

Hydrology. The project site is located within the Southern Mojave watershed (Hydrologic Unit Code 18100100). Average annual precipitation is less than 1.5 inches in the region. Ephemeral washes within the project vicinity flow to the south-southwest to Bristol Lake, a dry lake, where they evaporate.

Vegetation. Vegetation communities within the project site consist of creosote bush (*Larrea tridentata*), white burr sage (*Ambrosia dumosa*) scrub, brittle bush (*Encelia farinosa*) scrub, and creosote bush – brittle bush scrub. Other shrubs within the project site include burrobrush (*Hymenoclea salsola*), sweetbush *(Bebbia juncea),* saltbush (*Atriplex canescen),* catclaw acacia *(Acacia greggii*), desert lavender (*Hyptis emoryi*), desert trumpet (*Eriogonum inflatum*), smoke tree (*Psorothamnus spinosa*), white ratany (*Krameria grayi*), brittle spineflower (*Chorizanthe brevicornu*), Mormon tea (*Ephedra viridis*), and bladderpod (*Cleome isomeris*). Cacti observed include golden cholla (*Opuntia echinocarpa*), beavertail (*Opuntia basilaris*), barrel cactus (*Ferocactus acanthodes*), diamond cholla (*Opuntia ramosissima*), pincushion cactus (*Mammillaria* sp.), and hedgehog cactus (*Echinocereus* sp.).

METHODS

Himes Consulting LLC conducted field measurements of ephemeral washes within the Amboy Limestone Quarry permitting boundary at regular intervals using a measuring tape on May 26 and 27, 2013. Prior to the field survey, recent aerial photographs were reviewed and assessed to evaluate potential waters present within the project site.

RESULTS

Federal Jurisdiction

Surface water from the site flows downstream towards Bristol Lake, a dry lakebed south of the project site. As these waters collect and evaporate at Bristol Lake, they are considered isolated and do not connect to downstream navigable waters. Therefore these washes are not subject to federal jurisdiction under Section 404 of the Clean Water Act. A letter from the US Army Corps of Engineers dated December 3, 1996, confirms that the original project did not discharge into waters of the U.S.

State Jurisdiction

Waters of the state are regulated by the California Department of Fish & Wildlife under Section 1600-1616 of the California Fish and Game Code (1602 Permit) and the Colorado River Basin Regional Water Quality Control Board (RWQCB) (waste discharge).

Jurisdictional waters are shown in Figure 3. A total of approximately 1.76 acres of waters of the State under the jurisdiction of the CDFW and Colorado River Basin RWQCB are estimated to occur within the permit boundary (see Figure 3), including along the existing access road. All of these are ephemeral washes which flow only in direct response to storm events. Of this total, approximately 0.2 acres have already been disturbed under Streambed Alteration Agreement No. 5-443-96.

TABLE 1
JURISDICTIONAL DELINEATION SUMMARY
OMY AMBOY LIMESTONE QUARRY

DRAINAGE	SQUARE FEET
A	9800
B	2900
C	1000
D	800
E	1625
F	810
G	1900
H	10750
I	1400
J	1400
K	840
L	1120
M	2660
N1	980
N2	840
N3	980
N4	2660
O	2520
P	26400
P1	5250
TOTAL	**76635**

TABLE 2

Jurisdictional Delineation - OMYA Amboy Limestone Quarry

Wash A

Meas.	Feet	Sq. Feet
0	6	
400	8	2800
650	10	2250
1000	8	3150
1200	8	1600
Total		9800

Wash B

Meas.	Feet	Sq. Feet
0	5	
200	3	800
800	4	1400
1000	3	700
Total		2900

Wash C

Meas.	Feet	Sq. Feet
0	3	
200	2	500
400	3	500
Total		1000

Wash D

Meas.	Feet	Sq. Feet
0	8	
100	8	800
Total		800

Wash E

Meas.	Feet	Sq. Feet
0	5	
250	8	1625
Total		1625

Wash F

Meas.	Feet	Sq. Feet
0	4	
180	5	810
Total		810

Wash G

Meas.	Feet	Sq. Feet
0	2	
200	5	700
500	3	1200
Total		1900

Wash H

Meas.	Feet	Sq. Feet
0	3	
500	16	4750
1000	8	6000
Total		10750

Wash I

Meas.	Feet	Sq. Feet
0	10	
140	10	1400
Total		1400

Wash J

Meas.	Feet	Sq. Feet
0	10	
140	10	1400
Total		1400

Wash K

Meas.	Feet	Sq. Feet
0	6	
140	6	840
Total		840

Wash L

Meas.	Feet	Sq. Feet
0	8	
140	8	1120
Total		1120

Wash M

Meas.	Feet	Sq. Feet
0	19	
140	19	2660
Total		2660

Wash N1

Meas.	Feet	Sq. Feet
0	7	
140	7	980
Total		980

Wash N2

Meas.	Feet	Sq. Feet
0	6	
140	6	840
Total		840

Wash N3

Meas.	Feet	Sq. Feet
0	7	
140	7	980
Total		980

Wash N4

Meas.	Feet	Sq. Feet
0	19	
140	19	2660
Total		2660

Wash O

Meas.	Feet	Sq. Feet
0	18	
140	18	2520
Total		2520

Wash P

Meas.	Feet	Sq. Feet
0	2	
400	10	2400
800	20	6000
1500	30	7500
1800	40	10500
Total		26400

Wash P1

Meas.	Feet	Sq. Feet
0	1	
500	20	5250
Total		5250
Total area		76635
Total disturbed area		8400

APPENDIX A
MAPS

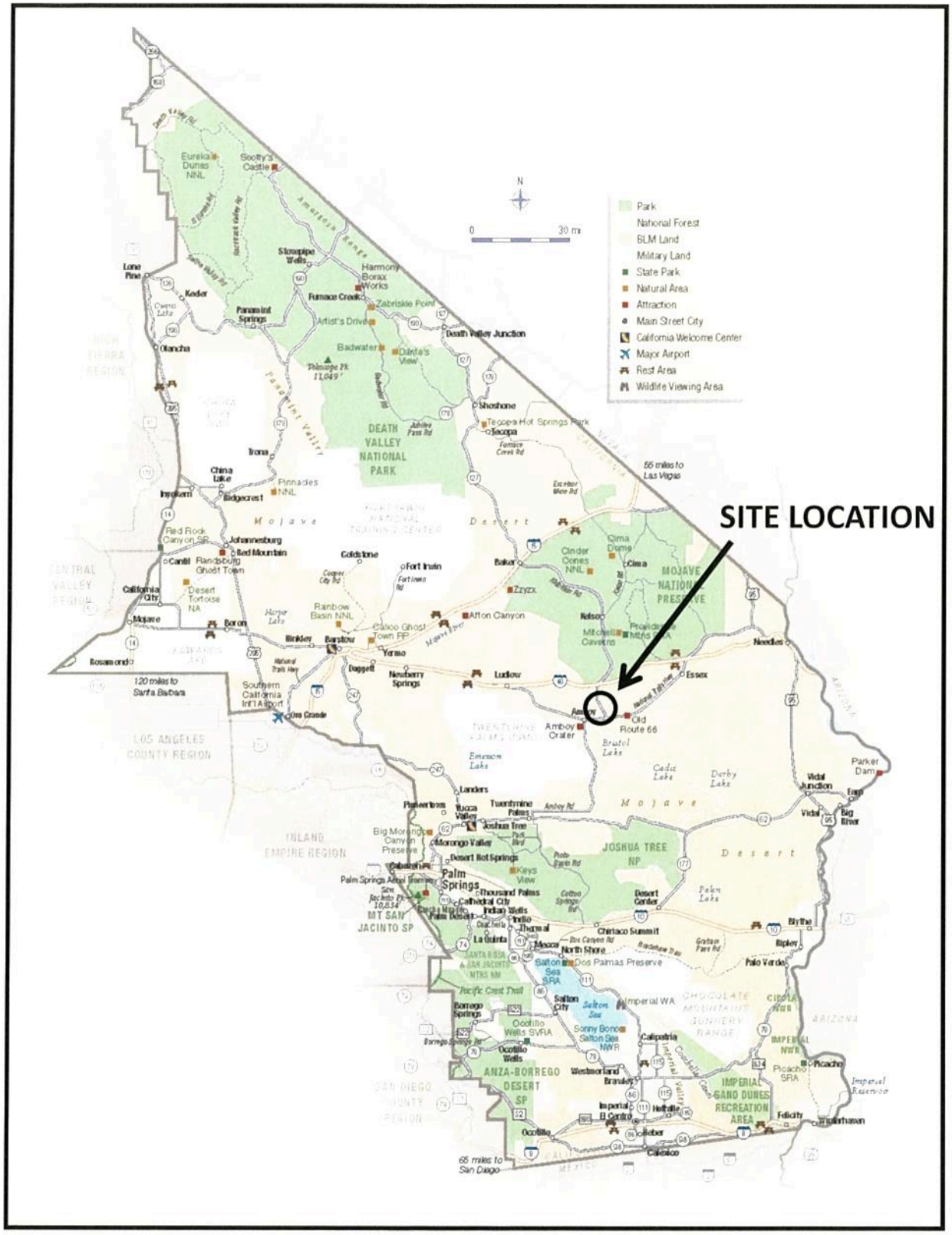


Figure 1. State Vicinity Map. OMYA Amboy Quarry. San Bernardino County, CA. Data source: www.visitcalifornia.com

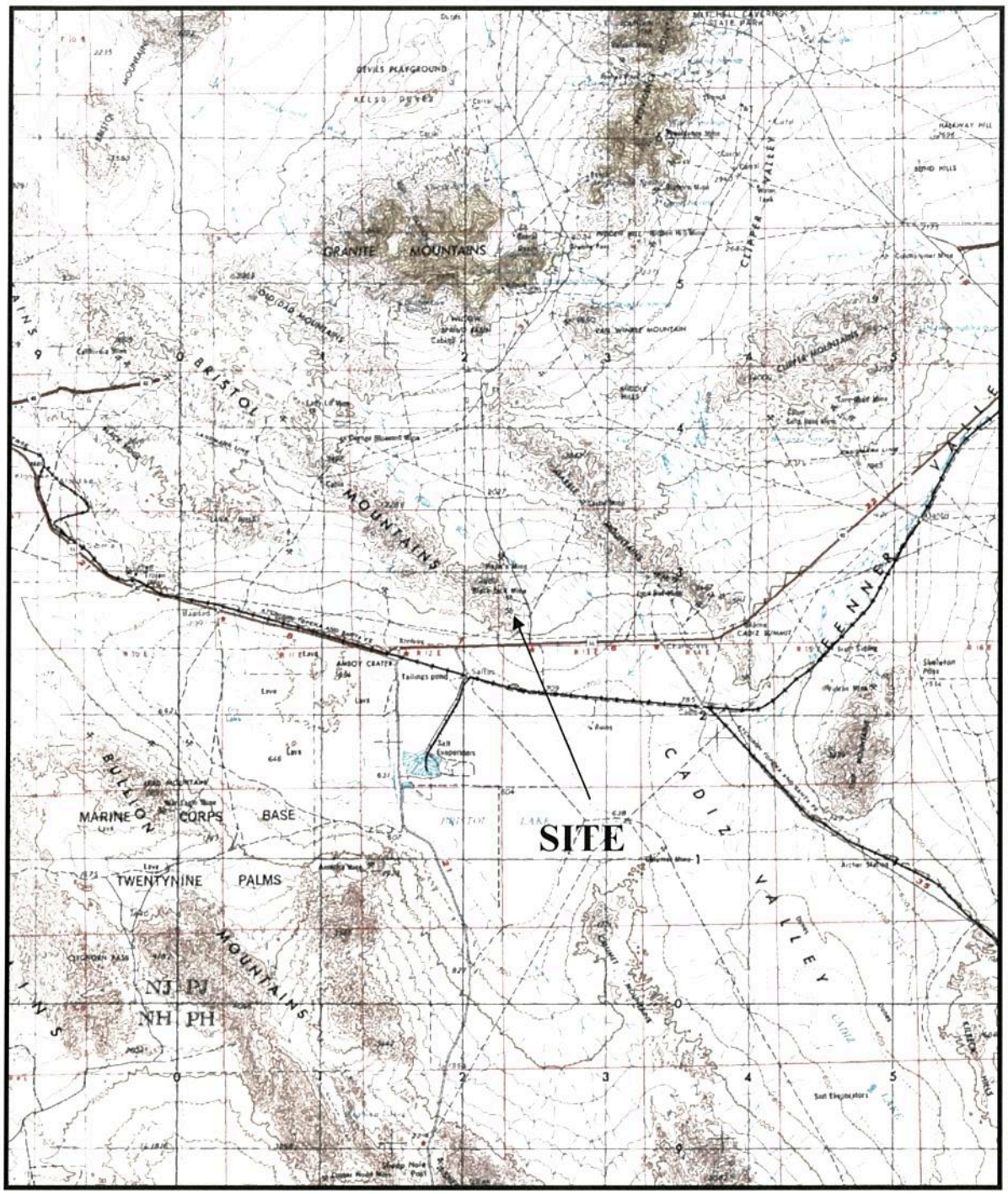


Figure 2. Vicinity Map.
OMYA Amboy Quarry.
USGS 1:250,000 Scale Topo Map: Needles, Calif.-AZ (1969)

0 2 miles

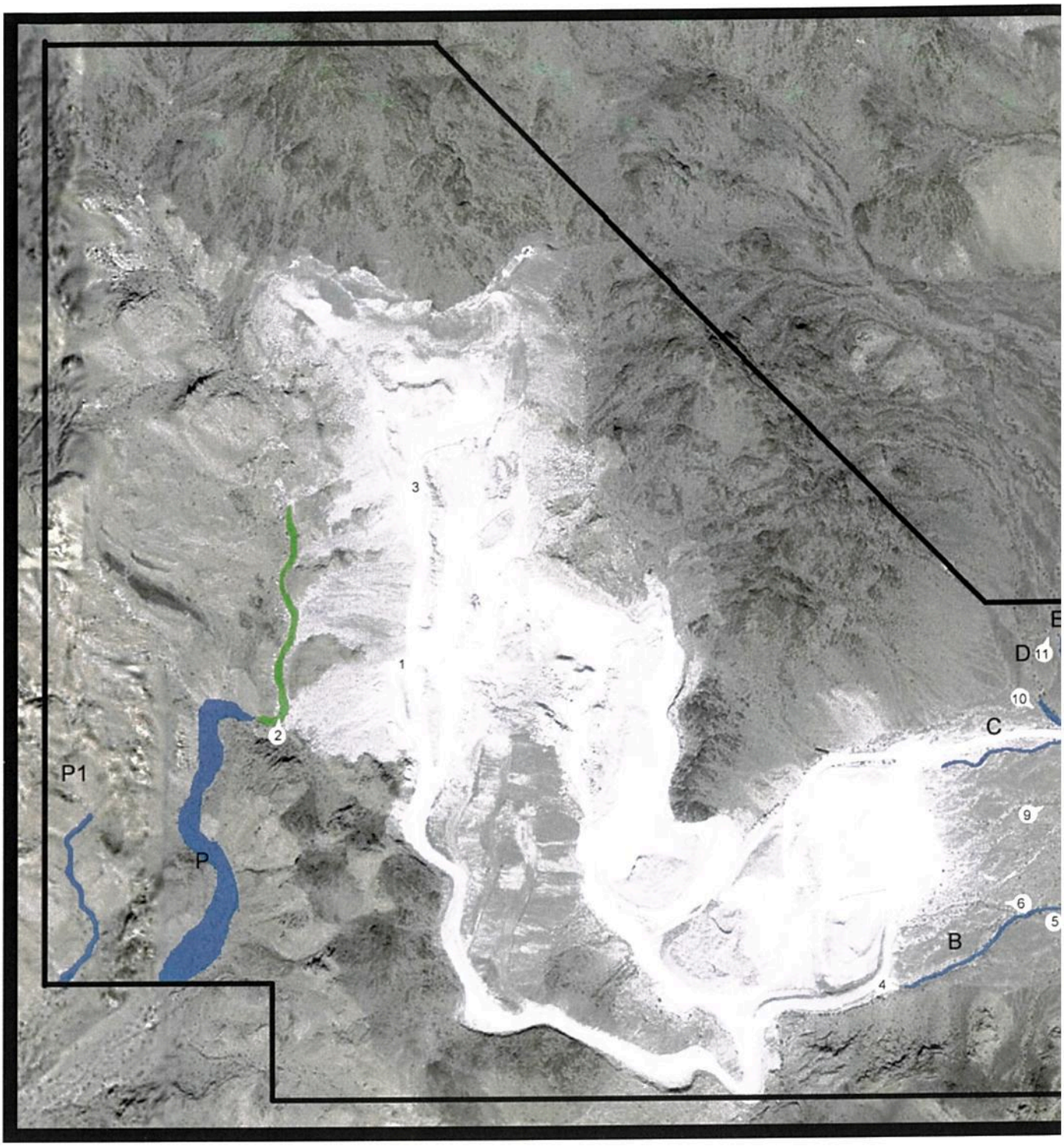
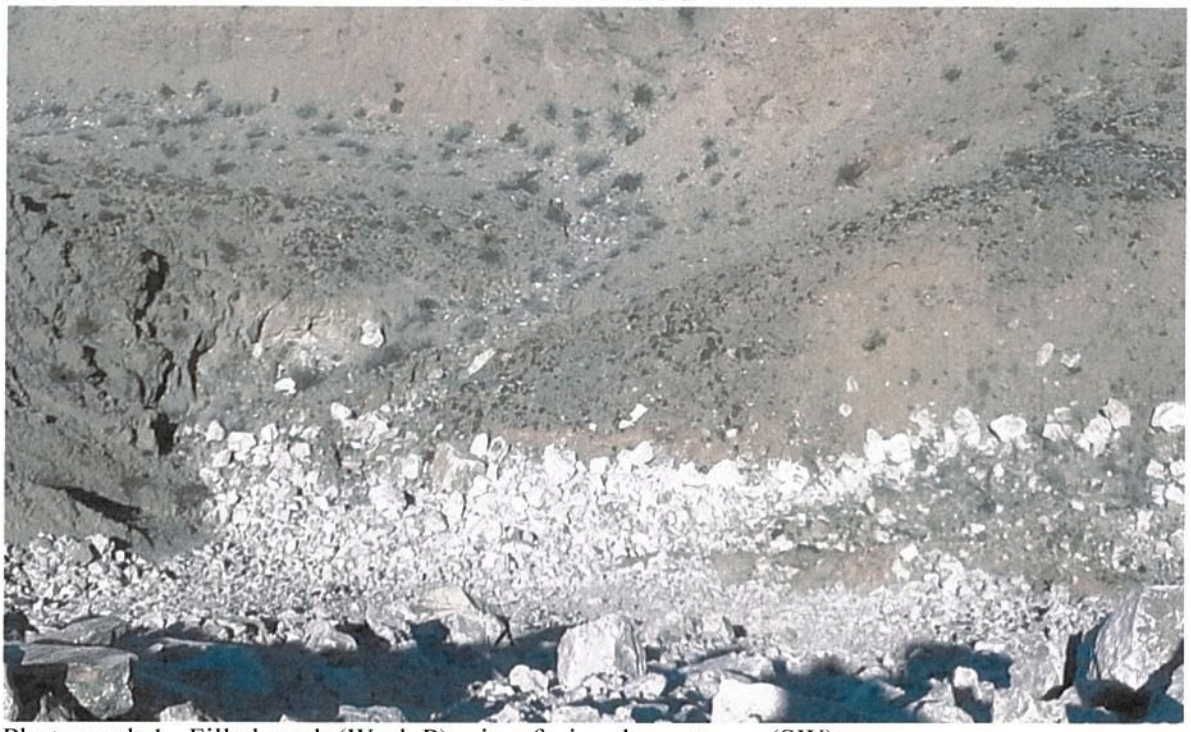


Figure 3. Jurisdictional Waters
OMYA Amboy Limestone Quarry

APPENDIX B

PHOTOGRAPH LOG

PHOTOGRAPH LOG



Photograph 1. Filled wash (Wash P); view facing downstream (SW).

Photograph 2. Filled wash, view facing upstream (N).

Photograph 3. Upstream end of Wash P (rock outcrop drop-off); view facing upstream.

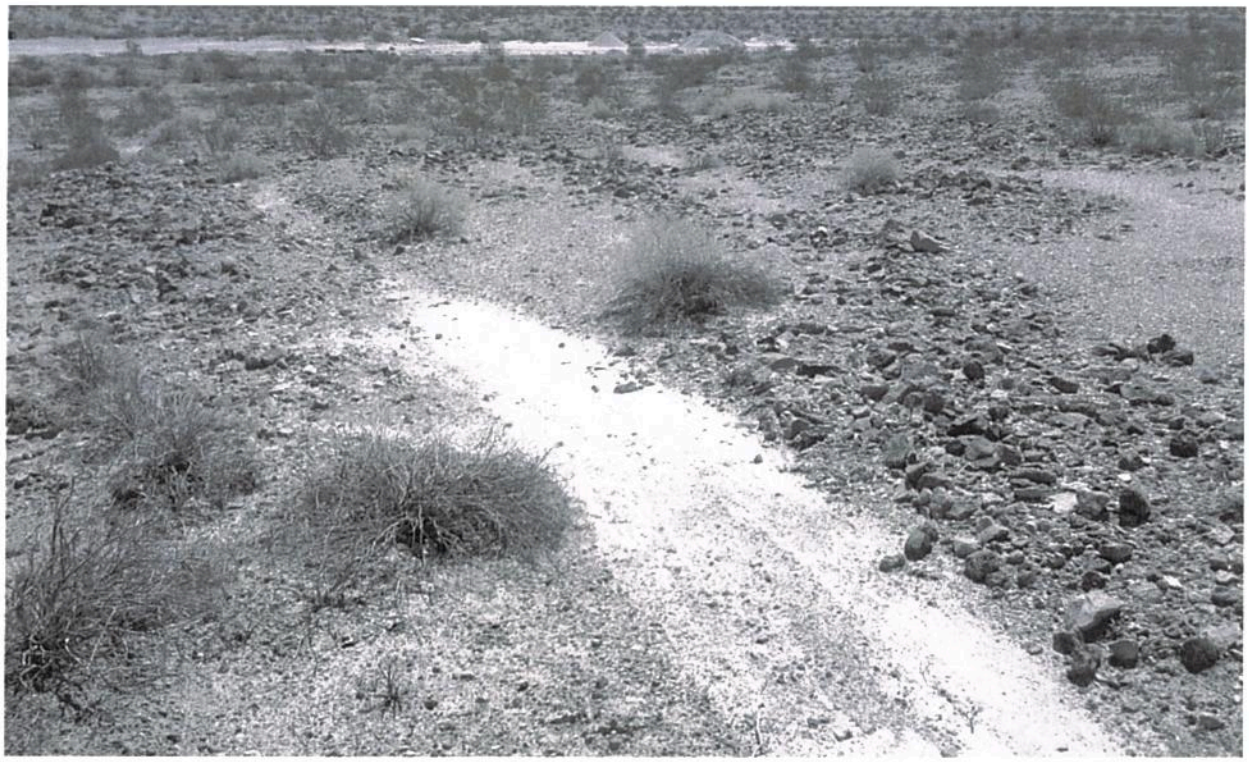
Photograph 4. View of Wash B, culverted, facing downstream. Streambed and bank visible.

Photograph 5. Wash B, view facing downstream.

Photograph 6. Small topographic change but no streambed or bank observed, vegetation is homogeneous; view facing W.

Photograph 7. No streambed and homogenous vegetation observed, view facing NW.

Photograph 8. Example of small topographic rills or swales with no jurisdictional waters observed.



Photograph 9. Example of deposited dust in low topographical area; no waters, bed, or bank observed.

Photograph 10. Drainage D, 8' wide; view facing downstream.

Photograph 11. Wash E, 8' wide, view facing upstream

Photograph 12. Wash E, view facing upstream.

Photograph 13. Wash A, view facing downstream.

Photograph 14. Wash M, view facing upstream.

Photograph 15. Tributary N1, view facing upstream.

Photograph 16. Tributary N2, view facing upstream

DEPARTMENT OF THE ARMY
LOS ANGELES DISTRICT, CORPS OF ENGINEERS
SEVEN OAKS DAM RESIDENT OFFICE
32330 SANTA ANA CANYON ROAD
HIGHLAND, CALIFORNIA 92346

REPLY TO
ATTENTION OF:

DEC - 3 1997

Office of the Chief
Regulatory Branch

Mr. George A. Webber
Webber & Webber Mining Consultants, Inc.
1323 Colton Ave., Suite 217
Redlands, California 92374

Dear Mr. Webber:

Reference is made to your application (No. 97-30008-AJS) dated November 5, 1996 for a Department of the Army Permit to establish a 73-acre limestone quarry near Amboy, San Bernardino County, California. The application was submitted on behalf of Pluess-Staufer (California), Inc.

Based on the information furnished in your application and a site visit with our staff, we have determined that your proposed project does not discharge dredged or fill material into a water of the United States or an adjacent wetland. Therefore, the project is not subject to our jurisdiction under Section 404 of the Clean Water Act and a Section 404 permit is not required from our office.

The receipt of your application is appreciated. If you have any questions, please contact Antal Szijj of my staff at (909) 794-7704.

Sincerely,

Mark Durham

Mark Durham
Chief, South Coast Section
Regulatory Branch

APPENDIX M

Revegetation Plan Update
September 2014

REVEGETATION PLAN UPDATE

OMYA AMBOY LIMESTONE QUARRY

Amboy USGS 7.5' quadrangle
Section 30, Township 6 North Range 13 East
CA Mine ID Number 91-36-0140
APN 558-151-10 and 558-151-11

SAN BERNARDINO COUNTY, CALIFORNIA

Prepared for:

OMYA, Inc.
9987 Carver Road, Suite 300
Cincinnati, OH 45242
(513) 387-4696

Prepared by:

Himes Consulting, L.L.C.
3301 West Genoa Way
Chandler, AZ 85226
(480) 899-5708 ph. (602) 499-9253 mobile

Project Number 14-08

September 2014

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1.0 INTRODUCTION

This Revegetation Plan is prepared in support of the reclamation of the Amboy limestone quarry, operated by OMYA, Inc (OMYA). The Amboy quarry lies approximately 6 miles northeast of Amboy in San Bernardino County, California (Figures 1 and 2). OMYA is in the process of amending their existing Mine Reclamation Plan to expand the permitted boundary and to include a buffer area around their existing limestone quarry operations. Current disturbance within their property boundary is approximately 69 acres (Figure 3). Future disturbances include expansion of the western overburden area, expansion of the existing quarry to the northeast, and expansion of the eastern stockpile area. Total future disturbances are approximately 14 acres.

Revegetation and reclamation information was provided in the Plan of Operations and Reclamation Plan (1996). In addition, a Revegetation Plan was prepared for the project by Biological Resource Specialists (January 1998). This Revegetation Plan combines and summarizes elements from both sources to provide definitive revegetation guidelines as requested by the Office of Mine Reclamation in support of the revised Plan of Operations and Reclamation Plan (Sespe Consulting 2014).

2.0 EXISTING CONDITIONS

2.1 VEGETATION

The project site is located within the Mojave Desert geographical region. Vegetation within the project area is sparse due in part to the very arid climate and the presence of desert pavement. Vegetation within the project site is characterized by three plant communities that most closely correspond with Sawyer et. al's (2009) creosote bush–white bursage scrub community, brittle bush scrub, and creosote bush-brittle bush scrub (Himes Consulting LLC, 2014).

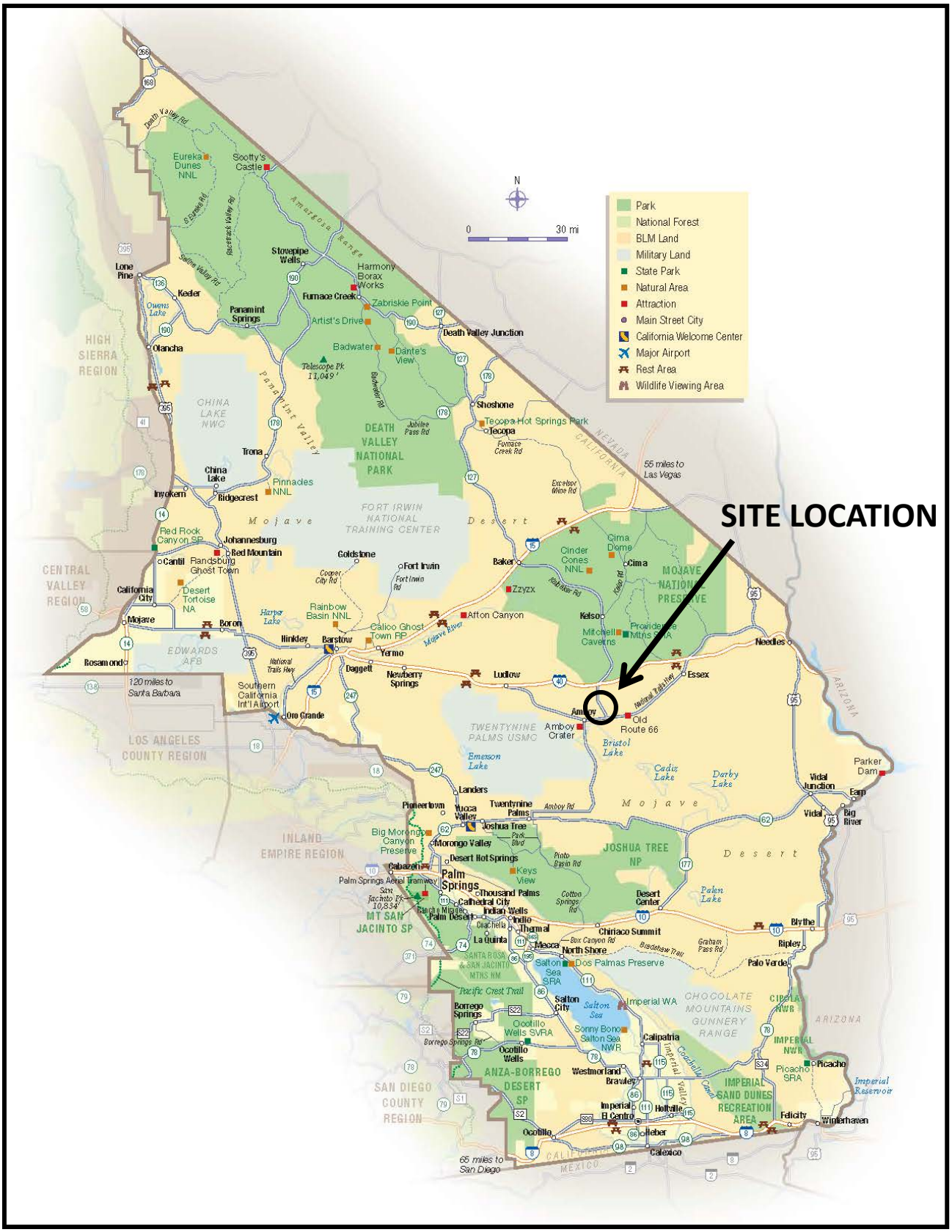

Figure 1. State Vicinity Map. OMYA Amboy Quarry. San Bernardino County, CA. Data source: www.visitcalifornia.com

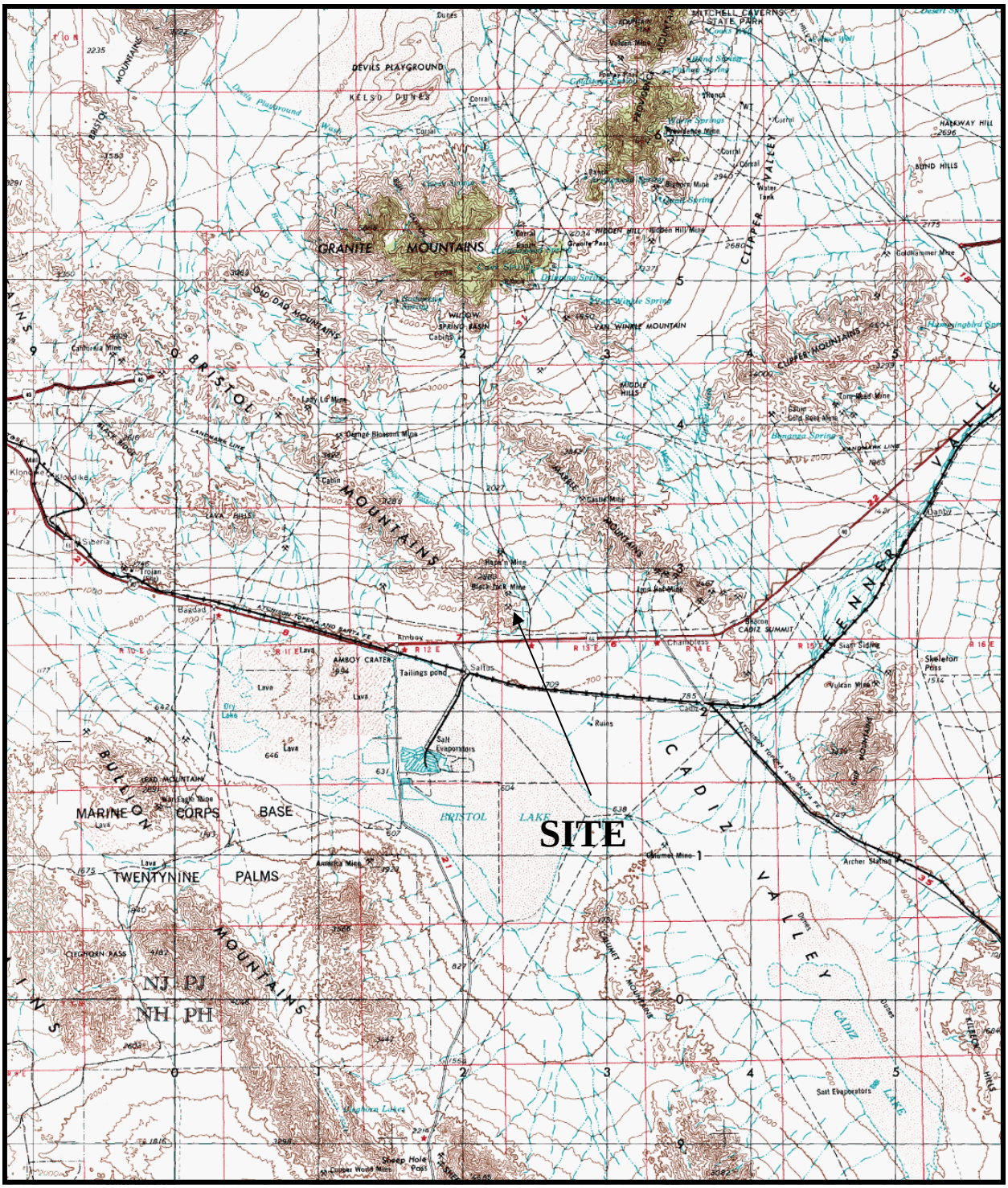

Figure 2. Vicinity Map.
OMYA Amboy Quarry.
USGS 1:250,000 Scale Topo Map: Needles, Calif.-AZ (1969)

0 2 miles

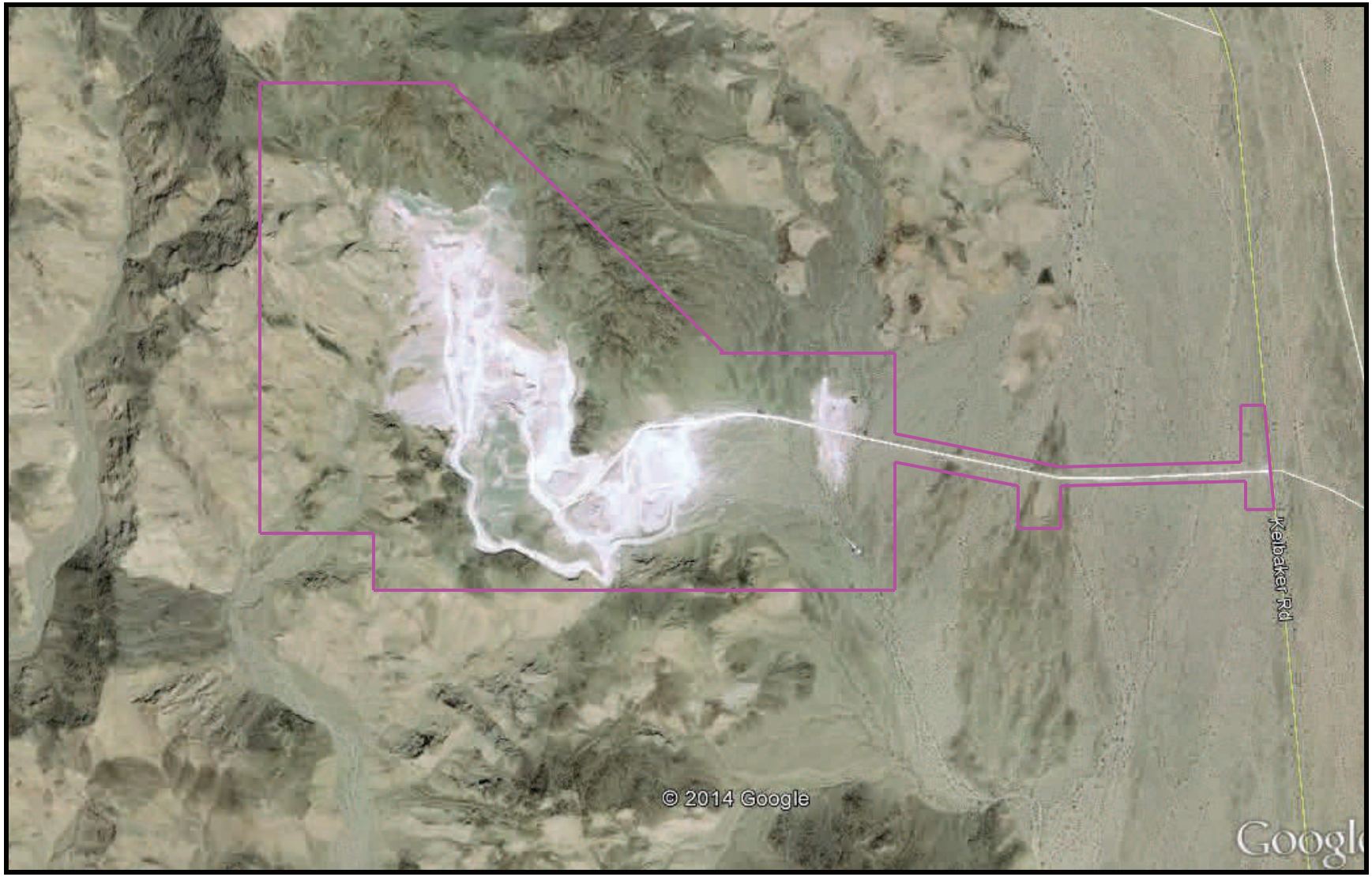

Figure 3. Existing Quarry Conditions and Permit Boundary. OMYA Amboy Quarry. Google Aerial Photograph. 2014.

0 1000 ft

2.2 EXISTING VEGETATIVE COVER

2.3.1 Methods

Baseline vegetation transects were conducted by Biological Resource Specialists (1998) prior to development of the quarry by OMYA to document vegetative species density and diversity in undisturbed areas. Forty non-intercepting 50 meters x 1 meter belt transects were established within three areas of the project site. This baseline transect data was used to provide information for revegetation goals and seeding mix and rate.

2.3.2 Results

Total cover for all 40 transects averaged 10.62 percent with a species diversity of 16. Ninety-four percent of the relative ground cover was found from the following three species: creosotebush (*Larrea tridentata*), rayless encelia (*Encelia fructescens*), and white bursage (*Ambrosia dumosa*).

3.0 REVEGETATION PLAN

3.1 REVEGETATION GOAL

The goal of revegetation at the Amboy quarry is to establish a vegetation cover on disturbed areas that is equivalent to 80 percent of the native plant cover. Vegetation transects indicate that the total cover averages 10.62. The revegetation goal is then 8.5 percent cover. The revegetation plan to achieve this goal is described below.

3.2 METHODS

Successful revegetation will be accomplished using common revegetation techniques as described below.

3.2.1 Site Preparation

Following recontouring as directed by the Reclamation Plan, compacted areas will be scarified to a depth of at least one foot. Accessible benches and pit bottoms will be scarified to aid in revegetation prior to receiving growth medium.

3.2.2 Growth Medium

Availability of growth medium is limited at the quarry, as portions of the site are bedrock outcroppings with limited soil. Prior to mining, top soil will be salvaged to the extent possible and placed in the growth media storage site, located on approximately 4 acres in the southeast portion of the quarry. As growth medium is limited, available stockpiled growth medium will be applied in irregularly-shaped islands 2-3 feet thick. Accessible benches with the most visibility will receive the highest priority for growth media placement. Benches with no visibility, at the lower elevations or those that face to the west, will receive growth medium as possible based on supply.

3.2.3 Cactus Salvage

Individual cactus plants within the 11 acres of undisturbed areas proposed for disturbance will be salvaged where possible during their dormant season (September through February) and taken to a nursery area for long-term holding. North-facing sides of each side will be marked. Salvaged cacti will then be transplanted for revegetation after seeding at a rate of 5 cacti per acre or as available.

3.2.4 Planting

Planting will be achieved by broadcast seeding. Seeds collected from the surrounding area will be used in the seeding effort, supplemented with purchased seed if needed. Pure live seed will be dispersed using a mechanical broadcast seeder. The seeded areas will be chain-dragged to achieve soil coverage of seeds. Natural colonization will supplement the revegetation efforts to promote long-term habitat productivity for the area.

3.2.5 Season

Site preparation will occur in the fall, immediately prior to planting. Seeding will occur in late October or early November with plant growth occurring in the spring when temperature and moisture conditions are optimal.

3.3 SEED TYPES AND AMOUNTS

A seed mix was designed for the project site by to promote a plant community similar to that found in undisturbed areas. This seed mix will serve as a guideline for the revegetation plant community. However, final plant selection will occur at closure and will be based on availability, success rates, and cost. Seed types, amounts, and costs are provided by vegetation type in Tables 1-3 below. Slight variations are provided by vegetation type, however, overall vegetation communities are similar in species type and diversity. In addition, cacti will be transplanted to all areas at a rate of 5 plants per acre.

TABLE 1
CREOSOTEBUSH - WHITE BURSAGE SCRUB SEED MIX

COMMON NAME	SCIENTIFIC NAME	LBS/ACRE (PLS)
Creosotebush	*Larrea tridentata*	10
White bursage	*Ambrosia dumosa*	2
Cheesebush	*Hymenoclea salsola*	2
Rayless encelia	*Enclia frutescens*	1
Desert lavender	*Hyptis emoryi*	1
Wire lettuce	*Stephanomeria pauciflora*	2
Bladderpod	*Isomeris arborea*	0.5
Prickly poppy	*Argemone munica*	1
Desert dandelion	*Malacothrix glabrata*	1
Evening primrose	*Camissonia claviformis*	1
Yellow cups	*Camissonia brevipes*	0.5
Purple heather	*Krameria erecta*	0.5
Desert trumpet	*Eriogonum inflatum*	2
Total		**24.5**

TABLE 2
CREOSOTEBUSH - BRITTLE BUSH SCRUB SEED MIX

COMMON NAME	SCIENTIFIC NAME	LBS/ACRE (PLS)
Creosotebush	*Larrea tridentata*	4
White bursage	*Ambrosia dumosa*	2
Cheesebush	*Hymenoclea salsola*	2
Rayless encelia	*Encelia frutescens*	4
Brittlebush	*Encelia farinosa*	4
Wire lettuce	*Stephanomeria pauciflora*	2
Desert lavender	*Hyptis emoryi*	1
Prickly poppy	*Argemone munica*	1
Desert trumpet	*Eriogonum inflatum*	2
Total		**22**

TABLE 3
BRITTLE BUSH SCRUB SEED MIX

COMMON NAME	SCIENTIFIC NAME	LBS/ACRE (PLS)
Creosotebush	*Larrea tridentata*	2
White bursage	*Ambrosia dumosa*	2
Cheesebush	*Hymenoclea salsola*	2
Rayless encelia	*Encelia frutescens*	6
Brittlebush	*Encelia farinosa*	6
Pygmy cedar	*Peucephyllum schottii*	1
Wire lettuce	*Stephanomeria pauciflora*	2
Desert lavender	*Hyptis emoryi*	1
Prickly poppy	*Argemone munica*	1
Desert trumpet	*Eriogonum inflatum*	2
Total		**25**

3.4 REVEGETATION AMENDMENTS AND SUPPLEMENTAL IRRIGATION

No irrigation is proposed at this time, based on native conditions. Normal precipitation should be sufficient to provide seed germination and root establishment of native species. The planting season was selected to maximize the amount of rainfall potential for germination and growth, encouraging long-term revegetation success. Irrigation is not

proposed so as to discourage growth of non-native invasive species. Fertilizer will be applied on an as-needed basis.

3.5 MAINTENANCE & MONITORING

Periodic inspections of the revegetation efforts will occur for approximately five years during the establishment of the seedlings as part of ongoing reclamation maintenance, or until reclamation goals have been met. Maintenance seeding will be conducted in sparse areas if needed during this period. Manual removal of weeds such as Russian thistle (*Salsola kali*) will be conducted during the maintenance period.

Revegetation success will be assessed by conducting transects (50 m x 1 m) within each vegetative community type to evaluate density. Revegetation shall be deemed successful if it has reached 8.5 percent total cover or greater on an average property-wide basis. If vegetative cover has not reached this goal, continued maintenance seeding and monitoring will be conducted annually until the goal is achieved.

4.0 REFERENCES

Biological Resource Specialists, 1998. Revegetation Plan for the Pleuss-Staufer (California) Inc. Amboy Limestone Quarry, Bristol Mountains, San Bernardino County, CA. January.

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APPENDIX N

Financial Assurance Cost Estimate
(previously provided)