PRELIMINARY

Hydrology Study & Flood Analysis

Sigma Clay Mine Project

Sec. 28, T.6N, R.2W, S.B.M.
County of San Bernardino, CA
APN 0464-022-54-0000

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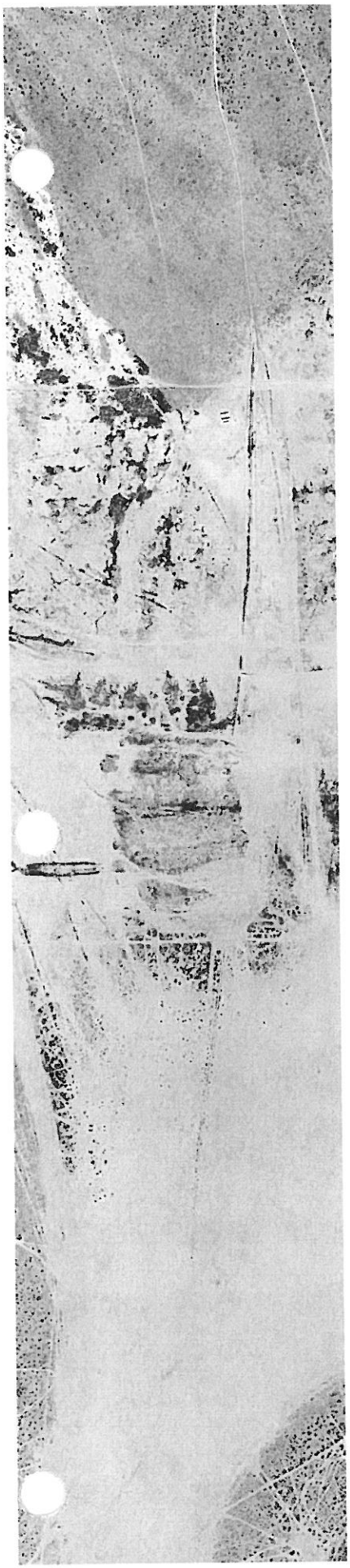

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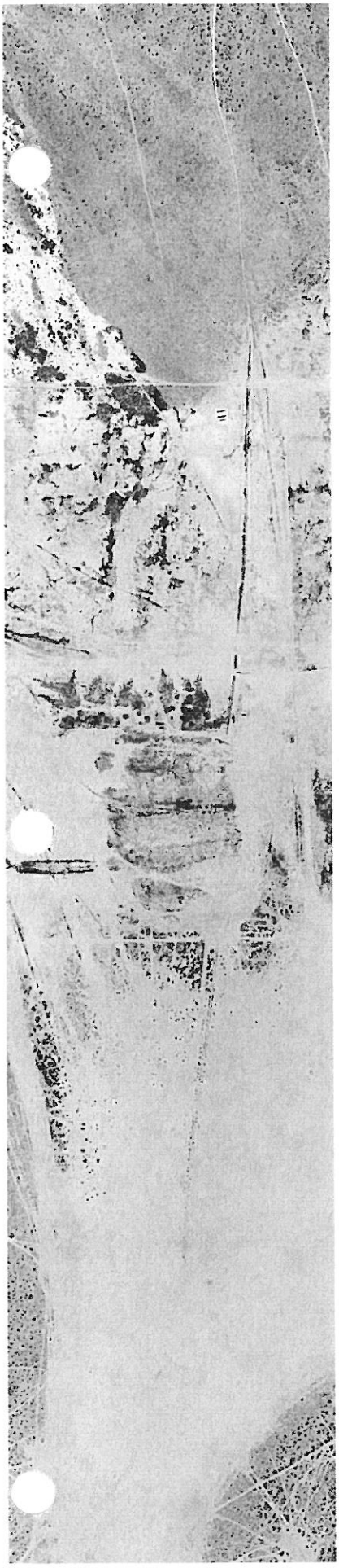

Exhibits

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NRCS Web Soils Survey Map/Data	"B"
Hydrology Study Map	"C"
FLO-2D Analysis – 100-Year, 24-Hour Maximum Flow Depths	"D.1"
FLO-2D Analysis – 100-Year, 24-Hour Maximum Flow Velocities	"D.2"
FLO-2D Analysis – 100-Year, 5-Day Maximum Flow Depths	"E.1"
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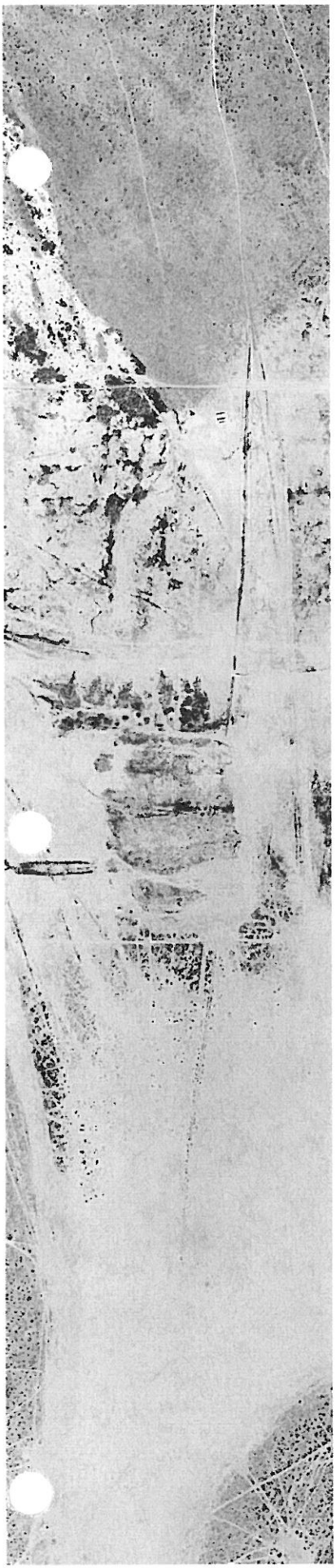

Attachments

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Preliminary Hydrology Study & Flood Analysis

A. Introduction

1.1 Purpose & Scope

The following Preliminary Hydrology Study & Flood Analysis has been prepared to examine 100-Year Flood impacts to the approximately 40.80-acre Sigma Clay Mine project in San Bernardino County pursuant to the request of Webber & Webber Mining Consultants, Inc.

The scope of this Analysis is as follows:

- Identification of tributary watershed to the proposed Sigma Clay Mine project site.
- Calculation of 100-year, 24-hour and 100-year, 5-day storm peak flows and runoff volumes for the identified tributary watershed.
- FLO-2D floodplain simulations for the 100-year, 24-hour and 100-year, 5-day storm events.
- Analysis of maximum flood depths and maximum flood velocities for the 100-year, 24-hour and 100-year, 5-day storm events, assuming ultimate mine excavation to 40 feet.
- Identification of Federal Emergency Management Agency (FEMA) floodplain(s) impacting the site, if any.

1.2 Project Overview

The proposed project site (approximately 40.80 acres) is located near Lucerne Valley in the High Desert of San Bernardino County, Assessor's Parcel Number (APN) 0464-022-54-0000, in Section 28 of Township 6 North, Range 2 West, San Bernardino Meridian. The project site is located within the Fairview Dry Lake and is impacted by several significant blue line streams/washes.

Based on the conceptual plans provided by Webber & Webber (see *Attachment No. 2*), the proposed Sigma Clay Mine will have an ultimate excavation of 40-feet deep at 3:1 side slopes. Per the conceptual plans, drainage or flood protection improvements are limited to 4-foot berms along the perimeter of the mine.

1.3 References

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

1.) San Bernardino County Hydrology Manual, August 1986.

2.) San Bernardino County Hydrology Manual Addendum, April 2010.

3.) NOAA Atlas 14, 2006.

4.) NRCS Soil Survey for San Bernardino County, CA, Mojave River Area, V. 5, September 26, 2008.

5.) FLO-2D User's Manual, October 2004.

6.) FEMA Flood Insurance Rate Map (FIRM) Panel No. 06071C5875H (Undated/Unpublished).

B. Methodology

1.1 General Methodology

The requirements and recommendations found in the San Bernardino County Flood Control District (SBCFCD) Hydrology Manual (August 1986), in conjunction with the SBCFCD Hydrology Manual Addendum dated April 2010 (see *Attachment No. 1*), were used as the basis for the Unit Hydrograph hydrology calculations in this Analysis.

1.2 Watershed Precipitation

Per the recommendation of the Hydrology Manual Addendum, NOAA Atlas 14 100-year rainfall depth values were used in lieu of the isohyetal maps found in the Hydrology Manual. These values were area-averaged for the study watershed, and are tabulated below:

Table 1 – Area-Averaged Water Precipitation (NOAA Atlas 14)

STORM FREQUENCY	DURATION	AREA-AVERAGED PRECIPITATION (IN)
100-YEAR	1-HOUR	1.45
	6-HOUR	2.78
	24-HOUR	4.96

Refer to *Exhibit "A"* for the NOAA Atlas 14 isohyetals used for the area-averaged precipitation values tabulated above.

1.3 Watershed Losses

Per the recommendation of the Hydrology Manual Addendum NRCS soil survey data (see *Exhibit "B"*) was used in lieu of the soils maps found in the Hydrology Manual. This data was used in conjunction with the SCS tables included in the Hydrology Manual to produce the area-averaged SCS values tabulated below:

Table 2 – Area-Averaged Watershed SCS Curve No. Values (AMC II)

% OF WATERSHED	APPROX. ACREAGE	RUNOFF INDEX COVER TYPE	HYDROLOGIC GROUP	COVER QUALITY	SCS CURVE NO.
36%	4,090.68	OPEN BRUSH	A	POOR	62
12%	1,363.56	OPEN BRUSH	B	POOR	76
8%	909.04	OPEN BRUSH	C	POOR	84
44%	4,999.72	BARREN (ROCKLAND)	D	N/A	93

Per the Antecedent Moisture Condition (AMC) Map included with the Hydrology Manual Addendum, AMC III was used for the unit hydrograph calculations in this Analysis.

1.4 Topography

The following topographic data was utilized in this Analysis:

- USGS Quadrangle raster data obtained from the USGS Seamless Data Distribution Server were used for identification of the watershed tributary to the project site and for elevation values used in all hydrograph calculations.
- 1/3 meter Digital Elevation Model (DEM) data obtained from the USGS Seamless Data Distribution Server was used for generation of a.) The elevation grid used for FLO-2D analyses, and b.) Associated topographic contours shown on the FLO-2D results exhibits included in this Analysis.

1.5 Flood Analysis (FLO-2D)

The recommendations of the FLO-2D User's Manual (2004) were used as the basis for the flood analyses of this Analysis. A 50-foot grid was generated using the DEM discussed in Section 1.4, above (this existing topographic surface was altered to include the approximately 40-acre excavated mine, 40-feet deep at 3:1 uniform slopes, and a 4-foot berm around the perimeter of the mine).

Two flood analyses were performed, for the 100-year, 24-hour event (total simulation duration of 28.822 hours) and the 100-year, 5-day event (total simulation duration of 124.70 hours).

C. Hydrology Calculations

The project site is located within the Fairview Dry Lake Bed. This bed is impacted by an approximately 11,363 –acre tributary watershed. Hydrograph input data pertaining to this watershed is tabulated as follows:

Table 3 – Unit Hydrograph Input Values (Watershed)

DRAINAGE AREA	SIZE (AC)	PERVIOUS %	LONGEST WATERCOURSE (FT)	LCA (FT)	U.S. ELEV. (FT)	D.S. ELEV. (FT)	CHANGE (FT)	MANNING'S
A	11,363	100%	28,013	8,996	5,200	3,180	2,020	0.035

The resulting hydrograph calculations for the 100-year, 24-hour and 100-year, 5-day storm events are summarized as follows:

Table 4 – Unit Hydrograph Calculations Summary

STORM YEAR	STORM DURATION	TC (HR)	PEAK FLOW (CFS)	TOTAL RUNOFF (AF)
100	24-HOUR	0.627	12,790	3,795
100	5-DAY	0.627	12,790	6,740

Refer to *Attachment No. 3* for the 100-year, 24-hour unit hydrograph calculations. Refer to *Attachment No. 4* for the 100-year, 5-day unit hydrograph calculations. Refer to *Exhibit "C"* for the Hydrology Study Map.

D. Flood Analysis (FLO-2D)

Input data for the 100-year, 24-hour and 100-year, 5-day FLO-2D floodplain simulations is tabulated below:

Table 5 – FLO-2D Flood Analyses Input Data

STORM YEAR	STORM DURATION	SIMULATION DURATION (HR)	SIMULATION STEPS (HR)	SIMULATION SIZE (AC)	GRID SIZE (FT)
100	24-HOUR	28.822	0.0833	2,041	50
100	5-DAY	124.700	0.0833	2,041	50

The results of the 100-year, 24-hour and 100-year, 5-day simulations are summarized as follows:

Table 6 – FLO-2D Flood Analyses Output Summary

STORM YEAR	STORM DURATION	MAXIMUM W.S.E. (FT)	MAXIMUM FLOW DEPTH (FT)	MAXIMUM FLOW VELOCITY (FPS)	MAXIMUM DEPTH ABOVE MINE RIM (FT)	MAXIMUM FLOW VELOCITY WITHIN MINE (FPS)
100	24-HOUR	3,186.89	53.31	19.42	13.31	10.41
100	5-DAY	3,193.56	59.99	25.11	19.99	10.86

Refer to *Attachment No. 5* for the 100-year, 24-hour floodplain simulation calculations. Refer to *Attachment No. 6* for the 100-year, 5-day floodplain simulation calculations. *Exhibit D.1* and *Exhibit D.2* illustrate the 100-year, 24-hour maximum flood depths and 100-year, 24-hour maximum velocities. *Exhibit E.1* and *Exhibit E.2* illustrate the 100-year, 5-day maximum flood depths and 100-year, 5-day maximum velocities.

E. FEMA Floodplain Identification

Pursuant to FEMA Flood Insurance Rate Map (FIRM) Panel No. 06071C5875H (undated and unpublished), the site is located within a Zone "D" floodplain. Zone "D" is defined by FEMA as "Areas with possible but undetermined flood hazards. No flood hazard analysis has been conducted. Flood insurance rates are commensurate with the uncertainty of the flood risk."

Zone D

F. Summary

As illustrated on *Exhibits D.1* and *E.1*, the Fairview Dry Lake Bed acts as a large regional basin for the watershed. This basin has a total capacity of approximately 7,879 acre-feet, and fills to a natural spillway water surface elevation of approximately 3196' prior to discharging to the south. As such, 100% of the total 100-year, 24-hour runoff volume of 3,795 acre-feet, and 100% of the total 100-year, 5-day runoff volume of 6,740 acre-feet, is contained within the basin.

The proposed mine is located near the low point of the existing basin. As such, the proposed mine shows as completely submerged for both analyzed events, with a maximum of 13.31 feet of water over the rim of the

mine for the 100-year, 24-hour event, and a maximum of 19.99 feet above the rim of the mine for the 100-year, 5-day event.

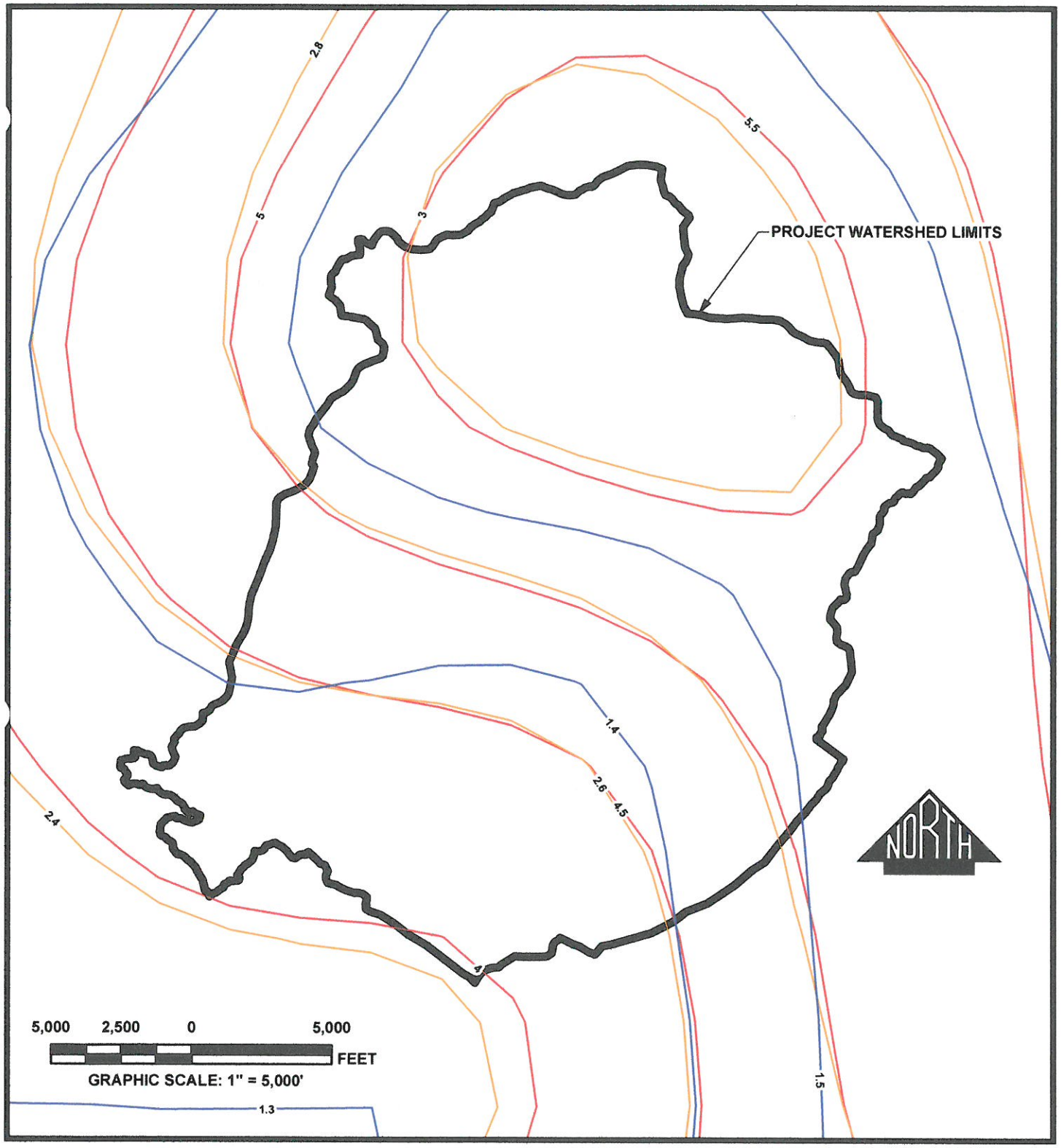
As illustrated on *Exhibits D.2* and *E.2*, the maximum flow velocity within the mine is 10.41 f.p.s. for the 100-year, 24-hour event, and 10.86 f.p.s. for the 100-year, 5-day event.

Note: Refer to *Attachment No. 7* for a CD of this complete Analysis (PDF format).

(END)

EXHIBIT "A"

NOAA Atlas 14 Precipitation



AREA-AVERAGED WATERSHED PRECIPITATION VALUES:

STORM FREQUENCY	DURATION	AREA-AVERAGED PRECIPITATION (IN)
100-YEAR	1-HOUR	1.45
	6-HOUR	2.78
	24-HOUR	4.96

100-YEAR, 1-HOUR
100-YEAR, 6-HOUR
100-YEAR, 24-HOUR

NOAA ATLAS 14 PRECIPITATION
WATERSHED TRIBUTARY TO APN 0464-022-54-0000
IN THE COUNTY OF SAN BERNARDINO, CA

BY	MARK	REVISION DESCRIPTION	DATE
JDN	1	ENTIRE EXHIBIT	10-06-10

PREPARED FOR:	WEBBER & WEBBER
JOB NO:	093543
PREPARED BY:	JDN
CHECKED BY:	JJG

NOAA ATLAS 14 PRECIPITATION
WATERSHED TRIBUTARY TO APN 0464-022-54-0000
IN THE COUNTIES SAN BERNARDINO, CA

DISREGARD PRINTS BEARING EARLIER REVISION DATES ⟹ 10-06-10

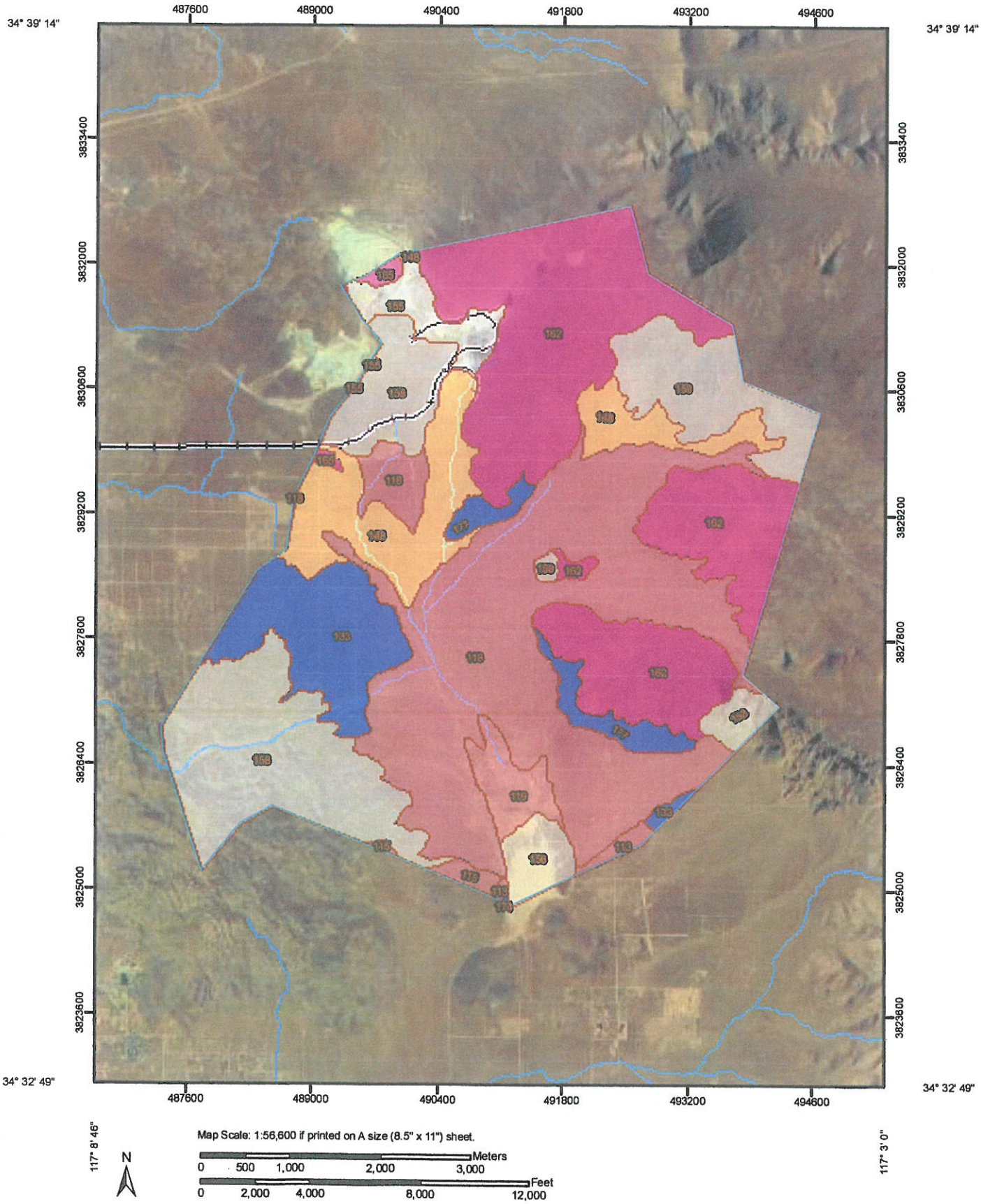
A

SHEET: 1 OF 1

EXHIBIT "B"

NRCS Web Soils Survey Map/Data

EXHIBIT "B"
NRCS WEB SOILS SURVEY MAP/DATA



MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Units

Soil Ratings

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Political Features

- Cities

Water Features

- Oceans
- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads

MAP INFORMATION

Map Scale: 1:56,600 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 11N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: San Bernardino County, California, Mojave River Area
Survey Area Data: Version 5, Sep 26, 2008

Date(s) aerial images were photographed: 6/19/2005

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.

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — San Bernardino County, California, Mojave River Area				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
113	CAJON SAND, 2 TO 9 PERCENT SLOPES	A	43.0	0.5%
115	CAJON GRAVELLY SAND, 2 TO 15 PERCENT SLOPES	A	46.0	0.5%
118	CAJON-ARIZO COMPLEX, 2 TO 15 PERCENT SLOPES*	A	2,656.2	29.1%
119	CAJON-WASCO, COOL COMPLEX, 2 TO 9 PERCENT SLOPES*	A	178.9	2.0%
133	HELENDALE-BRYMAN LOAMY SANDS, 2 TO 5 PERCENT SLOPES*	B	601.4	6.6%
148	MIRAGE SANDY LOAM, 2 TO 5 PERCENT SLOPES*	C	780.4	8.6%
155	PITS		204.7	2.2%
156	PLAYAS		144.1	1.6%
158	ROCK OUTCROP-LITHIC TORRIORTHENTS COMPLEX, 15 TO 50 PERCENT SLOPES*		1,934.2	21.2%
162	SPARKHULE-ROCK OUTCROP COMPLEX, 15 TO 50 PERCENT SLOPES*	D	2,297.1	25.2%
165	TRIGGER-SPARKHULE-ROCK OUTCROP ASSOCIATION, STEEP*	D	32.7	0.4%
174	WASCO SANDY LOAM, COOL, 2 TO 5 PERCENT SLOPES	B	1.4	0.0%
177	YERMO-KIMBERLINA, COOL, ASSOCIATION, SLOPING*	B	201.7	2.2%
Totals for Area of Interest			**9,121.6**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: *None Specified*

Tie-break Rule: Lower

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

CURVE NUMBERS FOR PERVIOUS AREAS

SAN BERNARDINO COUNTY HYDROLOGY MANUAL

FIGURE C-3.1

EXHIBIT "C"

Hydrology Study Map

I. INTRODUCTION

After publication of the NOAA Atlas 14 rainfall atlas and the associated data base (NOAA, 2004, revised 2006), the County of San Bernardino Water Resources Division assessed the new publication towards the possibility of updating its Hydrology Manual (1983, revised 1986), particularly in the arid regions of the County. NOAA Atlas 2 (NOAA, 1973) served as the basis for the San Bernardino Hydrology Manual dated 1986. The updated NOAA Atlas 14 publication includes data from several rain gages which were not available at the time of the prior publication of NOAA Atlas 2, as well as 25 years of additional data at several of the rain gages used in NOAA Atlas 2. Consequently, thousands of additional station years of data are included in the updated NOAA Atlas 14. Upon assessing the new NOAA Atlas 14 rainfall statistics and mapping, the County updated their Hydrology Manual criteria to reflect the changes in rainfall statistics and trends developed with NOAA Atlas 14. This Addendum provides a summary of these updated criteria.

It is noted that numerous rain gages found in the NOAA Atlas 14 study area are not included in the NOAA Atlas 14 update and therefore care is needed when applying the updated Hydrology Manual criteria. Hydrology studies need to consider all available rainfall data by identifying rain gages located near or in the vicinity of the study area and need to obtain and review the relevant rainfall data. Such additional rainfall information includes, but is by no means limited to: NOAA (http://www.nws.noaa.gov/), CA-DWR (http://cdec.water.ca.gov/), CIMIS (http://wwwcimis.water.ca.gov/cimis/welcome.jsp), as well as gage data available from San Bernardino County. The results of such a review should be compared with the NOAA Atlas 14 results and a determination made as to the appropriateness in using the NOAA Atlas 14 results or whether a re-assessment of all rainfall data relevant to the study area should be made. Such determinations and reviews must be coordinated with the County in order to conclude the most appropriate rainfall statistics to use, including assessments of station record length and quality, among other factors.

The primary topics considered in the Addendum are:

1. Rainfall quantities for various peak durations of rainfall, and related return periods;
2. Antecedent Moisture Conditions (or "AMC") used in hydrology studies for design and planning;
3. Soil Grouping designations and related maps.

II. RAINFALL STATISTICS

The County of San Bernardino Hydrology Manual (1986) contains isohyetal curves developed for estimating the 2-year return frequency values for the peak 6- and 24-hour durations of rainfall, the 10-year 1-hour rainfalls, and the 100-year 1-hour, 6-hour and 24-hour rainfalls. These isohyetal maps are based upon use of the NOAA Atlas 2 (1973) information. The NOAA Atlas 14 provides information for various peak durations of rainfall depths and for various return periods (return frequencies), including all of the key durations and return periods detailed in the Hydrology Manual.

Access to the NOAA Atlas 14 information is found at http://hdsc.nws.noaa.gov/hdsc/pfds/.

Another resource available for assessing rainfall for hydrology studies is the depth duration frequency studies developed by the California Department of Water Resources (DWR). Some of the gages analyzed by DWR are not included in the NOAA Atlas 14 and should be considered for appropriateness in studies submitted to the county. The depth-duration frequency tables can be obtained as Microsoft Excel files from the DWR website at the following address:

http://www.water.ca.gov/floodmgmt/hafoo/csc/climate_data/.

It is noted that the Hydrology Manual provides interpolation methods for development of rainfall estimates for the 5-minute, 30-minute, 1-, 3-, 6-, and 24-hours of peak rainfall, including recommendations regarding log-log slopes of the relevant mass rainfall plots (for example, see Hydrology Manual Figures E-36 through E-45). The NOAA Atlas 14 provides estimates for these peak durations of rainfall depths directly in tabular form, on a rain gage by rain gage basis (for those gages used in the NOAA Atlas 14 analysis). Hydrology studies prepared using this Addendum should develop the relevant rainfall quantities required for the Hydrology Manual using the newer NOAA Atlas 14 estimates and, if available, the DWR estimates to assess the appropriate rainfall quantities to be used. Additionally, the study should consider all other rain gage information available in the proximity of the study watershed. The submittal should consider these several forms of rainfall information and provide a recommendation as to the appropriate rainfall information to use.

III. ANTECEDENT MOISTURE CONDITIONS (AMC)

The Antecedent Moisture Condition (AMC) concept is a classification of the watershed runoff conditions and is related to the prior five-day precipitation. By examining this prior five-day rainfall, the watershed can be categorized as being wet, average or dry. This classification of the watershed impacts the runoff which can be expected during a particular storm event. Original literature regarding AMC conditions were published by the Soil Conservation Service (SCS) in 1964 in the National Engineering Handbook,

Section 4. (The SCS had since changed to be the Natural Resources Conservation Service (NRSC).) In the 1993 update to the National Engineering handbook, the NRSC revised the AMC concept to that of Antecedent Runoff Condition (ARC), where ARC values correspond to statistical envelopments of the relevant rainfall-runoff information, versus the AMC concept correlating to contemplated prior moisture conditions of the watershed. Similar to many other agencies, the County continues to use the AMC approach in order to determine runoff quantities appropriate for design and planning purposes. The AMC approach should be used in all hydrologic studies prepared for County review or approval as presented in the Hydrology Manual (1986), without modification.

Based on the NOAA Atlas 14 statistical data, updated AMC designations for use in arid region hydrology studies are as shown in Addendum Figures ADD-1. It is noted that the NOAA Atlas 14 did not include all available rain gages, and therefore the hydrology study should examine other relevant rainfall gages to assess the appropriateness of the AMC designations shown in Addendum Figures ADD-1. Regional or Master Plan studies should consider all sources of information. The AMC condition used for these studies must be approved by the County.

IV. SOIL GROUPING DESIGNATIONS

The soil grouping information contained in Section C of the Hydrology Manual (1986) has been updated and can be accessed at http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx. Use of this information follows the directions provided in the Hydrology Manual (1986).

V. REFERENCES

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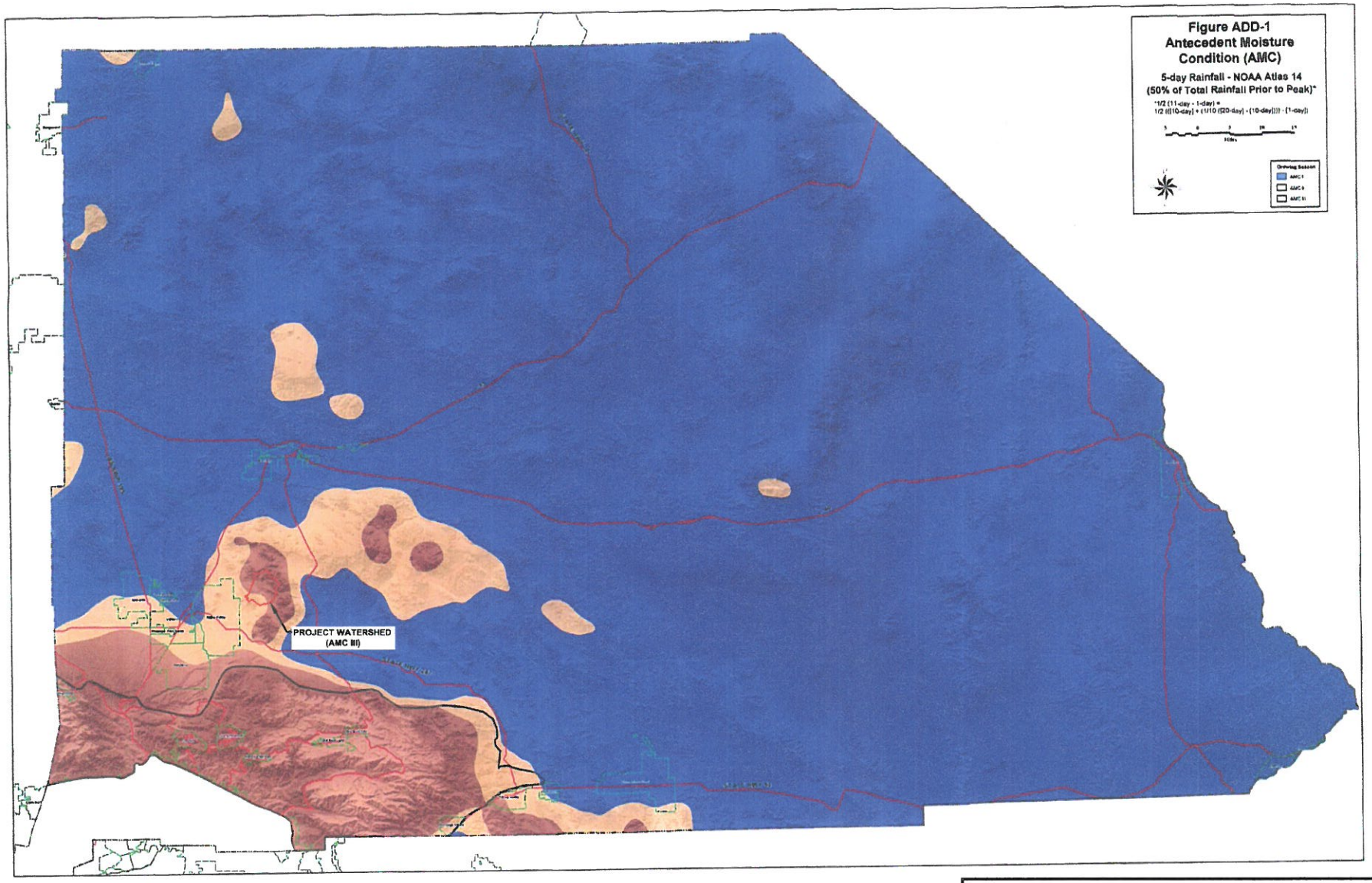


AMC ZONES MAP

PER APRIL 2010 HYDROLOGY MANUAL ADDENDUM
SIGMA CLAY MINE (APN 0464-022-54)
IN THE COUNTY OF SAN BERNARDINO, CA

PREPARED FOR: WEBBER & WEBBER

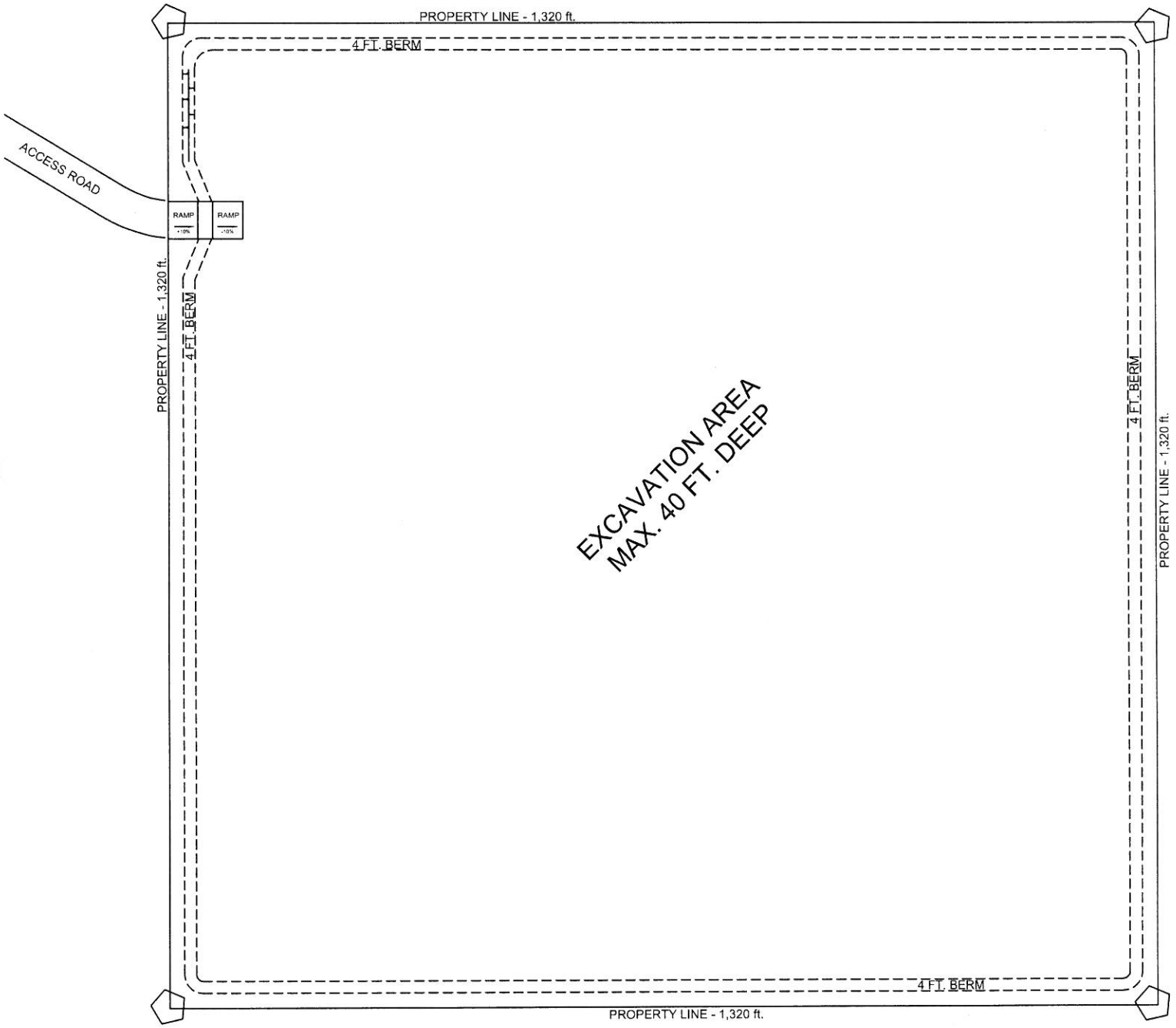
SHEET: 1 OF 1

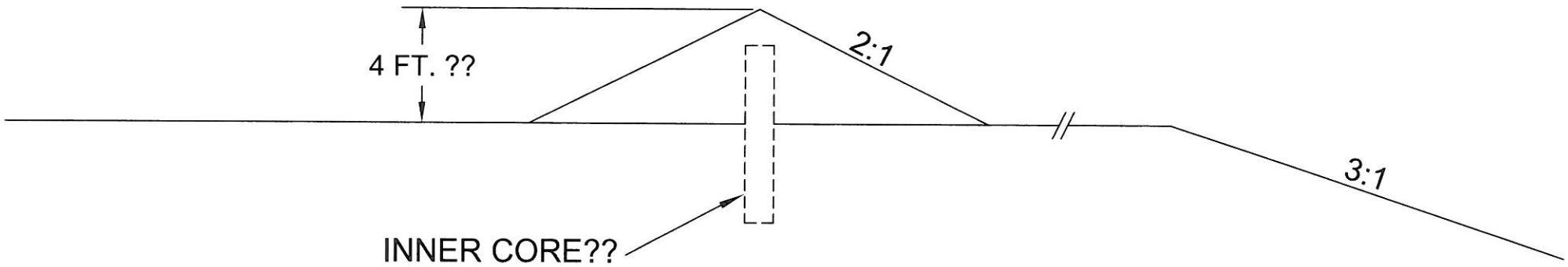
ATTACHMENT 2

Conceptual Sigma Mine
Layout Drawings

SIGMA CLAY MINE

CONCEPTUAL DESIGN - FALL 2009




4 FT. ??
2:1
3:1
INNER CORE??