Comment Letter No. 11 (continued)

<u>Comment No. 11-44</u>

Software User's Guide: URBEMIS2007 for Windows

Version 9.2
Emissions Estimation for
Land Use Development Projects

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- Bay Area Air Pollution Control District;
- Feather River Air Quality Management District;
- Imperial County Air Pollution Control District;
- Mendocino County Air Pollution Control District;
- Monterey Bay Unified Air Pollution Control District;
- Placer County Air Quality Management District;
- Sacramento Metropolitan Air Quality Management District;
- San Joaquin Valley Air Pollution Control District;
- San Luis Obispo County Air Pollution Control District;
- Santa Barbara Air Pollution Control District;
- South Coast Air Quality Management District; and
- Yolo-Solano Air Quality Management District.

The primary URBEMIS2007 (Version 9.2) improvements include:

- Incorporation of EMFAC2007 emission rates for on-road mobile sources;
- Incorporation of OFFROAD2007 emission rates for off-road mobile sources;
- Upgrading URBEMIS to the .net programming environment;
- Making URBEMIS easier to use for the novice user while enhancing capabilities for power users;
- Enhancing the construction module that provides for additional phasing options; and
- Improving the reporting options, including exporting results to Excel and PDF file formats.

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INTRODUCTION

URBEMIS2007 for Windows Version 9.2, like its predecessors, is designed to estimate air emissions from land use development projects.

The flowchart shown on the following page (Figure 1) provides a conceptual overview of URBEMIS2007. Once the URBEMIS2007 program has been initiated, the user must first either select an existing project or start a new one. For new projects, the air district in which the project is located must be selected. Then, the user typically goes to the land uses module to enter land use information relevant to his project. Once land use information has been entered, the user must select the relevant construction, area, and operational assumptions that apply to the project. Mitigation measures can also be selected as applicable. Once all information has been selected for a project, the user clicks the Recalc button to obtain the emission estimates. After reviewing the results, the user can either save the project or go back and edit the land use or construction/area/operational module assumptions for the project.

Differences from Previous Versions

Several versions of URBEMIS have been released by the California Air Resources Board (ARB) since the early 1980s: Urbemis1, Urbemis2, Urbemis3, and Urbemis5, URBEMIS7G for DOS, URBEMIS7G for Windows, URBEMIS2001 version 6.2.2, URBEMIS2002 version 7.4, URBEMIS2002 version 7.5, URBEMIS2002 version 8.7, and URBEMIS2007 Version 9.2. (Urbemis4 was not released for use by the public.) Previous versions of URBEMIS allowed the user to estimate motor vehicle emissions associated with vehicle trips generated by land use development projects. Generally, each new release of URBEMIS has been associated with ARB's update of its motor vehicle emission factors.

URBEMIS7G represented the successor to URBEMIS5. URBEMIS7G differed from URBEMIS5 in several ways. First, URBEMIS7G was an updated version of URBEMIS5 because it included EMFAC7G, ARB's California motor vehicle emission factors model.

Another difference is that, for the first time, URBEMIS7G provided users with the ability to estimate construction and area source emissions. In addition, URBEMIS7G gave the user the ability to select mitigation measures for construction, area source, and motor vehicle emissions, another option not available in previous versions. And, URBEMIS7G provided estimates of the emissions benefits of those mitigation measures.

URBEMIS7G also included a series of enhanced land use selection screens. The enhancements included additional land uses, updated trip generation rates, trip generation rates for certain land uses based on equations included in the ITE Trip Generation Manual Version 6.0 (Institute of Transportation Engineers 1996), and the option of specifying whether the project is located is an urban versus a rural environment.

Previous versions of URBEMIS did not allow for estimation of reentrained road dust. URBEMIS7G estimated road dust emissions for both paved and unpaved roads.

Figure 1. URBEMIS Conceptual Flowchart

URBEMIS7G also allowed the user to select a new "double-counting" option. This option was designed to minimize double counting of internal vehicle trips between residential and nonresidential land uses. Finally, URBEMIS7G allowed users to select a new "pass-by trips" option. With this option selected, URBEMIS7G could be used to estimate vehicle trip emissions based on the percentage of primary trips, diverted linked trips, and pass-by trips assumed for specific land use types.

URBEMIS7G was superceded by URBEMIS7G for Windows. The primary advantage of this enhancement is that it allowed the user to estimate emissions from within the Windows operating system environment. Several other minor improvements were made to fix previously identified bugs. URBEMIS2001 was released in early 2002, following by URBEMIS2002 in March 2003. URBEMIS2001 incorporated EMFAC2001 emissions factors, while URBEMIS2002 version 7.5 incorporated EMFAC2002 emissions factors and ITE Trip Generation, 7th edition emission factors. Additionally, EMFAC2002 included several additional land uses, contained a major enhancement to the construction emissions and mitigation measures module, and included a screening analysis option. URBEMIS2002 Version 8.7 included enhancements to the area source emission factors, and to the area source and operational mitigation measures. URBEMIS2007 version 9.2 includes updates that include adding EMFAC2007 input files, OFFROAD2007 input files, PM2.5 and CO2 emissions, enhanced construction phasing, and improved reporting capabilities.

Getting Started

Operating System Requirements

URBEMIS2007 is written in C++ within the Microsoft .net programming environment. Infragistrics controls have also been incorporated into URBEMIS. The program can be used within either the Microsoft XP or the Vista Operating Systems.

Disk Limits

URBEMIS2007 requires substantial amounts of hard disk space, primarily to store EMFAC2007 database files. Consequently, the program has been set up so that you can download only the EMFAC2007 files and associated air district default files needed.

Installation

URBEMIS2007 can be downloaded and installed by going to the following web site location: http://www.urbemis.com/software/download.html

Once you have navigated to this URBEMIS web site, follow the directions listed there to install URBEMIS directly onto your computer. You are given the option of either installing the .msi file directly from the web site or copying the .msi file to your computer, then using it to install URBEMIS. The later procedure is the recommended approach.

The installation routine provides an icon on the desktop that can be clicked to start URBEMIS. The URBEMIS icon is found in Figure 2 below.

Figure 2. URBEMIS2007 Desktop Icon

Starting URBEMIS2007

Once URBEMIS2007 has been successfully installed, it can be started by selecting the URBEMIS2007 icon from the desktop or by clicking on the Windows Start button, selecting Programs from the list, then selecting URBEMIS2007 from the list of programs. Figure 3 below consists of a portion of the Windows Desktop with the URBEMIS2007 icon. Double clicking on that icon starts the URBEMIS2007 program.

Figure 3. URBEMIS2007 Icon on Windows Desktop

One problem that frequently arises when starting URBEMIS2007 is that the program does not fit entirely within the computer screen. The optimal screen settings for running URBEMIS2002 are 1024 x 768 pixels, with the small fonts advanced setting option. These are Windows settings that can be changed by selecting the Start/Settings/Control Panel/Display from within the Windows operating system.

Quick Start

Once URBEMIS2007 has been started, you are first taken to STEP 1 – Open a New or Existing Project. Once you have started a new project, you can quickly obtain project results using the following steps. First, enter each of the land uses associated with your project (STEP 2). Then make sure that the construction phasing is correct (STEP 3). Then, check that the operational start year is correct (STEP 5). Finally, click on the dirty cloud icon at the top of the center bar. This will give you a quick estimate of your project's emissions. At this point, you may want to go back and refine your project's data by editing information in STEPS 3, 4, and 5. Before doing so, however, save your project (STEP 7). Then modify the project assumptions as necessary.

Where Else to Get Help

There are several options available to obtain help with URBEMIS. They include:

- Hitting the F1 key within any part of URBEMIS, which provides context sensitive help,
- Clicking on the Click for Instructions buttons found within each step of URBEMIS,
- Going to User Help forums located at www.urbemis.com/phpbb/index.php, and
- Consulting this URBEMIS2007 Users Manual.

Using URBEMIS2007

Appearance

When URBEMIS2007 is started, an introductory screen is presented (see Figure 4). The left side of the screen shows seven steps that can be completed for typical URBEMIS runs. Not all of these screens need to be completed to generate emission estimates, though they do provide the novice user with a roadmap for conducting URBEMIS runs. All users must complete Step 1. Open a New or Existing Project, before they can proceed. If a new project is selected, then the user should then go to Step 2. Enter Land Use Data specific to the project in question. Once land use data has been entered, the user can go directly to Step 6. View and Print Output, though its generally recommended that the user go to Steps 3, 4, and 5 to make sure that project specific information is accurately depicted.

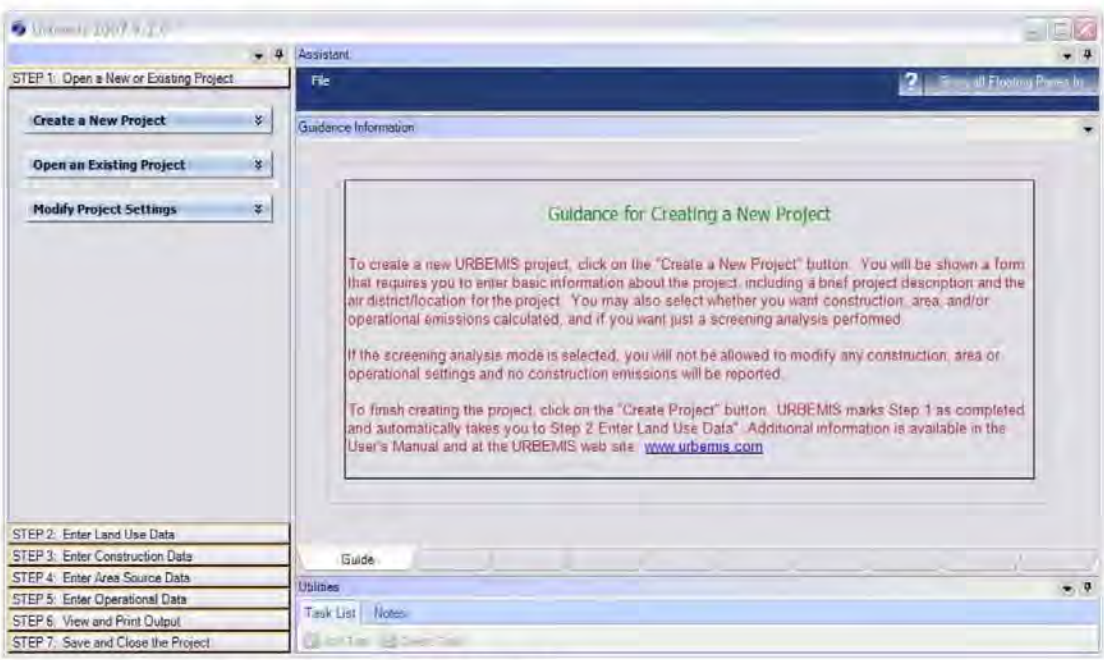

Figure 4. Introductory URBEMIS2007 Windows Screen

Step 1: Open A New or Existing Project

Figure 5 shows expanded and contracted views of the Step 1 menu. The three options within Step 1 include 1) Start a new project, 2) Open an Existing Project, 3) Modify Project Settings. As Figure 5 illustrates, each of these three Step 1 options can be expanded by clicking on the arrows at the right of each option.

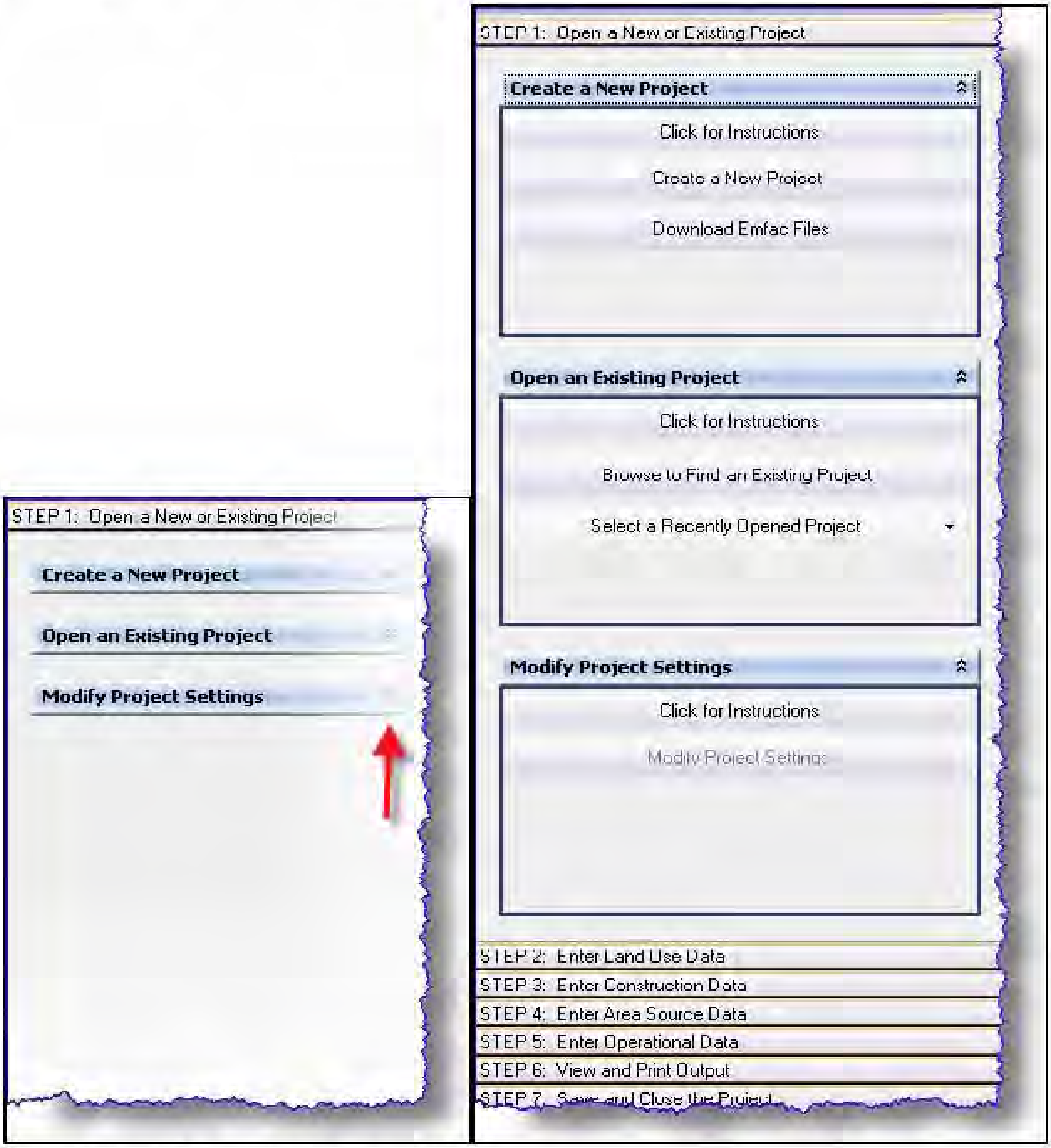

Figure 5. Step 1: Expanded and Contracted Screens

For example, clicking on Create a New Project expands this menu to include three suboptions: a) Click for Instructions, b) Create a New Project, or c) Download EMFAC files. If you attempt to Start a New Project in a location for which you have not downloaded the EMFAC files, then you will need to first download the EMFAC and air district and associated county default files.

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Creating a New Project

Figure 6 shows the screen URBEMIS shows when the Create a New Project button is selected. In this example, the user wants to create a new project located in the Mountain Counties Air Basin. Since the Mountain Counties Air Basin is not shown in the list, that county's EMFAC files need to be downloaded first. To do this, you would need to cancel out of the Start a New Project screen and click on the Download EMFAC Files button within the Start a New Project button.

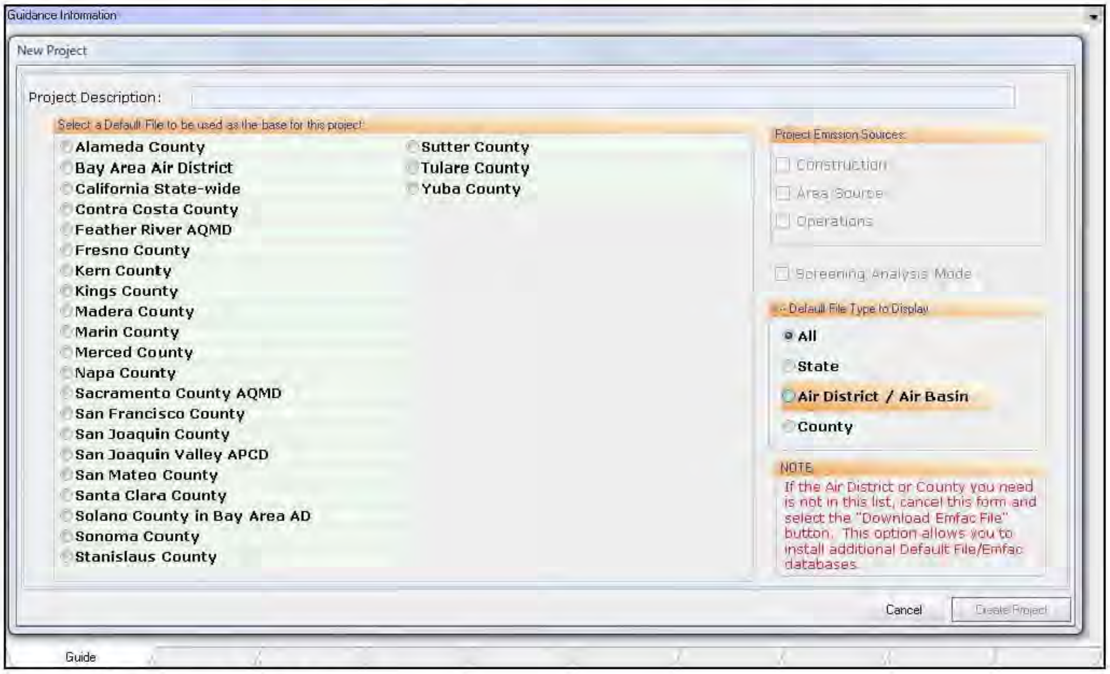

Figure 6. New Project Setup Screen

Figure 7 shows the Download EMFAC Files screen. In this example, the Mountain Counties Air Basin EMFAC database has been selected and is shown downloading. Once that database has downloaded, then you would need to Start New Project and select Mountain Counties Air Basin (see Figure 8). Also, on the Create a New Project Screen, you will need to enter a Project Description. This Project Description is not the same thing as the File Name used to store and retrieve the file on your computer. Once you have selected the project location and entered the Project Description, hit the Create Project button. URBEMIS then takes you to STEP 2.

One additional option to be aware of in the new project screen is the "screening analysis mode" checkbox located on the right side of menu. If the user turns on the "screening analysis option", they will not be able to edit the default values for construction, area sources, or operational emissions. In addition, because the construction module depends on several key assumptions that must be reviewed by the user, the screening analysis mode only generates emissions for the area and operational emission categories.

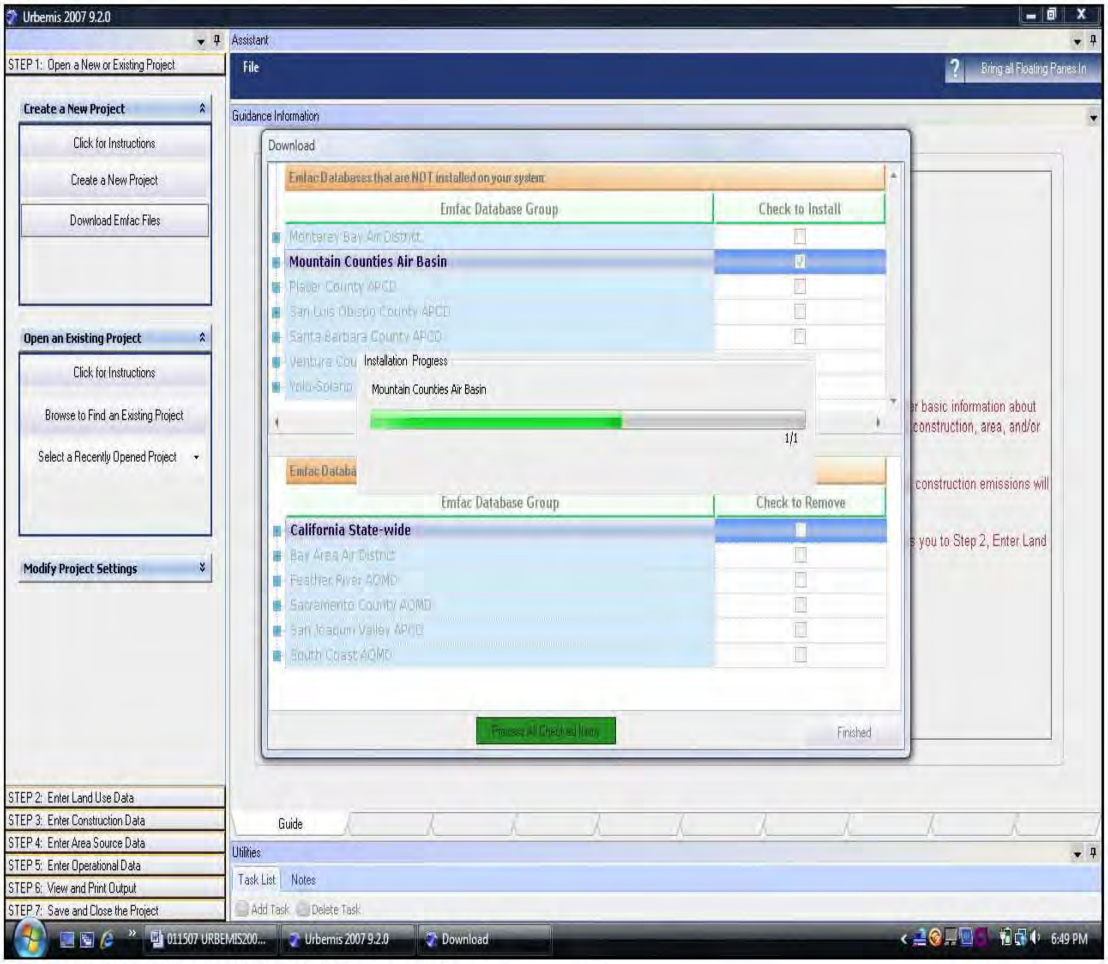

Figure 7. Download EMFAC Database Screen

Figure 8. New Project Setup Screen

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Open an Existing Project

To open an existing project, the user should click on either the a) Browse to Find an Existing Project or b) Select a Recently Opened Project bar (see Figure 5). Once you have opened a previously created project, URBEMIS takes you to STEP 2.

Another option for starting an existing or new project is to click on the word "File" shown on the project assistant bar (see Figure 9). Clicking on File reveals a drop down menu that can be used to start a new project or open an existing project

Modify Project Settings

The third option under STEP 1 involves modifying project settings. This option is available for projects that have already been created. Under this option, you can modify the project description, turn on or off the construction, area, and operational phases, and turn the screening analysis mode on or off.

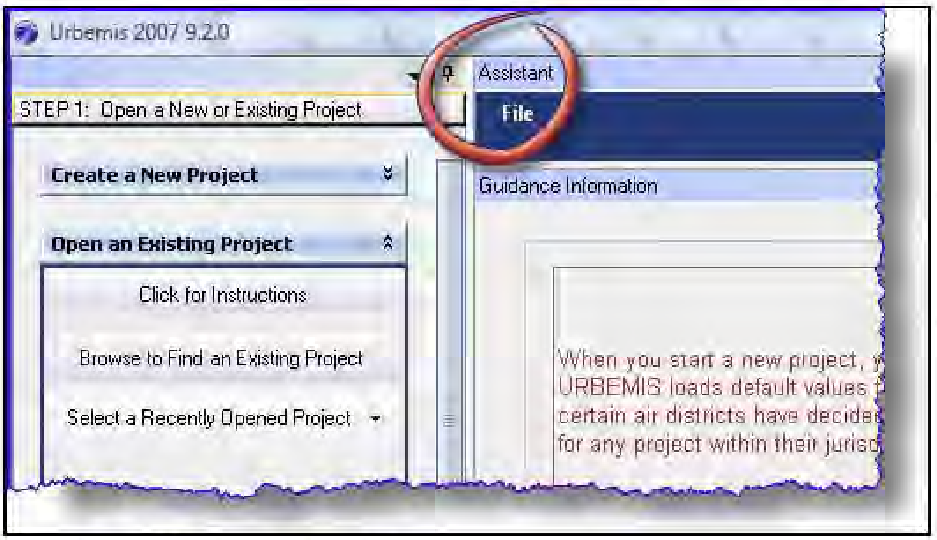

Figure 9. Select File from the Assistant Bar

Step 2 – Enter Land Use Data

Once you have opened an existing project or started a new one, URBEMIS takes you to Step 2 - Enter Land Use Data. The first land use screen displays residential land uses, which represent the first of eight possible land use screens.

- residential;
- educational;
- recreational;
- large retail;
- retail;
- commercial;

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- industrial; and
- blank.

Figure 10 shows the residential land use screen with 222 single family residential uses entered. URBEMIS assumes 9.57 trips per day per residential land use. URBEMIS also assumes 3 single family residential land uses per acre. Both the trips per day and acreage values can be modified by the user.

You may access the land uses associated with either of the eight land use screens by either clicking on the appropriate tab (shown with arrow in Figure 10) or by double clicking on the appropriate land use name in the left window pane shown under Step 2.

Figure 10. Land Use Screens

Figure 11. Land Use Tabs

In Figure 12, the educational tab has been selected and 20 has been entered as the unit amount for day-care center. The 20 represents 20,000 square feet with a daily trip generation rate of 79.26 per 1000 square feet.

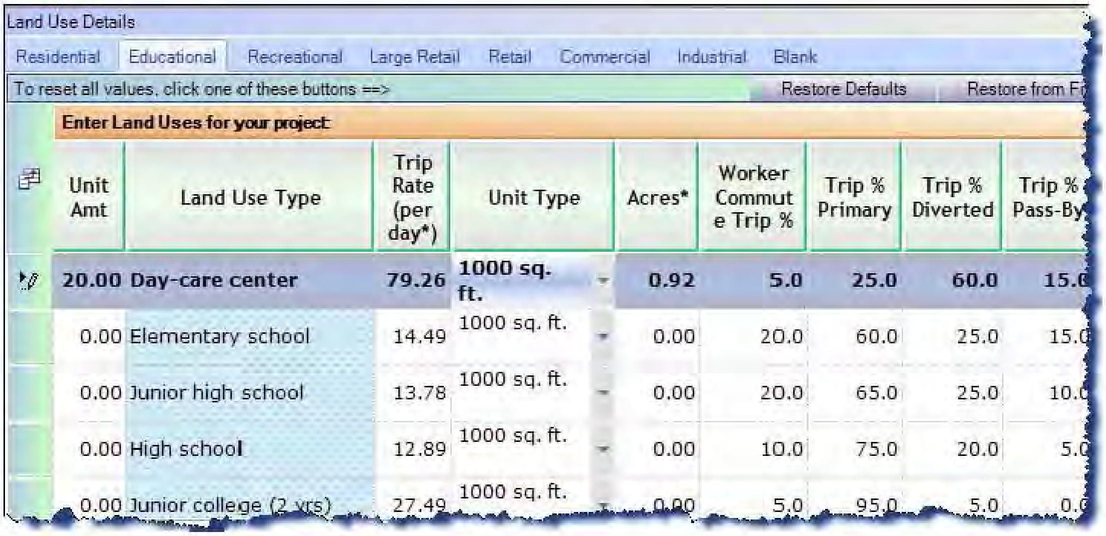

Figure 12. Educational Land Use Screen

Figure 13 shows the Blank land use tab. In this screen, the user can enter land uses that have not been entered in either of the seven previous screens. The user must enter unit amount, land use type, acres, and trip rate. Although URBEMIS will calculate acreage (as twice the building square footage), the user is urged to override this value if specific acreage data is available. Figure 14 shows an entry in the first row of the Blank Screen. A two acre dog park with 100 trips per acre has been entered.

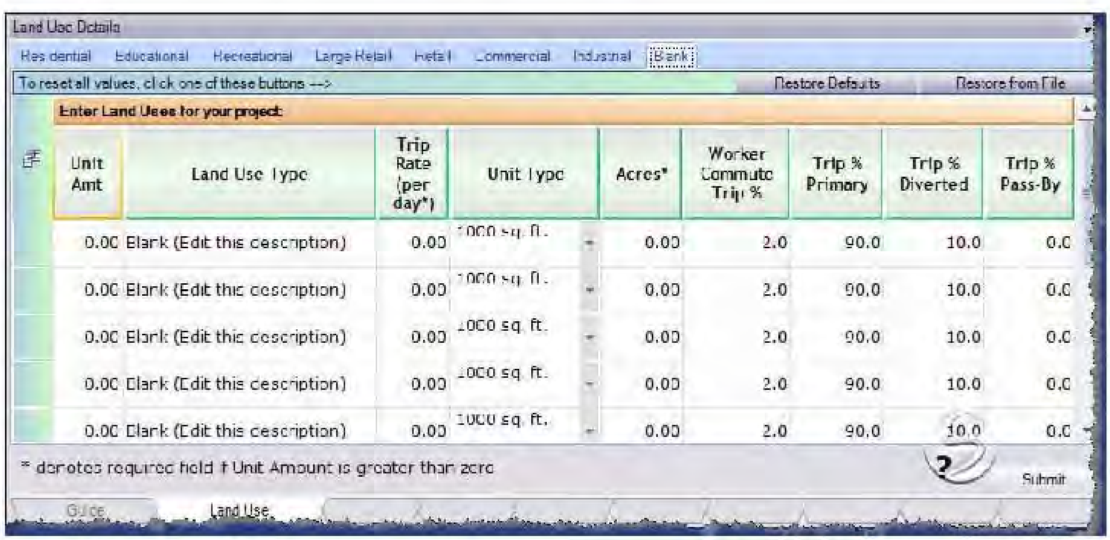

Figure 13. Blank Land Uses

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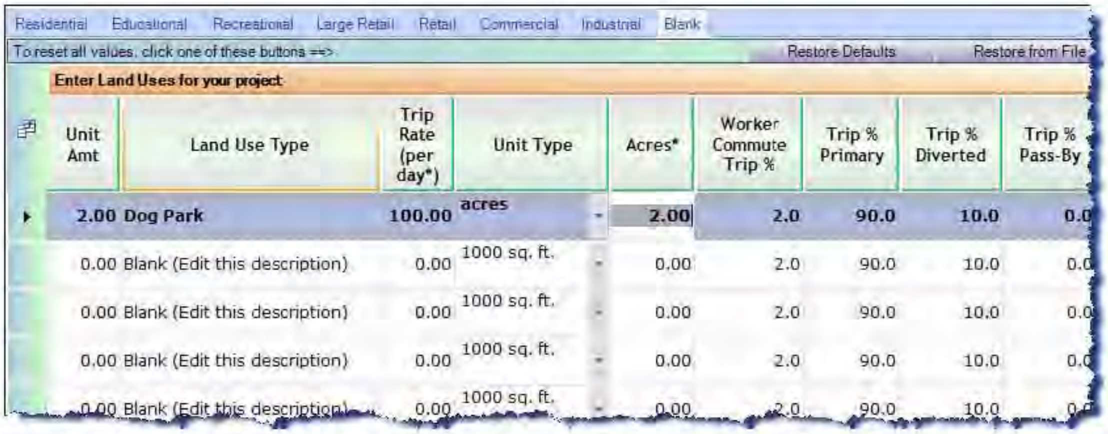

Unit Amt	Land Use Type	Trip Rate (per day*)	Unit Type	Acres*	Worker Commute Trip %	Trip % Primary	Trip % Diverted	Trip % Pass-By
2.00	Dog Park	100.00	acres	2.00	2.0	90.0	10.0	0.0
0.00	Blank (Edit this description)	0.00	1000 sq. ft.	0.00	2.0	90.0	10.0	0.0
0.00	Blank (Edit this description)	0.00	1000 sq. ft.	0.00	2.0	90.0	10.0	0.0
0.00	Blank (Edit this description)	0.00	1000 sq. ft.	0.00	2.0	90.0	10.0	0.0
0.00	Blank (Edit this description)	0.00	1000 sq. ft.	0.00	2.0	90.0	10.0	0.0

Figure 14. Sample Blank Screen Entry

Table 1 lists each of the URBEMIS2007 land uses, provides a definition of each land use, and shows the percentage of worker commute trips associated with each land use. Those percentages are called Percent Worker Commute in Table 1.

For each land use type, you are given the option of entering the project size or unit amount. For all land uses, URBEMIS2007 automatically calculates the acreage associated with that land use type and the trip rate based on the unit amount. The user can and should modify the acreage for a project if it differs from the default values used by URBEMIS. For residential projects, changing the project acreage will, however, also change the trip rate using the procedure described in Appendix D of this manual. For non-residential land uses, URBEMIS estimates acreage by assuming that acreage equals twice the building square footage. For residential land uses, URBEMIS assumes the following acreage:

- single family residential – 3 units per acre;
- low rise apartments and condos/townhouse units – 16 units per acre;
- mid rise apartments – 38 units per acre;
- high rise apartments – 62 units per acre;
- high rise condos – 64 units per acre;
- mobile home parks – 6 units per acre;
- congregate care (assisted living) – 16 units per acre.

The equation or value used to estimate trip generation is shown in Table 2. You can override the trip rate by typing in a different rate. For certain land uses, you also can select a different unit type by clicking on the "Unit Type" arrow.

For all non-residential land uses, you also have the option of modifying the default "% Worker Commute" value. This value represents the percentage of worker commute trips attracted to that land use as a percentage of all trips generated by that land use.

Table 1. Land Use Definitions and Percent Worker Commute

	Land Use Definition	Percent Worker Commute
First Land Use Screen: Residential		
Single Family Housing	Detached homes on individual lots	N/A
Apartments, Low Rise	Buildings with one to three floors	N/A
Apartments, Medium Rise	Buildings with four to ten floors	
Apartments, High Rise	Buildings with more than ten floors	N/A
Condo/Townhouse General	Condos and townhomes in buildings with one or two levels.	N/A
Condo/Townhouse High Rise	Condos and townhomes in buildings with 3 or more levels.	N/A
Mobile Home Park	Trailers sited and installed on permanent foundations.	N/A
Retirement Community	Self-contained villages restricted to adults or senior citizens	N/A
Congregate Care (Assisted Living) Facility	One or more multiunit buildings designed for elderly living and may contain dining rooms, medical, and recreational facilities.	N/A
Second Land Use Screen: Educational		
Day-Care Center	Facilities that care for pre-school children, normally during daytime hours. May also include after-school care for older children.	5
Elementary School	Generally includes Kindergarten through either 6th or 8th grades.	20
Junior High School	Includes 7th, 8th, and often 9th grades.	20
High School	Includes 10th, 11th, and 12th grades and oftentimes 9th grade.	10
Junior College (2 years)	Most have facilities separate from other land uses and exclusive access points and parking facilities.	5
University/College (4 years)	Four year and graduate educational institutions.	5
Library	Public or private facility, which houses books, and includes reading rooms and possibly meeting rooms.	5
Place of Worship	Building(s) providing public worship services.	3
Blank (Edit all 5 columns)	Blank commercial land use that can be entered by the URBEMIS2007 user.	2
Third Land Use Screen: Recreational		
City Park	Owned and operated by a city, these facilities can vary widely as to location, type, and number of facilities. May including boating, swimming, ball fields, camp sites, and picnic facilities.	
Racquet Club	Privately owned facilities with tennis, racquetball, and/or handball courts, exercise rooms, and/or swimming pools and/or weight rooms	5
Racquet/Health Club	Privately owned facilities with tennis, racquetball, and/or handball courts.	5
Quality Restaurant	Typically with customer turnover rates of at least one hour.	8
High Turnover (sit-down Restaurant)	Typically with high customer turnover rates of less than one hour.	5
Fast Food Restaurant with Drive Through	Includes fast food restaurants with drive through windows, such as McDonald's, Burger King, and Taco Bell.	5
Fast Food Restaurant without Drive Through	Includes fast food restaurants without drive through windows, such as McDonald's, Burger King, and Taco Bell.	5
Hotel	Place of lodging providing sleeping accommodations, restaurants, and meeting or convention facilities.	5
Motel	Place of lodging providing accommodations and often, a restaurant.	5
Fourth Land Use Screen: Large Retail		
Free-Standing Discount Store	Free-standing store with off-street parking, can be part of neighborhood shopping centers.	2
Free-Standing Discount Superstore	Same as free-standing discount store but also include full service grocery department under the same roof.	2
Discount Club	Discount/warehouse store whose shoppers pay a membership fee to take advantage of discounted prices.	2

	Land Use Definition	Percent Worker Commute
Regional Shopping Center	Integrated group of commercial establishments that are planned, developed, owned, and managed as a unit.	2
Electronics Superstore	Free-standing warehouse type facilities specializing in the sale of home and vehicle electronic merchandise, as well as TVs, compact disc and cassette tape players, cameras, radios, videos, and general electronic accessories.	2
Home Improvement Superstore	Free-standing warehouse type facilities specializing in lumber, tools, paint, lighting, wallpaper and paneling, kitchen and bathroom fixtures, lawn equipment, and garden plants and accessories.	2
Fifth Land Use Screen: Retail		
Strip Mall	Neighborhood store complexes with a variety of retail outlets.	2
Hardware/Paint Store	Stores selling general hardware items and/or paints and supplies.	2
Supermarket	Free-standing stores selling a complete assortment of food, food preparation and wrapping materials, and household cleaning and servicing items. May also contain money machines, photo centers, pharmacies, and video rental areas.	2
Convenience market (24 hour)	These markets sell convenience foods, newspapers, etc. and do not have gasoline pumps. (Trip generation rates with gas pumps is approximately 12% higher than without.	2
Convenience market with gas pumps	These markets sell convenience foods, newspapers, etc. and do have gasoline pumps.	2
Gasoline/Service Station	Excludes gasoline stations with convenience stores or car washes.	2
Sixth Land Use Screen: Commercial		
Bank (with drive-through)	Banks with one or more drive-up windows.	2
General Office Building	Houses multiple tenants in a location where affairs of businesses, commercial or industrial organizations or professional persons or firms are conducted.	35
Office Park	Contain general office buildings and related support services, arranged in a park- or campus-like setting.	48
Government Office Building	Individual building containing the entire function or simply one agency of a city, county, state, or federal government.	10
Government (Civic Center)	Group of government buildings connected with pedestrian walkways	10
Pharmacy/Drugstore with Drive Through	Retail facilities selling prescription and non-prescription drugs. Also typically sell cosmetics, toiletries, medications, stationary, personal care products, limited food products, and general merchandise. These facilities include a drive-through window.	2
Pharmacy/Drugstore without Drive Through	Retail facilities selling prescription and non-prescription drugs. Also typically sell cosmetics, toiletries, medications, stationary, personal care products, limited food products, and general merchandise. These facilities do not contain a drive-through window.	2
Medical Office Building	Includes both medical and dental office buildings that provide diagnoses and outpatient care. Generally operated by one or more private physicians or dentists.	7
Hospital	Any institution where medical or surgical care is give to non-ambulatory and ambulatory patients and overnight accommodations are provided.	25
Seventh Land Use Screen: Industrial		
Warehouse	Buildings devoted to the storage of materials, also include office and maintenance areas.	2
General Light Industry	Typical light industrial activities include: print plants, material testing labs, and assemblers of data processing equipment. They employ fewer than 500 persons and tend to be free-standing.	50
General Heavy Industry	Could also be categorized as manufacturing facilities. However, heavy industrial uses are limited to the production of large items.	90
Industrial Park	Contain a number of industrial or related facilities and are characterized by a mix of manufacturing, service, and warehouse facilities. May contain highly diversified facilities, a number of small businesses, or one or two dominant industries.	41.5
Manufacturing	Sites where the primary activity is the conversion of raw materials or parts into finished products. May also included associated office, warehouse, research, and other functions.	48

Percent worker commute represents the percentage of total trips that are work-related commute trips.

Table 2. URBEMIS2007 Trip Generation Rates

Land Use	Trip Generation Rate	Units *	Source
Single Family Housing	9.57	Dwelling Unit	ITE (210)
Apartment, Low Rise	6.9	Dwelling Unit	ITE (221)
Apartment, Mid Rise	5.76	Dwelling Unit	ITE (223)
Apartment, High Rise	5.29	Dwelling Unit	ITE (222)
Condominium/Townhouse, General	6.9	Dwelling Unit	ITE (230)
Condominium/Townhouse, High Rise	5.26	Dwelling Unit	ITE (232)
Mobil Home Park	4.99	Dwelling Unit	ITE (240)
Retirement Community	3.71	Dwelling Unit	ITE (251)
Congregate Care (Assisted Living) Facility	2.02	Dwelling Unit	ITE (253)
Day-Care Center	79.3	1000 sq. ft.	ITE (565)
Elementary School	14.49	1000 sq. ft.	ITE (520)
Elementary School	1.29	Student	ITE (520)
Junior High School	13.78	1000 sq. ft.	ITE (522)
Junior High School	1.62	Student	ITE (522)
High School	12.89	1000 sq. ft.	ITE (530)
High School	1.71	Student	ITE (530)
Junior College (2 Years)	27.49	1000 sq. ft	ITE (540)
Junior College (2 Years)	1.2	Student	ITE (540)
University/College (4 Years)	2.38	Student	ITE (550)
Library	54	1000 sq. ft.	ITE (590)
Place of Worship	9.21	1000 sq. ft.	ITE (560)
City Park	1.59	Acre	ITE (411)
Racquet Club	14.03	1000 sq. ft.	ITE (491)
Racquetball/Health Club	32.93	1000 sq. ft.	ITE (492)
Quality Restaurant	89.95	1000 sq. ft.	ITE (931)
High-Turnover (Sit-Down) Restaurant	127.15	1000 sq. ft.	ITE (932)
Fast-Food Restaurant w/o Drive-Through Window	716	1000 sq. ft.	ITE (933)
Fast-Food Restaurant with Drive-Through Window	496.12	1000 sq. ft.	ITE (934)
Hotel	8.17	Rooms	ITE (310)
Motel	5.63	Rooms	ITE (320)
Free-Standing Discount Store	56.02	1000 sq. ft.	ITE (815)
Free-Standing Discount Superstore	49.21	1000 sq. ft.	ITE (813)
Discount Club	41.8	1000 sq. ft.	ITE (861)
Regional Shopping Center	42.94	1000 sq. ft.	ITE (820)
Electronics Superstore	45.04	1000 sq. ft.	ITE(863)
Home Improvement Superstore	29.8	1000 sq. ft.	ITE(862)
Strip Mall	42.94	1000 sq. ft.	ITE (820)
Hardware/Paint Store	51.29	1000 sq. ft	ITE(816)
Supermarket	102.24	1000 sq. ft.	ITE(850)
Convenience Market (24 hr.)	737.99	1000 sq. ft.	ITE (851)

Land Use	Trip Generation Rate	Units *	Source
Convenience Market with Gasoline Pumps	845.6	1000 sq. ft.	ITE (853)
Gasoline /Service Station	162.78	Fueling Positions	ITE (945)
Bank (with Drive-Through)	246.49	1000 sq. ft.	ITE (912)
General Office Building	3.32	1000 sq. ft.	ITE (710)
Office Park	11.42	1000 sq. ft.	ITE (750)
Government Office Building	68.93	1000 sq. ft.	ITE (730)
Government (Civic Center)	27.92	1000 sq. ft.	ITE (733)
Pharmacy/Drugstore without Drive Through	88.16	1000 sq. ft	ITE(880)
Pharmacy/Drugstore with Drive Through	90.06	1000 sq. ft	ITE(881)
Medical/Dental Office Building	36.13	1000 sq. ft.	ITE (720)
Hospital	17.57	1000 sq. ft.	ITE (610)
Hospital	11.81	Beds	ITE (610)
Warehouse	4.96	1000 sq. ft.	ITE(150)
General Light Industry	6.97	1000 sq. ft.	ITE (110)
General Light Industry	51.8	Acre	ITE (110)
General Light Industry	3.02	Employee	ITE (110)
General Heavy Industry	1.5	1000 sq. ft.	ITE (120)
General Heavy Industry	6.75	Acre	ITE (120)
Industrial Park	6.96	1000 sq. ft.	ITE (130)
Industrial Park	63.11	Acre	ITE (130)
Industrial Park	3.34	Employee	ITE (130)
Manufacturing	3.82	1000 sq. ft.	ITE (140)

Notes:

sq. ft. = Square Feet

All trip generation rates from ITE Trip Generation Rate Manual, 7th Edition.

* "Dwelling unit" is a residential housing unit (including 'single room occupancy' units and 'granny flats'). "Square feet" refers to the total floor area (on all levels) of buildings, but does not include parking structures even if they are within a building (also known as 'gross leasable area'). "Acres" refers to the gross surface of the entire site, including any structures, streets, sidewalks, parking, and landscaping (but not including building or parking lot floor areas above the first level).

Pass-by Trips

URBEMIS2007 allows users to select a pass-by trip option, which results in lower operational emissions. The pass-by trip option splits trips into percentages of primary, pass-by, and diverted-linked trips. Primary trips are trips made for the specific purpose of visiting the designated land use. The stop at that trip generator is the primary reason for the trip. Pass-by trips are trips made as intermediate stops on the way from an origin to a primary trip destination. Pass-by trips are attracted from traffic passing the site on an adjacent street that contains direct access to the generator. Diverted-linked trips are trips attracted from the traffic volume on roadways in the vicinity of the generator but which require a diversion from that roadway to another roadway to gain access to the site.

When the pass-by option is turned off, URBEMIS assumes all trips are primary trips. When pass-by is turned on, lower emissions result because a percentage of trips associated with each land use is assumed to be pass-by and diverted linked trips (see Table 3). Pass-by and diverted-linked trips have a lower trip distance than primary trips. URBEMIS assumes that pass-by trips result in virtually no extra travel, with an assumed trip length of 0.1 miles. Diverted-linked trip lengths are assumed to equal 25% of the primary trip length.

As shown in Table 3, the "fast-food restaurant without drive-through window" land use consists of 50% primary trips, 40% diverted linked trips, and 10% pass-by trips. Assuming a trip length of 10 miles, emissions calculated using the pass-by trip option would be calculated by assuming that 50% of the trips would be 10 miles, 40% of the trips would be 2.5 miles, and 10% of the trips would be 0.1 miles.

Table 3. URBEMIS Land Uses Sorted by Category with Trip Percentages

Land Use	Land Use Category	Primary Trip (%)	Diverted Linked Trip (%)	Pass-By Trip (%)	Source
Single-Family Housing	Residential	85	10	5	Sandag 1996
Apartment, Low Rise	Residential	85	10	5	Sandag 1996
Apartment, High Rise	Residential	85	10	5	Sandag 1996
Condominium/Townhouse, General	Residential	85	10	5	Sandag 1996
Condominium/Townhouse, High Rise	Residential	85	10	5	Sandag 1996
Mobile Home Park	Residential	85	10	5	Sandag 1996
Retirement Community	Residential	85	10	5	Sandag 1996
Residential Planned Unit Development (PUD)	Residential	85	10	5	Sandag 1996
Congregate Care (Assisted Living) Facility	Residential	85	10	5	Sandag 1996
Day-Care Center	Educational	25	60	15	Sandag 1996
Elementary School	Educational	60	25	15	Sandag 1996
High School	Educational	75	20	5	Sandag 1996
Junior High School	Educational	65	25	10	Sandag 1996
Junior College (2 Years)	Educational	95	5	0	Sandag 1996
University/College (4 Years)	Educational	90	10	0	Sandag 1996
Library	Educational	45	45	10	Sandag 1996
Church	Educational	65	25	10	Sandag, 1996
City Park	Recreational	70	25	5	Sandag 1996
Racquet Club	Recreational	50	40	10	Sandag 1996
Racquetball/Health Club	Recreational	50	40	10	Sandag 1996
Quality Restaurant	Recreational	50	40	10	Sandag 1996
High-Turnover (Sit-Down) Restaurant	Recreational	30	40	30	ITE 1997
Fast-Food Restaurant without Drive-Through Window	Recreational	50	40	10	Sandag 1996
Fast-Food Restaurant with Drive-Through Window	Recreational	30	30	40	ITE 1997
Hotel	Recreational	60	35	5	Sandag 1996
Motel	Recreational	60	35	5	Sandag 1996
Free-Standing Discount Store	Large Retail	45	45	10	Sandag 1996
Free-Standing Discount Superstore	Large Retail	55	40	5	ITE 1997

Land Use	Land Use Category	Primary Trip (%)	Diverted Linked Trip (%)	Pass-By Trip (%)	Source
Discount Club	Large Retail	55	40	5	Sandag 1996
Regional Shopping Center	Large Retail	55	35	10	Sandag 1996
Electronics Superstore	Large Retail	45	40	15	Sandag 1996
Home Improvement Superstore	Large Retail	45	40	15	Sandag 1996
Strip Mall	Retail	45	40	15	Sandag 1996
Hardware/Paint Store	Retail	45	40	15	Sandag 1996
Supermarket	Retail	45	40	15	Sandag 1996
Convenience Market (24 hr.)	Retail	25	30	45	ITE 1997
Convenience Market (w/gas pumps)	Retail	25	30	45	ITE 1997
Gasoline/Service Station	Retail	20	40	40	ITE 1997
Bank (with Drive-Through)	Commercial	35	45	20	Sandag 1996
General Office Building	Commercial	75	20	5	Sandag 1996
Office Park	Commercial	80	15	5	Sandag 1996
Government Office Building	Commercial	50	35	15	Sandag 1996
Government (Civic Center)	Commercial	50	35	15	Sandag 1996
Pharmacy/Drugstore with Drive Through	Commercial	45	40	15	Sandag 1996
Pharmacy/Drugstore without Drive Through	Commercial	45	40	15	Sandag 1996
Medical Office Building	Commercial	60	30	10	Sandag 1996
Hospital	Commercial	75	25	0	Sandag 1996
Warehouse	Industrial	90	5	5	Sandag 1996
General Light Industry	Industrial	80	20	0	Sandag 1996
General Heavy Industry	Industrial	90	5	5	Sandag 1996
Industrial Park	Industrial	80	20	0	Sandag 1996
Manufacturing	Industrial	90	5	5	Sandag 1996

STEP 3: Enter Construction Data

The construction emissions portion of URBEMIS2007 has been substantially modified from previous versions. STEP 3 - Enter Construction Data represents the most complicated step within URBEMIS. This is primarily because construction phasing varies considerably from project to project.

The STEP 3: Enter Construction Data screen allows you to estimate area-source emissions for up to seven different types of construction phases. The emission factors and equations used by URBEMIS2007 to estimate construction emissions are described in detail in Appendix A.

When you enter URBEMIS, you can click on STEP 3 without either opening a project or entering land use data. If you then go to STEP 3, you will see the screen shown in the left half of Figure 15. That screen shows the seven construction phases allowed by URBEMIS. If you have opened an existing project, or started a new project, and have entered one or more land uses, you will see the right half of Figure 15 when you go to STEP 3. The only exception to this is for projects within the South Coast Air District, where all seven phases are assumed as part of the construction phase setup.

This list of generic phases and schedules should only be used if specific construction information is unavailable for the project in question.

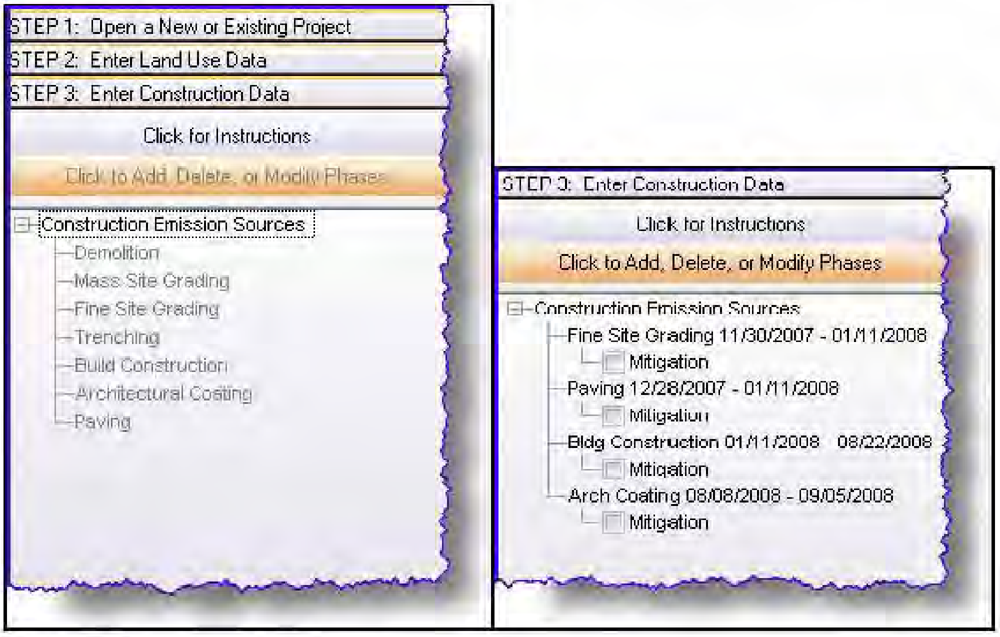

Figure 15. Construction Start Screens

Setting Up Construction Phases

The phases and schedules included in the generic construction phasing are as follows:

- Fine Site Grading,
- Asphalt,
- Building Construction, and
- Architectural Coatings.

These phases can be deleted or their phasing can be altered by clicking on the button: Click to Add, Delete, or Modify Phases (orange button just below the STEP3. Enter Construction Data button).

Figure 16. Adding, Deleting and Modifying Construction Phases

This will take you to a screen that allows you to add or delete phases. The seven types of phases that be included in URBEMIS are:

- Demolition,
- Mass Site Grading,
- Fine Site Grading,
- Trenching,
- Building Construction,
- Asphalt, and
- Coating (paints)

For each phase, you must identify construction phase settings that include phase type, start date, end date, work days/week, and a description. There is no limit to the number of phases that can be entered. More than one phase of any type can be entered. The only limitation is that phases of the same type must have a unique start date/end date pair. For any phase, the start and end dates must be on or after January 1, 2005 and the end date must be on or before December 31, 2040.

Phases can overlap, occur sequentially, or have time gaps between them.

As shown in Figure 16, a second tab allows you to View a Calendar of Phases. When you select that tab, you are shown a calendar (See Figure 17). This calendar shows all days that have any phase activity as bolded days. If you place your cursor over any bolded day, the number of phases occurring on that date are displayed, and if you click a day, the phases that occur on that day will be displayed in the box on the right.

Once you are satisfied that your project's construction phasing has been set up correctly, from within the Enter Phase Data tab click on the Done, Process these Changes Button. This will save your changes and display your project's phases in the left hand pane of STEP 3 (see Figure 18).

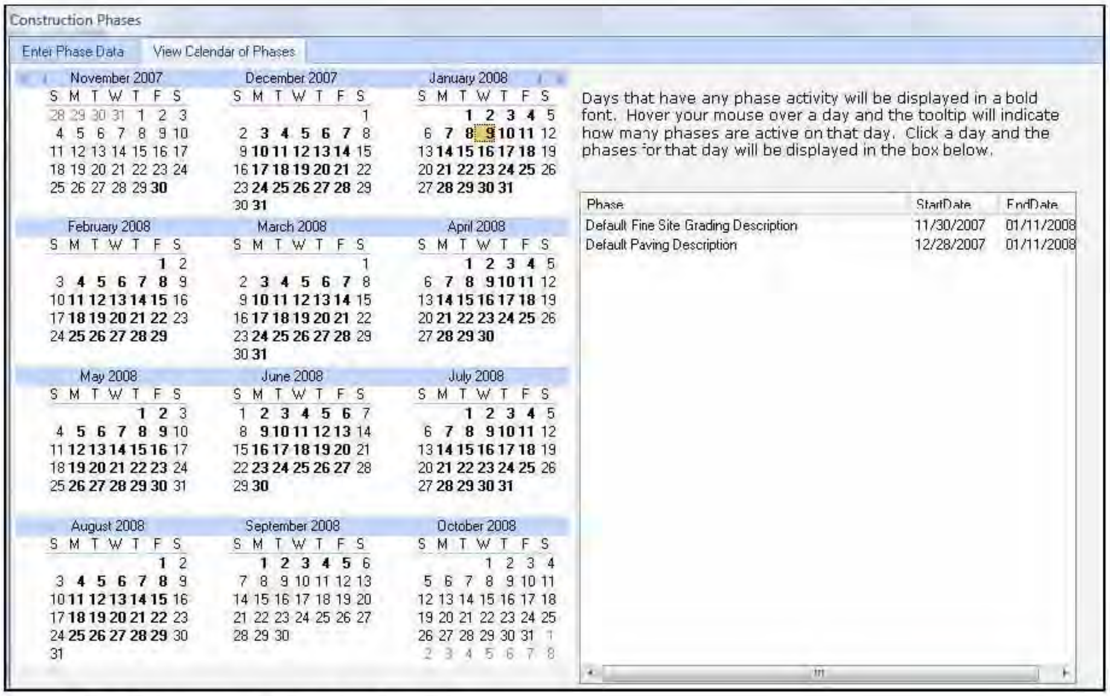

Figure 17. Construction Calendar of Phases

Figure 18. Seven Phase Example with Demolition Screen Showing

Demolition

Figure 18 shows the construction phasing in the left hand window pane. In this example, the demolition line has been selected, resulting in the first demolition tab being shown in the right hand pane. In this screen, the user is required to enter the volume of the building that will be demolished. URBEMIS then uses that information to estimate the amount of truck vehicle miles traveled needed to haul the demolished material away.

URBEMIS also generates estimates of the demolition equipment that would be needed to demolish the building. That estimate is based on the acreage of the demolition project. Figure 19 shows that URBEMIS estimates 3 excavators and 2 rubber tired dozers will be used in this demolition project. The user can change those values by entering different numbers in the column labeled Amt Model Uses (Click to Sort). For example, assume for your project that only 2 excavators and 2 rubber tired dozers would be used during demolition. You can enter the 2 in the third column. The user is cautioned, however, that URBEMIS will automatically override any values you enter if you change any land use values (STEP 2) unless you uncheck the box in the first column.

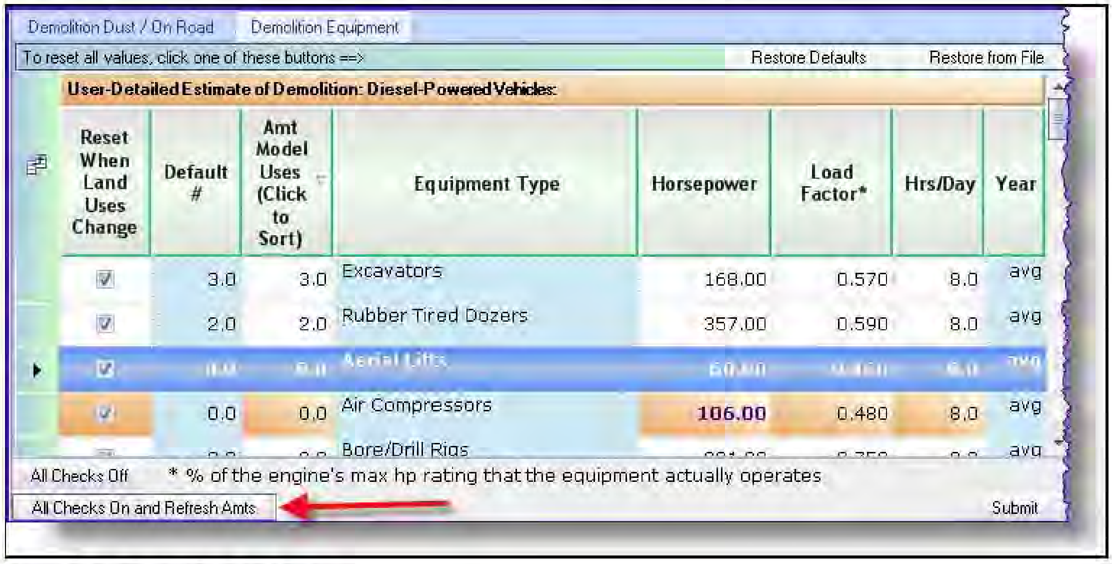

Figure 19. Demolition Equipment

Fine Site Grading

Figure 20 shows the first of the four tabs in the fine grading screen. This screen shows the acreage estimates that URBEMIS uses to estimate fugitive dust and fine site grading equipment emissions. The total acreage to be graded and maximum daily acreage disturbed estimates are shown at the bottom of the page.

URBEMIS uses the acreages entered in the residential and non-residential land use screens. For non-residential land uses, URBEMIS assumes that acreage is twice the size of the building square footage, unless the values are overridden by the user. URBEMIS also assumes that the maximum daily acreage disturbed is 25 percent of total acreage to be graded.

The user should change the maximum daily acreage disturbed value if they know that their project would have different values. The user should also be aware that if the maximum daily acreage disturbed value is changed, URBEMIS will reset that value whenever a land use is modified (STEP 2) unless the reset acreage with land use changes box has been unchecked (see arrow at bottom right of Figure 20).

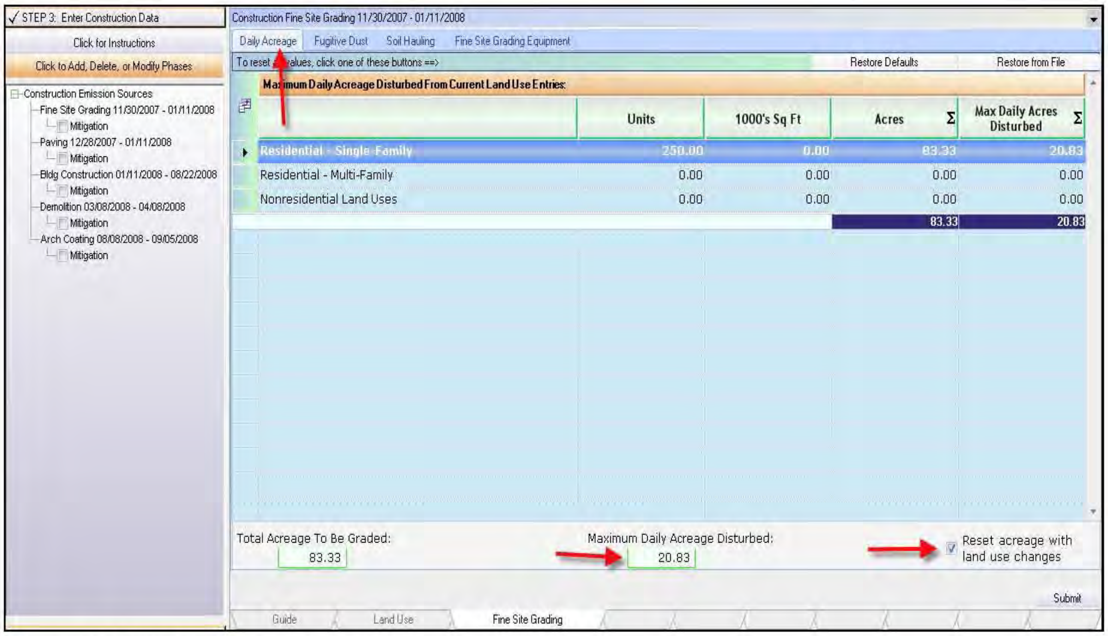

Figure 20. Construction Fine Grading

Figure 21 shows the Fine Site Grading tab. URBEMIS automatically estimates the number and type of construction equipment based on the maximum daily acreage disturbed (Daily Acreage tab). The amount of construction equipment the model uses can be overridden by the user. However, unless the box in column 1 is turned off, the amount of equipment entered by the user will change whenever the maximum daily acreage disturbed value changes. (See also Appendix H for the equipment list).

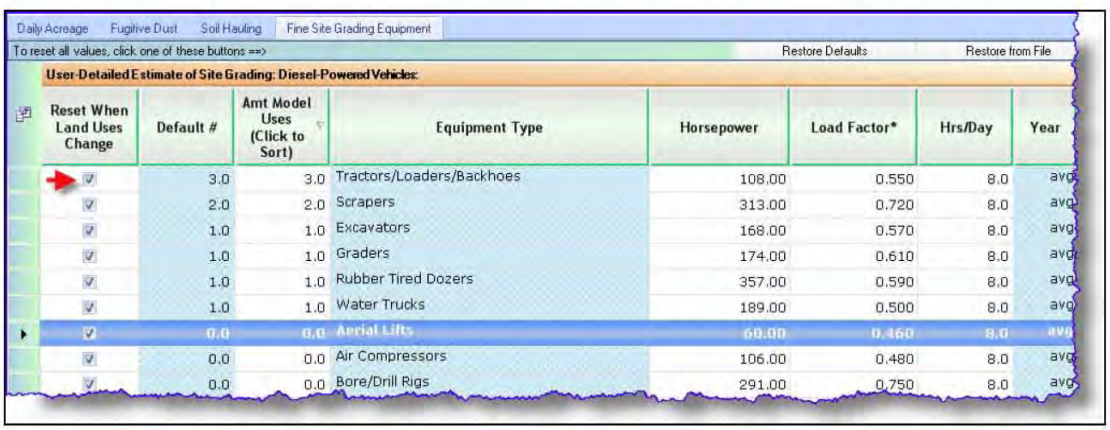

Figure 21. Fine Site Grading

Mass Site Grading

The mass site grading phase works identically to the fine site grading phase. Please refer to the fine site grading discussion above for more information.

Trenching

Trenching typically consists of digging trenches for installation of natural gas and water pipelines, and electric conduit. If trenching is selected as a phase, URBEMIS generates estimates of trenching equipment type and number based on the amount of disturbed acreage per day. URBEMIS uses 25% of the total project acreage (as entered on the land use screens) and determines the trenching equipment use based on the equipment values shown in Appendix H.

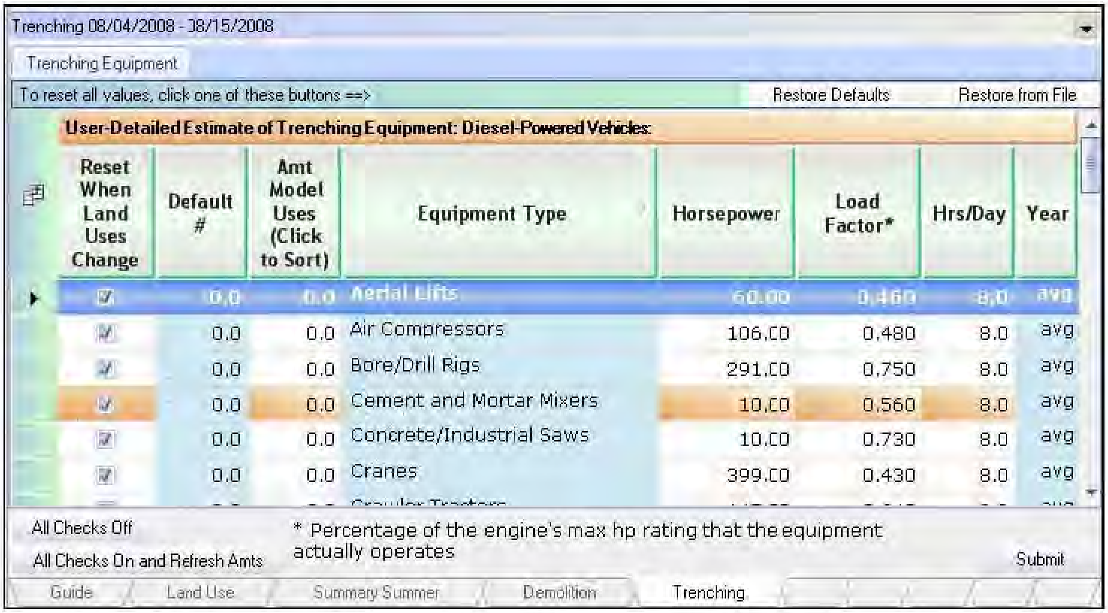

Figure 22. Trenching

Building Construction

Figure 23 shows the first tab of the building construction phase: worker trips. Two additional tabs are available, vendor trips and construction equipment. All of the values in each tab can be modified by the user. URBEMIS estimates on-road worker trips and vendor trips based on the values in these two tabs and on the land uses entered by the user.

URBEMIS uses 25% of the total project acreage (as entered on the land use screens) and determines the construction equipment use based on the equipment values shown in Appendix H.

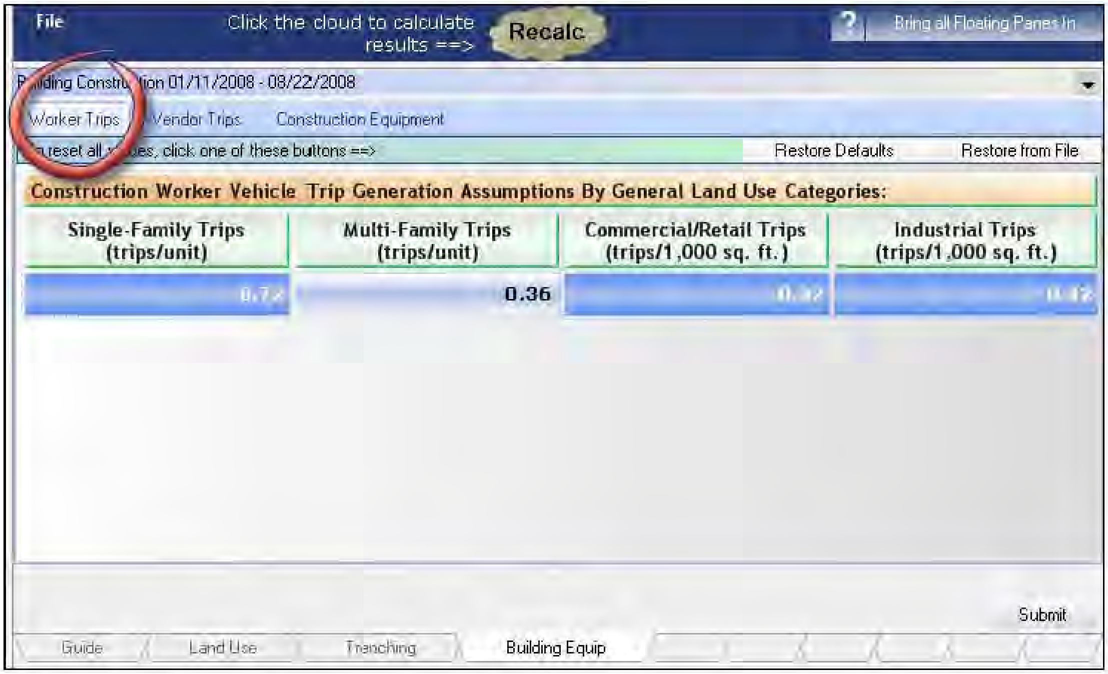

Figure 23. Building Construction

Asphalt

URBEMIS estimates asphalt emissions associated with asphalt off-gassing, asphalt off-road and on-road equipment, and worker trips. Figure 24 shows the first tab of the two asphalt paving tabs. Circled in red is URBEMIS' best estimate of the total acreage to be paved with asphalt. That value equals 25% of the total building project acreage. This value should be overridden if a more accurate, project-specific value is available. The user should understand that, to reset the default acreage, the "Reset Acreage with Land Use Changes" value box must be unchecked. Otherwise, URBEMIS will replace the user entered number with the URBEMIS generated number whenever land uses is modified.

The user can also select the Paving Equipment tab. URBEMIS will generate estimates of paving equipment based on total acreage to be paved. As with off-road construction equipment shown in other phases such as fine site grading, URBEMIS generates estimates of construction equipment that can be overridden by the user.

Figure 24. Asphalt Paving

Architectural Coating

When the user selects architectural coatings, the VOC content for each of four coating types are displayed. The VOC content is based on architectural coatings rules that have been developed by each air district. Consequently, they cannot be modified by the user.

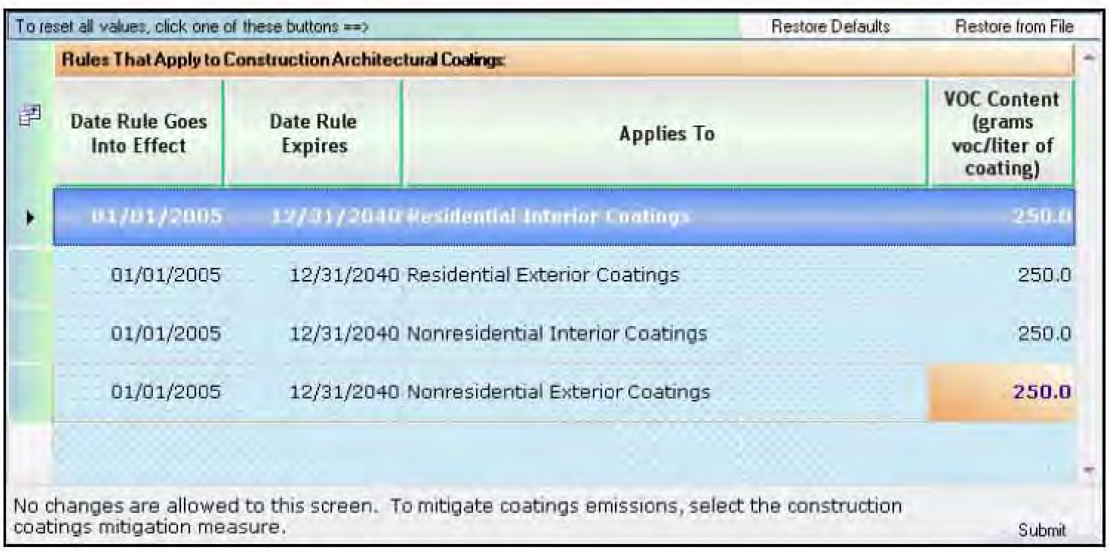

Figure 25. Architectural Coatings

Construction Mitigation Measures

Construction mitigation measures include measures to reduce fugitive dust and off-road construction emissions. URBEMIS2007 allows the user to identify specific mitigation measures for individual classes of construction equipment. Figure 26 shows the mitigation measures that can be selected for fine site grading. In this example, the excavator line has been checked to show the types of mitigation measures allowed for excavators. The options include use of aqueous diesel fuel, diesel particulate filters, and diesel oxidation catalysts. The user needs to turn on each mitigation measure that applies. In addition, several of the mitigation measures have drop down boxes (arrow on far right in Figure 26) that allows the user to select the stringency of each mitigation measure.

Construction Equipment Exhaust

The mitigation measure shown in Figure 26 works in the same way for all construction phases that have off-road construction equipment, which includes six of the seven phase types (does not include architectural coatings). However, the mitigation measures must be selected separately for each phase.

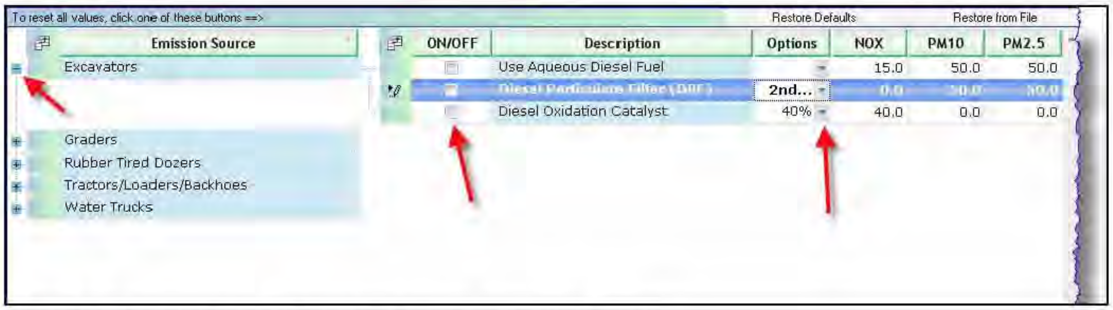

Figure 26. Construction Equipment Exhaust Mitigation Measures

Fugitive Dust Mitigation

Both fine and mass site grading also include methods to mitigated fugitive dust generated by travel on unpaved roads and by soil disturbance from off-road equipment operating on a construction site. To specify mitigation, the user needs to enter a check in on/off column for each mitigation measure that applies (see Figure 27). By clicking on the Unpaved Roads Mitigation tab, the user can also select those mitigation measures that apply.

Figure 27. Soil Disturbance Mitigation

Figure 28 shows the architectural mitigation measures screen. The user simply turns on one or more of the four percentage reductions that apply. The user can also edit the ROG percent reduction.

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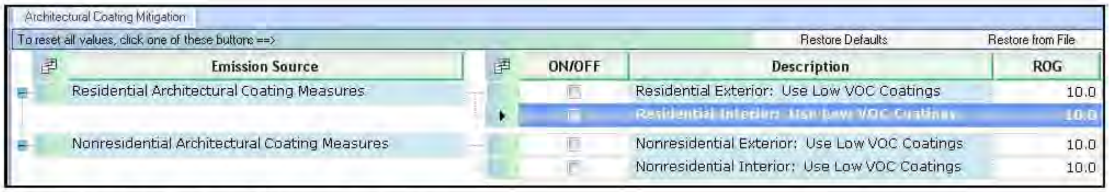

Figure 28. Architectural Coatings Mitigation

STEP 4 – Enter Area Source Data

The "Area-Source Emission" screen allows you to estimate area-source emissions for up to five categories of emission sources. Figure 29 lists those five categories in the left hand column. Three of these five categories are fuel combustion related: natural gas, hearths, and landscape maintenance. Two categories, consumer products and architectural coatings, consist of evaporative emissions. The emission factors and equations used by URBEMIS2007 to estimate area-source emissions are described in detail in Appendix B.

Figure 29. STEP 4 – Area Source Screen with Natural Gas Combustion Selected

Natural Gas Combustion

Figure 29 shows STEP 4 after the Natural Gas Fuel Combustion line has been selected in the left column. By double-clicking on the Natural Gas Fuel Combustion line, the screen on the right is presented. It shows the default values associated with this category. None of these values need be changed unless project specific information is available.

Hearth Fuel Combustion

Clicking on the second item in the left column, Hearth Fuel Combustion, results in the screen shown in Figure 30. URBEMIS shows the percentages of wood stoves, wood fireplaces, natural gas fireplaces associated with the project (assuming the project includes residential units). For projects that include no residential units, the Hearth Fuel Combustion category generates no emissions. The user can opt to change the percentages of the hearth categories, though they must total to 100 percent. (The user should also be aware that the hearth percentages screen looks slightly different for projects in the San Joaquin Valley. This is because the percentages are specified by the San Joaquin Valley Air Pollution Control District's wood fuel combustion rule.)

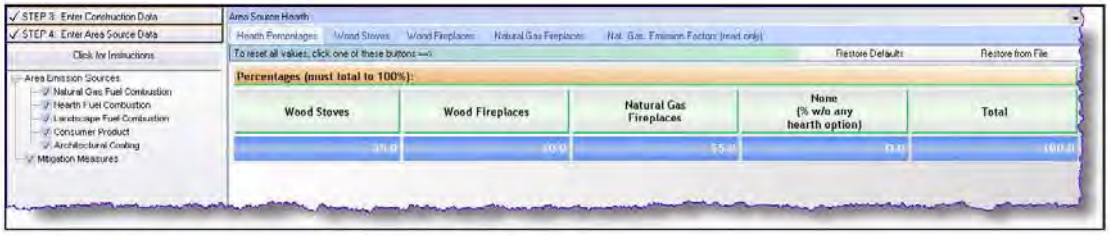

Figure 30. Area Source Hearth Fuel Combustion Screen

Wood Stoves

The Hearth Fuel Combustion category also includes additional tabs for wood stoves, wood fireplaces, natural gas fireplaces, and natural gas emission factors. Figure 31 shows the wood stoves tab. The screen shows emission factors (pounds of pollutant per ton fuel burned) by stove type, the percentage of each stove type assumed by URBEMIS, and, at the bottom of the screen, the amount of wood burned per stove each year, the number of days each stove is used, and pounds of wood per cord. All of these values except the emission factors can be modified by the user.

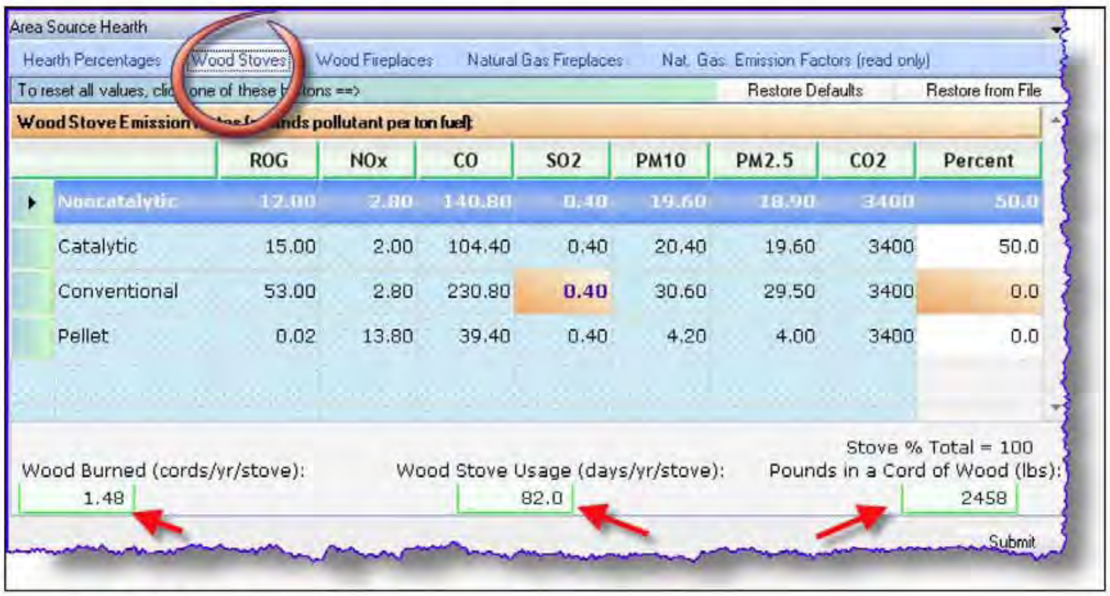

Figure 31. Wood Stoves Screen

Fireplaces

Figure 32 shows the wood fireplaces tab. It is similar to the wood stoves tab in that all of the values except the emission rates can be modified by the user. The user is cautioned about revising any of these values, however, because they represent defaults set by the individual air districts.

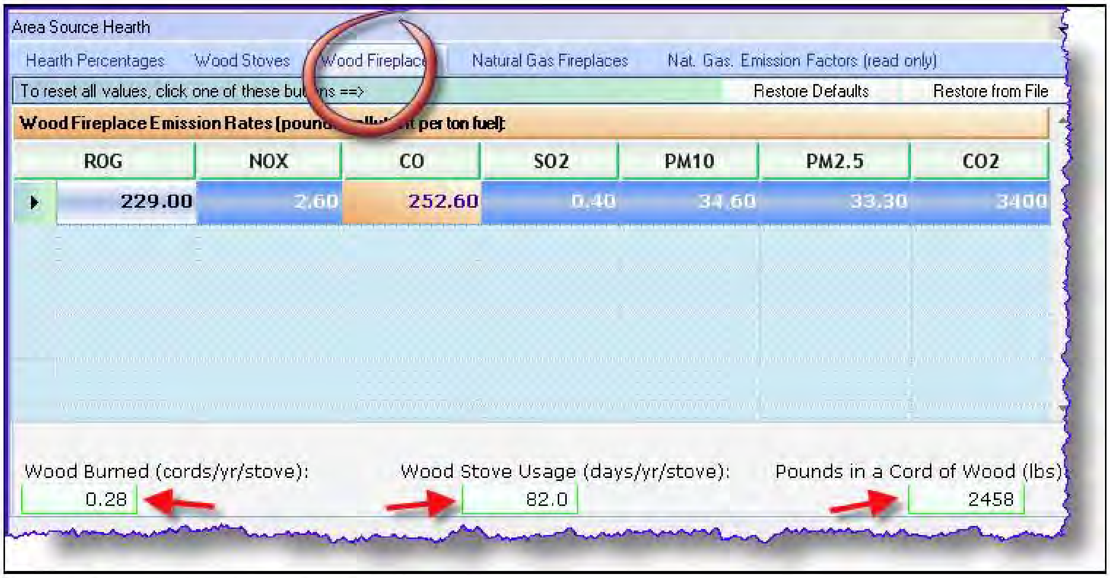

Figure 32. Wood Fireplace Screen

Natural Gas Fireplaces

Figure 33 shows the natural gas fireplace tab. This screen shows the default fireplace use information for single family and multi family fireplaces. These values can be modified by the user. The natural gas fireplace emission factors, which are in the fourth tab, cannot be modified by the user.

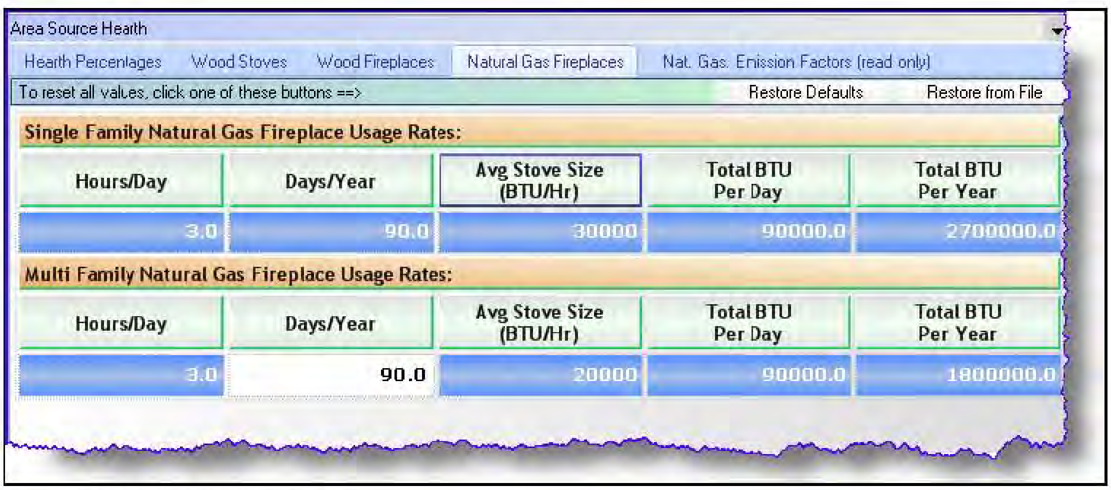

Figure 33. Natural Gas Fireplaces

Landscape Equipment Fuel Combustion

Figure 34 shows the screen when landscape equipment fuel combustion has been selected. Only one screen is available, which shows data for the length of the summer period and the year being analyzed. Landscape emissions can only be calculated for the summer period. Both of these values can be modified by the user. The year being analyzed should be consistent with the project's operational year.

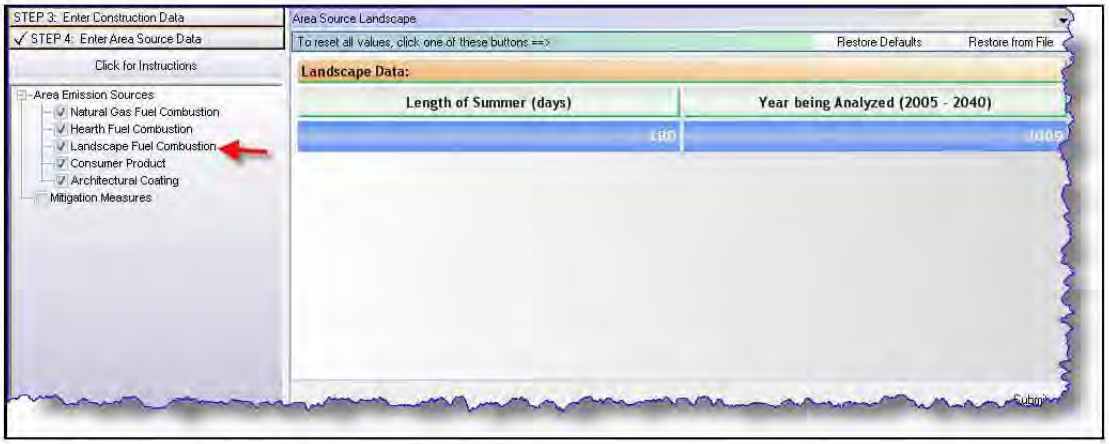

Figure 34. Landscape Fuel Combustion

Consumer Products

Figure 35 shows the consumer product screen. This screen includes the pounds of ROG emitted per person per day and the number of persons per residential unit. Consumer product emissions are only generated for residential land uses.

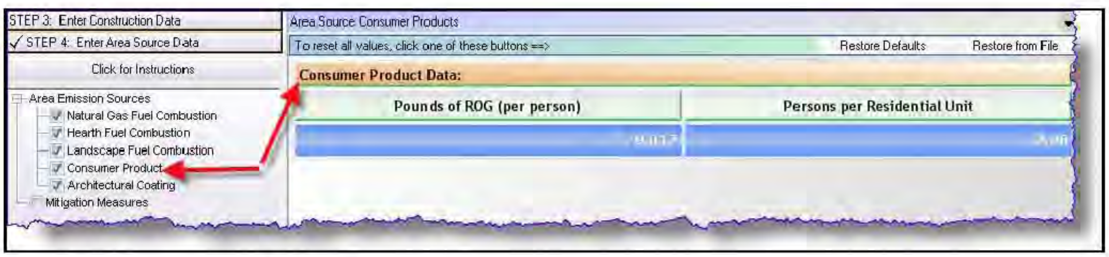

Figure 35. Consumer Products

Architectural Coatings

The last emission category for Step 4. Area Sources is architectural coatings. Architectural coatings is similar to architectural coatings included in construction (Phase 3), except that here a percentage of the buildings are assumed to be repainted each year. As a default, URBEMIS assumes 10% of residential and non-residential building surface area is repainted each year. These percentages can be modified by the user. The coatings rules upon which emission estimates are based, cannot be modified.

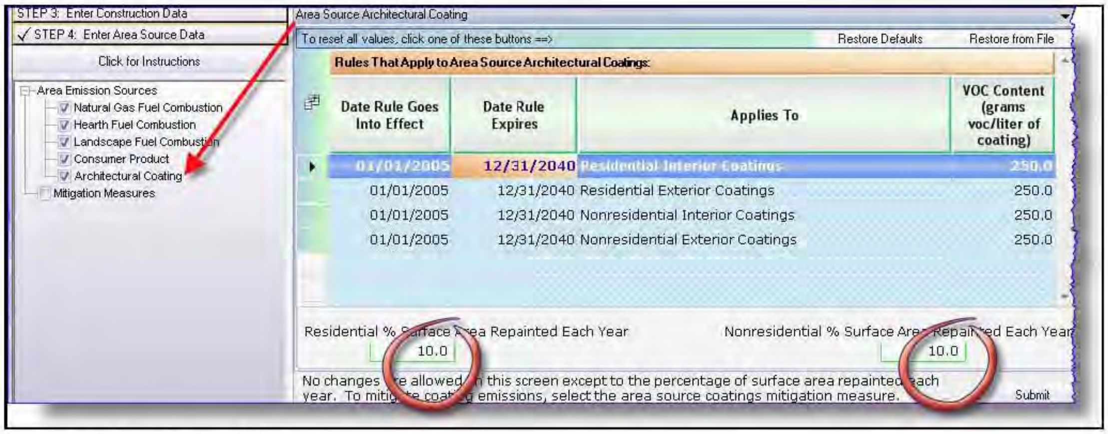

Figure 36. Architectural Coatings

Area-Source Mitigation Measures

From the "Area Source" main menu, you may select area-source mitigation measures by clicking the "Mitigation Measures" checkbox in the left pane list. This action forces URBEMIS2007 to display the area source mitigation measures in the right pane. The user can select one of three tabs in the right hand pane: Energy Efficiency, Landscape, or Architectural Coating. (A fourth tab for hearths is available for projects located within the San Joaquin Valley Air Basin.)

Energy Efficiency Mitigation

Figure 37 shows the Energy Efficiency tab. Users can turn on residential, commercial, and/or industrial energy efficiency mitigation and modify the % increase in efficiency.

Figure 37. Energy Efficiency Mitigation Measures

Landscape Maintenance Equipment Mitigation

The second tab (see Figure 38) consists of landscape maintenance mitigation measures. Users can turn on the residential and/or commercial/industrial mitigation measures and alter the percentage of applicable equipment.

Figure 38. Landscape Mitigation Measures

Architectural Coatings Mitigation

Figure 39 shows the architectural coating mitigation tab. The user can select a % reduction of VOC for one or more of four coating types. The user can also modify the percentage reduction.

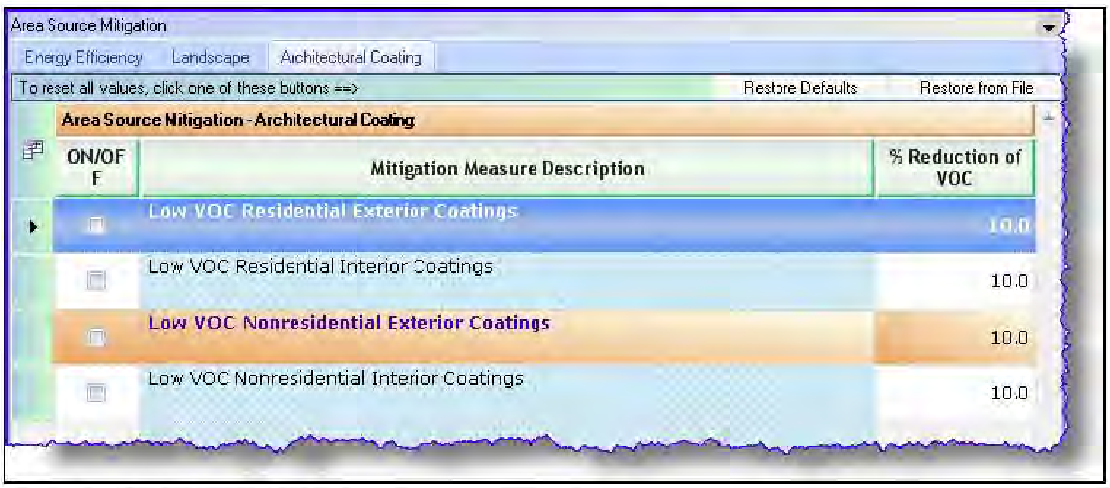

Figure 39. Architectural Coating

STEP 5 – Enter Operational Data

Step 5 involves entering operational data so as to generate estimates of on-road vehicle emissions. Figure 40 shows Step 5 in the left hand pane. Under Step 5, seven lines are listed under Operational Emission Sources, ignoring Mitigation Measures. Clicking on the first of those seven lines, Year & Vehicle Fleet, results in the screen shown on the right in Figure 40.

The user should be sure that the project start year is correct (see arrow in Figure 40). Changing the project start year also changes the fleet mix. URBEMIS uses the fleet mix information included in the EMFAC2007 files to generate the fleet mix estimates. For example, if the user changes the project start year to 2020 (and the project is in Los Angeles County), then URBEMIS goes to the 2020 Los Angeles County EMFAC file to obtain the average fleet mix for that location and year. For certain project types, the user may want to use a fleet mix that differs from the average vehicle fleet mix. For example, a project may consist of an industrial land use with 80 percent heavy-heavy duty truck trips. In that situation, the user should click on the check mark to the right of the year. That check box reads "Keep Current Fleet Mix When Changing Years". If that check box is turned on, then URBEMIS will not update the fleet mix hat a user has entered if the user opts to change the year.

For each vehicle type, there are three fuel/technology classes: non-catalyst (gasoline), catalyst (gasoline), and diesel. Within the right pane, you can modify any of the fleet percentages or fuel/technology classes. The total fleet percentage must total to 100. Also, for each vehicle type, the three fuel/technology classes must subtotal to 100 percent.

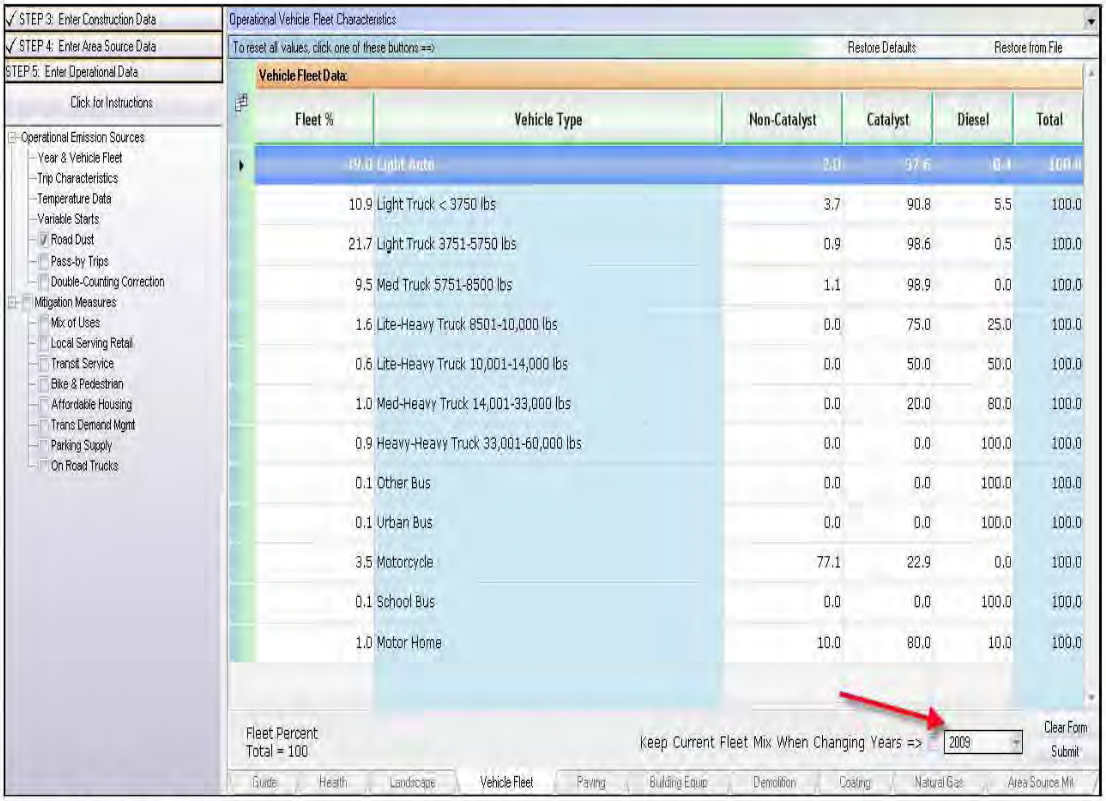

Figure 40. Operational Emissions Entry Screen

Trip Characteristics

The "Trip Characteristics" screen can be modified by clicking on the "Trip Characteristics Settings" node in the left pane. This action displays the trip characteristics in the right pane. Several pieces of information are contained in the "Trip Characteristics" screen: average trip speeds, trip percentages, and trip lengths for six different trip types (home-based work trips, home-based shopping trips, home-based other trips, work trips, commercial-based non-work trips, and commercial-based customer trips) (see Figure 41). The trip characteristics screen also includes an urban/rural project checkbox in the lower left hand corner. URBEMIS uses the urban trip lengths if the urban project check box is turned on, rural trip lengths if the rural project box is checked.

Note that the "Trip Characteristics" screen allows you to enter the trip percentages for home-based trips, which must total 100 percent. However, this same screen does not permit you to enter trip percentages for commercial-based trips. Instead, commercial-based percentages are calculated separately by URBEMIS2007 for each nonresidential land use selected in the "Land Use" screens.

The "% Worker Commute" information from the land use screens corresponds to the commercial-based commute work trip value. The commercial-based commute trip percentage is then used to estimate commercial-based non commute work trip and customer based trip percentages for each land use. If the commercial-based commute trip value exceeds 50 percent, then the commercial-based non commute trip percentage equals 100 percent minus the commute trip percentage, multiplied by 50 percent. If the commercial-based commute trip value is less than 50 percent, then the commercial-based non commute trip percentage equals one half of the commercial-based commute trip value. Finally, for each land use, customer based trips are assumed to equal the 100 percent minus the total of the commercial commute and non commute percentages.

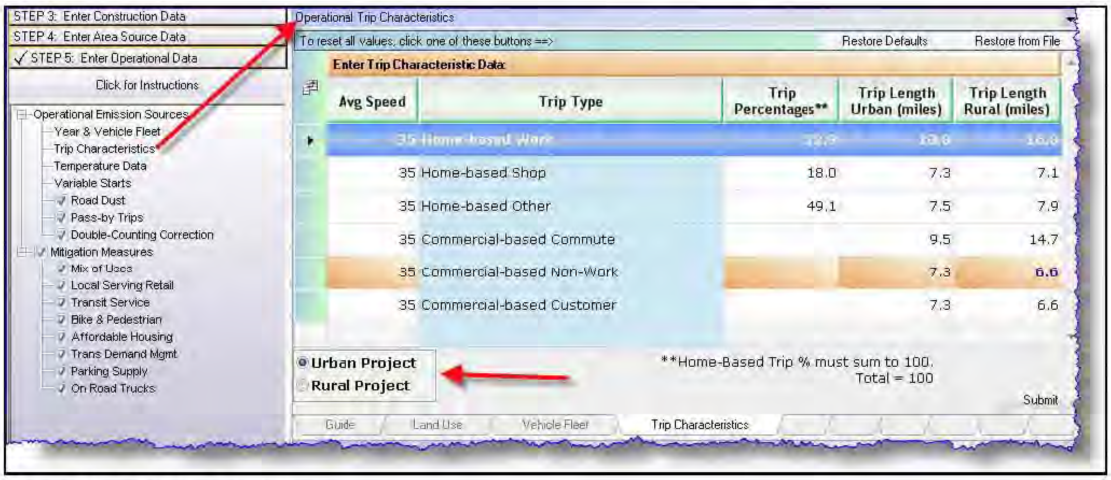

Figure 41. Trip Characteristics

Temperature Data

By clicking on the temperature data in the left pane, temperature options are presented in the right pane. You have the option of modifying both winter and summer ambient temperatures, which are used to estimate winter and summer emission estimates and which correspond to the summer versus winter gasoline specifications used in California outside of the South Coast Air Basin (greater Los Angeles).

Variable Starts

You may modify the "Variable Starts" information by clicking on the "Variable Starts" settings button shown in the left pane. This action causes URBEMIS2007 to display variable starts information in the right pane. That screen includes information on "Variable Start Percentages by Trip Type and Time since Engine Stopped". EMFAC2007 requires the vehicle engine shut-off percentages for 18 time increments, ranging from 5 minutes to 720 minutes. The information provided in this screen by trip type represents statewide averages of pre-start cool-down profiles from an ARB analysis of the 1991 California Department of Transportation household travel survey. These percentages should not be modified unless better information is available.

Road Dust

You may turn the Road Dust option on or off by clicking the check box in the left pane. This action will also display in the right pane information on "Entrained Road Dust Emissions". You have the option to modify the distribution of travel between paved and unpaved roads. You also have the option to modify the paved road or unpaved road defaults by clicking on the accompanying tabs.

If you click on the "Change Paved Road Defaults..." tab, you are taken to the "Paved Road Dust Emissions" screen. From within that screen, you may modify the default emission factors and percentage of travel for each of four road types.

You may also click on the "Change Unpaved Road Defaults" tab, where URBEMIS2007 will display the "Unpaved Road Dust Emissions" screen. From this screen, you can select either the U.S. EPA methodology for calculating emissions or you can use the California Air Resources Board's emission factor. If you select the U.S. EPA methodology, you are allowed to modify one or more of the five variables used to estimate unpaved road dust emissions.

Pass-by Trips

You may select the "Pass-By Trips" button from the left pane list. When you select "Pass-By Trips", no optional information is presented in the right pane. Selecting the "Pass-By Trips" button allows URBEMIS2007 to calculate emissions from vehicle trips that are generally lower than estimates without the pass-by trip option. The pass-by trip algorithm is described in Appendix C.

Double Counting

Another option available to URBEMIS2007 users is to adjust for double-counting.. The double-counting adjustment is designed to reduce double counting of internal trips between residential and nonresidential land uses. Consequently, selecting this option is available only when you have selected both residential and nonresidential land uses. You must click the check box in the left pane where URBEMIS2007 displays the "Double Counting Correction".

Then you are shown the number of residential and nonresidential trips that would be generated based on the land uses selected (see example in Figure 42). You are given the option of entering the number of internal trips between residential and nonresidential land uses. The value entered represents the number of internal trips that will not be included in the emissions estimate. This value can often be obtained from a traffic report prepared for the project.

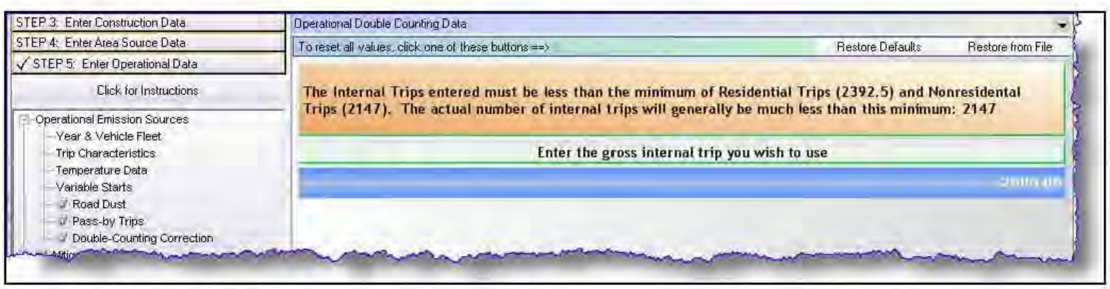

Figure 42. Double Counting Correction

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Operational Mitigation Measures

Operational mitigation relies on a variety of smart growth measures that reduce the number of vehicle trips. From within STEP 5, you have the option of turning on operational mitigation measures by selecting one or more of eight optional "Mitigation Measures" options in the left pane (see Figure 43):

- Mix of uses
- Local serving retail
- Transit use
- Bike and pedestrian
- Affordable housing
- Transportation demand management
- Parking supply; and
- On-Road Trucks

Each of these is briefly described below. A much more detailed description is included in Appendix D.

Mix of Uses Mitigation

Figure 43 shows the Mix of Uses screen when the Mix of Uses line has been selected in the left hand pane. The following procedure is used to adjust trip generation rates as a function of the mix of land uses for any particular project.

Trip reduction = (1- (ABS (1.5 * h e) / (1.5 * h + e)) 0.25) / 0.25 * 0.03

Where: h = study area households (or housing units)
e = study area employment.

This formula assumes an "ideal" housing balance of 1.5 jobs per household and a baseline diversity of 0.25. The maximum possible reduction using this formula is 9%. Negative reductions of up to 3% can result when the housing to jobs ratio falls to levels less than the baseline diversity of 0.25. This reduction takes into account overall jobs-population balance.

The number of households or housing units and employment should be based on the area located within a 1/2 mile radius of the project's center.

In the example shown in Figure 43, the user has entered 500 residential uses located within ½ of the proposed project (which includes the 250 units from the project) and a study area employment of 750.

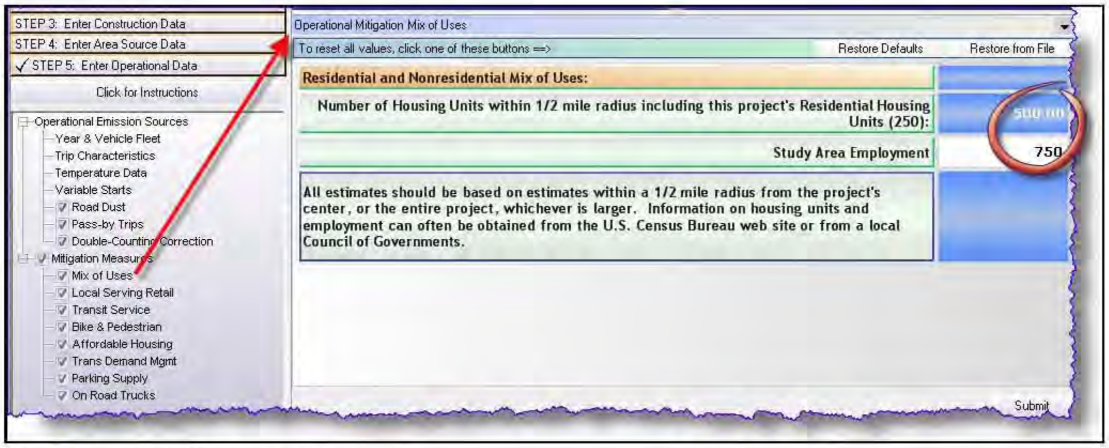

Figure 43. Mix of Uses Mitigation

Operational Local Serving Retail Mitigation

The presence of local serving retail can be expected to bring further trip reduction benefits, and an additional reduction of 2% is assumed. This is towards the lower end of the values presented in the research, in order to avoid double counting with the diversity indicator.

Operational Transit Mitigation

The Transit Service Index emphasizes frequency but with greater weighting given to rail services. Greater weight is also given to dedicated shuttles, in recognition of the fact that these are likely to be more closely targeted to the needs of the development. Information on transit availability and frequency can be obtained from transit agency maps and schedules.

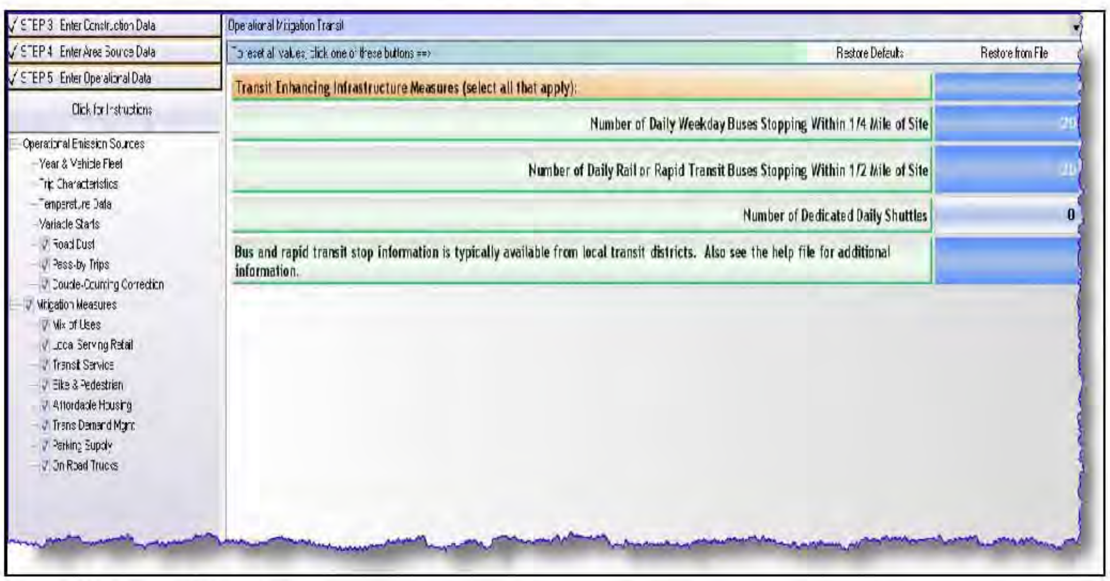

Figure 44. Transit Mitigation

The Transit Service Index is determined as follows:

- Number of average daily weekday buses stopping within 1/4 mile of the site; plus
- Twice the number of daily rail or bus rapid transit trips stopping within 1/2 mile of the site; plus
- Twice the number of dedicated daily shuttle trips;
- Divided by 900, the point at which the maximum benefits are assumed. (This equates to a BART station on a single line, plus four bus lines at 15-minute headways.)

Developments that are larger than 0.5 miles across in any direction must be broken into smaller units for purposes of determining the transit service index. The average of all units would then be used.

The figure shown below provides some examples of how service frequencies translate into Transit Service Index scores (note these are additive, if a location has more than one component).

Example Transit Service Index Scores

Transit Service	Score	Assumptions
BART (single line)	0.33	150 trips per day (15-20 minute headways in each direction from 4 AM-12 AM)
15-minute bus	0.17	4 buses per hour
30-minute bus	0.06	2 buses per hour
Amtrak San Joaquin	0.03	6 trips per day in each direction
Dedicated commute shuttle	0.02	5 trips per commute period (single direction)

As well as existing service, planned and funded transit service should be included in the calculation. Purely demand responsive service should not be included. A maximum trip reduction of 15% is assumed.

To account for non-motorized access to transit, half the reduction is dependent on the pedestrian/bicycle friendliness score. This ensures that places with good pedestrian and bicycle access to transit are rewarded.

*Trip reduction = t * 0.075+ t * ped/bike score * 0.075*

Where: t = transit service index

Operational Bike and Pedestrian Mitigation

Figure 45 shows the bike and pedestrian mitigation screen. The user must enter information on the project's number of intersections per square mile, the percent of streets with sidewalks on one or both sides, and the percent of arterials/collectors with bike lanes.

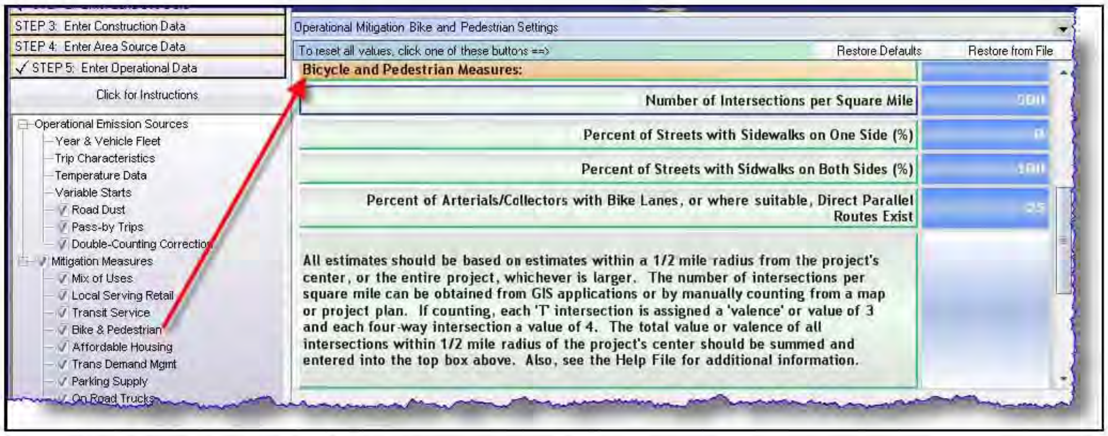

Figure 45. Bike and Pedestrian Mitigation

The pedestrian/bicycle factor is calculated as follows:

Ped/bike factor = (network density + sidewalk completeness + bike lane completeness) / 3

Where: Network density = intersections [sum of valences] per square mile / 1300 (or 1.0, whichever is less)

Note: In most GIS applications, intersections are counted based on the number of line segment terminations, or each "valence." Intersections have a valence of 3 or higher. A valence of 3 is a "T" intersection, 4 is a four-way intersection. Therefore, if intersections are counted manually on a map or project plan, care needs to be taken to distinguish between 3-, 4- and 5-way intersections, and factor them up accordingly. The 1,300 value roughly equates to a dense grid with four-way intersections every 300 feet. Intersections with dedicated routes for pedestrians and/or bicyclists should be included in this calculation.

*Sidewalk completeness = % streets with sidewalks on both sides + 0.5 * % streets with sidewalk on one side*

Bike lane completeness = % arterials and collectors with bicycle lanes, or where suitable, direct parallel routes exist

A maximum reduction of 9% is assumed. The trip reduction is calculated as:

*Trip reduction = 9% * ped/bike factor*

No reduction is allowed if the entire area within a half-mile walk of the project center consists of a single use. (Note that this applies to a half-mile walk, rather than straight-line distance, to account for barriers such as freeways.) However, the ped/bike factor can still be used to calculate pedestrian access to transit, as part of the transit mitigation measure.

Information on the number of intersections can be obtained from street plans or maps. Information on sidewalk completeness and bike lane completeness can be obtained from site observations or from aerials such as those obtainable from http://terraserver.microsoft.com or from Google's Google Earth software.

Operational Affordable Housing Mitigation

It is difficult if not impossible to account for the exact incomes of residents in URBEMIS, most obviously because the occupants are not known at the pre-development stage. However, the percentage of deed-restricted below-market-rate (BMR) housing does offer a way to incorporate this effect.

URBEMIS assumes a 4% reduction in vehicle trips for each deed-restricted BMR unit. Thus, the total reduction is as follows:

Trip reduction = % units that are BMR * 0.04

A development with 20% BMR units would thus gain a 0.8% reduction. A development with 100% BMR units would gain a 4% reduction.

Operational Transportation Demand Management

Figure 46 shows the first of three transit demand management screens: parking and transit passes. Figures 47 and 48 show the remaining two screens, telecommuting, and other transportation demand measures.

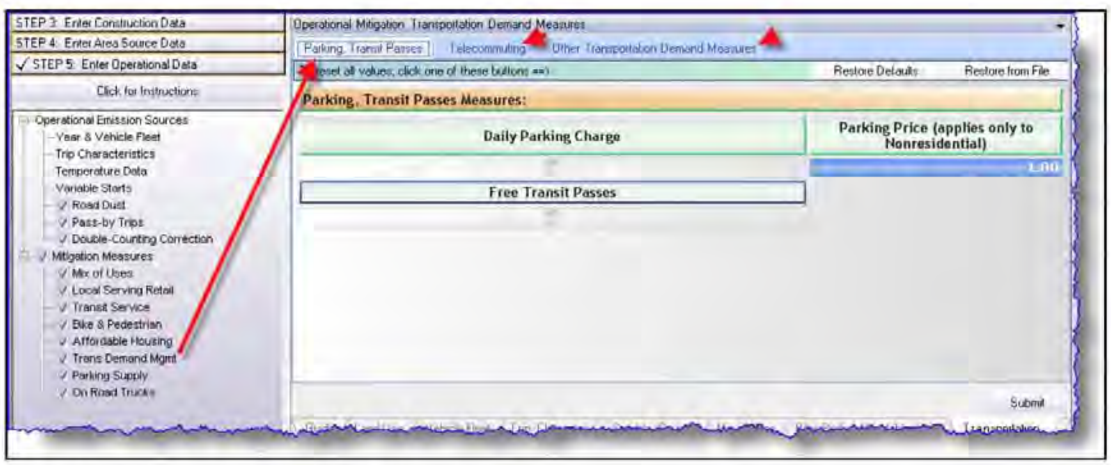

Figure 46. Transportation Demand Management

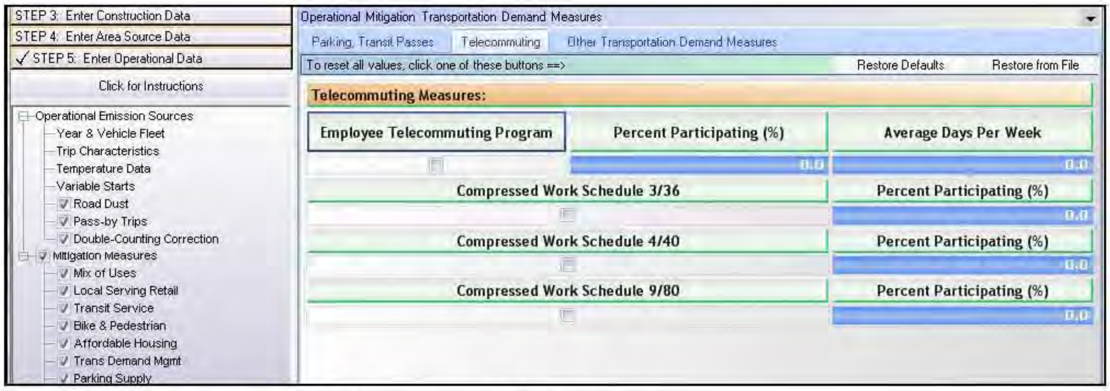

Figure 47. Transportation Demand Management – Telecommuting

Figure 48. Transportation Demand Management – Other Transportation Demand Measures

Daily Parking Charge

URBEMIS assumes a maximum trip reduction of 25% for projects that commit to introducing parking pricing. The maximum reduction applies to prices of $6 per day or greater (in 2004 dollars).

The trip reduction will therefore be as follows:

*Trip reduction = daily parking charge / 6 * 0.25*

If the parking charge is more than $6, the 25% reduction is taken. If parking charges do not apply to all trips to a site (e.g. customers are exempt), the reduction is pro-rated by the percentage of trips that the charges apply to. If little or no on-site parking is provided, the parking charges are applied to those of surrounding public facilities.

Free Transit Passes
Some California transit agencies, most notably VTA in Santa Clara County, have EcoPass or similar programs, whereby employers or property managers bulk-purchase transit passes for (free) distribution to their employees or tenants. Eco Pass programs have been shown to increase transit ridership by 50-79% and reduce vehicle trips by 19%. (Note that many of these new riders were making new trips, or ones previously made by walking or cycling.)

We therefore recommend that any project committing to providing free transit passes would receive an additional credit equivalent to 25% of the reduction granted for transit service. Thus, the credit is more valuable in places that have good transit service. This reduction only applies to the portion of trips generated by those granted the free transit passes (e.g. residents and/or employees, but excluding shoppers and other visitors).

Telecommuting
As with the reductions for other mitigation measures, there must be an enforceable commitment (e.g. development agreement) for telecommuting programs, which cover both the take-up rate (employees actually telecommuting or using compressed work schedules) as well as the provision of the option.

The percentage reduction is not additive (in contrast to most other trip reduction measures). For example, if 20% of employees telecommute, and other trip reduction measures are estimated to reduce vehicle trips from 1,000 to 800 per day, the 20% reduction is applied to the 800 trips, not the original 1,000.

Other TDMs
Other TDM program elements that do not include financial incentives tend to have a smaller impact on travel behavior. Trip and associated emission reductions for other TDMs selected within URBEMIS are based on the number of the following elements incorporated into the program.

- Secure bicycle parking (at least one space per 20 vehicle parking spaces)
- Showers/changing facilities
- Guaranteed Ride Home
- Car-sharing services
- Information on transportation alternatives, such as bus schedules and bike maps
- Dedicated employee transportation coordinator
- Carpool matching programs
- Preferential carpool/vanpool parking

The impact of a TDM program also depends on the travel alternatives available. A program will have more impact if the site is served by frequent transit, for example (although note that a TDM program can do much to promote carpooling even in other locations). For this reason, part of the TDM credit is used to adjust the credits granted for transit service and pedestrian/bicycle friendliness (see table below).

Recommended TDM Program Reductions

Level	Number of Elements	Trip Reduction
Major	At least 5 elements	2%, plus 10% of the credit for transit and pedestrian/bike friendliness
Minor	At least 3 elements	1%, plus 5% of the credit of transit and pedestrian/bike friendliness
No program	Less than 3	None

Operational Parking Supply Mitigation

The parking supply mitigation measure uses the Institute of Transportation Engineers Parking Generation, 3rd Edition handbook as the baseline. It applies only to non-residential land uses. The trip reduction is calculated as follows:

Trip reduction = 1- (Actual parking provision / (ITE Parking Generation rate * # units)

Since ITE parking generation rates use the same land use codes as the trip generation rates, URBEMIS calculates the ITE estimated values of parking demand. The user is only required to enter the actual parking provision for each land use.

The Parking Generation handbook covers most common land uses. For some land uses, however, no parking generation rates are available: in these cases, this particular mitigation measure may not be used. Those land uses without parking generation rates include:

- City Park
- Gas/Service Station

To avoid double counting with other trip reduction measures, the impacts of parking supply are assessed in conjunction with all other non-residential trip reduction measures as follows:

The total of all other non-residential trip reduction measures is used if this is greater than or equal to the trip reduction from parking supply measures. For example, if parking supply is reduced 10% from ITE levels, and transit, mixed use and pedestrian/bicycle trip reductions amount to 20%, the 20% figure is used.

If the total of all other non-residential trip reduction measures (r1) is less than the trip reduction from parking supply measures (r2), the total trip reduction is as follows:

$$r1 + 0.5 * (r2 - r1)$$

In effect, the parking supply reduction is only used if it is greater than the impact from other trip reduction measures, and the difference is discounted by 50%. For example, if parking supply is reduced 25% from ITE levels, and transit, mixed use and pedestrian/bicycle credits amount to 15%, the total reduction would be:

$$15 + 0.5 * (25-15) = 20\%.$$

This reduction should only be granted if measures to control overspill are in place, such as Residential Permit Parking programs, time limits or meters.

Operational On-Road Truck Mitigation

For project applicants wishing to provide on-road mitigation for diesel trucks, the applicant has two choices.

The first choice requires that the user enter an estimate of the pounds per day and tons per year emission reductions associated with the project. This information will typically be provided as a result of consultation with the applicable air district. The district-approved emission reductions should be entered into the operational mitigation: on-road trucks screen.

The second choice requires that the user select a mitigation measure by diesel truck (or bus) fleet type category. This mitigation measure will only be applied to truck trips associated with non-residential land uses and only to the non-commute portion of those trips. Each mitigation measure has a specific emission reduction percentage applied to it. The user also has the option of entering their own mitigation and the associated emission reduction by pollutant class (ROG, NOx, CO, SO2, and PM10). The percentage reductions are only applied to the percentage of diesel vehicles within each truck class.

STEP 6 – View and Print Output

As mentioned earlier, to view and print output in Step 6, you do not need to proceed through each proceeding step. Instead, once you have entered one or more land uses, the Recalc button appears at the top of the screen (see Figure 49). This button, in the form of a dirty cloud, should be clicked to generate emission estimates. Once the Recalc button has been pressed, URBEMIS generates emission estimates that appear as part of Step 6 (see Figures 50 and 51).

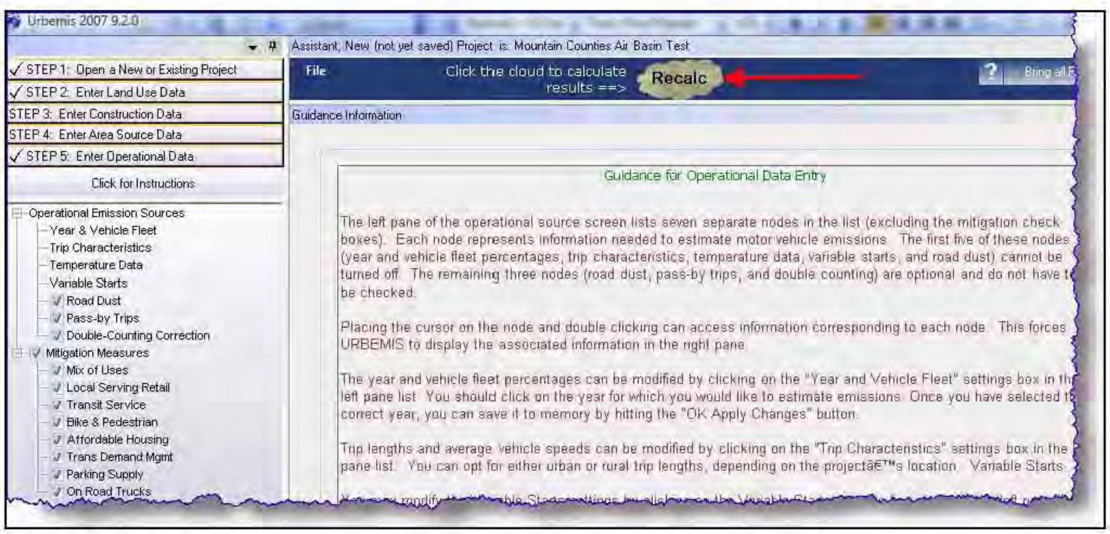

Figure 49. Recalc Button

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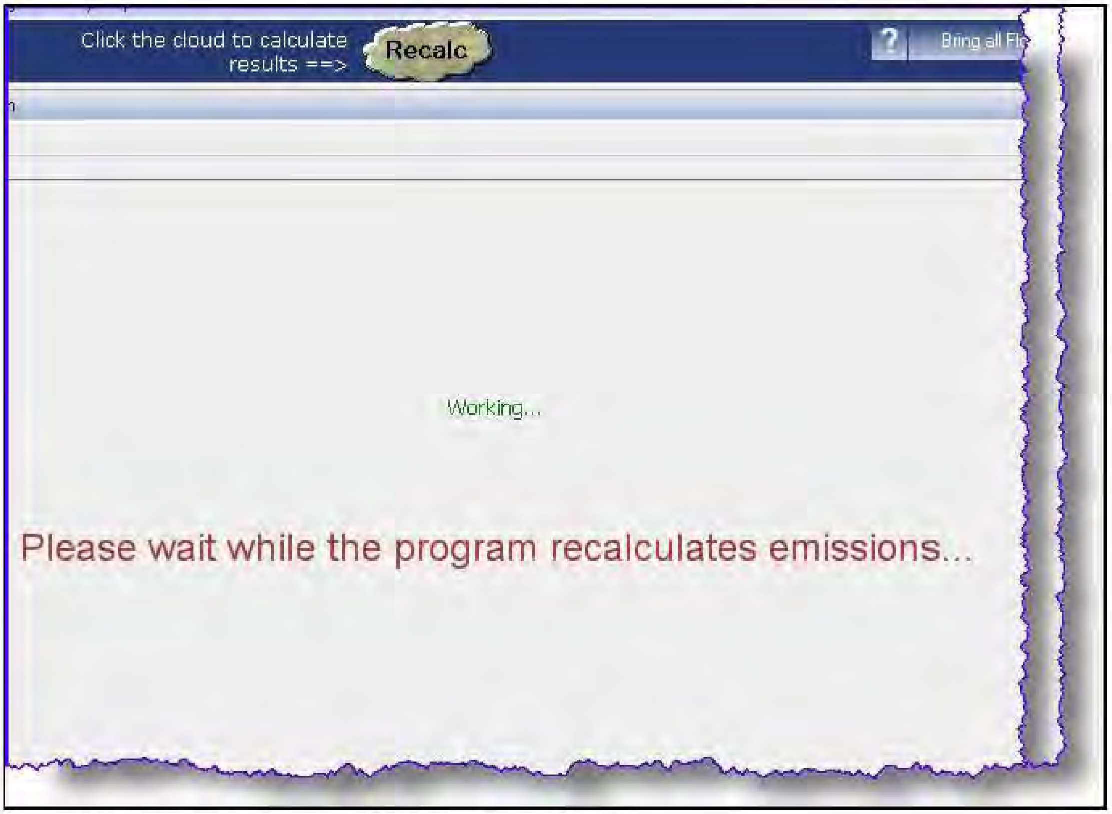

Figure 50. URBEMIS Recalculating After Recalc Pressed

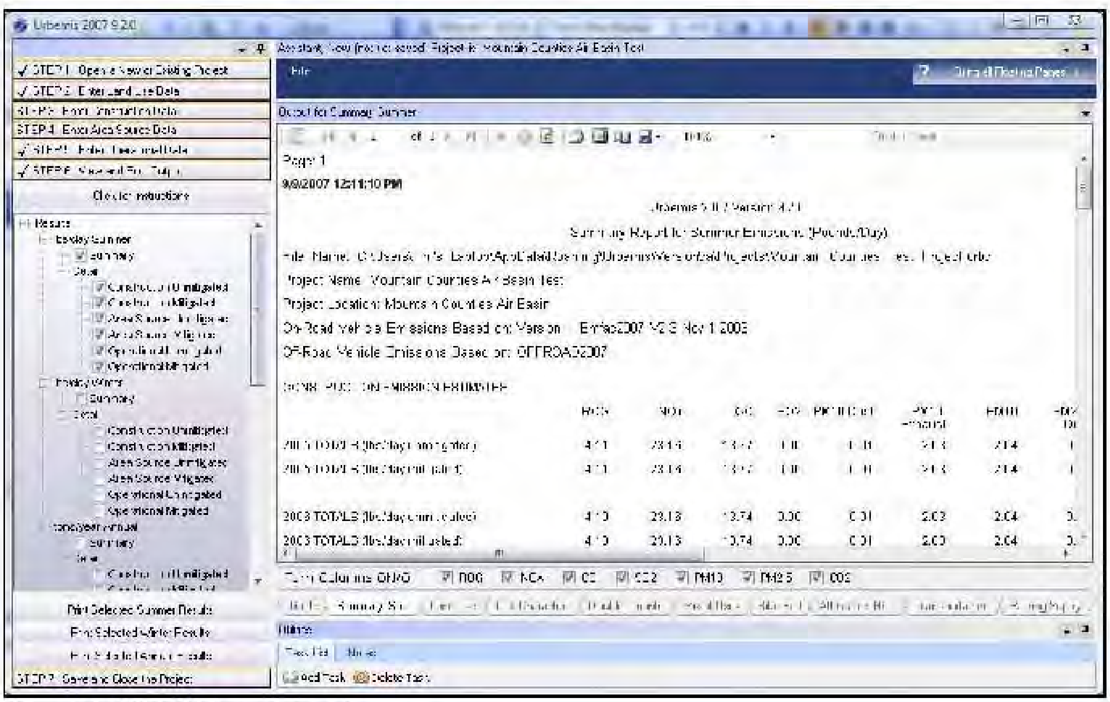

Figure 51. URBEMIS Recalc Results

As Figure 51 shows, when the Recalc button has been pressed, URBEMIS generates emission estimates and automatically shows the Summer summary results in the right hand pane. Double-clicking on any of the print results lines in the left hand pane forces URBEMIS to calculate emissions for that option. For example, if you click on the Construction Unmitigated line under lbs/day Winter, URBEMIS displays winter construction emissions in the right hand pane.

Figure 52 shows winter construction emissions. In this example, all pollutants except ROG, NO, and CO2 have been turned off. Pollutant can be turned off by unchecking them, as shown in the bottom of Figure 52 in the highlighted area. Also, the first time slice has been expanded by clicking the plus sign to the left of time slice. In addition, the asphalt phase in that time slice has been expanded to show the individual components of asphalt emissions (see red arrows in highlighted area). Time slices are described in detail in Appendix A.

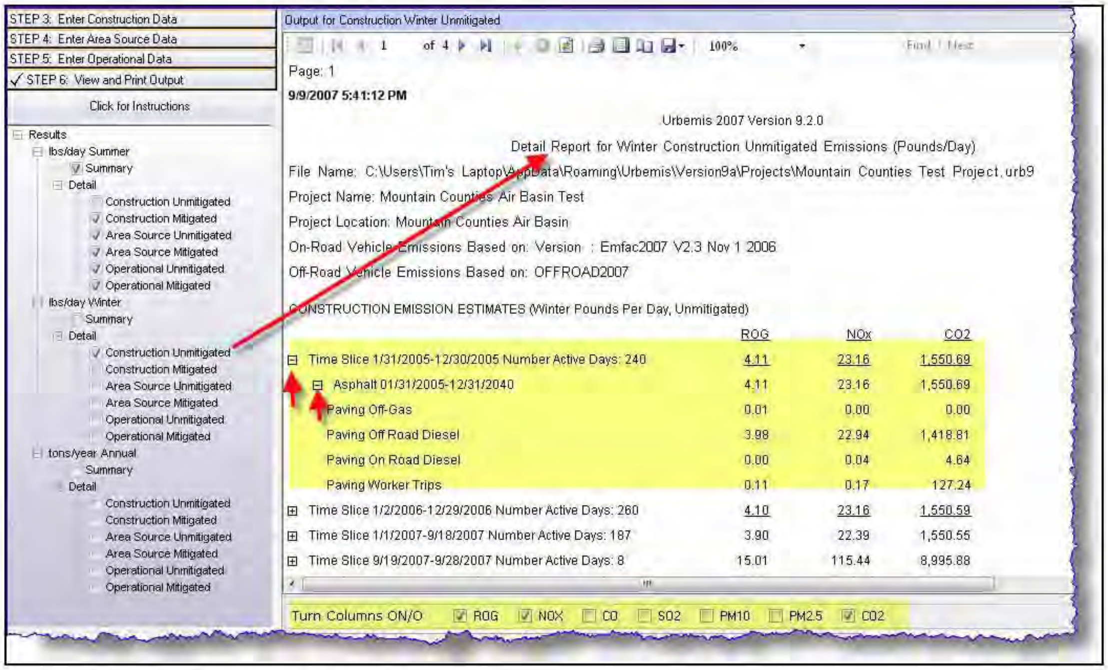

Figure 52. Winter Construction Emissions Results

URBEMIS also allows the user to send one or more of the items checked in the left hand pane to a single report that will be shown in the right hand pane. Three separate reports can be run: summer, winter, and annual. Figure 53 shows printing of the selected summer results. All of the summer emission categories have been checked (highlighted area). Then the Print Selected Summer Results button was clicked, which generated the report in the right hand pane.

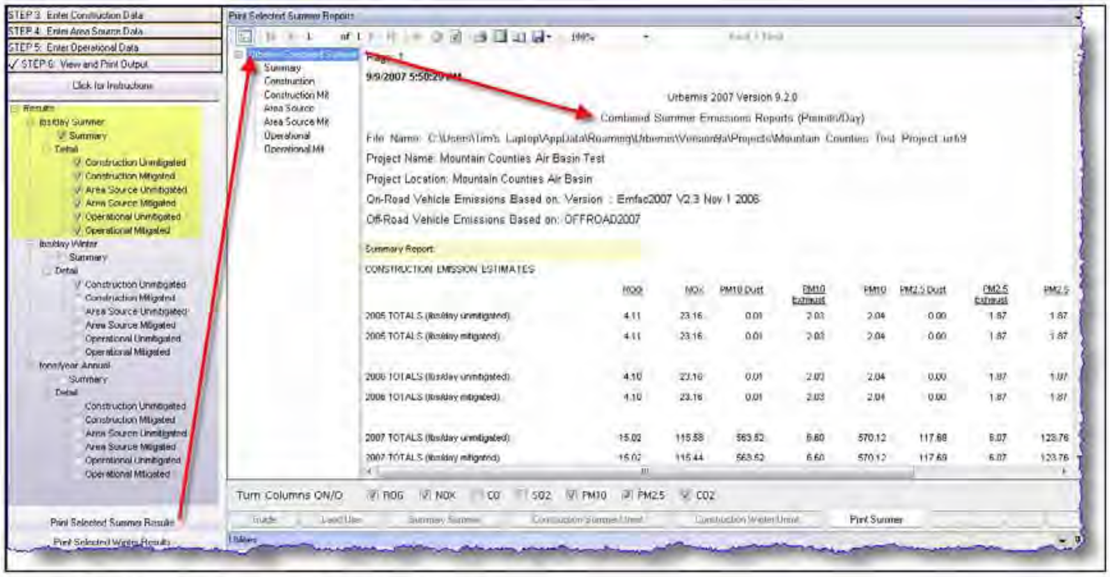

Figure 53. Combined Summer Emission Results

Printing Reports

Once a report has been generated and is displayed in the right hand pane, it can be sent to a printer, to an Excel file, or to a PDF file. Figure 54 illustrates how to print a report. First, click on the printer icon, shown circled. This will pop up the print window, which allows you to select a printer destination. Please note that you cannot print to a text file with URBEMIS2007. Once you have selected your printer destination and printer preferences (such as two sided printing), you must hit the apply button, then the print button.

Excel or PDF Reports

Although URBEMIS2007 does not allow a report to be sent to a text file, you can send it to either a PDF or Excel file by selecting the blue diskette icon, denoted with a arrow in the top line of Figure 54.

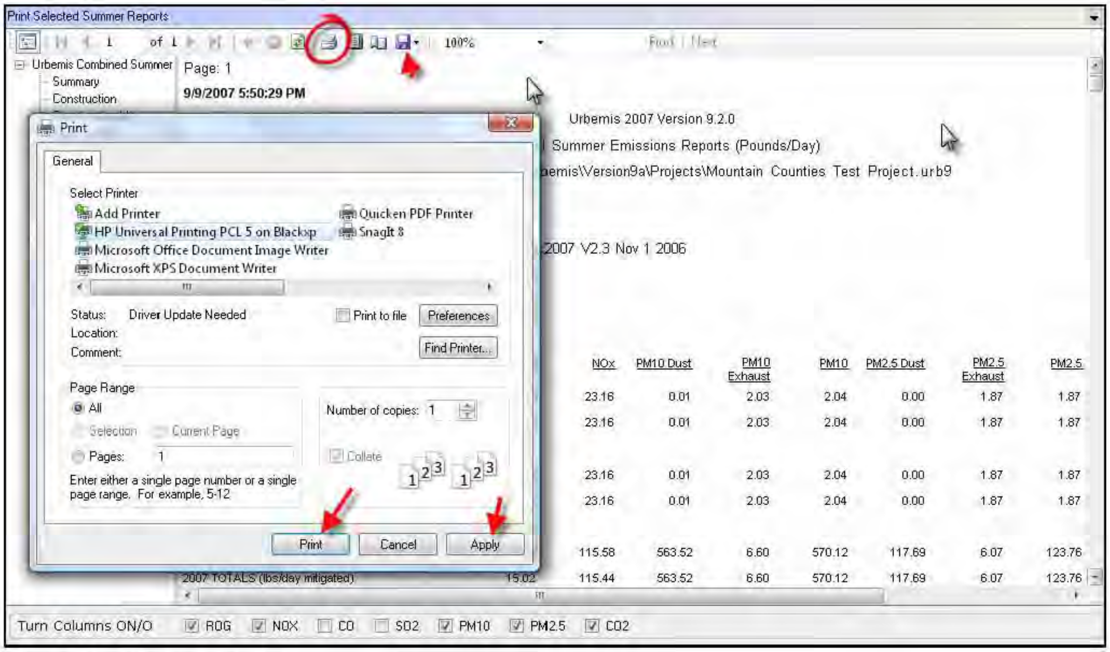

Figure 54. Printing a Report

STEP 7 – Save and Close the Project

Saving and/or closing a project is straightforward in URBEMIS2007. Clicking on Step 7 – Save and Close the Project results in the screen shown in Figure 55. A project can be saved with the current name, as a different project (with different name), or URBEMIS can be closed and exited. If you opt to close the project and you have turned on the "Save on Closing, Without a Prompt", then URBEMIS will save the current project with the current project name. Also, if you opt to just "X" out of the program by hitting the x in the top right hand corner of the program, the project will automatically be saved with the current project name.

Figure 55. Saving and Closing a Project

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Response to Comment No. 11-44

The Software User's Guide: URBEMIS2007 for Windows presented above is outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" with respect to cumulative impacts within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5.

However, this document is referenced in the DEIR. (See DEIR Volume I, Sections 4.2.5.1, 4.7.3.1, 4.7.5.2, 4.7.5.3.)

Comment Letter No. 11 (continued)

Comment No. 11-45

Appendix A. Construction Emissions

TABLES

Introduction

URBEMIS2007 allows users to generate estimates of construction emissions (inhalable particulate matter [PM10], fine particulate matter [PM2.5], carbon monoxide [CO], reactive organic gases [ROG], sulfur oxides [SOx], oxides of nitrogen [NOx]), and carbon dioxide [CO_2]. Emissions can be estimated as pounds per day or tons per years. The construction pounds per day estimates for summer versus winter do not differ.

URBEMIS includes seven phases:

1) Demolition
2) Fine Site Grading
3) Mass Site Grading
4) Trenching
5) Building Construction
6) Architectural Coating
7) Paving

Emissions are estimated separately by phase and by phase component. The user can opt to estimate emissions for any single phase or combination of phases. Each phase can be scheduled to overlap with other phases or to occur independently. Each independent grouping of emissions is called a time slice. When starting a new project, URBEMIS automatically assumes that specific phases would be used and assumes the start and end dates for each phase. Those phases can be deleted, and/or their start and end dates can be modified. Also, additional phases can be added.

Two or more phases of the same type can be added. For example, two demolition phases can be added, but each must have a unique set of start and end dates. As mentioned earlier, each phase has several components. Each of those components is assumed to generate emissions throughout the entire phase length. The seven phases and their associated components are identified in Table A-1.

Table A-1. URBEMIS Default Construction Phases, Phase Lengths, and Equipment Estimates

Phase	Off-Road Fugitive Dust	Off-Road Constructi on Exhaust	On-Road Vehicle Exhaust	Worker Trips	Vendor Trips	Off-Gassing
Demolition	X	X	X	X		
Mass Site Grading	X	X	X	X		
Fine Site Grading	X	X	X	X		
Trenching		X		X		
Asphalt		X	X	X		X
Building Construction		X	X	X	X	
Architectural Coatings				X		X

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Table A-1 shows the phases and their individual components. There are six unique components that include:

- off-road fugitive dust,
- off-road construction equipment,
- on-road exhaust,
- worker trips,
- vendor trips and
- off-gassing.

Six of the seven phases include off-road construction emissions. Only architectural coatings do not include emissions from off-road construction equipment. All seven phases include emissions associated with worker trips.

Time Slices

A time slice represents a period of days when daily emissions are constant. A different time slice occurs whenever there is a change in a project's average daily emissions. This most typically happens when two phases overlap but can also occur when the same phase crosses over into a different year.

Table A-2 shows three separate time slices. The first time slice of nine active days results when trenching occurs without any other construction activities. The second time slice of six active days occurs when trenching and fine site-grading overlap. Emissions for this second time slice are the combination of fine grading and trenching. The third time slice of 14 days occurs when fine site grading occurs without any other construction activities.

Table A-2. Time Slice Example

Construction Unmitigated Detail Report:

CONSTRUCTION EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

	ROG	NOx	CO	SO2	PM10 Dust
Time Slice 11/19/2007-11/29/2007 Active Days: 9	1.52	15.78	4.65	0.00	0.00
Trenching 11/19/2007-12/08/2007	1.52	15.78	4.65	0.00	0.00
Time Slice 11/30/2007-12/7/2007 Active Days: 6	23.44	219.33	109.68	0.00	49,721.62
Fine Grading 11/30/2007-01/11/2008	21.92	203.55	105.03	0.00	49,721.62
Trenching 11/19/2007-12/08/2007	1.52	15.78	4.65	0.00	0.00
Time Slice 12/10/2007-12/27/2007 Active Days: 14	21.92	203.55	105.03	0.00	49,721.62
Fine Grading 11/30/2007-01/11/2008	21.92	203.55	105.03	0.00	49,721.62

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Each phase within a time slice contains individual components that make up that phase. The procedure used to estimate emissions for each component of each phase is described below.

Demolition Emissions

Demolition Dust

If the user chooses to estimate construction emissions, the user will be prompted to select the types of construction emissions that they would like to estimate. If the user selects demolition emissions, then the user is prompted to enter the total volume of all buildings to be demolished and the maximum volume of all buildings to be demolished in a single day. URBEMIS2007 calculates the total days required to complete demolition activities.

The following equation is used to estimate daily PM10 generated by demolition:

*PM10 (pounds/day) = (0.00042 pounds of PM10 / feet3) * (N * O * P) / Q.*

Where: N = building width (feet)
O = building length (feet)
P = building height (feet)
Q = number of days required to demolish the building(s).

This equation is based on Table A9-9-H of the South Coast Air Quality Management District's (SCAQMD's) California Environmental Quality Act (CEQA) Air Quality Handbook (South Coast Air Quality Management District 1993).

URBEMIS2007 does not provide default information on building dimensions slated for demolition. The user must provide URBEMIS2007 with that information.

Demolition On-Road Diesel Exhaust

URBEMIS estimates exhaust emissions from the construction equipment used in demolition, including the on-road vehicles used to haul demolished materials to the nearest landfill. Based on information provided by the user regarding the building volume to be demolished, URBEMIS generates default information regarding demolition hauling. The user can override that information.

For example, URBEMIS assumes a hauling round trip of 20 miles and a truck capacity of 20 cubic yards unless overridden by the user. Similarly, URBEMIS generates a default estimate of the number of round trips required per day using the following equation:

*Round trips/day = Total yd^3 to be demolished/days demolition * 0.25 * trip/20 yd^3*

The user must enter total cubic yards to be demolished. The number of days required for demolition is calculated using the demolition phase length entered by the user. The number of round trips per day and the vehicle miles traveled per day are based on the maximum daily volume of material to be demolished (reduced by 75% to account for air space), the truck capacity, and the miles per round trip. Maximum daily emissions are obtained from EMFAC2007 and are estimated by multiplying VMT by the grams per mile emissions for heavy-heavy duty trucks traveling at the commercial customer average speed found in the Operational Trip Characteristics screen.

Demolition – Off Road Diesel Exhaust

In addition to truck hauling, demolition emissions are generated by the operation of other construction equipment, such as concrete saws, cranes, and bulldozers. The URBEMIS user is presented with a list of construction equipment, as shown in Table A-3. Default values for these types of equipment are generated by URBEMIS using information found in the equipment selection spreadsheet shown in Appendix H. The user can and should override the default values if project specific information is available.

Table A-3. Construction Equipment Used for Demolition

To reset all values, click one of these buttons ==> Restore Defaults Restore from File

User-Detailed Estimate of Site Grading: Diesel-Powered Vehicles:

Reset When Acreage Changes	Default #	Amt Model Uses (Click to Sort)	Equipment Type	Horsepower	Load Factor*	Hrs/Day	Year
☑	0.0	0.0	**Aerial Lifts**	60.00	0.460	8.0	avg
☑	0.0	0.0	Air Compressors	[illegible]	[illegible]	[illegible]	avg
☑	0.0	0.0	Bore/Drill Rigs	291.00	0.750	8.0	avg
☑	0.0	0.0	Cement and Mortar Mixers	10.00	0.560	8.0	avg
☑	0.0	0.0	Concrete/Industrial Saws	10.00	0.730	8.0	avg
☑	0.0	0.0	Cranes	399.00	0.430	8.0	avg
☑	0.0	0.0	Crawler Tractors	147.00	0.640	8.0	avg
☑	0.0	0.0	Crushing/Processing Equip	142.00	0.780	8.0	avg
☑	0.0	0.0	Dumpers/Tenders	16.00	0.380	8.0	avg
☑	0.0	0.0	Excavators	168.00	0.570	8.0	avg
☑	0.0	0.0	Forklifts	145.00	0.300	8.0	avg
☑	0.0	0.0	Generator Sets	549.00	0.740	8.0	avg
☑	0.0	0.0	Off Highway Tractors	267.00	0.650	8.0	avg
☑	0.0	0.0	Off Highway Trucks	479.00	0.570	8.0	avg
☑	0.0	0.0	Other Equipment	190.00	0.620	8.0	avg

	☑	0.0	0.0	Other General Industrial	238.00	0.510	8.0	avg
	☑	0.0	0.0	Other Material Handling	191.00	0.590	8.0	avg
	☑	0.0	0.0	Pavers	100.00	0.620	8.0	avg
	☑	0.0	0.0	Paving Equipment	104.00	0.530	8.0	avg
	☑	0.0	0.0	Plate Compactors	8.00	0.430	8.0	avg
	☑	0.0	0.0	Pressure Washers	1.00	0.600	8.0	avg
	☑	0.0	0.0	Pumps	53.00	0.740	8.0	avg
	☑	0.0	0.0	Rollers	95.00	0.560	8.0	avg
	☑	0.0	0.0	Rough Terrain Forklifts	93.00	0.600	8.0	avg
	☑	0.0	0.0	Rubber Tired Loaders	164.00	0.540	8.0	avg
	☑	0.0	0.0	Scrapers	313.00	0.720	8.0	avg
	☑	0.0	0.0	Signal Boards	15.00	0.780	8.0	avg
	☑	0.0	0.0	Skid Steer Loaders	44.00	0.550	8.0	avg
	☑	0.0	0.0	Surfacing Eqipment	362.00	0.450	8.0	avg
	☑	0.0	0.0	Sweepers/Scrubbers	91.00	0.680	8.0	avg
	☑	0.0	0.0	Trenchers	63.00	0.750	8.0	avg
	☑	0.0	0.0	Welders	45.00	0.450	8.0	avg
	☑	1.0	1.0	Graders	174.00	0.610	6.0	avg
	☑	1.0	1.0	Rubber Tired Dozers	357.00	0.590	6.0	avg
	☑	1.0	1.0	Tractors/Loaders/Backhoes	108.00	0.550	7.0	avg
	☑	1.0	1.0	Water Trucks	189.00	0.500	8.0	avg

For each piece of equipment selected, URBEMIS generates an emission estimate. The emission equation used by URBEMIS for each piece of equipment is as follows:

Equipment Emissions (pounds/day) = # of pieces of equipment * grams per brake horsepower-hour * equipment horsepower * hours/day * load factor

Where: ***grams per brake-horsepower hour is based on the construction year and represents a statewide average for each piece of equipment. Grams per brake horsepower per hour emissions are based on the California Air Resources Board's OFFROAD2007 model (California Air Resources Board, 2006). The pounds per day emission factors are found in Appendix I.***

Demolition Worker Commute Trips

Demolition worker commute trips assume that the number of workers equals 125% of the total pieces of construction equipment selected. The emission estimates assume a construction worker commute fleet mix of 50% light duty autos and 50% light duty trucks. The worker commute travel distance, speed, and temperature are based on the worker commute speed information included in the Operational Trip Characteristics screen.

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Fine Site Grading Emissions

Fine Site Grading Fugitive Dust

The fugitive dust emission estimates within URBEMIS2007 use the methodology developed for SCAQMD by the Midwest Research Institute. That four-tiered methodology allows for more refined PM10 estimates based on the level of detail known for the construction project. URBEMIS estimates emissions using the level of detail known for a project, as shown in Table A-4.

Table A-4. Fugitive Dust Estimation Approach

Basis for Emission Factor	Recommended PM10 Construction Emission Factor
Default Level: Only area and duration known	Apply 0.22 tons/acre-month (average conditions)[1] Apply 0.42 ton/acre-month (worst-case conditions)
Low Level of Detail: Area and amount of earthmoving known	Apply 0.11 ton/acre-month for each month of construction activity Plus 0.059 ton/1,000 yd^3 of onsite cut/fill Plus 0.22 ton/1,000 yd^3 of offsite cut/fill These values assume that one scrapper can move 70,000 yd^3 of earth in one month and 35,000 yd^3 of material can be moved by truck in one month. If the on-/offsite fraction is not known, assume 100% onsite.
Medium Level of Detail: More detailed information available on duration of earthmoving and other material movement	Apply 0.13 lb/acre-work hr Plus 49 lb/scraper-hr for onsite haulage Plus 94 lb/hr for offsite haulage
High Level of Detail: Detailed information known on acres, hours or construction work, number of truck units or VMT, and truck travel distances.	Apply 0.13 lb/acre-work hr Plus 0.21 lb/ton-mile for onsite haulage Plus 0.62 lb/ton-mile for offsite haulage

A key component of the site grading dust emissions is the maximum acreage that will be disturbed on a daily basis. URBEMIS2007 estimates default acreage graded per day based on the land use sizes specified by the user. URBEMIS assumes the following number of residential units per acre:

- single-family residential units – 3
- low rise apartments and condos/townhouse units – 16
- mid rise apartments – 38
- high rise apartments – 62
- high rise condos – 64

[1] The Midwest Research Institute has derived a value of 0.11 tons/acre/month, which converts to 10 pounds per day, assuming 22 workdays per month. The California Air Resources Board review has reviewed this factor and concluded that it represents PM10 emissions with watering. Consequently, ARB concludes that 20 pounds per acre day is more appropriate for unmitigated fugitive dust conditions (http://www.arb.ca.gov/ei/areasrc/fullpdf/full7-7.pdf)

- mobile home parks – 6
- retirement community – 5
- congregate care (assisted living) – 16.

For commercial uses, URBEMIS2007 assumes that the total project acreage equals twice the size of each building's square footage. For example, URBEMIS2007 assumes that a 100,000-square-foot industrial park would require 200,000 square feet (4.6 acres) of land disturbance. As a default estimate, URBEMIS2007 assumes that 25% of total land acreage slated to be disturbed will actually be disturbed on the worst-case day.

URBEMIS provides the user with a form similar to that shown in Table A-5. The user has the option of modifying URBEMIS' estimates of the maximum acreage to be disturbed per day.

In the example shown in Table A-5, a project that includes 1200 units of single-family residential, 600 units of multi-family residential, and 100,000 square feet of commercial development will result in a total estimated acreage of 399.15 acres. Assuming that 25% of that total acreage is graded on the worse case day, the maximum acreage disturbed equals 99.84 acres. The user has the option of overriding the maximum daily disturbed. This acreage is important, because URBEMIS bases its estimates of both fugitive dust and construction equipment on the maximum daily acreage disturbed value.

Table A-5. Acreage Estimates for Grading

Land Use	User-Entered Values	Estimated Acreage	Estimated Maximum Acreage Disturbed per Day
Residential—Single Family	1200 units	370	92.5
Residential—Multi-family	600 units	24.55	6.14
Commercial	100,000 sq. ft.	4.6	1.2
Totals	Not applicable	399.15	99.84

Fine Site Grading Equipment Off-Road Diesel Exhaust

Site grading emissions are generated by the operation of off-road construction equipment, such as scrapers, bulldozers, and loaders. URBEMIS presents the user with a list of construction equipment, as shown previously in Table A-3. The user has the option of either selecting the number of each type of equipment that will be used or having URBEMIS generate estimates of construction use.

To estimate off-road construction equipment-related construction exhaust emissions, URBEMIS uses an approach based on ARB's OFFROAD2007 emissions model (California Air Resources Board, 2006). That model uses a methodology in which emission factors for construction equipment are based on an average fleet mix that accounts for the turnover rate and average emissions for specific types of construction equipment. URBEMIS generates default values and allows the user to override the defaults for equipment horsepower and load factors.

For each piece of equipment selected, URBEMIS generates an emission estimate. The emission equation that will be used by URBEMIS for each piece of equipment is as follows:

Equipment Emissions (pounds/day) = # of pieces of equipment * grams per brake horsepower-hour * equipment horsepower * hours/day * load factor

Where: grams per brake-horsepower hour is based on the construction year and vehicle type. Grams per brake horsepower per hour emissions are from the California Air Resources Board's (ARB's) OFFROAD2007 model (California Air Resources Board 2007). Appendix I lists the grams per horsepower hours for each year and each type of equipment.

Fine Site Grading On-Road Diesel Exhaust

One additional enhancement to URBEMIS' treatment of grading equipment exhaust involves specifying whether the project will require soil to be imported to or exported from the site. If soil is to be imported or exported, the user must to enter the volume of soil. URBEMIS will use that information to calculate the number of on-road vehicle trucks trips and vehicle miles traveled per day (as shown in Table A-6). The user has the option of overriding the default assumptions programmed into URBEMIS.

Table A-6. Construction Grading Soil-Hauling Assumptions

Soil Import/Export Hauling	Parameter
Amount of soil to import (cubic yards)	0
Amount of soil to export (cubic yards)	0
Total soil imported + exported (cubic yards)	0
Haul-truck capacity (cubic yards)	20
Number of days to conduct hauling	Based on phase length
Round trips/day	Calculated
Round-trip distance (miles)	Calculated
Vehicle miles traveled/day (calculated)	Calculated

Once vehicle miles traveled per day is known, URBEMIS calculates haul-trip emissions using the following formula:

On-Road Haul Truck Emissions (pounds/day) = vehicle miles traveled/day * grams pollutant/mile (from EMFAC2007) * pound/454 grams

Fine Site Grading Worker Commute Trips

For site grading, the number of workers is estimated as 125% of the total number of construction equipment (vehicles and machines) selected. The emission estimates assume a construction worker commute fleet mix of 50% light duty autos and 50% light duty trucks. The worker commute travel distance, speed, and temperature are based on the trip characteristics information for home to work trips found under the trip characteristics node of the operational emissions module.

Mass Site Grading

Mass Site Grading works in a manner similar to fine site grading. Mass site grading typically differs from fine site grading in that it applied to larger grading acreages. Each of the descriptions for the mass site grading components below is similar to those for fine site grading.

Mass Site Grading Fugitive Dust

The fugitive dust emission screen allows the user to select from one of four levels. The fugitive dust emission levels are based on a report prepared for the South Coast Air Quality Management District (Midwest Research Institute, 1996). The mass site grading fugitive dust calculations used by URBEMIS are identical to those used in the fine site grading fugitive dust calculations as described above and shown in Table A-4.

Mass Site Grading On-Road Diesel Exhaust

The amount of on-road emissions associated with soil hauling site grading is based on the amount of material that must be imported to and/or exported from site, the distance that trucks must travel, and haul truck capacity. URBEMIS includes default values for truck capacity (cubic yards) and round trip mileage, both of which can be modified by the user. The number of round trips per day and the vehicle miles traveled per day (VMT) are based on the maximum daily volume of material to be demolished, the truck capacity, and the miles per round trip. Maximum daily emissions are obtained from EMFAC2007 and are estimated by multiplying VMT by the grams per mile emissions for heavy heavy-duty trucks traveling at the commercial-based customer average speed found in the trip characteristics screen.

Mass Site Grading Off-Road Diesel Exhaust

Mass site grading off-road exhaust emissions are calculated based on equipment that the user must select from 36 equipment types. The user can enter the number of pieces of equipment to be used, and can edit default values for horsepower, load factor, and hours per day. The load factor is the percentage of time that the equipment is in use during the typical construction day. Based on the information entered by the user, emissions are estimated by multiplying by the grams per horsepower hour for the respective equipment. The equation for each equipment type is as follows:

Emissions (pounds per day) = Pieces of Equipment * hp * load factor * hours per day * grams/hp-hr * pounds / 454 grams

The grams per horsepower hour values, listed in Appendix I, vary by construction year. The construction emission rates found in the default file are based on the California Air Resources Board's OFFROAD2007 emissions model (California Air Resources Board, 2006).

Mass Site Grading Worker Commute Trips

Worker trips are estimated separately by each of the three construction phases. For site grading, the number of workers is estimated as 125% of the total number of construction equipment (vehicles and machines) selected. The emission estimates assume a construction-worker commute fleet mix of 50% light duty autos and 50% light duty trucks. The worker commute travel distance, speed, and temperature are based on the trip characteristics information for home to work trips found under the trip characteristics node of the operational emissions module.

Trenching

Trenching Off-Road Diesel

Off-road trenching exhaust emissions are calculated based on 36 equipment types that can be selected. The user can enter the number of pieces of equipment to be used, and can edit default values for horsepower, load factor, and hours per day. The load factor is the percentage of time that the equipment is in use during the typical construction day. Based on the information entered by the user, emissions are estimated by multiplying by the grams per horsepower hour for the respective equipment. The equation for each equipment type is as follows:

Emissions (pounds per day) = Pieces of Equipment * hp * load factor * hours per day * grams/hp-hr * pounds / 454 grams

The grams per horsepower hour values vary by construction year (see Appendix I) and are based on the California Air Resources Board's OFFROAD2007 model (California Air Resources Board, 2006).

Trenching Commute Trips

Construction trenching worker trip emissions are estimated by assuming that the number of workers equals 125% of the total number of construction equipment selected. The emission estimates assume a construction worker commute mix of 50% light duty autos and 50% light duty trucks. The worker commute travel distance and speed are based on the trip characteristics for home to work trips found under the trip characteristics node of the operational emissions module.

Building Construction

Building Construction Off-Road Diesel Exhaust

Building construction emissions consist of emissions from construction equipment. Table A-3 lists equipment that can be selected for building construction. The number and type of equipment can vary substantially, depending on the type of building and its location. The amount of concrete, masonry, wood, and metal products used in building construction varies widely, and can have a large impact on the type of construction equipment needed for a construction project.

Building Construction Worker Commute Trips

Emissions from construction worker vehicle commute trips are estimated by multiplying total daily employee vehicle miles traveled (VMT) by an emission rate (grams per mile). URBEMIS2007 estimates construction-related employee trip generation as follows. Each land use type selected as part of the project is grouped into one of four general land use categories: multifamily, single-family, commercial/retail, and office/industrial. Then, for each category, the number of trips is estimated using the following equations:

*Multifamily Trips = 0.36 trips/unit * number of units*
*Single-Family Trips = 0.72 trips/unit * number of units*
*Commercial or Retail Trips = 0.32 trips/1,000 feet^2 * number of 1,000 feet^2*
*Office or Industrial Trips = 0.42 trips/1,000 feet^2 * number of 1,000 feet^2*

These trip generation rates are based on information contained in the Sacramento Metropolitan Air Quality Management District's Air Quality Thresholds of Significance Handbook (Sacramento Metropolitan Air Quality Management District (1994).

URBEMIS2007 totals trips from the four general land use categories and multiplies by the average trip length to obtain daily VMT. Trip length is found under the trip characteristics tab of the operational emissions module of URBEMIS. URBEMIS2007 uses the construction year identified by the user to select EMFAC emission rates that will be multiplied by VMT/day.

Building Construction Vendor Trips

Vendor trips represent the on-road trips needed to bring building supplies to the worksite. URBEMIS estimates construction related vendor trips using the following trip generation rates:

*Multifamily Construction Vendor Trips = 0.11 trips/unit * number of units*
*Single-Family Construction Vendor Trips = 0.11 trips/unit * number of units*
*Commercial or Retail Construction Worker Trips = 0.05 trips/1,000 feet^2 * number of 1,000 feet^2*
*Industrial Construction Worker Trips = 0.38 trips/1,000 feet^2 * number of 1,000 feet^2*

These trip generation rates are based on information provided by the Sacramento Metropolitan Air Quality Management District. URBEMIS2007 totals trips from the four general land use categories and multiplies by the average trip length to obtain daily VMT. Trip length is based on the urban trip length found for commercial-based customer trips in the Operational Trip Characteristics screen. URBEMIS2007 uses the construction year in which the trips would occur and the trip speed for home to work trips to identify the appropriate EMFAC emission rates to use. Vendor trips are assumed to consist of 100% heavy heavy-duty trucks.

Vendor trip rates can be overridden if the actual number of total vendor trips is known.

Architectural Coatings

Off-Gas Emissions

URBEMIS72007 estimates ROG emissions resulting from the evaporation of solvents contained in paints, varnishes, primers, and other surface coatings. Separate procedures are used to estimate evaporative emissions from application of residential and nonresidential architectural coatings. The following emission factors are used for residential coating emissions:

Emission estimates are divided into four categories:

- residential interior,
- residential exterior,
- non-residential interior, and
- non-residential exterior.

For each of these four categories, each air district has specified an average VOC content. These VOC content limits may change as district rules become more stringent. The user cannot alter these VOC content limits as each air district has specified them. The statewide average is assumed to be 250 grams VOC per liter of paint. For each category of paint, VOC content is converted to an emission factor in pounds VOC per square feet of paint applied by assuming a coating coverage of 180 square feet per gallon.

The following equation is estimated for each of the four categories to obtain an emission factor in pounds of VOC (or ROG) per square foot:

ROG (pounds / square feet) = (grams VOC per liter paint / 454 grams per pound * 3.785 liters per gallon / 180 square feet per gallon).

Then, the square feet to be painted is estimated for each of the four categories as follows:

Residential

*Square feet interior square footage to be coated = ((Number of single-family units * square feet per unit) + (Number of multi-family units * square feet per unit)) * 2.7)) * 0.75*

*Square feet exterior square footage to be coated = ((Number of single-family units * square feet per unit) + (Number of multi-family units * square feet per unit)) * 2.7)) * 0.25*

The value 2.7 in each equation is used to convert total building square footage to surface area to be coated. As these equations indicate, 75% of total residential coatings assumed to be interior and 25% exterior.

URBEMIS assumes 1800 square feet per single-family residential unit and 850 square feet per multi-family residential unit.

Non-Residential

*Non residential interior square footage to be coated = ((Total building square footage * 2.0) * 0.75*

*Non residential exterior square footage to be coated = ((Total building square footage * 2.0) * 0.25*

The value 2.0 in each equation is used to convert non-residential building square footage to surface area to be coated. As these equations indicated, 75% of total non-residential coatings assumed to be interior and 25% exterior.

Total Emissions

To obtain total emissions, emissions for each of the four categories must be calculated by multiplying the emission factor per square feet times the total square footage for that category. Once emissions have been estimated for each of the four categories, the total emissions must be summed up over the four categories, providing total emissions. That value is then divided by the total number of days that coatings are applied to obtain an average daily emission estimate.

Architectural Painting Worker Commute Trips

Worker commute trips associated with architectural painting are assumed to equal 20 percent of worker commute trips for building construction. Consequently, architectural coating emissions from worker commute trips will equal approximately 20 percent of building construction worker commute trip emissions.

Asphalt Paving

Asphalt Paving Off-Gas Emissions

URBEMIS2007 estimates ROG emissions associated with asphalt paving. The emissions are estimated based on the procedure identified in the SMAQMD manual (Sacramento Metropolitan Air Quality Management District 1994). ROG emissions are estimated using the following formula:

*ROG (pounds per day) = (2.62 pounds ROG / acre) * (total acres paved /paving days)*

Asphalt Paving Off-Road Diesel Exhaust

Unless overridden by the user, URBEMIS assumes that 25% of the total project area will be paved. URBEMIS generates an estimate of the number and types of equipment based on the acreage to be paved. See Appendix H for the types of equipment assumed to be used by URBEMIS for paving.

The user can override URBEMIS' estimates of the equipment to be used, and can edit default values for horsepower, load factor, and hours per day. The equation for each equipment type is as follows:

*Emissions (pounds per day) = Pieces of Equipment * hp * load factor * hours per day * grams/hp-hr * pounds / 454 grams*

The grams per horsepower hour values vary by construction year. The construction emission rates are based on the California Air Resources Board's OFFROAD2007 model (see Appendix I).

Asphalt Paving On-Road Diesel Exhaust

URBEMIS estimates vehicle miles traveled per day for asphalt hauling using information entered by the user regarding acreage to be paved per day. Using that information, URBEMIS estimates the total volume per day of asphalt required by multiplying acreage by an assumed asphalt thickness of 3 inches (Asphalt Institute, 2002). The asphalt volume is then used to estimate the number of truck trips, assuming a truck volume capacity of 20 cubic yards. Vehicle miles are estimated based on the number of truck trips, and haul emissions are estimated using the following equation:

*On-Road Asphalt Haul Truck Emissions (pounds/day) = vehicle miles traveled/day * grams pollutant/mile * pound/454 grams*

Asphalt Worker Trips

Asphalt worker trips are estimated separately. For asphalt paving, the number of workers is estimated as 125% of the total number of construction equipment (vehicles and machines) selected. The emission estimates assume a construction worker commute fleet mix of 50% light duty autos and 50% light duty trucks. The worker commute travel distance and speed are based on the trip characteristics information for home to work trips found under the trip characteristics node of the operational emissions module.

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South Coast Air Quality Management District. 1993. CEQA air quality handbook. Diamond Bar, CA.

Appendix B. Area Source Emissions

TABLES

Area Source Emissions

URBEMIS2007 has been enhanced so that both novice and experienced users can generate accurate estimates of area source emissions. Novice users can generate estimates using default assumptions programmed into URBEMIS2007. Users experienced in estimating area source emissions can modify the area source assumptions to suit their particular project.

URBEMIS2007 allows the user to estimate area source emissions from:

- fuel combustion emissions from space and water heating, including wood stoves, fireplaces, and natural gas fired stoves;
- fuel combustion emissions from landscape maintenance equipment;
- consumer product ROG emissions; and
- architectural coatings.

Natural Gas Combustion

URBEMIS2007 can be used to estimate fuel combustion emissions from water and space heating using the approach described in Tables A9-12, A9-12-A, and A9-12-B in the South Coast Air Quality Management District CEQA handbook (South Coast Air Quality Management District 1993) and emission factors developed by the U.S. Environmental Protection Agency (U.S. EPA 1995). With one exception, all emission estimates assume natural gas is used as the primary source of water and space heating. The one exception is wood used for fireplaces and wood stoves. The equation used to estimate CO, ROG, NOx, and PM10 emissions from natural gas combustion is as follows for each land use type:

*Emissions = H * ({[F*G]/30}/1,000,000) * P*

Where: H = emission factor for each criteria pollutant in pounds of pollutant per million cubic feet of natural gas consumed:
CO: 40 pounds/million cubic feet
ROG: 7.26 pounds/Million cubic feet
NOx: 94.0 pounds/Million cubic feet [residential]
NOx 100.0 pounds/Million cubic feet [nonresidential]
PM10: 0.18 pounds/Million cubic feet
PM2.5: 0.18 pounds/Million cubic feet
CO2: 120,000 pounds/Million cubic feet

F = units per land use type:
residential (number of units)
industrial (customers)
hotel/retail/office (square feet)

G = Natural gas usage rates:
Residential: Single-Family: 6,665.0 feet^3 / unit / month
Multifamily: 4,011.5 feet^3 / unit / month

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Nonresidential: industrial: 241,611 feet^3 / customer / month
hotel/motel: 4.8 feet^3 / square feet / month
retail/shopping: 2.9 feet^3 / square feet / month
office: 2.0 feet^3 / square feet / month

P = percentage using natural gas
Residential 60%
Nonresidential 100%

The percentage of residential and nonresidential using natural gas may differ based on default values specified by individual air districts.

Hearth Fuel Combustion

The hearth fuel combustion category consists of wood stoves, fireplaces, and natural gas fired stoves. The user is required to enter the percentage of each associated with a project. If the San Joaquin Valley Air District is selected, the percentage of each hearth type is limited based on the District's wood stove rule.

Wood Combustion –Wood Stoves

Wood stove emissions can be estimated using the following equation:

*Wood Stove Emissions (pounds per day) = ((A * C) + (B * D) + (E * F) + (J * K)) * (G) * (H * I)*

Where:
A = EPA-certified noncatalytic stove emission rate (grams pollutant per ton of kilogram wood burned)
B = EPA-certified catalytic stove emission rate (grams pollutant per kilogram of wood burned)
C = Percent of all stoves assumed to be noncatalytic
D = Percent of all stoves assumed to be catalytic
E = Conventional wood stove emission rate (grams pollutant per kilogram wood)
F = Percent of all stoves assumed to be conventional
G = Cords of wood burned per year per residential unit
H = Number of residential units
I = Percentage of residential units with wood stoves
J = Pellet stove emission rate (grams pollutant per kilogram wood burned)
K = Percent of all stoves assumed to be pellet

URBEMIS2007 assumes the following defaults for wood stove emissions:

A = 9.8 grams PM10 / kilogram, 70.4 grams CO / kilogram, 7.5 grams ROG / kilogram, 1.4 grams NOx / kilogram
B = 10.2 grams PM10 / kilogram, 52.2 grams CO / kilogram, 7.8 grams ROG / kilogram, 1.0 grams NOx / kilogram
C = 50% (entered as 0.50)
D = 50% (entered as 0.50)
E = 15.3 grams PM10 / kilogram, 115.4 grams CO / kilogram, 21.9 grams ROG / kilogram, 1.4 grams NOx / kilogram
F = 0.0%
G = 1.48 cords per year per residential unit
H = based on land uses specified by the user
I = 35% (entered as 0.35)
J = 2.1 grams PM10 / kilogram, 19.7 grams CO / kilogram, 0.01 grams ROG / kilogram, 6.9 grams NOx / kilogram
K = 0.0%

The emission factors shown above are based on EPA's AP-42 document (U.S. Environmental Protection Agency 1995). The emission factor assumes an even split between noncatalytic and catalytic stoves. The default assumption assumes that no conventional nor pellet stoves will be included, although the equation will allow the user to include conventional and pellet stoves in the emission calculation. Annual emissions assume a specific amount of wood would be burned per stove per residential unit during the heating season. That amount of wood varies by air district.

Wood Combustion –Fireplaces

Fireplace emissions are estimated using the following equation:

*Fireplace Emissions (pounds per day) = (J * K * L * M)*

Where: J = Fireplace emission rate (pounds of pollutant per residential unit per ton of wood burned)
K = Cords of wood burned per day year residential unit
L = Number of residential units
M = Percentage of residential units with wood stoves

URBEMIS2007 will assume the following defaults for fireplace emissions:

J = 34.6 pounds of PM10 / ton, 252.6 pounds of CO / ton, 229.0 pounds of ROG / ton, 2.6 pounds of NOx / ton
K = 1.48 cords burned per year per residential unit
L = residential units are based on the residential land uses specified by the user
M = 10% (entered as 0.10)

These emission rates are based on information published by EPA (U.S. Environmental Protection Agency 1995). As with wood stove emissions, the user can modify each of the variables used to estimate fireplace emissions. Annual emissions are estimated based on annual wood combustion.

Natural Gas Fired Stoves

URBEMIS uses AP-42 emission factors to estimate emissions from natural gas combustion in natural gas fireplaces/stoves. The emission equation assumes that the average stove is 30,000 Btus for single family, 20,000 Btus for multi-family, that there are 1,020 Btus per standard cubic foot of natural gas, that the stove is used for an average of two hours per day during the winter months, and 100 days per year (200 hours per year). The values for single and multi-family Btus per stove can vary by air district.

Landscape Maintenance

Landscape maintenance equipment generates emissions from fuel combustion, from evaporation of unburned fuel, and from fugitive dust generated by equipment such as leaf blowers. Emissions include NOx, ROG, CO, SO2, PM10, PM2.5, and CO2. The emission factors used to estimate equipment emissions include exhaust and evaporation. Emission factors have not yet been developed for the fugitive dust generated by certain types of equipment generate.

Equipment in the landscape category includes lawn mowers, roto tillers, shredders/grinders, blowers, trimmers, chain saws, and hedge trimmers used in residential and commercial applications. Engines in this category are 25 horsepower or less. This category also includes air compressors, generators, and pumps used primarily in commercial applications.

The California Air Resources Board has enacted regulations to limit emissions from landscape maintenance equipment. Beginning in 1994 these regulations imposed emission limits on all landscape maintenance equipment sold. Those regulations became more stringent for equipment sold in 1999 and later. Consequently, the emissions from this source category are similar to automobile emissions in that the turnover in the equipment fleet plays an important part in how quickly emission reductions are achieved.

URBEMIS2007 estimates emissions from this source category based on the year in which the user is attempting to estimate emissions. The California Air Resources Board's OFFROAD2007 model was used to generate estimates of landscape maintenance equipment emissions in 2000 and 2010. Separate modeling runs were made for residential and non-residential equipment use. Residential emissions were limited to single-family residential units. The commercial equation is based on emissions per business unit and includes multifamily residential land uses.

The emission factors used by URBEMIS2007 are shown in Tables B-1 and B-2.

Table B-1. Landscape Maintenance Emission Factors (pounds per residential unit per day)

Year	ROG	CO	NOx	SO2	PM	PM10	PM2.5	CO2
2000	0.011192	0.062226	0.000468	0.000003	0.000171	0.000171	0.000169	0.071478
2001	0.010879	0.060467	0.000471	0.000003	0.000166	0.000166	0.000164	0.071497
2002	0.010567	0.058709	0.000475	0.000003	0.000160	0.000160	0.000159	0.071517
2003	0.010255	0.056950	0.000478	0.000003	0.000155	0.000155	0.000153	0.071537
2004	0.009942	0.055192	0.000482	0.000003	0.000150	0.000150	0.000148	0.071557
2005	0.009630	0.053433	0.000485	0.000003	0.000144	0.000144	0.000143	0.071577
2006	0.009317	0.051675	0.000489	0.000003	0.000139	0.000139	0.000138	0.071597
2007	0.009005	0.049916	0.000492	0.000003	0.000134	0.000134	0.000132	0.071617
2008	0.008693	0.048158	0.000496	0.000002	0.000129	0.000129	0.000127	0.071637
2009	0.008380	0.046399	0.000499	0.000002	0.000123	0.000123	0.000122	0.071657
2010	0.008068	0.044640	0.000503	0.000002	0.000118	0.000118	0.000117	0.071677

The residential emission factors shown for 2000 are based on total California single-family landscape maintenance emissions divided by total California single-family housing units in 2000. Similarly, the commercial emission factors for 2000 are based on total California non-farm business emissions divided by the California's total 2000 business units. For the commercial equations, URBEMIS2007 bases the number of business units on the number of non single-family housing land uses specified by the user.

Table B-2. Landscape Maintenance Emission Factors (pounds per business unit/day)

Year	ROG	CO	NOx	SO2	PM	PM10	PM2.5	CO2
2000	0.199471	2.127123	0.019558	0.000120	0.005154	0.005154	0.005103	2.776671
2001	0.191818	2.068940	0.019670	0.000117	0.005200	0.005200	0.005148	2.779879
2002	0.184166	2.010757	0.019782	0.000113	0.005245	0.005245	0.005192	2.783087
2003	0.176513	1.952574	0.019895	0.000110	0.005290	0.005290	0.005237	2.786295
2004	0.168861	1.894391	0.020007	0.000107	0.005335	0.005335	0.005282	2.789504
2005	0.161208	1.836208	0.020119	0.000103	0.005381	0.005381	0.005327	2.792712
2006	0.153556	1.778025	0.020231	0.000100	0.005426	0.005426	0.005371	2.795920
2007	0.145903	1.719842	0.020344	0.000097	0.005471	0.005471	0.005416	2.799128
2008	0.138250	1.661659	0.020456	0.000093	0.005516	0.005516	0.005461	2.802336
2009	0.130598	1.603476	0.020568	0.000090	0.005561	0.005561	0.005506	2.805544
2010	0.122945	1.545293	0.020681	0.000087	0.005607	0.005607	0.005551	2.808752

The 2010 emission rates were estimated using the OFFROAD2007 model, with separate emission estimates for the residential and commercial categories.

For emission factors between 2001 through 2009, URBEMIS2007 interpolates emission factors by assuming a uniform decrease in the emission rate each year between 2000 and 2010. In 2010 and succeeding years, the 2010 emission rates are used.

Average annual emissions assume that daily emissions would occur only during the summer period of 180 days. The end user can modify the length of the summer period.

Consumer Product Emissions

Consumer product emissions are generated by a wide range of product categories, including air fresheners, automotive products, household cleaners, and personal care products. Emissions associated with these products primarily depend on the increased population associated with residential development. Consequently, URBEMIS2007 can be used to estimate consumer product emissions when the user has selected one or more residential land uses. Emissions are based on the following equation:

ROG (pounds/day) = 0.0171 pounds of ROG per person * Number of residential units * 2.861 persons per unit

The ROG emission factor is based on the total estimated ROG emissions from consumer products divided by the total California population (California Air Resources Board 2006; California Department of Finance 1994).

URBEMIS2007 will base the number of residential units on information provided by the user on residential land uses. The user can modify each of the variables in the ROG emissions equation.

Annual emissions are estimated by multiplying pounds of ROG emitted per day by 365 days per year.

Architectural Coatings

Architectural coatings emissions associated with area sources is estimated using the same set of equations as construction related architectural coatings (described in Appendix A), with one exception. In the area source architectural coatings screens, the user can enter the percentage of total building square footage to be repainted each year. The default is set to 10% for both residential and nonresidential land uses.

Area Source Mitigation Measures

The area source mitigation measures allow three different types of mitigation measures to be specified. They include energy efficiency (primarily space heating), landscape maintenance measures, and architectural coatings measures. With one exception, URBEMIS does not currently have mitigation measures for hearth fuel combustion or for consumer products. The exception is that for projects in the San Joaquin Valley, the user can select hearth fuel combustion mitigation measures.

Energy Efficiency Mitigation Measures

URBEMIS includes three mitigation measures for natural gas combustion. Each measure is based on building energy efficiency relative to Title 24, California's energy efficiency regulation for residential and non-residential buildings. The user can turn on the appropriate measure and enter the percentage increase in energy efficiency above Title 24. Emission reductions are assumed to be proportional to the increase in building energy efficiency beyond Title 24. For example, if the user enters a mitigation measure showing an increase in residential energy efficiency of 10 % beyond Title 24, URBEMIS calculates a 10% reduction in emissions generated by residential energy consumption. Title 24 requires that compliance (with Title 24) be demonstrated before a building permit can be issued. This requirement applies to any heated building in California. Consequently, the percentage increase in energy efficiency beyond Title 24 should be based on the required compliance documentation.

Landscape Maintenance Mitigation Measures

URBEMIS includes two mitigation measures for landscape maintenance equipment. The first measure applies to residences, the second measure applies to commercial and industrial landscape equipment. For each of these measures, the user can specify the percentage of landscape equipment that would be electrically powered.

Architectural Coatings Mitigation Measures

For architectural coatings, URBEMIS allows the user to specify low VOC coatings percentages. The percentages reflect the reduction in VOC emissions as compared to existing coatings rules.

Hearth Fuel Combustion Mitigation Measures

Hearth mitigation measures only apply when a project has been selected for the San Joaquin Valley or one of the eight counties within the Valley. URBEMIS automatically selects the highest emitting percentage of wood stove, wood fireplaces, and natural gas fireplaces allowed by Rule 4901. Under the hearth fuel mitigation option, the user can select different percentages as long as they are allowed by the rule.

Appendix B References

California Air Resources Board. 2006. Offroad2007 Model. http://www.arb.ca.gov/msei/offroad/offroad.htm.

California Department of Finance. 1994. California statistical abstract. Sacramento, CA.

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Appendix C. Operational (Motor Vehicle) Emissions

Exhaust Emission Factors

URBEMIS2007 estimates vehicle exhaust emissions using several pieces of input entered by the user. That information is found within the URBEMIS input screens of the operational emissions module. The operational emissions module input screens include project year, vehicle fleet percentages, winter and summer temperature, trip characteristics, variable start information, and the percentage of travel on paved versus unpaved roads.

Once the user has entered the appropriate information into the operational emissions input screens and selects the emissions output, URBEMIS2007 calls the appropriate summertime and wintertime EMFAC2002 files based on the analysis year selected by the user. URBEMIS then goes to the appropriate locations within those files based on the average vehicle speeds and temperature. For each pollutant, URBEMIS obtains information from several locations within the EMFAC input file. For certain pollutants, URBEMIS generates pounds per mile emission estimates by multiplying the grams per mile values for each technology class within EMFAC (fleet mix vehicle type and technology class [non-catalyst, catalyst, diesel] by the percentage supplied by the user in the fleet mix screen. This results in a fleet average grams per mile value, which is then converted to pounds per day.

A similar approach is used to estimate trip emissions for certain pollutants. Separate tables in EMFAC2007 contain grams per trip emissions based on the length of time since the vehicle engine was turned off. URBEMIS uses the variable starts table, which shows the percentage of vehicles in several time classes (minutes since the vehicle engine was turned off) and for the six trip modes. URBEMIS uses the information in the variable starts table and the grams per trip values within EMFAC2002 to estimate weighted grams per trip values. The weighted grams per trip value is then multiplied by the number of trips calculated from the land use information to estimate total emissions per trip per pollutant.

Once the EMFAC2007 file has been read, URBEMIS2007 calculates criteria pollutant emissions for:

- running exhaust (grams per mile of ROG, CO, NOx, PM10),
- tire wear particulates (grams per mile, PM10),
- brake wear particulates (grams per mile, PM10),
- variable starts (grams per trip, ROG, CO, NOx),
- hot soaks (grams per trip, ROG),
- diurnals (grams per hour, ROG) ,
- resting losses (grams per hour, ROG), and
- evaporative running losses (grams per mile, ROG).

The estimated operational criteria pollutant emissions are summed in the emissions output page.

Entrained Road Dust Emissions

Entrained road dust emissions are generated by vehicles traveling on both paved and unpaved roads. URBEMIS2007 provides end users with a default percentage of VMT for paved versus unpaved roads. End users are asked whether they want to modify those percentages. Default percentages assume that 100 percent of VMT occurs on paved roads and 0 percent on unpaved roads.

Paved Roads

For paved roads, URBEMIS2007 uses the following equation:

PAVED = k (sL/2)0.65 (W/3)1.5

Where: *PAVED = particulate emission factor (lb/VMT);*
k = particle size multiplier for particle size range and units of interest;
sL = road surface silt loading (grams per square meter);
W = average weight of the vehicles traveling the road (megagrams).

The following default assumptions are used by URBEMIS2007:

k = 0.016 (for the 10 microns and under particle size cutoff)
sL = 0.1 (allowable range of 0.02 – 400 grams per square meter)
W = 2.2 (allowable range of 1.8-38 megagrams)

This equation is based on the paved roads emission factor found in AP-42 (U.S. Environmental Protection Agency 2003a). URBEMIS2007 allows the user to modify silt loading (sL) and average vehicle fleet weight (W). The equation was developed using silt loads ranging from 0.02 – 400 grams per square meter and mean average fleet vehicle weight ranging from 1.8-39 megagrams (2.0-42 tons). The equation was also developed using vehicles traveling at speeds ranging from 10-55 miles per hour, although speed is not used in the equation. A particle size multiplier (k) of 0.016 lbs PM10 per VMT is used by URBEMIS2007. This particle size multiplier cannot be changed by the user.

URBEMIS2007 uses the emission factor equation to calculate emissions per vehicle mile traveled. That value is then multiplied by the total vehicle miles traveled per day and by the percentage of vehicles traveling on paved roads.

Unpaved Roads

The unpaved road equation is as follows:

UNPAVED = (k (s/12)1.0 (S/30)0.5)/ ((M/0.5)0.2)

Where: UNPAVED = the fleet average unpaved road dust emissions (pounds/VMT)
k = the fraction of particles less than or equal to the particle size cutoff of 10 microns
s = surface material silt content (%)
S = the average vehicle speed (mph, input by the user)
M = surface moisture content (%)

This equation is based on EPA's emission factor equation for unpaved roads (Environmental Protection Agency 2003b). The following default assumptions are used by URBEMIS2007:

k = 1.8 (for the 10 microns and under particle size cutoff)
s = 4.3 % (allowable range [1.8 - 25.2 %])
S = 40 miles per hour (allowable range [10 - 43 mph])
M = 0.5 % (allowable range 0.03 – 13 %)

Of these default assumptions, all except k can be modified by the user. Once calculated, the emission rate in pounds per vehicle mile traveled is multiplied by the total VMT for the project and then by the percentage of travel on unpaved roads.

Double Counting of Mixed-Use Projects

URBEMIS2007 contains a procedure that reduces double counting of internal trips in a mixed-use project or community plan area. The procedure only applies when at least one residential and one non-residential land use are specified by the URBEMIS2007 user and the user selects the double-counting correction algorithm.

Because trip generation rates account for both trip productions and attractions, adding the gross trip generation for two land uses in a project double counts the trips between them. The procedure described below is designed to count the internal trips only once.

URBEMIS2007 displays a screen showing the number of residential and nonresidential trips. Then the user is prompted to enter the gross internal trip number, which limits the number of internal trips estimated by URBEMIS2007. The gross internal trip limit reported by the program is based on a comparison of residential trips versus nonresidential trips; the smaller of the two is the limiting value.

As presented above, the proposed double-counting correction is applied only to trips between residential and nonresidential land uses. A small amount of double counting may remain for trips between different residential land uses and/or between non-residential uses.

Pass-By Trips

According to the Institute of Transportation Engineers' (ITE) document Trip Generation, 5th Edition (ITE 1991), vehicle trips associated with a trip generator can be divided into three categories:

- *Primary Trips* are trips made for the specific purpose of visiting the generator. The stop at that generator is the primary reason for the trip. For example, a home to shopping to home combination of trips is a primary trip set.
- *Pass-By Trips* are trips made as intermediate stops on the way from an origin to a primary trip destination. Pass-by trips are attracted from traffic passing the site on an adjacent street that contains direct access to the generator. These trips do not require a diversion from another roadway.
- *Diverted Linked Trips* are trips attracted from the traffic volume on roadways within the vicinity of the generator but which require a diversions from that roadway to another roadway to gain access to the site. These roadways could include streets or freeways adjacent to the generator, but without access to the generator.

In calculating the emissions associated with a proposed project, the distinction between these three categories of trips is important. Pass-by and diverted linked trips associated with a proposed project generate substantially lower levels of net emissions than a primary trip.

For air quality impact analysis, the major difference between a pass-by trip and a diverted linked trip is the added vehicle miles traveled associated with the diverted linked trip. Pass-by trips, by definition, do not require a diversion from the original trip route. Conversely, diverted linked trips do involve diversion from the original trip route. A major difficulty in estimating the additional travel associated with a diverted linked trip is that the amount of additional travel is sensitive to local site factors. In particular, the distance from the project site to major arterials or freeways strongly influences the amount of additional travel.

Pass-by and diverted linked trips are most important for retail commercial land uses. As an example of how important these trips are, the February 1995 update to ITE's Trip Generation, 5th Edition, notes that an average of 87% of trips made to gasoline stations in the p.m. peak hour are pass-by and diverted linked trips. Not accounting for pass-by and diverted linked trips substantially overstates the amount of indirect source emissions associated with a proposed gasoline station.

URBEMIS2007 has an option that allows the user to account for pass-by and diverted linked trips. The primary data sources for appropriate pass-by and diverted linked trip adjustments are ITE's Trip Generation, 5th Edition, and the February 1995 update (ITE 1991; ITE 1995). The San Diego Association of Governments (SANDAG) has also produced a document that includes estimates of pass-by and diverted linked trips for specific land uses (SANDAG 1990). These three documents present pass-by and diverted linked trip values as a percentage of total trips for several land use categories. One distinction between the ITE versus SANDAG estimates are that for pass-by trips, SANDAG assumes that any diversion requiring 1 additional mile or less is a pass-by trip. In contrast, ITE assumes that any diversion off of the intended travel route is a diverted linked trip.

Table 3 shows estimates of pass-by and diverted linked trip percentages using data contained in ITE's Trip Generation, 5th Edition, the February 1995 update to the 5th edition, and the SANDAG report (ITE 1991, ITE 1995; SANDAG 1990). The ITE and SANDAG trip generation data primarily describe peak-hour versus average daily conditions. Jones & Stokes Associates has developed average daily percentages of primary trips, diverted-linked trips and pass-by trips associated with each land use for the URBEMIS2007 model.

When the pass-by trip correction algorithm is selected by the user, URBEMIS2007 adjusts trip end emissions (i.e., cold start, hot start, and hot soak) associated with pass-by and diverted linked trips.

For traffic impact analyses, pass-by trips are generally eliminated from consideration; they have no net effect on traffic volumes. Similarly, diverted linked trips may have a minimal effect on traffic volumes. Conversely, pass-by and diverted linked trips may have a substantial effect on air quality, and this effect may increase in the future as trip end emissions become a larger portion of total vehicle trip emissions. A pass-by or diverted linked trip associated with a shopping center is a good example of how these trips can affect air quality. Such a trip would have little or no net effect on traffic volumes. However, if the shopper stays at the shopping center for 1 hour, a substantial portion of a hot soak episode would occur and, for a catalytic converter-equipped vehicle, the trip leaving the shopping center would begin in a cold-start mode.

URBEMIS2007 estimates trip end emissions associated with pass-by and diverted linked trips and additional travel associated with diverted linked trips. Jones & Stokes Associates has modified URBEMIS2007 so that it makes separate emission estimates for primary trips, pass-by trips, and diverted-linked trips.

For primary trips, the emission estimating procedure do not change except that the trip generation rate for each land use would be multiplied by that land use's primary trip percentage shown in Table 3.

For pass-by trips, the trip generation rate for each land use are multiplied by that land use's pass-by trip percentage shown in Table 3. In addition, the trip length for each trip type (e.g., home-work, home-shop) is set to 0.1 miles. The change in trip length reflects the pass-by trip definition in that these trips result in virtually no additional travel. However, emissions associated with pass-by trips still occur. Consequently, the hot and cold start percentages are increased by 10 percent to reflect additional emissions from these operating modes.

For diverted-linked trips, the trip generation rate for each land use is multiplied by that land use's diverted-linked trip percentage shown in Table 3. The trip length is also adjusted downward to equal 25 percent of the primary trip length for each trip type. By doing so, it accounts for the additional travel associated with diverted-linked trips. Also, the hot and cold start percentages for each trip type are increased by 10 percent to reflect additional emissions from these operating modes.

Method for Calculating Default Trip Lengths from Travel Survey Data

Trip lengths are one of the most important data elements used in calculating project emissions. Air districts or other agencies responsible environmental review should ensure that default trip length values used in their area have a sound basis. Unfortunately, the data most readily available from regional travel models for this purpose is typically formatted differently than is used in URBEMIS. This section provides a method for converting available data for use as URBEMIS2007 defaults.

One source of data is the Caltrans Statewide Travel Survey. The most recent version was published in 1991. The data is stratified by trip purpose. The trip categories are home to work (H-W), home to shop (H-S), home to other (H-O), other to work (O-W), and other to other (O-O). The survey provides trip lengths for only H-W and total trips. More detailed breakdowns may be available from the Regional Transportation Planning Agency in your area. The survey and most RTPA models provide trip lengths in terms of minutes. The average speed is used to convert minutes to miles.

The H-W, H-S, and H-O trip lengths can be used directly in URBEMIS. However, for non-home based trips, URBEMIS uses work (W) and non-work (N-W) trips when analyzing all non-residential projects (commercial, industrial, institutional, etc). To produce work-related trip lengths for non-residential projects analyzed in URBEMIS, a composite work trip length is calculated that is a composite of H-W and O-W trip lengths. For URBEMIS, non-work trips are a composite of H-S, H-O, and O-O trip lengths. Both are based on the relative occurrence of the individual trip types.

The following table illustrates this concept using Southern California data as an example:

Travel Survey Trip Types:	H-W	H-S	H-O	O-W	O-O	Total
Percent trip type:	20%	9%	43%	11%	17%	100%
Trip length in minutes:	19.63	7.91	9.58	15.06	8.96	
Trip length in miles:	11.5	4.87	6.02	9.07	5.66	

URBEMIS non-residential Work trip lengths = composite of H-W + O-W.

Work Trip Length Formula:

(%H-W / (%H-W + %O-W) x H-W TRIP LENGTH) +
(%O-W / (%H-W + %O-W) x O-W TRIP LENGTH)

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URBEMIS non-residential Non-Work trip lengths = composite of H-S + H-O + O-O.

Non-Work Trip Length Formula:

(%H-S / (%H-S + %H-O + %O-O) x H-S TRIP LENGTH) +
(%H-O / (%H-S + %H-O + %O-O) x H-O TRIP LENGTH) +
(%O-O / (%H-S + %H-O + %O-O) x O-O TRIP LENGTH)

Example Calculation Using South Coast Data:

Commute Trip (W)

(20%/(20%+11%) X 11.5 mi.) + (11%/(20%+11%) X 9.07 mi.) = 10.6 mile W trip

Non-Work Trip (N-W)

(9%/(9%+43%+17%) X 4.87 mi.) + (43%/(9%+43%+17%) X 6.02 mi.) +
(17%/(9%+43%+17%) X 5.66 mi.) = 5.78 mile N-W trip

Default Values for Emission Calculations

Diurnal Soak Hours per Day:	7.1
Resting Loss Hours per Day:	12.9
Vehicles per Household:	1.8

Appendix C References

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Appendix D. URBEMIS2007 Mobile Source Mitigation Component

TABLES

Mobile Source Mitigation Component

Background

The purpose of this appendix is to document the basis of the emission reduction quantification system used in the URBEMIS2007 Mobile Source Mitigation Measures module. The mitigation measures module is based on an approach developed by Nelson\Nygaard Consulting Associates specifically for the URBEMIS module. Nelson\Nygaard's findings are described in the remainder of this appendix.

Introduction

The following discussion is based on procedures for operational smart growth mitigation developed for URBEMIS2002. Those same procedures have been incorporated into URBEMIS2007.

This report sets out recommendations to revise the operational mitigation component of URBEMIS 2002. These have been developed with three main aims in mind:

- **Simplify** the existing mitigation component (of URBEMIS version 7.5), which while extremely detailed, is daunting to new users and has extensive data requirements. In particularly, the division between "environment factors" and "mitigation measures" can be confusing.
- **Improve consistency.** Many of the inputs to the URBEMIS 7.5 mitigation component are extremely subjective (e.g. whether some, few or no bike routes provide wide paved shoulders and have few curb cuts). We propose making these more quantitative, and/or providing additional guidance in the users' manual or within the program itself.
- **Improve accuracy and transparency.** While many of the inputs to the current mitigation component (of URBEMIS 7.5) have been proven to have an impact on travel behavior, research is still at an early stage of assessing quantitative impacts, and how these interrelate with other mitigation strategies. The recommendations here update the current mitigation component in the light of new research.

An extensive body of research has been compiled as to the impacts of particular mitigation strategies on travel behavior. However, in general, this has either had an academic focus, or been undertaken for the purposes of developing citywide or regional travel models. For example, many agencies have sophisticated procedures for assessing non-single occupancy auto travel at the level of TAZ or above, but not at the development level. There is extremely little guidance on how to use this data in the type of application needed for URBEMIS 2002 – namely, to provide quantitative estimates of the impact on trip generation and vehicle miles traveled (VMT) at the development level.

Many agencies do provide credits for individual developments that implement mitigation measures, for example when assessing impact fees or conducting traffic studies. Some California examples include C/CAG in San Mateo County and VTA in Santa Clara County. A brief, national review was also conducted for purposes of this report.[1] In general, however, these credit programs are only loosely based on the latest travel research, and it could be argued that they function more at a policy level, in providing incentives for developers to incorporate elements such as demand management programs that the agency considers desirable.

The recommendations here therefore attempt to bridge the gap between academic studies and complex regional or area-wide models on the one hand, and more site-specific traffic assessments on the other hand. The emphasis is on providing the best possible estimate while minimizing data requirements. The overall effect, compared to the existing mitigation component, is to reduce the number of inputs required, but make them more quantitative.

[1] Agencies contacted included: New York Metropolitan Transportation Council; Atlanta Regional Commission; Alameda County, CA; and San Luis Obispo County, CA.

It cannot be too highly stressed that the trip reductions recommended here are valid at a sketch-planning level only, and are subject to considerable uncertainty. While they should ideally be expressed as a range, in order to expressly account for this uncertainty, a single value is needed for purposes of the Indirect Source Review in order to allow the appropriate fee to be calculated. The same limitations noted in the documentation for the existing mitigation component still apply, and are worth repeating here:

> The URBEMIS 2002 mitigation component is a significant advance over past attempts to quantify the benefits of air quality mitigation measures, however, users should recognize that travel behavior is very complex and difficult to predict. The component relies on the user to determine factors critical to travel behavior that are somewhat subjective. As GIS and electronic traffic monitoring and data collection become a reality in many cities, the ability to identify factors critical to walking, bicycling, and transit use will be enhanced. The URBEMIS 2002 mitigation component provides a starting point for using currently available data to demonstrate the benefits of urban design and traditional mitigation measures in reducing air quality impacts.

The mitigation component results, however, should still be interpreted as the mid-point of a range. Recent research has pointed towards the dangers inherent in reporting precise values, when the results are the subject of considerable uncertainty (Shoup, 2003). However, although the methodological dangers are obvious, there is generally no question about the *direction* of the relationship, only its size and the appropriate variable. Some adjustment is better than none at all – which is what most conventional trip generation methodologies provide (Ewing & Cervero, 2001). In addition, existing project-level trip generation methodologies, even though well-accepted within the transportation planning and engineering profession, are themselves subject to considerable uncertainty, and results are reported with unwarranted precision (Shoup, 2003).

Other considerations that should be noted include:

- The key output that is sought here is reduction in *vehicle trips*. Research results, however, often report results in terms of VMT. Where no alternative is available, we assume that VMT is proportional to vehicle trips.
- Elasticities are generally used to make the calculations, since when used with care, they provide a satisfactory, means of preparing first-cut aggregate response estimates for various types of transportation system changes (Pratt *et. al.*, 2000). They also provide a transparent and accessible method of reporting results, that can be transferred from one region to another (Ewing & Cervero, 2001).
- There are major theoretical issues regarding the direction of causality that have still to be resolved in the research. For example, does an increase in density lower vehicle trip generation rates, or do more dense places attract people who tend to make fewer vehicle trips? For the purposes of this analysis, however, the distinction is unimportant. The key issue (using the same example) is that more dense places are associated with fewer vehicle trips.
- Local planning controls and development economics are assumed to provide an important "reasonableness" check on the recommended trip reductions. For example, reductions in parking supply will not normally be allowed unless the local jurisdiction is confident that complementary trip reduction measures will be applied. Equally, it is unlikely that frequent transit service will be provided to a destination with low potential ridership, given competing demands on an agency for service.

About the Trip Generation Manual

At its heart, the URBEMIS mitigation component is a tool for modifying the average trip rates reported in the Institute for Transportation Engineers' *Trip Generation* manual to make them more accurate, so that they fairly reflect the particular characteristics of a proposed development. Before modifying these average rates, it is therefore useful to understand the manual itself: how the average rates were derived; the original data sources that underlie the manual; and the manual's own recommendations about when, and why, its average trip generation rates should be modified. Some key points are these:

- The ITE manual normally predicts trip generation from new buildings using just two variables. Typically, the user first selects a broad *land use type* (e.g. "High-Rise Residential Condominium/Townhouse"). Second, the user inputs the *quantity* of that land use type (e.g. "100 dwelling units").
- An important advantage of this simple approach is that very little information about a project is needed to predict trip generation, and trip generation calculations are simple.
- A primary disadvantage of such two-variable formulas is that they do not take into account the multiple other variables (parking price, transit service, etc.) that transportation research has shown to strongly affect trip generation, and so the variation in trip rates *within* each land use category is frequently very high.

Recognizing these points, the *Trip Generation* manual therefore advises the reader that the average trip generation rates reported in the manual "represent weighted averages from studies conducted throughout the United States and Canada since the 1960s. Data were primarily collected at suburban locations having little or no transit service, nearby pedestrian amenities, or travel demand management (TDM) programs. At specific sites, the user may wish to modify trip generation rates presented in this document to reflect the presence of public transportation service, ridesharing or other TDM measures, enhanced pedestrian and bicycle trip-making opportunities, or other special characteristics of the site or surrounding area."

However, while the studies may have been *primarily* conducted at such suburban sites, it appears from the sources referenced that for some land uses, particularly higher density residential land uses, many sites studied included at least some transit service, sidewalks, and other characteristics associated with lower vehicle trip rates. For the "High-Rise Residential Condominium/Townhouse", for example, the manual's text shows that sites were surveyed in such cities as Vancouver, Canada: a city where it is difficult to find high-density condominiums that lack sidewalks, transit service, and a mix of uses nearby.

As part of our research, we made several calls to and exchanged correspondence with the staff at the Institute for Transportation Engineers. The staff was unable to provide any additional data (beyond the text of the manual itself) on the characteristics of the developments used in its trip generation studies, and was also unable to provide the actual studies – the original data – which underlie the manual's conclusions. Therefore, it is not possible to define with certainty the precise characteristics of an "average site".

Given this paucity of information available on the original sources for the *Trip Generation* manual's, conclusions about the average characteristics of the different land uses in the manual (e.g., average residential density, or the percentage of neighborhood streets with sidewalks) necessarily must be estimated, rather than precisely calculated. Fortunately, a large body of other research on travel behavior and land use is available, and reasonable estimates can be made based upon this research.

Recommendations

1. Combine "environmental factors" and "mitigation measures."

URBEMIS 2002 distinguishes between "environmental factors" for pedestrians, cyclists and transit (i.e., the character of the existing neighborhood), and "mitigation measures" (i.e. those added by the development). The environmental factors both provide a mitigation measure in themselves (e.g. the credit for existing or planned transit service), and are also used to weight the mitigation measures (i.e., a lower credit is given for a mitigation measure in an area that has a low environmental factor).

The distinction does make it easier to give credits for specific mitigation measures (e.g. bus bulbs, sidewalks and bicycle parking). However, we recommend that the distinction be removed, since it also brings several important disadvantages. Most of these relate to either complexity, or the relative advantages of infill vs. greenfield development, as follows:

- The pedestrian environmental factors appear to be given less weight than the mitigation measures, even when it is taken into account that the environmental factors are also used to weight the mitigation measures. The credit for the surrounding pedestrian environment is 2%, compared to the maximum allowable reduction of 9%. This means that smaller, infill developments will be eligible for lower credits, since by their nature they will be more dependent on the surrounding environment and have more limited ability to fund mitigation measures.
- On a related point, the importance of the environmental factors compared to mitigation measures is largely a function of scale, i.e. development size. Larger projects, particularly on greenfield sites, will be starting from a "blank sheet," and on-site mitigation measures will be paramount. The appropriate trip reductions for smaller, infill developments, in contrast, will be more a function of the surrounding environment.
- Combining the environmental factors and mitigation measures would make the component easier to understand, particularly for inexperienced users. At present, the separation can be confusing.

2. Scale

This question relates to the area that should be analyzed. We recommend that this should be either the area within a half-mile radius from the center of the project, or the entire project area, whichever is larger. This is the same approach taken in the existing URBEMIS mitigation component. In effect, the smaller the development, the greater the consideration given to the wider project area.

3. Provide Post-Modeling Adjustments to Reward Other Mitigation Measures

One of the impacts of these recommendations would be to narrow the range of mitigation measures that are considered in the analysis. Some potential mitigation measures are excluded even though they are likely to have a travel behavior impact, either because they cannot be readily quantified, or because this would risk double counting an impact already quantified elsewhere (i.e. another variable, such as intersection density, serves as a proxy). We therefore recommend consideration of how post-model adjustments can be used to provide financial incentives for developers to incorporate these mitigation measures. This may include all those that are in the current mitigation component, but are not recommended for continued inclusion, including:

- Street trees
- Traffic calming
- Design maximizing visual interest for pedestrians, and "eyes on the street"
- Zero building setbacks
- Direct pedestrian connections
- Street furniture and artwork
- Pedestrian signalization and signage
- Street lighting
- Low speed limits on bicycle routes
- Safe routes to schools
- Bicycle parking ordinance
- Transit stop amenities
- Route signs and displays
- Bus turnouts and bulbs
- Structured parking

4. Modifying Average Trip Generation Rates

In general, both the recommended trip rate modifications and the overall philosophy of the mitigation component are similar to those in the existing URBEMIS model, and build extensively off this work. The major differences between the existing mitigation component and these recommendations are found in (a) the input variables, which are designed to be more quantitative and less subjective, and are fewer in number, and (b) the formulas, which take advantage of the latest research on residential travel behavior.

Neighborhood-level trip generation and vehicle miles traveled vary by more than 80% in California cities (Figure D-1). As the documentation for the existing mitigation component recognizes, areas with low trip generation and VMT levels have the highest development densities, a wide variety of uses within walking distance, safe and comfortable pedestrian access, paid parking requirements, and a high level of transit service.

Similarly, residential trip rates reported in the *Trip Generation* manual vary widely, both *within* individual land use types, and *between* land use types (Figure D-2). For the land use type "Single Family Detached Housing", for example, reported rates ranged from a low of 4.31 daily trips per dwelling unit, to a high of 21.85 daily trips. The *Trip Generation* manual reports that, "This land use included data from a wide variety of units with different sizes, price ranges, locations and ages. Consequently, there was a wide variation in trips generated within this category." Between residential land use categories, the variation is still greater, as would be expected. For example, the average trip rate for the "Residential Condominium/Townhouse" land use type is 5.86 (or 39% lower than the average single-family detached house), while the lowest trip rate is 1.83 (or 80.9% lower). At the extremes, considering all residential land uses, the highest residential rate reported (21.85 trips/day) is more than ten-fold higher than the lowest rate reported (1.83 trips/day).

Figure D-1. Daily Trips by Density, San Francisco Bay Area

	Households/Residential Acre					
	<2	2-5	5-10	10-20	20-50	>50
Mean Households/Residential Acre	1.4	3.6	6.7	13.5	30.6	121.9
Daily Vehicle Trips/Household	6.4	5.9	5.0	3.8	2.9	1.2
% Reduction in Daily Vehicle Trips/Household compared to lowest density areas	0%	9%	23%	41%	55%	82%

Source: MTC Household Travel Survey, 1990, cited in Holtzclaw, 2002

Figure D-2. ITE Trip Rates for Selected Residential Land Uses

		ITE Trip Rate		
Land Use Code	**Land Use Type**	**Low**	**Average**	**High**
210	Single-Family Detached Housing	4.31	9.57	21.85
221	Low-Rise Apartment	5.1	6.59	9.24
230	Residential Condominium/Townhouse	1.83	5.86	11.79
222	High-Rise Apartment	3	4.2	6.45
232	High-Rise Residential Condo./Townhouse	3.91	4.18	4.93

Based on these data in Figures 1 and 2, and a wide range of additional transportation research, we have developed a set of formulas for modifying the average trip rates for residential land uses has been developed. For the URBEMIS user, the procedure for modifying residential trip generation rates will remain generally similar to the existing process, with three basic steps:

1. In the "Land Use Selection" screen, the user will enter the land use types (e.g. "Apartment, Low-Rise") and the number of dwelling units of each type.
2. Next, if the mitigation component is used, the user will be prompted to review the default values for several key variables (e.g. residential density, level of transit service) for each residential land use type. If the project's land uses have characteristics that are different from the default values (as they usually will be), the user will enter the correct values, in place of the default values.
3. Within the program, the formulas described hereafter will be used to calculate the resulting trip generation rates.

In keeping with the conclusions of current transportation research, a single set of formulas is used to modify the trip rates for all residential land use types. The input variables for these formulas assess five key land use characteristics (or "mitigation measures", in URBEMIS terms):

- Net residential density (measured by Households per Residential Acre)
- Mix of uses (using a jobs/housing measure)
- Presence of local-serving retail
- Level of transit service (measured by a transit service index)

- Bicycle and pedestrian friendliness (measured by an "pedestrian factor" index based on intersection density, sidewalk completeness, and bike lane completeness)

For each ITE residential land use type, a set of default values for these variables has been defined. If the default values for a residential land use type are left unchanged when running the mitigation component, then the resulting trip generation rate will be the standard ITE average trip generation rate for that land use type. For single-family detached housing, for example, the default values include a residential density of three units per residential acre, a transit service index score of 0 (representing no transit service within one-quarter mile of the site), and an intersection density of 250 intersections per square mile (typical of post-war cul-de-sac residential subdivisions). Figure D-4 shows the default values for each land use type.

To achieve the lowest residential trip rate reported in *Trip Generation* (a manual which primarily measures stand-alone, single-use projects with little or no transit service), the input values required would include a density of 160 units per residential acre, the maximum level of transit service, the best possible mix of uses and local retail, and a pedestrian score equivalent to a complete sidewalk coverage with a network of blocks no larger than 300 feet on a side. This would result in a rate of 1.83 trips/day, or an 81% reduction from the average single-family house rate).

This is similar to the 82% difference in household trip generation between the lowest density areas with the poorest transit service (6.4 vehicle trips per household per day), and the highest-density areas with good transit and a higher quality pedestrian environment (1.2 vehicle trips per household per day), as shown in Figure D-1. Figure D-4 shows the input values that would be required to achieve this rate, as well as the input values required to achieve maximum possible reduction allowed.

In theory, choosing the maximum possible values for each of the *physical design variables* described above could result in a residential trip generation rate as low as 0.9 daily trips per unit. This represents a 90% reduction from the average rate for a single-family detached house. To achieve this rate, however, a neighborhood would have to have remarkable characteristics, similar to Manhattan or Hong Kong: a density of 380 units per acre, or more than three times the average density of San Francisco's densest neighborhoods (North Beach and Chinatown), the highest possible level of transit service, and so on.[2]

The recommended reductions for the individual physical design mitigation measures for residential uses are summarized in Figure D-3. The remainder of the report discusses the justification for these levels, along with the mitigation measures for non-residential uses. In general, the recommended maximums for individual components have been set at a level so that this overall 90% maximum reduction from the average single-family house rate is maintained for residential land uses. While a greater reduction may sometimes seem warranted for an individual measure, a lower value has been selected to stay within this 90% maximum – a practice that helps avoid the considerable dangers of double counting.

In addition to the variables above, which primarily measure physical design characteristics, the formulas include mitigation measures that assess *demand management programs and similar measures*. A maximum additional reduction of 7.75% from the average single-family house rate is possible through these measures.

[2] While rare in California, these extreme cases of Manhattan-like densities can be seen in projects such as San Francisco's single-room occupancy hotels for very low income residents, which achieve such densities by omitting parking and providing very small living quarters.

Non-Residential Land Uses

For non-residential land uses, the general procedure for modifying rates is similar, and based upon many of the same research results. To modify non-residential trip generation rates, the following procedure is used:

1. For *physical design* mitigation measures, the formulas to determine percentage reductions are identical to the formulas for residential land uses, except for the 'Residential Density' measure, which cannot apply.
2. Additional mitigation measures are applied for *demand management programs and similar measures*. For non-residential uses, the number of available demand management measures is greater, as is the possible percentage reduction.

However, there is a key difference between the formulas used to modify residential rates, and the formulas used to modify non-residential rates:

1. For residential land uses, the percentage reductions shown for each mitigation measure refer to the percentage reduction from 9.57 trips per day (the rate for single family homes). The default values for each residential land use (Figure D-4) are set at levels such that keeping these values generates the average trip rate for that land use.
2. For non-residential land uses, the percentage reductions shown for each mitigation measure refer simply to the percentage reduction from the average ITE trip generation rate for that land use. No special default values are required: they are simply set to create a 0% reduction as the starting value.

Figure D-3. Summary of Recommended Trip Reductions

	Residential	Non-Residential	Comments
Physical Measures			
Net Residential Density	Up to 55%	N/A	
Mix of Uses	Up to 9%	Up to 9%	
Local-Serving Retail	2%	2%	
Transit Service	Up to 15%	Up to 15%	
Pedestrian/Bicycle Friendliness	Up to 9%	Up to 9%	
Physical Measures sub-total	*Up to 90%*	*Up to 35%*	
Demand Management and Similar Measures			
Affordable Housing	Up to 4%	N/A	
Parking Supply	N/A	No limit	Only if greater than sum of other trip reduction measures
Parking Pricing/Cash Out	N/A	Up to 25%	
Free Transit Passes	25% * reduction for transit service	25% * reduction for transit service	
Telecommuting	N/A	No limit	Not additive with other trip reduction measures (see text)
Other TDM Programs	N/A	Up to 2%, plus 10% of the credit for transit and ped/bike friendliness	
Demand Management sub-total[3]	*Up to 7.75%*	*Up to 31.65%*	

[3] This sub-total excepts the measures for parking supply and telecommuting, which have no limit.

Figure D-4. Default Values for Residential Land Use Trip Generation Formulas

DEFAULT VALUES FOR RESIDENTIAL TRIP RATE FORMULAS

Land Use Code	Land Use Type	Residential Density	Housing Units	Employees	Retail?	Transit Service	Intersection Density	Sidewalks	Bike Lanes	Ped Factor	ITE Trip Rate		
											Low	Average	High
210	Single-Family Detached Housing	3	100	17	no	0.00	250	0	0	0.06	**4.31**	**9.57**	**21.85**
221	Low-Rise Apartment	16	100	26	no	0.06	250	0.5	0	0.23	**5.1**	**6.59**	**9.24**
230	Residential Condominium/Townhouse	16	100	60	yes	0.10	400	1	0	0.44	**1.83**	**5.86**	**11.79**
223	Mid-Rise Apartment	38	100	60	yes	0.14	400	1	0	0.44	**NA**	**4.68**	**NA**
222	High-Rise Apartment	62	100	60	yes	0.14	400	1	0	0.44	**3**	**4.2**	**6.45**
232	High-Rise Residential Condo./Townhouse	64	100	60	yes	0.14	400	1	0	0.44	**3.91**	**4.18**	**4.93**

TRIP RATES RESULTING WHEN DEFAULT VALUES ARE USED

Land Use Code	Land Use Type	Reductions						Resulting Trip Rate
		Residential Density	Mix of Uses	Local Retail	Transit	Bike/Ped	Total	
210	Single-Family Detached Housing	0.0%	-0.6%	0.0%	0.0%	0.6%	0.0%	9.57
221	Low-Rise Apartment	27.9%	0.5%	0.0%	0.6%	2.1%	31.1%	6.59
230	Residential Condominium/Townhouse	27.9%	3.9%	2.0%	1.1%	3.9%	38.8%	5.86
223	Mid-Rise Apartment	39.8%	3.9%	2.0%	1.5%	3.9%	51.1%	4.68
222	High-Rise Apartment	44.8%	3.9%	2.0%	1.5%	3.9%	56.1%	4.20
232	High-Rise Residential Condo./Townhouse	45.1%	3.9%	2.0%	1.5%	3.9%	56.3%	4.18

EXAMPLE RESIDENTIAL TRIP RATE CALCULATIONS

Land Use Code	Land Use Type	Residential Density	Housing Units	Employees	Retail?	Transit Service	Intersection Density	Sidewalks	Bike Lanes	Ped Factor	ITE Trip Rate		
											Low	Average	High
210	"Worst Case" Singe-Family Detached	0.1	100	0	no	0.00	80	0	0	0.02	**-**	**-**	**21.85**
230	"Best Case" Res. Condo/Townhouse	160	100	150	yes	1.00	1300	1	0	0.67	**1.83**	**-**	**-**
N/A	Maximum Possible Reduction	380	100	150	yes	1.00	1300	1	1	1.00	**NA**	**NA**	**NA**

TRIP RATES RESULTING WHEN EXAMPLE VALUES ARE USED

Land Use Code	Land Use Type	Reductions						Resulting Trip Rate
		Residential Density	Mix of Uses	Local Retail	Transit	Bike/Ped	Total	
210	"Worst Case" Singe-Family Detached	-20.7%	-3.0%	2.0%	0.0%	0.2%	-21.5%	11.63
230	"Best Case" Res. Condo/Townhouse	51.4%	9.0%	2.0%	12.5%	6.0%	80.9%	1.82
N/A	Maximum Possible Reduction	55.0%	9.0%	2.0%	15.0%	9.0%	90.0%	0.95

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5. Data Requirements

Figure D-5 shows the inputs that are required to complete the mitigation component in full, along with suggested data sources. Note, however, that the mitigation component can still be run, even if some of these inputs are missing. While no reduction would be granted for the particular mitigation measure for which the input was required, credits could be granted for other trip reduction measures.

Figure D-5. Data Requirements and Suggested Sources

	Suggested Source		
Required Input	**Project**	**Surrounding Development**	**Comments**
Net residential density	Project plans	Block-level census data	Net residential data excludes land not devoted to residential uses
Number of housing units	Project plans	Block-level census data	Same basic source as for net residential density
Number of jobs	Project plans	Census Transportation Planning Package. Local jurisdiction may provide more current or fine-grained data	If data are only available per square foot, US Dept. Energy produces figures on average employee density
Local serving retail	Project plans	Site observations	
Below-market-rate units	Project plans	N/A	
Parking supply	Project plans	N/A	
Transit service	Transit agency maps/schedules		
Intersection density	Project plans	Street plans	Count can be automated if available in GIS
Sidewalk completeness	Project plans	Site observations	Count can be automated if available in GIS
Bike lane completeness	Project plans	Site observations	Count can be automated if available in GIS
Parking pricing	Development agreement or similar	Site observations (if applicable)	
Free transit pass provision	Development agreement or similar	N/A	
Telecommuting/flexible work schedules	Development agreement or similar	N/A	
Other TDM programs	Development agreement or similar	N/A	

6. Procedure for Small Projects

For developments in an established urban area below a certain size threshold, we recommend allowing them to adjust their trip generation rates based on the mode share in that census tract. This would avoid a disproportionate burden in gathering the data to document their likely trip reduction. (The analyst would need to certify that the project was similar in character to the existing development.) The recommended threshold is 50 average daily baseline vehicle trips, with the baseline being that calculated by URBEMIS before any of the reductions from mitigation measures are applied.

7. Substitute Methodologies

The recommended mitigation levels are, in our judgment, the most appropriate for a model that must apply to an extremely wide range of projects and geographic contexts. However, it must be recognized that there may be "special cases," where these standard reductions may not apply. For this reason, we recommend that any methodology for calculating reductions in VMT and vehicle trips may be substituted, provided that this is mutually agreed between the Air District and project proponent.

8. Measures Reducing VMT

The existing mitigation component allows for reductions in VMT (but not trip generation) for park-and-ride lots and satellite telecommuting centers. We do not recommend any changes to this aspect of the mitigation component.

9. Correction Factors

The existing mitigation component provides for trip type correction factors, based on evidence suggesting that certain trips are more likely to be captured by one mode rather than another. We do not recommend any changes to this aspect of the mitigation component.

A second correction factor in the existing mitigation component relates to trip distance, because, the documentation argues, bicycle and walking trips replace mostly shorter automobile trips. We recommend that this correction factor be eliminated, as there is little evidence to suggest that this phenomenon exists. Indeed, more complex changes in travel behavior are likely, such as mode shift to bicycling and walking trips being accompanied by a shift to closer destinations. For example, rather than drive to a grocery store on a freeway interchange, a household may walk to a smaller store in the neighborhood. Mixed use, compact neighborhoods are characterized by short overall trip lengths (see, for example, Kuzmyak et. al., 2003). Further evidence comes from the elasticities for trip reduction with respect to density, which are the same for both vehicle trips and VMT (Ewing & Cervero, 2001), suggesting that there is no impact on trip length.

Detailed Justification of Recommended Mitigation Levels

Default Values for Residential Land Uses

To develop the default values for residential land uses shown in Figure D-4, we had to overcome a significant hurdle: ITE retains no data on the characteristics of the developments used in their trip generation studies. Default values for average density, transit service levels, and other variables had to be estimated using two alternative methods. First, we reviewed representative projects through research of literature and discussions with professionals in the fields of architecture and town planning, to ascertain typical ranges for density and other characteristics of each land use type (for useful summaries, see Calthorpe, 1993, and Local Government Commission,2002).

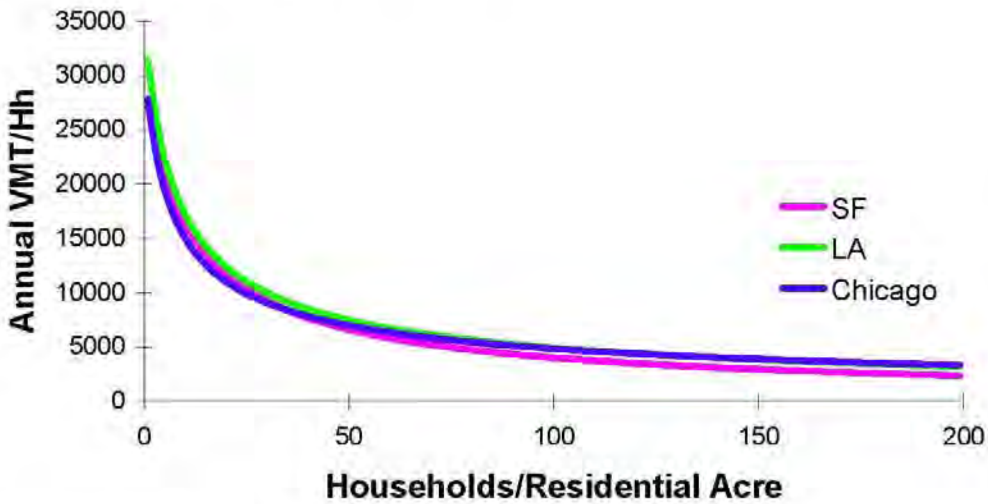
Second, these ranges of values were plugged into the formulas for the mitigation measures, and adjusted until the baseline values for each characteristic equaled the average ITE trip generation rates for each land use. For example, baseline density for Mid-Rise Apartments (64 units per residential acre) falls within the typical range observed from research of 45 to 125 units/acre, and when combined with other baseline characteristics for the land use, results in a 56.1% reduction in trip generation from the average rate for single family homes – the average reduction set forth in the ITE manual.

Finally, since the *Trip Generation* manual provides no daily trip generation rate for the "Mid-Rise Apartment" land use, we estimated a rate by extrapolating from the daily trip rate for the "High-Rise Apartment" land use type. The PM peak hour trip rate of 0.39 trips per unit for mid-rise apartments is 11.4% higher than the PM peak hour rate for high-rise apartments (0.35 trips/unit). Therefore, the daily trip rate for the "Mid-Rise Apartment" land use was estimated to be 4.68 trips per unit, or 11.4% higher than the daily trip for high-rise apartments (4.2 trips/unit).

Density

A considerable volume of research has investigated the links between density, particularly residential density, and travel behavior (for summaries, see Kuzmyak et. al, 2003; Boarnet & Crane, 2001). Overall, the conclusions can be summarized thus: there is a significant, quantifiable relationship between residential density and automobile use (see Figure D-6), but there is uncertainty regarding the degree to which this effect is due to the inherent effects of density, as opposed to factors for which density serves as a proxy, such as parking price, local retail, transit service frequency and pedestrian friendliness.

Figure D-6. Residential Density Vs. Vehicle Travel



Source: Holtzclaw et. al. (2002).

Fewer studies have attempted to disentangle the effects of density itself. Three of the main exceptions are:

- Typical elasticities for vehicular travel with respect to density are –0.1 to –0.04. These elasticities refer to the effect of density itself, isolated from variables that tend to be correlated with density such as transit frequency, and are additive to elasticities of other built environment factors. When these factors are not isolated, typical elasticities for VMT with respect to density are –0.22 to –0.27 (Kuzmyak et. al, 2003).
- The elasticity of density, when isolated from three other variables (diversity, design and destinations), is –0.043 with respect to vehicle trips, and – 0.035 with respect to VMT (Criterion and Fehr & Peers, 2001). However, this does not control for transit service levels.
- Cervero & Ewing (2001), in an update to this work, suggest a slightly higher elasticity of –0.05 with respect to both vehicle trips and VMT.

Note that density has been shown to have a nonlinear relationship with vehicle travel, with a threshold value of 25-30 units per acre below which the travel impacts of increased density are particularly large (Holtzclaw et. al, 2002). Holtzclaw et. al found that the best single variable equations to predict household vehicle travel (VMT per household, or VMT/Hh) relied on Households per Residential Acre (Hh/RA). For the Los Angeles region, San Francisco and Chicago regions, these equations varied only slightly, producing the curves shown in Figure D-6. For the Los Angeles region, this formula takes the form:

$$\frac{VMT}{Hh} = 19749\left(\frac{4.814 + Hh/RA}{4.814 + 7.140}\right)^{-0.639}$$

Based on this formula, the following elasticity formula is recommended for vehicle trips with respect to density. It is the same as Holtzclaw et. al' work, but reduced by 40% to take account of the fact that much of this impact will be realized through transit service, mix of uses and bicycle and pedestrian levels (which tends to correlate with density). The baseline assumed to correspond to a zero percent trip reduction is three units per acre, at which density the Holtzclaw formula results in 25,914 annual vehicle miles traveled per household. This translates into the following formula:

Trip reduction = 0.6(1-(19749*((4.814+households per residential acre)/(4.814+7.14))^-0.639)/25914)*

An apartment development of 16 units per residential acre, for example, would be estimated to generate 27.9% fewer trips than a three unit per acre project. The maximum allowable reduction recommended is 55% (equivalent to a 380 unit per acre development).

With this formula, "negative" reductions also apply, with less dense developments below the baseline level of three units per acre (for example large-lot housing) resulting in higher trip generation rates. (However, as long as the mitigation component is optional for developers or project proponents to complete, they will be unlikely to use it for projects whose overall score, for all components, will result in a finding to their disadvantage. For purposes of more accurately predicting vehicle trips and emissions, however, this negative reduction is useful and reflects the findings of the research literature.

Trip generation at the non-residential end is also influenced by density, but to a much lesser degree (Cervero, 1989, cited in Kuzmyak et. al, 2003). There are also far fewer studies investigating this relationship, and there is no comparable dataset to that for residential density. No reduction is recommended here.

Mix of Uses

Many references point to the impact of "diversity" or mix of uses on travel behavior. This is true both at the macro-scale, e.g. jobs-housing balance, and the micro-scale, e.g. the availability of services within walking distance. Key references, related to both the direction and magnitude of this relationship, include:

- Higher densities are most beneficial to transit ridership when they result in a mix of residential, commercial and office uses (Lund et. al., 2004).
- The elasticity of vehicle trips with respect to "diversity" is –0.051. The elasticity of VMT is –0.032. In this case, "diversity" is a measure of how the project affects regional population/employment balance. (Criterion and Fehr & Peers, 2001)
- Typical elasticities for vehicle trips with respect to local diversity (mix) are –0.03, and those for VMT are –0.05 (Ewing & Cervero, 2001).

- A balance of 1.5 jobs per household is estimated to produce a bus mode share 2 percentage points over the share for a single use area, although the degree of mix is not a useful estimating variable (Messenger & Ewing, 1996, cited in Kuzmyak et. al, 2003).
- Suburban activity centers with some on-site housing had 3-5% more transit, bike and walk commute trips (Cervero, 1989, cited in Kuzmyak et. al, 2003).
- The presence of retail reduces auto mode share by 2-5%, depending on neighborhood density. (Parsons Brinkerhoff, 1996, cited in Kuzmyak et. al, 2003).
- At suburban activity centers, the presence of retail in office buildings lowers vehicle trip rates by 6-8% (NTI, 2000, cited in Kuzmyak et. al, 2003).

4. Employment sites with "good" nearby retail and commercial services have a vehicle trip rate 21.5% below the ambient rate. Sites with "fair" services showed an 8.3% reduction, and those with "poor" services a 5.3% reduction. This is attributed not just to the presence of these services, but the fact that they make TDM programs more likely to succeed (Comsis, 1994, cited in Kuzmyak et. al, 2003).

The analysis is complicated by the fact that some of the most beneficial developments from this perspective may be single-use, in an area where another use is predominant (e.g. residential in an employment area). To take this into account, the following procedure is proposed (adapted from Criteron and Fehr & Peers, 2001):

$$\text{Trip reduction} = (1 - (ABS(1.5 * h - e) / (1.5 * h + e)) - 0.25) / 0.25 * 0.03$$

Where: h = study area households (or housing units)
e = study area employment

Negative reductions of up to 3% can result, and should be included.

This formula assumes an "ideal" housing balance of 1.5 jobs per household, based on Messenger & Ewing (1996), and a baseline diversity of 0.25. The maximum possible reduction using this formula is 9%.

This reduction takes into account overall jobs-population balance. The presence of local serving *retail* can be expected to bring further trip reduction benefits, and an additional reduction of 2% is recommended. This is towards the lower end of the values presented in the research discussed above, in order to avoid double counting with the diversity indicator.

Transit

The existing URBEMIS 2002 mitigation model places its primary emphasis on mode, i.e. whether service is provided by high-speed rail, commuter rail or bus. Within this framework, consideration is given to frequency (e.g. bus headways of 15 minutes or less score more highly than headways of 15-30 minutes).

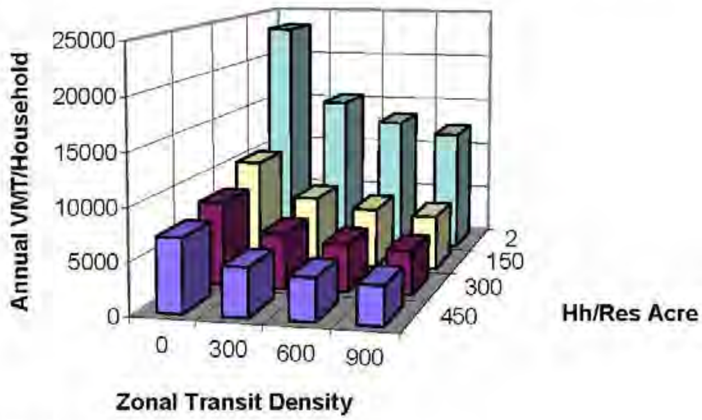
For example, the current mitigation component would award the maximum score of 100 to a development 0.5 miles from a BART station, even if no other transit were available. A part of the city with several bus lines offering 10-minute service, in contrast, would score much lower, even though these transit lines would carry many more passengers.

Current transit planning thinking, however, emphasizes that frequency and speed are two of the most important factors determining mode choice, rather than whether the service is provided by bus, bus rapid transit, or rail. Researchers have found that there is no *inherent* preference for rail over bus, provided that the quality of service is the same (for example, Ben-Akiva & Morikawa, cited in Transportation & Land Use Coalition, 2002).

Key references include:

- The average elasticity of ridership with respect to frequency is +0.3 to +0.5. Higher elasticities of +1.0 have been observed in suburban systems, with the +0.3 value more typical of urban systems. (Kittelson & Associates et. al, 2003).
- Pratt et. al. (2003) suggest an elasticity of ridership with respect to service hours (i.e. a combined measure of frequency and service span) of +0.5. Ridership is most sensitive to frequency changes when the past service was infrequent.
- Modeling in Massachusetts suggests that halving transit service headways from 30 to 15 minutes leads to an 8% drop in vehicle trips. A further decrease to 5 minutes leads to a further 4% drop in vehicle trips (Pratt et. al., 2003).
- Holtzclaw et. al. (2002) show that vehicle travel falls as transit service levels increase, even when holding density constant (Figure D-7). In the San Francisco Bay Area, a doubling of transit service from 300 to 600 (using the index described below) is associated with a 13% drop in VMT. An increase from 300 to 900 is associated with a 20% drop in VMT. In the Los Angeles region, the decreases in VMT are 12% and 18% respectively. However, the variable was omitted from the vehicle travel model presented in this paper, since density was used as a proxy for transit service.
- The maximum distance that people are willing to walk to transit tends to be 0.25 miles for bus, and 0.5 miles for rail (and, presumably bus rapid transit). (Kittelson & Associates et. al, 2003). It is unclear whether there is a "distance decay" effect, whereas people are more likely to use transit at closer distances within this range (see Lund et. al, 2004).

Figure D-7. VMT vs. Residential Density and Transit Use, San Francisco Bay Area



Source: Holtzclaw et. al. (2002).

Unfortunately, the elasticity of service with respect to transit ridership is difficult to convert to vehicle trip reduction, firstly because the baseline ridership needs to be known, and secondly because only a proportion (18-67% is cited by Pratt et. al., 2003) of new transit trips were formerly made by private auto. While it is clear that there is a direct correlation between transit service and vehicle trips, it is difficult to employ these elasticities directly. For this reason, the approach here is more in line with the existing mitigation component, which assumes a maximum percentage reduction for transit, and then reduces this based on a transit environment factor.

Various frequency-based transit service indices have been developed which have shown strong correlations with ridership. For example:

- In Los Angeles, the quality of four components of transit service (MTA rail, Rapid Bus, local bus and regional services) were rated on a scale of 0-3 for each community area, and then summed to provide the Transit Service Index on a scale of 0-12. (Nelson\Nygaard, 2002b).
- The studies by Holtzclaw et. al. (2002) used Zonal Transit Density, defined as the daily average number of buses or trains per hour times the fraction of the zone within 1/4 mile of the bus stop, or 1/2 mile of the rail station or ferry terminal, summed for all transit routes in or near the zone.

The Transit Service Index recommended here would combine the important features of all these approaches, with emphasis on frequency but with greater weighting given to rail services. Greater weight is also given to dedicated shuttles, in recognition of the fact that these are likely to be more closely targeted to the needs of the development. The Transit Service Index would be determined as follows:

- Number of average daily weekday buses stopping within 1/4 mile of the site; plus

- *Twice* the number of daily rail or bus rapid transit trips stopping within 1/2 mile of the site
- *Twice* the number of dedicated daily shuttle trips
- Divided by 900, the point at which the maximum benefits are assumed. (This equates to a BART station on a single line, plus four bus lines at 15-minute headways.)
- Developments that are larger than 0.5 miles across in any direction must be broken into smaller units for purposes of determining the transit service index. The average of all units would then be used.

Figure D-8 shows some examples of how service frequencies translate into Transit Service Index scores (note these are additive, if a location has more than one component).

Figure D-8. Example Transit Service Index Scores

Transit Service	Score	Assumptions
BART (single line)	0.33	150 trips per day (15-20 minute headways in each direction from 4 AM-12 AM)
15-minute bus, 5 AM – 12 AM	0.17	
30-minute bus, 5 AM – 7 PM	0.06	
Amtrak San Joaquin	0.03	6 trips per day in each direction
Dedicated commute shuttle	0.02	5 trips per commute period (single direction)

As well as existing service, planned and funded transit service would be included in the calculation. Purely demand responsive service would not be included.

A maximum trip reduction of 15% is recommended. This is the same as the existing URBEMIS 2002 trip reduction for existing and planned transit service.

In order to account for non-motorized access to transit, we also recommend that half the reduction be dependent on the pedestrian/bicycle friendliness score (calculated in the following section), similar to the approach taken in the existing mitigation component. This ensures that places with good pedestrian and bicycle access to transit are rewarded.

$$\textit{Trip reduction} = t * 0.075 + t * \textit{ped/bike score} * 0.075$$

Where t = transit service index

Bicycle and Pedestrian

Since bicycle mode share and pedestrian mode share depend on similar neighborhood characteristics, such as a fine-grained street grid, we recommend that a single factor be used to account for both modes. The bicycle and pedestrian components of the URBEMIS 2002 mitigation component are already well developed. However, the inputs are largely subjective, and there is still little evidence to justify the precise amount of credits for many of the individual mitigation measures (e.g. street trees).

Many street design factors have, however, been shown to promote walking and cycling. These include:

- Street connectivity, with traditional street networks that are more New Urbanist or grid-like, as opposed to the loops, lollipops and cul-de-sacs of most conventional subdivision. There are various measures of connectivity (summarized in Dill, 2003), such as:
  - Block length, size or density
  - Intersection density
  - Street density
  - Connected node ratio (number of street intersections divided by the number of intersections plus cul-de-sacs)
  - Link-node ratio (links are roadway or pathway segments between two nodes, which are intersections or cul-de-sac ends)
  - Grid pattern (percentage of intersections that are four- or more way).
  - Pedestrian Route Directness (ratio of route distance to straight line distance)
  - Effective Walking Area (% of parcels within 1/4 mile, that are also within 1/4 mile walking distance)
- Human-scale streetscapes with adequate pedestrian amenities, access to shopping and other amenities, and higher densities (Lund et. al., 2004)

Other relevant research includes:

- A composite indicator, the "Pedestrian Environment Factor," provides a statistically significant correlation with trip generation and VMT. It is comprised of four inputs (Parsons Brinkerhoff, 1993):
  - Ease of street crossings
  - Sidewalk continuity
  - Local street characteristics (grid vs. cul de sac)
  - Topography
- In Portland, OR, an increase in the PEF from "pedestrian hostile" to "almost average" reduces daily vehicle trips by 0.4 per household (7%). An increase from "almost average" to "fairly good" provides a daily reduction of 0.2 trips (Parsons Brinkerhoff, 1993, cited in Kuzmyak et. al, 2003).
- Sidewalk completeness, route directness and network density together have a vehicle trip elasticity of -0.05 (Ewing & Cervero, 2001).
  - For a high degree of walkability, block lengths of approximately 300 feet are recommended. Short blocks provide more pedestrian crossing opportunities and direct walking routes, and mean that traffic is more likely to be dispersed. Downtown Los Angeles, for comparison, has about 150 intersections per square mile. (Ewing, 1999).

There is a strong tradeoff here between simplicity and low data requirements on the one hand, and robustness and accuracy on the other. Pedestrian and bicycle level of service work for the Florida Department of Transportation and FHWA, for example, has shown that there are numerous statistically significant factors that can be included to assess the quality of the bicycle and pedestrian environment. These include motor vehicle volumes and speeds, truck volumes, roadway widths, urban design, and lateral separation between pedestrians and motor vehicles (for example, FHWA, 1998; Landis et. al, 2001).

However, we recommend that in order to keep data requirements to a minimum, one or two of the street design indicators discussed by Dill (2003) and Ewing and Cervero (2001) be used, together with a single bicycle measure. Since route directness and network density measure similar characteristics, we recommend the use of one of these (network density, which is inversely related to block size) plus sidewalk completeness and bicycle network completeness. The pedestrian/bicycle factor would then be calculated as follows:

Ped/bike factor = (network density + sidewalk completeness + bike lane completeness) / 3

Where: Network density = intersections per square mile / 1300 (or 1.0, whichever is less)

Note: In most GIS applications, intersections are counted based on the number of line segment terminations, or each "valence." Intersections have a valence of 3 or higher – a valence of 3 is a "T" intersection, 4 is a four-way intersection, and so on.[4] (Georgia Institute of Technology, 2002). Therefore, if intersections are counted manually on a map or project plan, care needs to be taken to distinguish between 3-, 4- and 5-way intersections, and factor them up accordingly. The 1,300 value roughly equates to a dense grid with four-way intersections every 300 feet, per the recommendation of Ewing (1999). Intersections with dedicated routes for pedestrians and/or bicyclists should be included in this calculation.

*Sidewalk completeness = % streets with sidewalks on both sides + 0.5 * % streets with sidewalk on one side*

Bike lane completeness = % arterials and collectors with bicycle lanes, or where suitable, direct parallel routes exist

A maximum reduction of 9% is proposed, based on the existing URBEMIS mitigation component.[5] The trip reduction would then be calculated as:

*Trip reduction = 9% * ped/bike factor*

No reduction should be allowed if the entire area within a half-mile walk of the project center consists of a single use. (Note that this applies to a half-mile walk, rather than straight-line

[4] A valence of 1 indicates that a line segment has terminated, e.g. in a cul-de-sac. A valence of 2 means that the street is continuing.

[5] Note that this excludes the bicycle reduction in the current mitigation component. However, this compensates for the fact that the reductions recommended for the mixed use and density variables will be realized in practice through pedestrian and bicycle mode share.

distance, to account for barriers such as freeways.) However, the ped/bike factor can still be used to calculate pedestrian access to transit, as part of the transit mitigation measure.

Affordable and Senior Housing

A significant amount of evidence points to the fact that lower-income households and senior citizens own fewer vehicles and drive less. Research includes:

- Russo (2001) cites evidence from the San Francisco Bay Area travel survey, which shows that households earning under $25,000 per year make 5.5 vehicle trips per day, compared to a regional average of 7.6. High income households (earning more than $75,000 per year) make an average of 10.5 trips. Note that this data does not control for other factors, such as density and transit access.
- In the San Francisco Bay Area, Los Angeles and Chicago, income was one of four variables with sufficient independent explanatory power to include in the model of VMT and vehicle ownership (Holtzclaw et. al., 2002).

Obviously, it is difficult if not impossible to account for the exact incomes of residents in URBEMIS, most obviously because the occupants are not known at the pre-development stage. However, the percentage of deed-restricted below-market-rate (BMR) housing does offer a way to incorporate this effect.

We recommend a 3% reduction in vehicle trips for each deed-restricted BMR unit.[6] Thus, the total reduction is as follows:

*Trip reduction = % units that are BMR * 0.04*

A development with 20% BMR units would thus gain a 0.8% reduction. A development with 100% BMR units would gain a 4% reduction.

Parking Supply

Significant correlations between parking supply and employee mode split have been observed. For example, a study of the link between parking availability and transit use in eight Canadian downtowns found an extremely high elasticity of –0.77 (Morrall & Bolger, 1996, cited in Kuzmyak et. al., 2003b). In California, the number of parking spaces per worker was found to be one of the main two elements of a binomial logit model predicting transit mode share among TOD office workers (Lund et. al, 2004).

As with residential density, the extent to which parking supply itself is a causal factor is uncertain. In practice, it probably serves as a proxy for variables such as price, high quality public transit, mix of uses, and pedestrian friendliness (Kuzmyak et. al., 2003b). Indeed, in

[6] Calculated from Holtzclaw et. al. (2002), assuming 12,000 average annual VMT per vehicle, median per capita income of $33,000 (2002 figures per California State Department of Finance), and an average income in BMR units 25% below median. Holtzclaw calculate the coefficient of -0.0565. Therefore, expected VMT reduction can be calculated as 0.0565 * 33,000 * 0.25 / 12,000 = 4%

practice there is a two-way relationship between parking supply and mode split. Free parking, for example, can be seen as both a cause of high parking supply (more parking is needed to satisfy the greater demand), and a consequence (the market price of parking is zero once an effectively unlimited supply is provided) (see, for example, Shoup, 1999).

Theoretically, it is possible to reduce parking provision to below the level of actual demand, should drivers park in neighboring lots or on-street in surrounding areas. However, planning approval is not likely to be granted for developments that significantly under-provide parking, unless complementary Residential Permit Parking programs or other measures to combat this type of overspill are introduced. Indeed, the main reason for minimum parking requirements levied by local jurisdictions is to address these overspill issues (Shoup, 1999).

Similarly, market realities are likely to prevent a developer from providing too little parking. The challenges in persuading lenders to finance developments that have below-code parking are difficult enough to overcome, even where there is clear, documented evidence to show that parking supply will be enough to meet demand (see for example, Parzen & Sigal, 2004). In contrast, the opposite tendency is likely to be apparent – that developments are prevented from taking full advantage of the opportunities to reduce parking supply by zoning codes (see, for example, Nelson\Nygaard, 2002).

The measure proposed here uses the Institute of Transportation Engineers' *Parking Generation* handbook as the baseline. This is assumed to equate to unconstrained demand. The trip reduction can therefore be calculated as follows:

Trip reduction = Actual parking provision / ITE Parking Generation rate

Since ITE parking generation rates use the same land use codes as the trip generation rates, these could be provided within the URBEMIS model itself. The user would only be required to enter the actual parking provision for each land use.

For land uses with rates for both weekday and weekend, the formula will use whichever rate is higher. The *Parking Generation* handbook covers most common land uses. For some land uses, however, no parking generation rates are available: in these cases, this particular mitigation measure may not be used.[7] Those land uses without parking generation rates include:

- Single Family Detached Housing
- Mid-rise Apartments
- High-rise Condominium/Townhouse
- Mobile Home Parks

[7] The next edition of *Parking Generation*, currently under development by an ITE Task Force, is likely to provide date for some of these missing land uses. While it would be ideal to have parking generation data for every single land use before introducing this mitigation measure into URBEMIS, the data does not yet exist. Rather than abandoning this mitigation measure entirely until perfect data exists, we recommend allowing the measure to be used for the many land uses where reasonable data is available.

- Residential Planned Unit Development (PUD)
- Day-care center
- Elementary school
- Junior High school
- Library
- City Park
- Discount Superstore
- Discount Club
- Electronic Superstore
- Home Improvement Superstore
- Gas/Service Station
- Pharmacy/Drugstore with and with/out Drive Through
- Medical Office Building
- General Heavy Industry

To avoid double counting with other trip reduction measures, the impacts of parking supply are proposed to be assessed in conjunction with all other non-residential trip reduction measures as follows:

- The total of all other non-residential trip reduction measures should be used if this is greater than or equal to the trip reduction from parking supply measures. For example, if parking supply is reduced 10% from ITE levels, and transit, mixed use and pedestrian/bicycle trip reductions amount to 20%, the 20% figure would be used.
- If the total of all other non-residential trip reduction measures (r_1) is less than the trip reduction from parking supply measures (r_2), the total trip reduction is as follows:

$$r_1 + 0.5 * (r_2 - r_1)$$

In effect, the parking supply reduction is only used if it is greater than the impact from other trip reduction measures, and the difference is discounted by 50%. For example, if parking supply is reduced 25% from ITE levels, and transit, mixed use and pedestrian/bicycle credits amount to 15%, the total reduction would be:

$$15 + 0.5 * (25\text{-}15) = 20\%.$$

This reduction should only be granted if measures to control overspill are in place, such as Residential Permit Parking programs, time limits or meters.

Transportation Demand Management

Transportation Demand Management programs have been shown to have a major impact on travel behavior. Site-level employee vehicle trip reductions of up to 38% have been achieved, particularly for programs that have included parking pricing (Shoup & Willson, 1980; Comsis, 1993; Valk & Wasch, 1998; Pratt, 2000). Parking price elasticities of –0.1 to –0.3 have been reported (Pratt, 2000).

This component of the existing URBEMIS 2002 mitigation component is well developed. However, there is considerable scope to adapt it in two ways:

- Provide greater emphasis for the three elements that have the greatest impact on travel behavior – parking pricing/cash out; free transit passes; and telecommuting.
- Simplify the remaining elements, through offering broader options such as "major program", "minor program", and "no program," for elements that are likely to have a smaller trip reduction potential.

We recommend that none of these reductions be permitted, unless they form part of a legally enforceable agreement specifying, for example, minimum parking prices and other TDM measures. This might form part of a development agreement, be enforced through any TDM ordinance in the local jurisdiction, or consist of another mechanisms mutually agreed by the air district and project proponent. Otherwise, there is little to guarantee that some of the promised measures (e.g. parking pricing) will actually be implemented and maintained.

Parking Pricing and Cash Out

We recommend that a maximum trip reduction of 25% be applied to projects that commit to introducing parking pricing. This is based on the approximate midpoint of observed reductions, which range from 15% to 38% (Shoup & Willson, 1990; Comsis, 1993; Pratt, 2000). Note that most of these studies apply to before-after or with-without comparisons, with no increase in transit service or other measures to reduce vehicle trips. This maximum reduction should apply to prices of $6 per day or greater (in 2004 dollars).

The trip reduction will therefore be as follows:

Trip reduction = daily parking charge / 6 * 0.25

If the parking charge is more than $6, the 25% reduction is taken. If parking charges do not apply to all trips to a site (e.g. customers are exempt), the reduction is pro-rated by the percentage of trips that the charges apply to. If little or no on-site parking is provided, the parking charges should be those of surrounding public facilities.

Parking cash-out programs should be eligible for 50% of the reduction for direct parking charges, in recognition of the fact that their impacts tend to be significantly lower (Pratt, 2000). This is partly due to the fact that cash-out payments are a taxable benefit.

Free Transit Passes

Some California transit agencies, most notably VTA in Santa Clara County, have EcoPass or similar programs, whereby employers or property manager's bulk-purchase transit passes for (free) distribution to their employees or tenants. Eco Pass programs have been shown to increase transit ridership by 50-79% (City of Boulder, undated; Caltrans, 2002), and reduce vehicle trips by 19% (Shoup, 1999). (Note that many of these new riders were making new trips, or ones previously made by walking or cycling.)

We therefore recommend that any project committing to providing free transit passes would receive an additional credit equivalent to 25% of the reduction granted for transit service. Thus, the credit is more valuable in places that have good transit service. This reduction would only apply to the portion of trips generated by those granted the free transit passes (e.g. residents and/or employees, but excluding shoppers and other visitors).

Telecommuting

We recommend the retention of the reductions granted for telecommuting and compressed work schedules in the existing mitigation component, with two clarifications:

- As with the reductions for other mitigation measures, there must be an enforceable commitment (e.g. development agreement), which covers both the take-up rate (employees actually telecommuting or using compressed work schedules) as well as the provision of the option.
- The percentage reduction should not be additive (in contrast to most other trip reduction measures). For example, if 20% of employees telecommute, and other trip reduction measures are estimated to reduce vehicle trips from 1,000 to 800 per day, the 20% reduction would apply to the 800 trips, not the original 1,000.

Other TDM Programs

Other TDM program elements, that do not include financial incentives, tend to have a smaller impact on travel behavior. We recommend that reductions be based on the number of the following elements incorporated into the program, per Figure D-7:

- Secure bicycle parking (at least one space per 20 vehicle parking spaces)
- Showers/changing facilities
- Guaranteed Ride Home
- Car-sharing services
- Information on transportation alternatives, such as bus schedules and bike maps
- Dedicated employee transportation coordinator
- Carpool matching programs
- Preferential carpool/vanpool parking

The impact of a TDM program will also depend on the travel alternatives available. A program will have more impact if the site is served by frequent transit, for example (although note that a TDM program can do much to promote carpooling even in other locations). For this reason, we recommend that part of the TDM credit be used to adjust the credits granted for transit service and pedestrian/bicycle friendliness (see Figure D-9).

Figure D-9. Recommended TDM Program Reductions

Level	Number of Elements	Recommended Reduction
Major	At least 5 elements	2%, plus 10% of the credit for transit and pedestrian/ bike friendliness
Minor	At least 3 elements	1%, plus 5% of the credit of transit and pedestrian/bike friendliness
No program	None	None

Examples

It is important to recognize that any type of calibration is beyond the scope of this analysis, which relies on existing references to build on the ranges established in the existing mitigation component. Figure D-10, however, does provide some examples to indicate the trip reductions that would apply to specific places.

The data are drawn from the database compiled for the Location Efficient Mortgage program (for details, see Holtzclaw et. al., 2002), and from the San Francisco Bay Area Metropolitan Transportation Commission's TAZ files. For these reasons, the examples are limited to the San Francisco Bay Area. Transit service was estimated from schedules and route maps. Sidewalk and bike lane completeness were estimated based on local knowledge. For these reasons of limited data, the examples are intended as illustrations only, rather than to refer to a particular project.

The reductions are calculated for the physical and environmental factors only, for residential uses. They exclude any additional reductions from TDM programs and affordable housing.

The final column compares average vehicle miles traveled (no vehicle trip data were readily available) in these neighborhoods to the Brentwood baseline, as a rough comparison to the reductions granted through the proposed trip reductions for URBEMIS. As can be seen, while there are significant discrepancies, the overall correspondence is acceptable for this type of sketch planning model.

Figure D-10. Example Trip Reductions

		Vehicle Trip Reduction Granted For:						
Example	TAZ	Residential Density	Mix of Uses	Local Retail	Transit	Ped/Bike Friendliness	Total Reduction	% Reduction in VMT from Brentwood
Brentwood	899	1.4%	-3.0%	0.0%	0.1%	1.7%	0.3%	0.0%
Orinda	831	-9.5%	5.8%	0.0%	3.7%	1.4%	1.4%	5.6%
Pleasant Hill BART	806	14.4%	7.2%	3.0%	8.3%	3.3%	36.3%	40.2%
Emeryville	723	39.0%	1.7%	3.0%	4.4%	4.9%	53.1%	47.8%
Downtown Palo Alto	245	19.8%	4.4%	3.0%	6.1%	7.5%	40.8%	50.6%

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Appendix E. California Air District Contacts

Go to the following web site for a list of air district contacts:

http://www.arb.ca.gov/capcoa/roster.htm

Appendix F. State Of California Counties and Air Basins

A California Air Basin map is available on the internet at:
http://www.arb.ca.gov/knowzone/basin/basin.swf

and information on local air districts can be found at:
www.arb.ca.gov/capcoa/roster.htm

Appendix G. Construction Equipment Emission Factors

Equipment	MaxHP	AvgHP	Load
Aerial Lifts	15	15	0.46
Aerial Lifts	25	19	0.46
Aerial Lifts	50	34	0.46
Aerial Lifts	120	66	0.46
Aerial Lifts	500	369	0.46
Aerial Lifts	750	667	0.46
Air Compressors	15	12	0.48
Air Compressors	25	24	0.48
Air Compressors	50	37	0.48
Air Compressors	120	78	0.48
Air Compressors	175	147	0.48
Air Compressors	250	218	0.48
Air Compressors	500	385	0.48
Air Compressors	750	595	0.48
Air Compressors	1000	808	0.48
Bore/Drill Rigs	15	11	0.75
Bore/Drill Rigs	25	17	0.75
Bore/Drill Rigs	50	33	0.75
Bore/Drill Rigs	120	82	0.75
Bore/Drill Rigs	175	150	0.75
Bore/Drill Rigs	250	200	0.75
Bore/Drill Rigs	500	331	0.75
Bore/Drill Rigs	750	654	0.75
Bore/Drill Rigs	1000	987	0.75
Cement and Mortar Mixers	15	9	0.56
Cement and Mortar Mixers	25	25	0.56
Concrete/Industrial Saws	25	18	0.73
Concrete/Industrial Saws	50	33	0.73
Concrete/Industrial Saws	120	81	0.73
Concrete/Industrial Saws	175	175	0.73
Cranes	50	43	0.43
Cranes	120	93	0.43
Cranes	175	149	0.43
Cranes	250	208	0.43
Cranes	500	334	0.43
Cranes	750	562	0.43
Cranes	9999	1800	0.43
Crushing/Proc. Equipment	50	45	0.78

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Equipment	MaxHP	AvgHP	Load
Crushing/Proc. Equipment	120	85	0.78
Crushing/Proc. Equipment	175	171	0.78
Crushing/Proc. Equipment	250	250	0.78
Crushing/Proc. Equipment	500	382	0.78
Crushing/Proc. Equipment	750	602	0.78
Crushing/Proc. Equipment	1000	1337	0.78
Dumpers/Tenders	50	16	0.38
Excavators	120	23	0.57
Excavators	175	35	0.57
Excavators	250	103	0.57
Excavators	500	157	0.57
Excavators	750	222	0.57
Excavators	9999	327	0.57
Excavators	25	542	0.57
Forklifts	25	39	0.3
Forklifts	50	83	0.3
Forklifts	120	149	0.3
Forklifts	175	205	0.3
Forklifts	250	295	0.3
Generator Sets	500	11	0.74
Generator Sets	750	19	0.74
Generator Sets	50	33	0.74
Generator Sets	120	84	0.74
Generator Sets	175	153	0.74
Generator Sets	250	229	0.74
Generator Sets	500	363	0.74
Generator Sets	15	586	0.74
Generator Sets	25	1130	0.74
Graders	50	36	0.61
Graders	120	98	0.61
Graders	175	162	0.61
Graders	250	225	0.61
Graders	500	300	0.61
Graders	750	635	0.61
Off-Highway Tractors	9999	115	0.65
Off-Highway Tractors	50	160	0.65
Off-Highway Tractors	120	160	0.65
Off-Highway Tractors	175	697	0.65
Off-Highway Tractors	250	999	0.65
Off-Highway Trucks	500	175	0.57
Off-Highway Trucks	750	233	0.57

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Equipment	MaxHP	AvgHP	Load
Off-Highway Trucks	120	381	0.57
Off-Highway Trucks	175	618	0.57
Off-Highway Trucks	250	874	0.57
Other General Industrial Equipment	750	10	0.51
Other General Industrial Equipment	1000	24	0.51
Other General Industrial Equipment	175	34	0.51
Other General Industrial Equipment	250	97	0.51
Other General Industrial Equipment	500	150	0.51
Other General Industrial Equipment	750	212	0.51
Other General Industrial Equipment	1000	415	0.51
Other General Industrial Equipment	15	684	0.51
Other General Industrial Equipment	25	875	0.51
Other Material Handling Equipment	50	41	0.59
Other Material Handling Equipment	120	82	0.59
Other Material Handling Equipment	175	165	0.59
Other Material Handling Equipment	500	196	0.59
Other Material Handling Equipment	15	259	0.59
Other Material Handling Equipment	25	1002	0.59
Pavers	50	24	0.62
Pavers	120	36	0.62
Pavers	175	89	0.62
Pavers	250	165	0.62
Pavers	500	250	0.62
Pavers	750	300	0.62
Paving Equipment	1000	19	0.53
Paving Equipment	50	36	0.53
Paving Equipment	120	82	0.53
Paving Equipment	175	152	0.53
Paving Equipment	250	184	0.53
Pressure Washers	500	13	0.3
Pressure Washers	9999	19	0.3
Pressure Washers	25	38	0.3
Pressure Washers	50	64	0.3
Pressure Washers	120	152	0.6
Pressure Washers	175	191	0.6
Pumps	250	8	0.74
Pumps	500	21	0.74
Pumps	25	37	0.74
Pumps	50	84	0.74
Pumps	120	151	0.74
Pumps	175	217	0.74

Equipment	MaxHP	AvgHP	Load
Pumps	250	372	0.74
Pumps	15	615	0.74
Pumps	15	1460	0.74
Rollers	25	9	0.56
Rollers	50	19	0.56
Rollers	120	37	0.56
Rollers	15	84	0.56
Rollers	25	154	0.56
Rollers	50	218	0.56
Rollers	120	312	0.56
Rough Terrain Forklifts	175	45	0.6
Rough Terrain Forklifts	250	83	0.6
Rough Terrain Forklifts	500	166	0.6
Rough Terrain Forklifts	750	227	0.6
Rough Terrain Forklifts	9999	341	0.6
Rubber Tired Dozers	15	175	0.59
Rubber Tired Dozers	25	248	0.59
Rubber Tired Dozers	50	358	0.59
Rubber Tired Dozers	120	539	0.59
Rubber Tired Dozers	175	800	0.59
Rubber Tired Loaders	250	25	0.54
Rubber Tired Loaders	500	46	0.54
Rubber Tired Loaders	50	87	0.54
Rubber Tired Loaders	120	157	0.54
Rubber Tired Loaders	175	220	0.54
Rubber Tired Loaders	250	350	0.54
Rubber Tired Loaders	500	717	0.54
Rubber Tired Loaders	175	877	0.54
Scrapers	250	104	0.72
Scrapers	500	164	0.72
Scrapers	750	232	0.72
Scrapers	1000	356	0.72
Scrapers	25	615	0.72
Signal Boards	50	6	0.82
Signal Boards	120	37	0.78
Signal Boards	175	82	0.78
Signal Boards	250	158	0.78
Signal Boards	500	216	0.78
Skid Steer Loaders	750	20	0.55
Skid Steer Loaders	1000	37	0.55
Skid Steer Loaders	120	62	0.55

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Equipment	MaxHP	AvgHP	Load
Surfacing Equipment	175	25	0.45
Surfacing Equipment	250	113	0.45
Surfacing Equipment	500	152	0.45
Surfacing Equipment	750	239	0.45
Surfacing Equipment	15	392	0.45
Surfacing Equipment	50	615	0.45
Sweepers/Scrubbers	120	14	0.68
Sweepers/Scrubbers	175	23	0.68
Sweepers/Scrubbers	250	37	0.68
Sweepers/Scrubbers	25	88	0.68
Sweepers/Scrubbers	50	163	0.68
Sweepers/Scrubbers	120	190	0.68
Tractors/Loaders/Backhoes	50	23	0.55
Tractors/Loaders/Backhoes	120	44	0.55
Tractors/Loaders/Backhoes	175	75	0.55
Tractors/Loaders/Backhoes	250	147	0.55
Tractors/Loaders/Backhoes	500	249	0.55
Tractors/Loaders/Backhoes	750	500	0.55
Tractors/Loaders/Backhoes	15	750	0.55
Trenchers	25	9	0.75
Trenchers	50	35	0.75
Trenchers	120	35	0.75
Trenchers	175	69	0.75
Trenchers	250	153	0.75
Trenchers	25	237	0.75
Trenchers	50	331	0.75
Trenchers	120	624	0.75
Welders	175	11	0.45
Welders	250	20	0.45
Welders	500	46	0.45
Welders	750	70	0.45
Welders	15	174	0.45
Welders	25	211	0.45
Welders	50	297	0.45

Appendix H. Equipment Selection Spreadsheet

Demolition – One Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	1
Concrete Saw	1	8
Excavator		
Bore/Drill Rigs		
Other Equip (Water Truck)		
Tractor/Loader/Backhoe	2	6
	4	

Demolition – Two Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	1
Concrete Saw	1	8
Excavator		
Bore/Drill Rigs		
Other Equip (Water Truck)		
Tractor/Loader/Backhoe	2	6
	4	

Demolition – Three Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	1
Concrete Saw	1	8
Excavator		
Bore/Drill Rigs		
Other Equip (Water Truck)		
Tractor/Loader/Backhoe	2	6
	4	

Demolition – Five Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	1
Concrete Saw	1	8
Excavator		
Bore/Drill Rigs		
Other Equip (Water Truck)		
Tractor/Loader/Backhoe	2	6
	4	

Demolition – Ten Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	8
Concrete Saw	1	8
Excavator		
Bore/Drill Rigs		
Other Equip (Water Truck)		
Tractor/Loader/Backhoe	3	8
	5	

Demolition – Fifteen Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	8
Concrete Saw		
Excavator		
Bore/Drill Rigs		
Other Equip (Water Truck)		
Tractor/Loader/Backhoe	3	8
	4	

Demolition – Twenty Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	2	8
Concrete Saw		
Excavator	3	8
Bore/Drill Rigs		
Other Equip (Water Truck)		
Tractor/Loader/Backhoe		
	5	

Demolition – Twenty-five Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	2	8
Concrete Saw		
Excavator	3	8
Bore/Drill Rigs		
Other Equip (Water Truck)		
Tractor/Loader/Backhoe		
	5	

Demolition – Thirty Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	2	8
Concrete Saw		
Excavator	3	8
Bore/Drill Rigs		
Other Equip (Water Truck)		
Tractor/Loader/Backhoe		
	5	

Demolition – Thirty-four Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	2	8
Concrete Saw		
Excavator	3	8
Bore/Drill Rigs		
Other Equip (Water Truck)		
Tractor/Loader/Backhoe		
	5	

Grading – One Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	6
Excavators		
Graders	1	6
Scrapers		
Tractor/Loader/Backhoe	1	7
Water Truck	1	8
	4	

Grading – Two Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	6
Excavators		
Graders	1	6
Scrapers		
Tractor/Loader/Backhoe	1	7
Water Truck	1	8
	4	

Grading – Three Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	6
Excavators		
Graders	1	6
Scrapers		
Tractor/Loader/Backhoe	1	7
Water Truck	1	8
	4	

Grading – Five Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	6
Excavators		
Graders	1	6
Scrapers		
Tractor/Loader/Backhoe	1	7
Water Truck	1	8
	4	

Grading – Ten Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	8
Excavators		
Graders	1	8
Scrapers		
Tractor/Loader/Backhoe	2	7
Water Truck	1	8
	5	

Grading – Fifteen Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	8
Excavators		
Graders	1	8
Scrapers		
Tractor/Loader/Backhoe	2	7
Water Truck	1	8
	5	

Grading – Twenty Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	8
Excavators	1	8
Graders	1	8
Scrapers		
Tractor/Loader/Backhoe	3	8
Water Truck	1	8
	7	

Grading – Twenty-five Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	8
Excavators	1	8
Graders	1	8
Scrapers	2	8
Tractor/Loader/Backhoe	3	8
Water Truck	1	8
	9	

Grading – Thirty Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	8
Excavators	1	8
Graders	1	8
Scrapers	2	8
Tractor/Loader/Backhoe	3	8
Water Truck	1	8
	9	

Grading – Thirty-four Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	8
Excavators	1	8
Graders	1	8
Scrapers	2	8
Tractor/Loader/Backhoe	3	8
Water Truck	1	8
	9	

Grading 73 acres		
Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	8
Excavators	1	8
Graders	1	8
Scrapers	3	8
Tractor/Loader/Backhoe	3	8
Water Truck	1	8
	10	

Grading 78 acres		
Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	8
Excavators	1	8
Graders	1	8
Scrapers	3	8
Tractor/Loader/Backhoe	3	8
Water Truck	1	8
	10	

Grading 86 acres		
Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	2	8
Excavators	1	8
Graders	1	8
Scrapers	3	8
Tractor/Loader/Backhoe	2	8
Water Truck	1	8
	10	

Grading 112 acres		
Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	2	8
Excavators		
Graders	2	8
Scrapers	4	8
Tractor/Loader/Backhoe	2	8
Water Truck	2	8
		8
	12	

Grading 138 acres		
Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	2	8
Excavators		
Graders	2	8
Scrapers	4	8
Tractor/Loader/Backhoe	1	8
Water Truck	2	8
Compactor	1	8
	12	

Grading 151 acres		
Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	2	8
Excavators		
Graders	2	8
Scrapers	5	8
Tractor/Loader/Backhoe	1	8
Water Truck	2	8
Compactor	1	8
	13	

Grading 189 acres		
Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	3	8
Excavators		
Graders	2	8
Scrapers	6	8
Tractor/Loader/Backhoe		
Water Truck	2	8
Compactor	1	8
	14	

Construction One Acre		
Equipment Type	No. of Equip	hr/day
Crane	1	4
Electric Welders		
Excavator		
Fork Lift	2	6
Generator Sets		
Tractor/Loader/Backhoe	1	8
	4	

Construction Two Acre		
Equipment Type	No. of Equip	hr/day
Crane	1	6
Electric Welders	3	8
Excavator		
Fork Lift	2	6
Generator Sets	1	8
Tractor/Loader/Backhoe	1	8
	8	

Construction Three Acre		
Equipment Type	No. of Equip	hr/day
Crane	1	6
Electric Welders	3	8
Excavator		
Fork Lift	2	6
Generator Sets	1	8
Tractor/Loader/Backhoe	1	8
	8	

Construction Five Acre		
Equipment Type	No. of Equip	hr/day
Crane	1	6
Electric Welders	3	8
Excavator		
Fork Lift	2	6
Generator Sets	1	8
Tractor/Loader/Backhoe	1	8
	8	

Construction Ten Acre		
Equipment Type	No. of Equip	hr/day
Crane	1	6
Electric Welders	3	8
Excavator		
Fork Lift	2	6
Generator Sets	1	8
Tractor/Loader/Backhoe	1	8
	8	

Construction Fifteen Acre		
Equipment Type	No. of Equip	hr/day
Crane	1	7
Electric Welders	3	8
Excavator		
Fork Lift	2	7
Generator Sets	1	8
Tractor/Loader/Backhoe	1	8
	8	

Construction Twenty Acre		
Equipment Type	No. of Equip	hr/day
Crane	1	7
Electric Welders	1	8
Excavator		
Fork Lift	3	8
Generator Sets	1	8
Tractor/Loader/Backhoe	3	7
	9	

Construction Twenty-five Acre		
Equipment Type	No. of Equip	hr/day
Crane	1	7
Electric Welders	1	8
Excavator		
Fork Lift	3	8
Generator Sets	1	8
Tractor/Loader/Backhoe	3	7
	9	

Construction Thirty Acre		
Equipment Type	No. of Equip	hr/day
Crane	1	7
Electric Welders	1	8
Excavator		
Fork Lift	3	8
Generator Sets	1	8
Tractor/Loader/Backhoe	3	7
	9	

Construction Thirty-four Acre		
Equipment Type	No. of Equip	hr/day
Crane	1	7
Electric Welders	1	8
Excavator		
Fork Lift	3	8
Generator Sets	1	8
Tractor/Loader/Backhoe	3	7
	9	

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Coating/Paving One Acre		
Equipment Type	No. of Equip	hr/day
Pavers	1	7
Paving Equipment		
Cement Mortar Mixers	4	6
Plate Compactor		
Roller	1	7
Tractor/Loader/Backhoe	1	7
	7	

Coating/Paving Two Acre		
Equipment Type	No. of Equip	hr/day
Pavers	1	7
Paving Equipment	1	8
Cement Mortar Mixers	4	6
Plate Compactor		
Roller	1	7
Tractor/Loader/Backhoe	1	7
	8	

Coating/Paving Three Acre		
Equipment Type	No. of Equip	hr/day
Pavers	1	7
Paving Equipment	1	8
Cement Mortar Mixers	4	6
Plate Compactor		
Roller	1	7
Tractor/Loader/Backhoe	1	7
	8	

Coating/Paving Five Acre		
Equipment Type	No. of Equip	hr/day
Pavers	1	7
Paving Equipment	2	6
Cement Mortar Mixers	4	6
Plate Compactor		
Roller	1	7
Tractor/Loader/Backhoe	1	7
	9	

Coating/Paving Ten Acre		
Equipment Type	No. of Equip	hr/day
Pavers	1	7
Paving Equipment	2	6
Cement Mortar Mixers	4	6
Plate Compactor		
Roller	1	7
Tractor/Loader/Backhoe		
	8	

Coating/Paving Fifteen Acre		
Equipment Type	No. of Equip	hr/day
Pavers	1	8
Paving Equipment	2	6
Cement Mortar Mixers		
Plate Compactor		
Roller	2	6
Tractor/Loader/Backhoe		
	5	

Coating/Paving Twenty Acre		
Equipment Type	No. of Equip	hr/day
Pavers	1	8
Paving Equipment	2	6
Cement Mortar Mixers		
Plate Compactor		
Roller	2	6
Tractor/Loader/Backhoe		
	5	

Coating/Paving Twenty-five Acre		
Equipment Type	No. of Equip	hr/day
Pavers	1	8
Paving Equipment	2	6
Cement Mortar Mixers		
Plate Compactor		
Roller	2	6
Tractor/Loader/Backhoe		
	5	

Coating/Paving Thirty Acre		
Equipment Type	No. of Equip	hr/day
Pavers	1	8
Paving Equipment	2	8
Cement Mortar Mixers		
Plate Compactor		
Roller	2	6
Tractor/Loader/Backhoe		
	5	

Coating/Paving Thirty-four Acre		
Equipment Type	No. of Equip	hr/day
Pavers	1	8
Paving Equipment	2	8
Cement Mortar Mixers		
Plate Compactor		
Roller	2	6
Tractor/Loader/Backhoe		
	5	

Trenching 1-90 acres	No. of Equip	hr/day
Boom Trucks (Other Industrial)	1	8
Excavators	2	8
Loader	1	8

Trenching 90+ acres	No. of Equip	hr/day
Boom Trucks (Other Industrial)	2	8
Excavators	4	8
Loader	2	8

Trenching based on information from SMAQMD and assumes 1 trenching crew for up to 90 acres, 2 crews for projects in excess of 90 acres.

Appendix I. Construction Equipment Emission Factors (grams per brake-horsepower hour)

2005		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Aerial Lifts	15	0.386	1.649	2.533	0.036	0.181	261.653
	25	0.680	1.687	2.695	0.030	0.212	261.653
	50	1.194	2.756	2.781	0.030	0.295	261.653
	120	0.585	1.774	3.600	0.027	0.290	261.653
	500	0.238	0.975	2.843	0.023	0.094	261.653
	750	0.244	0.975	2.908	0.024	0.095	261.653
Air Compressors	15	0.640	2.065	3.615	0.038	0.287	273.029
	25	0.740	1.816	2.830	0.031	0.225	273.029
	50	1.639	3.619	3.053	0.032	0.372	273.029
	120	0.697	1.996	4.025	0.029	0.362	273.029
	175	0.458	1.593	3.679	0.028	0.200	273.029
	250	0.320	0.893	3.465	0.028	0.126	273.029
	500	0.283	1.135	3.129	0.024	0.114	273.029
	750	0.289	1.135	3.201	0.025	0.115	273.029
	1000	0.353	1.397	3.757	0.025	0.124	273.029
Bore/Drill Rigs	15	0.540	2.605	3.562	0.060	0.255	426.608
	25	0.633	1.898	3.885	0.049	0.251	426.608
	50	1.575	4.183	4.161	0.050	0.437	426.608
	120	0.770	2.814	4.894	0.045	0.432	426.608
	175	0.482	2.279	4.404	0.043	0.225	426.608
	250	0.275	0.810	4.140	0.043	0.104	426.608
	500	0.234	0.787	3.399	0.038	0.096	426.608
	750	0.247	0.787	3.591	0.040	0.099	426.608
	1000	0.361	0.968	4.832	0.040	0.127	426.608
Cement and Mortar Mixers	15	0.497	2.044	3.206	0.045	0.232	318.534
	25	0.821	2.042	3.269	0.037	0.256	318.534
Concrete/Industrial Saws	25	0.574	1.776	3.699	0.048	0.236	415.232
	50	2.201	4.972	4.533	0.049	0.518	415.232
	120	0.984	2.921	5.917	0.044	0.501	415.232
	175	0.645	2.335	5.405	0.042	0.276	415.232
Cranes	50	1.725	3.738	2.855	0.029	0.376	244.589
	120	0.688	1.905	3.878	0.026	0.363	244.589
	175	0.455	1.530	3.539	0.025	0.202	244.589
	250	0.343	0.956	3.380	0.025	0.138	244.589
	500	0.305	1.272	3.027	0.022	0.123	244.589
	750	0.308	1.270	3.091	0.023	0.124	244.589
	9999	0.342	1.450	3.543	0.023	0.120	244.589
Crawler Tractors	50	2.651	5.713	4.299	0.043	0.573	364.039
	120	1.073	2.925	6.034	0.039	0.559	364.039
	175	0.712	2.373	5.494	0.037	0.317	364.039
	250	0.552	1.551	5.268	0.037	0.225	364.039
	500	0.490	2.328	4.735	0.032	0.198	364.039
	750	0.494	2.324	4.823	0.034	0.200	364.039

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2005		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	1000	0.542	2.580	5.471	0.034	0.195	364.039
Crushing/Proc. Equipment	50	2.742	6.051	4.979	0.052	0.619	443.672
	120	1.144	3.276	6.553	0.047	0.601	443.672
	175	0.751	2.615	5.987	0.045	0.331	443.672
	250	0.518	1.434	5.633	0.045	0.205	443.672
	500	0.458	1.800	5.047	0.039	0.184	443.672
	750	0.462	1.726	5.167	0.041	0.184	443.672
	9999	0.573	2.193	6.122	0.041	0.200	443.672
Dumpers/Tenders	25	0.440	1.175	2.094	0.025	0.152	216.148
Excavators	25	0.419	1.342	2.812	0.037	0.179	324.222
	50	2.114	4.737	3.670	0.038	0.477	324.222
	120	0.844	2.453	4.727	0.034	0.463	324.222
	175	0.555	1.960	4.314	0.033	0.251	324.222
	250	0.378	1.010	4.072	0.033	0.146	324.222
	500	0.337	1.149	3.550	0.029	0.132	324.222
	750	0.342	1.148	3.661	0.030	0.134	324.222
Forklifts	50	1.162	2.554	1.949	0.020	0.258	170.643
	120	0.457	1.292	2.483	0.018	0.253	170.643
	175	0.303	1.022	2.286	0.017	0.137	170.643
	250	0.184	0.466	2.118	0.017	0.069	170.643
	500	0.164	0.480	1.852	0.015	0.063	170.643
Generator Sets	15	0.852	3.183	5.429	0.059	0.359	420.920
	25	0.875	2.799	4.364	0.048	0.311	420.920
	50	1.841	4.286	4.445	0.049	0.461	420.920
	120	0.923	2.822	5.727	0.045	0.454	420.920
	175	0.602	2.255	5.233	0.043	0.250	420.920
	250	0.417	1.249	4.929	0.043	0.159	420.920
	500	0.374	1.504	4.535	0.037	0.147	420.920
	750	0.386	1.504	4.640	0.038	0.149	420.920
	9999	0.503	1.876	5.458	0.038	0.180	420.920
Graders	50	2.312	5.089	3.970	0.041	0.514	346.974
	120	0.934	2.653	5.299	0.037	0.498	346.974
	175	0.615	2.129	4.834	0.035	0.275	346.974
	250	0.449	1.244	4.599	0.035	0.179	346.974
	500	0.398	1.610	4.086	0.031	0.160	346.974
	750	0.403	1.608	4.185	0.032	0.162	346.974
Off-Highway Tractors	120	1.163	3.084	6.557	0.039	0.590	369.727
	175	0.781	2.535	5.981	0.038	0.345	369.727
	250	0.638	1.817	5.777	0.038	0.263	369.727
	750	0.568	3.043	5.323	0.034	0.231	369.727
	1000	0.608	3.279	5.887	0.034	0.224	369.727
Off-Highway Trucks	175	0.579	2.004	4.418	0.033	0.261	324.222
	250	0.401	1.057	4.176	0.033	0.154	324.222
	500	0.361	1.220	3.644	0.029	0.139	324.222
	750	0.364	1.219	3.754	0.030	0.141	324.222
	1000	0.416	1.472	4.502	0.030	0.145	324.222
Other Construction Equipment	15	0.447	2.153	2.945	0.050	0.211	352.662

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2005		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	25	0.523	1.569	3.211	0.040	0.208	352.663
	50	1.843	4.255	3.781	0.041	0.440	352.663
	120	0.805	2.476	4.803	0.037	0.426	352.663
	175	0.524	1.981	4.381	0.036	0.231	352.663
	500	0.314	1.164	3.652	0.031	0.127	352.663
Other General Industrial Equipment	15	0.314	1.771	2.211	0.040	0.164	290.093
	25	0.373	1.201	2.521	0.033	0.160	290.093
	50	2.024	4.391	3.362	0.034	0.444	290.093
	120	0.806	2.235	4.471	0.030	0.432	290.093
	175	0.532	1.782	4.086	0.029	0.238	290.093
	250	0.365	0.984	3.843	0.029	0.143	290.093
	500	0.324	1.242	3.433	0.025	0.129	290.093
	750	0.329	1.242	3.514	0.026	0.131	290.093
	1000	0.392	1.540	4.134	0.026	0.137	290.093
Other Material Handling Equipment	50	2.310	5.016	3.874	0.039	0.507	335.598
	120	0.925	2.571	5.150	0.035	0.493	335.598
	175	0.610	2.051	4.707	0.034	0.272	335.598
	250	0.419	1.135	4.427	0.034	0.165	335.598
	500	0.372	1.434	3.959	0.029	0.148	335.598
	9999	0.452	1.777	4.766	0.029	0.157	335.598
Pavers	25	0.776	2.022	3.475	0.040	0.259	352.663
	50	2.466	5.310	4.129	0.041	0.536	352.663
	120	1.026	2.805	5.883	0.037	0.523	352.663
	175	0.682	2.286	5.353	0.036	0.300	352.663
	250	0.545	1.566	5.152	0.036	0.225	352.663
	500	0.482	2.452	4.671	0.031	0.197	352.663
Paving Equipment	25	0.447	1.341	2.745	0.035	0.177	301.470
	50	2.086	4.493	3.522	0.035	0.454	301.470
	120	0.871	2.383	5.005	0.032	0.443	301.470
	175	0.577	1.939	4.551	0.031	0.253	301.470
	250	0.463	1.334	4.381	0.031	0.191	301.470
Plate Compactors	15	0.321	1.496	2.147	0.034	0.152	244.588
Pressure Washers	15	0.345	1.291	2.201	0.024	0.145	170.643
	25	0.355	1.135	1.769	0.020	0.126	170.643
	50	0.612	1.486	1.752	0.020	0.165	170.643
	120	0.344	1.093	2.223	0.018	0.163	170.643
Pumps	15	0.986	3.183	5.574	0.059	0.442	420.920
	25	1.141	2.799	4.364	0.048	0.347	420.920
	50	1.953	4.495	4.487	0.049	0.479	420.920
	120	0.948	2.864	5.808	0.045	0.471	420.920
	175	0.619	2.289	5.307	0.043	0.260	420.920
	250	0.430	1.273	4.999	0.043	0.166	420.920
	500	0.385	1.578	4.585	0.037	0.152	420.920
	750	0.396	1.578	4.690	0.038	0.154	420.920
	9999	0.511	1.954	5.514	0.038	0.182	420.920
Rollers	15	0.403	1.945	2.660	0.045	0.190	318.534

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2005		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	25	0.473	1.417	2.901	0.037	0.187	318.534
	50	1.955	4.312	3.591	0.037	0.441	318.534
	120	0.828	2.368	4.841	0.034	0.427	318.534
	175	0.545	1.905	4.417	0.032	0.238	318.534
	250	0.415	1.192	4.222	0.032	0.168	318.534
	500	0.367	1.608	3.810	0.028	0.149	318.534
Rough Terrain Forklifts	50	2.171	4.823	3.845	0.040	0.489	341.286
	120	0.878	2.543	5.011	0.036	0.472	341.286
	175	0.577	2.031	4.575	0.035	0.258	341.286
	250	0.406	1.115	4.330	0.035	0.160	341.286
	500	0.359	1.314	3.831	0.030	0.144	341.286
Rubber Tired Dozers	175	0.732	2.350	5.534	0.034	0.324	335.598
	250	0.599	1.690	5.348	0.034	0.246	335.598
	500	0.532	2.862	4.849	0.030	0.215	335.598
	750	0.534	2.857	4.919	0.031	0.216	335.598
	1000	0.566	3.068	5.432	0.031	0.210	335.598
Rubber Tired Loaders	25	0.424	1.314	2.736	0.035	0.175	307.158
	50	2.024	4.460	3.502	0.036	0.451	307.158
	120	0.819	2.334	4.656	0.033	0.436	307.158
	175	0.539	1.872	4.251	0.031	0.241	307.158
	250	0.392	1.087	4.042	0.031	0.156	307.158
	500	0.347	1.385	3.590	0.027	0.140	307.158
	750	0.352	1.383	3.679	0.029	0.141	307.158
	1000	0.403	1.611	4.302	0.029	0.141	307.158
Scrapers	120	1.211	3.295	6.829	0.043	0.628	409.544
	175	0.804	2.676	6.216	0.042	0.357	409.544
	250	0.629	1.776	5.968	0.042	0.257	409.544
	500	0.558	2.699	5.375	0.036	0.226	409.544
	750	0.563	2.695	5.472	0.038	0.228	409.544
Signal Boards	15	0.558	2.848	3.552	0.066	0.263	466.425
	50	2.229	5.076	4.779	0.052	0.534	443.672
	120	1.032	3.085	6.207	0.047	0.523	443.672
	175	0.674	2.467	5.667	0.045	0.288	443.672
	250	0.563	1.634	6.449	0.055	0.220	536.104
Skid Steer Loaders	25	0.770	1.941	3.165	0.036	0.244	312.846
	50	1.520	3.627	3.263	0.037	0.375	312.846
	120	0.673	2.165	4.020	0.033	0.367	312.846
Surfacing Equipment	50	1.351	3.053	2.800	0.030	0.318	255.965
	120	0.620	1.830	3.750	0.027	0.311	255.965
	175	0.406	1.476	3.417	0.026	0.174	255.965
	250	0.308	0.917	3.268	0.026	0.123	255.965
	500	0.275	1.248	2.972	0.023	0.111	255.965
	750	0.280	1.246	3.035	0.024	0.112	255.965
Sweepers/Scrubbers	15	0.419	2.362	2.947	0.054	0.218	386.791
	25	0.509	1.657	3.453	0.044	0.216	386.791
	50	2.534	5.546	4.383	0.045	0.565	386.791
	120	1.019	2.878	5.646	0.041	0.550	386.791

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2005		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	175	0.671	2.276	5.188	0.039	0.299	386.791
	250	0.428	1.121	4.829	0.039	0.164	386.791
Tractors/Loaders/Backhoes	25	0.572	1.583	2.970	0.036	0.206	312.846
	50	1.879	4.261	3.454	0.037	0.433	312.846
	120	0.768	2.294	4.396	0.033	0.419	312.846
	175	0.503	1.832	4.016	0.032	0.227	312.846
	250	0.337	0.914	3.785	0.032	0.131	312.846
	500	0.298	1.007	3.299	0.032	0.118	312.846
	750	0.304	1.006	3.406	0.033	0.120	312.846
Trenchers	15	0.510	2.605	3.249	0.060	0.241	426.608
	25	0.589	1.824	3.800	0.049	0.242	426.608
	50	2.840	6.142	4.943	0.050	0.624	426.608
	120	1.217	3.351	7.074	0.045	0.611	426.608
	175	0.809	2.739	6.439	0.043	0.353	426.608
	250	0.655	1.906	6.207	0.043	0.271	426.608
	500	0.579	3.060	5.655	0.038	0.238	426.608
	750	0.586	3.054	5.743	0.040	0.239	426.608
Welders	15	0.600	1.936	3.389	0.036	0.269	255.965
	25	0.694	1.702	2.654	0.029	0.211	255.965
	50	1.411	3.154	2.813	0.030	0.328	255.965
	120	0.626	1.825	3.689	0.027	0.320	255.965
	175	0.410	1.458	3.371	0.026	0.177	255.965
	250	0.287	0.817	3.176	0.026	0.113	255.965
	500	0.255	1.049	2.883	0.023	0.102	255.965
Water Trucks	175	0.579	2.004	4.418	0.033	0.261	324.222
	250	0.401	1.057	4.176	0.033	0.154	324.222
	500	0.361	1.220	3.644	0.029	0.139	324.222
	750	0.364	1.219	3.754	0.030	0.141	324.222
	1000	0.416	1.472	4.502	0.030	0.145	324.222

2006		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Aerial Lifts	15	0.386	1.649	2.533	0.036	0.181	261.653
	25	0.680	1.687	2.695	0.030	0.212	261.653
	50	1.194	2.756	2.781	0.030	0.295	261.653
	120	0.585	1.774	3.600	0.027	0.290	261.653
	500	0.238	0.975	2.843	0.023	0.094	261.653
	750	0.244	0.975	2.908	0.024	0.095	261.653
Air Compressors	15	0.640	2.065	3.615	0.038	0.287	273.029
	25	0.740	1.816	2.830	0.031	0.225	273.029
	50	1.639	3.619	3.053	0.032	0.372	273.029
	120	0.697	1.996	4.025	0.029	0.362	273.029
	175	0.458	1.593	3.679	0.028	0.200	273.029
	250	0.320	0.893	3.465	0.028	0.126	273.029
	500	0.283	1.135	3.129	0.024	0.114	273.029
	750	0.289	1.135	3.201	0.025	0.115	273.029
	1000	0.353	1.397	3.757	0.025	0.124	273.029
Bore/Drill Rigs	15	0.540	2.605	3.562	0.060	0.255	426.608
	25	0.633	1.898	3.885	0.049	0.251	426.608
	50	1.575	4.183	4.161	0.050	0.437	426.608
	120	0.770	2.814	4.894	0.045	0.432	426.608
	175	0.482	2.279	4.404	0.043	0.225	426.608
	250	0.275	0.810	4.140	0.043	0.104	426.608
	500	0.234	0.787	3.399	0.038	0.096	426.608
	750	0.247	0.787	3.591	0.040	0.099	426.608
	1000	0.361	0.968	4.832	0.040	0.127	426.608
Cement and Mortar Mixers	15	0.497	2.044	3.206	0.045	0.232	318.534
	25	0.821	2.042	3.269	0.037	0.256	318.534
Concrete/Industrial Saws	25	0.574	1.776	3.699	0.048	0.236	415.232
	50	2.201	4.972	4.533	0.049	0.518	415.232
	120	0.984	2.921	5.917	0.044	0.501	415.232
	175	0.645	2.335	5.405	0.042	0.276	415.232
Cranes	50	1.725	3.738	2.855	0.029	0.376	244.589
	120	0.688	1.905	3.878	0.026	0.363	244.589
	175	0.455	1.530	3.539	0.025	0.202	244.589
	250	0.343	0.956	3.380	0.025	0.138	244.589
	500	0.305	1.272	3.027	0.022	0.123	244.589
	750	0.308	1.270	3.091	0.023	0.124	244.589
	9999	0.342	1.450	3.543	0.023	0.120	244.589
Crawler Tractors	50	2.651	5.713	4.299	0.043	0.573	364.039
	120	1.073	2.925	6.034	0.039	0.559	364.039
	175	0.712	2.373	5.494	0.037	0.317	364.039
	250	0.552	1.551	5.268	0.037	0.225	364.039
	500	0.490	2.328	4.735	0.032	0.198	364.039
	750	0.494	2.324	4.823	0.034	0.200	364.039
	1000	0.542	2.580	5.471	0.034	0.195	364.039
Crushing/Proc. Equipment	50	2.742	6.051	4.979	0.052	0.619	443.672
	120	1.144	3.276	6.553	0.047	0.601	443.672

2006		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	175	0.751	2.615	5.987	0.045	0.331	443.672
	250	0.518	1.434	5.633	0.045	0.205	443.672
	500	0.458	1.800	5.047	0.039	0.184	443.672
	750	0.462	1.726	5.167	0.041	0.184	443.672
	9999	0.573	2.193	6.122	0.041	0.200	443.672
Dumpers/Tenders	25	0.440	1.175	2.094	0.025	0.152	216.148
Excavators	25	0.419	1.342	2.812	0.037	0.179	324.222
	50	2.114	4.737	3.670	0.038	0.477	324.222
	120	0.844	2.453	4.727	0.034	0.463	324.222
	175	0.555	1.960	4.314	0.033	0.251	324.222
	250	0.378	1.010	4.072	0.033	0.146	324.222
	500	0.337	1.149	3.550	0.029	0.132	324.222
	750	0.342	1.148	3.661	0.030	0.134	324.222
Forklifts	50	1.162	2.554	1.949	0.020	0.258	170.643
	120	0.457	1.292	2.483	0.018	0.253	170.643
	175	0.303	1.022	2.286	0.017	0.137	170.643
	250	0.184	0.466	2.118	0.017	0.069	170.643
	500	0.164	0.480	1.852	0.015	0.063	170.643
Generator Sets	15	0.852	3.183	5.429	0.059	0.359	420.920
	25	0.875	2.799	4.364	0.048	0.311	420.920
	50	1.841	4.286	4.445	0.049	0.461	420.920
	120	0.923	2.822	5.727	0.045	0.454	420.920
	175	0.602	2.255	5.233	0.043	0.250	420.920
	250	0.417	1.249	4.929	0.043	0.159	420.920
	500	0.374	1.504	4.535	0.037	0.147	420.920
	750	0.386	1.504	4.640	0.038	0.149	420.920
	9999	0.503	1.876	5.458	0.038	0.180	420.920
Graders	50	2.312	5.089	3.970	0.041	0.514	346.974
	120	0.934	2.653	5.299	0.037	0.498	346.974
	175	0.615	2.129	4.834	0.035	0.275	346.974
	250	0.449	1.244	4.599	0.035	0.179	346.974
	500	0.398	1.610	4.086	0.031	0.160	346.974
	750	0.403	1.608	4.185	0.032	0.162	346.974
Off-Highway Tractors	120	1.163	3.084	6.557	0.039	0.590	369.727
	175	0.781	2.535	5.981	0.038	0.345	369.727
	250	0.638	1.817	5.777	0.038	0.263	369.727
	750	0.568	3.043	5.323	0.034	0.231	369.727
	1000	0.608	3.279	5.887	0.034	0.224	369.727
Off-Highway Trucks	175	0.579	2.004	4.418	0.033	0.261	324.222
	250	0.401	1.057	4.176	0.033	0.154	324.222
	500	0.361	1.220	3.644	0.029	0.139	324.222
	750	0.364	1.219	3.754	0.030	0.141	324.222
	1000	0.416	1.472	4.502	0.030	0.145	324.222
Other Construction Equipment	15	0.447	2.153	2.945	0.050	0.211	352.662
	25	0.523	1.569	3.211	0.040	0.208	352.663
	50	1.843	4.255	3.781	0.041	0.440	352.663
	120	0.805	2.476	4.803	0.037	0.426	352.663

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2006		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	175	0.524	1.981	4.381	0.036	0.231	352.663
	500	0.314	1.164	3.652	0.031	0.127	352.663
Other General Industrial Equipment	15	0.314	1.771	2.211	0.040	0.164	290.093
	25	0.373	1.201	2.521	0.033	0.160	290.093
	50	2.024	4.391	3.362	0.034	0.444	290.093
	120	0.806	2.235	4.471	0.030	0.432	290.093
	175	0.532	1.782	4.086	0.029	0.238	290.093
	250	0.365	0.984	3.843	0.029	0.143	290.093
	500	0.324	1.242	3.433	0.025	0.129	290.093
	750	0.329	1.242	3.514	0.026	0.131	290.093
	1000	0.392	1.540	4.134	0.026	0.137	290.093
Other Material Handling Equipment	50	2.310	5.016	3.874	0.039	0.507	335.598
	120	0.925	2.571	5.150	0.035	0.493	335.598
	175	0.610	2.051	4.707	0.034	0.272	335.598
	250	0.419	1.135	4.427	0.034	0.165	335.598
	500	0.372	1.434	3.959	0.029	0.148	335.598
	9999	0.452	1.777	4.766	0.029	0.157	335.598
Pavers	25	0.776	2.022	3.475	0.040	0.259	352.663
	50	2.466	5.310	4.129	0.041	0.536	352.663
	120	1.026	2.805	5.883	0.037	0.523	352.663
	175	0.682	2.286	5.353	0.036	0.300	352.663
	250	0.545	1.566	5.152	0.036	0.225	352.663
	500	0.482	2.452	4.671	0.031	0.197	352.663
Paving Equipment	25	0.447	1.341	2.745	0.035	0.177	301.470
	50	2.086	4.493	3.522	0.035	0.454	301.470
	120	0.871	2.383	5.005	0.032	0.443	301.470
	175	0.577	1.939	4.551	0.031	0.253	301.470
	250	0.463	1.334	4.381	0.031	0.191	301.470
Plate Compactors	15	0.321	1.496	2.147	0.034	0.152	244.588
Pressure Washers	15	0.345	1.291	2.201	0.024	0.145	170.643
	25	0.355	1.135	1.769	0.020	0.126	170.643
	50	0.612	1.486	1.752	0.020	0.165	170.643
	120	0.344	1.093	2.223	0.018	0.163	170.643
Pumps	15	0.986	3.183	5.574	0.059	0.442	420.920
	25	1.141	2.799	4.364	0.048	0.347	420.920
	50	1.953	4.495	4.487	0.049	0.479	420.920
	120	0.948	2.864	5.808	0.045	0.471	420.920
	175	0.619	2.289	5.307	0.043	0.260	420.920
	250	0.430	1.273	4.999	0.043	0.166	420.920
	500	0.385	1.578	4.585	0.037	0.152	420.920
	750	0.396	1.578	4.690	0.038	0.154	420.920
	9999	0.511	1.954	5.514	0.038	0.182	420.920
Rollers	15	0.403	1.945	2.660	0.045	0.190	318.534
	25	0.473	1.417	2.901	0.037	0.187	318.534
	50	1.955	4.312	3.591	0.037	0.441	318.534
	120	0.828	2.368	4.841	0.034	0.427	318.534
	175	0.545	1.905	4.417	0.032	0.238	318.534

2006		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	250	0.415	1.192	4.222	0.032	0.168	318.534
	500	0.367	1.608	3.810	0.028	0.149	318.534
Rough Terrain Forklifts	50	2.171	4.823	3.845	0.040	0.489	341.286
	120	0.878	2.543	5.011	0.036	0.472	341.286
	175	0.577	2.031	4.575	0.035	0.258	341.286
	250	0.406	1.115	4.330	0.035	0.160	341.286
	500	0.359	1.314	3.831	0.030	0.144	341.286
Rubber Tired Dozers	175	0.732	2.350	5.534	0.034	0.324	335.598
	250	0.599	1.690	5.348	0.034	0.246	335.598
	500	0.532	2.862	4.849	0.030	0.215	335.598
	750	0.534	2.857	4.919	0.031	0.216	335.598
	1000	0.566	3.068	5.432	0.031	0.210	335.598
Rubber Tired Loaders	25	0.424	1.314	2.736	0.035	0.175	307.158
	50	2.024	4.460	3.502	0.036	0.451	307.158
	120	0.819	2.334	4.656	0.033	0.436	307.158
	175	0.539	1.872	4.251	0.031	0.241	307.158
	250	0.392	1.087	4.042	0.031	0.156	307.158
	500	0.347	1.385	3.590	0.027	0.140	307.158
	750	0.352	1.383	3.679	0.029	0.141	307.158
	1000	0.403	1.611	4.302	0.029	0.141	307.158
Scrapers	120	1.211	3.295	6.829	0.043	0.628	409.544
	175	0.804	2.676	6.216	0.042	0.357	409.544
	250	0.629	1.776	5.968	0.042	0.257	409.544
	500	0.558	2.699	5.375	0.036	0.226	409.544
	750	0.563	2.695	5.472	0.038	0.228	409.544
Signal Boards	15	0.558	2.848	3.552	0.066	0.263	466.425
	50	2.229	5.076	4.779	0.052	0.534	443.672
	120	1.032	3.085	6.207	0.047	0.523	443.672
	175	0.674	2.467	5.667	0.045	0.288	443.672
	250	0.563	1.634	6.449	0.055	0.220	536.104
Skid Steer Loaders	25	0.770	1.941	3.165	0.036	0.244	312.846
	50	1.520	3.627	3.263	0.037	0.375	312.846
	120	0.673	2.165	4.020	0.033	0.367	312.846
Surfacing Equipment	50	1.351	3.053	2.800	0.030	0.318	255.965
	120	0.620	1.830	3.750	0.027	0.311	255.965
	175	0.406	1.476	3.417	0.026	0.174	255.965
	250	0.308	0.917	3.268	0.026	0.123	255.965
	500	0.275	1.248	2.972	0.023	0.111	255.965
	750	0.280	1.246	3.035	0.024	0.112	255.965
Sweepers/Scrubbers	15	0.419	2.362	2.947	0.054	0.218	386.791
	25	0.509	1.657	3.453	0.044	0.216	386.791
	50	2.534	5.546	4.383	0.045	0.565	386.791
	120	1.019	2.878	5.646	0.041	0.550	386.791
	175	0.671	2.276	5.188	0.039	0.299	386.791
	250	0.428	1.121	4.829	0.039	0.164	386.791
Tractors/Loaders/Backhoes	25	0.572	1.583	2.970	0.036	0.206	312.846
	50	1.879	4.261	3.454	0.037	0.433	312.846

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2006		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	120	0.768	2.294	4.396	0.033	0.419	312.846
	175	0.503	1.832	4.016	0.032	0.227	312.846
	250	0.337	0.914	3.785	0.032	0.131	312.846
	500	0.298	1.007	3.299	0.032	0.118	312.846
	750	0.304	1.006	3.406	0.033	0.120	312.846
Trenchers	15	0.510	2.605	3.249	0.060	0.241	426.608
	25	0.589	1.824	3.800	0.049	0.242	426.608
	50	2.840	6.142	4.943	0.050	0.624	426.608
	120	1.217	3.351	7.074	0.045	0.611	426.608
	175	0.809	2.739	6.439	0.043	0.353	426.608
	250	0.655	1.906	6.207	0.043	0.271	426.608
	500	0.579	3.060	5.655	0.038	0.238	426.608
	750	0.586	3.054	5.743	0.040	0.239	426.608
Welders	15	0.600	1.936	3.389	0.036	0.269	255.965
	25	0.694	1.702	2.654	0.029	0.211	255.965
	50	1.411	3.154	2.813	0.030	0.328	255.965
	120	0.626	1.825	3.689	0.027	0.320	255.965
	175	0.410	1.458	3.371	0.026	0.177	255.965
	250	0.287	0.817	3.176	0.026	0.113	255.965
	500	0.255	1.049	2.883	0.023	0.102	255.965
Water Trucks	175	0.579	2.004	4.418	0.033	0.261	324.222
	250	0.401	1.057	4.176	0.033	0.154	324.222
	500	0.361	1.220	3.644	0.029	0.139	324.222
	750	0.364	1.219	3.754	0.030	0.141	324.222
	1000	0.416	1.472	4.502	0.030	0.145	324.222

2007		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Aerial Lifts	15	0.361	1.628	2.367	0.004	0.166	261.653
	25	0.636	1.611	2.629	0.003	0.198	261.653
	50	1.147	2.710	2.745	0.003	0.279	261.653
	120	0.559	1.758	3.499	0.003	0.272	261.653
	500	0.222	0.900	2.708	0.003	0.086	261.653
	750	0.229	0.900	2.773	0.003	0.087	261.653
Air Compressors	15	0.614	2.031	3.493	0.004	0.268	273.029
	25	0.705	1.756	2.779	0.003	0.213	273.029
	50	1.588	3.576	3.018	0.004	0.353	273.029
	120	0.669	1.982	3.916	0.003	0.342	273.029
	175	0.439	1.586	3.524	0.003	0.188	273.029
	250	0.301	0.842	3.314	0.003	0.115	273.029
	500	0.267	1.036	2.982	0.003	0.104	273.029
	750	0.273	1.036	3.054	0.003	0.105	273.029
	1000	0.336	1.294	3.658	0.003	0.115	273.029
Bore/Drill Rigs	15	0.510	2.605	3.251	0.007	0.234	426.608
	25	0.591	1.839	3.726	0.005	0.238	426.608
	50	1.347	3.967	4.067	0.006	0.396	426.608
	120	0.668	2.772	4.653	0.005	0.376	426.608
	175	0.418	2.280	3.906	0.005	0.196	426.608
	250	0.255	0.801	3.700	0.005	0.097	426.608
	500	0.223	0.778	3.061	0.004	0.090	426.608
	750	0.233	0.778	3.223	0.004	0.093	426.608
	1000	0.322	0.889	4.540	0.004	0.114	426.608
Cement and Mortar Mixers	15	0.464	2.011	3.005	0.005	0.212	318.534
	25	0.777	1.966	3.199	0.004	0.241	318.534
Concrete/Industrial Saws	25	0.541	1.737	3.532	0.005	0.225	415.232
	50	2.079	4.833	4.451	0.005	0.484	415.232
	120	0.926	2.885	5.705	0.005	0.465	415.232
	175	0.606	2.317	5.102	0.005	0.256	415.232
Cranes	50	1.640	3.644	2.812	0.003	0.353	244.589
	120	0.652	1.880	3.740	0.003	0.338	244.589
	175	0.432	1.514	3.351	0.003	0.187	244.589
	250	0.322	0.898	3.198	0.003	0.124	244.589
	500	0.288	1.152	2.859	0.002	0.111	244.589
	750	0.291	1.151	2.922	0.002	0.112	244.589
	9999	0.323	1.322	3.421	0.002	0.110	244.589
Crawler Tractors	50	2.527	5.578	4.239	0.005	0.538	364.039
	120	1.020	2.886	5.830	0.004	0.521	364.039
	175	0.678	2.347	5.217	0.004	0.294	364.039
	250	0.523	1.469	5.001	0.004	0.204	364.039
	500	0.467	2.143	4.490	0.004	0.181	364.039
	750	0.470	2.140	4.577	0.004	0.183	364.039
	1000	0.514	2.381	5.289	0.004	0.180	364.039
Crushing/Proc. Equipment	50	2.644	5.964	4.918	0.006	0.586	443.672
	120	1.094	3.251	6.362	0.005	0.566	443.672

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2007		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	175	0.718	2.605	5.710	0.005	0.311	443.672
	250	0.487	1.348	5.364	0.005	0.185	443.672
	500	0.431	1.639	4.791	0.004	0.168	443.672
	750	0.437	1.580	4.925	0.004	0.168	443.672
	9999	0.545	2.035	5.958	0.004	0.185	443.672
Dumpers/Tenders	25	0.388	1.087	2.009	0.003	0.138	216.148
Excavators	25	0.405	1.335	2.668	0.004	0.173	324.222
	50	1.958	4.569	3.601	0.004	0.442	324.222
	120	0.787	2.424	4.538	0.004	0.424	324.222
	175	0.518	1.952	4.015	0.004	0.229	324.222
	250	0.353	0.948	3.792	0.004	0.131	324.222
	500	0.318	1.061	3.303	0.003	0.119	324.222
	750	0.322	1.061	3.408	0.003	0.121	324.222
Forklifts	50	1.077	2.454	1.907	0.002	0.239	170.643
	120	0.427	1.276	2.375	0.002	0.233	170.643
	175	0.283	1.017	2.129	0.002	0.126	170.643
	250	0.168	0.423	1.968	0.002	0.060	170.643
	500	0.151	0.425	1.712	0.002	0.056	170.643
Generator Sets	15	0.813	3.131	5.245	0.007	0.335	420.920
	25	0.830	2.707	4.284	0.005	0.293	420.920
	50	1.764	4.209	4.385	0.005	0.435	420.920
	120	0.879	2.796	5.563	0.005	0.425	420.920
	175	0.572	2.241	4.999	0.005	0.234	420.920
	250	0.389	1.177	4.702	0.005	0.145	420.920
	500	0.350	1.391	4.316	0.004	0.135	420.920
	750	0.360	1.391	4.419	0.004	0.136	420.920
	9999	0.476	1.754	5.304	0.004	0.165	420.920
Graders	50	2.183	4.950	3.907	0.004	0.480	346.974
	120	0.881	2.618	5.103	0.004	0.461	346.974
	175	0.580	2.111	4.552	0.004	0.254	346.974
	250	0.421	1.171	4.331	0.004	0.162	346.974
	500	0.376	1.462	3.842	0.003	0.145	346.974
	750	0.380	1.460	3.938	0.003	0.147	346.974
Off-Highway Tractors	120	1.116	3.046	6.367	0.004	0.553	369.727
	175	0.749	2.506	5.729	0.004	0.322	369.727
	250	0.609	1.736	5.532	0.004	0.242	369.727
	750	0.544	2.847	5.095	0.004	0.213	369.727
	1000	0.581	3.073	5.716	0.004	0.207	369.727
Off-Highway Trucks	175	0.543	1.995	4.116	0.004	0.238	324.222
	250	0.376	0.992	3.892	0.004	0.138	324.222
	500	0.342	1.125	3.397	0.003	0.125	324.222
	750	0.344	1.124	3.501	0.003	0.127	324.222
	1000	0.391	1.356	4.324	0.003	0.133	324.222
Other Construction Equipment	15	0.422	2.153	2.687	0.005	0.194	352.662
	25	0.489	1.520	3.080	0.004	0.196	352.662
	50	1.708	4.109	3.707	0.005	0.408	352.662
	120	0.746	2.446	4.614	0.004	0.391	352.663

2007		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	175	0.485	1.972	4.076	0.004	0.212	352.663
	500	0.291	1.067	3.395	0.003	0.114	352.663
Other General Industrial Equipment	15	0.303	1.771	2.133	0.005	0.156	290.093
	25	0.363	1.194	2.391	0.004	0.155	290.093
	50	1.954	4.326	3.325	0.004	0.420	290.093
	120	0.776	2.219	4.348	0.003	0.408	290.093
	175	0.512	1.775	3.915	0.003	0.224	290.093
	250	0.346	0.928	3.676	0.003	0.130	290.093
	500	0.309	1.135	3.272	0.003	0.118	290.093
	750	0.313	1.135	3.354	0.003	0.120	290.093
	1000	0.375	1.425	4.026	0.003	0.127	290.093
Other Material Handling Equipment	50	2.232	4.945	3.832	0.004	0.481	335.598
	120	0.891	2.554	5.009	0.004	0.466	335.598
	175	0.587	2.043	4.511	0.004	0.257	335.598
	250	0.397	1.070	4.236	0.004	0.150	335.598
	500	0.354	1.310	3.775	0.003	0.136	335.598
	9999	0.431	1.645	4.642	0.003	0.146	335.598
Pavers	25	0.695	1.884	3.345	0.004	0.237	352.663
	50	2.370	5.205	4.075	0.005	0.505	352.663
	120	0.979	2.767	5.694	0.004	0.488	352.663
	175	0.650	2.258	5.102	0.004	0.279	352.663
	250	0.516	1.485	4.908	0.004	0.205	352.663
	500	0.458	2.259	4.444	0.003	0.181	352.662
Paving Equipment	25	0.418	1.300	2.633	0.004	0.168	301.470
	50	2.007	4.407	3.476	0.004	0.428	301.470
	120	0.830	2.350	4.842	0.004	0.414	301.470
	175	0.550	1.914	4.340	0.003	0.236	301.470
	250	0.437	1.263	4.175	0.003	0.174	301.470
Plate Compactors	15	0.305	1.493	1.991	0.004	0.140	244.589
Pressure Washers	15	0.329	1.269	2.126	0.003	0.136	170.643
	25	0.336	1.098	1.737	0.002	0.119	170.643
	50	0.582	1.454	1.726	0.002	0.155	170.643
	120	0.326	1.082	2.158	0.002	0.153	170.643
Pumps	15	0.946	3.131	5.385	0.007	0.413	420.920
	25	1.087	2.707	4.284	0.005	0.328	420.920
	50	1.875	4.418	4.427	0.005	0.453	420.920
	120	0.905	2.838	5.643	0.005	0.442	420.920
	175	0.590	2.275	5.071	0.005	0.244	420.920
	250	0.403	1.199	4.771	0.005	0.151	420.920
	500	0.360	1.455	4.364	0.004	0.139	420.920
	750	0.371	1.455	4.468	0.004	0.141	420.920
	9999	0.484	1.823	5.360	0.004	0.168	420.920
Rollers	15	0.381	1.945	2.427	0.005	0.175	318.534
	25	0.442	1.373	2.782	0.004	0.177	318.534
	50	1.864	4.212	3.536	0.004	0.414	318.534
	120	0.783	2.336	4.671	0.004	0.397	318.534
	175	0.515	1.885	4.181	0.004	0.220	318.534

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2007		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	250	0.388	1.122	3.994	0.004	0.152	318.534
	500	0.345	1.456	3.598	0.003	0.136	318.534
Rough Terrain Forklifts	50	2.035	4.672	3.776	0.004	0.455	341.286
	120	0.824	2.513	4.819	0.004	0.436	341.286
	175	0.541	2.019	4.290	0.004	0.238	341.286
	250	0.376	1.040	4.057	0.004	0.143	341.286
	500	0.335	1.196	3.581	0.003	0.129	341.286
Rubber Tired Dozers	175	0.703	2.323	5.300	0.004	0.302	335.598
	250	0.574	1.617	5.122	0.004	0.226	335.598
	500	0.512	2.685	4.641	0.003	0.198	335.598
	750	0.514	2.681	4.710	0.003	0.199	335.598
	1000	0.542	2.883	5.277	0.003	0.194	335.598
Rubber Tired Loaders	25	0.401	1.285	2.613	0.004	0.167	307.158
	50	1.911	4.338	3.446	0.004	0.422	307.158
	120	0.772	2.304	4.484	0.004	0.404	307.158
	175	0.508	1.856	4.001	0.003	0.222	307.158
	250	0.367	1.022	3.804	0.003	0.141	307.158
	500	0.328	1.258	3.374	0.003	0.127	307.158
	750	0.332	1.256	3.460	0.003	0.128	307.158
	1000	0.379	1.469	4.144	0.003	0.129	307.158
Scrapers	120	1.153	3.250	6.600	0.005	0.585	409.544
	175	0.766	2.646	5.910	0.005	0.332	409.544
	250	0.595	1.682	5.672	0.005	0.234	409.544
	500	0.531	2.482	5.102	0.004	0.207	409.544
	750	0.535	2.478	5.197	0.004	0.208	409.544
Signal Boards	15	0.546	2.848	3.428	0.007	0.251	466.425
	50	2.133	4.980	4.711	0.006	0.503	443.672
	120	0.980	3.055	6.017	0.005	0.489	443.672
	175	0.639	2.452	5.393	0.005	0.269	443.672
	250	0.526	1.536	6.129	0.006	0.200	536.104
Skid Steer Loaders	25	0.715	1.846	3.079	0.004	0.227	312.846
	50	1.381	3.484	3.194	0.004	0.346	312.846
	120	0.614	2.139	3.845	0.004	0.333	312.846
Surfacing Equipment	50	1.285	2.982	2.756	0.003	0.299	255.965
	120	0.584	1.805	3.619	0.003	0.288	255.965
	175	0.382	1.461	3.232	0.003	0.161	255.965
	250	0.289	0.866	3.090	0.003	0.112	255.965
	500	0.258	1.144	2.808	0.003	0.101	255.965
	750	0.263	1.143	2.868	0.003	0.102	255.965
Sweepers/Scrubbers	15	0.404	2.362	2.843	0.006	0.208	386.791
	25	0.494	1.619	3.298	0.005	0.208	386.791
	50	2.400	5.398	4.307	0.005	0.529	386.791
	120	0.966	2.850	5.444	0.005	0.514	386.791
	175	0.635	2.267	4.895	0.004	0.279	386.791
	250	0.394	1.032	4.546	0.004	0.145	386.791
Tractors/Loaders/Backhoes	25	0.500	1.462	2.845	0.004	0.187	312.846
	50	1.736	4.108	3.387	0.004	0.401	312.846

2007		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	120	0.713	2.267	4.221	0.004	0.384	312.846
	175	0.467	1.826	3.729	0.004	0.207	312.846
	250	0.312	0.859	3.518	0.004	0.117	312.846
	500	0.279	0.932	3.064	0.004	0.107	312.846
	750	0.284	0.932	3.165	0.004	0.109	312.846
Trenchers	15	0.499	2.605	3.135	0.007	0.229	426.608
	25	0.556	1.784	3.629	0.005	0.231	426.608
	50	2.734	6.028	4.878	0.006	0.588	426.608
	120	1.162	3.307	6.854	0.005	0.571	426.608
	175	0.771	2.706	6.144	0.005	0.329	426.608
	250	0.621	1.812	5.921	0.005	0.247	426.608
	500	0.551	2.833	5.388	0.004	0.218	426.608
	750	0.557	2.829	5.474	0.004	0.219	426.608
Welders	15	0.575	1.904	3.275	0.004	0.251	255.965
	25	0.661	1.646	2.605	0.003	0.200	255.965
	50	1.362	3.108	2.778	0.003	0.311	255.965
	120	0.599	1.810	3.586	0.003	0.301	255.965
	175	0.392	1.450	3.225	0.003	0.166	255.965
	250	0.269	0.770	3.034	0.003	0.103	255.965
	500	0.240	0.957	2.746	0.003	0.093	255.965
Water Trucks	175	0.543	1.995	4.116	0.004	0.238	324.222
	250	0.376	0.992	3.892	0.004	0.138	324.222
	500	0.342	1.125	3.397	0.003	0.125	324.222
	750	0.344	1.124	3.501	0.003	0.127	324.222
	1000	0.391	1.356	4.324	0.003	0.133	324.222

2008		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Aerial Lifts	15	0.341	1.613	2.223	0.004	0.145	261.653
	25	0.589	1.530	2.557	0.003	0.184	261.653
	50	1.101	2.668	2.711	0.003	0.270	261.653
	120	0.532	1.744	3.358	0.003	0.264	261.653
	500	0.209	0.832	2.585	0.003	0.081	261.653
	750	0.215	0.832	2.649	0.003	0.083	261.653
Air Compressors	15	0.589	1.999	3.380	0.004	0.255	273.029
	25	0.673	1.701	2.730	0.003	0.204	273.029
	50	1.536	3.535	2.985	0.004	0.344	273.029
	120	0.641	1.969	3.764	0.003	0.334	273.029
	175	0.423	1.582	3.381	0.003	0.184	273.029
	250	0.285	0.795	3.173	0.003	0.108	273.029
	500	0.253	0.947	2.847	0.003	0.099	273.029
	750	0.258	0.947	2.918	0.003	0.100	273.029
	1000	0.320	1.200	3.562	0.003	0.110	273.029
Bore/Drill Rigs	15	0.502	2.605	3.164	0.007	0.193	426.608
	25	0.560	1.798	3.584	0.005	0.213	426.608
	50	1.118	3.759	3.984	0.006	0.348	426.608
	120	0.565	2.729	4.183	0.005	0.330	426.608
	175	0.364	2.280	3.468	0.005	0.177	426.608
	250	0.239	0.794	3.312	0.005	0.093	426.608
	500	0.215	0.772	2.772	0.004	0.088	426.608
	750	0.222	0.772	2.904	0.004	0.090	426.608
	1000	0.289	0.832	4.262	0.004	0.106	426.608
Cement and Mortar Mixers	15	0.437	1.987	2.831	0.005	0.187	318.534
	25	0.729	1.884	3.125	0.004	0.226	318.534
Concrete/Industrial Saws	25	0.520	1.716	3.387	0.005	0.200	415.232
	50	1.949	4.690	4.369	0.005	0.460	415.232
	120	0.865	2.849	5.394	0.005	0.444	415.232
	175	0.568	2.301	4.810	0.005	0.245	415.232
Cranes	50	1.547	3.543	2.768	0.003	0.337	244.589
	120	0.615	1.857	3.548	0.003	0.324	244.589
	175	0.410	1.503	3.171	0.003	0.179	244.589
	250	0.304	0.846	3.024	0.003	0.117	244.589
	500	0.273	1.054	2.699	0.002	0.105	244.589
	750	0.275	1.053	2.762	0.002	0.106	244.589
	9999	0.305	1.215	3.300	0.002	0.105	244.588
Crawler Tractors	50	2.392	5.435	4.179	0.005	0.516	364.039
	120	0.964	2.847	5.542	0.004	0.499	364.039
	175	0.645	2.323	4.949	0.004	0.282	364.039
	250	0.496	1.393	4.744	0.004	0.193	364.039
	500	0.446	1.973	4.256	0.004	0.172	364.039
	750	0.448	1.970	4.341	0.004	0.173	364.039
	1000	0.488	2.196	5.107	0.004	0.171	364.039
Crushing/Proc. Equipment	50	2.539	5.875	4.859	0.006	0.568	443.672
	120	1.044	3.227	6.089	0.005	0.550	443.672

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2008		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	175	0.689	2.597	5.453	0.005	0.303	443.672
	250	0.459	1.271	5.115	0.005	0.174	443.672
	500	0.409	1.495	4.556	0.004	0.159	443.672
	750	0.415	1.448	4.700	0.004	0.160	443.672
	9999	0.519	1.891	5.796	0.004	0.177	443.672
Dumpers/Tenders	25	0.342	1.009	1.932	0.003	0.122	216.148
Excavators	25	0.397	1.335	2.547	0.004	0.151	324.222
	50	1.790	4.397	3.534	0.004	0.414	324.222
	120	0.726	2.394	4.242	0.004	0.397	324.222
	175	0.484	1.946	3.731	0.004	0.216	324.222
	250	0.331	0.894	3.527	0.004	0.122	324.222
	500	0.302	0.984	3.074	0.003	0.111	324.222
	750	0.304	0.983	3.173	0.003	0.113	324.222
Forklifts	50	0.976	2.339	1.861	0.002	0.223	170.643
	120	0.393	1.257	2.208	0.002	0.218	170.643
	175	0.262	1.012	1.967	0.002	0.118	170.643
	250	0.157	0.402	1.832	0.002	0.056	170.643
	500	0.143	0.394	1.587	0.002	0.052	170.643
Generator Sets	15	0.777	3.082	5.074	0.007	0.317	420.920
	25	0.789	2.623	4.209	0.005	0.280	420.920
	50	1.686	4.133	4.326	0.005	0.420	420.920
	120	0.835	2.771	5.331	0.005	0.412	420.920
	175	0.545	2.230	4.782	0.005	0.227	420.920
	250	0.365	1.111	4.491	0.005	0.137	420.920
	500	0.328	1.287	4.113	0.004	0.127	420.920
	750	0.338	1.287	4.215	0.004	0.129	420.920
	9999	0.451	1.641	5.154	0.004	0.158	420.920
Graders	50	2.044	4.804	3.844	0.004	0.456	346.974
	120	0.824	2.585	4.816	0.004	0.439	346.974
	175	0.548	2.096	4.284	0.004	0.242	346.974
	250	0.396	1.105	4.076	0.004	0.151	346.974
	500	0.357	1.335	3.615	0.003	0.137	346.974
	750	0.360	1.333	3.707	0.003	0.138	346.974
Off-Highway Tractors	120	1.066	3.008	6.105	0.004	0.534	369.727
	175	0.718	2.478	5.482	0.004	0.310	369.727
	250	0.582	1.659	5.293	0.004	0.230	369.727
	750	0.522	2.661	4.873	0.004	0.204	369.727
	1000	0.556	2.876	5.543	0.004	0.199	369.727
Off-Highway Trucks	175	0.509	1.988	3.831	0.004	0.225	324.222
	250	0.355	0.934	3.624	0.004	0.128	324.222
	500	0.325	1.040	3.167	0.003	0.117	324.222
	750	0.327	1.040	3.264	0.003	0.119	324.222
	1000	0.369	1.252	4.143	0.003	0.127	324.222
Other Construction Equipment	15	0.415	2.153	2.615	0.005	0.159	352.663
	25	0.463	1.487	2.963	0.004	0.176	352.663
	50	1.567	3.962	3.634	0.005	0.381	352.663
	120	0.685	2.415	4.311	0.004	0.367	352.663

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2008		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	175	0.449	1.964	3.791	0.004	0.201	352.663
	500	0.270	0.980	3.159	0.003	0.107	352.663
Other General Industrial Equipment	15	0.301	1.771	2.115	0.005	0.118	290.093
	25	0.355	1.194	2.281	0.004	0.136	290.093
	50	1.878	4.258	3.290	0.004	0.408	290.093
	120	0.745	2.204	4.177	0.003	0.397	290.093
	175	0.494	1.769	3.753	0.003	0.218	290.093
	250	0.329	0.878	3.519	0.003	0.123	290.093
	500	0.296	1.038	3.123	0.003	0.112	290.093
	750	0.299	1.038	3.205	0.003	0.113	290.093
	1000	0.359	1.320	3.918	0.003	0.123	290.093
Other Material Handling Equipment	50	2.148	4.871	3.792	0.004	0.468	335.598
	120	0.855	2.536	4.814	0.004	0.454	335.598
	175	0.566	2.036	4.327	0.004	0.250	335.598
	250	0.378	1.012	4.056	0.004	0.141	335.598
	500	0.339	1.199	3.605	0.003	0.129	335.598
	9999	0.413	1.524	4.519	0.003	0.141	335.598
Pavers	25	0.621	1.757	3.223	0.004	0.212	352.663
	50	2.264	5.092	4.020	0.005	0.486	352.663
	120	0.929	2.730	5.432	0.004	0.471	352.663
	175	0.619	2.232	4.860	0.004	0.269	352.663
	250	0.489	1.409	4.673	0.004	0.193	352.663
	500	0.435	2.079	4.228	0.003	0.171	352.663
Paving Equipment	25	0.396	1.271	2.533	0.004	0.151	301.470
	50	1.921	4.316	3.430	0.004	0.413	301.470
	120	0.788	2.317	4.620	0.004	0.399	301.470
	175	0.524	1.891	4.136	0.003	0.227	301.470
	250	0.414	1.196	3.976	0.003	0.164	301.470
Plate Compactors	15	0.292	1.493	1.862	0.004	0.118	244.589
Pressure Washers	15	0.315	1.249	2.057	0.003	0.128	170.643
	25	0.320	1.063	1.706	0.002	0.114	170.643
	50	0.552	1.423	1.702	0.002	0.149	170.643
	120	0.308	1.072	2.066	0.002	0.147	170.643
Pumps	15	0.909	3.082	5.210	0.007	0.393	420.920
	25	1.038	2.623	4.209	0.005	0.314	420.920
	50	1.795	4.343	4.370	0.005	0.438	420.920
	120	0.860	2.814	5.409	0.005	0.428	420.920
	175	0.562	2.264	4.853	0.005	0.236	420.920
	250	0.378	1.132	4.559	0.005	0.143	420.920
	500	0.338	1.342	4.160	0.004	0.132	420.920
	750	0.348	1.342	4.262	0.004	0.134	420.920
	9999	0.459	1.701	5.209	0.004	0.160	420.920
Rollers	15	0.375	1.945	2.362	0.005	0.144	318.534
	25	0.418	1.343	2.676	0.004	0.159	318.534
	50	1.762	4.104	3.480	0.004	0.395	318.534
	120	0.736	2.306	4.430	0.004	0.380	318.534
	175	0.487	1.869	3.957	0.004	0.211	318.534

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2008		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	250	0.364	1.057	3.777	0.004	0.142	318.534
	500	0.325	1.329	3.399	0.003	0.128	318.534
Rough Terrain Forklifts	50	1.889	4.515	3.707	0.004	0.430	341.286
	120	0.767	2.483	4.532	0.004	0.414	341.286
	175	0.508	2.009	4.018	0.004	0.226	341.286
	250	0.349	0.970	3.797	0.004	0.132	341.286
	500	0.313	1.089	3.346	0.003	0.120	341.286
Rubber Tired Dozers	175	0.675	2.298	5.071	0.004	0.290	335.598
	250	0.551	1.548	4.900	0.004	0.216	335.598
	500	0.494	2.517	4.441	0.003	0.189	335.598
	750	0.495	2.513	4.508	0.003	0.191	335.598
	1000	0.520	2.706	5.120	0.003	0.186	335.598
Rubber Tired Loaders	25	0.385	1.269	2.505	0.004	0.148	307.158
	50	1.787	4.207	3.389	0.004	0.400	307.158
	120	0.722	2.275	4.232	0.004	0.384	307.158
	175	0.479	1.844	3.764	0.003	0.212	307.158
	250	0.345	0.965	3.579	0.003	0.132	307.158
	500	0.310	1.151	3.173	0.003	0.119	307.158
	750	0.314	1.150	3.256	0.003	0.121	307.158
	1000	0.357	1.347	3.987	0.003	0.122	307.158
Scrapers	120	1.091	3.206	6.282	0.005	0.562	409.544
	175	0.729	2.617	5.614	0.005	0.318	409.544
	250	0.565	1.595	5.387	0.005	0.220	409.544
	500	0.507	2.282	4.842	0.004	0.196	409.544
	750	0.510	2.279	4.935	0.004	0.198	409.544
Signal Boards	15	0.543	2.848	3.400	0.007	0.189	466.425
	50	2.037	4.890	4.648	0.006	0.485	443.672
	120	0.929	3.027	5.748	0.005	0.472	443.672
	175	0.608	2.440	5.142	0.005	0.261	443.672
	250	0.493	1.449	5.837	0.006	0.188	536.104
Skid Steer Loaders	25	0.662	1.755	2.996	0.004	0.211	312.846
	50	1.235	3.339	3.129	0.004	0.318	312.846
	120	0.553	2.112	3.547	0.004	0.308	312.846
Surfacing Equipment	50	1.213	2.907	2.712	0.003	0.285	255.965
	120	0.547	1.781	3.430	0.003	0.275	255.965
	175	0.360	1.448	3.057	0.003	0.154	255.965
	250	0.270	0.819	2.922	0.003	0.105	255.965
	500	0.242	1.051	2.653	0.003	0.096	255.965
	750	0.247	1.050	2.711	0.003	0.096	255.965
Sweepers/Scrubbers	15	0.401	2.362	2.820	0.006	0.157	386.791
	25	0.483	1.599	3.162	0.005	0.187	386.791
	50	2.224	5.198	4.218	0.005	0.499	386.791
	120	0.900	2.815	5.111	0.005	0.490	386.791
	175	0.595	2.257	4.577	0.004	0.266	386.791
	250	0.358	0.942	4.241	0.004	0.131	386.791
Tractors/Loaders/Backhoes	25	0.467	1.411	2.754	0.004	0.170	312.846
	50	1.584	3.950	3.322	0.004	0.374	312.846

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2008		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	120	0.655	2.240	3.937	0.004	0.360	312.846
	175	0.434	1.822	3.460	0.004	0.196	312.846
	250	0.291	0.811	3.268	0.004	0.109	312.846
	500	0.263	0.870	2.847	0.004	0.100	312.846
	750	0.267	0.870	2.942	0.004	0.102	312.846
Trenchers	15	0.497	2.605	3.110	0.007	0.173	426.608
	25	0.534	1.763	3.480	0.005	0.206	426.608
	50	2.617	5.904	4.813	0.006	0.567	426.608
	120	1.103	3.263	6.548	0.005	0.551	426.608
	175	0.735	2.676	5.861	0.005	0.317	426.608
	250	0.589	1.724	5.646	0.005	0.235	426.608
	500	0.524	2.621	5.134	0.004	0.208	426.608
	750	0.529	2.617	5.218	0.004	0.209	426.608
Welders	15	0.552	1.874	3.168	0.004	0.239	255.965
	25	0.631	1.595	2.559	0.003	0.191	255.965
	50	1.312	3.065	2.745	0.003	0.302	255.965
	120	0.572	1.796	3.442	0.003	0.293	255.965
	175	0.376	1.444	3.090	0.003	0.162	255.965
	250	0.254	0.727	2.902	0.003	0.097	255.965
	500	0.226	0.874	2.620	0.003	0.088	255.965
Water Trucks	175	0.509	1.988	3.831	0.004	0.225	324.222
	250	0.355	0.934	3.624	0.004	0.128	324.222
	500	0.325	1.040	3.167	0.003	0.117	324.222
	750	0.327	1.040	3.264	0.003	0.119	324.222
	1000	0.369	1.252	4.143	0.003	0.127	324.222

2009		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Aerial Lifts	15	0.326	1.604	2.100	0.004	0.127	261.653
	25	0.542	1.449	2.484	0.003	0.169	261.653
	50	1.053	2.623	2.677	0.003	0.260	261.653
	120	0.506	1.730	3.222	0.003	0.256	261.653
	500	0.197	0.769	2.467	0.003	0.077	261.653
	750	0.202	0.769	2.529	0.003	0.078	261.653
Air Compressors	15	0.566	1.968	3.268	0.004	0.242	273.029
	25	0.642	1.647	2.682	0.003	0.194	273.029
	50	1.479	3.489	2.952	0.004	0.334	273.029
	120	0.614	1.957	3.614	0.003	0.325	273.029
	175	0.407	1.579	3.239	0.003	0.179	273.029
	250	0.269	0.751	3.035	0.003	0.102	273.029
	500	0.240	0.867	2.716	0.003	0.093	273.029
	750	0.245	0.867	2.786	0.003	0.095	273.029
	1000	0.305	1.115	3.468	0.003	0.105	273.029
Bore/Drill Rigs	15	0.498	2.605	3.121	0.007	0.157	426.608
	25	0.538	1.773	3.459	0.005	0.191	426.608
	50	0.921	3.590	3.925	0.006	0.305	426.608
	120	0.475	2.693	3.767	0.005	0.289	426.608
	175	0.318	2.281	3.088	0.005	0.160	426.608
	250	0.227	0.789	2.974	0.005	0.090	426.608
	500	0.208	0.767	2.531	0.004	0.086	426.608
	750	0.214	0.767	2.634	0.004	0.087	426.608
	1000	0.264	0.795	4.027	0.004	0.099	426.608
Cement and Mortar Mixers	15	0.415	1.970	2.679	0.005	0.166	318.534
	25	0.679	1.798	3.045	0.004	0.211	318.534
Concrete/Industrial Saws	25	0.508	1.710	3.263	0.005	0.178	415.232
	50	1.820	4.550	4.292	0.005	0.437	415.232
	120	0.807	2.816	5.099	0.005	0.423	415.232
	175	0.533	2.288	4.532	0.005	0.234	415.232
Cranes	50	1.451	3.441	2.726	0.003	0.321	244.589
	120	0.579	1.836	3.366	0.003	0.309	244.589
	175	0.389	1.493	2.998	0.003	0.172	244.589
	250	0.287	0.799	2.858	0.003	0.109	244.589
	500	0.260	0.972	2.549	0.002	0.099	244.589
	750	0.261	0.971	2.610	0.002	0.100	244.589
	9999	0.290	1.124	3.186	0.002	0.100	244.589
Crawler Tractors	50	2.255	5.292	4.121	0.005	0.492	364.039
	120	0.910	2.810	5.265	0.004	0.476	364.039
	175	0.613	2.301	4.690	0.004	0.269	364.039
	250	0.472	1.323	4.496	0.004	0.182	364.039
	500	0.427	1.817	4.035	0.004	0.163	364.039
	750	0.429	1.814	4.117	0.004	0.164	364.039
	1000	0.464	2.027	4.933	0.004	0.163	364.039
Crushing/Proc. Equipment	50	2.425	5.772	4.802	0.006	0.548	443.672
	120	0.993	3.205	5.822	0.005	0.533	443.672

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2009		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	175	0.660	2.590	5.201	0.005	0.294	443.672
	250	0.433	1.200	4.873	0.005	0.163	443.672
	500	0.388	1.369	4.331	0.004	0.150	443.672
	750	0.394	1.332	4.482	0.004	0.152	443.672
	9999	0.495	1.761	5.636	0.004	0.170	443.672
Dumpers/Tenders	25	0.322	0.977	1.876	0.003	0.112	216.148
Excavators	25	0.394	1.335	2.509	0.004	0.131	324.222
	50	1.625	4.232	3.473	0.004	0.385	324.222
	120	0.669	2.367	3.962	0.004	0.370	324.222
	175	0.452	1.940	3.465	0.004	0.203	324.222
	250	0.312	0.845	3.279	0.004	0.113	324.222
	500	0.287	0.915	2.865	0.003	0.105	324.222
	750	0.290	0.914	2.956	0.003	0.106	324.222
Forklifts	50	0.872	2.224	1.817	0.002	0.206	170.643
	120	0.359	1.240	2.045	0.002	0.203	170.643
	175	0.242	1.008	1.819	0.002	0.110	170.643
	250	0.150	0.388	1.702	0.002	0.053	170.643
	500	0.138	0.374	1.472	0.002	0.049	170.643
Generator Sets	15	0.742	3.034	4.907	0.007	0.299	420.920
	25	0.750	2.540	4.135	0.005	0.267	420.920
	50	1.606	4.057	4.269	0.005	0.404	420.920
	120	0.791	2.748	5.106	0.005	0.398	420.920
	175	0.518	2.221	4.571	0.005	0.220	420.920
	250	0.341	1.050	4.288	0.005	0.129	420.920
	500	0.306	1.191	3.918	0.004	0.121	420.920
	750	0.316	1.191	4.017	0.004	0.122	420.920
	9999	0.427	1.535	5.009	0.004	0.151	420.920
Graders	50	1.903	4.659	3.785	0.004	0.432	346.974
	120	0.770	2.554	4.545	0.004	0.416	346.974
	175	0.517	2.084	4.030	0.004	0.230	346.974
	250	0.374	1.047	3.836	0.004	0.142	346.974
	500	0.340	1.227	3.402	0.003	0.129	346.974
	750	0.343	1.225	3.491	0.003	0.131	346.974
Off-Highway Tractors	120	1.017	2.970	5.850	0.004	0.515	369.727
	175	0.688	2.452	5.242	0.004	0.299	369.727
	250	0.557	1.585	5.060	0.004	0.219	369.727
	750	0.501	2.485	4.659	0.004	0.195	369.727
	1000	0.532	2.690	5.377	0.004	0.190	369.727
Off-Highway Trucks	175	0.477	1.982	3.564	0.004	0.212	324.222
	250	0.336	0.883	3.375	0.004	0.120	324.222
	500	0.310	0.965	2.955	0.003	0.110	324.222
	750	0.312	0.964	3.045	0.003	0.112	324.222
	1000	0.351	1.157	3.973	0.003	0.121	324.222
Other Construction Equipment	15	0.411	2.153	2.580	0.005	0.130	352.663
	25	0.445	1.465	2.859	0.004	0.158	352.663
	50	1.431	3.823	3.569	0.005	0.356	352.663
	120	0.628	2.388	4.031	0.004	0.345	352.663

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2009		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	175	0.416	1.958	3.529	0.004	0.190	352.663
	500	0.252	0.905	2.944	0.003	0.100	352.663
Other General Industrial Equipment	15	0.301	1.771	2.115	0.005	0.087	290.093
	25	0.352	1.194	2.246	0.004	0.118	290.093
	50	1.793	4.178	3.253	0.004	0.395	290.093
	120	0.713	2.188	4.006	0.003	0.384	290.093
	175	0.475	1.763	3.590	0.003	0.211	290.093
	250	0.314	0.831	3.361	0.003	0.116	290.093
	500	0.284	0.952	2.977	0.003	0.106	290.093
	750	0.287	0.952	3.058	0.003	0.108	290.093
	1000	0.344	1.224	3.812	0.003	0.118	290.093
Other Material Handling Equipment	50	2.054	4.783	3.750	0.004	0.452	335.598
	120	0.818	2.518	4.619	0.004	0.441	335.598
	175	0.545	2.030	4.141	0.004	0.242	335.598
	250	0.359	0.957	3.877	0.004	0.133	335.598
	500	0.325	1.099	3.437	0.003	0.122	335.598
	9999	0.396	1.414	4.397	0.003	0.136	335.598
Pavers	25	0.555	1.644	3.111	0.004	0.189	352.663
	50	2.156	4.978	3.968	0.005	0.468	352.663
	120	0.881	2.695	5.180	0.004	0.453	352.663
	175	0.590	2.209	4.628	0.004	0.258	352.663
	250	0.463	1.338	4.449	0.004	0.183	352.663
	500	0.415	1.914	4.023	0.003	0.163	352.663
Paving Equipment	25	0.380	1.253	2.444	0.004	0.135	301.470
	50	1.833	4.223	3.386	0.004	0.398	301.470
	120	0.748	2.287	4.407	0.004	0.384	301.470
	175	0.500	1.870	3.941	0.003	0.218	301.470
	250	0.392	1.133	3.786	0.003	0.155	301.470
Plate Compactors	15	0.289	1.493	1.822	0.004	0.101	244.589
Pressure Washers	15	0.301	1.230	1.990	0.003	0.121	170.643
	25	0.304	1.030	1.677	0.002	0.108	170.643
	50	0.521	1.391	1.678	0.002	0.143	170.643
	120	0.291	1.062	1.977	0.002	0.141	170.643
Pumps	15	0.872	3.034	5.038	0.007	0.372	420.920
	25	0.990	2.540	4.135	0.005	0.300	420.920
	50	1.714	4.267	4.313	0.005	0.422	420.920
	120	0.817	2.791	5.183	0.005	0.414	420.920
	175	0.536	2.255	4.641	0.005	0.229	420.920
	250	0.354	1.070	4.353	0.005	0.135	420.920
	500	0.317	1.238	3.963	0.004	0.125	420.920
	750	0.326	1.238	4.064	0.004	0.127	420.920
	9999	0.434	1.588	5.064	0.004	0.153	420.920
Rollers	15	0.372	1.945	2.331	0.005	0.117	318.534
	25	0.402	1.324	2.582	0.004	0.143	318.534
	50	1.660	3.994	3.426	0.004	0.377	318.534
	120	0.691	2.279	4.202	0.004	0.363	318.534
	175	0.460	1.857	3.743	0.004	0.202	318.534

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2009		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	250	0.342	0.999	3.572	0.004	0.134	318.534
	500	0.306	1.222	3.212	0.003	0.121	318.534
Rough Terrain Forklifts	50	1.744	4.364	3.644	0.004	0.405	341.286
	120	0.714	2.455	4.261	0.004	0.392	341.286
	175	0.477	2.002	3.761	0.004	0.215	341.286
	250	0.325	0.908	3.553	0.004	0.122	341.286
	500	0.295	0.996	3.127	0.003	0.112	341.286
Rubber Tired Dozers	175	0.647	2.274	4.849	0.004	0.279	335.598
	250	0.528	1.482	4.685	0.004	0.206	335.598
	500	0.476	2.357	4.248	0.003	0.181	335.598
	750	0.477	2.354	4.313	0.003	0.182	335.598
	1000	0.500	2.538	4.967	0.003	0.179	335.598
Rubber Tired Loaders	25	0.376	1.265	2.414	0.004	0.132	307.158
	50	1.662	4.077	3.336	0.004	0.378	307.158
	120	0.674	2.249	3.994	0.004	0.365	307.158
	175	0.452	1.835	3.540	0.003	0.202	307.158
	250	0.325	0.914	3.367	0.003	0.124	307.158
	500	0.295	1.065	2.985	0.003	0.112	307.158
	750	0.298	1.064	3.064	0.003	0.114	307.158
	1000	0.337	1.245	3.839	0.003	0.117	307.158
Scrapers	120	1.032	3.165	5.977	0.005	0.538	409.544
	175	0.694	2.592	5.330	0.005	0.305	409.544
	250	0.537	1.515	5.114	0.005	0.208	409.544
	500	0.485	2.099	4.596	0.004	0.186	409.544
	750	0.487	2.097	4.686	0.004	0.188	409.544
Signal Boards	15	0.543	2.848	3.400	0.007	0.139	466.425
	50	1.939	4.799	4.587	0.006	0.466	443.672
	120	0.879	3.002	5.491	0.005	0.456	443.672
	175	0.578	2.431	4.902	0.005	0.252	443.672
	250	0.462	1.369	5.557	0.006	0.177	536.104
Skid Steer Loaders	25	0.612	1.669	2.916	0.004	0.195	312.846
	50	1.095	3.202	3.071	0.004	0.291	312.846
	120	0.496	2.087	3.273	0.004	0.284	312.846
Surfacing Equipment	50	1.141	2.832	2.671	0.003	0.271	255.965
	120	0.512	1.759	3.251	0.003	0.263	255.965
	175	0.339	1.437	2.892	0.003	0.147	255.965
	250	0.253	0.776	2.764	0.003	0.099	255.965
	500	0.228	0.970	2.509	0.003	0.090	255.965
	750	0.232	0.969	2.564	0.003	0.091	255.965
Sweepers/Scrubbers	15	0.401	2.362	2.820	0.006	0.115	386.791
	25	0.474	1.593	3.044	0.005	0.166	386.791
	50	2.029	4.972	4.124	0.005	0.466	386.791
	120	0.830	2.778	4.767	0.005	0.461	386.791
	175	0.553	2.246	4.247	0.004	0.252	386.791
	250	0.336	0.897	3.964	0.004	0.122	386.791
Tractors/Loaders/Backhoes	25	0.442	1.374	2.672	0.004	0.156	312.846
	50	1.437	3.799	3.263	0.004	0.347	312.846

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2009		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	120	0.601	2.214	3.672	0.004	0.335	312.846
	175	0.403	1.818	3.209	0.004	0.184	312.846
	250	0.273	0.770	3.036	0.004	0.102	312.846
	500	0.250	0.817	2.650	0.004	0.094	312.846
	750	0.252	0.816	2.738	0.004	0.096	312.846
Trenchers	15	0.497	2.605	3.110	0.007	0.127	426.608
	25	0.522	1.757	3.353	0.005	0.183	426.608
	50	2.499	5.780	4.751	0.006	0.546	426.608
	120	1.046	3.221	6.253	0.005	0.530	426.608
	175	0.701	2.647	5.589	0.005	0.305	426.608
	250	0.558	1.640	5.382	0.005	0.223	426.608
	500	0.498	2.423	4.891	0.004	0.198	426.608
	750	0.503	2.420	4.973	0.004	0.199	426.608
Welders	15	0.530	1.845	3.064	0.004	0.226	255.965
	25	0.602	1.544	2.515	0.003	0.182	255.965
	50	1.259	3.019	2.713	0.003	0.292	255.965
	120	0.546	1.784	3.302	0.003	0.285	255.965
	175	0.361	1.439	2.958	0.003	0.157	255.965
	250	0.239	0.686	2.774	0.003	0.091	255.965
	500	0.214	0.800	2.498	0.003	0.084	255.965
Water Trucks	175	0.477	1.982	3.564	0.004	0.212	324.222
	250	0.336	0.883	3.375	0.004	0.120	324.222
	500	0.310	0.965	2.955	0.003	0.110	324.222
	750	0.312	0.964	3.045	0.003	0.112	324.222
	1000	0.351	1.157	3.973	0.003	0.121	324.222

2010		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Aerial Lifts	15	0.314	1.599	2.001	0.004	0.111	261.653
	25	0.497	1.370	2.412	0.003	0.155	261.653
	50	0.996	2.566	2.639	0.003	0.249	261.653
	120	0.477	1.715	3.074	0.003	0.246	261.653
	500	0.183	0.707	2.340	0.003	0.073	261.653
	750	0.188	0.707	2.402	0.003	0.074	261.653
Air Compressors	15	0.540	1.935	3.149	0.004	0.228	273.029
	25	0.609	1.590	2.632	0.003	0.185	273.029
	50	1.408	3.421	2.915	0.004	0.321	273.029
	120	0.583	1.943	3.451	0.003	0.314	273.029
	175	0.389	1.575	3.086	0.003	0.174	273.029
	250	0.252	0.705	2.887	0.003	0.095	273.029
	500	0.227	0.792	2.577	0.003	0.088	273.029
	750	0.231	0.792	2.646	0.003	0.089	273.029
	1000	0.289	1.032	3.360	0.003	0.101	273.029
Bore/Drill Rigs	15	0.497	2.605	3.110	0.007	0.127	426.608
	25	0.524	1.760	3.354	0.005	0.173	426.608
	50	0.749	3.443	3.877	0.006	0.267	426.608
	120	0.400	2.662	3.405	0.005	0.252	426.608
	175	0.281	2.281	2.767	0.005	0.146	426.608
	250	0.217	0.785	2.687	0.005	0.087	426.608
	500	0.204	0.763	2.337	0.004	0.084	426.608
	750	0.208	0.763	2.412	0.004	0.085	426.608
	1000	0.246	0.785	3.818	0.004	0.095	426.608
Cement and Mortar Mixers	15	0.398	1.958	2.548	0.005	0.146	318.534
	25	0.628	1.709	2.963	0.004	0.194	318.534
Concrete/Industrial Saws	25	0.505	1.710	3.223	0.005	0.158	415.232
	50	1.692	4.413	4.219	0.005	0.413	415.232
	120	0.752	2.786	4.817	0.005	0.403	415.232
	175	0.500	2.277	4.266	0.005	0.224	415.232
Cranes	50	1.354	3.340	2.686	0.003	0.304	244.589
	120	0.545	1.816	3.191	0.003	0.294	244.589
	175	0.369	1.485	2.832	0.003	0.164	244.589
	250	0.271	0.755	2.698	0.003	0.102	244.589
	500	0.247	0.900	2.407	0.002	0.093	244.589
	750	0.249	0.899	2.465	0.002	0.094	244.589
	9999	0.275	1.044	3.072	0.002	0.096	244.588
Crawler Tractors	50	2.117	5.150	4.067	0.005	0.469	364.039
	120	0.858	2.776	5.000	0.004	0.453	364.039
	175	0.583	2.282	4.442	0.004	0.257	364.039
	250	0.450	1.258	4.260	0.004	0.172	364.039
	500	0.409	1.675	3.827	0.004	0.155	364.039
	750	0.411	1.673	3.905	0.004	0.156	364.039
	1000	0.442	1.872	4.759	0.004	0.156	364.039
Crushing/Proc. Equipment	50	2.289	5.637	4.737	0.006	0.524	443.672
	120	0.939	3.178	5.540	0.005	0.512	443.672
	175	0.628	2.583	4.936	0.005	0.283	443.672

2010		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	250	0.407	1.129	4.620	0.005	0.153	443.672
	500	0.367	1.252	4.098	0.004	0.141	443.672
	750	0.373	1.224	4.254	0.004	0.143	443.672
	9999	0.469	1.633	5.455	0.004	0.163	443.672
Dumpers/Tenders	25	0.307	0.954	1.827	0.003	0.103	216.148
Excavators	25	0.392	1.335	2.486	0.004	0.113	324.222
	50	1.466	4.076	3.419	0.004	0.357	324.222
	120	0.616	2.342	3.700	0.004	0.344	324.222
	175	0.423	1.936	3.220	0.004	0.192	324.222
	250	0.297	0.804	3.052	0.004	0.106	324.222
	500	0.275	0.855	2.675	0.003	0.099	324.222
	750	0.277	0.854	2.759	0.003	0.100	324.222
Forklifts	50	0.768	2.112	1.777	0.002	0.188	170.643
	120	0.326	1.224	1.903	0.002	0.186	170.643
	175	0.223	1.006	1.677	0.002	0.102	170.643
	250	0.143	0.377	1.577	0.002	0.050	170.643
	500	0.133	0.359	1.362	0.002	0.047	170.643
Generator Sets	15	0.706	2.983	4.731	0.007	0.282	420.920
	25	0.712	2.451	4.057	0.005	0.254	420.920
	50	1.515	3.965	4.207	0.005	0.387	420.920
	120	0.745	2.724	4.869	0.005	0.382	420.920
	175	0.490	2.212	4.348	0.005	0.212	420.920
	250	0.317	0.988	4.075	0.005	0.121	420.920
	500	0.285	1.098	3.715	0.004	0.114	420.920
	750	0.294	1.098	3.812	0.004	0.115	420.920
	9999	0.400	1.430	4.848	0.004	0.143	420.920
Graders	50	1.764	4.516	3.730	0.004	0.407	346.974
	120	0.719	2.527	4.290	0.004	0.393	346.974
	175	0.488	2.074	3.789	0.004	0.219	346.974
	250	0.355	0.995	3.610	0.004	0.134	346.974
	500	0.325	1.137	3.205	0.003	0.122	346.974
	750	0.327	1.137	3.289	0.003	0.124	346.974
Off-Highway Tractors	120	0.969	2.934	5.601	0.004	0.495	369.727
	175	0.659	2.427	5.008	0.004	0.287	369.727
	250	0.533	1.516	4.834	0.004	0.208	369.727
	750	0.482	2.319	4.454	0.004	0.186	369.727
	1000	0.509	2.514	5.208	0.004	0.182	369.727
Off-Highway Trucks	175	0.449	1.976	3.317	0.004	0.200	324.222
	250	0.319	0.837	3.144	0.004	0.112	324.222
	500	0.297	0.898	2.761	0.003	0.104	324.222
	750	0.299	0.897	2.845	0.003	0.105	324.222
	1000	0.334	1.072	3.802	0.003	0.115	324.222
Other Construction Equipment	15	0.411	2.153	2.571	0.005	0.105	352.663
	25	0.433	1.455	2.773	0.004	0.143	352.663
	50	1.302	3.692	3.511	0.005	0.332	352.663
	120	0.576	2.363	3.772	0.004	0.323	352.663
	175	0.387	1.954	3.287	0.004	0.180	352.663
	500	0.237	0.842	2.750	0.003	0.094	352.663

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2010		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Other General Industrial Equipment	15	0.301	1.771	2.115	0.005	0.079	290.093
	25	0.351	1.194	2.225	0.004	0.101	290.093
	50	1.689	4.071	3.210	0.004	0.378	290.093
	120	0.676	2.168	3.817	0.003	0.368	290.093
	175	0.454	1.756	3.408	0.003	0.203	290.093
	250	0.297	0.781	3.188	0.003	0.108	290.093
	500	0.271	0.870	2.819	0.003	0.100	290.093
	750	0.273	0.870	2.899	0.003	0.101	290.093
	1000	0.327	1.130	3.688	0.003	0.114	290.093
Other Material Handling Equipment	50	1.938	4.664	3.700	0.004	0.433	335.598
	120	0.776	2.496	4.403	0.004	0.423	335.598
	175	0.521	2.022	3.934	0.004	0.233	335.598
	250	0.340	0.901	3.679	0.004	0.124	335.598
	500	0.309	1.004	3.255	0.003	0.115	335.598
	9999	0.376	1.305	4.255	0.003	0.131	335.598
Pavers	25	0.525	1.597	3.030	0.004	0.175	352.663
	50	2.047	4.863	3.919	0.005	0.449	352.663
	120	0.835	2.662	4.940	0.004	0.435	352.663
	175	0.563	2.188	4.406	0.004	0.248	352.663
	250	0.440	1.272	4.234	0.004	0.173	352.663
	500	0.396	1.763	3.828	0.003	0.155	352.662
Paving Equipment	25	0.370	1.244	2.370	0.004	0.122	301.470
	50	1.744	4.129	3.344	0.004	0.382	301.470
	120	0.709	2.259	4.204	0.004	0.370	301.470
	175	0.477	1.853	3.753	0.003	0.210	301.470
	250	0.371	1.075	3.604	0.003	0.146	301.470
Plate Compactors	15	0.286	1.493	1.798	0.004	0.086	244.589
Pressure Washers	15	0.286	1.209	1.918	0.003	0.114	170.643
	25	0.289	0.994	1.645	0.002	0.103	170.643
	50	0.487	1.357	1.652	0.002	0.136	170.643
	120	0.272	1.052	1.884	0.002	0.136	170.643
Pumps	15	0.833	2.983	4.855	0.007	0.351	420.920
	25	0.939	2.451	4.057	0.005	0.284	420.920
	50	1.621	4.174	4.252	0.005	0.404	420.920
	120	0.770	2.767	4.944	0.005	0.399	420.920
	175	0.508	2.247	4.416	0.005	0.221	420.920
	250	0.329	1.007	4.138	0.005	0.126	420.920
	500	0.295	1.138	3.758	0.004	0.118	420.920
	750	0.304	1.138	3.857	0.004	0.119	420.920
	9999	0.408	1.475	4.901	0.004	0.145	420.920
Rollers	15	0.371	1.945	2.322	0.005	0.095	318.534
	25	0.391	1.314	2.504	0.004	0.129	318.534
	50	1.557	3.885	3.375	0.004	0.358	318.534
	120	0.649	2.255	3.987	0.004	0.346	318.534
	175	0.435	1.847	3.541	0.004	0.194	318.534
	250	0.321	0.945	3.377	0.004	0.125	318.534
	500	0.289	1.132	3.036	0.003	0.114	318.534
Rough Terrain Forklifts	50	1.603	4.219	3.586	0.004	0.380	341.286

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2010		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	120	0.663	2.430	4.004	0.004	0.369	341.286
	175	0.448	1.995	3.518	0.004	0.205	341.286
	250	0.304	0.853	3.323	0.004	0.113	341.286
	500	0.279	0.914	2.925	0.003	0.105	341.286
Rubber Tired Dozers	175	0.622	2.251	4.635	0.004	0.269	335.598
	250	0.508	1.419	4.478	0.004	0.196	335.598
	500	0.459	2.206	4.063	0.003	0.174	335.598
	750	0.460	2.203	4.126	0.003	0.175	335.598
	1000	0.481	2.379	4.812	0.003	0.171	335.598
Rubber Tired Loaders	25	0.374	1.265	2.384	0.004	0.117	307.158
	50	1.538	3.949	3.286	0.004	0.356	307.158
	120	0.629	2.225	3.768	0.004	0.344	307.158
	175	0.426	1.828	3.326	0.003	0.192	307.158
	250	0.308	0.868	3.166	0.003	0.116	307.158
	500	0.282	0.991	2.810	0.003	0.106	307.158
	750	0.284	0.990	2.885	0.003	0.108	307.158
	1000	0.318	1.157	3.691	0.003	0.112	307.158
Scrapers	120	0.975	3.127	5.685	0.005	0.513	409.544
	175	0.661	2.569	5.057	0.005	0.291	409.544
	250	0.512	1.440	4.852	0.005	0.197	409.544
	500	0.465	1.934	4.364	0.004	0.177	409.544
	750	0.467	1.932	4.450	0.004	0.178	409.544
Signal Boards	15	0.543	2.848	3.400	0.007	0.127	466.425
	50	1.830	4.691	4.522	0.006	0.446	443.672
	120	0.827	2.976	5.225	0.005	0.438	443.672
	175	0.548	2.422	4.652	0.005	0.243	443.672
	250	0.430	1.289	5.270	0.006	0.166	536.104
Skid Steer Loaders	25	0.564	1.587	2.838	0.004	0.179	312.846
	50	0.962	3.073	3.020	0.004	0.266	312.846
	120	0.444	2.064	3.022	0.004	0.260	312.846
Surfacing Equipment	50	1.070	2.758	2.632	0.003	0.258	255.965
	120	0.479	1.740	3.084	0.003	0.251	255.965
	175	0.320	1.429	2.736	0.003	0.141	255.965
	250	0.238	0.737	2.616	0.003	0.094	255.965
	500	0.215	0.901	2.374	0.003	0.086	255.965
	750	0.218	0.900	2.427	0.003	0.087	255.965
Sweepers/Scrubbers	15	0.401	2.362	2.820	0.006	0.106	386.791
	25	0.471	1.593	3.005	0.005	0.148	386.791
	50	1.828	4.745	4.033	0.005	0.432	386.791
	120	0.762	2.742	4.434	0.005	0.431	386.791
	175	0.512	2.237	3.947	0.004	0.236	386.791
	250	0.319	0.867	3.701	0.004	0.116	386.791
Tractors/Loaders/Backhoes	25	0.421	1.344	2.596	0.004	0.142	312.846
	50	1.296	3.658	3.211	0.004	0.322	312.846
	120	0.550	2.191	3.426	0.004	0.312	312.846
	175	0.375	1.815	2.977	0.004	0.173	312.846
	250	0.258	0.735	2.822	0.004	0.095	312.846
	500	0.239	0.771	2.471	0.004	0.089	312.846
	750	0.241	0.770	2.552	0.004	0.090	312.846

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2010		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Trenchers	15	0.497	2.605	3.110	0.007	0.117	426.608
	25	0.519	1.757	3.311	0.005	0.162	426.608
	50	2.381	5.657	4.692	0.006	0.525	426.608
	120	0.992	3.182	5.971	0.005	0.510	426.608
	175	0.668	2.622	5.328	0.005	0.294	426.608
	250	0.530	1.562	5.130	0.005	0.211	426.608
	500	0.475	2.240	4.661	0.004	0.188	426.608
	750	0.479	2.238	4.740	0.004	0.189	426.608
Welders	15	0.507	1.814	2.952	0.004	0.213	255.965
	25	0.571	1.491	2.467	0.003	0.173	255.965
	50	1.197	2.960	2.677	0.003	0.281	255.965
	120	0.518	1.770	3.152	0.003	0.275	255.965
	175	0.344	1.435	2.818	0.003	0.152	255.965
	250	0.224	0.645	2.638	0.003	0.085	255.965
	500	0.201	0.730	2.370	0.003	0.079	255.965
Water Trucks	175	0.449	1.976	3.317	0.004	0.200	324.222
	250	0.319	0.837	3.144	0.004	0.112	324.222
	500	0.297	0.898	2.761	0.003	0.104	324.222
	750	0.299	0.897	2.845	0.003	0.105	324.222
	1000	0.334	1.072	3.802	0.003	0.115	324.222

2011		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Aerial Lifts	15	0.310	1.598	1.964	0.004	0.099	261.653
	25	0.454	1.296	2.344	0.003	0.142	261.653
	50	0.925	2.490	2.594	0.003	0.236	261.653
	120	0.444	1.697	2.907	0.003	0.235	261.653
	500	0.167	0.646	2.168	0.003	0.065	261.653
	750	0.172	0.646	2.228	0.003	0.066	261.653
Air Compressors	15	0.513	1.899	3.019	0.004	0.212	273.029
	25	0.573	1.528	2.576	0.003	0.174	273.029
	50	1.317	3.324	2.869	0.004	0.306	273.029
	120	0.548	1.925	3.270	0.003	0.301	273.029
	175	0.368	1.568	2.914	0.003	0.167	273.029
	250	0.233	0.659	2.692	0.003	0.085	273.029
	500	0.211	0.720	2.393	0.003	0.079	273.029
	750	0.214	0.720	2.462	0.003	0.081	273.029
	1000	0.270	0.947	3.189	0.003	0.095	273.029
Bore/Drill Rigs	15	0.497	2.605	3.110	0.007	0.122	426.608
	25	0.519	1.757	3.315	0.005	0.157	426.608
	50	0.599	3.311	3.835	0.006	0.233	426.608
	120	0.335	2.634	3.087	0.005	0.221	426.608
	175	0.251	2.280	2.495	0.005	0.135	426.608
	250	0.202	0.781	2.297	0.005	0.073	426.608
	500	0.194	0.759	2.043	0.004	0.071	426.608
	750	0.196	0.759	2.084	0.004	0.072	426.608
	1000	0.225	0.777	3.400	0.004	0.086	426.608
Cement and Mortar Mixers	15	0.384	1.950	2.439	0.005	0.130	318.534
	25	0.578	1.624	2.884	0.004	0.179	318.534
Concrete/Industrial Saws	25	0.503	1.710	3.194	0.005	0.141	415.232
	50	1.566	4.278	4.150	0.005	0.391	415.232
	120	0.699	2.759	4.546	0.005	0.383	415.232
	175	0.468	2.268	4.012	0.005	0.214	415.232
Cranes	50	1.257	3.240	2.649	0.003	0.288	244.588
	120	0.511	1.798	3.022	0.003	0.279	244.589
	175	0.350	1.479	2.672	0.003	0.157	244.589
	250	0.255	0.714	2.513	0.003	0.093	244.589
	500	0.234	0.833	2.240	0.002	0.085	244.589
	750	0.236	0.833	2.296	0.002	0.086	244.589
	9999	0.262	0.970	2.912	0.002	0.090	244.589
Crawler Tractors	50	1.979	5.010	4.017	0.005	0.446	364.039
	120	0.808	2.743	4.746	0.004	0.430	364.039
	175	0.555	2.265	4.208	0.004	0.246	364.039
	250	0.427	1.199	3.990	0.004	0.159	364.039
	500	0.391	1.548	3.586	0.004	0.143	364.039
	750	0.392	1.546	3.660	0.004	0.145	364.039
	1000	0.420	1.732	4.521	0.004	0.147	364.039
Crushing/Proc. Equipment	50	2.126	5.461	4.663	0.006	0.497	443.672
	120	0.879	3.146	5.234	0.005	0.488	443.672
	175	0.593	2.572	4.648	0.005	0.271	443.672

2011		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	250	0.378	1.059	4.293	0.005	0.137	443.672
	500	0.343	1.142	3.793	0.004	0.127	443.672
	750	0.348	1.121	3.946	0.004	0.129	443.672
	9999	0.441	1.502	5.160	0.004	0.154	443.672
Dumpers/Tenders	25	0.293	0.934	1.782	0.003	0.096	216.148
Excavators	25	0.391	1.335	2.475	0.004	0.098	324.222
	50	1.319	3.933	3.371	0.004	0.331	324.222
	120	0.567	2.319	3.458	0.004	0.319	324.222
	175	0.397	1.932	2.994	0.004	0.181	324.222
	250	0.280	0.769	2.785	0.004	0.095	324.222
	500	0.262	0.803	2.444	0.003	0.089	324.222
	750	0.264	0.803	2.522	0.003	0.090	324.222
Forklifts	50	0.675	2.022	1.749	0.002	0.172	170.643
	120	0.295	1.210	1.771	0.002	0.169	170.643
	175	0.205	1.005	1.542	0.002	0.094	170.643
	250	0.137	0.368	1.428	0.002	0.045	170.643
	500	0.128	0.350	1.229	0.002	0.042	170.643
Generator Sets	15	0.673	2.928	4.544	0.007	0.266	420.920
	25	0.681	2.355	3.971	0.005	0.241	420.920
	50	1.409	3.851	4.137	0.005	0.367	420.920
	120	0.694	2.697	4.611	0.005	0.365	420.920
	175	0.459	2.203	4.106	0.005	0.203	420.920
	250	0.290	0.925	3.796	0.005	0.109	420.920
	500	0.260	1.008	3.448	0.004	0.102	420.920
	750	0.268	1.008	3.543	0.004	0.104	420.920
	9999	0.372	1.322	4.594	0.004	0.133	420.920
Graders	50	1.625	4.376	3.679	0.004	0.384	346.974
	120	0.671	2.502	4.050	0.004	0.371	346.974
	175	0.461	2.067	3.562	0.004	0.209	346.974
	250	0.336	0.949	3.344	0.004	0.122	346.974
	500	0.309	1.066	2.970	0.003	0.111	346.974
	750	0.311	1.065	3.048	0.003	0.113	346.974
Off-Highway Tractors	120	0.923	2.900	5.359	0.004	0.475	369.727
	175	0.632	2.404	4.782	0.004	0.277	369.727
	250	0.510	1.450	4.578	0.004	0.195	369.727
	750	0.463	2.162	4.219	0.004	0.175	369.727
	1000	0.487	2.348	4.987	0.004	0.173	369.727
Off-Highway Trucks	175	0.423	1.972	3.088	0.004	0.189	324.222
	250	0.302	0.798	2.876	0.004	0.100	324.222
	500	0.282	0.840	2.529	0.003	0.094	324.222
	750	0.284	0.840	2.606	0.003	0.095	324.222
	1000	0.317	0.996	3.554	0.003	0.108	324.222
Other Construction Equipment	15	0.411	2.153	2.571	0.005	0.101	352.663
	25	0.429	1.452	2.740	0.004	0.130	352.663
	50	1.179	3.569	3.459	0.005	0.309	352.663
	120	0.527	2.341	3.532	0.004	0.303	352.663
	175	0.360	1.950	3.064	0.004	0.171	352.663
	500	0.221	0.788	2.510	0.003	0.084	352.663

2011		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Other General Industrial Equipment	15	0.301	1.771	2.115	0.005	0.080	290.093
	25	0.350	1.194	2.214	0.004	0.088	290.093
	50	1.559	3.927	3.155	0.004	0.356	290.093
	120	0.632	2.142	3.599	0.003	0.349	290.093
	175	0.429	1.746	3.202	0.003	0.193	290.093
	250	0.276	0.729	2.958	0.003	0.097	290.093
	500	0.254	0.790	2.608	0.003	0.090	290.093
	750	0.256	0.790	2.686	0.003	0.091	290.093
	1000	0.307	1.035	3.490	0.003	0.107	290.093
Other Material Handling Equipment	50	1.792	4.502	3.638	0.004	0.409	335.598
	120	0.726	2.467	4.154	0.004	0.401	335.598
	175	0.492	2.011	3.697	0.004	0.222	335.598
	250	0.316	0.841	3.415	0.004	0.111	335.598
	500	0.290	0.911	3.012	0.003	0.103	335.598
	9999	0.355	1.195	4.027	0.003	0.123	335.598
Pavers	25	0.502	1.562	2.959	0.004	0.163	352.663
	50	1.938	4.750	3.872	0.005	0.430	352.663
	120	0.791	2.631	4.710	0.004	0.417	352.663
	175	0.537	2.170	4.194	0.004	0.239	352.663
	250	0.417	1.211	3.989	0.004	0.160	352.663
	500	0.378	1.627	3.603	0.003	0.144	352.663
Paving Equipment	25	0.367	1.241	2.342	0.004	0.111	301.470
	50	1.652	4.033	3.303	0.004	0.367	301.470
	120	0.672	2.234	4.010	0.004	0.355	301.470
	175	0.455	1.837	3.574	0.003	0.202	301.470
	250	0.351	1.022	3.397	0.003	0.135	301.470
Plate Compactors	15	0.285	1.493	1.786	0.004	0.074	244.589
Pressure Washers	15	0.273	1.187	1.842	0.003	0.108	170.643
	25	0.276	0.955	1.610	0.002	0.098	170.643
	50	0.449	1.316	1.623	0.002	0.129	170.643
	120	0.252	1.041	1.783	0.002	0.129	170.643
Pumps	15	0.791	2.928	4.654	0.007	0.327	420.920
	25	0.883	2.355	3.971	0.005	0.268	420.920
	50	1.510	4.055	4.182	0.005	0.384	420.920
	120	0.718	2.740	4.683	0.005	0.381	420.920
	175	0.476	2.237	4.171	0.005	0.212	420.920
	250	0.302	0.943	3.856	0.005	0.113	420.920
	500	0.270	1.041	3.489	0.004	0.106	420.920
	750	0.279	1.041	3.586	0.004	0.108	420.920
	9999	0.380	1.360	4.646	0.004	0.136	420.920
Rollers	15	0.371	1.945	2.322	0.005	0.091	318.534
	25	0.388	1.312	2.475	0.004	0.117	318.534
	50	1.454	3.776	3.327	0.004	0.340	318.534
	120	0.608	2.233	3.782	0.004	0.330	318.534
	175	0.412	1.839	3.349	0.004	0.186	318.534
	250	0.300	0.895	3.150	0.004	0.114	318.534
	500	0.271	1.052	2.827	0.003	0.104	318.534
Rough Terrain Forklifts	50	1.463	4.078	3.532	0.004	0.357	341.286

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2011		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	120	0.614	2.407	3.760	0.004	0.347	341.286
	175	0.421	1.990	3.288	0.004	0.194	341.286
	250	0.285	0.807	3.056	0.004	0.101	341.286
	500	0.263	0.844	2.685	0.003	0.094	341.286
Rubber Tired Dozers	175	0.597	2.230	4.429	0.004	0.259	335.598
	250	0.486	1.359	4.245	0.004	0.184	335.598
	500	0.441	2.063	3.853	0.003	0.163	335.598
	750	0.442	2.060	3.913	0.003	0.164	335.598
	1000	0.462	2.228	4.610	0.003	0.163	335.598
Rubber Tired Loaders	25	0.372	1.265	2.363	0.004	0.105	307.158
	50	1.416	3.824	3.240	0.004	0.335	307.158
	120	0.586	2.203	3.555	0.004	0.325	307.158
	175	0.402	1.822	3.125	0.003	0.183	307.158
	250	0.290	0.827	2.930	0.003	0.105	307.158
	500	0.267	0.929	2.600	0.003	0.097	307.158
	750	0.269	0.928	2.670	0.003	0.098	307.158
	1000	0.300	1.080	3.477	0.003	0.105	307.158
Scrapers	120	0.921	3.091	5.405	0.005	0.489	409.544
	175	0.631	2.550	4.798	0.005	0.279	409.544
	250	0.487	1.372	4.555	0.005	0.182	409.544
	500	0.444	1.787	4.096	0.004	0.164	409.544
	750	0.446	1.785	4.179	0.004	0.165	409.544
Signal Boards	15	0.543	2.848	3.400	0.007	0.129	466.425
	50	1.701	4.555	4.449	0.006	0.423	443.672
	120	0.770	2.946	4.940	0.005	0.418	443.672
	175	0.514	2.413	4.384	0.005	0.233	443.672
	250	0.395	1.209	4.897	0.006	0.148	536.104
Skid Steer Loaders	25	0.519	1.511	2.765	0.004	0.165	312.846
	50	0.839	2.956	2.976	0.004	0.242	312.846
	120	0.397	2.044	2.806	0.004	0.238	312.846
Surfacing Equipment	50	1.000	2.686	2.595	0.003	0.245	255.965
	120	0.447	1.722	2.927	0.003	0.239	255.965
	175	0.301	1.422	2.589	0.003	0.135	255.965
	250	0.222	0.701	2.441	0.003	0.086	255.965
	500	0.201	0.841	2.213	0.003	0.079	255.965
	750	0.205	0.840	2.263	0.003	0.079	255.965
Sweepers/Scrubbers	15	0.401	2.362	2.820	0.006	0.107	386.791
	25	0.469	1.593	2.977	0.005	0.132	386.791
	50	1.625	4.519	3.947	0.005	0.398	386.791
	120	0.694	2.707	4.142	0.005	0.399	386.791
	175	0.472	2.230	3.655	0.004	0.220	386.791
	250	0.301	0.840	3.381	0.004	0.105	386.791
Tractors/Loaders/Backhoes	25	0.405	1.321	2.526	0.004	0.131	312.846
	50	1.162	3.528	3.165	0.004	0.298	312.846
	120	0.504	2.170	3.198	0.004	0.289	312.846
	175	0.350	1.812	2.763	0.004	0.164	312.846
	250	0.243	0.707	2.567	0.004	0.085	312.846
	500	0.227	0.732	2.251	0.004	0.080	312.846
	750	0.229	0.731	2.324	0.004	0.081	312.846

2011		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Trenchers	15	0.497	2.605	3.110	0.007	0.118	426.608
	25	0.517	1.757	3.282	0.005	0.145	426.608
	50	2.263	5.534	4.636	0.006	0.504	426.608
	120	0.940	3.145	5.701	0.005	0.491	426.608
	175	0.638	2.598	5.080	0.005	0.283	426.608
	250	0.502	1.488	4.841	0.005	0.196	426.608
	500	0.452	2.072	4.394	0.004	0.175	426.608
	750	0.455	2.070	4.471	0.004	0.177	426.608
Welders	15	0.481	1.780	2.830	0.004	0.199	255.965
	25	0.537	1.432	2.415	0.003	0.163	255.965
	50	1.121	2.879	2.635	0.003	0.267	255.965
	120	0.485	1.753	2.987	0.003	0.263	255.965
	175	0.324	1.430	2.662	0.003	0.146	255.965
	250	0.206	0.604	2.461	0.003	0.077	255.965
	500	0.185	0.664	2.201	0.003	0.071	255.965
Water Trucks	175	0.423	1.972	3.088	0.004	0.189	324.222
	250	0.302	0.798	2.876	0.004	0.100	324.222
	500	0.282	0.840	2.529	0.003	0.094	324.222
	750	0.284	0.840	2.606	0.003	0.095	324.222
	1000	0.317	0.996	3.554	0.003	0.108	324.222

2012		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Aerial Lifts	15	0.308	1.598	1.941	0.004	0.090	261.653
	25	0.414	1.229	2.280	0.003	0.129	261.653
	50	0.849	2.407	2.547	0.003	0.223	261.653
	120	0.410	1.679	2.728	0.003	0.219	261.653
	500	0.154	0.602	2.007	0.003	0.059	261.653
	750	0.159	0.602	2.066	0.003	0.060	261.653
Air Compressors	15	0.484	1.861	2.882	0.004	0.196	273.029
	25	0.535	1.462	2.517	0.003	0.162	273.029
	50	1.215	3.210	2.820	0.004	0.289	273.029
	120	0.510	1.904	3.070	0.003	0.282	273.029
	175	0.345	1.562	2.731	0.003	0.156	273.029
	250	0.219	0.631	2.506	0.003	0.078	273.029
	500	0.199	0.669	2.219	0.003	0.072	273.029
	750	0.202	0.669	2.286	0.003	0.074	273.029
	1000	0.251	0.865	3.009	0.003	0.088	273.029
Bore/Drill Rigs	15	0.497	2.605	3.110	0.007	0.120	426.608
	25	0.517	1.757	3.289	0.005	0.143	426.608
	50	0.482	3.209	3.805	0.006	0.205	426.608
	120	0.284	2.613	2.780	0.005	0.182	426.608
	175	0.227	2.279	2.261	0.005	0.111	426.608
	250	0.190	0.779	1.978	0.005	0.061	426.608
	500	0.185	0.757	1.802	0.004	0.060	426.608
	750	0.186	0.757	1.827	0.004	0.060	426.608
	1000	0.207	0.771	3.042	0.004	0.078	426.608
Cement and Mortar Mixers	15	0.378	1.946	2.395	0.005	0.118	318.534
	25	0.532	1.546	2.809	0.004	0.164	318.534
Concrete/Industrial Saws	25	0.502	1.710	3.177	0.005	0.127	415.232
	50	1.439	4.144	4.084	0.005	0.368	415.232
	120	0.647	2.733	4.270	0.005	0.358	415.232
	175	0.437	2.261	3.760	0.005	0.199	415.232
Cranes	50	1.162	3.143	2.614	0.003	0.272	244.589
	120	0.479	1.780	2.850	0.003	0.260	244.589
	175	0.331	1.473	2.514	0.003	0.146	244.589
	250	0.241	0.677	2.336	0.003	0.085	244.589
	500	0.222	0.773	2.082	0.002	0.078	244.589
	750	0.223	0.772	2.135	0.002	0.079	244.589
	9999	0.250	0.902	2.758	0.002	0.085	244.589
Crawler Tractors	50	1.846	4.877	3.969	0.005	0.423	364.039
	120	0.760	2.714	4.492	0.004	0.403	364.039
	175	0.528	2.250	3.979	0.004	0.230	364.039
	250	0.406	1.145	3.735	0.004	0.146	364.039
	500	0.373	1.435	3.358	0.004	0.132	364.039
	750	0.375	1.433	3.428	0.004	0.134	364.039
	1000	0.400	1.606	4.293	0.004	0.139	364.039
Crushing/Proc. Equipment	50	1.943	5.257	4.581	0.006	0.466	443.672
	120	0.814	3.111	4.895	0.005	0.454	443.672
	175	0.554	2.561	4.335	0.005	0.251	443.672

2012		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	250	0.354	1.015	3.973	0.005	0.124	443.672
	500	0.325	1.064	3.498	0.004	0.115	443.672
	750	0.328	1.048	3.640	0.004	0.117	443.672
	9999	0.411	1.370	4.838	0.004	0.143	443.672
Dumpers/Tenders	25	0.282	0.919	1.740	0.003	0.089	216.148
Excavators	25	0.391	1.335	2.472	0.004	0.094	324.222
	50	1.183	3.802	3.328	0.004	0.307	324.222
	120	0.521	2.299	3.215	0.004	0.290	324.222
	175	0.372	1.929	2.777	0.004	0.164	324.222
	250	0.266	0.742	2.542	0.004	0.085	324.222
	500	0.250	0.762	2.235	0.003	0.080	324.222
	750	0.252	0.762	2.305	0.003	0.081	324.222
Forklifts	50	0.589	1.946	1.727	0.002	0.157	170.643
	120	0.264	1.198	1.638	0.002	0.150	170.643
	175	0.188	1.005	1.409	0.002	0.084	170.643
	250	0.131	0.362	1.288	0.002	0.041	170.643
	500	0.123	0.344	1.106	0.002	0.038	170.643
Generator Sets	15	0.641	2.870	4.351	0.007	0.251	420.920
	25	0.655	2.254	3.881	0.005	0.228	420.920
	50	1.293	3.726	4.063	0.005	0.346	420.920
	120	0.641	2.669	4.332	0.005	0.341	420.920
	175	0.426	2.195	3.851	0.005	0.189	420.920
	250	0.268	0.887	3.533	0.005	0.099	420.920
	500	0.240	0.944	3.196	0.004	0.093	420.920
	750	0.248	0.944	3.290	0.004	0.095	420.920
	9999	0.343	1.214	4.332	0.004	0.123	420.920
Graders	50	1.490	4.240	3.631	0.004	0.360	346.974
	120	0.624	2.479	3.806	0.004	0.343	346.974
	175	0.435	2.062	3.341	0.004	0.193	346.974
	250	0.317	0.909	3.094	0.004	0.110	346.974
	500	0.294	1.004	2.751	0.003	0.101	346.974
	750	0.296	1.003	2.823	0.003	0.103	346.974
Off-Highway Tractors	120	0.877	2.867	5.114	0.004	0.451	369.727
	175	0.605	2.383	4.560	0.004	0.262	369.727
	250	0.487	1.388	4.332	0.004	0.183	369.727
	750	0.444	2.016	3.995	0.004	0.164	369.727
	1000	0.466	2.193	4.772	0.004	0.165	369.727
Off-Highway Trucks	175	0.397	1.968	2.870	0.004	0.173	324.222
	250	0.286	0.768	2.631	0.004	0.090	324.222
	500	0.269	0.793	2.317	0.003	0.084	324.222
	750	0.271	0.793	2.389	0.003	0.085	324.222
	1000	0.301	0.928	3.321	0.003	0.100	324.222
Other Construction Equipment	15	0.411	2.153	2.571	0.005	0.099	352.663
	25	0.428	1.452	2.719	0.004	0.118	352.663
	50	1.061	3.452	3.411	0.005	0.287	352.663
	120	0.482	2.320	3.289	0.004	0.276	352.663
	175	0.334	1.947	2.847	0.004	0.155	352.663
	500	0.210	0.753	2.299	0.003	0.076	352.662

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2012		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Other General Industrial Equipment	15	0.301	1.771	2.115	0.005	0.082	290.093
	25	0.350	1.194	2.211	0.004	0.085	290.093
	50	1.421	3.773	3.099	0.004	0.334	290.093
	120	0.587	2.116	3.367	0.003	0.324	290.093
	175	0.402	1.737	2.988	0.003	0.179	290.093
	250	0.261	0.697	2.742	0.003	0.088	290.093
	500	0.241	0.734	2.412	0.003	0.082	290.093
	750	0.243	0.734	2.487	0.003	0.083	290.093
	1000	0.287	0.943	3.286	0.003	0.100	290.093
Other Material Handling Equipment	50	1.635	4.328	3.573	0.004	0.384	335.598
	120	0.674	2.438	3.887	0.004	0.373	335.598
	175	0.461	2.000	3.450	0.004	0.206	335.598
	250	0.298	0.804	3.166	0.004	0.101	335.598
	500	0.275	0.846	2.785	0.003	0.094	335.598
	9999	0.334	1.089	3.793	0.003	0.115	335.598
Pavers	25	0.482	1.533	2.894	0.004	0.152	352.663
	50	1.829	4.637	3.827	0.005	0.412	352.663
	120	0.748	2.603	4.479	0.004	0.395	352.663
	175	0.512	2.153	3.985	0.004	0.225	352.663
	250	0.396	1.155	3.756	0.004	0.148	352.663
	500	0.360	1.505	3.390	0.003	0.134	352.663
Paving Equipment	25	0.366	1.241	2.324	0.004	0.101	301.470
	50	1.561	3.937	3.264	0.004	0.351	301.470
	120	0.636	2.211	3.815	0.004	0.337	301.470
	175	0.434	1.825	3.397	0.003	0.191	301.470
	250	0.332	0.973	3.199	0.003	0.125	301.470
Plate Compactors	15	0.285	1.493	1.783	0.004	0.071	244.589
Pressure Washers	15	0.260	1.163	1.764	0.003	0.102	170.643
	25	0.266	0.914	1.573	0.002	0.092	170.643
	50	0.409	1.273	1.593	0.002	0.121	170.643
	120	0.231	1.031	1.675	0.002	0.120	170.643
Pumps	15	0.746	2.870	4.443	0.007	0.302	420.920
	25	0.824	2.254	3.881	0.005	0.250	420.920
	50	1.389	3.923	4.107	0.005	0.362	420.920
	120	0.664	2.711	4.399	0.005	0.357	420.920
	175	0.443	2.229	3.911	0.005	0.197	420.920
	250	0.280	0.903	3.589	0.005	0.103	420.920
	500	0.251	0.971	3.235	0.004	0.097	420.920
	750	0.259	0.971	3.329	0.004	0.098	420.920
	9999	0.351	1.246	4.382	0.004	0.125	420.920
Rollers	15	0.371	1.945	2.322	0.005	0.089	318.534
	25	0.386	1.312	2.456	0.004	0.107	318.534
	50	1.354	3.671	3.282	0.004	0.323	318.534
	120	0.569	2.213	3.574	0.004	0.310	318.534
	175	0.389	1.832	3.159	0.004	0.174	318.534
	250	0.280	0.850	2.935	0.004	0.104	318.534
	500	0.255	0.981	2.630	0.003	0.095	318.534
Rough Terrain Forklifts	50	1.326	3.941	3.482	0.004	0.333	341.286

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2012		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	120	0.567	2.385	3.511	0.004	0.320	341.286
	175	0.395	1.986	3.062	0.004	0.178	341.286
	250	0.270	0.779	2.814	0.004	0.092	341.286
	500	0.252	0.796	2.471	0.003	0.085	341.286
Rubber Tired Dozers	175	0.573	2.210	4.226	0.004	0.245	335.598
	250	0.466	1.303	4.021	0.004	0.172	335.598
	500	0.424	1.928	3.652	0.003	0.153	335.598
	750	0.425	1.926	3.710	0.003	0.154	335.598
	1000	0.443	2.085	4.414	0.003	0.155	335.598
Rubber Tired Loaders	25	0.371	1.265	2.350	0.004	0.094	307.158
	50	1.297	3.704	3.197	0.004	0.314	307.158
	120	0.545	2.183	3.339	0.004	0.300	307.158
	175	0.379	1.817	2.928	0.003	0.168	307.158
	250	0.274	0.791	2.707	0.003	0.095	307.158
	500	0.254	0.875	2.405	0.003	0.088	307.158
	750	0.256	0.875	2.470	0.003	0.089	307.158
	1000	0.283	1.013	3.274	0.003	0.099	307.158
Scrapers	120	0.868	3.058	5.124	0.005	0.460	409.544
	175	0.601	2.533	4.544	0.005	0.262	409.544
	250	0.463	1.310	4.272	0.005	0.168	409.544
	500	0.425	1.656	3.843	0.004	0.152	409.544
	750	0.426	1.655	3.922	0.004	0.153	409.544
Signal Boards	15	0.543	2.848	3.400	0.007	0.132	466.425
	50	1.558	4.398	4.369	0.006	0.397	443.672
	120	0.710	2.915	4.624	0.005	0.389	443.672
	175	0.477	2.403	4.096	0.005	0.215	443.672
	250	0.367	1.158	4.536	0.006	0.134	536.104
Skid Steer Loaders	25	0.479	1.441	2.697	0.004	0.152	312.846
	50	0.731	2.859	2.945	0.004	0.221	312.846
	120	0.353	2.026	2.587	0.004	0.209	312.846
Surfacing Equipment	50	0.931	2.614	2.560	0.003	0.232	255.965
	120	0.418	1.706	2.768	0.003	0.224	255.965
	175	0.283	1.416	2.446	0.003	0.126	255.965
	250	0.208	0.669	2.276	0.003	0.078	255.965
	500	0.189	0.788	2.062	0.003	0.072	255.965
	750	0.192	0.788	2.110	0.003	0.073	255.965
Sweepers/Scrubbers	15	0.401	2.362	2.820	0.006	0.109	386.791
	25	0.467	1.593	2.961	0.005	0.119	386.791
	50	1.442	4.338	3.887	0.005	0.367	386.791
	120	0.628	2.676	3.854	0.005	0.360	386.791
	175	0.433	2.225	3.367	0.004	0.197	386.791
	250	0.285	0.820	3.077	0.004	0.095	386.791
Tractors/Loaders/Backhoes	25	0.392	1.305	2.465	0.004	0.121	312.846
	50	1.037	3.407	3.124	0.004	0.275	312.846
	120	0.460	2.151	2.970	0.004	0.261	312.846
	175	0.327	1.810	2.560	0.004	0.147	312.846
	250	0.230	0.684	2.334	0.004	0.076	312.846
	500	0.217	0.700	2.052	0.004	0.071	312.846
	750	0.218	0.700	2.118	0.004	0.072	312.846

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2012		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Trenchers	15	0.497	2.605	3.110	0.007	0.121	426.608
	25	0.516	1.757	3.264	0.005	0.130	426.608
	50	2.146	5.412	4.583	0.006	0.484	426.608
	120	0.890	3.111	5.428	0.005	0.466	426.608
	175	0.608	2.577	4.834	0.005	0.267	426.608
	250	0.475	1.420	4.565	0.005	0.182	426.608
	500	0.430	1.920	4.141	0.004	0.163	426.608
	750	0.433	1.918	4.215	0.004	0.164	426.608
Welders	15	0.454	1.745	2.702	0.004	0.184	255.965
	25	0.501	1.371	2.360	0.003	0.152	255.965
	50	1.036	2.786	2.590	0.003	0.253	255.965
	120	0.451	1.735	2.807	0.003	0.247	255.965
	175	0.304	1.424	2.497	0.003	0.137	255.965
	250	0.193	0.577	2.292	0.003	0.070	255.965
	500	0.174	0.617	2.041	0.003	0.065	255.965
Water Trucks	175	0.397	1.968	2.870	0.004	0.173	324.222
	250	0.286	0.768	2.631	0.004	0.090	324.222
	500	0.269	0.793	2.317	0.003	0.084	324.222
	750	0.271	0.793	2.389	0.003	0.085	324.222
	1000	0.301	0.928	3.321	0.003	0.100	324.222

2013		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Aerial Lifts	15	0.306	1.598	1.925	0.004	0.081	261.653
	25	0.394	1.197	2.231	0.003	0.121	261.653
	50	0.772	2.322	2.444	0.003	0.204	261.653
	120	0.376	1.662	2.555	0.003	0.202	261.653
	500	0.144	0.570	1.855	0.003	0.054	261.653
	750	0.149	0.570	1.913	0.003	0.055	261.653
Air Compressors	15	0.456	1.824	2.746	0.004	0.180	273.029
	25	0.497	1.397	2.459	0.003	0.151	273.029
	50	1.106	3.089	2.711	0.004	0.266	273.029
	120	0.472	1.884	2.872	0.003	0.261	273.029
	175	0.322	1.556	2.557	0.003	0.144	273.029
	250	0.207	0.611	2.325	0.003	0.071	273.029
	500	0.189	0.631	2.051	0.003	0.066	273.029
	750	0.192	0.631	2.117	0.003	0.067	273.029
	1000	0.232	0.788	2.827	0.003	0.082	273.029
Bore/Drill Rigs	15	0.497	2.605	3.110	0.007	0.121	426.608
	25	0.516	1.757	3.271	0.005	0.131	426.608
	50	0.397	3.136	3.530	0.006	0.165	426.608
	120	0.247	2.599	2.535	0.005	0.142	426.608
	175	0.213	2.279	2.096	0.005	0.091	426.608
	250	0.180	0.778	1.731	0.005	0.050	426.608
	500	0.177	0.756	1.606	0.004	0.049	426.608
	750	0.178	0.756	1.622	0.004	0.050	426.608
	1000	0.191	0.766	2.739	0.004	0.071	426.608
Cement and Mortar Mixers	15	0.375	1.945	2.367	0.005	0.108	318.534
	25	0.491	1.474	2.739	0.004	0.151	318.534
Concrete/Industrial Saws	25	0.501	1.710	3.168	0.005	0.123	415.232
	50	1.313	4.011	3.929	0.005	0.339	415.232
	120	0.596	2.708	4.006	0.005	0.330	415.232
	175	0.407	2.255	3.528	0.005	0.183	415.232
Cranes	50	1.071	3.050	2.526	0.003	0.252	244.589
	120	0.448	1.765	2.687	0.003	0.240	244.589
	175	0.314	1.468	2.365	0.003	0.136	244.589
	250	0.227	0.643	2.169	0.003	0.077	244.589
	500	0.211	0.719	1.933	0.002	0.070	244.589
	750	0.212	0.718	1.983	0.002	0.071	244.589
	9999	0.239	0.839	2.611	0.002	0.080	244.589
Crawler Tractors	50	1.720	4.750	3.844	0.005	0.395	364.039
	120	0.715	2.687	4.252	0.004	0.375	364.039
	175	0.503	2.237	3.764	0.004	0.214	364.039
	250	0.387	1.096	3.494	0.004	0.134	364.039
	500	0.357	1.335	3.144	0.004	0.122	364.039
	750	0.358	1.333	3.210	0.004	0.123	364.039
	1000	0.382	1.495	4.077	0.004	0.131	364.039
Crushing/Proc. Equipment	50	1.755	5.049	4.394	0.006	0.426	443.672
	120	0.748	3.076	4.564	0.005	0.416	443.672
	175	0.515	2.551	4.042	0.005	0.229	443.672

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2013		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	250	0.335	0.984	3.666	0.005	0.113	443.672
	500	0.310	1.007	3.218	0.004	0.105	443.672
	750	0.312	0.995	3.346	0.004	0.107	443.672
	9999	0.382	1.249	4.517	0.004	0.132	443.672
Dumpers/Tenders	25	0.274	0.907	1.703	0.003	0.082	216.148
Excavators	25	0.391	1.335	2.472	0.004	0.093	324.222
	50	1.057	3.681	3.186	0.004	0.275	324.222
	120	0.478	2.280	2.991	0.004	0.258	324.222
	175	0.349	1.927	2.581	0.004	0.148	324.222
	250	0.254	0.724	2.321	0.004	0.076	324.222
	500	0.241	0.731	2.048	0.003	0.072	324.222
	750	0.242	0.731	2.112	0.003	0.073	324.222
Forklifts	50	0.510	1.878	1.660	0.002	0.139	170.643
	120	0.237	1.187	1.513	0.002	0.130	170.643
	175	0.173	1.006	1.287	0.002	0.074	170.643
	250	0.125	0.356	1.158	0.002	0.037	170.643
	500	0.119	0.339	1.004	0.002	0.035	170.643
Generator Sets	15	0.610	2.812	4.160	0.007	0.236	420.920
	25	0.631	2.154	3.791	0.005	0.215	420.920
	50	1.175	3.596	3.898	0.005	0.317	420.920
	120	0.587	2.642	4.058	0.005	0.314	420.920
	175	0.393	2.187	3.610	0.005	0.173	420.920
	250	0.249	0.860	3.280	0.005	0.091	420.920
	500	0.224	0.897	2.955	0.004	0.085	420.920
	750	0.232	0.897	3.046	0.004	0.087	420.920
	9999	0.315	1.113	4.070	0.004	0.113	420.920
Graders	50	1.361	4.111	3.493	0.004	0.330	346.974
	120	0.580	2.458	3.577	0.004	0.313	346.974
	175	0.411	2.057	3.134	0.004	0.177	346.974
	250	0.301	0.873	2.860	0.004	0.100	346.974
	500	0.281	0.951	2.547	0.003	0.092	346.974
	750	0.282	0.950	2.614	0.003	0.093	346.974
Off-Highway Tractors	120	0.834	2.836	4.878	0.004	0.425	369.727
	175	0.580	2.363	4.348	0.004	0.247	369.727
	250	0.465	1.330	4.097	0.004	0.170	369.727
	750	0.426	1.881	3.780	0.004	0.153	369.727
	1000	0.446	2.049	4.566	0.004	0.156	369.727
Off-Highway Trucks	175	0.374	1.965	2.671	0.004	0.156	324.222
	250	0.272	0.747	2.409	0.004	0.080	324.222
	500	0.258	0.757	2.127	0.003	0.075	324.222
	750	0.260	0.757	2.192	0.003	0.077	324.222
	1000	0.285	0.867	3.102	0.003	0.093	324.222
Other Construction Equipment	15	0.411	2.153	2.571	0.005	0.100	352.663
	25	0.427	1.452	2.704	0.004	0.108	352.663
	50	0.949	3.343	3.258	0.005	0.258	352.663
	120	0.439	2.302	3.064	0.004	0.247	352.663
	175	0.310	1.944	2.652	0.004	0.139	352.663
	500	0.201	0.726	2.107	0.003	0.068	352.663

2013		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Other General Industrial Equipment	15	0.301	1.771	2.115	0.005	0.083	290.093
	25	0.350	1.194	2.211	0.004	0.083	290.093
	50	1.282	3.619	2.979	0.004	0.306	290.093
	120	0.541	2.091	3.140	0.003	0.297	290.093
	175	0.375	1.729	2.787	0.003	0.164	290.093
	250	0.248	0.675	2.534	0.003	0.080	290.093
	500	0.231	0.692	2.224	0.003	0.075	290.093
	750	0.233	0.692	2.298	0.003	0.076	290.093
	1000	0.268	0.859	3.082	0.003	0.092	290.093
Other Material Handling Equipment	50	1.476	4.151	3.435	0.004	0.352	335.598
	120	0.622	2.409	3.626	0.004	0.342	335.598
	175	0.431	1.991	3.219	0.004	0.188	335.598
	250	0.284	0.778	2.927	0.004	0.092	335.598
	500	0.263	0.798	2.569	0.003	0.086	335.598
	9999	0.314	0.991	3.558	0.003	0.106	335.598
Pavers	25	0.466	1.510	2.836	0.004	0.142	352.663
	50	1.721	4.526	3.714	0.005	0.388	352.663
	120	0.707	2.577	4.259	0.004	0.372	352.663
	175	0.489	2.140	3.785	0.004	0.211	352.663
	250	0.376	1.103	3.532	0.004	0.137	352.663
	500	0.344	1.399	3.187	0.003	0.124	352.663
Paving Equipment	25	0.365	1.241	2.311	0.004	0.093	301.470
	50	1.470	3.841	3.168	0.004	0.331	301.470
	120	0.602	2.190	3.629	0.004	0.317	301.470
	175	0.414	1.814	3.228	0.003	0.180	301.470
	250	0.315	0.928	3.009	0.003	0.115	301.470
Plate Compactors	15	0.285	1.493	1.783	0.004	0.070	244.589
Pressure Washers	15	0.247	1.140	1.686	0.003	0.096	170.643
	25	0.256	0.873	1.537	0.002	0.087	170.643
	50	0.369	1.229	1.527	0.002	0.110	170.643
	120	0.211	1.021	1.569	0.002	0.110	170.643
Pumps	15	0.702	2.812	4.234	0.007	0.277	420.920
	25	0.766	2.154	3.791	0.005	0.233	420.920
	50	1.264	3.786	3.943	0.005	0.332	420.920
	120	0.610	2.684	4.120	0.005	0.328	420.920
	175	0.409	2.221	3.666	0.005	0.181	420.920
	250	0.261	0.875	3.332	0.005	0.094	420.920
	500	0.235	0.919	2.991	0.004	0.088	420.920
	750	0.242	0.919	3.084	0.004	0.090	420.920
	9999	0.323	1.139	4.117	0.004	0.115	420.920
Rollers	15	0.371	1.945	2.322	0.005	0.090	318.534
	25	0.385	1.312	2.442	0.004	0.098	318.534
	50	1.256	3.569	3.166	0.004	0.300	318.534
	120	0.533	2.194	3.377	0.004	0.288	318.534
	175	0.367	1.826	2.979	0.004	0.162	318.534
	250	0.263	0.809	2.731	0.004	0.094	318.534
	500	0.240	0.918	2.445	0.003	0.086	318.534
Rough Terrain Forklifts	50	1.191	3.808	3.343	0.004	0.303	341.286

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2013		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	120	0.522	2.364	3.276	0.004	0.289	341.286
	175	0.369	1.983	2.855	0.004	0.162	341.286
	250	0.259	0.759	2.589	0.004	0.083	341.286
	500	0.243	0.760	2.274	0.003	0.078	341.286
Rubber Tired Dozers	175	0.549	2.192	4.033	0.004	0.231	335.598
	250	0.445	1.250	3.807	0.004	0.161	335.598
	500	0.407	1.803	3.460	0.003	0.144	335.598
	750	0.408	1.800	3.515	0.003	0.145	335.598
	1000	0.426	1.952	4.225	0.003	0.147	335.598
Rubber Tired Loaders	25	0.371	1.265	2.343	0.004	0.091	307.158
	50	1.183	3.591	3.075	0.004	0.288	307.158
	120	0.506	2.165	3.136	0.004	0.274	307.158
	175	0.358	1.813	2.745	0.003	0.155	307.158
	250	0.259	0.760	2.500	0.003	0.086	307.158
	500	0.242	0.829	2.224	0.003	0.079	307.158
	750	0.243	0.829	2.284	0.003	0.081	307.158
	1000	0.268	0.953	3.084	0.003	0.093	307.158
Scrapers	120	0.819	3.028	4.859	0.005	0.429	409.544
	175	0.573	2.519	4.305	0.005	0.244	409.544
	250	0.440	1.253	4.005	0.005	0.155	409.544
	500	0.406	1.543	3.604	0.004	0.140	409.544
	750	0.408	1.542	3.679	0.004	0.141	409.544
Signal Boards	15	0.543	2.848	3.400	0.007	0.133	466.425
	50	1.412	4.237	4.187	0.006	0.363	443.672
	120	0.650	2.884	4.319	0.005	0.356	443.672
	175	0.441	2.394	3.828	0.005	0.197	443.672
	250	0.343	1.123	4.192	0.006	0.122	536.104
Skid Steer Loaders	25	0.457	1.407	2.643	0.004	0.143	312.846
	50	0.634	2.774	2.794	0.004	0.192	312.846
	120	0.314	2.010	2.390	0.004	0.179	312.846
Surfacing Equipment	50	0.865	2.546	2.466	0.003	0.215	255.965
	120	0.389	1.692	2.619	0.003	0.207	255.965
	175	0.267	1.411	2.310	0.003	0.117	255.965
	250	0.195	0.640	2.121	0.003	0.071	255.965
	500	0.177	0.743	1.921	0.003	0.066	255.965
	750	0.180	0.742	1.966	0.003	0.066	255.965
Sweepers/Scrubbers	15	0.401	2.362	2.820	0.006	0.110	386.791
	25	0.467	1.593	2.951	0.005	0.115	386.791
	50	1.265	4.170	3.735	0.005	0.328	386.791
	120	0.564	2.647	3.575	0.005	0.317	386.791
	175	0.396	2.223	3.090	0.004	0.175	386.791
	250	0.271	0.805	2.784	0.004	0.085	386.791
Tractors/Loaders/Backhoes	25	0.385	1.295	2.439	0.004	0.111	312.846
	50	0.921	3.298	2.983	0.004	0.246	312.846
	120	0.420	2.134	2.761	0.004	0.232	312.846
	175	0.305	1.809	2.375	0.004	0.132	312.846
	250	0.219	0.668	2.124	0.004	0.067	312.846
	500	0.208	0.675	1.874	0.004	0.064	312.846
	750	0.209	0.675	1.933	0.004	0.065	312.846

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2013		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Trenchers	15	0.497	2.605	3.110	0.007	0.121	426.608
	25	0.515	1.757	3.255	0.005	0.126	426.608
	50	2.030	5.291	4.448	0.006	0.458	426.608
	120	0.842	3.079	5.169	0.005	0.440	426.608
	175	0.580	2.559	4.601	0.005	0.252	426.608
	250	0.450	1.357	4.304	0.005	0.168	426.608
	500	0.409	1.783	3.901	0.004	0.151	426.608
	750	0.412	1.781	3.973	0.004	0.153	426.608
Welders	15	0.427	1.710	2.575	0.004	0.168	255.965
	25	0.466	1.310	2.305	0.003	0.142	255.965
	50	0.946	2.688	2.489	0.003	0.233	255.965
	120	0.417	1.717	2.629	0.003	0.229	255.965
	175	0.282	1.419	2.340	0.003	0.126	255.965
	250	0.181	0.559	2.128	0.003	0.064	255.965
	500	0.164	0.582	1.888	0.003	0.059	255.965
Water Trucks	175	0.374	1.965	2.671	0.004	0.156	324.222
	250	0.272	0.747	2.409	0.004	0.080	324.222
	500	0.258	0.757	2.127	0.003	0.075	324.222
	750	0.260	0.757	2.192	0.003	0.077	324.222
	1000	0.285	0.867	3.102	0.003	0.093	324.222

2014		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Aerial Lifts	15	0.305	1.598	1.914	0.004	0.078	261.653
	25	0.380	1.176	2.189	0.003	0.115	261.653
	50	0.696	2.239	2.344	0.003	0.186	261.653
	120	0.343	1.645	2.400	0.003	0.184	261.653
	500	0.134	0.542	1.675	0.003	0.049	261.653
	750	0.138	0.542	1.732	0.003	0.050	261.653
Air Compressors	15	0.429	1.789	2.616	0.004	0.164	273.029
	25	0.462	1.336	2.402	0.003	0.140	273.029
	50	0.998	2.970	2.605	0.004	0.243	273.029
	120	0.433	1.864	2.695	0.003	0.238	273.029
	175	0.299	1.551	2.389	0.003	0.131	273.029
	250	0.195	0.594	2.114	0.003	0.065	273.029
	500	0.180	0.600	1.852	0.003	0.060	273.029
	750	0.182	0.600	1.918	0.003	0.062	273.029
	1000	0.214	0.718	2.649	0.003	0.076	273.029
Bore/Drill Rigs	15	0.497	2.605	3.110	0.007	0.121	426.608
	25	0.515	1.757	3.259	0.005	0.127	426.608
	50	0.351	3.097	3.290	0.006	0.131	426.608
	120	0.226	2.591	2.353	0.005	0.113	426.608
	175	0.203	2.280	1.974	0.005	0.074	426.608
	250	0.167	0.777	1.393	0.005	0.041	426.608
	500	0.165	0.755	1.304	0.004	0.040	426.608
	750	0.166	0.755	1.316	0.004	0.040	426.608
	1000	0.179	0.763	2.487	0.004	0.065	426.608
Cement and Mortar Mixers	15	0.373	1.945	2.349	0.005	0.099	318.534
	25	0.470	1.441	2.687	0.004	0.142	318.534
Concrete/Industrial Saws	25	0.501	1.710	3.165	0.005	0.120	415.232
	50	1.188	3.883	3.780	0.005	0.310	415.232
	120	0.548	2.686	3.771	0.005	0.301	415.232
	175	0.378	2.251	3.311	0.005	0.167	415.232
Cranes	50	0.983	2.963	2.440	0.003	0.233	244.589
	120	0.419	1.750	2.531	0.003	0.221	244.589
	175	0.297	1.463	2.224	0.003	0.125	244.589
	250	0.214	0.614	1.982	0.003	0.069	244.589
	500	0.199	0.672	1.763	0.002	0.064	244.589
	750	0.200	0.672	1.811	0.002	0.065	244.588
	9999	0.230	0.782	2.470	0.002	0.076	244.589
Crawler Tractors	50	1.601	4.630	3.723	0.005	0.367	364.039
	120	0.673	2.663	4.027	0.004	0.347	364.039
	175	0.479	2.227	3.562	0.004	0.199	364.039
	250	0.366	1.051	3.222	0.004	0.123	364.039
	500	0.340	1.248	2.898	0.004	0.112	364.039
	750	0.341	1.247	2.960	0.004	0.113	364.039
	1000	0.365	1.396	3.873	0.004	0.123	364.039
Crushing/Proc. Equipment	50	1.571	4.850	4.215	0.006	0.386	443.672
	120	0.685	3.043	4.269	0.005	0.376	443.672
	175	0.478	2.542	3.766	0.005	0.207	443.672

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2014		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	250	0.316	0.959	3.310	0.005	0.102	443.672
	500	0.295	0.961	2.890	0.004	0.095	443.672
	750	0.296	0.952	3.001	0.004	0.097	443.672
	9999	0.356	1.140	4.209	0.004	0.121	443.672
Dumpers/Tenders	25	0.268	0.899	1.686	0.003	0.076	216.148
Excavators	25	0.391	1.335	2.472	0.004	0.092	324.222
	50	0.943	3.573	3.051	0.004	0.245	324.222
	120	0.439	2.262	2.788	0.004	0.228	324.222
	175	0.328	1.924	2.405	0.004	0.132	324.222
	250	0.241	0.711	2.064	0.004	0.068	324.222
	500	0.230	0.708	1.821	0.003	0.064	324.222
	750	0.231	0.708	1.878	0.003	0.065	324.222
Forklifts	50	0.436	1.815	1.595	0.002	0.122	170.643
	120	0.211	1.177	1.395	0.002	0.111	170.643
	175	0.158	1.007	1.173	0.002	0.064	170.643
	250	0.119	0.352	1.008	0.002	0.033	170.643
	500	0.115	0.335	0.889	0.002	0.031	170.643
Generator Sets	15	0.581	2.758	3.977	0.007	0.221	420.920
	25	0.608	2.059	3.704	0.005	0.202	420.920
	50	1.057	3.469	3.739	0.005	0.289	420.920
	120	0.535	2.616	3.813	0.005	0.286	420.920
	175	0.360	2.181	3.382	0.005	0.157	420.920
	250	0.231	0.837	2.981	0.005	0.082	420.920
	500	0.207	0.857	2.669	0.004	0.077	420.920
	750	0.214	0.857	2.758	0.004	0.079	420.920
	9999	0.288	1.020	3.815	0.004	0.103	420.920
Graders	50	1.241	3.992	3.362	0.004	0.301	346.974
	120	0.540	2.438	3.365	0.004	0.284	346.974
	175	0.368	2.053	2.943	0.004	0.162	346.974
	250	0.284	0.842	2.590	0.004	0.090	346.974
	500	0.266	0.906	2.305	0.003	0.083	346.974
	750	0.267	0.906	2.367	0.003	0.084	346.974
Off-Highway Tractors	120	0.792	2.808	4.654	0.004	0.400	369.727
	175	0.556	2.345	4.146	0.004	0.233	369.727
	250	0.443	1.275	3.835	0.004	0.159	369.727
	750	0.407	1.756	3.538	0.004	0.143	369.727
	1000	0.428	1.915	4.368	0.004	0.148	369.727
Off-Highway Trucks	175	0.351	1.962	2.492	0.004	0.140	324.222
	250	0.258	0.732	2.151	0.004	0.072	324.222
	500	0.246	0.730	1.898	0.003	0.068	324.222
	750	0.247	0.730	1.958	0.003	0.069	324.222
	1000	0.269	0.814	2.897	0.003	0.086	324.222
Other Construction Equipment	15	0.411	2.153	2.571	0.005	0.100	352.663
	25	0.426	1.452	2.694	0.004	0.105	352.662
	50	0.844	3.242	3.114	0.005	0.230	352.663
	120	0.399	2.284	2.866	0.004	0.219	352.663
	175	0.288	1.943	2.475	0.004	0.124	352.663
	500	0.191	0.705	1.867	0.003	0.061	352.663

2014		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Other General Industrial Equipment	15	0.301	1.771	2.115	0.005	0.083	290.093
	25	0.350	1.194	2.211	0.004	0.082	290.093
	50	1.147	3.472	2.863	0.004	0.277	290.093
	120	0.497	2.067	2.936	0.003	0.268	290.093
	175	0.350	1.722	2.596	0.003	0.148	290.093
	250	0.235	0.657	2.297	0.003	0.073	290.093
	500	0.220	0.658	2.006	0.003	0.068	290.093
	750	0.221	0.658	2.077	0.003	0.069	290.093
	1000	0.250	0.783	2.882	0.003	0.085	290.093
Other Material Handling Equipment	50	1.320	3.982	3.301	0.004	0.319	335.598
	120	0.572	2.382	3.391	0.004	0.309	335.598
	175	0.401	1.983	2.999	0.004	0.171	335.598
	250	0.268	0.757	2.654	0.004	0.084	335.598
	500	0.251	0.759	2.317	0.003	0.078	335.598
	9999	0.296	0.904	3.328	0.003	0.098	335.598
Pavers	25	0.452	1.490	2.782	0.004	0.133	352.663
	50	1.614	4.417	3.604	0.005	0.365	352.663
	120	0.668	2.554	4.051	0.004	0.348	352.663
	175	0.466	2.128	3.596	0.004	0.198	352.663
	250	0.356	1.056	3.280	0.004	0.126	352.663
	500	0.327	1.307	2.956	0.003	0.114	352.663
Paving Equipment	25	0.364	1.241	2.303	0.004	0.090	301.470
	50	1.379	3.747	3.074	0.004	0.311	301.470
	120	0.569	2.170	3.453	0.004	0.298	301.470
	175	0.395	1.805	3.066	0.003	0.169	301.470
	250	0.298	0.886	2.794	0.003	0.106	301.470
Plate Compactors	15	0.285	1.493	1.783	0.004	0.069	244.589
Pressure Washers	15	0.235	1.118	1.612	0.003	0.090	170.643
	25	0.247	0.835	1.502	0.002	0.082	170.643
	50	0.329	1.187	1.463	0.002	0.100	170.643
	120	0.191	1.011	1.475	0.002	0.100	170.643
Pumps	15	0.661	2.758	4.034	0.007	0.253	420.920
	25	0.712	2.059	3.704	0.005	0.216	420.920
	50	1.139	3.651	3.783	0.005	0.303	420.920
	120	0.556	2.657	3.871	0.005	0.299	420.920
	175	0.376	2.215	3.434	0.005	0.165	420.920
	250	0.242	0.852	3.030	0.005	0.086	420.920
	500	0.218	0.875	2.702	0.004	0.080	420.920
	750	0.225	0.875	2.793	0.004	0.082	420.920
	9999	0.296	1.042	3.859	0.004	0.105	420.920
Rollers	15	0.371	1.945	2.322	0.005	0.090	318.534
	25	0.385	1.312	2.434	0.004	0.095	318.534
	50	1.161	3.471	3.055	0.004	0.278	318.534
	120	0.497	2.176	3.189	0.004	0.267	318.534
	175	0.347	1.821	2.809	0.004	0.150	318.534
	250	0.246	0.773	2.497	0.004	0.085	318.534
	500	0.226	0.861	2.230	0.003	0.078	318.534
Rough Terrain Forklifts	50	1.063	3.684	3.210	0.004	0.273	341.286

2014		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	120	0.479	2.345	3.067	0.004	0.259	341.286
	175	0.346	1.980	2.664	0.004	0.146	341.286
	250	0.246	0.743	2.325	0.004	0.075	341.286
	500	0.232	0.732	2.037	0.003	0.070	341.286
Rubber Tired Dozers	175	0.527	2.175	3.850	0.004	0.218	335.598
	250	0.425	1.200	3.570	0.004	0.150	335.598
	500	0.389	1.686	3.243	0.003	0.134	335.598
	750	0.390	1.684	3.296	0.003	0.135	335.598
	1000	0.408	1.828	4.045	0.003	0.140	335.598
Rubber Tired Loaders	25	0.371	1.265	2.342	0.004	0.089	307.158
	50	1.077	3.486	2.958	0.004	0.263	307.158
	120	0.470	2.148	2.948	0.004	0.249	307.158
	175	0.338	1.809	2.576	0.003	0.141	307.158
	250	0.245	0.733	2.261	0.003	0.077	307.158
	500	0.229	0.789	2.010	0.003	0.072	307.158
	750	0.231	0.788	2.066	0.003	0.073	307.158
	1000	0.255	0.899	2.905	0.003	0.087	307.158
Scrapers	120	0.772	3.002	4.611	0.005	0.398	409.544
	175	0.546	2.507	4.080	0.005	0.228	409.544
	250	0.417	1.201	3.703	0.005	0.142	409.544
	500	0.386	1.447	3.331	0.004	0.129	409.544
	750	0.388	1.446	3.401	0.004	0.130	409.544
Signal Boards	15	0.543	2.848	3.400	0.007	0.133	466.425
	50	1.269	4.084	4.013	0.006	0.330	443.672
	120	0.593	2.856	4.049	0.005	0.323	443.672
	175	0.406	2.388	3.578	0.005	0.178	443.672
	250	0.319	1.095	3.792	0.006	0.110	536.104
Skid Steer Loaders	25	0.442	1.384	2.596	0.004	0.135	312.846
	50	0.543	2.693	2.649	0.004	0.165	312.846
	120	0.278	1.995	2.209	0.004	0.150	312.846
Surfacing Equipment	50	0.801	2.481	2.377	0.003	0.199	255.965
	120	0.363	1.679	2.478	0.003	0.192	255.965
	175	0.251	1.407	2.184	0.003	0.108	255.965
	250	0.181	0.614	1.941	0.003	0.065	255.965
	500	0.166	0.702	1.754	0.003	0.060	255.965
	750	0.168	0.702	1.797	0.003	0.060	255.965
Sweepers/Scrubbers	15	0.401	2.362	2.820	0.006	0.110	386.791
	25	0.467	1.593	2.949	0.005	0.112	386.791
	50	1.098	4.018	3.591	0.005	0.291	386.791
	120	0.504	2.622	3.314	0.005	0.276	386.791
	175	0.362	2.222	2.835	0.004	0.154	386.791
	250	0.257	0.792	2.455	0.004	0.076	386.791
Tractors/Loaders/Backhoes	25	0.381	1.290	2.421	0.004	0.103	312.846
	50	0.817	3.200	2.851	0.004	0.218	312.846
	120	0.384	2.119	2.572	0.004	0.204	312.846
	175	0.285	1.807	2.210	0.004	0.117	312.846
	250	0.208	0.657	1.875	0.004	0.060	312.846
	500	0.198	0.657	1.656	0.004	0.057	312.846
	750	0.200	0.657	1.708	0.004	0.058	312.846

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2014		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Trenchers	15	0.497	2.605	3.110	0.007	0.122	426.608
	25	0.515	1.757	3.252	0.005	0.124	426.608
	50	1.915	5.172	4.318	0.006	0.431	426.608
	120	0.797	3.050	4.923	0.005	0.413	426.608
	175	0.553	2.543	4.380	0.005	0.237	426.608
	250	0.426	1.299	4.007	0.005	0.156	426.608
	500	0.389	1.661	3.627	0.004	0.140	426.608
	750	0.391	1.660	3.696	0.004	0.142	426.608
Welders	15	0.402	1.677	2.453	0.004	0.154	255.965
	25	0.433	1.252	2.252	0.003	0.131	255.965
	50	0.856	2.590	2.391	0.003	0.213	255.965
	120	0.382	1.700	2.469	0.003	0.209	255.965
	175	0.262	1.415	2.190	0.003	0.115	255.965
	250	0.170	0.544	1.936	0.003	0.058	255.965
	500	0.155	0.553	1.706	0.003	0.054	255.965
Water Trucks	175	0.351	1.962	2.492	0.004	0.140	324.222
	250	0.258	0.732	2.151	0.004	0.072	324.222
	500	0.246	0.730	1.898	0.003	0.068	324.222
	750	0.247	0.730	1.958	0.003	0.069	324.222
	1000	0.269	0.814	2.897	0.003	0.086	324.222

2015		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Aerial Lifts	15	0.305	1.598	1.909	0.004	0.077	261.653
	25	0.368	1.157	2.150	0.003	0.108	261.653
	50	0.626	2.169	2.256	0.003	0.169	261.653
	120	0.310	1.630	2.223	0.003	0.166	261.653
	500	0.124	0.520	1.502	0.003	0.044	261.653
	750	0.128	0.520	1.556	0.003	0.045	261.653
Air Compressors	15	0.404	1.757	2.497	0.004	0.150	273.029
	25	0.430	1.281	2.349	0.003	0.130	273.029
	50	0.898	2.868	2.510	0.004	0.221	273.029
	120	0.395	1.845	2.493	0.003	0.214	273.029
	175	0.274	1.546	2.164	0.003	0.118	273.029
	250	0.183	0.580	1.906	0.003	0.059	273.029
	500	0.170	0.576	1.660	0.003	0.054	273.029
	750	0.172	0.576	1.723	0.003	0.056	273.029
	1000	0.197	0.658	2.478	0.003	0.069	273.029
Bore/Drill Rigs	15	0.497	2.605	3.110	0.007	0.121	426.608
	25	0.515	1.757	3.254	0.005	0.125	426.608
	50	0.322	3.072	3.079	0.006	0.103	426.608
	120	0.208	2.587	2.067	0.005	0.089	426.608
	175	0.187	2.280	1.622	0.005	0.060	426.608
	250	0.154	0.777	1.111	0.005	0.033	426.608
	500	0.153	0.755	1.054	0.004	0.032	426.608
	750	0.153	0.755	1.061	0.004	0.032	426.608
	1000	0.164	0.760	2.285	0.004	0.055	426.608
Cement and Mortar Mixers	15	0.372	1.945	2.336	0.005	0.096	318.534
	25	0.455	1.419	2.641	0.004	0.135	318.534
Concrete/Industrial Saws	25	0.501	1.710	3.165	0.005	0.119	415.232
	50	1.075	3.774	3.646	0.005	0.283	415.232
	120	0.500	2.665	3.499	0.005	0.272	415.232
	175	0.347	2.248	3.005	0.005	0.152	415.232
Cranes	50	0.900	2.879	2.357	0.003	0.214	244.589
	120	0.390	1.736	2.352	0.003	0.202	244.589
	175	0.280	1.459	2.035	0.003	0.115	244.589
	250	0.202	0.592	1.807	0.003	0.062	244.589
	500	0.189	0.633	1.604	0.002	0.058	244.589
	750	0.190	0.633	1.650	0.002	0.059	244.589
	9999	0.219	0.730	2.335	0.002	0.070	244.589
Crawler Tractors	50	1.488	4.517	3.605	0.005	0.340	364.039
	120	0.632	2.641	3.770	0.004	0.320	364.039
	175	0.453	2.218	3.290	0.004	0.184	364.039
	250	0.347	1.011	2.965	0.004	0.113	364.039
	500	0.323	1.173	2.666	0.004	0.103	364.039
	750	0.324	1.172	2.725	0.004	0.104	364.039
	1000	0.347	1.310	3.680	0.004	0.115	364.039
Crushing/Proc. Equipment	50	1.403	4.682	4.056	0.006	0.349	443.672
	120	0.623	3.013	3.935	0.005	0.336	443.672
	175	0.439	2.536	3.391	0.005	0.186	443.672

2015		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	250	0.299	0.938	2.968	0.005	0.092	443.672
	500	0.280	0.925	2.579	0.004	0.086	443.672
	750	0.280	0.918	2.672	0.004	0.087	443.672
	9999	0.330	1.049	3.919	0.004	0.109	443.672
Dumpers/Tenders	25	0.265	0.894	1.675	0.003	0.071	216.148
Excavators	25	0.391	1.335	2.472	0.004	0.092	324.222
	50	0.842	3.478	2.924	0.004	0.217	324.222
	120	0.402	2.247	2.549	0.004	0.200	324.222
	175	0.304	1.922	2.141	0.004	0.117	324.222
	250	0.228	0.701	1.826	0.004	0.061	324.222
	500	0.219	0.689	1.612	0.003	0.057	324.222
	750	0.220	0.689	1.663	0.003	0.058	324.222
Forklifts	50	0.371	1.761	1.534	0.002	0.105	170.643
	120	0.186	1.169	1.261	0.002	0.094	170.643
	175	0.146	1.008	1.038	0.002	0.057	170.643
	250	0.114	0.349	0.882	0.002	0.029	170.643
	500	0.110	0.332	0.785	0.002	0.028	170.643
Generator Sets	15	0.554	2.709	3.808	0.007	0.208	420.920
	25	0.588	1.975	3.622	0.005	0.190	420.920
	50	0.950	3.362	3.598	0.005	0.262	420.920
	120	0.482	2.592	3.532	0.005	0.257	420.920
	175	0.326	2.177	3.065	0.005	0.142	420.920
	250	0.213	0.818	2.691	0.005	0.074	420.920
	500	0.192	0.825	2.394	0.004	0.070	420.920
	750	0.198	0.825	2.479	0.004	0.071	420.920
	9999	0.261	0.941	3.572	0.004	0.092	420.920
Graders	50	1.131	3.883	3.237	0.004	0.273	346.974
	120	0.501	2.421	3.113	0.004	0.257	346.974
	175	0.364	2.049	2.670	0.004	0.147	346.974
	250	0.267	0.816	2.338	0.004	0.081	346.974
	500	0.252	0.868	2.081	0.003	0.075	346.974
	750	0.253	0.867	2.138	0.003	0.076	346.974
Off-Highway Tractors	120	0.751	2.781	4.402	0.004	0.376	369.727
	175	0.530	2.329	3.885	0.004	0.219	369.727
	250	0.422	1.225	3.585	0.004	0.147	369.727
	750	0.389	1.642	3.307	0.004	0.133	369.727
	1000	0.409	1.793	4.180	0.004	0.139	369.727
Off-Highway Trucks	175	0.326	1.959	2.228	0.004	0.124	324.222
	250	0.244	0.721	1.911	0.004	0.064	324.222
	500	0.233	0.708	1.686	0.003	0.060	324.222
	750	0.235	0.708	1.740	0.003	0.061	324.222
	1000	0.253	0.769	2.707	0.003	0.078	324.222
Other Construction Equipment	15	0.411	2.153	2.571	0.005	0.100	352.663
	25	0.426	1.452	2.690	0.004	0.103	352.663
	50	0.752	3.158	2.985	0.005	0.205	352.663
	120	0.361	2.269	2.622	0.004	0.193	352.663
	175	0.264	1.941	2.197	0.004	0.110	352.663
	500	0.182	0.688	1.646	0.003	0.055	352.663

2015		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Other General Industrial Equipment	15	0.301	1.771	2.115	0.005	0.083	290.093
	25	0.350	1.194	2.211	0.004	0.082	290.093
	50	1.026	3.350	2.759	0.004	0.250	290.093
	120	0.454	2.046	2.710	0.003	0.240	290.093
	175	0.323	1.717	2.346	0.003	0.133	290.093
	250	0.222	0.642	2.066	0.003	0.066	290.093
	500	0.209	0.631	1.796	0.003	0.061	290.093
	750	0.210	0.631	1.864	0.003	0.063	290.093
	1000	0.233	0.719	2.692	0.003	0.077	290.093
Other Material Handling Equipment	50	1.181	3.840	3.180	0.004	0.288	335.598
	120	0.521	2.356	3.130	0.004	0.276	335.598
	175	0.369	1.977	2.710	0.004	0.153	335.598
	250	0.254	0.739	2.387	0.004	0.076	335.598
	500	0.238	0.728	2.075	0.003	0.070	335.598
	9999	0.277	0.830	3.108	0.003	0.089	335.598
Pavers	25	0.442	1.474	2.755	0.004	0.124	352.663
	50	1.509	4.310	3.497	0.005	0.341	352.663
	120	0.630	2.532	3.811	0.004	0.324	352.663
	175	0.442	2.119	3.342	0.004	0.185	352.663
	250	0.337	1.013	3.039	0.004	0.116	352.663
	500	0.311	1.227	2.736	0.003	0.105	352.663
Paving Equipment	25	0.364	1.241	2.299	0.004	0.088	301.470
	50	1.289	3.655	2.982	0.004	0.292	301.470
	120	0.536	2.153	3.249	0.004	0.278	301.470
	175	0.374	1.798	2.850	0.003	0.158	301.470
	250	0.281	0.848	2.588	0.003	0.097	301.470
Plate Compactors	15	0.285	1.493	1.783	0.004	0.069	244.589
Pressure Washers	15	0.224	1.098	1.544	0.003	0.084	170.643
	25	0.238	0.801	1.468	0.002	0.077	170.643
	50	0.293	1.151	1.407	0.002	0.090	170.643
	120	0.170	1.002	1.367	0.002	0.089	170.643
Pumps	15	0.623	2.709	3.849	0.007	0.231	420.920
	25	0.662	1.975	3.622	0.005	0.200	420.920
	50	1.026	3.537	3.641	0.005	0.275	420.920
	120	0.503	2.632	3.587	0.005	0.270	420.920
	175	0.342	2.210	3.113	0.005	0.148	420.920
	250	0.224	0.832	2.735	0.005	0.077	420.920
	500	0.203	0.840	2.424	0.004	0.072	420.920
	750	0.209	0.840	2.511	0.004	0.074	420.920
	9999	0.269	0.958	3.614	0.004	0.094	420.920
Rollers	15	0.371	1.945	2.322	0.005	0.091	318.534
	25	0.384	1.312	2.430	0.004	0.093	318.534
	50	1.068	3.376	2.949	0.004	0.256	318.534
	120	0.463	2.160	2.969	0.004	0.245	318.534
	175	0.325	1.816	2.572	0.004	0.139	318.534
	250	0.230	0.744	2.278	0.004	0.077	318.534
	500	0.213	0.813	2.029	0.003	0.071	318.534
Rough Terrain Forklifts	50	0.950	3.580	3.090	0.004	0.245	341.286

2015		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	120	0.438	2.328	2.822	0.004	0.230	341.286
	175	0.320	1.978	2.390	0.004	0.130	341.286
	250	0.233	0.729	2.075	0.004	0.068	341.286
	500	0.222	0.710	1.815	0.003	0.063	341.286
Rubber Tired Dozers	175	0.503	2.160	3.615	0.004	0.205	335.598
	250	0.404	1.153	3.342	0.004	0.139	335.598
	500	0.371	1.578	3.035	0.003	0.125	335.598
	750	0.373	1.577	3.086	0.003	0.126	335.598
	1000	0.391	1.714	3.872	0.003	0.131	335.598
Rubber Tired Loaders	25	0.371	1.265	2.342	0.004	0.088	307.158
	50	0.979	3.390	2.848	0.004	0.238	307.158
	120	0.435	2.132	2.725	0.004	0.225	307.158
	175	0.316	1.806	2.334	0.003	0.128	307.158
	250	0.231	0.710	2.039	0.003	0.069	307.158
	500	0.217	0.754	1.812	0.003	0.065	307.158
	750	0.219	0.754	1.863	0.003	0.066	307.158
	1000	0.241	0.850	2.737	0.003	0.080	307.158
Scrapers	120	0.726	2.977	4.325	0.005	0.369	409.544
	175	0.517	2.497	3.777	0.005	0.212	409.544
	250	0.395	1.155	3.416	0.005	0.130	409.544
	500	0.367	1.362	3.071	0.004	0.118	409.544
	750	0.369	1.361	3.138	0.004	0.120	409.544
Signal Boards	15	0.543	2.848	3.400	0.007	0.133	466.425
	50	1.141	3.957	3.859	0.006	0.299	443.672
	120	0.537	2.830	3.741	0.005	0.290	443.672
	175	0.370	2.383	3.230	0.005	0.160	443.672
	250	0.297	1.071	3.408	0.006	0.099	536.104
Skid Steer Loaders	25	0.428	1.364	2.551	0.004	0.127	312.846
	50	0.464	2.621	2.516	0.004	0.139	312.846
	120	0.245	1.983	1.975	0.004	0.124	312.846
Surfacing Equipment	50	0.740	2.418	2.292	0.003	0.183	255.965
	120	0.337	1.666	2.311	0.003	0.176	255.965
	175	0.235	1.404	2.001	0.003	0.100	255.965
	250	0.169	0.591	1.772	0.003	0.059	255.965
	500	0.155	0.666	1.598	0.003	0.054	255.965
	750	0.158	0.666	1.638	0.003	0.055	255.965
Sweepers/Scrubbers	15	0.401	2.362	2.820	0.006	0.110	386.791
	25	0.467	1.593	2.949	0.005	0.111	386.791
	50	0.942	3.881	3.453	0.005	0.255	386.791
	120	0.447	2.601	3.011	0.005	0.237	386.791
	175	0.328	2.223	2.493	0.004	0.134	386.791
	250	0.243	0.782	2.143	0.004	0.068	386.791
Tractors/Loaders/Backhoes	25	0.379	1.288	2.408	0.004	0.097	312.846
	50	0.724	3.114	2.728	0.004	0.192	312.846
	120	0.349	2.105	2.341	0.004	0.177	312.846
	175	0.264	1.806	1.954	0.004	0.103	312.846
	250	0.197	0.650	1.648	0.004	0.053	312.846
	500	0.189	0.643	1.458	0.004	0.051	312.846
	750	0.190	0.643	1.503	0.004	0.052	312.846

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2015		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Trenchers	15	0.497	2.605	3.110	0.007	0.122	426.608
	25	0.515	1.757	3.252	0.005	0.122	426.608
	50	1.802	5.055	4.192	0.006	0.405	426.608
	120	0.752	3.024	4.641	0.005	0.388	426.608
	175	0.525	2.530	4.082	0.005	0.222	426.608
	250	0.403	1.246	3.724	0.005	0.144	426.608
	500	0.369	1.555	3.366	0.004	0.130	426.608
	750	0.371	1.554	3.432	0.004	0.131	426.608
Welders	15	0.379	1.648	2.341	0.004	0.140	255.965
	25	0.403	1.201	2.203	0.003	0.122	255.965
	50	0.773	2.505	2.303	0.003	0.194	255.965
	120	0.348	1.684	2.287	0.003	0.189	255.965
	175	0.240	1.412	1.986	0.003	0.104	255.965
	250	0.159	0.531	1.748	0.003	0.052	255.965
	500	0.146	0.530	1.531	0.003	0.049	255.965
Water Trucks	175	0.326	1.959	2.228	0.004	0.124	324.222
	250	0.244	0.721	1.911	0.004	0.064	324.222
	500	0.233	0.708	1.686	0.003	0.060	324.222
	750	0.235	0.708	1.740	0.003	0.061	324.222
	1000	0.253	0.769	2.707	0.003	0.078	324.222

2016		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Aerial Lifts	15	0.305	1.598	1.907	0.004	0.076	261.653
	25	0.357	1.141	2.114	0.003	0.102	261.653
	50	0.560	2.106	2.175	0.003	0.152	261.653
	120	0.278	1.615	2.053	0.003	0.148	261.653
	500	0.115	0.502	1.338	0.003	0.040	261.653
	750	0.119	0.502	1.389	0.003	0.041	261.653
Air Compressors	15	0.389	1.740	2.414	0.004	0.139	273.029
	25	0.411	1.251	2.308	0.003	0.123	273.029
	50	0.803	2.777	2.423	0.004	0.199	273.029
	120	0.358	1.828	2.302	0.003	0.191	273.029
	175	0.251	1.543	1.947	0.003	0.105	273.029
	250	0.173	0.568	1.707	0.003	0.053	273.029
	500	0.162	0.555	1.480	0.003	0.049	273.029
	750	0.163	0.555	1.538	0.003	0.050	273.029
	1000	0.184	0.622	2.332	0.003	0.063	273.029
Bore/Drill Rigs	15	0.497	2.605	3.110	0.007	0.122	426.608
	25	0.515	1.757	3.252	0.005	0.123	426.608
	50	0.303	3.056	2.895	0.006	0.080	426.608
	120	0.193	2.584	1.830	0.005	0.069	426.608
	175	0.171	2.280	1.323	0.005	0.047	426.608
	250	0.142	0.777	0.882	0.005	0.026	426.608
	500	0.142	0.755	0.857	0.004	0.026	426.608
	750	0.142	0.755	0.862	0.004	0.026	426.608
	1000	0.150	0.758	2.136	0.004	0.046	426.608
Cement and Mortar Mixers	15	0.371	1.945	2.328	0.005	0.094	318.534
	25	0.442	1.399	2.599	0.004	0.128	318.534
Concrete/Industrial Saws	25	0.501	1.710	3.165	0.005	0.118	415.232
	50	0.966	3.674	3.521	0.005	0.256	415.232
	120	0.453	2.646	3.239	0.005	0.244	415.232
	175	0.318	2.247	2.710	0.005	0.136	415.232
Cranes	50	0.821	2.801	2.278	0.003	0.195	244.589
	120	0.363	1.723	2.183	0.003	0.184	244.589
	175	0.263	1.456	1.857	0.003	0.105	244.589
	250	0.191	0.574	1.643	0.003	0.057	244.589
	500	0.180	0.602	1.456	0.002	0.053	244.589
	750	0.181	0.602	1.500	0.002	0.053	244.589
	9999	0.208	0.682	2.207	0.002	0.064	244.589
Crawler Tractors	50	1.382	4.411	3.492	0.005	0.314	364.039
	120	0.594	2.621	3.529	0.004	0.295	364.039
	175	0.429	2.211	3.033	0.004	0.170	364.039
	250	0.328	0.975	2.724	0.004	0.103	364.039
	500	0.307	1.110	2.449	0.004	0.094	364.039
	750	0.308	1.109	2.504	0.004	0.095	364.039
	1000	0.330	1.236	3.499	0.004	0.107	364.039
Crushing/Proc. Equipment	50	1.244	4.529	3.908	0.006	0.312	443.672
	120	0.562	2.985	3.615	0.005	0.296	443.672
	175	0.401	2.530	3.032	0.005	0.165	443.672

2016		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	250	0.282	0.920	2.640	0.005	0.082	443.672
	500	0.266	0.895	2.287	0.004	0.077	443.672
	750	0.265	0.891	2.359	0.004	0.078	443.672
	9999	0.310	0.995	3.670	0.004	0.100	443.672
Dumpers/Tenders	25	0.263	0.891	1.665	0.003	0.067	216.148
Excavators	25	0.391	1.335	2.472	0.004	0.092	324.222
	50	0.754	3.397	2.807	0.004	0.191	324.222
	120	0.367	2.233	2.331	0.004	0.174	324.222
	175	0.281	1.921	1.896	0.004	0.102	324.222
	250	0.215	0.692	1.607	0.004	0.054	324.222
	500	0.207	0.673	1.420	0.003	0.051	324.222
	750	0.208	0.673	1.464	0.003	0.052	324.222
Forklifts	50	0.325	1.724	1.478	0.002	0.091	170.643
	120	0.169	1.164	1.147	0.002	0.080	170.643
	175	0.137	1.010	0.919	0.002	0.050	170.643
	250	0.108	0.347	0.771	0.002	0.026	170.643
	500	0.106	0.330	0.688	0.002	0.025	170.643
Generator Sets	15	0.534	2.683	3.688	0.007	0.196	420.920
	25	0.573	1.929	3.558	0.005	0.181	420.920
	50	0.849	3.267	3.470	0.005	0.236	420.920
	120	0.432	2.570	3.267	0.005	0.230	420.920
	175	0.294	2.173	2.763	0.005	0.127	420.920
	250	0.196	0.801	2.414	0.005	0.067	420.920
	500	0.178	0.798	2.135	0.004	0.063	420.920
	750	0.183	0.798	2.214	0.004	0.064	420.920
	9999	0.240	0.892	3.365	0.004	0.084	420.920
Graders	50	1.029	3.784	3.119	0.004	0.247	346.974
	120	0.464	2.405	2.879	0.004	0.231	346.974
	175	0.340	2.047	2.415	0.004	0.133	346.974
	250	0.252	0.794	2.106	0.004	0.072	346.974
	500	0.239	0.835	1.874	0.003	0.067	346.974
	750	0.240	0.835	1.926	0.003	0.068	346.974
Off-Highway Tractors	120	0.712	2.756	4.162	0.004	0.352	369.727
	175	0.505	2.315	3.636	0.004	0.205	369.727
	250	0.401	1.178	3.346	0.004	0.137	369.727
	750	0.371	1.538	3.087	0.004	0.124	369.727
	1000	0.391	1.681	4.000	0.004	0.131	369.727
Off-Highway Trucks	175	0.302	1.957	1.982	0.004	0.108	324.222
	250	0.230	0.711	1.690	0.004	0.057	324.222
	500	0.221	0.690	1.491	0.003	0.053	324.222
	750	0.222	0.690	1.539	0.003	0.054	324.222
	1000	0.237	0.733	2.537	0.003	0.071	324.222
Other Construction Equipment	15	0.411	2.153	2.571	0.005	0.100	352.663
	25	0.425	1.452	2.688	0.004	0.102	352.663
	50	0.668	3.083	2.866	0.005	0.180	352.663
	120	0.326	2.255	2.397	0.004	0.167	352.663
	175	0.241	1.941	1.939	0.004	0.096	352.663
	500	0.172	0.675	1.445	0.003	0.049	352.663

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2016		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Other General Industrial Equipment	15	0.301	1.771	2.115	0.005	0.083	290.093
	25	0.350	1.194	2.211	0.004	0.083	290.093
	50	0.915	3.245	2.662	0.004	0.224	290.093
	120	0.412	2.027	2.494	0.003	0.212	290.093
	175	0.296	1.713	2.106	0.003	0.118	290.093
	250	0.210	0.629	1.844	0.003	0.059	290.093
	500	0.198	0.609	1.598	0.003	0.055	290.093
	750	0.200	0.609	1.660	0.003	0.056	290.093
	1000	0.220	0.680	2.528	0.003	0.071	290.093
Other Material Handling Equipment	50	1.052	3.716	3.069	0.004	0.258	335.598
	120	0.473	2.334	2.881	0.004	0.244	335.598
	175	0.339	1.972	2.433	0.004	0.136	335.598
	250	0.239	0.724	2.131	0.004	0.068	335.598
	500	0.226	0.702	1.846	0.003	0.063	335.598
	9999	0.263	0.785	2.919	0.003	0.082	335.598
Pavers	25	0.435	1.464	2.736	0.004	0.116	352.663
	50	1.408	4.207	3.394	0.005	0.318	352.663
	120	0.593	2.513	3.583	0.004	0.301	352.663
	175	0.419	2.111	3.100	0.004	0.172	352.663
	250	0.319	0.974	2.810	0.004	0.106	352.663
	500	0.296	1.156	2.528	0.003	0.097	352.663
Paving Equipment	25	0.364	1.241	2.298	0.004	0.087	301.470
	50	1.201	3.565	2.894	0.004	0.272	301.470
	120	0.505	2.136	3.055	0.004	0.259	301.470
	175	0.355	1.792	2.643	0.003	0.147	301.470
	250	0.265	0.814	2.392	0.003	0.089	301.470
Plate Compactors	15	0.285	1.493	1.783	0.004	0.070	244.589
Pressure Washers	15	0.216	1.088	1.495	0.003	0.080	170.643
	25	0.232	0.782	1.442	0.002	0.073	170.643
	50	0.260	1.120	1.356	0.002	0.081	170.643
	120	0.151	0.994	1.264	0.002	0.079	170.643
Pumps	15	0.599	2.683	3.721	0.007	0.215	420.920
	25	0.634	1.929	3.558	0.005	0.189	420.920
	50	0.919	3.437	3.513	0.005	0.249	420.920
	120	0.452	2.609	3.317	0.005	0.241	420.920
	175	0.309	2.206	2.807	0.005	0.133	420.920
	250	0.208	0.814	2.454	0.005	0.070	420.920
	500	0.189	0.810	2.162	0.004	0.065	420.920
	750	0.194	0.810	2.243	0.004	0.067	420.920
	9999	0.249	0.906	3.404	0.004	0.086	420.920
Rollers	15	0.371	1.945	2.322	0.005	0.091	318.534
	25	0.384	1.312	2.428	0.004	0.092	318.534
	50	0.979	3.286	2.848	0.004	0.235	318.534
	120	0.430	2.144	2.761	0.004	0.225	318.534
	175	0.304	1.812	2.347	0.004	0.127	318.534
	250	0.217	0.721	2.073	0.004	0.069	318.534
	500	0.202	0.773	1.842	0.003	0.064	318.534
Rough Terrain Forklifts	50	0.847	3.487	2.978	0.004	0.218	341.286

2016		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	120	0.398	2.312	2.592	0.004	0.202	341.286
	175	0.295	1.977	2.131	0.004	0.116	341.286
	250	0.221	0.718	1.840	0.004	0.060	341.286
	500	0.211	0.692	1.608	0.003	0.057	341.286
Rubber Tired Dozers	175	0.480	2.146	3.389	0.004	0.192	335.598
	250	0.384	1.109	3.125	0.004	0.129	335.598
	500	0.354	1.479	2.836	0.003	0.116	335.598
	750	0.355	1.478	2.885	0.003	0.117	335.598
	1000	0.373	1.608	3.707	0.003	0.123	335.598
Rubber Tired Loaders	25	0.371	1.265	2.342	0.004	0.087	307.158
	50	0.889	3.303	2.744	0.004	0.215	307.158
	120	0.403	2.118	2.517	0.004	0.202	307.158
	175	0.295	1.803	2.108	0.003	0.116	307.158
	250	0.218	0.692	1.835	0.003	0.062	307.158
	500	0.206	0.725	1.630	0.003	0.058	307.158
	750	0.208	0.725	1.677	0.003	0.059	307.158
	1000	0.227	0.806	2.581	0.003	0.074	307.158
Scrapers	120	0.683	2.955	4.054	0.005	0.341	409.544
	175	0.490	2.489	3.490	0.005	0.196	409.544
	250	0.374	1.112	3.145	0.005	0.119	409.544
	500	0.349	1.288	2.827	0.004	0.108	409.544
	750	0.350	1.287	2.890	0.004	0.110	409.544
Signal Boards	15	0.543	2.848	3.400	0.007	0.133	466.425
	50	1.020	3.843	3.717	0.006	0.268	443.672
	120	0.483	2.806	3.447	0.005	0.258	443.672
	175	0.336	2.379	2.895	0.005	0.143	443.672
	250	0.277	1.050	3.040	0.006	0.089	536.104
Skid Steer Loaders	25	0.416	1.347	2.510	0.004	0.121	312.846
	50	0.396	2.561	2.394	0.004	0.116	312.846
	120	0.216	1.972	1.764	0.004	0.101	312.846
Surfacing Equipment	50	0.682	2.360	2.213	0.003	0.168	255.965
	120	0.313	1.655	2.153	0.003	0.162	255.965
	175	0.219	1.401	1.829	0.003	0.092	255.965
	250	0.158	0.572	1.615	0.003	0.053	255.965
	500	0.146	0.635	1.453	0.003	0.049	255.965
	750	0.148	0.634	1.491	0.003	0.050	255.965
Sweepers/Scrubbers	15	0.401	2.362	2.820	0.006	0.110	386.791
	25	0.467	1.593	2.949	0.005	0.110	386.791
	50	0.798	3.759	3.323	0.005	0.220	386.791
	120	0.393	2.581	2.720	0.005	0.199	386.791
	175	0.303	2.225	2.203	0.004	0.118	386.791
	250	0.232	0.775	1.873	0.004	0.061	386.791
Tractors/Loaders/Backhoes	25	0.378	1.288	2.399	0.004	0.094	312.846
	50	0.642	3.040	2.614	0.004	0.167	312.846
	120	0.317	2.092	2.133	0.004	0.153	312.846
	175	0.243	1.805	1.720	0.004	0.090	312.846
	250	0.187	0.644	1.442	0.004	0.047	312.846
	500	0.180	0.632	1.279	0.004	0.045	312.846
	750	0.181	0.632	1.317	0.004	0.046	312.846

2016		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Trenchers	15	0.497	2.605	3.110	0.007	0.122	426.608
	25	0.515	1.757	3.252	0.005	0.121	426.608
	50	1.691	4.942	4.071	0.006	0.380	426.608
	120	0.710	3.000	4.374	0.005	0.362	426.608
	175	0.498	2.519	3.798	0.005	0.208	426.608
	250	0.381	1.198	3.455	0.005	0.132	426.608
	500	0.351	1.463	3.119	0.004	0.120	426.608
	750	0.353	1.462	3.183	0.004	0.121	426.608
Welders	15	0.365	1.631	2.263	0.004	0.131	255.965
	25	0.385	1.173	2.164	0.003	0.115	255.965
	50	0.694	2.430	2.223	0.003	0.175	255.965
	120	0.315	1.669	2.114	0.003	0.169	255.965
	175	0.219	1.409	1.790	0.003	0.093	255.965
	250	0.149	0.520	1.568	0.003	0.047	255.965
	500	0.138	0.511	1.366	0.003	0.044	255.965
Water Trucks	175	0.302	1.957	1.982	0.004	0.108	324.222
	250	0.230	0.711	1.690	0.004	0.057	324.222
	500	0.221	0.690	1.491	0.003	0.053	324.222
	750	0.222	0.690	1.539	0.003	0.054	324.222
	1000	0.237	0.733	2.537	0.003	0.071	324.222

2017		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Aerial Lifts	15	0.305	1.598	1.907	0.004	0.075	261.653
	25	0.348	1.128	2.082	0.003	0.097	261.653
	50	0.497	2.049	2.099	0.003	0.136	261.653
	120	0.248	1.602	1.894	0.003	0.131	261.653
	500	0.108	0.488	1.197	0.003	0.036	261.653
	750	0.110	0.488	1.234	0.003	0.037	261.653
Air Compressors	15	0.378	1.729	2.348	0.004	0.131	273.029
	25	0.399	1.232	2.272	0.003	0.117	273.029
	50	0.712	2.693	2.340	0.004	0.179	273.029
	120	0.323	1.813	2.120	0.003	0.168	273.029
	175	0.229	1.541	1.743	0.003	0.093	273.029
	250	0.163	0.558	1.520	0.003	0.047	273.029
	500	0.155	0.540	1.324	0.003	0.044	273.029
	750	0.156	0.540	1.367	0.003	0.045	273.029
	1000	0.174	0.599	2.202	0.003	0.058	273.029
Bore/Drill Rigs	15	0.497	2.605	3.110	0.007	0.122	426.608
	25	0.515	1.757	3.252	0.005	0.122	426.608
	50	0.289	3.045	2.738	0.006	0.061	426.608
	120	0.181	2.582	1.639	0.005	0.053	426.608
	175	0.157	2.280	1.085	0.005	0.037	426.608
	250	0.131	0.777	0.708	0.005	0.020	426.608
	500	0.131	0.755	0.690	0.004	0.020	426.608
	750	0.131	0.755	0.694	0.004	0.020	426.608
	1000	0.139	0.756	2.021	0.004	0.039	426.608
Cement and Mortar Mixers	15	0.371	1.945	2.323	0.005	0.093	318.534
	25	0.430	1.383	2.560	0.004	0.121	318.534
Concrete/Industrial Saws	25	0.501	1.710	3.165	0.005	0.118	415.232
	50	0.859	3.576	3.400	0.005	0.229	415.232
	120	0.407	2.627	2.985	0.005	0.215	415.232
	175	0.289	2.245	2.423	0.005	0.121	415.232
Cranes	50	0.749	2.730	2.202	0.003	0.177	244.589
	120	0.337	1.711	2.027	0.003	0.167	244.589
	175	0.246	1.453	1.690	0.003	0.096	244.589
	250	0.181	0.561	1.490	0.003	0.051	244.589
	500	0.171	0.576	1.318	0.002	0.048	244.589
	750	0.172	0.576	1.359	0.002	0.048	244.589
	9999	0.197	0.639	2.085	0.002	0.059	244.589
Crawler Tractors	50	1.282	4.312	3.383	0.005	0.289	364.039
	120	0.557	2.604	3.303	0.004	0.271	364.039
	175	0.405	2.206	2.792	0.004	0.157	364.039
	250	0.310	0.944	2.498	0.004	0.093	364.039
	500	0.291	1.057	2.245	0.004	0.086	364.039
	750	0.292	1.057	2.297	0.004	0.087	364.039
	1000	0.314	1.174	3.329	0.004	0.099	364.039
Crushing/Proc. Equipment	50	1.095	4.390	3.769	0.006	0.277	443.672
	120	0.506	2.960	3.314	0.005	0.258	443.672
	175	0.366	2.527	2.694	0.005	0.145	443.672

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2017		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	250	0.266	0.906	2.332	0.005	0.073	443.672
	500	0.253	0.874	2.032	0.004	0.069	443.672
	750	0.252	0.870	2.080	0.004	0.069	443.672
	9999	0.295	0.961	3.453	0.004	0.091	443.672
Dumpers/Tenders	25	0.262	0.890	1.659	0.003	0.065	216.148
Excavators	25	0.391	1.335	2.472	0.004	0.092	324.222
	50	0.676	3.328	2.698	0.004	0.166	324.222
	120	0.335	2.220	2.132	0.004	0.150	324.222
	175	0.259	1.919	1.671	0.004	0.089	324.222
	250	0.203	0.685	1.405	0.004	0.047	324.222
	500	0.196	0.661	1.247	0.003	0.045	324.222
	750	0.197	0.660	1.283	0.003	0.045	324.222
Forklifts	50	0.291	1.696	1.424	0.002	0.079	170.643
	120	0.155	1.160	1.044	0.002	0.069	170.643
	175	0.128	1.011	0.810	0.002	0.044	170.643
	250	0.103	0.346	0.667	0.002	0.022	170.643
	500	0.101	0.329	0.598	0.002	0.022	170.643
Generator Sets	15	0.518	2.666	3.590	0.007	0.186	420.920
	25	0.561	1.900	3.503	0.005	0.173	420.920
	50	0.754	3.180	3.350	0.005	0.212	420.920
	120	0.386	2.550	3.017	0.005	0.203	420.920
	175	0.264	2.171	2.480	0.005	0.112	420.920
	250	0.182	0.788	2.155	0.005	0.060	420.920
	500	0.166	0.777	1.911	0.004	0.057	420.920
	750	0.170	0.777	1.970	0.004	0.058	420.920
	9999	0.223	0.860	3.180	0.004	0.077	420.920
Graders	50	0.936	3.694	3.008	0.004	0.222	346.974
	120	0.430	2.391	2.663	0.004	0.207	346.974
	175	0.318	2.044	2.179	0.004	0.120	346.974
	250	0.238	0.776	1.892	0.004	0.065	346.974
	500	0.226	0.808	1.684	0.003	0.061	346.974
	750	0.227	0.808	1.731	0.003	0.061	346.974
Off-Highway Tractors	120	0.675	2.734	3.934	0.004	0.329	369.727
	175	0.481	2.303	3.399	0.004	0.192	369.727
	250	0.381	1.134	3.120	0.004	0.126	369.727
	750	0.354	1.446	2.878	0.004	0.115	369.727
	1000	0.373	1.581	3.829	0.004	0.122	369.727
Off-Highway Trucks	175	0.278	1.956	1.753	0.004	0.094	324.222
	250	0.216	0.702	1.485	0.004	0.050	324.222
	500	0.209	0.676	1.314	0.003	0.047	324.222
	750	0.210	0.676	1.353	0.003	0.048	324.222
	1000	0.224	0.709	2.387	0.003	0.064	324.222
Other Construction Equipment	15	0.411	2.153	2.571	0.005	0.100	352.663
	25	0.425	1.452	2.688	0.004	0.101	352.663
	50	0.589	3.014	2.753	0.005	0.157	352.663
	120	0.293	2.242	2.187	0.004	0.144	352.663
	175	0.220	1.940	1.699	0.004	0.084	352.663
	500	0.164	0.665	1.267	0.003	0.043	352.663

2017		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Other General Industrial Equipment	15	0.301	1.771	2.115	0.005	0.083	290.093
	25	0.350	1.194	2.211	0.004	0.083	290.093
	50	0.812	3.152	2.572	0.004	0.200	290.093
	120	0.373	2.011	2.292	0.003	0.186	290.093
	175	0.272	1.712	1.882	0.003	0.104	290.093
	250	0.198	0.618	1.638	0.003	0.052	290.093
	500	0.189	0.593	1.426	0.003	0.049	290.093
	750	0.190	0.593	1.473	0.003	0.050	290.093
	1000	0.209	0.655	2.382	0.003	0.065	290.093
Other Material Handling Equipment	50	0.932	3.608	2.964	0.004	0.230	335.598
	120	0.428	2.315	2.648	0.004	0.214	335.598
	175	0.311	1.970	2.174	0.004	0.120	335.598
	250	0.226	0.712	1.892	0.004	0.061	335.598
	500	0.216	0.683	1.648	0.003	0.057	335.598
	9999	0.252	0.756	2.751	0.003	0.075	335.598
Pavers	25	0.430	1.457	2.721	0.004	0.110	352.663
	50	1.311	4.110	3.295	0.005	0.295	352.663
	120	0.558	2.495	3.367	0.004	0.279	352.663
	175	0.397	2.104	2.870	0.004	0.160	352.663
	250	0.302	0.939	2.593	0.004	0.097	352.663
	500	0.281	1.094	2.331	0.003	0.089	352.663
Paving Equipment	25	0.364	1.241	2.298	0.004	0.086	301.470
	50	1.116	3.478	2.809	0.004	0.252	301.470
	120	0.474	2.121	2.870	0.004	0.240	301.470
	175	0.336	1.787	2.446	0.003	0.137	301.470
	250	0.251	0.783	2.206	0.003	0.081	301.470
Plate Compactors	15	0.285	1.493	1.783	0.004	0.070	244.589
Pressure Washers	15	0.210	1.081	1.456	0.003	0.075	170.643
	25	0.228	0.770	1.420	0.002	0.070	170.643
	50	0.228	1.091	1.308	0.002	0.072	170.643
	120	0.133	0.986	1.168	0.002	0.070	170.643
Pumps	15	0.583	2.666	3.620	0.007	0.202	420.920
	25	0.615	1.900	3.503	0.005	0.180	420.920
	50	0.818	3.344	3.391	0.005	0.223	420.920
	120	0.405	2.589	3.062	0.005	0.213	420.920
	175	0.279	2.204	2.519	0.005	0.118	420.920
	250	0.193	0.800	2.191	0.005	0.063	420.920
	500	0.177	0.787	1.935	0.004	0.059	420.920
	750	0.181	0.787	1.996	0.004	0.060	420.920
	9999	0.232	0.872	3.217	0.004	0.079	420.920
Rollers	15	0.371	1.945	2.322	0.005	0.091	318.534
	25	0.384	1.312	2.428	0.004	0.091	318.534
	50	0.893	3.202	2.752	0.004	0.214	318.534
	120	0.398	2.130	2.565	0.004	0.204	318.534
	175	0.284	1.809	2.135	0.004	0.116	318.534
	250	0.205	0.702	1.880	0.004	0.063	318.534
	500	0.192	0.740	1.667	0.003	0.058	318.534
Rough Terrain Forklifts	50	0.749	3.400	2.869	0.004	0.192	341.286

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2017		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	120	0.361	2.297	2.372	0.004	0.175	341.286
	175	0.271	1.976	1.885	0.004	0.101	341.286
	250	0.209	0.708	1.618	0.004	0.054	341.286
	500	0.201	0.679	1.424	0.003	0.051	341.286
Rubber Tired Dozers	175	0.457	2.134	3.173	0.004	0.179	335.598
	250	0.364	1.069	2.918	0.004	0.120	335.598
	500	0.337	1.390	2.647	0.003	0.108	335.598
	750	0.338	1.389	2.694	0.003	0.108	335.598
	1000	0.356	1.512	3.551	0.003	0.115	335.598
Rubber Tired Loaders	25	0.371	1.265	2.342	0.004	0.087	307.158
	50	0.807	3.224	2.647	0.004	0.193	307.158
	120	0.372	2.105	2.325	0.004	0.180	307.158
	175	0.276	1.801	1.899	0.003	0.105	307.158
	250	0.206	0.678	1.646	0.003	0.056	307.158
	500	0.196	0.701	1.463	0.003	0.052	307.158
	750	0.197	0.701	1.506	0.003	0.053	307.158
	1000	0.214	0.767	2.436	0.003	0.067	307.158
Scrapers	120	0.642	2.935	3.800	0.005	0.314	409.544
	175	0.463	2.482	3.219	0.005	0.181	409.544
	250	0.353	1.074	2.890	0.005	0.108	409.544
	500	0.331	1.223	2.596	0.004	0.099	409.544
	750	0.332	1.223	2.656	0.004	0.100	409.544
Signal Boards	15	0.543	2.848	3.400	0.007	0.133	466.425
	50	0.905	3.736	3.584	0.006	0.239	443.672
	120	0.432	2.784	3.169	0.005	0.227	443.672
	175	0.304	2.377	2.580	0.005	0.126	443.672
	250	0.258	1.033	2.695	0.006	0.080	536.104
Skid Steer Loaders	25	0.407	1.333	2.473	0.004	0.114	312.846
	50	0.353	2.521	2.286	0.004	0.096	312.846
	120	0.196	1.965	1.589	0.004	0.084	312.846
Surfacing Equipment	50	0.627	2.304	2.137	0.003	0.154	255.965
	120	0.290	1.644	2.005	0.003	0.148	255.965
	175	0.204	1.398	1.668	0.003	0.084	255.965
	250	0.148	0.555	1.468	0.003	0.048	255.965
	500	0.137	0.607	1.318	0.003	0.045	255.965
	750	0.139	0.607	1.354	0.003	0.045	255.965
Sweepers/Scrubbers	15	0.401	2.362	2.820	0.006	0.110	386.791
	25	0.467	1.593	2.949	0.005	0.110	386.791
	50	0.700	3.682	3.208	0.005	0.191	386.791
	120	0.357	2.571	2.481	0.005	0.170	386.791
	175	0.283	2.229	1.954	0.004	0.105	386.791
	250	0.221	0.770	1.640	0.004	0.054	386.791
Tractors/Loaders/Backhoes	25	0.378	1.288	2.392	0.004	0.093	312.846
	50	0.572	2.979	2.511	0.004	0.145	312.846
	120	0.289	2.082	1.945	0.004	0.131	312.846
	175	0.224	1.804	1.508	0.004	0.078	312.846
	250	0.176	0.639	1.255	0.004	0.042	312.846
	500	0.171	0.622	1.117	0.004	0.040	312.846
	750	0.172	0.622	1.149	0.004	0.040	312.846

2017		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Trenchers	15	0.497	2.605	3.110	0.007	0.122	426.608
	25	0.515	1.757	3.252	0.005	0.121	426.608
	50	1.584	4.832	3.955	0.006	0.355	426.608
	120	0.669	2.977	4.119	0.005	0.338	426.608
	175	0.471	2.509	3.526	0.005	0.194	426.608
	250	0.360	1.154	3.199	0.005	0.122	426.608
	500	0.333	1.382	2.885	0.004	0.110	426.608
	750	0.335	1.381	2.945	0.004	0.112	426.608
Welders	15	0.354	1.621	2.201	0.004	0.123	255.965
	25	0.374	1.155	2.130	0.003	0.110	255.965
	50	0.618	2.360	2.148	0.003	0.158	255.965
	120	0.284	1.655	1.949	0.003	0.150	255.965
	175	0.199	1.407	1.605	0.003	0.083	255.965
	250	0.140	0.511	1.399	0.003	0.042	255.965
	500	0.131	0.497	1.222	0.003	0.040	255.965
Water Trucks	175	0.278	1.956	1.753	0.004	0.094	324.222
	250	0.216	0.702	1.485	0.004	0.050	324.222
	500	0.209	0.676	1.314	0.003	0.047	324.222
	750	0.210	0.676	1.353	0.003	0.048	324.222
	1000	0.224	0.709	2.387	0.003	0.064	324.222

2018		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Aerial Lifts	15	0.305	1.598	1.907	0.004	0.074	261.653
	25	0.340	1.115	2.063	0.003	0.092	261.653
	50	0.438	1.995	2.026	0.003	0.121	261.653
	120	0.220	1.591	1.744	0.003	0.114	261.653
	500	0.102	0.478	1.070	0.003	0.033	261.653
	750	0.104	0.478	1.099	0.003	0.033	261.653
Air Compressors	15	0.368	1.720	2.288	0.004	0.123	273.029
	25	0.388	1.216	2.239	0.003	0.112	273.029
	50	0.625	2.613	2.262	0.004	0.158	273.029
	120	0.290	1.799	1.946	0.003	0.146	273.029
	175	0.209	1.540	1.551	0.003	0.082	273.029
	250	0.154	0.551	1.344	0.003	0.042	273.029
	500	0.148	0.529	1.185	0.003	0.040	273.029
	750	0.149	0.529	1.217	0.003	0.041	273.029
	1000	0.165	0.581	2.078	0.003	0.054	273.029
Bore/Drill Rigs	15	0.497	2.605	3.110	0.007	0.122	426.608
	25	0.515	1.757	3.252	0.005	0.121	426.608
	50	0.280	3.039	2.607	0.006	0.047	426.608
	120	0.171	2.581	1.499	0.005	0.040	426.608
	175	0.144	2.281	0.880	0.005	0.028	426.608
	250	0.122	0.777	0.567	0.005	0.015	426.608
	500	0.122	0.755	0.553	0.004	0.015	426.608
	750	0.122	0.755	0.556	0.004	0.015	426.608
	1000	0.128	0.756	1.935	0.004	0.033	426.608
Cement and Mortar Mixers	15	0.371	1.945	2.322	0.005	0.092	318.534
	25	0.420	1.368	2.525	0.004	0.115	318.534
Concrete/Industrial Saws	25	0.501	1.710	3.165	0.005	0.118	415.232
	50	0.755	3.482	3.282	0.005	0.203	415.232
	120	0.364	2.610	2.743	0.005	0.188	415.232
	175	0.262	2.245	2.152	0.005	0.106	415.232
Cranes	50	0.681	2.666	2.130	0.003	0.160	244.589
	120	0.312	1.700	1.882	0.003	0.149	244.589
	175	0.229	1.451	1.531	0.003	0.086	244.589
	250	0.172	0.550	1.345	0.003	0.046	244.589
	500	0.163	0.555	1.188	0.002	0.043	244.589
	750	0.164	0.555	1.226	0.002	0.044	244.589
	9999	0.187	0.604	1.972	0.002	0.054	244.589
Crawler Tractors	50	1.190	4.220	3.278	0.005	0.265	364.039
	120	0.523	2.588	3.092	0.004	0.248	364.039
	175	0.381	2.201	2.564	0.004	0.144	364.039
	250	0.292	0.916	2.286	0.004	0.084	364.039
	500	0.275	1.011	2.054	0.004	0.078	364.039
	750	0.276	1.011	2.102	0.004	0.079	364.039
	1000	0.298	1.117	3.169	0.004	0.092	364.039
Crushing/Proc. Equipment	50	0.957	4.264	3.636	0.006	0.243	443.672
	120	0.453	2.938	3.031	0.005	0.222	443.672
	175	0.334	2.525	2.381	0.005	0.126	443.672

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2018		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	250	0.251	0.895	2.047	0.005	0.065	443.672
	500	0.242	0.859	1.805	0.004	0.062	443.672
	750	0.241	0.857	1.841	0.004	0.062	443.672
	9999	0.282	0.936	3.254	0.004	0.084	443.672
Dumpers/Tenders	25	0.261	0.890	1.655	0.003	0.064	216.148
Excavators	25	0.391	1.335	2.472	0.004	0.092	324.222
	50	0.607	3.267	2.595	0.004	0.143	324.222
	120	0.305	2.210	1.949	0.004	0.127	324.222
	175	0.238	1.919	1.465	0.004	0.076	324.222
	250	0.191	0.679	1.223	0.004	0.041	324.222
	500	0.186	0.650	1.093	0.003	0.039	324.222
	750	0.186	0.650	1.119	0.003	0.040	324.222
Forklifts	50	0.263	1.670	1.368	0.002	0.066	170.643
	120	0.143	1.156	0.947	0.002	0.058	170.643
	175	0.119	1.011	0.702	0.002	0.038	170.643
	250	0.097	0.345	0.566	0.002	0.019	170.643
	500	0.095	0.328	0.521	0.002	0.019	170.643
Generator Sets	15	0.504	2.652	3.502	0.007	0.176	420.920
	25	0.551	1.875	3.452	0.005	0.166	420.920
	50	0.663	3.098	3.234	0.005	0.188	420.920
	120	0.342	2.532	2.779	0.005	0.178	420.920
	175	0.237	2.170	2.214	0.005	0.099	420.920
	250	0.168	0.777	1.912	0.005	0.054	420.920
	500	0.157	0.762	1.711	0.004	0.051	420.920
	750	0.160	0.762	1.755	0.004	0.052	420.920
	9999	0.208	0.836	3.006	0.004	0.071	420.920
Graders	50	0.852	3.614	2.904	0.004	0.198	346.975
	120	0.398	2.378	2.464	0.004	0.184	346.974
	175	0.297	2.042	1.961	0.004	0.108	346.974
	250	0.225	0.762	1.696	0.004	0.058	346.974
	500	0.215	0.785	1.510	0.003	0.054	346.974
	750	0.216	0.785	1.553	0.003	0.055	346.974
Off-Highway Tractors	120	0.640	2.713	3.718	0.004	0.307	369.727
	175	0.458	2.292	3.173	0.004	0.179	369.727
	250	0.362	1.094	2.904	0.004	0.117	369.727
	750	0.337	1.364	2.680	0.004	0.106	369.727
	1000	0.356	1.491	3.667	0.004	0.115	369.727
Off-Highway Trucks	175	0.255	1.955	1.541	0.004	0.081	324.222
	250	0.203	0.695	1.297	0.004	0.044	324.222
	500	0.197	0.664	1.156	0.003	0.042	324.222
	750	0.198	0.664	1.185	0.003	0.042	324.222
	1000	0.211	0.693	2.252	0.003	0.058	324.222
Other Construction Equipment	15	0.411	2.153	2.571	0.005	0.100	352.663
	25	0.425	1.452	2.688	0.004	0.100	352.663
	50	0.519	2.951	2.649	0.005	0.136	352.663
	120	0.263	2.231	1.994	0.004	0.122	352.663
	175	0.201	1.940	1.482	0.004	0.072	352.663
	500	0.156	0.658	1.110	0.003	0.038	352.663

2018		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Other General Industrial Equipment	15	0.301	1.771	2.115	0.005	0.083	290.093
	25	0.350	1.194	2.211	0.004	0.083	290.093
	50	0.717	3.070	2.484	0.004	0.176	290.093
	120	0.337	1.997	2.102	0.003	0.161	290.093
	175	0.249	1.712	1.673	0.003	0.091	290.093
	250	0.188	0.611	1.445	0.003	0.047	290.093
	500	0.181	0.582	1.274	0.003	0.044	290.093
	750	0.181	0.582	1.309	0.003	0.045	290.093
	1000	0.199	0.637	2.245	0.003	0.060	290.093
Other Material Handling Equipment	50	0.822	3.511	2.864	0.004	0.203	335.598
	120	0.386	2.299	2.428	0.004	0.185	335.598
	175	0.285	1.970	1.932	0.004	0.105	335.598
	250	0.214	0.703	1.670	0.004	0.054	335.598
	500	0.206	0.670	1.472	0.003	0.051	335.598
	9999	0.242	0.734	2.592	0.003	0.069	335.598
Pavers	25	0.428	1.453	2.711	0.004	0.107	352.663
	50	1.219	4.017	3.200	0.005	0.273	352.663
	120	0.525	2.478	3.163	0.004	0.258	352.663
	175	0.375	2.098	2.651	0.004	0.148	352.663
	250	0.286	0.907	2.388	0.004	0.089	352.663
	500	0.267	1.041	2.145	0.003	0.081	352.663
Paving Equipment	25	0.364	1.241	2.298	0.004	0.086	301.470
	50	1.035	3.397	2.728	0.004	0.234	301.470
	120	0.446	2.107	2.693	0.004	0.221	301.470
	175	0.317	1.782	2.258	0.003	0.127	301.470
	250	0.237	0.756	2.031	0.003	0.074	301.470
Plate Compactors	15	0.285	1.493	1.783	0.004	0.070	244.589
Pressure Washers	15	0.204	1.075	1.420	0.003	0.071	170.643
	25	0.223	0.760	1.400	0.002	0.067	170.643
	50	0.199	1.064	1.262	0.002	0.064	170.643
	120	0.117	0.979	1.076	0.002	0.061	170.643
Pumps	15	0.568	2.652	3.528	0.007	0.190	420.920
	25	0.598	1.875	3.452	0.005	0.172	420.920
	50	0.721	3.257	3.275	0.005	0.198	420.920
	120	0.360	2.571	2.821	0.005	0.187	420.920
	175	0.251	2.203	2.249	0.005	0.104	420.920
	250	0.179	0.789	1.944	0.005	0.056	420.920
	500	0.168	0.772	1.733	0.004	0.053	420.920
	750	0.170	0.772	1.779	0.004	0.054	420.920
	9999	0.217	0.847	3.041	0.004	0.073	420.920
Rollers	15	0.371	1.945	2.322	0.005	0.091	318.534
	25	0.384	1.312	2.428	0.004	0.091	318.534
	50	0.812	3.123	2.662	0.004	0.194	318.534
	120	0.367	2.116	2.382	0.004	0.184	318.534
	175	0.264	1.806	1.935	0.004	0.105	318.534
	250	0.194	0.688	1.699	0.004	0.057	318.534
	500	0.183	0.713	1.504	0.003	0.053	318.534
Rough Terrain Forklifts	50	0.660	3.320	2.765	0.004	0.167	341.286

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2018		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	120	0.326	2.284	2.168	0.004	0.149	341.286
	175	0.249	1.976	1.659	0.004	0.088	341.286
	250	0.197	0.700	1.414	0.004	0.047	341.286
	500	0.192	0.669	1.259	0.003	0.045	341.286
Rubber Tired Dozers	175	0.434	2.123	2.966	0.004	0.167	335.598
	250	0.346	1.031	2.722	0.004	0.111	335.598
	500	0.321	1.310	2.468	0.003	0.100	335.598
	750	0.322	1.309	2.513	0.003	0.101	335.598
	1000	0.340	1.425	3.404	0.003	0.108	335.598
Rubber Tired Loaders	25	0.371	1.265	2.342	0.004	0.087	307.158
	50	0.732	3.154	2.555	0.004	0.172	307.158
	120	0.344	2.094	2.149	0.004	0.160	307.158
	175	0.257	1.799	1.705	0.003	0.093	307.158
	250	0.195	0.667	1.473	0.003	0.050	307.158
	500	0.187	0.681	1.309	0.003	0.047	307.158
	750	0.188	0.681	1.348	0.003	0.048	307.158
	1000	0.202	0.733	2.302	0.003	0.061	307.158
Scrapers	120	0.603	2.916	3.561	0.005	0.288	409.544
	175	0.437	2.476	2.963	0.005	0.167	409.544
	250	0.333	1.041	2.651	0.005	0.098	409.544
	500	0.313	1.168	2.380	0.004	0.090	409.544
	750	0.315	1.167	2.436	0.004	0.091	409.544
Signal Boards	15	0.543	2.848	3.400	0.007	0.133	466.425
	50	0.795	3.636	3.457	0.006	0.211	443.672
	120	0.385	2.765	2.907	0.005	0.197	443.672
	175	0.274	2.376	2.287	0.005	0.111	443.672
	250	0.242	1.020	2.374	0.006	0.071	536.104
Skid Steer Loaders	25	0.399	1.321	2.453	0.004	0.109	312.846
	50	0.323	2.494	2.191	0.004	0.080	312.846
	120	0.181	1.961	1.441	0.004	0.069	312.846
Surfacing Equipment	50	0.575	2.253	2.067	0.003	0.140	255.965
	120	0.268	1.634	1.867	0.003	0.134	255.965
	175	0.190	1.396	1.517	0.003	0.077	255.965
	250	0.139	0.542	1.331	0.003	0.044	255.965
	500	0.130	0.584	1.194	0.003	0.040	255.965
	750	0.131	0.584	1.227	0.003	0.041	255.965
Sweepers/Scrubbers	15	0.401	2.362	2.820	0.006	0.110	386.791
	25	0.467	1.593	2.949	0.005	0.110	386.791
	50	0.630	3.630	3.102	0.005	0.165	386.791
	120	0.329	2.565	2.271	0.005	0.147	386.791
	175	0.266	2.233	1.729	0.004	0.093	386.791
	250	0.212	0.767	1.429	0.004	0.048	386.791
Tractors/Loaders/Backhoes	25	0.378	1.288	2.388	0.004	0.092	312.846
	50	0.512	2.926	2.415	0.004	0.125	312.846
	120	0.263	2.072	1.776	0.004	0.111	312.846
	175	0.206	1.803	1.316	0.004	0.067	312.846
	250	0.166	0.634	1.086	0.004	0.037	312.846
	500	0.162	0.614	0.974	0.004	0.035	312.846
	750	0.163	0.614	0.998	0.004	0.035	312.846

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2018		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Trenchers	15	0.497	2.605	3.110	0.007	0.122	426.608
	25	0.515	1.757	3.252	0.005	0.121	426.608
	50	1.480	4.726	3.843	0.006	0.330	426.608
	120	0.630	2.957	3.878	0.005	0.314	426.608
	175	0.446	2.501	3.268	0.005	0.180	426.608
	250	0.341	1.115	2.957	0.005	0.111	426.608
	500	0.317	1.310	2.663	0.004	0.101	426.608
	750	0.318	1.310	2.721	0.004	0.103	426.608
Welders	15	0.345	1.612	2.145	0.004	0.116	255.965
	25	0.364	1.140	2.099	0.003	0.105	255.965
	50	0.545	2.294	2.075	0.003	0.140	255.965
	120	0.254	1.643	1.793	0.003	0.131	255.965
	175	0.181	1.407	1.431	0.003	0.073	255.965
	250	0.132	0.504	1.239	0.003	0.038	255.965
	500	0.125	0.487	1.095	0.003	0.036	255.965
Water Trucks	175	0.255	1.955	1.541	0.004	0.081	324.222
	250	0.203	0.695	1.297	0.004	0.044	324.222
	500	0.197	0.664	1.156	0.003	0.042	324.222
	750	0.198	0.664	1.185	0.003	0.042	324.222
	1000	0.211	0.693	2.252	0.003	0.058	324.222

2019		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Aerial Lifts	15	0.305	1.598	1.907	0.004	0.074	261.653
	25	0.334	1.105	2.049	0.003	0.088	261.653
	50	0.382	1.943	1.955	0.003	0.106	261.653
	120	0.194	1.580	1.600	0.003	0.099	261.653
	500	0.096	0.471	0.952	0.003	0.029	261.653
	750	0.098	0.471	0.975	0.003	0.030	261.653
Air Compressors	15	0.360	1.712	2.233	0.004	0.116	273.029
	25	0.378	1.202	2.209	0.003	0.107	273.029
	50	0.543	2.538	2.184	0.004	0.138	273.029
	120	0.259	1.786	1.781	0.003	0.125	273.029
	175	0.193	1.540	1.381	0.003	0.072	273.029
	250	0.146	0.544	1.187	0.003	0.038	273.029
	500	0.141	0.522	1.054	0.003	0.036	273.029
	750	0.142	0.522	1.080	0.003	0.037	273.029
	1000	0.156	0.568	1.957	0.003	0.049	273.029
Bore/Drill Rigs	15	0.497	2.605	3.110	0.007	0.122	426.608
	25	0.515	1.757	3.252	0.005	0.121	426.608
	50	0.274	3.034	2.499	0.006	0.036	426.608
	120	0.162	2.580	1.383	0.005	0.030	426.608
	175	0.132	2.281	0.706	0.005	0.021	426.608
	250	0.114	0.777	0.454	0.005	0.012	426.608
	500	0.114	0.755	0.444	0.004	0.012	426.608
	750	0.114	0.755	0.446	0.004	0.012	426.608
	1000	0.119	0.755	1.872	0.004	0.028	426.608
Cement and Mortar Mixers	15	0.371	1.945	2.322	0.005	0.091	318.534
	25	0.412	1.355	2.505	0.004	0.110	318.534
Concrete/Industrial Saws	25	0.501	1.710	3.165	0.005	0.118	415.232
	50	0.657	3.394	3.170	0.005	0.177	415.232
	120	0.324	2.594	2.515	0.005	0.161	415.232
	175	0.241	2.245	1.913	0.005	0.094	415.232
Cranes	50	0.619	2.608	2.063	0.003	0.143	244.589
	120	0.287	1.690	1.746	0.003	0.133	244.589
	175	0.213	1.449	1.381	0.003	0.077	244.589
	250	0.162	0.540	1.208	0.003	0.042	244.589
	500	0.155	0.537	1.068	0.002	0.039	244.589
	750	0.156	0.537	1.101	0.002	0.039	244.589
	9999	0.178	0.575	1.869	0.002	0.049	244.589
Crawler Tractors	50	1.103	4.134	3.178	0.005	0.242	364.039
	120	0.490	2.573	2.894	0.004	0.226	364.039
	175	0.359	2.197	2.349	0.004	0.131	364.039
	250	0.276	0.891	2.087	0.004	0.076	364.039
	500	0.261	0.971	1.875	0.004	0.071	364.039
	750	0.262	0.971	1.920	0.004	0.071	364.039
	1000	0.282	1.067	3.020	0.004	0.085	364.039
Crushing/Proc. Equipment	50	0.831	4.151	3.509	0.006	0.210	443.672
	120	0.405	2.919	2.767	0.005	0.188	443.672
	175	0.308	2.525	2.108	0.005	0.111	443.672

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2019		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	250	0.238	0.886	1.796	0.005	0.058	443.672
	500	0.231	0.849	1.598	0.004	0.056	443.672
	750	0.230	0.848	1.628	0.004	0.056	443.672
	9999	0.270	0.916	3.066	0.004	0.077	443.672
Dumpers/Tenders	25	0.261	0.890	1.651	0.003	0.064	216.148
Excavators	25	0.391	1.335	2.472	0.004	0.092	324.222
	50	0.547	3.214	2.499	0.004	0.122	324.222
	120	0.279	2.200	1.783	0.004	0.108	324.222
	175	0.219	1.918	1.279	0.004	0.065	324.222
	250	0.179	0.674	1.060	0.004	0.036	324.222
	500	0.176	0.643	0.957	0.003	0.035	324.222
	750	0.176	0.642	0.976	0.003	0.035	324.222
Forklifts	50	0.238	1.646	1.312	0.002	0.054	170.643
	120	0.132	1.152	0.854	0.002	0.048	170.643
	175	0.110	1.010	0.615	0.002	0.032	170.643
	250	0.091	0.344	0.485	0.002	0.016	170.643
	500	0.090	0.327	0.451	0.002	0.016	170.643
Generator Sets	15	0.490	2.639	3.420	0.007	0.166	420.920
	25	0.542	1.853	3.405	0.005	0.159	420.920
	50	0.577	3.019	3.122	0.005	0.165	420.920
	120	0.301	2.516	2.553	0.005	0.153	420.920
	175	0.215	2.170	1.977	0.005	0.088	420.920
	250	0.157	0.768	1.693	0.005	0.048	420.920
	500	0.148	0.752	1.523	0.004	0.046	420.920
	750	0.150	0.752	1.559	0.004	0.047	420.920
	9999	0.193	0.817	2.836	0.004	0.065	420.920
Graders	50	0.777	3.543	2.807	0.004	0.177	346.974
	120	0.369	2.366	2.281	0.004	0.163	346.974
	175	0.276	2.041	1.759	0.004	0.096	346.974
	250	0.213	0.751	1.516	0.004	0.052	346.974
	500	0.204	0.767	1.352	0.003	0.049	346.974
	750	0.205	0.767	1.390	0.003	0.049	346.974
Off-Highway Tractors	120	0.606	2.695	3.515	0.004	0.286	369.727
	175	0.435	2.283	2.958	0.004	0.167	369.727
	250	0.343	1.058	2.701	0.004	0.107	369.727
	750	0.320	1.292	2.492	0.004	0.098	369.727
	1000	0.340	1.411	3.514	0.004	0.107	369.727
Off-Highway Trucks	175	0.234	1.954	1.350	0.004	0.070	324.222
	250	0.191	0.689	1.129	0.004	0.038	324.222
	500	0.187	0.655	1.015	0.003	0.037	324.222
	750	0.187	0.655	1.036	0.003	0.037	324.222
	1000	0.199	0.680	2.131	0.003	0.052	324.222
Other Construction Equipment	15	0.411	2.153	2.571	0.005	0.100	352.663
	25	0.425	1.452	2.688	0.004	0.100	352.662
	50	0.458	2.896	2.552	0.005	0.116	352.662
	120	0.238	2.222	1.821	0.004	0.102	352.663
	175	0.186	1.940	1.295	0.004	0.063	352.663
	500	0.148	0.653	0.969	0.003	0.034	352.663

2019		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Other General Industrial Equipment	15	0.301	1.771	2.115	0.005	0.083	290.093
	25	0.350	1.194	2.211	0.004	0.083	290.093
	50	0.629	2.993	2.398	0.004	0.153	290.093
	120	0.304	1.985	1.922	0.003	0.137	290.093
	175	0.231	1.712	1.488	0.003	0.080	290.093
	250	0.177	0.604	1.273	0.003	0.041	290.093
	500	0.172	0.574	1.131	0.003	0.040	290.093
	750	0.173	0.574	1.159	0.003	0.040	290.093
	1000	0.188	0.623	2.112	0.003	0.055	290.093
Other Material Handling Equipment	50	0.720	3.423	2.765	0.004	0.176	335.598
	120	0.347	2.284	2.219	0.004	0.158	335.598
	175	0.264	1.971	1.719	0.004	0.093	335.598
	250	0.203	0.695	1.471	0.004	0.048	335.598
	500	0.196	0.662	1.307	0.003	0.046	335.598
	9999	0.231	0.718	2.439	0.003	0.063	335.598
Pavers	25	0.426	1.452	2.702	0.004	0.105	352.663
	50	1.133	3.931	3.108	0.005	0.252	352.663
	120	0.494	2.463	2.970	0.004	0.238	352.663
	175	0.355	2.093	2.445	0.004	0.137	352.663
	250	0.270	0.879	2.196	0.004	0.081	352.663
	500	0.254	0.994	1.971	0.003	0.074	352.663
Paving Equipment	25	0.364	1.241	2.298	0.004	0.086	301.470
	50	0.958	3.320	2.650	0.004	0.215	301.470
	120	0.418	2.094	2.526	0.004	0.204	301.470
	175	0.299	1.778	2.080	0.003	0.117	301.470
	250	0.225	0.733	1.864	0.003	0.067	301.470
Plate Compactors	15	0.285	1.493	1.783	0.004	0.070	244.589
Pressure Washers	15	0.199	1.070	1.386	0.003	0.067	170.643
	25	0.220	0.751	1.380	0.002	0.064	170.643
	50	0.171	1.038	1.217	0.002	0.056	170.643
	120	0.101	0.973	0.990	0.002	0.052	170.643
Pumps	15	0.554	2.639	3.442	0.007	0.179	420.920
	25	0.583	1.853	3.405	0.005	0.165	420.920
	50	0.629	3.173	3.162	0.005	0.174	420.920
	120	0.318	2.555	2.590	0.005	0.161	420.920
	175	0.229	2.203	2.008	0.005	0.092	420.920
	250	0.168	0.780	1.721	0.005	0.050	420.920
	500	0.159	0.761	1.544	0.004	0.048	420.920
	750	0.161	0.761	1.580	0.004	0.049	420.920
	9999	0.203	0.828	2.869	0.004	0.066	420.920
Rollers	15	0.371	1.945	2.322	0.005	0.091	318.534
	25	0.364	1.312	2.428	0.004	0.091	318.534
	50	0.736	3.051	2.578	0.004	0.175	318.534
	120	0.338	2.103	2.211	0.004	0.165	318.534
	175	0.246	1.803	1.747	0.004	0.094	318.534
	250	0.184	0.676	1.529	0.004	0.052	318.534
	500	0.175	0.690	1.353	0.003	0.048	318.534
Rough Terrain Forklifts	50	0.582	3.249	2.667	0.004	0.144	341.286

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2019		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	120	0.294	2.272	1.981	0.004	0.126	341.286
	175	0.231	1.976	1.462	0.004	0.077	341.286
	250	0.186	0.693	1.234	0.004	0.042	341.286
	500	0.182	0.662	1.109	0.003	0.040	341.286
Rubber Tired Dozers	175	0.412	2.114	2.769	0.004	0.156	335.598
	250	0.328	0.997	2.535	0.004	0.102	335.598
	500	0.305	1.238	2.298	0.003	0.092	335.598
	750	0.306	1.237	2.341	0.003	0.093	335.598
	1000	0.324	1.347	3.265	0.003	0.101	335.598
Rubber Tired Loaders	25	0.371	1.265	2.342	0.004	0.087	307.158
	50	0.665	3.092	2.469	0.004	0.153	307.158
	120	0.318	2.083	1.988	0.004	0.141	307.158
	175	0.239	1.797	1.526	0.003	0.083	307.158
	250	0.185	0.659	1.313	0.003	0.045	307.158
	500	0.177	0.664	1.169	0.003	0.042	307.158
	750	0.178	0.664	1.202	0.003	0.043	307.158
	1000	0.191	0.705	2.180	0.003	0.056	307.158
Scrapers	120	0.566	2.899	3.337	0.005	0.264	409.544
	175	0.412	2.472	2.722	0.005	0.153	409.544
	250	0.315	1.011	2.427	0.005	0.089	409.544
	500	0.297	1.119	2.178	0.004	0.082	409.544
	750	0.298	1.119	2.230	0.004	0.083	409.544
Signal Boards	15	0.543	2.848	3.400	0.007	0.133	466.425
	50	0.693	3.543	3.336	0.006	0.184	443.672
	120	0.341	2.748	2.662	0.005	0.169	443.672
	175	0.251	2.376	2.031	0.005	0.098	443.672
	250	0.227	1.009	2.089	0.006	0.063	536.104
Skid Steer Loaders	25	0.393	1.311	2.438	0.004	0.103	312.846
	50	0.300	2.475	2.105	0.004	0.065	312.846
	120	0.170	1.958	1.314	0.004	0.057	312.846
Surfacing Equipment	50	0.526	2.205	2.001	0.003	0.127	255.965
	120	0.248	1.625	1.739	0.003	0.121	255.965
	175	0.177	1.394	1.376	0.003	0.070	255.965
	250	0.131	0.532	1.204	0.003	0.039	255.965
	500	0.123	0.564	1.078	0.003	0.037	255.965
	750	0.124	0.564	1.109	0.003	0.037	255.965
Sweepers/Scrubbers	15	0.401	2.362	2.820	0.006	0.110	386.791
	25	0.467	1.593	2.949	0.005	0.110	386.791
	50	0.572	3.587	2.998	0.005	0.142	386.791
	120	0.306	2.560	2.078	0.005	0.127	386.791
	175	0.249	2.236	1.518	0.004	0.081	386.791
	250	0.201	0.765	1.230	0.004	0.042	386.791
Tractors/Loaders/Backhoes	25	0.377	1.288	2.386	0.004	0.091	312.846
	50	0.462	2.882	2.327	0.004	0.106	312.846
	120	0.241	2.064	1.625	0.004	0.093	312.846
	175	0.190	1.803	1.144	0.004	0.058	312.846
	250	0.157	0.631	0.937	0.004	0.032	312.846
	500	0.154	0.608	0.848	0.004	0.031	312.846
	750	0.154	0.608	0.865	0.004	0.031	312.846

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2019		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Trenchers	15	0.497	2.605	3.110	0.007	0.122	426.608
	25	0.515	1.757	3.252	0.005	0.121	426.608
	50	1.379	4.625	3.736	0.006	0.306	426.608
	120	0.593	2.938	3.649	0.005	0.290	426.608
	175	0.422	2.494	3.022	0.005	0.167	426.608
	250	0.323	1.079	2.727	0.005	0.102	426.608
	500	0.301	1.248	2.455	0.004	0.093	426.608
	750	0.303	1.247	2.510	0.004	0.094	426.608
Welders	15	0.337	1.605	2.093	0.004	0.109	255.965
	25	0.355	1.127	2.070	0.003	0.100	255.965
	50	0.475	2.230	2.004	0.003	0.123	255.965
	120	0.227	1.632	1.643	0.003	0.113	255.965
	175	0.167	1.406	1.276	0.003	0.065	255.965
	250	0.124	0.497	1.096	0.003	0.034	255.965
	500	0.119	0.480	0.974	0.003	0.032	255.965
Water Trucks	175	0.234	1.954	1.350	0.004	0.070	324.222
	250	0.191	0.689	1.129	0.004	0.038	324.222
	500	0.187	0.655	1.015	0.003	0.037	324.222
	750	0.187	0.655	1.036	0.003	0.037	324.222
	1000	0.199	0.680	2.131	0.003	0.052	324.222

2020		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Aerial Lifts	15	0.305	1.598	1.907	0.004	0.074	261.653
	25	0.328	1.096	2.037	0.003	0.084	261.653
	50	0.339	1.904	1.890	0.003	0.093	261.653
	120	0.175	1.573	1.472	0.003	0.086	261.653
	500	0.091	0.467	0.840	0.003	0.026	261.653
	750	0.092	0.467	0.860	0.003	0.026	261.653
Air Compressors	15	0.352	1.704	2.182	0.004	0.109	273.029
	25	0.369	1.188	2.180	0.003	0.102	273.029
	50	0.481	2.481	2.113	0.004	0.121	273.029
	120	0.235	1.777	1.634	0.003	0.108	273.029
	175	0.180	1.539	1.229	0.003	0.064	273.029
	250	0.139	0.539	1.044	0.003	0.033	273.029
	500	0.134	0.517	0.930	0.003	0.032	273.029
	750	0.135	0.517	0.952	0.003	0.033	273.029
	1000	0.147	0.557	1.839	0.003	0.045	273.029
Bore/Drill Rigs	15	0.497	2.605	3.110	0.007	0.122	426.608
	25	0.515	1.757	3.252	0.005	0.121	426.608
	50	0.269	3.030	2.414	0.006	0.027	426.608
	120	0.155	2.579	1.288	0.005	0.022	426.608
	175	0.122	2.281	0.563	0.005	0.015	426.608
	250	0.108	0.777	0.367	0.005	0.010	426.608
	500	0.107	0.755	0.359	0.004	0.010	426.608
	750	0.107	0.755	0.361	0.004	0.010	426.608
	1000	0.112	0.755	1.832	0.004	0.024	426.608
Cement and Mortar Mixers	15	0.371	1.945	2.322	0.005	0.091	318.534
	25	0.405	1.344	2.490	0.004	0.105	318.534
Concrete/Industrial Saws	25	0.501	1.710	3.165	0.005	0.118	415.232
	50	0.583	3.326	3.066	0.005	0.155	415.232
	120	0.294	2.583	2.311	0.005	0.140	415.232
	175	0.224	2.245	1.699	0.005	0.084	415.232
Cranes	50	0.562	2.556	1.998	0.003	0.128	244.589
	120	0.265	1.681	1.618	0.003	0.117	244.589
	175	0.197	1.447	1.239	0.003	0.068	244.589
	250	0.154	0.532	1.079	0.003	0.037	244.589
	500	0.148	0.521	0.957	0.002	0.035	244.589
	750	0.148	0.521	0.985	0.002	0.035	244.589
	9999	0.169	0.553	1.774	0.002	0.045	244.589
Crawler Tractors	50	1.023	4.055	3.083	0.005	0.220	364.039
	120	0.460	2.560	2.709	0.004	0.205	364.039
	175	0.337	2.193	2.148	0.004	0.120	364.039
	250	0.260	0.869	1.903	0.004	0.069	364.039
	500	0.247	0.936	1.709	0.004	0.064	364.039
	750	0.248	0.936	1.750	0.004	0.065	364.039
	1000	0.267	1.022	2.882	0.004	0.079	364.039
Crushing/Proc. Equipment	50	0.740	4.068	3.394	0.006	0.182	443.672
	120	0.369	2.906	2.537	0.005	0.161	443.672
	175	0.287	2.525	1.868	0.005	0.098	443.672

2020		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	250	0.226	0.879	1.573	0.005	0.051	443.672
	500	0.220	0.842	1.405	0.004	0.049	443.672
	750	0.220	0.842	1.433	0.004	0.049	443.672
	9999	0.258	0.900	2.888	0.004	0.070	443.672
Dumpers/Tenders	25	0.261	0.890	1.649	0.003	0.063	216.148
Excavators	25	0.391	1.335	2.472	0.004	0.092	324.222
	50	0.498	3.170	2.413	0.004	0.104	324.222
	120	0.257	2.193	1.637	0.004	0.091	324.222
	175	0.203	1.918	1.117	0.004	0.056	324.222
	250	0.169	0.669	0.918	0.004	0.031	324.222
	500	0.166	0.637	0.836	0.003	0.030	324.222
	750	0.166	0.637	0.850	0.003	0.031	324.222
Forklifts	50	0.220	1.626	1.257	0.002	0.045	170.643
	120	0.122	1.148	0.784	0.002	0.040	170.643
	175	0.102	1.009	0.535	0.002	0.026	170.643
	250	0.085	0.344	0.412	0.002	0.014	170.643
	500	0.084	0.327	0.384	0.002	0.013	170.643
Generator Sets	15	0.479	2.627	3.345	0.007	0.158	420.920
	25	0.534	1.832	3.362	0.005	0.152	420.920
	50	0.512	2.959	3.019	0.005	0.144	420.920
	120	0.270	2.504	2.351	0.005	0.133	420.920
	175	0.198	2.170	1.763	0.005	0.078	420.920
	250	0.147	0.760	1.493	0.005	0.043	420.920
	500	0.140	0.745	1.346	0.004	0.041	420.920
	750	0.142	0.745	1.377	0.004	0.042	420.920
	9999	0.179	0.802	2.673	0.004	0.059	420.920
Graders	50	0.710	3.480	2.716	0.004	0.156	346.974
	120	0.342	2.356	2.115	0.004	0.144	346.974
	175	0.257	2.039	1.574	0.004	0.085	346.974
	250	0.201	0.742	1.351	0.004	0.046	346.974
	500	0.194	0.751	1.207	0.003	0.044	346.974
	750	0.195	0.751	1.240	0.003	0.044	346.974
Off-Highway Tractors	120	0.574	2.678	3.322	0.004	0.266	369.727
	175	0.412	2.275	2.754	0.004	0.155	369.727
	250	0.325	1.025	2.507	0.004	0.099	369.727
	750	0.305	1.227	2.313	0.004	0.090	369.727
	1000	0.324	1.339	3.370	0.004	0.100	369.727
Off-Highway Trucks	175	0.217	1.954	1.183	0.004	0.061	324.222
	250	0.181	0.684	0.982	0.004	0.034	324.222
	500	0.177	0.648	0.891	0.003	0.033	324.222
	750	0.177	0.648	0.907	0.003	0.033	324.222
	1000	0.188	0.670	2.021	0.003	0.047	324.222
Other Construction Equipment	15	0.411	2.153	2.571	0.005	0.100	352.663
	25	0.425	1.452	2.688	0.004	0.100	352.663
	50	0.414	2.856	2.465	0.005	0.099	352.663
	120	0.219	2.216	1.672	0.004	0.087	352.663
	175	0.174	1.940	1.130	0.004	0.054	352.663
	500	0.140	0.649	0.841	0.003	0.029	352.663

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2020		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Other General Industrial Equipment	15	0.301	1.771	2.115	0.005	0.083	290.093
	25	0.350	1.194	2.211	0.004	0.083	290.093
	50	0.564	2.936	2.318	0.004	0.132	290.093
	120	0.278	1.976	1.762	0.003	0.118	290.093
	175	0.215	1.713	1.323	0.003	0.071	290.093
	250	0.168	0.599	1.118	0.003	0.036	290.093
	500	0.163	0.569	0.997	0.003	0.035	290.093
	750	0.164	0.569	1.020	0.003	0.035	290.093
	1000	0.178	0.611	1.984	0.003	0.050	290.093
Other Material Handling Equipment	50	0.645	3.357	2.674	0.004	0.153	335.598
	120	0.318	2.274	2.035	0.004	0.136	335.598
	175	0.246	1.971	1.529	0.004	0.082	335.598
	250	0.192	0.689	1.292	0.004	0.042	335.598
	500	0.187	0.656	1.152	0.003	0.040	335.598
	9999	0.221	0.705	2.291	0.003	0.057	335.598
Pavers	25	0.426	1.452	2.697	0.004	0.104	352.663
	50	1.052	3.850	3.021	0.005	0.231	352.663
	120	0.464	2.449	2.789	0.004	0.218	352.663
	175	0.335	2.089	2.251	0.004	0.126	352.663
	250	0.256	0.855	2.015	0.004	0.074	352.663
	500	0.241	0.953	1.808	0.003	0.068	352.663
Paving Equipment	25	0.364	1.241	2.298	0.004	0.086	301.470
	50	0.885	3.247	2.575	0.004	0.197	301.470
	120	0.392	2.081	2.368	0.004	0.187	301.470
	175	0.282	1.774	1.911	0.003	0.107	301.470
	250	0.213	0.713	1.708	0.003	0.061	301.470
Plate Compactors	15	0.285	1.493	1.783	0.004	0.070	244.589
Pressure Washers	15	0.194	1.065	1.356	0.003	0.064	170.643
	25	0.217	0.743	1.363	0.002	0.062	170.643
	50	0.150	1.019	1.176	0.002	0.048	170.643
	120	0.090	0.969	0.912	0.002	0.045	170.643
Pumps	15	0.542	2.627	3.365	0.007	0.169	420.920
	25	0.570	1.832	3.362	0.005	0.157	420.920
	50	0.560	3.109	3.058	0.005	0.153	420.920
	120	0.286	2.543	2.385	0.005	0.140	420.920
	175	0.212	2.203	1.791	0.005	0.082	420.920
	250	0.158	0.772	1.519	0.005	0.044	420.920
	500	0.150	0.754	1.364	0.004	0.043	420.920
	750	0.152	0.754	1.396	0.004	0.043	420.920
	9999	0.189	0.812	2.703	0.004	0.060	420.920
Rollers	15	0.371	1.945	2.322	0.005	0.091	318.534
	25	0.364	1.312	2.428	0.004	0.091	318.534
	50	0.666	2.986	2.499	0.004	0.157	318.534
	120	0.311	2.092	2.052	0.004	0.146	318.534
	175	0.228	1.801	1.570	0.004	0.084	318.534
	250	0.175	0.666	1.369	0.004	0.046	318.534
	500	0.167	0.670	1.215	0.003	0.044	318.534
Rough Terrain Forklifts	50	0.525	3.197	2.577	0.004	0.123	341.286

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2020		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	120	0.270	2.264	1.818	0.004	0.108	341.286
	175	0.215	1.975	1.287	0.004	0.067	341.286
	250	0.176	0.688	1.075	0.004	0.036	341.286
	500	0.172	0.657	0.969	0.003	0.035	341.286
Rubber Tired Dozers	175	0.391	2.106	2.582	0.004	0.146	335.598
	250	0.311	0.965	2.359	0.004	0.094	335.598
	500	0.290	1.175	2.137	0.003	0.085	335.598
	750	0.291	1.175	2.178	0.003	0.086	335.598
	1000	0.308	1.278	3.133	0.003	0.095	335.598
Rubber Tired Loaders	25	0.371	1.265	2.342	0.004	0.087	307.158
	50	0.606	3.037	2.390	0.004	0.135	307.158
	120	0.293	2.073	1.840	0.004	0.124	307.158
	175	0.222	1.796	1.362	0.003	0.073	307.158
	250	0.175	0.651	1.166	0.003	0.040	307.158
	500	0.169	0.650	1.041	0.003	0.038	307.158
	750	0.169	0.650	1.070	0.003	0.038	307.158
	1000	0.180	0.681	2.069	0.003	0.051	307.158
Scrapers	120	0.531	2.884	3.127	0.005	0.240	409.544
	175	0.387	2.467	2.495	0.005	0.140	409.544
	250	0.298	0.986	2.218	0.005	0.081	409.544
	500	0.282	1.077	1.990	0.004	0.074	409.544
	750	0.283	1.077	2.039	0.004	0.075	409.544
Signal Boards	15	0.543	2.848	3.400	0.007	0.133	466.425
	50	0.616	3.473	3.226	0.006	0.161	443.672
	120	0.308	2.736	2.447	0.005	0.146	443.672
	175	0.233	2.376	1.803	0.005	0.087	443.672
	250	0.215	1.001	1.835	0.006	0.056	536.104
Skid Steer Loaders	25	0.388	1.303	2.426	0.004	0.099	312.846
	50	0.282	2.459	2.029	0.004	0.053	312.846
	120	0.159	1.955	1.205	0.004	0.047	312.846
Surfacing Equipment	50	0.481	2.161	1.939	0.003	0.115	255.965
	120	0.229	1.617	1.620	0.003	0.109	255.965
	175	0.164	1.392	1.244	0.003	0.063	255.965
	250	0.124	0.523	1.086	0.003	0.036	255.965
	500	0.117	0.547	0.972	0.003	0.033	255.965
	750	0.118	0.547	0.999	0.003	0.034	255.965
Sweepers/Scrubbers	15	0.401	2.362	2.820	0.006	0.110	386.791
	25	0.467	1.593	2.949	0.005	0.110	386.791
	50	0.520	3.542	2.890	0.005	0.118	386.791
	120	0.283	2.554	1.890	0.005	0.106	386.791
	175	0.233	2.237	1.340	0.004	0.069	386.791
	250	0.190	0.763	1.065	0.004	0.036	386.791
Tractors/Loaders/Backhoes	25	0.377	1.288	2.385	0.004	0.090	312.846
	50	0.420	2.846	2.246	0.004	0.090	312.846
	120	0.221	2.058	1.492	0.004	0.078	312.846
	175	0.176	1.802	0.994	0.004	0.049	312.846
	250	0.148	0.628	0.807	0.004	0.028	312.846
	500	0.146	0.603	0.738	0.004	0.027	312.846
	750	0.146	0.602	0.750	0.004	0.027	312.846

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November 2007

2020		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Trenchers	15	0.497	2.605	3.110	0.007	0.122	426.608
	25	0.515	1.757	3.252	0.005	0.122	426.608
	50	1.284	4.529	3.634	0.006	0.283	426.608
	120	0.558	2.921	3.434	0.005	0.268	426.608
	175	0.399	2.488	2.791	0.005	0.155	426.608
	250	0.306	1.047	2.511	0.005	0.093	426.608
	500	0.287	1.194	2.260	0.004	0.085	426.608
	750	0.288	1.193	2.311	0.004	0.086	426.608
Welders	15	0.330	1.597	2.046	0.004	0.102	255.965
	25	0.346	1.114	2.044	0.003	0.096	255.965
	50	0.422	2.180	1.939	0.003	0.108	255.965
	120	0.205	1.624	1.510	0.003	0.098	255.965
	175	0.155	1.406	1.137	0.003	0.058	255.965
	250	0.118	0.492	0.965	0.003	0.030	255.965
	500	0.114	0.475	0.861	0.003	0.029	255.965
Water Trucks	175	0.217	1.954	1.183	0.004	0.061	324.222
	250	0.181	0.684	0.982	0.004	0.034	324.222
	500	0.177	0.648	0.891	0.003	0.033	324.222
	750	0.177	0.648	0.907	0.003	0.033	324.222
	1000	0.188	0.670	2.021	0.003	0.047	324.222

Response to Comment No. 11-45

Appendix A from the Software User's Guide: URBEMIS2007 for Windows presented above is outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" with respect to cumulative impacts within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5.

However, this document is referenced in the DEIR. (See DEIR Volume I, Sections 4.2.5.1, 4.7.3.1, 4.7.5.2, 4.7.5.3.)

Comment Letter No. 11 (continued)

Comment No. 11-46

Demographia

USA Urbanized Areas Over 500,000: 2000 Rankings

CORRECTIONS TO TABLE BELOW

On 25 August, the US Census Bureau released the following urbanized area corrections for 2000. Tables will be updated to reflect this information in the future.

Urbanized Area	Population	Land Area (Square Miles)	Population per Square Mile
Fort Collins, CO	206,757	83.7	2,472
Hanford, CA (New)	69,639	25.5	2,734
Holland, MI	91,921	48.0	1,917
San Francisco--Oakland, CA	3,228,605	526.7	6,130
San Rafael--Novato, CA (now included in San Francisco-Oakland)	0	0.0	0

RANK BY POPULATION

Rank	Urbanized Area	Population	Square Miles	Population Density
1	New York--Newark, NY--NJ--CT	17,799,861	3,353	5,309
2	Los Angeles--Long Beach--Santa Ana, CA	11,789,487	1,668	7,068
3	Chicago, IL--IN	8,307,904	2,123	3,914
4	Philadelphia, PA--NJ--DE--MD	5,149,079	1,799	2,861
5	Miami, FL	4,919,036	1,116	4,407
6	Dallas--Fort Worth--Arlington, TX	4,145,659	1,407	2,946
7	Boston, MA--NH--RI	4,032,484	1,736	2,323
8	Washington, DC--VA--MD	3,933,920	1,157	3,401
9	Detroit, MI	3,903,377	1,261	3,094
10	Houston, TX	3,822,509	1,295	2,951
11	Atlanta, GA	3,499,840	1,963	1,783
12	San Francisco--Oakland, CA	2,995,769	428	7,004
13	Phoenix--Mesa, AZ	2,907,049	799	3,638
14	Seattle, WA	2,712,205	954	2,844
15	San Diego, CA	2,674,436	782	3,419
16	Minneapolis--St. Paul, MN	2,388,593	894	2,671
17	St. Louis, MO--IL	2,077,662	829	2,506
18	Baltimore, MD	2,076,354	683	3,041
19	Tampa--St. Petersburg, FL	2,062,339	802	2,571
20	Denver--Aurora, CO	1,984,887	499	3,979
21	Cleveland, OH	1,786,647	647	2,761
22	Pittsburgh, PA	1,753,136	852	2,057
23	Portland, OR--WA	1,583,138	474	3,340
24	San Jose, CA	1,538,312	260	5,914
25	Riverside--San Bernardino, CA	1,506,816	439	3,434
26	Cincinnati, OH--KY--IN	1,503,262	672	2,238

27	Virginia Beach, VA	1,394,439	527	2,647
28	Sacramento, CA	1,393,498	369	3,776
29	Kansas City, MO--KS	1,361,744	584	2,330
30	San Antonio, TX	1,327,554	408	3,257
31	Las Vegas, NV	1,314,357	286	4,597
32	Milwaukee, WI	1,308,913	487	2,688
33	Indianapolis, IN	1,218,919	553	2,205
34	Providence, RI--MA	1,174,548	504	2,332
35	Orlando, FL	1,157,431	453	2,554
36	Columbus, OH	1,133,193	398	2,849
37	New Orleans, LA	1,009,283	198	5,102
38	Buffalo, NY	976,703	367	2,664
39	Memphis, TN--MS--AR	972,091	400	2,431
40	Austin, TX	901,920	318	2,835
41	Bridgeport--Stamford, CT--NY	888,890	465	1,910
42	Salt Lake City, UT	887,650	231	3,847
43	Jacksonville, FL	882,295	411	2,149
44	Louisville, KY--IN	863,582	391	2,207
45	Hartford, CT	851,535	469	1,814
46	Richmond, VA	818,836	437	1,875
47	Charlotte, NC--SC	758,927	435	1,745
48	Nashville-Davidson, TN	749,935	431	1,741
49	Oklahoma City, OK	747,003	322	2,317
50	Tucson, AZ	720,425	291	2,473
51	Honolulu, HI	718,182	154	4,660
52	Dayton, OH	703,444	324	2,174
53	Rochester, NY	694,396	295	2,353
54	El Paso, TX--NM	674,801	219	3,080
55	Birmingham, AL	663,615	392	1,693
56	Omaha, NE--IA	626,623	226	2,768
57	Albuquerque, NM	598,191	224	2,671
58	Allentown--Bethlehem, PA--NJ	576,408	289	1,991
59	Springfield, MA--CT	573,610	309	1,857
60	Akron, OH	570,215	308	1,853
61	Sarasota--Bradenton, FL	559,229	270	2,068
62	Albany, NY	558,947	284	1,966
63	Tulsa, OK	558,329	261	2,136
64	Fresno, CA	554,923	139	4,003
65	Concord, CA	552,624	176	3,132
66	Raleigh, NC	541,527	320	1,694
67	Grand Rapids, MI	539,080	257	2,095
68	Mission Viejo, CA	533,015	137	3,894
69	New Haven, CT	531,314	285	1,862
70	McAllen, TX	523,144	314	1,667
71	Toledo, OH--MI	503,008	202	2,486
	Total	140,022,057	44,013	3,181

RANK BY LAND AREA

			Square	Population

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Rank	Urbanized Area	Population	Miles	Density
1	New York--Newark, NY--NJ--CT	17,799,861	3,353	5,309
2	Chicago, IL--IN	8,307,904	2,123	3,914
3	Atlanta, GA	3,499,840	1,963	1,783
4	Philadelphia, PA--NJ--DE--MD	5,149,079	1,799	2,861
5	Boston, MA--NH--RI	4,032,484	1,736	2,323
6	Los Angeles--Long Beach--Santa Ana, CA	11,789,487	1,668	7,068
7	Dallas--Fort Worth--Arlington, TX	4,145,659	1,407	2,946
8	Houston, TX	3,822,509	1,295	2,951
9	Detroit, MI	3,903,377	1,261	3,094
10	Washington, DC--VA--MD	3,933,920	1,157	3,401
11	Miami, FL	4,919,036	1,116	4,407
12	Seattle, WA	2,712,205	954	2,844
13	Minneapolis--St. Paul, MN	2,388,593	894	2,671
14	Pittsburgh, PA	1,753,136	852	2,057
15	St. Louis, MO--IL	2,077,662	829	2,506
16	Tampa--St. Petersburg, FL	2,062,339	802	2,571
17	Phoenix--Mesa, AZ	2,907,049	799	3,638
18	San Diego, CA	2,674,436	782	3,419
19	Baltimore, MD	2,076,354	683	3,041
20	Cincinnati, OH--KY--IN	1,503,262	672	2,238
21	Cleveland, OH	1,786,647	647	2,761
22	Kansas City, MO--KS	1,361,744	584	2,330
23	Indianapolis, IN	1,218,919	553	2,205
24	Virginia Beach, VA	1,394,439	527	2,647
25	Providence, RI--MA	1,174,548	504	2,332
26	Denver--Aurora, CO	1,984,887	499	3,979
27	Milwaukee, WI	1,308,913	487	2,688
28	Portland, OR--WA	1,583,138	474	3,340
29	Hartford, CT	851,535	469	1,814
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31	Orlando, FL	1,157,431	453	2,554
32	Riverside--San Bernardino, CA	1,506,816	439	3,434
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35	Nashville-Davidson, TN	749,935	431	1,741
36	San Francisco--Oakland, CA	2,995,769	428	7,004
37	Jacksonville, FL	882,295	411	2,149
38	San Antonio, TX	1,327,554	408	3,257
39	Memphis, TN--MS--AR	972,091	400	2,431
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41	Birmingham, AL	663,615	392	1,693
42	Louisville, KY--IN	863,582	391	2,207
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44	Buffalo, NY	976,703	367	2,664
45	Dayton, OH	703,444	324	2,174
46	Oklahoma City, OK	747,003	322	2,317
47	Raleigh, NC	541,527	320	1,694
48	Austin, TX	901,920	318	2,835

49	McAllen, TX	523,144	314	1,667
50	Springfield, MA--CT	573,610	309	1,857
51	Akron, OH	570,215	308	1,853
52	Rochester, NY	694,396	295	2,353
53	Tucson, AZ	720,425	291	2,473
54	Allentown--Bethlehem, PA--NJ	576,408	289	1,991
55	Las Vegas, NV	1,314,357	286	4,597
56	New Haven, CT	531,314	285	1,862
57	Albany, NY	558,947	284	1,966
58	Sarasota--Bradenton, FL	559,229	270	2,068
59	Tulsa, OK	558,329	261	2,136
60	San Jose, CA	1,538,312	260	5,914
61	Grand Rapids, MI	539,080	257	2,095
62	Salt Lake City, UT	887,650	231	3,847
63	Omaha, NE--IA	626,623	226	2,768
64	Albuquerque, NM	598,191	224	2,671
65	El Paso, TX--NM	674,801	219	3,080
66	Toledo, OH--MI	503,008	202	2,486
67	New Orleans, LA	1,009,283	198	5,102
68	Concord, CA	552,624	176	3,132
69	Honolulu, HI	718,182	154	4,660
70	Fresno, CA	554,923	139	4,003
71	Mission Viejo, CA	533,015	137	3,894

RANK BY DENSITY

Rank	Urbanized Area	Population	Square Miles	Population Density
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2	San Francisco--Oakland, CA	2,995,769	428	7,004
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Response to Comment No. 11-46

The listing of "USA Urbanized Areas Over 500,000: 2000 Rankings" presented above is outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" with respect to cumulative impacts within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5.

This comment is noted for the record and will be forwarded to the decision makers.

Comment Letter No. 11 (continued)

Comment No. 11-47

Demographia

USA Urbanized Areas Over 500,000: 2000 Rankings

CORRECTIONS TO TABLE BELOW

On 25 August, the US Census Bureau released the following urbanized area corrections for 2000. Tables will be updated to reflect this information in the future.

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6	Los Angeles--Long Beach--Santa Ana, CA	11,789,487	1,668	7,068
7	Dallas--Fort Worth--Arlington, TX	4,145,659	1,407	2,946
8	Houston, TX	3,822,509	1,295	2,951
9	Detroit, MI	3,903,377	1,261	3,094
10	Washington, DC--VA--MD	3,933,920	1,157	3,401
11	Miami, FL	4,919,036	1,116	4,407
12	Seattle, WA	2,712,205	954	2,844
13	Minneapolis--St. Paul, MN	2,388,593	894	2,671
14	Pittsburgh, PA	1,753,136	852	2,057
15	St. Louis, MO--IL	2,077,662	829	2,506
16	Tampa--St. Petersburg, FL	2,062,339	802	2,571
17	Phoenix--Mesa, AZ	2,907,049	799	3,638
18	San Diego, CA	2,674,436	782	3,419
19	Baltimore, MD	2,076,354	683	3,041
20	Cincinnati, OH--KY--IN	1,503,262	672	2,238
21	Cleveland, OH	1,786,647	647	2,761
22	Kansas City, MO--KS	1,361,744	584	2,330
23	Indianapolis, IN	1,218,919	553	2,205
24	Virginia Beach, VA	1,394,439	527	2,647
25	Providence, RI--MA	1,174,548	504	2,332
26	Denver--Aurora, CO	1,984,887	499	3,979
27	Milwaukee, WI	1,308,913	487	2,688
28	Portland, OR--WA	1,583,138	474	3,340
29	Hartford, CT	851,535	469	1,814
30	Bridgeport--Stamford, CT--NY	888,890	465	1,910
31	Orlando, FL	1,157,431	453	2,554
32	Riverside--San Bernardino, CA	1,506,816	439	3,434
33	Richmond, VA	818,836	437	1,875
34	Charlotte, NC--SC	758,927	435	1,745
35	Nashville-Davidson, TN	749,935	431	1,741
36	San Francisco--Oakland, CA	2,995,769	428	7,004
37	Jacksonville, FL	882,295	411	2,149
38	San Antonio, TX	1,327,554	408	3,257
39	Memphis, TN--MS--AR	972,091	400	2,431
40	Columbus, OH	1,133,193	398	2,849
41	Birmingham, AL	663,615	392	1,693
42	Louisville, KY--IN	863,582	391	2,207
43	Sacramento, CA	1,393,498	369	3,776
44	Buffalo, NY	976,703	367	2,664
45	Dayton, OH	703,444	324	2,174
46	Oklahoma City, OK	747,003	322	2,317
47	Raleigh, NC	541,527	320	1,694
48	Austin, TX	901,920	318	2,835

49	McAllen, TX	523,144	314	1,667
50	Springfield, MA--CT	573,610	309	1,857
51	Akron, OH	570,215	308	1,853
52	Rochester, NY	694,396	295	2,353
53	Tucson, AZ	720,425	291	2,473
54	Allentown--Bethlehem, PA--NJ	576,408	289	1,991
55	Las Vegas, NV	1,314,357	286	4,597
56	New Haven, CT	531,314	285	1,862
57	Albany, NY	558,947	284	1,966
58	Sarasota--Bradenton, FL	559,229	270	2,068
59	Tulsa, OK	558,329	261	2,136
60	San Jose, CA	1,538,312	260	5,914
61	Grand Rapids, MI	539,080	257	2,095
62	Salt Lake City, UT	887,650	231	3,847
63	Omaha, NE--IA	626,623	226	2,768
64	Albuquerque, NM	598,191	224	2,671
65	El Paso, TX--NM	674,801	219	3,080
66	Toledo, OH--MI	503,008	202	2,486
67	New Orleans, LA	1,009,283	198	5,102
68	Concord, CA	552,624	176	3,132
69	Honolulu, HI	718,182	154	4,660
70	Fresno, CA	554,923	139	4,003
71	Mission Viejo, CA	533,015	137	3,894

RANK BY DENSITY

Rank	Urbanized Area	Population	Square Miles	Population Density
1	Los Angeles--Long Beach--Santa Ana, CA	11,789,487	1,668	7,068
2	San Francisco--Oakland, CA	2,995,769	428	7,004
3	San Jose, CA	1,538,312	260	5,914
4	New York--Newark, NY--NJ--CT	17,799,861	3,353	5,309
5	New Orleans, LA	1,009,283	198	5,102
6	Honolulu, HI	718,182	154	4,660
7	Las Vegas, NV	1,314,357	286	4,597
8	Miami, FL	4,919,036	1,116	4,407
9	Fresno, CA	554,923	139	4,003
10	Denver--Aurora, CO	1,984,887	499	3,979
11	Chicago, IL--IN	8,307,904	2,123	3,914
12	Mission Viejo, CA	533,015	137	3,894
13	Salt Lake City, UT	887,650	231	3,847
14	Sacramento, CA	1,393,498	369	3,776
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42	Tucson, AZ	720,425	291	2,473
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53	Jacksonville, FL	882,295	411	2,149
54	Tulsa, OK	558,329	261	2,136
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69	Raleigh, NC	541,527	320	1,694
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Response to Comment No. 11-47

This comment is a duplicate of Comment No. 11-46; refer to Response to Comment No. 11-46, above.

BY ELECTRONIC MAIL AND FACSIMILE

April 3, 2012

Gina Gibson, Planner
City of Rialto
150 S. Palm Avenue
Rialto, CA 92376-6487
ggibson@rialtoca.gov

RE: Proposed Lytle Creek Ranch Specific Plan Recirculated Draft Environmental Impact Report

Dear Ms. Gibson:

The Endangered Habitats League (EHL) is pleased to provide the following comments on the Recirculated Draft Environmental Impact Report (RDEIR) for the Lytle Creek Ranch Specific Plan (the "Project"). EHL also joins in the comments submitted concurrently by Chatten-Brown & Carstens on behalf of Save Lytle Creek Wash (SLCW).

Although the RDEIR purports to remedy the deficiencies in the original EIR the court found in *Endangered Habitats League v. City of Rialto* (Case No. CIVDS 1011874), it fails to provide the accurate and good faith analysis of the Project's impact on climate change-inducing greenhouse gas emissions and on traffic, in addition to the issues identified by SLCW. The RDEIR thus does not provide an adequate basis for the City to re-approve the Project consistent with CEQA.

The RDEIR Fails to Provide an Accurate Picture of the Project's Contribution to Climate Change.

The trial court found the original EIR's treatment of GHG emissions inadequate because it failed to adequately explain the basis for its claim that the Project would result in an overall 32.6% reduction in emissions from a Business As Usual (BAU) scenario. Despite this finding, the RDEIR essentially repeats in substance the earlier analysis. It is still a mystery exactly how these reductions will be achieved and to what extent *Project* features (as opposed to contextual changes) is responsible for these claimed reductions.

For example, the RDEIR claims that operational GHG emissions from transportation sources—totaling over half of total emissions associated with the Project (RDEIR Table 2.1-31 at p. 2-87)—will decline by 43% from a BAU scenario (see Table 2.1-40, at p. 2-99). Excluding the benefits of the Pavley low emissions requirements for autos contained in AB 1493,[1]

[1] Signed into law in 2002, AB 1493 requires carmakers to reduce GHG emissions from new passenger cars and light trucks beginning in 2011. The California Air Resources Board (CARB) adopted regulations

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emissions would decline by a whopping 29% (id) from a BAU scenario, apparently solely from what the RDEIR cryptically refers to as "project design features"—a reduction absolutely necessary to support a "less-than significant" conclusion with respect to GHG emissions. (RDEIR at p. 2-93.)

As applied to mobile source emissions, project design will:

"(1) . . . provide physical linkages between land uses that promote walking and bicycling and provide alternatives to automobile use; (2) … link together parks and other activity nodes on the site via a 23.5-acre 'Grand Paseo'; (3) … reduce its footprint and allow for transportation and open space corridors; (4). . . [have] commercial areas [that are] centrally located and walkable; and(5) [have] a circulation system . . . designed to encourage residents to make multiple stops per trip." (RDEIR at p. 2-85.)

These vague "project design features" are all well and good, but how do these features realistically translate into travel behavior changes so fundamental that they collectively account for GHG emissions reductions that are roughly *double* the emissions reductions attributable to aggressive vehicle and fuel technology mandates? (See Table 2.1-40, at p. 2-99 [attributing approximately 14% of reductions to AB 1493 out of a total of 43%].) The RDEIR itself "leaves the reader in the dark" as to how these massive reductions from travel behavior are achieved. (See Court Order at p. 20.)

The study contained in the RDEIR technical appendix purports to describe the analytical methodology, but close scrutiny actually raises more questions than answers. The RDEIR's "Revised Climate Change Technical Report" by ENVIRON states that mobile source GHG emissions were calculated using URBEMIS, an urban emissions model designed to estimate air emissions from land use development projects. According to the technical report, total daily vehicle trips from the Project with its "design features" would total 49,964, while an "unmitigated" hypothetical development without those design features would generate 70,377 trips, a whopping 41% increase. (ENVIRON Report at Table 5-7, p. 127.) In other words, the Project would be so innovative and so significantly depart from the typical ex-urban auto-dependent development that walking, bicycling, transit and trip chaining would replace almost one out of every three trips that would otherwise be taken by a car—over 20,000 trips per day.

To put this startling claim into perspective, the Inland Empire is currently one of the most auto-dependent places on the planet. The Lincoln Land Institute estimated U.S. GHG emissions from the transportation sector (Brown et al. 2008) and ranked the Riverside-San Bernardino-

in 2004, which took effect in 2009 with the release of a waiver from the US Environmental Protection Agency (EPA) granting California the right to implement the bill. CARB anticipates that the Pavley standards will reduce GHG emissions from new California passenger vehicles by about 22% in 2012 and about 30% in 2016, all while improving fuel efficiency and reducing motorists' costs.

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Ontario metropolitan area near the bottom—number 92 out of the 100 U.S. metro areas in terms of the highest GHG emissions per capita from transportation (1.89 metric tons per person in the Inland Empire versus 1.30 for the 100-metro average). This is largely because the region as a whole "lacks a well developed transit infrastructure and an existing mixed-use land use pattern to build on. *Land use and transit system changes occur over many decades.*"[2] (Emphasis added.) An already severe regional jobs-housing imbalance exacerbates this trend.

According to the San Bernardino Association of Governments' 2011 Non-Motorized Vehicle Transportation Plan, currently only about one out every 300 trips to work in the County is taken on a bicycle (0.038%). Over the next 20 years, or by 2030 (build-out year for the Project), SANBAG hopes to increase this share to 0.53%, or about one in every 200 work trips. Similarly, about one of every seventy-five work trips is a walking one (1.53%).[3] According to the SCAG 2012 Regional Transportation Plan PEIR, total transit mode share for all trips for the County is currently at 0.58%, or a little more than one of every 200 trips. (See SCAG 2012 RTP PEIR, Table 3.2-16 at p 3.12-11.) These statistics are in sharp contrast to the claims of the RDEIR that about *one of every three* of total trips generated by the residential portions of the Project will use alternative transportation modes or trip-chaining.

Similarly, GHG emissions reductions from land use and transportation for the entire SCAG region under SB 375 is 16% by 2035. (See SCAG 201 RTP Performance Measures Appendix at p. 13.) If the RDEIR's conclusions are to be believed, the Project's 29% reduction from project design features would likely vastly out-perform most new development in the region—including urban infill in dense Los Angeles County—despite the project's location in one of the most auto-dependent sub-regions in the SCAG region.

How is what can only be called a *miraculous* transformation in travel behavior—when viewed in light of the sobering regional statistics cited above—by the eventual occupants of the Project to be achieved? The ENVIRON Technical Report does not specifically say. It only says that the increased density of the Project and other "project design features" are responsible. It also says that an unspecified "portion" of Project residents would take transit. How this translates into a massive 29% reduction in mobile source GHG emissions is not stated.

The Technical Report does assert that housing density scales with trip rates according to an equation it provides. (See ENVIRON Report at p. 124.) The Report also accurately states that the equation comes from Appendix D of the URBEMIS User's Guide. What the ENVIRON Report does *not* disclose, however, is that the URBEMIS User's Guide explicitly states that this equation *was derived from Los Angeles* and is consistent with empirically derived curves *for San Francisco and Chicago*. (See Appendix D of the URBEMIS User's Guide, at pp. D-14 and D-

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[2] Willson, Draft Travel Characteristics of Residents of Multi-Family Housing in the Inland Empire, (Leonard Transportation Center California State University San Bernardino, August 2010) at p. 3.

[3] See 2011 SANBAG Non-Motorized Transportation Plan, submitted concurrently

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15, submitted concurrently.) Unlike the Rialto area, these cities have the highest population densities in the nation, huge job bases and massive transit systems. Indeed, Los Angeles metropolitan area has the *highest* such density in the nation.[4]

Nothing in the Users Guide states that this formula is valid for the ex-urban fringes of Rialto in San Bernardino County. To the contrary, the Users Guide emphasizes that the effect of density on transportation behavior is highly context specific:

> "there is a significant, quantifiable relationship between residential density and automobile use (see Figure D-6), *but there is uncertainty regarding the degree to which this effect is due to the inherent effects of density, as opposed to factors for which density serves as a proxy, such as parking price, local retail, transit service frequency and pedestrian friendliness*." (URBEMIS Users Guide at p. D-13, emphasis added.)

The Users Guide also cautions that the values stated in the model are just a starting point; care should be taken to make sure the model is appropriate in a particular location: "[U]sers should recognize that travel behavior is very complex and difficult to predict. The component relies on the user to determine factors critical to travel behavior that are somewhat subjective." (Id. at p. D-3.) Indeed, the creators of URBEMIS underscored that it is not just density, but a combination of regional and sub-regional attributes that affect travel behavior:

- Net residential density (measured by Households per Residential Acre)
- Mix of uses (using a jobs/housing measure)
- Presence of local-serving retail
- Level of transit service (measured by a transit service index)
- Bicycle and pedestrian friendliness (measured by a "pedestrian factor" index based on intersection density, sidewalk completeness, and bike lane completeness) (URBEMIS2007 for Windows Users' Guide Appendix D – URBEMIS 2007 Mobile Source Mitigation Component, Page D-8 Version 9.2 November 2007)

[4] Los Angeles' average densities handily exceed even those of the New York City metropolitan area. As of the year 2000, average density in New York NY—Newark was 5, 309 residents per square mile while Los Angeles--Long Beach--Santa Ana, CA has 7,068 residents per square mile. San Francisco comes in second at 7,004 residents, while Chicago has 3,914 residents per square mile. (http://www.demographia.com/db-ua2000r.htm) Los Angeles also has relative robust transit. The region is second in the nation in transit patronage, behind only New York. Even on a market share basis (passenger transit miles traveled as a share of all miles traveled), Los Angeles's ridership rate is relatively high: 11th among the 50 largest urban areas. (http://www.freakonomics.com/2009/03/03/los-angeles-transportation-facts-and-fiction-transit/) Los Angeles is and will be very "jobs rich," while Rialto is and will be very "jobs poor." (See Maps 2 & 3: http://www.scag.ca.gov/Housing/pdfs/introduction.pdf)

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Neither the ENVIRON Report nor the RDEIR attempt to calculate the impact of these other factors, even though it is clear from the discussion above that on virtually all them the area around Rialto would fare very poorly. Nor is there any effort to quantify any of these factors (other than density) for the BAU scenario against which the Project is compared. Without knowing how much transit and cycling and walking infrastructure was assumed for the BAU scenario, it is impossible to make an informed comparison.

We do know, however, that on jobs/housing balance, both the region and the Project get a failing grade. Neither the City nor Real Parties disputed the following discussion of this issue in Petitioners' Opening Brief:

> "The Project would worsen the severe jobs/housing imbalance in the Inland Empire region. While 1.5 jobs per housing unit is considered to be a "standard" balance (T:11 P:909.), the City of Rialto had only 0.78 jobs per household in 1997, unincorporated San Bernardino County had a dismal ratio of 0.46. (T:11 P:917.) The EIR states that the Project's projected operational jobs-housing ratio is estimated to be 0.40 (3,398 jobs/8,407 units) jobs per dwelling unit (T:11 P:929), but the actual contribution to the imbalance could be much worse. While the Specific Plan contemplates 101 sq ft of retail/commercial space per dwelling unit (849,420 sq. ft/8,407 d/u), the actual development agreement would permit full build-out of the residential portion of the project after the completion of only 250,000 sq ft of retail commercial--resulting in only 29 sq ft per d/u. (T:8 P:121.) Using the EIR's assumption of one new primary job for every 250 square feet of commercial use (T:9 P:371), the Project could permissibly result in a jobs/housing ratio of about 0.12. The long commutes from this extreme imbalance would further contribute to adverse environmental impacts and congestion burdens on regional highways." (Opening Brief, at p. 4.)

On level of transit service, the ENVIRON report states merely that there are 34 Daily Weekday Buses and 19 Daily Rail or Rapid Transit Buses. (ENVIRON Report at p. 126.) There is no mention of head times, hours of service, or other key indicia of transit service. There is no reference to the funding these transit lines and they are not part of the Project; CEQA accordingly precludes assuming these benefits. (See *Save Our Peninsula Committee v. Monterey County Board of Supervisors* (2001) 87 Cal.App.4th 99; *Endangered Habitats League, Inc. v. County of Orange* (2005) 131 Cal.App.4th 777 [fee program must support traffic mitigation to be valid].) And current transit service levels in the Project area are almost nonexistent.

While the ENVIRON report also mentions that most streets will have sidewalks and there will be some bike lanes. However, this is also true of many newer, auto dependent communities. There is no showing or explanation how the presence of these amenities will cut the number of auto trips otherwise taken by nearly *one third*. For example, these same amenities exist in most parts of the auto-dependent city of Irvine, California.

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Most fundamentally, there is no discussion of how or whether the values and relationships in the sample equation lifted from the URBEMIS Users Guide accurately reflects the land use and transportation characteristics of the surrounding area, which is one of entrenched auto-dependency. Nor is there any discussion of how a relationship between travel behavior and density that was derived from urban, dense, and jobs and retail-rich Los Angeles is valid for Inland Empire jobs-starved residential sprawl. In summary, the GHG analysis takes a density number without properly factoring in the surrounding land use and transportation context, and disregards the other crucial factors.

Because the mobile source component is by far the largest source of GHG emissions, this lack of transparency and misapplication of the URBEMIS model is fatal to the revised GHG emissions analysis. Just as the trial court originally found in reviewing the adequacy of the GHG emissions reduction demonstration, "the discussion leaves the reader in the dark as to how the 32.6% reduction was arrived. [citations.] Substantial evidence is not demonstrated to support [the] conclusion" that GHG emissions are reduced to an insignificant level. (Judgment at p. 20.)

The Project Inappropriately Takes Credit for Underlying Regulatory Changes in Assessing GHG Emissions Reductions.

In calculating the purported GHG emissions reductions attributable to the Project, the RDEIR and supporting technical reports make clear that already enacted laws mandating decreased GHG emissions from light duty autos are included for purposes of assessing Project emissions, but are omitted for purposes of the future BAU land use scenario. The ENVIROM Report states that the BAU scenario uses "EMFAC2007 values for the year 2030, which are based upon past vehicle emission trends *and do not incorporate future regulatory actions."* (ENVIRON Report at p. 123, emphasis added; See also table 5-10, at p. 130; RDEIR at p. 2-92.)

The most prominent regulatory action, AB 1493, or the Pavley law, has already been enacted and is currently being implemented statewide. As a result, autos used by drivers in the hypothetical BAU community against which the Project is compared would also be subject to its mandates. There is consequently no reason why the Project alone should be credited with the GHG emissions benefits of AB 1493. Doing so misleads the reader into thinking that the Project is more beneficial than it really is when determining the significance of impacts.

To comply with CEQA, the GHG emissions impacts should be recalculated and reanalyzed after attributing the benefits of AB 1493 to both the Project and the hypothetical BAU land use scenario.

The RDEIR Uses an Improper Threshold of Significance to Assess GHG Impacts.

The threshold of significance for evaluating the Project's GHG emissions is articulated as follows:

> "Impede the State's ability to achieve the reduction to 1990 levels in GHG emissions required by California Global Warming Solutions Act of 2006 (AB 32). An impediment to the achievement of the GHG reduction goals of AB 32 would occur if Project-wide emissions are not reduced to achieve a 28.5 percent reduction of GHG emissions over 2020 forecasted BAU conditions." (RDEIR at p. 2-30.)

The implementation period for the Project spans a 20-year period commencing in 2014, meaning that the Project will not be built out and occupied until approximately 2034, about 14 years *after* the year 2020 emissions reduction goal of AB 32. This means that standards the Legislature deemed appropriate for the year 2020 are being arbitrarily applied to activities that will commence as late as 2034. This is absurd on its face.

Indeed, the State of California has recognized that AB 32 is only a *first step* in regulating GHG emissions, and that further reductions are needed urgently. For example, the Governor's Executive Order S-3-05 provides

> "That the following greenhouse gas emission reduction targets are hereby established for California: by 2010, reduce GHG emissions to 2000 levels; by 2020, reduce GHG emissions to 1990 levels; *by 2050, reduce GHG emissions to 80 percent below 1990 levels*"

For this reason, using a 2020-based standard for a project that will largely be built and come into operation well after that year could actually be counter-productive. The City therefore abused its discretion in setting this threshold for the Project.

Although other thresholds may also be appropriate, EHL suggests interpolating the 2050 standard of reductions equaling 80% below 1990 levels contained in Governor Schwarzenegger's Executive Order. Interpolating for the year 2034 would result in a goal of about 37% below 1990 levels by the year 2034.

The GHG emissions analysis must be re-done after a threshold method that is defensible for projects implemented in 2034 is developed.

Traffic Assumptions Used for the Traffic and GHG Analyses Are Internally Inconsistent.

In a footnote, the RDEIR acknowledges that for purposes of estimating traffic impacts, Crain and Associates estimates 47,545 added daily vehicle trips for the Project, while the GHG emissions analysis assumes 49,946 added weekday vehicle trips. (RDEIR at p. 2-95, n. 143.) Both cannot be right, and the RDEIR makes no effort to reconcile the two figures.

This discrepancy casts further doubt on the reliability of the methods used to assess both the traffic and GHG emission impacts.

The RDEIR's Traffic Analysis Fails to Employ a Consistent Baseline Premised on Existing Conditions in Violation of *Sunnyvale.*

A core CEQA requirement is that a Project's impacts must be measured against existing conditions, generally defined in the issuance of the Notice of Preparation of the EIR. In *Sunnyvale West Neighborhood Assn. v. City of Sunnyvale City Council* (2010) 190 Cal.App.4th 1351, the court invalidated an EIR for using hypothetical future traffic conditions as the baseline against which to measure the traffic impacts of a project. The trial court invalidated the EIR here for the same reason.

In revising the EIR to remedy the *Sunnyvale* problem, the City has again committed the legal error of failing to use *existing* conditions as the baseline against which to measure Project impacts on traffic. Instead of using existing 2011 conditions as required by *Sunnyvale*, the RDEIR uses 2011 only for the *transportation infrastructure* component of the existing environmental setting. For the levels of existing *traffic* against which the trips from the Project would be added, the City reaches nearly 5 years *back* in time to the year 2007. There is no explanation or justification provided for this internal discrepancy.

Although *Sunnyvale* invalidated the improper reliance on hypothetical *future* conditions, the same risk of misleading the public exists when *historical* conditions are used in lieu of *existing* conditions to assess a project. Intervening growth and impacts may not be accounted for. Moreover, if any date in the past could be used, then the analysis could be subject to manipulation to achieve a desired outcome. That is particularly true here, where the *supply* of transportation infrastructure has been maximized by updating the baseline to 2011, but where the traffic *demand* for that infrastructure may be potentially understated by holding the demand constant at 2007 rates. The RDEIR must be revised to employ a consistent baseline year.

Gina Gibson, Planner
City of Rialto
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Final Remarks

Thank you for your consideration of these comments. As always, EHL seeks to engage in a productive dialogue to find mutually acceptable solutions for all stakeholders. Should you wish to discuss the Project or any of the matters raised in EHL's or SLCW's letters, please contact the undersigned.

Respectfully submitted,

Dan Silver, MD
Executive Director

cc: Save Lytle Creek Wash

DEVELOPERS RESEARCH

To: Dan Silver, Endangered Habitat League

From: Barry Gross, Developers Research

RE: CBRE Report, December 2011

Date: April 2, 2012

At your request, Developers Research reviewed the *Financial Feasibility Analysis of the Lytle Creek Ranch Specific Plan Project and Alternatives to the Project Discussed in the Lytle Creek Ranch Specific Plan EIR* ("RDEIR") by CBRE Consulting dated December 2011. The purpose of this report is to compare various alternatives for development of this 2,447 acre parcel.

The Financial Feasibility Analysis states that it contains information provided to CBRE Consulting by: CBRE Valuation and Advisory Services, the Otte Berkeley Group, HM-2, Marketing Development and Reeb Development Consulting. These independent reports have been combined by CBRE Consulting to support the basis of their findings. This information has not been made available as part of the RDEIR or its appendices.

On Page iii of the letter from CBRE Valuation and Advisory Services to CBRE Consulting, there is a disclaimer titled Extraordinary Assumptions and Hypothetical Conditions. This disclaimer states,

> *"This is a Restricted Appraisal Report that is intended to comply with reporting requirements set forth under Standards Rule 2–2 (c) of the Uniform Standards of Professional Appraisal Practice for a Restricted Appraisal Report. As such, it does not include discussions of the data, reasoning, and analysis that we used in the appraisal process to develop the appraiser's opinion of value. Supporting documentation concerning the data, reasoning, and analyses is retained in the appraiser's file. The information contained in this report is specific to the needs of the client and for the intended use stated in this report. The appraiser is not responsible for unauthorized use of this report.*

Developers Research has pointed out several areas in our accompanying discussion where CBRE Consulting appears to have internal inconsistencies in their treatment of the data. However, as stated in the quotation above, supporting documentation has been withheld, largely precluding substantive critique of the conclusions reached in the document.

The report contains financial analyses for 5 project alternatives including:

1. Proposed Project
2. No Project / Existing Zoning
3. Avoidance of SBKR / LBV-Occupied Habitat
4. Avoidance of Riversidian Alluvium Fan Sage Scrub (RAFSS)
5. Avoidance of the Jurisdictional Waters

Financial Feasibility

The report makes an argument in favor of the proposed specific plan based on financial feasibility stating:

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> *"In order to obtain financing commitments for these high-risk projects, commercial developers must be able to demonstrate potential return on total capital investment of 15 to 25 percent to offset the significant risks related to entitlements, construction cost overruns, interest rate changes, capitalization rate changes and ups and downs in the local, national and international economy during the 15 to 20 year construction period that will affect future commercial and residential land prices."*

Figure 1 below is a summary of the IRR conclusions for each project shown in the CBRE Consulting report.

Figure 1

Project (Millions)	Gross Revenues	Net Dev. Costs	Developer Cash Flow	Developer IRR
Proposed Project	$654	$340	$314	15.2%
No Project/Existing	$234	$231	$3	0.3%
Avoidance of SBKR	$389	$316	$74	3.8%
Avoidance of Riversidian Alluvium Fan Sage Scrub (RAFSS)	$396	$306	$89	7.1%
Avoidance of Jurisdictional Waters	$311	$253	$58	5.3%

Based on the table reproduced above (Figure 1), CBRE concluded that the only feasible project for the 2,447 acre parcel is the proposed specific plan as it is the only project with an IRR greater than 15%.

Developers Research reviewed the various cash flows that produced the IRR figures listed above and compiled comments and questions on various aspects of the document. These issues are discussed below.

Commercial Revenue

The Proposed Project cash flow shows a total of $38.1 Million in revenues from Retail Town Center on a total of 849,000 sf. This equates to an average sales price of $44.81/sf. For sake of comparison, the SBKR Avoidance alternative shows $23.3 Million in Retail Town Center sales on a total of 820,000 sf. This equates to an average sales price of $28.41/sf.

Decreasing the Proposed Project's Commercial sales price to that of the other projects reduces the IRR by approximately 0.25% to 14.95%

Other alternatives commercial sales prices are similarly deflated relative to the Proposed Project. For comparison, a $44.81/sf Commercial sales price equates to approximately 150% of the prices for comparable land currently achieved in Irvine, CA, which is a higher priced market than Rialto, CA.

The RDEIR contains no explanation why the Commercial sales price per square foot increases dramatically only for the Proposed Project.

Commercial Revenue Inflation Rate

The Proposed Project has an anomalous Commercial Revenue Inflation Rate, which starts at 100% and increases to 170.24% by 2029. All other projects start at 100% and increase to 155.97% by 2029.

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Decreasing the Commercial Revenue Inflation Rate to that applied to the Project alternatives reduces the Proposed Project IRR by approximately 0.1%.

The RDEIR contains no explanation why the CBRE Commercial Revenue Inflation Rate is 3% for the Proposed Project while it is 2.5% for all other projects.

Commerical Revenue Conclusions

It appears the commercial revenues between the Proposed Project and Project Alternatives have not been given equal treatment in the CBRE Analysis. The result of this unequal treatment is a total of approximately 0.35% in additional IRR being attributed to the Proposed Project.

With the Commercial Revenues being treated equally between projects, the Proposed Project would have an IRR of 14.85%, below the investment threshold defined by CBRE.

Inconsistent Unit Counts

Developers Research compared the unit count for the Proposed Project to the detail provided in *Volume 1 Draft Environmental Impact Report State Clearinghouse No. 2009061113 Lytle Creek Specific Plan* and there is an inconsistency in Neighborhood III on Page 2-36. The Specific Plan states that Neighborhood III has 3,329 units but summing the individual line items yields 3,203 units. This arithmetic error is pervasive throughout the documents and into the CBRE report.

If the detail in the Specific Plan is correct, the Proposed Project should have 8,281 units instead of 8,407 units. For the sake of this memorandum, Developer's Research has assumed that this was an arithmetic error and the Proposed Project should have 8,281 units.

The obvious result of this error is that additional revenue is attributed to the Proposed Project. $3.5 million in Blue Top value or $7.3 million in Finished Lot value has been added because of these 126 extra units.

The addition of 126 units to the Proposed Project increases the IRR by approximately 0.2%.

Backbone Improvement Costs

Table 2 on page 20 of the appraisal titled, "Summary Comparison of Development Cost" includes estimated backbone costs prepared by the Otte-Berkeley Group. This table (Figure 2) includes backbone cost estimates for the various alternatives in the project, which may be summarized as follows:

Figure 2

Project	Backbone Costs	Units	Cost per Unit	Residential Acres	Cost per Residential Acre
Proposed Project	$216,048,588	8,281	$25,700	940	$229,800
No Project/Existing	$132,915,205	2,215	$60,000	940	$141,400
Avoidance of Riversidian Alluvium Fan Sage Scrub (RAFSS)	$137,128,640	4,873	$28,100	566	$242,300
Avoidance of Listed Species	$198,179,345	7,484	$26,500	841	$235,000
Waters of US and State	$191,776,660	5,846	$32,800	636	$301,500

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Developers Research has extensive experience preparing budgets for large-scale developments such as Lytle Creek and has reviewed over 8,000 different projects; however, we only were provided with specific plan level documents that did not indicate the type and size of specific improvements. As a result, analysis of these costs is not possible with the data provided. Our standard operating procedure for reviewing costs is to review maps and documents that indicate the specific quantity and specific location of each improvement. At a summary level, it appears that the Backbone Costs for the Proposed Project are too low and the alternative projects are too high; however, it is difficult to make an informed opinion without the detailed cost assumptions and review of a preliminary improvement plan. Generally, estimates of development costs before detailed drawings are made on a per-unit or acre basis, and the costs provided by Otte-Berkeley group are not linearly related to either acres or units.

Developers Research would like the opportunity to review the Otte-Berkeley Group's detailed cost to make an informed opinion on the reasonableness of these Backbone costs.

Impact Fees

The Otte-Berkeley Group included Impact Fees for the Proposed Project of approximately $21.3 million. Developers Research contacted the appropriate public agencies to obtain their impact fee schedules and our estimate of the Impact Fees for the proposed project is approximately $175 million. Figure 3 is the schedule of the impact fees that we obtained.

Figure 3

Agency	Unit	Description	Amount
Rialto Water Connection Fee 5/8 - 3/4 Inch - Displacement	DU	Detached	$5,100.00
Rialto Wastewater Collection Fee	DU	Detached	$1,200.00
Rialto Wastewater Connection Fee	DU	Detached	$2,170.00
Rialto General Facilities Fee	DU	Detached	$247.00
Rialto Open Space Fee	DU	Detached	$606.82
Rialto Open Space Fee	DU	Attached	$137.81
Rialto Traffic Fee	DU	Detached	$2,775.77
Rialto Traffic Fee	DU	Attached	$1,923.03
Rialto Park Fee	DU	Detached	$2,102.32
Rialto Park Fee	DU	Attached	$1,977.97
Rialto Library Fee	DU	Detached	$65.96
Rialto Library Fee	DU	Attached	$51.51
Rialto Law Enforcement Fee	DU	Detached	$422.00
Rialto Law Enforcement Fee	DU	Attached	$988.00
Rialto Fire Facilities Fee	DU	Detached	$390.00
Rialto Fire Facilities Fee	DU	Attached	$413.00
Rialto Storm Drainage Fee	DU	Detached	$3,051.00
Rialto Storm Drainage Fee	DU	Attached	$769.00
Rialto Unified School District	SF		$3.62
Total fees for 8,281 units			$175,500,000

When we see large discrepancies such as this one in impact fees, it usually relates to the definition of the product being delivered (Blue Topped lots vs. Finished Lots). Most often, Impact Fees, although paid at the purchase of building permits, are included in the definition of a finished lot. Some firms will only include the Storm Drainage fees if providing Blue

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Topped lots, but if this were the case the total should be $18.5 million. Based upon the information provided to us, we are unable to determine which of the impact fees included in the Otte Berkeley Group budget of $21.3 million are included in the list above.

Developers Research would like the opportunity to review the Otte-Berkeley Group's fee schedule to make an informed opinion on the reasonableness of these costs.

Representative Comments on Costs

In Table 1 on Page 19 titled "Development Cost for Project by Phase" there are high-level budgets for the various projects. Without having the detailed backup prepared by the Otte-Berkeley Group, we are unable to compare "apples to apples". However, we can comment on the reasonableness of their estimate at a summary level. We have extracted certain line items from this budget, which are shown below.

Figure 4

Extracted Cost Estimate Items

Description	Proposed Project	No Project Alternative	Avoidance of RAFSS Area	Avoidance SB Kangaroo Rat
Units	8,281	2,215	4,872	7,485
Civil Engineering	$5,427,000	$5,020,000	$4,692,000	$5,751,000
Per Unit	*$655*	*$2,266*	*$963*	*$768*
Impact Fees	$21,325,040	$7,030,868	$11,224,318	$18,673,565
Per Unit	*$2,575*	*$3,174*	*$2,304*	*$2,495*
Grading	$46,043,229	$30,761,308	$21,988,080	$41,420,255
Per Unit	*$5,560*	*$13,888*	*$4,513*	*$5,534*
Storm Drain / Levee	$48,032,091	$38,653,295	$35,505,705	$49,630,691
Per Unit	*$5,800*	*$17,451*	*$7,288*	*$6,631*
Special Amenities	$30,704,125	$14,574,125	$8,500,000	$23,074,125
Per Unit	*$3,708*	*$6,580*	*$1,745*	*$3,083*
Parks	$15,173,750	$1,007,500	$15,173,750	$14,573,750
Per Unit	*$1,832*	*$455*	*$3,114*	*$1,947*

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Civil Engineering Costs:

In the table above (Figure 4), the civil engineering budget per dwelling unit varies dramatically. They range from $655 per unit for the Proposed Project to as much as $2,266 for the No Project Alternative, a variance of more than 3 times. In our experience, civil engineering costs for projects over 2,000 units are usually estimated at approximately $2,000 per unit. The scope of work for this figure would include preparation of all tentative tract maps and subsequent improvement drawings. Our database indicates that when the project exceeds approximately 2,000 units, the cost for providing the civil engineering services is directly proportional to the number of lots included in the project.

Grading Costs:

The Grading line item includes a cost of $46 million for the Proposed Project and over $41 million for the avoidance of the San Bernardino Kangaroo Rat Alternative (SBKR). In reviewing the disturbed acres, the SBKR alternative disturbs a total of 937 acres whereas the proposed project disturbs approximately 1,540 acres. Although we have not been provided with the data supporting these cost estimates, exactly how a 40% reduction in disturbed area would only yield a 10% reduction in grading costs is not explained; these costs are usually, on average, linearly related to disturbed acres.

Levee Costs:

The levee is a substantial line item in each of the project alternatives (greater than $35 million). Without having any preliminary design information, we cannot form an informed opinion on the reasonableness of these costs. Generally, levees such as the one proposed at Lytle Creek are intended to raise the proposed development above the 100 year flood level. Developers Research reviewed FEMA (Federal Emergency Management Agency) Map 06071C7920H, which depicts the 100 year flood zone for the Lytle Creek area and it appears not all of the subject property is within the 100 year flood zone. Therefore, it is possible if the development envelope is limited to areas outside of the 100 year flood zone; this cost could potentially be avoided. While we are not licensed civil engineers or engineering geologists, we recommend that a formal study be conducted to assess a different development option, one which avoids building the levee.

Large, up-front backbone costs such as the levee proposed at Lytle Creek drives down the IRR of smaller projects because the major infrastructure cost is distributed over a smaller number of units. Also, the up-front nature of the cost requires the developer to borrow more money increasing financing costs and extends revenue events until later in the development timeline. All of these factors negatively affect a project's IRR.

We believe that not all potentially feasible development options have been considered. It is possible that a smaller project which specifically avoids the levee costs would provide the developer with an IRR of over 15%.

Special Amenities:

The Special Amenities are a particularly important aspect of the Financial Feasibility analysis because they affect both development costs *and* revenues. Below is a table reproduced from the report that is based upon the marketing report prepared by HM2 Marketing Development.

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Figure 5

Project	Impact of Amenities on Home Prices
Proposed Project	+8.0%
Avoidance of Jurisdictional Waters	+4.9%
Avoidance of RAFSS Areas	+2.2%
Avoidance of SBKR / LBV Habitat	-6.0%
No Project/Existing Zoning	-8.4%

This table (Figure 5) shows the percentage increase (or decrease) in home prices based on amenities included (or not included) in the various development alternatives. This becomes extremely significant when the size of the project is as large as Lytle Creek. Referring to Figure 1 above, the Proposed Project shows $654 Million in Finished Lot Revenues and Figure 5 shows an 18.4% swing in home prices (between the Existing Zoning and Proposed Project).

This potentially provides a revenue swing of $120 million.

Knowing the importance of the Amenity score applied by HM2, we researched this issue further. The Otte-Berkeley Group included special amenity costs for all of the project alternatives that range from $30.7 million for the proposed Project to $8.5 million for the RAFSS avoidance program as shown on the Extracted Cost Estimate Table below (Figure 6). Again, the lack of detail makes it impossible to make anything more than summary comments; however, we calculated *per unit costs* budgeted by Otte-Berkeley Group for amenities and other improvements that HM2 valued highly in their analysis.

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Figure 6

Budget Items that will affect Home Prices (according to HM2)				
Description	**Proposed Project**	**No Project Alternative**	**Avoidance of RAFSS Area**	**Avoidance SB Kangaroo Rat**
Units	8,281	2,215	4,872	7,485
Premium Entry	$780,000	$400,000	$375,000	$780,000
Per Unit	***$94***	***$181***	***$77***	***$104***
Perimeter Upgrade	$3,714,500	$3,199,000	$3,118,000	$3,714,500
Per Unit	***$449***	***$1,444***	***$640***	***$496***
Enhanced Landscaping	$6,129,205	$3,530,305	$5,969,655	$3,648,408
Per Unit	***$740***	***$1,593***	***$1,225***	***$487***
Streets With Medians and Parkways	$7,668,328	$7,114,793	$7,940,642	$7,339,048
Per Unit	***$926***	***$3,212***	***$1,629***	***$980***
Parks	$15,173,750	$1,007,500	$15,173,750	$14,573,750
Per Unit	***$1,832***	***$455***	***$3,114***	***$1,947***
Special Amenities	$30,704,125	$14,574,125	$8,500,000	$23,074,125
Per Unit	***$3,707***	***$6,579***	***$1,744***	***$3,083***

Reviewing the table above (Figure 6), many of the gross line items are higher in the Proposed Project; however, many of the *per unit costs* are *lower*, oftentimes substantially lower. We are therefore unsure why HM2 assigned some of the amenity values that they did (pp. 24-33 HM2 Report).

For example, the Proposed Project received 7 out of 9 for "Private Recreational Facilities" and the No Project Alternative received a 1.

Because the No Project Alternative has a higher per unit cost for Special Amenities (nearly double at $3,707 vs. $6,579) the data provided does not show where the $14,574,125 budgeted for Special Amenities is being spent.

As stated above, this is extremely significant because not only is a large cost introduced; the No Project Alternative seems to have been denied its revenue benefit from the Special Amenities included in the budget. Similarly, the Avoidance of SBKR plan also received 1 out of 9 in "Private Recreational Facilities" and has $23,074,125 budgeted for Special Amenities. These are only two examples, and, as shown in the table above, there are many other instances of the per unit prices being higher in the budgets but inexplicably these projects are receiving a revenue penalty rather than a benefit.

We believe the Marketing Scores should reflect *per unit* or *per acre* costs that are in the Otte-Berkeley budget because many development costs are estimated to be linearly related to unit count or disturbed acres. The data provided do not justify why the project alternatives do not receive equal treatment when it comes to the amenity scores applied. Reviewing the per

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unit costs in Figure 6 indicates that many of the Amenity scores in the project alternatives should be higher. The Project Alternatives are therefore not receiving the revenue benefits associated with the amenities in their respective budgets.

There is a disconnect between the amounts budgeted by the Otte-Berkeley Group and the Amenity ratings received by the project alternatives.

Master Planned Developments

The definition of a "true" master planned community is discussed on pg. 14 of the HM2 Marketing Report. They determined that two of the project alternatives did not fall into this category: Existing Zoning and SBKR Avoidance. This led HM2 to subtract 1.5 points from their Amenity Score. This subtraction is *much* more important than it seems on the surface. In reality, they have subtracted 1.5 ***average*** points which equates to ***6%*** decrease in sales value. This amounts to a loss of $24.8 million in revenues, and, according to the definition of a master planned community, the Otte-Berkeley group has adequate funds budgeted to satisfy most of the requirements.

Based on the definition of a master planned community and the budgets provided, it seems that the moniker "true master planned community" is not being distributed fairly between the project alternatives.

Figure 7 below shows the total Gross Sales for the No Project / Existing Zoning alternative. According to Figure 5, if the amenities included in the proposed project were added to the existing project, it would receive an 18.4% swing in home values amounting to a total of $156,000,000 in increased sales prices. Furthermore, as shown in Figure 6, it seems that many of these improvements are already budgeted. On a per-unit basis, only the Parks budget would need to be increased by $1377/unit for a total of $3,050,000.

Following the CBRE logic, a $3 million dollar expense will provide $156 million in revenue benefit to the Existing Zoning. If this is true, any reasonable developer would invest the additional money.

Figure 7

	Units	Proposed Plan Price	Total Sales	Deflated Existing Zoning Price	Total Sales
SFR - 1	1,887	$450,000	$849,150,000	$376,200	$709,889,400
SFR - 2	328	$325,000	$106,600,000	$271,700	$89,117,600
SFR - 3	0	$250,000	$0	$209,000	$0
MDR	0	$175,000	$0	$146,300	$0
HDR	0	$150,000	$0	$125,400	$0
Total	2,215		$955,750,000	$360,726	$799,007,000

Similarly, for the Avoidance of SBKR alternative, enhanced landscaping could be increased by $253/unit and Special Amenities by $624/unit for a total of $6.6 million to reach the equivalent of the Proposed Project. Furthermore, cost savings could be refunded to the

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SBKR project if some of the line items are lowered to that of the Proposed Project. For example, Premium Entry, Perimeter Upgrade, Streets with Medians and Parkways and Parks could be decreased by a total of $226/unit for $1.7 million in savings.

Therefore, a net investment of $4.9 million in the SBKR alternative would account for a 14% increase in sales price (Figure 5; -6.0% to +8.0%), a total of $272 million in additional revenues (See Figure 7-2)

Figure 7-2

	Units	Proposed Plan Price	Total Sales	Deflated SBKR Price	Total Sales
SFR - 1	936	$450,000	$421,200,000	$387,000	$362,232,000
SFR - 2	1,549	$325,000	$503,425,000	$279,500	$432,945,500
SFR - 3	2,419	$250,000	$604,750,000	$215,000	$520,085,000
MDR	1,256	$175,000	$219,800,000	$150,500	$189,028,000
HDR	1,325	$150,000	$198,750,000	$129,000	$170,925,000
Total	7,485		$1,947,925,000	$223,810	$1,675,215,500

Discrepancies between July 2010 and December 2011 Reports

We also reviewed a Financial Feasibility Analysis of Alternatives to the Project Discussed in the Lytle Creek Specific Plan and EIR also prepared by CBRE dated July 2010. There were several modified assumptions between the two reports. The first item is that the sales prices for finished lots and related costs have changed (Figure 8).

Figure 8

	July 2010 Report			December 2011 Report			Variance		
	Finished Lot Value	Intract Costs	Blue Top Value	Finished Lot Value	Intract Costs	Blue Top Value	Finished Lot Value	Intract Costs	Blue Top Value
SFR – 1	$140,000	$55,000	$85,000	$164,000	$65,000	$99,000	$24,000	$10,000	$14,000
SFR – 2	$105,000	$50,000	$55,000	$120,000	$55,000	$65,000	$15,000	$5,000	$10,000
SFR – 3	$80,000	$45,000	$35,000	$93,000	$45,000	$48,000	$13,000	$0	$13,000
MFR	$60,000	$35,000	$25,000	$69,000	$35,000	$34,000	$9,000	$0	$9,000
HDR	$45,000	$30,000	$15,000	$58,000	$30,000	$28,000	$13,000	$0	$13,000
Total	**$694 Mil**	**$359 Mil**	**$335 Mil**	**$810 Mil**	**$378 Mil**	**$432 Mil**	**$116 Mil**	**$19 Mil**	**$97 Mil**

In Figure 8 above, the total finished lot value increased by $116 million and the total blue top values increased by $97 million. More specifically, the report indicates the value for SFR-1 finished lots increased from $140,000 per unit to $164,000, an increase of approximately 17%. In fact, for all the product types, finished lot values have increased by more than 10%. Although we do not prepare market studies, this information does not reasonably reflect what we perceive to be current market conditions.

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We also noted that for products SFR-1 and SFR-2, the costs have increased by more than 10% whereas the costs for the SFR-3, MFR and HDR have remained static. Our experience indicates that the different product types are not being treated equally; however, again it is difficult to make an informed opinion when so little of the detail is included in the report.

Developers Research would like the opportunity to review the reasoning behind the differences of the July 2010 report and the December 2011 report.

Community Facilities District Financing

On page 3 of the report, CBRE states, "In light of the current market conditions and recent case law, which creates major uncertainties as to future development costs (Azusa Land Partners vs. Dept. of Industrial Relations), combined with the weak financial standing of the City of Rialto, it is highly unlikely that CFD would be approved for the project or any of the alternatives." We agree with the assumptions contained in the statement, however, we do not agree with the conclusion. The appraisal indicates that the seller has projected that for any of the alternatives, the sales will exceed 10 years. There is also considerable debate regarding the court's decision for inclusion of future development costs any public financing district. Finally, the financial condition of the city of Rialto may not have a significant impact on the ability to sell bonds since another public agency could be the bond sponsor. In our opinion, a public financing district that includes a minimal tax burden of 0.3% would be acceptable in the local marketplace and the proceeds could be used to offset certain of the backbone development costs.

Existing Golf Course

Page 18 of the CBR appraisal states that the appraised value of a "substantial portion of the project site" was $58 million, based upon a CBRE appraisal completed in September 2009. To this appraised value, CBRE added $20 million for the acquisition of an existing adjacent golf course with the potential for an additional 300 residential lots. For the purposes of calculating the land residual value for the development envelope, CBRE deducted $15 million which they state is the "operating value of the existing golf course."

Our experience in providing land residual valuations for public "pay for play" golf courses is that they rarely generate positive cash flow. We have observed operating expenses for many Southern California golf courses and the costs, especially the cost of irrigation water, reduce the value of a golf course significantly. Furthermore, the greens fees for "pay for play" golf courses have been reduced during the past real estate cycle as many golfers are unable to afford the costs associated with playing. If the golf course is currently an operating facility, we would like the opportunity to review the current discounted cash flow to determine the investment value of the course.

In fact, our recent observation of indicated that the most significant benefit of an active golf course is the lot premiums associated with houses constructed adjacent to the course and HM2 has taken this into consideration in its pricing analysis.

We have not had a chance to review the September 2009 CBRE appraisal for the golf course but we believe that during the intervening 3 years, the value the golf course has been reduced, which conclusion is further supported by the fact the golf course is currently not operating.

Based upon our experience, we believe the existing golf course that is currently closed and not maintained, is overvalued in the CBRE Appraisal.

Absorption Rates

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RE: CBRE Report, December 2011
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The absorption rates assumed in the CBRE report are delineated on pages 24-25 and are not consistent between the project alternatives. The Proposed Project is projected to absorb 100 multifamily units per year eventually increasing to 400 units per year in 2021. The Avoidance of RAFSS is projected to absorb 100 units per year and eventually increasing to 300 units per year. We understand the difficulty in projecting absorption rates over long time frames; however, it is unclear to us why the projections would change depending on the project alternative. CBRE makes no justification for these discrepancies. In our experience, these absorption rates are aggressive, but taking them at face value, we believe they should at least be kept consistent.

It is unclear to us why the residential absorption rates are not kept consistent between the project alternatives.

Conclusions

Generally, the report intends to show that the Proposed Project is the only feasible project because it generates an internal rate of return greater than 15%, which is above the investment threshold determined by CBRE. For many of the reasons discussed above, we believe the various project alternatives were not treated equally in this analysis. For example, if the Commercial Revenue Inflation and Commercial sales prices were not inexplicably inflated in the Proposed Project and not the other projects, the proposed project would not have reached its target of greater than 15% IRR (which it barely achieves). Furthermore, the project alternatives would have higher IRR's if they were not arbitrarily penalized for lacking amenities which can be clearly found in the Otte-Berkeley budget. Based on per unit costs, many of the project alternatives should have received *higher* amenity scores than the Proposed Project and would thus have an *increased* revenue benefit applied.

As stated above, without cost detail schedules or justifications for many of the CBRE assumptions, it seems that the Project Alternatives are being arbitrarily penalized while the Proposed Project is being arbitrarily increased to reach the target >15% IRR.

Before any further decision is made on the feasibility of the Project Alternatives, we believe that CBRE needs to explain the assumptions and reasoning behind the various issues described above.

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RESOURCE PAPER

The Effect of Housing Near Transit Stations on Vehicle Trip Rates and Transit Trip Generation

A summary review of available evidence

by

Richard W. Lee
and
Robert Cervero

for the

California Department of Housing and Community Development and the California Department of Transportation

September 20, 2007

University of California, Insitute of Urban and Regional Development
WC07-2460

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INTRODUCTION: DESCRIPTION OF STUDY PURPOSE

Pursuant to the passage of Proposition 1C (codified as Chapter 27, 2006 (SB 1689)), the Department of Housing and Community Development will provide local assistance for the development of Transit Oriented Development (TODs), more specifically, assistance for developing or facilitating the development of higher density housing uses within close proximity to transit stations. By doing this, it is expected that public transit ridership will increase and private vehicle use will be minimized.

The legislation provides for State Assistance Loans for the development and construction of housing within one-quarter mile of a transit station as well as grants for the provision of infrastructure necessary to support higher density uses within close proximity to a transit station (within one-half mile). A total of approximately $285 million from Prop 1C bond funds will be awarded over a period of three to four years.

1. To be eligible, a proposed Housing Development must:

   a. Be located within one of the following urbanized areas as defined by the U.S. Census Bureau:
      - Antioch
      - Concord
      - Fairfield
      - Fresno
      - Livermore
      - Los Angeles-Long Beach-Santa Ana
      - Mission Viejo
      - Riverside-San Bernardino
      - Sacramento
      - San Diego
      - San Francisco-Oakland
      - San Jose
      - Santa Barbara
      - Santa Cruz
      - Santa Rosa
      - Stockton
      - Tracy
      - Vallejo

      i. b, Have a qualifying Transit Station defined as a rail or light-rail station, ferry terminal, bus hub, or bus transfer station. Included in this definition are planned transit stations whose construction is programmed into a Regional or State Transportation Improvement Program to be completed prior to the scheduled completion and occupancy of the supported Housing Development(s) but in no case more than five years from the application due date. Transit service available along the primary travel corridor from the qualifying Transit Station must:

2. Be within one-fourth mile from a Transit Station, measured in a straight line from the nearest boundary of the Housing Development parcel to the outer boundary of the Transit Station property, and

3. Be within one-half mile from a Transit Station, measured from the Transit Station fare machines to the entrance of the housing unit furthest from the Transit Station fare machines, along a walkable route. The walkable route, after completion of the proposed Project, shall be free of negative environmental conditions, such as barriers, stretches without sidewalks or walking

paths; noisy tunnels; streets, arterials or highways without regulated pedestrian crossing; or stretches without lighted streets.

Eligible Applicants include: Cities, cities and counties, transit agencies, and developers.

Per the proposed evaluation criteria developments assisted pursuant to this program must include at least 15 percent of the proposed housing units affordable to persons of very low and low income for a period of at least 55 years. Eligible infrastructure must be necessary for the development of higher density uses within close proximity to a transit station, or to facilitate connections between that development and the station. Housing developments may include mixed uses consisting of both residential and nonresidential (e.g., retail) activities.

Rating/Ranking criteria for applications must include, but are not limited to:

1) the extent to which the project or development will increase public transit ridership and reduce automobile trips.

2) bonus points for projects or developments that are in an area designated by the appropriate council of governments for infill development as part of a regional plan.

This Resource Paper is intended to clarify and substantiate these criteria, particularly the criteria relevant to item #1.

Outline of Approach for Estimating Ridership and Vehicle Trip Reduction Benefits of TOD

In order to show the ridership benefits of TOD, we examined the best empirical information available for adjusting vehicle trip generation rates and estimating transit ridership. Fortunately, a fair amount of empirical evidence has been gathered in California over the past decade on TOD's ridership impacts.

The approach taken parallels somewhat that employed for the Air Resources Board's URBEMIS model that aims to evaluate the potential emission-reduction benefits of smart-growth strategies. The URBEMIS model provides a range of "adjustment factors" for reducing estimated vehicle trip volumes by specific percentages based on characteristics of built environments – including the 3Ds of density, diversity, and design. We propose that the evaluative tool, like URBEMIS, will begin with standard ITE vehicle trip generation rates to estimate the potential reductions in vehicle use a TOD offers compared to a conventional suburban development (the basis of the most use ITE trip rates).

Much research has now been published that suggests either elasticities or "percentage reductions" that might be applied in adjusting vehicle trip rates based on key land use and access factors that have come to be known as the 5Ds: density, diversity, design, destination accessibility, and distance to transit. This Resource Paper attempts to pull together the best empirical evidence available demonstrating how different elements of the 5Ds are associated with two or three key travel-demand metrics: transit modals splits; vehicle trips (per 1000 households); and VMT per household. These are summarized in a matrix format. The matrices for distance to transit are currently stratified by specific mode of transit (e.g., commuter rail; heavy rail; light rail). While introducing different modes helps to refine the analysis, it does so at the expense of creating multiple dimensions and thus greater data demands. Data on the first four Ds is only available at an aggregate level, while data on the 5^{th} D – the crucial effect of distance to transit, is only readily available for the San Francisco Bay Area. Nonetheless, this proved a useful starting point for operationalizing the analysis. An expert panel's informed judgments were used to generalize the findings to all California metropolitan environments and transit modes. The presence of data gaps can serve help guide future research and studies.

Thus, this Resource Paper combines best available empirical evidence with expert judgment to "fill the cells" of the matrices. While many empirical studies are available on built environments and travel, as mentioned earlier, this analysis focuses on relationships in California transit station areas.

Proposed Evaluation Tool Format and Content:

1) Standard ITE vehicle trip generation rates will be the starting point for estimating vehicle trip volumes for station-based TODs. Trip rates will be stratified by land uses that are likely to be proposed as part of TODs.

2) Based on the best empirical evidence available, a range of "adjustment factors" for reducing estimated vehicle trip volumes by specific percentages based on the 5D characteristics of built environments, individually and in combinations, was developed.

The literature reviewed for this Resource Paper suggests that Distance to frequent, reliable Transit, along with Density and Destination Accessibility appear to have the biggest impacts on travel behavior for projects in transit environments, while Diversity has a larger impact on non-work trips. Within a quarter- to half-mile walkshed of a transit stop, Design appears to matter somewhat less, at least in influencing the decision of taking transit or not. The influence of urban design and amenities could be indirect, however – such as allowing higher densities to be attained (by "softening" peoples' perceptions of densities) so as to support high-quality transit services. Moreover, design may encourage more pedestrian travel among both transit users and other station area residents and visitors.

Beyond the 5Ds, Transportation demand management (TDM) strategies, such as parking and enhanced shuttle connections, also are known to influence travel behavior. How such TDM measures interact with the 5Ds (individually and collectively) to shape transit usage in and around stations has received little empirical attention to date. In this regard, the views and inputs from the panel of experts proved of value, in that they suggested that many such TDM measures are correlated with the density of transit station area's catchment area. This is an area for further research.

3) Based on these data, matrices were developed for modifying the ITE vehicle trip generation rates for potential TOD projects. It is recognized that some cells contain provisional values, reflecting knowledge gaps. A separate step to estimate increased transit ridership generated by TOD projects was also devised, as this is also a legally mandated transportation criterion for evaluating Proposition 1C TOD proposals.

Expert Research Panel Meeting

A draft of this Resource Paper was sent to a panel of experts (representing both the research community and California's four largest MPOs; see Appendix C). A meeting of this panel took place on August 20, 2007 in Oakland to discuss, refine and validate the methodology. In a quasi-Delphi format, the panel reviewed and discussed the proposed trip rate adjustments, and through group discussions suggested changes and refinements and identified further studies and data of value. The views of the Expert Research Panel on how the 5Ds might interact with TDM strategies like parking management to influence travel behavior were also solicited. In the end, a plausible range of adjustment factors was agreed upon for specific types of TOD settings in California.

SUMMARY OF THE LITERATURE REVIEW

Theory and Background on the 5-Ds and Transit Oriented Development

The beginnings of the 5-D analysis methodology lie in research by Robert Cervero[1]. This original research found that certain characteristics of the neighborhood around a household affected the number of vehicle trips and vehicle-miles traveled generated by that household. This effect was independent of household characteristics (income, household size, number of workers, etc.) typically used in vehicle trip generation equations. Related research has found that 5-D factors also promote transit ridership when they occur near rail transit stations.

The trip generation step in traffic impact analyses should therefore include an adjustment of household-based trip-generation rates to reflect the characteristics of the area surrounding the household. In fact the ITE *Trip Generation* manual has been recommending such an adjustment for its last three editions. Presently, the Transit Cooperative Research Program (TCRP) project H-27A ("Ensuring Full Potential Ridership from Transit-Oriented Development") is being conducted to develop such trip-rate adjustments. TCRP H-27A has compiled driveway tube counts for 17 multi-family housing projects near rail stations in the San Francisco Bay Area and San Diego County and its findings will be available sometime in 2008 to further refine the data presented in this resource paper.

Development near transit that is higher density has an appropriate diversity of land uses in an environment designed for easy walking and biking reduces auto use for several interrelated reasons:

Better regional accessibility – especially via high-capacity transit, reduces auto commuting.

[1] Cervero, R. and K. Kockelman (1997) "Travel Demand and the 3Ds: Density, Diversity, and Design," *Transportation Research D*, Vol. 2, pp. 199-219

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- More local opportunities lessen need for auto dependence
- Diversity of uses near transit stops encourages station-area residents to ride transit by allowing "trip chaining" (i.e., walking to nearby shops en route to residences from stations after work).

There will also be reduced vehicle trips and vehicle miles of travel due to:

- Fewer autos owned
- More trips by walking
- Shorter auto trips

It is noteworthy that many TOD proponents point to benefits beyond transportation. For example, local shops and services would provide a benefit to residents even if they do not use transit.

The 5-D TOD Characteristics Explored for the Trip Rate Adjustment Model

The literature on neighborhood characteristics that affect trip generation is evolving over time and may definitions still vary from study to study. The variables described below define the 5Ds.

Net Residential Density – This variable is measured in units of dwelling units per residential acre. The acreage should include not only land zoned and devoted to residential uses but also associated pocket parks and local streets, but exclude large parks, open space, lakes, steep slopes, and off-site non-residential uses. This matches the practice in general plans where areas designated for residential development typically show large non-residential features separately but typically do include acreage that will be devoted to local streets and neighborhood amenities. Research suggests that, all else being equal, denser developments generate fewer vehicle-trips per dwelling unit than less dense developments.

Jobs/Housing Diversity – Research suggests that having residences and jobs in close proximity will reduce the vehicle-trips generated by each by allowing some trips to be made on foot or by bicycle. This variable measures how closely the neighborhood in question matches the "ideal" mix of jobs and households, which is assumed to be the ratio of jobs to households measured across the region as a whole.

Walkable Design – Many pedestrian and bicycle improvement projects are based on the assumption (supported by some research findings) that improving the walking/biking environment will result in more non-auto trips and a reduction in auto travel. The difficulty with using this variable in an equation is that there are many factors that influence the pedestrian experience and it is difficult to come up with a single definition that captures them all. It has also been found that the data required to specify the design variable is often either not available or would be expensive and time-consuming to obtain. In any case, the design variable when isolated usually has the weakest influence on the overall adjustment of the D factors, though it also seems to have important synergistic effects in conjunction with density and diversity.

Destinations – Research shows that, all else being equal, households situated near the regional center of activity generate fewer auto trips and vehicle-miles of travel. When comparing different potential sites for the same type of development, this variable is very important.

Distance to Rail Mass Transit Station – If a site is located near a rail transit station, research indicates that further reductions in the automobile trip-generate rate are warranted. In general, transit ridership rates among station-area residents increase exponentially as the distance to a rail station declines. This is documented in a recent and comprehensive study of TODs in California[2].

Distance to Transit – The Fifth and Foremost D: Summary of Findings of Lund, Willson, Cervero Study of TOD and Ridership in California

Travel Characteristics of Transit-Oriented Development in California gauges the ridership bonus of TOD residency in California, followed by statistical modeling of factors influencing residents' mode choices and before-and-after comparisons of travel behavior. The work builds upon an earlier study of transit ridership among households located near rail stations in California's five largest metropolitan areas.[3] Both studies found that the fifth D – Distance to Transit -- the most influential "D" in increasing transit ridership and reducing vehicle use. Lund et al's (2004) analyses draw upon a database on travel and other attributes of

[2] Lund, Cervero, Willson, (January 2004), *Travel Characteristics of Transit-Oriented Development in California*

[3] Cervero (1993), *Ridership Impacts of Transit-Focused Development in California*. Berkeley: Report to the California Department of Transportation, IURD Monograph.

nearly 1000 residents living in 26 housing projects within ½ mile of California urban rail stations who were surveyed in 2003. The 26 surveyed housing projects were served by a variety of rail services: heavy rail (i.e., powered by a high-voltage third rail in an exclusive right-of-way) in the San Francisco Bay Area and Los Angeles; light rail (i.e., powered by overhead electrical wires) in Los Angeles, San Diego, and Sacramento; and commuter rail (i.e., diesel-electric locomotion) serving the San Francisco-San Jose axis, northern San Diego County, and Los Angeles-Orange County.

Findings on the Ridership Bonus of TOD. Based on one-day travel diaries completed by adult residents of the 26 surveyed TOD housing projects, the mean share of commute trips by transit was 27 percent. This figure was compared to those living in a "donut": an area between ½ and 3 miles of a station. The mean share of commute trips via transit among those residing in the donut was 7 percent. Thus, those living within ½ mile of a rail stop were around four times as likely to rail-commute as those living within a distance more oriented to bus access (i.e., ½ to 3 miles). And when compared to those living beyond 3 miles but within the same city as the housing projects under study, the differential in transit commute shares was six-fold.

Analysis and modeling by Cervero (2006) of the survey data collected by Lund et al suggests local policy-makers have fewer levers available to influence transit riding among station-area residents than regional policy-makers. Local officials can control land uses around stations, however these variables had minimal explanatory power. Regional agencies, on the other hand, are in a position to introduce measures that encourage employers to promote transit (e.g., underwriting the cost of transit passes) and discourage car commuting (e.g., eliminating free parking) – both "workplace policy" variables were significant predictors. California has considerable precedence in this regard under the "Employer Commute Options" initiatives mandated by Federal and State clean-air legislation in the 1990s; today, such employer-based policies are largely voluntary.

The findings of Lund et al and Cervero confirm that when it comes to transit-based residences, the greatest ridership pay-off comes for intensifying station-area housing. While streetscape improvements, parking provisions, and other physical-design elements might influence the attractiveness of station-area housing among prospective tenants, such factors appear to exert minimal influences on whether station-area residents opt for transit or not. It is housing supplies, not station-area designs and parking levels, which are the strongest localized factors influencing ridership in neighborhoods abutting rail stations in California. Moreover, studies suggest that high ridership among those living near California rail stations is significantly a product of "self selection" – for lifestyle reasons (e.g., the desire to rail commute instead of drive to work), some households purposely move into residences that are convenient to high-quality transit (Cervero 2007). Using data from the San Francisco Bay Area, Cervero (2007) estimates that around 40% of the change in the odds-ratio of rail commuting among station-area residences can be attributed to residential self-selection. The policy implications of this finding is that local officials should seek to zone land, set building codes, and provide local services so that market-responsive housing products are built near California rail stations.

The finding that urban design factors have relatively minor influence on transit riding within a walkshed of rail stations suggests the presence of an "indifference zone": for those living within a half-mile or so of a station, they will generally ride transit regardless of local urban design features, as long as there is a safe walkable route to the station. On the other hand, out-of-neighborhood attributes, like job accessibility and street connectivity at the destination, have a significant bearing on transit usage (Cervero 2006).

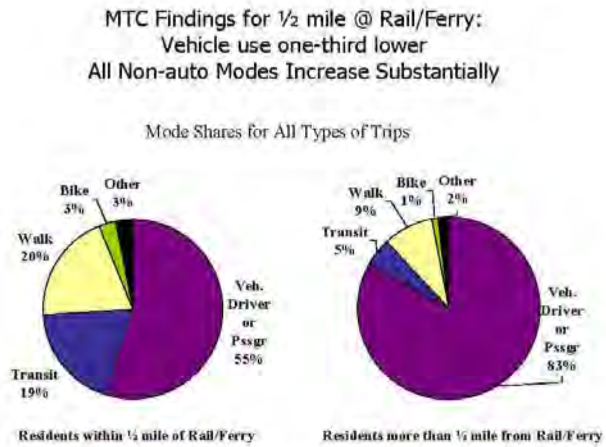
Quantifying the Effects of Proximity to Transit: A Keystone Study by MTC

In *Characteristics of Rail and Ferry Station Area Residents in the San Francisco Bay Area (2006)* the San Francisco Bay Area Metropolitan Transportation Commission studied existing Transit Oriented Development (defined as development within a one-half-mile *walking* distance of a rail or ferry terminal. Demographic and travel data were from MTC's 2000 Household Travel Survey. This survey compiled travel and demographic data for some 35,000 individuals age 16 years and above residing in nearly 15,000 Bay Area households.

Extensive analysis of this large Bay Area data base reveals that people living within a half mile of a transit or ferry station are four times more likely to use transit than those living more than a half mile from a transit or ferry station. This more or less confirms the findings on variation in modal splits by distance to transit found by Cervero (1994) and Lund et al. (2003). The Bay Area survey results show that residents living and working within a half mile of transit or ferry stations average 42% of their daily trips by transit, walking or biking (see Figure 1). Nearly a third of households within a half mile of ferry or transit stations have no vehicle. Households within a half mile of ferry or transit stations generate half the VMT of suburban and rural residents.

Figure 1 also indicates that residents within a half mile of a rail station or ferry terminal have a vehicle mode share 28 percent lower than for the region as a whole. The same data also indicate that the transit mode share of residents increased by 14 percent. This suggests that about half of the reduction in vehicle trips observed for station/terminal area residents may be attributed to the substitution of transit for private vehicle trips.

FIGURE 1: MTC Findings for ½ Mile around Rail/Ferry



MTC Study Method

Using Geographic Information Systems (GIS), BATS2000 households and residents were parsed into groups based on the household's proximity to rail and ferry stations in the Bay Area (the report's Volume II, Appendix G contains a detailed discussion of the GIS methodology). Only stations or stops that existed in the year 2000 (the year the BATS survey was administered) were examined. The seven rail and ferry operators included in this study are:

1) Altamont Commuter Express (ACE) stations,
2) Amtrak stations,
3) Bay Area Rapid Transit (BART) stations,
4) Caltrain stations
5) Ferry terminals (excluding Alcatraz Island ferries and seasonal ball park ferries),
6) San Francisco Municipal Railway (MUNI light rail lines and cable car stops), and
7) Santa Clara Valley Transit Authority (VTA) light rail stations.

Geographic areas (or buffers) were created around each rail and ferry stop in the Bay Area (in the case of MUNI, buffers were created around the light rail lines). The buffers were created around rail/ferry stops to create three distance categories: within ½ mile, ½ mile to 1 mile, and greater than 1 mile. Households were then placed into one of the three distance categories based on the location of the household with respect to the nearest rail/ferry stop. Households beyond one mile from a rail/ferry station were further disaggregated by population density, which was determined using Census 2000 block group data. The four population density categories along with examples of cities and communities for each group were as follows.

1) Urban 10,000 or more persons/square mile e.g., San Francisco, Berkeley, Oakland
2) High-Suburban 6,000 to 9,999 persons/ square mile, e.g., Palo Alto, Vallejo, Richmond, San Leandro
3) Low-Suburban 500 to 5,999 persons/ square mile, e.g., Lafayette, Walnut Creek, Sausalito
4) Rural Less than 500 persons/square mile e.g., Oakland Hills, Point Reyes Station, Guerneville

Since the station areas studied vary from ferry terminals with fewer than ten daily departures to BART and Muni light rail (with average headways under 15 minutes at most stations and major stops) the results are truly a composite – a theoretical "average" transit station. MTC also conducted some mode specific analysis, which is summarized in Table 1 and Figure 2 below. Detailed mode split data, used to estimate vehicle trip reductions in TODs surrounding various rail modes, is found in Appendix A.

The important finding: TOD residents living around high frequency rapid rail (BART or Muni LRT) stations exhibit 50% fewer vehicle trips compared to the region. Commuter rail and VTA light rail station area residents appear to make vehicle trips at rates more comparable to the rates observed for region as a whole; residents living within ½ mile of a VTA station do make significantly more transit trips compared to the region as a whole (nearly 50 percent more); within ¼ mile of VTA, residents make more than twice as many trips by transit as the regional average.

TABLE 1: Effect of Transit Proximity by Mode
Vehicle Trip Reduction Factors and Transit Increase Factors by Transit Operator/Mode
Calculated as Station Area Mode Share ÷ Regional mode share
(First factor in each cell is for within ¼ mile circle; second is for ¼ – ½ mile band
See Appendix A for Data and Calculations)

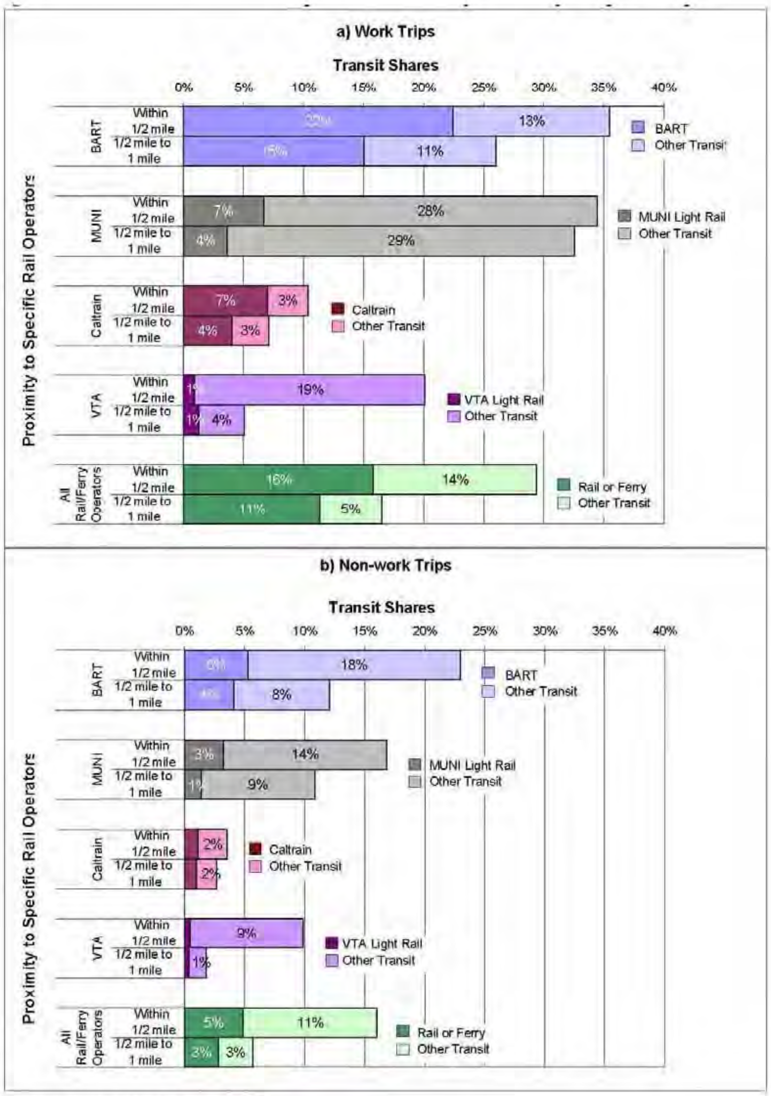
BART (Rapid Rail)	**Caltrain (Commuter Rail)**	**SF Muni (Light Rail)**	**VTA (Light Rail)**
Vehicle Trip Rate Reduction Factor:	Vehicle Trip Rate Reduction Factor:	Vehicle Trip Rate Reduction Factor:	Vehicle Trip Rate Reduction Factor:
0.63 | 0.57	**1.03 | 1.10**	**0.58 | 0.64**	**0.94 | 1.04**
Transit Trip Rate Increase Factor: ¼ mile: | ¼ – ½ mile	Transit Trip Rate Increase Factor:	Transit Trip Rate Increase Factor:	Transit Trip Rate Increase Factor:
3.16 | 3.56	**1.01 | 0 .74**	**3.22 | 3.61**	**2.40 | 0.55**

The effects are shown to vary by mode, with the most marked effects observed around rail systems with high frequency service that includes direct service to the region's major transit-oriented employment and service center, downtown San Francisco, i.e., BART and Muni. Somewhat ironically, BART and MUNI exhibit a higher transit trip rate increase factor, and MUNI lower vehicle trip rates, in the ¼-mile to ½-mile band versus the immediate ¼-mile station buffer. The differences are minor, and the authors recommend that for services with comparable frequencies and system-wide access to regional destinations, there may not be a need to distinguish between the first and second ¼-mile rings.

For VTA, whose light rail lines came within ¼ mile of approximately 7 square miles of Santa Clara County in 2000 (about two percent of its urbanized service area of 326 square miles at that date), the first ¼ mile ring appears to be more productive of transit trips (and, reductive of vehicle trips) compared to the second ring. The ¼-mile circle is also more productive/reductive (though to a much lesser degree) for Caltrain, which in 2000 had peak frequencies of over 20 minutes and hourly headways through much of the day.

The authors believe these systems roughly bracket the range of rail transit modes in California. *There is a need to fill in the gaps with data for other rail systems in the state, and well as for high-frequency bus hubs zones that are also eligible for TOD housing grants.*

FIGURE 2: Work and Non-Work Trip Transit Shares by Proximity to Specific Operators (MTC 2006)



Source: Bay Area Travel Survey 2000

In response to questions regarding how the Bay Area compares to the rest of the State of California, MTC extended the analysis, performing a statewide analysis of all transit (rail and ferry) stations. This was limited to journey to work data from the US Census, which asks approximately one-in-eight households about commute behavior, but not about non-work trips. (Each of the four major MPOs conduct a household survey which does ask about non-work trips, but the format and survey year vary too significantly for the other MPOs travel surveys to permit easy comparisons).

The MTC comparative analysis indicates that the drive-alone mode share of work trips is approximately one-third lower within a half mile of a transit station compared to the regional/statewide average. This holds true both within the MTC region and for the remainder of the state. Transit ridership also increases by comparable proportions.

This leads to an important conclusion: *Assuming relationships between commute and non-work travel observed in the Bay Area hold elsewhere, this comparative analysis suggests that the Bay Area data can be applied elsewhere in the state.*

The Effectiveness of the Other 4Ds: Consensus Results

In 2001 Fehr & Peers, under contract through Criterion Engineers and Planners to the US EPA, developed a literature synthesis and a methodology for estimating travel demand impacts from land-use and urban design changes. The methodology uses a set of elasticity factors that relate a neighborhood's built environment characteristics and regional accessibility to the amount of vehicular travel generated in the neighborhood. These factors are used to compute the percentage change in vehicle trips (VT) and vehicle miles traveled (VMT) resulting from different land-use plans and urban designs.

The methodology was developed by Fehr & Peers Associates under contract to Criterion Planners/Engineers for use in Criterion's INDEX models, including the U.S. EPA version known as Smart Growth INDEX.

Research Approach

The 4D method is based on research into the relationship between land-use and travel behavior. Nationally, over forty studies were reviewed; each of the studies examine how changes in land-use characteristics, such as density, relate to changes in travel generation was measured by vehicle trips and vehicle miles of travel. The bibliography of the research is included as Attachment A.

Using this research data, a 4D traffic analysis method was developed in three steps as follows:

1) Elasticities were derived between vehicular travel (VT and VMT) and primary descriptors of the built environment and accessibility for each study whose research provided valid, comparable results. An elasticity is a measure of the percentage change that occurs in a dependent variable (VT or VMT) as a result of a percentage change in an influential variable (density, diversity, design or destinations). For example, if vehicle trips increase by 0.1% for each 1% increase in development density, then vehicle trips are said to have an elasticity of 0.1 with respect to density. If vehicle trips *decrease* by 0.05% for each 1% increase in density, then vehicle trips are said to have an elasticity of -0.05 with respect to density.

2) Individual study results were synthesized into a unified matrix of partial elasticities. These express percentage changes in VT and VMT as a function of percentage changes in each of the 4Ds. The 4Ds are expressed in terms of: 1) density (population and employment per square mile); 2) diversity (the ratio of jobs to population); 3) design (pedestrian environment variables including street grid density, sidewalk completeness, and route directness); and 4) destinations (accessibility to other activity concentrations, expressed as the mean travel time to all other destinations within the region, e.g. a location within the

regional core will ordinarily have a higher 'destinations' rating than a location on the fringe of the urban area, because the central location offers greater accessibility to a higher percentage of the region's employment).

3) Creation of a table of elasticities for assessing the relative benefits of one land-use pattern compared with another.

In 2003, these synthesis values were updated using a Delphi Panel. The tables below present the results of the Delphi Panel survey's recommendations regarding the 4D elasticities, i.e., the 4 Ds apart from Distance to rail transit or other transit with performance characteristics similar to urban rail transit.

TABLE 2: Delphi Panel Consensus Elasticity Values for the 3 Ds[1]

	Vehicle $Trips_{total}$	Vehicle Miles Traveled $(VMT)_{total}$
	Recommended Value	**Recommended Value**
Residential Density	-0.05	-0.11
Diversity	-0.07	-0.12
Design	-0.03	-0.09

Note
1. For use when relative regional accessibility between study sites cannot be estimated or is constant.

TABLE 3: 2003 Delphi Panel Consensus Elasticity Values for the 4 Ds[2]

	Vehicle $Trips_{total}$	Vehicle Miles Traveled $(VMT)_{total}$
	Recommended Value	Recommended Value
Density	-0.04	-0.05
Diversity	-0.06	-0.05
Design	-0.02	-0.04
Destination Accessibility	-0.03	-0.20

Note:
2. For use when relative regional accessibility between study sites can be estimated or is not constant.

Using the data in Table 3 is straightforward once the relevant D variable is calculated. For example, if a project is twice the prevailing density in the station area, it would produce 4 percent fewer vehicle trips per unit.

With respect to transit trip production, analysis by Ross and Dunning (1997) of the 1995 National Personal Transportation Survey (NPTS) suggests that about one-third of the vehicle trip reduction in denser urban areas compared to less dense areas translates into new transit trips. As noted above in the discussion of Figure 1, MTC data for 2000 suggests that in station areas there ratio of new transit trips produced to auto trips reduced is greater, i.e., about one-half. The consensus of the Expert Panel was to use the MTC ratio. Thus in the example in the preceding paragraph, two percent of the eliminated vehicle trips would translate to new transit trips. The other two percent would be attributable to other modes, e.g., walking.

The studies reviewed in 2001 used a variety of definitions of the 4Ds; the 2003 Delphi Panel update standardized the definition for the study participants: these standard definitions are presented in Table 4.

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TABLE 4:
D-Variable Definitions for Tables 1 and 2

Density	=	Percent Change in [(Population + Employment) per Square Mile]
Diversity	=	Percent Change in {1 - [ABS(b * population - employment) / (b * population + employment)]}
where:		*b* = regional employment / regional population
Design	=	Percent Change in Design Index (see below)
Design Index	=	0.0195 * street network density + 1.18 * sidewalk completeness + 3.63 * route directness
where:		
street network density = length of street in miles/area of neighborhood in square miles		
sidewalk completeness = length of sidewalk/length of public street frontage		
route directness = average airline distance to the neighborhood center/average road distance to the neighborhood center		
Destination Accessibility	=	Percent Change in Gravity Model denominator for study TAZs "i": Sum[Attractions(j)*Travel Impedance(i,j)] for all regional TAZs "j"

Review of Recent Literature

For this Resource Paper, more than 200 studies were reviewed with an eye toward updating these consensus elasticities. These are listed in the appended Bibliography; About half of the more relevant studies have been included in an annotated bibliography, also appended. Studies that address the themes of interest (TOD area vehicular trip generation, transit trip generation, and elasticities associated with the 5Ds generally) were examined in detail. Most of these studies are based on relationships in urban settings outside of California, an appreciable share are drawn from California's five largest metropolitan areas.

While there have been many newer studies, apart from the studies discusses above by Cervero (1993), Lund et al (2003), and MTC (both of which are primarily concerned with the effects of distance to transit), the new studies tend to reinforce the direction and magnitude of the effects of the other four Ds. Relevant findings of studies that address the 5Ds and travel variable elasticities associated with the 5Ds are summarized in Appendix B. Again, based on the review of the current authors, there is support for the direction and general magnitude of the elastiticies listed in Table 3 above. Neither the authors nor the Expert Panel found any compelling reasons to change these consensus values.

Findings of the Expert Research Panel

A draft of this Resource Paper, *The Effect of Housing Near Transit Stations on Vehicle Trip Rates and Transit Trip Generation: A Summary Review of Available Evidence* (August 10, 2007 v2), was prepared and distributed for review by a panel of researchers and transportation modelers, referred to as the "Expert Research Panel". Panel members and their affiliations are listed in Appendix C.

This Expert Research Panel was called together to discuss the findings of a draft and further refine the vehicle trip rates and transit trip generation information in support of the development of a spreadsheet model. This spreadsheet model, to be subsequently developed by the researchers through a Caltrans contract with California PATH, will be used to calculate the relative benefits as they relate to reduced auto trips and increased transit ridership of proposed projects applying for TOD Program funding.

The Expert Research Panel, in a session facilitated by Judith MacBrine of Caltrans, and using a modified Delphi process, reached a working consensus on the following items. These will be incorporated into the evaluation method embedded in the model.

Item 1: There is insufficient basis to warrant distinguishing between residential Transit-Oriented Developments located within a quarter-mile of a transit station and a half-mile of a transit station.

Item 2: The relative impact of TODs on standard ITE rates is as shown in Table 5 below:

TABLE 5:
Expert Panel Recommendations of Vehicle Trip Reduction by Mode and Station Vicinity Density

Vehicle Trip Rate → **↓ Transit Mode**	**Low Density**	**Medium Density**	**High Density**
Heavy Rail (e.g., electrified 3rd Rail: BART, METRO)	80%	63%	50%
Light Rail	95%	80%	60%
Bus Rapid Transit (BRT)	95%	80%	65%
Rapid Bus/Express Bus	99%	90%	80%
Commuter Rail, (e.g., Capitol Corridor, Caltrain, Metrolink, Surfliner)	97%	90%	85%
Ferry, Non-Express Bus Hub	97%	90%	85%

Example: If 100 vehicle trips were typically expected from a housing development in high density location, then location of that housing development as a TOD within one-half mile of a BART station (heavy rail) would result in a 50 percent reduction of vehicle trips (or 50 vehicle trips).

Item 3: High, Medium and Low Densities will be determined by measuring the gross density within a four-mile radius of the transit station. Density will be measured as gross residential population divided by square miles of land (excluding water). All Census 2000 census blocks with any portion falling within the four-mile radius will be included in this calculation.

Based on analysis of California station-areas, it is anticipated that the density ranges will be:

- High Density: 7,500+ residents per square mile.
- Medium Density: 4,500 to 7,499 residents per square mile.
- Low Density: <4,500 residents per square mile.

Additional data will be reviewed to determine whether the resident per square mile values should be further adjusted.

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The four-mile radius measurement is based on research by Cervero and Duncan (2006). This research indicates that the balance point for a vehicle reduction shed is a four-mile radius rather than a two-, three- or six-mile radius.

Item 4: Additional adjustments based on elasticity values can be made for the following, subject to adjustment relative to measurement feasibility:

- Residential Density: -0.04.
- Diversity: -0.06
- Design (re: pedestrian and bicycle): -0.02.

Item 5: The increase in transit ridership would be identified as 50 percent of the reduction in vehicle trips. In the above example of a TOD at a BART station within a high density location, the TOD would be projected to generate 25 transit trips.

Other General Comments by the Expert Research Panel on the Proposed TOD Program Guidelines:

- The definition of "bus hub" (which in the statute) should be refined.
- Transit service quality is important.
- There may be a sixth 'D" to consider: demographics (ethnicity, income, and years in U.S. for immigrants)?
- Parking policies and unbundled parking are critical components to successful TODs.

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Summary and Recommendations

(1) The tool will apply the TOD vehicle trip factors for the appropriate transit mode and station vicinity per Table 5). This effectively covers the most important D factor – Distance to Transit – and also serves as a surrogate for the regional Destinations accessibility variable.

(2) Next, the tool will apply elasticity factors for density, diversity and design as summarized in Table 3 and as defined in Table 4. The elasticity should be applied to the ratio of the proposed projects value versus that of the entire half-mile station area. These adjustments will be applied to the extent that it is feasible to quantify these values using data available to all applicants.

(3) Finally, factors beyond the 5Ds, such as TDM measures, that might further increase transit ridership or decrease vehicle trips, will be noted qualitatively.

A Hypothetical Example of Method as Envisaged:

Project:: A 150-unit multifamily housing development at a Light Rail Station in a high-density area

Vehicle Trip Reduction:

(Unadjusted) ITE vehicle trips projection:	900 daily vehicle trips
Apply vehicle trips reduction factor:	.60 x 900
Result after application of 5th D factor:	540 vehicle trips (-360)

Then apply additional factors for the station area:
(From Table 3)

Assume that the Project:

Density = 2 x the ½ mile TOD average:	-4% reduction → -22 vehicle trips (4% of 540)
Diversity measure increases by 100%:	-6% reduction → -32 vehicle trips (6% of 540)
Design Index increases by 100%:	-2% reduction → -11 vehicle trips (2% of 540)
Total Vehicle Trip Reduction:	-360 - 22 -32 -11 = -425;
Resulting Vehicle Trips:	900 – 425 = 475 vehicle trips

Transit Trip Increase:

Assume 1/2 of Vehicle trip reduction from other 4Ds represents additional transit trips	1/2 x (-425) → -212
Resulting Transit Trip Generation:	212 new daily transit trips

Following the process outlined above, credits would be applied for TDM measures such as parking charges, parking management, or frequent shuttle services.

APPENDIX A: MODE SHARES, AND VEHICLE AND TRANSIT TRIP RATES (MTC)

TABLE A-1: Mode Shares and Calculated Vehicle Trip Reduction and Transit Trip Increase Factors – BART Rapid Rail

CIRCULAR BUFFER ANALYSIS

	Proximity of Resident's Home to **BART Stations**							
	Within	1/4 mile to	1/2 mile to	Greater than 1 mile				
Travel Characteristic	1/4 mile	1/2 mile	1 mile	Urban	High-Sub	Low-Sub	Rural	Total
MODE SHARES								
Home-Based Work								
In-Vehicle Person	**49.4%**	**47.9%**	**63.3%**	**79.1%**	**89.1%**	**88.8%**	**94.0%**	**81.7%**
Vehicle Driver	42.9%	36.2%	55.7%	71.3%	82.5%	83.4%	88.6%	74.9%
Vehicle Passenger	6.5%	11.7%	7.6%	7.7%	6.6%	5.3%	5.5%	6.8%
Total Transit	**39.2%**	**28.7%**	**25.1%**	**14.6%**	**7.4%**	**7.2%**	**4.0%**	**12.2%**
BART	31.3%	18.8%	11.7%	3.4%	2.6%	3.9%	1.4%	5.1%
Other Transit	8.0%	9.9%	13.4%	11.2%	4.8%	3.3%	2.6%	7.0%
Bicycle	**0.8%**	**6.2%**	**2.6%**	**1.3%**	**1.3%**	**1.7%**	**0.5%**	**1.8%**
Walk	**8.7%**	**15.4%**	**6.9%**	**3.5%**	**1.8%**	**1.8%**	**1.2%**	**3.4%**
Other	**1.9%**	**1.8%**	**2.2%**	**1.4%**	**0.4%**	**0.5%**	**0.2%**	**1.0%**
Non-Work Trips								
In-Vehicle Person	**52.1%**	**47.5%**	**65.3%**	**73.8%**	**84.7%**	**87.2%**	**88.9%**	**79.5%**
Vehicle Driver	33.2%	30.5%	40.2%	45.1%	52.6%	56.3%	57.0%	50.0%
Vehicle Passenger	18.9%	16.9%	25.1%	28.7%	32.1%	30.9%	31.9%	29.5%
Total Transit	**15.2%**	**19.7%**	**11.5%**	**5.4%**	**2.1%**	**1.7%**	**1.2%**	**4.4%**
BART	8.5%	4.0%	2.9%	0.9%	0.4%	0.5%	0.2%	1.0%
Other Transit	6.7%	15.7%	8.5%	4.6%	1.7%	1.2%	1.0%	3.4%
Bicycle	**4.6%**	**2.9%**	**1.7%**	**1.3%**	**1.2%**	**1.3%**	**0.6%**	**1.4%**
Walk	**23.1%**	**28.1%**	**19.8%**	**15.7%**	**9.7%**	**8.4%**	**5.8%**	**12.3%**
Other	**5.0%**	**1.8%**	**1.8%**	**3.8%**	**2.2%**	**1.4%**	**3.5%**	**2.4%**
Total Trips								
In-Vehicle Person	**51.6%**	**47.6%**	**64.8%**	**75.1%**	**85.7%**	**87.5%**	**89.9%**	**80.0%**
Vehicle Driver	34.9%	31.9%	43.9%	51.4%	59.3%	61.7%	63.2%	55.5%
Vehicle Trip Factor	***62.9%***	***57.4%***						
Vehicle Passenger	16.7%	15.7%	20.9%	23.6%	26.4%	25.8%	26.7%	24.5%
Total Transit	**19.4%**	**21.9%**	**14.7%**	**7.7%**	**3.3%**	**2.8%**	**1.7%**	**6.2%**
Transit Trip Factor	***315.7%***	***355.6%***						
BART	12.5%	7.6%	5.0%	1.5%	0.9%	1.2%	0.4%	1.9%
Other Transit	6.9%	14.3%	9.7%	6.2%	2.4%	1.6%	1.3%	4.2%
Bicycle	**3.9%**	**3.7%**	**1.9%**	**1.3%**	**1.2%**	**1.4%**	**0.6%**	**1.5%**
Walk	**20.6%**	**25.0%**	**16.7%**	**12.7%**	**7.9%**	**7.1%**	**4.9%**	**10.3%**
Other	**4.4%**	**1.8%**	**1.9%**	**3.3%**	**1.8%**	**1.2%**	**2.9%**	**2.1%**

Note: Trip Factors = "within ¼ mile" & "¼ mile to ½ mile" mode share divided by Regional "Total" mode share

TABLE A-2: Mode Shares and Calculated Vehicle Trip Reduction and Transit Trip Increase Factors – Caltrain Commuter Rail

CIRCULAR BUFFER ANALYSIS

	Proximity of Resident's Home to **Caltrain Stations**							
	Within	1/4 mile to	1/2 mile to	Greater than 1 mile				
Travel Characteristic	1/4 mile	1/2 mile	1 mile	Urban	High-Sub	Low-Sub	Rural	Total
MODE SHARES								
Home-Based Work								
In-Vehicle Person	**80.8%**	**87.4%**	**81.0%**	**68.8%**	**87.9%**	**87.8%**	**94.9%**	**81.7%**
Vehicle Driver	76.8%	78.8%	75.1%	60.4%	80.8%	82.4%	89.4%	74.9%
Vehicle Passenger	4.0%	8.7%	5.9%	8.3%	7.1%	5.3%	5.4%	6.8%
Total Transit	**12.4%**	**7.8%**	**12.4%**	**20.6%**	**8.6%**	**7.9%**	**3.2%**	**12.2%**
Caltrain	5.0%	4.9%	3.4%	0.9%	0.5%	0.3%	0.2%	0.9%
Other Transit	7.3%	2.9%	9.0%	19.7%	8.0%	7.7%	3.0%	11.3%
Bicycle	**1.1%**	**1.9%**	**2.7%**	**2.3%**	**1.1%**	**1.7%**	**0.5%**	**1.6%**
Walk	**5.7%**	**2.7%**	**2.8%**	**6.5%**	**1.8%**	**2.0%**	**1.2%**	**3.4%**
Other	**0.0%**	**0.2%**	**1.0%**	**1.7%**	**0.7%**	**0.6%**	**0.2%**	**1.0%**
Non-Work Trips								
In-Vehicle Person	**72.1%**	**81.0%**	**75.4%**	**66.8%**	**83.8%**	**86.3%**	**89.9%**	**79.5%**
Vehicle Driver	50.6%	54.6%	48.0%	40.5%	51.9%	55.6%	57.8%	50.0%
Vehicle Passenger	21.5%	26.4%	27.4%	26.4%	31.8%	30.7%	32.1%	29.5%
Total Transit	**4.3%**	**3.4%**	**5.9%**	**9.5%**	**2.5%**	**1.9%**	**1.2%**	**4.4%**
Caltrain	1.6%	1.4%	0.5%	0.1%	0.1%	0.1%	0.0%	0.1%
Other Transit	2.7%	2.0%	5.4%	9.4%	2.4%	1.8%	1.1%	4.3%
Bicycle	**2.6%**	**1.7%**	**1.3%**	**1.8%**	**1.1%**	**1.3%**	**0.6%**	**1.4%**
Walk	**16.8%**	**12.4%**	**13.9%**	**18.7%**	**10.3%**	**9.1%**	**5.2%**	**12.3%**
Other	**4.2%**	**1.6%**	**3.6%**	**3.2%**	**2.3%**	**1.4%**	**3.2%**	**2.4%**
Total Trips								
In-Vehicle Person	**74.2%**	**82.7%**	**76.8%**	**67.3%**	**84.7%**	**86.6%**	**90.9%**	**80.0%**
Vehicle Driver	56.9%	60.9%	54.6%	45.2%	58.5%	61.0%	64.0%	55.5%
Vehicle Trip Factor	***102.5%***	***109.6%***						
Vehicle Passenger	17.3%	21.8%	22.2%	22.1%	26.3%	25.6%	26.9%	24.5%
Total Transit	**6.2%**	**4.5%**	**7.5%**	**12.1%**	**3.9%**	**3.1%**	**1.6%**	**6.2%**
Transit Trip Factor	***101.2%***	***73.5%***						
Caltrain	2.4%	2.3%	1.2%	0.3%	0.2%	0.1%	0.1%	0.3%
Other Transit	3.8%	2.2%	6.3%	11.9%	3.7%	3.0%	1.5%	5.9%
Bicycle	**2.2%**	**1.7%**	**1.6%**	**2.0%**	**1.1%**	**1.4%**	**0.6%**	**1.5%**
Walk	**14.1%**	**9.9%**	**11.2%**	**15.8%**	**8.4%**	**7.7%**	**4.4%**	**10.3%**
Other	**3.2%**	**1.2%**	**2.9%**	**2.8%**	**2.0%**	**1.2%**	**2.6%**	**2.1%**

Note: Trip Factors = "within ¼ mile" & "¼ mile to ½ mile" mode share divided by Regional "Total" mode share

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TABLE A-3: Mode Shares and Calculated Vehicle Trip Reduction and Transit Trip Increase Factors – San Francisco MUNI Light Rail

CIRCULAR BUFFER ANALYSIS

	Proximity of Resident's Home to **MUNI Light Rail Lines**							
	Within	1/4 mile to	1/2 mile to	Greater than 1 mile				
Travel Characteristic	1/4 mile	1/2 mile	1 mile	Urban	High-Sub	Low-Sub	Rural	Total
MODE SHARES								
Home-Based Work								
In-Vehicle Person	**43.2%**	**41.6%**	**60.2%**	**79.7%**	**88.0%**	**87.8%**	**93.7%**	**81.7%**
Vehicle Driver	36.4%	36.5%	54.3%	70.6%	81.2%	82.4%	88.3%	74.9%
Vehicle Passenger	6.8%	5.2%	5.9%	9.1%	6.8%	5.4%	5.3%	6.8%
Total Transit	**32.5%**	**38.0%**	**31.9%**	**13.8%**	**8.2%**	**8.0%**	**4.4%**	**12.2%**
MUNI Light Rail	8.2%	2.7%	2.3%	0.2%	0.1%	0.1%	0.0%	0.7%
Other Transit	24.3%	35.4%	29.6%	13.6%	8.1%	7.9%	4.4%	11.5%
Bicycle	**5.7%**	**1.9%**	**1.8%**	**1.8%**	**1.3%**	**1.7%**	**0.5%**	**1.8%**
Walk	**15.6%**	**16.5%**	**5.9%**	**3.2%**	**1.8%**	**2.0%**	**1.2%**	**3.4%**
Other	**3.0%**	**1.9%**	**0.2%**	**1.5%**	**0.6%**	**0.5%**	**0.2%**	**1.0%**
Non-Work Trips								
In-Vehicle Person	**52.1%**	**56.3%**	**61.3%**	**72.0%**	**83.9%**	**86.3%**	**89.0%**	**79.5%**
Vehicle Driver	30.9%	34.9%	34.3%	44.7%	52.1%	55.7%	57.2%	50.0%
Vehicle Passenger	21.2%	21.4%	27.1%	27.3%	31.8%	30.6%	31.8%	29.5%
Total Transit	**15.6%**	**17.3%**	**10.5%**	**7.1%**	**2.4%**	**2.0%**	**1.1%**	**4.4%**
MUNI Light Rail	4.1%	0.8%	0.8%	0.2%	0.0%	0.2%	0.0%	0.3%
Other Transit	11.5%	16.5%	9.8%	7.0%	2.4%	1.8%	1.1%	4.1%
Bicycle	**2.0%**	**2.0%**	**1.3%**	**1.7%**	**1.3%**	**1.3%**	**0.6%**	**1.4%**
Walk	**27.5%**	**23.4%**	**25.5%**	**15.4%**	**10.1%**	**9.1%**	**5.9%**	**12.3%**
Other	**2.8%**	**1.1%**	**1.3%**	**3.7%**	**2.3%**	**1.4%**	**3.4%**	**2.4%**
Total Trips								
In-Vehicle Person	**49.8%**	**52.8%**	**61.1%**	**73.8%**	**84.9%**	**86.6%**	**89.9%**	**80.0%**
Vehicle Driver	32.3%	35.3%	38.7%	50.9%	58.7%	61.1%	63.3%	55.5%
Vehicle Trip Factor	***58.2%***	***63.5%***						
Vehicle Passenger	17.5%	17.5%	22.4%	23.0%	26.2%	25.5%	26.6%	24.5%
Total Transit	**19.9%**	**22.2%**	**15.2%**	**8.7%**	**3.7%**	**3.2%**	**1.8%**	**6.2%**
Transit Trip Factor	***322.9%***	***361.4%***						
MUNI Light Rail	5.1%	1.2%	1.1%	0.2%	0.0%	0.1%	0.0%	0.4%
Other Transit	14.7%	21.0%	14.1%	8.5%	3.7%	3.0%	1.8%	5.7%
Bicycle	**2.9%**	**2.0%**	**1.4%**	**1.7%**	**1.3%**	**1.3%**	**0.6%**	**1.5%**
Walk	**24.5%**	**21.7%**	**21.2%**	**12.5%**	**8.2%**	**7.7%**	**5.0%**	**10.3%**
Other	**2.9%**	**1.3%**	**1.1%**	**3.2%**	**2.0%**	**1.2%**	**2.8%**	**2.1%**

Note: Trip Factors = "within ¼ mile" & "¼ mile to ½ mile" mode share divided by Regional "Total" mode share

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TABLE A-4: Mode Shares and Calculated Vehicle Trip Reduction and Transit Trip Increase Factors – Santa Clara VTA Light Rail

CIRCULAR BUFFER ANALYSIS

	Proximity of Resident's Home to **VTA Light Rail Stations**							
	Within	1/4 mile to	1/2 mile to	Greater than 1 mile				
Travel Characteristic	1/4 mile	1/2 mile	1 mile	Urban	High-Sub	Low-Sub	Rural	Total
MODE SHARES								
Home-Based Work								
In-Vehicle Person	**74.2%**	**90.8%**	**89.7%**	**69.6%**	**87.1%**	**87.5%**	**93.7%**	**81.7%**
Vehicle Driver	70.6%	81.5%	83.2%	61.2%	80.1%	82.2%	88.3%	74.9%
Vehicle Passenger	3.6%	9.3%	6.5%	8.3%	7.0%	5.2%	5.4%	6.8%
Total Transit	**24.0%**	**6.1%**	**4.3%**	**20.3%**	**8.8%**	**8.1%**	**4.5%**	**12.2%**
VTA Light Rail	0.4%	1.4%	1.2%	0.4%	0.1%	0.0%	1.0%	0.3%
Other Transit	23.6%	4.7%	3.1%	19.9%	8.6%	8.1%	3.4%	11.9%
Bicycle	**1.3%**	**0.7%**	**0.3%**	**2.4%**	**1.4%**	**1.8%**	**0.4%**	**1.8%**
Walk	**0.6%**	**2.2%**	**1.5%**	**6.4%**	**2.0%**	**2.0%**	**1.2%**	**3.4%**
Other	**0.0%**	**0.2%**	**4.2%**	**1.3%**	**0.7%**	**0.6%**	**0.2%**	**1.0%**
Non-Work Trips								
In-Vehicle Person	**72.6%**	**84.7%**	**78.0%**	**67.1%**	**83.4%**	**86.3%**	**88.9%**	**79.5%**
Vehicle Driver	45.3%	49.4%	46.4%	41.4%	51.8%	55.7%	57.2%	50.0%
Vehicle Passenger	27.3%	35.4%	31.6%	25.8%	31.6%	30.5%	31.8%	29.5%
Total Transit	**11.3%**	**2.5%**	**1.9%**	**9.7%**	**2.5%**	**1.9%**	**1.1%**	**4.4%**
VTA Light Rail	0.6%	0.2%	0.6%	0.0%	0.0%	0.0%	0.0%	0.1%
Other Transit	10.7%	2.3%	1.3%	9.7%	2.5%	1.9%	1.1%	4.4%
Bicycle	**0.7%**	**0.5%**	**0.5%**	**1.8%**	**1.3%**	**1.3%**	**0.6%**	**1.4%**
Walk	**7.1%**	**9.0%**	**9.7%**	**19.0%**	**10.5%**	**9.2%**	**5.9%**	**12.3%**
Other	**8.3%**	**3.3%**	**9.9%**	**2.3%**	**2.4%**	**1.4%**	**3.5%**	**2.4%**
Total Trips								
In-Vehicle Person	**73.0%**	**86.2%**	**80.8%**	**67.7%**	**84.2%**	**86.5%**	**89.9%**	**80.0%**
Vehicle Driver	52.1%	57.4%	55.2%	46.1%	58.1%	61.1%	63.3%	55.5%
Vehicle Trip Factor	***93.9%***	***103.5%***						
Vehicle Passenger	20.9%	28.8%	25.6%	21.6%	26.1%	25.4%	26.6%	24.5%
Total Transit	**14.7%**	**3.4%**	**2.5%**	**12.2%**	**3.9%**	**3.1%**	**1.8%**	**6.2%**
Transit Trip Factor	***239.7%***	***54.9%***						
VTA Light Rail	0.6%	0.5%	0.7%	0.1%	0.1%	0.0%	0.2%	0.1%
Other Transit	14.2%	2.9%	1.8%	12.1%	3.8%	3.1%	1.6%	6.0%
Bicycle	**0.9%**	**0.5%**	**0.5%**	**2.0%**	**1.3%**	**1.4%**	**0.6%**	**1.5%**
Walk	**5.3%**	**7.3%**	**7.8%**	**16.0%**	**8.6%**	**7.7%**	**5.0%**	**10.3%**
Other	**6.1%**	**2.5%**	**8.5%**	**2.1%**	**2.0%**	**1.2%**	**2.8%**	**2.1%**

Note: Trip Factors = "within ¼ mile" & "¼ mile to ½ mile" mode share divided by Regional "Total" mode share

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APPENDIX B: SUMMARIES OF ELASTICITY DATA FROM SELECTED STUDIES REVIEWED FOR THIS RESOURCE PAPER (*Thanks To Reid Ewing, who compiled the majority of the studies' data*)

Table B-1. Multivariate Statistical Studies Using Aggregate Data

	Study Design	Subjects	Geography	Sample (N)	Source of Elasticities	Model Form	Outcome Variables	Built Environmental Variables	Control Variables	Elasticities	Comments
Messenger and Ewing (1996)	cross sectional	bus stops	½-mile buffers		computed from model coefficients	linear equations estimated jointly					
Bhatia (2004)	cross sectional	general population	communities of varying size	20 DC area communities	derived from author's dataset	linear regression for walk share loglinear regression of transit share	% walk trips % transit trips	household density	average household size median household income	walk share of all trips household density: 1.100 (median household income: 0.1973) transit share of all trips household density: 0.7889 (median household income: -0.4035)	
Braza et al., (2004)	cross sectional	elementary school students		34 schools in California (with their aggregate mode shares)	derived from authors' dataset	linear regression	% walk or bike to school	population density within ½ mile of school intersections per street mile within ½ mile of school	school size % students receiving public assistance % students of various ethnicities minimum distance for busing	walk share of school trips population density: 0.2965 intersections per street mile: 0.5776 (% receiving public assistance: 0.1780)	

Table B-2. Multivariate Statistical Studies Using Disaggregate Data

	Study Design	Subjects	Geography	Sample (#)	Source of Elasticities	Model Form	Outcome Variables	Built Environmental Variables	Control Variables	Elasticities	Comments
Ewing et al. (1996)	cross sectional							accessibility index walking quality factor proportion four-way intersections proportion quadrilateral blocks average sidewalk proportion of area within ¼ mile of proportion commercial parcels with front or side parking	annual income per person number of children under 5 gender driver's license employed status trip distance transit service intensity	proportion within ¼ mile of store: 0.365 walking quality factor: 0.119 walking/biking/transit choice for non-work intensity factor: 0.084 walking quality factor 0.183 sidewalk width: 0.087 front and side parking: -0.121	other variables have insignificant coefficients
Kitamura et al. (1997)	cross sectional (with neighborhoods matched on income and disparate in land use characteristics)	general population	large neighborhoods and varying distances around residences	3,793-10,767 individuals in San Francisco Bay Area	computed from model coefficients	linear regression	fraction of walk/bike trips fraction of transit trips	high density presence of backyard distance to nearest grocery store distance to nearest distance to nearest bus stop sidewalks in neighborhood	household size number of driver's license high school graduate degree professional occupation high personal income medium personal income attitudes on a variety of subjects	share of walk/bike distance to nearest bus stop: -1.034 distance to nearest park: -1.07 (household size: - share of transit trips distance to nearest rail station: -1.619 distance to nearest park: -1.450 (number of vehicles: -8.794)	
Kockelman (1997)	cross sectional	adults	TAZs and census tracts	52,650 trips in the San Francisco Bay Area	reported by author	binomial logit	probability of walking or biking	job accessibility (gravity formulation) population density job density land use mix (dissimilarity index) land use balance (entropy formulation) non-work land use balance (entropy formulation)	household size auto ownership income per gender age driver's license employment race professional occupation	walk/bike choice accessibility: 0.22 non-work land use balance: 0.23 (vehicles per person: -0.60) (household size: 0.48)	

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Greenwald and Boarnet (2001)	cross sectional	general population		1,084 individuals in Portland, OR	computed from model coefficients	ordered probit	number of nonwork walk trips per person	population density of census block group retail employment density w/i 1-mile of % quadrilateral street sections pedestrian environment factor population density of zip code retail job density w/i zip code	age number of vehicles per gender household number of number of employed ethnicity workday median trip distance median trip speed		mean values of dependent and independent variables supplied by used census block group and 1-mile buffer variables rather than zip code level variables as the smaller geography is more
Cervero (2002)	cross sectional	general population		1,960 trips for all purposes in Montgomery County, MD	reported by author	multinomial logit	probability of taking transit	gross density land-use diversity ratio of sidewalk to road miles proportion of multi-family households within ¼ mile of metrorail station	vehicle gender driver's license full-time employment	transit choice all trip purposes gross density origin: 0.511 gross density destination: 0.268 land-use diversity origin: 0.615 land-use diversity destination: 0.452 sidewalk ratio destination: 0.327 proportion multifamily with ¼ mile of station origin: 0.195	add Cervero's explanation
Reilly (2002)	cross sectional	general population	buffer widths around residences of ¼ to 4 miles	7,604 trips for non-work purposes in San Francisco, CA	computed from model coefficients	multinomial logit	probability of walking probability of taking transit	population density distance to closest commercial use proportion commercial uses dissimilarity index mean block size intersection density proportion detached homes median year built mean parcel size	age driver's license employment race/ethnicity household size household vehicles/driver home ownership weekend trip transit access index		

Cervero and Duncan (2003)	cross sectional	general population		7,835 trips for selected purposes in San Francisco, CA	computed from model coefficients	multinomial logit	probability of walking on a trip of less than 5 miles probability of biking on a trip of less than 5 miles	employment density land-use diversity factor pedestrian-friendly design factor	gender race disability number of household vehicles number of household bicycles trip purpose trip distance weekend trip nighttime trip rainfall slope low-income neighborhood	walk choice employment density at origin: 0.0411 land-use diversity at origin land-use diversity at destination pedestrian-friendly design at origin pedestrian-friendly design at destination (trip distance: -3.734) (number of vehicles: -1.241)	
Rajamani et al. (2003)	cross-sectional	general population		2,500 home-based nonwork trips in Portland, OR	reported by authors	multinomial logit	probability of walking on nonwork trip probability of taking transit on nonwork trip	population density land use mix diversity index % cul-de-sacs in neighborhood street connectivity index accessibility indices (only for recreation trips)	age gender handicap race household income vehicles per adult number of children number of adults travel times and costs	walk choice for nonwork trips population density: 0.0046 land use mix diversity index: 0.3610 % cul-de-sacs: -0.0046 (walk travel time: -0.8635) (vehicles per adult: -1.0464) (number of children: -0.1687) transit choice for nonwork trips population density: 0.0775 land use mix: -0.0370 % cul-de-sacs: 0.0004 (transit travel time: -0.8689) (vehicles per adult: 0.0444) (number of children: -0.2104)	check with Garrit both on calculation of elasticities and definitions of BE variables what happened to other variables they say higher densities improve the chances of walking but elasticity is small probabilities aggregated to obtain elasticities of mode shares didn't include bike elasticities due to small sample of bike trips
Ewing et al. (2004)	cross sectional	students	TAZs	711 trips to school in Gainesville, FL	reported by author	multinomial logit					

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Zheng (2004)	cross sectional	general population		1,019 home-based work trips and 1,036 home-based nonwork trips in Boston (separate sample of trips for Hong Kong)	reported by author	multinomial logit	probability of walk or bike trip probability of transit trip	population density (origin and destination) job density (origin and destination) land use balance (origin and destination – entropy formulation) % cul-de-sac intersections (origin and destination)	age less than 30 full-time worker status home ownership female no children vehicles per worker distance to nearest transit station travel cost and time by different modes	walk/bike choice for work: population density: 0.108 job density: 0.020 land use balance: -0.017 % cul-de-sacs: -0.072 (walk time: -0.5534) (vehicles per worker: -0.2483) walk/bike choice for: population density: 0.060 job density: -0.004 land use balance: 0.118 % cul-de-sacs: -0.047 (walk time: -0.8285) (vehicles per worker: -0.2817) transit choice for work trips population density: 0.118 job density: 0.090 land use balance: -0.020 % cul-de-sacs: -0.083 (transit time: -0.2794) (vehicles per worker: -0.3688) transit choice for nonwork trips population density: 0.128 job density: 0.004 land use balance: 0.121 % cul-de-sacs: -0.044 (transit time: -0.2307) (vehicles per worker: -0.2826)	elasticities reported are probability weighted average individual elasticities for each mode relative to built environmental variables averaged for origin and destination these elasticities may not relate to mode share but instead to probabilities – ask author

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Held and Vance (2006)	German Mobility Panel: eight overlapping waves (1996–2003) each comprising a group of households surveyed for one week in three successive years	Each licensed driver of each household (4300 individuals in 2600 households)	Germany	4300 individuals in 2600 households	Reported by authors	2-part model: probit and OLS estimators 3-tiers (individual, household, zip code (insufficient data for hierarchical modeling) Instrumented neighborhood variables (IV) % bldgs <1945 % bldgs 1945-65	Vehicle trips VMT	Commercial diversity: entropy mix of 3 types of commercial Commercial density: commercial businesses per acre in zip code Street density: sq feet per acre in zip code Access to transit: walk minutes to bus stop	Disposable per capita income, age, gender, education, employment status, home/work distance, auto ownership	VT elasticities: Commerc density = -0.031 Comm diversity* = +0.132 Transit walk dist = +0.022 VMT elasticities: Commerc density = -1.556 Comm diversity* = +2.646 Transit walk dist = +3.151 Street density* = -0.092 * *Not significant at the 5% level* VT elasticities: Commerc density = -0.083 Comm diversity* = -0.335 Transit walk dist = +0.032 VMT elasticities: Commerc density = -4.349 Comm diversity* = -34.53 Transit walk dist = +2.567 Street density = -0.534 * *Not significant at the 5% level*	
Guo, Bhat, Copperman	SF Bay Area Travel Survey, 2000	Statistical sample of Bay Area households	Sample of households in 9 urban area counties	19,400 individuals	Print model "parameters" reported.	Bivariate ordered probit model	Home-based auto trip generation (excludes HHB) for 1) maintenance and 2) discretionary	Mix of resid, comm, other land use; Pop density, bike network density, street density and grain, transit availability, maintenance business density, discretionary business density, TAZ accessibility to shopping, rec, employment	Household size, income, structure, autos, individual age, gender, ethnicity	"Parameters" for Maintenance trips: Pop density = -2.464 "Parameters" for Discretionary trips: % lu diversity: -0.188 Fraction residential = +0.52 Pop density = -1.531 Highway density = -0.016	Does not address self-selection

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Cao, Mokhtarian, Handy	Mail-out survey to with response by 320 movers and 230 non-movers	Households who moved within region to 4 traditional and 4 suburban neighborhoods	Eight No. Cal. neighborhoods in Mt View area, Sacramento, Santa Rosa, Modesto	547 households, of which about 320 had moved within year prior to survey		Maximum Likelihood est; Structural Equations Model	Changes in auto ownership, driving	Accessibility to mall, downtown, amenities Outdoor spaciousness (yard size, off-street parking Socializing: diverse neighbors, outdoor presence	Residential preference, travel attitudes	SEM Total Effects: Spaciousness = +0.014 Accessibility = -0.225 Socializing = -0.132 Leisure businesses = -0.011	

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Table B-3. Quasi-Experimental Studies Using Disaggregate Data

	Study Design	Subjects	Geography	Sample (N)	Source of Elasticities/ Effect Sizes	Model Form	Outcome Variables	Built Environmental Variables	Control Variables	Marginal Effects	Comments
Ewing et al. (1994)					derived from authors' dataset						
Cervero and Radisch (1996)	quasi-experimental with neighborhoods matched on regional location, transit and freeway access, and household	general population	2 neighborhoods in East Bay of San Francisco-Oakland	920 work trips (620 residents for nonwork travel survey) (840 residents for work travel survey)	computed from model coefficients	binomial logit	probability of walking to work	traditional neighborhood design (Rockridge dummy variable)	household size household income	with traditional design [illegible]% greater probability of walking to nonwork destinations	assumed a mean of two vehicles per household
Hess et al. (1999)	quasi-experimental with neighborhoods matched on population density and median	neighborhood commercial centers	12 neighborhoods in Seattle, WA	12 commercial centers	derived from authors' dataset	linear regression	pedestrians/1000 residents	urban neighborhood design (dummy for urban neighborhoods with small blocks, sidewalks, and direct routes)	population density median household income number of businesses	with urban neighborhood design 140% more walk trips to commercial centers	sidewalk completeness and block size are highly correlated
Handy and Clifton (2001)	quasi-experimental with neighborhoods matched on income (statistical controls for individual SES differences)	general population	6 neighborhoods in Austin, TX (2 traditional, 2 early-modern, 2 late-modern)	1,377 residents	computed from model coefficients	linear regression	number of walk trips for shopping	traditional neighborhood design (Old West Austin neighborhood dummy)	age children in household gender income miles to store quality of stores index walking incentive index walking comfort index strolling frequency	with traditional design (20% more walk trips for shopping)	marginal effect was computed at mean values of all independent variables
Lund (2003)	quasi-experimental with neighborhoods matched on *** (statistical controls for individual SES differences)	residents of single-family homes	8 neighborhoods in Portland, OR (4 urban, 4 suburban)	427 residents	computed from model coefficients	linear regression	number of walk trips to destinations number of strolling trips	on-site retail on-site retail and park university location	age gender race children of varying ages homeowner status length of residence attitudes on a variety of subjects	with on-site retail 14% more walk trips to destinations 18% fewer strolling trips with on-site retail and park 33% more walk trips to destinations 9% fewer strolling trips at university locations 6% more walk trips to destinations 2% fewer strolling trips	marginal effect was

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Khattak and Rodriguez (2004)	quasi-experimental with neighborhoods matched on house value, age of development, transit service availability, and regional	residents of single-family homes	2 suburban neighborhoods in Chapel Hill, NC	711 residents	computed from model coefficients	negative binomial regression	number of walk and bike trips	neo-traditional neighborhood design (Southern Village dummy)	gender age number of vehicles household size housing type (single family)	with neo-traditional design [illegible]% more walk and bike trips overall [illegible]% more recreational walk and bike trips [illegible]% more utilitarian walk and bike trips	
Rose and Dill (2004)	quasi-experimental with neighborhoods matched on house size, house value, age of development, and regional location (statistical	residents of single-family homes	3 suburban neighborhoods in Portland, OR	210 residents	computed from model coefficients	poisson regression	number of walk trips number of walk trips for shopping number of walk trips for recreation	neo-traditional neighborhood design (Fairview Village dummy)	age number of vehicles gender number of children	% more walk trips % more walk trips for shopping % more walk trips for recreation	marginal effect sizes computed at mean values of all independent variables base is average for two conventional neighborhoods
Mohammadian A. Zhang	US National Household Travel Survey, 2001, market-segment cluster analyses	Statistical sample of US households	Sample of households in 50 US states	640,000 trips, 160,000 people, 70,000 households	(none available, just cluster differences)	Cluster analyses, categories incl. Young achievers	Trips by purpose, VMT, % transit, non-motorized trips, hours	Census tract: Housing density, employt density, pop density, intersection density, road density, block size,	Household age group, education, occupation Other component analysis factors: vehicles, income, ethnicity,	(None available)	Sample cluster results for: 2,3: Young suburbans
Dill	Home-delivered survey with response by 312 households		8 developments near MAX stations in the Portland, OR area	312 households, 247 suburban, between 13 and 68 households in each study development			Percent Commuting by Transit	Estimated walk trip time from transit station to work/school		>30% transit share for walk trip times <15 minutes 20-25% transit share for walk trip times 15-30 minutes <5% transit share for walk trip times >30 minutes	
Zhou, Gould, O'Flaherty	South Coast Air Quality Management District Survey	UCLA Faculty and Staff	Greater Los Angeles area	2,484 employees			Transit share	Within 1/4 Mile of Bus Stop Transit Carrier		7-12% higher transit mode share, depending on carrier	
MTC Planning Section	SF Bay Area Travel Survey, 2000	Statistical sample of Bay Area households	San Francisco Bay Area	35,000 residents in 15,000 households			Transit share Auto Ownership VMT	Distance from train/ferry station for residence and work		Those living and working within 1/2 mile of transit make 42% of commutes About 1/3 of households within 1/2 mile radius of transit/ferry station have no auto Households within 1/2 mile of transit/ferry station generate half the VMT of suburban and rural residents	

APPENDIX C: EXPERT RESEARCH PANEL PARTICIPANTS

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- **Reviewer, Invited and Unable to Attend**
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    Metropolitan Transportation Commission (MTC)

- **Proposition 1C TOD Program Staff Attending**
  - Linda Wheaton, Assistant Deputy
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ANNOTATED BIBLIOGRAPHY (Partial):

Anderson, Michael David and Sharfi, Khalid and Gholston, Sampson. *Direct Demand Forecasting Model for Small Urban Communities Using Multiple Linear Regression*. Transportation Research Board, 2006.

Forecasting traffic volumes to support infrastructure decisions is the heart of the travel demand modeling process. The most commonly used methodology for obtaining these forecasted traffic volumes is the four-step process that considers generation, distribution, mode choice, and route assignment of trips. Each step of the process is performed independently, almost always through the use of computer software, to achieve the final traffic volumes. This paper examines the possibility of forecasting traffic volumes by using a multiple linear regression model to perform what is termed direct demand forecasting. The direct demand forecasting model generates traffic volumes for roadways through the development of a functional relationship between roadway characteristics and socioeconomic influences. A direct demand travel forecasting model has been developed and applied, with a small urban area as a case study community. Results are consistent with those obtained from the traditional four-step methodology.

de Abreu e Silva, João and Golob, Thomas F and Goulias, Konstadinos G. Effects of Land Use Characteristics on Residence and Employment Location and Travel Behavior of Urban Adult Workers. Transportation Research Board, TRR 1977, 2006.

The relationships between socioeconomic and demographic characteristics, land use characteristics around the residence and work locations, and a variety of travel behavior indicators are examined by using a structural equations model. This simultaneous equations system allows one to model the effects of land use characteristics on travel behavior while controlling for self-selection bias: certain types of persons choose to live and work in areas that suit their lifestyles and resources. In the model, travel behavior choices are multidimensional; total time away from home, trips and trip distances by three types of modes, car ownership, and possession of a transit pass are included. Land use is captured in geographic information system-based measures of land use and transport supply variables centered on both home and work locations. These measures are reduced to eight land use factors. The analysis provides strong evidence in favor of using land use and urban form designs and planning both around residential neighborhoods and workplace areas. Results provide quantitative evidence of the extent to which workers living in denser, central, compact, and mixed zones make more intense use of transit and nonmotorized modes and tend to have lower car ownership levels. Workers in areas well served by freeways tend to make more intense use of their cars, although this does not inhibit use of transit. The results show that land use measures differ in their ability to explain different travel demands even when controlling for socioeconomic and demographic effects.

Bagley, M. & Mokhtarian, P. (2002). The Impact of Residential Neighborhood Type on Travel Behavior: A Structural Equations Modeling Approach. *Annals of Regional Science, 36*, 279-297.

In this paper, the authors examine the relationship of residential neighborhood type to travel behavior, incorporating attitudinal lifestyle, and demographic variables. The variable are drawn from data collected from residents of five neighborhoods in the San Francisco Bay Area in 1993.

Barnes, G. (2001). *Population and Employment Density and Travel Behavior in Large U.S. Cities*. Minneapolis: Minnesota Department of Transportation.

This research project sought to determine whether high-population density or some other aggregate land use characteristic can be used to create beneficial effects on travel behavior at the level of the entire urbanized area. The research also looked at gaining a better understanding of the reasons for variations in travel behavior across large U.S. cities. This research involved a comprehensive analysis, considering an unusually large number of factors. Researchers also developed a number of ways to describe aggregate "macro" land use in an urbanized area specifically for this study. The study found that land use, at the aggregate level studied in this project, is not a major leverage point in determining overall population travel choices. Much policy seems to be based on the belief that relatively small changes to land use will have a big impact on travel choices. The findings here imply just the opposite - that even very big, widespread differences in land use have very little impact on travel behavior, in good ways or in bad ways.

Bhat, C. R and Guo, J. Y. (2006). *Comprehensive Analysis of Built Environment Characteristics on Household Residential Choice and Automobile Ownership Levels*. Washington, DC: Transportation Research Board.

This research paper identifies the research designs and methodologies that may be used to test the presence of ?true? causality versus residential sorting-based ?spurious? associations in the land-use transportation connection. The paper then develops a methodological formulation to control for residential sorting effects in the analysis of the effect of built environment attributes on travel behavior-related choices. The formulation is applied to comprehensively examine the impact of the built environment, transportation network attributes, and demographic characteristics on residential choice and car ownership decisions. The model formulation takes the form of a joint mixed multinomial logit-ordered response structure that accommodates differential sensitivity to the built environment and transportation network variables due to both demographic and unobserved household attributes and controls for the self-selection of individuals into neighborhoods based on car ownership preferences stemming from both demographic characteristics and unobserved household factors. The analysis in the paper represents, to our knowledge, the first instance of the formulation and application of a unified mixed multinomial logit-ordered response structure in the econometric literature. The empirical analysis in the paper is based on the residential choice and car ownership decisions of San Francisco Bay area residents.

Boarnet, M and Crane, R. (2001, November). The Influence of Land Use on Travel Behavior: Specification and Estimation Strategies. *Transportation Research Part A: Policy and* Practice, *35*(9), 823-845.

Even though the relationship between urban form and travel behavior is a key element of many current planning initiatives aimed at reducing car travel, the literature faces 2 major problems. First, this relationship is extremely complex, and second, several specification and estimation issues are poorly addressed in prior work, possibly generating biased results. In this paper, the authors argue that many of the latter problems are overcome by systematically isolating the separable influences of urban design characteristics on travel and then properly analyzing individual-level data. The results that directly follow from alternative land use arrangements, as well as those that do not, are then clarified, thus identifying specific hypotheses to be tested against the data. More reliable tests of these hypotheses are then developed, and implications of alternative behavioral assumptions regarding travel costs are explored. The measured influence of land use on travel behavior is shown to be very sensitive to the form of the empirical strategy.

Boarnet, M & Crane, R. (2001). *Travel by Design: The Influence of Urban Form on Travel*. New York: Oxford University Press.

Combining urban design and transportation planning with the idea that neighborhoods and cities can be designed to change travel behavior is a popular idea. The goal is to reduce car use and increase the quality of life in the neighborhood. This book looks into the premise of urban design and transportation planning. It seeks to answer three questions: Can it work, Will it be put into practice, and Is it a good idea? The book is divided into four parts: an introduction, a section on travel behavior, a section on the supply of place, and a section on the role of travel by design. Topics include traffic, urban form, travel, demand for travel, a study of travel behavior, neighborhood supply, mathematical models for trip generation, transit-oriented planning, and a case study of planning.

Cao, X., Mokhtarian, P. L., & Handy, S. L. (2006). Neighborhood Design and Vehicle Type Choice: Evidence from Northern California. *Transportation Research Part D, 11*, 133–145.

Previous studies have found that suburban development is associated with the unbalanced choice of light duty trucks. The specific aspects of the built environment that influence vehicle choice, however, have not been well-established. Further, these studies have not shed much light on the underlying direction of causality: whether neighborhood designs themselves, as opposed to preferences for neighborhood characteristics or attitudes towards travel, more strongly influence individuals' decisions regarding vehicle type. Using a sample from Northern California, this study investigated the relationship between neighborhood design and vehicle type choice, controlling for residential self-selection. Correlation analyses showed that neighborhood design has a strong association with vehicle type choice. Specifically, traditional neighborhood designs are correlated with the choice of passenger cars, while suburban designs are associated with the choice of light duty trucks. The nested logit model suggests that sociodemographic and attitudinal factors play an important role, and that an outdoor spaciousness measure (based on perceptions of yard sizes and off-street parking availability) and commute distance also impact vehicle type choice after controlling for those other influences. This study, therefore, supports the premise that land use policies have at least some potential to reduce the choice of light duty trucks, thereby reducing emissions.

Cao, X., Mokhtarian, P. L., & Handy, S. L. (2006). *Impacts of the Built Environment and Residential Self-Selection on Nonwork Travel: Seemingly Unrelated Regression Approach.* Washington, DC: Transportation Research Board.

Many studies have found that residents living in suburban neighborhoods drive more and walk less than their counterparts in traditional neighborhoods. This evidence provides support to the idea of using smart growth strategies to alter individuals' travel behavior. However, the observed differences in travel behavior may be more of a residential choice than a travel choice. Applying seemingly unrelated regression to a sample from Northern California, we explored the relationship between the built environment and nonwork travel behavior, controlling for measures of residential self-selection. This study shows that, at the neighborhood level, individuals' non-motorized travel is greatly influenced by residential self-selection, and residential preference and travel attitudes provide an incremental contribution in explaining the variation in auto and transit travel. After accounting for the influence of self-selection, we also found that neighborhood characteristics themselves affect individuals' travel choices. Therefore, if cities use land use policies to offer residents opportunities to drive less and use alternative modes more, the evidence suggests that they will tend to do so.

Cao, X., Handy, S. L., & Mokhtarian, P. L. (2006). The influences of built environment and residential self-selection on pedestrian behavior: evidence from Austin, TX. *Transportation, 33*, 1-20.

Planners and public health officials are encouraging policies that improve the quality of the built environment for pedestrians: mixed land uses, interconnected street networks, sidewalks, and other facilities. Whether such policies will prove effective partly depends on two issues. First, the impact of the built environment on pedestrian behavior may depend on the purpose of the trip, whether for utilitarian or recreational purposes. Second, the connection between the built environment and pedestrian behavior may be more a matter of residential location choice than of travel choice. This study aims to provide new evidence on both questions. Using information from a 1995 survey conducted in six neighborhoods in Austin, TX, two separate negative binomial models were estimated for the frequencies of strolling trips and pedestrian shopping trips within neighborhoods. An overview of average frequencies for both types of travel in these neighborhoods shows that strolling trips account for the majority of total walking trips made by respondents. Findings suggest that although residential self-selection impacts both types of trips, it is the most important factor explaining walking to a destination, i.e. for shopping. After accounting for self-selection, neighborhood characteristics (especially perceptions of these characteristics) impact strolling frequency, while characteristics of local commercial areas are important in facilitating shopping trips. This result implies that strolling trips and shopping trips are influenced by different dimensions of the built environment.

Cao, Xinyu, Mokhtarian, Patricai L., and Handy, Susan L. (2007) *Do Changes in Neighborhood Characteristics Lead to Changes in Travel Behavior?* Paper Presentation at the 11th World Conference on Transportation Research, June 24-28, 2007. University of California, Berkeley.

Suburban sprawl has been widely criticized for its contribution to auto dependence. Numerous studies have found that residents in suburban neighborhoods drive more and walk less than their counterparts in traditional environments. However, most studies confirm only an association between the built environment and travel behavior, and have yet to establish the predominant underlying causal link: whether neighborhood design independently influences travel behavior or whether preferences for travel options affect residential choice. That is, residential self-selection may be at work. A few studies have recently addressed the influence of self-selection. However, our understanding on the causality issue is still immature. To address this issue, this study took into account individuals' self-selection by employing a quasi-longitudinal design and by controlling for residential preferences and travel attitudes. In particular, using data collected from 547 movers currently living in four traditional neighborhoods and four suburban neighborhoods in Northern California, we developed a Structural Equations Model to investigate the relationships among changes in the built environment, changes in auto ownership, and changes in travel behavior. The results provide some encouragement that land-use policies designed to put residents closer to destinations and provide them with alternative transportation options will actually lead to less driving and more walking.

Cervero, R. (1993). Ridership Impacts of Transit-Focused Development in California. Berkeley: Report to the California Department of Transportation, IURD Monograph.
This report examines evidence on the degree to which existing large-scale developments near rail stations in California have encouraged transit usage. Ridership patterns are studied for housing, office-workplace, and retail developments. In addition to quantifying the ridership impacts of transit-focused developments, the study also seeks to explain those factors which appear to most directly account for the travel choices of people living, working, and shopping near rail stations.

Cervero, R. (1994). Rail-Oriented Office Development in California: How Successful? *Transportation Quarterly*, *48*, 33-44.
Can transit-focused development lure significant number of Californians out of their cars? This paper explores this question by examining the ridership impacts of existing large-scale office projects near stations of five rail transit systems in the state--Bay Area Rapid Transit (BART), Santa Clara Light Rail Transit, Peninsula CalTrain, Sacramento Regional Transit and San Diego Trolley. Among California's urban rail systems, these have been in operation the longest and thus provide a context for studying the ridership impacts of office developments around more mature station environments. In addition to documenting transit ridership impacts, this paper also identifies key factors that influence the modal choices of station-area office workers. The effects of the built environment--such as density and land-use mixtures--on rail modal splits are also studied.

Cervero, R. (1995). Rail Access Modes and Catchment Areas for the BART System. BART @ 20 Study, IURD, Monograph 50.
The purpose of this report is to provide a 20-year perspective into the land use impacts of BART. The analysis concentrates on historical changes in private residential and non-residential land development for a sample of stations on various segments of the BART system. This report concentrates on documenting land use changes around specific stations and generalizing about the land use impacts of BART among classes of stations. For a sample of stations, differences in land use changes around BART stations and matched pairs of nearby freeway interchanges are also compared. Models are also presented that identify factors associated with station-area land-use changes. The report concludes by merging the results of individual station-area studies, and drawing policy inferences from these findings.

Cervero, R. (1996). Mixed Land-Uses and Commuting: Evidence from the American Housing Survey. *Transportation Research A*, 30, 361-377.
This paper investigates how mixed land-uses influence the commuting choices of residents from large metropolitan areas using data from the 1985 American Housing Survey. The analysis examines the effects of mixed-use levels as well as other features of the built environment like residential densities on three measures of transportation demand: commuting mode choice, commuting distance and household vehicle ownership levels. The effects of land-use environments on mode choice are modeled using binomial logit analysis.

Cervero, R. (2001). Walk-and-Ride: Factors Influencing Pedestrian Access to Transit, *Journal of Public Transportation*, 3(4), 1-23.
The article discusses the problems pedestrians face in trying to gain access to transit, as the predominant means of reaching suburban transit stations in the United States is by private car. In this article, analyses are carried out at two resolutions to address the problem: San Francisco Bay Area's compact, mixed-use settings with minimal obstructions that are conductive to walk-and-ride rail patronage; and Montgomery County, Maryland's urban design with sidewalk provisions and street dimensions that significantly aid access to transit by foot. The paper presents elasticities that summarize findings.

Cervero, R. (2002, June). Built Environments and Mode Choice: Toward a Normative Framework. *Transportation Research Part D: Transport and Environment, 7*(4), 265-284.

Many studies contend that compact, mixed-use, pedestrian friendly urban development can significantly influence mode choice. However, most of these studies have failed to adequately specify relationships for purposes of drawing inferences about the importance of built-environmental factors in shaping mode choice. This paper seeks to overcome some of the deficiencies of past mode-choice analyses through an expanded specification of mode-choice utility. Mode choice in Montgomery County, Maryland is considered around a normative model that weighs the influences of not only three core dimensions of build environments (density, diversity and design) but factors related to generalized cost and socioeconomic attributes of travelers as well. The marginal contributions of built-environment factors to a traditionally specified utility-based model of mode choice are measured. The analysis reveals intensities and mixtures of land use significantly influence decisions to drive alone, share a ride or use public transit, while the influences of urban design tend to be less significant. Elasticities that summarize relationships are also presented. Results indicate that land-use variables should be explicitly included in the utility expressions of mode choice models in urban settings. It is also important to include economic attributes such as travel time and price variables of competing modes in the specification of models that test the influences of land-use factors on travel demand.

Cervero, R. (2006). Alternative Approaches to Modeling the Travel-Demand Impacts of Smart Growth. *Journal of the American Planning Association, 72*(3), 285-295.

Although planners have often used traditional four-step travel demand forecasting models to estimate the travel impacts of smart growth, they are not really appropriate for estimating the travel impacts of neighborhood-scale projects or development near transit stops. This article presents some alternatives to traditional modeling of neighborhood-scale transportation projects, including the direct (or off-line) modeling approach. Examples are presented of direct modeling of rail and transit-oriented land use proposals for the Charlotte, North Carolina metropolitan area, the San Francisco Bay Area, and south St. Louis County in Missouri. Results indicate that concentrating development near rail stations produced an appreciable jump in ridership. These applications also demonstrate that the alternative modeling approaches are well-suited for producing orders-of-magnitude estimates of the travel demand effects of smart growth scenarios and are useful supplements to traditional four-step models.

Cervero, R. (2006). Office Development, Rail Transit, and Commuting Choices, *Journal of Public Transportation*, 9(5), 41-55.

Decentralized employment growth has cut into transit ridership across the United States. In California, about 20% of those working in office buildings near rail stations regularly commute by transit, nearly 3 times transit's modal share among those working away from rail stations. Mode choice models reveal that office workers are most likely to rail-commute if frequent feeder bus services are available, employers help cover the cost of taking transit, and parking is in short supply. However, factors such as trip-chaining and absence of restaurants and retail shops near suburban offices deter transit-commuting. Policymakers can promote transit-commuting to offices near rail stops by flexing parking standards, introducing high-quality feeder buses, and initiating workplace incentives such as deeply discounted transit passes. While housing has generally been the focus of transit-oriented development, unless the workplace end of the commute trip is also convenient to transit, transit will continue to struggle in winning over commuters in an environment of increasingly decentralized employment growth.

Cervero, R & Duncan, M. (2006). Which Reduces Vehicle Travel More: Jobs-Housing Balance or Retail-Housing Mixing? *Journal of the American Planning Association, 72*(4), 475-490.

This paper investigates which land-use strategy yields the greatest reductions in vehicular travel: improving the proximity of jobs to housing, or bringing retail services closer to residential areas. Using data from the San Francisco Bay Area, the degree to which job accessibility is associated with reduced work travel is examined. In addition, the correlation of retail and service accessibility with mile sand hours spent getting to shopping destinations is probed. Findings show that the jobs-housing balance more successfully reduces travel. However, the vehicle miles traveled and vehicle hours traveled reduction elasticities for both polices were estimated to be well above zero, suggesting that pursuing both strategies could yield benefits in many settings. Local and regional initiatives to balance the growth of jobs and housing are discussed.

Cervero, R. & Duncan, M. (2002). Residential Self Selection and Rail Commuting: A Nested Logit Analysis. Berkeley: UCTC Working Paper; http://www.uctc.net/papers/604.pdf
In this article, the authors examine the influence of transit-based housing on rail commuting in the San Francisco Bay Area. Using a logit formulation, factors such as travel times of competing modes and demographic characteristics of trip-makers are used for predicting the probabilities that residents opt for rail transit to reach their workplaces. The authors focus on improving upon model specifications by strongly rooting their analysis in urban location theory. They hypothesize that the decision to commute by rail can be significantly explained by residential choice.

Cervero, R. and Duncan, M. (2006). Which Reduces Vehicle Travel More: Jobs-Housing Balance or Retail-Housing Mixing? *Journal of the American Planning Association*, 72(4), 475-490.
This paper investigates which land-use strategy yields the greatest reductions in vehicular travel: improving the proximity of jobs to housing, or bringing retail services closer to residential areas. Using data from the San Francisco Bay Area, the degree to which job accessibility is associated with reduced work travel is examined. In addition, the correlation of retail and service accessibility with mile sand hours spent getting to shopping destinations is probed. Findings show that the jobs-housing balance more successfully reduces travel. However, the vehicle miles traveled and vehicle hours traveled reduction elasticities for both polices were estimated to be well above zero, suggesting that pursuing both strategies could yield benefits in many settings. Local and regional initiatives to balance the growth of jobs and housing are discussed.

Cervero, R and Ewing, R. (2002). Travel and the Built Environment-Synthesis, University of California at Berkeley Institute of Urban and Regional Development.
The potential to moderate travel demand through changes in the built environment is the subject of more than 50 recent empirical studies. The majority of recent studies are summarized. Elasticities of travel demand with respect to density, diversity, design, and regional accessibility are then derived from selected studies. These elasticity values may be useful in travel forecasting and sketch planning and have already been incorporated into one sketch planning tool, the Environmental Protection Agency's Smart Growth Index model. In weighing the evidence, what can be said, with a degree of certainty, about the effects of built environments on key transportation "outcome" variables: trip frequency, trip length, mode choice, and composite measures of travel demand, vehicle miles traveled (VMT) and vehicle hours traveled ((VHT)? Trip frequencies have attracted considerable academic interest of late. They appear to be primarily a function of socioeconomic characteristics of travelers and secondarily a function of the built environment. Trip lengths have received relatively little attention, which may account for the various degrees of importance attributed to the built environment in recent studies. Trip lengths are primarily a function of the built environment and secondarily a function of socioeconomic characteristics. Mode choices have received the most intensive study over the decades. Mode choices depend on both the built environment and socioeconomics (although they probably depend more on the latter). Studies of overall VMT or VHT find the built environment to be much more significant, a product of the differential trip lengths that factor into calculations of VMT and VHT.

Cervero, R & Gorham, R. (1995). Commuting in Transit Versus Automobile Neighborhoods. *Journal of the American Planning Association*, *61(1)*, 210-225.
A recent shift in the suburbs from automobile dependence to transit accessibility, walking, and bicycling is occurring nationwide. This article compares commuting characteristics of transit-oriented and auto-oriented suburban neighborhoods in the San Francisco Bay Area and in Southern California. Researchers found that transit neighborhoods averaged higher densities and had more gridded street patterns compared to their auto-oriented counterparts. Neighborhoods were matched in terms of median incomes and, to the extent possible, transit service levels, to control for these effects. For both metropolitan areas, pedestrian modal shares and trip generation rates tended to be considerably higher in transit than in auto-oriented neighborhoods. Transit neighborhoods had significantly higher rates of bus commuting only in the Bay Area. Islands of transit-oriented

neighborhoods surrounded by freeway-oriented suburbs seem to have negligible effects on transit commuting.

Cervero, R & Kockelman, K. (1997). Travel Demand and the 3Ds: Density, Diversity, & Design. *Transportation Research D, 2*, 199-219.

This paper examines the connection between the 3Ds of the built environment and travel demand. Notably, it tries to sort through the relative influences of the three dimensions after controlling for other explainers, like travellers' demographic characteristics. It does this mainly by applying the technique of factor analysis to gauge the relative influence of each dimension as well as their collective impacts. The paper tests the propositions of the new urbanists and others that compact neighborhoods, mixed land uses, and pedestrian-friendly designs 'degenerate' vehicle trips and encourage residents to walk, bike, or take transit as substitutes for automobile travel, particularly for non-work purposes.

Cervero, R., Landis, J., and Hall, P. (1992). Transit Joint Development in the United States: A Review of Recent Experiences and an Assessment of Future Potential. Washington: Urban Mass Transportation Administration, U.S. Department of Transportation; Monograph 42, Institute of Urban and Regional Development.

This report reviews transit-linked development in over two dozen U.S> cities, the history of joint development, and the evolving role of the Federal Transit Administration. The report attempts to classify and catalogue existing joint-development projects by size, type, location, and year of completion. Included as an appendix are brief description of the more than one hundred existing U.S. joint-development projects. An analysis was made on the financial impact joint development has had on the capital budgets of transit agencies that pursue joint development and the policy framework in which it occurs. In addition, the study presents the results of a survey of transit officials responsible for negotiating joint development agreements and their appraisal of its effect on their agency's operating and financial performance as well as other goals. The study concludes with an assessment of the institutional and market conditions necessary for successful joint development and recommendations to FTA for promoting and facilitating local joint-development efforts.

Cervero, R & Seskin, S. (1995). *An Evaluation of the Relationships Between Transit and Urban Form*. Washington, D.C: Transit Cooperative Research Program, Transportation Research Board.

This TCRP Digest summarizes the results of Phase I of TCRP Project H-1, "An Evaluation of the Relationships Between Transit and Urban Form". The objectives of this phase were to 1) review the existing literature on transit and urban form relations, 2) develop a framework to synthesize this knowledge, 3) identify gaps in current knowledge, and 4) develop the research plan for the balance of the project. This Digest, which brings together the results of more than 30 years of theoretical and practical examinations of transit and urban form relationships, provides a base of knowledge for future planning and decision making. The research plan will be implemented in Phase II. The contents of this Digest are organized as follows: (1.1) Introduction; (1.2) The Changing Urban Form of North American Cities; (1.3) Transit Impacts on Urban Form and Land Use; (1.4) Urban Form and Land-Use Impacts on Transit Demand; (1.5) Interactive Impacts of Transit and Urban Form; and (1.6) Research in Progress. A Bibliography is included.

Cervero, R., et. al. (2004). *Transit Oriented Development in the United States: Experiences, Challenges, Prospects*. TCRP Report 102.

Focusing development around transit facilities has become a significant way to improve accessibility, support community and regional goals of enhancing the quality of life, and support the financial success of transit investment. The experiences of a new generation of transit systems highlight the powerful role that transit investments play in channeling urban development. Benefits attributable to transit-oriented development (TOD) initiatives include improved air quality, preservation of open space, pedestrian-friendly environments, increased ridership and revenue, reduction of urban sprawl, and reorientation of urban development patterns around both rail and bus transit facilities. Today, many transit systems and communities across the country are participating in TOD programs. TOD participants range from small local and intercity bus systems with community-related services to large local and intercity rail systems with numerous projects. Increasingly, transit agencies are looking at programs and analyzing real-estate competitiveness to solicit developer interest. This report defines

TOD and joint development and offers insight into the various aspects of implementing TOD, including political and institutional factors; planning and land-use strategies, benefits, and impacts; fiscal considerations and partnerships; and design challenges and considerations. The report focuses on TOD and joint development and practice; the level of collaboration between various partners (e.g., the development community, financial partners, planning and land-use agencies, and government entities); the impacts of TOD and joint development on land values; the potential benefits of TOD; and successful design principles and characteristics. This report will be helpful to transit agencies, the development community, and local decision makers considering TOD. Some data on travel behavior is presented, including evidence that grid street networks can increase transit use by as much as 20 percent.

Chapleau, R and Morency, C and Madituc, G. *IMPACTS OF SETTLEMENT PATTERNS AND DYNAMICS ON URBAN MOBILITY BEHAVIOUR: FINDINGS FROM THE ANALYSIS OF MULTIPLE DATA SOURCES*. Elsevier, 2001.
This paper describes how there is a widespread recognition that transportation and land-use are strongly related. Actually, an extensive literature documents our current understanding of relationships linking urban form factors (residential and employment density, transit supply, auto ownership, accessibility and socio-economic factors such as income, age, gender and occupation) with travel activity (travel distances, modal split, mobility rate). Worth mention is a review of literature conducted in 1998 that summarized the current understanding of the implications of land-use on transit and the implications of transit on urban form in terms of influent factors. Noted in this research is the fact that "while transportation and land-use are strongly related, the current means of analyzing this relationship are limited". Urban sprawl, when observed according to its time dynamics, generates strong structural changes in travel behavior for commuters. For metropolitan transportation planners, recent and urgent concerns are emphasizing needs for clarifying the mutual impacts between land-use and transportation networks. In the same context, transport systems analysis at the metropolitan level faces the methodological challenge of accessing, structuring and exploiting relevant information from multiple data sources. This paper defines an analytical framework for modeling the impacts of settlement patterns and related mobility behavior by the incorporation of multi-dimensional variables in order to represent the complexity of the urban process phenomena. The question of forecasting future settlement pattern and related mobility is also addressed. An extensive experimentation with the Montreal data constitutes a demonstration of the applied methodology.

Chatman, D. G. (2003). How Density and Mixed Uses at the Workplace Affect Personal Commercial Travel and Commute Mode Choice. *Transportation Research Board*, TRR 1831.
A high density of shops and services near the workplace may make it easier to carry out personal commercial activities on foot before, during, and after work, enabling reduced vehicle use during the rest of the day. Investigating this question is an important addition to the current research, which has focused on residential neighborhoods. Data from the 1995 Nationwide Personal Transportation Survey are used to investigate the influence of workplace employment density and share of retail employment on commute mode choice and vehicle miles traveled (VMT) to access personal commercial activities. The analysis controls for socioeconomic characteristics and accounts for the endogeneity of commute mode choice and personal commercial VMT by employing a joint logit-Tobit model. Employment density at the workplace is found to be associated with a lower likelihood of automobile commuting and reduced personal commercial VMT, while the presence of employment in the retail category does not play a significant role. Workplace density is more clearly related to reduced VMT and automobile commuting than to characteristics of workers' residential neighborhoods and could have significant influences on personal commercial VMT and automobile commuting when increasing over a large area. The results suggest that land use planners should focus on encouraging employment density to a greater extent than is the current practice, although further research is needed on the role played by correlated factors such as higher parking costs, increased road congestion, and better transit service

Clifton, K. J. & Dill, J. (2005). *Women's Travel Behavior and Land Use: Will New Styles of Neighborhoods Lead to More Women Walking?* Washington, DC: Transportation Research Board.

Many travel behavior researchers have explored the links between land use characteristics and travel patterns. Several of them have demonstrated that certain patterns, such as density, mixed uses, and street connectivity, are associated with fewer or shorter vehicle trips, or both. There is also a considerable body of literature demonstrating the differences between men's and women's travel patterns. Yet less effort has been devoted to examining how land use may interact with sex to influence travel outcomes. If land use does affect travel, does it affect men's and women's travel differently? In particular, will both women and men take advantage of the walkable features of new urbanist neighborhoods? This study examines these questions in more detail through empirical analysis of land use and travel data. The relationships between walking behaviors, land use, and sex are emphasized. The findings reveal that women in new urbanist neighborhoods may walk more than do women in less walkable environments. However, men appear more likely to respond to these environments and walk more than their female counterparts. Land use and urban design may also remove some of the current barriers to women's walking, particularly safety concerns; however, the results indicate that women's ability or inclination to walk may be rooted in other reasons, such as family responsibilities.

Crane, R. (1996) On form versus function: Will the New Urbanism reduce traffic or increase it? *Journal of Planning Education and Research, 15*(3), 117-126.
A major attraction of the popular and influential planning movements known as the new urbanism, transit-oriented development, and neotraditional planning are their presumed transportation benefits. Though the architects and planners promoting these ideas are usually careful to emphasize the many ingredients necessary to obtain desired results--straightening of streets to open the local network, "calming" of traffic, better integration of land uses and densities, and so on -- a growing literature and number of plans feature virtually any combination of these elements as axiomatic improvements. The potential problem is that the traffic impacts of the new plans are generally indeterminate, and it is unclear whether designers understand the reasons well enough to avoid unintended results. This paper proposes a simple behavioral model to identify and assess the tradeoffs these ideas impose on transportation and subdivision planners.

Crane, R. (1996). Cars and Drivers in the New Suburbs: Linking Access to Travel in Neotraditional Planning. *Journal of the American Planning Association, 62*, 51-65.
Various "new suburb" land-use designs have emerged to address several social and environmental problems, including the dominance of automobile travel. Transportation benefits are expected from reducing the surface street distance between locations, mixing land uses, "calming" traffic, and promoting walking, bicycling, and transit via redesigned streets and streetscapes. The assumption that auto travel will decrease is a largely unchallenged premise of these designs. The evidence that exists on the subject is weak or contrary; this paper presents a simple behavioral argument to explain why. Generally speaking, driving is both discouraged and facilitated in the new suburbs, with the net effect being an empirical matter. The number of automobile trips and vehicle-miles traveled can actually increase with an increase in access, such as a move to a more grid-like land-use pattern. Clearly, the merits of the neotraditional and transit-oriented designs with their transportation benefits have been oversold. Each development must be evaluated as a separate case to determine whether its net impact on auto use is positive or negative.

Crane, R. (2000). The Influence of Urban Form on Travel: An Interpretive Review. *Journal of Planning Literature, 15*(1), 3-23.
This article explores whether neighborhood design can improve traffic. A scheme is first proposed for categorizing research addressing this and other related issues. Next, a detailed discussion of key studies of urban form and travel behavior is presented. The research strategies employed and the data, methods, and results of these studies are then evaluated in detail. The article concludes that although this body of research is improving in several respects and should be encouraged by policymakers and scholars alike, the current understanding of this complex group of relationships remains tentative. The basis for using land use and urban design to selectively change travel behavior thus appears limited in the near term, whereas research opportunities abound.

Dill, Jennifer. (2003). "Transit Use and Proximity to Rail: Results from Large Employment Sites in the San Francisco Bay Area", Transportation Research Board Annual Meeting CD-ROM.

Survey data from more than 1,000 large employment sites in the San Francisco Bay Area are used to examine the link between transit use and proximity to rail stations. The data were collected as part of an employer trip-reduction rule. Findings show that sites within one-quarter mile of a rail station have significantly higher rates of transit use than sites between one-quarter and one-half mile from stations. Transit use drops even further one-half mile from stations. That relationship holds true for all three rail systems in the Bay area. A closer look at 20 work sites near two light rail stations in Santa Clara County reveals that actual walking distance is also an important factor related to transit use. However, site design often lengthens walking distance unnecessarily. In addition, certain types of employers have higher rates of transit use than others.

Dill, J. (2006). *Travel and Transit Use at Portland Area Transit-Oriented Developments (TODs)*. TransNow, Department of Civil Engineering, University of Washington, Seattle WA.

In recent years there has been a growing interest in using land use planning to reduce reliance on the automobile long-term, through ideas such as smart growth, New Urbanism, pedestrian pockets, and transit-oriented developments (TODs). Many growing regions throughout the United States, are turning to these concepts to address problems of traffic congestion and suburban sprawl. However, the effectiveness of such policies in reducing automobile travel and improving livability is largely unknown. Portland was one of the early adopters and is often pointed to as a model for other regions. The Region's 2040 Growth Concept, adopted by the Metro regional government, includes many smart growth concepts. Metro uses a number of programs and policies to implement the 2040 Growth Concept, including subsidies to TODs. This research surveyed residents of TODs in the Portland area to help answer the following questions: (1) Do residents of TODs drive vehicles less, use transit more, and/or walk and bicycle more than residents of other neighborhoods? (2) To what extent can TODs increase transit ridership? (3) How do features of the TOD influence travel choices? (4) Do the features of TODs induce people to change their travel behavior? Alternatively, are people who move to these neighborhoods already active transit users, walkers, or cyclists, i.e., are they seeking an environment in which to practice their preferred travel behaviors? These questions are key to understanding the cause-effect relationship between the built environment and travel behavior. (5) How do people's attitudes toward travel and their neighborhood influence travel behavior?

DKS Associates, University of California, Irvine, University of California, Santa Barbara and Utah State University. (2007). Assessment of Local Models and Tools for Analyzing Smart-Growth Strategies. Final Report. Prepared for the State of California Business, Transportation and Housing Agency, and California Department of Transportation.

There is a growing interest in California in "smart-growth" land- use and transportation strategies designed to provide mobility options and reduce demand on automobile-oriented facilities. This study focuses on models and tools available for use by cities and counties in California for assessing the potential effects of smart-growth strategies.

The majority of regional agencies and local jurisdictions in California currently use a version of the Urban Transportation Modeling System (UTMS), commonly referred to as the "four-step travel demand model." This study provides a review of the steps in the UTMS process to identify where sensitivity to smart-growth strategies may be limited during the modeling process, and suggests ways that improvements could be made.

The greatest degree of modeling smart-growth sensitivity was found among UTMS models used by larger Metropolitan Planning Organizations (MPOs) or Congestion Management Agencies (CMAs). Several larger MPOs in California are also implementing new types of models, such as activity-based travel models or integrated land use/economic/transportation models. Some local jurisdictions also already use advanced models or travel demand models with high levels of smart-growth sensitivity. The report suggests that if local jurisdictions are already using models with "moderate" to "high" levels of smart-growth sensitivity, they should continue to enhance their models.

However, many local jurisdictions' models have very little sensitivity to smart-growth land use or transportation strategies. In such cases, the study suggests the appropriate use of a planning tool and/or post-processing application that incorporates "4D elasticities" (e.g., Density, Diversity, Design and Destinations). The report finds that 4D elasticities tools can be used as part of local planning, public participation, and decision-making processes, such as: reviewing major land-use development proposals, preparing updates to city and county general plans and specific area community plans, and during regional "visioning" and other public participation processes. Therefore, local jurisdictions with low-sensitivity models should consider using a 4Ds methodology to gain increased sensitivity to smart-growth strategies, either applied in "sketch-planning" software (such as I-PLACE[3]S, INDEX), or as a spreadsheet post-processor to a travel demand model.

However, before a decision is made to implement a 4D elasticities tool, the available travel demand model should first be tested to determine its sensitivity to smart-growth strategies. In addition, the report suggests that methods used to capture smart-growth sensitivity (either via improvements to a travel model and/or supplemental tools) should first be calibrated with local data and tested for reasonableness before being applied.

The report cautions against using 4D elasticities tools for conducting detailed corridor planning of streets or highways, for transportation impact studies of proposed land-use projects or traffic impact fee programs, or for CEQA or NEPA documentation - unless they are applied in specific ways (which are described). Other significant findings, conclusions, and recommendations are provided in Chapter 7.

Eliasson, John and Mattsson, L-G. *A Model for Integrated Analysis of Household Location and Travel Choices.* Transportation Research A 34, 375-394, Elsevier, 2000.

In this paper, the authors develop a model for integrated analysis of household location and travel choices and investigate it from a theoretical point of view. Each household makes a joint choice of location (zone and house type) and a travel pattern that maximizes utility subject to budget and time constraints. Prices for housing are calculated so that demand equals supply in each submarket. The travel pattern consists of a set of expected trip frequencies to various destinations with different modes. Joint time and budget constraints ensure that time and cost sensitivities are consistent throughout the model. Choosing the entire travel pattern at once, as opposed to doing so as a series of isolated choices, allows the marginal utilities of trips to depend on which other trips are made. When choosing trip frequencies to destinations, households are assumed to prefer variation to an extent varying with the purpose of the trip. The travel pattern will tend to be more evenly distributed across trip ends the less similar destinations and individual preferences are. These heterogeneities of destinations and individual preferences, respectively, are expressed in terms of a set of parameters to be estimated.

Ewing, R. (1995). Beyond Density, Mode Choice, & Single-Purpose Trips. *Transportation Quarterly, 49*, 15-24.

This study investigates the independent effects of land use on house-hold travel behavior, controlling for sociodemographic differences among households. It appears that even in a sprawling sunbelt environment, land use patterns matter. However, their effect is not exactly as envisioned by the advocates. Accessibility to regional activities has much more effect on household travel patterns than does density or land use mix in the immediate area; accessibility has as much effect on the frequency and length of trips as the mode of travel; and these relationships can be best understood in terms of multi-purpose trip making.

Ewing, R & R. Cervero. (2001). Travel and the Built Environment: A Synthesis. *Transportation Research Record, 1780*, 87-114.

The potential to moderate travel demand through changes in the built environment is the subject of more than 50 recent empirical studies. The majority of recent studies are summarized. Elasticities of travel demand with respect to density, diversity, design, and regional accessibility are then derived from selected studies. These elasticity values may be useful in travel forecasting and sketch planning and have already been incorporated into one sketch planning tool, the Environmental Protection Agency's Smart Growth Index model. In weighing the evidence, what can be said, with a degree of certainty, about the effects of built environments on key transportation "outcome" variables: trip frequency, trip length, mode choice, and composite measures of travel demand, vehicle miles traveled (VMT) and vehicle hours traveled ((VHT)? Trip frequencies have attracted considerable academic interest of late. They appear to be primarily a function of socioeconomic characteristics of travelers and secondarily a function of the built environment. Trip lengths have received relatively little attention, which may account for the various degrees of importance attributed to the built environment in recent studies. Trip lengths are primarily a function of the built environment and secondarily a function of socioeconomic characteristics. Mode choices have received the most intensive study over the decades. Mode choices depend on both the built environment and socioeconomics (although they probably depend more on the latter). Studies of overall VMT or VHT find the built environment to be much more significant, a product of the differential trip lengths that factor into calculations of VMT and VHT.

Ewing, R., DeAnna, M., & Li, S. (1996). Land Use Impacts on Trip Generation Rates. *Transportation Research Record, 1518*, 1-7.

In the conventional four-step travel demand modeling process, the number of trips made by a household is modeled in terms of household size, income, and other sociodemographic variables; any effect of location, land use, or transportation service level is discounted. This is the same as discounting any effect of household accessibility to out-of-home activities as a factor in trip generation (accessibility depending on all three: location, land use, and transportation service level). In contrast to the practice of trip generation, theory tells us that trip rates must vary with accessibility, and some (not all) empirical studies have found that they do. In light of conflicting empirical studies, and the obvious need for more precise and policy-sensitive travel forecasts, this issue is revisited. The independent effects of land use and accessibility variables on household trip rates were tested for using data from Florida travel surveys. It was found that, after controlling for sociodemographic variables, residential density, mixed use, and accessibility do not have significant, independent effects on household trip rates. Conventional trip generation models, which generate person trips by vehicle (not by all modes) and do so without regard to residential location, may not be as bad as one would imagine a priori.

Ewing, R., Dumbaugh, E., & Brown, M. (2001). *Internalizing Travel by Mixing Land Uses: Study of Master-Planned Communities in South Florida*. Washington, DC: Transportation Research Board.

Planners, public officials, and large-scale land developers increasingly promote mixed-use developments as an alternative to sprawl. They list among the benefits of such developments the "internal capture" of trips; that is, trips that would otherwise have filtered onto the regional road network will remain on site. Yet, so little information is available about internal capture rates that traffic impact studies for mixed-use developments become little more than exercises in speculation. In an attempt to advance basic knowledge of the subject and move toward better prediction methods, 20 mixed-use communities in south Florida were studied to determine the effect of land use mix on internal capture rates. The sample of communities studied had internal capture rates ranging from 0 to 57% of all trip ends generated. When modeled in terms of land use and accessibility variables, both the scale of a development and regional accessibility proved significant, with the former directly related to internal capture and the latter inversely related to internal capture. The best-fit model explained just under half of the variance in internal capture rates. Controlling for scale and regional accessibility, land use mix and density did not have independent predictive powers. Whether because of limitations of the data set, model specification, or method of analysis, the benefits of mixed-use development were not borne out.

Ewing, R., Haliyur, P., & Page, G.W. (1994) Getting Around a Traditional City, a Suburban PUD, & Everything In-Between. *Transportation Research Record, 1466*, 53-62.

Beyond some studies relating density to mode choice, vehicle miles of travel, or gasoline consumption, little is known about the relationship of location and land use to household travel patterns. Against this backdrop a 16,000-record travel survey for Palm Beach County, Florida, was analyzed. Six communities were culled from the larger data base, and household travel data were then tested for statistically significant differences in trip frequency, mode choice, trip chaining, trip length, and overall vehicle hours of travel. Households in a sprawling suburb generate almost two-thirds more vehicle hours of travel per person than comparable households in a traditional city. Although travel differences are significant, they are smaller than one might expect given the more than 10-fold difference in accessibility among the communities. Sprawl dwellers compensate for poor accessibility by linking trips of household members in multipurpose tours. Implications for land planning are more complex than simply pedestrianizing or transitizing the suburbs. Communities should internalize as many facilities and services as possible. This is true even where the automobile reigns supreme. Communities should concentrate facilities and services in centers and corridors. This will facilitate efficient automobile trips and tours. The more sprawling the area, the more important this becomes, for through activity centers, linked accessibility to activities can be maintained even as direct accessibility falls off.

Ewing, R., Pendall, R., & Chen, D. (2003). *Measuring Sprawl and Its Transportation Impacts*. Washington, DC: Transportation Research Board.
Across the United States, urban sprawl, its impacts, and appropriate containment policies have become the most hotly debated issues in urban planning. Today's debates have no anchoring definition of sprawl, which has contributed to their unfocused, dogmatic quality. Efforts to measure sprawl and test for relationships between sprawl and transportation outcomes are described. This is the first use of the newly minted Rutgers-Cornell sprawl indicators. Sprawl is operationalized by combining many variables into a few factors representing density, land use mix, degree of centering, and street accessibility. This consolidation of variables is accomplished with principal component analysis. These factors are then related to vehicle ownership, commute mode choice, commute time, vehicle miles traveled per capita, traffic delay per capita, traffic fatalities per capita, and 8-h ozone level. These associations are made with multiple regression analysis. For most travel and transportation outcomes, sprawling regions perform less well than compact ones. The exceptions are average commute time and annual traffic delay per capita, which do not clearly favor compactness over sprawl. The main limitation of this study has to do with the data it uses. By necessity, the study uses highly aggregate data from a variety of sources that are not always consistent as to the area under study and time period. They are simply the best data available from national sources with sufficient breadth to provide a panoramic view of sprawl in the United States. Results will have to be validated through follow-up work of a more focused nature.

Ewing, R., Handy, S. L., Brownson, R., & Clemente, O. (2006). *Identifying and Measuring Urban Design Qualities Related to Walkability*. Washington, DC: Transportation Research Board.
A growing body of research provides evidence of a link between the built environment and active living. However, to date, the measures used to characterize the built environment have been mostly gross qualities such as neighborhood density and street connectivity (see reviews by Ewing and Cervero 2001; Handy 2004; and Ewing 2005). The urban design literature points to subtler qualities that may influence choices about active travel and active leisure time. These qualities will be referred to as perceptual qualities of the urban environment or, alternately, just as urban design qualities. The urban design literature presumes that these qualities are important for walkability, without much empirical evidence. Until urban design qualities can be measured, this presumption will remain untested.

Fontaine, M D. *Factors Affecting Traveler Mode Choice: A Synthesis of the Literature*. Virginia Transportation Research Council; Virginia Department of Transportation, 2003.
The purpose of this study was to review the literature related to how travelers make mode choice decisions in order to identify factors that influence mode choice and determine possible ways that the Virginia Department of Transportation (VDOT) could alter the mode split. This report does not deal with prediction or modeling of mode splits but rather provides information on what qualities are important to travelers when making mode choice decisions. The literature review revealed several factors that influence the mode choice of a specific traveler: practical availability of mode; connectivity; monetary cost; travel time; trip reliability; trip distance; trip purpose; income; age; and safety. The literature review also revealed several methods that VDOT or other agencies could use to create changes in mode split in the near term: High Occupancy Vehicle (HOV) facilities; park and ride lots; transit fare changes; increased transit frequency; increased transit coverage; and changes in parking price.

Frank, L., Chapman, J., & Bradley, M., & Lawton, T. K. (2005). *Travel Behavior, Emissions & Land Use Correlation Analysis in the Central Puget Sound*. Washington State Department of Transportation.
A growing body of research documents that land use relates with travel mode choice, distances and time spent traveling, and household level vehicle emissions. However, to date little work has been done at a sufficiently disaggregate scale to gain an understanding of how local governments should

alter their land use policies and plans to reduce vehicle use and encourage transit and non-motorized forms of travel. This study of the four county Central Puget Sound region links parcel level land use data with travel data collected from the Puget Sound Household Travel Survey (PSHTS). The primary aim of the study is to describe how measures of land use mix, density, and street connectivity where people live and work influences their trip making patterns including trip chaining and mode choice for home based work trips, home based non-work trips, and mid day trips from work. Land use measures are developed within one km of the household and employment trip ends in the survey. Tour based models are developed to estimate the relative utility of travel across available modes when controlling for level of service, regional accessibility to employment, and socio-demographic factors. A secondary aim of the project is to estimate the linkages between land use and household generations of Oxides of Nitrogen and Volatile Organic Compounds that are precursors to the formation of harmful ozone. Emissions are estimated based on modeled speeds for AM, PM, and off peak travel at the trip link level and then aggregated to the household level. Household emissions are then correlated with land use patterns where people live when controlling for socio-demographic factors. An exploratory analysis was also conducted as part of this work to estimate how land use patterns where people work influences their modal choice and engagement in travel demand management (TDM) programs offered by employers. The project relied on the Commute Trip Reduction Database from Washington State Department of Transportation (WSDOT). However, it was found that additional development of these data is necessary before this type of analysis can be done. Results are presented that document how much of an increase in the utilization of specific modes of travel for work and non-work travel would likely accrue from specific types of land use changes, and from changes to travel cost and travel time.

Gorham, R. *Comparative Neighborhood Travel Analysis: An Approach to Understanding the Relationship between Planning and Travel Behavior. In: In Perpetual Motion: Travel Behavior Research Opportunities and Application Challenges.* Elsevier, 2002.

Within the overall research framework of the relationship between planning and travel behavior, this report attempts to determine the nature of the interaction between the form of human spatial settlements and the travel behavior of people who live in these various settlements. It is the human element that creates the connection; people react to the built environment, take their cues from it, and engage in a number of behaviors (of which travel is only one) that make them comfortable. The challenge then, is for researchers to represent and interpret what it is that people do perceive in the urban environment that influences their travel decisions. This study applied a typological approach to 2 regions—the San Francisco Bay Area and the Stockholm Metropolitan Region—as a way of examining the interaction between urban form and travel behavior in a comparative context.

Giuliano, Genevieve and Hu, His-Hwa and Lee, Kyoung. *Travel Patterns of the Elderly: The Role of Land Use.* METRANS Transportation Center; University of Southern California. School of Policy, Planning, and Development; California Department of Transportation; Dept. of Transportation Research and Special Programs Administration, 2003.

This report presents an examination of the relationships between residential location and travel patterns of the elderly. Using the 1995 Nationwide Personal Transportation Survey, the authors describe travel patterns of the elderly and estimate models of trip making daily travel and transit use. They find that land use and travel relationships are primarily the same for the elderly as for the non-elderly, although it is evident that the oldest elderly may be more sensitive to local accessibility. The authors consider the potential effectiveness of various land use strategies. Promoting more transit-friendly, mixed-use communities may increase local accessibility, but current preference for automobile travel, low-density living environments, and the benefits of aging in place indicate that these types of strategies will have a limited effect in addressing mobility problems of the elderly. Safer vehicles and transportation facilities behavioral adjustments, and development of paratransit options more competitive with the private vehicle may be strategies suitable for addressing mobility of the elderly.

Greenwald, Michael. *Relationship Between Land Use and Trip Internalization Behaviors: Evidence and Implications.* Transportation Research Board, 2006.

This paper addresses the relationship between land use and destination selection, and the question of destination selection on travel mode choice. Specifically, this work focuses on internalized trips, a sub-category of trip making where both trip origin and trip destination are contained in the same geographic unit of analysis. This investigation uses data from the 1994 Household Activity and Travel Diary Survey conducted by Portland Metro. Using multinomial logit and binary logistic models to measure travel mode choice and decision to internalize trips, the evidence here supports three conclusions: 1.) urban design elements do more to alter travel mode choice than alter trip destination; 2.) there is a threshold effect in the ability of mixed use to alter travel behavior; and 3.) greater emphasis to destinations within the area where the home is located needs to be given in trip distribution models.

Greenwald, M. J. (2003). The Road Less Traveled: New Urbanist Inducements to Travel Mode Substitution for Nonwork Trips. *Journal of Planning Education and Research*, 23, (39-57).

This article tests the New Urbanist ideas about travel mode substitution, based on the argument that urban design is deliberately planned to automatically get travelers to substitute walking and transit for personal car use. The article uses data from a 1994 Household Activity and Travel Behavior Survey conducted in Portland, Oregon, to suggest that New Urbanist concepts serve to increase walking substitution, but public transit is not affected. This seems true even when travelers self-select into a specific residential environment.

Greenwald, M. J. (2006). *The Relationship between Land Use and Intrazonal Trip Making Behaviors: Evidence and Implications*. Washington, DC: Transportation Research Board.

Abstract: This paper addresses the relationship between land use, destination selection, and travel mode choice. Specifically, it focuses on intrazonal trips, a sub-category of trip making where both trip origin and trip destination are contained in the same geographic unit of analysis, using data from the 1994 Household Activity and Travel Diary Survey conducted by Portland Metro in Oregon. Using multinomial logit and binary logistic models to measure travel mode choice and decision to internalize trips, the evidence supports the conclusions that (1) intrazonal trips characteristics suggest mode choice for these trips might be influenced by urban form, which in turn affects regional trip distribution; (2) there is a threshold effect in the ability of economic diversity/mixed use to alter travel behavior; and (3) greater emphasis to destinations within the area where an individual?s home is located needs to be given in trip distribution models.

Greenwald, M. J & Boarnet, M. G. (2001). *Built Environment as Determinant of Walking Behavior: Analyzing Nonwork Pedestrian Travel in Portland, Oregon*. Washington, DC: Transportation Research Board.

Much has been written about the connection between land use/urban form and transportation from the perspective of affecting automobile trip generation. This addresses only half the issue. The theoretical advances in land use-transportation relationships embodied in paradigms such as the jobs-housing balance, neotraditional design standards, and transit-oriented development rely very heavily on the generation of pedestrian traffic to realize their proposed benefits. The present analysis uses models and data sets similar to those used in previous work for the Portland, Oregon, area but applies them toward analysis of nonwork walking travel. The results suggest that regardless of the effects that land use has on individual nonwork walking trip generation, the impacts take place at the neighborhood level.

Handy, S. L. (1993). Regional Versus Local Accessibility: Implications for Non-Work Travel. *Transportation Research Record 1400*, 58-66.

The question of how alternative forms of development affect travel patterns has recently been the focus of a heated debate, much of which centers on the effects of suburbanization in particular. The concept of accessibility provides an important tool for resolving this question. By measuring both the accessibility to activity within the community, or "local" accessibility, and the accessibility to regional centers of activity from that community, or "regional" accessibility, the structure of a community is more fully characterized. The research summarized uses the concepts of local and regional accessibility to test the implications for shopping travel of alternative forms of development in a case study of the San Francisco Bay Area. The results show that higher levels of both local and regional accessibility are associated with lower average shopping distances but are not associated with differences in shopping frequency. As a result, higher levels of both local and regional accessibility are associated with less total shopping travel. However, the effect of high levels of local accessibility is greatest when regional accessibility is low and vice versa. These findings suggest that policies should be directed toward enhancing both types of accessibility, but that the effects may work against each other to some degree.

Handy, S. L. (1996). Methodologies for Exploring the Link between Urban Form and Travel Behavior. *Transportation Research D, 1*(2), 151-165.
Communities are increasingly looking to urban design and the concept of the New Urbanism as an effective strategy for reducing automobile dependence in suburban areas. This paper reviews alternative approaches for exploring the link between urban form and travel behavior, outlines issues and complexities that this research must address, and, finally, suggests that the focus of this research should shift from the search for strategies to change behavior to a search for strategies to provide choices.

Handy, S. L. (1996). Urban Form and Pedestrian Choices: Study of Austin Neighborhoods. *Transportation Research Record 1552*, 135-144.
Supporters of the New Urbanism suggest that the right design will encourage walking, thereby encouraging interaction and a greater sense of community and discouraging automobile dependence. Existing research provides insufficient evidence to support this belief, however, largely because of limitations in the data and methodologies that researchers have used. The research described moves beyond a simple test of correlations to an exploration of how urban form fits into a more comprehensive model of choices about pedestrian trips. First, a model for individual choices about pedestrian trips is proposed. Second, the results of a study of six neighborhoods in Austin, Texas, are presented. Data from a survey of residents in these neighborhoods support the proposed model and suggest that certain aspects of urban form can play an important role in encouraging walks to a destination but that the savings in travel from the substitution of walking for driving is likely to be small.

Handy, S L. *Travel Behaviour--Land Use Interactions: An Overview and Assessment of the Research. In: In Perpetual Motion: Travel Behavior Research Opportunities and Application Challenges.* Elsevier, 2002.
This report looks at the research to date on the nature of the relationship between travel behavior and land use. The types of research approaches that have been used previously are reviewed, and a long list of issues relevant to this topic that have yet to be adequately addressed are discussed.

Handy, S. L., Cao, X., & Mokhtarian, P. L. (2006). Self-selection in the relationship between the built environment and walking. *Journal of the American Planning Association, 72*, 55-74.
Previous studies have established correlations, but not a causal relationship, between the built environment and walking. This has led researchers to debate whether "self-section" explains the observed correlations; i.e., if residents who prefer to walk choose to live in more walkable neighborhoods. Using data from a survey of residents of eight neighborhoods in Northern California, this paper presents new evidence on the possibility of a causal relationship between the built environment and walking behavior. The current study improves on previous research by incorporating travel attitudes and neighborhood preferences into the analysis of walking behavior, and by using a quasi-longitudinal design to test the relationship between changes in the built environment and changes in walking. Both analyses show that the built environment has an impact on walking behavior, even after accounting for attitudes and preferences. The implications of these findings for planning and policy are discussed, and directions for future research are suggested.

Handy, S. L., & Mokhtarian, P. L, & Kwong, K. (2006). *The Role of Attitudes and Neighborhood Characteristics in Explaining Transit Use: A Study of Eight Northern California Neighborhoods.* Washington, DC: Transportation Research Board.
This paper describes how transit ridership has been declining since its peak during World War II, and automobile use has been increasing. Efforts to lessen automobile dependence by improving transit service have seen limited success: outside of major urban centers, most individuals who have the option to drive choose to drive. Nevertheless, some do choose transit, and understanding the factors that influence this choice may be helpful in developing strategies to promote increased transit

ridership. The role of attitudes and neighborhood design are of particular interest. Using data from a 2003 survey on travel behavior, this paper explores the factors associated with transit use in eight Northern California neighborhoods. Multivariate analyses for transit use and frequent transit use showed that attitudes play a more significant role than neighborhood design. A case study of the Mountain View neighborhood illustrated the importance of direct transit service to work in explaining commute mode choice. If planners hope to increase transit ridership, then they must consider the attitudes of travelers about transit in addition to neighborhood design and the quality of transit service.

Handy, S. L., Mokhtarian, P. L & Cao, X. (2006). *Does the Built Environment Influence Vehicle Type Choice? Evidence from Northern California*. Washington, DC: Transportation Research Board.

It is evident that compact development can lower auto ownership, reduce trip lengths, and increase the uses of alternative modes. Recently, several studies found that suburban development is associated with the unbalanced choice of light duty trucks (LDTs). These studies have not shed much light, however, on the underlying direction of causality- whether neighborhood designs as opposed to attitudes towards vehicle choice more strongly influence individuals' decisions on vehicle type choice. The available evidence thus leaves unanswered questions: if policies require more compact, mixed-use development, will more people choose to drive passenger automobiles? And if so, what are the implications for air quality? Using a survey of 1682 respondents in Northern California, this study applied correlational analyses and multinomial logit model (MNL) to investigate the causal link from the built environment to vehicle type choice. The results from correlational analyses showed that the built environment has a strong association with vehicle type choice. Specifically, traditional designs (exhibiting mixed land uses and/or high accessibility) are correlated with the choice of passenger automobiles, while suburban designs (including large yards and off-street parking) are associated with the choice of LDTs- especially minivans and pickup trucks. The MNL model suggests that attitudinal factors play an important role, and that the built environment impacts vehicle type choice after controlling for attitudinal and demographic variables. Therefore, this study provides supportive evidence for the argument that smart growth strategies have the potential to reduce the choice of LDTs, thereby reducing emissions. However, the mediating effects of attitudinal factors suggest that ignoring the role of attitudes will lead to an overestimation of the influences of smart growth strategies on vehicle type choice and thus emissions.

Handy, S., Cao, X., & Mokhtarian, P. L. (2005). Correlation or Causality between the Built Environment and Travel Behavior? Evidence from Northern California. *Transportation Research Part D, 10*, 427–444.

Previous studies have shown that, all else being equal, residents of neighborhoods with higher levels of density, land-use mix, transit accessibility, and pedestrian friendliness drive less than residents of neighborhoods with lower levels of these characteristics. However, these studies have not established the underlying direction of causality--in particular, whether neighborhood design influences travel behavior or whether travel preferences influence the choice of neighborhood. This leaves a key question largely unanswered: if cities use land use policies to bring residents closer to destinations and provide viable alternatives to driving, will people drive less and thereby reduce emissions? The present study uses quasi-longitudinal design to investigate the relationship between neighborhood characteristics and travel behavior while taking into account the role of travel preferences and neighborhood preferences in explaining this relationship. A multivariate analysis of cross-sectional data shows that differences in travel behavior between suburban and traditional neighborhoods are largely explained by attitudes and that the effect of the built environment mostly disappears when attitudes and sociodemographic factors are accounted for. However, a quasi-longitudinal analysis of changes in travel behavior and changes in the built environment shows significant associations, even when attitudes have been accounted for, providing support for a causal relationship. Although these results provide some evidence that land-use policies designed to put residents closer to destinations and provide them with alternatives to driving will actually lead to less driving, the analyses presented here are not definitive, nor do they clarify the nature of the causal relationship. Directions for future research are discussed.

Handy, S.L. & Clifton, K.J. (2001). Local Shopping as a Strategy for Reducing Automobile Travel, *Transportation 28*, 317-346.

Suburban development in the United States is widely criticized for its contribution to automobile dependence and its consequences. This paper explores how residents in existing neighborhoods make use of the local shopping opportunities currently available to them and, based on that, evaluates the possibility that providing local shopping opportunities could help reduce automobile dependence. Two sets of questions were addressed, using both quantitative and qualitative evidence for six neighborhoods in Austin, Texas. The questions were: 1) To what degree do residents choose local shopping over more distant opportunities, and why?; and 2) To what degree do residents choose to walk rather than drive to the local shopping center and why? The results and conclusions are provided.

Hendricks, Sara, J., et. Al., (2005) *Impacts of Transit Oriented Development on Public Transportation Ridership*. Center for Urban Transportation Research, University of South Florida, Tampa, FL.
The purpose of Phase I of this study was to develop a research design to better establish the relationship between transit oriented development (TOD) and travel mode share. The initial hypothesis that good quality transit combined with good quality TOD would succeed in shifting travelers from single-occupant vehicle travel to transit was found to be an oversimplification. Good quality transit service is necessary and good quality TOD is likely helpful and important to shifting mode share but not sufficient. Other necessary factors include supporting elements of the larger urban spatial structure, disincentives to driving alone, favorable marketability of TOD for non-transportation reasons, and incentives to use transit. Research literature suggests that elements of urban form are perhaps not the most important determinants of travel behavior, specifically mode choice, number of trips taken and length of trips. However, urban form does appear to exert some kind of influence, and for that reason, it is worthwhile to further specify the relationship to ascertain how policy initiatives relating to TOD can support the goal to balance mode share in the direction of greater transit use. To better define the elements of TOD that shape travel behavior, this study describes a research design for the development of a panel survey, using recently developed cell phone technology, to track the same individuals and households over time. Using a pre-test post-test design, the survey data collected for a region in Florida would be a sound investment for improved travel forecasting, modeling and other uses.

Hensher D A (ed.) Travel Behaviour Research. The Leading Edge. Elsevier, 2001.
Abstract for Chapter entitled "Interfaces between Location, Land Use and Travel Decisions": This paper focuses on some current trends and new research issues. Connection between land use and various traffic measures, the effects of urban development on mode shares, the connection between location choice and choice of car ownership and total vehicle miles traveled, and the influence of accessibility on residential location, modelling the joint choice of location and travel pattern represent some of the areas discussed.

Hess, P M and Moudon, A V and Logsdon, M G. Measuring Land Use Patterns for Transportation Research. *Transportation Research Board, 2001.*
Density and land use mix are focused on as the two primary variables for characterization of land use in transportation research. As commonly constructed, these variables do not capture well actual development patterns on the ground, thus obscuring a potentially strong relationship between land use and transportation behavior. To overcome these limitations, parcel-level data and geographic information system software were used to identify and measure attributes of land use. These data are at a level of resolution that closely corresponds to the spatial distribution of development patterns. A method for location of concentrations of medium- to high-density housing and commercial development in suburban areas identified in previous research is described. The method includes the use of metrics derived from landscape ecology to model these development patterns and, specifically, their shapes and their functional and spatial mixes.

Jin, X and Beimborn, E and Greenwald, M. *Impacts Of Accessibility, Connectivity and Mode Captivity on Transit Choice*. University of Wisconsin, Milwaukee; Federal Transit Administration, 2004.
It is the objective of this report to examine the way that transit service factors such as accessibility and connectivity can be used to define mode captivity, and seek to incorporate these factors in mode split models to see whether segmentation between the captivity groups can lead to better methods of forecasting. The data for this study come from the Portland, Oregon 1994 Household Activity and

Travel Diary Survey, the Regional Land Information System for the Portland Area, the U.S. Environmental Protection Agency Fuel Economy Database, and the U.S. Department of Energy. Individual trip data were segmented into transit captive, auto captive and choice users based on information about private vehicle availability, transit connectivity and distance from a transit stop. Traditional transit mode split models are compared to models that segment users into choice and captive groups. The results suggest that traditional models underestimate the variation in mode choice for captive users, while overestimating the attractiveness of transit for choice users. Incorporating mode captivity factors can improve the accuracy of the logit model, either by segmenting the market or by employing the factors as independent variables. The explanatory power of the models will largely increase when captivity conditions are used in the equation to predict transit use. Multinomial regression model was developed to predict captivity. Transit captives could be predicted by auto ownership patterns. Auto captivity is dependent on trip origin-destination locations and transit service frequency and coverage besides the factor of auto ownership. Additionally, among choice transit users, differences in travel times between automobile and transit modes does little to influence mode selection; while automobile ownership, and out-of-vehicle time are the most important factors in terms of influencing mode choice.

Johansson, Maria. *Childhood Influences on Adult Travel Mode Choice*. International Conference of Traffic and Transport Psychology, Elsevier, 2005.

A large number of European children are today chauffeured by car to school and leisure activities. This increased car use for children's trips affects the local and global environment negatively. Parents have a crucial role in the decision of travel mode choice. In a study of 357 Swedish children ages 8-11 years, the parents had decided upon travel mode for 73% of the children's trips. Research in the related fields of driving behavior shows that the parents' attitudes and behavior may transfer to young drivers, partly through modeling of parental life style and driving style. This paper discusses the impact of parental attitudes and mode choice in childhood on adult choice of travel mode. Travel mode choice is based on a large number of factors, including more psychological variables such as values and norms, attitudes, and habits, but also physical environment, more practical matters such as time and weather conditions, and health aspect play a role in individual travel patterns.

Kain, J F. *A Tale of Two Cities: Relationships between Urban Form, Car Ownership and Use and Implications for Public Policy. In: Recent Developments in Transport Economics*. Edward Elgar Publishing Incorporated, 2003.

This paper is concerned with the interrelationships among household incomes, urban development patterns, car ownership, trip-making and modal choice and with appropriate policy responses to what are still perceived as growing problems associated with rapid increases in car ownership and use. In this research two separate papers were used as references, the paper also reviews research on car ownership and use by other authors.

Khattak, A. J. et. al. (2005, February). *Traditional Neighborhood Development Trip Generation Study*. North Carolina Department of Transportation.

Since the beginning of the new urbanist movement, alternately referred to as Traditional Neighborhood Developments (TNDs), planners and architects have touted their neighborhood and community designs for reducing residents' reliance on the automobile by creating compact, mixed use, and pedestrian friendly developments. However, researchers have not explicitly examined how travel behavior and traffic impacts differ in a tightly controlled comparison of conventional and traditional developments. Additionally, current forecasting models and trip generation procedures need to be tested for their applicability to these new developments. This report aims to fill that void by studying a matched-pair of neighborhoods: One conventional and one traditional. The neighborhoods are located in the Chapel Hill/Carrboro area of North Carolina. Traffic counts were taken at all entrances and exits to the developments, and a detailed behavioral survey of the residents was conducted in the two neighborhoods during 2003. The results show that households in Southern Village, the TND, make about the same amount of total trips, but significantly fewer automobile trips, fewer external trips and they travel fewer miles, when compared to households in the conventional neighborhoods. However, this reduction of trips in a suburban environment does little to decrease delay at "over-designed" intersections along major highways. Finally, ITE trip generation methods and rates are acceptable for predicting the trip generation of the study neighborhoods. The implications of these results are discussed in the report.

Kim, Tae-Gyu and Goulias, Konstadinos G and Burbidge M.A., Shaunna K.. *Travel Behavior Comparisons of Active Living and Inactive Living Lifestyles*. Transportation Research Board, 2006.
The past century?s radical change and innovation in transportation technology and concomitant increase in options for our travel modes moves us away from walking to an almost total extinction of modes that require physical exercise. This is accompanied by a modern American city design that requires the use of an automobile with urban sprawl creating distant destinations that alter older methods of travel and make active forms of transportation almost impossible. However, many more reasons exist that motivate people to choose physically inactive modes as our research shows here. Using a two-day activity diary collected in Centre County, Pennsylvania, we identify which factors influence active versus inactive mode choice. In this analysis, the paper examines the correlations between trip purpose and travel mode and between age and travel mode, and perform an analysis of travel distances to determine what the distance threshold is for active modes. In addition, a latent class cluster analysis establishes a profile for both physically active as well as inactive travelers and their correlation with person and household characteristics. Key findings include that trips made using active modes are significantly different than trips made by inactive modes and persons with active transportation lifestyles are significantly different than persons with inactive lifestyles. This raises the following issue: policies designed for and motivated by persons with active lifestyles risk to fail if they do not succeed in meeting the needs for everyday life of those with inactive lifestyles.

Kitamura, R., Akiyama, T., Tamamoto, T., & Golob, T. F. (2001). *Accessibility in a Metropolis: Toward A Better Understanding of Land Use and Travel*. Washington, DC: Transportation Research Board, TRR 1780, 64-75.
An attempt was made to determine how accessibility affects aspects of long-term and short-term travel behavior. The accessibility indices that were used represent the ease with which opportunities for engagement in activities can be reached from a geographical zone in an urban area. The behavioral aspects examined include engagement in activities, automobile ownership and use, and travel patterns as represented by the number of trips, number of trip chains, and total travel time expenditure. Data from the Kyoto-Osaka-Kobe metropolitan area of Japan and the southern California coast are used to examine the following conjectures: time availability is more closely associated with engagement in activities than accessibility; accessibility no longer affects automobile ownership or use in the metropolises of industrialized countries where motorization has matured; and given automobile ownership and use, travel patterns are conditionally independent of accessibility.

Knapp, G. & Song, Y. (2005). The Transportation – Land Use Policy Connection. Chapter 5 In D. Levinson and K. Krizek (Eds.), *Access to Destinations*. London: Elsevier.
The paper explores the transportation-land use policy connection. More specifically, it considers the question, can land use policy be used to alter transportation behavior? The answer is of some importance. If the answer is yes, then there is hope that land use policies can be designed and implemented that will bring some relief to the congestion and complex transportation problems that are facing US metropolitan areas. This is the underlying assumption behind most smart growth policy reforms. If the answer is no, then land use policy may still be important, but is not likely to play an important role in resolving transportation issues. The paper then offers a schematic that identifies necessary conditions for land use policy to play a role in addressing transportation issues. Specifically, the paper argues that for land use policy to play an effective role, three conditions must hold. First, land use must be able to alter transportation behavior; secondly, transportation infrastructure must not fully determine land use; and thirdly, the condition on which the authors consider most extensively, land use policy must significantly and constructively affect land use. After presenting the schematic, the paper considers the evidence on each of these conditions. Based on the review of the evidence, the paper concludes that land use policy can play an effective role in transportation issues, but that the role is likely to be small, often counter productive, and most effective at the neighborhood scale.

Krizek, K. J. (2000). A Pre-test/Post-test Strategy for Researching Neighborhood-scale Urban Form and Travel Behavior. *Transportation Research Record, 1722*, 48-55.

Communities are increasingly looking to land use planning strategies based on a less auto-dependent urban form to reduce the need for travel, especially drive-alone travel. In recent years, several studies have attempted to test the impact urban form has on travel behavior to determine if such designs are warranted. The results of these studies are mixed because of several shortcomings. Some shortcomings can be attributed to data availability; others are a product of the techniques used to characterize urban form or travel. Still other shortcomings are embedded in the strategies employed, using cross-sectional travel data and correlating travel outcomes with urban form. The line of research is being extended, aimed at isolating the influence of urban form on travel behavior; a new research strategy is presented using longitudinal travel data in concert with detailed measures of travel behavior and urban form. Data sources from the Puget Sound are described and a research strategy is presented that permits a pretest-posttest analysis of households' travel behavior before and after they changed residential location. Early results show few changes in household travel behavior after a move, suggesting that attitudes toward travel are firmly entrenched and postmove travel provides little insight into how changes in urban form affect travel. Although a pretest-posttest makes valiant strides in shedding new light on the matter, the complex phenomenon being addressed requires myriad approaches. More comprehensive research techniques and even research approaches based on different traditions are much needed to better understand how urban form and travel interact.

Krizek, K. J. (2003). Planning, Household Travel, & Household Lifestyles. In K.G. Goulias (Ed.) *Transportation Systems Planning: Methods and Applications*. Boca Raton, FL: CRC Press, 6.1-6.42.

Concerns about urban sprawl, growth, and traffic are now among the most important issues facing the U.S. Consequently, transport planners are looking to a variety of solutions. One prescription that has recently received increased scrutiny is the joining of transportation planning with land use planning as a means of influencing travel. This chapter aims to provide an overview of past and current research on this subject and describes the relevance of related land use--transportation policy.

Krizek, K. J. (2003). Neighborhood Services, Trip Purpose, & Tour-Based Travel. *Transportation*, 30, 387-410.

This paper investigates the relationship between accessible land use patterns and household travel behavior. A framework is described that provides a more behavior-based understanding of household travel than traditional trip-based travel analysis, which often does not consider the linked nature of most travel. The framework highlights travel tours, the sequence of trips that begin and end at home, as the basic unit of analysis. A typology of travel tours is offered to account for different travel purpose. This typology helps in the understanding of tours relative to the range of services typically offered in accessible neighborhoods. The relationship between tour type and neighborhood access is empirically analyzed using detailed travel data from the Central Puget Sound region of Seattle, Washington. Findings indicate that households living in areas with higher levels of neighborhood access tend to leave home more often, but make fewer stops per tour. These households make more simple tours for work and maintenance (i.e., personal, appointment and shopping) trip purposes, but there is no difference in the frequency of other types of tours. While they travel shorter distances for maintenance-type errands, a large portion of their maintenance travel is still pursued outside the neighborhood. These results suggest that living close to services has a surprisingly small savings effect on vehicle miles of travel.

Krizek, K. J. (2003). Operationalizing Neighborhood Accessibility for Land Use-Travel Behavior Research and Regional Modeling. *Journal of Planning Education and Research, 22*(3), 270-287.

Many land use–transportation planning proposals aim to create neighborhoods with higher levels of neighborhood accessibility (NA). This article focuses on how such features are operationalized for purposes of research and/or regional modeling. The first section reviews specific variables classified by three basic tenets of NA; density, land use framework, and streets/design. The second section describes challenges in measuring NA to provide a better understanding of how such challenges shape research efforts and applications. The final section creates an NA index that is applied to the Central Puget Sound metropolitan area. The index uses detailed measures of density, land use mix, and street patterns and makes at least five contributions for urban form research.

Krizek, K. J. (2003, Spring). Residential Relocation and Changes in Urban Travel: Does Neighborhood-Scale Urban Form Matter? *Journal of the American Planning Association, 69*(3), 265-281.
This paper presents an empirical study of the relationship between neighborhood-scale urban form and travel behavior. The focus is on households that relocate within the Central Puget Sound region (Washington) to determine if they change their travel behavior when they move from a given neighborhood type to a different one. Regression models are used to predict change in travel behavior as a function of change in neighborhood accessibility, controlling for changes in life cycle, regional accessibility, and workplace accessibility. A special feature of the study is that it analyzes the travel behavior of the same households in a longitudinal manner in concert with detailed urban form measures. Findings suggest that households change travel behaviors when exposed to differing urban forms. In particular, relocating to areas with higher neighborhood accessibility decreases vehicle miles traveled.

Krizek, K. J. (2005). *Household Lifestyles and Their Relationship to Land-Use and Transportation Planning*. Minneapolis: Humphrey Institute of Public Affairs.
This article examines the links between different dimensions of household decision making, including the types of ravel residents engage in, the types of activities they tend to pursue, and factors affecting their choice of neighborhood. The author analyzes these and other factors in a synergistic manner to come up with a concept called household lifestyles. The author compiled a large data set from a variety of sources, including the Travel Behavior Inventory Home Interview Survey (conducted in the seven county Twin Cities, Minnesota area). The author discusses the implications of the household lifestyles concept for urban planning initiatives, many of which are focusing on making walking in cities easier, more attractive, and more available. The author contends that recognizing how household decisions form together into different groups helps one better understand how relevant decisions related to one another, the market segments of different populations, and subsequently the merits of various policy scenarios.

Krizek, K. J. (2005). Perspectives on Accessibility and Travel. In D. Levinson and K. J. Krizek (Eds.), *Access to Destinations* (pp. 109-130). London: Elsevier.
This paper describes how urban form, whether it is compact, multi-nodal, or sprawling, impacts they type and cost of transportation systems needed to serve residents of a metropolitan area. On the other hand, the type and location of major transportation facilities greatly influences urban form. Almost a half of century's worth of study on the link between the two provides a solid foundation to understand some inherent interactions between land use and transportation. These interactions manifest themselves in two forms: (1) the influence of urban form on transportation systems, travel demand, and urban travel behavior; and (2) the influence of transportation systems and transportation investments on metropolitan urban form. The two phenomena share a common heritage; however each asks different questions, and they often relate to different scales of analysis. This paper attempts to describe the issues that emanate from the former question—that is, what do we know abut the manner in which land use patterns affect household travel. In doing so, the paper discusses how the relationship between urban form and transportation has historically been conceptualized and also summarizes some of the existing research. The paper then turns to describing how the history relates to new and pressing research questions that provide the impetus for studying more in depth matters related to accessibility.

Krizek, K. J. (2006). *Lifestyles, Residential Location Decisions, & Pedestrian and Transit Activity*. Washington, DC: Transportation Research Board, TRR 1981, 171-178.
The idea of using land use patterns to influence people's behavior is popular in urban planning circles these days. Activity-based travel modeling has begun to make significant progress toward a more behavioral framework for simulating household travel behavior and understanding, in particular, pedestrian activity. A significant challenge remains in the need to address the interaction of pedestrian use with longer-term household choices of neighborhood choice, other activities, and overall travel. The choices often depend on one another and jointly define the lifestyle of an individual. This paper refines a framework to analyze household choices relating to three dimensions of lifestyle: travel patterns (including pedestrian activity), activity participation, and neighborhood characteristics. Cluster analysis on data from the Twin Cities metropolitan region in Minnesota

uncovers seven classifications of lifestyle. These clusters demonstrate empirically how decisions about residential location reinforce and affect daily decisions related to travel patterns, pedestrian and transit use, and activity participation. The final section comments on the applicability of these lifestyle clusters for land use–transportation planning.

Krizek, K. J. (2006, Summer). Two Approaches to Valuing Some of Bicycle Facilities' Presumed Benefits. *Journal of the American Planning Association*, *72*(3), 309-320.

This study uses two different approaches to value the benefits of bicycle lanes and trails. In the first approach, an adaptive stated preference survey is used to measure how much travel time individuals are willing to spend to obtain particular features of on- and off-street bicycle facilities. These findings indicate that bicycle commuters in Minneapolis and St. Paul prefer bicycle lanes on existing streets over off-street bicycle trails, and also prefer them over streets that have no on-street parking but lack designated bicycle lanes. In the second approach, home sales data was used to investigate the effect of bicycle trail proximity on home value. Findings indicate that the three types of bicycle facilities (lanes on existing streets, facilities separated from roadways by curbs or landscaping, and facilities within open spaces) were valued differently. Results also show that bicycle facilities have different values in the city than they do in the suburbs and that bicycle facilities are not always considered an amenity. Although proximity to most bicycle facilities did not significantly affect home values in city neighborhoods, bicycle facilities significantly reduced home value in suburban locations. Home values in both city and suburban neighborhoods were most reduced by proximity to roadside trails.

Krizek, K. J, & P. J. Johnson (2006, Winter). Proximity to Trails and Retail: Effects on Urban Cycling and Walking, *Journal of the American Planning Association*, *72*(1), 33-42.

In this study, multivariate modeling techniques are used to estimate the effect of household proximity to retail and bicycle facilities on the odds of walking and cycling. The authors analyzed these relationships employing detailed geographic information systems data and individual-level travel diary data from Minneapolis and St. Paul, Minnesota. Findings indicate that distances to retail and bicycle facilities are statistically significant predictors of choosing active modes of transport and close distances. However, the relationships do not appear to be linear. One needs to live very close for such facilities to have a statistically significant effect on cycling or walking. The results also underscore that walking and bicycling are fringe modes and represent rare travel behaviors. The overall findings cast doubt on the potential of community design to induce physical activity.

Krizek, K. J & Roland, R. (2005). What is at the End of the Road? Understanding Discontinuities of On-Street Bicycle Lanes in Urban Settings. *Transportation Research Part D*, *10*(1), 55-68.

Although demarcating on-street bicycle facilities is an important strategy in encouraging bicycle safety and bicycle travel, few studies have focused on instances where separate on-street bicycle facilities end. This paper seeks to determine bicyclists' comfort levels when encountering discontinuities and examines the strength of explanatory factors affecting their severity. The authors identify 30 discontinuities of on-street bicycle lanes in Minneapolis, Minnesota, and collect primary data measuring their physical attributes and cyclists' perceptions of the level of comfort while cycling through each. Using multivariate analysis, the findings suggest that discontinuities ending on the left side of the street, with increased distance of crossing intersections, having parking after the discontinuities, and wider width of the curb lanes are statistical elements that contribute to higher levels of discomfort. The findings from this study draw attention to the worst discontinuities. The study also offers a taxonomy for transportation planners to better understand

Krizek, K. J & Waddell, P. (2002). Analysis of Lifestyles Choices: Neighborhood Type, Travel Patterns, & Activity Participation. *Transportation Research Record*, *1807*, 119-128.

Activity-based travel modeling has begun to make significant progress toward a more behavioral framework for simulating household travel behavior. A significant challenge remains in the need to address the interaction of daily activity and travel patterns with longer-term household choices of vehicle ownership, residential location, and employment location. The choices often depend on one another and jointly define the lifestyle of the household. These choices are likely to evolve over the course of the life cycle as households are formed; as children are born, raised, and ultimately depart to form their own households; and as retirement and old age change patterns of residence, work, and travel. A framework is developed for analyzing household choices relating to three dimensions of lifestyle: travel patterns (including vehicle ownership), activity participation, and residential location (neighborhood type). With cluster analysis on data from the Puget Sound Transportation Panel, nine classifications of lifestyle are uncovered. These clusters demonstrate empirically how decisions of residential location reinforce and affect daily decisions related to travel patterns and activity participation. The applicability of these lifestyle clusters for land use transportation planning is discussed.

Krizek, K. J., El-Geneidy, A., & Thompson, K. (2007). A Detailed Analysis of How an Urban Trail System Affects Cyclists' Travel. Transportation Research Board 86th Annual Meeting.

Transportation specialists, urban planners, and public health officials are steadfast in encouraging active modes of transportation over the past few decades. Conventional thinking, however, suggests that providing infrastructure for cycling and walking in the form of off-street trails is critically important. An outstanding question in the literature, however, is how such facilities relate to larger issues of travel behavior. This research describes a highly detailed analysis of use along a primarily off-street trail in Minneapolis, Minnesota, USA. The core questions addressed in this investigation aim to understand relationships between: (1) the propensity of trail use and distance from residence, and (2) how far out of their way do trail users appear to travel for the benefit of using the trail. The data source used in the analysis for this research was collected as a human intercept survey along a section of an off-street facility. Trail users seem to travel significantly out of their way (14.6 percent longer) in order to include a trail facility on their route. The effect is heightened on weekends and on longer trips. The results and analysis in this study may be used to guide planning, maintenance, and programming of Hennepin County's trail system in upcoming years. The distance decay and shortest path versus taken path analysis offer insight into how far bicyclists are willing to travel in order to use a trail facility. This information can be used to guide the spacing of new trails to maximize levels of use.

Lin, J & Long, L. *What Neighborhood Are You In? Empirical Findings on Relationships Between Residential Location, Lifestyle, & Travel*. Washington, DC: Transportation Research Board, 2006.

This paper describes how neighborhood type and lifestyle are important factors influencing household and individual travel behavior. This paper presents a statistical clustering approach coupled with Geographic Information System (GIS) spatial analysis to characterize neighborhood lifestyles using sixty-four features extracted from the Census Transportation Planning Package (CTPP) 2000 data. The resulting ten clusters reveal different neighborhood lifestyles in terms of individual or household socio-economics, demographics, and land use. Travel characteristics of each cluster using the 2001 National Household Travel Survey (NHTS) travel data suggest five factors influencing household travel, socio-economic status, residential location and land use, household life cycle, activity type, and ethnics. This study has important implications to the travel demand modeling and transportation planning community. Statistical classification coupled with GIS spatial tools provides a means to associate a household with its neighborhood environment. Each neighborhood type is distinctively defined and reasonably homogenous in terms of socio-economic and travel characteristics. This not only improves travel demand prediction capability but is also more desirable when transferring travel information between geographic zones. The empirical findings from NHTS also shed lights to transportation decisions that involve the transportation-land use relationship, increasing mobility and accessibility for city low incomes, and coping with changes of travel due to demographic change.

Lund, H. M., & Cervero, R., & Wilson, R. W. (2004). *Travel Characteristics of Transit-Oriented-Development in California*. Pomona, CA: California State University.

This study presents a 2003 measurement of travel behavior in transit- oriented developments (TODs) in California. It builds upon previous studies conducted in the early 1990 by adding new residential, office and hotel sites to address new questions, and includes TODs built ore recently. It examines a range of potential rail users, such as residents, office workers, hotel employees and patrons, and retail patrons. It presents results of surveys conducted along each of California's major urban rail systems. The study also collects detailed data on site and neighborhood factors that potentially affect the likelihood of using transit and models those factors as they relate to individual and project-level travel behaviors. The study is intended to assess the success of TODs in enhancing transit ridership and to identify TOD design and policy features that contribute to success.

Lund, H. (2006). Reasons for Living in a Transit-Oriented Development and Associated Transit Use. *Journal of the American Planning Association*, *72*(3), 357-366.

Transit-oriented development (TOD) near rail stations offers the hope of increasing both transit use and the number and range of housing opportunities. This paper reports the results of a survey of households who moved to TODs in the San Francisco Bay Area, Los Angeles, or San Diego within the last five years. Findings showed a wide range of motivations, with type or quality of housing, cost of housing and quality of neighborhood being the most frequently cited factors. Only about one-third of respondents reported access to transit as one of their top three reasons for choosing to live in a TOD. Those who reported that their choice of residence location was motivated in part by access to transit were 13 to 40 times more likely to use transit than those who did not. TOD residents do appear to use transit at a relatively high rate compared to the general population.

Maat, Kees and Timmermans, Harry J P. *Influence of Land Use on Tour Complexity: A Dutch Case.* Transportation Research Board, 2006.

It is assumed that in new urban designs and compact cities, average travel distances tend to be shorter and more activities are linked in chains. As there is relatively little empirical evidence about the relationship between chain behavior and land use, especially from Europe, a study was done to obtain a better understanding of the influence of chains (referred to as tours) to test the hypothesis that compact urban forms reduce travel. The results indicate that higher densities lead not only to greater activity and greater tour demand but also to more complex tours. Although greater tour frequencies reduce mean tour distance, daily distance traveled increases. Moreover, complex tours have an encouraging effect on both tour distance and daily distance traveled. This confirms the hypothesis and previous evidence that more frequent tours and more stops per tour in high-density areas lead to more travel.

Matsumura, H and Kawata, H. *Socio-Economic Characteristics, Land Use and Travel Patterns.* American Society of Civil Engineers, 2000.

Osaka City is located in the central part of Japan. The city is bordered to the west by Osaka Bay and to the south and north by the Yamato and Kanzaki Rivers, respectively. The city serves as a business center for the western portion of the country, as well as Osaka metropolitan area, which includes Kyoto, Kobe, and Nara, covering an area within a radius of 50 km from the city. Osaka encompasses an area of approximately 220 square km, including newly reclaimed off shore land. This paper discusses the effects of socioeconomic aspects, land use factors, and locations of major facilities on travel patterns in Osaka City, and also provides an overview of its transportation network and infrastructure and public transit systems.

McCormack, E., Rutherford, G. S., & Wilkinson, M. G. (2001). *Travel Impacts of Mixed Land Use Neighborhoods in Seattle, Washington.* Washington, DC: Transportation Research Board.

In response to suburban transportation problems, developers and planners have suggested that mixing land uses can reduce automobile dependency by making more goods and services available within walking, biking, and short driving distances. This view has resulted in a neotraditional planning movement that promotes neighborhoods designed with traditional characteristics including a mix of land uses. However, few studies have empirically explored the transportation implications for these neighborhoods. This issue is addressed by using a travel diary collected in three greater Seattle area neighborhoods characterized by neotraditional neighborhood elements including mixed land use. These data were compared with those collected in an identical diary from individuals throughout the region. It was found that residents of the mixed land use study neighborhoods in Seattle traveled 28% fewer kilometers (miles) than residents in adjacent areas and up to 120% fewer kilometers than residents in suburban areas. This trend of lower travel distances held across different socioeconomic characteristics. However, the differences in travel distances among the areas were not seen when travel time was considered. The daily travel time was about 90 min/person (including walking), regardless of where that person lived and that person's socioeconomic status. One implication of this finding is that if a neotraditional neighborhood development does make shopping and other chores less time-consuming, there may simply be more time in the travel budget for additional regional travel. This suggests that travel from the neotraditional neighborhoods needs to be examined in a regional context.

Mesa, J L and Baron, F F. *Socioeconomic Characteristics, Land Use And Travel Patterns: A Profile Of Miami-Dade County.* American Society of Civil Engineers, 2000.
Miami-Dade County is a large metropolitan area located near the tip of the Florida peninsula along its southeast coast. This area has experienced significant growth in recent years. This paper provides an overview of the historical development, land use and urban form, transportation networks, urban transit networks, airport and sea port, and population and demographics of the greater Miami-Dade County metropolitan area. The paper concludes with remarks on the current and future transportation preferences of County residents, which continue to show a fondness for auto travel as the primary transportation mode.

Newman, P. and Kenworthy, J. (2006). Urban Design to Reduce Automobile Dependence. *Opolis: An International Journal of Suburban and Metropolitan Studies*, 2(1), Article 3.
A major goal of urban design, especially in centers, is to reduce automobile dependence in order to address issues of viability and sustainability. Long-term data from cities around the world appear to show that there is a fundamental threshold of urban intensity (residents and jobs) of around 35 per hectare1 where automobile dependence is significantly reduced. This article seeks to determine a theoretical base for what the data show. It suggests that below the threshold intensity of urban activity, the physical constraints of distance and time enforce car use as the norm. The basis of these physical constraints is outlined and the link between density and access to services that provide amenity is established, including the service levels of public transport. A design technique for viability of centers is suggested as well as how a city can restructure itself to overcome automobile dependence.

Noreen C. McDonald, Travel and the social environment: Evidence from Alameda County, California. Transportation Research Part D: Transport and Environment. Volume 12, Issue 1, January 2007, Pages 53-63
The relationship between travel and the environment has been the subject of much study but the focus has mainly been on the physical and built environment. This ignores a large body of research in sociology showing that social processes are spatially embedded and affect individual behavior. This analysis asks whether the neighborhood social environment – in addition to the built environment – influences children's decision to walk to school in Alameda County, California. The results show that social factors, particularly neighborhood cohesion, do influence the decision to walk particularly when children face trips of less than 1.6 km. These findings provide initial evidence for transportation analysts to broaden their definition of the environment to include social factors.

Nunes da Silva, F. & de Abreu e Silva, J. (2003). To What Extent Does Urban Density Influence the Modal Split? The Lisbon Metropolitan Area Case Study. In L.J. Sucharov and C.A. Brebbia (Eds.) *Urban Transport IX.* Ashurt, UK: WIT Press.
The relationship between urban density and car use appears to have a growing importance as urban areas experience sprawl and tend to be more diffuse. With this in mind, this paper examines a recent mobility survey conducted in the Lisbon Metropolitan Area (LMA). The main aim was to determine the extent to which density influences the modal split in identical situations of public transport supply and population demographics. Vehicle weight was considered the dependent variable, with 2 approaches developed: 1) one that considers the urban density, for each specific socioeconomic level, as the only explicative variable; and 2) one that uses a multivariate regression analysis using density, availability, family income, public transport supply, and public transit comfort levels as explicative variables of car use. Results obtained from both methods are compared and discussed in order to identify the real weight of density as an explicative variable of car use in LMA.

Polzin, S. (2004). The Relationship between Land Use, Urban Form and Vehicle Miles of Travel. Tampa: Center for Urban Transportation Research, University of South Florida.
This white paper provides a review of the literature and a synthesis of findings regarding the relationship between land use and urban form and the vehicle miles of travel by persons. The paper begins with a conceptual outline of the transportation-land use relationship. It synthesizes a broad review of the literature and explores various aspects of the state of knowledge regarding the transportation-land use relationship. Various perspectives and motivations, analytical methods, variables for measurement, and urban scale focuses are discussed in the paper. An overview of

research findings categorized by geographic scale ranging from site level, to neighborhood level, to urban area level is provided. Policy Implications are provided and a concluding section offers observations on how the available knowledge can be used in decision-making.

Racca, D. P & Ratledge, E. (2003). *Factors that Affect and/or Can Alter Mode Choice*. Prepared for Delaware Transportation Institute and Delaware Department of Transportation.

This project uses data about individuals, their characteristics, the trips they make, and the costs and benefits of travel modes, to identify factors that can be used in models for travel mode choice. In Delaware, for the past eight years, the Delaware Department of Transportation (DelDOT) has sponsored the DelDOT Household Survey. Approximately 200 people of the age of 16 or older are called on the telephone and asked to describe the trips they have taken in the previous day. Trip origins and destinations are geo-coded to a small geographic unit (modified grid), and information is obtained for trip time, purpose, incidental stops, travel preferences, demographic data, vehicle occupancy, travel mode, and other information. This is a wealth of information very suited to the modeling goals of this project. The modeling of transit use was a focus in this project. Automobiles offer large advantages over transit in convenience, flexibility, and travel time. A particular level of service of transit is necessary to have people choose to use transit over a car when they have the choice. Factors that reflect the transit level of service are necessary in any model, and level of service factors certainly significantly influence mode choice. A review of the literature indicates many types of service factors that have been used in mode choice models. Level of service is often very difficult to quantify. This project employed road network models and optimum routing algorithms as available in geographical information systems to estimate travel times and service factors for trips taken by individuals. This project is the first part in a two part modeling effort. Once mode choice is modeled at the individual and trip level, a study will be done on how travel mode split can be modeled at the smaller levels of geography like traffic zones for use in route planning and travel demand forecasting.

Rodriguez, D A and Joo, J. *The Relationship between Non-Motorized Mode Choice and the Local Physical Environment*. Transportation Research Part D, 9, 2: 151-173, Elsevier, 2004.

This study uses multinomial choice models to examine the relationship between travel mode choice and attributes of the local physical environment such as residential density, walking and cycling paths, topography, and sidewalk availability. The relationship between mode choice and the objectively measured environmental attributes are illustrated using data for student and staff commuters at the University of North Carolina in Chapel Hill. The modeling approach is used in conjunction with traditional modal measures such as travel time, access time, and cost. Results suggest that the four attributes of the local physical environment jointly make significant marginal contributions in explaining travel mode choice. In particular, the estimates reveal that local topography and sidewalk availability are significantly associated with the attractiveness of bicycling and walking modes, respectively. Point elasticities are provided. The findings highlight the importance of considering non-motorized options in travel mode choice studies and incorporating measures of the local physical environment to refine calculations of generalized costs.

Salon, Deborah. *Cars and the City? A Model of the Determinants of Auto Ownership and Use For Commuting in New York City with Endogenous Choice of Residential Location*. Transportation Research Board, 2006.

Cities around the world are trying out a multitude of transportation policy and investment alternatives with the aim of reducing car-induced externalities. However, without a solid understanding of how people make their transportation and residential location choices, it is hard to tell which of these policies and investments are really doing the job and which are wasting precious city resources. The focus of this paper is on the determinants of the choice of car ownership within the context of the related decisions of residential neighborhood and commute mode. Treating all three of these choices as endogenous, I estimate a discrete choice model using survey data from 1997-98 collected in the New York metropolitan area. New York City is unique within the United States in that it has unusually low auto ownership rates. Identifying both the relative contributions of and the potential synergies between the factors that cause New Yorkers to be content to live without cars is important, and could lead to policy solutions for cities aiming to reduce their car dependence. Results indicate that in New York City, the most effective way to reduce car use for commuting is to decrease commute time for non-car modes. To reduce car ownership, the most important policy-sensitive variable appears to be population density. But effectiveness is not necessarily the same as cost-effectiveness. To use these results to inform policy, they must be combined with cost information about competing policy alternatives to identify the most cost-effective options.

Scheiner, Joachim. *Housing Mobility and Travel Behaviour: A Process-Oriented Approach to Spatial Mobility: Evidence from a New Research Field in Germany.* Elsevier, 2006.
In recent years, some effort has been made to understand the location changes in the life course underlying travel demand in Germany. Such studies have presented travel behavior and long-term housing mobility as intertwined decision flows within the life course. This perspective calls for new methods, such as comparisons of travel behavior before and after relocation, or comparisons between different ?relocation types?. A number of studies have been conducted on this new perspective. Although there are certain methodological problems arising, notable progress has already been made towards a more precise understanding of travel demand. This includes the investigation of the use of transport modes as well as traveled distances and activity spaces. This paper provides an overview of these studies. Theoretical groundwork, empirically validated aspects, and deficits and blind spots of research are discussed.

Schneider, Robert James and Rodriguez, Daniel A. and Young, Hannah M.. *Easy-to-Compute Index for Identifying Built Environments That Support Walking.* Transportation Research Board, 2006.
The variety and spatial co-variation of built environment attributes associated with non-automobile travel have resulted in the estimation of composite scores or indices summarizing these attributes. This paper builds on prior practical and research applications of these environmental scores or indices by proposing and testing a built environment index (BEI) calculated at the traffic analysis zone and that relies predominantly on widely available data. By computing the BEI using three different analytical methods used in prior research (principal components analysis, cluster analysis and an ANOVA method), we examine whether the indices created are comparable. Results suggest a high correlation between the BEI calculated with these methods, with principal components analysis appearing slightly superior to the two other methods. We also compare the BEI with Portland's Pedestrian Environment Factor (PEF) and find a high degree of consistency between the two. Because the BEI can be readily calculated, does not rely on field survey data and has high validity, we recommend it as an overview tool to classify built environments in their ability to support walking. When appropriate, additional disaggregate data can be used to examine the urban neighborhood with higher spatial resolution.

Schwanen, T. & Mokhtarian, P. L. (2005). *What Affects Commute Mode Choice: Neighborhood Physical Structure or Preferences toward Neighborhoods?* London: Elsevier.
The academic literature on the impact of urban form on travel behavior has increasingly recognized that residential location choice and travel choices may be interconnected. We contribute to the understanding of this interrelation by studying to what extent commute mode choice differs by residential neighborhood and by neighborhood type dissonance—the mismatch between a commuter s current neighborhood type and her preferences regarding physical attributes of the residential neighborhood. Using data from the San Francisco Bay Area, we find that neighborhood type dissonance is statistically significantly associated with commute mode choice: dissonant urban residents are more likely to commute by private vehicle than consonant urbanites but not quite as likely as true suburbanites. However, differences between neighborhoods tend to be larger than between consonant and dissonant residents within a neighborhood. Physical neighborhood structure thus appears to have an autonomous impact on commute mode choice. The analysis also shows that the impact of neighborhood type dissonance interacts with that of commuters' beliefs about automobile use, suggesting that these are to be reckoned with when studying the joint choices of residential location and commute mode.

Shay, E. & Khattak, A. J. (2005). *Automobile Ownership and Use in Neotraditional and Conventional Neighborhoods.* Washington, DC: Transportation Research Board. TRR 1902, 18-25.
Although the commonly accepted link between automobile ownership and automobile use has inspired some municipalities to experiment with neighborhood design in an attempt to influence both automobile ownership and travel behavior, the underlying relationship between neighborhood design

and automobile ownership is still unclear. Evidence suggests that automobile ownership is tightly linked to income and household size and is less responsive to urban design. This research uses data from a matched pair of neighborhoods, one conventional and one neotraditional, to consider the relationship between neighborhood design and automobile ownership and the relationship between these factors and automobile use. Statistically significant differences were found for automobile ownership in the two neighborhoods. In addition, there were clear differences in automobile use: residents of neotraditional developments made fewer automobile trips, traveled fewer miles in their vehicles, and spent less time driving. This has implications for planning strategies that may help reduce automobile trips and miles separately from changes in automobile ownership.

Shay, E., Fan, Y., Rodriguez, D. A., & Khattak, A. J. (2006). *Drive or Walk? Utilitarian Trips Within a Neotraditional Neighborhood.* Washington, DC: Transportation Research Board. TRR 1985, 1-15.
An extensive body of literature has developed on the relationship between the physical environment and travel behavior. Although many studies have found that neotraditional neighborhood development supports nonautomobile travel by providing good street connectivity, pedestrian and cycling facilities, and internal destinations, questions remain about the travel behavior of individuals within such neighborhoods. This study uses travel diaries to examine utilitarian trip-making behavior within a neotraditional neighborhood and compares total trips with mode-specific (i.e., walk and drive) trips. Negative binomial regression is used to examine the effect of a set of independent variables, including personal and household characteristics, select attitudinal factors, and distance from residences to the commercial center. It is found that within the neotraditional neighborhood, walk trips drop off quickly with increasing distance to destinations, whereas drive trips increase. The analysis demonstrates the importance of short distances for within-neighborhood travel and the merit in considering trips separately for walk and drive modes to avoid obscuring important factors associated with trip making.

Soltani, A. & Allan, A. (2006, September). Analyzing the Impacts of Microscale Urban Attributes on Travel: Evidence from Suburban Adelaide, Australia. *Journal of Urban Planning and Development, 132*(3), 132-137.
Metropolitan Adelaide in Australia is dominated by low-density suburbs with an extensive and large road supply, which brings with it car-dependent lifestyles that are ultimately unsustainable in the longer term. Changes are needed to make a city such as Adelaide less car-dependent toward a city that relies on more sustainable transport modes for its day to day urban travel needs. This paper presents the results from a comparative study of travel patterns among residents of four suburban residential areas in metropolitan Adelaide. Using existing datasets together with inventory data of urban environment characteristics from original fieldwork, this paper examines to what extent there are associations between various attributes of a particular urban location as they relate to travel behavior and household socio-economics. The findings derived from multinomial logit models show that suburban development pattern and design attributes can potentially create shifts in transport modal split suggesting that microscale urban features should be given more attention in transport policy making.

Srinivasan, S. (2001). *Quantifying Spatial Characteristics for Travel Behavior Models.* Washington, DC: Transportation Research Board.
Land use initiatives represent a potentially effective tool for coping with the kinds of mobility patterns that North American cities face in the 1990s and in the coming century. As fine-grained data about land use and travel activity become available, they provide the opportunity to improve the understanding of the linkage between land use and transportation. The neighborhood characteristics that could affect travel behavior on the nonwork tour are examined in detail. Neighborhood characteristics include land use, network, and accessibility-related characteristics quantified through the use of a geographic information system. Ultimately, such measures could be used in conjunction with detailed surveys of travel behavior to specify, calibrate, and use models of modal choice and trip type that are more sensitive to the fine-grained spatial structure of neighborhoods and transportation corridors in metropolitan areas. Microlevel data for the Boston metropolitan area, together with a 1991 activity survey of approximately 10,000 residents, provide a rich empirical basis for experimenting with relevant neighborhood measures and for simulating their effects on travel behavior. Spatial

characteristics affect travel behavior even on the relatively (spatially) restricted nonwork tour and could be potentially useful for transportation planning.

Srinivasan, S. (2005). *Influence of Residential Location on Travel Behavior of Women in Chennai, India*. Washington, DC: Transportation Research Board.

The visible impact of urban transportation is in access to employment. However, transportation also affects access to other services such as shopping and social service facilities. Past research in Chennai, a large city in India, indicates that the relocation of the very poor in peripheral informal settlements severely affects their accessibility to jobs and services because of the commuting distances involved when employment opportunities continue to remain highly centralized. In this study an attempt was made to understand the influence of relative location within the city on travel behavior by using a sample of 116 low-income households from a variety of locations in Chennai. In particular, the travel behavior of women as affected by location was assessed. Models estimated to determine the influence of location characteristics on household travel behavior indicate that availability of transportation choices did affect the travel behavior of women even after differences in their life-cycle stage are accounted for. Recently, Chennai has been investing heavily in rail for public transportation without estimating current travel demand by spatial location within the city. The implications of this policy for integrated land use and transportation planning are especially pertinent in this context.

Steiner, R. L., Wright, S. A., & Paul, J. B. (2000). *Travel in New Urbanist and Traditional Communities: A Case Study of Downtown Orlando, Volume I: Final Report and Appendix A*. Tallahassee: Florida Department of Transportation.

The claim that traditional urban forms reduce the level of automobile dependence, especially for trips to and from work and during the peak travel time, is examined in this research. While it would be ideal to consider New Urbanist communities, it is widely accepted that they have not reached the maturity necessary to allow them to be considered. Thus, this research considers the travel of residents who choose to live in traditional neighborhoods that afford the use of a range of transportation options. Downtown Orlando, including its adjacent neighborhoods, has been chosen as the location of this research because it appears to have the characteristics that encourage non-automobile travel. The downtown is built on a grid street network. Transit service is widely available. Many jobs are available in downtown Orlando. The city of Orlando's policies support a high quality of life in neighborhoods and encourage traditional neighborhood development in existing neighborhoods and the new development within the Naval Training Center Plan and Southeast Sector Plan. Many people who live in downtown Orlando have an income high enough to allow them the full options of transportation services, including automobile ownership. Thus, this research characterizes the travel of medium to high-income residents of the neighborhoods of downtown Orlando. The results of this research will begin to clarify whether the Florida Department of Transportation, as a matter of policy, should support such development, and, if so, what other policies should be in place to make it more effective.

TRB, Transit Cooperative Research Program (TCRP) Report 95: Chapter 15 – Land Use and Site Design, 2003

While transportation is a long-acknowledged factor in shaping cities and determining land development potential, as the result of enhanced accessibility, the reciprocal impact of land use decisions on transportation outcomes has only gradually achieved recognition. It is these reciprocal impacts, of interest in treating land use or site design options as "transportation" strategies that provide the impetus for this chapter. Presented here is information on the relationships between land use/site design and travel behavior, drawn primarily from research studies that have attempted to measure and explain the effects. TCRP Report 95: Chapter 15, Land Use and Site Design will be of interest to transit, transportation, and land use planning practitioners; educators and researchers; and professionals across a broad spectrum of transportation and planning agencies, MPOs, and local, state, and federal government agencies.

Waling, H. *Socio-Economic Land Use and Travel Patterns in Amsterdam*. American Society of Civil Engineers, 2000.

The number of inhabitants in Amsterdam is influenced by various developments such as the transition of population to the suburbs and the effects of foreign immigration on growth and prosperity. Many demographic factors, such as the age and number of inhabitants, play a part in the social and economic structure of the city. This paper deals with land use and the various social and economic characteristics of the occupants of Amsterdam and their travel patterns, and how these factors impact on public transportation.

WEINER, E and Gorham, R. *LAND USE--TRANSPORTATION INTERACTIONS: WORKSHOP REPORT. IN: IN PERPETUAL MOTION: TRAVEL BEHAVIOR RESEARCH OPPORTUNITIES AND APPLICATION CHALLENGES*. Elsevier, 2002.
This report describes a workshop that focused on methodologies and needs of researchers looking into whether a causal link exists between human settlement patterns in urbanized regions and travel behavior. Workshop participants generally agreed that the interactions between these phenomena are quite complicated, and that land-use policy alone will be insufficient in reducing car dependency. The central issue then becomes, how can researchers isolate the effects of land-use if it is apparent that land-use alone is not sufficient to influence travel behavior. This problem is discussed in detail.

Zegras, P.C. (2004). The influence of land use on travel behavior: Empirical evidence from Santiago de Chile. *83rd Annual Meeting of the Transportation Research Board*, Washington, DC.

Zegras, P.C. (2006). *The Built Environment and Motor Vehicle Ownership and Use: Evidence from Santiago de Chile*. Paper #07-3034. Washington, DC: Transportation Research Board.
This paper examines the role that the built environment – both micro-scale "neighborhood" design characteristics and meso-scale relative location – play in influencing motor vehicle ownership and use in a rapidly motorizing, developing city context: Santiago de Chile. The paper first answers the question: what role, if any, do factors such as dwelling unit density, land use mix, street design, and proximity to public transportation stations play in determining household motor vehicle ownership? The question is answered by specification and estimation of a multinomial logit model of vehicle choice. The paper then turns to a second-stage question: what role does the built environment play on household automobile use? This question will be answered by specification and estimation of an ordinary least squares regression model, predicting the amount of total household automobile use (measured by distances traveled on a given day). The two models are explicitly linked via the use of the "selectivity bias correction factor." The implications of the findings for planning and design are discussed.

Zhang, M. (2005). *Intercity Variations in the Relationship Between Urban Form and Automobile Dependence: Disaggregate Analyses of Boston, Massachusetts; Portland, Oregon; and Houston, Texas*. TRR 1902. Washington, DC: Transportation Research Board.
This study was motivated by the need for more empirical research on the urban form-travel connection. A two-tiered travel effect is expected from strengthening the urban form-travel connection: the enhancement of access to choices and a shift in travel mode choice from driving to nondriving. Existing studies have focused primarily on the second-tier effect but have largely omitted the first. This study attempted to fill that gap. Through joint-logit modeling of choice set formation and travel mode choice in three cities: Boston, Massachusetts; Portland, Oregon; and Houston, Texas; the study measured the degree of automobile dependence in the three cities. It also estimated elasticities of automobile dependence and of driving probabilities with respect to land use densification, transit access improvement, and control of motorization. There were large variations in the levels of automobile dependence and their elasticity estimates among the three cities. Public policies aimed at reducing automobile dependence should be formulated and evaluated based not just on the final outcome of modal split but also on the provision of travel options to travelers. As cities differ in their existing urban forms, currently available transportation services, and prevailing preferences of travel, it is important to recognize that the same set of policy strategies implemented in different cities is unlikely to generate the same level of effects in reducing automobile dependence.

LADOT
Moving Los Angeles Forward

The City of Los Angeles Transportation Profile

The City of Los Angeles Transportation Profile 2009

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Mayor Antonio R. Villaraigosa

Mayor Villaraigosa has dedicated himself to developing viable and convenient alternatives to driving, managing our existing road system, making our transportation system safer and increasing street and freeway capacity. His transportation initiatives are to increase convenience, reliability, safety, and speed of Los Angeles' transportation system and change how Los Angeles looks and how people move throughout the City.

To do this, Mayor Villaraigosa has relentlessly pursued state and federal transit funds, and continues to fight for Los Angeles' fair share, so that we can have a first-class bus system and a true regional rail transit network.

In order to reduce our reliance and dependence on driving, Mayor Villaraigosa is working to transform Los Angeles into a city with 60 new transit-oriented development areas alongside subway lines. These developments combine dense housing, walkable streets and mixed-used developments near transit options. It is the Mayor's hope that addition of these new developments will reduce our reliance and dependence on the single passenger vehicles and will help Los Angeles become a cleaner and greener city.

After all, Los Angeles is on track to become the cleanest and greenest big city in America. More than half of all city vehicles are hybrid vehicles or run on alternative fuels. The Los Angeles River is being restored and air pollution for the Port of Los Angeles is being reduced by 45%.

The mission of the City of Los Angeles Department of Transportation (LADOT) is to provide for safe and optimal mobility of people and goods throughout the City of Los Angeles in support of economic activity and a desirable quality of life. The City of Los Angeles is a dynamic city of the 21st Century and Mayor Villaraigosa is working with Rita L. Robinson and the Department of Transportation to ensure that it is a vibrant city with enhanced mobility.

Commissions

The Los Angeles Department of Transportation works with two Commissions: the Transportation Commission and Taxicab Commission. Members of the Commissions serve as advisors to the General Manager of the Department of Transportation and are appointed by the Mayor. LADOT asks the Commissions to gather inputs on transportation-related issues. The Commissions' findings help the Department of Transportation connect with key transportation stakeholders in the City.

The Board of Transportation Commissioners establishes regulations that govern the operation of utilities, makes recommendations regarding the public utility franchises and permits granted by the City and is responsible for managing the Special Parking Revenue Fund. The Board also must approve all Department-initiated amendments to the Municipal Code. The Board generally serves in an advisory capacity to the General Manager.

The Board of Taxicab Commissioners has the authority to determine the proper services to be furnished and the rates to be charged; to prescribe rules/regulations and to investigate complaints regarding the services provided and rates charged; to verify compliance with franchise terms and conditions, ordinances and laws; to establish quality of service standards; to provide performance evaluations; and to make recommendations to the City Council on the granting of taxicab franchise applications and the setting of taxi meter rates of fare.

Rita L. Robinson, General Manager


Rita L. Robinson, General Manager

The City of Los Angeles is the international gateway for people and goods moving between and to North America, the Asian Pacific Rim and Europe. It provides the entry for the land bridge between Asia and Europe and the free trade zones between the United States and Canada and the United States and Mexico. It is an acknowledged critical linchpin for the global logistics for movements within the global economy. Los Angeles would be considered the 7th largest nation in the world based on Gross Domestic Product and one of two projected mega cities in North America in the 21st Century. The small mission outpost of the 19th Century is today, a worldwide powerhouse.

In the 21st century, the City of Los Angeles continues to experience rapid growth in jobs, population, economic activity, business travel and tourism. This growth in population brings economic benefits to the City but also expands demands for moving people and goods. The City is part of a complex, multi-participant transportation system and transportation-related decisions made and implemented here affect not only City residents, employers, employees and visitors, but also have national and international implications.

The Los Angeles Department of Transportation

The Department of Transportation (LADOT) is comprised of nearly 2,200 employees (engineers, planners, parking enforcement and traffic control officers, school crossing guards and support staff) organized into four Offices, which oversee 14 Bureaus and 25 field locations.

LADOT operates three public transit systems—Commuter Express, DASH and City Ride.

We are also responsible for all traffic operations in the City, including:

- 4,300 signalized intersections
- 6,499.5 miles of streets
- Tens of thousands of traffic control devices
- Operation of the most advanced city-based traffic control center: ATSAC
- Striping all streets and painting all curbs
- Installation and maintenance of a transit priority system for regional transit operator
- Regulation of the taxi, medical transport and pipeline industries
- Preparation and administration of federal and state grants and funds
- Ownership and operation of City parking lots and garages
- Handling of parking enforcement
- Providing traffic control for daily travel and special events
- Designing and promoting bicycle facilities and bicycle safety
- Improving public safety with the regional traffic safety education campaign known as "Watch the Road"
- Planning for the City's transportation system by reviewing proposed developments
- Preparing neighborhood-based traffic and transportation plans
- Providing technical resources for the City's representatives on regional transportation activities

LADOT delivers safe, reliable and accessible surface transportation services. These services enhance the quality of life and the movement of people, vehicles, bicyclists and goods in the City of Los Angeles.

We are a recognized leader in the delivery of exceptional transportation services to our customers through continuous improvement, innovation and teamwork. As we move into the future, that innovation and teamwork will help us continue to improve the quality of life in our City of Los Angeles.

4

Transportation Infrastructure

Funding

Adopted 2006-07 DOT Budget: $143,713,078
Actual 2007-08 DOT Budget: $140,913,546

Sources of Funds, City of L.A., Office of the Mayor FY Budget 07-08

Source	Total
General Fund:	$110,798,583
Traffic Safety Fund (Sch. 4):	$7,478,290
Special Gas Tax Street Improvement Fund (Sch. 5):	$4,473,539
Mobile Source Air Poll. Reduction Fund (Sch. 10):	$507,601
Special Parking Revenue Fund (Sch. 11):	
Sewer Capital (Sch. 14):	$90,033
Prop. A Local Transit Fund: (Sch. 26):	$5,998,346
Prop. C Anti-Gridlock Transit Fund (Sch. 27):	$10,327,637
Coastal Transportation Corridor Fund (Sch. 29):	$294,225
West L.A. Transportation Improvement and Mitigation (Sch. 29):	$87,778
Ventura/Cahuenga Corridor Plan (Sch. 29):	$749,956
Warner Center Transportation Develop. (Sch. 29):	$90,529
Local Transportation Fund (Sch. 34):	$17,426

5

Background: The City and County of Los Angeles

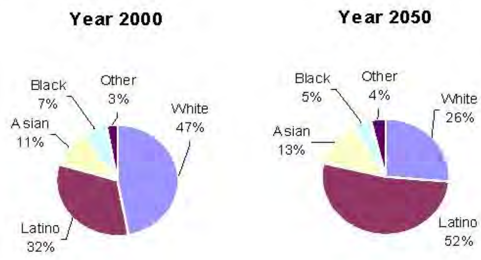
The County of Los Angeles covers 4,079 square miles and includes 88 incorporated cities. The central city is Los Angeles. According to the U.S. Census Bureau, the estimated 2005 population of Los Angeles County is 9,758,886.

The City of Los Angeles covers 470 square miles and has a population of approximately 3.7 million. It is the second largest city in the United States by population and the city with the fifth largest population growth in 2000. The 3.7 million residents living in the City of Los Angeles have created a mosaic of diverse communities where numerous languages are commonly spoken. The City's topography is just as diverse, with hillside, valley and beach neighborhoods as well as highly urbanized and quasi-rural neighborhoods.

The faces of California's changing future

The Changing Face of California

New projections from the State Department of Finance show that Latinos will be the majority in California by the year 2050.



Population Increases

County	2000	2050	%
	In millions		
Riverside	1.6	4.7	203
Imperial	0.14	0.39	170
San Bernadino	1.8	3.7	113
Ventura	0.76	1.2	62
San Diego	2.8	4.6	59
Orange	2.9	4	39
Los Angeles	9.6	13.1	36
California	34.1	59.5	74

Note: Ranked by percent of rate growth. Percents based on unrounded numbers

Source: California Dept. of Finance

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Los Angeles World Airports (LAWA)

Photo: Courtesy of LAWA

Los Angeles owns and operates Los Angeles World Airports, a system of four different airports: Los Angeles International (LAX), Ontario (ONT), Van Nuys (VNY) and Palmdale Regional (PMD).

Los Angeles International (LAX)

Los Angeles International is ranked fifth in the world for the number of passengers and seventh for the tonnage of cargo handled. In 2003, 55 million passengers used LAX (14.6 million international; 40.3 million domestic) and there were 622,378 operations (takeoffs and landings).

There are approximately 1,000 cargo flights daily at LAX, handled in the 98-acre Century Cargo Complex, the 57.4-acre Imperial Complex, the Imperial Cargo Center and a number of terminals on the south side of the airport. In 2003, there were more than 2 million tons of freight and mail shipped.

Ontario International (ONT)

Ontario International is a medium-hub, full-service airport located 35 miles east of Downtown Los Angeles and less than 50 miles from both Los Angeles and Long Beach Harbors. Seven million passengers used the airport and 602,326 tons of air freight was shipped in 2006.

Van Nuys (VNY)

Van Nuys is located in the San Fernando Valley and is the world's busiest general aviation airport, with nearly 500,000 non-commercial takeoffs and landings annually.

Van Nuys reduces congestion and delays at the other airports by providing a place for general aviation, which encompasses all flying other than scheduled air carrier service or the military.

Palmdale Regional (PMD)

Palmdale is located in the Antelope Valley, 60 miles away from Downtown Los Angeles. It shares an airfield with the United States Air Force.

In June of 2007, Palmdale opened up to commercial flights for the first time. Palmdale's terminal is capable of handling up to 300,000 passengers annually. The United Airlines flights operating there go to and from San Francisco.

Palmdale Terminal Remodel
Photo: Jay Berkowitz, LAWA.

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The Port of Los Angeles

The Port of Los Angeles is located 20 miles south of Downtown Los Angeles in San Pedro Bay.

The Port is a department of the City of Los Angeles, often referred to as the Los Angeles Harbor Department. It is a proprietary Department, meaning the Port is not supported by taxes. Revenue is derived from fees for shipping services such as dockage, wharfage, pilotage, property royalties and other port services.

The Port consists of 7,500 acres, 43 miles of waterfront and features 27 cargo terminals, including dry and liquid bulk, container, breakbulk, automobile and omni facilities. These terminals handle almost 190 million metric revenue tons of cargo annually.

The Port is also home to the nation's most secure cruise passenger complex, the World Cruise Center.

The Port of Los Angeles receives more than 42% of total U.S. waterborne containerized imports, and 70% of imports come from Asia. Since 1999, container cargo passing through the Port of Los Angeles has doubled, and since 1995, it has tripled.

Photo: Courtesy of LAHD

Photo: Courtesy of LAHD

Goods Movement: Existing Conditions and Constraints

Los Angeles is the primary goods movement gateway for the country. The Los Angeles Customs District includes the ports of Los Angeles, Long Beach, Port Hueneme and Los Angeles International Airports.

Manufacturing Activity and the Retail Market

L.A. County has the country's largest manufacturing base, with nearly 500,000 manufacturing workers employed in 2005. It also has one of the country's largest retail markets, with $140 billion in taxable retail sales in 2002.

Many of the manufacturing districts are located in or near Downtown Los Angeles. According to the U.S. Census American Community Survey for 2005, the City of Los Angeles employs approximately 183,443 manufacturing workers.

LADOT's Goods Movement Improvement Program

In the last 12 years, LADOT has used innovative technology and practices to identify and correct truck movement problems on the City's surface streets. This program has produced three citywide studies that identified over 75 truck movement problem locations and played a vital role in securing funding and implementing internal measures to address truck movement problems.

Waterborne and Airborne Cargo: The Port of Los Angeles and Los Angeles World Airports

The Port of Los Angeles in San Pedro Bay handles approximately 40,000 container units daily and is home to the highest-volume container ports complex in the nation and the fifth largest in the world.

In 2005, it handled 14.2 million container units, a full one-third of all U.S. waterborne container traffic. Most of these container units are still drayed by truck to off-port intermodal facilities and regional distribution centers.

Los Angeles International Airport handles most of Southern California's air cargo. In 2003, there were more than 2 million tons of freight and mail shipped. The LAX Master Plan projects an increase of up to 3.1 million annual tons of air cargo by 2015.

Ontario International Airport (ONT) is part of a rapidly developing freight movement system including the airport, two railroads, four major freeways (the 10, the 15, the 60 and the 210 freeways), and an expanding network of freight forwarders. Some of the major U.S. air freight carriers that service ONT include Airborne Express, Ameriflight, Arrow Air, Centurian Airlines, DHL, Empire Airways, Evergreen Aviation, Express Net, Federal Express, Gulf and Caribbean Cargo, IFL Group, Kalitta Air, United Parcel Service and West Air.

This air cargo eventually moves onto tractor-trailer or short-haul delivery trucks for transport on streets and freeways.

Rail

Los Angeles County operates as a major rail hub. The region is linked to the national rail network by main lines operated by Union Pacific (UP) and Burlington Northern Santa Fe (BNSF). UP has four terminals, with one located near the ports and the other located in Los Angeles. BNSF operates three terminals, with one located in the City of Los Angeles.

In 2002, the Alameda Corridor opened, providing a 20-mile, grade-separated freight rail link between rail yards near Downtown Los Angeles and inland, and the San Pedro Bay ports. However, waterborne cargo destined for markets within a 500-mile radius of the ports still moves largely by truck, although the ports have extensive on-dock rail facilities.

Trucks

Trucks move in a time-sensitive environment between ports, airports, intermodal rail yards, truck terminals, distribution centers, warehouses, factories, businesses and stores. Trucks travel on surface streets for some of their journey—surface streets that fall under LADOT jurisdiction.

The Goods Movement Improvement Program's three studies identified some of the heaviest traveled truck routes within the City of Los Angeles. The three study areas were:

Phase I Study Area (October 1999):	Central City East and the Port of Los Angeles, linked by the Alameda Corridor
Phase II Study Area (February 2002):	Northeast Los Angeles and the San Fernando Valley
Phase III Study Area (January 2006):	Hollywood, Mid-City, South Los Angeles, West Los Angeles, LAX, and the Port of Los Angeles

The study considered any route with more than 3% trucks during peak hours as a truck route. Within Central City East, some streets carried as much as 15% trucks during peak hours.

Phase I: Central City East Study Area	
Street	**Percentage of Trucks During Peak Hours**
Santa Fe (Between Washington and 7th)	15%
Olympic (Between Soto and Santa Fe)	13%
Central (Between Washington and Olympic)	9%

In northeast Los Angeles and the San Fernando Valley, there was significantly less truck activity, barring a slight increase near the Van Nuys Airport.

Phase II: West Fernando Valley Study Area	
Street	**Percentage of Trucks During Peak Hours**
Nordhoff (Between Balboa and Reseda)	3%
De Soto (Between Roscoe and the 118 Freeway)	4%
Sepulveda (Between Roscoe and Sherman)	4%

Phase III focused on an area around Los Angeles International Airport.

Phase III: LAX Study Area	
Street	**Percentage of Trucks During Peak Hours**
Century (Between Jefferson and Airport)	11%
Imperial (Between Aviation and La Cienega)	7%
La Cienega (Between Imperial and Century)	8%

Streets Inventory and Freeway System

How many miles of street are there in the City of Los Angeles?

There are approximately 6,499.5 miles of dedicated public streets in an area of approximately 470 square miles. There are 181 miles of freeway.

Los Angeles County has approximately 527 miles of freeway. There are just over 470 HOV lane miles in Los Angeles County, more than 1/3 of the total number in the State of California.

How many traffic signals are there in the City of Los Angeles?

There are 4,300 signalized intersections and 1,800 signalized approaches with left-turn arrows.

How many intersections are there in the City of Los Angeles?

There are 40,000 intersections in the City of Los Angeles.

How many crosswalks are there in the City of Los Angeles?

There are 22,000 marked crosswalks in the City of Los Angeles.

Los Angeles County Freeway System

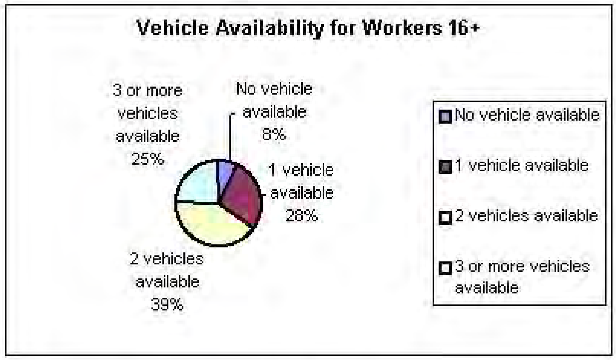
Freeway Number	Freeway Name	Freeway Number	Freeway Name
2	Glendale	5	Golden State/Santa Ana
10	Santa Monica/San Bernardino	14	Antelope Valley
22	Garden Grove	30	Foothill
57	Orange	60	Pomona
71	Corona Expwy	90	Marina
91	Riverside/Artesia	101	Ventura/Hollywood
105	Glen Anderson	110	Pasadena/Harbor
118	Simi Valley/San Fernando Valley	134	Ventura
170	Hollywood	210	Foothill
405	San Diego	605	San Gabriel River
710	Long Beach		

How many miles of curb marking are there in the City of Los Angeles?

There are 1,200 miles of red, yellow, white, green and blue curb markings in the City of Los Angeles. Most of that is red curb marking.

Automobile Availability and Mode Share in the City of Los Angeles

According to 2005 U.S. Census data, there are approximately 1,662,238 workers over the age of 16 in the City of Los Angeles. Of these 1,662,238 workers, all but 7.8% live in households where at least one car is available. 25.2% live in households where there are 3 or more cars available.



*U.S. Census, American Community Survey 2005
*Total Workers Age 16+ = 1,662,238, +/-28,414

How many cars are there in Los Angeles?

According to the California Department of Motor Vehicles (DMV), there were 6,675,888 automobiles, commercial vehicles and motorcycles registered in the County of Los Angeles as of January 1, 2007. There were 5,484,606 automobiles, 123,669 motorcycles and 1,068,213 commercial vehicles.

In the City of Los Angeles, there are a total number of 2,499,764 registered vehicles. Of that, 1,977,803 are automobiles.

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Commuting

According to the 2005 U.S. Census data for the City of Los Angeles, 52% of workers over 16 who work outside of the home spend less than half an hour commuting to work; 12% of workers over 16 who work outside the home spend an hour or more commuting to work. The average commute time was 29.6 minutes.

Subject	Total	Male	Female
Workers 16 years and over	1,662,238	954,410	707,828
MEANS OF TRANSPORTATION TO WORK			
Car, truck, or van	79.50%	81.00%	77.50%
Drove alone	67.80%	68.90%	66.40%
Carpooled	11.70%	12.10%	11.10%
In 2-person carpool	9.00%	9.20%	8.70%
In 3-person carpool	1.70%	1.90%	1.50%
In 4-or-more person carpool	0.90%	1.00%	0.90%
Workers per car, truck, or van	1.37	1.34	1.4
Public transportation (excluding taxicab)	10.30%	9.30%	11.70%
Walked	3.20%	2.90%	3.50%
Bicycle	0.60%	0.90%	0.20%
Taxicab, motorcycle, or other means	1.70%	1.80%	1.50%
Worked at home	4.70%	4.00%	5.70%

*U.S. Census, American Community Survey 2005
*Total Workers Age 16+ = 1,662,238

Subject	Total	Male	Female
Workers 16 years and over who did not work at home	1,583,856	916,115	667,741
TRAVEL TIME TO WORK			
Less than 10 minutes	7.80%	7.00%	8.90%
10 to 14 minutes	10.40%	10.30%	10.50%
15 to 19 minutes	13.60%	13.30%	14.10%
20 to 24 minutes	14.20%	13.60%	15.20%
25 to 29 minutes	6.10%	5.90%	6.20%
30 to 34 minutes	19.30%	20.70%	17.30%
35 to 44 minutes	7.80%	7.90%	7.70%
45 to 59 minutes	9.20%	9.00%	9.40%
60 or more minutes	11.60%	12.30%	10.70%
Mean travel time to work (minutes)	29.6	30.3	28.6

*U.S. Census, American Community Survey 2005
*Total Workers Age 16+ and who did not work at home = 1,583,856

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Traffic Congestion and Neighborhood Traffic Management Plans

What is the per capita delay due to traffic congestion?

According to the Texas Transportation Institute, in 2003, people traveling on the roadways in Los Angeles/Orange counties experienced a total of 93 hours of delay per person, the highest among the metropolitan areas in the nation.

Signals and red light cameras are part of traffic management.

Neighborhood Traffic Management Plans

A Neighborhood Traffic Management (NTM) Plan may be developed when a problem of excessive bypass traffic or speeding is documented on a network of local, residential streets. In developing an NTM Plan, a package of traffic management and calming measures are considered so that bypass routes are less attractive to commuters, speeding is reduced and the quality of life is enhanced.

LADOT has implemented 23 Neighborhood Traffic Management plans in Los Angeles neighborhoods from Silver Lake to Encino to Baldwin Hills.

There are currently five projects being implemented, with approved plans, in neighborhoods reaching from Carthay Square to Western Heights.

There are also several other projects, both big and small, in various stages of completion throughout the City.

The variety of projects ranges from the installation of speed humps and stop signs to the construction of landscaped median islands and the timing of signals.

A majority of these projects are funded from LADOT's general fund.

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Traffic Collisions

How many resulted in property damage only as compared to fatalities?

According to Traffic Collision Data reported by the Los Angeles Department of Transportation for the City of Los Angeles, in the year 2002, 45% of all traffic collisions resulted in property damage only, compared to 55% that resulted in some kind of injury.

In 2002, throughout the City of Los Angeles, there were 50,317 collisions reported, with a total of 166 fatal injuries resulting from a traffic collision.

How does that compare to property damage/fatality collision rates across the nation?

Data from the National Highway Traffic Safety Administration for the year 2000 shows the cost of traffic collisions in both the State of California, as well as the country as a whole.

Traffic Collisions in U.S. and California — Annual Deaths/Injuries/PDO/Cost

	Deaths	Injuries	P.D.O.**	Cost
U.S.	43,443	2,699,000	13,487,355	$231 Billion
California	4,329	292,798	984,577	$21 Billion

Source:
•The Economic Impact of Motor Vehicle Crashes, 2000. NHTSA (Numbers for California for Injuries and PDO have been interpolated)
**PDO – Property Damage Only

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Parking

Citywide inventory of On-and-Off-street parking controls:

- On-street parking meters.....37,709
- Off-street parking meters.....2,703
- Operated parking garage spaces.....5,395
- Operated Off-street lot spaces.....1,723
- Free non-metered off-street spaces.....1,276

Parking Classifications: Residential Parking Zones, Preferential Parking Districts and Park and Pay Stations and Meters

- LADOT manages 112 established Preferential Parking Districts (PPDs), with the majority concentrated in Central Los Angeles
- LADOT recently established 15 Overnight Parking Districts
- There are 38 requests for expansions and/or establishments of new Districts

Clean Air Vehicle Parking

On October 1, 2004, participation in this free metered parking program was extended to four hybrid vehicle models: the Honda Insight, Honda Civic Hybrid, Toyota Prius, and the Ford Escape Hybrid. On June 21, 2006, the Los Angeles City Council voted to extend the program providing free parking at City parking meters for hybrid vehicles.

The Council also directed the City Attorney to prepare an ordinance limiting participation in the free parking program to only those vehicles that have Clean Air Vehicle Decals issued by the California Department of Motor Vehicles. (Free Parking for Zero Emission Vehicles (ZEVs), Super Ultra Low Emission Vehicles (SULEVs) and certain Hybrid Vehicles - Pilot Program)

A parking enforcement officer also guides traffic.

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LADOT Transit Facilities and Services

LADOT's transit fleet consists of nearly 400 vehicles that operate over 800,000 revenue hours and serve over 30 million passenger boardings per year. Transit ridership by clients of the Cityride program amounted to approximately 1.5 million trips in FY 05-06, including an estimated 14 million trips utilizing the Metro bus passes, 800,000 utilizing City-franchised taxis and 170,000 utilizing the City-operated Dial-A-Ride services.

DASH buses cost a quarter to ride.

DASH: DASH, originally an acronym for Downtown Area Short Hop, started out as a small circulation bus to provide access to the various activity sites in Downtown. DASH buses travel meandering fixed routes and provide access to various activity centers, such as parks, recreation centers, cultural sites, medical facilities and retail areas. The DASH concept has since been expanded to 27 routes that serve various communities throughout the City, including six in Downtown.

Commuter Express: LADOT provides 16 fixed Commuter Express Routes, 11 of which provide service between Downtown and various communities using the freeway. The buses operate during peak commuting hours. In the Downtown area or the major activity center, bus stops are frequent. In the community end, the stops are approximately one-half mile apart.

City Ride: Cityride is a special dial-a-ride and taxicab service for seniors 65 years and older and persons with disabilities. This program enables clients to gain access to senior centers, medical facilities, supermarkets and other sites.

Metrolink Shuttle Bus: Direct service for Metrolink passengers is available to Bunker Hill in the morning and back to Union Station in the afternoon via this special Metrolink shuttle route.

City of Los Angeles Charter Bus Program: LADOT contracts with charter bus operators to provide free bus service to qualified seniors, youth and disabled groups, allowing them to have recreational and educational opportunities at various activity centers.

There are 16 Commuter Express routes.

LADOT-Operated Transit Centers/Park & Ride

Development of transit centers or hubs is also a primary responsibility of LADOT. These hubs offer enhanced on-street facilities and will increase transit service over the entire region.

LADOT also develops park and ride lots. We currently utilize the Encino Park and Ride in the San Fernando Valley. This facility supports much of LADOT's Commuter Express service, providing parking spaces, bicycle lockers and electric vehicle-recharging stations. LADOT facilities and Metrolink stations are located at:

Metrolink Stations: Chatsworth, Cal State University Northridge, Van Nuys, Sylmar/San Fernando, Sun Valley.

Transit Centers: El Sereno, Highland Park, and Warner Center

Park and Ride Lots: Encino

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LADOT inspects the taxicabs.

Taxis

Currently, there are 2,300 authorized taxicabs operated by nine companies and regulated in the City. They are:

- Bell Cab;
- Beverly Hills Cab;
- City Cab;
- Independent Taxi Owner's Association (ITO);
- LA Checker;
- United Checker;
- United Independent Taxi Drivers (UITD);
- United Taxi of San Fernando Valley (UTSV); and
- Yellow Cab

The Los Angeles Department of Transportation mandates that all taxicabs use meters to determine a ride's cost. The City establishes meter rates, including a flat rate between the Los Angeles International Airport and Downtown.

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Other Transit Services: Metro and Municipal Bus Services

Local Transit Service and Facilities: Bus, Transitways

Bus: The regional public transit service in Los Angeles County is the Metropolitan Transit Authority, more commonly known as Metro. On an average weekday, Metro operates 2,000 peak-hour buses throughout Los Angeles County. Metro also funds 16 municipal bus operators.

Foothill Transit is a municipal bus operator that also serves Downtown Los Angeles.

Metro Rapid Buses are intended to speed up the commute by limiting stops.

FlyAway: FlyAway is a shuttle bus that runs between Union Station and LAX, Westwood and LAX, and Van Nuys and LAX. Shuttles run non-stop every half-hour.

Regional High Capacity Transit Service: Light Rail, Regional Express Bus, and Metrolink

Light Rail (Metro Rail): Metro operates 73.1 miles of Metro Rail service.

The Metro Rail system is made up of the Metro Red and Purple Line subway system, the Metro Blue Line, the Metro Green Line, and the Metro Gold Line. It serves 62 rail stations from Long Beach to Downtown Los Angeles to Hollywood, Universal City and North Hollywood in the San Fernando Valley, from Downtown Los Angeles to Pasadena and from Norwalk to El Segundo.

Regional Express Bus (Metro Rapid): Metro Rapid is a limited-stop express bus. Red Metro Rapid buses are tied to the ATSAC system; buses are equipped with transponders that communicate with traffic signals, causing them to be favored by lights.

Metrolink: Metrolink is a commuter rail service that connects the Southern California Region, including Los Angeles, Orange, Ventura, San Bernardino and Riverside Counties. Metrolink has seven lines, 54 stations and services 40,000 passengers annually, on average.

Union Station is the center of much of the rail activity in the City of Los Angeles.

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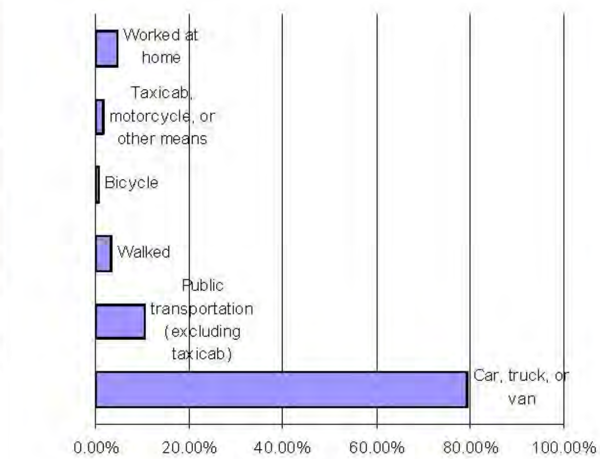
Pedestrians and Bicyclists

Means of Transportation to Work



	Car, truck, or van	Public transportation	Walked	Bicycle	Taxicab, motorcycle, or	Worked at home
Series1	79.50%	10.30%	3.20%	0.60%	1.70%	4.70%

*U.S. Census, American Community Survey 2005
*Total Workers Age 16+ = 1,662,238, +/-28,414

How many people ride their bicycles to work?

According to the 2005 U.S. Census data, there are approximately 1,662,238 workers over the age of 16 in the City of Los Angeles. Out of these workers, 7.8% live in households where there are no cars.

3.2% of these 1,662,238 workers commute to work by walking and .6% commute by bicycle.

There are more than 130 miles of bike lanes in the City of Los Angeles.

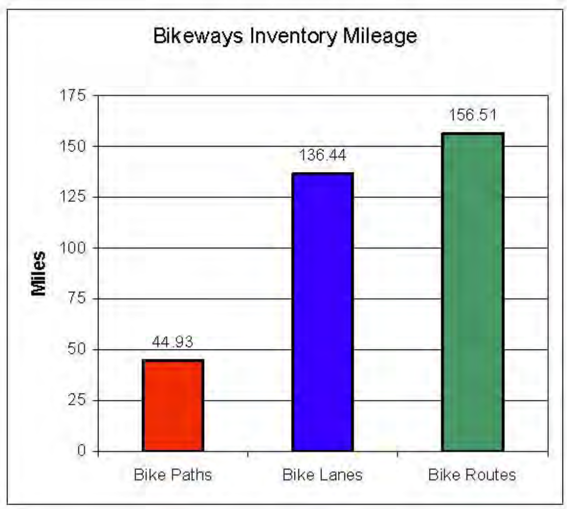
How many miles of bikeways are there?

Bikeways include bicycle paths, bicycle lanes and bicycle routes. Bicycle lanes are installed in Los Angeles along feasible street locations to serve commuters, students and bicycle enthusiasts.

Los Angeles bikeway examples include those along Venice Boulevard, Hoover Street, Westwood Boulevard, De Soto Avenue, and Rinaldi Street. To date, there are more than 130 miles of bicycle lanes in the network.

Bicycle pathways are built specifically for bicyclists and do not allow automobile traffic. Bicycle pathways can be found along Venice Beach, Sepulveda Basin, Culver Boulevard and the Los Angeles River.

Over 2,900 bicycle racks have been installed along City streets and at transit stations throughout Los Angeles.



Work on Santa Monica Boulevard was recently completed and plans are underway to extend the Los Angeles River Bike Path and to construct a new path in conjunction with the North Hollywood-to-Warner Center Busway Project.

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Development Review

What is "development review?"

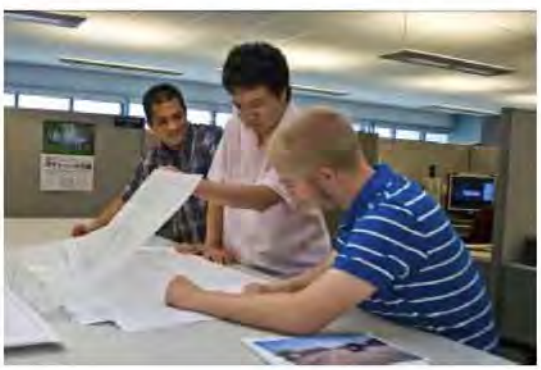
Consistent with adopted City policy and environmental laws, the Los Angeles Department of Transportation reviews land development projects. These projects are reviewed in the context of:

- Economic development
- Balanced growth
- Current levels of traffic congestion
- Preservation of neighborhood livability

All projects are reviewed with respect to project size, location and safety of proposed driveways and conditions for approval. Conditions for approval may include off-site traffic improvements, such as new traffic signals or street widening along the project frontage.

How many development reviews are there per year?

On average, there are approximately 100 traffic study reviews, 500 building permit sign-offs and 300 driveway permit sign-offs per year.



Next Steps

Los Angeles continues to experience substantial growth in jobs, population, economic activity, business travel and tourism. While its rise as the international gateway for the movement of people and goods has many benefits, it also renders the task of efficiently moving people and goods far more challenging. Los Angeles is a part of a complex, multiple component transportation system; there is no single solution to our mobility challenges. As a recognized leader in the delivery of exceptional transportation services through continuous improvement, innovation and teamwork, LADOT looks forward to meeting these challenges, given adequate resources.

LADOT will continue to provide innovation and teamwork to support the growth of our City by working with our partners at Metro and Caltrans. In addition, we are forming strong alliances with the Planning Department and other members of the City family to leverage our resources, solutions and public outreach. Finally, following the leadership of our Mayor and City Council, we must include the community in the discussion of any solutions and proposals.

The Department will be reviewing capital improvement projects and existing programs to ensure that they reflect the citywide transportation vision articulated in the City's General Plan Transportation Element, while also developing a Transportation Strategic Plan: a functional action plan to strategically implement, manage and monitor the City's transportation projects and programs aimed at the achievement of that vision during the period 2009 to 2030.

The Strategic Plan, to be released in May 2009, will identify innovative transportation strategies for the City, sustainable funding streams, a prioritized list of transportation projects and programs, and specific steps necessary to achieve the goals and objectives set forth in the Plan's mission statement. The mission statement commits us to improve accessibility and mobility in Los Angeles, to protect the quality of life in the City's neighborhoods through sensible land use planning and thoughtful management of the City's streets, to ensure that the City's transportation systems are safe and reliable, to promote the City's long-term competitiveness as a center for world trade by facilitating the movement of goods, and to develop sufficient and stable funding to maintain and rehabilitate our existing transportation infrastructure.

The Department continues to strive to improve the quality of life for those who live and work in Los Angeles by enhancing mobility and accessibility while helping Los Angeles become cleaner and greener.

LADOT
Moving Los Angeles Forward

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As a covered entity under Title II of the Americans with Disabilities Act, the City of Los Angeles does not discriminate on the basis of disability and upon request will provide reasonable accommodation to ensure equal access to its programs, services and activities.

The New Economy and Jobs/Housing Balance in Southern California

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ABSTRACT

The information and recommendations in this paper are designed to spur debates on how to better balance jobs with housing in the region. It is also intended to assist subregions and individual jurisdictions in the Southern California Association of Governments' (SCAG) region in their respective planning efforts to address the issue of jobs/housing balance. Of particular interest is the opportunity to seek planning funds under new appropriations from the California Department of Housing and Community Development (HCD). Assembly Bill 2864 (Torlakson) establishes the Jobs-Housing Balance Improvement Program that provides state funding ($110 million) to local governments for projects that will mitigate the imbalance of jobs and housing in communities throughout the state.

The paper's major findings include:

- A geographic balance between housing and jobs in a region confers many benefits, including reduced driving and congestion, fewer air emissions, lower costs to businesses and commuters, lower public expenditures on facilities and services, greater family stability, and higher quality of life.
- Jobs-rich areas are located primarily along the coast, in Los Angeles and Orange Counties.
- Housing-rich areas are located primarily in the Inland Empire and North Los Angeles County, which house many commuters working in jobs-rich areas.
- Jobs/housing ratios are forecast to increase in the western portion of the Inland Empire by 2025, but much of the Inland Empire and all of North Los Angeles County are forecast to remain housing rich.
- Based on current densities, Los Angeles and Orange Counties do not have enough raw, developable land to satisfy their forecast housing needs in 2025.
- There is an excess amount of vacant land in Los Angeles County that is zoned for commercial and industrial purposes relative to forecast housing needs in 2025.
- High-tech "New Economy" jobs and venture capital investments that have a strong tendency to cluster at culturally- and amenity-rich urban locations are powering the job growth in coastal areas.
- California taxation laws and fiscal policies act as disincentives to housing production by creating a bias among many financially strapped cities and counties toward sales tax-generating land uses. In addition, the State returns very little property tax revenues back to the cities.

The major recommendations include:

- Promote infill housing in Los Angeles County and Orange County. This would help house the forecast population, give employees the opportunity to live closer to work, and potentially reduce inter-county commutes.
- Promote wealth-generating, high paying, "New Economy" jobs in the Inland Empire. This would enable Inland Empire residents to find comparable work to the western regions and would shorten commutes of Inland Empire residents.

Proposed housing strategies include:

- Infill housing development
- Transit-oriented development and Location Efficient Mortgage
- Brownfields redevelopment into housing
- State and local finance reform
- Zoning revisions

Proposed jobs-creation strategies include:

- Investments in public education
- Development of high technology business parks and incubation centers
- Fiber optic cable investments
- Airport investment and promotion

EXECUTIVE SUMMARY

The continuing economic recovery of the SCAG Region has brought problems and challenges along with its economic benefits. Jobs are now plentiful, but housing is scarce and housing prices and rents have soared. Highway congestion has increased substantially and commute times have lengthened. Meeting strict air quality standards in the face of increased driving and congestion has become even more challenging. These problems largely result from a lack of new housing construction, especially near major job centers, and the inability of many workers to purchase the housing being produced.

Problems associated with inadequate and unaffordable housing in job-rich areas have become so pronounced throughout the state that they have galvanized the State Legislature to try to solve them. Assembly Bill 2864 (Torlakson) establishes the Jobs-Housing Balance Improvement Program that provides state funding to local governments for projects that will mitigate the imbalance of jobs and housing in local communities. This bill provides $110 million for projects and programs in housing-rich communities that will attract new businesses and jobs, and projects in jobs-rich communities that will increase the supply of housing. **A primary objective of this paper is to guide and assist local governments in the SCAG Region in applying for funds offered through AB 2864 by describing the relationship of employment to household growth in the region.**

An analysis of the current jobs/housing ratios in the SCAG region finds that jobs-rich areas are located primarily in Los Angeles and Orange Counties. Housing-rich areas are located on the periphery, primarily in the Inland Empire and northern Los Angeles County. Jobs/housing ratios are forecast to increase over the next 25 years in the western portion of the Inland Empire. Still, much of the Inland Empire and all of northern Los Angeles County are forecast to remain housing-rich in 2025.

Housing-rich areas, particularly in the Inland Empire, have seen substantial job growth over the last decade. This job growth is forecast to continue, which will result in increasing jobs/housing ratios for areas in the western portion of the Inland Empire. In fact, the Regional Statistical Area (RSA) around Ontario Airport is forecast to become very jobs-rich by the year 2025. Nevertheless, much of the job growth of the Inland Empire has been in relatively low-paying blue-collar sectors of the economy, and the gap in per capita income between it and the rest of the region has been increasing. The average wage of the job base of some areas in the Inland Empire is insufficient to purchase the average local house, and many local workers are forced to commute in from outlying areas where housing is less expensive.

The job growth of North Los Angeles County, another housing-rich area, has not been as robust as that of the Inland Empire. The new jobs created though have in general been higher paying, with the migration of white-collar professional jobs to Santa Clarita Valley and with the consolidation of the aerospace industry in the Antelope Valley. North Los Angeles County is forecast to remain housing rich in 2025. In fact, the Santa Clarita RSA is forecast to change from a balanced status to being housing-rich in 2025.

An analysis of land development needs for accommodating forecast housing shows that there is an insufficient amount of raw, developable land in Orange and Los Angeles counties to accommodate their forecast housing needs at current densities. Development strategies involving infill of currently vacant and underutilized lots, and developing at higher densities are necessary for these counties to meet their forecast housing needs and achieve the benefits of jobs/housing balance.

An analysis of the development capacity of 1993/1994 general plans and zoning shows that most counties have excess vacant land zoned for commercial and industrial uses, relative to existing land use ratios. From a jobs/housing standpoint, this could be justified in housing rich areas. However, this is contrary to achieving jobs/housing balance in jobs-rich counties like Los Angeles County where low-and moderate-income workers are having an increasingly difficult time finding affordable housing.

Historically, the geographic imbalance between jobs and housing in the SCAG Region has been a problem that has been largely self-correcting. Jobs have moved from their original centers to housing-rich suburbs to take advantage of lower land and labor costs and provide shorter commute trips for their employees. The end result is the multi-centered urban fabric that characterizes the region today. This phenomenon also explains why average home-to-work commute times in the region have remained relatively constant over the last several decades.

However, there are several emerging trends that threaten to exacerbate problems associated with jobs/housing imbalance. The high-tech and knowledge-based New Economy has been extremely important to the economic resurgence of the region. New Economy firms, particularly those dealing with Internet content, tend to be collaborative in nature and tend to concentrate in urban core locations. They are relatively insensitive to traditional land and labor cost factors and locate in areas with a wide variety of cultural amenities so that they can compete for the young, highly educated information workers that are keys to their success. When housing is limited around high-tech nodes, these affluent knowledge workers displace low and moderate-income groups in a process of gentrification. It is very difficult to disperse New Economy companies to housing-rich areas because of their tendency to coalesce and their high priority placed on locating in culturally rich urban environments. In the SCAG Region, high-tech clusters are located predominantly in coastal locations.

The other trend that runs counter to achieving jobs/housing balance is the "fiscalization of land use." State tax law has created competition among cities for sales tax-generating commercial uses of land. Because of limitations on property tax revenues, cities place lower priority on accommodating residential development, and higher priority on sales tax generating uses. This has greatly contributed to a trend of housing production lagging job growth and population increases. In combination with community apprehension over multifamily housing, a shortage of vacant land for housing in urban areas, and construction defect litigation problems, the fiscalization of land use makes it very difficult to implement strategies for promoting infill housing that is affordable to low and moderate-income workers. Many service and blue-collar workers, along with moderate-income white-collar workers employed in and around high-tech nodes, are consequently forced to commute long distances from areas where they can find affordable homes.

To help alleviate problems associated with jobs/housing imbalance, policy makers can look to both conventional and New Economy mechanisms to spur housing development in job-rich areas, and well-paying job creation in housing-rich areas. To encourage housing production, this paper presents the following strategies for policy makers:

- Alleviate roadblocks in building infill housing and in converting brownfield sites to housing
- Encourage transit-oriented development
- Reevaluate zoning policies and rewrite zoning ordinances to make more land available for housing construction
- Institute appropriate state and local finance reform that will help increase incentives for housing production by returning property taxes to local governments and reducing competition among jurisdictions for sales tax generating land uses.

New Economy jobs in the high-tech fields pay high salaries. To encourage the development and growth of these companies in housing-rich areas, this paper offers the following strategies to policy makers

- Target education and research toward new economy jobs through research parks
- Institute community–based job training programs to train and retrain workers for new economy jobs
- Promote and cultivate venture capital investment
- Sponsor business incubation programs
- Invest in telecommunications, specifically fiber optic investments
- Promote airport construction and development

High technology companies demand educated employees. This may require colleges and universities to redirect their training efforts, and primary and secondary schooling to better prepare their students before they get to college. High technology companies also need access to venture capital investments and a place to grow. University-affiliated research parks and other incubation centers offer places to develop new high-tech businesses. Public investments in fiber optic cable can make areas more attractive to New Economy firms. High technology firms require reliable air travel, both commercial and air cargo, to move their employees and their products quickly throughout the world. Developing and expanding airports in outlying areas can help spread New Economy companies across the region.

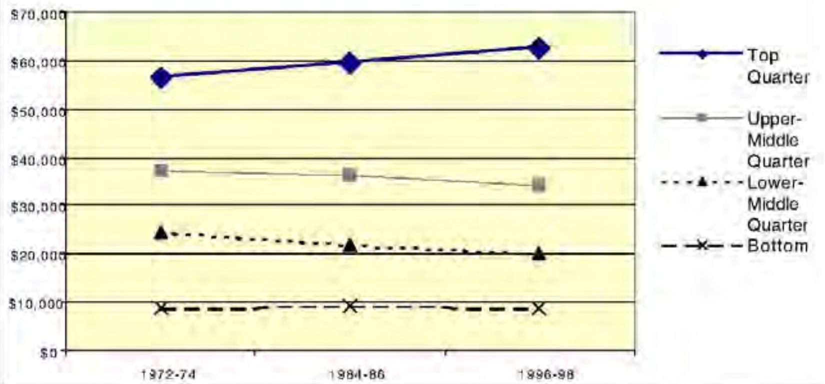
Old economy jobs are expanding into the Inland Empire. Whether or not people living there will work in these jobs or continue to commute to jobs closer to the coast remains to be seen. New Economy jobs are beginning to move inland, but this change will take time to have a substantial impact. Meanwhile, the housing crisis is worsening.

There needs to be a two-pronged approach to addressing regional jobs/housing imbalance. Affordable housing is in desperate demand in northern Orange County and southern Los Angeles County. High paying jobs are needed particularly in the Inland Empire and other outlying areas where higher incomes are needed for workers to purchase the housing that is being constructed. Using a variety of conventional and innovative new strategies, policy makers can begin to address problems associated with regional jobs/housing imbalance.

I. INTRODUCTION

The issue of the geographic balance between the location of jobs and housing in a region has attracted considerable attention in California. Since 1972, the median annual earnings of the top quartile in the SCAG region have surged upward, while the median annual earnings of the two middle quartile groups decreased with the expanding economy and population (Figure 1). Housing prices in the jobs-rich coastal areas have soared, forcing many of the bottom 75% of the region's earners to search for affordable housing in outlying areas such as northern Los Angeles County and the Inland Empire. Residents of the region not only have to contend with mounting traffic congestion and commute times, but they find it increasingly difficult to find affordable housing in proximity to their employment. This problem has become particularly acute in the San Francisco Bay Area, but afflicts the SCAG Region as well.

Figure 1: Estimated Median Annual Earnings by Quartile Groups (1998 Dollars)



Source: Ong 2000.

The purpose of this paper is to provide a brief overview of the causes and impacts of the job/housing balance problem, and to document the extent of the problem in the SCAG Region. It also recommends potential strategies that can be applied on both regional and local levels to help bring the future production of jobs and housing into greater balance among all subregions. Further research is needed to determine which of the recommended strategies may be most appropriate for different cities and subregions within the SCAG region.

A distinct focus of the paper is an examination of the high-tech New Economy and its impacts on jobs/housing patterns in the region, and strategies that can spread the benefits of the New Economy to areas in the region with high housing availability but relatively little high-tech employment. Subregions may use this paper as a guide as they apply for funds from HCD to address the jobs/housing imbalance in their subregion.

The data used in the analyses in this report are from SCAG's Draft 2001 Regional Transportation Plan (RTP). These numbers are displayed in Table 1. Two of these analyses use Regional Statistical Areas (RSAs) as the unit of measurement for the analysis. Table 2 lists the RSAs located within each subregion. The federal government devised the RSAs for the 1960 census to reflect economic development areas. Counties influenced their configuration as the RSAs were based on countywide planning areas. The boundaries were drawn coterminous with census tract boundaries without splitting them. The RSAs are used in report summary preparation and have become a common statistical reporting configuration. The boundaries have remained the same because there has been a strong desire to have continuity in the geographic frame of reference. The consistent boundaries allow planners to keep comparisons with historic data.

Table 1

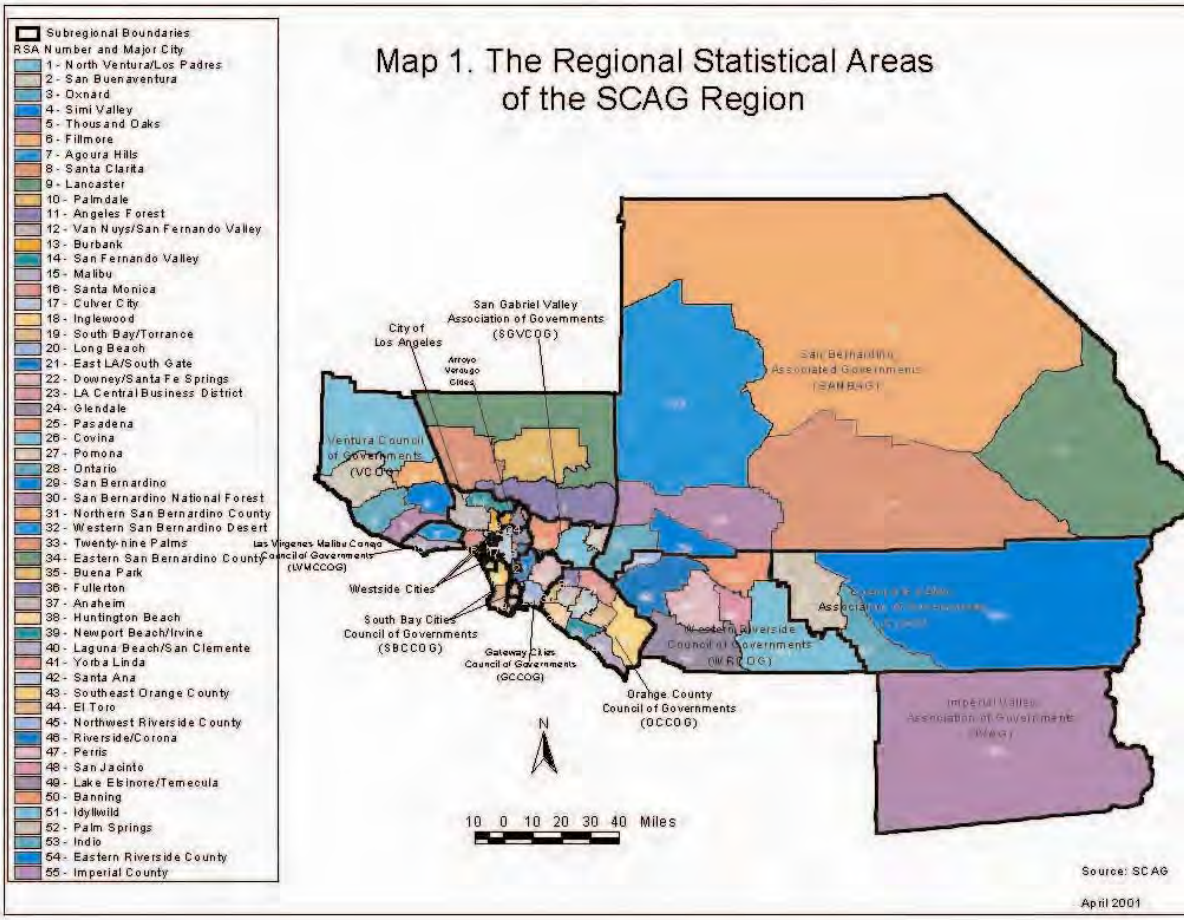
Population, Households, and Employment for the SCAG Region, 1997 Base Year and 2025 Projections, as Used in the Draft 2001 RTP

Subregion	Population 1997	Population 2025	Households 1997	Households 2025	Employment 1997	Employment 2025
Imperial Valley Association of Governments	141,596	317,733	38,384	97,883	55,572	94,064
Arroyo Verdugo Cities	391,556	480,849	142,004	180,071	180,717	268,172
Gateway Cities Council of Governments	1,982,922	2,308,667	570,714	641,168	784,127	987,956
Las Virgenes Malibu Conejo Council of Governmen	77,244	98,123	27,127	36,855	39,524	45,150
City of Los Angeles	3,733,427	4,876,537	1,251,722	1,769,462	1,700,941	2,060,085
North Los Angeles County	502,409	1,268,768	153,943	444,731	136,472	304,163
San Gabriel Valley Council of Governments	1,763,554	2,141,654	519,104	606,177	689,846	845,524
South Bay Cities Council of Governments	852,829	915,002	294,034	319,219	404,512	510,526
Westside Cities	233,170	248,865	112,064	121,088	222,536	269,335
Orange County Council of Governments	2,699,911	3,416,034	887,888	1,068,049	1,341,203	2,043,665
Coachella Valley Association of Governments	329,134	600,708	113,749	212,470	119,194	205,741
Western Riverside Council of Governments	1,090,132	2,232,981	349,078	721,423	311,622	800,676
San Bernardino Associated Governments	1,613,419	2,786,936	508,551	880,965	510,695	1,085,706
Ventura Council of Governments	725,914	951,080	232,831	309,209	290,779	431,501
Subregion	**16,137,217**	**22,643,937**	**5,201,193**	**7,408,770**	**6,787,740**	**9,952,264**
Source: SCAG Draft 2001 RTP						

Table 2

Regional Statistical Areas within Each Subregion

Subregion	RSAs within Each Subregion
Imperial Valley Association of Governments	55
Arroyo Verdugo Cities	13, 24, 25
Gateway Cities Council of Governments	19, 20, 21, 22
Las Virgenes Malibu Conejo Council of Governments	7, 15
City of Los Angeles	12, 13, 14, 16, 17, 18, 19, 21, 23
North Los Angeles County	8, 9, 10, 11
San Gabriel Valley Council of Governments	11, 21, 25, 26, 27
South Bay Cities Council of Governments	18, 19, 21
Westside Cities	16, 17
Orange County Council of Governments	35, 36, 37, 38, 39, 40, 41, 42, 43, 44
Coachella Valley Association of Governments	52, 53, 54
Western Riverside Council of Governments	45, 46, 47, 48, 49, 50, 51
San Bernardino Associated Governments	28, 29, 30, 31, 32, 33, 34
Ventura Council of Governments	1, 2, 3, 4, 5, 6
Source: SCAG	


Map 1. The Regional Statistical Areas of the SCAG Region
Subregional Boundaries
RSA Number and Major City
1 - North Ventura/Los Padres
2 - San Buenaventura
3 - Oxnard
4 - Simi Valley
5 - Thousand Oaks
6 - Fillmore
7 - Agoura Hills
8 - Santa Clarita
9 - Lancaster
10 - Palmdale
11 - Angeles Forest
12 - Van Nuys/San Fernando Valley
13 - Burbank
14 - San Fernando Valley
15 - Malibu
16 - Santa Monica
17 - Culver City
18 - Inglewood
19 - South Bay/Torrance
20 - Long Beach
21 - East LA/South Gate
22 - Downey/Santa Fe Springs
23 - LA Central Business District
24 - Glendale
25 - Pasadena
26 - Covina
27 - Pomona
28 - Ontario
29 - San Bernardino
30 - San Bernardino National Forest
31 - Northern San Bernardino County
32 - Western San Bernardino Desert
33 - Twenty-nine Palms
34 - Eastern San Bernardino County
35 - Buena Park
36 - Fullerton
37 - Anaheim
38 - Huntington Beach
39 - Newport Beach/Irvine
40 - Laguna Beach/San Clemente
41 - Yorba Linda
42 - Santa Ana
43 - Southeast Orange County
44 - El Toro
45 - Northwest Riverside County
46 - Riverside/Corona
47 - Perris
48 - San Jacinto
49 - Lake Elsinore/Temecula
50 - Banning
51 - Idyllwild
52 - Palm Springs
53 - Indio
54 - Eastern Riverside County
55 - Imperial County
San Gabriel Valley Association of Governments (SGVCOG)
City of Los Angeles
Arroyo Verdugo Cities
San Bernardino Associated Governments (SANBAG)
Ventura Council of Governments (VCOG)
Las Virgenes Malibu Conejo Council of Governments (LVMCCOG)
Westside Cities
South Bay Cities Council of Governments (SBCCOG)
Gateway Cities Council of Governments (GCCOG)
Western Riverside Council of Governments (WRCOG)
Orange County Council of Governments (OCCOG)
Imperial Valley Association of Governments
N
10 0 10 20 30 40 Miles
Source: SCAG
April 2001

In this report, we are using these geographies because they help paint a clearer picture of future trends while keeping the historical perspective of past analyses. Table 2 displays the RSAs located within each subregion. Table 3, located in the appendix, lists the cities within each RSA. Map 1 portrays the location of each RSA. Recognizing that the RSA boundaries include jobs-rich cities with housing-rich cities, a summary of current (1997 base year) population, employment, and households is included in the Appendix as Table 4.

II. DEFINITION OF JOBS/HOUSING BALANCE

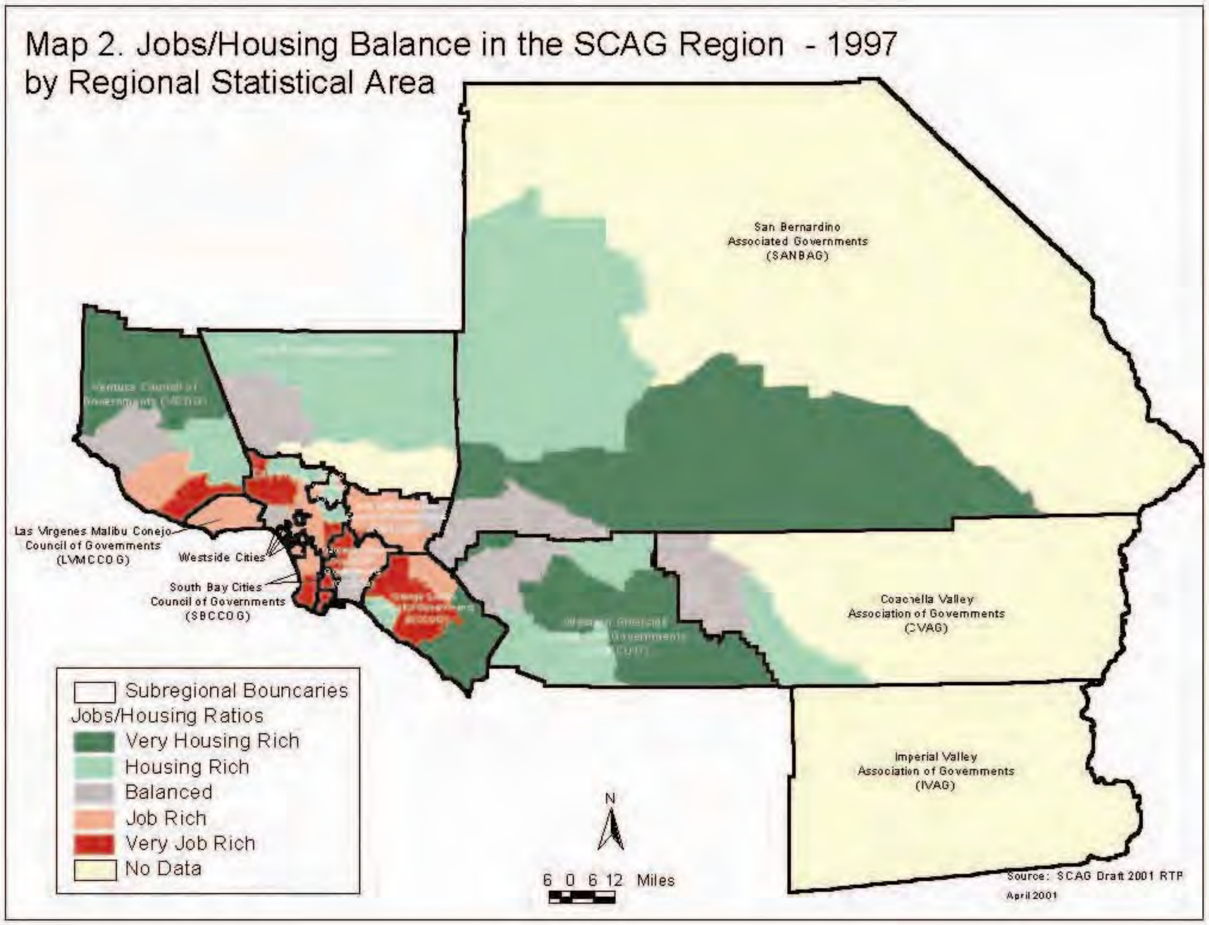
Defining what constitutes a balance between jobs and housing is not an easy task. Assuming a simple ratio of to one job to one household is inappropriate to modern economies that have many households with more than one person in the workforce. Another definition states "balance occurs when both the quality and the quantity of housing opportunities match the job opportunities within an area" (California Planning Roundtable 1988, 16).

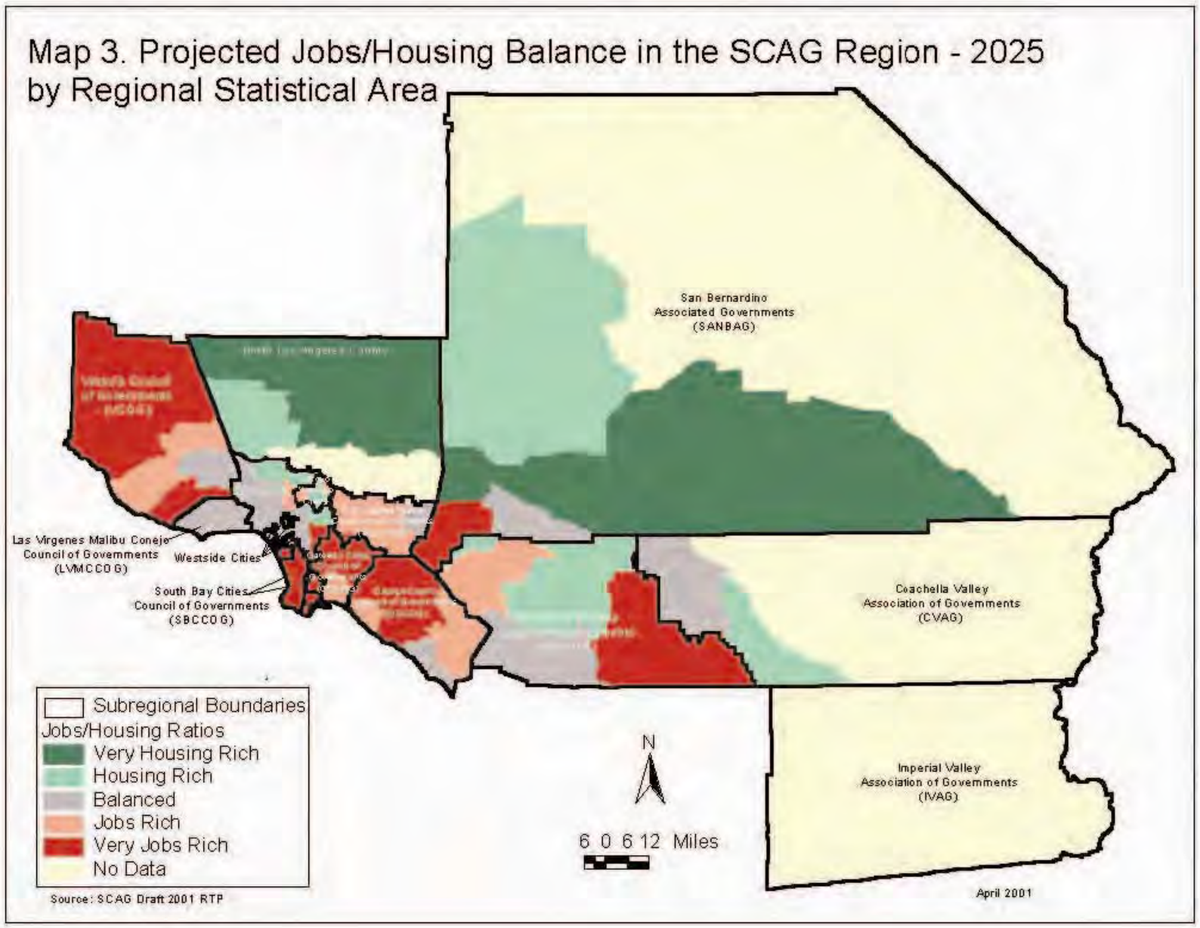
In this paper, a balance between jobs and housing in a metropolitan region can be defined as a provision of an adequate supply of housing to house workers employed in a defined area (i.e., community or subregion). Alternatively, a jobs/housing balance can be defined as an adequate provision of employment in a defined area that generates enough local workers to fill the housing supply. The definition of an area can be stated in terms of an optimal "commute shed" around employment centers that conforms to expressed commuter preferences about home-to-work commute distances. According to a 1990 survey of public opinions about jobs/housing balance and urban form, the expressed ideal commute time (one way) for workers in the region is 14 minutes (Southern California Association of Governments (SCAG) 1990). The average time people said it actually took them to travel from home to work in 1990, at the beginning of a major recession, was 24 minutes. There was very little support for commute times over 30 minutes. According to data collected in 1999, the average commute speed in the region was 28.4 mph (SCAG 1999). For a maximum commute of 30 minutes, this translates to commute sheds having radii of about 14 miles around employment centers.

The current (1997) regional average ratio of jobs to households is 1.25 jobs per household (a household is defined as an occupied housing unit). Therefore, jobs/housing balance for this region can be defined as an area extending about 14 miles around an employment center with a ratio between jobs and household on the order of 1.0-1.29 jobs per household. This ratio is the current (1997) range of jobs/housing ratios for the middle 20% of the SCAG region. Job centers vary by size and are not evenly dispersed throughout the region, and congestion and average commute times also vary by location (and will change in the future). However the area or "commute shed" is defined, if it has a jobs to household ratio that significantly differs from the 1.0 to 1.29 standard, than it can be considered out of balance.

Maps 2 and 3 display current and forecast jobs/housing ratios by the 55 regional statistical areas (RSAs) in the region. They show that in general, jobs-rich areas currently (1997) are located in the highly urbanized areas in the western portion of the region, primarily in southern and western Los Angeles County, and in central and northern Orange County. Housing-rich areas are in the suburban eastern and northern portions of the region. By 2025, it is forecast that both job and housing growth will spread outwardly, tilting some housing-rich or balanced areas around jobs-rich areas towards being more jobs-rich, and tilting areas on the very northern and eastern peripheries of the region towards being even more housing-rich. A more detailed discussion of this analysis can be found in Section IV.

The impacts on commuting resulting from these regional imbalances between jobs and housing are shown in Tables 5 and 6. Table 5 displays the percentage of workers from each county in the


Map 2. Jobs/Housing Balance in the SCAG Region - 1997
by Regional Statistical Area
San Bernardino
Associated Governments
(SANBAG)
Las Virgenes Malibu Conejo
Council of Governments
(LVMCCOG)
Westside Cities
South Bay Cities
Council of Governments
(SBCCOG)
Coachella Valley
Association of Governments
(CVAG)
Imperial Valley
Association of Governments
(IVAG)
Subregional Bouncaries
Jobs/Housing Ratios
Very Housing Rich
Housing Rich
Balanced
Job Rich
Very Job Rich
No Data
N
6 0 6 12 Miles
Source: SCAG Draft 2001 RTP
April 2001


Map 3. Projected Jobs/Housing Balance in the SCAG Region - 2025
by Regional Statistical Area
San Bernardino Associated Governments (SANBAG)
Las Virgenes Malibu Conejo Council of Governments (LVMCCOG)
Westside Cities
South Bay Cities Council of Governments (SBCCOG)
Coachella Valley Association of Governments (CVAG)
Imperial Valley Association of Governments (IVAG)
Subregional Boundaries
Jobs/Housing Ratios
Very Housing Rich
Housing Rich
Balanced
Jobs Rich
Very Jobs Rich
No Data
N
6 0 6 12 Miles
Source: SCAG Draft 2001 RTP
April 2001

region who work in counties that are different from the county in which they live. It shows that the most housing-rich counties, San Bernardino and Riverside, have the lowest percentage of workers who both live and work in the county – 68%. Table 6 shows home-to-work commute distances by county of trip origination as of 1999. Again, the most housing-rich counties house workers that have the longest commute distances – over twenty-one miles. Given an average current commute speed of 28.4 miles per hour, this translates to an average one-way commute time of about forty-five minutes.

Table 5

Home Based Work Person Trip Distribution

From/To	Los Angeles	Orange	Riverside	San Bernardino	Ventura	Total Productions
Los Angeles	4,576,759	219,753	4,432	42,001	37,474	4,880,419
	93.78%	4.50%	0.09%	0.86%	0.77%	100.00%
Orange	389,168	1,308,649	10,345	12,064	8	1,720,234
	22.63%	76.07%	0.60%	0.70%	0.00%	100.00%
Riverside	51,283	68,904	436,945	99,607	32	656,771
	7.81%	10.49%	66.53%	15.17%	0.00%	100.00%
San Bernardino	154,214	44,685	76,664	519,774	175	795,512
	19.39%	5.62%	9.64%	65.34%	0.02%	100.00%
Ventura	109,597	245	0	90	317,391	427,323
	25.66%	0.06%	0.00%	0.02%	74.26%	100.00%
Total Attractions	5,281,221	1,645,236	528,389	673,536	354,880	8,480,259
	62.28%	19.37%	6.23%	7.94%	4.18%	100.00%

Table 6

Average Home to Work Commute Distance (By County), 1999

County	Miles
Riverside	21.6
San Bernardino	21.3
Ventura	16.3
Orange	16.1
Los Angeles	14.9
Imperial	14.5

Source: SCAG State of the Commute Report, 1999

III. BENEFITS OF JOBS/HOUSING BALANCE

Achieving an ideal geographic relationship between the provision of jobs and housing in local communities can produce a myriad of measurable and perceived benefits for the region as a whole. These would include:

A. Reduced Congestion and Commute Times

The opportunity to live close to the workplace afforded by providing housing close to well paying jobs translates to lower congestion and commute times by eliminating the necessity for long-distance commutes. It also provides increase opportunities to use transit, bike, or walk to work in lieu of driving. Of course, placing housing in close proximity to employment is no guarantee that those who live in the housing will work at the nearby jobs, or vice versa. This would be particularly true for two income households who split the difference between the locations of their two employment destinations in choosing where to live. It does, however, eliminate barriers for those who wish to live close to work, and reduce the need for long-distance commuting and the congestion it contributes to the regional highway system. In SCAG's 1990 survey of attitudes about job/housing balance, 44% of respondents wished that their home and their workplace were closer together.

B. Air Quality Benefits

As the need for driving long distances is reduced by greater jobs/housing balance, so are the emissions associated with driving that impairs the attainment of clean air. SCAG's 1989 *Regional Growth Management Plan* evaluated a regional jobs/housing strategy that assumed the redistribution of 9% of the region's forecast employment growth to the year 2010 from jobs-rich to job-poor areas, and 5% of the forecast housing growth from housing-rich to housing-poor areas. This strategy was estimated to reduce regional vehicle-miles-traveled (VMT) by 33.4 million miles (8.5%), vehicle-hours-traveled (VHT) by 7.2 million hours (37%) and reactive organic gases (ROG) by 45.5 tons. This jobs/housing strategy alone achieved 33% of all ROG reductions targeted to be accomplished by all transportation, land use and energy conservation measures.

C. Economic and Fiscal Benefits

Since the successful implementation of job/housing balance strategies result in less need for long-distance commuting and associated congestion, fewer public resources would be required for congestion mitigation improvements to the regional transportation system. Also, the reduced hours spent in long-distance travel by commuters translates to lower fuel costs and other automobile-related expenses, lower costs to employers in terms of reduced employee tardiness and higher productivity, and lower business trip costs. Further, since jobs/housing balance implies a more compact urban form with less suburban sprawl, the cost to local government of providing new facilities and services to new development is less since those facilities and services can be provided more efficiently.

D. Quality of Life Benefits

All of the benefits of achieving greater jobs/housing balance cited above will confer a higher quality of life for residents in the region. Quality of life benefits include cleaner air, reduced stress in commuting, and more leisure time. Families can be negatively impacted when its members are under the stress and strain of long commutes. The family in which both parents work is becoming the norm; longer commutes take time away from home and family members, result in higher child care expenses and reduce leisure and recreation time. The added financial and emotional pressures on the family can cause tension between family members. Increased job/housing balance can therefore contribute to greater family stability and cohesion.

A good geographic balance between jobs and housing also implies a more diverse, compact, and convenient urban form, without the strict segregation of land uses found in many suburban areas. Quality of life is maximized for all population groups where available housing types are well matched with the wage stratification of local employment. In general, people associate diverse urban settings that are affordable and accessible to a broad range of people with cultural richness. They have increasingly negative attitudes about working and living in environments that are uniformly homogenous and lack opportunities for a variety of experiences. As discussed in section V of this report, employees of high-tech New Economy firms are particularly attracted to culturally diverse urban environments. Paradoxically, however, the dominating impact of New Economy firms on cities that they favor can diminish the cultural diversity of those cities, and create severe problems associated with jobs/housing balance.

Transit Mode Share Trends Looking Steady; Rail Appears to Encourage Non-Automobile Commutes

Yonah Freemark
October 13th, 2010 | **44 Comments**

» Results of the 2009 American Community Survey show major declines in carpooling, significant increases in biking.

Just how effective have new investments in transit been in promoting a shift of Americans towards public transportation? Has the recent livable communities movement resulted in increased commuting by bike or by foot?

The Census' **American Community Survey**, released at the end of last month with the most recent 2009 data, provides a glimpse of what can change over nine years. These data are approximations in advance of the much bigger (and more accurate) sample set that is Census 2010, whose results will be released next year. The information detailed here applies to commutes *only*, not all trips.

By looking at America's 30 largest cities — from New York to Portland — we can get some idea of how people are choosing to get to work, and how patterns are changing based on the availability of alternative transportation modes. I have chosen *not* to analyze metropolitan regions as a whole because I want to focus on the effects of improvements to transit systems and increasing walkability, two characteristics common to center cities but not necessarily to their suburbs. This biases the information, especially for places like Washington or Boston, where the central city represents a relatively small percentage of the overall regional population.

Nevertheless, the data demonstrate a number of interesting trends. Most notable are the huge declines in carpooling and large increases in biking noted over the largest cities. As the chart below shows, over the past nine years, carpooling's mode share decreased *on average* by 25.9% and biking's share increased by 58.5% (note that these are percent changes, not point changes, which are documented in a chart at the bottom of this article). The declines in carpooling were matched with a slight uptick in single-person driving, a 1.5% increase, and a decrease in transit share of 6.4%. These mode shares are not the same as total modal use; it is possible for transit ridership to increase even as modal share goes down (for instance, if city population increases), and vice-verse.

% Change in Mode Share, 2000-2009, Averaged Across America's Biggest Cities

	Total Auto	Total Non-Auto	Driving Alone	Carpooling	Transit	Biking	Walking
All Cities	-3.4	-2.0	1.5	-25.9	-6.4	58.5	1.8
Cities with no rail	-1.4	-6.3	2.9	-23.9	-8.0	40.3	-2.7
Cities with rail, but no major new rail investment	-5.0	1.1	1.5	-29.0	-2.6	156.3	1.7
Cities with major new rail investments	-4.9	1.5	0.2	-26.7	-4.3	56.7	4.2
Non-Texas Cities with major new rail investments	-5.9	5.4	-0.1	-26.1	0.0	66.9	4.5

Overall, the percentage of people commuting by automobile declined by 3.4%, and the mode share of those using non-automobile modes decreased by 2.0%. It was possible for both to decline because of an increase in people not *traveling* to work at all but telecommuting.

Though these numbers show little change in use for automobile and transit overall, they do provide some clue as to the effects of rail investments. When comparing cities that have no rail lines with those that have existing lines or have invested in new ones, a correlation between rail and transit use is apparent. Cities with no rail saw far smaller declines in automobile mode shares than their rail counterparts; they also saw declining non-automobile mode shares, compared to increases in the rail cities. These differences were especially considerable when considering rail cities outside of Texas; excluding them, transit saw no mode share change, whereas single-person commuting by car decreased (albeit by a minuscule amount).

This may indicate that rail lines can play an important role in encouraging the population to try modes other than the automobile. The non-automobile mode share, which includes transit, biking, and walking, is particularly interesting from this perspective because it may reflect the number of people choosing to live in areas where it is acceptable to use transportation other than the private car. Is this conclusive evidence that rail works better than bus service to encourage people out of their cars? Not necessarily, but it's certainly a part of the overall equation.

Looking city-by-city, modal share changes reflect some overall trends. Automobile usage continues to decrease in the nation's older, densely developed cities: The places recording the largest declines in overall car share were, in order, Washington, New York, Boston, San Francisco, Seattle, Portland, and Chicago. Those with the largest declines in non-automobile share were largely sprawling cities, including, in order, Columbus, Houston, Dallas, Fort Worth, Las Vegas, and Nashville.

% Change in Mode Share, 2000-2009 in America's Biggest Cities

	Total Auto	Total Non-Auto	Driving alone	Carpooling	Transit	Biking	Walking
Austin	-5.1	4.5	-1.2	-25.2	12.0	11.9	-11.4
Baltimore	0.5	-6.6	11.0	-37.1	-12.7	200.6	0.7
Boston	-11.9	9.7	-10.0	-16.4	6.9	117.7	8.4
Charlotte	-5.7	24.3	-1.6	16.2	8.5	3.6	59.4
Chicago	-6.0	4.1	1.4	-31.5	1.6	129.2	4.7
Columbus	0.3	-24.0	4.3	-29.1	39.7	107.3	-18.8
Dallas	0.6	-20.8	10.6	-40.0	28.1	9.3	-2.3
Denver	-2.4	-3.2	1.7	-23.3	-7.5	89.8	-15.5
Detroit	-3.3	7.0	4.1	-33.1	12.0	392.4	58.4
El Paso	-2.4	14.4	4.3	-35.0	2.5	47.6	26.5
Fort Worth	1.5	-16.4	4.7	-29.9	1.5	-18.2	-31.5
Houston	0.7	-23.5	5.3	19.6	33.0	-17.9	-0.4
Indianapolis	-0.3	-2.6	3.0	-21.8	-17.1	129.1	1.1
Jacksonville	1.1	-11.3	0.4	-10.4	16.5	-4.1	-4.7
Las Vegas	-0.1	-15.7	5.5	-27.5	-28.5	-10.7	16.7
Los Angeles	-3.6	9.2	2.0	-28.7	10.7	63.8	-4.3
Memphis	1.5	7.9	2.7	-22.2	7.6	78.7	-4.0
Milwaukee	0.9	-10.1	2.4	-7.2	-18.1	90.3	0.4
Nashville	1.3	-15.6	2.6	-24.9	21.7	-23.3	-39.5
New York	-12.6	5.3	-6.6	-34.3	4.0	28.6	-1.1
Philadelphia	-3.5	1.2	4.3	-33.5	2.1	150.7	-4.0
Phoenix	1.2	-3.5	3.9	-22.3	1.4	4.6	9.0
Portland	-7.2	18.6	-3.3	-28.1	6.4	230.0	6.3
San Antonio	-0.6	-9.9	4.2	-24.6	12.0	11.7	-6.2
San Diego	-1.5	-15.2	3.5	-31.4	-12.4	14.6	-19.6
San Francisco	-9.6	6.2	-3.9	-31.0	2.0	50.3	10.5
San Jose	-2.1	2.1	0.0	-13.3	21.3	43.1	32.8
Seattle	-7.7	12.5	-6.5	-14.1	10.9	59.0	4.4
Washington	-12.7	9.3	-5.1	-39.3	12.0	86.2	5.9

The places recording the largest increases in transit modal share were Nashville, Washington, Austin, Seattle, Los Angeles, Charlotte, and Boston. All but Austin, Boston, and Nashville have spent hundreds of millions of dollars investing in expanded rail transit systems; Boston already has a large one. Portland, unsurprisingly because of its municipal investment decisions, had the largest modal increase in bike usage, but other cities less known for biking like Baltimore, Detroit, Philadelphia, and Chicago also saw significant increases as well.

How can we explain the significant public transportation mode share declines in Houston and Dallas, two cities that invested considerably in their respective rail transit systems? Both saw increases in ridership of their transit systems between **2000** and **2008**: Houston saw a 1.05% increase, Dallas a 11.7% jump. Those increases, however, were **entirely lost by 2010**, which has been a terrible year for transit in the two cities. At the same time, their city populations increased by 15.7% and 9.3%, respectively; transit improvements couldn't keep up. This may be because of poor choices in public transportation investments or de-densification in the urban cores of these cities (or annexation, spreading the population out), but either way these are not model cities for transit investments.

I'll conclude with the below table, which documents mode share in 2009 in the biggest cities of the United States. As the chart shows, automobiles have a majority share in all cities except New York, Boston, Washington, and San Francisco. Unsurprisingly, these are dense cities and the places in the United States with the most complete transit systems.

2009 Mode Share in America's Biggest Cities

	Total workers	Total Auto	Total Non-Auto	Driving Alone	Carpooling	Transit	Biking	Walking
Austin	428979	83.1	8.3	72.7	10.4	5.0	1.0	2.3
Baltimore	267185	70.3	25.2	60.7	9.6	17.0	1.0	7.2
Boston	336393	44.7	50.6	37.0	7.7	34.5	2.1	14.1
Charlotte	348693	87.8	6.0	76.6	11.2	3.5	0.2	2.4
Chicago	1271744	60.7	33.6	50.8	9.9	26.5	1.1	5.9
Columbus	379681	90.0	5.7	82.4	7.6	2.4	0.7	2.6
Dallas	599034	89.1	6.0	76.5	10.7	3.9	0.1	1.9
Denver	307556	79.8	13.3	69.4	10.4	7.8	1.8	3.7
Detroit	262217	82.8	12.5	71.4	11.4	7.6	0.5	4.5
El Paso	255975	90.1	5.0	79.8	10.3	2.4	0.2	2.5
Fort Worth	331894	92.3	2.8	80.6	11.7	1.5	0.1	1.2
Houston	1058450	88.4	6.6	75.6	12.8	3.9	0.4	2.3
Indianapolis	364749	92.0	4.5	82.4	9.6	2.0	0.5	2.0
Jacksonville	370090	91.6	3.9	79.6	12.0	1.7	0.4	1.7
Las Vegas	245695	88.8	6.3	77.9	10.9	3.4	0.3	2.6
Los Angeles	1749419	77.6	15.7	67.1	10.6	11.3	1.0	3.4
Louisville	256223	89.1	6.8	79.2	9.9	4.1	0.5	2.1
Memphis	271801	90.9	4.6	78.7	12.2	2.8	0.0	1.9
Milwaukee	264010	83.1	13.8	70.4	12.6	8.4	0.6	4.7
Nashville	298121	90.8	3.7	80.6	10.1	2.2	0.1	1.4
New York	3731917	28.7	65.8	23.5	5.3	54.9	0.6	10.3
Philadelphia	616150	59.8	35.6	51.3	6.5	24.9	2.2	8.7
Phoenix	686643	88.0	6.1	74.5	13.5	3.2	0.9	2.0
Portland	289700	70.1	22.9	61.6	8.5	11.5	5.8	5.6
San Antonio	606446	90.3	5.5	78.8	11.5	3.3	0.1	2.0
San Diego	626126	84.9	7.4	76.5	8.4	3.7	0.8	2.9
San Francisco	437073	46.4	45.1	38.9	7.4	31.8	3.0	10.3
San Jose	442980	88.5	6.0	76.4	12.2	3.2	0.8	1.9
Seattle	354740	62.5	30.2	52.9	9.6	19.5	3.0	7.7
Washington	291083	43.1	50.4	36.5	6.7	37.1	2.2	11.1

Louisville, the nation's 29th-largest city, is not included here because it merged with the surrounding county, significantly changing demographics, in 2003. I have calculated "averages" not in terms of total trips, but city-by-city; thus modal share in Portland is considered just as important as that in New York, despite the latter being much bigger. Note city classification in *the first table based on changes during the 2000-2009 period:*

- ***No Rail**: Austin, Columbus, Detroit, El Paso, Fort Worth, Indianapolis, Jacksonville, Las Vegas, Memphis*, Milwaukee, Nashville*, San Antonio.*
- ***No new significant rail investments**: Baltimore, Boston, Philadelphia*.*
- ***New significant rail investments**: Charlotte, Chicago, Dallas, Denver, Houston, Los Angeles, New York, Phoenix, Portland, San Diego, San Francisco, San Jose, Seattle, Washington.*

* The minimal nature of Nashville's Music City Star means I won't include it as a "significant" rail investment here. Nor will I include streetcar projects in such cities as Memphis and Philadelphia.

Update: Mode Share Changes 2000-2009 by Point Change
(One Point = 1% of All Commuting Trips)

	Total Auto	Total Non Auto	Driving alone	Carpooling	Transit	Biking	Walking
Austin	-4.42	0.35	-0.81	-3.51	0.54	0.17	-0.39
Baltimore	0.35	-1.76	6.03	-5.65	-2.48	0.66	0.05
Boston	-6.03	4.48	-4.52	-1.52	2.24	1.14	1.09
Charlotte	-5.36	1.16	-1.21	-2.16	0.27	0.01	0.90
Chicago	-3.88	1.33	0.66	-4.56	0.42	0.65	0.27
Columbus	0.30	-1.79	3.42	-3.13	1.56	0.36	-0.59
Dallas	0.55	-1.57	7.66	-7.11	1.53	0.01	-0.04
Denver	-1.99	-0.45	1.16	-3.15	-0.62	0.85	-0.67
Detroit	-2.83	0.91	2.62	-5.65	-1.04	0.31	1.64
El Paso	-2.24	0.63	3.29	-5.53	0.06	0.06	0.52
Fort Worth	-1.36	-0.54	3.60	-4.96	0.02	-0.02	-0.54
Houston	0.64	-2.03	3.80	-3.16	-1.94	-0.08	-0.01
Indianapolis	-0.28	-0.12	2.40	-2.69	-0.41	0.27	0.07
Jacksonville	-1.05	-0.48	0.34	-1.39	-0.36	-0.02	-0.06
Las Vegas	-0.07	-1.00	4.07	-4.14	-1.36	-0.04	0.40
Los Angeles	-2.92	1.32	1.31	-4.23	1.09	0.39	-0.15
Memphis	1.42	-0.40	2.06	-3.49	0.23	-0.09	-0.03
Milwaukee	0.70	-1.54	1.68	-0.97	-1.86	0.30	0.02
Nashville	1.17	-0.56	2.18	-3.35	0.39	-0.03	-0.94
New York	-4.13	2.11	-1.39	-2.74	2.08	0.14	-0.12
Philadelphia	-2.20	0.41	2.10	-4.30	-0.52	1.30	-0.36
Phoenix	-1.07	-0.22	2.81	-3.88	-0.05	0.04	-0.21
Portland	-5.43	3.59	-2.09	-3.34	-0.79	4.05	0.33
San Antonio	-0.54	-0.61	3.19	-3.74	0.46	-0.02	-0.13
San Diego	-1.27	-1.13	2.56	-3.83	0.52	0.11	-0.72
San Francisco	-4.91	2.62	-1.57	-3.34	0.64	1.00	0.96
San Jose	-1.90	-0.13	-0.04	-1.87	0.87	0.27	0.47
Seattle	-5.24	3.54	-3.66	-1.58	1.91	1.11	0.32
Washington	-6.25	4.27	-1.94	-4.31	3.96	1.00	-0.69

Mode Share in Nation's Largest Metropolitan Areas – 2009

Metro Area (MSA)	Total Workers	Driving Alone	Carpooling	Transit	Biking	Walking
Atlanta	2520867	77.21	10.55	3.66	0.20	1.41
Baltimore	1322360	76.78	9.16	6.21	0.33	2.85
Boston	2316315	68.52	8.03	12.24	1.03	5.12
Chicago	4411503	70.92	8.79	11.48	0.57	3.17
Cincinnati	1016920	81.11	8.84	2.42	0.16	3.16

Metro Area (MSA)	Total Workers	Driving Alone	Carpooling	Transit	Biking	Walking
Cleveland	935744	81.50	8.16	3.79	0.22	2.25
Dallas	3042460	81.24	10.32	1.53	0.13	1.40
Denver	1277368	75.60	9.46	4.64	0.72	2.15
Detroit	1786498	84.02	8.56	1.62	0.32	1.65
Houston	2708967	78.78	12.06	2.24	0.27	1.55
Kansas City	1003553	82.47	8.88	1.23	0.21	1.48
Las Vegas	874449	79.47	10.33	3.18	0.34	1.78
Los Angeles	5806655	73.62	10.80	6.20	0.86	2.63
Miami	2446844	77.71	10.43	3.51	0.61	1.77
Minneapolis	1688996	78.12	8.80	4.67	0.86	2.26
New York	8765356	50.39	7.02	30.50	0.40	6.28
Orlando	938873	80.75	9.03	1.85	0.45	0.97
Philadelphia	2769040	73.65	7.92	9.28	0.73	3.75
Phoenix	1893856	76.17	11.98	2.26	0.91	1.80
Pittsburgh	1090107	77.05	9.37	5.77	0.24	3.71
Portland	1050429	71.63	9.89	6.08	2.13	3.17
Riverside	1627806	74.53	15.56	1.78	0.27	2.03
Sacramento	916946	75.78	11.55	2.69	1.62	1.84
St. Louis	1328691	82.25	8.95	2.55	0.30	1.64
San Antonio	919348	79.35	11.40	2.32	0.18	2.02
San Diego	1406411	75.80	9.87	3.08	0.62	2.80
San Francisco	2083775	61.86	10.19	14.59	1.54	4.40
Seattle	1702972	69.54	11.05	8.69	0.92	3.57
Tampa	1191969	80.84	8.98	1.40	0.70	1.43
Washington	2861983	66.10	10.61	14.15	0.57	3.21

Image at top: San Francisco's Market Street, by Yonah Freemark

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Patrick M
13 October 2010 at 23:31 · Reply

The final table, sorted by Non-Auto mode, shows how in terms of work travel, the Northeast Corridor is more or less a different country compared to most of the rest of the USA.

Throw in San Fran and it hammers home the point that while there is a lot at the policy level one can do to influence travel behavior, there's really nothing like being an old coastal city that flourished well before 1900 to maintain a strong non-auto travel structure in 2010.

Keith H
19 April 2011 at 21:07 · Reply

Patrick M is right on point. It's not the age of the city that's important, it's when it grew. Portland does so well because it grew early (as did many coastal cities); much of the current city was already in place at the end of the streetcar era. Compare newer cities where 80-90% of the growth took place after 1950, and you'll see the results in (auto) mode share. Even today, those neighborhoods developed before 1940 continue to have high transit mode share, regardless of income (often high) and even in the most car-dominant cities. It's all about well-connected street networks in neighborhoods with at least a modest density and some notion of mixed land uses in the general vicinity.

Brent
13 October 2010 at 23:44 · Reply

The overall premise is interesting, but I can't help but wonder if it would be more meaningful to show the percentile change instead. A 8.5% increase in the transit modal share for Charlotte sounds impressive, for example, until you get to the second table and see that all this has done is increase the transit modal share to 3.5%. A similar concept in reverse for transit-heavy cities.

(I find a similar problem exists in transportation policies, for example, to increase bike commuting by 50%, which sounds impressive until you realize that it means increasing the modal share from 2% to 3%, making little dent in auto travel.)

One other benefit of this approach is that the total net change should be zero, so it's easier to see where the trips went if a sizable decline in auto share occurs (e.g., if the auto share declined by 5 percentile points, while transit increased by 4 and walking/cycling increased by 1).

Yonah Freemark
14 October 2010 at 00:21 · Reply

For your viewing pleasure, I've added that information to a new table at the bottom of the post.

Alon Levy
14 October 2010 at 01:43 · Reply

Could you add a table on the metro area level, and not just central cities? In many American regions, transit looks good until you realize that it's rarely used outside the core cities, people who commute to the core CBD excepted.

Yonah Freemark
14 October 2010 at 02:14 · Reply

I've added the table (the last I'm going to add!) but I should point out that the reason I focused on the cities themselves, rather than the whole metro region, is that they are the places where investments in transit and other sustainable transportation infrastructure can really pay off. Though metro areas represent a larger percentage of the overall population than just the central cities, they are slower to respond to changes in transportation options and do not have the walkable environment in place for people to be able to adapt easily to alternatives.

Jonah
13 December 2010 at 12:11 · Reply

While that may be true in some places, it doesn't necessarily hold true in others. Many transit agencies operate at the county, or multi-county level.

Further, some cities (Los Angeles, for example) are much better represented by their metro area, as it's just as important if someone is taking the bus in Hollywood (city of LA) as it is if they're in West Hollywood (separate city, same metro)

J
14 October 2010 at 01:56 · Reply

"No new significant rail investments: Baltimore, Boston, Philadelphia."

Why exclude major BRT? At around 25,000 riders a day, Bostons Silver Line (including 3 underground stations) is certainly a major investment.

And Detroit, Jacksonville and Vegas all have rail lines via people movers or monorails. While ridership is tiny, compared to, say, NYC, it's still a decent amount when looking at a bus line in Oklahoma city as a comparison point.

At about 20,000 riders a day, Id say the Vegas monorail counts as a major rail investment, and it opened in 2004.

Yonah Freemark

14 October 2010 at 02:16 · Reply

I made a subjective choice not to include people movers or BRT; feel free to disagree with that decision.

J
14 October 2010 at 16:09 · Reply

But that ignores the monorail. Of course, it seems like all official ridership collections exclude the monorail….

IMO, theres no difference between the vegas monorail and elevated heavy rail like the miami system. Both have similar pros and cons.

Ken
14 October 2010 at 07:56 · Reply

Because BRT isn't rail, by definition.

Patrick M
14 October 2010 at 15:26 · Reply

Ask residents if they think the MBTA Silver Line is an improvement over the Washington St Elevated that was torn down decades ago.

Or, look up the Sierra Club's 20 page report on the Silver line and look at the picture on the back cover of the report, which as always, is worth 1000 words.

J
14 October 2010 at 16:08 · Reply

The waterfront branch is a huge improvement over what was there before.

Nathanael
14 October 2010 at 20:20 · Reply

What was there before was nothing at all. But the industrial area at the waterfront didn't really need expensive mass transit improvements….

The airport branch, while being a bit more functional, is hardly worth it, given the Blue Line-Red Line service.

k
14 October 2010 at 10:11 · Reply

i think the author's strict rail criteria works fine in this case.

alternatively, one could group exclusive and partially exclusive ROW systems and thereby include light & heavy rail, BRT, & ferry, while excluding shared ROW systems (bus, streetcar). along those lines, the modes share similar rider catchment areas (approx. 1/2 mi and 1/4 mi, respectively)

simple
14 October 2010 at 10:56 · Reply

Yonah, do you know how the ACS asks respondents to specify their mode? It's my understanding that it requires respondents to pick one and only one mode that represents their commute. This troubles me because it prevents us from understanding those commuters for whom mode choice varies on a daily/weekly/seasonally basis (as it does for me personally – transit/walk, and for many colleagues – often auto/transit/bike). Maybe this would all be a wash in terms of the overall stats, but maybe not — especially since "auto" is such a large share, if a relatively small part of those people actually sometimes use transit it could significantly boost the "actual" transit share.

Perhaps more importantly, the real value of transit and the other non-auto modes is that they are available to be used when needed. If these stats only indicate those who mostly use non-auto, they undercount the percentage of mostly auto commuters for whom non-auto modes are still "relevant" — which is an important point to make politically. For instance, if a person drives most days because their main office is in the suburbs, but takes the train 1 or 2 days a week when they need to work downtown (or bikes only when the weather is nice, etc.), they show up as auto-only and the fact that transit (or bicycling) is relevant for them is lost in the data.

Is this correct?

mulad
14 October 2010 at 13:57 · Reply

Yeah, I agree that this is a problem with the ACS data. Many more people occasionally use a non-auto mode, and there's seasonality to commuting as well—people are much more likely to bike in the summer, for instance. There is also a lot of noise in ACS information for biking since the share is so small. With only 0.5 percent, that translates to just a few dozen respondents in most large cities.

A major thing that strikes me with ACS commuting information is that walking is somewhere around 6× as popular as biking in most areas, so even a 150% increase barely makes a dent in most places. Biking can be very effective for getting people around since it's usually faster than transit, but it has its drawbacks too (lockable storage on a bike is rare, for instance).

Other things that make me think: For metro areas, the highest mode share for transit, biking, and walking are many multiples of the lowest mode shares, but the highest carpool mode share is about 15%, while the lowest is about 7%—only a 2× difference. However, in most places, carpooling is the most common option other than driving alone.

From the first table, we should probably be really disappointed that carpooling has declined so much. It does seem like a lot of trips have simply disappeared, though. A combination of telecommuting and a poor job market in 2009, I suspect.

Brent
14 October 2010 at 21:24 · Reply

A major transportation survey in the Toronto area (the Transportation Tomorrow Survey) asks respondents about the trips they made on a specific date. In theory, that is supposed to balance out respondents that occasionally take a different mode — if five different respondents take transit one day a week, it's likely that (on average) one will take transit on that particular day.

Alon Levy
15 October 2010 at 22:09 · Reply

The ACS asks people to name the mode they used primarily in the previous week. It doesn't have the granularity of asking about a specific day, but it's probably the most consistent thing there is in a mailed survey, as opposed to a phone survey. Asking about a day may produce bias because people may not remember so far back, and asking about the day before the survey may produce bias because people may answer the survey only on specific days (say, weekends).

Danny
14 October 2010 at 10:58 · Reply

Part of the problem with any sort of broad based analysis here is that many cities have increased service levels with some investments and then cut service elsewhere. Maybe the proper analysis would be to measure transit VMT rather than "rail investment".

Ken
14 October 2010 at 11:48 · Reply

Wonder what Jarrett Walker of Human Transit would say about this? He seems to have a distinct anti-rail, pro-bus bias.

David Keddie
14 October 2010 at 11:54 · Reply

I think that he would say that the densities of almost all American cities support bus more effectively than rail. I was struck in light of the arc tunnel cancellation by the discovery that the one bus lane through the Lincoln tunnel takes more commuters into Manhattan than NJTransit rail does into Penn Station. Many of those buses moreover are run by profitable private companies. Apart from a hope to improve rail so as to enable major densification in New Jersey (where I live) and provide fossil fuel free transit, it would seem that expansion of bus infrastructure might more effectively get commuters into Manhattan.

Alon Levy
14 October 2010 at 15:53 · Reply

David, the reason the Lincoln Tunnel is so productive is that the buses get to hog two full blocks of prime real estate. Building more capacity for that is going to be even more expensive than the ARC cavern.

Adirondacker12800
14 October 2010 at 18:14 · Reply

Many NJTransit train riders use PATH or the ferries to get into Manhattan. More buses was one of the alternatives examined before the decision was made to build a rail tunnel. More buses means more highway all over the state. Means another road tunnel into Manhattan. Once the buses get to Manhattan there would have to be a new bus terminal. The cheapest option is more rail.

Ted King
14 October 2010 at 14:50 · Reply

It would be more accurate to say that Jarrett's bias is in favor of effective transit without regard to technology. I've been reading his blog for quite a while and attended one of his talks. He would be in favor of motorized skateboards if that were cost (dollars, time, and space) effective and got the job done.

Realist
15 October 2010 at 18:13 · Reply

I think you're right Ted, that's exactly what he would say. But, I wonder, does he rank his restaurants based on calories per hour and ignore flavor / experience?

Alon Levy
15 October 2010 at 22:10 · Reply

No, but as a food service industry consultant, he might just rank restaurants based on profit.

David Keddie
14 October 2010 at 11:49 · Reply

I don't find these statistics particularly encouraging. If you can forgive the characterization it seems like on the margin (work commutes as opposed to all travel) of the margin (city limits as opposed to metro area) of the margin (non-Texas cities) they show that transit market share was kept flat instead of falling. This reminds me of the grim statistics for Portland that show no significant modal shift away from driving alone despite decades of investment. It is encouraging to see the revival of some urban living and the increases in walking and bike commuting. These however seem to be serving a niche audience.

Michael Farrell
22 October 2010 at 13:00 · Reply

Did you look at the numbers for Portland? Here they are.

* The City of Portland had a non-auto share of 22.9% in 2009, which puts it in ninth place out of the thirty cities. Not just a "niche audience".
* Between 2000 and 2009, Portland achieved a 3.59 percentage point (not percent) growth in non-auto mode share – the third highest growth rate of the thirty cities.
* Over the same period, Portland achieved a 2.09 percentage point decrease in drive alone mode share – once again, the third largest such decrease among the thirty.
* Car pooling fell in every city; Portland's decline of 3.34 percentage points was in the middle.
* The greater Portland MSA had a drive alone rate of 71.63%, the seventh lowest rate of the thirty Metro areas.

Portland definitely outperforms other cities of its size and age.

David Keddie
24 October 2010 at 00:03 · Reply

I was referencing this:

http://www.humantransit.org/2010/01/portland-another-challenging-chart.html

It's true that Portland outperforms some similar cities, though notably not Seattle, but the truth remains that despite major investments in light rail, an urban growth boundary and major support for densification Portland is a fundamentally car-dependent city with transit little used and only moderate densification in the core. These statistics moreover cover only work trips. When one looks at all travel the mode share for autos rises to 90% even in New York. 80% in Paris. I find my transit idealism suffering in the face of statistics.

Yonah Freemark
24 October 2010 at 00:14 · Reply

I don't know where you're getting your statistics, but **at least in Paris**, the mode share in terms of **all trips** (not km of travel) is:

For the city itself:
- 16.3% cars/motorcycles
- 33.9% transit
- 49.9% walk/bike

For the whole region:
- 45.3% cars/motorcycles
- 20.5% transit
- 34.2% walk/bike

The majority of trips in the region, as these statistics show, are done in modes outside of the private automobile.

David Keddie
25 October 2010 at 08:56 · Reply

Thanks Yonah. I believe I got that number from an analysis of kms travelled which certainly masks the greater opportunities to take trips on foot and by bike in most of the Paris region.

There still seems to be a significant barrier in the US to development of new transit-oriented neighborhoods. Where I live in Princeton, NJ the developers are suing to try to build at greater densities (or any density as it's now mostly open parking) next to the Junction train station, but it seems that it's harder to encourage TOD in cities such as Portland that mostly developed around the automobile. At a minimum I hope that New Urbanist design catches on as the one such new neighborhood we have in central Jersey is wildly popular, but that's still not really designed as TOD except insofar as it allows local walking and biking.

mulad
14 October 2010 at 14:27 · Reply

Some X-Y plots of different data columns and some statistical correlation probably needs to be put into effect here. Staring at these numbers, I'm becoming very concerned about how much the carpool share has declined. In most places, the most popular mode shares are ranked as:

1. driving alone
2. carpooling
3. transit
4. walking
5. biking

That's basically the opposite of what's desirable from a carbon footprint perspective:

1. walking
2. biking
3. transit
4. carpooling
5. driving alone

Well, biking is more efficient than walking, but ideally you want to be close enough so you don't have to bike. They also take up a fair amount of space, so truly constrained locations may put transit up higher. But hell, I think we should plaster that second list to the door of every planning office in the country. However, to get there, every mode other than driving alone has to be encouraged. We want to see carpooling decline someday, but probably not right now.

Dan
14 October 2010 at 14:49 · Reply

Fort Worth Texas has a commuter rail line with frequent service, so I don't know if it should be included in the No Rail cities. See **http://www.subways.net/usa/dfw/dfwrail.htm**

Keith H
19 April 2011 at 21:13 · Reply

The Ft Worth commuter rail line tends to carry people away from the city in the morning peak and back in the afternoon (most are going to Dallas). There are commuters to downtown Ft Worth, but it's not the dominant pattern. For the most part, Ft Worth is like any suburban (bedroom) community on a commuter rail line.

wanderer
14 October 2010 at 15:49 · Reply

First, I wouldn't overinterpret any of this data. ACS data have had significant quality control problems. For example, in Oakland, they showed several thousand housing units disappearing between one year and the next! The data simply aren't as good as in the "real" decennial Census, which isn't perfect but is better.

With that caveat, there were some interesting distinctions between the cities and their metros. In metro Los Angeles, for example, the drive alone share is 74%, it drops to 67% in the city of Los Angeles. That's hardly the target, but it does mean 600,000 people primarily commuting by means other than driving in the city where "everybody drives." In Portland, the gap is even wider 72% driving alone in the metro but only 62% in the city. If you calculated a "Metro outside city" drive alone share the difference with the city would be even wider.

To me, it speaks to the ongoing importance of a smart growth as well as a transit agenda.

In the most sprawling cities, like San Antonio, there wasn't much of a difference.

John Ballo
14 October 2010 at 16:06 · Reply

None of these changes would have anything to do with decreases in urban jobs and rises in office vacancies during 2007-2010, would it?

wanderer
14 October 2010 at 16:32 · Reply

It's hard to see how. You'd think if anything that the recession would lead to more carpooling. Presumably the recession would have affected the baseline number the most, and lead to overall falls in both drive alone and other commuters.

Andrew
16 October 2010 at 09:03 · Reply

It is surprising no one has noted how it seems that most new bike users switched from transit.

Also surprising that the impact of fare increases is not considered. Base fares approaching $3.00 are not trivial to most people. Sure, the cost of driving also rose, but if you have a car with gas in it, hopping in and heading out feels as cost-free as ever.

Howard Bingham
16 October 2010 at 22:57 · Reply

Why no figures on Houston..?According to statistics published in Metro-Magazine (A transit industry publication), on the 100 largest transit systems, Houston has increased from 14 to 12.

I am a frequent user of METRO during off-peak and during peak travel periods, it would appear ridership as in many other cities of Houston's size, does leave plenty of room for improvement along lines of equipment utilization, primarily in the need for smaller buses to run middle of day, NON-peak travel times. Metro revamped bus schedules February 14, 2010 on many routes, and has made changes on other routes since early summer 2010.. Light-Rail ridership during peak travel times often runs at crush loads 220+ per LRV unit, with multiple units of up to 450 capacity. There is need for new cars to supplement this fleet, as they near heave overhaul dates, the big problem. Metro ran afoul of FTW Buy America requirements and permitting the contractor to modify it's contract after bids were opened..!

Metro will need a re-authorization election before 2014 (Sooner than later as delivery date of NEW LRV's will take 2+ years from date contract is awarded..!).

Amber
17 October 2010 at 13:18 · Reply

It depends on how he defines "effective". For stimulating growth, it's hard to beat rail with a bus.

Amber
17 October 2010 at 13:19 · Reply

Oops! That's meant to be in reference to Jarrett Walker.

Alexander Quinn
29 November 2010 at 20:00 · Reply

It's difficult to use 2000 as the start date. For many metropolitan areas, 2000 was a highwater mark for employment, and therefore congestion was at peak levels. The 2000 Census came will before the demise of the Dot Com boom and unemployment in San Francisco, LA, New York, and Atlanta was less than 5%. In this inflated job market, commute congestion was significant. As a result, people looked to alternative means of transportation to get to their place of work. One only needs to remember the crowded BART trains from the East Bay to San Francisco to understand the impact of the economy on ridership. Conversely, 2009 represents a low employment level with peak hour congestion down significantly. The fact that cities have made any progress during these very different economic periods implies a lasting trend towards reduced personal vehicle commutes.

An Extensive New Addition to Dallas' Light Rail Network Makes it America's Longest | DFW REimagined – The future of real estate
10 December 2010 at 12:48 · Reply

[...] riders a day — a pittance in the context of the city's 1.3 million inhabitants. The most recent U.S. Census data show that the city's transit mode share stands at less than 4%; the metropolitan region's share is just 1.5%. Both are down from [...]

3.12 TRANSPORTATION, TRAFFIC & SECURITY

This section describes the current transportation system in the SCAG region, discusses the potential impacts of the 2012-2035 Regional Transportation Plan/Sustainable Communities Strategies (2012-2035 RTP/SCS or Plan) on transportation, identifies mitigation measures for the impacts, and evaluates the residual impacts.

REGULATORY FRAMEWORK

Federal

U.S. Department of Homeland Security (DHS). The DHS is charged with the responsibility of protecting the territory of the United States from terrorist attacks and responding to natural disasters. The department was established on November 25, 2002, by the Homeland Security Act of 2002. The primary mission of the Department is to (a) prevent terrorist attacks within the United States; (b) reduce the vulnerability of the United States to terrorism; and (c) minimize the damage, and assist in the recovery, from terrorist attacks that do occur within the United States.

Federal Emergency Management Agency (FEMA). In March 2003, FEMA became a department of the DHS. The primary mission of FEMA is to reduce the loss of life and property and protect the nation from all hazards, including natural disasters, acts of terrorism, and other human-made disasters, by leading and supporting the nation in a risk-based, comprehensive emergency management system of preparedness, protection, response, recovery, and mitigation.

National Response Framework (NRF). The NRF presents the guiding principles that enable all response partners to prepare for and provide a unified national response to disasters and emergencies. It establishes a comprehensive, national, all-hazards approach to domestic incident response. The National Response Plan was replaced by the NRF effective March 22, 2008.

The NRF defines the principles, roles, and structures that organize how we respond as a nation. The NRF:

- Describes how communities, tribes, states, the federal government, private-sectors, and nongovernmental partners work together to coordinate national response;
- Describes specific authorities and best practices for managing incidents; and
- Builds upon the National Incident Management System (NIMS), which provides a consistent template for managing incidents.

United States Department of Defense (DOD). The DOD has several installations within the SCAG region. In the case of a large-scale emergency, the DOD is authorized to provide resources when response and recovery requirements are beyond the capabilities of civilian authorities, and these efforts do not interfere with the DOD's core mission or ability to respond to operational contingencies.

Requests for Defense Support to Civilian Authorities (DSCA) are made through the local, county and state authorities as a request for assistance to the federal coordinating official in the appropriate lead federal agency and is normally accompanied by, or submitted after a request from the Governor for a disaster declaration from the President. The Defense Coordinating Officer coordinates the DOD resources to be provided. The California National Guard may be activated as part of the DSCA and can provide law enforcement support, crisis management and consequence management services. Activation of the National Guard for local support during emergencies is done by the Governor via the California Office of Emergency Services.

Transportation Security Administration (TSA). The TSA is a component of the DHS and is responsible for security of the nation's transportation systems. With state, local and regional partners, the TSA oversees security for highways, railroads, buses, mass transit systems, and ports. A vast majority of its resources are dedicated to aviation security and is primarily tasked with screening passengers and baggage.

Maritime Transportation Security Act of 2002. The Maritime Transportation Security Act of 2002, signed on November 25, 2002, is designed to protect the nation's ports and waterways from a terrorist attack. This law is the U.S. equivalent of the International Ship and Port Facility Security Code (ISPS), and was fully implemented on July 1, 2004. It requires vessels and port facilities to conduct vulnerability assessments and develop security plans that may include passenger, vehicle and baggage screening procedures; security patrols; establishing restricted areas; personnel identification procedures; access control measures; and/or installation of surveillance equipment.

The Disaster Mitigation Act of 2000 (DMA 2000). The DMA 2000 provides an opportunity for states, Tribes, and local governments to take a new and revitalized approach to mitigation planning. DMA 2000 amended the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988 by adding Section 322 – Mitigation Planning. Section 322 placed new emphasis on mitigation planning requiring governments to develop and submit mitigation plans as a condition of receiving any funding from the Hazard Mitigation Grant Program (HMGP) project grants. This Act reinforces the importance of pre-disaster infrastructure mitigation planning to reduce disaster losses nationwide, and is aimed primarily at the control and streamlining of the administration of federal disaster relief and programs to promote mitigation activities.

National Incident Management System/Standardized Emergency Management System (NIMS). The NIMS is a tool for states, counties and local jurisdictions to respond to catastrophic events through better communication and coordination. NIMS provides a consistent nationwide template to enable Federal, state, local, and tribal governments and private sector and non-governmental organizations to work together effectively and efficiently to prepare for, prevent, respond to, and recover from domestic incidents, regardless of cause, size, or complexity, including acts of catastrophic terrorism.

California has a similar management system called the Standard Emergency Management System (SEMS) which is mandated under California Government Code Section §8607(a). State of California Executive Order S205 requires the State to integrate, to the extent appropriate, the NIMS, into the State's SEMS.

The NIMS Integration Center strongly recommends that all elected officials who will be interacting with multiple jurisdictions and agencies during an emergency incident to take several NIMS courses, at a minimum:

- FEMA IS700: NIMS, an Introduction
- ICS100: Introduction to Incident Command System (ICS) or equivalent

All federal, state, local, tribal, private sector and nongovernmental personnel with a direct role in emergency management and response must be NIMS and ICS trained. This includes all emergency service related disciplines such as Emergency Medical Technicians, hospitals, public health, fire service, law enforcement, public works/utilities, skilled support personnel, and other emergency management response, support and volunteer personnel.

The NIMS employs two levels of incident management, depending upon the type of incident:

- The **Incident Command System (ICS)** is a standard, on scene, all-hazard incident management system. ICS allows users to adopt an integrated organizational structure to match the needs of single or multiple incidents; and
- **Multi-Agency Coordination Systems** are a combination of facilities, equipment, personnel, procedures and communications integrated into a common framework for coordinating and supporting incident management.

ICS has been in use for over 30 years and is used for planned events, fires, earthquakes, hurricanes and acts of terrorism; ICS helps all responders communicate and coordinate logistics.

NIMS requires all emergency plans and standard operating procedures to incorporate NIMS components, principles and policies, including emergency planning, training, response, exercises, equipment, evaluation, and corrective actions. Chief elected and appointed officials in a community need to be directly involved in these NIMS preparedness elements, especially the elements that deal with exercising community emergency management policies, plans, procedures and resources.

State

California Department of Transportation (Caltrans). Caltrans, in conjunction with the California Highway Patrol (CHP), has created Transportation Management Centers (TMCs) to rapidly detect and respond to incidents while managing the resulting congestion. With the help of intelligent transportation system technologies, such as electronic sensors in the pavement, freeway call boxes, video cameras, ramp meter sensors, earthquake monitors, motorist cellular calls, and commercial traffic reports; as well as Caltrans highway crews, 911 calls and officers on patrol, the TMC provides coordinated transportation management for general commutes, special events and incidents affecting traffic. The TMCs are operated within each Caltrans district. For the SCAG region, Districts 7, 8, 11 and 12 all have TMCs.

California Emergency Management Agency (EMA). The EMA was established as part of the Governor's Office in 1950 as the State Office of Civil Defense. Then called the Governor's Office of Emergency Services, it coordinated overall State agency response to major disasters in support of local government. The EMA is responsible for assuring the State's readiness to respond to and recover from natural, human-made, and war-caused emergencies, and for assisting local governments in their emergency preparedness, response and recovery efforts.

The EMA serves as the central contact point in the State for any emergency or imminent disaster. It coordinates the notification of appropriate State administering agencies that may be required to respond, as well as the emergency activities of all State agencies in the event of an emergency. In doing so, the EMA does not focus on security specifically, but rather more broadly on addressing all potential incidents that could impact the State, such as earthquakes, fires, floods, and terrorist attacks. Furthermore, EMA coordinates with federal agencies, such as the DHS and FEMA, as well as other State and local agencies such as the CHP.

California's vision, mission, and principles for emergency management, as well as goals and objectives are located in its publication "Strategic Plan 2010-2015 – Keeping California Safe."[1]

Multi-Hazard Mitigation Plans. The goal of hazard mitigation plans is to guide implementation activities to achieve the greatest reduction of vulnerability, which will result in saved lives, reduced injuries, reduced property damages, and greater protection of the environment.

[1] California Emergency Management Agency, *Strategic Plan 2010-2015 – Keeping California Safe*, 2010.

FEMA now requires state and local governments to develop hazard mitigation plans. The DMA 2000, Section 322 (ad) requires that local governments, as a condition of receiving federal disaster mitigation funds, have a mitigation plan that describes the process for identifying hazards, risks and vulnerabilities; identifies and prioritizes mitigation actions; encourage the development of local mitigation; and provides technical support for those efforts. "Local Governments" are defined in the DMA 2000 to typically include counties, local municipalities, and tribal governments, but can also include other local agencies and organizations, including Councils of Governments, schools and other special districts.

California approved its State of California Multi-Hazard Mitigation Plan in 2010. The State is required to adopt a federally-approved State Multi-Hazard Mitigation Plan to be eligible for certain disaster assistance and mitigation funding. The Plan is an evaluation the hazards California faces and the strategies, goals, and activities the State will pursue to address these hazards. The Plan:[2]

- Documents Statewide hazard mitigation planning in California;
- Describes strategies and priorities for future mitigation activities;
- Facilitates the integration of local and tribal hazard mitigation planning activities into Statewide efforts;
- Meets State and federal statutory and regulatory requirements; and
- Is an annex to the State Emergency Plan.

All six SCAG counties and a number of cities within the SCAG region have completed Hazard Mitigation Plans. EMA dictates that these plans must be updated every three years.

County Offices of Emergency Services. Counties and cities are generally the first responders to any security or emergency situation. These responders include fire departments, police and sheriff department, hospitals, ambulance services and transportation agencies. Coordination among public and private agencies within various cities and counties make the most use of all available resources in the event of any emergency.

While each city and county has their own security procedures, the policies are generally similar. Mutual Aid agreements between cities, counties and private organizations help to maximize resources and reduce the human suffering associated with disaster situations. Each SCAG county has a department in charge of security and emergency response see **Table 3.12-1**.

TABLE 3.12-1: COUNTY OFFICES OF EMERGENCY SERVICES

County	Office Information	County	Office Information
Imperial	Office of Emergency Services 1078 Dogwood Road Heber, CA 92249 (760) 482-2400	Riverside	Office of Emergency Services 4080 Lemon Street, Suite 8 P.O. Box 1412 Riverside, CA 925021412 (951) 955-4700
Los Angeles	Office of Emergency Management 1275 N. Eastern Avenue Los Angeles, CA 90063 (323) 980-2261	San Bernardino	Office of Emergency Services 1743 W. Miro Way Rialto, CA 92376 (909) 356-3998
Orange	Office of Emergency Services 2644 Santiago Canyon Road Silverado, CA 92676 (714) 628-7055	Ventura	Office of Emergency Services Ventura County 800 South Victoria Avenue Ventura, CA 93009 (805) 654-2551

SOURCE: TAHA, 2011.

[2] California Emergency Management Agency, *Multi Hazard Mitigation Plan*, 2010.

Mutual Aid Agreements (MAA). Immediately following the 1994 Northridge earthquake, city and county emergency managers in the coastal, southern, and inland regions developed a coordinated emergency management concept called the Emergency Managers Mutual Aid (EMMA) system. EMMA provided a valuable service in the emergency response and recovery efforts at the Southern Regional Emergency Operations Center (REOC), local Emergency Operations Centers (EOCs), the Disaster Field Office (DFO), and community service centers.

The purpose of EMMA is to support disaster operations in affected jurisdictions by providing professional emergency management personnel. In accordance with the Master Mutual Aid Agreement, local and State emergency managers have responded in support of each other under a variety of plans and procedures.

The objectives of the EMMA Plan include:[3]

- Providing emergency management personnel from unaffected areas to support local jurisdictions, Operational Areas, and regional emergency operations during proclaimed emergencies;
- Providing a system, including an organization, information, and forms necessary to coordinate the formal request, reception, assignment, and training of assigned personnel;
- Establishing a structure to maintain this document (the Emergency Managers Mutual Aid Plan) and its procedures;
- Providing for the coordination of training for emergency managers, including Standardized Emergency Management System (SEMS/NIMS) training, emergency management course work, exercises, and disaster response procedures; and
- Promoting professionalism in emergency management.

METRANS Transportation Center. The METRANS Transportation Center, which is a joint partnership between the University of Southern California and California State University, Long Beach, is a U.S. Department of Transportation University Transportation Center that was established in 1998 under the Transportation Equity Act for the 21st Century. The mission of METRANS is to 'solve transportation problems of large metropolitan regions through interdisciplinary research, education and outreach'. In doing so, METRANS conducts research in several areas relating to transportation, including safety, security, and vulnerability. Specifically, this study attempts to analyze safety and security issues, such as pedestrian and transit safety, vulnerability of major infrastructure, and safety and risk mitigation.

Intelligent Transportation System (ITS). One way to incorporate safety and security into transportation planning is through greater collaboration between transportation planning and operations. Collaboration is particularly critical in metropolitan regions and congested corridors where numerous jurisdictions, agencies, and service providers are responsible for the safety, security, and efficient operation of various aspects of the transportation system. Not only are the roadway and transit system operators themselves dependent on the transportation system, but so are police, fire, and medical services, emergency response and domestic security systems, and port authorities.

Collaboration enables regional strategic development of projects and policies that have regional effects on users, including activities, such as incident management, advanced traveler information services, public safety/EMS/security, special events, electronic payment services, and performance measures.

ITS are one method of establishing a collaborative relationship. ITS projects were originally designed to increase transportation efficiency. It was recognized early on that ITS investments may also serve to enhance the safety, security and emergency response capabilities of the region. Such systems may be of assistance in the detection, response and recovery to human-made and natural disasters.

[3] California Emergency Management Agency, *Emergency Managers Mutual Aid Plan*, November 1997.

Because the successful operation of ITS projects usually depend on coordination and communication between different agencies and the systems they operate, it is essential that there be a region-wide framework for cooperation to help achieve that coordination and communication in the most cost-effective manner. This framework is referred to as the Southern California Regional ITS Architecture.

Southern California Regional ITS Architecture. The Southern California ITS Regional Architecture includes all six counties in the SCAG region. The goal of the project is to document the ITS Architecture covering the region. An ITS Architecture is a framework for ensuring institutional agreement and technical integration of technologies for the implementation of projects or groups of projects under an ITS strategy. Local components to the ITS Architecture exist for Los Angeles County, Orange County, Inland Empire, Ventura County, and Imperial County.

California Critical Needs Assessments. There have also been several assessments of the critical State transportation infrastructure, which include identification of the key transportation facilities. Assessments have been conducted by the following bodies:

- The Governor's Office of Emergency Services
- The California Attorney General's Office

CHP conducted a vulnerability assessment of the State's highway system and has issued a confidential report to the State Legislature

The results of these assessments have been shared with the transportation system operators and incorporated into their security planning. However, security considerations have precluded the inclusion or discussion of these critical system elements in public documents.

Strategic Highway Network (STRAHNET). The STRAHNET routes within the SCAG region are essential to readily accommodate the movement of military supplies and personnel in times of national emergency. STRAHNET routes were selected by the federal government, and include the National Interstate system, as well as key "non-interstate" routes and connectors to ports and military installations.

Within the SCAG region, all interstates are part of the STRAHNET. SR-14, SR-101 and Route 395 are part of the non-interstate STRAHNET routes. Various connectors between the ports, as well as various military installations and STRAHNET are also included. A visual representation of the STRAHNET within the SCAG region is displayed in **Map 2.0-1** located in Chapter 8.0 (Maps).

Local

Congestion Management Programs (CMPs). In order to meet federal certification requirements, SCAG and the county Congestion Management Agencies (CMAs) have worked together to develop a congestion management process for the region. In the SCAG region, the Congestion Management System (CMS) is comprised of the combined activities of the RTP/SCS, the CMP and the Regional Transportation Improvement Program (RTIP).

Under California law, CMPs are prepared and maintained by the CMAs. The Los Angeles County Metropolitan Transportation Authority (Metro), Orange County Transportation Authority (OCTA), Riverside County Transportation Commission (RCTC), San Bernardino Associated Governments (SANBAG), and Ventura County Transportation Commission (VCTC) are the designated CMAs of each county and are subject to State requirements. While Imperial County is not subject to State CMP requirements, CMP-related activities there are accomplished through the development of the RTP/SCS and the RTIP by the Imperial County Transportation Commission (ICTC).

In addition to SCAG's RTP/SCS and RTIP, the key elements of the federal Congestion Management Process are addressed through the counties CMPs. Because the magnitude of congestion and degree of urbanization differ among the counties, each CMP differs in form and local procedure. By State law, all CMPs perform the monitoring and management functions shown below which also fulfill the federal CMP requirements.

- Highway Performance – Each CMA monitors the performance of an identified highway system. This monitoring allows each county to track how their system, and its individual components, is performing against established standards, and how performance changes over time.
- Multi-Modal Performance – In addition to highway performance, each CMP contains an element to evaluate the performance of other transportation modes including transit.
- Transportation Demand Management (TDM) – Each CMP contains a TDM component geared at reducing travel demand and promoting alternative transportation methods.
- Land Use Programs and Analysis – Each CMP incorporates a program for analyzing the effects of local land use decisions on the regional transportation system.
- Capital Improvement Program (CIP) – Using data and performance measures developed through the activities identified above, each CMP develops a CIP. This becomes the first step in developing the County Transportation Improvement Program (TIP). Under State law, projects funded through the RTIP must first be contained in the county CIP.
- Deficiency Planning – The CMP contains provisions for "deficiency plans" to address unacceptable levels of congestion. Deficiency plans can be developed for specific problem areas or on a system-wide basis. Projects implemented through the deficiency plans must, by statute, have both mobility and air quality benefits. In many cases, the deficiency plans capture the benefits of transportation improvements that occur outside the county TIPs and RTIP such as non-traditional strategies and/or non-regionally significant projects.

The regional transportation planning process and the county congestion management process should be compatible with one another. To ensure consistency, SCAG and the CMAs have developed the Regional Consistency and Compatibility Criteria for CMPs. Information on the CMP activities and resulting data is updated on a biennial basis by each CMA and supplied to SCAG and air quality management districts.

EXISTING SETTING

The Southern California transportation system is a complex intermodal network designed to carry both people and goods. It consists of roads and highways, public transit, paratransit, bus, rail, airports, seaports and intermodal terminals. The regional highway system consists of an interconnected network of local streets, arterial streets, freeways, carpool lanes and toll roads. This highway network allows for the operation of private autos, carpools, private and public buses, and trucks. Active transportation modes, such as bicycles and pedestrians share many of these facilities. The regional public transit system includes local shuttles, municipal and area-wide public bus operations, rail transit operations, regional commuter rail services, and inter-regional passenger rail service. The freight railroad network includes an extensive system of private railroads and several publicly owned freight rail lines serving industrial cargo and goods. The airport system consists of commercial, general, and military aviation facilities serving passenger, freight, business, recreational, and defense needs. The region's seaports support substantial international and interregional freight movement and tourist travel. Intermodal terminals consisting of freight processing facilities, which transfer, store, and distribute goods. The transportation system supports the region's economic needs, as well as the demand for personal travel.

Transit use is growing in the SCAG region. As of 2009, transit agencies in the SCAG Region reported 747.3 million boardings. This represents growth of nearly 20 percent in the ten years between 2000 and

2010, but only 4 percent growth in per capita trips due to population growth. Metrolink and Metro Rail (Los Angeles County) have seen ridership growth of 6 to 8 percent a year.

Transportation Planning in the SCAG Region

Numerous agencies are responsible for transportation planning and investment decisions within the SCAG region. SCAG helps integrate the transportation-planning activities in the region to ensure a balanced, multi-modal plan that meets regional as well as county, subregional, and local goals.

Table 3.12-2 identifies local, state and federal governmental agencies that participated in the development of the 2012-2035 RTP/SCS. Seven major entities and agencies are involved including SCAG as the designated Metropolitan Planning Organization (MPO), the County Transportation Commissions (CTCs), Sub-regional Councils of Governments (COG), local and county governments, transit and transportation owners, operators and implementing agencies, resource/regulating agencies and other private non-profit organizations, interest groups and tribal nations.

TABLE 3.12-2: STAKEHOLDERS IN THE DEVELOPMENT OF THE PLAN	
COUNTY TRANSPORTATION COMMISSIONS	
Imperial County Transportation Commission (ICTC)	Riverside County Transportation Commission (RCTC)
Los Angeles County Metropolitan Transportation Authority (Metro)	San Bernardino Associated Governments (SANBAG)
Orange County Transportation Authority (OCTA)	Ventura County Transportation Commission (VCTC)
SUBREGIONAL COUNCILS OF GOVERNMENTS	
Arroyo Verdugo Cities	SANBAG
Coachella Valley Association of Governments	San Fernando Valley COG
Gateway Cities Council of Governments (COG)	San Gabriel Valley COG
ICTC	South Bay Cities COG
Las Virgenes-Malibu-Conejo COG	Ventura County COG
City of Los Angeles	Western Riverside County COG
North Los Angeles County	Westside Cities COG
Orange County COG	
LOCAL, COUNTY, AND TRIBAL GOVERNMENTS	
OTHER OPERATORS AND IMPLEMENTING AGENCIES	
Caltrans	Transportation Corridor Agencies (TCA)
Airport Authorities	Transit / Rail Operators
Port Authorities	
RESOURCE/REGULATING AGENCIES	
US Department of Transportation • Federal Highway Administration (FHWA) • Federal Transit Administration (FTA) • Federal Aviation Administration (FAA) • Federal Railroad Administration (FRA)	U.S. Environmental Protection Agency (USEPA) California Air Resources Board (ARB) California Environmental Protection Agency (Cal/EPA) Air Districts
SOURCE: SCAG, 2012-2035 RTP/SCS Page 33, Table 8, 2011	

Each of the six counties in the SCAG region has a Transportation Commission or Authority. These agencies are charged with countywide transportation planning activities, allocation of locally generated transportation revenues and, in some cases, operation of transit services. In addition, there are 14 subregional COGs within the SCAG region which are groups of cities and communities geographically clustered (sometimes comprising an entire county), which work together to identify, prioritize, and seek transportation funding for needed investments in their respective areas.

Circulation System

Commute Patterns and Travel Characteristics

The existing transportation network serving the SCAG region supports the movement of people and goods. On a typical weekday in the six-county region, the transportation network supports a total of approximately 448 million vehicle miles of travel (VMT) and 13 million vehicle hours of travel (VHT). Of this total, over half occur in Los Angeles County and less in Orange County, San Bernardino County, Riverside County, Ventura County and Imperial County, respectively. A detailed summary of existing VMT and VHT for the region and six counties is presented in **Table 3.12-3**.

Much of the existing travel in the SCAG region takes place during periods of congestion, particularly during the morning (6:00 a.m. to 9:00 a.m.) and evening peak periods (3:00 p.m. to 7:00 p.m.). Congestion can be quantified as the amount of travel that takes place in delay (vehicle hours of delay or VHD) and, alternately, as the percentage of all travel time that occurs in delay (defined as the travel time spent on the highway due to congestion, which is the difference between VHT at free-flow speeds and VHT at congested speeds). **Table 3.12-4** presents the existing travel delays and percent of regional VHT in delay by County on freeways and arterials. As shown in **Table 3.12-4**, regional travel time in delay represents approximately 25 percent of all daily, 30 percent of all AM peak period, and 38 percent of all PM peak period travel times.

The average vehicle home-to-work trip duration in each county is generally similar while a greater range of average work distances is found in the different counties of the region (from a low of ten miles in Imperial County to a high of 18 miles in San Bernardino and Riverside Counties). Home-to-work trip duration and distance are both greater for the inland counties of Riverside and San Bernardino, reflecting regional housing and employment distribution patterns.

Map 3.12-1 located in Chapter 8.0 (Maps), shows AM peak period congestion delay on the regional freeway system. Major portions of the system are extremely congested during the AM peak period, particularly in Los Angeles and Orange Counties and the areas immediately to the east and west. A substantial portion of AM peak period travel in each county takes place in delay, ranging from a low of three percent in Imperial County to a high of 33 percent in Los Angeles County, as indicated in **Table 3.12-4**.

Map 3.12-2 located in Chapter 8.0 (Maps), shows PM peak period congestion delay on the regional freeway system. Major portions of the system are extremely congested during the PM peak period, particularly in Los Angeles and Orange Counties and the areas immediately to the east and west. A substantial portion of PM peak period travel in each county takes place in delay, ranging from a low of four percent in Imperial County to a high of 43 percent in Los Angeles County, as indicated in **Table 3.12-4**.

TABLE 3.12-3: SUMMARY OF EXISTING DAILY VEHICLE MILES & PERCENT VEHICLE HOURS OF TRAVEL

	Vehicle Miles of Travel (VMT)						Vehicle Hours of Travel (VHT)					
	AM Peak Period		PM Peak Period		Daily		AM Peak Period		PM Peak Period		Daily	
County	Miles	% of Region	Miles	% of Region	Miles	% of Region	Hours	% of Region	Hours	% of Region	Hours	% of Region
Imperial	1,087,000	1%	1,643,000	1%	6,136,000	1%	22,000	1%	34,000	1%	123,000	1%
Los Angeles	46,321,000	51%	74,635,000	51%	224,312,000	50%	1,627,000	57%	3,181,000	59%	7,428,000	56%
Orange	15,589,000	17%	24,793,000	17%	75,224,000	17%	474,000	16%	879,000	16%	2,171,000	17%
Riverside	12,099,000	13%	18,817,000	13%	60,494,000	14%	320,000	11%	542,000	10%	1,469,000	11%
San Bernardino	12,242,000	13%	18,944,000	13%	61,010,000	14%	307,000	11%	512,000	10%	1,416,000	11%
Ventura	4,340,000	5%	6,929,000	5%	20,722,000	5%	121,000	4%	217,000	4%	548,000	4%
Total	**91,678,000**	**100%**	**145,761,000**	**100%**	**447,898,000**	**100%**	**2,871,000**	**100%**	**5,365,000**	**100%**	**13,155,000**	**100%**

SOURCE: SCAG 2012-2035 RTP/SCS, Highways and Arterials Appendix, Page 52, Table A12, 2011.

TABLE 3.12-4: SUMMARY OF EXISTING DELAY AND WORK TRIP LENGTH

	Vehicle Hours of Delay			% of Travel in Delay			Average Home-to-Work Trip Distance (miles)	Average Home-to-Work Trip Duration (minutes)	
County	AM Peak Period	PM Peak Period	Daily	AM Peak Period	PM Peak Period	Daily	Vehicle Trips (AM Only)	Vehicle Trips (AM Only)	Transit Trips (AM only)
Imperial	1,000	1,000	5,000	3%	4%	4%	10	13	66
Los Angeles	554,000	1,387,000	2,204,000	34%	44%	30%	14	26	69
Orange	128,000	313,000	493,000	27%	36%	23%	13	21	78
Riverside	78,000	158,000	263,000	24%	29%	18%	18	29	95
San Bernardino	64,000	125,000	205,000	21%	24%	14%	18	29	116
Ventura	29,000	68,000	107,000	24%	32%	19%	16	27	109
Total	**854,000**	**2,052,000**	**3,277,000**	**30%**	**38%**	**25%**	**15**	**26**	**73**

SOURCE: SCAG 2012-2035 RTP/SCS, Highways and Arterials Appendix, Page 52, Table A12, 2011.

Based on average accident rates provided by Caltrans, transportation-related fatalities occur at an overall rate of 0.83 fatalities per 100 million vehicle miles traveled, taking into account the varying accident rates on different facility types (freeway, arterials) and travel modes (bus transit, rail transit). These specific accident rates and the resulting estimate of region-wide accidents are detailed in **Table 3.12-5**.

TABLE 3.12-5: TOTAL VEHICLE FATALITIES

County	Fatalities (2009)	Fatalities per 100 million Vehicle Miles Traveled	Annual Vehicle Miles Traveled per100 million
Imperial	37	1.76	21
Los Angeles	589	0.76	778
Orange	154	0.59	261
Riverside	219	1.04	210
San Bernardino	236	1.11	212
Ventura	62	0.86	72
Total	**1,297**	**0.83**	**1,554**

SOURCE: SCAG, 2011.

A summary of home-to-work trip characteristics by county is also presented in **Table 3.12-6**. Public transit in all forms (including school buses) carries approximately 2.4 percent of all trips in the SCAG region. Of these, the greatest number of travelers is carried by buses, with lesser patronage on Metro Rail, paratransit, commuter rail and other forms of public transit services. Work trips made via public transit account for 6.1 percent of all home-to-work trips in the region, as detailed in **Table 3.12-6**.

TABLE 3.12-6: EXISTING TRAVEL MODE SPLIT (% OF COUNTY TOTAL)

County	Person Trip Type	Drive Alone	2 Person Carpool	3 Person Carpool	Auto Passenger Trip	Transit	Non-Motorized	Total
Imperial	Home-Work/Univ	75%	3.9%	1.5%	7.6%	1.4%	10%	100%
	All Daily Trips	41%	7.4%	5.4%	20%	0.54%	25%	100%
Los Angeles	Home-Work/Univ	76%	3.4%	1.5%	7.1%	9.1%	3.0%	100%
	All Daily Trips	43%	8.0%	6.5%	24%	3.5%	14%	100%
Orange	Home-Work/Univ	81%	3.7%	1.5%	7.4%	3.4%	3.0%	100%
	All Daily Trips	46%	8.3%	6.8%	26%	1.4%	12%	100%
Riverside	Home-Work/Univ	82%	3.7%	1.8%	8.0%	1.5%	3.1%	100%
	All Daily Trips	42%	8.3%	7.3%	27%	0.72%	15%	100%
San Bernardino	Home-Work/Univ	82%	3.8%	1.8%	8.3%	1.4%	3.0%	100%
	All Daily Trips	43%	8.4%	7.3%	27%	0.58%	14%	100%
Ventura	Home-Work/Univ	82%	3.2%	1.4%	6.6%	2.7%	3.7%	100%
	All Daily Trips	43%	7.5%	6.3%	23%	1.1%	19%	100%
Total	**Home-Work/Univ**	**78%**	**3.5%**	**1.6%**	**7.3%**	**6.1%**	**3.1%**	**100%**
	All Daily Trips	**43%**	**8.1%**	**6.7%**	**25%**	**2.4%**	**14%**	**100%**

SOURCE: SCAG Transportation Modeling 2011.

Regional Freeway, Highway, and Arterial System

The regional freeway and highway system shown in **Map 3.12-3** located in Chapter 8.0 (Maps), is the primary means of person and freight movement for the region. This system provides for direct auto, bus and truck access to employment, services and goods. The network of freeways and State highways serves as the backbone of the system offering very high capacity limited-access travel and serving as the primary heavy-duty truck route system. The components of the regional highway and freeway system are included in **Table 3.12-7**.

TABLE 3.12-7: EXISTING REGIONAL FREEWAY ROUTE MILES AND LANE MILES BY COUNTY

County	Freeway Route Miles	Freeway Lane Miles
Imperial	95	379
Los Angeles	637	4,583
Orange	167	1,294
Riverside	309	1,722
San Bernardino	471	2,512
Ventura	93	532
Total	**1,772**	**9,424**

SOURCE: SCAG Transportation Modeling 2011.

Regional High Occupancy-Vehicle (HOV) System and Park & Ride System

The regional HOV system consists of exclusive lanes on freeways and arterials, as well as busways and exclusive rights-of-way dedicated to the use of high-occupant vehicles (HOVs). It includes lanes on freeways, ramps and freeway-to-freeway connectors. The regional HOV system is designed to maximize the person-carrying capacity of the freeway system through the encouragement of shared-ride travel modes. HOV lanes operate at a minimum occupancy threshold of either two or three persons. Many include on-line and off-line park and ride facilities, and several HOV lanes are full "transitways" including on-line and off-line stations for buses to board passengers. The current system is described in **Table 3.12-8**.

TABLE 3.12-8: EXISTING REGIONAL HIGH OCCUPANCY VEHICLE LANE MILES BY COUNTY

County	HOV Total Lane Miles
Imperial	0
Los Angeles	479
Orange	241
Riverside	83
San Bernardino	105
Ventura	0
Total	**908**

SOURCE: SCAG Transportation Modeling 2011.

Park and ride facilities are generally located at the urban fringe along heavily-traveled freeway and transit corridors and support shared-ride trips, either by transit, by carpool or vanpool. Most rail transit stations have park and ride lots nearby. There are currently 189 park and ride lots in the SCAG region, including Metrolink station parking lots. These facilities include: 106 in Los Angeles County, 20 park and ride facilities in Orange County, 25 in Riverside County, 17 in San Bernardino County and 21 in Ventura County.[4]

Arterial Street System

The local street system provides access for local businesses and residents. Arterials account for over 80 percent of the total road network and carry a high percentage of total traffic. In many cases arterials serve as alternate parallel routes to congested freeway corridors. Peak period congestion on the arterial street system occurs generally in the vicinity of activity centers, at bottleneck intersections and near many freeway interchanges. The region's arterial street system is described in terms of number of miles in **Table 3.12-9**.

[4] Riverside County Transportation Commission and the San Bernardino Associated Governments. IE511.org. 2011.

TABLE 3.12-9: EXISTING REGIONAL ARTERIAL ROUTE MILES AND LANE MILES BY COUNTY

County	Arterials	Lane Miles
Imperial	Principal	433
	Minor	697
Los Angeles	Principal	8,848
	Minor	9,076
Orange	Principal	3,242
	Minor	3,147
Riverside	Principal	1,181
	Minor	3,235
San Bernardino	Principal	1,934
	Minor	4,365
Ventura	Principal	908
	Minor	986
SCAG Total	**Principal**	**16,547**
	Minor	**21,506**

SOURCE: SCAG Transportation Modeling 2011.

Goods Movement

Wholesale and retail trade, transportation, and manufacturing support over 3.3 million jobs in the region according to statistics provided by the State's Employment Development Department. Goods movement includes trucking, rail freight, air cargo, marine cargo, and both domestic and international freight, the latter entering the country via the seaports, airports, and the international border with Mexico. Additionally, many cargo movements are intermodal, e.g. sea to truck, sea to rail, air to truck, or truck to rail. The goods movement system includes not only highways, railroads, sea lanes, and airways, but also intermodal terminals, truck terminals, railyards, warehousing, freight consolidation/de-consolidation terminals, freight forwarding, package express, customs inspection stations, truck stops, and truck queuing areas.

Railroads

The SCAG region is served by two main line commercial freight railroads - the Burlington Northern/Santa Fe Railway Co. (BNSF) and the Union Pacific Railroad (UP). These railroads link Southern California with other United States regions, Mexico and Canada either directly or via their connections with other railroads. They also provide freight rail service within California. In 2011, railroads moved approximately 150 million tons of cargo throughout California.

The SCAG region is also served by three short line or switching railroads:

- The Pacific Harbor Line (formerly the Harbor Belt Railroad), which handles all rail coordination involving the Ports of Los Angeles and Long Beach, including dispatching and local switching in the harbor area
- Los Angeles Junction Railway Company, owned by BNSF, which provides switching service in the Vernon area for both the BNSF and UP
- The Ventura County Railroad, owned by Rail America, Inc., which serves the Port of Hueneme and connects with the UP in Oxnard

These railroads perform specific local functions and serve as feeder lines to the trunk line railroads for moving goods to and from Southern California.

The two main line railroads also maintain and serve major facilities in the SCAG region. Intermodal facilities in Commerce (BNSF-Hobart), East Los Angeles (UP), San Bernardino (BNSF), and Carson near the San Pedro Bay Ports (UP-ICTF), the Los Angeles Transportation Center (UP-LATC), and the UP-City of Industry yards serve on-dock rail capacity at the Ports of Los Angeles (UP/BNSF) and Long Beach (UP/BNSF).

All of the major rail freight corridors in the region have some degree of grade separation, but most still have a substantial number of at-grade crossings on major streets with high volumes of vehicular traffic. These crossings cause both safety and reliability problems for the railroads and for those in motor vehicles at the affected crossings. Trespassing on railroad rights of way by pedestrians is another safety issue affecting both freight and commuter railroads.

As an example, the Colton Crossing, is an at-grade railroad crossing located south of I-10 between Rancho Avenue and Mount Vernon Avenue in the City of Colton, where BNSF's San Bernardino Line crosses UP's Alhambra/Yuma Lines. In 2008, the Colton Crossing saw on average 110 freight trains per day.[5]

Another key component of the regional rail network is the Alameda Corridor, a 20-mile, four-lane freight rail expressway that began operations in April 2002. In 2010, approximately 14,177 intermodal trains transited the Alameda Corridor, an approximate increase of 8.6 percent since 2009.[6]

Heavy-Duty Trucks

One of the key components of the region's goods movement system is the fleet of heavy-duty trucks, defined as cargo-carrying vehicles with a gross weight rating in excess of 8,500 pounds. Trucks provide a vital link in the distribution of all types of goods between the region's ports (sea and air), railroads, warehouses, factories, farms, construction sites and stores. The size and weight of heavy-duty trucks gives them unique operating characteristics; i.e., they accelerate and decelerate more slowly than lighter vehicles and require more road space to maneuver. Dedicated truck lanes currently exist at two major freeway interchanges: the junction of I-5 with the I-210 and the SR-14 and at the junction of the I-405 with the I-110. In addition, truck climbing lanes are located on northbound I-5 in northern Los Angeles County.

The trucking industry, including common carrier, private carrier, contract carrier, drayage and owner-operator services, handles both line-haul and pick-up and delivery. The industry uses the public highway system for over-the-road and local service. However, it is also served by a considerable infrastructure of its own. This infrastructure includes truck terminals, warehousing, consolidation and trans-loading facilities, freight forwarders, truck stops and maintenance facilities. These various facilities are especially prevalent in the case in the South Bay and Gateway Cities areas, including Wilmington and Carson and extending generally between LAX and the San Pedro Bay Ports, along the I-710 Corridor north to Vernon, Commerce, and downtown Los Angeles, east through the San Gabriel Valley to Industry, Pomona, and Ontario and then to the Inland Empire in Fontana and Rialto as well as in Glendale, Burbank and Bakersfield. Specialized facilities for trucking that provide air cargo ground transport are located around regional airport facilities, notably LAX and LA/Ontario International Airport.

Maritime Ports

Southern California is served by three major deep-water seaports. These ports—Hueneme, Long Beach and Los Angeles—handle Asia – North America trade, and are served by the two major railroads and numerous trucking companies in Southern California. The Port of Hueneme, with its recent expansion, ranks as one of

[5]SANBAG, 2011. Colton Crossing Project. http://www.coltoncrossing.com/EnvironmentalAndEngineeringDocuments/Colton%20Crossing_Final%20EA%20and%20FONSI_2011-05.pdf, accessed September 2011.

[6]Alameda Corridor Transportation Authority, Number of Trains Running on the Alameda Corridor (http://www.acta.org/pdf/CorridorTrainCounts.pdf), 2011.

the premier automobile and agricultural product-handling facilities in California. The Ports of Long Beach and Los Angeles are full-service ports with facilities for containers, autos and various bulk cargoes. With an extensive landside transportation network, the three ports moved more than 310 million metric tons of cargo in 2010.[7]

In particular, the San Pedro Bay Ports (Long Beach and Los Angeles) dominate the container trade in the Americas by shipping and receiving more than 11.8 million twenty-foot Equivalent Units (TEUs) of containers in 2009.[8] Together these two ports rank third in the world, behind Rotterdam and Hong Kong, as the busiest maritime ports.

Regional Aviation System

The SCAG region contains 56 public use airports, including six active commercial service airports, 44 general aviation, two active limited-commercial service (commuter) airports, two former military airfields (now public-use airports) and two joint-use facilities. The existing active commercial service airports (shown on **Map 3.12-4** located in Chapter 8.0 (Maps)) handle the majority of passenger air traffic. They are:

- Los Angeles International Airport
- LA/Ontario International Airport
- John Wayne/Orange County Airport
- Bob Hope Airport
- Imperial County Airport (limited commercial service)
- Long Beach Airport
- Palm Springs International Airport
- Oxnard (limited commercial service)

In all, some 81 million annual passengers (MAP) were served in the region in 2010, more than double the number served in 1980. The level of air passenger demand is forecast to be approximately 146 MAP by 2035. While none of the individual airports is the largest in the U.S., the region's airports collectively are the busiest of any region in the country. The existing level of activity reflecting air passenger demand (MAP), operations (take-offs and landings or TOAL) and air cargo demand at each of the six existing airports is shown in **Table 3.12-10**. A brief discussion of the location, major access routes and facilities at each of these airports follows. In addition, the six other regional airports at which major improvements and/or conversion to civilian uses are contemplated are also described below.

TABLE 3.12-10: EXISTING (2010) ACTIVITY AT MAJOR COMMERCIAL AIRPORTS IN THE SCAG REGION

	Burbank	John Wayne	Long Beach	Los Angeles	LA/ Ontario	Palm Springs	Regional Total
Passenger Volume (1,000)	4,461	8,663	2,978	59,069	4,808	1,420	81,399
Percent of Regional Total	5.5%	10.6%	3.7%	72.6%	5.9%	1.7%	100%
Cargo Volume (tons)	48,084	14,920	28,690	1,926,825	392,427	<100	2,410,946
Percent of Regional Total	2.0%	0.6%	1.2%	79.9%	16.3%	0.0%	100%
Annual Operations	112,658	200,278	315,340	575,835	98,332*	64,490	1,366,933
Average Daily Operations	309	549	864	1,578	269*	177	3,745
Percent of Regional Total	8.2%	14.7%	23.1%	42.1%	7.2%	4.7%	100%

Note: Ontario data is from 2009 statistics.
SOURCE: SCAG, 2011

[7]Port of Los Angeles 2010 Financial Statement; Port of Los Angeles 2010 Tonnage Statistics; and Port of Long Beach December 2010 Monthly Tonnage Summary Report.
[8]SCAG. *Port Activity and Competitiveness Tracker (PACT)*, 2011.

Los Angeles International Airport

Los Angeles International Airport (LAX), as shown in **Map 3.12-4** located in Chapter 8.0 (Maps), is located in the southwestern portion of the City of Los Angeles, bordered by Arbor Vitae / Westchester Parkway to the north, I-405 to the east, I-105 / Imperial Highway to the south, and the Pacific Ocean to the west. It is surrounded by the communities of Westchester and Playa del Rey to the north; the City of El Segundo to the south; and the City of Inglewood and unincorporated areas of Los Angeles County (Lennox and Del Aire) to the east. Major access routes include I-405 and I-105 and a complex network of surface streets extending throughout the surrounding area, including Sepulveda Boulevard, Lincoln Boulevard, La Cienega Boulevard, Aviation Boulevard, Century Boulevard, Arbor Vitae / Westchester Parkway and Imperial Highway.

LA/Ontario International Airport

LA/Ontario International Airport (ONT) is located in the southwest section of San Bernardino County within the city of Ontario, approximately two miles east of Ontario's Central Business District between Holt and Mission Boulevards, and between Haven and Grove Avenues, as shown in **Map 3.12-4** located in Chapter 8.0 (Maps). Major access routes include I-10 and SR-60 and the major surface streets in the surrounding area, including Holt Boulevard, Archibald and Vineyard Avenues.

John Wayne Airport

John Wayne Airport (SNA) is located in the western portion of Orange County, directly south of I-405, one mile east of SR-55, and one mile north of SR-73, as shown in **Map 3.12-4** located in Chapter 8.0 (Maps). Major access routes include these freeways and the major surface streets in the surrounding area, including MacArthur Boulevard and Michelson Drive. The majority of the land surrounding the Airport is within the cities of Newport Beach, Costa Mesa, and Irvine. In addition, the unincorporated community of Santa Ana Heights is located southeast of the Airport.

Bob Hope Airport

Bob Hope Airport (BUR) is located in the western portion of Los Angeles County, on the west side of the City of Burbank, one mile south of I-5, three miles east of SR-170, and three miles north of SR-134, as shown in **Map 3.12-4** located in Chapter 8.0 (Maps). Major access routes include these freeways and the major surface streets in the surrounding area, including Hollywood Way and San Fernando Road.

Long Beach Airport

Long Beach Airport (LGB) is located in the southern portion of Los Angeles County, in the center of the City of Long Beach, directly north of I-405, and three miles west of I-605, and three miles east of I-710, as shown in **Map 3.12-4** located in Chapter 8.0 (Maps). Major access routes include these freeways and the major surface streets in the surrounding area, including Lakewood Boulevard (SR 19).

Palm Springs International Airport

Palm Springs International Airport (PSP) is located in the central portion of Riverside County, in the City of Palm Springs, two miles southwest of I-10 and one mile northeast of Gene Autry Trail (SR-111), as shown in **Map 3.12-4** located in Chapter 8.0 (Maps). Major access routes include these highways and the major surface streets in the surrounding area, including Ramon Road.

Palmdale Regional Airport

Palmdale Regional Airport (PMD) is located in northern Los Angeles County, within the north central portion of the City of Palmdale in United States Air Force Plant 42 (AFP 42), one mile north of SR-138, and three miles east of SR-14, as shown in **Map 3.12-4** located in Chapter 8.0 (Maps). Major access routes include these highways and the major surface streets in the surrounding area, including 20th Street and Avenue P.

San Bernardino International Airport

San Bernardino Airport (SBD), formerly Norton Air Force Base, is within the City of San Bernardino and is surrounded by unincorporated areas of San Bernardino County and the cities of Redlands, Loma Linda, Highland, and Colton. The Airport is approximately three miles east of I-215, two miles north of I-10, and one mile west and two miles south of SR 30, as shown in **Map 3.12-4** located in Chapter 8.0 (Maps). Major access routes include these highways and the major surface streets in the surrounding area, including Tippecanoe Avenue, Mill Street and 3rd Street.

Southern California Logistics Airport

Southern California Logistics Airport (VCV), formerly George Air Force Base, is within the City of Victorville, surrounded by unincorporated areas of San Bernardino County and the cities of Victorville and Adelanto. It is approximately two miles east of Route 395, and three miles northwest of I-15, as shown in **Map 3.12-4** located in Chapter 8.0 (Maps). Major access routes include these highways and the major surface streets in the surrounding area, including Adelanto Road and Air Base Road.

March Air Reserve Base/March Inland Port

March Air Reserve Base / March Inland Port (March), formerly March Air Force Base, is located in the western portion of Riverside County east of and adjacent to I-215 and two miles south of SR-60, as shown in **Map 3.12-4** located in Chapter 8.0 (Maps). The joint-use facility is bordered by the cities of Moreno Valley to the north and east, Riverside to the northwest, and Perris to the south. Major access routes include these freeways and the major surface streets in the surrounding area, including Van Buren Boulevard and Perris Boulevard.

Security and Emergency Access

Southern California is home to significant natural disasters; including earthquakes, wildfires, flooding and mudslides (discussed in Section 3.5 Geology and Soils, of this PEIR). Although natural disasters, such as earthquakes and hurricanes, have produced significant regional casualties and property damage, none had the serious disruption to national travel and the national economy as the September 11th, 2001 terrorist attacks. The September 11th attacks created a new awareness of the vulnerabilities of transportation fleets and facilities. As concern about the threat of terrorism and consequences of natural disasters has grown, government (at all levels) has taken new measures to secure the welfare of its citizens. Transportation and transit agencies throughout the United States are taking increasing steps to protect their facilities against the threats of crime, terrorist activity, and natural disasters.

A large scale evacuation would be difficult in the SCAG region. The region already has severe traffic congestion and mobility issues. The region encompasses 38,000 square miles with a diverse geography, ranging from dense urban areas, to mountain ranges, to vast deserts. The interdependency of the jurisdictions and organizations makes regional cooperation and coordination essential to security and emergency preparedness. Typically, no single agency is responsible for transportation security. At the local level, especially within transit agencies, safety may be handled within one office. However, it is far less likely that the security of a surface transportation mode is managed by one entity and that this entity is even controlled by the transportation organization. For example, highways and transit networks traverse multiple police jurisdictions, local fire departments generally fill the incident command role after terrorist events, regional command and control centers respond to both natural and intentional disasters, and federal agencies intervene as needed and based on specific guidelines such as the crossing of state boundaries.[9]

The complexity of the SCAG region, with a range of potential terrorism targets, presents significant challenges in coordinating and implementing effective homeland security programs. The unexpected and complex nature of these natural and human-caused incidents require extensive coordination, collaboration and flexibility among all of the agencies and organizations involved in planning, mitigation, response and recovery.

Safety is defined as the protection of persons and property from unintentional damage or destruction caused by accidental or natural events.

Security is defined as the protection of persons or property from intentional damage or destruction caused by vandalism, criminal activity or terrorist attacks. The Transportation Research Board has classified emergency events that affect transportation agencies into several categories, which are illustrated below in **Table 3.12-11**.[10]

TABLE 3.12-11: TRANSPORTATION SECURITY VULNERABILITIES	
ROADWAYS AND FREEWAY	
Freeway Lanes Miles (excluding carpool)	9,424 miles
Carpool Lane Miles	1,033 miles
Road Lane Miles	38,871 miles
PUBLIC TRANSIT	
Buses	5,443 vehicles
Metro Rail	73 miles and 65 stations
Metrolink	512 miles and 55 stations
AVIATION/PORTS	
Commercial/General Aviation Airports	57
LAX rank among world's airports	6 in passengers and 11 in air cargo tonnage
Long Beach/Los Angeles rank among world container ports	5th
Share of United States Maritime Trade	41 percent
SOURCE: SCAG 2012-2035 RTP/SCS, Transportation Security Appendix, Page 3, 2011.	

International Border Crossings. Within the SCAG region, there are three international ports of entry along the Mexico-Imperial County border: two at Calexico (Calexico and Calexico-East); and, one at Andrade (near Yuma, Arizona). Traffic from these ports enters California on the I-8 corridor. U.S. Customs and the Border Protection Agency within the DHS are charged with the management and control of the official ports of entry. Security planning includes local emergency services, as well as the CHP.

Caltrans District 11 has developed the California-Baja California Border Master Plan, which establishes a process to institutionalize dialogue among local, State and federal stakeholders in the United States and Mexico. A key objective was to develop criteria that can be used in future studies to coordinate and prioritize projects related to existing and new Ports of Entry (POEs), as well as roads leading to the California Mexico POEs. Security was a major consideration in the development of the Border Master Plan.

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[9]National Cooperative Highway Research Project 525 Volume 3 Transportation Planning Process, page 16.
[10]National Cooperative Highway Research Program Report 525 Volume 9 "Guidelines for Transportation Emergency Training Exercises" McCormick Taylor Inc. 2006.

Seaports. The DHS has designated the seaports of Long Beach, Los Angeles, and Port Hueneme as at risk for potential terrorist actions.[11] Security at the ports is the joint responsibility of the U.S. Coast Guard, the U.S. Customs and Border Protection Agency, federal and State Homeland Security offices, Port police agencies, Harbor Patrols and emergency service agencies. The U.S. Coast Guard leads the local Area Maritime Security Commission, which coordinates activities and resources for all port stakeholders.

The Port of Los Angeles has a dedicated police force, the Los Angeles Port Police, to patrol the area within the jurisdiction of the Port of Los Angeles. The Port Police enforce federal, State and local public safety statutes, as well as environmental and maritime safety regulations in order to maintain the free flow of commerce and produce a safe, secure environment that promotes uninterrupted Port operations. In addition, the Port Police partner with other law enforcement agencies, such as the Los Angeles Police Department, CHP, and Customs and Border Protection in the Cargo Theft Interdiction Program (CTIP), which investigates cargo theft, and the High Intensity Drug Trafficking Area, which targets drug trafficking at the Ports of Los Angeles and Long Beach. Furthermore, per the Maritime Transportation Security Act of 2002, the Port of Los Angeles works with the Coast Guard to develop security plans for facilities at the port.

Similar to the Port of Los Angeles, security at the Port of Long Beach entails physical security enhancements, police patrols, coordination with federal, State, and local agencies to develop security plans for the port area and investigate suspicious incidents, and obtaining federal funding to pay for these enhancements. As with the Port of Los Angeles, the Port of Long Beach works with the Coast Guard to develop security plans for facilities at the port.

In contrast to the Port of Los Angeles, however, the Port of Long Beach does not have its own dedicated police force. Instead, the Long Beach Police Department is responsible for patrolling the port area. In doing so, the Port reimburses the Long Beach Police and Fire Departments for their port related activities and expenses. The Port also funds its own Harbor Patrol to supplement law enforcement work conducted by other agencies such as the Coast Guard.

In addition to the above, several programs are in place to effectively monitor and screen seaport cargo. They include:

Investigations: The federal Container Security Initiative (CSI) directs Customs agents, working with host governments, to inspect and examine all cargo containers deemed high-risk before they are loaded on U.S.-bound vessels. The CSI contains four core elements: identifying high-risk containers, pre-screening containers before they reach U.S. ports of entry, using technology to prescreen high-risk containers and developing and using smart and secure containers.

Inspections: The 24-hour rule requires manifest information on cargo containers to be delivered to U.S. Customs 24 hours before the container is loaded onto a vessel in a foreign port. Customs has the right to stop any container from being loaded, for any reason, while the container is still overseas.

Partnerships: Most of the largest U.S. importers and their trading partners participate in the Customs-Trade Partnership Against Terrorism (C-TPAT), a public-private partnership designed to improve security standards throughout the cargo supply chain.

Technology: U.S. Customs uses X-ray, gamma ray and radiation-detection devices to screen incoming cargo at U.S. ports.

Airports. The SCAG region supports the nation's largest regional airport system in terms of number of airports and aircraft operations, operating in a very complex airspace environment. The system has six established air carrier airports including Los Angeles International (LAX), Bob Hope (formerly Burbank), John Wayne, Long Beach, LA/Ontario International and Palm Springs. There are also three emerging air

[11] Fiscal Year 2006 Infrastructure Protection Program. U.S. Department of Homeland Security, September 25, 2006.

carrier airports in the Inland Empire and North Los Angeles County. These include San Bernardino International Airport (formerly Norton Air Force Base), March Inland Port (joint use with March Air Reserve Base) and Southern California Logistics Airport (formerly George Air Force Base). Palmdale Airport (joint use with Air Force Plant 42) was once thought to be a potential regional airport; however, it is currently a general aviation facility. The only commercial airline - United Airlines - that serviced the Airport with flights to/from San Francisco ceased operations in December 2008. There is no indication presently of any commercial air service, and Los Angeles World Airport has surrendered its federal certification to operate Palmdale Regional as a commercial facility. The airport features a modern 9,000-square-foot terminal capable of handling up to 300,000 passengers annually. The regional system includes 45 general aviation airports and two commuter airports, for a total of 57 public use airports.

Airport security planning is the joint responsibility of the federal Transportation Security Administration (TSA), the airlines, and the individual airports. Airports in the SCAG region have upgraded their security systems since 9/11 using a variety of strategies in conjunction with local, State and federal law enforcement. However, a number of aviation vulnerabilities continue to persist. These included effective screening of passengers and baggage for threat objects and explosives, adequate controls for limiting access to secure areas at airports, and adequate security for air traffic control computer systems and facilities.

Rail and Mass Transit. The dispersed nature and the daily volume of passengers using public transportation services, which include intercity passenger rail, commuter rail, subway systems, and bus transportation, make it an attractive target for terrorists and criminals. Today, regional transit in the SCAG region is comprised of:

- Approximately 640 bus routes
- Approximately 67 local bus (demand response and paratransit) operators
- 13 commuter express bus services[12]
- Two subway lines and 3 light rail lines situated within Los Angeles County

The numbers of customers using public transportation each and every day creates ongoing challenges for enhancing security within transit environments. A number of plans have been implemented to provide for basic protection. In the early 1990s, the California Public Utilities Commission required that transit agencies operating rail systems prepare a comprehensive System Safety Program Plan (SSPP) that also included a security component. Since 2004, all transit agencies are required to include a security and emergency management plan, which details how the agency would coordinate with first responder (law enforcement and fire) agencies, their respective County Office of Emergency Services and the Statewide Standardized Emergency Management System (SEMS).

Public Transit, Bicycle, or Pedestrian Facilities

Public Transit. In Southern California public transit service is comprised of local and express buses, transitways, Rapid Bus, urban rail, including subway and light rail principally centered in the core of Los Angeles County, commuter rail that spans five counties and shuttles/circulators that feed all transportation modes and activity centers. Transit service is provided by approximately 67 separate public agencies. 12 of these agencies provide 91 percent of the existing public bus transit service. Local service is supplemented by municipal lines and shuttle services. Private bus companies provide additional regional service.

Many people depend on reliable transit service to participate in the economic, cultural and social benefits of Southern California. Transit ridership was approximately 708 million in 2010.[13] The largest provider of public transit service in Imperial County is Imperial Valley Transit which serves the cities and communities

[12]Santa Clarita, Antelope Valley, LADOT and VISTA operate Commuter Express bus services. Santa Monica, Foothill, Montebello, Torrance, Gardena and Orange County operate local limited bus service into downtown Los Angeles.
[13]SCAG Transit Data Collection, 2011.

of Brawley, Bombay Beach, Calexico, Calipatria, El Centro, Heber, Hotville, Imperial, Niland, Ocotillo, Salton Sea, Seeley, Westmorland, and Winterhaven. There are approximately 28 routes with multiple trips daily Monday through Friday and a reduced schedule on Saturdays. In 2010, the system experienced approximately 49,000 average monthly boardings, and approximately 15 percent of the system's operating expenses were recovered through passenger fares.[14]

The largest provider of public transit service in Los Angeles County is the Los Angeles County Metropolitan Transportation Authority (Metro). Metro operates a comprehensive network of fixed-route bus routes and an urban light rail system (Metro Rail) and subway. Among the fixed-route bus services operated by the Metro is Metro Rapid Bus, which consists of a simple route layout, frequent service, less frequent stops, low-level buses for fast boarding and exiting, color-coded buses and stop, and bus priority at intersections. In 2010, the system experienced approximately 41.9-million average monthly boardings, and approximately 24 percent of the system's bus operating expenses were recovered through passenger fares.[15]

The largest provider of public transit service in Orange County is the Orange County Transportation Authority (OCTA), which operates 77 bus local and express routes and approximately 62,000 bus stops located throughout the urbanized portions of Orange County. In 2010, the system experienced approximately 4.8 million average monthly boardings, and approximately 25 percent of the system's operating expenses were recovered through passenger fares.[16]

The largest provider of public transit service in Riverside County is the Riverside Transit Agency (RTA), which is the primary provider of fixed-route and paratransit services throughout a 2,500 square mile service area in the western portion of the county. It operates 231 buses on approximately 43 local and express routes. In 2010, the system experienced approximately 950,000 average monthly boardings, and approximately 15 percent of the system's operating expenses were recovered through passenger fares.[17]

The largest provider of public transit service in San Bernardino County is Omnitrans, which provides bus and paratransit services in a 480 square mile area in Southwestern San Bernardino County, which includes the cities and communities of Chino, Colton, Fontana, Loma Linda, Montclair, Ontario, Redlands, Rialto, San Bernardino, Upland, Chino Hills, Grand Terrace, Highland, Rancho Cucamonga, Yucaipa, Bloomington, Mentone and Muscoy. It operates a fleet of more than 277 buses over approximately 27 routes. In 2010, the system experienced approximately 1.3 million average monthly boardings, and approximately 23 percent of the system's operating expenses were recovered through passenger fares.[18]

The largest provider of public transit service in Ventura County is Gold Coast Transit, which provides bus and paratransit services over 91 square miles in the western portion of the county. Service is provided to the cities of Ojai, Oxnard, Port Hueneme, Ventura and the unincorporated areas in between the cities. It operates a fleet of 78 buses over approximately 18 routes. In the fiscal year 2010, the system experienced approximately 407,000 average monthly boardings, and approximately 20 percent of the system's operating expenses were recovered through passenger fares.[19]

Rail transit ridership has been steadily increasing as new routes have been added. Commuter rail service has continued to grow steadily since its introduction in 1992, both in service and patronage. A summary of the current service and patronage for the largest transit operators in each county is presented in **Table 3.12-12**.

[14]National Transit Database, 2011.
[15]*Ibid.*
[16]*Ibid.*
[17]*Ibid.*
[18]*Ibid.*
[19]*Ibid.*

TABLE 3.12-12: STATISTICS FOR MAJOR TRANSIT OPERATORS (2010)

County	Largest Transit Operator	Average Weekday Boardings	Annual Boardings	Annual Vehicle Revenue Miles(VRM)	Passenger Fares as a % of Operation Expenses*
FIXED ROUTE BUS SERVICE					
Imperial	IVT	2,000	593,000	666,000	15.2%
Los Angeles	Metro	1,579,000	503,071,000	139,274,000	24.4%
Orange	OCTA	182,000	58,104,000	21,666,000	25.1%
Riverside	RTA	36,000	11,368,000	10,163,000	15.2%
San Bernardino	Omnitrans	49,000	15,685,000	10,035,000	22.9%
Ventura	Gold Coast Transit	15,000	4,880,000	3,853,000	19.6%
METRO RAIL – HEAVY RAIL					
Los Angeles	Metro	150,000	47,906,000	5,885,000	38.7%
METRO RAIL – LIGHT RAIL					
Los Angeles	Metro	146,000	46,409,000	9,646,000	18.3%
REGIONAL COMMUTER RAIL					
Various	SCRRA (Metrolink)	38,000	12,006,000	10,479,000	42.4%

SOURCE: National Transit Database. 2011.

Metro Rail System

Existing urban rail lines (Metro Rail) are located in Los Angeles County and are operated by Metro. They include the Metro Blue Line from Long Beach to Downtown Los Angeles, the Metro Green Line from Redondo Beach to Norwalk, the Metro Red Line subway, from Union Station to North Hollywood. The Metro Purple Line subway follows the Red Line from Union Station to Wilshire and Vermont but branches off to Western Avenue as shown in **Map 3.12-5** located in Chapter 8.0 (Maps), and the Metro Gold Line which runs from East Los Angeles (Atlantic station) to Pasadena via Union Station. The Metro Rail system is operated seven days a week. A system total of 79 route miles serves a total of 73 stations. Ridership on the Metro Rail system is approximately 303,000 boardings every day.[20]

Regional Commuter Rail

Commuter rail service is operated by the Southern California Regional Rail Authority (SCRRA). In October of 1992, the SCRRA began initial operation of the Metrolink commuter rail system on three lines. Service on the initial system was greatly expanded after the 1994 Northridge earthquake. Currently SCRRA operates seven routes including five from downtown Los Angeles to Ventura, Lancaster, San Bernardino, Riverside, and Oceanside, from San Bernardino to Oceanside, and from Riverside via Fullerton or City of Industry to downtown Los Angeles. As of September 2010, the system operated 144 trains on weekdays, 40 on Saturdays and 26 on Sundays to 55 stations on 512 route miles. Average weekday ridership is approximately 40,544 passengers.[21]

Amtrak provides significant regional and inter-regional service on the LOSSAN—San Diego to San Luis Obispo corridor (also known as Amtrak's Pacific Surfliner corridor) operating twelve daily round-trip services, which stop at the Los Angeles Union Station. Additionally, Amtrak operates four interstate routes

[20] Los Angeles Metropolitan Transportation Authority. Facts at a Glance – October 2011, 2011.
[21] Southern California Regional Rail Authority. (2010). http://www.metrolinktrains.com/about/?id=6, accessed September 2011.

within the region (Coast Starlight, Sunset Limited, Southwest Chief and Texas Eagle) that on average have one daily trip.[22] These regional commuter rail lines are shown in **Map 3.12-5** located in Chapter 8.0 (Maps).

Shuttles and Demand-Responsive Services

One component of the region's public transit system consists of publicly operated or funded demand-response taxis and dial-a-ride services; some open to the general public, others limited to elderly and disabled use. It also includes locally operated or funded shuttle buses (e.g., Los Angeles DASH, Pasadena ARTS, Glendale Beeline, Cerritos on Wheels, El Monte Transit, Riverside Orange Blossom, etc.). Access Paratransit, the largest provider of transportation services for the disabled in the region, operates in the vicinity of fixed-route bus and rail lines in Los Angeles County and extends into portions of the surrounding counties of San Bernardino, Orange and Ventura. These systems serve as local shuttles, internal circulators, connectors to other public transit, or as shoppers' shuttles. Service on these systems is usually limited to a prescribed geographic area.[23]

Bicycle and Pedestrian Facilities (Non-motorized Transportation)

Biking and walking primarily constitutes non-motorized transportation. Non-motorized transportation plays a bigger role in the densely-populated, mixed-land-use areas of the region. In 2009 biking and walking accounts for approximately 20.9 percent of total trips and 3.2 percent of trips to work or university from home.[24]

The region's bikeways encourage non-motorized travel, serve as recreational facility, and provide inexpensive, environmentally-friendly transportation opportunities. Class I bikeways are separate shared-use paths also used by pedestrians, Class II bikeways are striped lanes in streets, and Class III bikeways are signed routes. Nearly 4,615 miles of Class I and II bikeways exist through the region, as well as mountain bike trails, some of which are also designated for hiking and horseback riding.[25] The City of Los Angeles alone has more than 216 miles of Class I and II bikeways. Bike rack, locker and station programs are ongoing in a number of cities and transit operators. In addition, transit operators are integrating bicycle transportation with transit via bus bike racks, bike-on-train programs and bicycle lockers at transit centers. **Map 3.12-6** located in Chapter 8.0 (Maps) shows the regional bicycle.

Pedestrian access at and near public transit, in most major commercial areas and many residential areas is facilitated by sidewalks, a number of pedestrian malls, and in some cases local jogging and pedestrian trails or paths.

THRESHOLDS OF SIGNIFICANCE

The 2012-2035 RTP/SCS would have a significant impact related to transportation, traffic and security if it would:

- Conflict with an applicable plan, ordinance or policy establishing measures of effectiveness for the performance of the circulation system, taking into account all modes of transportation including mass transit and non-motorized travel and relevant components of the circulation system, including but not limited to intersections, streets, highways and freeways, pedestrian and bicycle paths, and mass transit;

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[22] Amtrak. (2011) Routes. http://www.amtrak.com/servlet/ContentServer?c=Page&pagename=am%2FLayout&p=1237405732511&cid=1237608331430, accessed September 2011.
[23] Access Services, About Us. http://www.asila.org/about_us/overview.html, accessed September 2011
[24] City of Los Angeles, *Bicycle Master Plan*, 2011.
[25] SCAG, *Draft 2012 Regional Transportation Plan*, 2011.

- Conflict with an applicable congestion management program, including, but not limited to level of service standards and travel demand measures, or other standards established by the county congestion management agency for designated roads or highways;
- Result in inadequate emergency access; and/or
- Conflict with adopted policies, plans, or programs regarding public transit, bicycle, or pedestrian facilities, or otherwise decrease the performance or safety of such facilities.

The following specific thresholds were developed by SCAG based on precedence as appropriate thresholds by which to determine significant impacts on transportation, traffic and security:

- Generate substantially more total daily Vehicle Miles of Travel (VMT) than the current daily VMT;
- Result in a substantially higher average Vehicle Hours of Delay (VHD) in delay for all trips compared to the current VHD delay;
- Result in substantially greater average delay and percent of total VHD in delay for heavy-duty truck trips than the current condition;
- Result in substantial decrease in the percent of work opportunities within 45 minutes travel time by personal vehicle or by transit, relative to the existing condition;
- Result in a substantially higher system-wide fatality accident rate for all travel modes compared to the existing condition;
- Result in a substantially higher system-wide injury accident rate for all travel modes compared to the existing condition; or
- Cause a cumulatively considerable adverse effect on regional transportation and associated environmental effects.

Methodology

Transportation data was obtained from the SCAG's Regional Travel Demand Model (RTDM, see a detailed description of that model in appendices to the RTP). This regional tool for characterizing the transportation environment divides the region into 11,267 Transportation Analysis Zones. Model inputs include: Socioeconomic Data by Census Block Group; Highway Networks; Land Use and Accessibility for Auto Ownership Model; Land Use, parking, pricing TDM, Walk and Bike for Mode Choice Model; Transit Networks; External Trips (inter-regional trips); Airport Trips and Employment, Commodity Flow, Ports and Warehouse Activities. The model includes modules that address Household Classification (size, number of workers, income, single-family or multi-family unit); Auto Ownership; Trip Generation; Trip Distribution; Mode Choice; Heavy Duty Trucks; Network Assignment; Model Convergence; and Highway Performance Monitoring System (HPMS) VMT-based Post processing.

A detailed description of the RTDM is provided in the Conformity Report, an appendix to the 2012-2035 RTP/SCS. A detailed description of the methodology used to identify growth is provided in the growth and SCS appendices of the RTP.

While the RTP has the ability to influence where growth occurs and therefore traffic in the region, it has no control over the forecasted increase in population growth. The anticipated increase in births over deaths as well as in-migration to the region is the reason that population growth and resulting traffic impacts occur.[26]

Cumulative Analysis

The 2012-2035 RTP/SCS addresses transportation projects and land use distribution patterns, including land use scenarios. These land use distribution patterns identify growth distribution and anticipated land use

[26] The Environmental Justice section of the Plan and associated appendix contains substantial analysis of accessibility and other transportation impacts to low income, minority and other protected groups. See Environmental Justice Appendix of the 2012-2035 RTP/SCS. However, the PEIR does not rely on this analysis as it addresses transportation impacts to the community as a whole.

development to accommodate growth projections. The Regional Travel Demand Model (RTDM) used for this analysis captures pass-through traffic that does not have an origin or destination in the region, but does impact the region, so that too is included in the project analysis. Although the similar level of development is anticipated even without the 2012-2035 RTP/SCS, this Plan would influence growth, including distribution patterns, throughout the region. To address this, the analysis in the PEIR covers overall impacts of all transportation projects and land development described in the 2012-2035 RTP/SCS. In addition, this PEIR considers cumulative impacts from other regional plans (e.g., the South Coast Air Quality Management Plan), which could result in additional impacts inside and outside the region.

Comparison with the No Project Alternative

The analysis of transportation resources includes a comparison between the expected future conditions with the Plan and the expected future conditions if no Plan were adopted (No Project Alternative). This evaluation is not included in the determination of the significance of impacts (which is based on a comparison of future conditions with the Plan to today); however it provides a meaningful perspective on the effects of the Plan.

Determination of Significance

The significance of impacts was determined by applying the significance criteria above to compare current regional transportation conditions to expected future conditions with the Plan. The RTDM provides performance data for future Plan conditions. The performance measure output for year 2035 with the Plan was compared to the existing regional conditions for each significance criterion to determine the significance of impacts. The 2035 transportation model output provides a regional and cumulative level of analysis for the impacts of the Plan on transportation resources.

IMPACTS

Impact 3.12-1: Potential to increase total daily Vehicle Miles of Travel (VMT) in 2035 compared to current daily VMT. The Plan would result in a significant impact related to VMT.

Regional VMT is related to growth and land use. The expansion of highways and local arterials has slowed down over the last decade. This has occurred in part due to roadway improvements not keeping pace with the growing population, this is at least in part because of increasing costs and environmental concerns. However, there are still critical gaps in the network that hinder access to certain parts of the region and/or hinder efficient regional operations. Locally-developed county transportation plans have identified projects to close these gaps and complete the system, and they are included in the Plan. These projects include the Limited Access Expressway SR-115 in Imperial County, the SR-710 Gap Closure in Los Angeles County, the High Desert Corridor in Los Angeles and San Bernardino Counties, the SR-241 Improvements in Orange County, the CETAP Inter-county Corridor A in Orange and Riverside Counties, and the U.S. 101 and SR-118 Improvements in Ventura County.

Heavy investment in HOV lanes has given the region one of the nation's most comprehensive HOV networks and highest rideshare rates. The Plan proposes strategic HOV gap closures and freeway-to-freeway direct HOV connectors to complete the system. Another key HOV strategy in the Plan is the conversion of certain HOV lanes in the region to allow for continuous access. Orange County has taken a leadership role on this over the past few years, and their recent studies have concluded that continuous-access HOV lanes do not perform any worse than limited-access HOV lanes. At the same time, they provide carpoolers with greater freedom of movement in and out of HOV lanes

Local streets and roads account for over 80 percent of the total road network and carry almost 50 percent of total traffic. They serve different purposes in different parts of the region, or even in different parts of the same city. Many streets serve as major thoroughfares or even alternate parallel routes to congested freeways. At the same time, street right-of-ways often support different modes of transportation besides the automobile, including bicycles, pedestrians, and transit. The Plan contains a host of arterial projects and improvements to achieve different purposes in different areas. In all parts of the region, it includes operational and technological improvements to maximize system productivity in a more cost-effective way than simply adding capacity. Such strategic improvements include spot widening, signal prioritization, driveway consolidation and relocation, and grade separations at high-volume intersections.

While the Plan's multimodal strategy aims to reduce per capita VMT over the next 25 years, total demand to move people and goods will continue to grow due to the region's population increase. A strategic expansion of the transportation system is needed in order to provide the region with the mobility it needs. The Plan targets this expansion around transportation systems that have room to grow, including transit, high-speed rail, active transportation, express lanes, and goods movement. Some of these systems, such as transit, active transportation, and express lanes, have proven over the years to be a reliable and convenient form of transportation for those who are able to easily access it.

The Plan calls for an impressive expansion of transit facilities and service over the next 25 years. While these capital projects will provide the SCAG region with a much more mature public transportation system, operational improvements and new transit pro-grams and policies will also contribute greatly to attracting more trips to transit and away from single-occupant vehicle travel. First, the expanding HOV and express lane networks calls for the development of an extensive express bus point-to-point network. Second, transit oriented and land use developments call for increasing the frequency and quality of fixed-route bus service by virtue of adding new bus rapid transit service, limited-stop service, increased frequencies along targeted corridors, and the introduction of local community circulators to provide residents of smart growth developments with the option of taking transit over using a car to make short, local trips.

The Plan proposes three passenger rail strategies that will provide additional travel options for long-distance travel within the region and to neighboring regions. These are improvements to the Los Angeles to San Diego Corridor (LOSSAN), improvements to the existing Metrolink system, and the implementation of Phase I of the California High-Speed Train (HST) project.

The recent release of the draft CA HST Business Plan confirmed the funding and implementation challenges of the project. The draft Business Plan now estimates a Phase I cost of $98.5 billion (in year of expenditure dollars) with service extended to the region in 2033. Within the draft Business Plan, there are a variety of strategies to connect Northern and Southern California to the State network. This plan assumes that Southern California will be connected to the network in 2033, but that incremental improvements can be made in advance of and in preparation for that connection. Therefore, stakeholders throughout Southern California are seeking to implement a phased and blended implementation strategy for high-speed rail by employing State and federal high-speed rail funds to improve existing services, eventually meeting the Federal Rail Administration's 110 miles per hour definition of high-speed service. These speed and service improvements to the existing LOSSAN and Metrolink corridors will deliver the California High-Speed Rail Authority's new blended approach, and at the same time permanently improve the region's commuter and intercity rail services.

Another emphasis on transit network improvements includes transit priority facilities, such as bus lanes and traffic signal priority. The region has virtually no bus lanes, especially compared to other major metropolitan areas. The Los Angeles County Metro Rapid Bus network employs bus signal priority that gives buses up to ten percent more green light time from the normal green light phase. This should be expanded to other counties in the region. Additional enhancements to the region's transit services include expanding bike-carrying capacity on transit vehicles, implementing regional and inter-county fare agreements and media, such as LA County's EZ Pass, and expanding and improving real-time passenger information systems.

Active transportation refers to transportation such as walking or using a bicycle, tricycle, velomobile, wheelchair, scooter, skates, skateboard, push scooter, trailer, hand cart, shopping car, or similar electrical devices. In the Plan, active transportation generally refers to bicycling and walking, the two most common methods. Walking and bicycling are essential parts of the SCAG transportation system and can help reduce roadway congestion. As the region works towards reducing congestion, walking and bicycling will become more essential to meet the future needs of Californians.

Substantial growth and development is anticipated to occur within the region between 2011 and 2035. Despite the regional planning efforts to reduce per capita VMT, predicted growth will increase total VMT. As shown in **Table 3.12-13**, average daily VMT is expected to grow from 448 million miles in 2011 to 517 million miles per day in 2035. This change constitutes a 13.3 percent increase over this period and includes light, medium and heavy-duty vehicle VMT in all six counties.[27] The greatest percentage increase in VMT will occur in Riverside County San followed by Bernardino County. Implementation of Mitigation Measures Mitigation Measures **MM-TR1** through **MM-TR98** would reduce VMT, however, impacts would remain significant.

TABLE 3.12-13: DAILY VEHICLE MILES TRAVELED IN 2012 AND 2035

	In Thousands		
County	2012	2035 No Project	2035 Plan
Imperial	6,000	10,000	10,000
Los Angeles	224,000	252,000	234,000
Orange	75,000	84,000	79,000
Riverside	60,000	89,000	89,000
San Bernardino	61,000	89,000	84,000
Ventura	21,000	23,000	22,000
SCAG Region	448,000	547,000	517,000

SOURCE: SCAG Transportation Modeling 2011, SCSG 2012-2035 RTP/SCS, Highways & Arterials Appendix, Tables A16, page 56, 2011

Impact 3.12-2: The Plan would reduce average Vehicle Hours of Delay (VHD) in 2035 compared to current condition. The Plan would result in less than significant impact related to VHD.

As shown in **Table 3.12-14**, total daily VHD in delay are expected to shrink from 3,277,000 vehicle-hours in 2011 to 3,115,000 vehicle-hours in 2035. This constitutes a decrease from existing conditions and includes light, medium and heavy-duty vehicles VHD in all six counties.[28] Delay would decrease in Los Angeles, Orange, and Ventura Counties and increase in Imperial, Riverside, and San Bernardino Counties. This result is considered to be a regional benefit. Therefore, the Plan would result in a less-than-significant impact related to VHD.

TABLE 3.12-14: TOTAL DAILY HOURS OF DELAY IN 2012 AND 2035

	In Thousands of Vehicle-Hours		
County	2012	2035 No Project	2035 Plan
Imperial	5	25	12
Los Angeles	2,204	3,031	1,895
Orange	493	688	437
Riverside	263	1,244	395
San Bernardino	205	846	279
Ventura	107	181	97
Regional	3,277	6,015	3,115

SOURCE: SCAG Transportation Modeling 2011, SCSG 2012-2035 RTP/SCS, Highways & Arterials Appendix, Tables A16, page 56, 2011

[27] SCAG, Regional Travel Demand Model Results, 2011.
[28] *Ibid.*

Impact 3.12-3: Potential to create substantially greater average daily VHD for heavy-duty truck trips in 2035 compared to current condition. The Plan would result in a significant impact related to truck VHD.

The transportation system is heavily influenced by goods movement, especially by heavy-duty trucks on the roadway network. Recent regional efforts have focused on strategies to develop a coherent, refined, and fully integrated regional goods movement system. In past RTPs, SCAG has envisioned a system of truck-only lanes extending from the San Pedro Bay Ports to downtown Los Angeles along the I-710, connecting to an east-west segment, and finally reaching the I-15 in San Bernardino County. Such a system would address the growing truck traffic on core highways through the region and serve key goods movement industries. Truck-only freight corridors are effective as they add capacity in congested corridors and improve truck operations and safety by separating trucks and autos.

Significant progress towards a regional freight corridor system has continued as evidenced by recent work on an environmental impact report (expected to be completed in 2012) for the I-710 segment. The Plan includes a refined concept for the east-west corridor component of the system and connections to an initial segment of I-15. The East-West Freight Corridor would carry between 58,000 and 70,000 trucks per day - trucks that would be removed from adjacent general-purpose lanes and local arterial roads.

Despite the regional planning efforts to improve the efficiency of goods movement, increased demand for goods will lead to substantial increased in total heavy-duty trucks on the roadway network under the Plan. As shown in **Table 3.12-15**, total daily heavy-duty truck trip VHD in delay are expected to increase from 117,000 average daily heavy-duty truck vehicle hours of delay in 2012 to 158,000 hours in 2035. This constitutes a 35 percent increase from conditions in 2012.[29] Implementation of Mitigation Measures Mitigation Measures **MM-TR1** through **MM-TR98** would reduce criteria pollutant impacts, however, impacts would remain significant.

TABLE 3.12-15: TOTAL DAILY HEAVY-DUTY TRUCKS TRIPS HOURS OF DELAY IN 2012 AND 2035

	In Thousands of Hours		
County	**2012 Base Year**	**2035 No Project**	**2035 Plan**
Imperial	0	2	1
Los Angeles	72	154	81
Orange	15	29	18
Riverside	14	73	30
San Bernardino	13	91	24
Ventura	3	6	4
Regional	117	354	158

SOURCE: SCAG Transportation Modeling 2011, SCSG 2012-2035 RTP/SCS, Highways & Arterials Appendix, Tables A16, page 56, 2011

Impact 3.12-4: Potential to increase the percent of work opportunities within 45 minutes travel time by personal vehicle or by transit in 2035 relative to the current condition. This result is considered to be a regional benefit. The Plan would result in a less-than-significant impact related to work commute.

PM peak period work trips were used to assess impacts to work commute as the evening is this is the portion of the day prone to the most vehicle delay. It was determined that 45 minutes represents a reasonable benchmark to account for commute lengths for both the auto and transit modes.

As shown in **Table 3.12-16**, 79 percent of the Existing PM peak period work trips take 45 minutes or less by single occupancy vehicle, 73 percent of the Existing PM peak period work trips take 45 minutes or less by high occupancy vehicle, and 22 percent occur within 45 minutes by transit.

[29] *Ibid.*

TABLE 3.12-16: PERCENTAGE OF PM PEAK PERIOD WORK TRIPS COMPLETED WITHIN 45 MINUTES			
County	2012	2035 No Project	2035 Plan
AUTOS –SINGLE OCCUPANCY VEHICLES			
Imperial	97%	96%	96%
Los Angeles	76%	76%	80%
Orange	87%	87%	88%
Riverside	77%	75%	81%
San Bernardino	78%	79%	80%
Ventura	80%	81%	82%
Region	79%	79%	82%
AUTOS – HIGH OCCUPANCY VEHICLES			
Imperial	90%	89%	87%
Los Angeles	73%	65%	77%
Orange	83%	83%	85%
Riverside	67%	64%	74%
San Bernardino	64%	61%	68%
Ventura	73%	70%	73%
Region	73%	68%	77%
TRANSIT			
Imperial	4%	4%	5%
Los Angeles	25%	22%	24%
Orange	12%	12%	12%
Riverside	9%	7%	9%
San Bernardino	4%	5%	6%
Ventura	9%	8%	9%
Region	22%	20%	21%

SOURCE: SCAG Transportation Modeling 2011.

In 2035, with the implementation of the Plan, 82 percent of the PM peak period work trips take 45 minutes or less by single occupancy vehicle, 77 percent of the PM peak period work trips take 45 minutes or less by high occupancy vehicle, and 21 percent occur within 45 minutes by transit.

There would be an increase in the percent of work opportunities within 45 minutes travel time by personal vehicle as compared to the current condition. The transit percentage would remain approximately the same. This result is considered to be a regional benefit. Therefore, the Plan would result in a less-than-significant impact related to work commute.

Impact 3.12-5: Potential to lower system-wide fatality accident rate for all travel modes in 2035 relative to the current condition. The Plan would result in a less-than-significant impact related to transportation fatality rates.

The Plan includes Transportation System Management strategies that improve safety through reducing the concentration of weaving and merging and that clear existing incidents and accidents more quickly. It was assumed that SCAG goals and the goals/actions outlined in the California Strategic Highway Safety Plan would reduce fatalities and injuries by 25 percent based on recent trends. As shown in **Table 3.12-17**, implementation of the Plan would result in a system-wide daily fatality rate of 0.17 fatalities per million persons for all travel modes, a decrease of 0.03 daily fatalities per million persons when compared to the existing rate of 0.20. Therefore, the Plan would result in a less-than-significant impact related to transportation fatality rates.

TABLE 3.12-17: EXISTING AND 2035 REGIONAL TRANSPORTATION SYSTEM ACCIDENT RATES			
Daily Per Million Persons	2012	2035 No Project	2035 Plan
Fatalities	0.20	0.18	0.17
Injuries	18.27	13.67	12.93
SOURCE: SCAG Transportation Modeling 2011.			

Impact 3.14-6: Potential to lower system-wide injury rate for all travel modes in 2035 relative to the current condition. Therefore, the Plan would result in a less-than-significant impact related to transportation injury rates.

The Plan includes Transportation System Management strategies that improve safety through reducing the concentration of weaving and merging, and that clear existing incidents and accidents more quickly, among other measures. As shown in **Table 3.12-17**, implementation of the Plan would result in a system-wide daily injury rate of 12.93 injuries per million persons for all travel modes, a decrease of 5.34 daily injuries per million persons when compared to the existing rate of 18.27. Therefore, the Plan would result in a less-than-significant impact related to transportation injury rates.

Cumulative Impact 3.12-7: Potential to contribute to a cumulatively considerable amount of transportation impacts, such as VMT and all-vehicle VHD, in areas outside of the SCAG region.

The RTDM analyzes the population, households, and employment projected for 2035, which is anticipated to be the year with the largest demand on the transportation system expected during the lifetime of the Plan. In accounting for the effects of regional growth, the model output provides a long-term and cumulative level of analysis for the impacts of the Plan on transportation resources. Forecast urban development and growth that would be accommodated by the transportation investments in the Plan, together with the increased mobility provided by the Plan would contribute to the significant impacts described in Impacts 3.12-1, 3.12-2, and 3.12-3 above. The regional growth, and thus cumulative impacts, is captured in the VMT, VHD, and heavy-duty truck VHD data reported for the above impacts.

As the population increases through 2035, the number of trips originating and ending in Santa Barbara, San Diego, and Kern counties to and from the SCAG region is anticipated to increase. The transportation demand from growth, in combination with the accommodating projects within the Plan would contribute to a cumulatively considerable transportation impact in these areas and potentially beyond.

MITIGATION MEASURES

Mitigation Measures **MM-TR1** through **MM-TR16** shall be implemented by SCAG over the lifetime of the 2012-2035 RTP/SCS. Mitigation Measures **MM-TR17** through **MM-TR21** shall be implemented by SCAG and can and should be implemented by project sponsors (for both development and transportation projects) as applicable. Mitigation Measures **MM-TR21** through **MM-TR98** can and should be implemented by project sponsors (for both development and transportation projects) as applicable. Project specific environmental documents may adjust these mitigation measures as necessary to respond to site-specific conditions. Projects taking advantage of CEQA Streamlining provisions of SB 375 can and should apply mitigation measures as appropriate to site-specific conditions.

MM-TR1: SCAG shall establish a forum where policy-makers can be educated and can develop consensus on regional transportation safety and security policies.

MM-TR2: SCAG shall work with local officials to assist with implementation of regional transportation safety and security policies.

MM-TR3: SCAG shall conduct workshops focused on Smart Growth strategies. Project-specific workshops should be held by local agencies.

MM-TR4: SCAG shall help ensure the rapid repair of transportation infrastructure in the event of an emergency. This will be accomplished by SCAG, in cooperation with local and State agencies, identifying critical infrastructure needs necessary for: a) emergency responders to enter the region, b) evacuation of affected facilities, and c) restoration of utilities. In addition, SCAG shall establish transportation infrastructure practices that promote and enhance security.

MM-TR5: SCAG shall continue to promote the use of intelligent transportation system (ITS) technologies that enhance transportation security. SCAG should work to expand the use of ITS to improve surveillance, monitoring and distress notification systems and to assist in the rapid evacuation of disaster areas. SCAG shall facilitate the incorporation of security into the Regional ITS Architecture. Transit operators should incorporate ITS technologies as part of their security and emergency preparedness and share that information with other operators. Aside from deploying ITS technologies for advanced customer information, transit agencies should work intensely with ethnic, local and disenfranchised communities through public information / outreach sessions ensuring public participation is utilized to its fullest. In case of evacuation, these transit dependent persons may need additional assistance to evacuate to safety.

MM-TR6: SCAG shall establish transportation infrastructure practices that promote and enhance security. SCAG shall work with transportation operators to plan and coordinate transportation projects, as appropriate, with DHS grant projects, to enhance the regional transit security strategy (RTSS). SCAG shall establish transportation infrastructure practices that identify and prioritize the design, retrofit, hardening, and stabilization of critical transportation infrastructure to prevent failure, to minimize loss of life and property, injuries, and avoid long term economic disruption. SCAG shall establish a Transportation Security Working Group (TSWG) with goals of 2012-2035 RTP/SCS consistency with RTSS, and to find ways SCAG programs can enhance RTSS.

MM-TR7: SCAG shall help to enhance the region's ability to deter and respond to acts of terrorism, human-caused or natural disasters through regionally cooperative and collaborative strategies. SCAG shall work with local officials to develop regional consensus on regional transportation safety, security, and safety security policies.

MM-TR8: SCAG shall help to enhance the region's ability to deter and respond to terrorist incidents, human-caused or natural disasters by strengthening relationship and coordination with transportation. This will be accomplished by the following:

- SCAG shall work with local officials to develop regional consensus on regional transportation safety, security, and safety security policies.
- SCAG shall encourage all SCAG elected officials are educated in NIMS.
- SCAG shall work with partner agencies, federal, State and local jurisdictions to improve communications and interoperability and to find opportunities to leverage and effectively utilize transportation and public safety/security resources in support of this effort.

MM-TR9: SCAG shall work to enhance emergency preparedness awareness among public agencies and with the public at large.

MM TR10: SCAG shall work with local officials to develop regional consensus on regional transportation safety, security, and safety security policies.

MM-TR11: SCAG shall work to improve the effectiveness of regional plans by maximizing the sharing and coordination of resources that would allow for proper response by public agencies.

MM-TR12: SCAG shall encourage and provide a forum for local jurisdictions to develop mutual aid agreements for essential government services during any incident recovery

MM-TR13: SCAG shall help to enhance the capabilities of local and regional organizations, including first responders, through provision and sharing of information. This will be accomplished by:

- SCAG shall work with local agencies to collect regional GeoData in a common format, and provide access to the GeoData for emergency planning, training and response.
- SCAG shall establish a forum for cooperation and coordination of these plans and programs among the regional partners including first responders and operations agencies
- SCAG shall develop and establish a regional information sharing strategy, linking SCAG and its member jurisdictions for ongoing sharing and provision of information pertaining to the region's transportation system and other critical infrastructure.

MM-TR14: SCAG shall provide the means for collaboration in planning, communication, and information sharing before, during, or after a regional emergency. This will be accomplished by the following:

- SCAG shall develop and incorporate strategies and actions pertaining to response and prevention of security incidents and events as part of the on-going regional planning activities.
- SCAG shall offer a regional repository of GIS data for use by local agencies in emergency planning, and response, in a standardized format.
- SCAG shall enter into mutual aid agreements with other MPOs to provide this data, in coordination with the California OES in the event that an event disrupts SCAG's ability to function.

MM-TR15: Congestion Pricing: SCAG shall advocate for a regional, market-based system to price or charge for auto trips during peak hours.

MM-TR16: Beyond the currently financially and institutionally feasible measures included in the 2012-2035 RTP/SCS, SCAG shall identify further reduction in VMT, and fuel consumption that could be obtained through land-use strategies, additional car-sharing programs, additional vanpools, additional bicycle programs, and implementation of a universal employee transit access pass (TAP) program.

MM-TR17: SCAG shall (for its employees) and local jurisdictions can and should institute teleconferencing, telecommute and/or flexible work hour programs to reduce unnecessary employee transportation.

MM-TR18: Local jurisdictions can and should create a ride-sharing program. Promote existing ride sharing programs e.g., by designating a certain percentage of parking spaces for ride sharing vehicles, designating adequate passenger loading and unloading for ride sharing vehicles, and providing a web site or message board for coordinating rides.

MM-TR19: SCAG shall and local jurisdictions can and should create or accommodate car sharing programs, e.g., provide parking spaces for car share vehicles at convenient locations accessible by public transportation.

MM-TR20: SCAG shall and local jurisdictions can and should provide a vanpool for employees.

MM-TR21: Transportation Planning: SCAG shall and local jurisdictions can and should ensure that new developments incorporate both local and regional transit measures into the project design that promote the use of alternative modes of transportation.

MM-TR22: As may be appropriate, project sponsors can and should submit fair share traffic payments to the local agency for funding capital improvement projects to accommodate future traffic demand in the area.

MM-TR23: Local jurisdictions can and should coordinate controlled intersections so that traffic passes more efficiently through congested areas. Where traffic signals or streetlights are installed, require the use of Light Emitting Diode (LED) technology.

MM-TR24: Local jurisdictions can and should promote ride sharing programs e.g., by designating a certain percentage of parking spaces for high-occupancy vehicles, providing larger parking spaces to accommodate vans used for ride-sharing, and designating adequate passenger loading and unloading and waiting areas.

MM-TR25: Local jurisdictions can and should encourage the use of car-sharing programs such as ZipCar. Accommodations for such programs include providing parking spaces for the car-share vehicles at convenient locations accessible by public transportation.

MM-TR26: The Plan includes measures intended to reduce vehicle hours of delay. These include: system management, increasing rideshare and work-at-home opportunities to reduce demand on the transportation system, investments in non-motorized transportation, maximizing the benefits of the land use-transportation connection and key transportation investments targeted to reduce delay. SCAG shall encourage local agencies to fully implement these policies and projects.

MM-TR27: The Plan includes measures intended to reduce daily heavy-duty truck vehicle hours of delay. These include: goods movement capacity enhancements, system management, increasing rideshare and work-at-home opportunities to reduce demand on the transportation system, investments in non-motorized transportation, maximizing the benefits of the land use-transportation connection and key transportation investments targeted to reduce heavy-duty truck delay. SCAG shall encourage local agencies to fully implement these policies and projects.

MM-TR28: Project sponsors of a commercial use can and should submit to the Lead Agency (or other appropriate government agency) a Transportation Demand Management (TDM) plan containing strategies to reduce on-site parking demand and single occupancy vehicle travel. The sponsor should implement the approved TDM plan. The TDM should include strategies to increase bicycle, pedestrian, transit, and carpools/vanpool use. All four modes of travel should be considered. Strategies to consider include the following:

- Inclusion of additional bicycle parking, shower, and locker facilities that exceed the requirement

- Construction of bike lanes per the prevailing Bicycle Master Plan (or other similar document)
- Signage and striping onsite to encourage bike safety
- Installation of pedestrian safety elements (such as cross walk striping, curb ramps, countdown signals, bulb outs, etc.) to encourage convenient crossing at arterials
- Installation of amenities such as lighting, street trees, trash and any applicable streetscape plan.
- Direct transit sales or subsidized transit passes
- Guaranteed ride home program
- Pre-tax commuter benefits (checks)
- On-site car-sharing program (such as City Car Share, Zip Car, etc.)
- On-site carpooling program
- Distribution of information concerning alternative transportation options
- Parking spaces sold/leased separately
- Parking management strategies; including attendant/valet parking and shared parking spaces

MM-TR29: Project sponsors and construction contractors can and should meet with the appropriate Lead Agency (or other government agency) to determine traffic management strategies to reduce, to the maximum extent feasible, traffic congestion and the effects of parking demand by construction workers during construction of this project and other nearby projects that could be simultaneously under construction. The project sponsor should develop a construction management plan for review and approval by the Lead Agency (or other government agency as appropriate). The plan should include at least the following items and requirements:

- A set of comprehensive traffic control measures, including scheduling of major truck trips and deliveries to avoid peak traffic hours, detour signs if required, lane closure procedures, signs, cones for drivers, and designated construction access routes.
- Notification procedures for adjacent property owners and public safety personnel regarding when major deliveries, detours, and lane closures will occur.
- Location of construction staging areas for materials, equipment, and vehicles at an approved location.
- A process for responding to, and tracking, complaints pertaining to construction activity, including identification of an onsite complaint manager. The manager should determine the cause of the complaints and should take prompt action to correct the problem. The Lead Agency should be informed who the Manager is prior to the issuance of the first permit.
- Provision for accommodation of pedestrian flow.
- As necessary, provision for parking management and spaces for all construction workers to ensure that construction workers do not park in on street spaces.
- Any damage to the street caused by heavy equipment, or as a result of this construction, should be repaired, at the project sponsor's expense, within one week of the occurrence of the damage (or excessive wear), unless further damage/excessive wear may continue; in such case, repair should occur prior to issuance of a final inspection of the building permit. All damage that is a threat to public health or safety should be repaired immediately. The street should be restored to its condition prior to the new construction as established by the Lead Agency (or other appropriate government agency) and/or photo documentation, at the sponsor's expense, before the issuance of a Certificate of Occupancy.
- Any heavy equipment brought to the construction site should be transported by truck, where feasible.

- No materials or equipment should be stored on the traveled roadway at any time.
- Prior to construction, a portable toilet facility and a debris box should be installed on the site, and properly maintained through project completion.
- All equipment should be equipped with mufflers.
- Prior to the end of each work-day during construction, the contractor or contractors should pick up and properly dispose of all litter resulting from or related to the project, whether located on the property, within the public rights-of-way, or properties of adjacent or nearby neighbors.

MM-TR30: Local jurisdictions can and should encourage the use of public transit systems by enhancing safety and cleanliness on vehicles and in and around stations, providing shuttle service to public transit, offering public transit incentives and providing public education and publicity about public transportation services.

MM-TR31: Local jurisdictions can and should encourage bicycling and walking by incorporating bicycle lanes into street systems in regional transportation plans, new subdivisions, and large developments, creating bicycle lanes and walking paths directed to the location of schools and other logical points of destination and provide adequate bicycle parking, and encouraging commercial projects to include facilities on-site to encourage employees to bicycle or walk to work.

MM-TR32: Transit agencies can and should encourage bicycling to transit facilities by providing additional bicycle parking, locker facilities, and bike lane access to transit facilities when feasible.

MM-TR33: Project sponsors can and should ensure that prior to construction all necessary local and State road and railroad encroachment permits are obtained. As deemed necessary by the governing jurisdiction, the road encroachment permits may require the contractor to prepare a traffic control plan in accordance with professional engineering standards prior to construction. Traffic control plans should include the following requirements:

- Identification of all roadway locations where special construction techniques (e.g., directional drilling or night construction) would be used to minimize impacts to traffic flow.
- Development of circulation and detour plans to minimize impacts to local street circulation. This may include the use of signing and flagging to guide vehicles through and/or around the construction zone.
- Scheduling of truck trips outside of peak morning and evening commute hours.
- Limiting of lane closures during peak hours to the extent possible.
- Usage of haul routes minimizing truck traffic on local roadways to the extent possible.
- Inclusion of detours for bicycles and pedestrians in all areas potentially affected by project construction.
- Installation of traffic control devices as specified in the California Department of Transportation Manual of Traffic Controls for Construction and Maintenance Work Zones.
- Development and implementation of access plans for highly sensitive land uses such as police and fire stations, transit stations, hospitals, and schools. The access plans would be developed with the facility owner or administrator. To minimize disruption of emergency vehicle access, affected jurisdictions should be asked to identify detours for emergency vehicles, which will then be posted by the contractor. Notify in advance the facility owner or operator of the timing, location, and duration of construction activities and the locations of detours and lane closures.

- Storage of construction materials only in designated areas
- Coordination with local transit agencies for temporary relocation of routes or bus stops in work zones, as necessary.

MM-TR34: Local jurisdictions can and should meet an identified transportation-related benchmark.

MM-TR35: Local jurisdictions can and should adopt a comprehensive parking policy that discourages private vehicle use and encourages the use of alternative transportation.

MM-TR36: Project sponsors can and should build or fund a major transit stop within or near the development.

MM-TR37: Local jurisdictions and transit agencies can and should provide public transit incentives such as free or low-cost monthly transit passes to employees, or free ride areas to residents and customers.

MM-TR38: Local jurisdictions and project sponsors can and should promote "least polluting" ways to connect people and goods to their destinations.

MM-TR39: Local jurisdictions and project sponsors can and should incorporate bicycle lanes, routes and facilities into street systems, new subdivisions, and large developments.

MM-TR40: Local jurisdictions can and should require amenities for non-motorized transportation, such as secure and convenient bicycle parking.

MM-TR41: Local jurisdictions can and should ensure that the project enhances, and does not disrupt or create barriers to, non-motorized transportation.

MM-TR42: Local jurisdictions can and should connect parks and open space through shared pedestrian/bike paths and trails to encourage walking and bicycling.

MM-TR43: Local jurisdictions can and should create bicycle lanes and walking paths directed to the location of schools, parks and other destination points.

MM-TR44: Local jurisdictions can and should work with the school districts to improve pedestrian and bike access to schools and to restore or expand school bus service using lower-emitting vehicles.

MM-TR45: Local jurisdictions and transit agencies can and should provide information on alternative transportation options for consumers, residents, tenants and employees to reduce transportation-related emissions.

MM-TR46: Local jurisdictions can and should educate consumers, residents, tenants and the public about options for reducing motor vehicle-related greenhouse gas emissions. Include information on trip reduction; trip linking; vehicle performance and efficiency (e.g., keeping tires inflated); and low or zero-emission vehicles.

MM-TR47: Local jurisdictions can and should purchase, or create incentives for purchasing, low or zero-emission vehicles.

MM-TR48: Local jurisdictions can and should create local "light vehicle" networks, such as neighborhood electric vehicle systems.

MM-TR49: Local jurisdictions can and should enforce and follow limits idling time for commercial vehicles, including delivery and construction vehicles.

MM-TR50: Local jurisdictions can and should provide the necessary facilities and infrastructure to encourage the use of low or zero-emission vehicles.

MM-TR51: Local jurisdictions can and should reduce GHG emissions by reducing vehicle miles traveled and by increasing or encouraging the use of alternative fuels and transportation technologies.

MM-TR52: Local jurisdictions can and should reduce VMT-related emissions by encouraging the use of public transit through adoption of new development standards that would require improvements to the transit system and infrastructure, increase safety and accessibility, and provide other incentives.

MM-TR53: Project Selection: Local jurisdictions can and should give priority to transportation projects that would contribute to a reduction in vehicle miles traveled per capita, while maintaining economic vitality and sustainability.

MM-TR54: Equal Pedestrian Access Local jurisdictions can and should include separated sidewalks whenever possible, on both sides of all new street improvement projects, except where there are severe topographic or natural resource constraints.

MM-TR55: Public Involvement: Local jurisdictions can and should carry out a comprehensive public involvement and input process that provides information about transportation issues, projects, and processes to community members and other stakeholders, especially to those traditionally underserved by transportation services.

MM-TR56: System Interconnectivity: Local jurisdictions can and should create an interconnected transportation system that allows a shift in travel from private passenger vehicles to alternative modes, including public transit, ride sharing, car sharing, bicycling and walking, by incorporating the following:

- Ensure transportation centers are multi-modal to allow transportation modes to intersect;
- Provide adequate and affordable public transportation choices, including expanded bus routes and service, as well as other transit choices such as shuttles, light rail, and rail;
- To the extent feasible, extend service and hours of operation to underserved arterials and population centers or destinations such as colleges;
- Focus transit resources on high-volume corridors and high-boarding destinations such as colleges, employment centers and regional destinations;
- Coordinate schedules and routes across service lines with neighboring transit authorities;
- Support programs to provide "station cars" for short trips to and from transit nodes (e.g., neighborhood electric vehicles);
- Study the feasibility of providing free transit to areas with residential densities of 15 dwelling units per acre or more, including options such as removing service from less dense, underutilized areas to do so;
- Employ transit-preferential measures, such as signal priority and bypass lanes. Where compatible with adjacent land use designations, right-of-way acquisition or parking removal may occur to accommodate transit-preferential measures or improve access to

transit. The use of access management should be considered where needed to reduce conflicts between transit vehicles and other vehicles;
- Provide safe and convenient access for pedestrians and bicyclists to, across, and along major transit priority streets;
- Use park-and-ride facilities to access transit stations only at ends of regional transitways or where adequate feeder bus service is not feasible.

MM-TR57: Transit System Infrastructure: Local jurisdictions can and should upgrade and maintain transit system infrastructure to enhance public use, including:

- Ensure transit stops and bus lanes are safe, convenient, clean and efficient;
- Ensure transit stops have clearly marked street-level designation, and are accessible;
- Ensure transit stops are safe, sheltered, benches are clean, and lighting is adequate;
- Place transit stations along transit corridors within mixed-use or transit-oriented development areas at intervals of three to four blocks, or no less than one-half mile.

MM-TR58: Customer Service: Transit agencies can and should enhance customer service and system ease-of-use, including:

- Develop a Regional Pass system to reduce the number of different passes and tickets required of system users;
- Implement "Smart Bus" technology, using GPS and electronic displays at transit stops to provide customers with "real-time" arrival and departure time information (and to allow the system operator to respond more quickly and effectively to disruptions in service);
- Investigate the feasibility of an on-line trip-planning program.

MM-TR59: Transit Funding: Local jurisdictions can and should prioritize transportation funding to support a shift from private passenger vehicles to transit and other modes of transportation, including:

- Give funding preference to improvements in public transit over other new infrastructure for private automobile traffic;
- Before funding transportation improvements that increase roadway capacity and VMT, evaluate the feasibility and effectiveness of funding projects that support alternative modes of transportation and reduce VMT, including transit, and bicycle and pedestrian access.

MM-TR60: Transit and Multimodal Impact Fees: Local jurisdictions can and should assess transit and multimodal impact fees on new developments to fund public transportation infrastructure, bicycle infrastructure, pedestrian infrastructure and other multimodal accommodations.

MM-TR61: Local jurisdictions can and should implement traffic and roadway management strategies to improve mobility and efficiency, and reduce associated emissions.

MM-TR62: System Monitoring: Local jurisdictions can and should monitor traffic and congestion to determine when and where new transportation facilities are needed in order to increase access and efficiency.

MM-TR63: Arterial Traffic Management: Local jurisdictions can and should modify arterial roadways to allow more efficient bus operation, including bus lanes and signal priority/preemption where necessary.

MM-TR64: Signal Synchronization: Local jurisdictions can and should expand signal timing programs where emissions reduction benefits can be demonstrated, including maintenance of the synchronization system, and will coordinate with adjoining jurisdictions as needed to optimize transit operation while maintaining a free flow of traffic.

MM-TR65: HOV Lanes: Local jurisdictions can and should encourage the construction of high-occupancy vehicle (HOV) lanes or similar mechanisms whenever necessary to relieve congestion and reduce emissions.

MM-TR66: Delivery Schedules: Local jurisdictions can and should establish ordinances or land use permit conditions limiting the hours when deliveries can be made to off-peak hours in high traffic areas.

MM-TR67: Local jurisdictions can and should reduce VMT related-emissions by implementing and supporting trip reduction programs.

MM-TR68: Ride-Share Programs: Local jurisdictions can and should promote ride sharing programs, including:

- Designate a certain percentage of parking spaces for ride-sharing vehicles;
- Designate adequate passenger loading, unloading, and waiting areas for ride-sharing vehicles;
- Provide a web site or message board for coordinating shared rides;
- Encourage private, for-profit community car-sharing, including parking spaces for car share vehicles at convenient locations accessible by public transit;
- Hire or designate a rideshare coordinator to develop and implement ridesharing programs.

MM-TR69: Employer-based Trip Reduction: Local jurisdictions can and should support voluntary, employer-based trip reduction programs, including:

- Provide assistance to regional and local ridesharing organizations;
- Advocate for legislation to maintain and expand incentives for employer ridesharing programs;
- Require the development of Transportation Management Associations for large employers and commercial/ industrial complexes;
- Provide public recognition of effective programs through awards, top ten lists, and other mechanisms.

MM-TR70: Ride Home Programs: Local jurisdictions can and should implement a "guaranteed ride home" program for those who commute by public transit, ride-sharing, or other modes of transportation, and encourage employers to subscribe to or support the program.

MM-TR71: Local Area Shuttles: Transit agencies can and should encourage and utilize shuttles to serve neighborhoods, employment centers and major destinations.

MM-TR72: Local jurisdictions and transit agencies can and should create a free or low-cost local area shuttle system that includes a fixed route to popular tourist destinations or shopping and business centers.

MM-TR73: Local jurisdictions can and should work with existing shuttle service providers to coordinate their services.

MM-TR74: Low- and No-Travel Employment Opportunities: Local jurisdictions can and should facilitate employment opportunities that minimize the need for private vehicle trips, including:

- Amend zoning ordinances and the Development Code to include live/work sites and satellite work centers in appropriate locations;
- Encourage telecommuting options with new and existing employers, through project review and incentives, as appropriate.

MM-TR75: Local jurisdictions can and should support bicycle use as a mode of transportation by enhancing infrastructure to accommodate bicycles and riders, and providing incentives.

MM-TR76: Development Standards for Bicycles: Local jurisdictions can and should establish standards for new development and redevelopment projects to support bicycle use, including:

- Amending the Development Code to include standards for safe pedestrian and bicyclist accommodations, by incorporating the following:
  - "Complete Streets" policies that foster equal access by all users in the roadway design;
  - Bicycle and pedestrian access internally and in connection to other areas through easements;
  - Safe access to public transportation and other non-motorized uses through construction of dedicated paths;
  - Safe road crossings at major intersections, especially for school children and seniors;
  - Adequate, convenient and secure bike parking at public and private facilities and destinations in all urban areas;
  - Street standards will include provisions for bicycle parking within the public right of way.

MM-TR77: Local jurisdictions can and should require new development and redevelopment projects to include bicycle facilities, as appropriate with the new land use, including:

- Construction of weatherproof bicycle facilities where feasible, and at a minimum, bicycle racks or covered, secure parking near the building entrances;
- Provision and maintenance of changing rooms, lockers, and showers at large employers or employment centers.
- Prohibit projects that impede bicycle and pedestrian access, such as large parking areas that cannot be safely crossed by non-motorized vehicles, and developments that block through access on existing or potential bicycle and pedestrian routes;
- Encourage the development of bicycle stations at intermodal hubs, with attended or "valet" bicycle parking, and other amenities such as bicycle rental and repair, and changing areas with lockers and showers;
- Conduct a connectivity analysis of the existing bikeway network to identify gaps, and prioritize bikeway development where gaps exist.

MM-TR78: Bicycle and Pedestrian Trails: Local jurisdictions can and should establish a network of multi-use trails to facilitate safe and direct off-street bicycle and pedestrian travel, and will provide bike racks along these trails at secure, lighted locations.

MM-TR79: Bicycle Safety Program: Local jurisdictions can and should develop and implement a bicycle safety educational program to teach drivers and riders the laws, riding protocols, routes, safety tips, and emergency maneuvers.

MM-TR80: Bicycle and Pedestrian Project Funding: Local jurisdictions can and should pursue and provide enhanced funding for bicycle and pedestrian facilities and access projects, including, as appropriate:

- Apply for regional, State, and federal grants for bicycle and pedestrian infrastructure projects;
- Establish development exactions and impact fees to fund bicycle and pedestrian facilities;
- Use existing revenues, such as State gas tax subventions, sales tax funds, and general fund monies for projects to enhance bicycle use and walking for transportation.

MM-TR81: Bicycle Parking: Local jurisdictions can and should adopt bicycle parking standards that ensure bicycle parking sufficient to accommodate 5 to 10 percent of projected use at all public and commercial facilities, and at a rate of at least one per residential unit in multiple-family developments (suggestion: check language with League of American Bicyclists).

MM-TR82: Local jurisdictions can and should establish parking policies and requirements that capture the true cost of private vehicle use and support alternative modes of transportation.

MM-TR83: Parking Policy: Local jurisdictions can and should adopt a comprehensive parking policy to discourage private vehicle use and encourage the use of alternative transportation by incorporating the following:

- Reduce the available parking spaces for private vehicles while increasing parking spaces for shared vehicles, bicycles, and other alternative modes of transportation;
- Eliminate or reduce minimum parking requirements for new buildings;
- "Unbundle" parking (require that parking is paid for separately and is not included in the base rent for residential and commercial space);
- Use parking pricing to discourage private vehicle use, especially at peak times;
- Create parking benefit districts, which invest meter revenues in pedestrian infrastructure and other public amenities;
- Establish performance pricing of street parking, so that it is expensive enough to promote frequent turnover and keep 15 percent of spaces empty at all times;
- Encourage shared parking programs in mixed-use and transit-oriented development areas.

MM-TR84: Event Parking Policies: Local jurisdictions can and should establish policies and programs to reduce onsite parking demand and promote ride-sharing and public transit at large events, including:

- Promote the use of peripheral parking by increasing on-site parking rates and offering reduced rates for peripheral parking;
- Encourage special event center operators to advertise and offer discounted transit passes with event tickets;
- Encourage special event center operators to advertise and offer discount parking incentives to carpooling patrons, with four or more persons per vehicle for on-site parking;
- Promote the use of bicycles by providing space for the operation of valet bicycle parking service.

MM-TR85: Parking "Cash-out" Program: Local jurisdictions can and should require new office developments with more than 50 employees to offer a Parking "Cash-out" Program to discourage private vehicle use.

MM-TR86: Electric/Alternative Fuel Vehicle Parking: Local jurisdictions can and should require new commercial and retail developments to provide prioritized parking for electric vehicles and vehicles using alternative fuels.

MM-TR87: Local jurisdictions can and should support and promote the use of low- and zero-emission vehicles, and alternative fuels, and other measures to directly reduce emissions from motor vehicles.

MM-TR88: Low and Zero Emission Vehicles: Local jurisdictions can and should support and promote the use of low- and zero-emission vehicles, by doing the following:

- Develop the necessary infrastructure to encourage the use of zero emission vehicles and clean alternative fuels, such as development of electric vehicle charging facilities and conveniently located alternative fueling stations;
- Encourage new construction to include vehicle access to properly wired outdoor receptacles to accommodate ZEV and/or plug in electric hybrids (PHEV);
- Encourage transportation fleet standards to achieve the lowest emissions possible, using a mix of alternate fuels, PZEV or better fleet mixes;
- Establish incentives, as appropriate, to taxicab owners to use alternative fuel or gas-electric hybrid vehicles.

MM-TR89: Vehicle Idling: Local jurisdictions can and should enforce State idling laws for commercial vehicles, including delivery and construction vehicles.

MM-TR90: Pedestrian and Bicycle Promotion: Local jurisdictions can and should work with local community groups and downtown business associations to organize and publicize walking tours and bicycle events, and to encourage pedestrian and bicycle modes of transportation.

MM-TR91: Local jurisdictions can and should organize events and workshops to promote GHG-reducing activities.

MM-TR92: Fleet Replacement: Local jurisdictions and agencies can and should establish a replacement policy and schedule to replace fleet vehicles and equipment with the most fuel efficient vehicles practical, including gasoline hybrid and alternative fuel or electric models.

MM-TR93: Local jurisdictions can and should implement measures to reduce employee vehicle trips and to mitigate emissions impacts from municipal travel.

MM-TR94: Trip Reduction Program: Local jurisdictions can and should implement a program to reduce vehicle trips by employees, including:

- Providing incentives and infrastructure for vanpooling and carpooling, such as pool vehicles, preferred parking, and a website or bulletin board to facilitate ride-sharing;
- Providing subsidized passes for mass transit;
- Offering compressed work hours, off-peak work hours, and telecommuting, where appropriate;
- Offer a guaranteed ride home for employees who use alternative modes of transportation to commute.

MM-TR95: Bicycle Transportation Support: Local jurisdictions can and should promote and support the use of bicycles as transportation, including:

- Providing bicycle stations with secure, covered parking, changing areas with storage lockers and showers, as well as a central facility where minor repairs can be made;
- Providing bicycles, including electric bikes, for employees to use for short trips during business hours;
- Implementing a police-on-bicycles program;
- Providing a bicycle safety program, and information about safe routes to work.

MM-TR96: Municipal Parking Management: Local jurisdictions can and should implement a Parking Management Program to discourage private vehicle use, including:

- Encouraging carpools and vanpools with preferential parking and a reduced parking fee;
- Institute a parking cash-out program;
- Renegotiate employee contracts, where possible, to eliminate parking subsidies;
- Install on-street parking meters with fee structures designed to discourage private vehicle use;
- Establish a parking fee for all single-occupant vehicles.

MM-TR97: Travel Mitigation: Local jurisdictions can and should mitigate business-related travel, especially air travel, through the annual purchase of verified carbon offsets.

MM-TR98: Transit Access to Municipal Facilities: Local jurisdiction and agency facilities can and should be located on major transit corridors, unless their use is plainly incompatible with other uses located along major transit corridors.

SIGNIFICANCE OF IMPACTS AFTER MITIGATION

Vehicle Miles Traveled

Implementation of Mitigation Measures **MM-TR1** through **MM-TR98** would to reduce VMT. However, 2035 VMT would still be substantially greater than existing VMT. Therefore, the Plan would result in a significant impact related to VMT.

Vehicle Hours Traveled in Delay for All Vehicles

Impacts related to VHD were determined to be less than significant without mitigation because vehicle hours in delay would improve under the Plan.

Vehicle Hours Traveled for Heavy-Duty Trucks

Implementation of Mitigation Measures **MM-TR1** through **MM-TR98** would reduce VHD for heavy trucks. However, the 2035 heavy-duty truck VHD would still be substantially greater than the existing VHD. Therefore, the Plan would result in a significant and unavoidable impact related to heavy-duty truck VHD.

Worker Commute

Impacts related to worker commute were determined to be less than significant without mitigation as the percentage of trips occurring within 45 minutes would increase under the Plan compared to today.

Transportation System Fatality Rate

Impacts related transportation system fatality rates were determined to be less than significant without mitigation because fatality rates are anticipated to decrease.

Transportation System Injury Rate

Impacts related to transportation system injury rates were determined to be less than significant without mitigation because injury rates are anticipated to decrease.

Cumulative Effects

Implementation of Mitigation Measures **MM-TR1** through **MM-TR98** identified in the Plan would be expected to reduce VMT and VHD. However, as the population increases through 2035, the number of trips originating and ending in Santa Barbara, San Diego and Kern counties to and from the SCAG region would increase. The transportation demand from growth, in combination with the accommodating projects in the Plan would contribute to a cumulatively considerable transportation impact in these other counties.

COMPARISION WITH THE NO PROJECT ALTERNATIVE

Direct Impacts

Vehicle Miles Traveled. The relationship between the VMT in 2035 with implementation of the Plan and without implementation of the Plan (the No Project Alternative) is shown in **Table 3.12-13**. The No Project Alternative would not include transportation and land use strategies that focus growth along existing corridors and in urbanized areas. As a result, population would be more scattered thought the region when compared to the Plan, and per capita VMT would not be reduced and other transportation metrics would not be improved. Implementation of the Plan would reduce vehicle miles of travel in 2035 from 547 million miles to 517 million miles. This constitutes a seven percent decrease from the No Project Alternative. **The Plan impact would be less than the No Project impacts for Impact 3.12-1.**

Vehicle Hours Traveled for All Vehicles in Delay. The relationship between the VHD in delay 2035 with implementation of the Plan and without implementation of the Plan (the No Project Alternative) is shown in **Table 3.12-4**. Implementation of the Plan would reduce VHD in 2035 from 6,015 thousand vehicle-hours to 3,115 thousand vehicle-hours. This constitutes a 48 percent decrease from the No Project Alternative and includes light, medium and heavy-duty truck VHD in all six counties. **The Plan impact would be less than the No Project impact for Impact 3.12-2.**

Vehicle Hours Traveled in Delay for Heavy-Duty Trucks. The relationship between the heavy-duty truck VHD in 2035 with implementation of the Plan and without implementation of the Plan (the No Project Alternative) is shown in **Table 3.12-15**. Implementation of the Plan would reduce heavy-duty truck VHD in 2035 from 354,000 hours to 158,000 thousand hours. This constitutes a 55 percent decrease from the No Project Alternative. **The Plan impact would be less than the No Project impacts for Impact 3.12-3.**

Worker Commute. The relationships between the percent of work opportunities within 45 minutes travel time with implementation of the Plan and without implementation of the Plan (the No Project alternative) are shown in **Table 3.12-16**. Implementation of the No Project Alternative would decrease the work opportunities within 45 minutes travel time by single occupancy vehicle in 2035 as compared to the Plan from 82 percent to 79 percent, would decrease the work opportunities within 45 minutes travel time by high occupancy vehicle from 77 to 68 percent, and would decrease the work opportunities within 45 minutes travel time by transit from 21 to 20 percent. The No Project Alternative would not improve the percent of work opportunities within 45 minutes travel time. **The Plan impact would be less than the No Project impacts for Impact 3.12-4.**

Transportation System Fatality Rate. The relationship between the transportation fatality rates in 2035 with implementation of the Plan and without implementation of the 2012-2035 RTP/SCS (the No Project Alternative) is shown in **Table 3.12-17**. Implementation of the Plan would result in a system-wide daily fatality rate of 0.17 fatalities per million persons for all travel modes, a decrease of 0.01 daily fatalities per million persons when compared to the No Project Alternative rate of 0.18. **The Plan impact would be less than the No Project impact for Impact 3.12-5.**

Transportation System Injury Rate. The relationship between the transportation injury rates in 2035 with implementation of the Plan and without implementation of the 2012-2035 RTP/SCS (the No Project Alternative) is shown in **Table 3.12-17**. Implementation of the Plan would result in a system-wide daily injury rate of 12.93 injuries per million persons for all travel modes, a decrease of 5.34 daily injuries per million persons when compared to the No Project Alternative rate of 13.67. **The Plan impact would be less than the No Project impact for Impact 3.12-6.**

Indirect Impacts

The Plan includes transportation and land use strategies that focus growth along existing corridors and in urbanized areas, rather than allowing development of vacant, open space/recreation and agricultural lands. This compact development pattern included in the Plan would concentrate population in urban areas and encourage alternative modes of travel other than automobiles. Without the planned development patterns, vehicles miles travels, vehicle hours of delay, worker commute trips, and accident rates would be higher than under the Plan. **The Plan impacts would be less than the No Project impacts for Impact 3.12-7.**

Draft

Travel Characteristics of Residents of Multi-Family Housing in the Inland Empire

August 31, 2010

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Executive Summary

This study examines the travel patterns of residents of multi-family housing in California's Inland Empire. The results are intended to support local community planning and the vehicle miles traveled reduction goals of SB 375. Using telephone and mail back surveys, the study finds that multi-family housing residents rely primarily on driving alone in private vehicles for their work and non-work trips. Looking at work trips, however, shows that the residents of multi-family housing have higher reported bus/rail transit shares than county averages for all types of housing. Yet the percentage of work trips in single occupant vehicle trips is similar to county-wide data for all residents, indicating that the use of alternative modes, such as carpooling, is lower for these multi-family housing residents.

Comparing the portion of survey respondents that are close to transit services with those that are farther away does not reveal significant differences in transit use, although those close to transit use the carpool mode more frequently. The projects studied near transit showed less transit use than found in mature transit oriented developments (TOD) elsewhere in California, but this is expected since Inland Empire transit service are less extensive. The housing developments near transit are reasonably dense, but they lack the other elements that reduce single occupant trips such as diversity of land uses, pedestrian design features, transit service frequency, and parking pricing.

These results show that multi-family housing does support transit ridership to a degree, but that the full potential of transit-oriented development in the Inland Empire lies with increased transit service and changes in land use patterns. Inland Empire cities such as San Bernardino, Ontario, and Montclair are actively pursuing TOD strategies; transit providers are developing service enhancements and new services. Cities can build on these existing housing clusters by focusing additional housing density at transit stops and introducing mixed use development that encourages walking trips for shopping and other activities. Site planning must support the pedestrian realm, easy access to transit, land use mixing, and revised parking standards and pricing approaches. Many redevelopment opportunities exist around the Metrolink stations, but since Metrolink alone cannot serve the dispersed geography of the Inland Empire, bus innovations are important as well, to act as connecters to the rail backbone and serve travel within the Inland Empire.

The study concludes with suggestions about future research to better understand the travel patterns of Inland Empire residents, employees, and shoppers, to measure results TOD implementation, and ensure that strategies fit the particular community and market conditions in the Inland Empire.

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Chapter 1. Introduction

Policy makers are seeking to coordinate land use, housing, and transportation planning to support environmental and community development goals. California's primary initiative in this regard is the SB 375 Sustainable Communities Strategy mandate that aims to reduce greenhouse gas (GHG) emissions by reducing vehicle miles traveled (VMT). Many regional, county, and local sustainability planning efforts have similar goals; bringing these policy goals to local implementation, however, involves many implementation challenges.

Historically, VMT has grown faster than population and employment, reflecting the impact of rising incomes and the concentration of growth in automobile-oriented suburbs. In past eras, the predominant response to VMT growth was expanding roadways. For the most part, environment and energy issues associated with VMT growth were addressed with regulations affecting pollution controls and vehicle fuel economy. While the state's GHG efforts include vehicle fuel economy and reducing the carbon content of fuels, SB 375's mandate to reduce VMT marks a significant new approach.

Planners face many questions in responding to SB 375. Can local and regional entities reduce per-capita VMT through coordinated land use and transportation planning? Can an automobile-oriented region such as the Inland Empire (IE) do so? Will the effects of growth in an area such as the Inland Empire swamp possible reductions in VMT per capita?

Numerous efforts are underway to develop plans and modeling techniques to answer these questions. The behavioral questions embedded in these policy directions are significant. To what degree will denser, mixed-use development and improved transit induce residents to use transit, walking, or bicycling modes? Will residents own fewer vehicles? To what degree will they choose destinations for work or shopping that are closer to their homes, reducing the distance drive and/or changing the travel mode used?

Answering all of these questions requires a comprehensive research program. Across the state, researchers are addressing many aspects of the issue. This report tackles a focused, fundamental starting point for considering these questions. Using the Inland Empire as an exemplar of a fast growing, automobile-oriented region, this study provides high quality, local information about the travel behavior of those who live in existing multifamily housing in the IE. It establishes a starting point for gauging the potential of VMT reduction strategies and assessing the results of plans designed to reduce VMT. The primary measure use is the mode choice of residents for work and non-work trips. The smaller the percentage of single occupancy trips, the less VMT.[1]

The travel behavior data provided here is derived from telephone and mail-back questionnaire surveys of the residents of a series of multi-family residential buildings in

[1] VMT can also be reduced by lessening the distance between trip destinations, reducing the number of trips, or combining trip purposes.

the urbanized portion of San Bernardino and Riverside County. The information is of use to the Southern California Association of Governments (SCAG) as they consider transit-oriented development (TOD) policy and develop the region's Sustainable Community Plan. The results can also be used by local cities to assess the likelihood and magnitude of changes that are possible with new land use and transportation policies. Furthermore, the data provide a baseline for future assessments of the success of land use/transportation strategies such as Sustainable Community Strategies and support the development of GIS-based modeling tools being developed by Leonard Transportation Center scholars, SCAG, and others.

Chapter 2. Literature Review

The past three decades have seen a dramatic increase in VMT in the U.S. VMT has tracked increases in gross domestic product (GDP), outpacing growth in population, and even further outpacing the number of lane-miles of roadway (Sorensen et al. 2008). The result of this trend is high levels of greenhouse gas (GHG) emissions from the transportation sector and extensive traffic congestion.

The run-up in VMT per capita is associated with factors such as increased wealth, increased female participation in the labor force, the influence of the baby boom population cohort on travel patterns, and the location of growth in automobile-oriented areas. Recently, VMT increases have moderated, and in the recent period of high gasoline prices, VMT actually decreased by a modest amount. Despite this, personal travel in vehicles is almost one-quarter of GHG emissions in the state.

VMT and Travel Trends

SB 375 challenges land use, housing, and transportation planners to develop strategies that reverse VMT growth, even when accounting for population and employment growth. Among U.S. regions, Southern California exhibits a pattern of high VMT. Vehicle miles traveled (VMT) per day in the Los Angeles MSA is the fifth highest of 14 major U.S. metro areas (Sorensen et al., 2008). Given the urban quality of many parts of the Los Angeles MSA, one would expect a lower VMT, but that is not the case. VMT is higher than the density would predict for transportation reasons (alternative modes are not well used) and land use reasons (the mix of land uses separates origins and destinations and does not support non-automobile modes).

VMT is likely to be lower in compact regions simply because trip origins and destinations are closer together and the greater mix of land uses mean that multiple trip purposes can be accomplished with one vehicle trip. The other important factor is the impact of land use and transportation planning on the travel mode used. Traditional suburban development patterns favor the automobile over other travel modes. By changing mode choice, each trip made using transit, carpool, vanpool, shuttle, walking, or bicycling reduces VMT.

The Lincoln Land Institute estimated U.S. GHG emissions from the transportation sector (Brown et al. 2008) and ranked the Riverside-San Bernardino-Ontario metropolitan area 92nd highest of the 100 U.S. metro areas in terms of GHG emission per capita from transportation (1.89 metric tons per person in the Inland Empire versus 1.30 for the 100 metro average). This total includes emissions from trucks; when they are excluded the ranking is 83, still among the worst (1.29 metric tons per person). In sum, the Inland Empire faces significant challenges in responding to SB 375 in that it lacks a well-developed transit infrastructure and an existing mixed-use land use pattern to build on. Land use and transit system changes occur over many decades.

Reducing VMT

Five dimensions are generally considered in assessing VMT reduction potential: 1) density of population and employment (making places closer together and encouraging alternative travel modes), 2) diversity of land uses (mixed residential and commercial uses and a balance of housing and jobs), 3) pedestrian- and transit-friendly design, 4) destination accessibility (ability to reach trip destinations), and 5) distance from home or work to transit (e.g., bus or rail within ¼ or ½ mile of trip origin) (National Research Council 2009). That study came to the conclusion that if the density of new and redeveloped housing across a metropolitan area was doubled, it "…might lower household VMT by about 4 to 12 percent, or perhaps as much as 25 percent, if coupled with higher employment concentrations, significant public transit improvements, mixed uses and other supportive demand management measures." (National Research Council 2009, pp. 4).

A key example of a VMT reduction strategy is TOD. TOD links denser, mixed-use development with transit in a walkable environment. This concept has gained popularity in urban areas across the U.S. and is of growing interest in suburban areas. For example, the city of San Bernardino is planning a TOD in its core in conjunction with Omnitrans' development of bus rapid transit service.

The State of California defines TOD in terms of proximity to transit services. For example, SB 375 provides CEQA exemptions for "sustainable community projects" if they are within ½ mile of a major transit stop or high quality transit corridor. The minimum transit threshold is either a rail transit station or a "high quality" transit corridor with a service interval no longer than 15 minutes during peak commute hours. (Section 21064.33 and 2155b).

Two previous California studies of the travel behavior of those who live in TOD provide a comparison point with this study (Lund et al., 2004; Lund and Willson, 2005). These studies showed that those who live near transit-oriented development (TOD) have higher levels of transit use than persons in nearby areas, and that they own fewer automobiles. The results of TOD, however, vary widely depending on the maturity of the transit system and local land use conditions. The best results are found in the Bay Area, where BART and other transit services have had time to mature and land use patterns have been focused around transit services. While most previous TOD studies examine housing around light and heavy rail transit, the focus here is bus and commuter rail.

Multi-Family Housing

Multi-family housing saves land as compared to single family housing, producing desirable outcomes in terms of housing cost per unit and reduced environmental impacts. In addition, multi-family housing generates fewer trips per day than single family housing. Residents of multi-family housing also own fewer automobiles per household, resulting in lower per-unit parking demand. Table 1 (next page) provides a comparison of different forms of data about the impacts of multi-family housing using national data derived from the Institute of Transportation Engineers (2003, 2004). These national sources are often used in local traffic impact and parking studies. The data show a significant difference in trips per weekday and in peak overnight parking occupancy between single family dwellings to multi-family forms of housing. According to these sources, increasing the share of multi-family housing may by itself have positive impacts in terms of SB 375's goals.

Table 1. Trip Generation and Parking Occupancy

Land Use	ITE Code	Trips per day, weekday	Overnight parking occupancy (associated with vehicle ownership)
Single Family dwelling	210	9.57	1.83
Apartment	220	6.72	N/A
Los rise apartment	221	6.59	1.2
High rise apartment	222	4.20	1.37
Condominium/townhouse	230	5.86	1.46

There are many reasons why multi-family housing has lower trips and parking demand. First, the household size is smaller in multi-family housing (families are more likely to live in a single-family dwelling). Second, these units may have a lower percentage of residents who travel by personal vehicle, such as lower income or older residents. Finally, the multi-family housing may be in a location with more walkable trip destinations, better transit services, and other travel options. These multiple factors mean that one cannot assume that a household's travel patterns are transformed simply because of the creation of a transit-friendly environment.

The trip generation of multi-family housing varies with according to the factors mentioned previously. For example, the range of rates used in computing the average trips per weekday for Land Use 220 is between 2.0 and 12.5 trips per weekday; the standard deviation is 3.02. ITE states that higher trip rates are expected from projects that have larger units, are more expensive (indicating an income effect), and farther from the CBD (less land use mixing and fewer alternatives to driving).

The idea behind SB 375 is to alter land use, housing and transportation patterns so new housing units generates fewer vehicle trips per day than the otherwise would. This can be accomplished by arranging job locations and transit services so that transit or carpools are more fully used in the work commute. Trips can also be reduced if walkable non-work destination are provided, allowing for walking or bicycling to shopping, recreation, education trips, etc. Finally, denser, mixed use development makes it economically feasible to offer more frequent and convenient transit services, which in turn attract more transit riders. Since ITE data concerns trips, not VMT, one must also consider that the goals of SB 375 are also met when the distance of trips is shorted by virtue of origins and destinations being closed together in denser, mixed use forms of development.

Literature on the Inland Empire

The Inland Empire is an understudied region, despite its importance in the future of California. This report and others sponsored by the Leonard Transportation Center seek to remedy that lack of study. One notable exception is Johnson et al. (2008), which provides a broad overview of existing and likely future conditions in the IE. They note that the region has grown at twice the rate of the rest of California and see the Inland Empire growing from 3.9 million in 2005 to 4.9 million in 2015. This growth is driven by migration from other parts of Southern California.

In the realm of housing policy, Bluffstone et al. (2008) critique the pattern of sprawl in the Inland Empire in terms of social costs. Further information on the Inland Empire is provided in Chapter 4, Characteristics of Study Area and Multi-Family Housing.

Chapter 3. Research Design

The research design described below involves surveys of residents of newer multi-family housing complexes in the Inland Empire, focusing on questions such as the mode of travel, vehicle ownership, trips patterns, and attitudes.

Research Goals and Questions

When this study was first conceptualized by the principal investigators, there were two major target populations for the study: Inland Empire residents who live in multi-family housing within 1/4 mile of a major transit stop or high quality transit corridor (termed the "study group") and those who live in multi-family housing but who have limited or no bus service or Metrolink service within ¼ mile (termed the "control group"). Initial field work revealed, however, that although the Inland Empire has many promising TOD plans and projects, there are few existing and occupied developments that meet the formal definition of TOD -- high frequency transit, density, and mixed land uses. In general, land use mixing and transit frequency are lacking. As a result, comparisons of study group vs. control group cannot be made with the same expectation as in previous TOD studies. Although those comparisons are provided in the analysis chapter, the main purpose of the study was revised to become a baseline measurement of travel behavior among multi-family housing residents in the Inland Empire, before the establishment of well-defined TODs.

The study's research goals include the following:

1. To provide an understanding of the travel behavior of residents of multi-family housing in the Inland Empire.
2. To provide a baseline measurement of trip making against which future TOD projects can be assessed.
3. To provide practical guidance for forms of development, transit options, and policies that can reduce household VMT from residents of multi-family housing in the IE.

Research questions that flow from these goals include the following:

1. What is the level of vehicle availability among residents?
2. Was access to transit a factor in respondents' residential location choice?
3. What are the respondents' perceptions of the local transportation environment, and do those perceptions differ between respondents from study sites and control sites?
4. What is the level of single-occupant vehicle and transit travel among residents? How do those mode choices vary among work and non-work trips? How do those mode choices vary between study sites and control sites?
5. How do respondents from study sites and control sites differ relative to demographics/socioeconomic characteristics, travel patterns (reason for the trip,

their mode of transportation, length of trip and parking at destination), attitudes toward transportation, and use of public transportation?

5. Are there relationships between various demographic/lifestyle factors and auto dependency (conceptualized as percent of single occupant vehicle trips)?

The study sites have densities of 20 units per acre or more and they are within ¼ mile of transit services, but they lack the required transit frequencies and land use mixing to be considered true TODs. While not meeting the formal definition of TOD, these study sites provide insight into *transit-proximate* development that could become full TOD with transit service improvements and land use intensification.

Survey Instrument

A variety of methods are available to derive information on travel behavior, including intercept surveys, household surveys, measurements of traffic volumes and transit use, and use of existing data sets. Household surveys are often combined with census data in regional modeling efforts. The full behavioral dimensions of travel are often best captured with a form of household survey because the data can be used to associate individual level demographic and attitudinal features with travel behavior.

Forms of household survey vary in their comprehensiveness, ranging from travel diaries in which household members report all trips for a defined time period to simpler survey instruments focusing on particular trips. This study uses a household survey completed by the head of household or partner that concerns the top three (as identified by the respondent) trips taken on the day surveyed.

The "top three trips" approach is a good compromise between expensive household surveys and aggregated data sources. Resources were not available for a full household travel diary. The survey approach does not provide a complete inventory of daily VMT but provides important information on mode choice, travel times and attitudinal factors. The "top three trips" follows the approach taken by Lund et al. (2004) and Lund and Willson (2005) in previous studies of TOD in California, allowing comparisons with those data sets. In other words, once we know the mode choice starting point for the Inland Empire, we can assess the prospects for the region approaching the transit trip shares found in more urbanized portions of the state.

Respondent Selection and Mode of Delivery

Selection of survey respondents began with the CPP research team providing IAR with a listing of multi-family housing complexes in Riverside and San Bernardino counties, some of which were classified as a study sites, and others which were classified as control sites.

Apartment complexes throughout the Inland Empire were screened to select candidate sites for study. Those sites are characterized by being newer, three- to four-story buildings with over 100 units. Field reconnaissance was conduct by windshield surveys in prospective areas, searching apartment rental websites, and searching on Google Earth, Google Maps, and Bing Maps.[2] Because a complete inventory of potential study sites was not readily available, it is possible that the methods used to find potential sites did not exhaust the list of qualified study sites. The number of housing units within each complex was obtained through telephone calls placed to each of the potential study sites. Using Google Earth and an online tool that measures the area of polygons made in Google Earth,[3] aerial photography of each site was used to calculate the number of acres occupied by each complex. The density of each complex was obtained through the division of the number of housing units and the area of each site. Researcher at IAR conducted further field checks from the list to determine the full list of addresses associated with each project. Appendix A summarizes the characteristics of each study site, organized in order of density measured by the number of units per acre (highest to lowest). A total of 4,062 units were identified in this group, with an average density of 27 units per acre.

The control group study sites are shown in Appendix B. It includes 5,759 units with an average density of 20.9 units per acre.

Although Lund et al (2004) and many other TOD survey used a mailed/mail-back questionnaire, the team decided that this study should be conducted via a phone survey approach. The study team wanted to test the potential of telephone surveys to yield a better level of accuracy and a response rate than mailed surveys.

Since apartment/condo owners and managers would not provide IAR with complete phone lists of apartment/condo dwellers, citing federal laws and corporate policies, IAR employed the following multi-step procedure to select survey respondents:

1) IAR purchased a sampling frame from *Scientific Telephone Sampling* (STS) which included phone numbers (both cell phones and land lines) for all listed phones within ¼ mile of the address. This list contained approximately 2,343 phone numbers, some of which were non-working numbers or business numbers rather than apartment/condo residential numbers. Even with increasing the number of call-backs to working numbers from 5 to 6, it was clear that this sampling frame would fall far short of obtaining the desired sample size.

2) IAR enriched the STS sampling frame by inputting every apartment/condo address (both study and control sites) into the on-line white pages so as to obtain additional working numbers.

3) In order to obtain unlisted numbers IAR employed a variation of a random digit dialing technique in which we added and subtracted constant numbers to the listed numbers, and a screening question was asked to confirm that indeed the respondent lived in multi-family housing within the geographical area of interest.

[2] The sites were identified by Michael Roberts, a graduate student in the Department of Urban and Regional Planning at CPP at part of his masters thesis research.
[3] GeoUtilities can be found at http://www.geo-news.net/index_geof.html

4) The above procedures still did not produce a sampling frame that would yield a sufficient sample size. The IAR Project Coordinator drove to one of the study site apartments and noted that the address provided was only one building of a larger apartment/condo complex. She confirmed that this was also the case for other study sites, thus the decision was made to contact the management office of every study site for a complete map of the complex. This approach yielded additional addresses and IAR staff found listed phone numbers for those addresses in the on-line white pages.

To the extent possible, therefore, each person with a telephone residing in the designated areas had an equal chance of being included in the survey.

A $200 gift card drawing was offered as an incentive for participation in the survey. The above procedures resulted in 306 completed phone surveys conducted between March 24 and April 12, 2010, with significantly more surveys from the control group than study group (not surprising since there were 22 control sites and only 10 study sites). Further, this sample size was still too small for a 95% level of confidence and an accuracy of +/- 5% typically employed for studies of this nature. IAR decided to modify the mode of delivery by sending post cards to 4,008 addresses of study site apartments/condos asking the recipient to call IAR to take the phone survey and receive a guaranteed incentive of a $10 gift card for the first 50 callers plus entrance into the lottery for the $200 drawing as an inducement to participate. This procedure yielded an additional 26 telephone surveys conducted between April 22 and May 6, 2010.

Sample size was still less than desired, so a final delivery approach was undertaken in which full printed surveys were mailed to 2,000 residents in study site apartment/condos. That mailed survey approach yielded an additional 83 surveys, received between June 17, 2010 and July 20, 2010. In all, the total sample size was 415 surveys completed with a mixed-mode survey approach.

Questionnaire Construction and Interview Procedures

To allow for comparisons with other studies, the starting point for the questionnaire was a mailed survey instrument used in Lund et al. (2004) and Lund and Willson (2005). The study team transformed and enhanced this instrument into a telephone survey so as to best meet the research needs of this project. IAR translated the questionnaire into Spanish, pretested the questionnaire, and modified and revised the questionnaire where warranted. The questionnaire was designed to last on average between 10 and 12 minutes. The mail survey was then constructed based on the telephone survey. The telephone and mail survey instruments are provided in Appendices C and D, respectively.

Telephone interviews were conducted by thoroughly trained CSUSB students via telephone from the facilities of CSUSB's Institute of Applied Research and Policy Analysis in San Bernardino, using Computer Assisted Telephone Interviewing (CATI) software. Spanish speaking interviewers were available throughout the interviewing process and used when considered necessary to improve the chances of the respondents' participation and the clarity of the data gathered.

Calls were made Monday through Friday from 9:00 a.m. to 9:00 p.m. and on the weekends (Saturday 9:00 a.m. to 5:00 p.m., and Sunday 1:00 p.m. to 7:00 p.m.). Institute Staff CATI Shift Supervisors (CSUSB students) will be present for all interviews conducted so as to ensure the quality and reliability of the interviews. To further ensure quality control, supervisory personnel randomly selected ten percent of all completed interviews (at least one completion per interviewer) and made call-backs for verification.

Chapter 4 Characteristics of Study Area and Projects

The study area is the Inland Empire (IE) portion of San Bernardino and Riverside counties lying south of the San Bernardino mountains, contiguous to the Los Angeles metropolitan area. The Inland Empire was selected for study because it represents a fast-growing suburban area that is experiencing a transition toward greater density, mixed-use development, and employment. A transit backbone of commuter rail (Metrolink) and bus is being developed and many cities have plans for denser, mixed-use development. For example, the city of Ontario recently adopted a new general plan that includes higher density, mixed-use land use designations.

As mentioned previously, the IE's population growth outpaces the region and California, fueled by migrants from the greater Los Angeles area seeking lower cost housing. On the economic side, major employment categories include manufacturing, construction, and transportation and distribution. Recently, the area has been hit hard by the housing crisis and recession, with the unemployment rate standing at about 15% in the summer of 2010.

The Inland Empire is represented on Figure 1. Encompassing portions of San Bernardino and Riverside counties, the area does not have an exact geographic definition, but it generally considered to be the core urbanized area the runs east/west along the I-10 and 60 freeways, bordered in the north by the San Bernardino Mountains and in the south by Orange County.

Study Area

The study area for this study is areas that are likely to have multi-family housing and a reasonable future prospect of TOD and transit development. That general area, shown in Figure 1 includes surveys from the San Bernardino cities of Chino, Chino Hills, Colton, Fontana, Highland, Loma Linda, Montclair, Ontario, Rancho Cucamonga, Redlands, Rialto, San Bernardino, Upland, Yucaipa. In Riverside County, surveys were received from residents in the cities of Moreno Valley and Riverside.

Figure 1: Inland Empire Study Area

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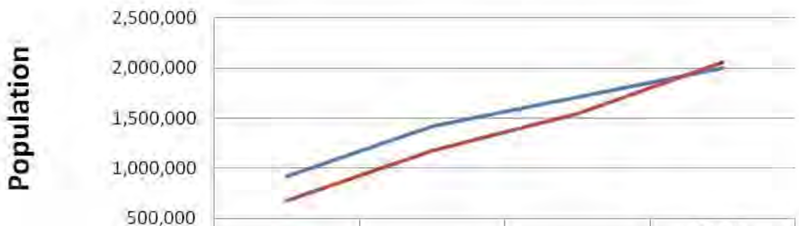
Study Area Characteristics

Figure 2 shows that rapid growth that has occurred in the two-county area. The fast growth is associated with available land and lower land costs on the edge of the Los Angeles metropolitan area. Although housing construction has slowed because of a national recession, it is expected to resume in the future. This makes the Inland Empire very important from the perspective of SB 375 because this is the area in which a significant portion of California's growth will occur. This is a place where land use, housing and transportation provision must be well coordinated if automobile dependency is to be reduced. The data that follows in this section is drawn from the U.S. Census and American Community Survey.

Figure 2. Population Growth in San Bernardino and Riverside Counties



	1980	1990	2000	2006-2008 (Estimate)
San Bernardino	919,700	1,418,380	1,709,434	1,999,753
Riverside	680,700	1,170,413	1,545,387	2,055,232

Source: Roberts 2010

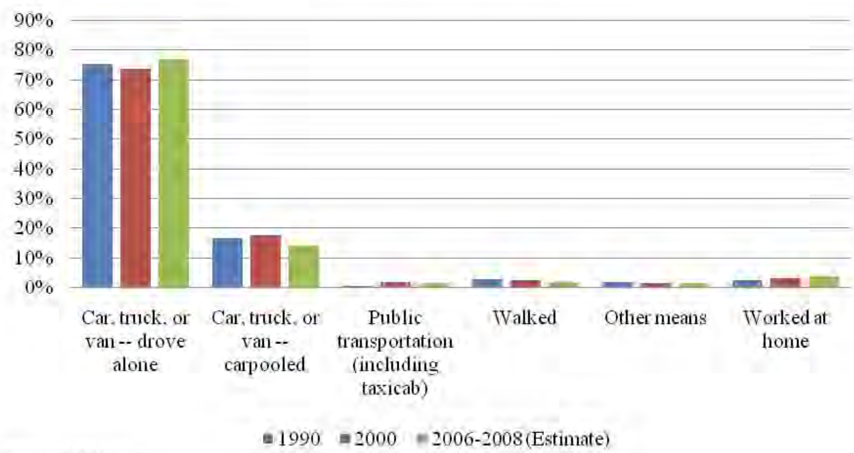
Table 2 (next page) shows the characteristics of the population in the two counties. Compared to California as a whole, the area represents the conditions at the expanding edges of metropolitan areas, with a greater share of owner-occupied housing, larger household size, and a younger population. Given that inland suburban areas are attractive for their lower cost housing, the population has a lower than average median household income. The lack of jobs/housing balance and spread out nature of San Bernardino and Riverside counties is reflected in longer travel time for work commutes; similar factors explain the higher level of single occupant vehicle commuters.

Table 2. Demographics of San Bernardino and Riverside Counties

2006 – 2008 (Estimate)	San Bernardino County	Riverside County	State of California
Population	1,999,753	2,055,232	36,418,499
Occupied housing units	589,058	647,443	12,177,852
% housing units renter occupied	35.2%	31.1%	42.2%
Average household size	3.32	3.13	2.92
Median household income	$56,575	$58,168	$61,154
Median age	30.3	31.6	34.7
Mean travel time to work (minutes)	29.2	31.6	27.0
Single occupant vehicle for the journey to work (%)	77.1%	75.2%	72.9%

Figure 3 provides time series information on the patterns of travel mode choice in the study counties. Consistent with regional trends, modest increases in transit use have been counteracted by decreases in carpooling and vanpooling, leading an *increased* percentage of work commuter driving alone. View simply in terms of past trends, there is no indication that planners should expect reductions in drive alone commuting without new plans and policies.

Figure 3. Trends in Commute Mode Share.



Source: Roberts (2010)

The average journey-to-work travel times for workers of San Bernardino and Riverside Counties are among the longest in the region, as shown on Table 3. This measure reflects

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three elements: trip length, travel speed, and mode choice (since transit door-to-door times are generally longer than driving). In the case of the Inland Empire, the major contributors are long travel times and low travel speeds associated with peak period congestion.

Table 3. Comparison of Travel Time to Work, 2006-08

County	Mean journey-to-work travel time (minutes)
Riverside	31.6
Los Angeles	29.2
San Bernardino	29.2
Ventura	26.4
Orange	25.9
Weighted five-county average	28.7

Because there are not sufficient jobs for local residents, there is a high level of commuting to employment outside the Inland Empire. Johnson et al (2008) show that despite strong local job growth, 20 percent of the region's workers commute to jobs outside the region, barely down from 21 percent in 2000. Those commuters tend to be the most highly educated of Inland Empire residents. While the largest job destinations for commuters are Los Angeles or Orange counties, Johnson et al. (2008) show that the greatest increase in commuting outside the region was to San Diego County.

Multi-Family Housing Characteristics

Although there are promising plans to develop TOD and transit in the IE, the concept is in its infancy. Inland Empire residential complexes are generally single-use developments and are designed primarily to accommodate private vehicular transportation. While transit service may be nearby, transit frequencies are low (e.g., 30-60 minutes between buses) and the level of connectivity to dispersed destinations is low. The housing complexes studied here are moderately dense, but most of them lack the transit service and mixed of land uses normally associated with TOD. The travel behavior measured in this study, therefore, represents travel choices under conditions of plentiful parking, unpriced road use, relatively low levels of transit provisions, and disconnected land uses. These are conditions where one would expect to find a high reliance on private vehicle use.

Figure 4 shows a typical project that was surveyed. While attractively landscaped, the project follows typical suburban design standards, including substantial setbacks, landscaped berms, plentiful parking and roadway capacity. In addition, the projects generally do not provide direct pedestrian connections to surrounding land uses.

Figure 4. Typical Project Surveyed

Photo credit: Roberts 2010

Chapter 5. Analysis of Travel Behavior and Vehicle Availability

This chapter presents the analysis of the survey results in two sections. The first section describes the results from the full set of 415 survey respondents, including rental and ownership multi-family housing. The second section describes the results from the subset of respondents in rental housing, focusing on household vehicle availability and its implications for parking demand (301 respondents).

Analysis of All Multi-Family Respondents

The following describes the analysis of the full set of respondents, including both renters and condominium owners. It provides information on the personal and household characteristics of respondents, length of residency, reasons for residential location, perception of the local transportation environment, travel patterns, attitudes toward transportation, open ended comments, and analysis of factors that explain travel choices. Because the study is interested in determining if respondents in a study area sites (residential complexes within ¼ mile of transit) have different characteristics than those that are not near transit (the control sites), the results for each group are shown in many of the tables that follow.

Personal Characteristics of Respondents

The following section describes the demographic characteristics of the respondents of this study. It should be noted that these are the personal characteristics of the responder (who is the head of household or partner) and should not used to determine the general characteristics of the households.

Age, Gender, Ethnicity and Occupation

The average age of the respondent was 44 years, with a range of 18 to 101 years. More females (65.0%) answered the combined survey than males (34.8%). Most were Caucasian (42%), followed by Hispanic (30.4%) and African American (21.7%). In terms of the occupation of the respondent, the largest category was "professional" (18.2%) which would be even larger if one were to collapse some of the other categories, such as medical, teacher/professor, etc. into the "professional" category.

Household Characteristics

This section addresses household characteristics, such as household type and size, number of available vehicles, parking and length of residency.

Household Income

The respondents were evenly distributed among the income categories, with the greatest single concentration of respondents indicating that their income was in the range of $45,001 to $60,000. A greater percentage of study site respondents, however, reported having a higher income than control site respondents (58.4% reported an annual household income greater than $45,000 compared to 40.9% of control site respondents). The reader will note that for households in which there are several roommates living together as a family unit, it is unclear if the respondent included the roommates' income in their response.

Household Type and Size

Regarding the type of household (apartment vs. condo/townhome) and size of the household (number of bedrooms and the number of people living in the household), there are some marked differences between households within the study site vs. the control site. Residents in the study sites are more likely to live in an apartment (89.4% study sites vs. 64.7% control sites), whereas residents within the control sites are more likely to live in a condo/townhouse (35.3% control sites vs. 10.6% study sites). Moreover, household size is smaller for study site households (66.7% of study site households have one or two residents vs. 50.2% of control households with one or two residents), and these households do not have as many bedrooms as control site households (39.4% of study site respondents live in studio or 1 bedroom apartments, vs. 26.6% of control site respondents). Finally control site respondents report children in the household under the age of 16 (56.5%) in larger numbers than study site respondents (27.6%). These factors may stem from the fact that study site are more likely to be smaller, newer units.

Vehicle Availability and Parking

Up to this point, our analysis suggests that the study sites have many of the same characteristics that one would expect in a fully developed TOD site…smaller household size, fewer children in the household, and fewer bedrooms than households in the control sites. But it was somewhat surprising to find that the study site respondents did not have fewer cars than respondents in control sites. The findings indicate that study site households have ***more*** vehicles than their counterparts in the control group (56.9% of study site households have more than one vehicle vs. 45.2% of control site households). One plausible explanation is found when looking at household income and number of drivers in the household. Specifically, study site households have a higher income when compared with the control group (see demographics above) and also are more likely to have at least one vehicle available for each person of driving age (74.1% vs. 53.1%).

In terms of where residents park their vehicles, overall 69.2% said they park their vehicle(s) in a private garage assigned to their unit (representing 345 vehicles), 47.9% park in a shared garage or outdoor lot in their development (representing 237 vehicles), and 11.7% said they park on the street (representing 63 vehicles). When looking at study vs. control site respondents, Table 4 shows the breakdown of where they park their cars.

Table 4. Where do you park?
(% of people who answered "yes")

	Study	Control	Total
Private garage assigned to unit	72.7% (112 vehicles)	67.4% (233 vehicles)	69.2% (345 vehicles)
Shared garage or outdoor lot in development	57.8% (98 vehicles)	43.0% (139 vehicles)	47.9% (237 vehicles)
On the street	7.8% (12 vehicles)	13.6% (51 vehicles)	11.7% (63 vehicles)

Length of Residency

Regarding length of residency, study site respondents report having lived in their current location for fewer years than control site respondents. Specifically, the mean length of residency for study site respondents is 1.98 years, as compared to control site respondent which is 4.49 years. In fact, almost two-thirds of study site respondents (62.6%) have lived in their current residence for one year or less (compared to only 29.2% of control site respondents). This finding might be expected since there are more respondents living in apartments in the study sites as opposed to control sites. As mentioned previously, this length of residency applies to the respondent, which might be different than the household in the case of unrelated household units.

Residential Location Choices

Respondents were read a list of the reasons for moving to their current residence and asked to identify which were important to them (note: this was a multiple response question where respondents could select more than one response). Overall, the top three factors include "cost of housing" (71.8%), "type or quality of housing" (61.9%) and "quality of neighborhood" (60.0%). They were then asked to identify the MOST important factor, and 32.4% said the "cost of housing", 16.4% said the "quality of the neighborhood" and 11.1% said the "type or quality of housing". Table 5 illustrates the differences between study site respondents and control site respondents as to the most important factor in deciding to move to their current location. Clearly, access to transit is a minor factor, ranked 7th of the list of reasons. This is not surprising because the level of transit service is low.

Table 5. Which was the MOST important factor to you in deciding to move to your current residence?

	Study	Control	Total
Cost of housing	22.7%	36.9%	32.4%
Type or quality of housing	18.2	7.8	11.1
Quality of local schools	0.8	12.8	8.9
Quality of neighborhood	12.9	18.1	16.4
Close to job	11.4	9.2	9.9
Access to shopping and services	1.5	5.0	3.9
Access to transit	0.8	1.4	1.2
Access to highway	1.5	0.4	0.7
Recreational opportunities	0.0	0.4	0.2
Other	3.8	8.2	6.8

Perceptions of Local Transportation Environment

Finally, respondents were asked to rate their neighborhood as a place to walk to destinations and as a place for people to take buses or trains. Overall, 59.9% of respondents rated their neighborhood as a "good" or "excellent" place for people to walk to destinations and 47.9% rated it as a "good" or "excellent" place for people to take buses or trains (see Table 6). Control group respondents generally gave higher ratings than their study site counterparts. These findings suggest that the study sites, despite being the close to transit service, do not provide the pedestrian environment or transit service frequencies that create a favorable environment for transit.

Table 6. Percent of Respondents who Rated their Neighborhood as "Good" or "Excellent"

	Study	Control	Total
A place for people to walk to destinations	48.5	65.2	59.9
A place for people to take buses or trains	46.4	48.5	47.9

Travel Patterns

Respondents were asked a variety of questions regarding the three main trips they took on the business day prior to the day they responded to the survey. Each trip refers to one direction of travel (for example home to work is one trip, work to home is another trip, etc.). Respondents self-identified the three main trips.

The following analysis describes the travel patterns in terms of reason for the trip, their mode of transportation, length of trip, and parking at their destination.

Trip Purpose, Mode of Transportation, Trip Length and Parking at Destination

For purposes of analysis, the reason for the trip was coded as "work" trips, "non-work" trips and trips to go "home". Non-work combines trip purpose such as school, shopping, meal or snack, errands, recreational, medical, etc. The majority of trips were for non-work (60.5%) and another 22.4% were work related. Study site respondents were more likely to report work trips than control site respondents (27.8% vs. 19.0%).

Table 7 shows the results for all reported trips -- the majority of respondents report that they drove alone (75.1%), while 16.2% carpooled and 5.3% said they used some sort of public transit, either the Metrolink (1.7%) or the bus (3.6%). Walk and bicycle trips consisted 2.2% of trips, a low percentage considering that non work trips are included in this total. This reflects the automobile orientation of the Inland Empire's transportation system and urban form.

Table 7. Trip Destination and Mode of Transportation

	Work	Non-Work	Home	Total
Drove Alone	76.1%	75.1%	73.0%	75.0%
Carpooled	12.6%	17.4%	17.2%	16.2%
Rode rail transit (Metrolink)	2.5%	0.7%	4.1%	1.7%
Rode the bus	6.9%	2.6%	3.3%	3.6%
Bicycled	0.6%	0.2%	0.8%	0.4%
Walked	0.0%	2.8%	0.8%	1.8%
Other	1.2%	1.1%	0.8%	1.1%

Study site respondents were more likely than control site respondents to have carpooled with someone (22.9% vs. 12.1%). There were no differences between the two regarding use of public transit (5.1% of study site respondents reported using the bus or train vs. 5.4% of control site respondents).

Overall, the average length of a trip was 33.29 minutes (34.76 minutes for trips taken by study site respondents and 32.37 for trips taken by control site respondents).

Work Trips: When breaking down commuting patterns by trip purpose, we see that control site respondents whose main purpose of travel was to go to work were more likely to have driven alone (79.8% for control site and 72.0% for study site). In fact, study site respondents were far more likely than control site respondents to have carpooled with someone (16.0% vs. 9.5%), and slightly more likely to have used public transportation (10.7% vs. 8.3%). For context, a survey of resident of TODs along the Metro's Gold line, which serves Pasadena and downtown Los Angeles, found a 15% transit share (Lund and Willson 2005). Approximately 1% of control site respondents report using Metrolink to commute to work (see Table 8).

Table 8. Mode of Transportation for Respondents Traveling to Work

	Study N=75	Control N=84	Total N=159
Drove Alone	72.0%	79.8%	76.1%
Carpooled	16.0%	9.5%	12.6%
Rode Rail Transit (Metrolink)	4.0%	1.2%	2.5%
Rode Bus	6.7%	7.1%	6.9%
Bicycled	1.3%	0.0%	0.6%
Walked	0.0%	0.0%	0.0%
Other	0.0%	1.2%	0.6%

In terms of parking at their workplace, the vast majority of trips for both study site and control site ended in parking that was "free and easy to find" (68.0% for study site respondents and 75.0% for control site respondents).

Average length of trip for study vs. control site respondents differed slightly, with 39.3 minutes of travel recorded for study site respondents compared with 34.9 minutes for control site respondents.

In addition, those who are employed and reported traveling to work on the previous day were asked a series of questions regarding their employer's policies on work schedules and commuting issues. The vast majority of respondents indicate that their employer provides free parking for the employees (85.1%). Almost one-half also said their employer allows them to work flexible hours (45.1%). When looking at study site respondents vs. control site respondents, we see that (with the exception of providing free parking) more study site respondents indicated that their employer offers work schedule flexibility and assistance with commuting than control site respondents (although the differences are relatively small). Table 9 shows the percentage of respondents who answered "yes" to these questions.

Table 9. Employer Policies on Work Schedules and Commuting Issues
(Respondents who said they traveled to work the previous business day)

	Study	Control	Total
Does your employer allow you to work flexible hours?	46.6%	43.5%	45.1%
Does your employer allow you to work from home?	20.5%	10.1%	15.5%
Does your employer provide a car for use during the day?	17.8%	5.7%	11.9%
Does your employer provide free parking?	81.7%	88.6%	85.1%
Does your employer help pay for transit?	17.1%	8.8%	13.0%
Does your employer help pay for tolls, fuel or other commuting costs?	21.9%	12.9%	17.5%

The preceding analysis looked only at people who reported that they traveled to work on the previous business day. The analysis on Table 10 depicts ***all*** people who said they are employed, regardless of whether they report traveling to work on the previous day (this also includes people who work from home).

Table 10. Employer Policies on Work Schedules and Commuting Issues (all workers)
(All respondents who are employed)

	Study	Control	Total
Does your employer allow you to work flexible hours?	50.0%	45.4%	47.5%
Does your employer allow you to work from home?	18.1%	10.2%	13.9%
Does your employer provide a car for use during the day?	12.8%	11.9%	12.3%
Does your employer provide free parking?	83.9%	89.9%	87.1%
Does your employer help pay for transit?	13.2%	11.3%	12.2%
Does your employer help pay for tolls, fuel or other commuting costs?	19.1%	15.7%	17.3%

Finally, respondents were asked how often they use the bus or rail to commute to work or school outside the home (Question 22). The vast majority (80.3%) said they "never" take it and 6.3% said they take it every day (5 or more days a week). Comparing study site and control site respondents use of public transit, more study site respondents report "never" using public transit (83.7%) as compared to control site respondents (77.8%). In addition, more study site respondents said they use it every day (7.7% vs. 5.2%).

Non-Work Trips: About 6 out of every 10 trips (60.5%) reported were for non-work related activities. These include medical appointments, shopping, visiting friends and/or relatives, running errands and going for a meal or a snack. Just about one-half of trips made by study site respondents were non-work trips (50.4%) and 66.7% of trips made by control site respondents were non-work trips. As we saw with work trips, Table 11 shows that control site respondents were more likely to have driven alone than study site respondents (80.3% vs. 64.0%), and study site respondents are more like to carpool with someone (28.7% vs. 12.2%). In addition, very few of them took public transit (2.9% for study site and 3.4% for control site respondents).

Table 11. Mode of Transportation for Respondents Taking Non-Work Trips

	Study N=136	Control N=294	Total N=430
Drove Alone	64.0%	80.3%	75.1%
Carpooled	28.7%	12.2%	17.4%
Rode Rail Transit (Metrolink)	0.0%	1.0%	0.7%
Rode Bus	2.9%	2.4%	2.6%
Bicycled	0.7%	0.0%	0.2%
Walked	3.7%	2.4%	2.8%
Other	0.0%	1.4%	0.9%

Regarding parking at their destination, nearly three-quarters of both study site (72.0%) and control site respondents (73.4%) report that parking was "free and easy to find".

There was a significant difference in length of non-work trip taken by the two groups: 32.2 minutes for trips taken by study site respondents and 29.5 minutes for trips taken by control site respondents.

Trips Home: The third category of trips that respondents reported taking were trips back home (17.2% of all reported trips). More study site respondents reported trips back home than control site respondents (21.9% vs. 14.3%). As opposed to all other trips, Table 12 shows that control site respondents were less likely to report traveling alone (69.8% vs. 76.3% for study site respondents) and study site respondents were more likely to have carpooled with another person (18.6% vs. 15.9% for control site respondents). Further, we see a difference with regard to traveling home using public transit. With work trips, study site respondents were more likely to have used public transit than control site respondents. With non-work trips study site respondents were slightly less likely to have used public transit. However, regarding trips back home more control site respondents reported taking public transit than study site respondents (11.1% for control site respondents and 3.4% for study site respondents).

Table 12. Mode of Transportation for Respondents Returning Home

	Study N=59	Control N=63	Total N=122
Drove Alone	76.3%	69.8%	73.0%
Carpooled	18.6%	15.9%	17.2%
Rode Rail Transit (Metrolink)	3.4%	4.8%	4.1%
Rode Bus	0.0%	6.3%	3.3%
Bicycled	1.7%	0.0%	0.8%
Walked	0.0%	1.6%	0.8%
Other	0.0%	1.6%	0.8%

When asked about parking once they got home, 74.6% of study site and 77.8% of control site respondents said that it was "free and easy to find."

There was a significant difference in length of trips home taken by the two groups: 35.07 minutes for trips taken by study site respondents and 42.67 for trips taken by control site respondents.

Attitudes Toward Transportation

In an effort to measure the respondent's attitudes toward public transportation versus driving in a car, respondents were asked to indicate whether they "strongly agree", "agree", "disagree" or "strongly disagree" with three attitudinal statements. Table 13 shows that just over 40% of respondents said they feel uncomfortable driving under certain conditions (such as long distances, nighttime, or unfamiliar routes), 62.2% think they would benefit greatly from being able to get around without a car, and 44% think that government should spend more transportation money on expanding roads and highways rather than on public transit expenditures. The following table shows the percentage of respondents from the study sites and the control sites who "strongly agree" or "agree" with each statement. The larger percentage of control residents indicating that they are uncomfortable driving a car under certain conditions does not correspond with typical expectations of TOD sites versus control sites, but may relate the older average

age of respondents in the control sites. In addition, few study site respondents picked the location for transit accessibility.

Table 13. Attitudes Toward Transportation

	Study	Control	Total
I feel uncomfortable driving a car under certain conditions, such as long distances, at nighttime, or on routes I don't know well.	35.1%	48.0%	43.9%
I and/or other members of my household would benefit greatly from being able to get around sometimes without a car.	68.1%	59.4%	62.2%
The government should spend more transportation money on expanding roads and highways rather than on public transit.	47.2%	42.5%	44.0%

Summary of Open Ended Comments

At the end of the questionnaire respondents were given an opportunity to provide any additional comments related to transportation in general. While respondents provided a wide range of responses, most of them centered on reasons why people do not use public transportation. Table 14 shows the most-often mentioned responses, provided by 15 study site respondents and 92 control site respondents:

Table 14. Open Ended Comments
General Comments (Number of mentions)

	Study	Control	Total
Improvements and better public transportation	2	25	27
More Metrolink Stops	2	8	10
More frequent stops per bus stop	1	7	8
Metrolink fare is too high, need group rates	2	3	5
Add more bus stops	1	6	7
Not enough buses	0	5	5
Longer hours for public transportation	0	5	5
Need assistance for the elderly and disabled	0	6	6

Analysis of Factors that Explain Transit Use

In this section, we examine relationships among variables that might help explain transit use.

Hypothesis #1: Respondents in the study sites are more likely to use public transportation than those in the control sites.

In order to determine if there is a difference between study site respondents and control site respondents in terms of their use of public transportation, a chi-square test of independence was conducted. The results of the chi-square were: X^2 (1, N=718) = .014, **p=.906,** therefore we cannot reject the null hypothesis that there are no differences between the two groups in terms of use of public transportation. This confirms that the study sites are not fully developed TOD sites and have not yet realized significantly higher transit shares.

Hypothesis #2: The respondents in the study group are less likely to drive alone than those in the control group.

A chi-square test of independence was conducted to determine if there is a difference between study site respondents and control site respondents in terms of whether or not they drove alone.

The results of the chi-square are as follows: X^2 (1, N=718) = .8.558, **p=.003**, therefore we reject the null hypothesis that there are no differences between the two groups and report that respondents in the study group are indeed less likely to drive alone than respondents in the control group. While this result might be interpreted that the study sites are demonstrating TOD characteristics, which include walking trips, bicycle trips, as well as transit trips, the difference between the study and control groups is mostly attributable to greater carpooling trips in the study sites. Carpooling is an effective transportation mode for automobile-oriented areas and does achieve greenhouse gas reduction and energy consumption goals, but it is not traditionally considered a feature of TOD. This higher rideshare rate in the study sites is an intriguing issue that deserves further study. If multi-family housing in emerging TODs can initially produce more carpooling, that outcome supports the goal of SB 375 and is well suited to accessing the dispersed origins and destination in the Inland Empire.

Hypothesis #3: There are differences in length of travel between control site and study site respondents in terms of overall travel, travel for work, non-work, and travel back home.

In order to determine if there are any differences between control site respondents and study site respondents regarding the average length of the trips they took, an Independent Samples T-test of means was performed. We looked at overall trip length, and we also broke it down by trip type (work, non-work, home). We see from Table 15 (next page) that there are no significant differences between the two groups regarding the length of the trips they reported taking.

Table 15. Average Trip Length
Independent Samples Test

		Site		P-Value
		Study	Control	
Overall Trip Length	Mean	34.76	32.37	.398
	N	258	412	
Work Trips	Mean	39.29	34.92	.411
	N	70	77	
Non-Work Trips	Mean	32.15	29.48	.494
	N	130	274	
Trips Home	Mean	35.07	42.67	.256
	N	57	60	

Hypothesis #4: There are relationships between various demographic/lifestyle factors with auto dependency (conceptualized as percent of single occupant vehicle trips). More specifically:

- People with higher incomes have more SOV trips than those with lower incomes
- People with more cars available in their household have more SOV trips than those with fewer cars
- People who rate their neighborhood negatively as a place to walk and take transit have more SOV trips than those who rate their neighborhood more positively.
- People who reported that access to transit was an important factor in their decision to move to their current residence have fewer SOV trips than those for whom access was not mentioned as being important.
- People who live in a condo have more SOV trips than those who live in an apartment

One measure of auto dependency is the percent of SOV (single occupancy vehicle) trips taken. A new variable was created representing the percentage of time the respondent said they drove alone on the previous day (for example, someone who made two trips and said they drove alone on one of those trips was coded as 50%, someone who made three trips and said they drove alone on two of them was coded as 66.67%, someone who made one trip and drove alone is coded as 100%).

Although the prior analyses have used either chi-square or t-tests to examine relationships between variables and differences between means, a non-parametric test of association such as Spearman correlation is more appropriate to look at the relationship between percent of SOV and income and ratings of the neighborhood (which are ordinal variables) and between SOV and number of available vehicles. As seen in Table 16 below, the only factor that is significant in determining auto dependence is the number of available vehicles.

Table 16. Factors that Might Influence Auto Dependency

	N	Spearman's rho	One-tailed P-Value
Income	290	.022	.354
Number of available vehicles	316	.130	.010
Rate of neighborhood in terms of walking	317	.049	.191
Rating of neighborhood in terms of taking the bus or train	302	-.006	.460

The Mann-Whitney U test (a non-parametric test of location) was used to examine the difference between auto dependence of apartment vs. condo dwellers and those who believe access to transit was an important factor in their decision to move to their current residence vs. those who did not. The analysis showed no differences ($p = .780$ for the analysis of apartment vs. condo dwellers and $p = .689$ for the analysis of importance of access to transit).

Hypothesis #5: People in the study sites are more likely to be younger (60 or younger) and working and those in the control sites are more likely to be over age 60 and retired.

This test was conducted to determine if some of the differences in travel are attributable to demographic factors rather than the study/control site distinction. Before we could examine the relationship between these variables, recoding was conducted based on certain assumptions. First, age was recoded into two categories: respondents age 60 and younger, and those over the age of 60. In addition, employment status was cross-tabulated with age and recoded under the assumption that anyone over age 60 that wasn't currently employed was retired. Therefore, our new employment variable included employed (anyone, regardless of age, who said they are employed), unemployed (those age 60 and under who said they were not currently employed), and retired (anyone over age 60 who said they are not currently employed).

As shown on Table 17, a chi-square test of independence was then run on each of these variables to see if there is a relationship between age and control vs. study site respondents, and employment status and control site vs. study site respondents.

Table 17. Chi-Square on Age and Employment Status vs. Site Location

	N	df	Value	P-Value
Age	399	1	11.937	.001
Employment Status	399	2	23.279	.000

As we see from the table above, there is a significant relationship between age and site location and employment status and site location. Specifically, those in the study sites are more likely to be younger and employed and those in the control sites tend to be older and retired.

Vehicle Availability/Parking Demand for Rental Housing

The survey asked respondents to indicate number of vehicles available, which is of interest because it is the basis of parking demand.[4] Local ordinances often use national standards, the requirements of their neighbors, and rule of thumb standards in requiring developers to provide parking for multi-family housing (Willson 2000).

The literature shows that parking demand is positively associated with income, and as a result, is likely to vary between rental and condominium units. This portion of analysis, therefore, concerns the 301 rental housing respondents.

Table 18 shows an implied parking demand of 1.45 spaces per occupied rental dwelling unit. This is somewhat higher than the often-cited Institute of Transportation Handbook rate for low/mid-rise apartments.

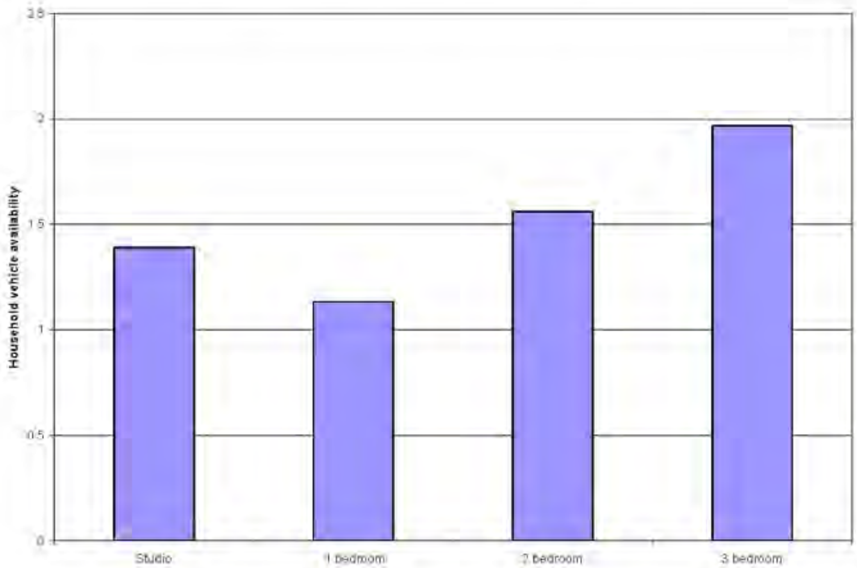
Table 18 Comparison of Parking Demand/Vehicle Availability per Occupied Dwelling

Data source	Unit of analysis	Mean peak demand/vehicle availability per occupied dwelling	Minimum/ maximum	Standard deviation
Vehicle availability, IE household survey, rental units (n=301)	Household	1.45 (1.32 in complex; 0.13 on-street)	0 - 5	0.77
ITE Land use 221 (19 sites across the U.S.)	Residential complex	1.2	0.68 - 1.94	0.32

Most ordinances set parking requirements based on the number of bedrooms, using the logic that larger units will have more people who own vehicles. Figure 5 shows the relationships reported by rental housing respondents.

[4] Household vehicle availability is not identical to per-unit parking occupancy counts. Household vehicle availability represents the greatest possible vehicle accumulation, but without overnight visitor parking. In contrast, occupancy counts present actual accumulation at a specific moment, which is reduced by overnight trips, night work-shifts, and off-site parking. It is likely that household vehicle availability exceeds overnight counts by a small degree because of these factors.

Figure 5. Vehicle Availability by Number of Bedrooms



The patterns shown in Figure 5 are generally consistent with city standards that apply requirements on a per unit basis, albeit at lower levels. Many ordinances use a 0.5 space stepped progression in linking requirements to bedrooms; this analysis support such a practice.

The parking demand levels reported here are generally lower than minimum requirements in Inland Empire cities. Table 19 summarizes the minimum residential parking requirements for the two cities that were well represented in the sample. Over-requiring parking in multi-family housing increases the cost of development and encourages vehicle ownership and use. Willson and Roberts (2010) provide a more detailed analysis of this issue.

Table 19. Parking Requirements in Ontario and Ranch Cucamonga

Requirement	Ontario	Rancho Cucamonga
One bedroom unit	1.75	1.5
Two bedroom unit	2	1.8
Three or more bedroom unit	2.5	2
Visitor Parking	1 space per 4-6 units, depending on size	1 space per 4 units

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Chapter 6. Conclusions, Policy Recommendations and Future Research

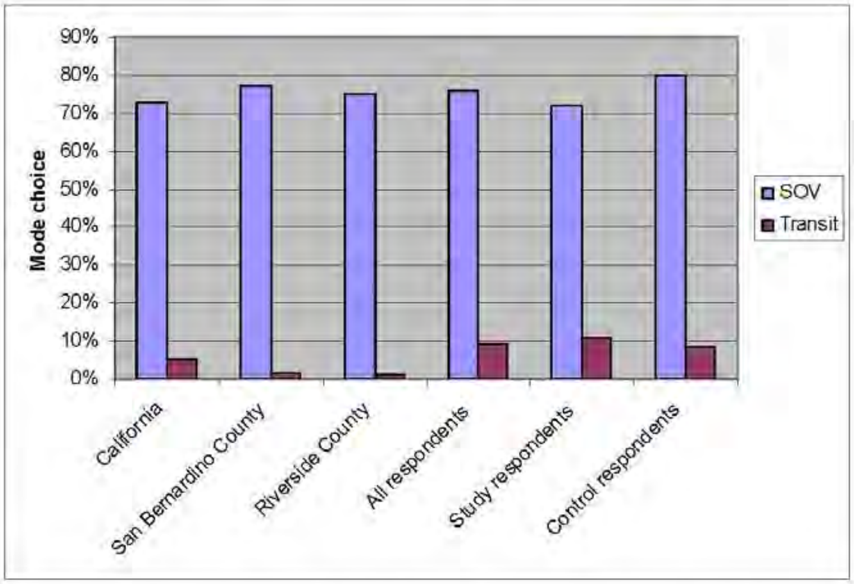
This study provides a benchmark for assessing future efforts to reduce automobile dependency in multi-family housing in the Inland Empire. In many ways, the Inland Empire is a region in transition from a past of single family housing and long automobile commutes to a future in which there are more housing and transportation options. In addition to fulfilling many local community goals, this transition will lessen VMT in support of SB 375.

This section outlines the key findings of the study, policy options that flow from these findings, and suggestions for future research.

Key Findings

Residents of multi-family housing in the Inland Empire are reliant on private vehicles for their work and non-work trips. To provide context, Figure 6 (next page) shows the journey-to-work mode choice results from the survey and compares them to 2006-08 American Community Survey (ACS) data for California and the counties of San Bernardino and Riverside. The tally for % SOV for all survey respondents is similar to ACS county-wide data. Note that this county-wide data is dominated by single family housing, indicating that these multi-family residents are no less dependent on SOV for work commuting. The transit share among all survey respondents is higher that county averages, however, but it appears that the transit ridership has been offset by reduced carpooling in the survey group.

Figure 6. Comparison of Journey-to-Work Mode Shares



The transit market itself appears to be bifurcated between bus riders, who may be more likely to be transit dependent populations making local trips and Metrolink rail riders, (more likely to be higher income and making Los Angeles and Orange County-bound trips).

Although the study group shows the highest transit share in Figure 6, the analysis did not find a statistically significant difference between the study and control groups in terms of transit use. The study group did, however, have a statistically significant lower SOV dependency than the control group. The projects in the study group, which were as close to TOD as could be identified in the Inland Empire, did not show the transit travel characteristics of mature TODs studied elsewhere in California. They do, however, perform better in terms of reduce SOV dependence.

As was noted in previous sections, the housing developments in the study group are reasonably dense, but hey lack the other d's that hold the key to reducing VMT: diversity of land uses (most are single-use developments), pedestrian- and transit-friendly design (arterials are wide, access is focused on the automobile), destination accessibility (trip destinations are dispersed, favoring automobile use), and distance from home or work to transit (in this case, transit service is near most developments but service frequencies and connectivity is lacking). Therefore, these modest results are consistent with theory in that the sites did not meet all the criteria of successful TODs. This may change in the future as mixed-use TODs are built next to augmented transit services.

Another dimension of mode choice is the cost of travel modes. For both work and non-work trips, free parking is the norm. This practice encourages auto ownership and use. In contrast, most of those reporting a work trip indicate that employers *do not* help pay for transit. Accordingly, it is not just the 5 d's mentioned above that affect these results – economic incentives for driving mean that the deck is stacked against transit, walking, and bicycling.

These results do not argue against policies for TOD in the Inland Empire – the region is just beginning a transition toward more diverse land use and transportation choices. Cities such as San Bernardino, Ontario, and Montclair are actively pursuing strategies. Plans for TOD, higher density mixed-use development, and improved transit are in place in many Inland Empire communities. Those projects will reduce SOV trips beyond these results.

The question for those responding to SB 375 mandates is *how much* might these new TODs reduce vehicle travel? And, *how much* will new transit services change travel mode choice among those living in existing developments? An order-of-magnitude check on the potential for reduction is found in the results obtained in a survey of residents along the Los Angeles County's Metro Gold Line, which connects Pasadena and downtown Los Angeles (Lund and Willson 2005). That study area has many factors that favor transit ridership – light rail transit, frequent bus service, dense development, significant transit dependent populations, and walkable communities. In that case, residents within ¼ mile of rail stations had a 14.8% transit share, with an additional 7.5% of trips by walking and bicycling modes. TOD plans in the Inland Empire over the next 25 years include improved Metrolink service, light rail, rapid bus, and local connectors. One could conclude that these improvements, along with planned land use changes, may help the Inland Empire approach levels of transit use found along the Gold Line. While this is possible, but not assured, the Inland Empire is unlikely to exceed the Gold Line's current rates. Therefore, SB 375 planning should be realistic about VMT reductions that are possible in the next few decades in the Inland Empire.

Policy Options

Although the focus of this study is basic research, not a policy analysis, a number of policy options has emerged in the course of analyzing the data.

First, cities can build on existing housing clusters by increasing housing density and introducing mixed use development (walkable trips for shopping, etc.). Some of the large multi-family developments studied here can be the basis for future TODs. The key is to develop a tight, walkable mixed-use cluster around improved transit service. Some cities already have plans in place for this development; they should consider streamlining and incentives to advance this development activity when the economy recovers. Cities that do not have plans should develop them now.

Second, careful site planning is important to making TODs work. This includes attention to the pedestrian realm, the ease with which developments can be served with transit, and land use mixing. A key element is parking, which when oversupplied often degrades other travel options. Cities should lower their parking requirements if they are beyond demand levels exhibited by TODs and require that developers unbundled the cost of parking from the cost of rent.

Third, there are redevelopment opportunities around the Metrolink stations. Many of these station areas have lower intensity industrial and commercial uses, reflecting their historical roles as rail corridors. Developments in these locations can divert work trips destined for downtown Los Angeles and Orange County to transit. Many redevelopment opportunities exist around those Metrolink stations, but the lack of community features in these areas mean that comprehensive community development is required. In Orange County, there is a plan to provide 30-minute, bi-directional Metrolink service throughout the day. Such a strategy turns Metrolink more into a traditional rail service, like light or heavy rail. This is a potential for the Inland Empire that could attract non-work trips to Metrolink. An example of a mature commuter rail system that is fully integrated into walkable communities can be found on the Caltrain system that connects San Jose with downtown San Francisco.

Finally, since Metrolink or other types of rail service cannot serve the dispersed trip origins and destinations in the large geography of the Inland Empire, bus service enhancements are vital connecters to the rail backbone and for travel within the area. Bus rapid transit systems can take advantage of the large arterial system already in place; they should be supported by local shuttles that connect to individual neighborhoods. The proposed Omnitrans sbX line is an example of such a project, which links key transit generators such as downtown San Bernardino, Cal State University San Bernardino, and Loma Linda University Adventist Health Center.

Future research

A number of future research projects are suggested by this analysis. They include the following:

- The higher carpool rate among study group respondents deserves further investigation. A better understanding of the reasons for carpooling among this group, as derived through supplemental surveys and/or focus groups, can provide insight into whether this positive outcome can be general expected in suburban TOD developments.
- Conduct surveys of Inland Empire workplaces and retail locations concerning travel patterns. Employer surveys would be distributed through employer cooperation, while retail location surveys would be carries out using intercept surveys.
- Replicate multi-family household surveys in a decade to measure changes associated with TOD development, transit development, and SB 375 planning efforts.
- Conduct surveys and focus groups among local planners, housing developers, project lenders and investors, community groups, and property managers to

determine their willingness to consider new models for multi-family development, addressing questions such as density, mixed uses, pedestrian facilities, reduced parking requirements and unbundling. Such research would develop practical strategies for achieving the 5d's of TOD in a manner that is realistic for market conditions in the Inland Empire.

- Conduct trip generation studies of multi-family housing complexes to determine if trip generation rates used in traffic studies are appropriate. This would be accomplished by pneumatic counters at development driveways, and would allow comparison to standard Institute of Engineers rates and other recent studies. If different rates are appropriate, they would included in traffic studies and environmental review documents for new development.
- Conduct focused studies to evaluate areas where dense, clustered development is occurring, such as the city of Ontario's 8,200 acre New Model Colony development and the city of San Bernardino's downtown redevelopment and TOD project. Such studies could track the factors that attract residents to these types of areas.
- Integrate the results provided here into the calibration of regional models and SB-375 modeling tools being developed by other Leonard Center researchers.

Given a twenty-year head start, more extensive transit systems, and supportive market demand, TOD in California's urban areas is well underway and is producing good results. It is TOD in suburban areas such as the Inland Empire that requires the greatest attention in research and planning. With a realistic understanding of travel behavior of these early transit-proximate developments, plans can ensure that the greatest VMT reduction is achieved through supportive land use, site design, and transit policies and programs. Given the large share of the State's growth that will occur in areas such as the Inland Empire, suburban TOD is vital to local visions of sustainability and the State's SB 375 goals. This research, along with other efforts, is intended to support the process of developing land use and transit plans that are tailored to local community preference, market conditions, and transportation patterns.

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Appendix A - Study Sites

Study Sites	Address	City	Zip Code	# of Units	Units/ acre	# of bus Routes	Headway Range	within 1/4 mile of ML	within 1/2 mile of ML
Colony Apts. at Ontario Towne Center	102 North Lemon Ave.	Ontario	91764	160	60.7	Omni - 61, 63, 80, 81, 83	15 - 60 minutes	No	No
AMLI at Empire Lakes	9200 Milliken Ave.	Rancho Cucamonga	91730	521	27.6	Omni - 81	60 minutes	No	Yes
Reserve at Empire Lakes	11210 Fourth Street	Rancho Cucamonga	91730	467	27.2	Omni - 61, 81, 82	15 - 60 minutes	No	No
Kincaid Townhomes	330 East B Street	Ontario	91762	140	23.8	Omni - 61, 63, 80, 81, 83	15 - 60 minutes	No	No
Rancho MonteVista Apartments	2100 West Arrow Route	Upland	91786	240	19.9	Multiple - near transcenter		No	Yes
College Park	250 College Park Drive	Upland	91786	448	17.2	Multiple - near transcenter		Yes	Yes
Verano at Rancho Cucamonga	8200 Haven Avenue	Rancho Cucamonga	91730	414	27.6	Omni - 66, 82	15/30 - 60 minutes	No	No
Waterbrook	10400 Arrow Route	Rancho Cucamonga	91730	624	23.3	Omni - 68, 82	30 - 60 minutes	No	No
Ironwood & Fairway Palms at Empire Lakes	11100 Fourth Street	Rancho Cucamonga	91730	496	22.4	Omni - 81, 82	60 minutes	No	No
Stonegate at Towngate	12640 Memorial Way	Moreno Valley	92553	552	20.5	RTA - 11, 16, 18	40 - 60 minutes	No	No
Total/Average				***4,062***	***27.0***				

Appendix B – Control Sites

Control Sites	Address	City	Zip Code	# of Units	Units/acre	# of bus Routes	Headway Range	within 1/4 mile of Metrolink	within 1/2 mile of Metrolink
Broadstone Rancho Belago	27625 E. Trail Ridge Way	Rancho Belago	92555	236	34.5	RTA - 35, 210	60 minutes	No	No
Vintage Apartment Homes	955 North Duesenberg Drive	Ontario	91764	300	27.8	Omni - 82	60 minutes	No	No
AMLI at Victoria Arbors	7922 Day Creek Blvd.	Rancho Cucamonga	91739	319	26.9	Omni - 81	60 minutes	No	No
AMLI at Day Creek	7828 Day Creek Blvd.	Rancho Cucamonga	91739	270	26.9	Omni - 81	60 minutes	No	No
Landmark at Ontario Towne Center	950 N. Duesenberg Dr.	Ontario	91764	469	26.3	Omni - 82	60 minutes	No	No
The Heights (2) - across the street	16011 Butterfield Ranch Road	Chino Hills	91709	124	22.5	None		No	No
di Renzo Apartments	5880 Lochmoor Drive	Riverside	92507	158	22.5	RTA - 16	40 minutes	No	No
Village Oaks	15773 High Knoll Dr.	Chino Hills	91709	280	21.6	None		No	No
Galleria at Towngate	12845 Frederick Street	Moreno Valley	92553	268	20.6	RTA - 11, 18	60 minutes	No	No
The Villas at Towngate	13120 Day Street	Moreno Valley	92553	394	20.5	RTA - 16	40 minutes	No	No
The Heights	16675 Slate Drive	Chino Hills	91709	208	20.4	None		No	No

Appendix B – Control Sites (continued)

Control Sites	Address	City	Zip Code	# of Units	Units/acre	# of bus Routes	Headway Range	within 1/4 mile of Metrolink	within 1/2 mile of Metrolink
Vista Springs Apartments	21550 Box Springs Rd	Moreno Valley	92557	212	20.0	RTA - 16	40 minutes	No	No
Highland Meadows	12080 Pigeon Pass Rd	Moreno Valley	92557	360	19.8	RTA - 11, 18	60 minutes	No	No
Windemere at Sycamore Highlands	5925 Sycamore Canyon Blvd	Riverside	92507	240	19.0	RTA - 16	40 minutes	No	No
CastleRock	5700 Lochmoor Drive	Riverside	92507	272	18.5	RTA - 16	40 minutes	No	No
Colonnade at Sycamore Highlands	5880 Fair Isle Drive	Riverside	92507	288	18.0	RTA - 16	40 minutes	No	No
Tuscany Hills	21012 Box Springs Rd	Moreno Valley	92557	144	17.8	RTA - 16	40 minutes	No	No
Mission Grove Park	7450 Northrop Drive	Riverside	92508	432	16.6	RTA - 20	50 minutes	No	No
El Dorado Point	12159 Calle Sombra	Moreno Valley	92557	330	15.4	RTA - 11	60 minutes	No	No
Broadstone River's Edge	2088 Lakeshore Drive	Lake Elsinore	92530	184	15.1	RTA - 7, 8	50-55 minutes	No	No
Broadstone Vesada	3390 Country Village Road	Riverside	92509	261	15.0	RTA - 21, 49	65-70 minutes	No	No
Broadstone Overlook Apartments	12963 Moreno Beach Drive	Moreno Valley	92555	246	13.3	RTA - 35, 210	60 minutes	No	No
Total/Average				***5,759***	***20.9***				

Appendix C - 2010 TOD Telephone Survey

SHELLO Hello, I am calling from the Institute of Applied Research at Cal State San Bernardino. We're conducting a scientific study of quality of life relative to transportation and traffic, and we need the input of the head of the household or his or her partner. Have I reached [READ PHONE # FROM SCREEN]?

1. CONTINUE
2. DISPOSITION SCREEN

SHELLO2 (used only to complete a survey already started)

Have I reached [READ PHONE NUMBER]? Hello, this is ______________, calling from the Institute of Applied Research at CSU San Bernardino. Recently, we started an interview with the [MALE/FEMALE] head of the household and I'm calling back to complete that interview. Is that person available?

SPAN INTERVIEWER: PLEASE CODE WHICH LANGUAGE THE INTERVIEW WILL BE CONDUCTED IN:

1. ENGLISH
2. SPANISH

SHEAD Are you that person?

1. Yes [SKIP TO INTRO]
2. No [CONTINUE]
3. DON'T KNOW/NO RESPONSE
4. REFUSED

SHEAD2 Is the head of the household or his or her partner at home?

1. Yes [SKIP TO INTRO]
2. No [CONTINUE]
3. DON'T KNOW/NO RESPONSE
4. REFUSED

CALLBK Is there a better time I could call back to reach the head of the household?

1. Yes [SKIP TO APPT]
2. No [ENDQUEST]

APART We are targeting residents who live within an apartment or condo, do you live in an apartment or a condo?
{INTERVIEWER: ATTACHED UNITS IS WHAT WE ARE LOOKING FOR 3/25}

1. Apartment
2. Condo/ Town House
3. NEITHER (Ex: single home, mobile home)

9. REFUSED

IF (ANS > 2) ENDQUEST

INTRO This survey takes about 10 minutes to complete, and your answers may be used by transportation officials to better understand travel behavior and to shape transportation policies in the Inland Empire. And to thank you for your participation, you will be entered into a drawing for a gift card of up to $200. Your identity and your responses will remain completely confidential, and of course, you are free to decline to answer any particular survey question. I should also mention that this call may be monitored by my supervisor for quality control purposes only.

Is it alright to ask you these questions now?

1. Yes [CONTINUE]
2. No [SKIP TO APPT]

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AGEQAL First, I'd like to verify that you are at least 18 years of age.
1. Yes [SKIP TO BEGIN]
2. No

QSORRY I'm sorry, but currently we are interviewing people 18 years of age and older. Thank you for your time. [ENDQUEST]

APPT Is it possible to make an appointment to ask you the survey questions at a more convenient time?
1. Yes (SPECIFY)_______________
2. No [ENDQUEST]

BEGIN I'd like to begin by asking you some general questions.

[INTERVIEWERS: PRESS ANY KEY TO CONTINUE]

Q1. What city do you live in?
1. CHINO HILLS
2. CLAREMONT
3. LAKE ELSINORE
4. MORENO VALLEY
5. ONTARIO
6. RANCHO BELAGO
7. RANCHO CUCAMONGA
8. RIVERSIDE
9. UPLAND
10. OTHER [STAY IN JUST INCASE CONDO ACROSS THE STREET CHANGES CITY] LIKE IN MV ONE SIDE APARTMENT IS MV OTHER IS RIVERSIDE
98. DON'T KNOW/REFUSED [TERMINATE CALL]

Q2. What is your zip code?
ZIP CODE: _________________________
99998. DON'T KNOW
99999. REFUSED

Q3. Including yourself, how many people live in your household?
NUMBER ______

998. DON'T KNOW
999. REFUSED

Q4. Again including yourself, how many are 16 years *or older*?
NUMBER ______

DON'T KNOW [ENTER 998]
REFUSED [ENTER 999]

Q5. How many motorized vehicle (s) are available for use by members of your household? [INTERVIEWER: IF RESPONDENT ASKS WHETHER TO INCLUDE "STORED" OR NON-WORKING ONES, SAY "YES"]
ENTER NUMBER ______ IF NUMBER = 0, 98, OR 99 SKIP TO Q7

DON'T KNOW [ENTER 98]
REFUSED [ENTER 99]

Q6INTRO. The next few questions deal with where you typically park your vehicle(s) at your residence. WE NEED TO KNOW WHERE THEY ***TYPICALLY*** PARK

Q6A1 [IF Q5 = 1] Do you park a vehicle in a private garage assigned to your unit?
1. YES SKIP TO Q7
0. NO CONTINUE WITH Q6B1
[IAR USES 1 FOR YES AND 2 FOR NO, AFTER THE FIRST 10 WE ADDED THE 2 FOR NO, WE LEFT THE 0 ALSO]
] 9. REFUSED (ONLY USE THIS IF THEY REFUSE TO TELL YOU WHERE THEY PARK THEIR CARS) ADDED AFTER THE FIRST 10 SURVYES.

Q6A2 [IF Q5 > 1] How many of your vehicles do you park in a private garage assigned to your unit?
NUMBER__________
COUNTER = COUNTER + NUMBER. IF COUNTER = VALUE FROM Q5, SKIP TO Q7

Q6B1. [IF Q5 = 1] Do you park in a shared garage or outdoor lot in your development?
1. YES SKIP TO Q7
0. NO CONTINUE WITH Q6C1

Q6B2 [IF Q5 > 1] How many of your vehicles do you park in an assigned space in a shared parking area?
NUMBER__________
COUNTER = COUNTER + NUMBER. IF COUNTER = VALUE FROM Q5, SKIP TO Q7

Q6C1. [IF Q5 = 1] Do you park on the street?
1. YES
0. NO
9. REFUSED (ONLY USE THIS IF THEY REFUSE TO TELLYOU WHERE THEY PARK THEIR CARS.

Q6C2 [IF Q5 > 1] How many of your vehicles do you park on the street?
NUMBER__________
COUNTER = COUNTER + NUMBER. IF COUNTER = VALUE FROM Q5, SKIP TO Q7

Q7. How many bedrooms do you have in your unit?
1. STUDIO APARTMENT
2. 1 BEDROOM
3. 2 BEDROOMS
4. 3 OR MORE BEDROOMS
9. REFUSED

Q8. Are you currently employed?

1.	YES	CONTINUE
2.	NO	SKIP TO Q11
9.	REFUSED	SKIP TO Q11

Q9. Do you work outside your place of residence?
1. YES
2. NO, I WORK FROM HOME SKIPTO Q11
9. REFUSED

Q10. What is your work zip code?
1.WORK ZIP CODE: ____________________
2. CITY IF THEY DO NOT KNOW THE ZIP CODE
8. DON'T KNOW
9. REFUSED

Q11. Are you currently enrolled in school?

1.	YES	CONTINUE
2.	NO	SKIPTO Q13
9.	REFUSED	SKIPTO Q13

Q12. Are you enrolled in an on-line program to take courses at home?
1. YES
2. NO
9. REFUSED

Q13. In what year did you move to your current residence?
YEAR: __________

DON'T KNOW [ENTER 9998]
REFUSED [ENTER 9999]

Q14. There are various reasons that people may choose to live in a certain location. I'm going to read you a list of some of these reasons and I'd like you to tell me whether each was important in deciding to move to your current residence. [INTERVIEWER: READ THE RESPONSES AND SELECT IF THEY SAY "YES"] – CHECK ALL THAT APPLY
____ 1. Cost of housing
____ 2. Type or quality of housing
____ 3. Quality of local schools
____ 4. Quality of neighborhood
_____ 5. Close to job
____ 6. Access to shops & services
____ 7. Access to transit
____ 8. Access to highway

____9. Recreational opportunities
____ 10.Other (Specify) _________________
____ 11. DON'T KNOW
____ 12 REFUSED

Q15. Of the reasons I just read, which was the MOST important to you in deciding to move to your current residence?

1. COST OF HOUSING
2. TYPE OR QUALITY OF HOUSING
3. QUALITY OF LOCAL SCHOOLS
4. QUALITY OF NEIGHBORHOOD
5. CLOSE TO JOB
6. ACCESS TO SHOPS & SERVICES
7. ACCESS TO TRANSIT
8. ACCESS TO HIGHWAY
9. RECREATIONAL OPPORTUNITIES
10. OTHER (SPECIFY) _________________
11. DON'T KNOW
12. REFUSED

Q16. On a scale of 1 to 5 with 1 being poor and 5 being excellent, how would you rate your neighborhood as a place for people to walk to destinations? In answering, think about things such as closeness of destinations, safety, and a nice street environment.

1. POOR
2. 2
3. 3
4. 4
5. EXCELLENT
8. DON'T KNOW
9. REFUSED

Q17. Using the same 1 to 5 scale with 1 being poor and 5 being excellent, how would you rate your neighborhood as a place for people to take buses or trains? In answering, think about things such as access to destinations, frequency of buses or trains, ease of reaching a bus stop or metro station, and safety

1. POOR
2. 2
3. 3
4. 4
5. EXCELLENT
8. DON'T KNOW
9. REFUSED

TRAVELDAY Now I'm going to ask you a series of questions regarding your travel on [INTERVIEWER LOOK AT THE DATE ON THE WHITE BOARD]

[NOTE TO INTERVIEWERS: EACH LEG OF THE TRIP IS CONSIDERED A "TRIP". SO HOME TO WORK IS A TRIP, WORK TO SHOPPING IS A TRIP, SHOPPING TO A FRIENDS HOUSE IS A TRIP...]

Q18a. On that day, how many trips did you make? (RECORD UP TO THREE) _______
[IF Q18A =0 SKIP TO QXXXXXXXX] EACH DESTINATION IS CONSIDERED ONE TRIP

1. ONE TRIP
2. TWO TRIPS
3. THREE TRIPS
4. NO TRIPS
8. DON'T KNOW
9. REFUSED

Q18a1. [IF Q18A > 1] Think about the first trip you made. What time did you leave?
INTERVIEWER: RECORD IN MILITARY TIME. REFER TO FALLBACK SHEET FOR TIME CONVERSION.

TIME: ___________

DON'T KNOW [ENTER 9998]
REFUSED [ENTER 9999]

Q18b1. What time did you arrive at your destination?

INTERVIEWER: RECORD IN MILITARY TIME. REFER TO FALLBACK SHEET FOR TIME CONVERSION.

TIME: ___________

DON'T KNOW [ENTER 9998]
REFUSED [ENTER 9999]

Q18c1. What was the main purpose of this trip?

1. GO TO WORK
2. GO TO SCHOOL
3. SHOPPING
4. MEAL OR SNACK
5. PICK UP/DROP OFF FAMILY
6. OTHER ERRANDS
7. VISIT FRIENDS & FAMILY MEMBERS
8. RECREATIONAL
9. MEDICAL APPORINTMENT
10. OTHER
11. GO HOME
98. DON'T KNOW
99. REFUSED

Q18d1. What was your primary means of travel/transportation?

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1. DROVE ALONE
2. CARPOOLED
3. RODE RAIL TRANSIT (METROLINK)
4. RODE BUS
5. BICYCLED
6. WALKED
7. OTHER (SPECIFY) ________________
8. DON'T KNOW
9. REFUSED

Q18e1. What was the zip code you left from?

1. ZIP CODE: ________________
2. ONLY KNOW CITY… SPECIFY
8. DON'T KNOW
9. REFUSED

Q18f1. What was the zip code of your destination?

1. ZIP CODE: ________________
2. ONLY KNOW CITY… SPECIFY
8. DON'T KNOW
9. REFUSED

Q18g1. Which of the following best describes the parking at your destination? Would you say it was.....

1. Free and easy to find,
2. Free but limited,
3. Paid hourly or daily, or
4. Paid monthly?
5. Quarterly
6. Annual
7. OTHER (SPECIFY) ____________
8. DON'T KNOW
9. REFUSED

IF Q18a = 1, SKIPTO TRANS3

Q19a1. OK, now I have those same questions for the second trip you took that day. What time did you leave?
INTERVIEWER: RECORD IN MILITARY TIME. REFER TO FALLBACK SHEET FOR TIME CONVERSION.

TIME: __________

DON'T KNOW [ENTER 9998]
REFUSED [ENTER 9999]

Q19b1. What time did you arrive?
INTERVIEWER: RECORD IN MILITARY TIME. REFER TO FALLBACK SHEET FOR TIME CONVERSION.

TIME: __________

DON'T KNOW [ENTER 9998]
REFUSED [ENTER 9999]

Q19c1 What was the main purpose of this trip?
1. GO TO WORK
2. GO TO SCHOOL
3. SHOPPING
4. MEAL OR SNACK
5. PICK UP/DROP OFF FAMILY
6. OTHER ERRANDS
7. VISIT FRIENDS OR FAMILY
8. RECREATIONAL
9. MEDICAL REASONS
10. OTHER
11. GO HOME
98. DON'T KNOW
99. REFUSED

Q19d1. What was your primary means of travel/transportation?
1. DROVE ALONE
2. CARPOOLED
3. RODE RAIL TRANSIT (METROLINK)
4. RODE BUS
5. BICYCLED
6. WALKED
7. OTHER (SPECIFY) ________________
8. DON'T KNOW
9. REFUSED

Q19e1. What was the zip code you left from?
1. ZIP CODE: ________________
2. City (IF THEY ONLY KNOW CITY... SPECIFY
8. DON'T KNOW
9. REFUSED [ENTER 99999]

Q19f1. What was the zip code of your destination?
1. ZIP CODE: ________________
2.ONLY KNOW CITY... SPECIFY
8.DON'T KNOW
9.REFUSED

Q19g1. Which of the following best describes the parking at your destination? Would you say it was.....
1. Free and easy to find,
2. Free but limited,
3. Paid hourly or daily, or

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4. Paid monthly?
5. Quarterly
6. Annual
7. OTHER (SPECIFY) ______________
8. DON'T KNOW
9. REFUSED

IF Q18a = 2, SKIPTO TRANS3

Q20a1. And finally I have those same questions for a third trip of that day. If you haven't already told me about a trip for work or school, this would be the time to do it. So for trip #3, What time did you leave?
INTERVIEWER: RECORD IN MILITARY TIME. REFER TO FALLBACK SHEET FOR TIME CONVERSION.

TIME: ___________

DON'T KNOW [ENTER 9998]
REFUSED [ENTER 9999]

Q20b1. What time did you arrive?
INTERVIEWER: RECORD IN MILITARY TIME. REFER TO FALLBACK SHEET FOR TIME CONVERSION.

TIME: ___________

DON'T KNOW [ENTER 9998]
REFUSED [ENTER 9999]

Q20c1. What was the main purpose of this trip?
1. GO TO WORK
2. GO TO SCHOOL
3. SHOPPING
4. MEAL OR SNACK
5. PICK UP/DROP OFF CHILD(REN)
6. OTHER ERRANDS
7. VISIT FRIENDS/ FAMILY MEMBERS
8. RECREATIONAL
9. MEDICAL REASONS
10. OTHER
98. DON'T KNOW
99. REFUSED

Q20d1. What was your primary means of travel/transportation?
1. DROVE ALONE
2. CARPOOLED
3. RODE RAIL TRANSIT (METROLINK)
4. RODE BUS

5. BICYCLED
6. WALKED
7. OTHER (SPECIFY) ________________
8. DON'T KNOW
9. REFUSED

Q20e1. What was the zip code you left from?
1.ZIP CODE: ________________
2.ONLY KNOW CITY…SPECIFY
8.DON'T KNOW
9.REFUSED

Q20f1. What was the zip code of your destination?
1.ZIP CODE: ________________
2.ONLY KNOW CITY…SPECIFY
8.DON'T KNOW
9.REFUSED

Q20g1. Which of the following best describes the parking at your destination? Would you say it was,….
1. Free and easy to find,
2. Free but limited,
3. Paid hourly or daily, or
4. Paid monthly?
5. Quarterly
6. Annual
7. OTHER (SPECIFY) ____________
8. DON'T KNOW
9. REFUSED

ONLY ASK THE FOLLOWING QUESTIONS IF RESPONDENT WORKS OUTSIDE THE HOME (IF Q8 > 1) SKIPTO TRANS4 AND IF (Q9 >1) SKIPTO TRANS4

TRANS3: Thank you…we're done with the hard part. These next few questions focus on your commute to work.
IF (Q8 > 1) SKIPTO TRANS4
IF (Q9 > 1) SKIPTO TRANS4

Q21a. Does your employer allow you to work flexible hours?
1. YES
2. NO
3. AT TIMES
8. DON'T KNOW
9. REFUSED

Q21b. Does your employer allow you to work from home?
1. YES
2. NO
3. AT TIMES
8. DON'T KNOW

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9. REFUSED

Q21c. Does your employer provide a car for use during the day?
1. YES
2. NO
3. IF NEED BE
8. DON'T KNOW
9. REFUSED

Q21d. Does your employer provide free parking?
1. YES
2. NO
8. DON'T KNOW
9. REFUSED

Q21e. Do they help pay for transit?
1. YES
2. NO
8. DON'T KNOW
9. REFUSED

Q21f. Do they help pay for tolls, fuel or other commuting costs?
1. YES
2. NO
8. DON'T KNOW
9. REFUSED

Q22. On average, how often do you use bus or rail to commute to work or school? Would you say you use it…..
1. Every day,[5 DAYS A WEEK OR MORE]
2. Two to three times a week,
3. Once a week,
4. Once a month,
5. Rarely, or
6. Never
8. DON'T KNOW
9. REFUSED

TRANS4: I'm going to read you a few statements regarding people's attitudes about transportation. For each of the following statements, please tell me whether you Strongly Agree, Agree, Disagree, or Strongly Disagree.

Q23. Here's the first statement… … I feel uncomfortable driving a car under certain conditions, such as long distances, at nighttime, or on routes I don't know well. [INTERVIEWER PROMPT ONLY IF NECESSARY WITH "DO YOU…]
1. Strongly Agree
2. Agree
3. Disagree
4. Strongly Disagree

7. NEITHER AGREE OR DISAGREE
8. DON'T KNOW
9. REFUSED

Q24. I and/or other members of my household would benefit greatly from being able to get around sometimes without a car. [INTERVIEWER: ONLY IF NECESSARY, PROMPT WITH "DO YOU STRONGLY AGREE, AGREE, DISAGREE, OR STRONGLY DISAGREE?"]

1. Strongly Agree
2. Agree
3. Disagree
4. Strongly Disagree
5. NEITHER AGREE OR DISAGREE
7. DON'T KNOW
8. REFUSED

Q25. The government should spend more transportation money on expanding roads and highways rather than on public transit. [INTERVIEWER: ONLY IF NECESSARY, PROMPT WITH "DO YOU STRONGLY AGREE, AGREE, DISAGREE, OR STRONGLY DISAGREE?"]

1.Strongly Agree
2.Agree
3.Disagree
4.Strongly Disagree
7.NEITHER AGREE OR DISAGREE
8.DON'T KNOW
9. REFUSED

DEMOG: And now I have a few last questions about you and your background, and then we're done.

D1. What was your age at your last birthday?
AGE: ___________

DON'T KNOW [ENTER 998]
REFUSED [ENTER 999]

D2. How would you describe your race or ethnicity?
[SELECT ALL THAT APPLY]
___ AFRICAN AMERICAN
___ AMERICAN INDIAN
___ PACIFIC ISLANDER
___ HISPANIC
___ WHITE
___ ASIAN
___ OTHER (SPECIFY) ___________________
___ DON'T KNOW
___ REFUSED
IF (Q8 >1) SKIPTO D4

D3. [ASK ONLY IF Q8 = 1] What is your current occupation?

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1. Accounting/Financial
2. Clerical/Secretarial
3. Manager/Administrator
4. Craftsman
5. Laborer
6. Sales
7. Service
8. Professional
9. Other (Specify) ____________________
10. Medical Field (Nurse, Doctor, Dentist)
98. DON'T KNOW
99. REFUSED

D4. Which of the following best describes your annual household income, after taxes for 2009?

1. $15,000 or less
2. $15,001 to $30,000
3. $30,001 to $45,000
4. $45,001 to $60,000
5. $60,001 to $75,000
6. $75,001 to $100,000
7. $100,001 to $150,000
8. $150,001 and over
98. DON'T KNOW
99. REFUSED

COMMENTS: Do you have any other comments about transportation that we haven't covered?

1. COMMETNS
2. NO COMMENTS

END Thank you for your time and assistance. If you win one of the gift cards I will be calling you no later than the end of April at this phone number to let you know.

[INTERVIEWER: IF ADDRESS IS FILLED IN USE "TO CONFIRM" IF NO ADDRESS DO NOT READ THOSE WORDS]
With this specialized survey we need (to confirm) your street address is ______________________________
to determine the distance between your address and a transit stop.

1. CORRECT
2. WHAT IS THE CORRECT ADDRESS
3. WHAT ARE THE CROSS STREETS

9. REFUSED

Well, that's it. Thank you very much for your time - we appreciate it.

INTERVIEWER QUESTIONS

GENDER The respondent was...

1. Male
2. Female
3. Couldn't tell

COOP How cooperative was the respondent?

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1. Cooperative
2. Uncooperative
3. Very Uncooperative

UNDSTD How well did the respondent understand the questions?
1. Very easily
2. Easily
3. Some difficulty
4. Great deal of difficulty

LNG In what language was the interview conducted?
1. English
2. Spanish

NAME Interviewer name?

Appendix D – Mail-Back Questionnaire

Information on your Household

Do you live in an apartment or condo/townhouse? ____ Apartment ____ Condo/Townhouse

What city do you live in? ______________________ Zip code______________

How many bedrooms do you have in your unit? ____ Studio ____ One ____Two ____Three or more

Including yourself, how many people live in your household? __________ How many are age 16 or older? ________

How many motorized vehicles are available for use by members of your household? __________

Information on your Vehicles

For each of the vehicles in your household, please check off where it is ***typically*** parked at your residence

	Vehicle #1	Vehicle #2	Vehicle #3	Vehicle #4	Vehicle #5	Vehicle #6
A private garage assigned to your unit	____	____	____	____	____	____
A shared garage or outdoor lot in your development	____	____	____	____	____	____
On the street	____	____	____	____	____	____

Information on your Place of Work/School

Are you currently employed? ____ Yes ____ No

Do you work or go to school outside your place of residence? ____ Yes ____ No ___ No, I work from home

What is your work zip code? __________

Are you currently enrolled in school? ____ Yes ____ No

Are you enrolled in an on-line program to take courses at home? ____ Yes ____ No

Information on your Place of Residence

In what year did you move into your current residence? ________________

When deciding to move to your current residence, what were the **three (3) most important** factors? (Place a 1 next to the most important, a 2 next to the second most important and a 3 next to the third most important):

___ cost of housing ___ type or quality of housing ___ quality of local schools ___ quality of neighborhood

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___ close to job ___ access to shops, services ___ access to transit
___ access to highway
___ recreational opportunities ___ close to family
___ safety
___ other (specify) ____________________

Using a scale of 1 to 5 (with 1 being poor and 5 being excellent), how would you rate your neighborhood as a **place for people to walk to destinations?** *In answering, think about things such as closeness of destinations, safety, and a nice street environment.* (circle your answer)

(poor) 1 2 3 4 5 (excellent)

Using the same 1 to 5 scale, how would you rate your neighborhood as a **place for people to take buses or trains?** *In answering, think about things such as access to destinations, frequency of buses or trains, ease of reaching a bus stop or metro station, and safety.* (circle your answer)

(poor) 1 2 3 4 5 (excellent)

Information on Commuting

Does your employer… (check all that apply)
____allow you to work flexible hours ____allow you to work from home ____provide a car for use during the day
____provide free parking ____help pay for transit ____help pay for tolls, fuel or other commuting costs

On average how often do you use transit (bus or rail) to commute to work or school?
____everyday ____2-3 times a week ___once a week ____once a month ____ rarely _____never

Attitudes Toward Transportation Options

Please check the response that best represents your opinion to the following statements

I feel uncomfortable driving a car under certain conditions, such as long distances, at nighttime, or on routes I don't know well.

__ strongly agree ___agree ___disagree ___strongly disagree ___neither

I and/or other members of my household would benefit greatly from being able to get around sometimes without a car.

__ strongly agree ___agree ___disagree ___strongly disagree ___neither

Continue on back

The government should spend more transportation money on expanding roads and highways rather than on public transit.

__ strongly agree ___agree ___disagree ___strongly disagree ___neither

Information on Travel

Please provide travel information on the **THREE MAIN TRIPS** you made on the **prior business day from today**, the day you are filling out the survey. Note that a trip refers to **one direction** of travel (for instance, from home to work, or home to grocery store or home to drop family off is one trip…to return home is a second trip). If you did not make three main trips, please provide the information for the trips you did make. Please record the **DATE** of travel: ____________________, 2010

	Trip #1	**Trip #2**	**Trip #3**
Time you left (circle a.m. or p.m.)	________ a.m. / p.m.	________ a.m. / p.m.	________ a.m. / p.m.
Time you arrived (circle a.m. or p.m.)	________ a.m. / p.m.	________ a.m. / p.m.	________ a.m. / p.m.
Primary trip purpose (check one)			
Go to work	☐	☐	☐
Go to school	☐	☐	☐
Shopping	☐	☐	☐
Meal or a snack	☐	☐	☐
Pick up / drop off family	☐	☐	☐
Other errands	☐	☐	☐
Visit friends or family members	☐	☐	☐
Recreational	☐	☐	☐
Medical reasons / appointment	☐	☐	☐
Other (please specify)	________	________	________
Return home	☐	☐	☐
Primary means of travel (check one)			
Drove alone	☐	☐	☐
Carpooled	☐	☐	☐
Rode rail transit (Metrolink)	☐	☐	☐
Rode bus	☐	☐	☐
Bicycled	☐	☐	☐
Walked	☐	☐	☐
Other (please specify)	________	________	________
Origin (where you left from)			
City	________	________	________
Zip Code	________	________	________
Destination (where you went to)			
City	________	________	________
Zip Code	________	________	________
Parking at Destination			

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(check one)			
Free & easy to find	☐	☐	☐
Free but limited	☐	☐	☐
Pay hourly or daily	☐	☐	☐
Pay monthly	☐	☐	☐
Pay Annual	☐	☐	☐
No parking needed	☐	☐	☐
Other (please specify)	______	______	______

Background Information

The following information is valuable to the success of this study. We appreciate any answers you can provide, and assure you that this information will be kept confidential.

Age at your last birthday: ______ **Gender**: ___Male ___Female

Race or Ethnicity:
___African American ___American Indian ___Pacific Islander ___Hispanic
___White ___Asian
___Other (please specify)______________________

Current Occupation:
___Accounting/Financial ___Clerical/Secretarial ___Manager/Administrator
___Craftsman
___Laborer ___Sales ___Service ___Professional ___Medical Field
___Education/Teacher
___Legal/Law Enforcement ___ Other (please specify) ______________

Approximate Household Income after taxes:
___$15,000 or less ___$15,001 - $30,000 ___$30,001 - $45,000 ___$45,001 - $60,000
___$60,001-$75,000 ___$75,001 - $100,000 ___$100,001 - $150,000 ___$150,001 and over

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Software User's Guide: URBEMIS2007 for Windows

Version 9.2
Emissions Estimation for
Land Use Development Projects

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- Bay Area Air Pollution Control District;
- Feather River Air Quality Management District;
- Imperial County Air Pollution Control District;
- Mendocino County Air Pollution Control District;
- Monterey Bay Unified Air Pollution Control District;
- Placer County Air Quality Management District;
- Sacramento Metropolitan Air Quality Management District;
- San Joaquin Valley Air Pollution Control District;
- San Luis Obispo County Air Pollution Control District;
- Santa Barbara Air Pollution Control District;
- South Coast Air Quality Management District; and
- Yolo-Solano Air Quality Management District.

The primary URBEMIS2007 (Version 9.2) improvements include:

- Incorporation of EMFAC2007 emission rates for on-road mobile sources;
- Incorporation of OFFROAD2007 emission rates for off-road mobile sources;
- Upgrading URBEMIS to the .net programming environment;
- Making URBEMIS easier to use for the novice user while enhancing capabilities for power users;
- Enhancing the construction module that provides for additional phasing options; and
- Improving the reporting options, including exporting results to Excel and PDF file formats.

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INTRODUCTION

URBEMIS2007 for Windows Version 9.2, like its predecessors, is designed to estimate air emissions from land use development projects.

The flowchart shown on the following page (Figure 1) provides a conceptual overview of URBEMIS2007. Once the URBEMIS2007 program has been initiated, the user must first either select an existing project or start a new one. For new projects, the air district in which the project is located must be selected. Then, the user typically goes to the land uses module to enter land use information relevant to his project. Once land use information has been entered, the user must select the relevant construction, area, and operational assumptions that apply to the project. Mitigation measures can also be selected as applicable. Once all information has been selected for a project, the user clicks the Recalc button to obtain the emission estimates. After reviewing the results, the user can either save the project or go back and edit the land use or construction/area/operational module assumptions for the project.

Differences from Previous Versions

Several versions of URBEMIS have been released by the California Air Resources Board (ARB) since the early 1980s: Urbemis1, Urbemis2, Urbemis3, and Urbemis5, URBEMIS7G for DOS, URBEMIS7G for Windows, URBEMIS2001 version 6.2.2, URBEMIS2002 version 7.4, URBEMIS2002 version 7.5, URBEMIS2002 version 8.7, and URBEMIS2007 Version 9.2. (Urbemis4 was not released for use by the public.) Previous versions of URBEMIS allowed the user to estimate motor vehicle emissions associated with vehicle trips generated by land use development projects. Generally, each new release of URBEMIS has been associated with ARB's update of its motor vehicle emission factors.

URBEMIS7G represented the successor to URBEMIS5. URBEMIS7G differed from URBEMIS5 in several ways. First, URBEMIS7G was an updated version of URBEMIS5 because it included EMFAC7G, ARB's California motor vehicle emission factors model.

Another difference is that, for the first time, URBEMIS7G provided users with the ability to estimate construction and area source emissions. In addition, URBEMIS7G gave the user the ability to select mitigation measures for construction, area source, and motor vehicle emissions, another option not available in previous versions. And, URBEMIS7G provided estimates of the emissions benefits of those mitigation measures.

URBEMIS7G also included a series of enhanced land use selection screens. The enhancements included additional land uses, updated trip generation rates, trip generation rates for certain land uses based on equations included in the ITE Trip Generation Manual Version 6.0 (Institute of Transportation Engineers 1996), and the option of specifying whether the project is located is an urban versus a rural environment.

Previous versions of URBEMIS did not allow for estimation of reentrained road dust. URBEMIS7G estimated road dust emissions for both paved and unpaved roads.

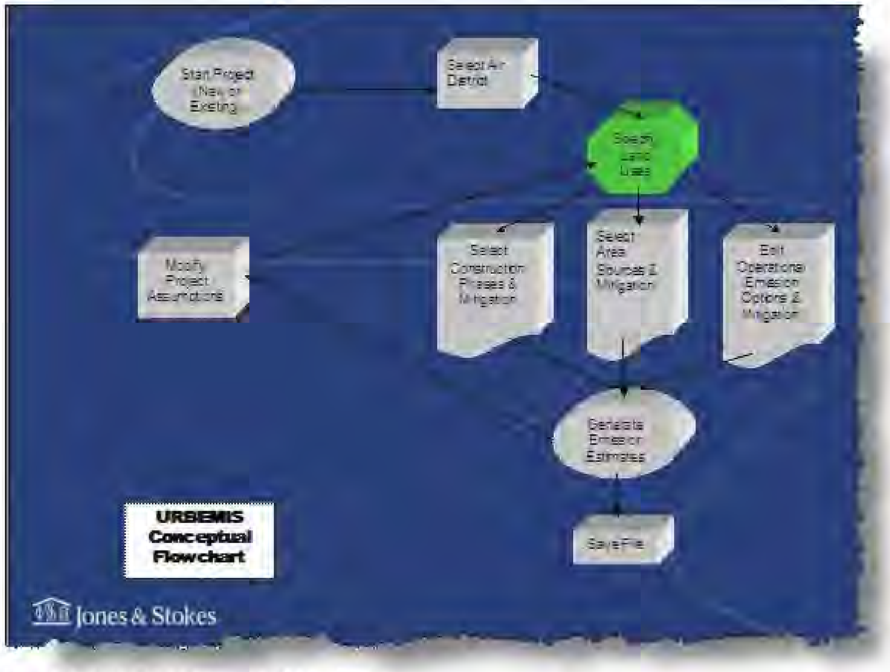

Figure 1. URBEMIS Conceptual Flowchart

URBEMIS7G also allowed the user to select a new "double-counting" option. This option was designed to minimize double counting of internal vehicle trips between residential and nonresidential land uses. Finally, URBEMIS7G allowed users to select a new "pass-by trips" option. With this option selected, URBEMIS7G could be used to estimate vehicle trip emissions based on the percentage of primary trips, diverted linked trips, and pass-by trips assumed for specific land use types.

URBEMIS7G was superceded by URBEMIS7G for Windows. The primary advantage of this enhancement is that it allowed the user to estimate emissions from within the Windows operating system environment. Several other minor improvements were made to fix previously identified bugs. URBEMIS2001 was released in early 2002, following by URBEMIS2002 in March 2003. URBEMIS2001 incorporated EMFAC2001 emissions factors, while URBEMIS2002 version 7.5 incorporated EMFAC2002 emissions factors and ITE Trip Generation, 7th edition emission factors. Additionally, EMFAC2002 included several additional land uses, contained a major enhancement to the construction emissions and mitigation measures module, and included a screening analysis option. URBEMIS2002 Version 8.7 included enhancements to the area source emission factors, and to the area source and operational mitigation measures. URBEMIS2007 version 9.2 includes updates that include adding EMFAC2007 input files, OFFROAD2007 input files, PM2.5 and CO2 emissions, enhanced construction phasing, and improved reporting capabilities.

Getting Started

Operating System Requirements

URBEMIS2007 is written in C++ within the Microsoft .net programming environment. Infragistrics controls have also been incorporated into URBEMIS. The program can be used within either the Microsoft XP or the Vista Operating Systems.

Disk Limits

URBEMIS2007 requires substantial amounts of hard disk space, primarily to store EMFAC2007 database files. Consequently, the program has been set up so that you can download only the EMFAC2007 files and associated air district default files needed.

Installation

URBEMIS2007 can be downloaded and installed by going to the following web site location: http://www.urbemis.com/software/download.html

Once you have navigated to this URBEMIS web site, follow the directions listed there to install URBEMIS directly onto your computer. You are given the option of either installing the .msi file directly from the web site or copying the .msi file to your computer, then using it to install URBEMIS. The later procedure is the recommended approach.

The installation routine provides an icon on the desktop that can be clicked to start URBEMIS. The URBEMIS icon is found in Figure 2 below.

Figure 2. URBEMIS2007 Desktop Icon

Starting URBEMIS2007

Once URBEMIS2007 has been successfully installed, it can be started by selecting the URBEMIS2007 icon from the desktop or by clicking on the Windows Start button, selecting Programs from the list, then selecting URBEMIS2007 from the list of programs. Figure 3 below consists of a portion of the Windows Desktop with the URBEMIS2007 icon. Double clicking on that icon starts the URBEMIS2007 program.

Figure 3. URBEMIS2007 Icon on Windows Desktop

One problem that frequently arises when starting URBEMIS2007 is that the program does not fit entirely within the computer screen. The optimal screen settings for running URBEMIS2002 are 1024 x 768 pixels, with the small fonts advanced setting option. These are Windows settings that can be changed by selecting the Start/Settings/Control Panel/Display from within the Windows operating system.

Quick Start

Once URBEMIS2007 has been started, you are first taken to STEP 1 – Open a New or Existing Project. Once you have started a new project, you can quickly obtain project results using the following steps. First, enter each of the land uses associated with your project (STEP 2). Then make sure that the construction phasing is correct (STEP 3). Then, check that the operational start year is correct (STEP 5). Finally, click on the dirty cloud icon at the top of the center bar. This will give you a quick estimate of your project's emissions. At this point, you may want to go back and refine your project's data by editing information in STEPS 3, 4, and 5. Before doing so, however, save your project (STEP 7). Then modify the project assumptions as necessary.

Where Else to Get Help

There are several options available to obtain help with URBEMIS. They include:

- Hitting the F1 key within any part of URBEMIS, which provides context sensitive help,
- Clicking on the Click for Instructions buttons found within each step of URBEMIS,
- Going to User Help forums located at www.urbemis.com/phpbb/index.php, and
- Consulting this URBEMIS2007 Users Manual.

Using URBEMIS2007

Appearance

When URBEMIS2007 is started, an introductory screen is presented (see Figure 4). The left side of the screen shows seven steps that can be completed for typical URBEMIS runs. Not all of these screens need to be completed to generate emission estimates, though they do provide the novice user with a roadmap for conducting URBEMIS runs. All users must complete Step 1. Open a New or Existing Project, before they can proceed. If a new project is selected, then the user should then go to Step 2. Enter Land Use Data specific to the project in question. Once land use data has been entered, the user can go directly to Step 6. View and Print Output, though its generally recommended that the user go to Steps 3, 4, and 5 to make sure that project specific information is accurately depicted.

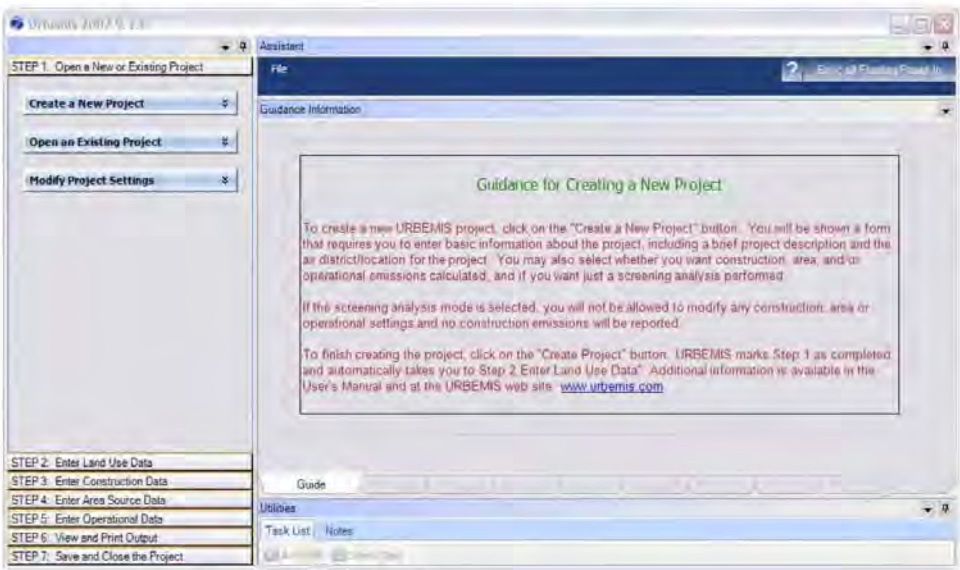

Figure 4. Introductory URBEMIS2007 Windows Screen

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Step 1: Open A New or Existing Project

Figure 5 shows expanded and contracted views of the Step 1 menu. The three options within Step 1 include 1) Start a new project, 2) Open an Existing Project, 3) Modify Project Settings. As Figure 5 illustrates, each of these three Step 1 options can be expanded by clicking on the arrows at the right of each option.

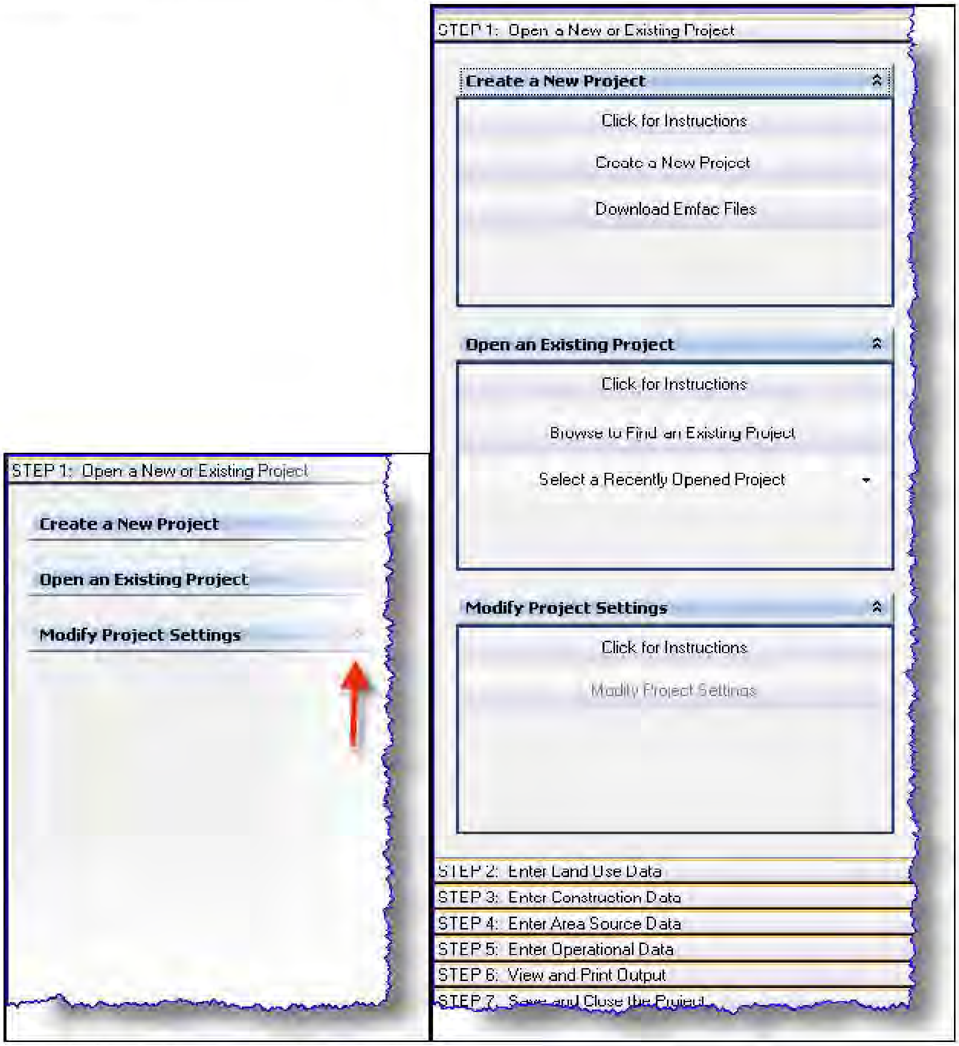

Figure 5. Step 1: Expanded and Contracted Screens

For example, clicking on Create a New Project expands this menu to include three suboptions: a) Click for Instructions, b) Create a New Project, or c) Download EMFAC files. If you attempt to Start a New Project in a location for which you have not downloaded the EMFAC files, then you will need to first download the EMFAC and air district and associated county default files.

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Creating a New Project

Figure 6 shows the screen URBEMIS shows when the Create a New Project button is selected. In this example, the user wants to create a new project located in the Mountain Counties Air Basin. Since the Mountain Counties Air Basin is not shown in the list, that county's EMFAC files need to be downloaded first. To do this, you would need to cancel out of the Start a New Project screen and click on the Download EMFAC Files button within the Start a New Project button.

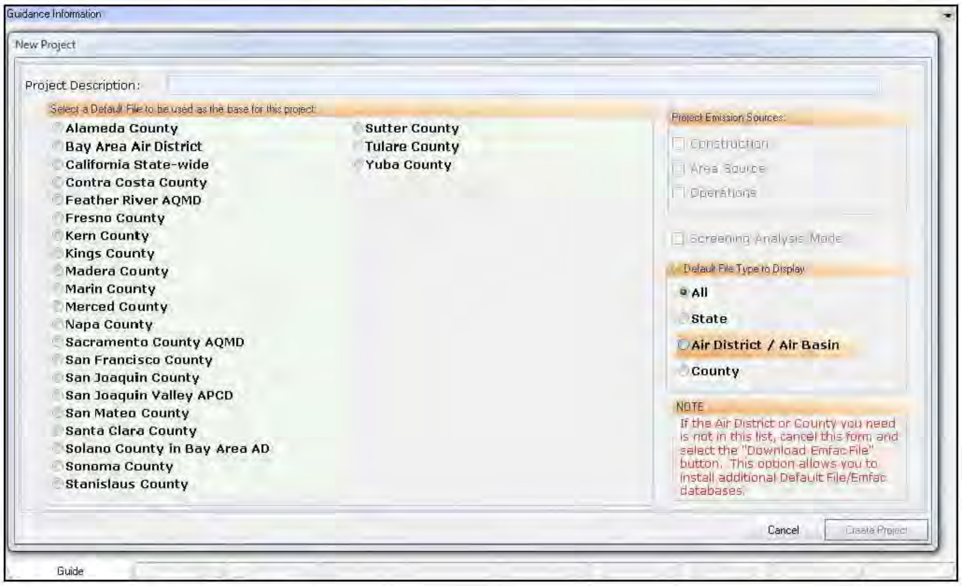

Figure 6. New Project Setup Screen

Figure 7 shows the Download EMFAC Files screen. In this example, the Mountain Counties Air Basin EMFAC database has been selected and is shown downloading. Once that database has downloaded, then you would need to Start New Project and select Mountain Counties Air Basin (see Figure 8). Also, on the Create a New Project Screen, you will need to enter a Project Description. This Project Description is not the same thing as the File Name used to store and retrieve the file on your computer. Once you have selected the project location and entered the Project Description, hit the Create Project button. URBEMIS then takes you to STEP 2.

One additional option to be aware of in the new project screen is the "screening analysis mode" checkbox located on the right side of menu. If the user turns on the "screening analysis option", they will not be able to edit the default values for construction, area sources, or operational emissions. In addition, because the construction module depends on several key assumptions that must be reviewed by the user, the screening analysis mode only generates emissions for the area and operational emission categories.

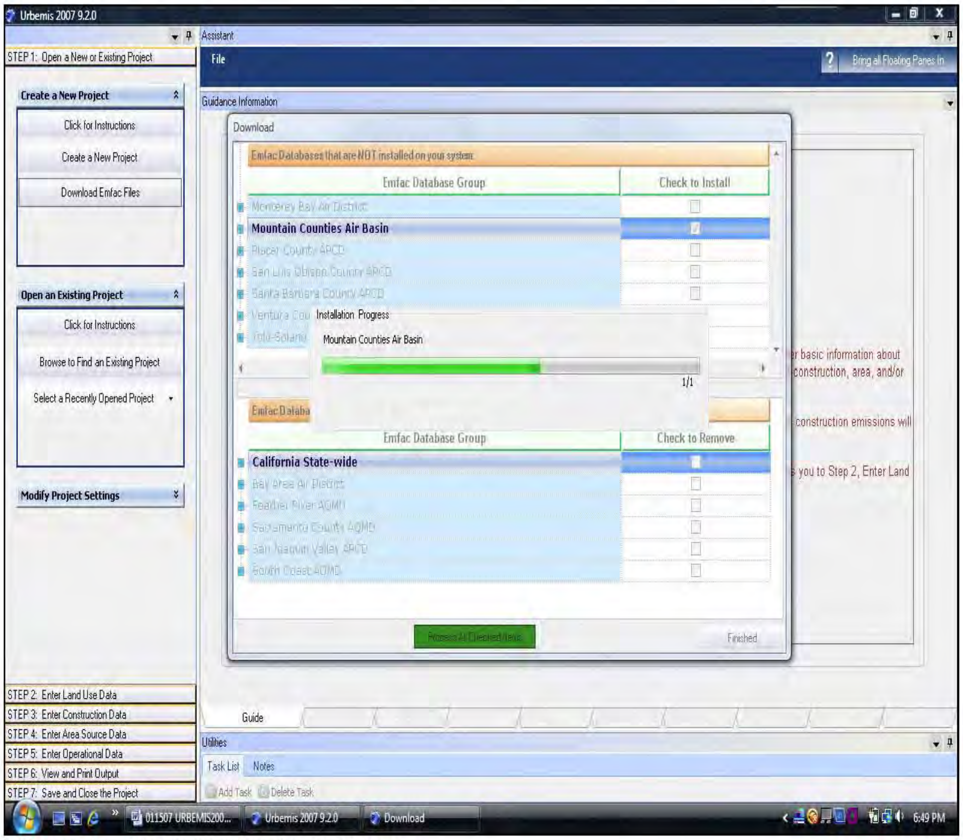

Figure 7. Download EMFAC Database Screen

Figure 8. New Project Setup Screen

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Open an Existing Project

To open an existing project, the user should click on either the a) Browse to Find an Existing Project or b) Select a Recently Opened Project bar (see Figure 5). Once you have opened a previously created project, URBEMIS takes you to STEP 2.

Another option for starting an existing or new project is to click on the word "File" shown on the project assistant bar (see Figure 9). Clicking on File reveals a drop down menu that can be used to start a new project or open an existing project

Modify Project Settings

The third option under STEP 1 involves modifying project settings. This option is available for projects that have already been created. Under this option, you can modify the project description, turn on or off the construction, area, and operational phases, and turn the screening analysis mode on or off.

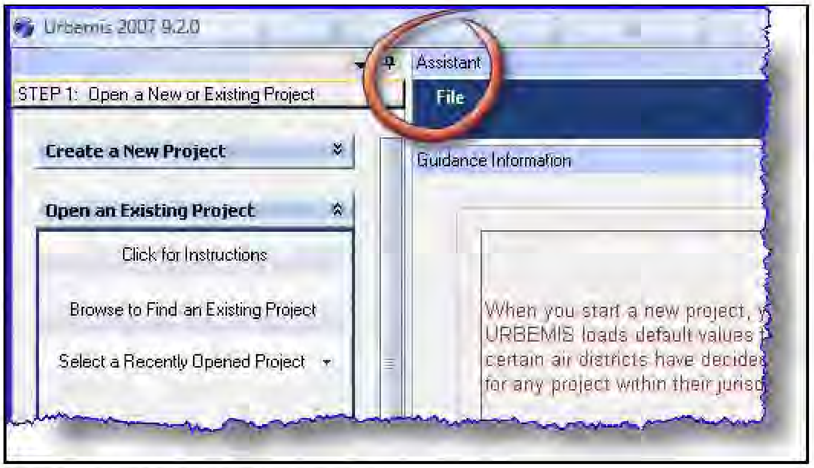

Figure 9. Select File from the Assistant Bar

Step 2 – Enter Land Use Data

Once you have opened an existing project or started a new one, URBEMIS takes you to Step 2 - Enter Land Use Data. The first land use screen displays residential land uses, which represent the first of eight possible land use screens.

- residential;
- educational;
- recreational;
- large retail;
- retail;
- commercial;

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- industrial; and
- blank.

Figure 10 shows the residential land use screen with 222 single family residential uses entered. URBEMIS assumes 9.57 trips per day per residential land use. URBEMIS also assumes 3 single family residential land uses per acre. Both the trips per day and acreage values can be modified by the user.

You may access the land uses associated with either of the eight land use screens by either clicking on the appropriate tab (shown with arrow in Figure 10) or by double clicking on the appropriate land use name in the left window pane shown under Step 2.

Figure 10. Land Use Screens

Figure 11. Land Use Tabs

In Figure 12, the educational tab has been selected and 20 has been entered as the unit amount for day-care center. The 20 represents 20,000 square feet with a daily trip generation rate of 79.26 per 1000 square feet.

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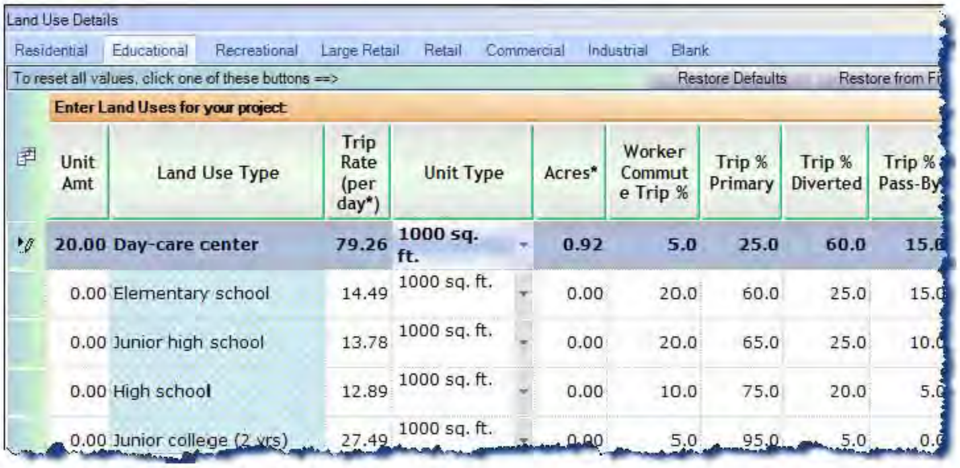

Land Use Details

Residential | Educational | Recreational | Large Retail | Retail | Commercial | Industrial | Blank

To reset all values, click one of these buttons ==> Restore Defaults | Restore from Fi

Enter Land Uses for your project:

Unit Amt	Land Use Type	Trip Rate (per day*)	Unit Type	Acres*	Worker Commute Trip %	Trip % Primary	Trip % Diverted	Trip % Pass-By
20.00	Day-care center	79.26	1000 sq. ft.	0.92	5.0	25.0	60.0	15.0
0.00	Elementary school	14.49	1000 sq. ft.	0.00	20.0	60.0	25.0	15.0
0.00	Junior high school	13.78	1000 sq. ft.	0.00	20.0	65.0	25.0	10.0
0.00	High school	12.89	1000 sq. ft.	0.00	10.0	75.0	20.0	5.0
0.00	Junior college (2 yrs)	27.49	1000 sq. ft.	0.00	5.0	95.0	5.0	0.0

Figure 12. Educational Land Use Screen

Figure 13 shows the Blank land use tab. In this screen, the user can enter land uses that have not been entered in either of the seven previous screens. The user must enter unit amount, land use type, acres, and trip rate. Although URBEMIS will calculate acreage (as twice the building square footage), the user is urged to override this value if specific acreage data is available. Figure 14 shows an entry in the first row of the Blank Screen. A two acre dog park with 100 trips per acre has been entered.

Land Use Details

Residential | Educational | Recreational | Large Retail | Retail | Commercial | Industrial | Blank

To reset all values, click one of these buttons ==> Restore Defaults | Restore from File

Enter Land Uses for your project:

Unit Amt	Land Use Type	Trip Rate (per day*)	Unit Type	Acres*	Worker Commute Trip %	Trip % Primary	Trip % Diverted	Trip % Pass-By
0.00	Blank (Edit this description)	0.00	1000 sq. ft.	0.00	2.0	90.0	10.0	0.0
0.00	Blank (Edit this description)	0.00	1000 sq. ft.	0.00	2.0	90.0	10.0	0.0
0.00	Blank (Edit this description)	0.00	1000 sq. ft.	0.00	2.0	90.0	10.0	0.0
0.00	Blank (Edit this description)	0.00	1000 sq. ft.	0.00	2.0	90.0	10.0	0.0
0.00	Blank (Edit this description)	0.00	1000 sq. ft.	0.00	2.0	90.0	10.0	0.0

* denotes required field if Unit Amount is greater than zero

Submit

Guide | Land Use

Figure 13. Blank Land Uses

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Figure 14. Sample Blank Screen Entry

Table 1 lists each of the URBEMIS2007 land uses, provides a definition of each land use, and shows the percentage of worker commute trips associated with each land use. Those percentages are called Percent Worker Commute in Table 1.

For each land use type, you are given the option of entering the project size or unit amount. For all land uses, URBEMIS2007 automatically calculates the acreage associated with that land use type and the trip rate based on the unit amount. The user can and should modify the acreage for a project if it differs from the default values used by URBEMIS. For residential projects, changing the project acreage will, however, also change the trip rate using the procedure described in Appendix D of this manual. For non-residential land uses, URBEMIS estimates acreage by assuming that acreage equals twice the building square footage. For residential land uses, URBEMIS assumes the following acreage:

- single family residential – 3 units per acre;
- low rise apartments and condos/townhouse units – 16 units per acre;
- mid rise apartments – 38 units per acre;
- high rise apartments – 62 units per acre;
- high rise condos – 64 units per acre;
- mobile home parks – 6 units per acre;
- congregate care (assisted living) – 16 units per acre.

The equation or value used to estimate trip generation is shown in Table 2. You can override the trip rate by typing in a different rate. For certain land uses, you also can select a different unit type by clicking on the "Unit Type" arrow.

For all non-residential land uses, you also have the option of modifying the default "% Worker Commute" value. This value represents the percentage of worker commute trips attracted to that land use as a percentage of all trips generated by that land use.

Table 1. Land Use Definitions and Percent Worker Commute

	Land Use Definition	Percent Worker Commute
First Land Use Screen: Residential		
Single Family Housing	Detached homes on individual lots	N/A
Apartments, Low Rise	Buildings with one to three floors	N/A
Apartments, Medium Rise	Buildings with four to ten floors	
Apartments, High Rise	Buildings with more than ten floors	N/A
Condo/Townhouse General	Condos and townhomes in buildings with one or two levels.	N/A
Condo/Townhouse High Rise	Condos and townhomes in buildings with 3 or more levels.	N/A
Mobile Home Park	Trailers sited and installed on permanent foundations.	N/A
Retirement Community	Self-contained villages restricted to adults or senior citizens	N/A
Congregate Care (Assisted Living) Facility	One or more multiunit buildings designed for elderly living and may contain dining rooms, medical, and recreational facilities.	N/A
Second Land Use Screen: Educational		
Day-Care Center	Facilities that care for pre-school children, normally during daytime hours. May also include after-school care for older children.	5
Elementary School	Generally includes Kindergarten through either 6th or 8th grades.	20
Junior High School	Includes 7th, 8th, and often 9th grades.	20
High School	Includes 10th, 11th, and 12th grades and oftentimes 9th grade.	10
Junior College (2 years)	Most have facilities separate from other land uses and exclusive access points and parking facilities.	5
University/College (4 years)	Four year and graduate educational institutions.	5
Library	Public or private facility, which houses books, and includes reading rooms and possibly meeting rooms.	5
Place of Worship	Building(s) providing public worship services.	3
Blank (Edit all 5 columns)	Blank commercial land use that can be entered by the URBEMIS2007 user.	2
Third Land Use Screen: Recreational		
City Park	Owned and operated by a city, these facilities can vary widely as to location, type, and number of facilities. May including boating, swimming, ball fields, camp sites, and picnic facilities.	
Racquet Club	Privately owned facilities with tennis, racquetball, and/or handball courts, exercise rooms, and/or swimming pools and/or weight rooms	5
Racquet/Health Club	Privately owned facilities with tennis, racquetball, and/or handball courts.	5
Quality Restaurant	Typically with customer turnover rates of at least one hour.	8
High Turnover (sit-down Restaurant)	Typically with high customer turnover rates of less than one hour.	5
Fast Food Restaurant with Drive Through	Includes fast food restaurants with drive through windows, such as McDonald's, Burger King, and Taco Bell.	5
Fast Food Restaurant without Drive Through	Includes fast food restaurants without drive through windows, such as McDonald's, Burger King, and Taco Bell.	5
Hotel	Place of lodging providing sleeping accommodations, restaurants, and meeting or convention facilities.	5
Motel	Place of lodging providing accommodations and often, a restaurant.	5
Fourth Land Use Screen: Large Retail		
Free-Standing Discount Store	Free-standing store with off-street parking, can be part of neighborhood shopping centers.	2
Free-Standing Discount Superstore	Same as free-standing discount store but also include full service grocery department under the same roof.	2
Discount Club	Discount/warehouse store whose shoppers pay a membership fee to take advantage of discounted prices.	2

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	Land Use Definition	Percent Worker Commute
Regional Shopping Center	Integrated group of commercial establishments that are planned, developed, owned, and managed as a unit.	2
Electronics Superstore	Free-standing warehouse type facilities specializing in the sale of home and vehicle electronic merchandise, as well as TVs, compact disc and cassette tape players, cameras, radios, videos, and general electronic accessories.	2
Home Improvement Superstore	Free-standing warehouse type facilities specializing in lumber, tools, paint, lighting, wallpaper and paneling, kitchen and bathroom fixtures, lawn equipment, and garden plants and accessories.	2
Fifth Land Use Screen: Retail		
Strip Mall	Neighborhood store complexes with a variety of retail outlets.	2
Hardware/Paint Store	Stores selling general hardware items and/or paints and supplies.	2
Supermarket	Free-standing stores selling a complete assortment of food, food preparation and wrapping materials, and household cleaning and servicing items. May also contain money machines, photo centers, pharmacies, and video rental areas.	2
Convenience market (24 hour)	These markets sell convenience foods, newspapers, etc. and do not have gasoline pumps. (Trip generation rates with gas pumps is approximately 12% higher than without.	2
Convenience market with gas pumps	These markets sell convenience foods, newspapers, etc. and do have gasoline pumps.	2
Gasoline/Service Station	Excludes gasoline stations with convenience stores or car washes.	2
Sixth Land Use Screen: Commercial		
Bank (with drive-through)	Banks with one or more drive-up windows.	2
General Office Building	Houses multiple tenants in a location where affairs of businesses, commercial or industrial organizations or professional persons or firms are conducted.	35
Office Park	Contain general office buildings and related support services, arranged in a park- or campus-like setting.	48
Government Office Building	Individual building containing the entire function or simply one agency of a city, county, state, or federal government.	10
Government (Civic Center)	Group of government buildings connected with pedestrian walkways	10
Pharmacy/Drugstore with Drive Through	Retail facilities selling prescription and non-prescription drugs. Also typically sell cosmetics, toiletries, medications, stationary, personal care products, limited food products, and general merchandise. These facilities include a drive-through window.	2
Pharmacy/Drugstore without Drive Through	Retail facilities selling prescription and non-prescription drugs. Also typically sell cosmetics, toiletries, medications, stationary, personal care products, limited food products, and general merchandise. These facilities do not contain a drive-through window.	2
Medical Office Building	Includes both medical and dental office buildings that provide diagnoses and outpatient care. Generally operated by one or more private physicians or dentists.	7
Hospital	Any institution where medical or surgical care is give to non-ambulatory and ambulatory patients and overnight accommodations are provided.	25
Seventh Land Use Screen: Industrial		
Warehouse	Buildings devoted to the storage of materials, also include office and maintenance areas.	2
General Light Industry	Typical light industrial activities include: print plants, material testing labs, and assemblers of data processing equipment. They employ fewer than 500 persons and tend to be free-standing.	50
General Heavy Industry	Could also be categorized as manufacturing facilities. However, heavy industrial uses are limited to the production of large items.	90
Industrial Park	Contain a number of industrial or related facilities and are characterized by a mix of manufacturing, service, and warehouse facilities. May contain highly diversified facilities, a number of small businesses, or one or two dominant industries.	41.5
Manufacturing	Sites where the primary activity is the conversion of raw materials or parts into finished products. May also included associated office, warehouse, research, and other functions.	48

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Percent worker commute represents the percentage of total trips that are work-related commute trips.

Table 2. URBEMIS2007 Trip Generation Rates

Land Use	Trip Generation Rate	Units *	Source
Single Family Housing	9.57	Dwelling Unit	ITE (210)
Apartment, Low Rise	6.9	Dwelling Unit	ITE (221)
Apartment, Mid Rise	5.76	Dwelling Unit	ITE (223)
Apartment, High Rise	5.29	Dwelling Unit	ITE (222)
Condominium/Townhouse, General	6.9	Dwelling Unit	ITE (230)
Condominium/Townhouse, High Rise	5.26	Dwelling Unit	ITE (232)
Mobil Home Park	4.99	Dwelling Unit	ITE (240)
Retirement Community	3.71	Dwelling Unit	ITE (251)
Congregate Care (Assisted Living) Facility	2.02	Dwelling Unit	ITE (253)
Day-Care Center	79.3	1000 sq. ft.	ITE (565)
Elementary School	14.49	1000 sq. ft.	ITE (520)
Elementary School	1.29	Student	ITE (520)
Junior High School	13.78	1000 sq. ft.	ITE (522)
Junior High School	1.62	Student	ITE (522)
High School	12.89	1000 sq. ft.	ITE (530)
High School	1.71	Student	ITE (530)
Junior College (2 Years)	27.49	1000 sq. ft	ITE (540)
Junior College (2 Years)	1.2	Student	ITE (540)
University/College (4 Years)	2.38	Student	ITE (550)
Library	54	1000 sq. ft.	ITE (590)
Place of Worship	9.21	1000 sq. ft.	ITE (560)
City Park	1.59	Acre	ITE (411)
Racquet Club	14.03	1000 sq. ft.	ITE (491)
Racquetball/Health Club	32.93	1000 sq. ft.	ITE (492)
Quality Restaurant	89.95	1000 sq. ft.	ITE (931)
High-Turnover (Sit-Down) Restaurant	127.15	1000 sq. ft.	ITE (932)
Fast-Food Restaurant w/o Drive-Through Window	716	1000 sq. ft.	ITE (933)
Fast-Food Restaurant with Drive-Through Window	496.12	1000 sq. ft.	ITE (934)
Hotel	8.17	Rooms	ITE (310)
Motel	5.63	Rooms	ITE (320)
Free-Standing Discount Store	56.02	1000 sq. ft.	ITE (815)
Free-Standing Discount Superstore	49.21	1000 sq. ft.	ITE (813)
Discount Club	41.8	1000 sq. ft.	ITE (861)
Regional Shopping Center	42.94	1000 sq. ft.	ITE (820)
Electronics Superstore	45.04	1000 sq. ft.	ITE(863)
Home Improvement Superstore	29.8	1000 sq. ft.	ITE(862)
Strip Mall	42.94	1000 sq. ft.	ITE (820)
Hardware/Paint Store	51.29	1000 sq. ft	ITE(816)
Supermarket	102.24	1000 sq. ft.	ITE(850)
Convenience Market (24 hr.)	737.99	1000 sq. ft.	ITE (851)

Land Use	Trip Generation Rate	Units *	Source
Convenience Market with Gasoline Pumps	845.6	1000 sq. ft.	ITE (853)
Gasoline /Service Station	162.78	Fueling Positions	ITE (945)
Bank (with Drive-Through)	246.49	1000 sq. ft.	ITE (912)
General Office Building	3.32	1000 sq. ft.	ITE (710)
Office Park	11.42	1000 sq. ft.	ITE (750)
Government Office Building	68.93	1000 sq. ft.	ITE (730)
Government (Civic Center)	27.92	1000 sq. ft.	ITE (733)
Pharmacy/Drugstore without Drive Through	88.16	1000 sq. ft	ITE(880)
Pharmacy/Drugstore with Drive Through	90.06	1000 sq. ft	ITE(881)
Medical/Dental Office Building	36.13	1000 sq. ft.	ITE (720)
Hospital	17.57	1000 sq. ft.	ITE (610)
Hospital	11.81	Beds	ITE (610)
Warehouse	4.96	1000 sq. ft.	ITE(150)
General Light Industry	6.97	1000 sq. ft.	ITE (110)
General Light Industry	51.8	Acre	ITE (110)
General Light Industry	3.02	Employee	ITE (110)
General Heavy Industry	1.5	1000 sq. ft.	ITE (120)
General Heavy Industry	6.75	Acre	ITE (120)
Industrial Park	6.96	1000 sq. ft.	ITE (130)
Industrial Park	63.11	Acre	ITE (130)
Industrial Park	3.34	Employee	ITE (130)
Manufacturing	3.82	1000 sq. ft.	ITE (140)

Notes:

sq. ft. = Square Feet

All trip generation rates from ITE Trip Generation Rate Manual, 7th Edition.

* "Dwelling unit" is a residential housing unit (including 'single room occupancy' units and 'granny flats'). "Square feet" refers to the total floor area (on all levels) of buildings, but does not include parking structures even if they are within a building (also known as 'gross leasable area'). "Acres" refers to the gross surface of the entire site, including any structures, streets, sidewalks, parking, and landscaping (but not including building or parking lot floor areas above the first level).

Pass-by Trips

URBEMIS2007 allows users to select a pass-by trip option, which results in lower operational emissions. The pass-by trip option splits trips into percentages of primary, pass-by, and diverted-linked trips. Primary trips are trips made for the specific purpose of visiting the designated land use. The stop at that trip generator is the primary reason for the trip. Pass-by trips are trips made as intermediate stops on the way from an origin to a primary trip destination. Pass-by trips are attracted from traffic passing the site on an adjacent street that contains direct access to the generator. Diverted-linked trips are trips attracted from the traffic volume on roadways in the vicinity of the generator but which require a diversion from that roadway to another roadway to gain access to the site.

When the pass-by option is turned off, URBEMIS assumes all trips are primary trips. When pass-by is turned on, lower emissions result because a percentage of trips associated with each land use is assumed to be pass-by and diverted linked trips (see Table 3). Pass-by and diverted-linked trips have a lower trip distance than primary trips. URBEMIS assumes that pass-by trips result in virtually no extra travel, with an assumed trip length of 0.1 miles. Diverted-linked trip lengths are assumed to equal 25% of the primary trip length.

As shown in Table 3, the "fast-food restaurant without drive-through window" land use consists of 50% primary trips, 40% diverted linked trips, and 10% pass-by trips. Assuming a trip length of 10 miles, emissions calculated using the pass-by trip option would be calculated by assuming that 50% of the trips would be 10 miles, 40% of the trips would be 2.5 miles, and 10% of the trips would be 0.1 miles.

Table 3. URBEMIS Land Uses Sorted by Category with Trip Percentages

Land Use	Land Use Category	Primary Trip (%)	Diverted Linked Trip (%)	Pass-By Trip (%)	Source
Single-Family Housing	Residential	85	10	5	Sandag 1996
Apartment, Low Rise	Residential	85	10	5	Sandag 1996
Apartment, High Rise	Residential	85	10	5	Sandag 1996
Condominium/Townhouse, General	Residential	85	10	5	Sandag 1996
Condominium/Townhouse, High Rise	Residential	85	10	5	Sandag 1996
Mobile Home Park	Residential	85	10	5	Sandag 1996
Retirement Community	Residential	85	10	5	Sandag 1996
Residential Planned Unit Development (PUD)	Residential	85	10	5	Sandag 1996
Congregate Care (Assisted Living) Facility	Residential	85	10	5	Sandag 1996
Day-Care Center	Educational	25	60	15	Sandag 1996
Elementary School	Educational	60	25	15	Sandag 1996
High School	Educational	75	20	5	Sandag 1996
Junior High School	Educational	65	25	10	Sandag 1996
Junior College (2 Years)	Educational	95	5	0	Sandag 1996
University/College (4 Years)	Educational	90	10	0	Sandag 1996
Library	Educational	45	45	10	Sandag 1996
Church	Educational	65	25	10	Sandag, 1996
City Park	Recreational	70	25	5	Sandag 1996
Racquet Club	Recreational	50	40	10	Sandag 1996
Racquetball/Health Club	Recreational	50	40	10	Sandag 1996
Quality Restaurant	Recreational	50	40	10	Sandag 1996
High-Turnover (Sit-Down) Restaurant	Recreational	30	40	30	ITE 1997
Fast-Food Restaurant without Drive-Through Window	Recreational	50	40	10	Sandag 1996
Fast-Food Restaurant with Drive-Through Window	Recreational	30	30	40	ITE 1997
Hotel	Recreational	60	35	5	Sandag 1996
Motel	Recreational	60	35	5	Sandag 1996
Free-Standing Discount Store	Large Retail	45	45	10	Sandag 1996
Free-Standing Discount Superstore	Large Retail	55	40	5	ITE 1997

Land Use	Land Use Category	Primary Trip (%)	Diverted Linked Trip (%)	Pass-By Trip (%)	Source
Discount Club	Large Retail	55	40	5	Sandag 1996
Regional Shopping Center	Large Retail	55	35	10	Sandag 1996
Electronics Superstore	Large Retail	45	40	15	Sandag 1996
Home Improvement Superstore	Large Retail	45	40	15	Sandag 1996
Strip Mall	Retail	45	40	15	Sandag 1996
Hardware/Paint Store	Retail	45	40	15	Sandag 1996
Supermarket	Retail	45	40	15	Sandag 1996
Convenience Market (24 hr.)	Retail	25	30	45	ITE 1997
Convenience Market (w/gas pumps)	Retail	25	30	45	ITE 1997
Gasoline/Service Station	Retail	20	40	40	ITE 1997
Bank (with Drive-Through)	Commercial	35	45	20	Sandag 1996
General Office Building	Commercial	75	20	5	Sandag 1996
Office Park	Commercial	80	15	5	Sandag 1996
Government Office Building	Commercial	50	35	15	Sandag 1996
Government (Civic Center)	Commercial	50	35	15	Sandag 1996
Pharmacy/Drugstore with Drive Through	Commercial	45	40	15	Sandag 1996
Pharmacy/Drugstore without Drive Through	Commercial	45	40	15	Sandag 1996
Medical Office Building	Commercial	60	30	10	Sandag 1996
Hospital	Commercial	75	25	0	Sandag 1996
Warehouse	Industrial	90	5	5	Sandag 1996
General Light Industry	Industrial	80	20	0	Sandag 1996
General Heavy Industry	Industrial	90	5	5	Sandag 1996
Industrial Park	Industrial	80	20	0	Sandag 1996
Manufacturing	Industrial	90	5	5	Sandag 1996

STEP 3: Enter Construction Data

The construction emissions portion of URBEMIS2007 has been substantially modified from previous versions. STEP 3 - Enter Construction Data represents the most complicated step within URBEMIS. This is primarily because construction phasing varies considerably from project to project.

The STEP 3: Enter Construction Data screen allows you to estimate area-source emissions for up to seven different types of construction phases. The emission factors and equations used by URBEMIS2007 to estimate construction emissions are described in detail in Appendix A.

When you enter URBEMIS, you can click on STEP 3 without either opening a project or entering land use data. If you then go to STEP 3, you will see the screen shown in the left half of Figure 15. That screen shows the seven construction phases allowed by URBEMIS. If you have opened an existing project, or started a new project, and have entered one or more land uses, you will see the right half of Figure 15 when you go to STEP 3. The only exception to this is for projects within the South Coast Air District, where all seven phases are assumed as part of the construction phase setup.

This list of generic phases and schedules should only be used if specific construction information is unavailable for the project in question.

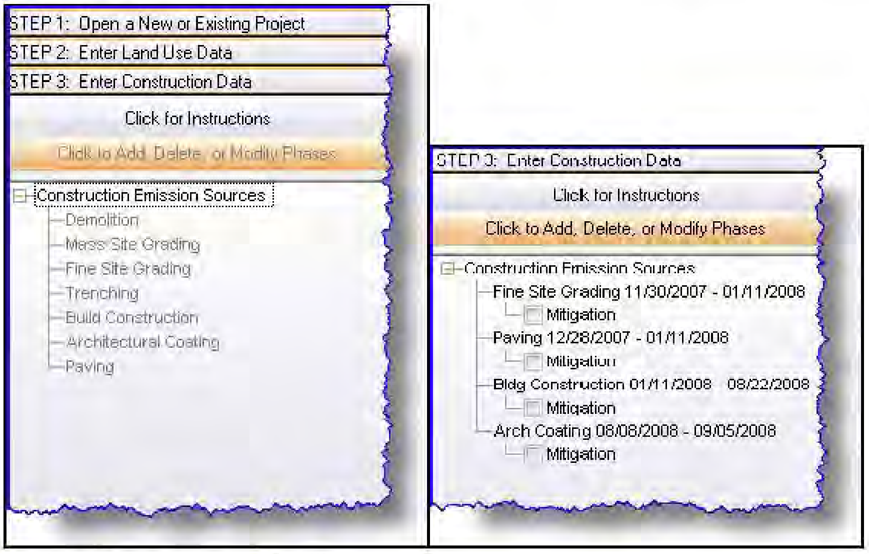

Figure 15. Construction Start Screens

Setting Up Construction Phases

The phases and schedules included in the generic construction phasing are as follows:

- Fine Site Grading,
- Asphalt,
- Building Construction, and
- Architectural Coatings.

These phases can be deleted or their phasing can be altered by clicking on the button: Click to Add, Delete, or Modify Phases (orange button just below the STEP3. Enter Construction Data button).

Figure 16. Adding, Deleting and Modifying Construction Phases

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This will take you to a screen that allows you to add or delete phases. The seven types of phases that be included in URBEMIS are:

- Demolition,
- Mass Site Grading,
- Fine Site Grading,
- Trenching,
- Building Construction,
- Asphalt, and
- Coating (paints)

For each phase, you must identify construction phase settings that include phase type, start date, end date, work days/week, and a description. There is no limit to the number of phases that can be entered. More than one phase of any type can be entered. The only limitation is that phases of the same type must have a unique start date/end date pair. For any phase, the start and end dates must be on or after January 1, 2005 and the end date must be on or before December 31, 2040.

Phases can overlap, occur sequentially, or have time gaps between them.

As shown in Figure 16, a second tab allows you to View a Calendar of Phases. When you select that tab, you are shown a calendar (See Figure 17). This calendar shows all days that have any phase activity as bolded days. If you place your cursor over any bolded day, the number of phases occurring on that date are displayed, and if you click a day, the phases that occur on that day will be displayed in the box on the right.

Once you are satisfied that your project's construction phasing has been set up correctly, from within the Enter Phase Data tab click on the Done, Process these Changes Button. This will save your changes and display your project's phases in the left hand pane of STEP 3 (see Figure 18).

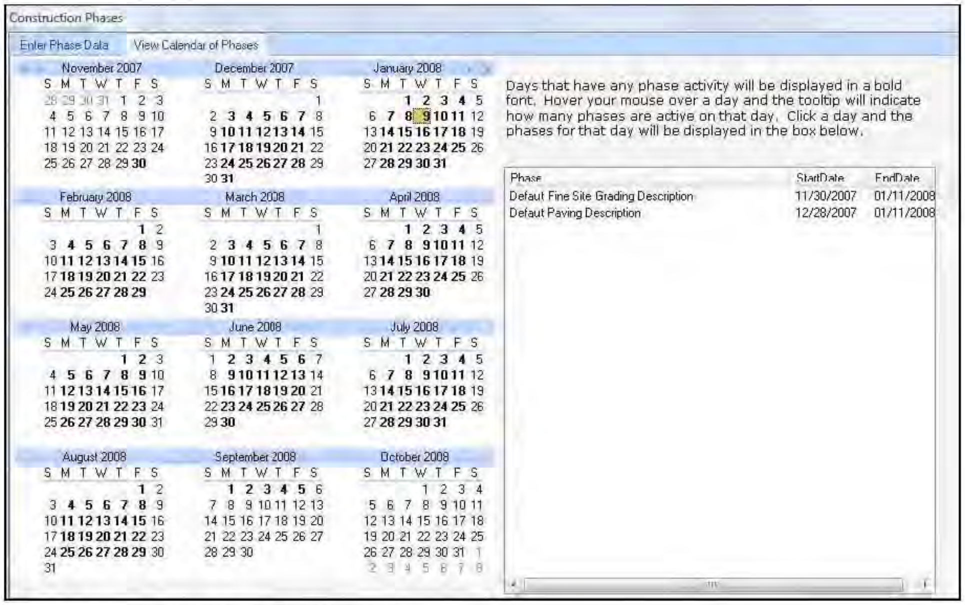

Figure 17. Construction Calendar of Phases

Figure 18. Seven Phase Example with Demolition Screen Showing

Demolition

Figure 18 shows the construction phasing in the left hand window pane. In this example, the demolition line has been selected, resulting in the first demolition tab being shown in the right hand pane. In this screen, the user is required to enter the volume of the building that will be demolished. URBEMIS then uses that information to estimate the amount of truck vehicle miles traveled needed to haul the demolished material away.

URBEMIS also generates estimates of the demolition equipment that would be needed to demolish the building. That estimate is based on the acreage of the demolition project. Figure 19 shows that URBEMIS estimates 3 excavators and 2 rubber tired dozers will be used in this demolition project. The user can change those values by entering different numbers in the column labeled Amt Model Uses (Click to Sort). For example, assume for your project that only 2 excavators and 2 rubber tired dozers would be used during demolition. You can enter the 2 in the third column. The user is cautioned, however, that URBEMIS will automatically override any values you enter if you change any land use values (STEP 2) unless you uncheck the box in the first column.

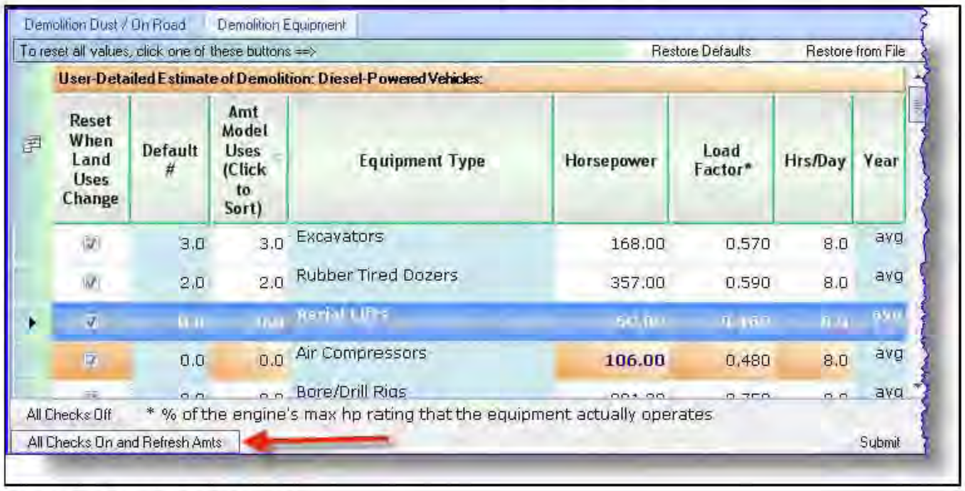

Figure 19. Demolition Equipment

Fine Site Grading

Figure 20 shows the first of the four tabs in the fine grading screen. This screen shows the acreage estimates that URBEMIS uses to estimate fugitive dust and fine site grading equipment emissions. The total acreage to be graded and maximum daily acreage disturbed estimates are shown at the bottom of the page.

URBEMIS uses the acreages entered in the residential and non-residential land use screens. For non-residential land uses, URBEMIS assumes that acreage is twice the size of the building square footage, unless the values are overridden by the user. URBEMIS also assumes that the maximum daily acreage disturbed is 25 percent of total acreage to be graded.

The user should change the maximum daily acreage disturbed value if they know that their project would have different values. The user should also be aware that if the maximum daily acreage disturbed value is changed, URBEMIS will reset that value whenever a land use is modified (STEP 2) unless the reset acreage with land use changes box has been unchecked (see arrow at bottom right of Figure 20).

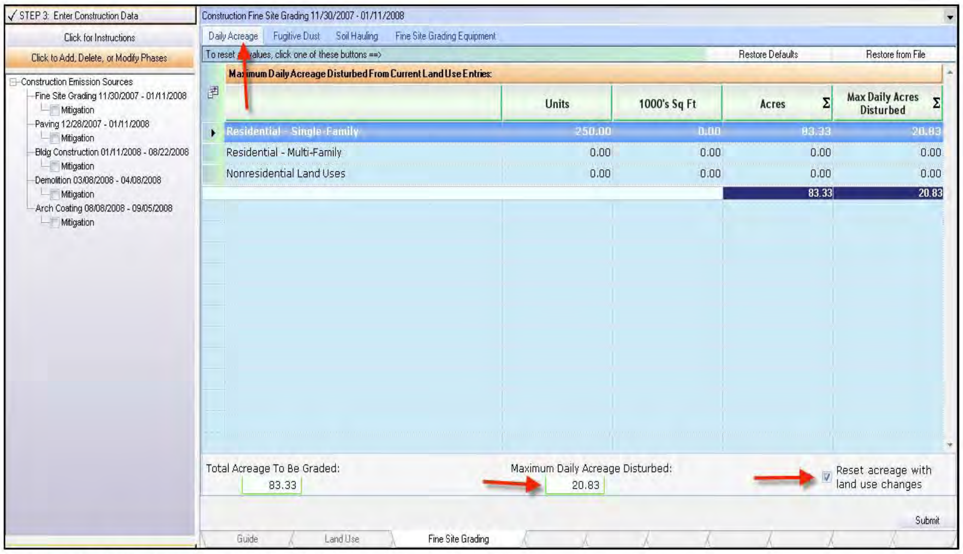

Figure 20. Construction Fine Grading

Figure 21 shows the Fine Site Grading tab. URBEMIS automatically estimates the number and type of construction equipment based on the maximum daily acreage disturbed (Daily Acreage tab). The amount of construction equipment the model uses can be overridden by the user. However, unless the box in column 1 is turned off, the amount of equipment entered by the user will change whenever the maximum daily acreage disturbed value changes. (See also Appendix H for the equipment list).

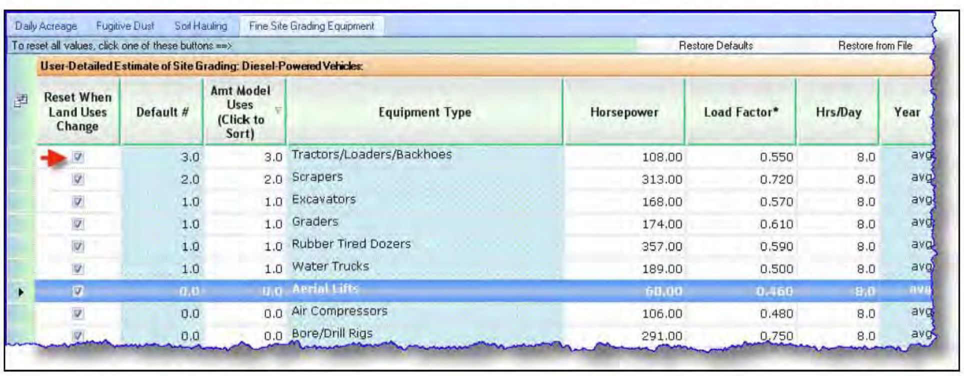

Figure 21. Fine Site Grading

Mass Site Grading

The mass site grading phase works identically to the fine site grading phase. Please refer to the fine site grading discussion above for more information.

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Trenching

Trenching typically consists of digging trenches for installation of natural gas and water pipelines, and electric conduit. If trenching is selected as a phase, URBEMIS generates estimates of trenching equipment type and number based on the amount of disturbed acreage per day. URBEMIS uses 25% of the total project acreage (as entered on the land use screens) and determines the trenching equipment use based on the equipment values shown in Appendix H.

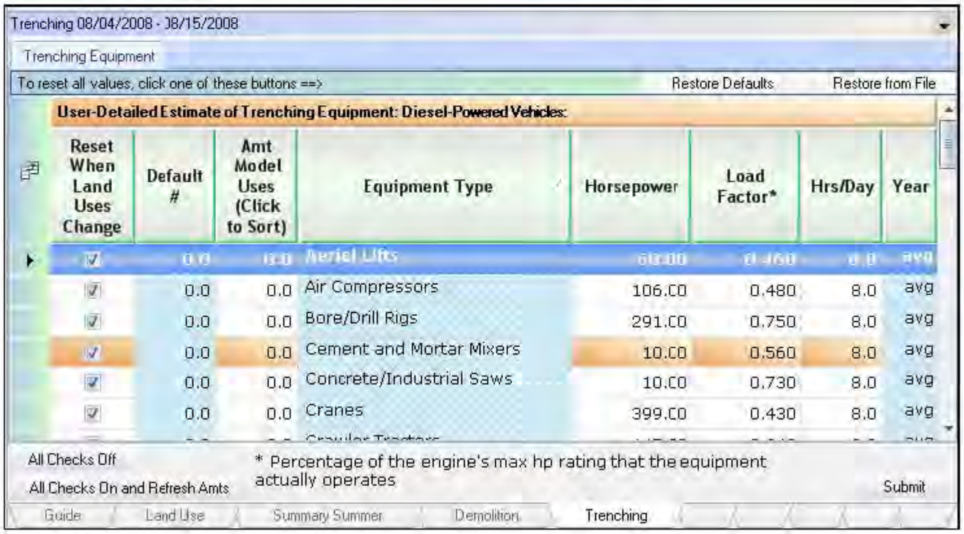

Figure 22. Trenching

Building Construction

Figure 23 shows the first tab of the building construction phase: worker trips. Two additional tabs are available, vendor trips and construction equipment. All of the values in each tab can be modified by the user. URBEMIS estimates on-road worker trips and vendor trips based on the values in these two tabs and on the land uses entered by the user.

URBEMIS uses 25% of the total project acreage (as entered on the land use screens) and determines the construction equipment use based on the equipment values shown in Appendix H.

Figure 23. Building Construction

Asphalt

URBEMIS estimates asphalt emissions associated with asphalt off-gassing, asphalt off-road and on-road equipment, and worker trips. Figure 24 shows the first tab of the two asphalt paving tabs. Circled in red is URBEMIS' best estimate of the total acreage to be paved with asphalt. That value equals 25% of the total building project acreage. This value should be overridden if a more accurate, project-specific value is available. The user should understand that, to reset the default acreage, the "Reset Acreage with Land Use Changes" value box must be unchecked. Otherwise, URBEMIS will replace the user entered number with the URBEMIS generated number whenever land uses is modified.

The user can also select the Paving Equipment tab. URBEMIS will generate estimates of paving equipment based on total acreage to be paved. As with off-road construction equipment shown in other phases such as fine site grading, URBEMIS generates estimates of construction equipment that can be overridden by the user.

Figure 24. Asphalt Paving

Architectural Coating

When the user selects architectural coatings, the VOC content for each of four coating types are displayed. The VOC content is based on architectural coatings rules that have been developed by each air district. Consequently, they cannot be modified by the user.

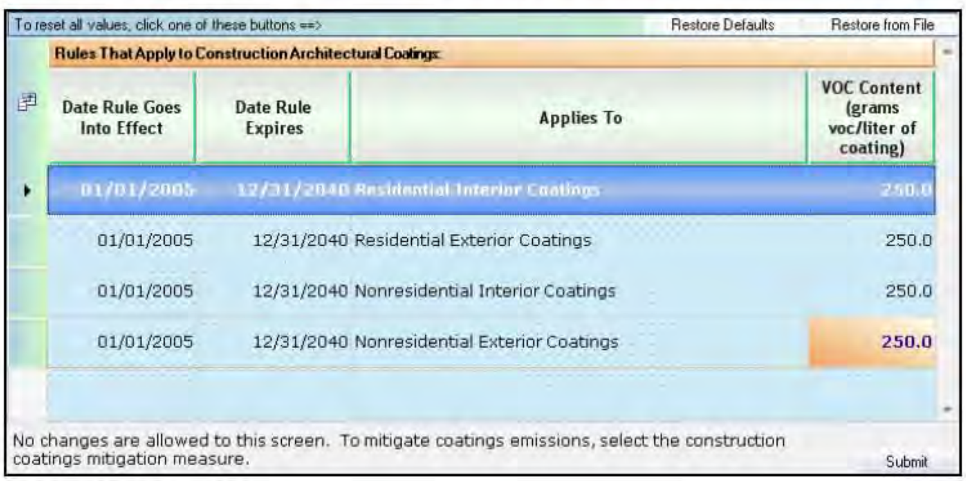

Figure 25. Architectural Coatings

Construction Mitigation Measures

Construction mitigation measures include measures to reduce fugitive dust and off-road construction emissions. URBEMIS2007 allows the user to identify specific mitigation measures for individual

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classes of construction equipment. Figure 26 shows the mitigation measures that can be selected for fine site grading. In this example, the excavator line has been checked to show the types of mitigation measures allowed for excavators. The options include use of aqueous diesel fuel, diesel particulate filters, and diesel oxidation catalysts. The user needs to turn on each mitigation measure that applies. In addition, several of the mitigation measures have drop down boxes (arrow on far right in Figure 26) that allows the user to select the stringency of each mitigation measure.

Construction Equipment Exhaust

The mitigation measure shown in Figure 26 works in the same way for all construction phases that have off-road construction equipment, which includes six of the seven phase types (does not include architectural coatings). However, the mitigation measures must be selected separately for each phase.

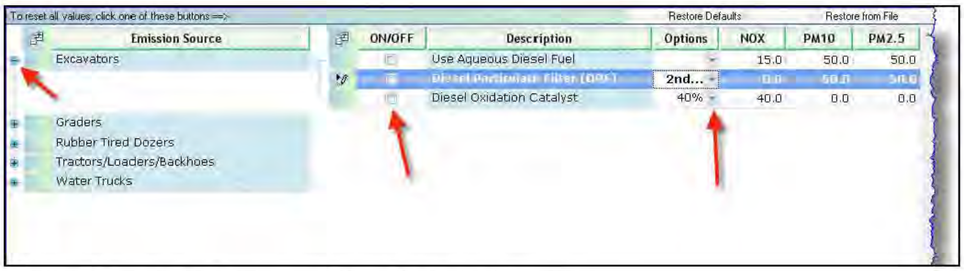

Figure 26. Construction Equipment Exhaust Mitigation Measures

Fugitive Dust Mitigation

Both fine and mass site grading also include methods to mitigated fugitive dust generated by travel on unpaved roads and by soil disturbance from off-road equipment operating on a construction site. To specify mitigation, the user needs to enter a check in on/off column for each mitigation measure that applies (see Figure 27). By clicking on the Unpaved Roads Mitigation tab, the user can also select those mitigation measures that apply.

Figure 27. Soil Disturbance Mitigation

Figure 28 shows the architectural mitigation measures screen. The user simply turns on one or more of the four percentage reductions that apply. The user can also edit the ROG percent reduction.

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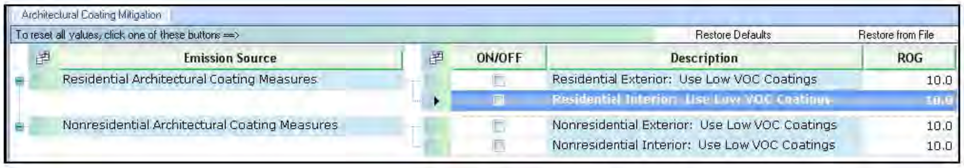

Figure 28. Architectural Coatings Mitigation

STEP 4 – Enter Area Source Data

The "Area-Source Emission" screen allows you to estimate area-source emissions for up to five categories of emission sources. Figure 29 lists those five categories in the left hand column. Three of these five categories are fuel combustion related: natural gas, hearths, and landscape maintenance. Two categories, consumer products and architectural coatings, consist of evaporative emissions. The emission factors and equations used by URBEMIS2007 to estimate area-source emissions are described in detail in Appendix B.

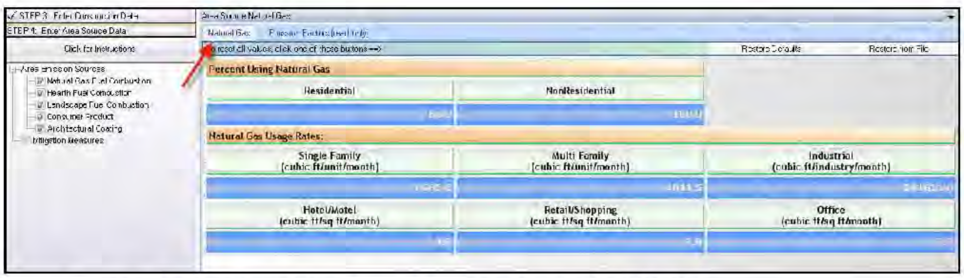

Figure 29. STEP 4 – Area Source Screen with Natural Gas Combustion Selected

Natural Gas Combustion

Figure 29 shows STEP 4 after the Natural Gas Fuel Combustion line has been selected in the left column. By double-clicking on the Natural Gas Fuel Combustion line, the screen on the right is presented. It shows the default values associated with this category. None of these values need be changed unless project specific information is available.

Hearth Fuel Combustion

Clicking on the second item in the left column, Hearth Fuel Combustion, results in the screen shown in Figure 30. URBEMIS shows the percentages of wood stoves, wood fireplaces, natural gas fireplaces associated with the project (assuming the project includes residential units). For projects that include no residential units, the Hearth Fuel Combustion category generates no emissions. The user can opt to change the percentages of the hearth categories, though they must total to 100 percent. (The user should also be aware that the hearth percentages screen looks slightly different for projects in the San Joaquin Valley. This is because the percentages are specified by the San Joaquin Valley Air Pollution Control District's wood fuel combustion rule.)

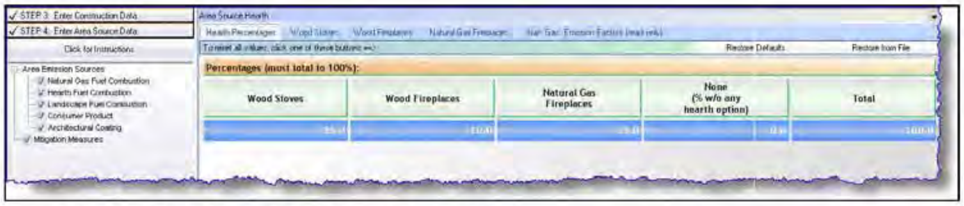

Figure 30. Area Source Hearth Fuel Combustion Screen

Wood Stoves

The Hearth Fuel Combustion category also includes additional tabs for wood stoves, wood fireplaces, natural gas fireplaces, and natural gas emission factors. Figure 31 shows the wood stoves tab. The screen shows emission factors (pounds of pollutant per ton fuel burned) by stove type, the percentage of each stove type assumed by URBEMIS, and, at the bottom of the screen, the amount of wood burned per stove each year, the number of days each stove is used, and pounds of wood per cord. All of these values except the emission factors can be modified by the user.

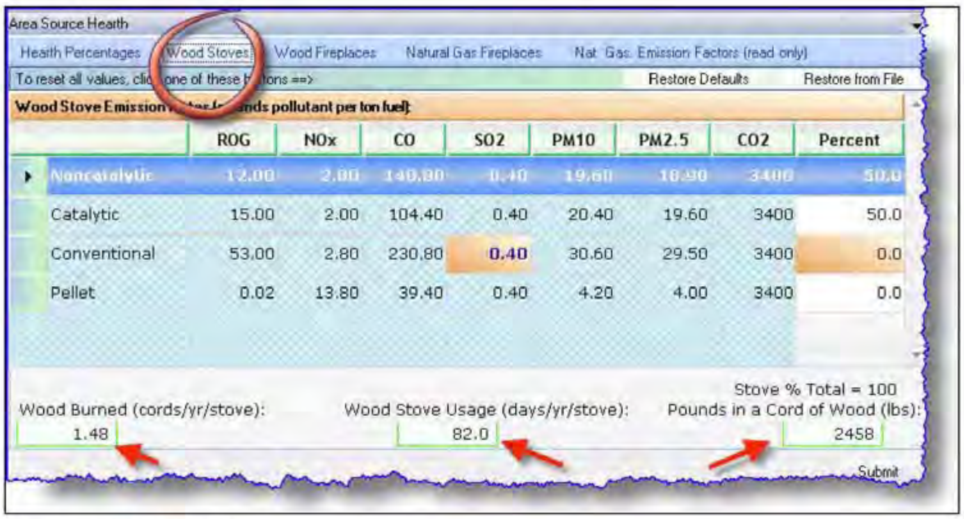

Figure 31. Wood Stoves Screen

Fireplaces

Figure 32 shows the wood fireplaces tab. It is similar to the wood stoves tab in that all of the values except the emission rates can be modified by the user. The user is cautioned about revising any of these values, however, because they represent defaults set by the individual air districts.

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Figure 32. Wood Fireplace Screen

Natural Gas Fireplaces

Figure 33 shows the natural gas fireplace tab. This screen shows the default fireplace use information for single family and multi family fireplaces. These values can be modified by the user. The natural gas fireplace emission factors, which are in the fourth tab, cannot be modified by the user.

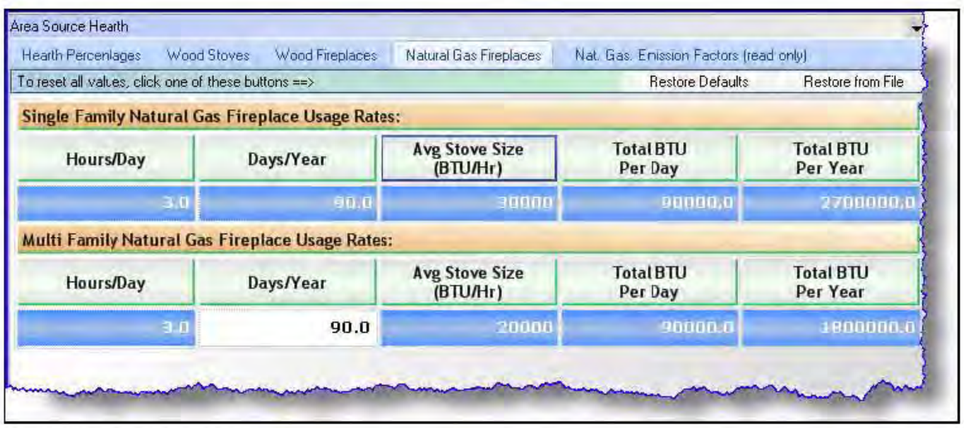

Figure 33. Natural Gas Fireplaces

Landscape Equipment Fuel Combustion

Figure 34 shows the screen when landscape equipment fuel combustion has been selected. Only one screen is available, which shows data for the length of the summer period and the year being analyzed. Landscape emissions can only be calculated for the summer period. Both of these values can be modified by the user. The year being analyzed should be consistent with the project's operational year.

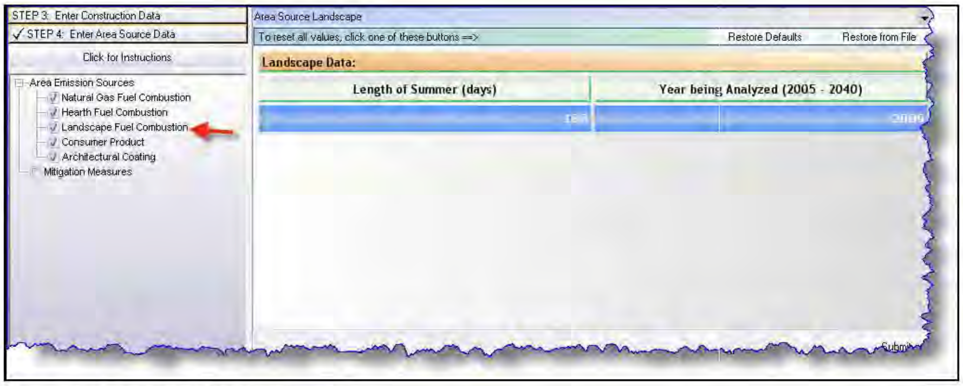

Figure 34. Landscape Fuel Combustion

Consumer Products

Figure 35 shows the consumer product screen. This screen includes the pounds of ROG emitted per person per day and the number of persons per residential unit. Consumer product emissions are only generated for residential land uses.

Figure 35. Consumer Products

Architectural Coatings

The last emission category for Step 4. Area Sources is architectural coatings. Architectural coatings is similar to architectural coatings included in construction (Phase 3), except that here a percentage of the buildings are assumed to be repainted each year. As a default, URBEMIS assumes 10% of residential and non-residential building surface area is repainted each year. These percentages can be modified by the user. The coatings rules upon which emission estimates are based, cannot be modified.

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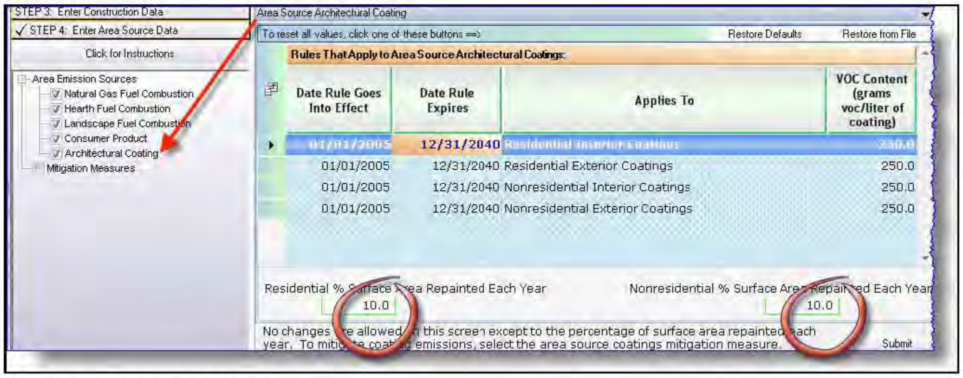

Figure 36. Architectural Coatings

Area-Source Mitigation Measures

From the "Area Source" main menu, you may select area-source mitigation measures by clicking the "Mitigation Measures" checkbox in the left pane list. This action forces URBEMIS2007 to display the area source mitigation measures in the right pane. The user can select one of three tabs in the right hand pane: Energy Efficiency, Landscape, or Architectural Coating. (A fourth tab for hearths is available for projects located within the San Joaquin Valley Air Basin.)

Energy Efficiency Mitigation

Figure 37 shows the Energy Efficiency tab. Users can turn on residential, commercial, and/or industrial energy efficiency mitigation and modify the % increase in efficiency.

Figure 37. Energy Efficiency Mitigation Measures

Landscape Maintenance Equipment Mitigation

The second tab (see Figure 38) consists of landscape maintenance mitigation measures. Users can turn on the residential and/or commercial/industrial mitigation measures and alter the percentage of applicable equipment.

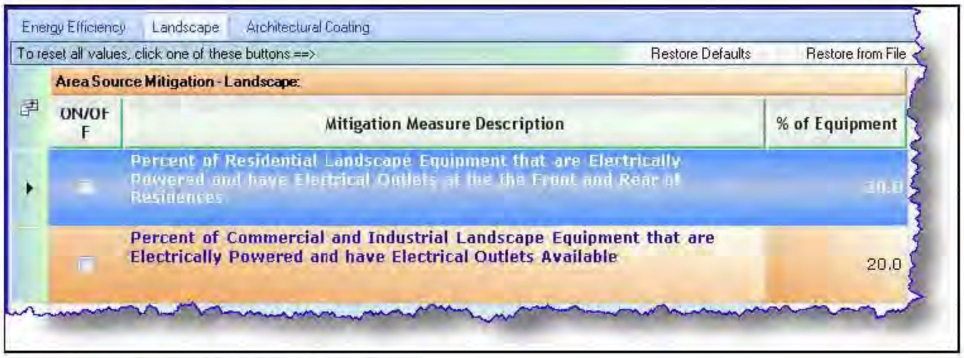

Figure 38. Landscape Mitigation Measures

Architectural Coatings Mitigation

Figure 39 shows the architectural coating mitigation tab. The user can select a % reduction of VOC for one or more of four coating types. The user can also modify the percentage reduction.

Figure 39. Architectural Coating

STEP 5 – Enter Operational Data

Step 5 involves entering operational data so as to generate estimates of on-road vehicle emissions. Figure 40 shows Step 5 in the left hand pane. Under Step 5, seven lines are listed under Operational Emission Sources, ignoring Mitigation Measures. Clicking on the first of those seven lines, Year & Vehicle Fleet, results in the screen shown on the right in Figure 40.

The user should be sure that the project start year is correct (see arrow in Figure 40). Changing the project start year also changes the fleet mix. URBEMIS uses the fleet mix information included in the EMFAC2007 files to generate the fleet mix estimates. For example, if the user changes the project start year to 2020 (and the project is in Los Angeles County), then URBEMIS goes to the 2020 Los Angeles County EMFAC file to obtain the average fleet mix for that location and year. For certain project types, the user may want to use a fleet mix that differs from the average vehicle fleet mix. For example, a project may consist of an industrial land use with 80 percent heavy-heavy duty truck trips. In that situation, the user should click on the check mark to the right of the year. That check box reads "Keep Current Fleet Mix When Changing Years". If that check box is turned on, then URBEMIS will not update the fleet mix hat a user has entered if the user opts to change the year.

For each vehicle type, there are three fuel/technology classes: non-catalyst (gasoline), catalyst (gasoline), and diesel. Within the right pane, you can modify any of the fleet percentages or fuel/technology classes. The total fleet percentage must total to 100. Also, for each vehicle type, the three fuel/technology classes must subtotal to 100 percent.

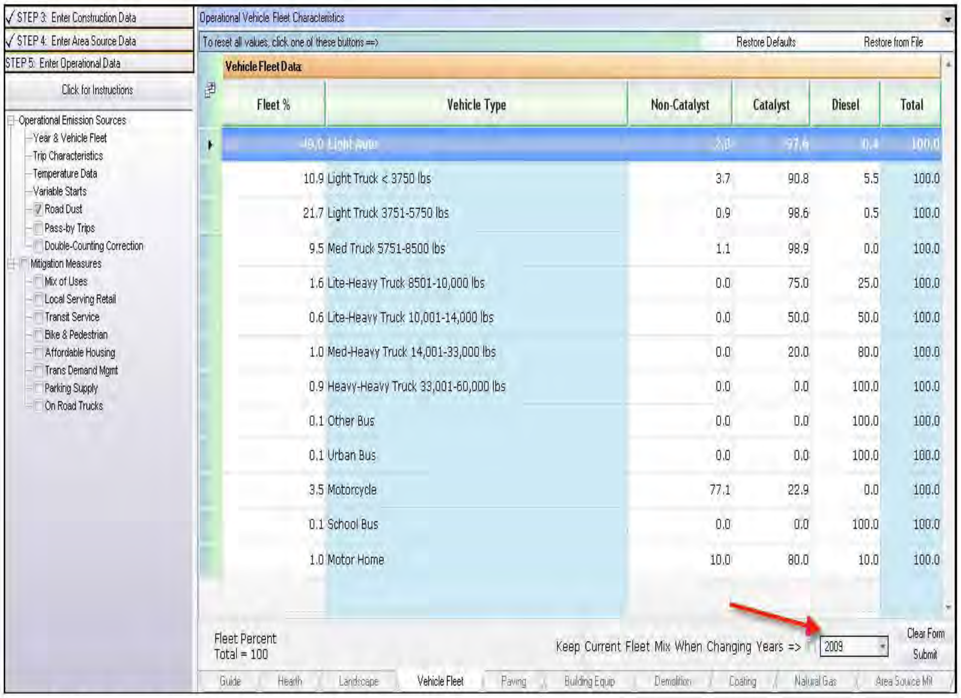

Figure 40. Operational Emissions Entry Screen

Trip Characteristics

The "Trip Characteristics" screen can be modified by clicking on the "Trip Characteristics Settings" node in the left pane. This action displays the trip characteristics in the right pane. Several pieces of information are contained in the "Trip Characteristics" screen: average trip speeds, trip percentages, and trip lengths for six different trip types (home-based work trips, home-based shopping trips, home-based other trips, work trips, commercial-based non-work trips, and commercial-based customer trips) (see Figure 41). The trip characteristics screen also includes an urban/rural project checkbox in the lower left hand corner. URBEMIS uses the urban trip lengths if the urban project check box is turned on, rural trip lengths if the rural project box is checked.

Note that the "Trip Characteristics" screen allows you to enter the trip percentages for home-based trips, which must total 100 percent. However, this same screen does not permit you to enter trip percentages for commercial-based trips. Instead, commercial-based percentages are calculated separately by URBEMIS2007 for each nonresidential land use selected in the "Land Use" screens.

The "% Worker Commute" information from the land use screens corresponds to the commercial-based commute work trip value. The commercial-based commute trip percentage is then used to estimate commercial-based non commute work trip and customer based trip percentages for each land use. If the commercial-based commute trip value exceeds 50 percent, then the commercial-based non commute trip percentage equals 100 percent minus the commute trip percentage, multiplied by 50 percent. If the commercial-based commute trip value is less than 50 percent, then the commercial-based non commute trip percentage equals one half of the commercial-based commute trip value. Finally, for each land use, customer based trips are assumed to equal the 100 percent minus the total of the commercial commute and non commute percentages.

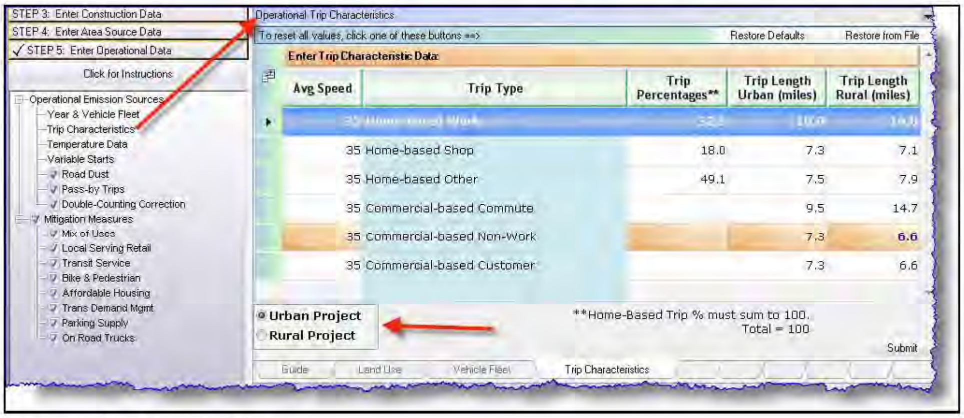

Figure 41. Trip Characteristics

Temperature Data

By clicking on the temperature data in the left pane, temperature options are presented in the right pane. You have the option of modifying both winter and summer ambient temperatures, which are used to estimate winter and summer emission estimates and which correspond to the summer versus winter gasoline specifications used in California outside of the South Coast Air Basin (greater Los Angeles).

Variable Starts

You may modify the "Variable Starts" information by clicking on the "Variable Starts" settings button shown in the left pane. This action causes URBEMIS2007 to display variable starts information in the right pane. That screen includes information on "Variable Start Percentages by Trip Type and Time since Engine Stopped". EMFAC2007 requires the vehicle engine shut-off percentages for 18 time increments, ranging from 5 minutes to 720 minutes. The information provided in this screen by trip type represents statewide averages of pre-start cool-down profiles from an ARB analysis of the 1991 California Department of Transportation household travel survey. These percentages should not be modified unless better information is available.

Road Dust

You may turn the Road Dust option on or off by clicking the check box in the left pane. This action will also display in the right pane information on "Entrained Road Dust Emissions". You have the option to modify the distribution of travel between paved and unpaved roads. You also have the option to modify the paved road or unpaved road defaults by clicking on the accompanying tabs.

If you click on the "Change Paved Road Defaults..." tab, you are taken to the "Paved Road Dust Emissions" screen. From within that screen, you may modify the default emission factors and percentage of travel for each of four road types.

You may also click on the "Change Unpaved Road Defaults" tab, where URBEMIS2007 will display the "Unpaved Road Dust Emissions" screen. From this screen, you can select either the U.S. EPA methodology for calculating emissions or you can use the California Air Resources Board's emission factor. If you select the U.S. EPA methodology, you are allowed to modify one or more of the five variables used to estimate unpaved road dust emissions.

Pass-by Trips

You may select the "Pass-By Trips" button from the left pane list. When you select "Pass-By Trips", no optional information is presented in the right pane. Selecting the "Pass-By Trips" button allows URBEMIS2007 to calculate emissions from vehicle trips that are generally lower than estimates without the pass-by trip option. The pass-by trip algorithm is described in Appendix C.

Double Counting

Another option available to URBEMIS2007 users is to adjust for double-counting.. The double-counting adjustment is designed to reduce double counting of internal trips between residential and nonresidential land uses. Consequently, selecting this option is available only when you have selected both residential and nonresidential land uses. You must click the check box in the left pane where URBEMIS2007 displays the "Double Counting Correction".

Then you are shown the number of residential and nonresidential trips that would be generated based on the land uses selected (see example in Figure 42). You are given the option of entering the number of internal trips between residential and nonresidential land uses. The value entered represents the number of internal trips that will not be included in the emissions estimate. This value can often be obtained from a traffic report prepared for the project.

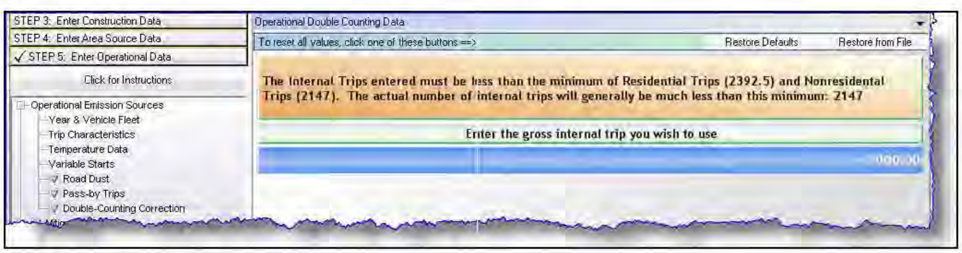

Figure 42. Double Counting Correction

Operational Mitigation Measures

Operational mitigation relies on a variety of smart growth measures that reduce the number of vehicle trips. From within STEP 5, you have the option of turning on operational mitigation measures by selecting one or more of eight optional "Mitigation Measures" options in the left pane (see Figure 43):

- Mix of uses
- Local serving retail
- Transit use
- Bike and pedestrian
- Affordable housing
- Transportation demand management
- Parking supply; and
- On-Road Trucks

Each of these is briefly described below. A much more detailed description is included in Appendix D.

Mix of Uses Mitigation

Figure 43 shows the Mix of Uses screen when the Mix of Uses line has been selected in the left hand pane. The following procedure is used to adjust trip generation rates as a function of the mix of land uses for any particular project.

*Trip reduction = (1- (ABS (1.5 * h e) / (1.5 * h + e)) 0.25) / 0.25 * 0.03*

Where: h = study area households (or housing units)
e = study area employment.

This formula assumes an "ideal" housing balance of 1.5 jobs per household and a baseline diversity of 0.25. The maximum possible reduction using this formula is 9%. Negative reductions of up to 3% can result when the housing to jobs ratio falls to levels less than the baseline diversity of 0.25. This reduction takes into account overall jobs-population balance.

The number of households or housing units and employment should be based on the area located within a 1/2 mile radius of the project's center.

In the example shown in Figure 43, the user has entered 500 residential uses located within ½ of the proposed project (which includes the 250 units from the project) and a study area employment of 750.

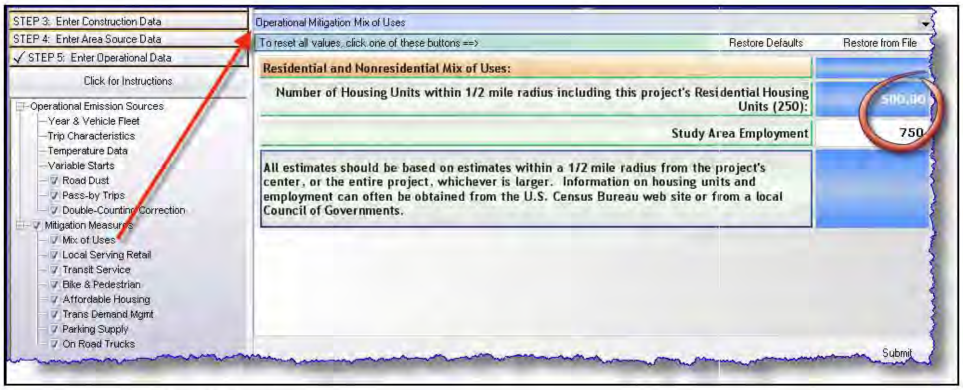

Figure 43. Mix of Uses Mitigation

Operational Local Serving Retail Mitigation

The presence of local serving retail can be expected to bring further trip reduction benefits, and an additional reduction of 2% is assumed. This is towards the lower end of the values presented in the research, in order to avoid double counting with the diversity indicator.

Operational Transit Mitigation

The Transit Service Index emphasizes frequency but with greater weighting given to rail services. Greater weight is also given to dedicated shuttles, in recognition of the fact that these are likely to be more closely targeted to the needs of the development. Information on transit availability and frequency can be obtained from transit agency maps and schedules.

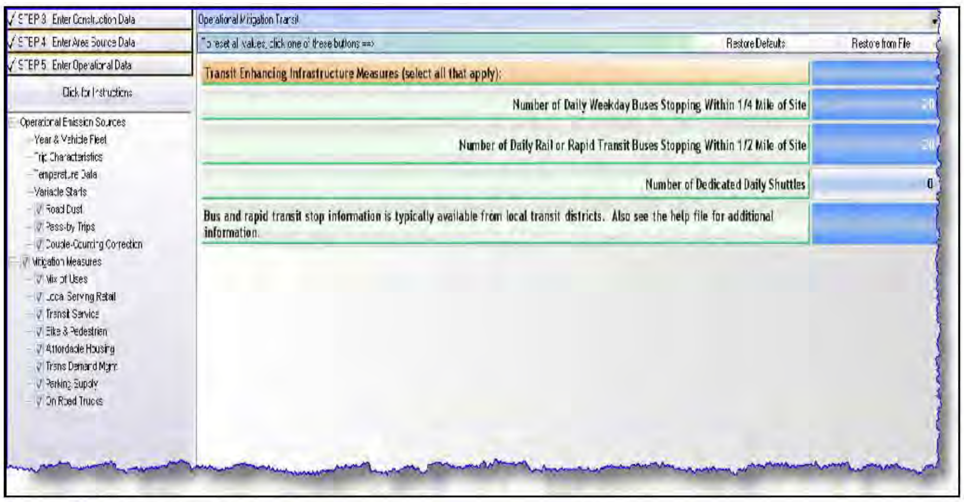

Figure 44. Transit Mitigation

The Transit Service Index is determined as follows:

- Number of average daily weekday buses stopping within 1/4 mile of the site; plus
- Twice the number of daily rail or bus rapid transit trips stopping within 1/2 mile of the site; plus
- Twice the number of dedicated daily shuttle trips;
- Divided by 900, the point at which the maximum benefits are assumed. (This equates to a BART station on a single line, plus four bus lines at 15-minute headways.)

Developments that are larger than 0.5 miles across in any direction must be broken into smaller units for purposes of determining the transit service index. The average of all units would then be used.

The figure shown below provides some examples of how service frequencies translate into Transit Service Index scores (note these are additive, if a location has more than one component).

Example Transit Service Index Scores

Transit Service	Score	Assumptions
BART (single line)	0.33	150 trips per day (15-20 minute headways in each direction from 4 AM-12 AM)
15-minute bus	0.17	4 buses per hour
30-minute bus	0.06	2 buses per hour
Amtrak San Joaquin	0.03	6 trips per day in each direction
Dedicated commute shuttle	0.02	5 trips per commute period (single direction)

As well as existing service, planned and funded transit service should be included in the calculation. Purely demand responsive service should not be included. A maximum trip reduction of 15% is assumed.

To account for non-motorized access to transit, half the reduction is dependent on the pedestrian/bicycle friendliness score. This ensures that places with good pedestrian and bicycle access to transit are rewarded.

*Trip reduction = t * 0.075+ t * ped/bike score * 0.075*

Where: t = transit service index

Operational Bike and Pedestrian Mitigation

Figure 45 shows the bike and pedestrian mitigation screen. The user must enter information on the project's number of intersections per square mile, the percent of streets with sidewalks on one or both sides, and the percent of arterials/collectors with bike lanes.

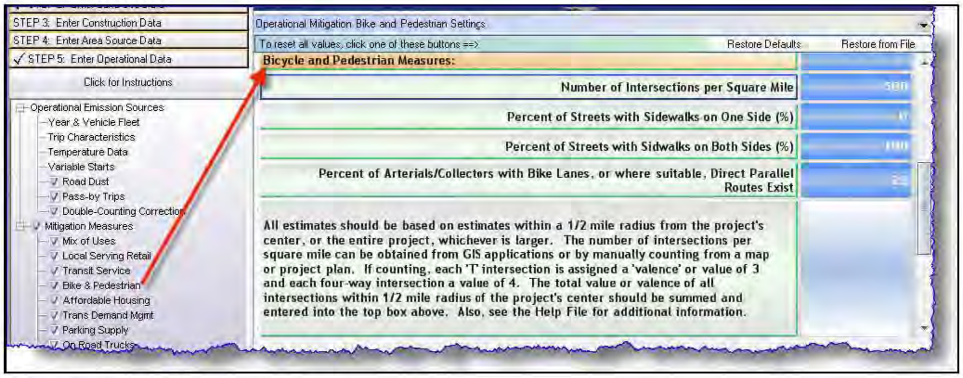

Figure 45. Bike and Pedestrian Mitigation

The pedestrian/bicycle factor is calculated as follows:

Ped/bike factor = (network density + sidewalk completeness + bike lane completeness) / 3

Where: Network density = intersections [sum of valences] per square mile / 1300 (or 1.0, whichever is less)

Note: In most GIS applications, intersections are counted based on the number of line segment terminations, or each "valence." Intersections have a valence of 3 or higher. A valence of 3 is a "T" intersection, 4 is a four-way intersection. Therefore, if intersections are counted manually on a map or project plan, care needs to be taken to distinguish between 3-, 4- and 5-way intersections, and factor them up accordingly. The 1,300 value roughly equates to a dense grid with four-way intersections every 300 feet. Intersections with dedicated routes for pedestrians and/or bicyclists should be included in this calculation.

*Sidewalk completeness = % streets with sidewalks on both sides + 0.5 * % streets with sidewalk on one side*

Bike lane completeness = % arterials and collectors with bicycle lanes, or where suitable, direct parallel routes exist

A maximum reduction of 9% is assumed. The trip reduction is calculated as:

*Trip reduction = 9% * ped/bike factor*

No reduction is allowed if the entire area within a half-mile walk of the project center consists of a single use. (Note that this applies to a half-mile walk, rather than straight-line distance, to account for barriers such as freeways.) However, the ped/bike factor can still be used to calculate pedestrian access to transit, as part of the transit mitigation measure.

Information on the number of intersections can be obtained from street plans or maps. Information on sidewalk completeness and bike lane completeness can be obtained from site observations or from

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aerials such as those obtainable from http://terrraserver.microsoft.com or from Google's Google Earth software.

Operational Affordable Housing Mitigation

It is difficult if not impossible to account for the exact incomes of residents in URBEMIS, most obviously because the occupants are not known at the pre-development stage. However, the percentage of deed-restricted below-market-rate (BMR) housing does offer a way to incorporate this effect.

URBEMIS assumes a 4% reduction in vehicle trips for each deed-restricted BMR unit. Thus, the total reduction is as follows:

*Trip reduction = % units that are BMR * 0.04*

A development with 20% BMR units would thus gain a 0.8% reduction. A development with 100% BMR units would gain a 4% reduction.

Operational Transportation Demand Management

Figure 46 shows the first of three transit demand management screens: parking and transit passes. Figures 47 and 48 show the remaining two screens, telecommuting, and other transportation demand measures.

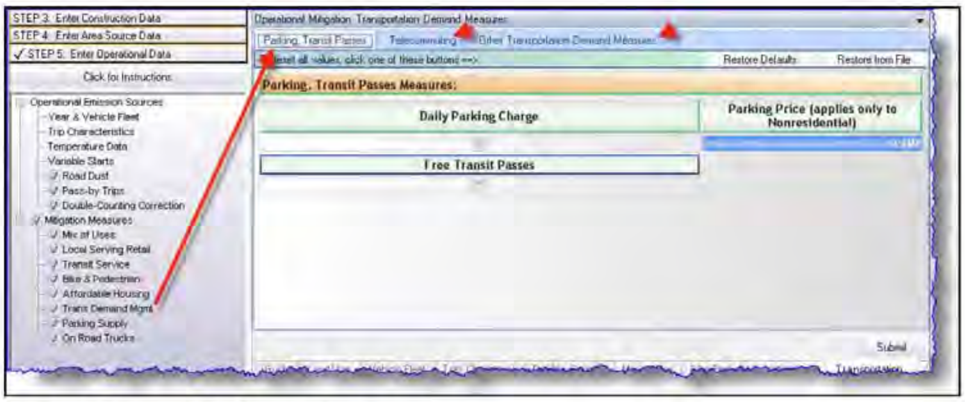

Figure 46. Transportation Demand Management

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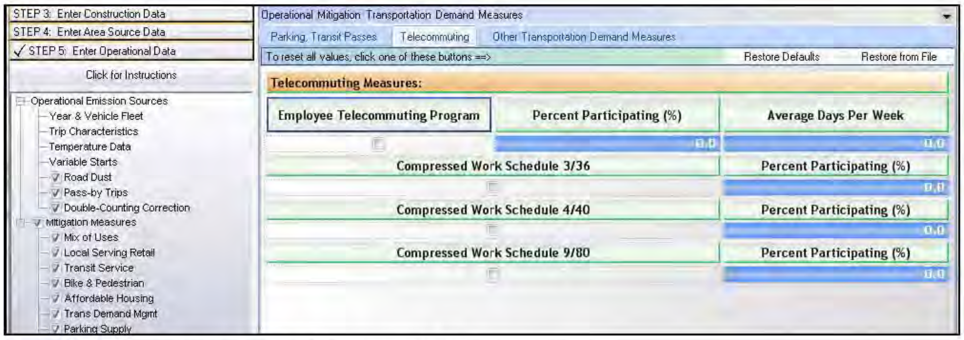

Figure 47. Transportation Demand Management – Telecommuting

Figure 48. Transportation Demand Management – Other Transportation Demand Measures

Daily Parking Charge

URBEMIS assumes a maximum trip reduction of 25% for projects that commit to introducing parking pricing. The maximum reduction applies to prices of $6 per day or greater (in 2004 dollars).

The trip reduction will therefore be as follows:

$$\textit{Trip reduction} = \textit{daily parking charge} / 6 * 0.25$$

If the parking charge is more than $6, the 25% reduction is taken. If parking charges do not apply to all trips to a site (e.g. customers are exempt), the reduction is pro-rated by the percentage of trips that the charges apply to. If little or no on-site parking is provided, the parking charges are applied to those of surrounding public facilities.

Free Transit Passes
Some California transit agencies, most notably VTA in Santa Clara County, have EcoPass or similar programs, whereby employers or property managers bulk-purchase transit passes for (free) distribution to their employees or tenants. Eco Pass programs have been shown to increase transit ridership by 50-79% and reduce vehicle trips by 19%. (Note that many of these new riders were making new trips, or ones previously made by walking or cycling.)

We therefore recommend that any project committing to providing free transit passes would receive an additional credit equivalent to 25% of the reduction granted for transit service. Thus, the credit is more valuable in places that have good transit service. This reduction only applies to the portion of trips generated by those granted the free transit passes (e.g. residents and/or employees, but excluding shoppers and other visitors).

Telecommuting
As with the reductions for other mitigation measures, there must be an enforceable commitment (e.g. development agreement) for telecommuting programs, which cover both the take-up rate (employees actually telecommuting or using compressed work schedules) as well as the provision of the option.

The percentage reduction is not additive (in contrast to most other trip reduction measures). For example, if 20% of employees telecommute, and other trip reduction measures are estimated to reduce vehicle trips from 1,000 to 800 per day, the 20% reduction is applied to the 800 trips, not the original 1,000.

Other TDMs
Other TDM program elements that do not include financial incentives tend to have a smaller impact on travel behavior. Trip and associated emission reductions for other TDMs selected within URBEMIS are based on the number of the following elements incorporated into the program.

- Secure bicycle parking (at least one space per 20 vehicle parking spaces)
- Showers/changing facilities
- Guaranteed Ride Home
- Car-sharing services
- Information on transportation alternatives, such as bus schedules and bike maps
- Dedicated employee transportation coordinator
- Carpool matching programs
- Preferential carpool/vanpool parking

The impact of a TDM program also depends on the travel alternatives available. A program will have more impact if the site is served by frequent transit, for example (although note that a TDM program can do much to promote carpooling even in other locations). For this reason, part of the TDM credit is used to adjust the credits granted for transit service and pedestrian/bicycle friendliness (see table below).

Recommended TDM Program Reductions

Level	Number of Elements	Trip Reduction
Major	At least 5 elements	2%, plus 10% of the credit for transit and pedestrian/bike friendliness
Minor	At least 3 elements	1%, plus 5% of the credit of transit and pedestrian/bike friendliness
No program	Less than 3	None

Operational Parking Supply Mitigation

The parking supply mitigation measure uses the Institute of Transportation Engineers Parking Generation, 3rd Edition handbook as the baseline. It applies only to non-residential land uses. The trip reduction is calculated as follows:

*Trip reduction = 1- (Actual parking provision / (ITE Parking Generation rate * # units)*

Since ITE parking generation rates use the same land use codes as the trip generation rates, URBEMIS calculates the ITE estimated values of parking demand. The user is only required to enter the actual parking provision for each land use.

The Parking Generation handbook covers most common land uses. For some land uses, however, no parking generation rates are available: in these cases, this particular mitigation measure may not be used. Those land uses without parking generation rates include:

- City Park
- Gas/Service Station

To avoid double counting with other trip reduction measures, the impacts of parking supply are assessed in conjunction with all other non-residential trip reduction measures as follows:

The total of all other non-residential trip reduction measures is used if this is greater than or equal to the trip reduction from parking supply measures. For example, if parking supply is reduced 10% from ITE levels, and transit, mixed use and pedestrian/bicycle trip reductions amount to 20%, the 20% figure is used.

If the total of all other non-residential trip reduction measures (r1) is less than the trip reduction from parking supply measures (r2), the total trip reduction is as follows:

$r1 + 0.5 * (r2 - r1)$

In effect, the parking supply reduction is only used if it is greater than the impact from other trip reduction measures, and the difference is discounted by 50%. For example, if parking supply is reduced 25% from ITE levels, and transit, mixed use and pedestrian/bicycle credits amount to 15%, the total reduction would be:

$15 + 0.5 * (25\text{-}15) = 20\%$.

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This reduction should only be granted if measures to control overspill are in place, such as Residential Permit Parking programs, time limits or meters.

Operational On-Road Truck Mitigation

For project applicants wishing to provide on-road mitigation for diesel trucks, the applicant has two choices.

The first choice requires that the user enter an estimate of the pounds per day and tons per year emission reductions associated with the project. This information will typically be provided as a result of consultation with the applicable air district. The district-approved emission reductions should be entered into the operational mitigation: on-road trucks screen.

The second choice requires that the user select a mitigation measure by diesel truck (or bus) fleet type category. This mitigation measure will only be applied to truck trips associated with non-residential land uses and only to the non-commute portion of those trips. Each mitigation measure has a specific emission reduction percentage applied to it. The user also has the option of entering their own mitigation and the associated emission reduction by pollutant class (ROG, NOx, CO, SO2, and PM10). The percentage reductions are only applied to the percentage of diesel vehicles within each truck class.

STEP 6 – View and Print Output

As mentioned earlier, to view and print output in Step 6, you do not need to proceed through each proceeding step. Instead, once you have entered one or more land uses, the Recalc button appears at the top of the screen (see Figure 49). This button, in the form of a dirty cloud, should be clicked to generate emission estimates. Once the Recalc button has been pressed, URBEMIS generates emission estimates that appear as part of Step 6 (see Figures 50 and 51).

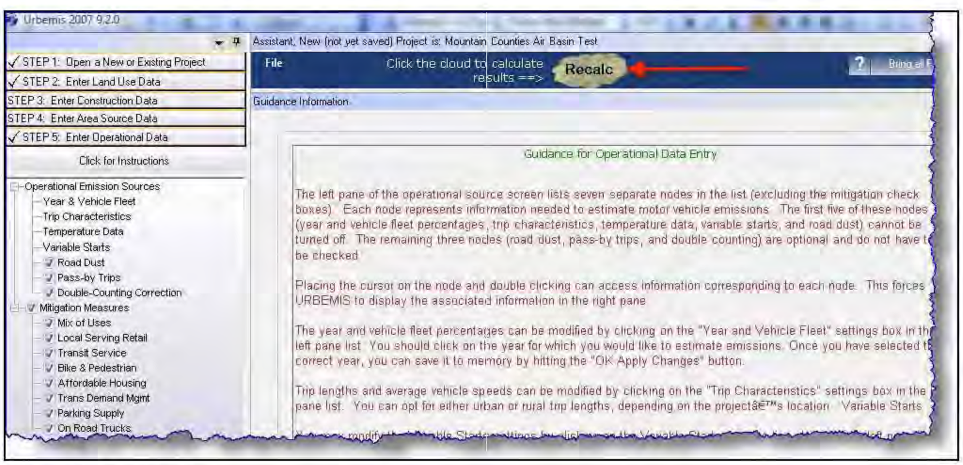

Figure 49. Recalc Button

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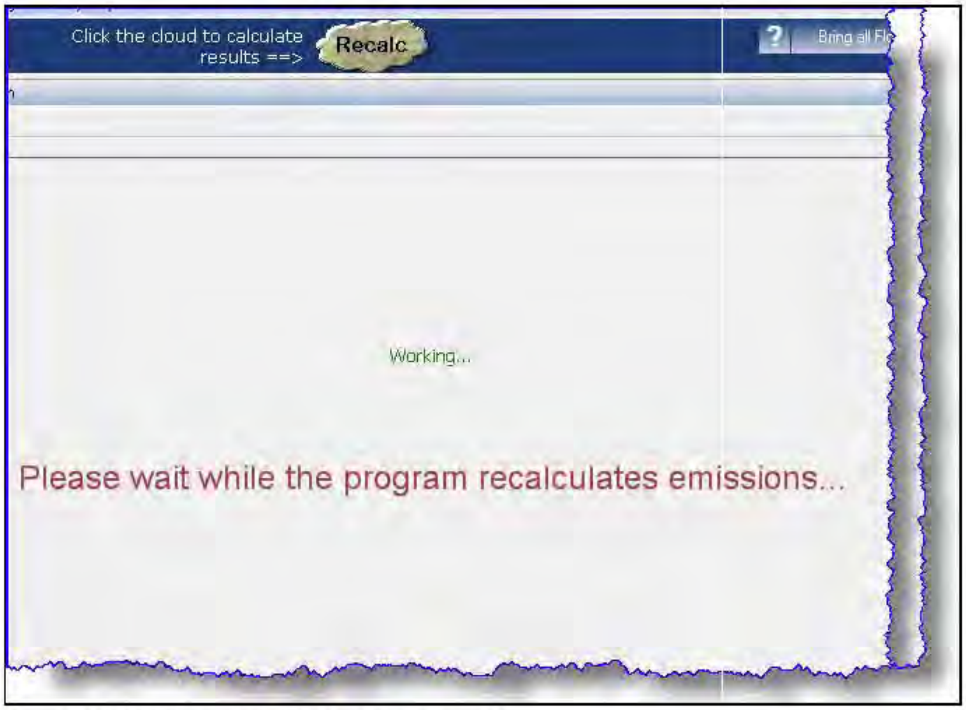

Figure 50. URBEMIS Recalculating After Recalc Pressed

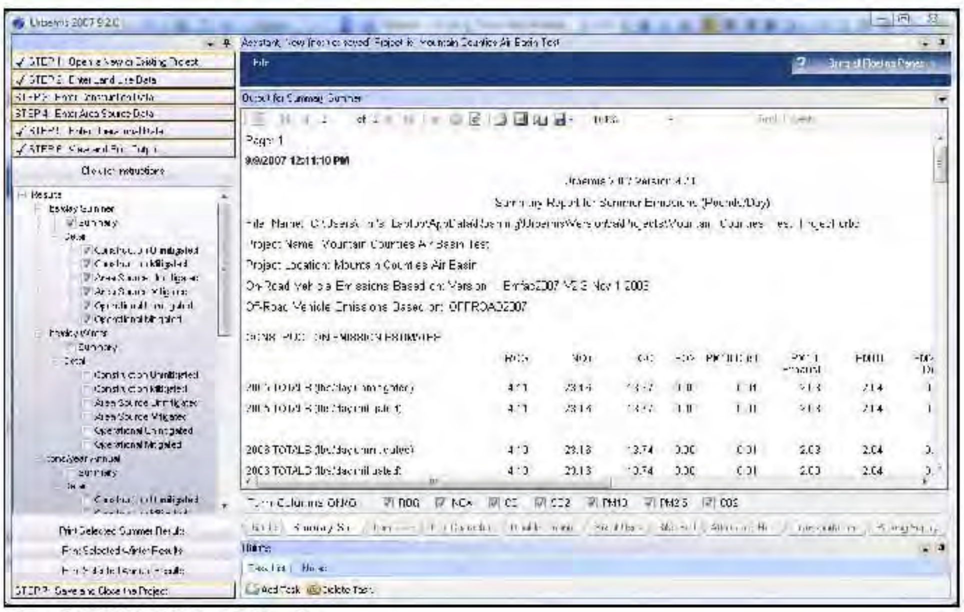

Figure 51. URBEMIS Recalc Results

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As Figure 51 shows, when the Recalc button has been pressed, URBEMIS generates emission estimates and automatically shows the Summer summary results in the right hand pane. Double-clicking on any of the print results lines in the left hand pane forces URBEMIS to calculate emissions for that option. For example, if you click on the Construction Unmitigated line under lbs/day Winter, URBEMIS displays winter construction emissions in the right hand pane.

Figure 52 shows winter construction emissions. In this example, all pollutants except ROG, NO, and CO2 have been turned off. Pollutant can be turned off by unchecking them, as shown in the bottom of Figure 52 in the highlighted area. Also, the first time slice has been expanded by clicking the plus sign to the left of time slice. In addition, the asphalt phase in that time slice has been expanded to show the individual components of asphalt emissions (see red arrows in highlighted area). Time slices are described in detail in Appendix A.

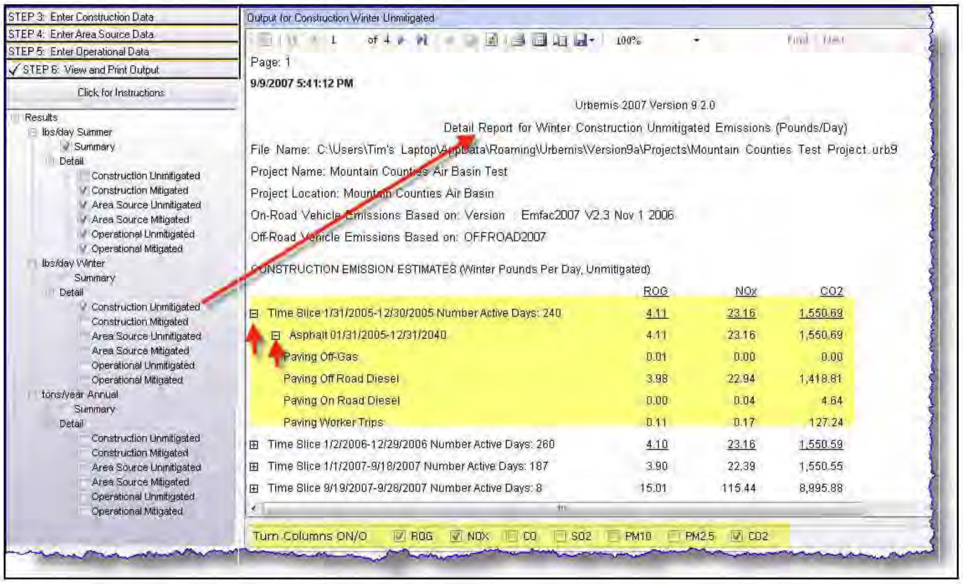

Figure 52. Winter Construction Emissions Results

URBEMIS also allows the user to send one or more of the items checked in the left hand pane to a single report that will be shown in the right hand pane. Three separate reports can be run: summer, winter, and annual. Figure 53 shows printing of the selected summer results. All of the summer emission categories have been checked (highlighted area). Then the Print Selected Summer Results button was clicked, which generated the report in the right hand pane.

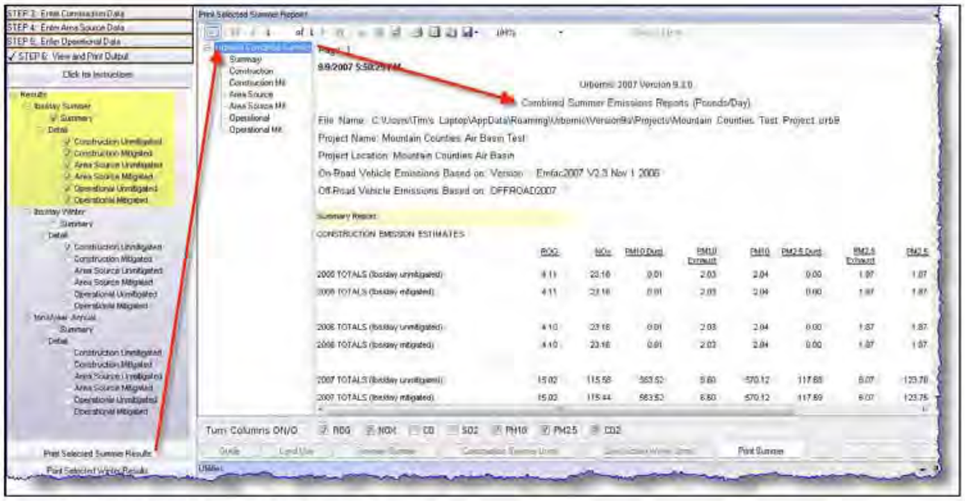

Figure 53. Combined Summer Emission Results

Printing Reports

Once a report has been generated and is displayed in the right hand pane, it can be sent to a printer, to an Excel file, or to a PDF file. Figure 54 illustrates how to print a report. First, click on the printer icon, shown circled. This will pop up the print window, which allows you to select a printer destination. Please note that you cannot print to a text file with URBEMIS2007. Once you have selected your printer destination and printer preferences (such as two sided printing), you must hit the apply button, then the print button.

Excel or PDF Reports

Although URBEMIS2007 does not allow a report to be sent to a text file, you can send it to either a PDF or Excel file by selecting the blue diskette icon, denoted with a arrow in the top line of Figure 54.

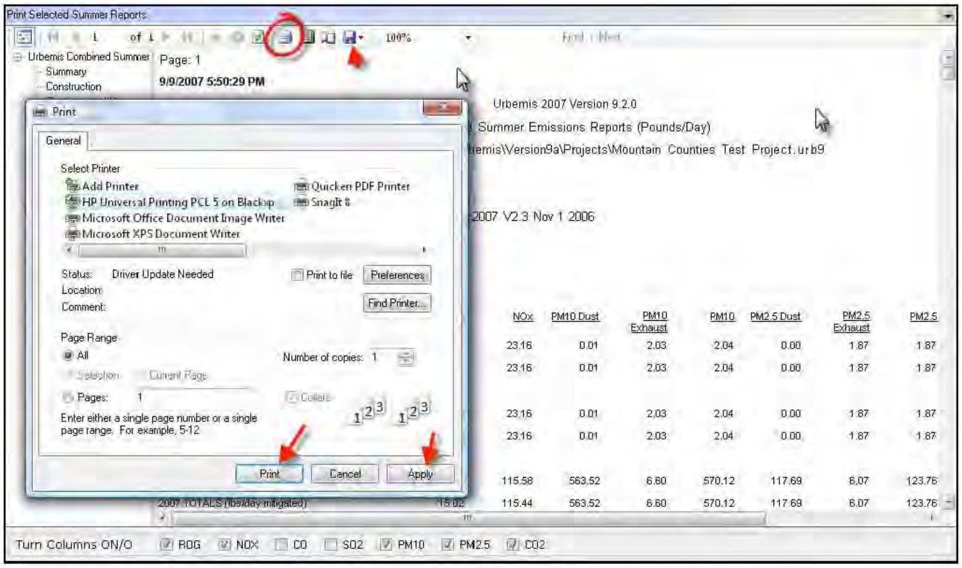

Figure 54. Printing a Report

STEP 7 – Save and Close the Project

Saving and/or closing a project is straightforward in URBEMIS2007. Clicking on Step 7 – Save and Close the Project results in the screen shown in Figure 55. A project can be saved with the current name, as a different project (with different name), or URBEMIS can be closed and exited. If you opt to close the project and you have turned on the "Save on Closing, Without a Prompt", then URBEMIS will save the current project with the current project name. Also, if you opt to just "X" out of the program by hitting the x in the top right hand corner of the program, the project will automatically be saved with the current project name.

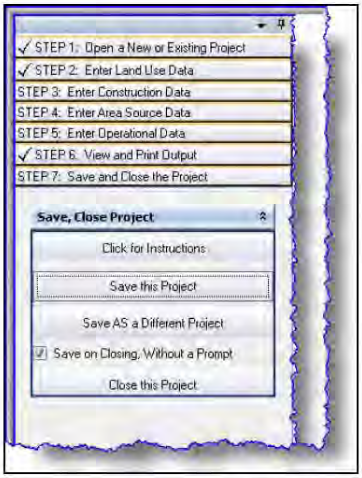

Figure 55. Saving and Closing a Project

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Appendix A. Construction Emissions

TABLES

Introduction

URBEMIS2007 allows users to generate estimates of construction emissions (inhalable particulate matter [PM10], fine particulate matter [PM2.5], carbon monoxide [CO], reactive organic gases [ROG], sulfur oxides [SOx], oxides of nitrogen [NOx]), and carbon dioxide [CO_2]. Emissions can be estimated as pounds per day or tons per years. The construction pounds per day estimates for summer versus winter do not differ.

URBEMIS includes seven phases:

1) Demolition
2) Fine Site Grading
3) Mass Site Grading
4) Trenching
5) Building Construction
6) Architectural Coating
7) Paving

Emissions are estimated separately by phase and by phase component. The user can opt to estimate emissions for any single phase or combination of phases. Each phase can be scheduled to overlap with other phases or to occur independently. Each independent grouping of emissions is called a time slice. When starting a new project, URBEMIS automatically assumes that specific phases would be used and assumes the start and end dates for each phase. Those phases can be deleted, and/or their start and end dates can be modified. Also, additional phases can be added.

Two or more phases of the same type can be added. For example, two demolition phases can be added, but each must have a unique set of start and end dates. As mentioned earlier, each phase has several components. Each of those components is assumed to generate emissions throughout the entire phase length. The seven phases and their associated components are identified in Table A-1.

Table A-1. URBEMIS Default Construction Phases, Phase Lengths, and Equipment Estimates

Phase	Off-Road Fugitive Dust	Off-Road Constructi on Exhaust	On-Road Vehicle Exhaust	Worker Trips	Vendor Trips	Off-Gassing
Demolition	X	X	X	X		
Mass Site Grading	X	X	X	X		
Fine Site Grading	X	X	X	X		
Trenching		X		X		
Asphalt		X	X	X		X
Building Construction		X	X	X	X	
Architectural Coatings				X		X

Table A-1 shows the phases and their individual components. There are six unique components that include:

- off-road fugitive dust,
- off-road construction equipment,
- on-road exhaust,
- worker trips,
- vendor trips and
- off-gassing.

Six of the seven phases include off-road construction emissions. Only architectural coatings do not include emissions from off-road construction equipment. All seven phases include emissions associated with worker trips.

Time Slices

A time slice represents a period of days when daily emissions are constant. A different time slice occurs whenever there is a change in a project's average daily emissions. This most typically happens when two phases overlap but can also occur when the same phase crosses over into a different year.

Table A-2 shows three separate time slices. The first time slice of nine active days results when trenching occurs without any other construction activities. The second time slice of six active days occurs when trenching and fine site-grading overlap. Emissions for this second time slice are the combination of fine grading and trenching. The third time slice of 14 days occurs when fine site grading occurs without any other construction activities.

Table A-2. Time Slice Example

Construction Unmitigated Detail Report:

CONSTRUCTION EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

	ROG	NOx	CO	SO2	PM10 Dust
Time Slice 11/19/2007-11/29/2007 Active Days: 9	1.52	15.78	4.65	0.00	0.00
Trenching 11/19/2007-12/08/2007	1.52	15.78	4.65	0.00	0.00
Time Slice 11/30/2007-12/7/2007 Active Days: 6	23.44	219.33	109.68	0.00	49,721.62
Fine Grading 11/30/2007-01/11/2008	21.92	203.55	105.03	0.00	49,721.62
Trenching 11/19/2007-12/08/2007	1.52	15.78	4.65	0.00	0.00
Time Slice 12/10/2007-12/27/2007 Active Days: 14	21.92	203.55	105.03	0.00	49,721.62
Fine Grading 11/30/2007-01/11/2008	21.92	203.55	105.03	0.00	49,721.62

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Each phase within a time slice contains individual components that make up that phase. The procedure used to estimate emissions for each component of each phase is described below.

Demolition Emissions

Demolition Dust

If the user chooses to estimate construction emissions, the user will be prompted to select the types of construction emissions that they would like to estimate. If the user selects demolition emissions, then the user is prompted to enter the total volume of all buildings to be demolished and the maximum volume of all buildings to be demolished in a single day. URBEMIS2007 calculates the total days required to complete demolition activities.

The following equation is used to estimate daily PM10 generated by demolition:

*PM10 (pounds/day) = (0.00042 pounds of PM10 / feet3) * (N * O * P) / Q.*

Where: N = building width (feet)
O = building length (feet)
P = building height (feet)
Q = number of days required to demolish the building(s).

This equation is based on Table A9-9-H of the South Coast Air Quality Management District's (SCAQMD's) California Environmental Quality Act (CEQA) Air Quality Handbook (South Coast Air Quality Management District 1993).

URBEMIS2007 does not provide default information on building dimensions slated for demolition. The user must provide URBEMIS2007 with that information.

Demolition On-Road Diesel Exhaust

URBEMIS estimates exhaust emissions from the construction equipment used in demolition, including the on-road vehicles used to haul demolished materials to the nearest landfill. Based on information provided by the user regarding the building volume to be demolished, URBEMIS generates default information regarding demolition hauling. The user can override that information.

For example, URBEMIS assumes a hauling round trip of 20 miles and a truck capacity of 20 cubic yards unless overridden by the user. Similarly, URBEMIS generates a default estimate of the number of round trips required per day using the following equation:

*Round trips/day = Total yd^3 to be demolished/days demolition * 0.25 * trip/20 yd^3*

The user must enter total cubic yards to be demolished. The number of days required for demolition is calculated using the demolition phase length entered by the user. The number

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of round trips per day and the vehicle miles traveled per day are based on the maximum daily volume of material to be demolished (reduced by 75% to account for air space), the truck capacity, and the miles per round trip. Maximum daily emissions are obtained from EMFAC2007 and are estimated by multiplying VMT by the grams per mile emissions for heavy-heavy duty trucks traveling at the commercial customer average speed found in the Operational Trip Characteristics screen.

Demolition – Off Road Diesel Exhaust

In addition to truck hauling, demolition emissions are generated by the operation of other construction equipment, such as concrete saws, cranes, and bulldozers. The URBEMIS user is presented with a list of construction equipment, as shown in Table A-3. Default values for these types of equipment are generated by URBEMIS using information found in the equipment selection spreadsheet shown in Appendix H. The user can and should override the default values if project specific information is available.

Table A-3. Construction Equipment Used for Demolition

To reset all values, click one of these buttons ==> Restore Defaults Restore from File

User-Detailed Estimate of Site Grading: Diesel-Powered Vehicles:

Reset When Acreage Changes	Default #	Amt Model Uses (Click to Sort)	Equipment Type	Horsepower	Load Factor*	Hrs/Day	Year
☑	0.0	0.0	**Aerial Lifts**	60.00	0.460	8.0	avg
☑	0.0	0.0	Air Compressors	[illegible]	[illegible]	[illegible]	avg
☑	0.0	0.0	Bore/Drill Rigs	291.00	0.750	8.0	avg
☑	0.0	0.0	Cement and Mortar Mixers	10.00	0.560	8.0	avg
☑	0.0	0.0	Concrete/Industrial Saws	10.00	0.730	8.0	avg
☑	0.0	0.0	Cranes	399.00	0.430	8.0	avg
☑	0.0	0.0	Crawler Tractors	147.00	0.640	8.0	avg
☑	0.0	0.0	Crushing/Processing Equip	142.00	0.780	8.0	avg
☑	0.0	0.0	Dumpers/Tenders	16.00	0.380	8.0	avg
☑	0.0	0.0	Excavators	168.00	0.570	8.0	avg
☑	0.0	0.0	Forklifts	145.00	0.300	8.0	avg
☑	0.0	0.0	Generator Sets	549.00	0.740	8.0	avg
☑	0.0	0.0	Off Highway Tractors	267.00	0.650	8.0	avg
☑	0.0	0.0	Off Highway Trucks	479.00	0.570	8.0	avg
☑	0.0	0.0	Other Equipment	190.00	0.620	8.0	avg

☑	0.0	0.0	Other General Industrial	238.00	0.510	8.0	avg
☑	0.0	0.0	Other Material Handling	191.00	0.590	8.0	avg
☑	0.0	0.0	Pavers	100.00	0.620	8.0	avg
☑	0.0	0.0	Paving Equipment	104.00	0.530	8.0	avg
☑	0.0	0.0	Plate Compactors	8.00	0.430	6.0	avg
☑	0.0	0.0	Pressure Washers	1.00	0.600	8.0	avg
☑	0.0	0.0	Pumps	53.00	0.740	8.0	avg
☑	0.0	0.0	Rollers	95.00	0.560	8.0	avg
☑	0.0	0.0	Rough Terrain Forklifts	93.00	0.600	8.0	avg
☑	0.0	0.0	Rubber Tired Loaders	164.00	0.540	8.0	avg
☑	0.0	0.0	Scrapers	313.00	0.720	8.0	avg
☑	0.0	0.0	Signal Boards	15.00	0.780	8.0	avg
☑	0.0	0.0	Skid Steer Loaders	44.00	0.550	8.0	avg
☑	0.0	0.0	Surfacing Eqipment	362.00	0.450	8.0	avg
☑	0.0	0.0	Sweepers/Scrubbers	91.00	0.680	8.0	avg
☑	0.0	0.0	Trenchers	63.00	0.750	8.0	avg
☑	0.0	0.0	Welders	45.00	0.450	8.0	avg
☑	1.0	1.0	Graders	174.00	0.610	6.0	avg
☑	1.0	1.0	Rubber Tired Dozers	357.00	0.590	6.0	avg
☑	1.0	1.0	Tractors/Loaders/Backhoes	108.00	0.550	7.0	avg
☑	1.0	1.0	Water Trucks	189.00	0.500	8.0	avg

For each piece of equipment selected, URBEMIS generates an emission estimate. The emission equation used by URBEMIS for each piece of equipment is as follows:

Equipment Emissions (pounds/day) = # of pieces of equipment * grams per brake horsepower-hour * equipment horsepower * hours/day * load factor

***Where:** grams per brake-horsepower hour is based on the construction year and represents a statewide average for each piece of equipment. Grams per brake horsepower per hour emissions are based on the California Air Resources Board's OFFROAD2007 model (California Air Resources Board, 2006). The pounds per day emission factors are found in Appendix I.*

Demolition Worker Commute Trips

Demolition worker commute trips assume that the number of workers equals 125% of the total pieces of construction equipment selected. The emission estimates assume a construction worker commute fleet mix of 50% light duty autos and 50% light duty trucks. The worker commute travel distance, speed, and temperature are based on the worker commute speed information included in the Operational Trip Characteristics screen.

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Fine Site Grading Emissions

Fine Site Grading Fugitive Dust

The fugitive dust emission estimates within URBEMIS2007 use the methodology developed for SCAQMD by the Midwest Research Institute. That four-tiered methodology allows for more refined PM10 estimates based on the level of detail known for the construction project. URBEMIS estimates emissions using the level of detail known for a project, as shown in Table A-4.

Table A-4. Fugitive Dust Estimation Approach

Basis for Emission Factor	Recommended PM10 Construction Emission Factor
Default Level: Only area and duration known	Apply 0.22 tons/acre-month (average conditions)[1] Apply 0.42 ton/acre-month (worst-case conditions)
Low Level of Detail: Area and amount of earthmoving known	Apply 0.11 ton/acre-month for each month of construction activity Plus 0.059 ton/1,000 yd^3 of onsite cut/fill Plus 0.22 ton/1,000 yd^3 of offsite cut/fill These values assume that one scrapper can move 70,000 yd^3 of earth in one month and 35,000 yd^3 of material can be moved by truck in one month. If the on-/offsite fraction is not known, assume 100% onsite.
Medium Level of Detail: More detailed information available on duration of earthmoving and other material movement	Apply 0.13 lb/acre-work hr Plus 49 lb/scraper-hr for onsite haulage Plus 94 lb/hr for offsite haulage
High Level of Detail: Detailed information known on acres, hours or construction work, number of truck units or VMT, and truck travel distances.	Apply 0.13 lb/acre-work hr Plus 0.21 lb/ton-mile for onsite haulage Plus 0.62 lb/ton-mile for offsite haulage

A key component of the site grading dust emissions is the maximum acreage that will be disturbed on a daily basis. URBEMIS2007 estimates default acreage graded per day based on the land use sizes specified by the user. URBEMIS assumes the following number of residential units per acre:

- single-family residential units – 3
- low rise apartments and condos/townhouse units – 16
- mid rise apartments – 38
- high rise apartments – 62
- high rise condos – 64

[1] The Midwest Research Institute has derived a value of 0.11 tons/acre/month, which converts to 10 pounds per day, assuming 22 workdays per month. The California Air Resources Board review has reviewed this factor and concluded that it represents PM10 emissions with watering. Consequently, ARB concludes that 20 pounds per acre day is more appropriate for unmitigated fugitive dust conditions (http://www.arb.ca.gov/ei/areasrc/fullpdf/full7-7.pdf)

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- mobile home parks – 6
- retirement community – 5
- congregate care (assisted living) – 16.

For commercial uses, URBEMIS2007 assumes that the total project acreage equals twice the size of each building's square footage. For example, URBEMIS2007 assumes that a 100,000-square-foot industrial park would require 200,000 square feet (4.6 acres) of land disturbance. As a default estimate, URBEMIS2007 assumes that 25% of total land acreage slated to be disturbed will actually be disturbed on the worst-case day.

URBEMIS provides the user with a form similar to that shown in Table A-5. The user has the option of modifying URBEMIS' estimates of the maximum acreage to be disturbed per day.

In the example shown in Table A-5, a project that includes 1200 units of single-family residential, 600 units of multi-family residential, and 100,000 square feet of commercial development will result in a total estimated acreage of 399.15 acres. Assuming that 25% of that total acreage is graded on the worse case day, the maximum acreage disturbed equals 99.84 acres. The user has the option of overriding the maximum daily disturbed. This acreage is important, because URBEMIS bases its estimates of both fugitive dust and construction equipment on the maximum daily acreage disturbed value.

Table A-5. Acreage Estimates for Grading

Land Use	User-Entered Values	Estimated Acreage	Estimated Maximum Acreage Disturbed per Day
Residential—Single Family	1200 units	370	92.5
Residential—Multi-family	600 units	24.55	6.14
Commercial	100,000 sq. ft.	4.6	1.2
Totals	Not applicable	399.15	99.84

Fine Site Grading Equipment Off-Road Diesel Exhaust

Site grading emissions are generated by the operation of off-road construction equipment, such as scrapers, bulldozers, and loaders. URBEMIS presents the user with a list of construction equipment, as shown previously in Table A-3. The user has the option of either selecting the number of each type of equipment that will be used or having URBEMIS generate estimates of construction use.

To estimate off-road construction equipment-related construction exhaust emissions, URBEMIS uses an approach based on ARB's OFFROAD2007 emissions model (California Air Resources Board, 2006). That model uses a methodology in which emission factors for construction equipment are based on an average fleet mix that accounts for the turnover rate and average emissions for specific types of construction equipment. URBEMIS generates default values and allows the user to override the defaults for equipment horsepower and load factors.

For each piece of equipment selected, URBEMIS generates an emission estimate. The emission equation that will be used by URBEMIS for each piece of equipment is as follows:

*Equipment Emissions (pounds/day) = # of pieces of equipment * grams per brake horsepower-hour * equipment horsepower * hours/day * load factor*

Where: grams per brake-horsepower hour is based on the construction year and vehicle type. Grams per brake horsepower per hour emissions are from the California Air Resources Board's (ARB's) OFFROAD2007 model (California Air Resources Board 2007). Appendix I lists the grams per horsepower hours for each year and each type of equipment.

Fine Site Grading On-Road Diesel Exhaust

One additional enhancement to URBEMIS' treatment of grading equipment exhaust involves specifying whether the project will require soil to be imported to or exported from the site. If soil is to be imported or exported, the user must to enter the volume of soil. URBEMIS will use that information to calculate the number of on-road vehicle trucks trips and vehicle miles traveled per day (as shown in Table A-6). The user has the option of overriding the default assumptions programmed into URBEMIS.

Table A-6. Construction Grading Soil-Hauling Assumptions

Soil Import/Export Hauling	Parameter
Amount of soil to import (cubic yards)	0
Amount of soil to export (cubic yards)	0
Total soil imported + exported (cubic yards)	0
Haul-truck capacity (cubic yards)	20
Number of days to conduct hauling	Based on phase length
Round trips/day	Calculated
Round-trip distance (miles)	Calculated
Vehicle miles traveled/day (calculated)	Calculated

Once vehicle miles traveled per day is known, URBEMIS calculates haul-trip emissions using the following formula:

*On-Road Haul Truck Emissions (pounds/day) = vehicle miles traveled/day * grams pollutant/mile (from EMFAC2007) * pound/454 grams*

Fine Site Grading Worker Commute Trips

For site grading, the number of workers is estimated as 125% of the total number of construction equipment (vehicles and machines) selected. The emission estimates assume a construction worker commute fleet mix of 50% light duty autos and 50% light duty trucks. The worker commute travel distance, speed, and temperature are based on the trip characteristics information for home to work trips found under the trip characteristics node of the operational emissions module.

Mass Site Grading

Mass Site Grading works in a manner similar to fine site grading. Mass site grading typically differs from fine site grading in that it applied to larger grading acreages. Each of the descriptions for the mass site grading components below is similar to those for fine site grading.

Mass Site Grading Fugitive Dust

The fugitive dust emission screen allows the user to select from one of four levels. The fugitive dust emission levels are based on a report prepared for the South Coast Air Quality Management District (Midwest Research Institute, 1996). The mass site grading fugitive dust calculations used by URBEMIS are identical to those used in the fine site grading fugitive dust calculations as described above and shown in Table A-4.

Mass Site Grading On-Road Diesel Exhaust

The amount of on-road emissions associated with soil hauling site grading is based on the amount of material that must be imported to and/or exported from site, the distance that trucks must travel, and haul truck capacity. URBEMIS includes default values for truck capacity (cubic yards) and round trip mileage, both of which can be modified by the user. The number of round trips per day and the vehicle miles traveled per day (VMT) are based on the maximum daily volume of material to be demolished, the truck capacity, and the miles per round trip. Maximum daily emissions are obtained from EMFAC2007 and are estimated by multiplying VMT by the grams per mile emissions for heavy heavy-duty trucks traveling at the commercial-based customer average speed found in the trip characteristics screen.

Mass Site Grading Off-Road Diesel Exhaust

Mass site grading off-road exhaust emissions are calculated based on equipment that the user must select from 36 equipment types. The user can enter the number of pieces of equipment to be used, and can edit default values for horsepower, load factor, and hours per day. The load factor is the percentage of time that the equipment is in use during the typical construction day. Based on the information entered by the user, emissions are estimated by multiplying by the grams per horsepower hour for the respective equipment. The equation for each equipment type is as follows:

*Emissions (pounds per day) = Pieces of Equipment * hp * load factor * hours per day * grams/hp-hr * pounds / 454 grams*

The grams per horsepower hour values, listed in Appendix I, vary by construction year. The construction emission rates found in the default file are based on the California Air Resources Board's OFFROAD2007 emissions model (California Air Resources Board, 2006).

Mass Site Grading Worker Commute Trips

Worker trips are estimated separately by each of the three construction phases. For site grading, the number of workers is estimated as 125% of the total number of construction equipment (vehicles and machines) selected. The emission estimates assume a construction-worker commute fleet mix of 50% light duty autos and 50% light duty trucks. The worker commute travel distance, speed, and temperature are based on the trip characteristics information for home to work trips found under the trip characteristics node of the operational emissions module.

Trenching

Trenching Off-Road Diesel

Off-road trenching exhaust emissions are calculated based on 36 equipment types that can be selected. The user can enter the number of pieces of equipment to be used, and can edit default values for horsepower, load factor, and hours per day. The load factor is the percentage of time that the equipment is in use during the typical construction day. Based on the information entered by the user, emissions are estimated by multiplying by the grams per horsepower hour for the respective equipment. The equation for each equipment type is as follows:

*Emissions (pounds per day) = Pieces of Equipment * hp * load factor * hours per day * grams/hp-hr * pounds / 454 grams*

The grams per horsepower hour values vary by construction year (see Appendix I) and are based on the California Air Resources Board's OFFROAD2007 model (California Air Resources Board, 2006).

Trenching Commute Trips

Construction trenching worker trip emissions are estimated by assuming that the number of workers equals 125% of the total number of construction equipment selected. The emission estimates assume a construction worker commute mix of 50% light duty autos and 50% light duty trucks. The worker commute travel distance and speed are based on the trip characteristics for home to work trips found under the trip characteristics node of the operational emissions module.

Building Construction

Building Construction Off-Road Diesel Exhaust

Building construction emissions consist of emissions from construction equipment. Table A-3 lists equipment that can be selected for building construction. The number and type of equipment can vary substantially, depending on the type of building and its location. The amount of concrete, masonry, wood, and metal products used in building construction varies widely, and can have a large impact on the type of construction equipment needed for a construction project.

Building Construction Worker Commute Trips

Emissions from construction worker vehicle commute trips are estimated by multiplying total daily employee vehicle miles traveled (VMT) by an emission rate (grams per mile). URBEMIS2007 estimates construction-related employee trip generation as follows. Each land use type selected as part of the project is grouped into one of four general land use categories: multifamily, single-family, commercial/retail, and office/industrial. Then, for each category, the number of trips is estimated using the following equations:

Multifamily Trips = 0.36 trips/unit * number of units
Single-Family Trips = 0.72 trips/unit * number of units
Commercial or Retail Trips = 0.32 trips/1,000 feet² * number of 1,000 feet²
Office or Industrial Trips = 0.42 trips/1,000 feet² * number of 1,000 feet²

These trip generation rates are based on information contained in the Sacramento Metropolitan Air Quality Management District's Air Quality Thresholds of Significance Handbook (Sacramento Metropolitan Air Quality Management District (1994).

URBEMIS2007 totals trips from the four general land use categories and multiplies by the average trip length to obtain daily VMT. Trip length is found under the trip characteristics tab of the operational emissions module of URBEMIS. URBEMIS2007 uses the construction year identified by the user to select EMFAC emission rates that will be multiplied by VMT/day.

Building Construction Vendor Trips

Vendor trips represent the on-road trips needed to bring building supplies to the worksite. URBEMIS estimates construction related vendor trips using the following trip generation rates:

Multifamily Construction Vendor Trips = 0.11 trips/unit * number of units
Single-Family Construction Vendor Trips = 0.11 trips/unit * number of units
Commercial or Retail Construction Worker Trips = 0.05 trips/1,000 feet² * number of 1,000 feet²
Industrial Construction Worker Trips = 0.38 trips/1,000 feet² * number of 1,000 feet²

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These trip generation rates are based on information provided by the Sacramento Metropolitan Air Quality Management District. URBEMIS2007 totals trips from the four general land use categories and multiplies by the average trip length to obtain daily VMT. Trip length is based on the urban trip length found for commercial-based customer trips in the Operational Trip Characteristics screen. URBEMIS2007 uses the construction year in which the trips would occur and the trip speed for home to work trips to identify the appropriate EMFAC emission rates to use. Vendor trips are assumed to consist of 100% heavy heavy-duty trucks.

Vendor trip rates can be overridden if the actual number of total vendor trips is known.

Architectural Coatings

Off-Gas Emissions

URBEMIS72007 estimates ROG emissions resulting from the evaporation of solvents contained in paints, varnishes, primers, and other surface coatings. Separate procedures are used to estimate evaporative emissions from application of residential and nonresidential architectural coatings. The following emission factors are used for residential coating emissions:

Emission estimates are divided into four categories:

- residential interior,
- residential exterior,
- non-residential interior, and
- non-residential exterior.

For each of these four categories, each air district has specified an average VOC content. These VOC content limits may change as district rules become more stringent. The user cannot alter these VOC content limits as each air district has specified them. The statewide average is assumed to be 250 grams VOC per liter of paint. For each category of paint, VOC content is converted to an emission factor in pounds VOC per square feet of paint applied by assuming a coating coverage of 180 square feet per gallon.

The following equation is estimated for each of the four categories to obtain an emission factor in pounds of VOC (or ROG) per square foot:

*ROG (pounds / square feet) = (grams VOC per liter paint / 454 grams per pound * 3.785 liters per gallon / 180 square feet per gallon).*

Then, the square feet to be painted is estimated for each of the four categories as follows:

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Residential

*Square feet interior square footage to be coated = ((Number of single-family units * square feet per unit) + (Number of multi-family units * square feet per unit)) * 2.7)) * 0.75*

*Square feet exterior square footage to be coated = ((Number of single-family units * square feet per unit) + (Number of multi-family units * square feet per unit)) * 2.7)) * 0.25*

The value 2.7 in each equation is used to convert total building square footage to surface area to be coated. As these equations indicate, 75% of total residential coatings assumed to be interior and 25% exterior.

URBEMIS assumes 1800 square feet per single-family residential unit and 850 square feet per multi-family residential unit.

Non-Residential

*Non residential interior square footage to be coated = ((Total building square footage * 2.0) * 0.75*

*Non residential exterior square footage to be coated = ((Total building square footage * 2.0) * 0.25*

The value 2.0 in each equation is used to convert non-residential building square footage to surface area to be coated. As these equations indicated, 75% of total non-residential coatings assumed to be interior and 25% exterior.

Total Emissions

To obtain total emissions, emissions for each of the four categories must be calculated by multiplying the emission factor per square feet times the total square footage for that category. Once emissions have been estimated for each of the four categories, the total emissions must be summed up over the four categories, providing total emissions. That value is then divided by the total number of days that coatings are applied to obtain an average daily emission estimate.

Architectural Painting Worker Commute Trips

Worker commute trips associated with architectural painting are assumed to equal 20 percent of worker commute trips for building construction. Consequently, architectural coating emissions from worker commute trips will equal approximately 20 percent of building construction worker commute trip emissions.

Asphalt Paving

Asphalt Paving Off-Gas Emissions

URBEMIS2007 estimates ROG emissions associated with asphalt paving. The emissions are estimated based on the procedure identified in the SMAQMD manual (Sacramento Metropolitan Air Quality Management District 1994). ROG emissions are estimated using the following formula:

*ROG (pounds per day) = (2.62 pounds ROG / acre) * (total acres paved /paving days)*

Asphalt Paving Off-Road Diesel Exhaust

Unless overridden by the user, URBEMIS assumes that 25% of the total project area will be paved. URBEMIS generates an estimate of the number and types of equipment based on the acreage to be paved. See Appendix H for the types of equipment assumed to be used by URBEMIS for paving.

The user can override URBEMIS' estimates of the equipment to be used, and can edit default values for horsepower, load factor, and hours per day. The equation for each equipment type is as follows:

*Emissions (pounds per day) = Pieces of Equipment * hp * load factor * hours per day * grams/hp-hr * pounds / 454 grams*

The grams per horsepower hour values vary by construction year. The construction emission rates are based on the California Air Resources Board's OFFROAD2007 model (see Appendix I).

Asphalt Paving On-Road Diesel Exhaust

URBEMIS estimates vehicle miles traveled per day for asphalt hauling using information entered by the user regarding acreage to be paved per day. Using that information, URBEMIS estimates the total volume per day of asphalt required by multiplying acreage by an assumed asphalt thickness of 3 inches (Asphalt Institute, 2002). The asphalt volume is then used to estimate the number of truck trips, assuming a truck volume capacity of 20 cubic yards. Vehicle miles are estimated based on the number of truck trips, and haul emissions are estimated using the following equation:

*On-Road Asphalt Haul Truck Emissions (pounds/day) = vehicle miles traveled/day * grams pollutant/mile * pound/454 grams*

Asphalt Worker Trips

Asphalt worker trips are estimated separately. For asphalt paving, the number of workers is estimated as 125% of the total number of construction equipment (vehicles and machines) selected. The emission estimates assume a construction worker commute fleet mix of 50% light duty autos and 50% light duty trucks. The worker commute travel distance and speed are based on the trip characteristics information for home to work trips found under the trip characteristics node of the operational emissions module.

References

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Sacramento Metropolitan Air Quality Management District. 1994. Air quality thresholds of significance, first edition. Sacramento, CA.

South Coast Air Quality Management District. 1993. CEQA air quality handbook. Diamond Bar, CA.

Appendix B. Area Source Emissions

TABLES

Area Source Emissions

URBEMIS2007 has been enhanced so that both novice and experienced users can generate accurate estimates of area source emissions. Novice users can generate estimates using default assumptions programmed into URBEMIS2007. Users experienced in estimating area source emissions can modify the area source assumptions to suit their particular project.

URBEMIS2007 allows the user to estimate area source emissions from:

- fuel combustion emissions from space and water heating, including wood stoves, fireplaces, and natural gas fired stoves;
- fuel combustion emissions from landscape maintenance equipment;
- consumer product ROG emissions; and
- architectural coatings.

Natural Gas Combustion

URBEMIS2007 can be used to estimate fuel combustion emissions from water and space heating using the approach described in Tables A9-12, A9-12-A, and A9-12-B in the South Coast Air Quality Management District CEQA handbook (South Coast Air Quality Management District 1993) and emission factors developed by the U.S. Environmental Protection Agency (U.S. EPA 1995). With one exception, all emission estimates assume natural gas is used as the primary source of water and space heating. The one exception is wood used for fireplaces and wood stoves. The equation used to estimate CO, ROG, NOx, and PM10 emissions from natural gas combustion is as follows for each land use type:

*Emissions = H * ({[F*G]/30}/1,000,000) * P*

Where: H = emission factor for each criteria pollutant in pounds of pollutant per million cubic feet of natural gas consumed:
CO: 40 pounds/million cubic feet
ROG: 7.26 pounds/Million cubic feet
NOx: 94.0 pounds/Million cubic feet [residential]
NOx 100.0 pounds/Million cubic feet [nonresidential]
PM10: 0.18 pounds/Million cubic feet
PM2.5: 0.18 pounds/Million cubic feet
CO2: 120,000 pounds/Million cubic feet

F = units per land use type:
residential (number of units)
industrial (customers)
hotel/retail/office (square feet)

G = Natural gas usage rates:
Residential: Single-Family: 6,665.0 feet^3 / unit / month
Multifamily: 4,011.5 feet^3 / unit / month

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Nonresidential: industrial: 241,611 feet^3 / customer / month
hotel/motel: 4.8 feet^3 / square feet / month
retail/shopping: 2.9 feet^3 / square feet / month
office: 2.0 feet^3 / square feet / month

P = percentage using natural gas
Residential 60%
Nonresidential 100%

The percentage of residential and nonresidential using natural gas may differ based on default values specified by individual air districts.

Hearth Fuel Combustion

The hearth fuel combustion category consists of wood stoves, fireplaces, and natural gas fired stoves. The user is required to enter the percentage of each associated with a project. If the San Joaquin Valley Air District is selected, the percentage of each hearth type is limited based on the District's wood stove rule.

Wood Combustion –Wood Stoves

Wood stove emissions can be estimated using the following equation:

*Wood Stove Emissions (pounds per day) = ((A * C) + (B * D) + (E * F) + (J * K)) * (G) * (H * I)*

Where: *A = EPA-certified noncatalytic stove emission rate (grams pollutant per ton of kilogram wood burned)*
B = EPA-certified catalytic stove emission rate (grams pollutant per kilogram of wood burned)
C = Percent of all stoves assumed to be noncatalytic
D = Percent of all stoves assumed to be catalytic
E = Conventional wood stove emission rate (grams pollutant per kilogram wood)
F = Percent of all stoves assumed to be conventional
G = Cords of wood burned per year per residential unit
H = Number of residential units
I = Percentage of residential units with wood stoves
J = Pellet stove emission rate (grams pollutant per kilogram wood burned)
K = Percent of all stoves assumed to be pellet

URBEMIS2007 assumes the following defaults for wood stove emissions:

A = 9.8 grams PM10 / kilogram, 70.4 grams CO / kilogram, 7.5 grams ROG / kilogram, 1.4 grams NOx / kilogram
B = 10.2 grams PM10 / kilogram, 52.2 grams CO / kilogram, 7.8 grams ROG / kilogram, 1.0 grams NOx / kilogram
C = 50% (entered as 0.50)
D = 50% (entered as 0.50)
E = 15.3 grams PM10 / kilogram, 115.4 grams CO / kilogram, 21.9 grams ROG / kilogram, 1.4 grams NOx / kilogram
F = 0.0%
G = 1.48 cords per year per residential unit
H = based on land uses specified by the user
I = 35% (entered as 0.35)
J = 2.1 grams PM10 / kilogram, 19.7 grams CO / kilogram, 0.01 grams ROG / kilogram, 6.9 grams NOx / kilogram
K = 0.0%

The emission factors shown above are based on EPA's AP-42 document (U.S. Environmental Protection Agency 1995). The emission factor assumes an even split between noncatalytic and catalytic stoves. The default assumption assumes that no conventional nor pellet stoves will be included, although the equation will allow the user to include conventional and pellet stoves in the emission calculation. Annual emissions assume a specific amount of wood would be burned per stove per residential unit during the heating season. That amount of wood varies by air district.

Wood Combustion –Fireplaces

Fireplace emissions are estimated using the following equation:

*Fireplace Emissions (pounds per day) = (J * K * L * M)*

Where: J = Fireplace emission rate (pounds of pollutant per residential unit per ton of wood burned)
K = Cords of wood burned per day year residential unit
L = Number of residential units
M = Percentage of residential units with wood stoves

URBEMIS2007 will assume the following defaults for fireplace emissions:

J = 34.6 pounds of PM10 / ton, 252.6 pounds of CO / ton, 229.0 pounds of ROG / ton, 2.6 pounds of NOx / ton
K = 1.48 cords burned per year per residential unit
L = residential units are based on the residential land uses specified by the user
M = 10% (entered as 0.10)

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These emission rates are based on information published by EPA (U.S. Environmental Protection Agency 1995). As with wood stove emissions, the user can modify each of the variables used to estimate fireplace emissions. Annual emissions are estimated based on annual wood combustion.

Natural Gas Fired Stoves

URBEMIS uses AP-42 emission factors to estimate emissions from natural gas combustion in natural gas fireplaces/stoves. The emission equation assumes that the average stove is 30,000 Btus for single family, 20,000 Btus for multi-family, that there are 1,020 Btus per standard cubic foot of natural gas, that the stove is used for an average of two hours per day during the winter months, and 100 days per year (200 hours per year). The values for single and multi-family Btus per stove can vary by air district.

Landscape Maintenance

Landscape maintenance equipment generates emissions from fuel combustion, from evaporation of unburned fuel, and from fugitive dust generated by equipment such as leaf blowers. Emissions include NOx, ROG, CO, SO2, PM10, PM2.5, and CO2. The emission factors used to estimate equipment emissions include exhaust and evaporation. Emission factors have not yet been developed for the fugitive dust generated by certain types of equipment generate.

Equipment in the landscape category includes lawn mowers, roto tillers, shredders/grinders, blowers, trimmers, chain saws, and hedge trimmers used in residential and commercial applications. Engines in this category are 25 horsepower or less. This category also includes air compressors, generators, and pumps used primarily in commercial applications.

The California Air Resources Board has enacted regulations to limit emissions from landscape maintenance equipment. Beginning in 1994 these regulations imposed emission limits on all landscape maintenance equipment sold. Those regulations became more stringent for equipment sold in 1999 and later. Consequently, the emissions from this source category are similar to automobile emissions in that the turnover in the equipment fleet plays an important part in how quickly emission reductions are achieved.

URBEMIS2007 estimates emissions from this source category based on the year in which the user is attempting to estimate emissions. The California Air Resources Board's OFFROAD2007 model was used to generate estimates of landscape maintenance equipment emissions in 2000 and 2010. Separate modeling runs were made for residential and non-residential equipment use. Residential emissions were limited to single-family residential units. The commercial equation is based on emissions per business unit and includes multifamily residential land uses.

The emission factors used by URBEMIS2007 are shown in Tables B-1 and B-2.

Table B-1. Landscape Maintenance Emission Factors (pounds per residential unit per day)

Year	ROG	CO	NOx	SO2	PM	PM10	PM2.5	CO2
2000	0.011192	0.062226	0.000468	0.000003	0.000171	0.000171	0.000169	0.071478
2001	0.010879	0.060467	0.000471	0.000003	0.000166	0.000166	0.000164	0.071497
2002	0.010567	0.058709	0.000475	0.000003	0.000160	0.000160	0.000159	0.071517
2003	0.010255	0.056950	0.000478	0.000003	0.000155	0.000155	0.000153	0.071537
2004	0.009942	0.055192	0.000482	0.000003	0.000150	0.000150	0.000148	0.071557
2005	0.009630	0.053433	0.000485	0.000003	0.000144	0.000144	0.000143	0.071577
2006	0.009317	0.051675	0.000489	0.000003	0.000139	0.000139	0.000138	0.071597
2007	0.009005	0.049916	0.000492	0.000003	0.000134	0.000134	0.000132	0.071617
2008	0.008693	0.048158	0.000496	0.000002	0.000129	0.000129	0.000127	0.071637
2009	0.008380	0.046399	0.000499	0.000002	0.000123	0.000123	0.000122	0.071657
2010	0.008068	0.044640	0.000503	0.000002	0.000118	0.000118	0.000117	0.071677

The residential emission factors shown for 2000 are based on total California single-family landscape maintenance emissions divided by total California single-family housing units in 2000. Similarly, the commercial emission factors for 2000 are based on total California non-farm business emissions divided by the California's total 2000 business units. For the commercial equations, URBEMIS2007 bases the number of business units on the number of non single-family housing land uses specified by the user.

Table B-2. Landscape Maintenance Emission Factors (pounds per business unit/day)

Year	ROG	CO	NOx	SO2	PM	PM10	PM2.5	CO2
2000	0.199471	2.127123	0.019558	0.000120	0.005154	0.005154	0.005103	2.776671
2001	0.191818	2.068940	0.019670	0.000117	0.005200	0.005200	0.005148	2.779879
2002	0.184166	2.010757	0.019782	0.000113	0.005245	0.005245	0.005192	2.783087
2003	0.176513	1.952574	0.019895	0.000110	0.005290	0.005290	0.005237	2.786295
2004	0.168861	1.894391	0.020007	0.000107	0.005335	0.005335	0.005282	2.789504
2005	0.161208	1.836208	0.020119	0.000103	0.005381	0.005381	0.005327	2.792712
2006	0.153556	1.778025	0.020231	0.000100	0.005426	0.005426	0.005371	2.795920
2007	0.145903	1.719842	0.020344	0.000097	0.005471	0.005471	0.005416	2.799128
2008	0.138250	1.661659	0.020456	0.000093	0.005516	0.005516	0.005461	2.802336
2009	0.130598	1.603476	0.020568	0.000090	0.005561	0.005561	0.005506	2.805544
2010	0.122945	1.545293	0.020681	0.000087	0.005607	0.005607	0.005551	2.808752

The 2010 emission rates were estimated using the OFFROAD2007 model, with separate emission estimates for the residential and commercial categories.

For emission factors between 2001 through 2009, URBEMIS2007 interpolates emission factors by assuming a uniform decrease in the emission rate each year between 2000 and 2010. In 2010 and succeeding years, the 2010 emission rates are used.

Average annual emissions assume that daily emissions would occur only during the summer period of 180 days. The end user can modify the length of the summer period.

Consumer Product Emissions

Consumer product emissions are generated by a wide range of product categories, including air fresheners, automotive products, household cleaners, and personal care products. Emissions associated with these products primarily depend on the increased population associated with residential development. Consequently, URBEMIS2007 can be used to estimate consumer product emissions when the user has selected one or more residential land uses. Emissions are based on the following equation:

*ROG (pounds/day) = 0.0171 pounds of ROG per person * Number of residential units * 2.861 persons per unit*

The ROG emission factor is based on the total estimated ROG emissions from consumer products divided by the total California population (California Air Resources Board 2006; California Department of Finance 1994).

URBEMIS2007 will base the number of residential units on information provided by the user on residential land uses. The user can modify each of the variables in the ROG emissions equation.

Annual emissions are estimated by multiplying pounds of ROG emitted per day by 365 days per year.

Architectural Coatings

Architectural coatings emissions associated with area sources is estimated using the same set of equations as construction related architectural coatings (described in Appendix A), with one exception. In the area source architectural coatings screens, the user can enter the percentage of total building square footage to be repainted each year. The default is set to 10% for both residential and nonresidential land uses.

Area Source Mitigation Measures

The area source mitigation measures allow three different types of mitigation measures to be specified. They include energy efficiency (primarily space heating), landscape maintenance measures, and architectural coatings measures. With one exception, URBEMIS does not currently have mitigation measures for hearth fuel combustion or for consumer products. The exception is that for projects in the San Joaquin Valley, the user can select hearth fuel combustion mitigation measures.

Energy Efficiency Mitigation Measures

URBEMIS includes three mitigation measures for natural gas combustion. Each measure is based on building energy efficiency relative to Title 24, California's energy efficiency regulation for residential and non-residential buildings. The user can turn on the appropriate measure and enter the percentage increase in energy efficiency above Title 24. Emission reductions are assumed to be proportional to the increase in building energy efficiency beyond Title 24. For example, if the user enters a mitigation measure showing an increase in residential energy efficiency of 10 % beyond Title 24, URBEMIS calculates a 10% reduction in emissions generated by residential energy consumption. Title 24 requires that compliance (with Title 24) be demonstrated before a building permit can be issued. This requirement applies to any heated building in California. Consequently, the percentage increase in energy efficiency beyond Title 24 should be based on the required compliance documentation.

Landscape Maintenance Mitigation Measures

URBEMIS includes two mitigation measures for landscape maintenance equipment. The first measure applies to residences, the second measure applies to commercial and industrial landscape equipment. For each of these measures, the user can specify the percentage of landscape equipment that would be electrically powered.

Architectural Coatings Mitigation Measures

For architectural coatings, URBEMIS allows the user to specify low VOC coatings percentages. The percentages reflect the reduction in VOC emissions as compared to existing coatings rules.

Hearth Fuel Combustion Mitigation Measures

Hearth mitigation measures only apply when a project has been selected for the San Joaquin Valley or one of the eight counties within the Valley. URBEMIS automatically selects the highest emitting percentage of wood stove, wood fireplaces, and natural gas fireplaces allowed by Rule 4901. Under the hearth fuel mitigation option, the user can select different percentages as long as they are allowed by the rule.

Appendix B References

California Air Resources Board. 2006. Offroad2007 Model. http://www.arb.ca.gov/msei/offroad/offroad.htm.

California Department of Finance. 1994. California statistical abstract. Sacramento, CA.

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Appendix C. Operational (Motor Vehicle) Emissions

Exhaust Emission Factors

URBEMIS2007 estimates vehicle exhaust emissions using several pieces of input entered by the user. That information is found within the URBEMIS input screens of the operational emissions module. The operational emissions module input screens include project year, vehicle fleet percentages, winter and summer temperature, trip characteristics, variable start information, and the percentage of travel on paved versus unpaved roads.

Once the user has entered the appropriate information into the operational emissions input screens and selects the emissions output, URBEMIS2007 calls the appropriate summertime and wintertime EMFAC2002 files based on the analysis year selected by the user. URBEMIS then goes to the appropriate locations within those files based on the average vehicle speeds and temperature. For each pollutant, URBEMIS obtains information from several locations within the EMFAC input file. For certain pollutants, URBEMIS generates pounds per mile emission estimates by multiplying the grams per mile values for each technology class within EMFAC (fleet mix vehicle type and technology class [non-catalyst, catalyst, diesel] by the percentage supplied by the user in the fleet mix screen. This results in a fleet average grams per mile value, which is then converted to pounds per day.

A similar approach is used to estimate trip emissions for certain pollutants. Separate tables in EMFAC2007 contain grams per trip emissions based on the length of time since the vehicle engine was turned off. URBEMIS uses the variable starts table, which shows the percentage of vehicles in several time classes (minutes since the vehicle engine was turned off) and for the six trip modes. URBEMIS uses the information in the variable starts table and the grams per trip values within EMFAC2002 to estimate weighted grams per trip values. The weighted grams per trip value is then multiplied by the number of trips calculated from the land use information to estimate total emissions per trip per pollutant.

Once the EMFAC2007 file has been read, URBEMIS2007 calculates criteria pollutant emissions for:

- running exhaust (grams per mile of ROG, CO, NOx, PM10),
- tire wear particulates (grams per mile, PM10),
- brake wear particulates (grams per mile, PM10),
- variable starts (grams per trip, ROG, CO, NOx),
- hot soaks (grams per trip, ROG),
- diurnals (grams per hour, ROG) ,
- resting losses (grams per hour, ROG), and
- evaporative running losses (grams per mile, ROG).

The estimated operational criteria pollutant emissions are summed in the emissions output page.

Entrained Road Dust Emissions

Entrained road dust emissions are generated by vehicles traveling on both paved and unpaved roads. URBEMIS2007 provides end users with a default percentage of VMT for paved versus unpaved roads. End users are asked whether they want to modify those percentages. Default percentages assume that 100 percent of VMT occurs on paved roads and 0 percent on unpaved roads.

Paved Roads

For paved roads, URBEMIS2007 uses the following equation:

PAVED = k (sL/2)0.65 (W/3)1.5

Where: *PAVED = particulate emission factor (lb/VMT);*
k = particle size multiplier for particle size range and units of interest;
sL = road surface silt loading (grams per square meter);
W = average weight of the vehicles traveling the road (megagrams).

The following default assumptions are used by URBEMIS2007:

k = 0.016 (for the 10 microns and under particle size cutoff)
sL = 0.1 (allowable range of 0.02 – 400 grams per square meter)
W = 2.2 (allowable range of 1.8-38 megagrams)

This equation is based on the paved roads emission factor found in AP-42 (U.S. Environmental Protection Agency 2003a). URBEMIS2007 allows the user to modify silt loading (sL) and average vehicle fleet weight (W). The equation was developed using silt loads ranging from 0.02 – 400 grams per square meter and mean average fleet vehicle weight ranging from 1.8-39 megagrams (2.0-42 tons). The equation was also developed using vehicles traveling at speeds ranging from 10-55 miles per hour, although speed is not used in the equation. A particle size multiplier (k) of 0.016 lbs PM10 per VMT is used by URBEMIS2007. This particle size multiplier cannot be changed by the user.

URBEMIS2007 uses the emission factor equation to calculate emissions per vehicle mile traveled. That value is then multiplied by the total vehicle miles traveled per day and by the percentage of vehicles traveling on paved roads.

Unpaved Roads

The unpaved road equation is as follows:

UNPAVED = (k (s/12)1.0 (S/30)0.5)/ ((M/0.5)0.2)

Where: UNPAVED = the fleet average unpaved road dust emissions (pounds/VMT)
k = the fraction of particles less than or equal to the particle size cutoff of 10 microns
s = surface material silt content (%)
S = the average vehicle speed (mph, input by the user)
M = surface moisture content (%)

This equation is based on EPA's emission factor equation for unpaved roads (Environmental Protection Agency 2003b). The following default assumptions are used by URBEMIS2007:

k = 1.8 (for the 10 microns and under particle size cutoff)
s = 4.3 % (allowable range [1.8 - 25.2 %])
S = 40 miles per hour (allowable range [10 - 43 mph])
M = 0.5 % (allowable range 0.03 – 13 %)

Of these default assumptions, all except k can be modified by the user. Once calculated, the emission rate in pounds per vehicle mile traveled is multiplied by the total VMT for the project and then by the percentage of travel on unpaved roads.

Double Counting of Mixed-Use Projects

URBEMIS2007 contains a procedure that reduces double counting of internal trips in a mixed-use project or community plan area. The procedure only applies when at least one residential and one non-residential land use are specified by the URBEMIS2007 user and the user selects the double-counting correction algorithm.

Because trip generation rates account for both trip productions and attractions, adding the gross trip generation for two land uses in a project double counts the trips between them. The procedure described below is designed to count the internal trips only once.

URBEMIS2007 displays a screen showing the number of residential and nonresidential trips. Then the user is prompted to enter the gross internal trip number, which limits the number of internal trips estimated by URBEMIS2007. The gross internal trip limit reported by the program is based on a comparison of residential trips versus nonresidential trips; the smaller of the two is the limiting value.

As presented above, the proposed double-counting correction is applied only to trips between residential and nonresidential land uses. A small amount of double counting may remain for trips between different residential land uses and/or between non-residential uses.

Pass-By Trips

According to the Institute of Transportation Engineers' (ITE) document Trip Generation, 5th Edition (ITE 1991), vehicle trips associated with a trip generator can be divided into three categories:

- *Primary Trips* are trips made for the specific purpose of visiting the generator. The stop at that generator is the primary reason for the trip. For example, a home to shopping to home combination of trips is a primary trip set.
- *Pass-By Trips* are trips made as intermediate stops on the way from an origin to a primary trip destination. Pass-by trips are attracted from traffic passing the site on an adjacent street that contains direct access to the generator. These trips do not require a diversion from another roadway.
- *Diverted Linked Trips* are trips attracted from the traffic volume on roadways within the vicinity of the generator but which require a diversions from that roadway to another roadway to gain access to the site. These roadways could include streets or freeways adjacent to the generator, but without access to the generator.

In calculating the emissions associated with a proposed project, the distinction between these three categories of trips is important. Pass-by and diverted linked trips associated with a proposed project generate substantially lower levels of net emissions than a primary trip.

For air quality impact analysis, the major difference between a pass-by trip and a diverted linked trip is the added vehicle miles traveled associated with the diverted linked trip. Pass-by trips, by definition, do not require a diversion from the original trip route. Conversely, diverted linked trips do involve diversion from the original trip route. A major difficulty in estimating the additional travel associated with a diverted linked trip is that the amount of additional travel is sensitive to local site factors. In particular, the distance from the project site to major arterials or freeways strongly influences the amount of additional travel.

Pass-by and diverted linked trips are most important for retail commercial land uses. As an example of how important these trips are, the February 1995 update to ITE's Trip Generation, 5th Edition, notes that an average of 87% of trips made to gasoline stations in the p.m. peak hour are pass-by and diverted linked trips. Not accounting for pass-by and diverted linked trips substantially overstates the amount of indirect source emissions associated with a proposed gasoline station.

URBEMIS2007 has an option that allows the user to account for pass-by and diverted linked trips. The primary data sources for appropriate pass-by and diverted linked trip adjustments are ITE's Trip Generation, 5th Edition, and the February 1995 update (ITE 1991; ITE 1995). The San Diego Association of Governments (SANDAG) has also produced a document that includes estimates of pass-by and diverted linked trips for specific land uses (SANDAG 1990). These three documents present pass-by and diverted linked trip values as a percentage of total trips for several land use categories. One distinction between the ITE versus SANDAG estimates are that for pass-by trips, SANDAG assumes that any diversion requiring 1 additional mile or less is a pass-by trip. In contrast, ITE assumes that any diversion off of the intended travel route is a diverted linked trip.

Table 3 shows estimates of pass-by and diverted linked trip percentages using data contained in ITE's Trip Generation, 5th Edition, the February 1995 update to the 5th edition, and the SANDAG report (ITE 1991, ITE 1995; SANDAG 1990). The ITE and SANDAG trip generation data primarily describe peak-hour versus average daily conditions. Jones & Stokes Associates has developed average daily percentages of primary trips, diverted-linked trips and pass-by trips associated with each land use for the URBEMIS2007 model.

When the pass-by trip correction algorithm is selected by the user, URBEMIS2007 adjusts trip end emissions (i.e., cold start, hot start, and hot soak) associated with pass-by and diverted linked trips.

For traffic impact analyses, pass-by trips are generally eliminated from consideration; they have no net effect on traffic volumes. Similarly, diverted linked trips may have a minimal effect on traffic volumes. Conversely, pass-by and diverted linked trips may have a substantial effect on air quality, and this effect may increase in the future as trip end emissions become a larger portion of total vehicle trip emissions. A pass-by or diverted linked trip associated with a shopping center is a good example of how these trips can affect air quality. Such a trip would have little or no net effect on traffic volumes. However, if the shopper stays at the shopping center for 1 hour, a substantial portion of a hot soak episode would occur and, for a catalytic converter-equipped vehicle, the trip leaving the shopping center would begin in a cold-start mode.

URBEMIS2007 estimates trip end emissions associated with pass-by and diverted linked trips and additional travel associated with diverted linked trips. Jones & Stokes Associates has modified URBEMIS2007 so that it makes separate emission estimates for primary trips, pass-by trips, and diverted-linked trips.

For primary trips, the emission estimating procedure do not change except that the trip generation rate for each land use would be multiplied by that land use's primary trip percentage shown in Table 3.

For pass-by trips, the trip generation rate for each land use are multiplied by that land use's pass-by trip percentage shown in Table 3. In addition, the trip length for each trip type (e.g., home-work, home-shop) is set to 0.1 miles. The change in trip length reflects the pass-by trip definition in that these trips result in virtually no additional travel. However, emissions associated with pass-by trips still occur. Consequently, the hot and cold start percentages are increased by 10 percent to reflect additional emissions from these operating modes.

For diverted-linked trips, the trip generation rate for each land use is multiplied by that land use's diverted-linked trip percentage shown in Table 3. The trip length is also adjusted downward to equal 25 percent of the primary trip length for each trip type. By doing so, it accounts for the additional travel associated with diverted-linked trips. Also, the hot and cold start percentages for each trip type are increased by 10 percent to reflect additional emissions from these operating modes.

Method for Calculating Default Trip Lengths from Travel Survey Data

Trip lengths are one of the most important data elements used in calculating project emissions. Air districts or other agencies responsible environmental review should ensure that default trip length values used in their area have a sound basis. Unfortunately, the data most readily available from regional travel models for this purpose is typically formatted differently than is used in URBEMIS. This section provides a method for converting available data for use as URBEMIS2007 defaults.

One source of data is the Caltrans Statewide Travel Survey. The most recent version was published in 1991. The data is stratified by trip purpose. The trip categories are home to work (H-W), home to shop (H-S), home to other (H-O), other to work (O-W), and other to other (O-O). The survey provides trip lengths for only H-W and total trips. More detailed breakdowns may be available from the Regional Transportation Planning Agency in your area. The survey and most RTPA models provide trip lengths in terms of minutes. The average speed is used to convert minutes to miles.

The H-W, H-S, and H-O trip lengths can be used directly in URBEMIS. However, for non-home based trips, URBEMIS uses work (W) and non-work (N-W) trips when analyzing all non-residential projects (commercial, industrial, institutional, etc). To produce work-related trip lengths for non-residential projects analyzed in URBEMIS, a composite work trip length is calculated that is a composite of H-W and O-W trip lengths. For URBEMIS, non-work trips are a composite of H-S, H-O, and O-O trip lengths. Both are based on the relative occurrence of the individual trip types.

The following table illustrates this concept using Southern California data as an example:

Travel Survey Trip Types:	H-W	H-S	H-O	O-W	O-O	Total
Percent trip type:	20%	9%	43%	11%	17%	100%
Trip length in minutes:	19.63	7.91	9.58	15.06	8.96	
Trip length in miles:	11.5	4.87	6.02	9.07	5.66	

URBEMIS non-residential Work trip lengths = composite of H-W + O-W.

Work Trip Length Formula:

(%H-W / (%H-W + %O-W) x H-W TRIP LENGTH) +
(%O-W / (%H-W + %O-W) x O-W TRIP LENGTH)

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URBEMIS non-residential Non-Work trip lengths = composite of H-S + H-O + O-O.

Non-Work Trip Length Formula:

(%H-S / (%H-S + %H-O + %O-O) x H-S TRIP LENGTH) +
(%H-O / (%H-S + %H-O + %O-O) x H-O TRIP LENGTH) +
(%O-O / (%H-S + %H-O + %O-O) x O-O TRIP LENGTH)

Example Calculation Using South Coast Data:

Commute Trip (W)

(20%/(20%+11%) X 11.5 mi.) + (11%/(20%+11%) X 9.07 mi.) = 10.6 mile W trip

Non-Work Trip (N-W)

(9%/(9%+43%+17%) X 4.87 mi.) + (43%/(9%+43%+17%) X 6.02 mi.) +
(17%/(9%+43%+17%) X 5.66 mi.) = 5.78 mile N-W trip

Default Values for Emission Calculations

Diurnal Soak Hours per Day:	7.1
Resting Loss Hours per Day:	12.9
Vehicles per Household:	1.8

Appendix C References

Institute of Transportation Engineers. 1991. Trip generation. 5th edition, Washington, DC.

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Appendix D. URBEMIS2007 Mobile Source Mitigation Component

TABLES

Mobile Source Mitigation Component

Background

The purpose of this appendix is to document the basis of the emission reduction quantification system used in the URBEMIS2007 Mobile Source Mitigation Measures module. The mitigation measures module is based on an approach developed by Nelson\Nygaard Consulting Associates specifically for the URBEMIS module. Nelson\Nygaard's findings are described in the remainder of this appendix.

Introduction

The following discussion is based on procedures for operational smart growth mitigation developed for URBEMIS2002. Those same procedures have been incorporated into URBEMIS2007.

This report sets out recommendations to revise the operational mitigation component of URBEMIS 2002. These have been developed with three main aims in mind:

- **Simplify** the existing mitigation component (of URBEMIS version 7.5), which while extremely detailed, is daunting to new users and has extensive data requirements. In particularly, the division between "environment factors" and "mitigation measures" can be confusing.
- **Improve consistency.** Many of the inputs to the URBEMIS 7.5 mitigation component are extremely subjective (e.g. whether some, few or no bike routes provide wide paved shoulders and have few curb cuts). We propose making these more quantitative, and/or providing additional guidance in the users' manual or within the program itself.
- **Improve accuracy and transparency.** While many of the inputs to the current mitigation component (of URBEMIS 7.5) have been proven to have an impact on travel behavior, research is still at an early stage of assessing quantitative impacts, and how these interrelate with other mitigation strategies. The recommendations here update the current mitigation component in the light of new research.

An extensive body of research has been compiled as to the impacts of particular mitigation strategies on travel behavior. However, in general, this has either had an academic focus, or been undertaken for the purposes of developing citywide or regional travel models. For example, many agencies have sophisticated procedures for assessing non-single occupancy auto travel at the level of TAZ or above, but not at the development level. There is extremely little guidance on how to use this data in the type of application needed for URBEMIS 2002 – namely, to provide quantitative estimates of the impact on trip generation and vehicle miles traveled (VMT) at the development level.

Many agencies do provide credits for individual developments that implement mitigation measures, for example when assessing impact fees or conducting traffic studies. Some California examples include C/CAG in San Mateo County and VTA in Santa Clara County. A brief, national review was also conducted for purposes of this report.[1] In general, however, these credit programs are only loosely based on the latest travel research, and it could be argued that they function more at a policy level, in providing incentives for developers to incorporate elements such as demand management programs that the agency considers desirable.

The recommendations here therefore attempt to bridge the gap between academic studies and complex regional or area-wide models on the one hand, and more site-specific traffic assessments on the other hand. The emphasis is on providing the best possible estimate while minimizing data requirements. The overall effect, compared to the existing mitigation component, is to reduce the number of inputs required, but make them more quantitative.

[1] Agencies contacted included: New York Metropolitan Transportation Council; Atlanta Regional Commission; Alameda County, CA; and San Luis Obispo County, CA.

It cannot be too highly stressed that the trip reductions recommended here are valid at a sketch-planning level only, and are subject to considerable uncertainty. While they should ideally be expressed as a range, in order to expressly account for this uncertainty, a single value is needed for purposes of the Indirect Source Review in order to allow the appropriate fee to be calculated. The same limitations noted in the documentation for the existing mitigation component still apply, and are worth repeating here:

> The URBEMIS 2002 mitigation component is a significant advance over past attempts to quantify the benefits of air quality mitigation measures, however, users should recognize that travel behavior is very complex and difficult to predict. The component relies on the user to determine factors critical to travel behavior that are somewhat subjective. As GIS and electronic traffic monitoring and data collection become a reality in many cities, the ability to identify factors critical to walking, bicycling, and transit use will be enhanced. The URBEMIS 2002 mitigation component provides a starting point for using currently available data to demonstrate the benefits of urban design and traditional mitigation measures in reducing air quality impacts.

The mitigation component results, however, should still be interpreted as the mid-point of a range. Recent research has pointed towards the dangers inherent in reporting precise values, when the results are the subject of considerable uncertainty (Shoup, 2003). However, although the methodological dangers are obvious, there is generally no question about the *direction* of the relationship, only its size and the appropriate variable. Some adjustment is better than none at all – which is what most conventional trip generation methodologies provide (Ewing & Cervero, 2001). In addition, existing project-level trip generation methodologies, even though well-accepted within the transportation planning and engineering profession, are themselves subject to considerable uncertainty, and results are reported with unwarranted precision (Shoup, 2003).

Other considerations that should be noted include:

- The key output that is sought here is reduction in *vehicle trips*. Research results, however, often report results in terms of VMT. Where no alternative is available, we assume that VMT is proportional to vehicle trips.
- Elasticities are generally used to make the calculations, since when used with care, they provide a satisfactory, means of preparing first-cut aggregate response estimates for various types of transportation system changes (Pratt *et. al.,* 2000). They also provide a transparent and accessible method of reporting results, that can be transferred from one region to another (Ewing & Cervero, 2001).
- There are major theoretical issues regarding the direction of causality that have still to be resolved in the research. For example, does an increase in density lower vehicle trip generation rates, or do more dense places attract people who tend to make fewer vehicle trips? For the purposes of this analysis, however, the distinction is unimportant. The key issue (using the same example) is that more dense places are associated with fewer vehicle trips.
- Local planning controls and development economics are assumed to provide an important "reasonableness" check on the recommended trip reductions. For example, reductions in parking supply will not normally be allowed unless the local jurisdiction is confident that complementary trip reduction measures will be applied. Equally, it is unlikely that frequent transit service will be provided to a destination with low potential ridership, given competing demands on an agency for service.

About the Trip Generation Manual

At its heart, the URBEMIS mitigation component is a tool for modifying the average trip rates reported in the Institute for Transportation Engineers' *Trip Generation* manual to make them more accurate, so that they fairly reflect the particular characteristics of a proposed development. Before modifying these average rates, it is therefore useful to understand the manual itself: how the average rates were derived; the original data sources that underlie the manual; and the manual's own recommendations about when, and why, its average trip generation rates should be modified. Some key points are these:

- The ITE manual normally predicts trip generation from new buildings using just two variables. Typically, the user first selects a broad *land use type* (e.g. "High-Rise Residential Condominium/Townhouse"). Second, the user inputs the *quantity* of that land use type (e.g. "100 dwelling units").
- An important advantage of this simple approach is that very little information about a project is needed to predict trip generation, and trip generation calculations are simple.
- A primary disadvantage of such two-variable formulas is that they do not take into account the multiple other variables (parking price, transit service, etc.) that transportation research has shown to strongly affect trip generation, and so the variation in trip rates *within* each land use category is frequently very high.

Recognizing these points, the *Trip Generation* manual therefore advises the reader that the average trip generation rates reported in the manual "represent weighted averages from studies conducted throughout the United States and Canada since the 1960s. Data were primarily collected at suburban locations having little or no transit service, nearby pedestrian amenities, or travel demand management (TDM) programs. At specific sites, the user may wish to modify trip generation rates presented in this document to reflect the presence of public transportation service, ridesharing or other TDM measures, enhanced pedestrian and bicycle trip-making opportunities, or other special characteristics of the site or surrounding area."

However, while the studies may have been *primarily* conducted at such suburban sites, it appears from the sources referenced that for some land uses, particularly higher density residential land uses, many sites studied included at least some transit service, sidewalks, and other characteristics associated with lower vehicle trip rates. For the "High-Rise Residential Condominium/Townhouse", for example, the manual's text shows that sites were surveyed in such cities as Vancouver, Canada: a city where it is difficult to find high-density condominiums that lack sidewalks, transit service, and a mix of uses nearby.

As part of our research, we made several calls to and exchanged correspondence with the staff at the Institute for Transportation Engineers. The staff was unable to provide any additional data (beyond the text of the manual itself) on the characteristics of the developments used in its trip generation studies, and was also unable to provide the actual studies – the original data – which underlie the manual's conclusions. Therefore, it is not possible to define with certainty the precise characteristics of an "average site".

Given this paucity of information available on the original sources for the *Trip Generation* manual's, conclusions about the average characteristics of the different land uses in the manual (e.g., average residential density, or the percentage of neighborhood streets with sidewalks) necessarily must be estimated, rather than precisely calculated. Fortunately, a large body of other research on travel behavior and land use is available, and reasonable estimates can be made based upon this research.

Recommendations

1. Combine "environmental factors" and "mitigation measures."

URBEMIS 2002 distinguishes between "environmental factors" for pedestrians, cyclists and transit (i.e., the character of the existing neighborhood), and "mitigation measures" (i.e. those added by the development). The environmental factors both provide a mitigation measure in themselves (e.g. the credit for existing or planned transit service), and are also used to weight the mitigation measures (i.e., a lower credit is given for a mitigation measure in an area that has a low environmental factor).

The distinction does make it easier to give credits for specific mitigation measures (e.g. bus bulbs, sidewalks and bicycle parking). However, we recommend that the distinction be removed, since it also brings several important disadvantages. Most of these relate to either complexity, or the relative advantages of infill vs. greenfield development, as follows:

- The pedestrian environmental factors appear to be given less weight than the mitigation measures, even when it is taken into account that the environmental factors are also used to weight the mitigation measures. The credit for the surrounding pedestrian environment is 2%, compared to the maximum allowable reduction of 9%. This means that smaller, infill developments will be eligible for lower credits, since by their nature they will be more dependent on the surrounding environment and have more limited ability to fund mitigation measures.
- On a related point, the importance of the environmental factors compared to mitigation measures is largely a function of scale, i.e. development size. Larger projects, particularly on greenfield sites, will be starting from a "blank sheet," and on-site mitigation measures will be paramount. The appropriate trip reductions for smaller, infill developments, in contrast, will be more a function of the surrounding environment.
- Combining the environmental factors and mitigation measures would make the component easier to understand, particularly for inexperienced users. At present, the separation can be confusing.

2. Scale

This question relates to the area that should be analyzed. We recommend that this should be either the area within a half-mile radius from the center of the project, or the entire project area, whichever is larger. This is the same approach taken in the existing URBEMIS mitigation component. In effect, the smaller the development, the greater the consideration given to the wider project area.

3. Provide Post-Modeling Adjustments to Reward Other Mitigation Measures

One of the impacts of these recommendations would be to narrow the range of mitigation measures that are considered in the analysis. Some potential mitigation measures are excluded even though they are likely to have a travel behavior impact, either because they cannot be readily quantified, or because this would risk double counting an impact already quantified elsewhere (i.e. another variable, such as intersection density, serves as a proxy). We therefore recommend consideration of how post-model adjustments can be used to provide financial incentives for developers to incorporate these mitigation measures. This may include all those that are in the current mitigation component, but are not recommended for continued inclusion, including:

- Street trees
- Traffic calming
- Design maximizing visual interest for pedestrians, and "eyes on the street"
- Zero building setbacks
- Direct pedestrian connections
- Street furniture and artwork
- Pedestrian signalization and signage
- Street lighting
- Low speed limits on bicycle routes
- Safe routes to schools
- Bicycle parking ordinance
- Transit stop amenities
- Route signs and displays
- Bus turnouts and bulbs
- Structured parking

4. Modifying Average Trip Generation Rates

In general, both the recommended trip rate modifications and the overall philosophy of the mitigation component are similar to those in the existing URBEMIS model, and build extensively off this work. The major differences between the existing mitigation component and these recommendations are found in (a) the input variables, which are designed to be more quantitative and less subjective, and are fewer in number, and (b) the formulas, which take advantage of the latest research on residential travel behavior.

Neighborhood-level trip generation and vehicle miles traveled vary by more than 80% in California cities (Figure D-1). As the documentation for the existing mitigation component recognizes, areas with low trip generation and VMT levels have the highest development densities, a wide variety of uses within walking distance, safe and comfortable pedestrian access, paid parking requirements, and a high level of transit service.

Similarly, residential trip rates reported in the *Trip Generation* manual vary widely, both *within* individual land use types, and *between* land use types (Figure D-2). For the land use type "Single Family Detached Housing", for example, reported rates ranged from a low of 4.31 daily trips per dwelling unit, to a high of 21.85 daily trips. The *Trip Generation* manual reports that, "This land use included data from a wide variety of units with different sizes, price ranges, locations and ages. Consequently, there was a wide variation in trips generated within this category." Between residential land use categories, the variation is still greater, as would be expected. For example, the average trip rate for the "Residential Condominium/Townhouse" land use type is 5.86 (or 39% lower than the average single-family detached house), while the lowest trip rate is 1.83 (or 80.9% lower). At the extremes, considering all residential land uses, the highest residential rate reported (21.85 trips/day) is more than ten-fold higher than the lowest rate reported (1.83 trips/day).

Figure D-1. Daily Trips by Density, San Francisco Bay Area

	Households/Residential Acre					
	<2	2-5	5-10	10-20	20-50	>50
Mean Households/Residential Acre	1.4	3.6	6.7	13.5	30.6	121.9
Daily Vehicle Trips/Household	6.4	5.9	5.0	3.8	2.9	1.2
% Reduction in Daily Vehicle Trips/Household compared to lowest density areas	0%	9%	23%	41%	55%	82%

Source: MTC Household Travel Survey, 1990, cited in Holtzclaw, 2002

Figure D-2. ITE Trip Rates for Selected Residential Land Uses

		ITE Trip Rate		
Land Use Code	**Land Use Type**	**Low**	**Average**	**High**
210	Single-Family Detached Housing	4.31	9.57	21.85
221	Low-Rise Apartment	5.1	6.59	9.24
230	Residential Condominium/Townhouse	1.83	5.86	11.79
222	High-Rise Apartment	3	4.2	6.45
232	High-Rise Residential Condo./Townhouse	3.91	4.18	4.93

Based on these data in Figures 1 and 2, and a wide range of additional transportation research, we have developed a set of formulas for modifying the average trip rates for residential land uses has been developed. For the URBEMIS user, the procedure for modifying residential trip generation rates will remain generally similar to the existing process, with three basic steps:

1. In the "Land Use Selection" screen, the user will enter the land use types (e.g. "Apartment, Low-Rise") and the number of dwelling units of each type.
2. Next, if the mitigation component is used, the user will be prompted to review the default values for several key variables (e.g. residential density, level of transit service) for each residential land use type. If the project's land uses have characteristics that are different from the default values (as they usually will be), the user will enter the correct values, in place of the default values.
3. Within the program, the formulas described hereafter will be used to calculate the resulting trip generation rates.

In keeping with the conclusions of current transportation research, a single set of formulas is used to modify the trip rates for all residential land use types. The input variables for these formulas assess five key land use characteristics (or "mitigation measures", in URBEMIS terms):

- Net residential density (measured by Households per Residential Acre)
- Mix of uses (using a jobs/housing measure)
- Presence of local-serving retail
- Level of transit service (measured by a transit service index)

- Bicycle and pedestrian friendliness (measured by an "pedestrian factor" index based on intersection density, sidewalk completeness, and bike lane completeness)

For each ITE residential land use type, a set of default values for these variables has been defined. If the default values for a residential land use type are left unchanged when running the mitigation component, then the resulting trip generation rate will be the standard ITE average trip generation rate for that land use type. For single-family detached housing, for example, the default values include a residential density of three units per residential acre, a transit service index score of 0 (representing no transit service within one-quarter mile of the site), and an intersection density of 250 intersections per square mile (typical of post-war cul-de-sac residential subdivisions). Figure D-4 shows the default values for each land use type.

To achieve the lowest residential trip rate reported in *Trip Generation* (a manual which primarily measures stand-alone, single-use projects with little or no transit service), the input values required would include a density of 160 units per residential acre, the maximum level of transit service, the best possible mix of uses and local retail, and a pedestrian score equivalent to a complete sidewalk coverage with a network of blocks no larger than 300 feet on a side. This would result in a rate of 1.83 trips/day, or an 81% reduction from the average single-family house rate).

This is similar to the 82% difference in household trip generation between the lowest density areas with the poorest transit service (6.4 vehicle trips per household per day), and the highest-density areas with good transit and a higher quality pedestrian environment (1.2 vehicle trips per household per day), as shown in Figure D-1. Figure D-4 shows the input values that would be required to achieve this rate, as well as the input values required to achieve maximum possible reduction allowed.

In theory, choosing the maximum possible values for each of the *physical design variables* described above could result in a residential trip generation rate as low as 0.9 daily trips per unit. This represents a 90% reduction from the average rate for a single-family detached house. To achieve this rate, however, a neighborhood would have to have remarkable characteristics, similar to Manhattan or Hong Kong: a density of 380 units per acre, or more than three times the average density of San Francisco's densest neighborhoods (North Beach and Chinatown), the highest possible level of transit service, and so on.[2]

The recommended reductions for the individual physical design mitigation measures for residential uses are summarized in Figure D-3. The remainder of the report discusses the justification for these levels, along with the mitigation measures for non-residential uses. In general, the recommended maximums for individual components have been set at a level so that this overall 90% maximum reduction from the average single-family house rate is maintained for residential land uses. While a greater reduction may sometimes seem warranted for an individual measure, a lower value has been selected to stay within this 90% maximum – a practice that helps avoid the considerable dangers of double counting.

In addition to the variables above, which primarily measure physical design characteristics, the formulas include mitigation measures that assess *demand management programs and similar measures*. A maximum additional reduction of 7.75% from the average single-family house rate is possible through these measures.

[2] While rare in California, these extreme cases of Manhattan-like densities can be seen in projects such as San Francisco's single-room occupancy hotels for very low income residents, which achieve such densities by omitting parking and providing very small living quarters.

Non-Residential Land Uses

For non-residential land uses, the general procedure for modifying rates is similar, and based upon many of the same research results. To modify non-residential trip generation rates, the following procedure is used:

1. For *physical design* mitigation measures, the formulas to determine percentage reductions are identical to the formulas for residential land uses, except for the 'Residential Density' measure, which cannot apply.
2. Additional mitigation measures are applied for *demand management programs and similar measures*. For non-residential uses, the number of available demand management measures is greater, as is the possible percentage reduction.

However, there is a key difference between the formulas used to modify residential rates, and the formulas used to modify non-residential rates:

1. For residential land uses, the percentage reductions shown for each mitigation measure refer to the percentage reduction from 9.57 trips per day (the rate for single family homes). The default values for each residential land use (Figure D-4) are set at levels such that keeping these values generates the average trip rate for that land use.
2. For non-residential land uses, the percentage reductions shown for each mitigation measure refer simply to the percentage reduction from the average ITE trip generation rate for that land use. No special default values are required: they are simply set to create a 0% reduction as the starting value.

Figure D-3. Summary of Recommended Trip Reductions

	Residential	Non-Residential	Comments
Physical Measures			
Net Residential Density	Up to 55%	N/A	
Mix of Uses	Up to 9%	Up to 9%	
Local-Serving Retail	2%	2%	
Transit Service	Up to 15%	Up to 15%	
Pedestrian/Bicycle Friendliness	Up to 9%	Up to 9%	
Physical Measures sub-total	*Up to 90%*	*Up to 35%*	
Demand Management and Similar Measures			
Affordable Housing	Up to 4%	N/A	
Parking Supply	N/A	No limit	Only if greater than sum of other trip reduction measures
Parking Pricing/Cash Out	N/A	Up to 25%	
Free Transit Passes	25% * reduction for transit service	25% * reduction for transit service	
Telecommuting	N/A	No limit	Not additive with other trip reduction measures (see text)
Other TDM Programs	N/A	Up to 2%, plus 10% of the credit for transit and ped/bike friendliness	
Demand Management sub-total[3]	*Up to 7.75%*	*Up to 31.65%*	

[3] This sub-total excepts the measures for parking supply and telecommuting, which have no limit.

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Figure D-4. Default Values for Residential Land Use Trip Generation Formulas

DEFAULT VALUES FOR RESIDENTIAL TRIP RATE FORMULAS

Land Use Code	Land Use Type	Residential Density	Housing Units	Employees	Retail?	Transit Service	Intersection Density	Sidewalks	Bike Lanes	Ped Factor	ITE Trip Rate		
											Low	Average	High
210	Single-Family Detached Housing	3	100	17	no	0.00	250	0	0	0.06	**4.31**	**9.57**	**21.85**
221	Low-Rise Apartment	16	100	26	no	0.06	250	0.5	0	0.23	**5.1**	**6.59**	**9.24**
230	Residential Condominium/Townhouse	16	100	60	yes	0.10	400	1	0	0.44	**1.83**	**5.86**	**11.79**
223	Mid-Rise Apartment	38	100	60	yes	0.14	400	1	0	0.44	**NA**	**4.68**	**NA**
222	High-Rise Apartment	62	100	60	yes	0.14	400	1	0	0.44	**3**	**4.2**	**6.45**
232	High-Rise Residential Condo./Townhouse	64	100	60	yes	0.14	400	1	0	0.44	**3.91**	**4.18**	**4.93**

TRIP RATES RESULTING WHEN DEFAULT VALUES ARE USED

Land Use Code	Land Use Type	Reductions						Resulting Trip Rate
		Residential Density	Mix of Uses	Local Retail	Transit	Bike/Ped	Total	
210	Single-Family Detached Housing	0.0%	-0.6%	0.0%	0.0%	0.6%	0.0%	9.57
221	Low-Rise Apartment	27.9%	0.5%	0.0%	0.6%	2.1%	31.1%	6.59
230	Residential Condominium/Townhouse	27.9%	3.9%	2.0%	1.1%	3.9%	38.8%	5.86
223	Mid-Rise Apartment	39.8%	3.9%	2.0%	1.5%	3.9%	51.1%	4.68
222	High-Rise Apartment	44.8%	3.9%	2.0%	1.5%	3.9%	56.1%	4.20
232	High-Rise Residential Condo./Townhouse	45.1%	3.9%	2.0%	1.5%	3.9%	56.3%	4.18

EXAMPLE RESIDENTIAL TRIP RATE CALCULATIONS

Land Use Code	Land Use Type	Residential Density	Housing Units	Employees	Retail?	Transit Service	Intersection Density	Sidewalks	Bike Lanes	Ped Factor	ITE Trip Rate		
											Low	Average	High
210	"Worst Case" Singe-Family Detached	0.1	100	0	no	0.00	80	0	0	0.02	**-**	**-**	**21.85**
230	"Best Case" Res. Condo/Townhouse	160	100	150	yes	1.00	1300	1	0	0.67	**1.83**	**-**	**-**
N/A	Maximum Possible Reduction	380	100	150	yes	1.00	1300	1	1	1.00	**NA**	**NA**	**NA**

TRIP RATES RESULTING WHEN EXAMPLE VALUES ARE USED

Land Use Code	Land Use Type	Reductions						Resulting Trip Rate
		Residential Density	Mix of Uses	Local Retail	Transit	Bike/Ped	Total	
210	"Worst Case" Singe-Family Detached	-20.7%	-3.0%	2.0%	0.0%	0.2%	-21.5%	11.63
230	"Best Case" Res. Condo/Townhouse	51.4%	9.0%	2.0%	12.5%	6.0%	80.9%	1.82
N/A	Maximum Possible Reduction	55.0%	9.0%	2.0%	15.0%	9.0%	90.0%	0.95

5. Data Requirements

Figure D-5 shows the inputs that are required to complete the mitigation component in full, along with suggested data sources. Note, however, that the mitigation component can still be run, even if some of these inputs are missing. While no reduction would be granted for the particular mitigation measure for which the input was required, credits could be granted for other trip reduction measures.

Figure D-5. Data Requirements and Suggested Sources

	Suggested Source		
Required Input	**Project**	**Surrounding Development**	**Comments**
Net residential density	Project plans	Block-level census data	Net residential data excludes land not devoted to residential uses
Number of housing units	Project plans	Block-level census data	Same basic source as for net residential density
Number of jobs	Project plans	Census Transportation Planning Package. Local jurisdiction may provide more current or fine-grained data	If data are only available per square foot, US Dept. Energy produces figures on average employee density
Local serving retail	Project plans	Site observations	
Below-market-rate units	Project plans	N/A	
Parking supply	Project plans	N/A	
Transit service	Transit agency maps/schedules		
Intersection density	Project plans	Street plans	Count can be automated if available in GIS
Sidewalk completeness	Project plans	Site observations	Count can be automated if available in GIS
Bike lane completeness	Project plans	Site observations	Count can be automated if available in GIS
Parking pricing	Development agreement or similar	Site observations (if applicable)	
Free transit pass provision	Development agreement or similar	N/A	
Telecommuting/flexible work schedules	Development agreement or similar	N/A	
Other TDM programs	Development agreement or similar	N/A	

6. Procedure for Small Projects

For developments in an established urban area below a certain size threshold, we recommend allowing them to adjust their trip generation rates based on the mode share in that census tract. This would avoid a disproportionate burden in gathering the data to document their likely trip reduction. (The analyst would need to certify that the project was similar in character to the existing development.) The recommended threshold is 50 average daily baseline vehicle trips, with the baseline being that calculated by URBEMIS before any of the reductions from mitigation measures are applied.

7. Substitute Methodologies

The recommended mitigation levels are, in our judgment, the most appropriate for a model that must apply to an extremely wide range of projects and geographic contexts. However, it must be recognized that there may be "special cases," where these standard reductions may not apply. For this reason, we recommend that any methodology for calculating reductions in VMT and vehicle trips may be substituted, provided that this is mutually agreed between the Air District and project proponent.

8. Measures Reducing VMT

The existing mitigation component allows for reductions in VMT (but not trip generation) for park-and-ride lots and satellite telecommuting centers. We do not recommend any changes to this aspect of the mitigation component.

9. Correction Factors

The existing mitigation component provides for trip type correction factors, based on evidence suggesting that certain trips are more likely to be captured by one mode rather than another. We do not recommend any changes to this aspect of the mitigation component.

A second correction factor in the existing mitigation component relates to trip distance, because, the documentation argues, bicycle and walking trips replace mostly shorter automobile trips. We recommend that this correction factor be eliminated, as there is little evidence to suggest that this phenomenon exists. Indeed, more complex changes in travel behavior are likely, such as mode shift to bicycling and walking trips being accompanied by a shift to closer destinations. For example, rather than drive to a grocery store on a freeway interchange, a household may walk to a smaller store in the neighborhood. Mixed use, compact neighborhoods are characterized by short overall trip lengths (see, for example, Kuzmyak et. al., 2003). Further evidence comes from the elasticities for trip reduction with respect to density, which are the same for both vehicle trips and VMT (Ewing & Cervero, 2001), suggesting that there is no impact on trip length.

Detailed Justification of Recommended Mitigation Levels

Default Values for Residential Land Uses

To develop the default values for residential land uses shown in Figure D-4, we had to overcome a significant hurdle: ITE retains no data on the characteristics of the developments used in their trip generation studies. Default values for average density, transit service levels, and other variables had to be estimated using two alternative methods. First, we reviewed representative projects through research of literature and discussions with professionals in the fields of architecture and town planning, to ascertain typical ranges for density and other characteristics of each land use type (for useful summaries, see Calthorpe, 1993, and Local Government Commission,2002).

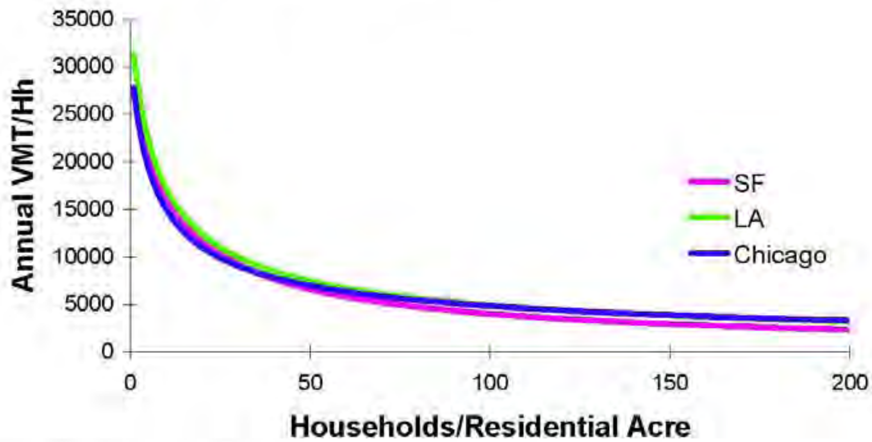
Second, these ranges of values were plugged into the formulas for the mitigation measures, and adjusted until the baseline values for each characteristic equaled the average ITE trip generation rates for each land use. For example, baseline density for Mid-Rise Apartments (64 units per residential acre) falls within the typical range observed from research of 45 to 125 units/acre, and when combined with other baseline characteristics for the land use, results in a 56.1% reduction in trip generation from the average rate for single family homes – the average reduction set forth in the ITE manual.

Finally, since the *Trip Generation* manual provides no daily trip generation rate for the "Mid-Rise Apartment" land use, we estimated a rate by extrapolating from the daily trip rate for the "High-Rise Apartment" land use type. The PM peak hour trip rate of 0.39 trips per unit for mid-rise apartments is 11.4% higher than the PM peak hour rate for high-rise apartments (0.35 trips/unit). Therefore, the daily trip rate for the "Mid-Rise Apartment" land use was estimated to be 4.68 trips per unit, or 11.4% higher than the daily trip for high-rise apartments (4.2 trips/unit).

Density

A considerable volume of research has investigated the links between density, particularly residential density, and travel behavior (for summaries, see Kuzmyak et. al, 2003; Boarnet & Crane, 2001). Overall, the conclusions can be summarized thus: there is a significant, quantifiable relationship between residential density and automobile use (see Figure D-6), but there is uncertainty regarding the degree to which this effect is due to the inherent effects of density, as opposed to factors for which density serves as a proxy, such as parking price, local retail, transit service frequency and pedestrian friendliness.

Figure D-6. Residential Density Vs. Vehicle Travel



Source: Holtzclaw et. al. (2002).

Fewer studies have attempted to disentangle the effects of density itself. Three of the main exceptions are:

- Typical elasticities for vehicular travel with respect to density are –0.1 to –0.04. These elasticities refer to the effect of density itself, isolated from variables that tend to be correlated with density such as transit frequency, and are additive to elasticities of other built environment factors. When these factors are not isolated, typical elasticities for VMT with respect to density are –0.22 to –0.27 (Kuzmyak et. al, 2003).
- The elasticity of density, when isolated from three other variables (diversity, design and destinations), is –0.043 with respect to vehicle trips, and – 0.035 with respect to VMT (Criterion and Fehr & Peers, 2001). However, this does not control for transit service levels.
- Cervero & Ewing (2001), in an update to this work, suggest a slightly higher elasticity of –0.05 with respect to both vehicle trips and VMT.

Note that density has been shown to have a nonlinear relationship with vehicle travel, with a threshold value of 25-30 units per acre below which the travel impacts of increased density are particularly large (Holtzclaw et. al, 2002). Holtzclaw et. al found that the best single variable equations to predict household vehicle travel (VMT per household, or VMT/Hh) relied on Households per Residential Acre (Hh/RA). For the Los Angeles region, San Francisco and Chicago regions, these equations varied only slightly, producing the curves shown in Figure D-6. For the Los Angeles region, this formula takes the form:

$$\frac{VMT}{Hh} = 19749\left(\frac{4.814 + Hh/RA}{4.814 + 7.140}\right)^{-0.639}$$

Based on this formula, the following elasticity formula is recommended for vehicle trips with respect to density. It is the same as Holtzclaw et. al' work, but reduced by 40% to take account of the fact that much of this impact will be realized through transit service, mix of uses and bicycle and pedestrian levels (which tends to correlate with density). The baseline assumed to correspond to a zero percent trip reduction is three units per acre, at which density the Holtzclaw formula results in 25,914 annual vehicle miles traveled per household. This translates into the following formula:

Trip reduction = 0.6(1-(19749*((4.814+ households per residential acre)/(4.814+7.14))-0.639)/25914)*

An apartment development of 16 units per residential acre, for example, would be estimated to generate 27.9% fewer trips than a three unit per acre project. The maximum allowable reduction recommended is 55% (equivalent to a 380 unit per acre development).

With this formula, "negative" reductions also apply, with less dense developments below the baseline level of three units per acre (for example large-lot housing) resulting in higher trip generation rates. (However, as long as the mitigation component is optional for developers or project proponents to complete, they will be unlikely to use it for projects whose overall score, for all components, will result in a finding to their disadvantage. For purposes of more accurately predicting vehicle trips and emissions, however, this negative reduction is useful and reflects the findings of the research literature.

Trip generation at the non-residential end is also influenced by density, but to a much lesser degree (Cervero, 1989, cited in Kuzmyak et. al, 2003). There are also far fewer studies investigating this relationship, and there is no comparable dataset to that for residential density. No reduction is recommended here.

Mix of Uses

Many references point to the impact of "diversity" or mix of uses on travel behavior. This is true both at the macro-scale, e.g. jobs-housing balance, and the micro-scale, e.g. the availability of services within walking distance. Key references, related to both the direction and magnitude of this relationship, include:

- Higher densities are most beneficial to transit ridership when they result in a mix of residential, commercial and office uses (Lund et. al., 2004).
- The elasticity of vehicle trips with respect to "diversity" is –0.051. The elasticity of VMT is –0.032. In this case, "diversity" is a measure of how the project affects regional population/employment balance. (Criterion and Fehr & Peers, 2001)
- Typical elasticities for vehicle trips with respect to local diversity (mix) are –0.03, and those for VMT are –0.05 (Ewing & Cervero, 2001).

- A balance of 1.5 jobs per household is estimated to produce a bus mode share 2 percentage points over the share for a single use area, although the degree of mix is not a useful estimating variable (Messenger & Ewing, 1996, cited in Kuzmyak et. al, 2003).
- Suburban activity centers with some on-site housing had 3-5% more transit, bike and walk commute trips (Cervero, 1989, cited in Kuzmyak et. al, 2003).
- The presence of retail reduces auto mode share by 2-5%, depending on neighborhood density. (Parsons Brinkerhoff, 1996, cited in Kuzmyak et. al, 2003).
- At suburban activity centers, the presence of retail in office buildings lowers vehicle trip rates by 6-8% (NTI, 2000, cited in Kuzmyak et. al, 2003).

4. Employment sites with "good" nearby retail and commercial services have a vehicle trip rate 21.5% below the ambient rate. Sites with "fair" services showed an 8.3% reduction, and those with "poor" services a 5.3% reduction. This is attributed not just to the presence of these services, but the fact that they make TDM programs more likely to succeed (Comsis, 1994, cited in Kuzmyak et. al, 2003).

The analysis is complicated by the fact that some of the most beneficial developments from this perspective may be single-use, in an area where another use is predominant (e.g. residential in an employment area). To take this into account, the following procedure is proposed (adapted from Criteron and Fehr & Peers, 2001):

$$\textit{Trip reduction} = (1 - (ABS(1.5 * h - e) / (1.5 * h + e)) - 0.25) / 0.25 * 0.03$$

Where: h = *study area households (or housing units)*
e = *study area employment*

Negative reductions of up to 3% can result, and should be included.

This formula assumes an "ideal" housing balance of 1.5 jobs per household, based on Messenger & Ewing (1996), and a baseline diversity of 0.25. The maximum possible reduction using this formula is 9%.

This reduction takes into account overall jobs-population balance. The presence of local serving *retail* can be expected to bring further trip reduction benefits, and an additional reduction of 2% is recommended. This is towards the lower end of the values presented in the research discussed above, in order to avoid double counting with the diversity indicator.

Transit

The existing URBEMIS 2002 mitigation model places its primary emphasis on mode, i.e. whether service is provided by high-speed rail, commuter rail or bus. Within this framework, consideration is given to frequency (e.g. bus headways of 15 minutes or less score more highly than headways of 15-30 minutes).

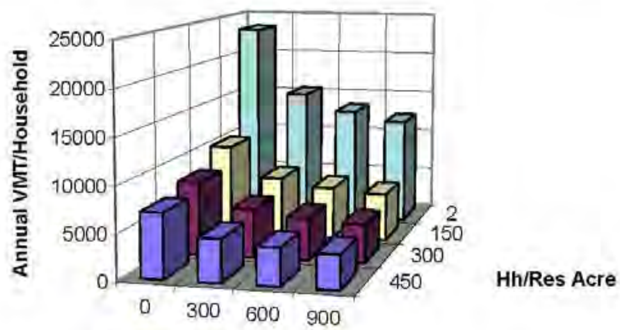
For example, the current mitigation component would award the maximum score of 100 to a development 0.5 miles from a BART station, even if no other transit were available. A part of the city with several bus lines offering 10-minute service, in contrast, would score much lower, even though these transit lines would carry many more passengers.

Current transit planning thinking, however, emphasizes that frequency and speed are two of the most important factors determining mode choice, rather than whether the service is provided by bus, bus rapid transit, or rail. Researchers have found that there is no *inherent* preference for rail over bus, provided that the quality of service is the same (for example, Ben-Akiva & Morikawa, cited in Transportation & Land Use Coalition, 2002).

Key references include:

- The average elasticity of ridership with respect to frequency is +0.3 to +0.5. Higher elasticities of +1.0 have been observed in suburban systems, with the +0.3 value more typical of urban systems. (Kittselson & Associates et. al, 2003).
- Pratt et. al. (2003) suggest an elasticity of ridership with respect to service hours (i.e. a combined measure of frequency and service span) of +0.5. Ridership is most sensitive to frequency changes when the past service was infrequent.
- Modeling in Massachusetts suggests that halving transit service headways from 30 to 15 minutes leads to an 8% drop in vehicle trips. A further decrease to 5 minutes leads to a further 4% drop in vehicle trips (Pratt et. al., 2003).
- Holtzclaw et. al. (2002) show that vehicle travel falls as transit service levels increase, even when holding density constant (Figure D-7). In the San Francisco Bay Area, a doubling of transit service from 300 to 600 (using the index described below) is associated with a 13% drop in VMT. An increase from 300 to 900 is associated with a 20% drop in VMT. In the Los Angeles region, the decreases in VMT are 12% and 18% respectively. However, the variable was omitted from the vehicle travel model presented in this paper, since density was used as a proxy for transit service.
- The maximum distance that people are willing to walk to transit tends to be 0.25 miles for bus, and 0.5 miles for rail (and, presumably bus rapid transit). (Kittelson & Associates et. al, 2003). It is unclear whether there is a "distance decay" effect, whereas people are more likely to use transit at closer distances within this range (see Lund et. al, 2004).

Figure D-7. VMT vs. Residential Density and Transit Use, San Francisco Bay Area



Source: Holtzclaw et. al. (2002).

Unfortunately, the elasticity of service with respect to transit ridership is difficult to convert to vehicle trip reduction, firstly because the baseline ridership needs to be known, and secondly because only a proportion (18-67% is cited by Pratt et. al., 2003) of new transit trips were formerly made by private auto. While it is clear that there is a direct correlation between transit service and vehicle trips, it is difficult to employ these elasticities directly. For this reason, the approach here is more in line with the existing mitigation component, which assumes a maximum percentage reduction for transit, and then reduces this based on a transit environment factor.

Various frequency-based transit service indices have been developed which have shown strong correlations with ridership. For example:

- In Los Angeles, the quality of four components of transit service (MTA rail, Rapid Bus, local bus and regional services) were rated on a scale of 0-3 for each community area, and then summed to provide the Transit Service Index on a scale of 0-12. (Nelson\Nygaard, 2002b).
- The studies by Holtzclaw et. al. (2002) used Zonal Transit Density, defined as the daily average number of buses or trains per hour times the fraction of the zone within 1/4 mile of the bus stop, or 1/2 mile of the rail station or ferry terminal, summed for all transit routes in or near the zone.

The Transit Service Index recommended here would combine the important features of all these approaches, with emphasis on frequency but with greater weighting given to rail services. Greater weight is also given to dedicated shuttles, in recognition of the fact that these are likely to be more closely targeted to the needs of the development. The Transit Service Index would be determined as follows:

- Number of average daily weekday buses stopping within 1/4 mile of the site; plus

- *Twice* the number of daily rail or bus rapid transit trips stopping within 1/2 mile of the site
- *Twice* the number of dedicated daily shuttle trips
- Divided by 900, the point at which the maximum benefits are assumed. (This equates to a BART station on a single line, plus four bus lines at 15-minute headways.)
- Developments that are larger than 0.5 miles across in any direction must be broken into smaller units for purposes of determining the transit service index. The average of all units would then be used.

Figure D-8 shows some examples of how service frequencies translate into Transit Service Index scores (note these are additive, if a location has more than one component).

Figure D-8. Example Transit Service Index Scores

Transit Service	Score	Assumptions
BART (single line)	0.33	150 trips per day (15-20 minute headways in each direction from 4 AM-12 AM)
15-minute bus, 5 AM – 12 AM	0.17	
30-minute bus, 5 AM – 7 PM	0.06	
Amtrak San Joaquin	0.03	6 trips per day in each direction
Dedicated commute shuttle	0.02	5 trips per commute period (single direction)

As well as existing service, planned and funded transit service would be included in the calculation. Purely demand responsive service would not be included.

A maximum trip reduction of 15% is recommended. This is the same as the existing URBEMIS 2002 trip reduction for existing and planned transit service.

In order to account for non-motorized access to transit, we also recommend that half the reduction be dependent on the pedestrian/bicycle friendliness score (calculated in the following section), similar to the approach taken in the existing mitigation component. This ensures that places with good pedestrian and bicycle access to transit are rewarded.

*Trip reduction = t * 0.075+ t * ped/bike score * 0.075*

Where t = transit service index

Bicycle and Pedestrian

Since bicycle mode share and pedestrian mode share depend on similar neighborhood characteristics, such as a fine-grained street grid, we recommend that a single factor be used to account for both modes. The bicycle and pedestrian components of the URBEMIS 2002 mitigation component are already well developed. However, the inputs are largely subjective, and there is still little evidence to justify the precise amount of credits for many of the individual mitigation measures (e.g. street trees).

Many street design factors have, however, been shown to promote walking and cycling. These include:

- Street connectivity, with traditional street networks that are more New Urbanist or grid-like, as opposed to the loops, lollipops and cul-de-sacs of most conventional subdivision. There are various measures of connectivity (summarized in Dill, 2003), such as:
  - Block length, size or density
  - Intersection density
  - Street density
  - Connected node ratio (number of street intersections divided by the number of intersections plus cul-de-sacs)
  - Link-node ratio (links are roadway or pathway segments between two nodes, which are intersections or cul-de-sac ends)
  - Grid pattern (percentage of intersections that are four- or more way).
  - Pedestrian Route Directness (ratio of route distance to straight line distance)
  - Effective Walking Area (% of parcels within 1/4 mile, that are also within 1/4 mile walking distance)
- Human-scale streetscapes with adequate pedestrian amenities, access to shopping and other amenities, and higher densities (Lund et. al., 2004)

Other relevant research includes:

- A composite indicator, the "Pedestrian Environment Factor," provides a statistically significant correlation with trip generation and VMT. It is comprised of four inputs (Parsons Brinkerhoff, 1993):
  - Ease of street crossings
  - Sidewalk continuity
  - Local street characteristics (grid vs. cul de sac)
  - Topography
- In Portland, OR, an increase in the PEF from "pedestrian hostile" to "almost average" reduces daily vehicle trips by 0.4 per household (7%). An increase from "almost average" to "fairly good" provides a daily reduction of 0.2 trips (Parsons Brinkerhoff, 1993, cited in Kuzmyak et. al, 2003).
- Sidewalk completeness, route directness and network density together have a vehicle trip elasticity of –0.05 (Ewing & Cervero, 2001).
  - For a high degree of walkability, block lengths of approximately 300 feet are recommended. Short blocks provide more pedestrian crossing opportunities and direct walking routes, and mean that traffic is more likely to be dispersed. Downtown Los Angeles, for comparison, has about 150 intersections per square mile. (Ewing, 1999).

There is a strong tradeoff here between simplicity and low data requirements on the one hand, and robustness and accuracy on the other. Pedestrian and bicycle level of service work for the Florida Department of Transportation and FHWA, for example, has shown that there are numerous statistically significant factors that can be included to assess the quality of the bicycle and pedestrian environment. These include motor vehicle volumes and speeds, truck volumes, roadway widths, urban design, and lateral separation between pedestrians and motor vehicles (for example, FHWA, 1998; Landis et. al, 2001).

However, we recommend that in order to keep data requirements to a minimum, one or two of the street design indicators discussed by Dill (2003) and Ewing and Cervero (2001) be used, together with a single bicycle measure. Since route directness and network density measure similar characteristics, we recommend the use of one of these (network density, which is inversely related to block size) plus sidewalk completeness and bicycle network completeness. The pedestrian/bicycle factor would then be calculated as follows:

Ped/bike factor = (network density + sidewalk completeness + bike lane completeness) / 3

Where: Network density = intersections per square mile / 1300 (or 1.0, whichever is less)

Note: In most GIS applications, intersections are counted based on the number of line segment terminations, or each "valence." Intersections have a valence of 3 or higher – a valence of 3 is a "T" intersection, 4 is a four-way intersection, and so on.[4] (Georgia Institute of Technology, 2002). Therefore, if intersections are counted manually on a map or project plan, care needs to be taken to distinguish between 3-, 4- and 5-way intersections, and factor them up accordingly. The 1,300 value roughly equates to a dense grid with four-way intersections every 300 feet, per the recommendation of Ewing (1999). Intersections with dedicated routes for pedestrians and/or bicyclists should be included in this calculation.

*Sidewalk completeness = % streets with sidewalks on both sides + 0.5 * % streets with sidewalk on one side*

Bike lane completeness = % arterials and collectors with bicycle lanes, or where suitable, direct parallel routes exist

A maximum reduction of 9% is proposed, based on the existing URBEMIS mitigation component.[5] The trip reduction would then be calculated as:

*Trip reduction = 9% * ped/bike factor*

No reduction should be allowed if the entire area within a half-mile walk of the project center consists of a single use. (Note that this applies to a half-mile walk, rather than straight-line

[4] A valence of 1 indicates that a line segment has terminated, e.g. in a cul-de-sac. A valence of 2 means that the street is continuing.

[5] Note that this excludes the bicycle reduction in the current mitigation component. However, this compensates for the fact that the reductions recommended for the mixed use and density variables will be realized in practice through pedestrian and bicycle mode share.

distance, to account for barriers such as freeways.) However, the ped/bike factor can still be used to calculate pedestrian access to transit, as part of the transit mitigation measure.

Affordable and Senior Housing

A significant amount of evidence points to the fact that lower-income households and senior citizens own fewer vehicles and drive less. Research includes:

- Russo (2001) cites evidence from the San Francisco Bay Area travel survey, which shows that households earning under $25,000 per year make 5.5 vehicle trips per day, compared to a regional average of 7.6. High income households (earning more than $75,000 per year) make an average of 10.5 trips. Note that this data does not control for other factors, such as density and transit access.
- In the San Francisco Bay Area, Los Angeles and Chicago, income was one of four variables with sufficient independent explanatory power to include in the model of VMT and vehicle ownership (Holtzclaw et. al., 2002).

Obviously, it is difficult if not impossible to account for the exact incomes of residents in URBEMIS, most obviously because the occupants are not known at the pre-development stage. However, the percentage of deed-restricted below-market-rate (BMR) housing does offer a way to incorporate this effect.

We recommend a 3% reduction in vehicle trips for each deed-restricted BMR unit.[6] Thus, the total reduction is as follows:

*Trip reduction = % units that are BMR * 0.04*

A development with 20% BMR units would thus gain a 0.8% reduction. A development with 100% BMR units would gain a 4% reduction.

Parking Supply

Significant correlations between parking supply and employee mode split have been observed. For example, a study of the link between parking availability and transit use in eight Canadian downtowns found an extremely high elasticity of –0.77 (Morrall & Bolger, 1996, cited in Kuzmyak et. al., 2003b). In California, the number of parking spaces per worker was found to be one of the main two elements of a binomial logit model predicting transit mode share among TOD office workers (Lund et. al, 2004).

As with residential density, the extent to which parking supply itself is a causal factor is uncertain. In practice, it probably serves as a proxy for variables such as price, high quality public transit, mix of uses, and pedestrian friendliness (Kuzmyak et. al., 2003b). Indeed, in

[6] Calculated from Holtzclaw et. al. (2002), assuming 12,000 average annual VMT per vehicle, median per capita income of $33,000 (2002 figures per California State Department of Finance), and an average income in BMR units 25% below median. Holtzclaw calculate the coefficient of -0.0565. Therefore, expected VMT reduction can be calculated as 0.0565 * 33,000 * 0.25 / 12,000 = 4%

practice there is a two-way relationship between parking supply and mode split. Free parking, for example, can be seen as both a cause of high parking supply (more parking is needed to satisfy the greater demand), and a consequence (the market price of parking is zero once an effectively unlimited supply is provided) (see, for example, Shoup, 1999).

Theoretically, it is possible to reduce parking provision to below the level of actual demand, should drivers park in neighboring lots or on-street in surrounding areas. However, planning approval is not likely to be granted for developments that significantly under-provide parking, unless complementary Residential Permit Parking programs or other measures to combat this type of overspill are introduced. Indeed, the main reason for minimum parking requirements levied by local jurisdictions is to address these overspill issues (Shoup, 1999).

Similarly, market realities are likely to prevent a developer from providing too little parking. The challenges in persuading lenders to finance developments that have below-code parking are difficult enough to overcome, even where there is clear, documented evidence to show that parking supply will be enough to meet demand (see for example, Parzen & Sigal, 2004). In contrast, the opposite tendency is likely to be apparent – that developments are prevented from taking full advantage of the opportunities to reduce parking supply by zoning codes (see, for example, Nelson\Nygaard, 2002).

The measure proposed here uses the Institute of Transportation Engineers' *Parking Generation* handbook as the baseline. This is assumed to equate to unconstrained demand. The trip reduction can therefore be calculated as follows:

Trip reduction = Actual parking provision / ITE Parking Generation rate

Since ITE parking generation rates use the same land use codes as the trip generation rates, these could be provided within the URBEMIS model itself. The user would only be required to enter the actual parking provision for each land use.

For land uses with rates for both weekday and weekend, the formula will use whichever rate is higher. The *Parking Generation* handbook covers most common land uses. For some land uses, however, no parking generation rates are available: in these cases, this particular mitigation measure may not be used.[7] Those land uses without parking generation rates include:

- Single Family Detached Housing
- Mid-rise Apartments
- High-rise Condominium/Townhouse
- Mobile Home Parks

[7] The next edition of *Parking Generation*, currently under development by an ITE Task Force, is likely to provide date for some of these missing land uses. While it would be ideal to have parking generation data for every single land use before introducing this mitigation measure into URBEMIS, the data does not yet exist. Rather than abandoning this mitigation measure entirely until perfect data exists, we recommend allowing the measure to be used for the many land uses where reasonable data is available.

- Residential Planned Unit Development (PUD)
- Day-care center
- Elementary school
- Junior High school
- Library
- City Park
- Discount Superstore
- Discount Club
- Electronic Superstore
- Home Improvement Superstore
- Gas/Service Station
- Pharmacy/Drugstore with and with/out Drive Through
- Medical Office Building
- General Heavy Industry

To avoid double counting with other trip reduction measures, the impacts of parking supply are proposed to be assessed in conjunction with all other non-residential trip reduction measures as follows:

- The total of all other non-residential trip reduction measures should be used if this is greater than or equal to the trip reduction from parking supply measures. For example, if parking supply is reduced 10% from ITE levels, and transit, mixed use and pedestrian/bicycle trip reductions amount to 20%, the 20% figure would be used.
- If the total of all other non-residential trip reduction measures (r_1) is less than the trip reduction from parking supply measures (r_2), the total trip reduction is as follows:

$$r_1 + 0.5 * (r_2 - r_1)$$

In effect, the parking supply reduction is only used if it is greater than the impact from other trip reduction measures, and the difference is discounted by 50%. For example, if parking supply is reduced 25% from ITE levels, and transit, mixed use and pedestrian/bicycle credits amount to 15%, the total reduction would be:

$$15 + 0.5 * (25\text{-}15) = 20\%.$$

This reduction should only be granted if measures to control overspill are in place, such as Residential Permit Parking programs, time limits or meters.

Transportation Demand Management

Transportation Demand Management programs have been shown to have a major impact on travel behavior. Site-level employee vehicle trip reductions of up to 38% have been achieved, particularly for programs that have included parking pricing (Shoup & Willson, 1980; Comsis, 1993; Valk & Wasch, 1998; Pratt, 2000). Parking price elasticities of –0.1 to –0.3 have been reported (Pratt, 2000).

This component of the existing URBEMIS 2002 mitigation component is well developed. However, there is considerable scope to adapt it in two ways:

- Provide greater emphasis for the three elements that have the greatest impact on travel behavior – parking pricing/cash out; free transit passes; and telecommuting.
- Simplify the remaining elements, through offering broader options such as "major program", "minor program", and "no program," for elements that are likely to have a smaller trip reduction potential.

We recommend that none of these reductions be permitted, unless they form part of a legally enforceable agreement specifying, for example, minimum parking prices and other TDM measures. This might form part of a development agreement, be enforced through any TDM ordinance in the local jurisdiction, or consist of another mechanisms mutually agreed by the air district and project proponent. Otherwise, there is little to guarantee that some of the promised measures (e.g. parking pricing) will actually be implemented and maintained.

Parking Pricing and Cash Out

We recommend that a maximum trip reduction of 25% be applied to projects that commit to introducing parking pricing. This is based on the approximate midpoint of observed reductions, which range from 15% to 38% (Shoup & Willson, 1990; Comsis, 1993; Pratt, 2000). Note that most of these studies apply to before-after or with-without comparisons, with no increase in transit service or other measures to reduce vehicle trips. This maximum reduction should apply to prices of $6 per day or greater (in 2004 dollars).

The trip reduction will therefore be as follows:

*Trip reduction = daily parking charge / 6 * 0.25*

If the parking charge is more than $6, the 25% reduction is taken. If parking charges do not apply to all trips to a site (e.g. customers are exempt), the reduction is pro-rated by the percentage of trips that the charges apply to. If little or no on-site parking is provided, the parking charges should be those of surrounding public facilities.

Parking cash-out programs should be eligible for 50% of the reduction for direct parking charges, in recognition of the fact that their impacts tend to be significantly lower (Pratt, 2000). This is partly due to the fact that cash-out payments are a taxable benefit.

Free Transit Passes

Some California transit agencies, most notably VTA in Santa Clara County, have EcoPass or similar programs, whereby employers or property manager's bulk-purchase transit passes for (free) distribution to their employees or tenants. Eco Pass programs have been shown to increase transit ridership by 50-79% (City of Boulder, undated; Caltrans, 2002), and reduce vehicle trips by 19% (Shoup, 1999). (Note that many of these new riders were making new trips, or ones previously made by walking or cycling.)

We therefore recommend that any project committing to providing free transit passes would receive an additional credit equivalent to 25% of the reduction granted for transit service. Thus, the credit is more valuable in places that have good transit service. This reduction would only apply to the portion of trips generated by those granted the free transit passes (e.g. residents and/or employees, but excluding shoppers and other visitors).

Telecommuting

We recommend the retention of the reductions granted for telecommuting and compressed work schedules in the existing mitigation component, with two clarifications:

- As with the reductions for other mitigation measures, there must be an enforceable commitment (e.g. development agreement), which covers both the take-up rate (employees actually telecommuting or using compressed work schedules) as well as the provision of the option.
- The percentage reduction should not be additive (in contrast to most other trip reduction measures). For example, if 20% of employees telecommute, and other trip reduction measures are estimated to reduce vehicle trips from 1,000 to 800 per day, the 20% reduction would apply to the 800 trips, not the original 1,000.

Other TDM Programs

Other TDM program elements, that do not include financial incentives, tend to have a smaller impact on travel behavior. We recommend that reductions be based on the number of the following elements incorporated into the program, per Figure D-7:

- Secure bicycle parking (at least one space per 20 vehicle parking spaces)
- Showers/changing facilities
- Guaranteed Ride Home
- Car-sharing services
- Information on transportation alternatives, such as bus schedules and bike maps
- Dedicated employee transportation coordinator
- Carpool matching programs
- Preferential carpool/vanpool parking

The impact of a TDM program will also depend on the travel alternatives available. A program will have more impact if the site is served by frequent transit, for example (although note that a TDM program can do much to promote carpooling even in other locations). For this reason, we recommend that part of the TDM credit be used to adjust the credits granted for transit service and pedestrian/bicycle friendliness (see Figure D-9).

Figure D-9. Recommended TDM Program Reductions

Level	Number of Elements	Recommended Reduction
Major	At least 5 elements	2%, plus 10% of the credit for transit and pedestrian/ bike friendliness
Minor	At least 3 elements	1%, plus 5% of the credit of transit and pedestrian/bike friendliness
No program	None	None

Examples

It is important to recognize that any type of calibration is beyond the scope of this analysis, which relies on existing references to build on the ranges established in the existing mitigation component. Figure D-10, however, does provide some examples to indicate the trip reductions that would apply to specific places.

The data are drawn from the database compiled for the Location Efficient Mortgage program (for details, see Holtzclaw et. al., 2002), and from the San Francisco Bay Area Metropolitan Transportation Commission's TAZ files. For these reasons, the examples are limited to the San Francisco Bay Area. Transit service was estimated from schedules and route maps. Sidewalk and bike lane completeness were estimated based on local knowledge. For these reasons of limited data, the examples are intended as illustrations only, rather than to refer to a particular project.

The reductions are calculated for the physical and environmental factors only, for residential uses. They exclude any additional reductions from TDM programs and affordable housing.

The final column compares average vehicle miles traveled (no vehicle trip data were readily available) in these neighborhoods to the Brentwood baseline, as a rough comparison to the reductions granted through the proposed trip reductions for URBEMIS. As can be seen, while there are significant discrepancies, the overall correspondence is acceptable for this type of sketch planning model.

Figure D-10. Example Trip Reductions

		Vehicle Trip Reduction Granted For:						
Example	TAZ	Residential Density	Mix of Uses	Local Retail	Transit	Ped/Bike Friendliness	Total Reduction	% Reduction in VMT from Brentwood
Brentwood	899	1.4%	-3.0%	0.0%	0.1%	1.7%	0.3%	0.0%
Orinda	831	-9.5%	5.8%	0.0%	3.7%	1.4%	1.4%	5.6%
Pleasant Hill BART	806	14.4%	7.2%	3.0%	8.3%	3.3%	36.3%	40.2%
Emeryville	723	39.0%	1.7%	3.0%	4.4%	4.9%	53.1%	47.8%
Downtown Palo Alto	245	19.8%	4.4%	3.0%	6.1%	7.5%	40.8%	50.6%

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Appendix E. California Air District Contacts

Go to the following web site for a list of air district contacts:

http://www.arb.ca.gov/capcoa/roster.htm

Appendix F. State Of California Counties and Air Basins

A California Air Basin map is available on the internet at:
http://www.arb.ca.gov/knowzone/basin/basin.swf

and information on local air districts can be found at:
www.arb.ca.gov/capcoa/roster.htm

Appendix G. Construction Equipment Emission Factors

Equipment	MaxHP	AvgHP	Load
Aerial Lifts	15	15	0.46
Aerial Lifts	25	19	0.46
Aerial Lifts	50	34	0.46
Aerial Lifts	120	66	0.46
Aerial Lifts	500	369	0.46
Aerial Lifts	750	667	0.46
Air Compressors	15	12	0.48
Air Compressors	25	24	0.48
Air Compressors	50	37	0.48
Air Compressors	120	78	0.48
Air Compressors	175	147	0.48
Air Compressors	250	218	0.48
Air Compressors	500	385	0.48
Air Compressors	750	595	0.48
Air Compressors	1000	808	0.48
Bore/Drill Rigs	15	11	0.75
Bore/Drill Rigs	25	17	0.75
Bore/Drill Rigs	50	33	0.75
Bore/Drill Rigs	120	82	0.75
Bore/Drill Rigs	175	150	0.75
Bore/Drill Rigs	250	200	0.75
Bore/Drill Rigs	500	331	0.75
Bore/Drill Rigs	750	654	0.75
Bore/Drill Rigs	1000	987	0.75
Cement and Mortar Mixers	15	9	0.56
Cement and Mortar Mixers	25	25	0.56
Concrete/Industrial Saws	25	18	0.73
Concrete/Industrial Saws	50	33	0.73
Concrete/Industrial Saws	120	81	0.73
Concrete/Industrial Saws	175	175	0.73
Cranes	50	43	0.43
Cranes	120	93	0.43
Cranes	175	149	0.43
Cranes	250	208	0.43
Cranes	500	334	0.43
Cranes	750	562	0.43
Cranes	9999	1800	0.43
Crushing/Proc. Equipment	50	45	0.78

Equipment	MaxHP	AvgHP	Load
Crushing/Proc. Equipment	120	85	0.78
Crushing/Proc. Equipment	175	171	0.78
Crushing/Proc. Equipment	250	250	0.78
Crushing/Proc. Equipment	500	382	0.78
Crushing/Proc. Equipment	750	602	0.78
Crushing/Proc. Equipment	1000	1337	0.78
Dumpers/Tenders	50	16	0.38
Excavators	120	23	0.57
Excavators	175	35	0.57
Excavators	250	103	0.57
Excavators	500	157	0.57
Excavators	750	222	0.57
Excavators	9999	327	0.57
Excavators	25	542	0.57
Forklifts	25	39	0.3
Forklifts	50	83	0.3
Forklifts	120	149	0.3
Forklifts	175	205	0.3
Forklifts	250	295	0.3
Generator Sets	500	11	0.74
Generator Sets	750	19	0.74
Generator Sets	50	33	0.74
Generator Sets	120	84	0.74
Generator Sets	175	153	0.74
Generator Sets	250	229	0.74
Generator Sets	500	363	0.74
Generator Sets	15	586	0.74
Generator Sets	25	1130	0.74
Graders	50	36	0.61
Graders	120	98	0.61
Graders	175	162	0.61
Graders	250	225	0.61
Graders	500	300	0.61
Graders	750	635	0.61
Off-Highway Tractors	9999	115	0.65
Off-Highway Tractors	50	160	0.65
Off-Highway Tractors	120	160	0.65
Off-Highway Tractors	175	697	0.65
Off-Highway Tractors	250	999	0.65
Off-Highway Trucks	500	175	0.57
Off-Highway Trucks	750	233	0.57

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Equipment	MaxHP	AvgHP	Load
Off-Highway Trucks	120	381	0.57
Off-Highway Trucks	175	618	0.57
Off-Highway Trucks	250	874	0.57
Other General Industrial Equipment	750	10	0.51
Other General Industrial Equipment	1000	24	0.51
Other General Industrial Equipment	175	34	0.51
Other General Industrial Equipment	250	97	0.51
Other General Industrial Equipment	500	150	0.51
Other General Industrial Equipment	750	212	0.51
Other General Industrial Equipment	1000	415	0.51
Other General Industrial Equipment	15	684	0.51
Other General Industrial Equipment	25	875	0.51
Other Material Handling Equipment	50	41	0.59
Other Material Handling Equipment	120	82	0.59
Other Material Handling Equipment	175	165	0.59
Other Material Handling Equipment	500	196	0.59
Other Material Handling Equipment	15	259	0.59
Other Material Handling Equipment	25	1002	0.59
Pavers	50	24	0.62
Pavers	120	36	0.62
Pavers	175	89	0.62
Pavers	250	165	0.62
Pavers	500	250	0.62
Pavers	750	300	0.62
Paving Equipment	1000	19	0.53
Paving Equipment	50	36	0.53
Paving Equipment	120	82	0.53
Paving Equipment	175	152	0.53
Paving Equipment	250	184	0.53
Pressure Washers	500	13	0.3
Pressure Washers	9999	19	0.3
Pressure Washers	25	38	0.3
Pressure Washers	50	64	0.3
Pressure Washers	120	152	0.6
Pressure Washers	175	191	0.6
Pumps	250	8	0.74
Pumps	500	21	0.74
Pumps	25	37	0.74
Pumps	50	84	0.74
Pumps	120	151	0.74
Pumps	175	217	0.74

Equipment	MaxHP	AvgHP	Load
Pumps	250	372	0.74
Pumps	15	615	0.74
Pumps	15	1460	0.74
Rollers	25	9	0.56
Rollers	50	19	0.56
Rollers	120	37	0.56
Rollers	15	84	0.56
Rollers	25	154	0.56
Rollers	50	218	0.56
Rollers	120	312	0.56
Rough Terrain Forklifts	175	45	0.6
Rough Terrain Forklifts	250	83	0.6
Rough Terrain Forklifts	500	166	0.6
Rough Terrain Forklifts	750	227	0.6
Rough Terrain Forklifts	9999	341	0.6
Rubber Tired Dozers	15	175	0.59
Rubber Tired Dozers	25	248	0.59
Rubber Tired Dozers	50	358	0.59
Rubber Tired Dozers	120	539	0.59
Rubber Tired Dozers	175	800	0.59
Rubber Tired Loaders	250	25	0.54
Rubber Tired Loaders	500	46	0.54
Rubber Tired Loaders	50	87	0.54
Rubber Tired Loaders	120	157	0.54
Rubber Tired Loaders	175	220	0.54
Rubber Tired Loaders	250	350	0.54
Rubber Tired Loaders	500	717	0.54
Rubber Tired Loaders	175	877	0.54
Scrapers	250	104	0.72
Scrapers	500	164	0.72
Scrapers	750	232	0.72
Scrapers	1000	356	0.72
Scrapers	25	615	0.72
Signal Boards	50	6	0.82
Signal Boards	120	37	0.78
Signal Boards	175	82	0.78
Signal Boards	250	158	0.78
Signal Boards	500	216	0.78
Skid Steer Loaders	750	20	0.55
Skid Steer Loaders	1000	37	0.55
Skid Steer Loaders	120	62	0.55

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Equipment	MaxHP	AvgHP	Load
Surfacing Equipment	175	25	0.45
Surfacing Equipment	250	113	0.45
Surfacing Equipment	500	152	0.45
Surfacing Equipment	750	239	0.45
Surfacing Equipment	15	392	0.45
Surfacing Equipment	50	615	0.45
Sweepers/Scrubbers	120	14	0.68
Sweepers/Scrubbers	175	23	0.68
Sweepers/Scrubbers	250	37	0.68
Sweepers/Scrubbers	25	88	0.68
Sweepers/Scrubbers	50	163	0.68
Sweepers/Scrubbers	120	190	0.68
Tractors/Loaders/Backhoes	50	23	0.55
Tractors/Loaders/Backhoes	120	44	0.55
Tractors/Loaders/Backhoes	175	75	0.55
Tractors/Loaders/Backhoes	250	147	0.55
Tractors/Loaders/Backhoes	500	249	0.55
Tractors/Loaders/Backhoes	750	500	0.55
Tractors/Loaders/Backhoes	15	750	0.55
Trenchers	25	9	0.75
Trenchers	50	35	0.75
Trenchers	120	35	0.75
Trenchers	175	69	0.75
Trenchers	250	153	0.75
Trenchers	25	237	0.75
Trenchers	50	331	0.75
Trenchers	120	624	0.75
Welders	175	11	0.45
Welders	250	20	0.45
Welders	500	46	0.45
Welders	750	70	0.45
Welders	15	174	0.45
Welders	25	211	0.45
Welders	50	297	0.45

Appendix H. Equipment Selection Spreadsheet

Demolition – One Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	1
Concrete Saw	1	8
Excavator		
Bore/Drill Rigs		
Other Equip (Water Truck)		
Tractor/Loader/Backhoe	2	6
	4	

Demolition – Two Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	1
Concrete Saw	1	8
Excavator		
Bore/Drill Rigs		
Other Equip (Water Truck)		
Tractor/Loader/Backhoe	2	6
	4	

Demolition – Three Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	1
Concrete Saw	1	8
Excavator		
Bore/Drill Rigs		
Other Equip (Water Truck)		
Tractor/Loader/Backhoe	2	6
	4	

Demolition – Five Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	1
Concrete Saw	1	8
Excavator		
Bore/Drill Rigs		
Other Equip (Water Truck)		
Tractor/Loader/Backhoe	2	6
	4	

Demolition – Ten Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	8
Concrete Saw	1	8
Excavator		
Bore/Drill Rigs		
Other Equip (Water Truck)		
Tractor/Loader/Backhoe	3	8
	5	

Demolition – Fifteen Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	8
Concrete Saw		
Excavator		
Bore/Drill Rigs		
Other Equip (Water Truck)		
Tractor/Loader/Backhoe	3	8
	4	

Demolition – Twenty Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	2	8
Concrete Saw		
Excavator	3	8
Bore/Drill Rigs		
Other Equip (Water Truck)		
Tractor/Loader/Backhoe		
	5	

Demolition – Twenty-five Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	2	8
Concrete Saw		
Excavator	3	8
Bore/Drill Rigs		
Other Equip (Water Truck)		
Tractor/Loader/Backhoe		
	5	

Demolition – Thirty Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	2	8
Concrete Saw		
Excavator	3	8
Bore/Drill Rigs		
Other Equip (Water Truck)		
Tractor/Loader/Backhoe		
	5	

Demolition – Thirty-four Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	2	8
Concrete Saw		
Excavator	3	8
Bore/Drill Rigs		
Other Equip (Water Truck)		
Tractor/Loader/Backhoe		
	5	

Grading – One Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	6
Excavators		
Graders	1	6
Scrapers		
Tractor/Loader/Backhoe	1	7
Water Truck	1	8
	4	

Grading – Two Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	6
Excavators		
Graders	1	6
Scrapers		
Tractor/Loader/Backhoe	1	7
Water Truck	1	8
	4	

Grading – Three Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	6
Excavators		
Graders	1	6
Scrapers		
Tractor/Loader/Backhoe	1	7
Water Truck	1	8
	4	

Grading – Five Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	6
Excavators		
Graders	1	6
Scrapers		
Tractor/Loader/Backhoe	1	7
Water Truck	1	8
	4	

Grading – Ten Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	8
Excavators		
Graders	1	8
Scrapers		
Tractor/Loader/Backhoe	2	7
Water Truck	1	8
	5	

Grading – Fifteen Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	8
Excavators		
Graders	1	8
Scrapers		
Tractor/Loader/Backhoe	2	7
Water Truck	1	8
	5	

Grading – Twenty Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	8
Excavators	1	8
Graders	1	8
Scrapers		
Tractor/Loader/Backhoe	3	8
Water Truck	1	8
	7	

Grading – Twenty-five Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	8
Excavators	1	8
Graders	1	8
Scrapers	2	8
Tractor/Loader/Backhoe	3	8
Water Truck	1	8
	9	

Grading – Thirty Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	8
Excavators	1	8
Graders	1	8
Scrapers	2	8
Tractor/Loader/Backhoe	3	8
Water Truck	1	8
	9	

Grading – Thirty-four Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	8
Excavators	1	8
Graders	1	8
Scrapers	2	8
Tractor/Loader/Backhoe	3	8
Water Truck	1	8
	9	

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Grading 73 acres		
Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	8
Excavators	1	8
Graders	1	8
Scrapers	3	8
Tractor/Loader/Backhoe	3	8
Water Truck	1	8
	10	

Grading 78 acres		
Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	8
Excavators	1	8
Graders	1	8
Scrapers	3	8
Tractor/Loader/Backhoe	3	8
Water Truck	1	8
	10	

Grading 86 acres		
Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	2	8
Excavators	1	8
Graders	1	8
Scrapers	3	8
Tractor/Loader/Backhoe	2	8
Water Truck	1	8
	10	

Grading 112 acres		
Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	2	8
Excavators		
Graders	2	8
Scrapers	4	8
Tractor/Loader/Backhoe	2	8
Water Truck	2	8
		8
	12	

Grading 138 acres		
Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	2	8
Excavators		
Graders	2	8
Scrapers	4	8
Tractor/Loader/Backhoe	1	8
Water Truck	2	8
Compactor	1	8
	12	

Grading 151 acres		
Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	2	8
Excavators		
Graders	2	8
Scrapers	5	8
Tractor/Loader/Backhoe	1	8
Water Truck	2	8
Compactor	1	8
	13	

Grading 189 acres		
Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	3	8
Excavators		
Graders	2	8
Scrapers	6	8
Tractor/Loader/Backhoe		
Water Truck	2	8
Compactor	1	8
	14	

Construction One Acre		
Equipment Type	No. of Equip	hr/day
Crane	1	4
Electric Welders		
Excavator		
Fork Lift	2	6
Generator Sets		
Tractor/Loader/Backhoe	1	8
	4	

Construction Two Acre		
Equipment Type	No. of Equip	hr/day
Crane	1	6
Electric Welders	3	8
Excavator		
Fork Lift	2	6
Generator Sets	1	8
Tractor/Loader/Backhoe	1	8
	8	

Construction Three Acre		
Equipment Type	No. of Equip	hr/day
Crane	1	6
Electric Welders	3	8
Excavator		
Fork Lift	2	6
Generator Sets	1	8
Tractor/Loader/Backhoe	1	8
	8	

Construction Five Acre		
Equipment Type	No. of Equip	hr/day
Crane	1	6
Electric Welders	3	8
Excavator		
Fork Lift	2	6
Generator Sets	1	8
Tractor/Loader/Backhoe	1	8
	8	

Construction Ten Acre		
Equipment Type	No. of Equip	hr/day
Crane	1	6
Electric Welders	3	8
Excavator		
Fork Lift	2	6
Generator Sets	1	8
Tractor/Loader/Backhoe	1	8
	8	

Construction Fifteen Acre		
Equipment Type	No. of Equip	hr/day
Crane	1	7
Electric Welders	3	8
Excavator		
Fork Lift	2	7
Generator Sets	1	8
Tractor/Loader/Backhoe	1	8
	8	

Construction Twenty Acre		
Equipment Type	No. of Equip	hr/day
Crane	1	7
Electric Welders	1	8
Excavator		
Fork Lift	3	8
Generator Sets	1	8
Tractor/Loader/Backhoe	3	7
	9	

Construction Twenty-five Acre		
Equipment Type	No. of Equip	hr/day
Crane	1	7
Electric Welders	1	8
Excavator		
Fork Lift	3	8
Generator Sets	1	8
Tractor/Loader/Backhoe	3	7
	9	

Construction Thirty Acre		
Equipment Type	No. of Equip	hr/day
Crane	1	7
Electric Welders	1	8
Excavator		
Fork Lift	3	8
Generator Sets	1	8
Tractor/Loader/Backhoe	3	7
	9	

Construction Thirty-four Acre		
Equipment Type	No. of Equip	hr/day
Crane	1	7
Electric Welders	1	8
Excavator		
Fork Lift	3	8
Generator Sets	1	8
Tractor/Loader/Backhoe	3	7
	9	

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Coating/Paving One Acre		
Equipment Type	No. of Equip	hr/day
Pavers	1	7
Paving Equipment		
Cement Mortar Mixers	4	6
Plate Compactor		
Roller	1	7
Tractor/Loader/Backhoe	1	7
	7	

Coating/Paving Two Acre		
Equipment Type	No. of Equip	hr/day
Pavers	1	7
Paving Equipment	1	8
Cement Mortar Mixers	4	6
Plate Compactor		
Roller	1	7
Tractor/Loader/Backhoe	1	7
	8	

Coating/Paving Three Acre		
Equipment Type	No. of Equip	hr/day
Pavers	1	7
Paving Equipment	1	8
Cement Mortar Mixers	4	6
Plate Compactor		
Roller	1	7
Tractor/Loader/Backhoe	1	7
	8	

Coating/Paving Five Acre		
Equipment Type	No. of Equip	hr/day
Pavers	1	7
Paving Equipment	2	6
Cement Mortar Mixers	4	6
Plate Compactor		
Roller	1	7
Tractor/Loader/Backhoe	1	7
	9	

Coating/Paving Ten Acre		
Equipment Type	No. of Equip	hr/day
Pavers	1	7
Paving Equipment	2	6
Cement Mortar Mixers	4	6
Plate Compactor		
Roller	1	7
Tractor/Loader/Backhoe		
	8	

Coating/Paving Fifteen Acre		
Equipment Type	No. of Equip	hr/day
Pavers	1	8
Paving Equipment	2	6
Cement Mortar Mixers		
Plate Compactor		
Roller	2	6
Tractor/Loader/Backhoe		
	5	

Coating/Paving Twenty Acre		
Equipment Type	No. of Equip	hr/day
Pavers	1	8
Paving Equipment	2	6
Cement Mortar Mixers		
Plate Compactor		
Roller	2	6
Tractor/Loader/Backhoe		
	5	

Coating/Paving Twenty-five Acre		
Equipment Type	No. of Equip	hr/day
Pavers	1	8
Paving Equipment	2	6
Cement Mortar Mixers		
Plate Compactor		
Roller	2	6
Tractor/Loader/Backhoe		
	5	

Coating/Paving Thirty Acre		
Equipment Type	No. of Equip	hr/day
Pavers	1	8
Paving Equipment	2	8
Cement Mortar Mixers		
Plate Compactor		
Roller	2	6
Tractor/Loader/Backhoe		
	5	

Coating/Paving Thirty-four Acre		
Equipment Type	No. of Equip	hr/day
Pavers	1	8
Paving Equipment	2	8
Cement Mortar Mixers		
Plate Compactor		
Roller	2	6
Tractor/Loader/Backhoe		
	5	

Trenching 1-90 acres	No. of Equip	hr/day
Boom Trucks (Other Industrial)	1	8
Excavators	2	8
Loader	1	8

Trenching 90+ acres	No. of Equip	hr/day
Boom Trucks (Other Industrial)	2	8
Excavators	4	8
Loader	2	8

Trenching based on information from SMAQMD and assumes 1 trenching crew for up to 90 acres, 2 crews for projects in excess of 90 acres.

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Appendix I. Construction Equipment Emission Factors (grams per brake-horsepower hour)

2005		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	MaxHP	ROG	CO	NOX	SOX	PM	CO2
Aerial Lifts	15	0.386	1.649	2.533	0.036	0.181	261.653
	25	0.680	1.687	2.695	0.030	0.212	261.653
	50	1.194	2.756	2.781	0.030	0.295	261.653
	120	0.585	1.774	3.600	0.027	0.290	261.653
	500	0.238	0.975	2.843	0.023	0.094	261.653
	750	0.244	0.975	2.908	0.024	0.095	261.653
Air Compressors	15	0.640	2.065	3.615	0.038	0.287	273.029
	25	0.740	1.816	2.830	0.031	0.225	273.029
	50	1.639	3.619	3.053	0.032	0.372	273.029
	120	0.697	1.996	4.025	0.029	0.362	273.029
	175	0.458	1.593	3.679	0.028	0.200	273.029
	250	0.320	0.893	3.465	0.028	0.126	273.029
	500	0.283	1.135	3.129	0.024	0.114	273.029
	750	0.289	1.135	3.201	0.025	0.115	273.029
	1000	0.353	1.397	3.757	0.025	0.124	273.029
Bore/Drill Rigs	15	0.540	2.605	3.562	0.060	0.255	426.608
	25	0.633	1.898	3.885	0.049	0.251	426.608
	50	1.575	4.183	4.161	0.050	0.437	426.608
	120	0.770	2.814	4.894	0.045	0.432	426.608
	175	0.482	2.279	4.404	0.043	0.225	426.608
	250	0.275	0.810	4.140	0.043	0.104	426.608
	500	0.234	0.787	3.399	0.038	0.096	426.608
	750	0.247	0.787	3.591	0.040	0.099	426.608
	1000	0.361	0.968	4.832	0.040	0.127	426.608
Cement and Mortar Mixers	15	0.497	2.044	3.206	0.045	0.232	318.534
	25	0.821	2.042	3.269	0.037	0.256	318.534
Concrete/Industrial Saws	25	0.574	1.776	3.699	0.048	0.236	415.232
	50	2.201	4.972	4.533	0.049	0.518	415.232
	120	0.984	2.921	5.917	0.044	0.501	415.232
	175	0.645	2.335	5.405	0.042	0.276	415.232
Cranes	50	1.725	3.738	2.855	0.029	0.376	244.589
	120	0.688	1.905	3.878	0.026	0.363	244.589
	175	0.455	1.530	3.539	0.025	0.202	244.589
	250	0.343	0.956	3.380	0.025	0.138	244.589
	500	0.305	1.272	3.027	0.022	0.123	244.589
	750	0.308	1.270	3.091	0.023	0.124	244.589
	9999	0.342	1.450	3.543	0.023	0.120	244.589
Crawler Tractors	50	2.651	5.713	4.299	0.043	0.573	364.039
	120	1.073	2.925	6.034	0.039	0.559	364.039
	175	0.712	2.373	5.494	0.037	0.317	364.039
	250	0.552	1.551	5.268	0.037	0.225	364.039
	500	0.490	2.328	4.735	0.032	0.198	364.039
	750	0.494	2.324	4.823	0.034	0.200	364.039

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2005		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	1000	0.542	2.580	5.471	0.034	0.195	364.039
Crushing/Proc. Equipment	50	2.742	6.051	4.979	0.052	0.619	443.672
	120	1.144	3.276	6.553	0.047	0.601	443.672
	175	0.751	2.615	5.987	0.045	0.331	443.672
	250	0.518	1.434	5.633	0.045	0.205	443.672
	500	0.458	1.800	5.047	0.039	0.184	443.672
	750	0.462	1.726	5.167	0.041	0.184	443.672
	9999	0.573	2.193	6.122	0.041	0.200	443.672
Dumpers/Tenders	25	0.440	1.175	2.094	0.025	0.152	216.148
Excavators	25	0.419	1.342	2.812	0.037	0.179	324.222
	50	2.114	4.737	3.670	0.038	0.477	324.222
	120	0.844	2.453	4.727	0.034	0.463	324.222
	175	0.555	1.960	4.314	0.033	0.251	324.222
	250	0.378	1.010	4.072	0.033	0.146	324.222
	500	0.337	1.149	3.550	0.029	0.132	324.222
	750	0.342	1.148	3.661	0.030	0.134	324.222
Forklifts	50	1.162	2.554	1.949	0.020	0.258	170.643
	120	0.457	1.292	2.483	0.018	0.253	170.643
	175	0.303	1.022	2.286	0.017	0.137	170.643
	250	0.184	0.466	2.118	0.017	0.069	170.643
	500	0.164	0.480	1.852	0.015	0.063	170.643
Generator Sets	15	0.852	3.183	5.429	0.059	0.359	420.920
	25	0.875	2.799	4.364	0.048	0.311	420.920
	50	1.841	4.286	4.445	0.049	0.461	420.920
	120	0.923	2.822	5.727	0.045	0.454	420.920
	175	0.602	2.255	5.233	0.043	0.250	420.920
	250	0.417	1.249	4.929	0.043	0.159	420.920
	500	0.374	1.504	4.535	0.037	0.147	420.920
	750	0.386	1.504	4.640	0.038	0.149	420.920
	9999	0.503	1.876	5.458	0.038	0.180	420.920
Graders	50	2.312	5.089	3.970	0.041	0.514	346.974
	120	0.934	2.653	5.299	0.037	0.498	346.974
	175	0.615	2.129	4.834	0.035	0.275	346.974
	250	0.449	1.244	4.599	0.035	0.179	346.974
	500	0.398	1.610	4.086	0.031	0.160	346.974
	750	0.403	1.608	4.185	0.032	0.162	346.974
Off-Highway Tractors	120	1.163	3.084	6.557	0.039	0.590	369.727
	175	0.781	2.535	5.981	0.038	0.345	369.727
	250	0.638	1.817	5.777	0.038	0.263	369.727
	750	0.568	3.043	5.323	0.034	0.231	369.727
	1000	0.608	3.279	5.887	0.034	0.224	369.727
Off-Highway Trucks	175	0.579	2.004	4.418	0.033	0.261	324.222
	250	0.401	1.057	4.176	0.033	0.154	324.222
	500	0.361	1.220	3.644	0.029	0.139	324.222
	750	0.364	1.219	3.754	0.030	0.141	324.222
	1000	0.416	1.472	4.502	0.030	0.145	324.222
Other Construction Equipment	15	0.447	2.153	2.945	0.050	0.211	352.662

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2005		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	25	0.523	1.569	3.211	0.040	0.208	352.663
	50	1.843	4.255	3.781	0.041	0.440	352.663
	120	0.805	2.476	4.803	0.037	0.426	352.663
	175	0.524	1.981	4.381	0.036	0.231	352.663
	500	0.314	1.164	3.652	0.031	0.127	352.663
Other General Industrial Equipment	15	0.314	1.771	2.211	0.040	0.164	290.093
	25	0.373	1.201	2.521	0.033	0.160	290.093
	50	2.024	4.391	3.362	0.034	0.444	290.093
	120	0.806	2.235	4.471	0.030	0.432	290.093
	175	0.532	1.782	4.086	0.029	0.238	290.093
	250	0.365	0.984	3.843	0.029	0.143	290.093
	500	0.324	1.242	3.433	0.025	0.129	290.093
	750	0.329	1.242	3.514	0.026	0.131	290.093
	1000	0.392	1.540	4.134	0.026	0.137	290.093
Other Material Handling Equipment	50	2.310	5.016	3.874	0.039	0.507	335.598
	120	0.925	2.571	5.150	0.035	0.493	335.598
	175	0.610	2.051	4.707	0.034	0.272	335.598
	250	0.419	1.135	4.427	0.034	0.165	335.598
	500	0.372	1.434	3.959	0.029	0.148	335.598
	9999	0.452	1.777	4.766	0.029	0.157	335.598
Pavers	25	0.776	2.022	3.475	0.040	0.259	352.663
	50	2.466	5.310	4.129	0.041	0.536	352.663
	120	1.026	2.805	5.883	0.037	0.523	352.663
	175	0.682	2.286	5.353	0.036	0.300	352.663
	250	0.545	1.566	5.152	0.036	0.225	352.663
	500	0.482	2.452	4.671	0.031	0.197	352.663
Paving Equipment	25	0.447	1.341	2.745	0.035	0.177	301.470
	50	2.086	4.493	3.522	0.035	0.454	301.470
	120	0.871	2.383	5.005	0.032	0.443	301.470
	175	0.577	1.939	4.551	0.031	0.253	301.470
	250	0.463	1.334	4.381	0.031	0.191	301.470
Plate Compactors	15	0.321	1.496	2.147	0.034	0.152	244.588
Pressure Washers	15	0.345	1.291	2.201	0.024	0.145	170.643
	25	0.355	1.135	1.769	0.020	0.126	170.643
	50	0.612	1.486	1.752	0.020	0.165	170.643
	120	0.344	1.093	2.223	0.018	0.163	170.643
Pumps	15	0.986	3.183	5.574	0.059	0.442	420.920
	25	1.141	2.799	4.364	0.048	0.347	420.920
	50	1.953	4.495	4.487	0.049	0.479	420.920
	120	0.948	2.864	5.808	0.045	0.471	420.920
	175	0.619	2.289	5.307	0.043	0.260	420.920
	250	0.430	1.273	4.999	0.043	0.166	420.920
	500	0.385	1.578	4.585	0.037	0.152	420.920
	750	0.396	1.578	4.690	0.038	0.154	420.920
	9999	0.511	1.954	5.514	0.038	0.182	420.920
Rollers	15	0.403	1.945	2.660	0.045	0.190	318.534

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2005		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	25	0.473	1.417	2.901	0.037	0.187	318.534
	50	1.955	4.312	3.591	0.037	0.441	318.534
	120	0.828	2.368	4.841	0.034	0.427	318.534
	175	0.545	1.905	4.417	0.032	0.238	318.534
	250	0.415	1.192	4.222	0.032	0.168	318.534
	500	0.367	1.608	3.810	0.028	0.149	318.534
Rough Terrain Forklifts	50	2.171	4.823	3.845	0.040	0.489	341.286
	120	0.878	2.543	5.011	0.036	0.472	341.286
	175	0.577	2.031	4.575	0.035	0.258	341.286
	250	0.406	1.115	4.330	0.035	0.160	341.286
	500	0.359	1.314	3.831	0.030	0.144	341.286
Rubber Tired Dozers	175	0.732	2.350	5.534	0.034	0.324	335.598
	250	0.599	1.690	5.348	0.034	0.246	335.598
	500	0.532	2.862	4.849	0.030	0.215	335.598
	750	0.534	2.857	4.919	0.031	0.216	335.598
	1000	0.566	3.068	5.432	0.031	0.210	335.598
Rubber Tired Loaders	25	0.424	1.314	2.736	0.035	0.175	307.158
	50	2.024	4.460	3.502	0.036	0.451	307.158
	120	0.819	2.334	4.656	0.033	0.436	307.158
	175	0.539	1.872	4.251	0.031	0.241	307.158
	250	0.392	1.087	4.042	0.031	0.156	307.158
	500	0.347	1.385	3.590	0.027	0.140	307.158
	750	0.352	1.383	3.679	0.029	0.141	307.158
	1000	0.403	1.611	4.302	0.029	0.141	307.158
Scrapers	120	1.211	3.295	6.829	0.043	0.628	409.544
	175	0.804	2.676	6.216	0.042	0.357	409.544
	250	0.629	1.776	5.968	0.042	0.257	409.544
	500	0.558	2.699	5.375	0.036	0.226	409.544
	750	0.563	2.695	5.472	0.038	0.228	409.544
Signal Boards	15	0.558	2.848	3.552	0.066	0.263	466.425
	50	2.229	5.076	4.779	0.052	0.534	443.672
	120	1.032	3.085	6.207	0.047	0.523	443.672
	175	0.674	2.467	5.667	0.045	0.288	443.672
	250	0.563	1.634	6.449	0.055	0.220	536.104
Skid Steer Loaders	25	0.770	1.941	3.165	0.036	0.244	312.846
	50	1.520	3.627	3.263	0.037	0.375	312.846
	120	0.673	2.165	4.020	0.033	0.367	312.846
Surfacing Equipment	50	1.351	3.053	2.800	0.030	0.318	255.965
	120	0.620	1.830	3.750	0.027	0.311	255.965
	175	0.406	1.476	3.417	0.026	0.174	255.965
	250	0.308	0.917	3.268	0.026	0.123	255.965
	500	0.275	1.248	2.972	0.023	0.111	255.965
	750	0.280	1.246	3.035	0.024	0.112	255.965
Sweepers/Scrubbers	15	0.419	2.362	2.947	0.054	0.218	386.791
	25	0.509	1.657	3.453	0.044	0.216	386.791
	50	2.534	5.546	4.383	0.045	0.565	386.791
	120	1.019	2.878	5.646	0.041	0.550	386.791

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2005		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	175	0.671	2.276	5.188	0.039	0.299	386.791
	250	0.428	1.121	4.829	0.039	0.164	386.791
Tractors/Loaders/Backhoes	25	0.572	1.583	2.970	0.036	0.206	312.846
	50	1.879	4.261	3.454	0.037	0.433	312.846
	120	0.768	2.294	4.396	0.033	0.419	312.846
	175	0.503	1.832	4.016	0.032	0.227	312.846
	250	0.337	0.914	3.785	0.032	0.131	312.846
	500	0.298	1.007	3.299	0.032	0.118	312.846
	750	0.304	1.006	3.406	0.033	0.120	312.846
Trenchers	15	0.510	2.605	3.249	0.060	0.241	426.608
	25	0.589	1.824	3.800	0.049	0.242	426.608
	50	2.840	6.142	4.943	0.050	0.624	426.608
	120	1.217	3.351	7.074	0.045	0.611	426.608
	175	0.809	2.739	6.439	0.043	0.353	426.608
	250	0.655	1.906	6.207	0.043	0.271	426.608
	500	0.579	3.060	5.655	0.038	0.238	426.608
	750	0.586	3.054	5.743	0.040	0.239	426.608
Welders	15	0.600	1.936	3.389	0.036	0.269	255.965
	25	0.694	1.702	2.654	0.029	0.211	255.965
	50	1.411	3.154	2.813	0.030	0.328	255.965
	120	0.626	1.825	3.689	0.027	0.320	255.965
	175	0.410	1.458	3.371	0.026	0.177	255.965
	250	0.287	0.817	3.176	0.026	0.113	255.965
	500	0.255	1.049	2.883	0.023	0.102	255.965
Water Trucks	175	0.579	2.004	4.418	0.033	0.261	324.222
	250	0.401	1.057	4.176	0.033	0.154	324.222
	500	0.361	1.220	3.644	0.029	0.139	324.222
	750	0.364	1.219	3.754	0.030	0.141	324.222
	1000	0.416	1.472	4.502	0.030	0.145	324.222

2006		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Aerial Lifts	15	0.386	1.649	2.533	0.036	0.181	261.653
	25	0.680	1.687	2.695	0.030	0.212	261.653
	50	1.194	2.756	2.781	0.030	0.295	261.653
	120	0.585	1.774	3.600	0.027	0.290	261.653
	500	0.238	0.975	2.843	0.023	0.094	261.653
	750	0.244	0.975	2.908	0.024	0.095	261.653
Air Compressors	15	0.640	2.065	3.615	0.038	0.287	273.029
	25	0.740	1.816	2.830	0.031	0.225	273.029
	50	1.639	3.619	3.053	0.032	0.372	273.029
	120	0.697	1.996	4.025	0.029	0.362	273.029
	175	0.458	1.593	3.679	0.028	0.200	273.029
	250	0.320	0.893	3.465	0.028	0.126	273.029
	500	0.283	1.135	3.129	0.024	0.114	273.029
	750	0.289	1.135	3.201	0.025	0.115	273.029
	1000	0.353	1.397	3.757	0.025	0.124	273.029
Bore/Drill Rigs	15	0.540	2.605	3.562	0.060	0.255	426.608
	25	0.633	1.898	3.885	0.049	0.251	426.608
	50	1.575	4.183	4.161	0.050	0.437	426.608
	120	0.770	2.814	4.894	0.045	0.432	426.608
	175	0.482	2.279	4.404	0.043	0.225	426.608
	250	0.275	0.810	4.140	0.043	0.104	426.608
	500	0.234	0.787	3.399	0.038	0.096	426.608
	750	0.247	0.787	3.591	0.040	0.099	426.608
	1000	0.361	0.968	4.832	0.040	0.127	426.608
Cement and Mortar Mixers	15	0.497	2.044	3.206	0.045	0.232	318.534
	25	0.821	2.042	3.269	0.037	0.256	318.534
Concrete/Industrial Saws	25	0.574	1.776	3.699	0.048	0.236	415.232
	50	2.201	4.972	4.533	0.049	0.518	415.232
	120	0.984	2.921	5.917	0.044	0.501	415.232
	175	0.645	2.335	5.405	0.042	0.276	415.232
Cranes	50	1.725	3.738	2.855	0.029	0.376	244.589
	120	0.688	1.905	3.878	0.026	0.363	244.589
	175	0.455	1.530	3.539	0.025	0.202	244.589
	250	0.343	0.956	3.380	0.025	0.138	244.589
	500	0.305	1.272	3.027	0.022	0.123	244.589
	750	0.308	1.270	3.091	0.023	0.124	244.589
	9999	0.342	1.450	3.543	0.023	0.120	244.589
Crawler Tractors	50	2.651	5.713	4.299	0.043	0.573	364.039
	120	1.073	2.925	6.034	0.039	0.559	364.039
	175	0.712	2.373	5.494	0.037	0.317	364.039
	250	0.552	1.551	5.268	0.037	0.225	364.039
	500	0.490	2.328	4.735	0.032	0.198	364.039
	750	0.494	2.324	4.823	0.034	0.200	364.039
	1000	0.542	2.580	5.471	0.034	0.195	364.039
Crushing/Proc. Equipment	50	2.742	6.051	4.979	0.052	0.619	443.672
	120	1.144	3.276	6.553	0.047	0.601	443.672

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2006		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	175	0.751	2.615	5.987	0.045	0.331	443.672
	250	0.518	1.434	5.633	0.045	0.205	443.672
	500	0.458	1.800	5.047	0.039	0.184	443.672
	750	0.462	1.726	5.167	0.041	0.184	443.672
	9999	0.573	2.193	6.122	0.041	0.200	443.672
Dumpers/Tenders	25	0.440	1.175	2.094	0.025	0.152	216.148
Excavators	25	0.419	1.342	2.812	0.037	0.179	324.222
	50	2.114	4.737	3.670	0.038	0.477	324.222
	120	0.844	2.453	4.727	0.034	0.463	324.222
	175	0.555	1.960	4.314	0.033	0.251	324.222
	250	0.378	1.010	4.072	0.033	0.146	324.222
	500	0.337	1.149	3.550	0.029	0.132	324.222
	750	0.342	1.148	3.661	0.030	0.134	324.222
Forklifts	50	1.162	2.554	1.949	0.020	0.258	170.643
	120	0.457	1.292	2.483	0.018	0.253	170.643
	175	0.303	1.022	2.286	0.017	0.137	170.643
	250	0.184	0.466	2.118	0.017	0.069	170.643
	500	0.164	0.480	1.852	0.015	0.063	170.643
Generator Sets	15	0.852	3.183	5.429	0.059	0.359	420.920
	25	0.875	2.799	4.364	0.048	0.311	420.920
	50	1.841	4.286	4.445	0.049	0.461	420.920
	120	0.923	2.822	5.727	0.045	0.454	420.920
	175	0.602	2.255	5.233	0.043	0.250	420.920
	250	0.417	1.249	4.929	0.043	0.159	420.920
	500	0.374	1.504	4.535	0.037	0.147	420.920
	750	0.386	1.504	4.640	0.038	0.149	420.920
	9999	0.503	1.876	5.458	0.038	0.180	420.920
Graders	50	2.312	5.089	3.970	0.041	0.514	346.974
	120	0.934	2.653	5.299	0.037	0.498	346.974
	175	0.615	2.129	4.834	0.035	0.275	346.974
	250	0.449	1.244	4.599	0.035	0.179	346.974
	500	0.398	1.610	4.086	0.031	0.160	346.974
	750	0.403	1.608	4.185	0.032	0.162	346.974
Off-Highway Tractors	120	1.163	3.084	6.557	0.039	0.590	369.727
	175	0.781	2.535	5.981	0.038	0.345	369.727
	250	0.638	1.817	5.777	0.038	0.263	369.727
	750	0.568	3.043	5.323	0.034	0.231	369.727
	1000	0.608	3.279	5.887	0.034	0.224	369.727
Off-Highway Trucks	175	0.579	2.004	4.418	0.033	0.261	324.222
	250	0.401	1.057	4.176	0.033	0.154	324.222
	500	0.361	1.220	3.644	0.029	0.139	324.222
	750	0.364	1.219	3.754	0.030	0.141	324.222
	1000	0.416	1.472	4.502	0.030	0.145	324.222
Other Construction Equipment	15	0.447	2.153	2.945	0.050	0.211	352.662
	25	0.523	1.569	3.211	0.040	0.208	352.663
	50	1.843	4.255	3.781	0.041	0.440	352.663
	120	0.805	2.476	4.803	0.037	0.426	352.663

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2006		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	175	0.524	1.981	4.381	0.036	0.231	352.663
	500	0.314	1.164	3.652	0.031	0.127	352.663
Other General Industrial Equipment	15	0.314	1.771	2.211	0.040	0.164	290.093
	25	0.373	1.201	2.521	0.033	0.160	290.093
	50	2.024	4.391	3.362	0.034	0.444	290.093
	120	0.806	2.235	4.471	0.030	0.432	290.093
	175	0.532	1.782	4.086	0.029	0.238	290.093
	250	0.365	0.984	3.843	0.029	0.143	290.093
	500	0.324	1.242	3.433	0.025	0.129	290.093
	750	0.329	1.242	3.514	0.026	0.131	290.093
	1000	0.392	1.540	4.134	0.026	0.137	290.093
Other Material Handling Equipment	50	2.310	5.016	3.874	0.039	0.507	335.598
	120	0.925	2.571	5.150	0.035	0.493	335.598
	175	0.610	2.051	4.707	0.034	0.272	335.598
	250	0.419	1.135	4.427	0.034	0.165	335.598
	500	0.372	1.434	3.959	0.029	0.148	335.598
	9999	0.452	1.777	4.766	0.029	0.157	335.598
Pavers	25	0.776	2.022	3.475	0.040	0.259	352.663
	50	2.466	5.310	4.129	0.041	0.536	352.663
	120	1.026	2.805	5.883	0.037	0.523	352.663
	175	0.682	2.286	5.353	0.036	0.300	352.663
	250	0.545	1.566	5.152	0.036	0.225	352.663
	500	0.482	2.452	4.671	0.031	0.197	352.663
Paving Equipment	25	0.447	1.341	2.745	0.035	0.177	301.470
	50	2.086	4.493	3.522	0.035	0.454	301.470
	120	0.871	2.383	5.005	0.032	0.443	301.470
	175	0.577	1.939	4.551	0.031	0.253	301.470
	250	0.463	1.334	4.381	0.031	0.191	301.470
Plate Compactors	15	0.321	1.496	2.147	0.034	0.152	244.588
Pressure Washers	15	0.345	1.291	2.201	0.024	0.145	170.643
	25	0.355	1.135	1.769	0.020	0.126	170.643
	50	0.612	1.486	1.752	0.020	0.165	170.643
	120	0.344	1.093	2.223	0.018	0.163	170.643
Pumps	15	0.986	3.183	5.574	0.059	0.442	420.920
	25	1.141	2.799	4.364	0.048	0.347	420.920
	50	1.953	4.495	4.487	0.049	0.479	420.920
	120	0.948	2.864	5.808	0.045	0.471	420.920
	175	0.619	2.289	5.307	0.043	0.260	420.920
	250	0.430	1.273	4.999	0.043	0.166	420.920
	500	0.385	1.578	4.585	0.037	0.152	420.920
	750	0.396	1.578	4.690	0.038	0.154	420.920
	9999	0.511	1.954	5.514	0.038	0.182	420.920
Rollers	15	0.403	1.945	2.660	0.045	0.190	318.534
	25	0.473	1.417	2.901	0.037	0.187	318.534
	50	1.955	4.312	3.591	0.037	0.441	318.534
	120	0.828	2.368	4.841	0.034	0.427	318.534
	175	0.545	1.905	4.417	0.032	0.238	318.534

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2006		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	250	0.415	1.192	4.222	0.032	0.168	318.534
	500	0.367	1.608	3.810	0.028	0.149	318.534
Rough Terrain Forklifts	50	2.171	4.823	3.845	0.040	0.489	341.286
	120	0.878	2.543	5.011	0.036	0.472	341.286
	175	0.577	2.031	4.575	0.035	0.258	341.286
	250	0.406	1.115	4.330	0.035	0.160	341.286
	500	0.359	1.314	3.831	0.030	0.144	341.286
Rubber Tired Dozers	175	0.732	2.350	5.534	0.034	0.324	335.598
	250	0.599	1.690	5.348	0.034	0.246	335.598
	500	0.532	2.862	4.849	0.030	0.215	335.598
	750	0.534	2.857	4.919	0.031	0.216	335.598
	1000	0.566	3.068	5.432	0.031	0.210	335.598
Rubber Tired Loaders	25	0.424	1.314	2.736	0.035	0.175	307.158
	50	2.024	4.460	3.502	0.036	0.451	307.158
	120	0.819	2.334	4.656	0.033	0.436	307.158
	175	0.539	1.872	4.251	0.031	0.241	307.158
	250	0.392	1.087	4.042	0.031	0.156	307.158
	500	0.347	1.385	3.590	0.027	0.140	307.158
	750	0.352	1.383	3.679	0.029	0.141	307.158
	1000	0.403	1.611	4.302	0.029	0.141	307.158
Scrapers	120	1.211	3.295	6.829	0.043	0.628	409.544
	175	0.804	2.676	6.216	0.042	0.357	409.544
	250	0.629	1.776	5.968	0.042	0.257	409.544
	500	0.558	2.699	5.375	0.036	0.226	409.544
	750	0.563	2.695	5.472	0.038	0.228	409.544
Signal Boards	15	0.558	2.848	3.552	0.066	0.263	466.425
	50	2.229	5.076	4.779	0.052	0.534	443.672
	120	1.032	3.085	6.207	0.047	0.523	443.672
	175	0.674	2.467	5.667	0.045	0.288	443.672
	250	0.563	1.634	6.449	0.055	0.220	536.104
Skid Steer Loaders	25	0.770	1.941	3.165	0.036	0.244	312.846
	50	1.520	3.627	3.263	0.037	0.375	312.846
	120	0.673	2.165	4.020	0.033	0.367	312.846
Surfacing Equipment	50	1.351	3.053	2.800	0.030	0.318	255.965
	120	0.620	1.830	3.750	0.027	0.311	255.965
	175	0.406	1.476	3.417	0.026	0.174	255.965
	250	0.308	0.917	3.268	0.026	0.123	255.965
	500	0.275	1.248	2.972	0.023	0.111	255.965
	750	0.280	1.246	3.035	0.024	0.112	255.965
Sweepers/Scrubbers	15	0.419	2.362	2.947	0.054	0.218	386.791
	25	0.509	1.657	3.453	0.044	0.216	386.791
	50	2.534	5.546	4.383	0.045	0.565	386.791
	120	1.019	2.878	5.646	0.041	0.550	386.791
	175	0.671	2.276	5.188	0.039	0.299	386.791
	250	0.428	1.121	4.829	0.039	0.164	386.791
Tractors/Loaders/Backhoes	25	0.572	1.583	2.970	0.036	0.206	312.846
	50	1.879	4.261	3.454	0.037	0.433	312.846

2006		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	120	0.768	2.294	4.396	0.033	0.419	312.846
	175	0.503	1.832	4.016	0.032	0.227	312.846
	250	0.337	0.914	3.785	0.032	0.131	312.846
	500	0.298	1.007	3.299	0.032	0.118	312.846
	750	0.304	1.006	3.406	0.033	0.120	312.846
Trenchers	15	0.510	2.605	3.249	0.060	0.241	426.608
	25	0.589	1.824	3.800	0.049	0.242	426.608
	50	2.840	6.142	4.943	0.050	0.624	426.608
	120	1.217	3.351	7.074	0.045	0.611	426.608
	175	0.809	2.739	6.439	0.043	0.353	426.608
	250	0.655	1.906	6.207	0.043	0.271	426.608
	500	0.579	3.060	5.655	0.038	0.238	426.608
	750	0.586	3.054	5.743	0.040	0.239	426.608
Welders	15	0.600	1.936	3.389	0.036	0.269	255.965
	25	0.694	1.702	2.654	0.029	0.211	255.965
	50	1.411	3.154	2.813	0.030	0.328	255.965
	120	0.626	1.825	3.689	0.027	0.320	255.965
	175	0.410	1.458	3.371	0.026	0.177	255.965
	250	0.287	0.817	3.176	0.026	0.113	255.965
	500	0.255	1.049	2.883	0.023	0.102	255.965
Water Trucks	175	0.579	2.004	4.418	0.033	0.261	324.222
	250	0.401	1.057	4.176	0.033	0.154	324.222
	500	0.361	1.220	3.644	0.029	0.139	324.222
	750	0.364	1.219	3.754	0.030	0.141	324.222
	1000	0.416	1.472	4.502	0.030	0.145	324.222

2007		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Aerial Lifts	15	0.361	1.628	2.367	0.004	0.166	261.653
	25	0.636	1.611	2.629	0.003	0.198	261.653
	50	1.147	2.710	2.745	0.003	0.279	261.653
	120	0.559	1.758	3.499	0.003	0.272	261.653
	500	0.222	0.900	2.708	0.003	0.086	261.653
	750	0.229	0.900	2.773	0.003	0.087	261.653
Air Compressors	15	0.614	2.031	3.493	0.004	0.268	273.029
	25	0.705	1.756	2.779	0.003	0.213	273.029
	50	1.588	3.576	3.018	0.004	0.353	273.029
	120	0.669	1.982	3.916	0.003	0.342	273.029
	175	0.439	1.586	3.524	0.003	0.188	273.029
	250	0.301	0.842	3.314	0.003	0.115	273.029
	500	0.267	1.036	2.982	0.003	0.104	273.029
	750	0.273	1.036	3.054	0.003	0.105	273.029
	1000	0.336	1.294	3.658	0.003	0.115	273.029
Bore/Drill Rigs	15	0.510	2.605	3.251	0.007	0.234	426.608
	25	0.591	1.839	3.726	0.005	0.238	426.608
	50	1.347	3.967	4.067	0.006	0.396	426.608
	120	0.668	2.772	4.653	0.005	0.376	426.608
	175	0.418	2.280	3.906	0.005	0.196	426.608
	250	0.255	0.801	3.700	0.005	0.097	426.608
	500	0.223	0.778	3.061	0.004	0.090	426.608
	750	0.233	0.778	3.223	0.004	0.093	426.608
	1000	0.322	0.889	4.540	0.004	0.114	426.608
Cement and Mortar Mixers	15	0.464	2.011	3.005	0.005	0.212	318.534
	25	0.777	1.966	3.199	0.004	0.241	318.534
Concrete/Industrial Saws	25	0.541	1.737	3.532	0.005	0.225	415.232
	50	2.079	4.833	4.451	0.005	0.484	415.232
	120	0.926	2.885	5.705	0.005	0.465	415.232
	175	0.606	2.317	5.102	0.005	0.256	415.232
Cranes	50	1.640	3.644	2.812	0.003	0.353	244.589
	120	0.652	1.880	3.740	0.003	0.338	244.589
	175	0.432	1.514	3.351	0.003	0.187	244.589
	250	0.322	0.898	3.198	0.003	0.124	244.589
	500	0.288	1.152	2.859	0.002	0.111	244.589
	750	0.291	1.151	2.922	0.002	0.112	244.589
	9999	0.323	1.322	3.421	0.002	0.110	244.589
Crawler Tractors	50	2.527	5.578	4.239	0.005	0.538	364.039
	120	1.020	2.886	5.830	0.004	0.521	364.039
	175	0.678	2.347	5.217	0.004	0.294	364.039
	250	0.523	1.469	5.001	0.004	0.204	364.039
	500	0.467	2.143	4.490	0.004	0.181	364.039
	750	0.470	2.140	4.577	0.004	0.183	364.039
	1000	0.514	2.381	5.289	0.004	0.180	364.039
Crushing/Proc. Equipment	50	2.644	5.964	4.918	0.006	0.586	443.672
	120	1.094	3.251	6.362	0.005	0.566	443.672

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2007		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	175	0.718	2.605	5.710	0.005	0.311	443.672
	250	0.487	1.348	5.364	0.005	0.185	443.672
	500	0.431	1.639	4.791	0.004	0.168	443.672
	750	0.437	1.580	4.925	0.004	0.168	443.672
	9999	0.545	2.035	5.958	0.004	0.185	443.672
Dumpers/Tenders	25	0.388	1.087	2.009	0.003	0.138	216.148
Excavators	25	0.405	1.335	2.668	0.004	0.173	324.222
	50	1.958	4.569	3.601	0.004	0.442	324.222
	120	0.787	2.424	4.538	0.004	0.424	324.222
	175	0.518	1.952	4.015	0.004	0.229	324.222
	250	0.353	0.948	3.792	0.004	0.131	324.222
	500	0.318	1.061	3.303	0.003	0.119	324.222
	750	0.322	1.061	3.408	0.003	0.121	324.222
Forklifts	50	1.077	2.454	1.907	0.002	0.239	170.643
	120	0.427	1.276	2.375	0.002	0.233	170.643
	175	0.283	1.017	2.129	0.002	0.126	170.643
	250	0.168	0.423	1.968	0.002	0.060	170.643
	500	0.151	0.425	1.712	0.002	0.056	170.643
Generator Sets	15	0.813	3.131	5.245	0.007	0.335	420.920
	25	0.830	2.707	4.284	0.005	0.293	420.920
	50	1.764	4.209	4.385	0.005	0.435	420.920
	120	0.879	2.796	5.563	0.005	0.425	420.920
	175	0.572	2.241	4.999	0.005	0.234	420.920
	250	0.389	1.177	4.702	0.005	0.145	420.920
	500	0.350	1.391	4.316	0.004	0.135	420.920
	750	0.360	1.391	4.419	0.004	0.136	420.920
	9999	0.476	1.754	5.304	0.004	0.165	420.920
Graders	50	2.183	4.950	3.907	0.004	0.480	346.974
	120	0.881	2.618	5.103	0.004	0.461	346.974
	175	0.580	2.111	4.552	0.004	0.254	346.974
	250	0.421	1.171	4.331	0.004	0.162	346.974
	500	0.376	1.462	3.842	0.003	0.145	346.974
	750	0.380	1.460	3.938	0.003	0.147	346.974
Off-Highway Tractors	120	1.116	3.046	6.367	0.004	0.553	369.727
	175	0.749	2.506	5.729	0.004	0.322	369.727
	250	0.609	1.736	5.532	0.004	0.242	369.727
	750	0.544	2.847	5.095	0.004	0.213	369.727
	1000	0.581	3.073	5.716	0.004	0.207	369.727
Off-Highway Trucks	175	0.543	1.995	4.116	0.004	0.238	324.222
	250	0.376	0.992	3.892	0.004	0.138	324.222
	500	0.342	1.125	3.397	0.003	0.125	324.222
	750	0.344	1.124	3.501	0.003	0.127	324.222
	1000	0.391	1.356	4.324	0.003	0.133	324.222
Other Construction Equipment	15	0.422	2.153	2.687	0.005	0.194	352.662
	25	0.489	1.520	3.080	0.004	0.196	352.662
	50	1.708	4.109	3.707	0.005	0.408	352.662
	120	0.746	2.446	4.614	0.004	0.391	352.663

2007		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	175	0.485	1.972	4.076	0.004	0.212	352.663
	500	0.291	1.067	3.395	0.003	0.114	352.663
Other General Industrial Equipment	15	0.303	1.771	2.133	0.005	0.156	290.093
	25	0.363	1.194	2.391	0.004	0.155	290.093
	50	1.954	4.326	3.325	0.004	0.420	290.093
	120	0.776	2.219	4.348	0.003	0.408	290.093
	175	0.512	1.775	3.915	0.003	0.224	290.093
	250	0.346	0.928	3.676	0.003	0.130	290.093
	500	0.309	1.135	3.272	0.003	0.118	290.093
	750	0.313	1.135	3.354	0.003	0.120	290.093
	1000	0.375	1.425	4.026	0.003	0.127	290.093
Other Material Handling Equipment	50	2.232	4.945	3.832	0.004	0.481	335.598
	120	0.891	2.554	5.009	0.004	0.466	335.598
	175	0.587	2.043	4.511	0.004	0.257	335.598
	250	0.397	1.070	4.236	0.004	0.150	335.598
	500	0.354	1.310	3.775	0.003	0.136	335.598
	9999	0.431	1.645	4.642	0.003	0.146	335.598
Pavers	25	0.695	1.884	3.345	0.004	0.237	352.663
	50	2.370	5.205	4.075	0.005	0.505	352.663
	120	0.979	2.767	5.694	0.004	0.488	352.663
	175	0.650	2.258	5.102	0.004	0.279	352.663
	250	0.516	1.485	4.908	0.004	0.205	352.663
	500	0.458	2.259	4.444	0.003	0.181	352.662
Paving Equipment	25	0.418	1.300	2.633	0.004	0.168	301.470
	50	2.007	4.407	3.476	0.004	0.428	301.470
	120	0.830	2.350	4.842	0.004	0.414	301.470
	175	0.550	1.914	4.340	0.003	0.236	301.470
	250	0.437	1.263	4.175	0.003	0.174	301.470
Plate Compactors	15	0.305	1.493	1.991	0.004	0.140	244.589
Pressure Washers	15	0.329	1.269	2.126	0.003	0.136	170.643
	25	0.336	1.098	1.737	0.002	0.119	170.643
	50	0.582	1.454	1.726	0.002	0.155	170.643
	120	0.326	1.082	2.158	0.002	0.153	170.643
Pumps	15	0.946	3.131	5.385	0.007	0.413	420.920
	25	1.087	2.707	4.284	0.005	0.328	420.920
	50	1.875	4.418	4.427	0.005	0.453	420.920
	120	0.905	2.838	5.643	0.005	0.442	420.920
	175	0.590	2.275	5.071	0.005	0.244	420.920
	250	0.403	1.199	4.771	0.005	0.151	420.920
	500	0.360	1.455	4.364	0.004	0.139	420.920
	750	0.371	1.455	4.468	0.004	0.141	420.920
	9999	0.484	1.823	5.360	0.004	0.168	420.920
Rollers	15	0.381	1.945	2.427	0.005	0.175	318.534
	25	0.442	1.373	2.782	0.004	0.177	318.534
	50	1.864	4.212	3.536	0.004	0.414	318.534
	120	0.783	2.336	4.671	0.004	0.397	318.534
	175	0.515	1.885	4.181	0.004	0.220	318.534

2007		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	250	0.388	1.122	3.994	0.004	0.152	318.534
	500	0.345	1.456	3.598	0.003	0.136	318.534
Rough Terrain Forklifts	50	2.035	4.672	3.776	0.004	0.455	341.286
	120	0.824	2.513	4.819	0.004	0.436	341.286
	175	0.541	2.019	4.290	0.004	0.238	341.286
	250	0.376	1.040	4.057	0.004	0.143	341.286
	500	0.335	1.196	3.581	0.003	0.129	341.286
Rubber Tired Dozers	175	0.703	2.323	5.300	0.004	0.302	335.598
	250	0.574	1.617	5.122	0.004	0.226	335.598
	500	0.512	2.685	4.641	0.003	0.198	335.598
	750	0.514	2.681	4.710	0.003	0.199	335.598
	1000	0.542	2.883	5.277	0.003	0.194	335.598
Rubber Tired Loaders	25	0.401	1.285	2.613	0.004	0.167	307.158
	50	1.911	4.338	3.446	0.004	0.422	307.158
	120	0.772	2.304	4.484	0.004	0.404	307.158
	175	0.508	1.856	4.001	0.003	0.222	307.158
	250	0.367	1.022	3.804	0.003	0.141	307.158
	500	0.328	1.258	3.374	0.003	0.127	307.158
	750	0.332	1.256	3.460	0.003	0.128	307.158
	1000	0.379	1.469	4.144	0.003	0.129	307.158
Scrapers	120	1.153	3.250	6.600	0.005	0.585	409.544
	175	0.766	2.646	5.910	0.005	0.332	409.544
	250	0.595	1.682	5.672	0.005	0.234	409.544
	500	0.531	2.482	5.102	0.004	0.207	409.544
	750	0.535	2.478	5.197	0.004	0.208	409.544
Signal Boards	15	0.546	2.848	3.428	0.007	0.251	466.425
	50	2.133	4.980	4.711	0.006	0.503	443.672
	120	0.980	3.055	6.017	0.005	0.489	443.672
	175	0.639	2.452	5.393	0.005	0.269	443.672
	250	0.526	1.536	6.129	0.006	0.200	536.104
Skid Steer Loaders	25	0.715	1.846	3.079	0.004	0.227	312.846
	50	1.381	3.484	3.194	0.004	0.346	312.846
	120	0.614	2.139	3.845	0.004	0.333	312.846
Surfacing Equipment	50	1.285	2.982	2.756	0.003	0.299	255.965
	120	0.584	1.805	3.619	0.003	0.288	255.965
	175	0.382	1.461	3.232	0.003	0.161	255.965
	250	0.289	0.866	3.090	0.003	0.112	255.965
	500	0.258	1.144	2.808	0.003	0.101	255.965
	750	0.263	1.143	2.868	0.003	0.102	255.965
Sweepers/Scrubbers	15	0.404	2.362	2.843	0.006	0.208	386.791
	25	0.494	1.619	3.298	0.005	0.208	386.791
	50	2.400	5.398	4.307	0.005	0.529	386.791
	120	0.966	2.850	5.444	0.005	0.514	386.791
	175	0.635	2.267	4.895	0.004	0.279	386.791
	250	0.394	1.032	4.546	0.004	0.145	386.791
Tractors/Loaders/Backhoes	25	0.500	1.462	2.845	0.004	0.187	312.846
	50	1.736	4.108	3.387	0.004	0.401	312.846

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2007		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	120	0.713	2.267	4.221	0.004	0.384	312.846
	175	0.467	1.826	3.729	0.004	0.207	312.846
	250	0.312	0.859	3.518	0.004	0.117	312.846
	500	0.279	0.932	3.064	0.004	0.107	312.846
	750	0.284	0.932	3.165	0.004	0.109	312.846
Trenchers	15	0.499	2.605	3.135	0.007	0.229	426.608
	25	0.556	1.784	3.629	0.005	0.231	426.608
	50	2.734	6.028	4.878	0.006	0.588	426.608
	120	1.162	3.307	6.854	0.005	0.571	426.608
	175	0.771	2.706	6.144	0.005	0.329	426.608
	250	0.621	1.812	5.921	0.005	0.247	426.608
	500	0.551	2.833	5.388	0.004	0.218	426.608
	750	0.557	2.829	5.474	0.004	0.219	426.608
Welders	15	0.575	1.904	3.275	0.004	0.251	255.965
	25	0.661	1.646	2.605	0.003	0.200	255.965
	50	1.362	3.108	2.778	0.003	0.311	255.965
	120	0.599	1.810	3.586	0.003	0.301	255.965
	175	0.392	1.450	3.225	0.003	0.166	255.965
	250	0.269	0.770	3.034	0.003	0.103	255.965
	500	0.240	0.957	2.746	0.003	0.093	255.965
Water Trucks	175	0.543	1.995	4.116	0.004	0.238	324.222
	250	0.376	0.992	3.892	0.004	0.138	324.222
	500	0.342	1.125	3.397	0.003	0.125	324.222
	750	0.344	1.124	3.501	0.003	0.127	324.222
	1000	0.391	1.356	4.324	0.003	0.133	324.222

2008		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Aerial Lifts	15	0.341	1.613	2.223	0.004	0.145	261.653
	25	0.589	1.530	2.557	0.003	0.184	261.653
	50	1.101	2.668	2.711	0.003	0.270	261.653
	120	0.532	1.744	3.358	0.003	0.264	261.653
	500	0.209	0.832	2.585	0.003	0.081	261.653
	750	0.215	0.832	2.649	0.003	0.083	261.653
Air Compressors	15	0.589	1.999	3.380	0.004	0.255	273.029
	25	0.673	1.701	2.730	0.003	0.204	273.029
	50	1.536	3.535	2.985	0.004	0.344	273.029
	120	0.641	1.969	3.764	0.003	0.334	273.029
	175	0.423	1.582	3.381	0.003	0.184	273.029
	250	0.285	0.795	3.173	0.003	0.108	273.029
	500	0.253	0.947	2.847	0.003	0.099	273.029
	750	0.258	0.947	2.918	0.003	0.100	273.029
	1000	0.320	1.200	3.562	0.003	0.110	273.029
Bore/Drill Rigs	15	0.502	2.605	3.164	0.007	0.193	426.608
	25	0.560	1.798	3.584	0.005	0.213	426.608
	50	1.118	3.759	3.984	0.006	0.348	426.608
	120	0.565	2.729	4.183	0.005	0.330	426.608
	175	0.364	2.280	3.468	0.005	0.177	426.608
	250	0.239	0.794	3.312	0.005	0.093	426.608
	500	0.215	0.772	2.772	0.004	0.088	426.608
	750	0.222	0.772	2.904	0.004	0.090	426.608
	1000	0.289	0.832	4.262	0.004	0.106	426.608
Cement and Mortar Mixers	15	0.437	1.987	2.831	0.005	0.187	318.534
	25	0.729	1.884	3.125	0.004	0.226	318.534
Concrete/Industrial Saws	25	0.520	1.716	3.387	0.005	0.200	415.232
	50	1.949	4.690	4.369	0.005	0.460	415.232
	120	0.865	2.849	5.394	0.005	0.444	415.232
	175	0.568	2.301	4.810	0.005	0.245	415.232
Cranes	50	1.547	3.543	2.768	0.003	0.337	244.589
	120	0.615	1.857	3.548	0.003	0.324	244.589
	175	0.410	1.503	3.171	0.003	0.179	244.589
	250	0.304	0.846	3.024	0.003	0.117	244.589
	500	0.273	1.054	2.699	0.002	0.105	244.589
	750	0.275	1.053	2.762	0.002	0.106	244.589
	9999	0.305	1.215	3.300	0.002	0.105	244.588
Crawler Tractors	50	2.392	5.435	4.179	0.005	0.516	364.039
	120	0.964	2.847	5.542	0.004	0.499	364.039
	175	0.645	2.323	4.949	0.004	0.282	364.039
	250	0.496	1.393	4.744	0.004	0.193	364.039
	500	0.446	1.973	4.256	0.004	0.172	364.039
	750	0.448	1.970	4.341	0.004	0.173	364.039
	1000	0.488	2.196	5.107	0.004	0.171	364.039
Crushing/Proc. Equipment	50	2.539	5.875	4.859	0.006	0.568	443.672
	120	1.044	3.227	6.089	0.005	0.550	443.672

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2008		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	175	0.689	2.597	5.453	0.005	0.303	443.672
	250	0.459	1.271	5.115	0.005	0.174	443.672
	500	0.409	1.495	4.556	0.004	0.159	443.672
	750	0.415	1.448	4.700	0.004	0.160	443.672
	9999	0.519	1.891	5.796	0.004	0.177	443.672
Dumpers/Tenders	25	0.342	1.009	1.932	0.003	0.122	216.148
Excavators	25	0.397	1.335	2.547	0.004	0.151	324.222
	50	1.790	4.397	3.534	0.004	0.414	324.222
	120	0.726	2.394	4.242	0.004	0.397	324.222
	175	0.484	1.946	3.731	0.004	0.216	324.222
	250	0.331	0.894	3.527	0.004	0.122	324.222
	500	0.302	0.984	3.074	0.003	0.111	324.222
	750	0.304	0.983	3.173	0.003	0.113	324.222
Forklifts	50	0.976	2.339	1.861	0.002	0.223	170.643
	120	0.393	1.257	2.208	0.002	0.218	170.643
	175	0.262	1.012	1.967	0.002	0.118	170.643
	250	0.157	0.402	1.832	0.002	0.056	170.643
	500	0.143	0.394	1.587	0.002	0.052	170.643
Generator Sets	15	0.777	3.082	5.074	0.007	0.317	420.920
	25	0.789	2.623	4.209	0.005	0.280	420.920
	50	1.686	4.133	4.326	0.005	0.420	420.920
	120	0.835	2.771	5.331	0.005	0.412	420.920
	175	0.545	2.230	4.782	0.005	0.227	420.920
	250	0.365	1.111	4.491	0.005	0.137	420.920
	500	0.328	1.287	4.113	0.004	0.127	420.920
	750	0.338	1.287	4.215	0.004	0.129	420.920
	9999	0.451	1.641	5.154	0.004	0.158	420.920
Graders	50	2.044	4.804	3.844	0.004	0.456	346.974
	120	0.824	2.585	4.816	0.004	0.439	346.974
	175	0.548	2.096	4.284	0.004	0.242	346.974
	250	0.396	1.105	4.076	0.004	0.151	346.974
	500	0.357	1.335	3.615	0.003	0.137	346.974
	750	0.360	1.333	3.707	0.003	0.138	346.974
Off-Highway Tractors	120	1.066	3.008	6.105	0.004	0.534	369.727
	175	0.718	2.478	5.482	0.004	0.310	369.727
	250	0.582	1.659	5.293	0.004	0.230	369.727
	750	0.522	2.661	4.873	0.004	0.204	369.727
	1000	0.556	2.876	5.543	0.004	0.199	369.727
Off-Highway Trucks	175	0.509	1.988	3.831	0.004	0.225	324.222
	250	0.355	0.934	3.624	0.004	0.128	324.222
	500	0.325	1.040	3.167	0.003	0.117	324.222
	750	0.327	1.040	3.264	0.003	0.119	324.222
	1000	0.369	1.252	4.143	0.003	0.127	324.222
Other Construction Equipment	15	0.415	2.153	2.615	0.005	0.159	352.663
	25	0.463	1.487	2.963	0.004	0.176	352.663
	50	1.567	3.962	3.634	0.005	0.381	352.663
	120	0.685	2.415	4.311	0.004	0.367	352.663

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2008		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	MaxHP	ROG	CO	NOX	SOX	PM	CO2
	175	0.449	1.964	3.791	0.004	0.201	352.663
	500	0.270	0.980	3.159	0.003	0.107	352.663
Other General Industrial Equipment	15	0.301	1.771	2.115	0.005	0.118	290.093
	25	0.355	1.194	2.281	0.004	0.136	290.093
	50	1.878	4.258	3.290	0.004	0.408	290.093
	120	0.745	2.204	4.177	0.003	0.397	290.093
	175	0.494	1.769	3.753	0.003	0.218	290.093
	250	0.329	0.878	3.519	0.003	0.123	290.093
	500	0.296	1.038	3.123	0.003	0.112	290.093
	750	0.299	1.038	3.205	0.003	0.113	290.093
	1000	0.359	1.320	3.918	0.003	0.123	290.093
Other Material Handling Equipment	50	2.148	4.871	3.792	0.004	0.468	335.598
	120	0.855	2.536	4.814	0.004	0.454	335.598
	175	0.566	2.036	4.327	0.004	0.250	335.598
	250	0.378	1.012	4.056	0.004	0.141	335.598
	500	0.339	1.199	3.605	0.003	0.129	335.598
	9999	0.413	1.524	4.519	0.003	0.141	335.598
Pavers	25	0.621	1.757	3.223	0.004	0.212	352.663
	50	2.264	5.092	4.020	0.005	0.486	352.663
	120	0.929	2.730	5.432	0.004	0.471	352.663
	175	0.619	2.232	4.860	0.004	0.269	352.663
	250	0.489	1.409	4.673	0.004	0.193	352.663
	500	0.435	2.079	4.228	0.003	0.171	352.663
Paving Equipment	25	0.396	1.271	2.533	0.004	0.151	301.470
	50	1.921	4.316	3.430	0.004	0.413	301.470
	120	0.788	2.317	4.620	0.004	0.399	301.470
	175	0.524	1.891	4.136	0.003	0.227	301.470
	250	0.414	1.196	3.976	0.003	0.164	301.470
Plate Compactors	15	0.292	1.493	1.862	0.004	0.118	244.589
Pressure Washers	15	0.315	1.249	2.057	0.003	0.128	170.643
	25	0.320	1.063	1.706	0.002	0.114	170.643
	50	0.552	1.423	1.702	0.002	0.149	170.643
	120	0.308	1.072	2.066	0.002	0.147	170.643
Pumps	15	0.909	3.082	5.210	0.007	0.393	420.920
	25	1.038	2.623	4.209	0.005	0.314	420.920
	50	1.795	4.343	4.370	0.005	0.438	420.920
	120	0.860	2.814	5.409	0.005	0.428	420.920
	175	0.562	2.264	4.853	0.005	0.236	420.920
	250	0.378	1.132	4.559	0.005	0.143	420.920
	500	0.338	1.342	4.160	0.004	0.132	420.920
	750	0.348	1.342	4.262	0.004	0.134	420.920
	9999	0.459	1.701	5.209	0.004	0.160	420.920
Rollers	15	0.375	1.945	2.362	0.005	0.144	318.534
	25	0.418	1.343	2.676	0.004	0.159	318.534
	50	1.762	4.104	3.480	0.004	0.395	318.534
	120	0.736	2.306	4.430	0.004	0.380	318.534
	175	0.487	1.869	3.957	0.004	0.211	318.534

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2008		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	250	0.364	1.057	3.777	0.004	0.142	318.534
	500	0.325	1.329	3.399	0.003	0.128	318.534
Rough Terrain Forklifts	50	1.889	4.515	3.707	0.004	0.430	341.286
	120	0.767	2.483	4.532	0.004	0.414	341.286
	175	0.508	2.009	4.018	0.004	0.226	341.286
	250	0.349	0.970	3.797	0.004	0.132	341.286
	500	0.313	1.089	3.346	0.003	0.120	341.286
Rubber Tired Dozers	175	0.675	2.298	5.071	0.004	0.290	335.598
	250	0.551	1.548	4.900	0.004	0.216	335.598
	500	0.494	2.517	4.441	0.003	0.189	335.598
	750	0.495	2.513	4.508	0.003	0.191	335.598
	1000	0.520	2.706	5.120	0.003	0.186	335.598
Rubber Tired Loaders	25	0.385	1.269	2.505	0.004	0.148	307.158
	50	1.787	4.207	3.389	0.004	0.400	307.158
	120	0.722	2.275	4.232	0.004	0.384	307.158
	175	0.479	1.844	3.764	0.003	0.212	307.158
	250	0.345	0.965	3.579	0.003	0.132	307.158
	500	0.310	1.151	3.173	0.003	0.119	307.158
	750	0.314	1.150	3.256	0.003	0.121	307.158
	1000	0.357	1.347	3.987	0.003	0.122	307.158
Scrapers	120	1.091	3.206	6.282	0.005	0.562	409.544
	175	0.729	2.617	5.614	0.005	0.318	409.544
	250	0.565	1.595	5.387	0.005	0.220	409.544
	500	0.507	2.282	4.842	0.004	0.196	409.544
	750	0.510	2.279	4.935	0.004	0.198	409.544
Signal Boards	15	0.543	2.848	3.400	0.007	0.189	466.425
	50	2.037	4.890	4.648	0.006	0.485	443.672
	120	0.929	3.027	5.748	0.005	0.472	443.672
	175	0.608	2.440	5.142	0.005	0.261	443.672
	250	0.493	1.449	5.837	0.006	0.188	536.104
Skid Steer Loaders	25	0.662	1.755	2.996	0.004	0.211	312.846
	50	1.235	3.339	3.129	0.004	0.318	312.846
	120	0.553	2.112	3.547	0.004	0.308	312.846
Surfacing Equipment	50	1.213	2.907	2.712	0.003	0.285	255.965
	120	0.547	1.781	3.430	0.003	0.275	255.965
	175	0.360	1.448	3.057	0.003	0.154	255.965
	250	0.270	0.819	2.922	0.003	0.105	255.965
	500	0.242	1.051	2.653	0.003	0.096	255.965
	750	0.247	1.050	2.711	0.003	0.096	255.965
Sweepers/Scrubbers	15	0.401	2.362	2.820	0.006	0.157	386.791
	25	0.483	1.599	3.162	0.005	0.187	386.791
	50	2.224	5.198	4.218	0.005	0.499	386.791
	120	0.900	2.815	5.111	0.005	0.490	386.791
	175	0.595	2.257	4.577	0.004	0.266	386.791
	250	0.358	0.942	4.241	0.004	0.131	386.791
Tractors/Loaders/Backhoes	25	0.467	1.411	2.754	0.004	0.170	312.846
	50	1.584	3.950	3.322	0.004	0.374	312.846

2008		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	120	0.655	2.240	3.937	0.004	0.360	312.846
	175	0.434	1.822	3.460	0.004	0.196	312.846
	250	0.291	0.811	3.268	0.004	0.109	312.846
	500	0.263	0.870	2.847	0.004	0.100	312.846
	750	0.267	0.870	2.942	0.004	0.102	312.846
Trenchers	15	0.497	2.605	3.110	0.007	0.173	426.608
	25	0.534	1.763	3.480	0.005	0.206	426.608
	50	2.617	5.904	4.813	0.006	0.567	426.608
	120	1.103	3.263	6.548	0.005	0.551	426.608
	175	0.735	2.676	5.861	0.005	0.317	426.608
	250	0.589	1.724	5.646	0.005	0.235	426.608
	500	0.524	2.621	5.134	0.004	0.208	426.608
	750	0.529	2.617	5.218	0.004	0.209	426.608
Welders	15	0.552	1.874	3.168	0.004	0.239	255.965
	25	0.631	1.595	2.559	0.003	0.191	255.965
	50	1.312	3.065	2.745	0.003	0.302	255.965
	120	0.572	1.796	3.442	0.003	0.293	255.965
	175	0.376	1.444	3.090	0.003	0.162	255.965
	250	0.254	0.727	2.902	0.003	0.097	255.965
	500	0.226	0.874	2.620	0.003	0.088	255.965
Water Trucks	175	0.509	1.988	3.831	0.004	0.225	324.222
	250	0.355	0.934	3.624	0.004	0.128	324.222
	500	0.325	1.040	3.167	0.003	0.117	324.222
	750	0.327	1.040	3.264	0.003	0.119	324.222
	1000	0.369	1.252	4.143	0.003	0.127	324.222

2009		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Aerial Lifts	15	0.326	1.604	2.100	0.004	0.127	261.653
	25	0.542	1.449	2.484	0.003	0.169	261.653
	50	1.053	2.623	2.677	0.003	0.260	261.653
	120	0.506	1.730	3.222	0.003	0.256	261.653
	500	0.197	0.769	2.467	0.003	0.077	261.653
	750	0.202	0.769	2.529	0.003	0.078	261.653
Air Compressors	15	0.566	1.968	3.268	0.004	0.242	273.029
	25	0.642	1.647	2.682	0.003	0.194	273.029
	50	1.479	3.489	2.952	0.004	0.334	273.029
	120	0.614	1.957	3.614	0.003	0.325	273.029
	175	0.407	1.579	3.239	0.003	0.179	273.029
	250	0.269	0.751	3.035	0.003	0.102	273.029
	500	0.240	0.867	2.716	0.003	0.093	273.029
	750	0.245	0.867	2.786	0.003	0.095	273.029
	1000	0.305	1.115	3.468	0.003	0.105	273.029
Bore/Drill Rigs	15	0.498	2.605	3.121	0.007	0.157	426.608
	25	0.538	1.773	3.459	0.005	0.191	426.608
	50	0.921	3.590	3.925	0.006	0.305	426.608
	120	0.475	2.693	3.767	0.005	0.289	426.608
	175	0.318	2.281	3.088	0.005	0.160	426.608
	250	0.227	0.789	2.974	0.005	0.090	426.608
	500	0.208	0.767	2.531	0.004	0.086	426.608
	750	0.214	0.767	2.634	0.004	0.087	426.608
	1000	0.264	0.795	4.027	0.004	0.099	426.608
Cement and Mortar Mixers	15	0.415	1.970	2.679	0.005	0.166	318.534
	25	0.679	1.798	3.045	0.004	0.211	318.534
Concrete/Industrial Saws	25	0.508	1.710	3.263	0.005	0.178	415.232
	50	1.820	4.550	4.292	0.005	0.437	415.232
	120	0.807	2.816	5.099	0.005	0.423	415.232
	175	0.533	2.288	4.532	0.005	0.234	415.232
Cranes	50	1.451	3.441	2.726	0.003	0.321	244.589
	120	0.579	1.836	3.366	0.003	0.309	244.589
	175	0.389	1.493	2.998	0.003	0.172	244.589
	250	0.287	0.799	2.858	0.003	0.109	244.589
	500	0.260	0.972	2.549	0.002	0.099	244.589
	750	0.261	0.971	2.610	0.002	0.100	244.589
	9999	0.290	1.124	3.186	0.002	0.100	244.589
Crawler Tractors	50	2.255	5.292	4.121	0.005	0.492	364.039
	120	0.910	2.810	5.265	0.004	0.476	364.039
	175	0.613	2.301	4.690	0.004	0.269	364.039
	250	0.472	1.323	4.496	0.004	0.182	364.039
	500	0.427	1.817	4.035	0.004	0.163	364.039
	750	0.429	1.814	4.117	0.004	0.164	364.039
	1000	0.464	2.027	4.933	0.004	0.163	364.039
Crushing/Proc. Equipment	50	2.425	5.772	4.802	0.006	0.548	443.672
	120	0.993	3.205	5.822	0.005	0.533	443.672

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2009		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	175	0.660	2.590	5.201	0.005	0.294	443.672
	250	0.433	1.200	4.873	0.005	0.163	443.672
	500	0.388	1.369	4.331	0.004	0.150	443.672
	750	0.394	1.332	4.482	0.004	0.152	443.672
	9999	0.495	1.761	5.636	0.004	0.170	443.672
Dumpers/Tenders	25	0.322	0.977	1.876	0.003	0.112	216.148
Excavators	25	0.394	1.335	2.509	0.004	0.131	324.222
	50	1.625	4.232	3.473	0.004	0.385	324.222
	120	0.669	2.367	3.962	0.004	0.370	324.222
	175	0.452	1.940	3.465	0.004	0.203	324.222
	250	0.312	0.845	3.279	0.004	0.113	324.222
	500	0.287	0.915	2.865	0.003	0.105	324.222
	750	0.290	0.914	2.956	0.003	0.106	324.222
Forklifts	50	0.872	2.224	1.817	0.002	0.206	170.643
	120	0.359	1.240	2.045	0.002	0.203	170.643
	175	0.242	1.008	1.819	0.002	0.110	170.643
	250	0.150	0.388	1.702	0.002	0.053	170.643
	500	0.138	0.374	1.472	0.002	0.049	170.643
Generator Sets	15	0.742	3.034	4.907	0.007	0.299	420.920
	25	0.750	2.540	4.135	0.005	0.267	420.920
	50	1.606	4.057	4.269	0.005	0.404	420.920
	120	0.791	2.748	5.106	0.005	0.398	420.920
	175	0.518	2.221	4.571	0.005	0.220	420.920
	250	0.341	1.050	4.288	0.005	0.129	420.920
	500	0.306	1.191	3.918	0.004	0.121	420.920
	750	0.316	1.191	4.017	0.004	0.122	420.920
	9999	0.427	1.535	5.009	0.004	0.151	420.920
Graders	50	1.903	4.659	3.785	0.004	0.432	346.974
	120	0.770	2.554	4.545	0.004	0.416	346.974
	175	0.517	2.084	4.030	0.004	0.230	346.974
	250	0.374	1.047	3.836	0.004	0.142	346.974
	500	0.340	1.227	3.402	0.003	0.129	346.974
	750	0.343	1.225	3.491	0.003	0.131	346.974
Off-Highway Tractors	120	1.017	2.970	5.850	0.004	0.515	369.727
	175	0.688	2.452	5.242	0.004	0.299	369.727
	250	0.557	1.585	5.060	0.004	0.219	369.727
	750	0.501	2.485	4.659	0.004	0.195	369.727
	1000	0.532	2.690	5.377	0.004	0.190	369.727
Off-Highway Trucks	175	0.477	1.982	3.564	0.004	0.212	324.222
	250	0.336	0.883	3.375	0.004	0.120	324.222
	500	0.310	0.965	2.955	0.003	0.110	324.222
	750	0.312	0.964	3.045	0.003	0.112	324.222
	1000	0.351	1.157	3.973	0.003	0.121	324.222
Other Construction Equipment	15	0.411	2.153	2.580	0.005	0.130	352.663
	25	0.445	1.465	2.859	0.004	0.158	352.663
	50	1.431	3.823	3.569	0.005	0.356	352.663
	120	0.628	2.388	4.031	0.004	0.345	352.663

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2009		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	MaxHP	ROG	CO	NOX	SOX	PM	CO2
	175	0.416	1.958	3.529	0.004	0.190	352.663
	500	0.252	0.905	2.944	0.003	0.100	352.663
Other General Industrial Equipment	15	0.301	1.771	2.115	0.005	0.087	290.093
	25	0.352	1.194	2.246	0.004	0.118	290.093
	50	1.793	4.178	3.253	0.004	0.395	290.093
	120	0.713	2.188	4.006	0.003	0.384	290.093
	175	0.475	1.763	3.590	0.003	0.211	290.093
	250	0.314	0.831	3.361	0.003	0.116	290.093
	500	0.284	0.952	2.977	0.003	0.106	290.093
	750	0.287	0.952	3.058	0.003	0.108	290.093
	1000	0.344	1.224	3.812	0.003	0.118	290.093
Other Material Handling Equipment	50	2.054	4.783	3.750	0.004	0.452	335.598
	120	0.818	2.518	4.619	0.004	0.441	335.598
	175	0.545	2.030	4.141	0.004	0.242	335.598
	250	0.359	0.957	3.877	0.004	0.133	335.598
	500	0.325	1.099	3.437	0.003	0.122	335.598
	9999	0.396	1.414	4.397	0.003	0.136	335.598
Pavers	25	0.555	1.644	3.111	0.004	0.189	352.663
	50	2.156	4.978	3.968	0.005	0.468	352.663
	120	0.881	2.695	5.180	0.004	0.453	352.663
	175	0.590	2.209	4.628	0.004	0.258	352.663
	250	0.463	1.338	4.449	0.004	0.183	352.663
	500	0.415	1.914	4.023	0.003	0.163	352.663
Paving Equipment	25	0.380	1.253	2.444	0.004	0.135	301.470
	50	1.833	4.223	3.386	0.004	0.398	301.470
	120	0.748	2.287	4.407	0.004	0.384	301.470
	175	0.500	1.870	3.941	0.003	0.218	301.470
	250	0.392	1.133	3.786	0.003	0.155	301.470
Plate Compactors	15	0.289	1.493	1.822	0.004	0.101	244.589
Pressure Washers	15	0.301	1.230	1.990	0.003	0.121	170.643
	25	0.304	1.030	1.677	0.002	0.108	170.643
	50	0.521	1.391	1.678	0.002	0.143	170.643
	120	0.291	1.062	1.977	0.002	0.141	170.643
Pumps	15	0.872	3.034	5.038	0.007	0.372	420.920
	25	0.990	2.540	4.135	0.005	0.300	420.920
	50	1.714	4.267	4.313	0.005	0.422	420.920
	120	0.817	2.791	5.183	0.005	0.414	420.920
	175	0.536	2.255	4.641	0.005	0.229	420.920
	250	0.354	1.070	4.353	0.005	0.135	420.920
	500	0.317	1.238	3.963	0.004	0.125	420.920
	750	0.326	1.238	4.064	0.004	0.127	420.920
	9999	0.434	1.588	5.064	0.004	0.153	420.920
Rollers	15	0.372	1.945	2.331	0.005	0.117	318.534
	25	0.402	1.324	2.582	0.004	0.143	318.534
	50	1.660	3.994	3.426	0.004	0.377	318.534
	120	0.691	2.279	4.202	0.004	0.363	318.534
	175	0.460	1.857	3.743	0.004	0.202	318.534

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2009		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	250	0.342	0.999	3.572	0.004	0.134	318.534
	500	0.306	1.222	3.212	0.003	0.121	318.534
Rough Terrain Forklifts	50	1.744	4.364	3.644	0.004	0.405	341.286
	120	0.714	2.455	4.261	0.004	0.392	341.286
	175	0.477	2.002	3.761	0.004	0.215	341.286
	250	0.325	0.908	3.553	0.004	0.122	341.286
	500	0.295	0.996	3.127	0.003	0.112	341.286
Rubber Tired Dozers	175	0.647	2.274	4.849	0.004	0.279	335.598
	250	0.528	1.482	4.685	0.004	0.206	335.598
	500	0.476	2.357	4.248	0.003	0.181	335.598
	750	0.477	2.354	4.313	0.003	0.182	335.598
	1000	0.500	2.538	4.967	0.003	0.179	335.598
Rubber Tired Loaders	25	0.376	1.265	2.414	0.004	0.132	307.158
	50	1.662	4.077	3.336	0.004	0.378	307.158
	120	0.674	2.249	3.994	0.004	0.365	307.158
	175	0.452	1.835	3.540	0.003	0.202	307.158
	250	0.325	0.914	3.367	0.003	0.124	307.158
	500	0.295	1.065	2.985	0.003	0.112	307.158
	750	0.298	1.064	3.064	0.003	0.114	307.158
	1000	0.337	1.245	3.839	0.003	0.117	307.158
Scrapers	120	1.032	3.165	5.977	0.005	0.538	409.544
	175	0.694	2.592	5.330	0.005	0.305	409.544
	250	0.537	1.515	5.114	0.005	0.208	409.544
	500	0.485	2.099	4.596	0.004	0.186	409.544
	750	0.487	2.097	4.686	0.004	0.188	409.544
Signal Boards	15	0.543	2.848	3.400	0.007	0.139	466.425
	50	1.939	4.799	4.587	0.006	0.466	443.672
	120	0.879	3.002	5.491	0.005	0.456	443.672
	175	0.578	2.431	4.902	0.005	0.252	443.672
	250	0.462	1.369	5.557	0.006	0.177	536.104
Skid Steer Loaders	25	0.612	1.669	2.916	0.004	0.195	312.846
	50	1.095	3.202	3.071	0.004	0.291	312.846
	120	0.496	2.087	3.273	0.004	0.284	312.846
Surfacing Equipment	50	1.141	2.832	2.671	0.003	0.271	255.965
	120	0.512	1.759	3.251	0.003	0.263	255.965
	175	0.339	1.437	2.892	0.003	0.147	255.965
	250	0.253	0.776	2.764	0.003	0.099	255.965
	500	0.228	0.970	2.509	0.003	0.090	255.965
	750	0.232	0.969	2.564	0.003	0.091	255.965
Sweepers/Scrubbers	15	0.401	2.362	2.820	0.006	0.115	386.791
	25	0.474	1.593	3.044	0.005	0.166	386.791
	50	2.029	4.972	4.124	0.005	0.466	386.791
	120	0.830	2.778	4.767	0.005	0.461	386.791
	175	0.553	2.246	4.247	0.004	0.252	386.791
	250	0.336	0.897	3.964	0.004	0.122	386.791
Tractors/Loaders/Backhoes	25	0.442	1.374	2.672	0.004	0.156	312.846
	50	1.437	3.799	3.263	0.004	0.347	312.846

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2009		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	120	0.601	2.214	3.672	0.004	0.335	312.846
	175	0.403	1.818	3.209	0.004	0.184	312.846
	250	0.273	0.770	3.036	0.004	0.102	312.846
	500	0.250	0.817	2.650	0.004	0.094	312.846
	750	0.252	0.816	2.738	0.004	0.096	312.846
Trenchers	15	0.497	2.605	3.110	0.007	0.127	426.608
	25	0.522	1.757	3.353	0.005	0.183	426.608
	50	2.499	5.780	4.751	0.006	0.546	426.608
	120	1.046	3.221	6.253	0.005	0.530	426.608
	175	0.701	2.647	5.589	0.005	0.305	426.608
	250	0.558	1.640	5.382	0.005	0.223	426.608
	500	0.498	2.423	4.891	0.004	0.198	426.608
	750	0.503	2.420	4.973	0.004	0.199	426.608
Welders	15	0.530	1.845	3.064	0.004	0.226	255.965
	25	0.602	1.544	2.515	0.003	0.182	255.965
	50	1.259	3.019	2.713	0.003	0.292	255.965
	120	0.546	1.784	3.302	0.003	0.285	255.965
	175	0.361	1.439	2.958	0.003	0.157	255.965
	250	0.239	0.686	2.774	0.003	0.091	255.965
	500	0.214	0.800	2.498	0.003	0.084	255.965
Water Trucks	175	0.477	1.982	3.564	0.004	0.212	324.222
	250	0.336	0.883	3.375	0.004	0.120	324.222
	500	0.310	0.965	2.955	0.003	0.110	324.222
	750	0.312	0.964	3.045	0.003	0.112	324.222
	1000	0.351	1.157	3.973	0.003	0.121	324.222

2010		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Aerial Lifts	15	0.314	1.599	2.001	0.004	0.111	261.653
	25	0.497	1.370	2.412	0.003	0.155	261.653
	50	0.996	2.566	2.639	0.003	0.249	261.653
	120	0.477	1.715	3.074	0.003	0.246	261.653
	500	0.183	0.707	2.340	0.003	0.073	261.653
	750	0.188	0.707	2.402	0.003	0.074	261.653
Air Compressors	15	0.540	1.935	3.149	0.004	0.228	273.029
	25	0.609	1.590	2.632	0.003	0.185	273.029
	50	1.408	3.421	2.915	0.004	0.321	273.029
	120	0.583	1.943	3.451	0.003	0.314	273.029
	175	0.389	1.575	3.086	0.003	0.174	273.029
	250	0.252	0.705	2.887	0.003	0.095	273.029
	500	0.227	0.792	2.577	0.003	0.088	273.029
	750	0.231	0.792	2.646	0.003	0.089	273.029
	1000	0.289	1.032	3.360	0.003	0.101	273.029
Bore/Drill Rigs	15	0.497	2.605	3.110	0.007	0.127	426.608
	25	0.524	1.760	3.354	0.005	0.173	426.608
	50	0.749	3.443	3.877	0.006	0.267	426.608
	120	0.400	2.662	3.405	0.005	0.252	426.608
	175	0.281	2.281	2.767	0.005	0.146	426.608
	250	0.217	0.785	2.687	0.005	0.087	426.608
	500	0.204	0.763	2.337	0.004	0.084	426.608
	750	0.208	0.763	2.412	0.004	0.085	426.608
	1000	0.246	0.785	3.818	0.004	0.095	426.608
Cement and Mortar Mixers	15	0.398	1.958	2.548	0.005	0.146	318.534
	25	0.628	1.709	2.963	0.004	0.194	318.534
Concrete/Industrial Saws	25	0.505	1.710	3.223	0.005	0.158	415.232
	50	1.692	4.413	4.219	0.005	0.413	415.232
	120	0.752	2.786	4.817	0.005	0.403	415.232
	175	0.500	2.277	4.266	0.005	0.224	415.232
Cranes	50	1.354	3.340	2.686	0.003	0.304	244.589
	120	0.545	1.816	3.191	0.003	0.294	244.589
	175	0.369	1.485	2.832	0.003	0.164	244.589
	250	0.271	0.755	2.698	0.003	0.102	244.589
	500	0.247	0.900	2.407	0.002	0.093	244.589
	750	0.249	0.899	2.465	0.002	0.094	244.589
	9999	0.275	1.044	3.072	0.002	0.096	244.588
Crawler Tractors	50	2.117	5.150	4.067	0.005	0.469	364.039
	120	0.858	2.776	5.000	0.004	0.453	364.039
	175	0.583	2.282	4.442	0.004	0.257	364.039
	250	0.450	1.258	4.260	0.004	0.172	364.039
	500	0.409	1.675	3.827	0.004	0.155	364.039
	750	0.411	1.673	3.905	0.004	0.156	364.039
	1000	0.442	1.872	4.759	0.004	0.156	364.039
Crushing/Proc. Equipment	50	2.289	5.637	4.737	0.006	0.524	443.672
	120	0.939	3.178	5.540	0.005	0.512	443.672
	175	0.628	2.583	4.936	0.005	0.283	443.672

2010		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	250	0.407	1.129	4.620	0.005	0.153	443.672
	500	0.367	1.252	4.098	0.004	0.141	443.672
	750	0.373	1.224	4.254	0.004	0.143	443.672
	9999	0.469	1.633	5.455	0.004	0.163	443.672
Dumpers/Tenders	25	0.307	0.954	1.827	0.003	0.103	216.148
Excavators	25	0.392	1.335	2.486	0.004	0.113	324.222
	50	1.466	4.076	3.419	0.004	0.357	324.222
	120	0.616	2.342	3.700	0.004	0.344	324.222
	175	0.423	1.936	3.220	0.004	0.192	324.222
	250	0.297	0.804	3.052	0.004	0.106	324.222
	500	0.275	0.855	2.675	0.003	0.099	324.222
	750	0.277	0.854	2.759	0.003	0.100	324.222
Forklifts	50	0.768	2.112	1.777	0.002	0.188	170.643
	120	0.326	1.224	1.903	0.002	0.186	170.643
	175	0.223	1.006	1.677	0.002	0.102	170.643
	250	0.143	0.377	1.577	0.002	0.050	170.643
	500	0.133	0.359	1.362	0.002	0.047	170.643
Generator Sets	15	0.706	2.983	4.731	0.007	0.282	420.920
	25	0.712	2.451	4.057	0.005	0.254	420.920
	50	1.515	3.965	4.207	0.005	0.387	420.920
	120	0.745	2.724	4.869	0.005	0.382	420.920
	175	0.490	2.212	4.348	0.005	0.212	420.920
	250	0.317	0.988	4.075	0.005	0.121	420.920
	500	0.285	1.098	3.715	0.004	0.114	420.920
	750	0.294	1.098	3.812	0.004	0.115	420.920
	9999	0.400	1.430	4.848	0.004	0.143	420.920
Graders	50	1.764	4.516	3.730	0.004	0.407	346.974
	120	0.719	2.527	4.290	0.004	0.393	346.974
	175	0.488	2.074	3.789	0.004	0.219	346.974
	250	0.355	0.995	3.610	0.004	0.134	346.974
	500	0.325	1.137	3.205	0.003	0.122	346.974
	750	0.327	1.137	3.289	0.003	0.124	346.974
Off-Highway Tractors	120	0.969	2.934	5.601	0.004	0.495	369.727
	175	0.659	2.427	5.008	0.004	0.287	369.727
	250	0.533	1.516	4.834	0.004	0.208	369.727
	750	0.482	2.319	4.454	0.004	0.186	369.727
	1000	0.509	2.514	5.208	0.004	0.182	369.727
Off-Highway Trucks	175	0.449	1.976	3.317	0.004	0.200	324.222
	250	0.319	0.837	3.144	0.004	0.112	324.222
	500	0.297	0.898	2.761	0.003	0.104	324.222
	750	0.299	0.897	2.845	0.003	0.105	324.222
	1000	0.334	1.072	3.802	0.003	0.115	324.222
Other Construction Equipment	15	0.411	2.153	2.571	0.005	0.105	352.663
	25	0.433	1.455	2.773	0.004	0.143	352.663
	50	1.302	3.692	3.511	0.005	0.332	352.663
	120	0.576	2.363	3.772	0.004	0.323	352.663
	175	0.387	1.954	3.287	0.004	0.180	352.663
	500	0.237	0.842	2.750	0.003	0.094	352.663

2010		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Other General Industrial Equipment	15	0.301	1.771	2.115	0.005	0.079	290.093
	25	0.351	1.194	2.225	0.004	0.101	290.093
	50	1.689	4.071	3.210	0.004	0.378	290.093
	120	0.676	2.168	3.817	0.003	0.368	290.093
	175	0.454	1.756	3.408	0.003	0.203	290.093
	250	0.297	0.781	3.188	0.003	0.108	290.093
	500	0.271	0.870	2.819	0.003	0.100	290.093
	750	0.273	0.870	2.899	0.003	0.101	290.093
	1000	0.327	1.130	3.688	0.003	0.114	290.093
Other Material Handling Equipment	50	1.938	4.664	3.700	0.004	0.433	335.598
	120	0.776	2.496	4.403	0.004	0.423	335.598
	175	0.521	2.022	3.934	0.004	0.233	335.598
	250	0.340	0.901	3.679	0.004	0.124	335.598
	500	0.309	1.004	3.255	0.003	0.115	335.598
	9999	0.376	1.305	4.255	0.003	0.131	335.598
Pavers	25	0.525	1.597	3.030	0.004	0.175	352.663
	50	2.047	4.863	3.919	0.005	0.449	352.663
	120	0.835	2.662	4.940	0.004	0.435	352.663
	175	0.563	2.188	4.406	0.004	0.248	352.663
	250	0.440	1.272	4.234	0.004	0.173	352.663
	500	0.396	1.763	3.828	0.003	0.155	352.662
Paving Equipment	25	0.370	1.244	2.370	0.004	0.122	301.470
	50	1.744	4.129	3.344	0.004	0.382	301.470
	120	0.709	2.259	4.204	0.004	0.370	301.470
	175	0.477	1.853	3.753	0.003	0.210	301.470
	250	0.371	1.075	3.604	0.003	0.146	301.470
Plate Compactors	15	0.286	1.493	1.798	0.004	0.086	244.589
Pressure Washers	15	0.286	1.209	1.918	0.003	0.114	170.643
	25	0.289	0.994	1.645	0.002	0.103	170.643
	50	0.487	1.357	1.652	0.002	0.136	170.643
	120	0.272	1.052	1.884	0.002	0.136	170.643
Pumps	15	0.833	2.983	4.855	0.007	0.351	420.920
	25	0.939	2.451	4.057	0.005	0.284	420.920
	50	1.621	4.174	4.252	0.005	0.404	420.920
	120	0.770	2.767	4.944	0.005	0.399	420.920
	175	0.508	2.247	4.416	0.005	0.221	420.920
	250	0.329	1.007	4.138	0.005	0.126	420.920
	500	0.295	1.138	3.758	0.004	0.118	420.920
	750	0.304	1.138	3.857	0.004	0.119	420.920
	9999	0.408	1.475	4.901	0.004	0.145	420.920
Rollers	15	0.371	1.945	2.322	0.005	0.095	318.534
	25	0.391	1.314	2.504	0.004	0.129	318.534
	50	1.557	3.885	3.375	0.004	0.358	318.534
	120	0.649	2.255	3.987	0.004	0.346	318.534
	175	0.435	1.847	3.541	0.004	0.194	318.534
	250	0.321	0.945	3.377	0.004	0.125	318.534
	500	0.289	1.132	3.036	0.003	0.114	318.534
Rough Terrain Forklifts	50	1.603	4.219	3.586	0.004	0.380	341.286

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2010		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	120	0.663	2.430	4.004	0.004	0.369	341.286
	175	0.448	1.995	3.518	0.004	0.205	341.286
	250	0.304	0.853	3.323	0.004	0.113	341.286
	500	0.279	0.914	2.925	0.003	0.105	341.286
Rubber Tired Dozers	175	0.622	2.251	4.635	0.004	0.269	335.598
	250	0.508	1.419	4.478	0.004	0.196	335.598
	500	0.459	2.206	4.063	0.003	0.174	335.598
	750	0.460	2.203	4.126	0.003	0.175	335.598
	1000	0.481	2.379	4.812	0.003	0.171	335.598
Rubber Tired Loaders	25	0.374	1.265	2.384	0.004	0.117	307.158
	50	1.538	3.949	3.286	0.004	0.356	307.158
	120	0.629	2.225	3.768	0.004	0.344	307.158
	175	0.426	1.828	3.326	0.003	0.192	307.158
	250	0.308	0.868	3.166	0.003	0.116	307.158
	500	0.282	0.991	2.810	0.003	0.106	307.158
	750	0.284	0.990	2.885	0.003	0.108	307.158
	1000	0.318	1.157	3.691	0.003	0.112	307.158
Scrapers	120	0.975	3.127	5.685	0.005	0.513	409.544
	175	0.661	2.569	5.057	0.005	0.291	409.544
	250	0.512	1.440	4.852	0.005	0.197	409.544
	500	0.465	1.934	4.364	0.004	0.177	409.544
	750	0.467	1.932	4.450	0.004	0.178	409.544
Signal Boards	15	0.543	2.848	3.400	0.007	0.127	466.425
	50	1.830	4.691	4.522	0.006	0.446	443.672
	120	0.827	2.976	5.225	0.005	0.438	443.672
	175	0.548	2.422	4.652	0.005	0.243	443.672
	250	0.430	1.289	5.270	0.006	0.166	536.104
Skid Steer Loaders	25	0.564	1.587	2.838	0.004	0.179	312.846
	50	0.962	3.073	3.020	0.004	0.266	312.846
	120	0.444	2.064	3.022	0.004	0.260	312.846
Surfacing Equipment	50	1.070	2.758	2.632	0.003	0.258	255.965
	120	0.479	1.740	3.084	0.003	0.251	255.965
	175	0.320	1.429	2.736	0.003	0.141	255.965
	250	0.238	0.737	2.616	0.003	0.094	255.965
	500	0.215	0.901	2.374	0.003	0.086	255.965
	750	0.218	0.900	2.427	0.003	0.087	255.965
Sweepers/Scrubbers	15	0.401	2.362	2.820	0.006	0.106	386.791
	25	0.471	1.593	3.005	0.005	0.148	386.791
	50	1.828	4.745	4.033	0.005	0.432	386.791
	120	0.762	2.742	4.434	0.005	0.431	386.791
	175	0.512	2.237	3.947	0.004	0.236	386.791
	250	0.319	0.867	3.701	0.004	0.116	386.791
Tractors/Loaders/Backhoes	25	0.421	1.344	2.596	0.004	0.142	312.846
	50	1.296	3.658	3.211	0.004	0.322	312.846
	120	0.550	2.191	3.426	0.004	0.312	312.846
	175	0.375	1.815	2.977	0.004	0.173	312.846
	250	0.258	0.735	2.822	0.004	0.095	312.846
	500	0.239	0.771	2.471	0.004	0.089	312.846
	750	0.241	0.770	2.552	0.004	0.090	312.846

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2010		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Trenchers	15	0.497	2.605	3.110	0.007	0.117	426.608
	25	0.519	1.757	3.311	0.005	0.162	426.608
	50	2.381	5.657	4.692	0.006	0.525	426.608
	120	0.992	3.182	5.971	0.005	0.510	426.608
	175	0.668	2.622	5.328	0.005	0.294	426.608
	250	0.530	1.562	5.130	0.005	0.211	426.608
	500	0.475	2.240	4.661	0.004	0.188	426.608
	750	0.479	2.238	4.740	0.004	0.189	426.608
Welders	15	0.507	1.814	2.952	0.004	0.213	255.965
	25	0.571	1.491	2.467	0.003	0.173	255.965
	50	1.197	2.960	2.677	0.003	0.281	255.965
	120	0.518	1.770	3.152	0.003	0.275	255.965
	175	0.344	1.435	2.818	0.003	0.152	255.965
	250	0.224	0.645	2.638	0.003	0.085	255.965
	500	0.201	0.730	2.370	0.003	0.079	255.965
Water Trucks	175	0.449	1.976	3.317	0.004	0.200	324.222
	250	0.319	0.837	3.144	0.004	0.112	324.222
	500	0.297	0.898	2.761	0.003	0.104	324.222
	750	0.299	0.897	2.845	0.003	0.105	324.222
	1000	0.334	1.072	3.802	0.003	0.115	324.222

2011		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Aerial Lifts	15	0.310	1.598	1.964	0.004	0.099	261.653
	25	0.454	1.296	2.344	0.003	0.142	261.653
	50	0.925	2.490	2.594	0.003	0.236	261.653
	120	0.444	1.697	2.907	0.003	0.235	261.653
	500	0.167	0.646	2.168	0.003	0.065	261.653
	750	0.172	0.646	2.228	0.003	0.066	261.653
Air Compressors	15	0.513	1.899	3.019	0.004	0.212	273.029
	25	0.573	1.528	2.576	0.003	0.174	273.029
	50	1.317	3.324	2.869	0.004	0.306	273.029
	120	0.548	1.925	3.270	0.003	0.301	273.029
	175	0.368	1.568	2.914	0.003	0.167	273.029
	250	0.233	0.659	2.692	0.003	0.085	273.029
	500	0.211	0.720	2.393	0.003	0.079	273.029
	750	0.214	0.720	2.462	0.003	0.081	273.029
	1000	0.270	0.947	3.189	0.003	0.095	273.029
Bore/Drill Rigs	15	0.497	2.605	3.110	0.007	0.122	426.608
	25	0.519	1.757	3.315	0.005	0.157	426.608
	50	0.599	3.311	3.835	0.006	0.233	426.608
	120	0.335	2.634	3.087	0.005	0.221	426.608
	175	0.251	2.280	2.495	0.005	0.135	426.608
	250	0.202	0.781	2.297	0.005	0.073	426.608
	500	0.194	0.759	2.043	0.004	0.071	426.608
	750	0.196	0.759	2.084	0.004	0.072	426.608
	1000	0.225	0.777	3.400	0.004	0.086	426.608
Cement and Mortar Mixers	15	0.384	1.950	2.439	0.005	0.130	318.534
	25	0.578	1.624	2.884	0.004	0.179	318.534
Concrete/Industrial Saws	25	0.503	1.710	3.194	0.005	0.141	415.232
	50	1.566	4.278	4.150	0.005	0.391	415.232
	120	0.699	2.759	4.546	0.005	0.383	415.232
	175	0.468	2.268	4.012	0.005	0.214	415.232
Cranes	50	1.257	3.240	2.649	0.003	0.288	244.588
	120	0.511	1.798	3.022	0.003	0.279	244.589
	175	0.350	1.479	2.672	0.003	0.157	244.589
	250	0.255	0.714	2.513	0.003	0.093	244.589
	500	0.234	0.833	2.240	0.002	0.085	244.589
	750	0.236	0.833	2.296	0.002	0.086	244.589
	9999	0.262	0.970	2.912	0.002	0.090	244.589
Crawler Tractors	50	1.979	5.010	4.017	0.005	0.446	364.039
	120	0.808	2.743	4.746	0.004	0.430	364.039
	175	0.555	2.265	4.208	0.004	0.246	364.039
	250	0.427	1.199	3.990	0.004	0.159	364.039
	500	0.391	1.548	3.586	0.004	0.143	364.039
	750	0.392	1.546	3.660	0.004	0.145	364.039
	1000	0.420	1.732	4.521	0.004	0.147	364.039
Crushing/Proc. Equipment	50	2.126	5.461	4.663	0.006	0.497	443.672
	120	0.879	3.146	5.234	0.005	0.488	443.672
	175	0.593	2.572	4.648	0.005	0.271	443.672

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2011		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	250	0.378	1.059	4.293	0.005	0.137	443.672
	500	0.343	1.142	3.793	0.004	0.127	443.672
	750	0.348	1.121	3.946	0.004	0.129	443.672
	9999	0.441	1.502	5.160	0.004	0.154	443.672
Dumpers/Tenders	25	0.293	0.934	1.782	0.003	0.096	216.148
Excavators	25	0.391	1.335	2.475	0.004	0.098	324.222
	50	1.319	3.933	3.371	0.004	0.331	324.222
	120	0.567	2.319	3.458	0.004	0.319	324.222
	175	0.397	1.932	2.994	0.004	0.181	324.222
	250	0.280	0.769	2.785	0.004	0.095	324.222
	500	0.262	0.803	2.444	0.003	0.089	324.222
	750	0.264	0.803	2.522	0.003	0.090	324.222
Forklifts	50	0.675	2.022	1.749	0.002	0.172	170.643
	120	0.295	1.210	1.771	0.002	0.169	170.643
	175	0.205	1.005	1.542	0.002	0.094	170.643
	250	0.137	0.368	1.428	0.002	0.045	170.643
	500	0.128	0.350	1.229	0.002	0.042	170.643
Generator Sets	15	0.673	2.928	4.544	0.007	0.266	420.920
	25	0.681	2.355	3.971	0.005	0.241	420.920
	50	1.409	3.851	4.137	0.005	0.367	420.920
	120	0.694	2.697	4.611	0.005	0.365	420.920
	175	0.459	2.203	4.106	0.005	0.203	420.920
	250	0.290	0.925	3.796	0.005	0.109	420.920
	500	0.260	1.008	3.448	0.004	0.102	420.920
	750	0.268	1.008	3.543	0.004	0.104	420.920
	9999	0.372	1.322	4.594	0.004	0.133	420.920
Graders	50	1.625	4.376	3.679	0.004	0.384	346.974
	120	0.671	2.502	4.050	0.004	0.371	346.974
	175	0.461	2.067	3.562	0.004	0.209	346.974
	250	0.336	0.949	3.344	0.004	0.122	346.974
	500	0.309	1.066	2.970	0.003	0.111	346.974
	750	0.311	1.065	3.048	0.003	0.113	346.974
Off-Highway Tractors	120	0.923	2.900	5.359	0.004	0.475	369.727
	175	0.632	2.404	4.782	0.004	0.277	369.727
	250	0.510	1.450	4.578	0.004	0.195	369.727
	750	0.463	2.162	4.219	0.004	0.175	369.727
	1000	0.487	2.348	4.987	0.004	0.173	369.727
Off-Highway Trucks	175	0.423	1.972	3.088	0.004	0.189	324.222
	250	0.302	0.798	2.876	0.004	0.100	324.222
	500	0.282	0.840	2.529	0.003	0.094	324.222
	750	0.284	0.840	2.606	0.003	0.095	324.222
	1000	0.317	0.996	3.554	0.003	0.108	324.222
Other Construction Equipment	15	0.411	2.153	2.571	0.005	0.101	352.663
	25	0.429	1.452	2.740	0.004	0.130	352.663
	50	1.179	3.569	3.459	0.005	0.309	352.663
	120	0.527	2.341	3.532	0.004	0.303	352.663
	175	0.360	1.950	3.064	0.004	0.171	352.663
	500	0.221	0.788	2.510	0.003	0.084	352.663

2011		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Other General Industrial Equipment	15	0.301	1.771	2.115	0.005	0.080	290.093
	25	0.350	1.194	2.214	0.004	0.088	290.093
	50	1.559	3.927	3.155	0.004	0.356	290.093
	120	0.632	2.142	3.599	0.003	0.349	290.093
	175	0.429	1.746	3.202	0.003	0.193	290.093
	250	0.276	0.729	2.958	0.003	0.097	290.093
	500	0.254	0.790	2.608	0.003	0.090	290.093
	750	0.256	0.790	2.686	0.003	0.091	290.093
	1000	0.307	1.035	3.490	0.003	0.107	290.093
Other Material Handling Equipment	50	1.792	4.502	3.638	0.004	0.409	335.598
	120	0.726	2.467	4.154	0.004	0.401	335.598
	175	0.492	2.011	3.697	0.004	0.222	335.598
	250	0.316	0.841	3.415	0.004	0.111	335.598
	500	0.290	0.911	3.012	0.003	0.103	335.598
	9999	0.355	1.195	4.027	0.003	0.123	335.598
Pavers	25	0.502	1.562	2.959	0.004	0.163	352.663
	50	1.938	4.750	3.872	0.005	0.430	352.663
	120	0.791	2.631	4.710	0.004	0.417	352.663
	175	0.537	2.170	4.194	0.004	0.239	352.663
	250	0.417	1.211	3.989	0.004	0.160	352.663
	500	0.378	1.627	3.603	0.003	0.144	352.663
Paving Equipment	25	0.367	1.241	2.342	0.004	0.111	301.470
	50	1.652	4.033	3.303	0.004	0.367	301.470
	120	0.672	2.234	4.010	0.004	0.355	301.470
	175	0.455	1.837	3.574	0.003	0.202	301.470
	250	0.351	1.022	3.397	0.003	0.135	301.470
Plate Compactors	15	0.285	1.493	1.786	0.004	0.074	244.589
Pressure Washers	15	0.273	1.187	1.842	0.003	0.108	170.643
	25	0.276	0.955	1.610	0.002	0.098	170.643
	50	0.449	1.316	1.623	0.002	0.129	170.643
	120	0.252	1.041	1.783	0.002	0.129	170.643
Pumps	15	0.791	2.928	4.654	0.007	0.327	420.920
	25	0.883	2.355	3.971	0.005	0.268	420.920
	50	1.510	4.055	4.182	0.005	0.384	420.920
	120	0.718	2.740	4.683	0.005	0.381	420.920
	175	0.476	2.237	4.171	0.005	0.212	420.920
	250	0.302	0.943	3.856	0.005	0.113	420.920
	500	0.270	1.041	3.489	0.004	0.106	420.920
	750	0.279	1.041	3.586	0.004	0.108	420.920
	9999	0.380	1.360	4.646	0.004	0.136	420.920
Rollers	15	0.371	1.945	2.322	0.005	0.091	318.534
	25	0.388	1.312	2.475	0.004	0.117	318.534
	50	1.454	3.776	3.327	0.004	0.340	318.534
	120	0.608	2.233	3.782	0.004	0.330	318.534
	175	0.412	1.839	3.349	0.004	0.186	318.534
	250	0.300	0.895	3.150	0.004	0.114	318.534
	500	0.271	1.052	2.827	0.003	0.104	318.534
Rough Terrain Forklifts	50	1.463	4.078	3.532	0.004	0.357	341.286

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2011		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	120	0.614	2.407	3.760	0.004	0.347	341.286
	175	0.421	1.990	3.288	0.004	0.194	341.286
	250	0.285	0.807	3.056	0.004	0.101	341.286
	500	0.263	0.844	2.685	0.003	0.094	341.286
Rubber Tired Dozers	175	0.597	2.230	4.429	0.004	0.259	335.598
	250	0.486	1.359	4.245	0.004	0.184	335.598
	500	0.441	2.063	3.853	0.003	0.163	335.598
	750	0.442	2.060	3.913	0.003	0.164	335.598
	1000	0.462	2.228	4.610	0.003	0.163	335.598
Rubber Tired Loaders	25	0.372	1.265	2.363	0.004	0.105	307.158
	50	1.416	3.824	3.240	0.004	0.335	307.158
	120	0.586	2.203	3.555	0.004	0.325	307.158
	175	0.402	1.822	3.125	0.003	0.183	307.158
	250	0.290	0.827	2.930	0.003	0.105	307.158
	500	0.267	0.929	2.600	0.003	0.097	307.158
	750	0.269	0.928	2.670	0.003	0.098	307.158
	1000	0.300	1.080	3.477	0.003	0.105	307.158
Scrapers	120	0.921	3.091	5.405	0.005	0.489	409.544
	175	0.631	2.550	4.798	0.005	0.279	409.544
	250	0.487	1.372	4.555	0.005	0.182	409.544
	500	0.444	1.787	4.096	0.004	0.164	409.544
	750	0.446	1.785	4.179	0.004	0.165	409.544
Signal Boards	15	0.543	2.848	3.400	0.007	0.129	466.425
	50	1.701	4.555	4.449	0.006	0.423	443.672
	120	0.770	2.946	4.940	0.005	0.418	443.672
	175	0.514	2.413	4.384	0.005	0.233	443.672
	250	0.395	1.209	4.897	0.006	0.148	536.104
Skid Steer Loaders	25	0.519	1.511	2.765	0.004	0.165	312.846
	50	0.839	2.956	2.976	0.004	0.242	312.846
	120	0.397	2.044	2.806	0.004	0.238	312.846
Surfacing Equipment	50	1.000	2.686	2.595	0.003	0.245	255.965
	120	0.447	1.722	2.927	0.003	0.239	255.965
	175	0.301	1.422	2.589	0.003	0.135	255.965
	250	0.222	0.701	2.441	0.003	0.086	255.965
	500	0.201	0.841	2.213	0.003	0.079	255.965
	750	0.205	0.840	2.263	0.003	0.079	255.965
Sweepers/Scrubbers	15	0.401	2.362	2.820	0.006	0.107	386.791
	25	0.469	1.593	2.977	0.005	0.132	386.791
	50	1.625	4.519	3.947	0.005	0.398	386.791
	120	0.694	2.707	4.142	0.005	0.399	386.791
	175	0.472	2.230	3.655	0.004	0.220	386.791
	250	0.301	0.840	3.381	0.004	0.105	386.791
Tractors/Loaders/Backhoes	25	0.405	1.321	2.526	0.004	0.131	312.846
	50	1.162	3.528	3.165	0.004	0.298	312.846
	120	0.504	2.170	3.198	0.004	0.289	312.846
	175	0.350	1.812	2.763	0.004	0.164	312.846
	250	0.243	0.707	2.567	0.004	0.085	312.846
	500	0.227	0.732	2.251	0.004	0.080	312.846
	750	0.229	0.731	2.324	0.004	0.081	312.846

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2011		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Trenchers	15	0.497	2.605	3.110	0.007	0.118	426.608
	25	0.517	1.757	3.282	0.005	0.145	426.608
	50	2.263	5.534	4.636	0.006	0.504	426.608
	120	0.940	3.145	5.701	0.005	0.491	426.608
	175	0.638	2.598	5.080	0.005	0.283	426.608
	250	0.502	1.488	4.841	0.005	0.196	426.608
	500	0.452	2.072	4.394	0.004	0.175	426.608
	750	0.455	2.070	4.471	0.004	0.177	426.608
Welders	15	0.481	1.780	2.830	0.004	0.199	255.965
	25	0.537	1.432	2.415	0.003	0.163	255.965
	50	1.121	2.879	2.635	0.003	0.267	255.965
	120	0.485	1.753	2.987	0.003	0.263	255.965
	175	0.324	1.430	2.662	0.003	0.146	255.965
	250	0.206	0.604	2.461	0.003	0.077	255.965
	500	0.185	0.664	2.201	0.003	0.071	255.965
Water Trucks	175	0.423	1.972	3.088	0.004	0.189	324.222
	250	0.302	0.798	2.876	0.004	0.100	324.222
	500	0.282	0.840	2.529	0.003	0.094	324.222
	750	0.284	0.840	2.606	0.003	0.095	324.222
	1000	0.317	0.996	3.554	0.003	0.108	324.222

2012		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Aerial Lifts	15	0.308	1.598	1.941	0.004	0.090	261.653
	25	0.414	1.229	2.280	0.003	0.129	261.653
	50	0.849	2.407	2.547	0.003	0.223	261.653
	120	0.410	1.679	2.728	0.003	0.219	261.653
	500	0.154	0.602	2.007	0.003	0.059	261.653
	750	0.159	0.602	2.066	0.003	0.060	261.653
Air Compressors	15	0.484	1.861	2.882	0.004	0.196	273.029
	25	0.535	1.462	2.517	0.003	0.162	273.029
	50	1.215	3.210	2.820	0.004	0.289	273.029
	120	0.510	1.904	3.070	0.003	0.282	273.029
	175	0.345	1.562	2.731	0.003	0.156	273.029
	250	0.219	0.631	2.506	0.003	0.078	273.029
	500	0.199	0.669	2.219	0.003	0.072	273.029
	750	0.202	0.669	2.286	0.003	0.074	273.029
	1000	0.251	0.865	3.009	0.003	0.088	273.029
Bore/Drill Rigs	15	0.497	2.605	3.110	0.007	0.120	426.608
	25	0.517	1.757	3.289	0.005	0.143	426.608
	50	0.482	3.209	3.805	0.006	0.205	426.608
	120	0.284	2.613	2.780	0.005	0.182	426.608
	175	0.227	2.279	2.261	0.005	0.111	426.608
	250	0.190	0.779	1.978	0.005	0.061	426.608
	500	0.185	0.757	1.802	0.004	0.060	426.608
	750	0.186	0.757	1.827	0.004	0.060	426.608
	1000	0.207	0.771	3.042	0.004	0.078	426.608
Cement and Mortar Mixers	15	0.378	1.946	2.395	0.005	0.118	318.534
	25	0.532	1.546	2.809	0.004	0.164	318.534
Concrete/Industrial Saws	25	0.502	1.710	3.177	0.005	0.127	415.232
	50	1.439	4.144	4.084	0.005	0.368	415.232
	120	0.647	2.733	4.270	0.005	0.358	415.232
	175	0.437	2.261	3.760	0.005	0.199	415.232
Cranes	50	1.162	3.143	2.614	0.003	0.272	244.589
	120	0.479	1.780	2.850	0.003	0.260	244.589
	175	0.331	1.473	2.514	0.003	0.146	244.589
	250	0.241	0.677	2.336	0.003	0.085	244.589
	500	0.222	0.773	2.082	0.002	0.078	244.589
	750	0.223	0.772	2.135	0.002	0.079	244.589
	9999	0.250	0.902	2.758	0.002	0.085	244.589
Crawler Tractors	50	1.846	4.877	3.969	0.005	0.423	364.039
	120	0.760	2.714	4.492	0.004	0.403	364.039
	175	0.528	2.250	3.979	0.004	0.230	364.039
	250	0.406	1.145	3.735	0.004	0.146	364.039
	500	0.373	1.435	3.358	0.004	0.132	364.039
	750	0.375	1.433	3.428	0.004	0.134	364.039
	1000	0.400	1.606	4.293	0.004	0.139	364.039
Crushing/Proc. Equipment	50	1.943	5.257	4.581	0.006	0.466	443.672
	120	0.814	3.111	4.895	0.005	0.454	443.672
	175	0.554	2.561	4.335	0.005	0.251	443.672

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2012		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	250	0.354	1.015	3.973	0.005	0.124	443.672
	500	0.325	1.064	3.498	0.004	0.115	443.672
	750	0.328	1.048	3.640	0.004	0.117	443.672
	9999	0.411	1.370	4.838	0.004	0.143	443.672
Dumpers/Tenders	25	0.282	0.919	1.740	0.003	0.089	216.148
Excavators	25	0.391	1.335	2.472	0.004	0.094	324.222
	50	1.183	3.802	3.328	0.004	0.307	324.222
	120	0.521	2.299	3.215	0.004	0.290	324.222
	175	0.372	1.929	2.777	0.004	0.164	324.222
	250	0.266	0.742	2.542	0.004	0.085	324.222
	500	0.250	0.762	2.235	0.003	0.080	324.222
	750	0.252	0.762	2.305	0.003	0.081	324.222
Forklifts	50	0.589	1.946	1.727	0.002	0.157	170.643
	120	0.264	1.198	1.638	0.002	0.150	170.643
	175	0.188	1.005	1.409	0.002	0.084	170.643
	250	0.131	0.362	1.288	0.002	0.041	170.643
	500	0.123	0.344	1.106	0.002	0.038	170.643
Generator Sets	15	0.641	2.870	4.351	0.007	0.251	420.920
	25	0.655	2.254	3.881	0.005	0.228	420.920
	50	1.293	3.726	4.063	0.005	0.346	420.920
	120	0.641	2.669	4.332	0.005	0.341	420.920
	175	0.426	2.195	3.851	0.005	0.189	420.920
	250	0.268	0.887	3.533	0.005	0.099	420.920
	500	0.240	0.944	3.196	0.004	0.093	420.920
	750	0.248	0.944	3.290	0.004	0.095	420.920
	9999	0.343	1.214	4.332	0.004	0.123	420.920
Graders	50	1.490	4.240	3.631	0.004	0.360	346.974
	120	0.624	2.479	3.806	0.004	0.343	346.974
	175	0.435	2.062	3.341	0.004	0.193	346.974
	250	0.317	0.909	3.094	0.004	0.110	346.974
	500	0.294	1.004	2.751	0.003	0.101	346.974
	750	0.296	1.003	2.823	0.003	0.103	346.974
Off-Highway Tractors	120	0.877	2.867	5.114	0.004	0.451	369.727
	175	0.605	2.383	4.560	0.004	0.262	369.727
	250	0.487	1.388	4.332	0.004	0.183	369.727
	750	0.444	2.016	3.995	0.004	0.164	369.727
	1000	0.466	2.193	4.772	0.004	0.165	369.727
Off-Highway Trucks	175	0.397	1.968	2.870	0.004	0.173	324.222
	250	0.286	0.768	2.631	0.004	0.090	324.222
	500	0.269	0.793	2.317	0.003	0.084	324.222
	750	0.271	0.793	2.389	0.003	0.085	324.222
	1000	0.301	0.928	3.321	0.003	0.100	324.222
Other Construction Equipment	15	0.411	2.153	2.571	0.005	0.099	352.663
	25	0.428	1.452	2.719	0.004	0.118	352.663
	50	1.061	3.452	3.411	0.005	0.287	352.663
	120	0.482	2.320	3.289	0.004	0.276	352.663
	175	0.334	1.947	2.847	0.004	0.155	352.663
	500	0.210	0.753	2.299	0.003	0.076	352.662

2012		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Other General Industrial Equipment	15	0.301	1.771	2.115	0.005	0.082	290.093
	25	0.350	1.194	2.211	0.004	0.085	290.093
	50	1.421	3.773	3.099	0.004	0.334	290.093
	120	0.587	2.116	3.367	0.003	0.324	290.093
	175	0.402	1.737	2.988	0.003	0.179	290.093
	250	0.261	0.697	2.742	0.003	0.088	290.093
	500	0.241	0.734	2.412	0.003	0.082	290.093
	750	0.243	0.734	2.487	0.003	0.083	290.093
	1000	0.287	0.943	3.286	0.003	0.100	290.093
Other Material Handling Equipment	50	1.635	4.328	3.573	0.004	0.384	335.598
	120	0.674	2.438	3.887	0.004	0.373	335.598
	175	0.461	2.000	3.450	0.004	0.206	335.598
	250	0.298	0.804	3.166	0.004	0.101	335.598
	500	0.275	0.846	2.785	0.003	0.094	335.598
	9999	0.334	1.089	3.793	0.003	0.115	335.598
Pavers	25	0.482	1.533	2.894	0.004	0.152	352.663
	50	1.829	4.637	3.827	0.005	0.412	352.663
	120	0.748	2.603	4.479	0.004	0.395	352.663
	175	0.512	2.153	3.985	0.004	0.225	352.663
	250	0.396	1.155	3.756	0.004	0.148	352.663
	500	0.360	1.505	3.390	0.003	0.134	352.663
Paving Equipment	25	0.366	1.241	2.324	0.004	0.101	301.470
	50	1.561	3.937	3.264	0.004	0.351	301.470
	120	0.636	2.211	3.815	0.004	0.337	301.470
	175	0.434	1.825	3.397	0.003	0.191	301.470
	250	0.332	0.973	3.199	0.003	0.125	301.470
Plate Compactors	15	0.285	1.493	1.783	0.004	0.071	244.589
Pressure Washers	15	0.260	1.163	1.764	0.003	0.102	170.643
	25	0.266	0.914	1.573	0.002	0.092	170.643
	50	0.409	1.273	1.593	0.002	0.121	170.643
	120	0.231	1.031	1.675	0.002	0.120	170.643
Pumps	15	0.746	2.870	4.443	0.007	0.302	420.920
	25	0.824	2.254	3.881	0.005	0.250	420.920
	50	1.389	3.923	4.107	0.005	0.362	420.920
	120	0.664	2.711	4.399	0.005	0.357	420.920
	175	0.443	2.229	3.911	0.005	0.197	420.920
	250	0.280	0.903	3.589	0.005	0.103	420.920
	500	0.251	0.971	3.235	0.004	0.097	420.920
	750	0.259	0.971	3.329	0.004	0.098	420.920
	9999	0.351	1.246	4.382	0.004	0.125	420.920
Rollers	15	0.371	1.945	2.322	0.005	0.089	318.534
	25	0.386	1.312	2.456	0.004	0.107	318.534
	50	1.354	3.671	3.282	0.004	0.323	318.534
	120	0.569	2.213	3.574	0.004	0.310	318.534
	175	0.389	1.832	3.159	0.004	0.174	318.534
	250	0.280	0.850	2.935	0.004	0.104	318.534
	500	0.255	0.981	2.630	0.003	0.095	318.534
Rough Terrain Forklifts	50	1.326	3.941	3.482	0.004	0.333	341.286

2012		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	120	0.567	2.385	3.511	0.004	0.320	341.286
	175	0.395	1.986	3.062	0.004	0.178	341.286
	250	0.270	0.779	2.814	0.004	0.092	341.286
	500	0.252	0.796	2.471	0.003	0.085	341.286
Rubber Tired Dozers	175	0.573	2.210	4.226	0.004	0.245	335.598
	250	0.466	1.303	4.021	0.004	0.172	335.598
	500	0.424	1.928	3.652	0.003	0.153	335.598
	750	0.425	1.926	3.710	0.003	0.154	335.598
	1000	0.443	2.085	4.414	0.003	0.155	335.598
Rubber Tired Loaders	25	0.371	1.265	2.350	0.004	0.094	307.158
	50	1.297	3.704	3.197	0.004	0.314	307.158
	120	0.545	2.183	3.339	0.004	0.300	307.158
	175	0.379	1.817	2.928	0.003	0.168	307.158
	250	0.274	0.791	2.707	0.003	0.095	307.158
	500	0.254	0.875	2.405	0.003	0.088	307.158
	750	0.256	0.875	2.470	0.003	0.089	307.158
	1000	0.283	1.013	3.274	0.003	0.099	307.158
Scrapers	120	0.868	3.058	5.124	0.005	0.460	409.544
	175	0.601	2.533	4.544	0.005	0.262	409.544
	250	0.463	1.310	4.272	0.005	0.168	409.544
	500	0.425	1.656	3.843	0.004	0.152	409.544
	750	0.426	1.655	3.922	0.004	0.153	409.544
Signal Boards	15	0.543	2.848	3.400	0.007	0.132	466.425
	50	1.558	4.398	4.369	0.006	0.397	443.672
	120	0.710	2.915	4.624	0.005	0.389	443.672
	175	0.477	2.403	4.096	0.005	0.215	443.672
	250	0.367	1.158	4.536	0.006	0.134	536.104
Skid Steer Loaders	25	0.479	1.441	2.697	0.004	0.152	312.846
	50	0.731	2.859	2.945	0.004	0.221	312.846
	120	0.353	2.026	2.587	0.004	0.209	312.846
Surfacing Equipment	50	0.931	2.614	2.560	0.003	0.232	255.965
	120	0.418	1.706	2.768	0.003	0.224	255.965
	175	0.283	1.416	2.446	0.003	0.126	255.965
	250	0.208	0.669	2.276	0.003	0.078	255.965
	500	0.189	0.788	2.062	0.003	0.072	255.965
	750	0.192	0.788	2.110	0.003	0.073	255.965
Sweepers/Scrubbers	15	0.401	2.362	2.820	0.006	0.109	386.791
	25	0.467	1.593	2.961	0.005	0.119	386.791
	50	1.442	4.338	3.887	0.005	0.367	386.791
	120	0.628	2.676	3.854	0.005	0.360	386.791
	175	0.433	2.225	3.367	0.004	0.197	386.791
	250	0.285	0.820	3.077	0.004	0.095	386.791
Tractors/Loaders/Backhoes	25	0.392	1.305	2.465	0.004	0.121	312.846
	50	1.037	3.407	3.124	0.004	0.275	312.846
	120	0.460	2.151	2.970	0.004	0.261	312.846
	175	0.327	1.810	2.560	0.004	0.147	312.846
	250	0.230	0.684	2.334	0.004	0.076	312.846
	500	0.217	0.700	2.052	0.004	0.071	312.846
	750	0.218	0.700	2.118	0.004	0.072	312.846

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2012		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Trenchers	15	0.497	2.605	3.110	0.007	0.121	426.608
	25	0.516	1.757	3.264	0.005	0.130	426.608
	50	2.146	5.412	4.583	0.006	0.484	426.608
	120	0.890	3.111	5.428	0.005	0.466	426.608
	175	0.608	2.577	4.834	0.005	0.267	426.608
	250	0.475	1.420	4.565	0.005	0.182	426.608
	500	0.430	1.920	4.141	0.004	0.163	426.608
	750	0.433	1.918	4.215	0.004	0.164	426.608
Welders	15	0.454	1.745	2.702	0.004	0.184	255.965
	25	0.501	1.371	2.360	0.003	0.152	255.965
	50	1.036	2.786	2.590	0.003	0.253	255.965
	120	0.451	1.735	2.807	0.003	0.247	255.965
	175	0.304	1.424	2.497	0.003	0.137	255.965
	250	0.193	0.577	2.292	0.003	0.070	255.965
	500	0.174	0.617	2.041	0.003	0.065	255.965
Water Trucks	175	0.397	1.968	2.870	0.004	0.173	324.222
	250	0.286	0.768	2.631	0.004	0.090	324.222
	500	0.269	0.793	2.317	0.003	0.084	324.222
	750	0.271	0.793	2.389	0.003	0.085	324.222
	1000	0.301	0.928	3.321	0.003	0.100	324.222

2013		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Aerial Lifts	15	0.306	1.598	1.925	0.004	0.081	261.653
	25	0.394	1.197	2.231	0.003	0.121	261.653
	50	0.772	2.322	2.444	0.003	0.204	261.653
	120	0.376	1.662	2.555	0.003	0.202	261.653
	500	0.144	0.570	1.855	0.003	0.054	261.653
	750	0.149	0.570	1.913	0.003	0.055	261.653
Air Compressors	15	0.456	1.824	2.746	0.004	0.180	273.029
	25	0.497	1.397	2.459	0.003	0.151	273.029
	50	1.106	3.089	2.711	0.004	0.266	273.029
	120	0.472	1.884	2.872	0.003	0.261	273.029
	175	0.322	1.556	2.557	0.003	0.144	273.029
	250	0.207	0.611	2.325	0.003	0.071	273.029
	500	0.189	0.631	2.051	0.003	0.066	273.029
	750	0.192	0.631	2.117	0.003	0.067	273.029
	1000	0.232	0.788	2.827	0.003	0.082	273.029
Bore/Drill Rigs	15	0.497	2.605	3.110	0.007	0.121	426.608
	25	0.516	1.757	3.271	0.005	0.131	426.608
	50	0.397	3.136	3.530	0.006	0.165	426.608
	120	0.247	2.599	2.535	0.005	0.142	426.608
	175	0.213	2.279	2.096	0.005	0.091	426.608
	250	0.180	0.778	1.731	0.005	0.050	426.608
	500	0.177	0.756	1.606	0.004	0.049	426.608
	750	0.178	0.756	1.622	0.004	0.050	426.608
	1000	0.191	0.766	2.739	0.004	0.071	426.608
Cement and Mortar Mixers	15	0.375	1.945	2.367	0.005	0.108	318.534
	25	0.491	1.474	2.739	0.004	0.151	318.534
Concrete/Industrial Saws	25	0.501	1.710	3.168	0.005	0.123	415.232
	50	1.313	4.011	3.929	0.005	0.339	415.232
	120	0.596	2.708	4.006	0.005	0.330	415.232
	175	0.407	2.255	3.528	0.005	0.183	415.232
Cranes	50	1.071	3.050	2.526	0.003	0.252	244.589
	120	0.448	1.765	2.687	0.003	0.240	244.589
	175	0.314	1.468	2.365	0.003	0.136	244.589
	250	0.227	0.643	2.169	0.003	0.077	244.589
	500	0.211	0.719	1.933	0.002	0.070	244.589
	750	0.212	0.718	1.983	0.002	0.071	244.589
	9999	0.239	0.839	2.611	0.002	0.080	244.589
Crawler Tractors	50	1.720	4.750	3.844	0.005	0.395	364.039
	120	0.715	2.687	4.252	0.004	0.375	364.039
	175	0.503	2.237	3.764	0.004	0.214	364.039
	250	0.387	1.096	3.494	0.004	0.134	364.039
	500	0.357	1.335	3.144	0.004	0.122	364.039
	750	0.358	1.333	3.210	0.004	0.123	364.039
	1000	0.382	1.495	4.077	0.004	0.131	364.039
Crushing/Proc. Equipment	50	1.755	5.049	4.394	0.006	0.426	443.672
	120	0.748	3.076	4.564	0.005	0.416	443.672
	175	0.515	2.551	4.042	0.005	0.229	443.672

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2013		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	250	0.335	0.984	3.666	0.005	0.113	443.672
	500	0.310	1.007	3.218	0.004	0.105	443.672
	750	0.312	0.995	3.346	0.004	0.107	443.672
	9999	0.382	1.249	4.517	0.004	0.132	443.672
Dumpers/Tenders	25	0.274	0.907	1.703	0.003	0.082	216.148
Excavators	25	0.391	1.335	2.472	0.004	0.093	324.222
	50	1.057	3.681	3.186	0.004	0.275	324.222
	120	0.478	2.280	2.991	0.004	0.258	324.222
	175	0.349	1.927	2.581	0.004	0.148	324.222
	250	0.254	0.724	2.321	0.004	0.076	324.222
	500	0.241	0.731	2.048	0.003	0.072	324.222
	750	0.242	0.731	2.112	0.003	0.073	324.222
Forklifts	50	0.510	1.878	1.660	0.002	0.139	170.643
	120	0.237	1.187	1.513	0.002	0.130	170.643
	175	0.173	1.006	1.287	0.002	0.074	170.643
	250	0.125	0.356	1.158	0.002	0.037	170.643
	500	0.119	0.339	1.004	0.002	0.035	170.643
Generator Sets	15	0.610	2.812	4.160	0.007	0.236	420.920
	25	0.631	2.154	3.791	0.005	0.215	420.920
	50	1.175	3.596	3.898	0.005	0.317	420.920
	120	0.587	2.642	4.058	0.005	0.314	420.920
	175	0.393	2.187	3.610	0.005	0.173	420.920
	250	0.249	0.860	3.280	0.005	0.091	420.920
	500	0.224	0.897	2.955	0.004	0.085	420.920
	750	0.232	0.897	3.046	0.004	0.087	420.920
	9999	0.315	1.113	4.070	0.004	0.113	420.920
Graders	50	1.361	4.111	3.493	0.004	0.330	346.974
	120	0.580	2.458	3.577	0.004	0.313	346.974
	175	0.411	2.057	3.134	0.004	0.177	346.974
	250	0.301	0.873	2.860	0.004	0.100	346.974
	500	0.281	0.951	2.547	0.003	0.092	346.974
	750	0.282	0.950	2.614	0.003	0.093	346.974
Off-Highway Tractors	120	0.834	2.836	4.878	0.004	0.425	369.727
	175	0.580	2.363	4.348	0.004	0.247	369.727
	250	0.465	1.330	4.097	0.004	0.170	369.727
	750	0.426	1.881	3.780	0.004	0.153	369.727
	1000	0.446	2.049	4.566	0.004	0.156	369.727
Off-Highway Trucks	175	0.374	1.965	2.671	0.004	0.156	324.222
	250	0.272	0.747	2.409	0.004	0.080	324.222
	500	0.258	0.757	2.127	0.003	0.075	324.222
	750	0.260	0.757	2.192	0.003	0.077	324.222
	1000	0.285	0.867	3.102	0.003	0.093	324.222
Other Construction Equipment	15	0.411	2.153	2.571	0.005	0.100	352.663
	25	0.427	1.452	2.704	0.004	0.108	352.663
	50	0.949	3.343	3.258	0.005	0.258	352.663
	120	0.439	2.302	3.064	0.004	0.247	352.663
	175	0.310	1.944	2.652	0.004	0.139	352.663
	500	0.201	0.726	2.107	0.003	0.068	352.663

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2013		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Other General Industrial Equipment	15	0.301	1.771	2.115	0.005	0.083	290.093
	25	0.350	1.194	2.211	0.004	0.083	290.093
	50	1.282	3.619	2.979	0.004	0.306	290.093
	120	0.541	2.091	3.140	0.003	0.297	290.093
	175	0.375	1.729	2.787	0.003	0.164	290.093
	250	0.248	0.675	2.534	0.003	0.080	290.093
	500	0.231	0.692	2.224	0.003	0.075	290.093
	750	0.233	0.692	2.298	0.003	0.076	290.093
	1000	0.268	0.859	3.082	0.003	0.092	290.093
Other Material Handling Equipment	50	1.476	4.151	3.435	0.004	0.352	335.598
	120	0.622	2.409	3.626	0.004	0.342	335.598
	175	0.431	1.991	3.219	0.004	0.188	335.598
	250	0.284	0.778	2.927	0.004	0.092	335.598
	500	0.263	0.798	2.569	0.003	0.086	335.598
	9999	0.314	0.991	3.558	0.003	0.106	335.598
Pavers	25	0.466	1.510	2.836	0.004	0.142	352.663
	50	1.721	4.526	3.714	0.005	0.388	352.663
	120	0.707	2.577	4.259	0.004	0.372	352.663
	175	0.489	2.140	3.785	0.004	0.211	352.663
	250	0.376	1.103	3.532	0.004	0.137	352.663
	500	0.344	1.399	3.187	0.003	0.124	352.663
Paving Equipment	25	0.365	1.241	2.311	0.004	0.093	301.470
	50	1.470	3.841	3.168	0.004	0.331	301.470
	120	0.602	2.190	3.629	0.004	0.317	301.470
	175	0.414	1.814	3.228	0.003	0.180	301.470
	250	0.315	0.928	3.009	0.003	0.115	301.470
Plate Compactors	15	0.285	1.493	1.783	0.004	0.070	244.589
Pressure Washers	15	0.247	1.140	1.686	0.003	0.096	170.643
	25	0.256	0.873	1.537	0.002	0.087	170.643
	50	0.369	1.229	1.527	0.002	0.110	170.643
	120	0.211	1.021	1.569	0.002	0.110	170.643
Pumps	15	0.702	2.812	4.234	0.007	0.277	420.920
	25	0.766	2.154	3.791	0.005	0.233	420.920
	50	1.264	3.786	3.943	0.005	0.332	420.920
	120	0.610	2.684	4.120	0.005	0.328	420.920
	175	0.409	2.221	3.666	0.005	0.181	420.920
	250	0.261	0.875	3.332	0.005	0.094	420.920
	500	0.235	0.919	2.991	0.004	0.088	420.920
	750	0.242	0.918	3.084	0.004	0.090	420.920
	9999	0.323	1.139	4.117	0.004	0.115	420.920
Rollers	15	0.371	1.945	2.322	0.005	0.090	318.534
	25	0.385	1.312	2.442	0.004	0.098	318.534
	50	1.256	3.569	3.166	0.004	0.300	318.534
	120	0.533	2.194	3.377	0.004	0.288	318.534
	175	0.367	1.826	2.979	0.004	0.162	318.534
	250	0.263	0.809	2.731	0.004	0.094	318.534
	500	0.240	0.918	2.445	0.003	0.086	318.534
Rough Terrain Forklifts	50	1.191	3.808	3.343	0.004	0.303	341.286

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2013		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	120	0.522	2.364	3.276	0.004	0.289	341.286
	175	0.369	1.983	2.855	0.004	0.162	341.286
	250	0.259	0.759	2.589	0.004	0.083	341.286
	500	0.243	0.760	2.274	0.003	0.078	341.286
Rubber Tired Dozers	175	0.549	2.192	4.033	0.004	0.231	335.598
	250	0.445	1.250	3.807	0.004	0.161	335.598
	500	0.407	1.803	3.460	0.003	0.144	335.598
	750	0.408	1.800	3.515	0.003	0.145	335.598
	1000	0.426	1.952	4.225	0.003	0.147	335.598
Rubber Tired Loaders	25	0.371	1.265	2.343	0.004	0.091	307.158
	50	1.183	3.591	3.075	0.004	0.288	307.158
	120	0.506	2.165	3.136	0.004	0.274	307.158
	175	0.358	1.813	2.745	0.003	0.155	307.158
	250	0.259	0.760	2.500	0.003	0.086	307.158
	500	0.242	0.829	2.224	0.003	0.079	307.158
	750	0.243	0.829	2.284	0.003	0.081	307.158
	1000	0.268	0.953	3.084	0.003	0.093	307.158
Scrapers	120	0.819	3.028	4.859	0.005	0.429	409.544
	175	0.573	2.519	4.305	0.005	0.244	409.544
	250	0.440	1.253	4.005	0.005	0.155	409.544
	500	0.406	1.543	3.604	0.004	0.140	409.544
	750	0.408	1.542	3.679	0.004	0.141	409.544
Signal Boards	15	0.543	2.848	3.400	0.007	0.133	466.425
	50	1.412	4.237	4.187	0.006	0.363	443.672
	120	0.650	2.884	4.319	0.005	0.356	443.672
	175	0.441	2.394	3.828	0.005	0.197	443.672
	250	0.343	1.123	4.192	0.006	0.122	536.104
Skid Steer Loaders	25	0.457	1.407	2.643	0.004	0.143	312.846
	50	0.634	2.774	2.794	0.004	0.192	312.846
	120	0.314	2.010	2.390	0.004	0.179	312.846
Surfacing Equipment	50	0.865	2.546	2.466	0.003	0.215	255.965
	120	0.389	1.692	2.619	0.003	0.207	255.965
	175	0.267	1.411	2.310	0.003	0.117	255.965
	250	0.195	0.640	2.121	0.003	0.071	255.965
	500	0.177	0.743	1.921	0.003	0.066	255.965
	750	0.180	0.742	1.966	0.003	0.066	255.965
Sweepers/Scrubbers	15	0.401	2.362	2.820	0.006	0.110	386.791
	25	0.467	1.593	2.951	0.005	0.115	386.791
	50	1.265	4.170	3.735	0.005	0.328	386.791
	120	0.564	2.647	3.575	0.005	0.317	386.791
	175	0.396	2.223	3.090	0.004	0.175	386.791
	250	0.271	0.805	2.784	0.004	0.085	386.791
Tractors/Loaders/Backhoes	25	0.385	1.295	2.439	0.004	0.111	312.846
	50	0.921	3.298	2.983	0.004	0.246	312.846
	120	0.420	2.134	2.761	0.004	0.232	312.846
	175	0.305	1.809	2.375	0.004	0.132	312.846
	250	0.219	0.668	2.124	0.004	0.067	312.846
	500	0.208	0.675	1.874	0.004	0.064	312.846
	750	0.209	0.675	1.933	0.004	0.065	312.846

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2013		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Trenchers	15	0.497	2.605	3.110	0.007	0.121	426.608
	25	0.515	1.757	3.255	0.005	0.126	426.608
	50	2.030	5.291	4.448	0.006	0.458	426.608
	120	0.842	3.079	5.169	0.005	0.440	426.608
	175	0.580	2.559	4.601	0.005	0.252	426.608
	250	0.450	1.357	4.304	0.005	0.168	426.608
	500	0.409	1.783	3.901	0.004	0.151	426.608
	750	0.412	1.781	3.973	0.004	0.153	426.608
Welders	15	0.427	1.710	2.575	0.004	0.168	255.965
	25	0.466	1.310	2.305	0.003	0.142	255.965
	50	0.946	2.688	2.489	0.003	0.233	255.965
	120	0.417	1.717	2.629	0.003	0.229	255.965
	175	0.282	1.419	2.340	0.003	0.126	255.965
	250	0.181	0.559	2.128	0.003	0.064	255.965
	500	0.164	0.582	1.888	0.003	0.059	255.965
Water Trucks	175	0.374	1.965	2.671	0.004	0.156	324.222
	250	0.272	0.747	2.409	0.004	0.080	324.222
	500	0.258	0.757	2.127	0.003	0.075	324.222
	750	0.260	0.757	2.192	0.003	0.077	324.222
	1000	0.285	0.867	3.102	0.003	0.093	324.222

2014		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Aerial Lifts	15	0.305	1.598	1.914	0.004	0.078	261.653
	25	0.380	1.176	2.189	0.003	0.115	261.653
	50	0.696	2.239	2.344	0.003	0.186	261.653
	120	0.343	1.645	2.400	0.003	0.184	261.653
	500	0.134	0.542	1.675	0.003	0.049	261.653
	750	0.138	0.542	1.732	0.003	0.050	261.653
Air Compressors	15	0.429	1.789	2.616	0.004	0.164	273.029
	25	0.462	1.336	2.402	0.003	0.140	273.029
	50	0.998	2.970	2.605	0.004	0.243	273.029
	120	0.433	1.864	2.695	0.003	0.238	273.029
	175	0.299	1.551	2.389	0.003	0.131	273.029
	250	0.195	0.594	2.114	0.003	0.065	273.029
	500	0.180	0.600	1.852	0.003	0.060	273.029
	750	0.182	0.600	1.918	0.003	0.062	273.029
	1000	0.214	0.718	2.649	0.003	0.076	273.029
Bore/Drill Rigs	15	0.497	2.605	3.110	0.007	0.121	426.608
	25	0.515	1.757	3.259	0.005	0.127	426.608
	50	0.351	3.097	3.290	0.006	0.131	426.608
	120	0.226	2.591	2.353	0.005	0.113	426.608
	175	0.203	2.280	1.974	0.005	0.074	426.608
	250	0.167	0.777	1.393	0.005	0.041	426.608
	500	0.165	0.755	1.304	0.004	0.040	426.608
	750	0.166	0.755	1.316	0.004	0.040	426.608
	1000	0.179	0.763	2.487	0.004	0.065	426.608
Cement and Mortar Mixers	15	0.373	1.945	2.349	0.005	0.099	318.534
	25	0.470	1.441	2.687	0.004	0.142	318.534
Concrete/Industrial Saws	25	0.501	1.710	3.165	0.005	0.120	415.232
	50	1.188	3.883	3.780	0.005	0.310	415.232
	120	0.548	2.686	3.771	0.005	0.301	415.232
	175	0.378	2.251	3.311	0.005	0.167	415.232
Cranes	50	0.983	2.963	2.440	0.003	0.233	244.589
	120	0.419	1.750	2.531	0.003	0.221	244.589
	175	0.297	1.463	2.224	0.003	0.125	244.589
	250	0.214	0.614	1.982	0.003	0.069	244.589
	500	0.199	0.672	1.763	0.002	0.064	244.589
	750	0.200	0.672	1.811	0.002	0.065	244.588
	9999	0.230	0.782	2.470	0.002	0.076	244.589
Crawler Tractors	50	1.601	4.630	3.723	0.005	0.367	364.039
	120	0.673	2.663	4.027	0.004	0.347	364.039
	175	0.479	2.227	3.562	0.004	0.199	364.039
	250	0.366	1.051	3.222	0.004	0.123	364.039
	500	0.340	1.248	2.898	0.004	0.112	364.039
	750	0.341	1.247	2.960	0.004	0.113	364.039
	1000	0.365	1.396	3.873	0.004	0.123	364.039
Crushing/Proc. Equipment	50	1.571	4.850	4.215	0.006	0.386	443.672
	120	0.685	3.043	4.269	0.005	0.376	443.672
	175	0.478	2.542	3.766	0.005	0.207	443.672

2014		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	250	0.316	0.959	3.310	0.005	0.102	443.672
	500	0.295	0.961	2.890	0.004	0.095	443.672
	750	0.296	0.952	3.001	0.004	0.097	443.672
	9999	0.356	1.140	4.209	0.004	0.121	443.672
Dumpers/Tenders	25	0.268	0.899	1.686	0.003	0.076	216.148
Excavators	25	0.391	1.335	2.472	0.004	0.092	324.222
	50	0.943	3.573	3.051	0.004	0.245	324.222
	120	0.439	2.262	2.788	0.004	0.228	324.222
	175	0.328	1.924	2.405	0.004	0.132	324.222
	250	0.241	0.711	2.064	0.004	0.068	324.222
	500	0.230	0.708	1.821	0.003	0.064	324.222
	750	0.231	0.708	1.878	0.003	0.065	324.222
Forklifts	50	0.436	1.815	1.595	0.002	0.122	170.643
	120	0.211	1.177	1.395	0.002	0.111	170.643
	175	0.158	1.007	1.173	0.002	0.064	170.643
	250	0.119	0.352	1.008	0.002	0.033	170.643
	500	0.115	0.335	0.889	0.002	0.031	170.643
Generator Sets	15	0.581	2.758	3.977	0.007	0.221	420.920
	25	0.608	2.059	3.704	0.005	0.202	420.920
	50	1.057	3.469	3.739	0.005	0.289	420.920
	120	0.535	2.616	3.813	0.005	0.286	420.920
	175	0.360	2.181	3.382	0.005	0.157	420.920
	250	0.231	0.837	2.981	0.005	0.082	420.920
	500	0.207	0.857	2.669	0.004	0.077	420.920
	750	0.214	0.857	2.758	0.004	0.079	420.920
	9999	0.288	1.020	3.815	0.004	0.103	420.920
Graders	50	1.241	3.992	3.362	0.004	0.301	346.974
	120	0.540	2.438	3.365	0.004	0.284	346.974
	175	0.388	2.053	2.943	0.004	0.162	346.974
	250	0.284	0.842	2.590	0.004	0.090	346.974
	500	0.266	0.906	2.305	0.003	0.083	346.974
	750	0.267	0.906	2.367	0.003	0.084	346.974
Off-Highway Tractors	120	0.792	2.808	4.654	0.004	0.400	369.727
	175	0.556	2.345	4.146	0.004	0.233	369.727
	250	0.443	1.275	3.835	0.004	0.159	369.727
	750	0.407	1.756	3.538	0.004	0.143	369.727
	1000	0.428	1.915	4.368	0.004	0.148	369.727
Off-Highway Trucks	175	0.351	1.962	2.492	0.004	0.140	324.222
	250	0.258	0.732	2.151	0.004	0.072	324.222
	500	0.246	0.730	1.898	0.003	0.068	324.222
	750	0.247	0.730	1.958	0.003	0.069	324.222
	1000	0.269	0.814	2.897	0.003	0.086	324.222
Other Construction Equipment	15	0.411	2.153	2.571	0.005	0.100	352.663
	25	0.426	1.452	2.694	0.004	0.105	352.662
	50	0.844	3.242	3.114	0.005	0.230	352.663
	120	0.399	2.284	2.866	0.004	0.219	352.663
	175	0.288	1.943	2.475	0.004	0.124	352.663
	500	0.191	0.705	1.867	0.003	0.061	352.663

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2014		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Other General Industrial Equipment	15	0.301	1.771	2.115	0.005	0.083	290.093
	25	0.350	1.194	2.211	0.004	0.082	290.093
	50	1.147	3.472	2.863	0.004	0.277	290.093
	120	0.497	2.067	2.936	0.003	0.268	290.093
	175	0.350	1.722	2.596	0.003	0.148	290.093
	250	0.235	0.657	2.297	0.003	0.073	290.093
	500	0.220	0.658	2.006	0.003	0.068	290.093
	750	0.221	0.658	2.077	0.003	0.069	290.093
	1000	0.250	0.783	2.882	0.003	0.085	290.093
Other Material Handling Equipment	50	1.320	3.982	3.301	0.004	0.319	335.598
	120	0.572	2.382	3.391	0.004	0.309	335.598
	175	0.401	1.983	2.999	0.004	0.171	335.598
	250	0.268	0.757	2.654	0.004	0.084	335.598
	500	0.251	0.759	2.317	0.003	0.078	335.598
	9999	0.296	0.904	3.328	0.003	0.098	335.598
Pavers	25	0.452	1.490	2.782	0.004	0.133	352.663
	50	1.614	4.417	3.604	0.005	0.365	352.663
	120	0.668	2.554	4.051	0.004	0.348	352.663
	175	0.466	2.128	3.596	0.004	0.198	352.663
	250	0.356	1.056	3.280	0.004	0.126	352.663
	500	0.327	1.307	2.956	0.003	0.114	352.663
Paving Equipment	25	0.364	1.241	2.303	0.004	0.090	301.470
	50	1.379	3.747	3.074	0.004	0.311	301.470
	120	0.569	2.170	3.453	0.004	0.298	301.470
	175	0.395	1.805	3.066	0.003	0.169	301.470
	250	0.298	0.886	2.794	0.003	0.106	301.470
Plate Compactors	15	0.285	1.493	1.783	0.004	0.069	244.589
Pressure Washers	15	0.235	1.118	1.612	0.003	0.090	170.643
	25	0.247	0.835	1.502	0.002	0.082	170.643
	50	0.329	1.187	1.463	0.002	0.100	170.643
	120	0.191	1.011	1.475	0.002	0.100	170.643
Pumps	15	0.661	2.758	4.034	0.007	0.253	420.920
	25	0.712	2.059	3.704	0.005	0.216	420.920
	50	1.139	3.651	3.783	0.005	0.303	420.920
	120	0.556	2.657	3.871	0.005	0.299	420.920
	175	0.376	2.215	3.434	0.005	0.165	420.920
	250	0.242	0.852	3.030	0.005	0.086	420.920
	500	0.218	0.875	2.702	0.004	0.080	420.920
	750	0.225	0.875	2.793	0.004	0.082	420.920
	9999	0.296	1.042	3.859	0.004	0.105	420.920
Rollers	15	0.371	1.945	2.322	0.005	0.090	318.534
	25	0.385	1.312	2.434	0.004	0.095	318.534
	50	1.161	3.471	3.055	0.004	0.278	318.534
	120	0.497	2.176	3.189	0.004	0.267	318.534
	175	0.347	1.821	2.809	0.004	0.150	318.534
	250	0.246	0.773	2.497	0.004	0.085	318.534
	500	0.226	0.861	2.230	0.003	0.078	318.534
Rough Terrain Forklifts	50	1.063	3.684	3.210	0.004	0.273	341.286

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2014		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	120	0.479	2.345	3.067	0.004	0.259	341.286
	175	0.346	1.980	2.664	0.004	0.146	341.286
	250	0.246	0.743	2.325	0.004	0.075	341.286
	500	0.232	0.732	2.037	0.003	0.070	341.286
Rubber Tired Dozers	175	0.527	2.175	3.850	0.004	0.218	335.598
	250	0.425	1.200	3.570	0.004	0.150	335.598
	500	0.389	1.686	3.243	0.003	0.134	335.598
	750	0.390	1.684	3.296	0.003	0.135	335.598
	1000	0.408	1.828	4.045	0.003	0.140	335.598
Rubber Tired Loaders	25	0.371	1.265	2.342	0.004	0.089	307.158
	50	1.077	3.486	2.958	0.004	0.263	307.158
	120	0.470	2.148	2.948	0.004	0.249	307.158
	175	0.338	1.809	2.576	0.003	0.141	307.158
	250	0.245	0.733	2.261	0.003	0.077	307.158
	500	0.229	0.789	2.010	0.003	0.072	307.158
	750	0.231	0.788	2.066	0.003	0.073	307.158
	1000	0.255	0.899	2.905	0.003	0.087	307.158
Scrapers	120	0.772	3.002	4.611	0.005	0.398	409.544
	175	0.546	2.507	4.080	0.005	0.228	409.544
	250	0.417	1.201	3.703	0.005	0.142	409.544
	500	0.386	1.447	3.331	0.004	0.129	409.544
	750	0.388	1.446	3.401	0.004	0.130	409.544
Signal Boards	15	0.543	2.848	3.400	0.007	0.133	466.425
	50	1.269	4.084	4.013	0.006	0.330	443.672
	120	0.593	2.856	4.049	0.005	0.323	443.672
	175	0.406	2.388	3.578	0.005	0.178	443.672
	250	0.319	1.095	3.792	0.006	0.110	536.104
Skid Steer Loaders	25	0.442	1.384	2.596	0.004	0.135	312.846
	50	0.543	2.693	2.649	0.004	0.165	312.846
	120	0.278	1.995	2.209	0.004	0.150	312.846
Surfacing Equipment	50	0.801	2.481	2.377	0.003	0.199	255.965
	120	0.363	1.679	2.478	0.003	0.192	255.965
	175	0.251	1.407	2.184	0.003	0.108	255.965
	250	0.181	0.614	1.941	0.003	0.065	255.965
	500	0.166	0.702	1.754	0.003	0.060	255.965
	750	0.168	0.702	1.797	0.003	0.060	255.965
Sweepers/Scrubbers	15	0.401	2.362	2.820	0.006	0.110	386.791
	25	0.467	1.593	2.949	0.005	0.112	386.791
	50	1.098	4.018	3.591	0.005	0.291	386.791
	120	0.504	2.622	3.314	0.005	0.276	386.791
	175	0.362	2.222	2.835	0.004	0.154	386.791
	250	0.257	0.792	2.455	0.004	0.076	386.791
Tractors/Loaders/Backhoes	25	0.381	1.290	2.421	0.004	0.103	312.846
	50	0.817	3.200	2.851	0.004	0.218	312.846
	120	0.384	2.119	2.572	0.004	0.204	312.846
	175	0.285	1.807	2.210	0.004	0.117	312.846
	250	0.208	0.657	1.875	0.004	0.060	312.846
	500	0.198	0.657	1.656	0.004	0.057	312.846
	750	0.200	0.657	1.708	0.004	0.058	312.846

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2014		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Trenchers	15	0.497	2.605	3.110	0.007	0.122	426.608
	25	0.515	1.757	3.252	0.005	0.124	426.608
	50	1.915	5.172	4.318	0.006	0.431	426.608
	120	0.797	3.050	4.923	0.005	0.413	426.608
	175	0.553	2.543	4.380	0.005	0.237	426.608
	250	0.426	1.299	4.007	0.005	0.156	426.608
	500	0.389	1.661	3.627	0.004	0.140	426.608
	750	0.391	1.660	3.696	0.004	0.142	426.608
Welders	15	0.402	1.677	2.453	0.004	0.154	255.965
	25	0.433	1.252	2.252	0.003	0.131	255.965
	50	0.856	2.590	2.391	0.003	0.213	255.965
	120	0.382	1.700	2.469	0.003	0.209	255.965
	175	0.262	1.415	2.190	0.003	0.115	255.965
	250	0.170	0.544	1.936	0.003	0.058	255.965
	500	0.155	0.553	1.706	0.003	0.054	255.965
Water Trucks	175	0.351	1.962	2.492	0.004	0.140	324.222
	250	0.258	0.732	2.151	0.004	0.072	324.222
	500	0.246	0.730	1.898	0.003	0.068	324.222
	750	0.247	0.730	1.958	0.003	0.069	324.222
	1000	0.269	0.814	2.897	0.003	0.086	324.222

2015		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Aerial Lifts	15	0.305	1.598	1.909	0.004	0.077	261.653
	25	0.368	1.157	2.150	0.003	0.108	261.653
	50	0.626	2.169	2.258	0.003	0.169	261.653
	120	0.310	1.630	2.223	0.003	0.166	261.653
	500	0.124	0.520	1.502	0.003	0.044	261.653
	750	0.128	0.520	1.556	0.003	0.045	261.653
Air Compressors	15	0.404	1.757	2.497	0.004	0.150	273.029
	25	0.430	1.281	2.349	0.003	0.130	273.029
	50	0.898	2.868	2.510	0.004	0.221	273.029
	120	0.395	1.845	2.493	0.003	0.214	273.029
	175	0.274	1.546	2.164	0.003	0.118	273.029
	250	0.183	0.580	1.906	0.003	0.059	273.029
	500	0.170	0.576	1.660	0.003	0.054	273.029
	750	0.172	0.576	1.723	0.003	0.056	273.029
	1000	0.197	0.658	2.478	0.003	0.069	273.029
Bore/Drill Rigs	15	0.497	2.605	3.110	0.007	0.121	426.608
	25	0.515	1.757	3.254	0.005	0.125	426.608
	50	0.322	3.072	3.079	0.006	0.103	426.608
	120	0.208	2.587	2.067	0.005	0.089	426.608
	175	0.187	2.280	1.622	0.005	0.060	426.608
	250	0.154	0.777	1.111	0.005	0.033	426.608
	500	0.153	0.755	1.054	0.004	0.032	426.608
	750	0.153	0.755	1.061	0.004	0.032	426.608
	1000	0.164	0.760	2.285	0.004	0.055	426.608
Cement and Mortar Mixers	15	0.372	1.945	2.336	0.005	0.096	318.534
	25	0.455	1.419	2.641	0.004	0.135	318.534
Concrete/Industrial Saws	25	0.501	1.710	3.165	0.005	0.119	415.232
	50	1.075	3.774	3.646	0.005	0.283	415.232
	120	0.500	2.665	3.499	0.005	0.272	415.232
	175	0.347	2.248	3.005	0.005	0.152	415.232
Cranes	50	0.900	2.879	2.357	0.003	0.214	244.589
	120	0.390	1.736	2.352	0.003	0.202	244.589
	175	0.280	1.459	2.035	0.003	0.115	244.589
	250	0.202	0.592	1.807	0.003	0.062	244.589
	500	0.189	0.633	1.604	0.002	0.058	244.589
	750	0.190	0.633	1.650	0.002	0.059	244.589
	9999	0.219	0.730	2.335	0.002	0.070	244.589
Crawler Tractors	50	1.488	4.517	3.605	0.005	0.340	364.039
	120	0.632	2.641	3.770	0.004	0.320	364.039
	175	0.453	2.218	3.290	0.004	0.184	364.039
	250	0.347	1.011	2.965	0.004	0.113	364.039
	500	0.323	1.173	2.666	0.004	0.103	364.039
	750	0.324	1.172	2.725	0.004	0.104	364.039
	1000	0.347	1.310	3.680	0.004	0.115	364.039
Crushing/Proc. Equipment	50	1.403	4.682	4.056	0.006	0.349	443.672
	120	0.623	3.013	3.935	0.005	0.336	443.672
	175	0.439	2.536	3.391	0.005	0.186	443.672

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2015		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	250	0.299	0.938	2.968	0.005	0.092	443.672
	500	0.280	0.925	2.579	0.004	0.086	443.672
	750	0.280	0.918	2.672	0.004	0.087	443.672
	9999	0.330	1.049	3.919	0.004	0.109	443.672
Dumpers/Tenders	25	0.265	0.894	1.675	0.003	0.071	216.148
Excavators	25	0.391	1.335	2.472	0.004	0.092	324.222
	50	0.842	3.478	2.924	0.004	0.217	324.222
	120	0.402	2.247	2.549	0.004	0.200	324.222
	175	0.304	1.922	2.141	0.004	0.117	324.222
	250	0.228	0.701	1.826	0.004	0.061	324.222
	500	0.219	0.689	1.612	0.003	0.057	324.222
	750	0.220	0.689	1.663	0.003	0.058	324.222
Forklifts	50	0.371	1.761	1.534	0.002	0.105	170.643
	120	0.186	1.169	1.261	0.002	0.094	170.643
	175	0.146	1.008	1.038	0.002	0.057	170.643
	250	0.114	0.349	0.882	0.002	0.029	170.643
	500	0.110	0.332	0.785	0.002	0.028	170.643
Generator Sets	15	0.554	2.709	3.808	0.007	0.208	420.920
	25	0.588	1.975	3.622	0.005	0.190	420.920
	50	0.950	3.362	3.598	0.005	0.262	420.920
	120	0.482	2.592	3.532	0.005	0.257	420.920
	175	0.326	2.177	3.065	0.005	0.142	420.920
	250	0.213	0.818	2.691	0.005	0.074	420.920
	500	0.192	0.825	2.394	0.004	0.070	420.920
	750	0.198	0.825	2.479	0.004	0.071	420.920
	9999	0.261	0.941	3.572	0.004	0.092	420.920
Graders	50	1.131	3.883	3.237	0.004	0.273	346.974
	120	0.501	2.421	3.113	0.004	0.257	346.974
	175	0.364	2.049	2.670	0.004	0.147	346.974
	250	0.267	0.816	2.338	0.004	0.081	346.974
	500	0.252	0.868	2.081	0.003	0.075	346.974
	750	0.253	0.867	2.138	0.003	0.076	346.974
Off-Highway Tractors	120	0.751	2.781	4.402	0.004	0.376	369.727
	175	0.530	2.329	3.885	0.004	0.219	369.727
	250	0.422	1.225	3.585	0.004	0.147	369.727
	750	0.389	1.642	3.307	0.004	0.133	369.727
	1000	0.409	1.793	4.180	0.004	0.139	369.727
Off-Highway Trucks	175	0.326	1.959	2.228	0.004	0.124	324.222
	250	0.244	0.721	1.911	0.004	0.064	324.222
	500	0.233	0.708	1.686	0.003	0.060	324.222
	750	0.235	0.708	1.740	0.003	0.061	324.222
	1000	0.253	0.769	2.707	0.003	0.078	324.222
Other Construction Equipment	15	0.411	2.153	2.571	0.005	0.100	352.663
	25	0.426	1.452	2.690	0.004	0.103	352.663
	50	0.752	3.158	2.985	0.005	0.205	352.663
	120	0.361	2.269	2.622	0.004	0.193	352.663
	175	0.264	1.941	2.197	0.004	0.110	352.663
	500	0.182	0.688	1.646	0.003	0.055	352.663

2015		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Other General Industrial Equipment	15	0.301	1.771	2.115	0.005	0.083	290.093
	25	0.350	1.194	2.211	0.004	0.082	290.093
	50	1.026	3.350	2.759	0.004	0.250	290.093
	120	0.454	2.046	2.710	0.003	0.240	290.093
	175	0.323	1.717	2.346	0.003	0.133	290.093
	250	0.222	0.642	2.066	0.003	0.066	290.093
	500	0.209	0.631	1.796	0.003	0.061	290.093
	750	0.210	0.631	1.864	0.003	0.063	290.093
	1000	0.233	0.719	2.692	0.003	0.077	290.093
Other Material Handling Equipment	50	1.181	3.840	3.180	0.004	0.288	335.598
	120	0.521	2.356	3.130	0.004	0.276	335.598
	175	0.369	1.977	2.710	0.004	0.153	335.598
	250	0.254	0.739	2.387	0.004	0.076	335.598
	500	0.238	0.728	2.075	0.003	0.070	335.598
	9999	0.277	0.830	3.108	0.003	0.089	335.598
Pavers	25	0.442	1.474	2.755	0.004	0.124	352.663
	50	1.509	4.310	3.497	0.005	0.341	352.663
	120	0.630	2.532	3.811	0.004	0.324	352.663
	175	0.442	2.119	3.342	0.004	0.185	352.663
	250	0.337	1.013	3.039	0.004	0.116	352.663
	500	0.311	1.227	2.736	0.003	0.105	352.663
Paving Equipment	25	0.364	1.241	2.299	0.004	0.088	301.470
	50	1.289	3.655	2.982	0.004	0.292	301.470
	120	0.536	2.153	3.249	0.004	0.278	301.470
	175	0.374	1.798	2.850	0.003	0.158	301.470
	250	0.281	0.848	2.588	0.003	0.097	301.470
Plate Compactors	15	0.285	1.493	1.783	0.004	0.069	244.589
Pressure Washers	15	0.224	1.098	1.544	0.003	0.084	170.643
	25	0.238	0.801	1.468	0.002	0.077	170.643
	50	0.293	1.151	1.407	0.002	0.090	170.643
	120	0.170	1.002	1.367	0.002	0.089	170.643
Pumps	15	0.623	2.709	3.849	0.007	0.231	420.920
	25	0.662	1.975	3.622	0.005	0.200	420.920
	50	1.026	3.537	3.641	0.005	0.275	420.920
	120	0.503	2.632	3.587	0.005	0.270	420.920
	175	0.342	2.210	3.113	0.005	0.148	420.920
	250	0.224	0.832	2.735	0.005	0.077	420.920
	500	0.203	0.840	2.424	0.004	0.072	420.920
	750	0.209	0.840	2.511	0.004	0.074	420.920
	9999	0.269	0.958	3.614	0.004	0.094	420.920
Rollers	15	0.371	1.945	2.322	0.005	0.091	318.534
	25	0.384	1.312	2.430	0.004	0.093	318.534
	50	1.068	3.376	2.949	0.004	0.256	318.534
	120	0.463	2.160	2.969	0.004	0.245	318.534
	175	0.325	1.816	2.572	0.004	0.139	318.534
	250	0.230	0.744	2.278	0.004	0.077	318.534
	500	0.213	0.813	2.029	0.003	0.071	318.534
Rough Terrain Forklifts	50	0.950	3.580	3.090	0.004	0.245	341.286

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2015		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	120	0.438	2.328	2.822	0.004	0.230	341.286
	175	0.320	1.978	2.390	0.004	0.130	341.286
	250	0.233	0.729	2.075	0.004	0.068	341.286
	500	0.222	0.710	1.815	0.003	0.063	341.286
Rubber Tired Dozers	175	0.503	2.160	3.615	0.004	0.205	335.598
	250	0.404	1.153	3.342	0.004	0.139	335.598
	500	0.371	1.578	3.035	0.003	0.125	335.598
	750	0.373	1.577	3.086	0.003	0.126	335.598
	1000	0.391	1.714	3.872	0.003	0.131	335.598
Rubber Tired Loaders	25	0.371	1.265	2.342	0.004	0.088	307.158
	50	0.979	3.390	2.848	0.004	0.238	307.158
	120	0.435	2.132	2.725	0.004	0.225	307.158
	175	0.316	1.806	2.334	0.003	0.128	307.158
	250	0.231	0.710	2.039	0.003	0.069	307.158
	500	0.217	0.754	1.812	0.003	0.065	307.158
	750	0.219	0.754	1.863	0.003	0.066	307.158
	1000	0.241	0.850	2.737	0.003	0.080	307.158
Scrapers	120	0.726	2.977	4.325	0.005	0.369	409.544
	175	0.517	2.497	3.777	0.005	0.212	409.544
	250	0.395	1.155	3.416	0.005	0.130	409.544
	500	0.367	1.362	3.071	0.004	0.118	409.544
	750	0.369	1.361	3.138	0.004	0.120	409.544
Signal Boards	15	0.543	2.848	3.400	0.007	0.133	466.425
	50	1.141	3.957	3.859	0.006	0.299	443.672
	120	0.537	2.830	3.741	0.005	0.290	443.672
	175	0.370	2.383	3.230	0.005	0.160	443.672
	250	0.297	1.071	3.408	0.006	0.099	536.104
Skid Steer Loaders	25	0.428	1.364	2.551	0.004	0.127	312.846
	50	0.464	2.621	2.516	0.004	0.139	312.846
	120	0.245	1.983	1.975	0.004	0.124	312.846
Surfacing Equipment	50	0.740	2.418	2.292	0.003	0.183	255.965
	120	0.337	1.666	2.311	0.003	0.176	255.965
	175	0.235	1.404	2.001	0.003	0.100	255.965
	250	0.169	0.591	1.772	0.003	0.059	255.965
	500	0.155	0.666	1.598	0.003	0.054	255.965
	750	0.158	0.666	1.638	0.003	0.055	255.965
Sweepers/Scrubbers	15	0.401	2.362	2.820	0.006	0.110	386.791
	25	0.467	1.593	2.949	0.005	0.111	386.791
	50	0.942	3.881	3.453	0.005	0.255	386.791
	120	0.447	2.601	3.011	0.005	0.237	386.791
	175	0.328	2.223	2.493	0.004	0.134	386.791
	250	0.243	0.782	2.143	0.004	0.068	386.791
Tractors/Loaders/Backhoes	25	0.379	1.288	2.408	0.004	0.097	312.846
	50	0.724	3.114	2.728	0.004	0.192	312.846
	120	0.349	2.105	2.341	0.004	0.177	312.846
	175	0.264	1.806	1.954	0.004	0.103	312.846
	250	0.197	0.650	1.648	0.004	0.053	312.846
	500	0.189	0.643	1.458	0.004	0.051	312.846
	750	0.190	0.643	1.503	0.004	0.052	312.846

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2015		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Trenchers	15	0.497	2.605	3.110	0.007	0.122	426.608
	25	0.515	1.757	3.252	0.005	0.122	426.608
	50	1.802	5.055	4.192	0.006	0.405	426.608
	120	0.752	3.024	4.641	0.005	0.388	426.608
	175	0.525	2.530	4.082	0.005	0.222	426.608
	250	0.403	1.246	3.724	0.005	0.144	426.608
	500	0.369	1.555	3.366	0.004	0.130	426.608
	750	0.371	1.554	3.432	0.004	0.131	426.608
Welders	15	0.379	1.648	2.341	0.004	0.140	255.965
	25	0.403	1.201	2.203	0.003	0.122	255.965
	50	0.773	2.505	2.303	0.003	0.194	255.965
	120	0.348	1.684	2.287	0.003	0.189	255.965
	175	0.240	1.412	1.986	0.003	0.104	255.965
	250	0.159	0.531	1.748	0.003	0.052	255.965
	500	0.146	0.530	1.531	0.003	0.049	255.965
Water Trucks	175	0.326	1.959	2.228	0.004	0.124	324.222
	250	0.244	0.721	1.911	0.004	0.064	324.222
	500	0.233	0.708	1.686	0.003	0.060	324.222
	750	0.235	0.708	1.740	0.003	0.061	324.222
	1000	0.253	0.769	2.707	0.003	0.078	324.222

2016		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Aerial Lifts	15	0.305	1.598	1.907	0.004	0.076	261.653
	25	0.357	1.141	2.114	0.003	0.102	261.653
	50	0.560	2.106	2.175	0.003	0.152	261.653
	120	0.278	1.615	2.053	0.003	0.148	261.653
	500	0.115	0.502	1.338	0.003	0.040	261.653
	750	0.119	0.502	1.389	0.003	0.041	261.653
Air Compressors	15	0.389	1.740	2.414	0.004	0.139	273.029
	25	0.411	1.251	2.308	0.003	0.123	273.029
	50	0.803	2.777	2.423	0.004	0.199	273.029
	120	0.358	1.828	2.302	0.003	0.191	273.029
	175	0.251	1.543	1.947	0.003	0.105	273.029
	250	0.173	0.568	1.707	0.003	0.053	273.029
	500	0.162	0.555	1.480	0.003	0.049	273.029
	750	0.163	0.555	1.538	0.003	0.050	273.029
	1000	0.184	0.622	2.332	0.003	0.063	273.029
Bore/Drill Rigs	15	0.497	2.605	3.110	0.007	0.122	426.608
	25	0.515	1.757	3.252	0.005	0.123	426.608
	50	0.303	3.056	2.895	0.006	0.080	426.608
	120	0.193	2.584	1.830	0.005	0.069	426.608
	175	0.171	2.280	1.323	0.005	0.047	426.608
	250	0.142	0.777	0.882	0.005	0.026	426.608
	500	0.142	0.755	0.857	0.004	0.026	426.608
	750	0.142	0.755	0.862	0.004	0.026	426.608
	1000	0.150	0.758	2.136	0.004	0.046	426.608
Cement and Mortar Mixers	15	0.371	1.945	2.328	0.005	0.094	318.534
	25	0.442	1.399	2.599	0.004	0.128	318.534
Concrete/Industrial Saws	25	0.501	1.710	3.165	0.005	0.118	415.232
	50	0.966	3.674	3.521	0.005	0.256	415.232
	120	0.453	2.646	3.239	0.005	0.244	415.232
	175	0.318	2.247	2.710	0.005	0.136	415.232
Cranes	50	0.821	2.801	2.278	0.003	0.195	244.589
	120	0.363	1.723	2.183	0.003	0.184	244.589
	175	0.263	1.456	1.857	0.003	0.105	244.589
	250	0.191	0.574	1.643	0.003	0.057	244.589
	500	0.180	0.602	1.456	0.002	0.053	244.589
	750	0.181	0.602	1.500	0.002	0.053	244.589
	9999	0.208	0.682	2.207	0.002	0.064	244.589
Crawler Tractors	50	1.382	4.411	3.492	0.005	0.314	364.039
	120	0.594	2.621	3.529	0.004	0.295	364.039
	175	0.429	2.211	3.033	0.004	0.170	364.039
	250	0.328	0.975	2.724	0.004	0.103	364.039
	500	0.307	1.110	2.449	0.004	0.094	364.039
	750	0.308	1.109	2.504	0.004	0.095	364.039
	1000	0.330	1.236	3.499	0.004	0.107	364.039
Crushing/Proc. Equipment	50	1.244	4.529	3.908	0.006	0.312	443.672
	120	0.562	2.985	3.615	0.005	0.296	443.672
	175	0.401	2.530	3.032	0.005	0.165	443.672

2016		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	250	0.282	0.920	2.640	0.005	0.082	443.672
	500	0.266	0.895	2.287	0.004	0.077	443.672
	750	0.265	0.891	2.359	0.004	0.078	443.672
	9999	0.310	0.995	3.670	0.004	0.100	443.672
Dumpers/Tenders	25	0.263	0.891	1.665	0.003	0.067	216.148
Excavators	25	0.391	1.335	2.472	0.004	0.092	324.222
	50	0.754	3.397	2.807	0.004	0.191	324.222
	120	0.367	2.233	2.331	0.004	0.174	324.222
	175	0.281	1.921	1.896	0.004	0.102	324.222
	250	0.215	0.692	1.607	0.004	0.054	324.222
	500	0.207	0.673	1.420	0.003	0.051	324.222
	750	0.208	0.673	1.464	0.003	0.052	324.222
Forklifts	50	0.325	1.724	1.478	0.002	0.091	170.643
	120	0.169	1.164	1.147	0.002	0.080	170.643
	175	0.137	1.010	0.919	0.002	0.050	170.643
	250	0.108	0.347	0.771	0.002	0.026	170.643
	500	0.106	0.330	0.688	0.002	0.025	170.643
Generator Sets	15	0.534	2.683	3.688	0.007	0.196	420.920
	25	0.573	1.929	3.558	0.005	0.181	420.920
	50	0.849	3.267	3.470	0.005	0.236	420.920
	120	0.432	2.570	3.267	0.005	0.230	420.920
	175	0.294	2.173	2.763	0.005	0.127	420.920
	250	0.196	0.801	2.414	0.005	0.067	420.920
	500	0.178	0.798	2.135	0.004	0.063	420.920
	750	0.183	0.798	2.214	0.004	0.064	420.920
	9999	0.240	0.892	3.365	0.004	0.084	420.920
Graders	50	1.029	3.784	3.119	0.004	0.247	346.974
	120	0.464	2.405	2.879	0.004	0.231	346.974
	175	0.340	2.047	2.415	0.004	0.133	346.974
	250	0.252	0.794	2.106	0.004	0.072	346.974
	500	0.239	0.835	1.874	0.003	0.067	346.974
	750	0.240	0.835	1.926	0.003	0.068	346.974
Off-Highway Tractors	120	0.712	2.756	4.162	0.004	0.352	369.727
	175	0.505	2.315	3.636	0.004	0.205	369.727
	250	0.401	1.178	3.346	0.004	0.137	369.727
	750	0.371	1.538	3.087	0.004	0.124	369.727
	1000	0.391	1.681	4.000	0.004	0.131	369.727
Off-Highway Trucks	175	0.302	1.957	1.982	0.004	0.108	324.222
	250	0.230	0.711	1.690	0.004	0.057	324.222
	500	0.221	0.690	1.491	0.003	0.053	324.222
	750	0.222	0.690	1.539	0.003	0.054	324.222
	1000	0.237	0.733	2.537	0.003	0.071	324.222
Other Construction Equipment	15	0.411	2.153	2.571	0.005	0.100	352.663
	25	0.425	1.452	2.688	0.004	0.102	352.663
	50	0.668	3.083	2.866	0.005	0.180	352.663
	120	0.326	2.255	2.397	0.004	0.167	352.663
	175	0.241	1.941	1.939	0.004	0.096	352.663
	500	0.172	0.675	1.445	0.003	0.049	352.663

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2016		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Other General Industrial Equipment	15	0.301	1.771	2.115	0.005	0.083	290.093
	25	0.350	1.194	2.211	0.004	0.083	290.093
	50	0.915	3.245	2.662	0.004	0.224	290.093
	120	0.412	2.027	2.494	0.003	0.212	290.093
	175	0.296	1.713	2.106	0.003	0.118	290.093
	250	0.210	0.629	1.844	0.003	0.059	290.093
	500	0.198	0.609	1.598	0.003	0.055	290.093
	750	0.200	0.609	1.660	0.003	0.056	290.093
	1000	0.220	0.680	2.528	0.003	0.071	290.093
Other Material Handling Equipment	50	1.052	3.716	3.069	0.004	0.258	335.598
	120	0.473	2.334	2.881	0.004	0.244	335.598
	175	0.339	1.972	2.433	0.004	0.136	335.598
	250	0.239	0.724	2.131	0.004	0.068	335.598
	500	0.226	0.702	1.846	0.003	0.063	335.598
	9999	0.263	0.785	2.919	0.003	0.082	335.598
Pavers	25	0.435	1.464	2.736	0.004	0.116	352.663
	50	1.408	4.207	3.394	0.005	0.318	352.663
	120	0.593	2.513	3.583	0.004	0.301	352.663
	175	0.419	2.111	3.100	0.004	0.172	352.663
	250	0.319	0.974	2.810	0.004	0.106	352.663
	500	0.296	1.156	2.528	0.003	0.097	352.663
Paving Equipment	25	0.364	1.241	2.298	0.004	0.087	301.470
	50	1.201	3.565	2.894	0.004	0.272	301.470
	120	0.505	2.136	3.055	0.004	0.259	301.470
	175	0.355	1.792	2.643	0.003	0.147	301.470
	250	0.265	0.814	2.392	0.003	0.089	301.470
Plate Compactors	15	0.285	1.493	1.783	0.004	0.070	244.589
Pressure Washers	15	0.216	1.088	1.495	0.003	0.080	170.643
	25	0.232	0.782	1.442	0.002	0.073	170.643
	50	0.260	1.120	1.356	0.002	0.081	170.643
	120	0.151	0.994	1.264	0.002	0.079	170.643
Pumps	15	0.599	2.683	3.721	0.007	0.215	420.920
	25	0.634	1.929	3.558	0.005	0.189	420.920
	50	0.919	3.437	3.513	0.005	0.249	420.920
	120	0.452	2.609	3.317	0.005	0.241	420.920
	175	0.309	2.206	2.807	0.005	0.133	420.920
	250	0.208	0.814	2.454	0.005	0.070	420.920
	500	0.189	0.810	2.162	0.004	0.065	420.920
	750	0.194	0.810	2.243	0.004	0.067	420.920
	9999	0.249	0.906	3.404	0.004	0.086	420.920
Rollers	15	0.371	1.945	2.322	0.005	0.091	318.534
	25	0.384	1.312	2.428	0.004	0.092	318.534
	50	0.979	3.286	2.848	0.004	0.235	318.534
	120	0.430	2.144	2.761	0.004	0.225	318.534
	175	0.304	1.812	2.347	0.004	0.127	318.534
	250	0.217	0.721	2.073	0.004	0.069	318.534
	500	0.202	0.773	1.842	0.003	0.064	318.534
Rough Terrain Forklifts	50	0.847	3.487	2.978	0.004	0.218	341.286

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2016		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	120	0.398	2.312	2.592	0.004	0.202	341.286
	175	0.295	1.977	2.131	0.004	0.116	341.286
	250	0.221	0.718	1.840	0.004	0.060	341.286
	500	0.211	0.692	1.608	0.003	0.057	341.286
Rubber Tired Dozers	175	0.480	2.146	3.389	0.004	0.192	335.598
	250	0.384	1.109	3.125	0.004	0.129	335.598
	500	0.354	1.479	2.836	0.003	0.116	335.598
	750	0.355	1.478	2.885	0.003	0.117	335.598
	1000	0.373	1.608	3.707	0.003	0.123	335.598
Rubber Tired Loaders	25	0.371	1.265	2.342	0.004	0.087	307.158
	50	0.889	3.303	2.744	0.004	0.215	307.158
	120	0.403	2.118	2.517	0.004	0.202	307.158
	175	0.295	1.803	2.108	0.003	0.116	307.158
	250	0.218	0.692	1.835	0.003	0.062	307.158
	500	0.206	0.725	1.630	0.003	0.058	307.158
	750	0.208	0.725	1.677	0.003	0.059	307.158
	1000	0.227	0.806	2.581	0.003	0.074	307.158
Scrapers	120	0.683	2.955	4.054	0.005	0.341	409.544
	175	0.490	2.489	3.490	0.005	0.196	409.544
	250	0.374	1.112	3.145	0.005	0.119	409.544
	500	0.349	1.288	2.827	0.004	0.108	409.544
	750	0.350	1.287	2.890	0.004	0.110	409.544
Signal Boards	15	0.543	2.848	3.400	0.007	0.133	466.425
	50	1.020	3.843	3.717	0.006	0.268	443.672
	120	0.483	2.806	3.447	0.005	0.258	443.672
	175	0.336	2.379	2.895	0.005	0.143	443.672
	250	0.277	1.050	3.040	0.006	0.089	536.104
Skid Steer Loaders	25	0.416	1.347	2.510	0.004	0.121	312.846
	50	0.396	2.561	2.394	0.004	0.116	312.846
	120	0.216	1.972	1.764	0.004	0.101	312.846
Surfacing Equipment	50	0.682	2.360	2.213	0.003	0.168	255.965
	120	0.313	1.655	2.153	0.003	0.162	255.965
	175	0.219	1.401	1.829	0.003	0.092	255.965
	250	0.158	0.572	1.615	0.003	0.053	255.965
	500	0.146	0.635	1.453	0.003	0.049	255.965
	750	0.148	0.634	1.491	0.003	0.050	255.965
Sweepers/Scrubbers	15	0.401	2.362	2.820	0.006	0.110	386.791
	25	0.467	1.593	2.949	0.005	0.110	386.791
	50	0.798	3.759	3.323	0.005	0.220	386.791
	120	0.393	2.581	2.720	0.005	0.199	386.791
	175	0.303	2.225	2.203	0.004	0.118	386.791
	250	0.232	0.775	1.873	0.004	0.061	386.791
Tractors/Loaders/Backhoes	25	0.378	1.288	2.399	0.004	0.094	312.846
	50	0.642	3.040	2.614	0.004	0.167	312.846
	120	0.317	2.092	2.133	0.004	0.153	312.846
	175	0.243	1.805	1.720	0.004	0.090	312.846
	250	0.187	0.644	1.442	0.004	0.047	312.846
	500	0.180	0.632	1.279	0.004	0.045	312.846
	750	0.181	0.632	1.317	0.004	0.046	312.846

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2016		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Trenchers	15	0.497	2.605	3.110	0.007	0.122	426.608
	25	0.515	1.757	3.252	0.005	0.121	426.608
	50	1.691	4.942	4.071	0.006	0.380	426.608
	120	0.710	3.000	4.374	0.005	0.362	426.608
	175	0.498	2.519	3.798	0.005	0.208	426.608
	250	0.381	1.198	3.455	0.005	0.132	426.608
	500	0.351	1.463	3.119	0.004	0.120	426.608
	750	0.353	1.462	3.183	0.004	0.121	426.608
Welders	15	0.365	1.631	2.263	0.004	0.131	255.965
	25	0.385	1.173	2.164	0.003	0.115	255.965
	50	0.694	2.430	2.223	0.003	0.175	255.965
	120	0.315	1.669	2.114	0.003	0.169	255.965
	175	0.219	1.409	1.790	0.003	0.093	255.965
	250	0.149	0.520	1.568	0.003	0.047	255.965
	500	0.138	0.511	1.366	0.003	0.044	255.965
Water Trucks	175	0.302	1.957	1.982	0.004	0.108	324.222
	250	0.230	0.711	1.690	0.004	0.057	324.222
	500	0.221	0.690	1.491	0.003	0.053	324.222
	750	0.222	0.690	1.539	0.003	0.054	324.222
	1000	0.237	0.733	2.537	0.003	0.071	324.222

2017		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Aerial Lifts	15	0.305	1.598	1.907	0.004	0.075	261.653
	25	0.348	1.128	2.082	0.003	0.097	261.653
	50	0.497	2.049	2.099	0.003	0.136	261.653
	120	0.248	1.602	1.894	0.003	0.131	261.653
	500	0.108	0.488	1.197	0.003	0.036	261.653
	750	0.110	0.488	1.234	0.003	0.037	261.653
Air Compressors	15	0.378	1.729	2.348	0.004	0.131	273.029
	25	0.399	1.232	2.272	0.003	0.117	273.029
	50	0.712	2.693	2.340	0.004	0.179	273.029
	120	0.323	1.813	2.120	0.003	0.168	273.029
	175	0.229	1.541	1.743	0.003	0.093	273.029
	250	0.163	0.558	1.520	0.003	0.047	273.029
	500	0.155	0.540	1.324	0.003	0.044	273.029
	750	0.156	0.540	1.367	0.003	0.045	273.029
	1000	0.174	0.599	2.202	0.003	0.058	273.029
Bore/Drill Rigs	15	0.497	2.605	3.110	0.007	0.122	426.608
	25	0.515	1.757	3.252	0.005	0.122	426.608
	50	0.289	3.045	2.738	0.006	0.061	426.608
	120	0.181	2.582	1.639	0.005	0.053	426.608
	175	0.157	2.280	1.085	0.005	0.037	426.608
	250	0.131	0.777	0.708	0.005	0.020	426.608
	500	0.131	0.755	0.690	0.004	0.020	426.608
	750	0.131	0.755	0.694	0.004	0.020	426.608
	1000	0.139	0.756	2.021	0.004	0.039	426.608
Cement and Mortar Mixers	15	0.371	1.945	2.323	0.005	0.093	318.534
	25	0.430	1.383	2.560	0.004	0.121	318.534
Concrete/Industrial Saws	25	0.501	1.710	3.165	0.005	0.118	415.232
	50	0.859	3.576	3.400	0.005	0.229	415.232
	120	0.407	2.627	2.985	0.005	0.215	415.232
	175	0.289	2.245	2.423	0.005	0.121	415.232
Cranes	50	0.749	2.730	2.202	0.003	0.177	244.589
	120	0.337	1.711	2.027	0.003	0.167	244.589
	175	0.246	1.453	1.690	0.003	0.096	244.589
	250	0.181	0.561	1.490	0.003	0.051	244.589
	500	0.171	0.576	1.318	0.002	0.048	244.589
	750	0.172	0.576	1.359	0.002	0.048	244.589
	9999	0.197	0.639	2.085	0.002	0.059	244.589
Crawler Tractors	50	1.282	4.312	3.383	0.005	0.289	364.039
	120	0.557	2.604	3.303	0.004	0.271	364.039
	175	0.405	2.206	2.792	0.004	0.157	364.039
	250	0.310	0.944	2.498	0.004	0.093	364.039
	500	0.291	1.057	2.245	0.004	0.086	364.039
	750	0.292	1.057	2.297	0.004	0.087	364.039
	1000	0.314	1.174	3.329	0.004	0.099	364.039
Crushing/Proc. Equipment	50	1.095	4.390	3.769	0.006	0.277	443.672
	120	0.506	2.960	3.314	0.005	0.258	443.672
	175	0.366	2.527	2.694	0.005	0.145	443.672

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2017		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	250	0.266	0.906	2.332	0.005	0.073	443.672
	500	0.253	0.874	2.032	0.004	0.069	443.672
	750	0.252	0.870	2.080	0.004	0.069	443.672
	9999	0.295	0.961	3.453	0.004	0.091	443.672
Dumpers/Tenders	25	0.262	0.890	1.659	0.003	0.065	216.148
Excavators	25	0.391	1.335	2.472	0.004	0.092	324.222
	50	0.676	3.328	2.698	0.004	0.166	324.222
	120	0.335	2.220	2.132	0.004	0.150	324.222
	175	0.259	1.919	1.671	0.004	0.089	324.222
	250	0.203	0.685	1.405	0.004	0.047	324.222
	500	0.196	0.661	1.247	0.003	0.045	324.222
	750	0.197	0.660	1.283	0.003	0.045	324.222
Forklifts	50	0.291	1.696	1.424	0.002	0.079	170.643
	120	0.155	1.160	1.044	0.002	0.069	170.643
	175	0.128	1.011	0.810	0.002	0.044	170.643
	250	0.103	0.346	0.667	0.002	0.022	170.643
	500	0.101	0.329	0.598	0.002	0.022	170.643
Generator Sets	15	0.518	2.666	3.590	0.007	0.186	420.920
	25	0.561	1.900	3.503	0.005	0.173	420.920
	50	0.754	3.180	3.350	0.005	0.212	420.920
	120	0.386	2.550	3.017	0.005	0.203	420.920
	175	0.264	2.171	2.480	0.005	0.112	420.920
	250	0.182	0.788	2.155	0.005	0.060	420.920
	500	0.166	0.777	1.911	0.004	0.057	420.920
	750	0.170	0.777	1.970	0.004	0.058	420.920
	9999	0.223	0.860	3.180	0.004	0.077	420.920
Graders	50	0.936	3.694	3.008	0.004	0.222	346.974
	120	0.430	2.391	2.663	0.004	0.207	346.974
	175	0.318	2.044	2.179	0.004	0.120	346.974
	250	0.238	0.776	1.892	0.004	0.065	346.974
	500	0.226	0.808	1.684	0.003	0.061	346.974
	750	0.227	0.808	1.731	0.003	0.061	346.974
Off-Highway Tractors	120	0.675	2.734	3.934	0.004	0.329	369.727
	175	0.481	2.303	3.399	0.004	0.192	369.727
	250	0.381	1.134	3.120	0.004	0.126	369.727
	750	0.354	1.446	2.878	0.004	0.115	369.727
	1000	0.373	1.581	3.829	0.004	0.122	369.727
Off-Highway Trucks	175	0.278	1.956	1.753	0.004	0.094	324.222
	250	0.216	0.702	1.485	0.004	0.050	324.222
	500	0.209	0.676	1.314	0.003	0.047	324.222
	750	0.210	0.676	1.353	0.003	0.048	324.222
	1000	0.224	0.709	2.387	0.003	0.064	324.222
Other Construction Equipment	15	0.411	2.153	2.571	0.005	0.100	352.663
	25	0.425	1.452	2.688	0.004	0.101	352.663
	50	0.589	3.014	2.753	0.005	0.157	352.663
	120	0.293	2.242	2.187	0.004	0.144	352.663
	175	0.220	1.940	1.699	0.004	0.084	352.663
	500	0.164	0.665	1.267	0.003	0.043	352.663

2017		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Other General Industrial Equipment	15	0.301	1.771	2.115	0.005	0.083	290.093
	25	0.350	1.194	2.211	0.004	0.083	290.093
	50	0.812	3.152	2.572	0.004	0.200	290.093
	120	0.373	2.011	2.292	0.003	0.186	290.093
	175	0.272	1.712	1.882	0.003	0.104	290.093
	250	0.198	0.618	1.638	0.003	0.052	290.093
	500	0.189	0.593	1.426	0.003	0.049	290.093
	750	0.190	0.593	1.473	0.003	0.050	290.093
	1000	0.209	0.655	2.382	0.003	0.065	290.093
Other Material Handling Equipment	50	0.932	3.608	2.964	0.004	0.230	335.598
	120	0.428	2.315	2.648	0.004	0.214	335.598
	175	0.311	1.970	2.174	0.004	0.120	335.598
	250	0.226	0.712	1.892	0.004	0.061	335.598
	500	0.216	0.683	1.648	0.003	0.057	335.598
	9999	0.252	0.756	2.751	0.003	0.075	335.598
Pavers	25	0.430	1.457	2.721	0.004	0.110	352.663
	50	1.311	4.110	3.295	0.005	0.295	352.663
	120	0.658	2.495	3.367	0.004	0.279	352.663
	175	0.397	2.104	2.870	0.004	0.160	352.663
	250	0.302	0.939	2.593	0.004	0.097	352.663
	500	0.281	1.094	2.331	0.003	0.089	352.663
Paving Equipment	25	0.364	1.241	2.298	0.004	0.086	301.470
	50	1.116	3.478	2.809	0.004	0.252	301.470
	120	0.474	2.121	2.870	0.004	0.240	301.470
	175	0.336	1.787	2.446	0.003	0.137	301.470
	250	0.251	0.783	2.206	0.003	0.081	301.470
Plate Compactors	15	0.285	1.493	1.783	0.004	0.070	244.589
Pressure Washers	15	0.210	1.081	1.456	0.003	0.075	170.643
	25	0.228	0.770	1.420	0.002	0.070	170.643
	50	0.228	1.091	1.308	0.002	0.072	170.643
	120	0.133	0.986	1.168	0.002	0.070	170.643
Pumps	15	0.583	2.666	3.620	0.007	0.202	420.920
	25	0.615	1.900	3.503	0.005	0.180	420.920
	50	0.818	3.344	3.391	0.005	0.223	420.920
	120	0.405	2.589	3.062	0.005	0.213	420.920
	175	0.279	2.204	2.519	0.005	0.118	420.920
	250	0.193	0.800	2.191	0.005	0.063	420.920
	500	0.177	0.787	1.935	0.004	0.059	420.920
	750	0.181	0.787	1.996	0.004	0.060	420.920
	9999	0.232	0.872	3.217	0.004	0.079	420.920
Rollers	15	0.371	1.945	2.322	0.005	0.091	318.534
	25	0.384	1.312	2.428	0.004	0.091	318.534
	50	0.893	3.202	2.752	0.004	0.214	318.534
	120	0.398	2.130	2.565	0.004	0.204	318.534
	175	0.284	1.809	2.135	0.004	0.116	318.534
	250	0.205	0.702	1.880	0.004	0.063	318.534
	500	0.192	0.740	1.667	0.003	0.058	318.534
Rough Terrain Forklifts	50	0.749	3.400	2.869	0.004	0.192	341.286

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2017		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	120	0.361	2.297	2.372	0.004	0.175	341.286
	175	0.271	1.976	1.885	0.004	0.101	341.286
	250	0.209	0.708	1.618	0.004	0.054	341.286
	500	0.201	0.679	1.424	0.003	0.051	341.286
Rubber Tired Dozers	175	0.457	2.134	3.173	0.004	0.179	335.598
	250	0.364	1.069	2.918	0.004	0.120	335.598
	500	0.337	1.390	2.647	0.003	0.108	335.598
	750	0.338	1.389	2.694	0.003	0.108	335.598
	1000	0.356	1.512	3.551	0.003	0.115	335.598
Rubber Tired Loaders	25	0.371	1.265	2.342	0.004	0.087	307.158
	50	0.807	3.224	2.647	0.004	0.193	307.158
	120	0.372	2.105	2.325	0.004	0.180	307.158
	175	0.276	1.801	1.899	0.003	0.105	307.158
	250	0.206	0.678	1.646	0.003	0.056	307.158
	500	0.196	0.701	1.463	0.003	0.052	307.158
	750	0.197	0.701	1.506	0.003	0.053	307.158
	1000	0.214	0.767	2.436	0.003	0.067	307.158
Scrapers	120	0.642	2.935	3.800	0.005	0.314	409.544
	175	0.463	2.482	3.219	0.005	0.181	409.544
	250	0.353	1.074	2.890	0.005	0.108	409.544
	500	0.331	1.223	2.596	0.004	0.099	409.544
	750	0.332	1.223	2.656	0.004	0.100	409.544
Signal Boards	15	0.543	2.848	3.400	0.007	0.133	466.425
	50	0.905	3.736	3.584	0.006	0.239	443.672
	120	0.432	2.784	3.169	0.005	0.227	443.672
	175	0.304	2.377	2.580	0.005	0.126	443.672
	250	0.258	1.033	2.695	0.006	0.080	536.104
Skid Steer Loaders	25	0.407	1.333	2.473	0.004	0.114	312.846
	50	0.353	2.521	2.286	0.004	0.096	312.846
	120	0.196	1.965	1.589	0.004	0.084	312.846
Surfacing Equipment	50	0.627	2.304	2.137	0.003	0.154	255.965
	120	0.290	1.644	2.005	0.003	0.148	255.965
	175	0.204	1.398	1.668	0.003	0.084	255.965
	250	0.148	0.555	1.468	0.003	0.048	255.965
	500	0.137	0.607	1.318	0.003	0.045	255.965
	750	0.139	0.607	1.354	0.003	0.045	255.965
Sweepers/Scrubbers	15	0.401	2.362	2.820	0.006	0.110	386.791
	25	0.467	1.593	2.949	0.005	0.110	386.791
	50	0.700	3.682	3.208	0.005	0.191	386.791
	120	0.357	2.571	2.481	0.005	0.170	386.791
	175	0.283	2.229	1.954	0.004	0.105	386.791
	250	0.221	0.770	1.640	0.004	0.054	386.791
Tractors/Loaders/Backhoes	25	0.378	1.288	2.392	0.004	0.093	312.846
	50	0.572	2.979	2.511	0.004	0.145	312.846
	120	0.289	2.082	1.945	0.004	0.131	312.846
	175	0.224	1.804	1.508	0.004	0.078	312.846
	250	0.176	0.639	1.255	0.004	0.042	312.846
	500	0.171	0.622	1.117	0.004	0.040	312.846
	750	0.172	0.622	1.149	0.004	0.040	312.846

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2017		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Trenchers	15	0.497	2.605	3.110	0.007	0.122	426.608
	25	0.515	1.757	3.252	0.005	0.121	426.608
	50	1.584	4.832	3.955	0.006	0.355	426.608
	120	0.669	2.977	4.119	0.005	0.338	426.608
	175	0.471	2.509	3.526	0.005	0.194	426.608
	250	0.360	1.154	3.199	0.005	0.122	426.608
	500	0.333	1.382	2.885	0.004	0.110	426.608
	750	0.335	1.381	2.945	0.004	0.112	426.608
Welders	15	0.354	1.621	2.201	0.004	0.123	255.965
	25	0.374	1.155	2.130	0.003	0.110	255.965
	50	0.618	2.360	2.148	0.003	0.158	255.965
	120	0.284	1.655	1.949	0.003	0.150	255.965
	175	0.199	1.407	1.605	0.003	0.083	255.965
	250	0.140	0.511	1.399	0.003	0.042	255.965
	500	0.131	0.497	1.222	0.003	0.040	255.965
Water Trucks	175	0.278	1.956	1.753	0.004	0.094	324.222
	250	0.216	0.702	1.485	0.004	0.050	324.222
	500	0.209	0.676	1.314	0.003	0.047	324.222
	750	0.210	0.676	1.353	0.003	0.048	324.222
	1000	0.224	0.709	2.387	0.003	0.064	324.222

2018		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Aerial Lifts	15	0.305	1.598	1.907	0.004	0.074	261.653
	25	0.340	1.115	2.063	0.003	0.092	261.653
	50	0.438	1.995	2.026	0.003	0.121	261.653
	120	0.220	1.591	1.744	0.003	0.114	261.653
	500	0.102	0.478	1.070	0.003	0.033	261.653
	750	0.104	0.478	1.099	0.003	0.033	261.653
Air Compressors	15	0.368	1.720	2.288	0.004	0.123	273.029
	25	0.388	1.216	2.239	0.003	0.112	273.029
	50	0.625	2.613	2.262	0.004	0.158	273.029
	120	0.290	1.799	1.946	0.003	0.146	273.029
	175	0.209	1.540	1.551	0.003	0.082	273.029
	250	0.154	0.551	1.344	0.003	0.042	273.029
	500	0.148	0.529	1.185	0.003	0.040	273.029
	750	0.149	0.529	1.217	0.003	0.041	273.029
	1000	0.165	0.581	2.078	0.003	0.054	273.029
Bore/Drill Rigs	15	0.497	2.605	3.110	0.007	0.122	426.608
	25	0.515	1.757	3.252	0.005	0.121	426.608
	50	0.280	3.039	2.607	0.006	0.047	426.608
	120	0.171	2.581	1.499	0.005	0.040	426.608
	175	0.144	2.281	0.880	0.005	0.028	426.608
	250	0.122	0.777	0.567	0.005	0.015	426.608
	500	0.122	0.755	0.553	0.004	0.015	426.608
	750	0.122	0.755	0.556	0.004	0.015	426.608
	1000	0.128	0.756	1.935	0.004	0.033	426.608
Cement and Mortar Mixers	15	0.371	1.945	2.322	0.005	0.092	318.534
	25	0.420	1.368	2.525	0.004	0.115	318.534
Concrete/Industrial Saws	25	0.501	1.710	3.165	0.005	0.118	415.232
	50	0.755	3.482	3.282	0.005	0.203	415.232
	120	0.364	2.610	2.743	0.005	0.188	415.232
	175	0.262	2.245	2.152	0.005	0.106	415.232
Cranes	50	0.681	2.666	2.130	0.003	0.160	244.589
	120	0.312	1.700	1.882	0.003	0.149	244.589
	175	0.229	1.451	1.531	0.003	0.086	244.589
	250	0.172	0.550	1.345	0.003	0.046	244.589
	500	0.163	0.555	1.188	0.002	0.043	244.589
	750	0.164	0.555	1.226	0.002	0.044	244.589
	9999	0.187	0.604	1.972	0.002	0.054	244.589
Crawler Tractors	50	1.190	4.220	3.278	0.005	0.265	364.039
	120	0.523	2.588	3.092	0.004	0.248	364.039
	175	0.381	2.201	2.564	0.004	0.144	364.039
	250	0.292	0.916	2.286	0.004	0.084	364.039
	500	0.275	1.011	2.054	0.004	0.078	364.039
	750	0.276	1.011	2.102	0.004	0.079	364.039
	1000	0.298	1.117	3.169	0.004	0.092	364.039
Crushing/Proc. Equipment	50	0.957	4.264	3.636	0.006	0.243	443.672
	120	0.453	2.938	3.031	0.005	0.222	443.672
	175	0.334	2.525	2.381	0.005	0.126	443.672

2018		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	250	0.251	0.895	2.047	0.005	0.065	443.672
	500	0.242	0.859	1.805	0.004	0.062	443.672
	750	0.241	0.857	1.841	0.004	0.062	443.672
	9999	0.282	0.936	3.254	0.004	0.084	443.672
Dumpers/Tenders	25	0.261	0.890	1.655	0.003	0.064	216.148
Excavators	25	0.391	1.335	2.472	0.004	0.092	324.222
	50	0.607	3.267	2.595	0.004	0.143	324.222
	120	0.305	2.210	1.949	0.004	0.127	324.222
	175	0.238	1.919	1.465	0.004	0.076	324.222
	250	0.191	0.679	1.223	0.004	0.041	324.222
	500	0.186	0.650	1.093	0.003	0.039	324.222
	750	0.186	0.650	1.119	0.003	0.040	324.222
Forklifts	50	0.263	1.670	1.368	0.002	0.066	170.643
	120	0.143	1.156	0.947	0.002	0.058	170.643
	175	0.119	1.011	0.702	0.002	0.038	170.643
	250	0.097	0.345	0.566	0.002	0.019	170.643
	500	0.095	0.328	0.521	0.002	0.019	170.643
Generator Sets	15	0.504	2.652	3.502	0.007	0.176	420.920
	25	0.551	1.875	3.452	0.005	0.166	420.920
	50	0.663	3.098	3.234	0.005	0.188	420.920
	120	0.342	2.532	2.779	0.005	0.178	420.920
	175	0.237	2.170	2.214	0.005	0.099	420.920
	250	0.168	0.777	1.912	0.005	0.054	420.920
	500	0.157	0.762	1.711	0.004	0.051	420.920
	750	0.160	0.762	1.755	0.004	0.052	420.920
	9999	0.208	0.836	3.006	0.004	0.071	420.920
Graders	50	0.852	3.614	2.904	0.004	0.198	346.975
	120	0.398	2.378	2.464	0.004	0.184	346.974
	175	0.297	2.042	1.961	0.004	0.108	346.974
	250	0.225	0.762	1.696	0.004	0.058	346.974
	500	0.215	0.785	1.510	0.003	0.054	346.974
	750	0.216	0.785	1.553	0.003	0.055	346.974
Off-Highway Tractors	120	0.640	2.713	3.718	0.004	0.307	369.727
	175	0.458	2.292	3.173	0.004	0.179	369.727
	250	0.362	1.094	2.904	0.004	0.117	369.727
	750	0.337	1.364	2.680	0.004	0.106	369.727
	1000	0.356	1.491	3.667	0.004	0.115	369.727
Off-Highway Trucks	175	0.255	1.955	1.541	0.004	0.081	324.222
	250	0.203	0.695	1.297	0.004	0.044	324.222
	500	0.197	0.664	1.156	0.003	0.042	324.222
	750	0.198	0.664	1.185	0.003	0.042	324.222
	1000	0.211	0.693	2.252	0.003	0.058	324.222
Other Construction Equipment	15	0.411	2.153	2.571	0.005	0.100	352.663
	25	0.425	1.452	2.688	0.004	0.100	352.663
	50	0.519	2.951	2.649	0.005	0.136	352.663
	120	0.263	2.231	1.994	0.004	0.122	352.663
	175	0.201	1.940	1.482	0.004	0.072	352.663
	500	0.156	0.658	1.110	0.003	0.038	352.663

2018		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Other General Industrial Equipment	15	0.301	1.771	2.115	0.005	0.083	290.093
	25	0.350	1.194	2.211	0.004	0.083	290.093
	50	0.717	3.070	2.484	0.004	0.176	290.093
	120	0.337	1.997	2.102	0.003	0.161	290.093
	175	0.249	1.712	1.673	0.003	0.091	290.093
	250	0.188	0.611	1.445	0.003	0.047	290.093
	500	0.181	0.582	1.274	0.003	0.044	290.093
	750	0.181	0.582	1.309	0.003	0.045	290.093
	1000	0.199	0.637	2.245	0.003	0.060	290.093
Other Material Handling Equipment	50	0.822	3.511	2.864	0.004	0.203	335.598
	120	0.386	2.299	2.428	0.004	0.185	335.598
	175	0.285	1.970	1.932	0.004	0.105	335.598
	250	0.214	0.703	1.670	0.004	0.054	335.598
	500	0.206	0.670	1.472	0.003	0.051	335.598
	9999	0.242	0.734	2.592	0.003	0.069	335.598
Pavers	25	0.428	1.453	2.711	0.004	0.107	352.663
	50	1.219	4.017	3.200	0.005	0.273	352.663
	120	0.525	2.478	3.163	0.004	0.258	352.663
	175	0.375	2.098	2.651	0.004	0.148	352.663
	250	0.286	0.907	2.388	0.004	0.089	352.663
	500	0.267	1.041	2.145	0.003	0.081	352.663
Paving Equipment	25	0.364	1.241	2.298	0.004	0.086	301.470
	50	1.035	3.397	2.728	0.004	0.234	301.470
	120	0.446	2.107	2.693	0.004	0.221	301.470
	175	0.317	1.782	2.258	0.003	0.127	301.470
	250	0.237	0.756	2.031	0.003	0.074	301.470
Plate Compactors	15	0.285	1.493	1.783	0.004	0.070	244.589
Pressure Washers	15	0.204	1.075	1.420	0.003	0.071	170.643
	25	0.223	0.760	1.400	0.002	0.067	170.643
	50	0.199	1.064	1.262	0.002	0.064	170.643
	120	0.117	0.979	1.076	0.002	0.061	170.643
Pumps	15	0.568	2.652	3.528	0.007	0.190	420.920
	25	0.598	1.875	3.452	0.005	0.172	420.920
	50	0.721	3.257	3.275	0.005	0.198	420.920
	120	0.360	2.571	2.821	0.005	0.187	420.920
	175	0.251	2.203	2.249	0.005	0.104	420.920
	250	0.179	0.789	1.944	0.005	0.056	420.920
	500	0.168	0.772	1.733	0.004	0.053	420.920
	750	0.170	0.772	1.779	0.004	0.054	420.920
	9999	0.217	0.847	3.041	0.004	0.073	420.920
Rollers	15	0.371	1.945	2.322	0.005	0.091	318.534
	25	0.384	1.312	2.428	0.004	0.091	318.534
	50	0.812	3.123	2.662	0.004	0.194	318.534
	120	0.367	2.116	2.382	0.004	0.184	318.534
	175	0.264	1.806	1.935	0.004	0.105	318.534
	250	0.194	0.688	1.699	0.004	0.057	318.534
	500	0.183	0.713	1.504	0.003	0.053	318.534
Rough Terrain Forklifts	50	0.660	3.320	2.765	0.004	0.167	341.286

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2018		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	120	0.326	2.284	2.168	0.004	0.149	341.286
	175	0.249	1.976	1.659	0.004	0.088	341.286
	250	0.197	0.700	1.414	0.004	0.047	341.286
	500	0.192	0.669	1.259	0.003	0.045	341.286
Rubber Tired Dozers	175	0.434	2.123	2.966	0.004	0.167	335.598
	250	0.346	1.031	2.722	0.004	0.111	335.598
	500	0.321	1.310	2.468	0.003	0.100	335.598
	750	0.322	1.309	2.513	0.003	0.101	335.598
	1000	0.340	1.425	3.404	0.003	0.108	335.598
Rubber Tired Loaders	25	0.371	1.265	2.342	0.004	0.087	307.158
	50	0.732	3.154	2.555	0.004	0.172	307.158
	120	0.344	2.094	2.149	0.004	0.160	307.158
	175	0.257	1.799	1.705	0.003	0.093	307.158
	250	0.195	0.667	1.473	0.003	0.050	307.158
	500	0.187	0.681	1.309	0.003	0.047	307.158
	750	0.188	0.681	1.348	0.003	0.048	307.158
	1000	0.202	0.733	2.302	0.003	0.061	307.158
Scrapers	120	0.603	2.916	3.561	0.005	0.288	409.544
	175	0.437	2.476	2.963	0.005	0.167	409.544
	250	0.333	1.041	2.651	0.005	0.098	409.544
	500	0.313	1.168	2.380	0.004	0.090	409.544
	750	0.315	1.167	2.436	0.004	0.091	409.544
Signal Boards	15	0.543	2.848	3.400	0.007	0.133	466.425
	50	0.795	3.636	3.457	0.006	0.211	443.672
	120	0.385	2.765	2.907	0.005	0.197	443.672
	175	0.274	2.376	2.287	0.005	0.111	443.672
	250	0.242	1.020	2.374	0.006	0.071	536.104
Skid Steer Loaders	25	0.399	1.321	2.453	0.004	0.109	312.846
	50	0.323	2.494	2.191	0.004	0.080	312.846
	120	0.181	1.961	1.441	0.004	0.069	312.846
Surfacing Equipment	50	0.575	2.253	2.067	0.003	0.140	255.965
	120	0.268	1.634	1.867	0.003	0.134	255.965
	175	0.190	1.396	1.517	0.003	0.077	255.965
	250	0.139	0.542	1.331	0.003	0.044	255.965
	500	0.130	0.584	1.194	0.003	0.040	255.965
	750	0.131	0.584	1.227	0.003	0.041	255.965
Sweepers/Scrubbers	15	0.401	2.362	2.820	0.006	0.110	386.791
	25	0.467	1.593	2.949	0.005	0.110	386.791
	50	0.630	3.630	3.102	0.005	0.165	386.791
	120	0.329	2.565	2.271	0.005	0.147	386.791
	175	0.266	2.233	1.729	0.004	0.093	386.791
	250	0.212	0.767	1.429	0.004	0.048	386.791
Tractors/Loaders/Backhoes	25	0.378	1.288	2.388	0.004	0.092	312.846
	50	0.512	2.926	2.415	0.004	0.125	312.846
	120	0.263	2.072	1.776	0.004	0.111	312.846
	175	0.206	1.803	1.316	0.004	0.067	312.846
	250	0.166	0.634	1.086	0.004	0.037	312.846
	500	0.162	0.614	0.974	0.004	0.035	312.846
	750	0.163	0.614	0.998	0.004	0.035	312.846

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2018		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Trenchers	15	0.497	2.605	3.110	0.007	0.122	426.608
	25	0.515	1.757	3.252	0.005	0.121	426.608
	50	1.480	4.726	3.843	0.006	0.330	426.608
	120	0.630	2.957	3.878	0.005	0.314	426.608
	175	0.446	2.501	3.268	0.005	0.180	426.608
	250	0.341	1.115	2.957	0.005	0.111	426.608
	500	0.317	1.310	2.663	0.004	0.101	426.608
	750	0.318	1.310	2.721	0.004	0.103	426.608
Welders	15	0.345	1.612	2.145	0.004	0.116	255.965
	25	0.364	1.140	2.099	0.003	0.105	255.965
	50	0.545	2.294	2.075	0.003	0.140	255.965
	120	0.254	1.643	1.793	0.003	0.131	255.965
	175	0.181	1.407	1.431	0.003	0.073	255.965
	250	0.132	0.504	1.239	0.003	0.038	255.965
	500	0.125	0.487	1.095	0.003	0.036	255.965
Water Trucks	175	0.255	1.955	1.541	0.004	0.081	324.222
	250	0.203	0.695	1.297	0.004	0.044	324.222
	500	0.197	0.664	1.156	0.003	0.042	324.222
	750	0.198	0.664	1.185	0.003	0.042	324.222
	1000	0.211	0.693	2.252	0.003	0.058	324.222

2019		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Aerial Lifts	15	0.305	1.598	1.907	0.004	0.074	261.653
	25	0.334	1.105	2.049	0.003	0.088	261.653
	50	0.382	1.943	1.955	0.003	0.106	261.653
	120	0.194	1.580	1.600	0.003	0.099	261.653
	500	0.096	0.471	0.952	0.003	0.029	261.653
	750	0.098	0.471	0.975	0.003	0.030	261.653
Air Compressors	15	0.360	1.712	2.233	0.004	0.116	273.029
	25	0.378	1.202	2.209	0.003	0.107	273.029
	50	0.543	2.538	2.184	0.004	0.138	273.029
	120	0.259	1.786	1.781	0.003	0.125	273.029
	175	0.193	1.540	1.381	0.003	0.072	273.029
	250	0.146	0.544	1.187	0.003	0.038	273.029
	500	0.141	0.522	1.054	0.003	0.036	273.029
	750	0.142	0.522	1.080	0.003	0.037	273.029
	1000	0.156	0.568	1.957	0.003	0.049	273.029
Bore/Drill Rigs	15	0.497	2.605	3.110	0.007	0.122	426.608
	25	0.515	1.757	3.252	0.005	0.121	426.608
	50	0.274	3.034	2.499	0.006	0.036	426.608
	120	0.162	2.580	1.383	0.005	0.030	426.608
	175	0.132	2.281	0.706	0.005	0.021	426.608
	250	0.114	0.777	0.454	0.005	0.012	426.608
	500	0.114	0.755	0.444	0.004	0.012	426.608
	750	0.114	0.755	0.446	0.004	0.012	426.608
	1000	0.119	0.755	1.872	0.004	0.028	426.608
Cement and Mortar Mixers	15	0.371	1.945	2.322	0.005	0.091	318.534
	25	0.412	1.355	2.505	0.004	0.110	318.534
Concrete/Industrial Saws	25	0.501	1.710	3.165	0.005	0.118	415.232
	50	0.657	3.394	3.170	0.005	0.177	415.232
	120	0.324	2.594	2.515	0.005	0.161	415.232
	175	0.241	2.245	1.913	0.005	0.094	415.232
Cranes	50	0.619	2.608	2.063	0.003	0.143	244.589
	120	0.287	1.690	1.746	0.003	0.133	244.589
	175	0.213	1.449	1.381	0.003	0.077	244.589
	250	0.162	0.540	1.208	0.003	0.042	244.589
	500	0.155	0.537	1.068	0.002	0.039	244.589
	750	0.156	0.537	1.101	0.002	0.039	244.589
	9999	0.178	0.575	1.869	0.002	0.049	244.589
Crawler Tractors	50	1.103	4.134	3.178	0.005	0.242	364.039
	120	0.490	2.573	2.894	0.004	0.226	364.039
	175	0.359	2.197	2.349	0.004	0.131	364.039
	250	0.276	0.891	2.087	0.004	0.076	364.039
	500	0.261	0.971	1.875	0.004	0.071	364.039
	750	0.262	0.971	1.920	0.004	0.071	364.039
	1000	0.282	1.067	3.020	0.004	0.085	364.039
Crushing/Proc. Equipment	50	0.831	4.151	3.509	0.006	0.210	443.672
	120	0.405	2.919	2.767	0.005	0.188	443.672
	175	0.308	2.525	2.108	0.005	0.111	443.672

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2019		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	250	0.238	0.886	1.796	0.005	0.058	443.672
	500	0.231	0.849	1.598	0.004	0.056	443.672
	750	0.230	0.848	1.628	0.004	0.056	443.672
	9999	0.270	0.916	3.066	0.004	0.077	443.672
Dumpers/Tenders	25	0.261	0.890	1.651	0.003	0.064	216.148
Excavators	25	0.391	1.335	2.472	0.004	0.092	324.222
	50	0.547	3.214	2.499	0.004	0.122	324.222
	120	0.279	2.200	1.783	0.004	0.108	324.222
	175	0.219	1.918	1.279	0.004	0.065	324.222
	250	0.179	0.674	1.060	0.004	0.036	324.222
	500	0.176	0.643	0.957	0.003	0.035	324.222
	750	0.176	0.642	0.976	0.003	0.035	324.222
Forklifts	50	0.238	1.846	1.312	0.002	0.054	170.643
	120	0.132	1.152	0.854	0.002	0.048	170.643
	175	0.110	1.010	0.615	0.002	0.032	170.643
	250	0.091	0.344	0.485	0.002	0.016	170.643
	500	0.090	0.327	0.451	0.002	0.016	170.643
Generator Sets	15	0.490	2.639	3.420	0.007	0.166	420.920
	25	0.542	1.853	3.405	0.005	0.159	420.920
	50	0.577	3.019	3.122	0.005	0.165	420.920
	120	0.301	2.516	2.553	0.005	0.153	420.920
	175	0.215	2.170	1.977	0.005	0.088	420.920
	250	0.157	0.768	1.693	0.005	0.048	420.920
	500	0.148	0.752	1.523	0.004	0.046	420.920
	750	0.150	0.752	1.559	0.004	0.047	420.920
	9999	0.193	0.817	2.836	0.004	0.065	420.920
Graders	50	0.777	3.543	2.807	0.004	0.177	346.974
	120	0.369	2.366	2.281	0.004	0.163	346.974
	175	0.276	2.041	1.759	0.004	0.096	346.974
	250	0.213	0.751	1.516	0.004	0.052	346.974
	500	0.204	0.767	1.352	0.003	0.049	346.974
	750	0.205	0.767	1.390	0.003	0.049	346.974
Off-Highway Tractors	120	0.606	2.695	3.515	0.004	0.286	369.727
	175	0.435	2.283	2.958	0.004	0.167	369.727
	250	0.343	1.058	2.701	0.004	0.107	369.727
	750	0.320	1.292	2.492	0.004	0.098	369.727
	1000	0.340	1.411	3.514	0.004	0.107	369.727
Off-Highway Trucks	175	0.234	1.954	1.350	0.004	0.070	324.222
	250	0.191	0.689	1.129	0.004	0.038	324.222
	500	0.187	0.655	1.015	0.003	0.037	324.222
	750	0.187	0.655	1.036	0.003	0.037	324.222
	1000	0.199	0.680	2.131	0.003	0.052	324.222
Other Construction Equipment	15	0.411	2.153	2.571	0.005	0.100	352.663
	25	0.425	1.452	2.688	0.004	0.100	352.662
	50	0.458	2.896	2.552	0.005	0.116	352.662
	120	0.238	2.222	1.821	0.004	0.102	352.663
	175	0.186	1.940	1.295	0.004	0.063	352.663
	500	0.148	0.653	0.969	0.003	0.034	352.663

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2019		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Other General Industrial Equipment	15	0.301	1.771	2.115	0.005	0.083	290.093
	25	0.350	1.194	2.211	0.004	0.083	290.093
	50	0.629	2.993	2.398	0.004	0.153	290.093
	120	0.304	1.985	1.922	0.003	0.137	290.093
	175	0.231	1.712	1.488	0.003	0.080	290.093
	250	0.177	0.604	1.273	0.003	0.041	290.093
	500	0.172	0.574	1.131	0.003	0.040	290.093
	750	0.173	0.574	1.159	0.003	0.040	290.093
	1000	0.188	0.623	2.112	0.003	0.055	290.093
Other Material Handling Equipment	50	0.720	3.423	2.765	0.004	0.176	335.598
	120	0.347	2.284	2.219	0.004	0.158	335.598
	175	0.264	1.971	1.719	0.004	0.093	335.598
	250	0.203	0.695	1.471	0.004	0.048	335.598
	500	0.196	0.662	1.307	0.003	0.046	335.598
	9999	0.231	0.718	2.439	0.003	0.063	335.598
Pavers	25	0.426	1.452	2.702	0.004	0.105	352.663
	50	1.133	3.931	3.108	0.005	0.252	352.663
	120	0.494	2.463	2.970	0.004	0.238	352.663
	175	0.355	2.093	2.445	0.004	0.137	352.663
	250	0.270	0.879	2.196	0.004	0.081	352.663
	500	0.254	0.994	1.971	0.003	0.074	352.663
Paving Equipment	25	0.364	1.241	2.298	0.004	0.086	301.470
	50	0.958	3.320	2.650	0.004	0.215	301.470
	120	0.418	2.094	2.526	0.004	0.204	301.470
	175	0.299	1.778	2.080	0.003	0.117	301.470
	250	0.225	0.733	1.864	0.003	0.067	301.470
Plate Compactors	15	0.285	1.493	1.783	0.004	0.070	244.589
Pressure Washers	15	0.199	1.070	1.386	0.003	0.067	170.643
	25	0.220	0.751	1.380	0.002	0.064	170.643
	50	0.171	1.038	1.217	0.002	0.056	170.643
	120	0.101	0.973	0.990	0.002	0.052	170.643
Pumps	15	0.554	2.639	3.442	0.007	0.179	420.920
	25	0.583	1.853	3.405	0.005	0.165	420.920
	50	0.629	3.173	3.162	0.005	0.174	420.920
	120	0.318	2.555	2.590	0.005	0.161	420.920
	175	0.229	2.203	2.008	0.005	0.092	420.920
	250	0.168	0.780	1.721	0.005	0.050	420.920
	500	0.159	0.761	1.544	0.004	0.048	420.920
	750	0.161	0.761	1.580	0.004	0.049	420.920
	9999	0.203	0.828	2.869	0.004	0.066	420.920
Rollers	15	0.371	1.945	2.322	0.005	0.091	318.534
	25	0.384	1.312	2.428	0.004	0.091	318.534
	50	0.736	3.051	2.578	0.004	0.175	318.534
	120	0.338	2.103	2.211	0.004	0.165	318.534
	175	0.246	1.803	1.747	0.004	0.094	318.534
	250	0.184	0.676	1.529	0.004	0.052	318.534
	500	0.175	0.690	1.353	0.003	0.048	318.534
Rough Terrain Forklifts	50	0.582	3.249	2.667	0.004	0.144	341.286

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2019		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	120	0.294	2.272	1.981	0.004	0.126	341.286
	175	0.231	1.976	1.462	0.004	0.077	341.286
	250	0.186	0.693	1.234	0.004	0.042	341.286
	500	0.182	0.662	1.109	0.003	0.040	341.286
Rubber Tired Dozers	175	0.412	2.114	2.769	0.004	0.156	335.598
	250	0.328	0.997	2.535	0.004	0.102	335.598
	500	0.305	1.238	2.298	0.003	0.092	335.598
	750	0.306	1.237	2.341	0.003	0.093	335.598
	1000	0.324	1.347	3.265	0.003	0.101	335.598
Rubber Tired Loaders	25	0.371	1.265	2.342	0.004	0.087	307.158
	50	0.665	3.092	2.469	0.004	0.153	307.158
	120	0.318	2.083	1.988	0.004	0.141	307.158
	175	0.239	1.797	1.526	0.003	0.083	307.158
	250	0.185	0.659	1.313	0.003	0.045	307.158
	500	0.177	0.664	1.169	0.003	0.042	307.158
	750	0.178	0.664	1.202	0.003	0.043	307.158
	1000	0.191	0.705	2.180	0.003	0.056	307.158
Scrapers	120	0.566	2.899	3.337	0.005	0.264	409.544
	175	0.412	2.472	2.722	0.005	0.153	409.544
	250	0.315	1.011	2.427	0.005	0.089	409.544
	500	0.297	1.119	2.178	0.004	0.082	409.544
	750	0.298	1.119	2.230	0.004	0.083	409.544
Signal Boards	15	0.543	2.848	3.400	0.007	0.133	466.425
	50	0.693	3.543	3.336	0.006	0.184	443.672
	120	0.341	2.748	2.662	0.005	0.169	443.672
	175	0.251	2.376	2.031	0.005	0.098	443.672
	250	0.227	1.009	2.089	0.006	0.063	536.104
Skid Steer Loaders	25	0.393	1.311	2.438	0.004	0.103	312.846
	50	0.300	2.475	2.105	0.004	0.065	312.846
	120	0.170	1.958	1.314	0.004	0.057	312.846
Surfacing Equipment	50	0.526	2.205	2.001	0.003	0.127	255.965
	120	0.248	1.625	1.739	0.003	0.121	255.965
	175	0.177	1.394	1.376	0.003	0.070	255.965
	250	0.131	0.532	1.204	0.003	0.039	255.965
	500	0.123	0.564	1.078	0.003	0.037	255.965
	750	0.124	0.564	1.109	0.003	0.037	255.965
Sweepers/Scrubbers	15	0.401	2.362	2.820	0.006	0.110	386.791
	25	0.467	1.593	2.949	0.005	0.110	386.791
	50	0.572	3.587	2.998	0.005	0.142	386.791
	120	0.306	2.560	2.078	0.005	0.127	386.791
	175	0.249	2.236	1.518	0.004	0.081	386.791
	250	0.201	0.765	1.230	0.004	0.042	386.791
Tractors/Loaders/Backhoes	25	0.377	1.288	2.386	0.004	0.091	312.846
	50	0.462	2.882	2.327	0.004	0.106	312.846
	120	0.241	2.064	1.625	0.004	0.093	312.846
	175	0.190	1.803	1.144	0.004	0.058	312.846
	250	0.157	0.631	0.937	0.004	0.032	312.846
	500	0.154	0.608	0.848	0.004	0.031	312.846
	750	0.154	0.608	0.865	0.004	0.031	312.846

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2019		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Trenchers	15	0.497	2.605	3.110	0.007	0.122	426.608
	25	0.515	1.757	3.252	0.005	0.121	426.608
	50	1.379	4.625	3.736	0.006	0.306	426.608
	120	0.593	2.938	3.649	0.005	0.290	426.608
	175	0.422	2.494	3.022	0.005	0.167	426.608
	250	0.323	1.079	2.727	0.005	0.102	426.608
	500	0.301	1.248	2.455	0.004	0.093	426.608
	750	0.303	1.247	2.510	0.004	0.094	426.608
Welders	15	0.337	1.605	2.093	0.004	0.109	255.965
	25	0.355	1.127	2.070	0.003	0.100	255.965
	50	0.475	2.230	2.004	0.003	0.123	255.965
	120	0.227	1.632	1.643	0.003	0.113	255.965
	175	0.167	1.406	1.276	0.003	0.065	255.965
	250	0.124	0.497	1.096	0.003	0.034	255.965
	500	0.119	0.480	0.974	0.003	0.032	255.965
Water Trucks	175	0.234	1.954	1.350	0.004	0.070	324.222
	250	0.191	0.689	1.129	0.004	0.038	324.222
	500	0.187	0.655	1.015	0.003	0.037	324.222
	750	0.187	0.655	1.036	0.003	0.037	324.222
	1000	0.199	0.680	2.131	0.003	0.052	324.222

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2020		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Aerial Lifts	15	0.305	1.598	1.907	0.004	0.074	261.653
	25	0.328	1.096	2.037	0.003	0.084	261.653
	50	0.339	1.904	1.890	0.003	0.093	261.653
	120	0.175	1.573	1.472	0.003	0.086	261.653
	500	0.091	0.467	0.840	0.003	0.026	261.653
	750	0.092	0.467	0.860	0.003	0.026	261.653
Air Compressors	15	0.352	1.704	2.182	0.004	0.109	273.029
	25	0.369	1.188	2.180	0.003	0.102	273.029
	50	0.481	2.481	2.113	0.004	0.121	273.029
	120	0.235	1.777	1.634	0.003	0.108	273.029
	175	0.180	1.539	1.229	0.003	0.064	273.029
	250	0.139	0.539	1.044	0.003	0.033	273.029
	500	0.134	0.517	0.930	0.003	0.032	273.029
	750	0.135	0.517	0.952	0.003	0.033	273.029
	1000	0.147	0.557	1.839	0.003	0.045	273.029
Bore/Drill Rigs	15	0.497	2.605	3.110	0.007	0.122	426.608
	25	0.515	1.757	3.252	0.005	0.121	426.608
	50	0.269	3.030	2.414	0.006	0.027	426.608
	120	0.155	2.579	1.288	0.005	0.022	426.608
	175	0.122	2.281	0.563	0.005	0.015	426.608
	250	0.108	0.777	0.367	0.005	0.010	426.608
	500	0.107	0.755	0.359	0.004	0.010	426.608
	750	0.107	0.755	0.361	0.004	0.010	426.608
	1000	0.112	0.755	1.832	0.004	0.024	426.608
Cement and Mortar Mixers	15	0.371	1.945	2.322	0.005	0.091	318.534
	25	0.405	1.344	2.490	0.004	0.105	318.534
Concrete/Industrial Saws	25	0.501	1.710	3.165	0.005	0.118	415.232
	50	0.583	3.326	3.066	0.005	0.155	415.232
	120	0.294	2.583	2.311	0.005	0.140	415.232
	175	0.224	2.245	1.699	0.005	0.084	415.232
Cranes	50	0.562	2.556	1.998	0.003	0.128	244.589
	120	0.265	1.681	1.618	0.003	0.117	244.589
	175	0.197	1.447	1.239	0.003	0.068	244.589
	250	0.154	0.532	1.079	0.003	0.037	244.589
	500	0.148	0.521	0.957	0.002	0.035	244.589
	750	0.148	0.521	0.985	0.002	0.035	244.589
	9999	0.169	0.553	1.774	0.002	0.045	244.589
Crawler Tractors	50	1.023	4.055	3.083	0.005	0.220	364.039
	120	0.460	2.560	2.709	0.004	0.205	364.039
	175	0.337	2.193	2.148	0.004	0.120	364.039
	250	0.260	0.869	1.903	0.004	0.069	364.039
	500	0.247	0.936	1.709	0.004	0.064	364.039
	750	0.248	0.936	1.750	0.004	0.065	364.039
	1000	0.267	1.022	2.882	0.004	0.079	364.039
Crushing/Proc. Equipment	50	0.740	4.068	3.394	0.006	0.182	443.672
	120	0.369	2.906	2.537	0.005	0.161	443.672
	175	0.287	2.525	1.868	0.005	0.098	443.672

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2020		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	250	0.226	0.879	1.573	0.005	0.051	443.672
	500	0.220	0.842	1.405	0.004	0.049	443.672
	750	0.220	0.842	1.433	0.004	0.049	443.672
	9999	0.258	0.900	2.888	0.004	0.070	443.672
Dumpers/Tenders	25	0.261	0.890	1.649	0.003	0.063	216.148
Excavators	25	0.391	1.335	2.472	0.004	0.092	324.222
	50	0.498	3.170	2.413	0.004	0.104	324.222
	120	0.257	2.193	1.637	0.004	0.091	324.222
	175	0.203	1.918	1.117	0.004	0.056	324.222
	250	0.169	0.669	0.918	0.004	0.031	324.222
	500	0.166	0.637	0.836	0.003	0.030	324.222
	750	0.166	0.637	0.850	0.003	0.031	324.222
Forklifts	50	0.220	1.626	1.257	0.002	0.045	170.643
	120	0.122	1.148	0.784	0.002	0.040	170.643
	175	0.102	1.009	0.535	0.002	0.026	170.643
	250	0.085	0.344	0.412	0.002	0.014	170.643
	500	0.084	0.327	0.384	0.002	0.013	170.643
Generator Sets	15	0.479	2.627	3.345	0.007	0.158	420.920
	25	0.534	1.832	3.362	0.005	0.152	420.920
	50	0.512	2.959	3.019	0.005	0.144	420.920
	120	0.270	2.504	2.351	0.005	0.133	420.920
	175	0.198	2.170	1.763	0.005	0.078	420.920
	250	0.147	0.760	1.493	0.005	0.043	420.920
	500	0.140	0.745	1.346	0.004	0.041	420.920
	750	0.142	0.745	1.377	0.004	0.042	420.920
	9999	0.179	0.802	2.673	0.004	0.059	420.920
Graders	50	0.710	3.480	2.716	0.004	0.156	346.974
	120	0.342	2.356	2.115	0.004	0.144	346.974
	175	0.257	2.039	1.574	0.004	0.085	346.974
	250	0.201	0.742	1.351	0.004	0.046	346.974
	500	0.194	0.751	1.207	0.003	0.044	346.974
	750	0.195	0.751	1.240	0.003	0.044	346.974
Off-Highway Tractors	120	0.574	2.678	3.322	0.004	0.266	369.727
	175	0.412	2.275	2.754	0.004	0.155	369.727
	250	0.325	1.025	2.507	0.004	0.099	369.727
	750	0.305	1.227	2.313	0.004	0.090	369.727
	1000	0.324	1.339	3.370	0.004	0.100	369.727
Off-Highway Trucks	175	0.217	1.954	1.183	0.004	0.061	324.222
	250	0.181	0.684	0.982	0.004	0.034	324.222
	500	0.177	0.648	0.891	0.003	0.033	324.222
	750	0.177	0.648	0.907	0.003	0.033	324.222
	1000	0.188	0.670	2.021	0.003	0.047	324.222
Other Construction Equipment	15	0.411	2.153	2.571	0.005	0.100	352.663
	25	0.425	1.452	2.688	0.004	0.100	352.663
	50	0.414	2.856	2.465	0.005	0.099	352.663
	120	0.219	2.216	1.672	0.004	0.087	352.663
	175	0.174	1.940	1.130	0.004	0.054	352.663
	500	0.140	0.649	0.841	0.003	0.029	352.663

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2020		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Other General Industrial Equipment	15	0.301	1.771	2.115	0.005	0.083	290.093
	25	0.350	1.194	2.211	0.004	0.083	290.093
	50	0.564	2.936	2.318	0.004	0.132	290.093
	120	0.278	1.976	1.762	0.003	0.118	290.093
	175	0.215	1.713	1.323	0.003	0.071	290.093
	250	0.168	0.599	1.118	0.003	0.036	290.093
	500	0.163	0.569	0.997	0.003	0.035	290.093
	750	0.164	0.569	1.020	0.003	0.035	290.093
	1000	0.178	0.611	1.984	0.003	0.050	290.093
Other Material Handling Equipment	50	0.645	3.357	2.674	0.004	0.153	335.598
	120	0.318	2.274	2.035	0.004	0.136	335.598
	175	0.246	1.971	1.529	0.004	0.082	335.598
	250	0.192	0.689	1.292	0.004	0.042	335.598
	500	0.187	0.656	1.152	0.003	0.040	335.598
	9999	0.221	0.705	2.291	0.003	0.057	335.598
Pavers	25	0.426	1.452	2.697	0.004	0.104	352.663
	50	1.052	3.650	3.021	0.005	0.231	352.663
	120	0.464	2.449	2.789	0.004	0.218	352.663
	175	0.335	2.089	2.251	0.004	0.126	352.663
	250	0.256	0.855	2.015	0.004	0.074	352.663
	500	0.241	0.953	1.808	0.003	0.068	352.663
Paving Equipment	25	0.364	1.241	2.298	0.004	0.086	301.470
	50	0.885	3.247	2.575	0.004	0.197	301.470
	120	0.392	2.081	2.368	0.004	0.187	301.470
	175	0.282	1.774	1.911	0.003	0.107	301.470
	250	0.213	0.713	1.708	0.003	0.061	301.470
Plate Compactors	15	0.285	1.493	1.783	0.004	0.070	244.589
Pressure Washers	15	0.194	1.065	1.356	0.003	0.064	170.643
	25	0.217	0.743	1.363	0.002	0.062	170.643
	50	0.150	1.019	1.176	0.002	0.048	170.643
	120	0.090	0.969	0.912	0.002	0.045	170.643
Pumps	15	0.542	2.627	3.365	0.007	0.169	420.920
	25	0.570	1.832	3.362	0.005	0.157	420.920
	50	0.560	3.109	3.058	0.005	0.153	420.920
	120	0.286	2.543	2.385	0.005	0.140	420.920
	175	0.212	2.203	1.791	0.005	0.082	420.920
	250	0.158	0.772	1.519	0.005	0.044	420.920
	500	0.150	0.754	1.364	0.004	0.043	420.920
	750	0.152	0.754	1.396	0.004	0.043	420.920
	9999	0.189	0.812	2.703	0.004	0.060	420.920
Rollers	15	0.371	1.945	2.322	0.005	0.091	318.534
	25	0.384	1.312	2.428	0.004	0.091	318.534
	50	0.666	2.986	2.499	0.004	0.157	318.534
	120	0.311	2.092	2.052	0.004	0.146	318.534
	175	0.228	1.801	1.570	0.004	0.084	318.534
	250	0.175	0.666	1.369	0.004	0.046	318.534
	500	0.167	0.670	1.215	0.003	0.044	318.534
Rough Terrain Forklifts	50	0.525	3.197	2.577	0.004	0.123	341.286

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2020		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
	120	0.270	2.264	1.818	0.004	0.108	341.286
	175	0.215	1.975	1.287	0.004	0.067	341.286
	250	0.176	0.688	1.075	0.004	0.036	341.286
	500	0.172	0.657	0.969	0.003	0.035	341.286
Rubber Tired Dozers	175	0.391	2.106	2.582	0.004	0.146	335.598
	250	0.311	0.965	2.359	0.004	0.094	335.598
	500	0.290	1.175	2.137	0.003	0.085	335.598
	750	0.291	1.175	2.178	0.003	0.086	335.598
	1000	0.308	1.278	3.133	0.003	0.095	335.598
Rubber Tired Loaders	25	0.371	1.265	2.342	0.004	0.087	307.158
	50	0.606	3.037	2.390	0.004	0.135	307.158
	120	0.293	2.073	1.840	0.004	0.124	307.158
	175	0.222	1.796	1.362	0.003	0.073	307.158
	250	0.175	0.651	1.166	0.003	0.040	307.158
	500	0.169	0.650	1.041	0.003	0.038	307.158
	750	0.169	0.650	1.070	0.003	0.038	307.158
	1000	0.180	0.681	2.069	0.003	0.051	307.158
Scrapers	120	0.531	2.884	3.127	0.005	0.240	409.544
	175	0.387	2.467	2.495	0.005	0.140	409.544
	250	0.298	0.986	2.218	0.005	0.081	409.544
	500	0.282	1.077	1.990	0.004	0.074	409.544
	750	0.283	1.077	2.039	0.004	0.075	409.544
Signal Boards	15	0.543	2.848	3.400	0.007	0.133	466.425
	50	0.616	3.473	3.226	0.006	0.161	443.672
	120	0.308	2.736	2.447	0.005	0.146	443.672
	175	0.233	2.376	1.803	0.005	0.087	443.672
	250	0.215	1.001	1.835	0.006	0.056	536.104
Skid Steer Loaders	25	0.388	1.303	2.426	0.004	0.099	312.846
	50	0.282	2.459	2.029	0.004	0.053	312.846
	120	0.159	1.955	1.205	0.004	0.047	312.846
Surfacing Equipment	50	0.481	2.161	1.939	0.003	0.115	255.965
	120	0.229	1.617	1.620	0.003	0.109	255.965
	175	0.164	1.392	1.244	0.003	0.063	255.965
	250	0.124	0.523	1.086	0.003	0.036	255.965
	500	0.117	0.547	0.972	0.003	0.033	255.965
	750	0.118	0.547	0.999	0.003	0.034	255.965
Sweepers/Scrubbers	15	0.401	2.362	2.820	0.006	0.110	386.791
	25	0.467	1.593	2.949	0.005	0.110	386.791
	50	0.520	3.542	2.890	0.005	0.118	386.791
	120	0.283	2.554	1.890	0.005	0.106	386.791
	175	0.233	2.237	1.340	0.004	0.069	386.791
	250	0.190	0.763	1.065	0.004	0.036	386.791
Tractors/Loaders/Backhoes	25	0.377	1.288	2.385	0.004	0.090	312.846
	50	0.420	2.846	2.246	0.004	0.090	312.846
	120	0.221	2.058	1.492	0.004	0.078	312.846
	175	0.176	1.802	0.994	0.004	0.049	312.846
	250	0.148	0.628	0.807	0.004	0.028	312.846
	500	0.146	0.603	0.738	0.004	0.027	312.846
	750	0.146	0.602	0.750	0.004	0.027	312.846

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2020		g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr	g/hp/hr
Equipment	**MaxHP**	ROG	CO	NOX	SOX	PM	CO2
Trenchers	15	0.497	2.605	3.110	0.007	0.122	426.608
	25	0.515	1.757	3.252	0.005	0.122	426.608
	50	1.284	4.529	3.634	0.006	0.283	426.608
	120	0.558	2.921	3.434	0.005	0.268	426.608
	175	0.399	2.488	2.791	0.005	0.155	426.608
	250	0.306	1.047	2.511	0.005	0.093	426.608
	500	0.287	1.194	2.260	0.004	0.085	426.608
	750	0.288	1.193	2.311	0.004	0.086	426.608
Welders	15	0.330	1.597	2.046	0.004	0.102	255.965
	25	0.346	1.114	2.044	0.003	0.096	255.965
	50	0.422	2.180	1.939	0.003	0.108	255.965
	120	0.205	1.624	1.510	0.003	0.098	255.965
	175	0.155	1.406	1.137	0.003	0.058	255.965
	250	0.118	0.492	0.965	0.003	0.030	255.965
	500	0.114	0.475	0.861	0.003	0.029	255.965
Water Trucks	175	0.217	1.954	1.183	0.004	0.061	324.222
	250	0.181	0.684	0.982	0.004	0.034	324.222
	500	0.177	0.648	0.891	0.003	0.033	324.222
	750	0.177	0.648	0.907	0.003	0.033	324.222
	1000	0.188	0.670	2.021	0.003	0.047	324.222

Demographia

USA Urbanized Areas Over 500,000: 2000 Rankings

CORRECTIONS TO TABLE BELOW

On 25 August, the US Census Bureau released the following urbanized area corrections for 2000. Tables will be updated to reflect this information in the future.

Urbanized Area	Population	Land Area (Square Miles)	Population per Square Mile
Fort Collins, CO	206,757	83.7	2,472
Hanford, CA (New)	69,639	25.5	2,734
Holland, MI	91,921	48.0	1,917
San Francisco--Oakland, CA	3,228,605	526.7	6,130
San Rafael--Novato, CA (now included in San Francisco-Oakland)	0	0.0	0

RANK BY POPULATION

Rank	Urbanized Area	Population	Square Miles	Population Density
1	New York--Newark, NY--NJ--CT	17,799,861	3,353	5,309
2	Los Angeles--Long Beach--Santa Ana, CA	11,789,487	1,668	7,068
3	Chicago, IL--IN	8,307,904	2,123	3,914
4	Philadelphia, PA--NJ--DE--MD	5,149,079	1,799	2,861
5	Miami, FL	4,919,036	1,116	4,407
6	Dallas--Fort Worth--Arlington, TX	4,145,659	1,407	2,946
7	Boston, MA--NH--RI	4,032,484	1,736	2,323
8	Washington, DC--VA--MD	3,933,920	1,157	3,401
9	Detroit, MI	3,903,377	1,261	3,094
10	Houston, TX	3,822,509	1,295	2,951
11	Atlanta, GA	3,499,840	1,963	1,783
12	San Francisco--Oakland, CA	2,995,769	428	7,004
13	Phoenix--Mesa, AZ	2,907,049	799	3,638
14	Seattle, WA	2,712,205	954	2,844
15	San Diego, CA	2,674,436	782	3,419
16	Minneapolis--St. Paul, MN	2,388,593	894	2,671
17	St. Louis, MO--IL	2,077,662	829	2,506
18	Baltimore, MD	2,076,354	683	3,041
19	Tampa--St. Petersburg, FL	2,062,339	802	2,571
20	Denver--Aurora, CO	1,984,887	499	3,979
21	Cleveland, OH	1,786,647	647	2,761
22	Pittsburgh, PA	1,753,136	852	2,057
23	Portland, OR--WA	1,583,138	474	3,340
24	San Jose, CA	1,538,312	260	5,914
25	Riverside--San Bernardino, CA	1,506,816	439	3,434
26	Cincinnati, OH--KY--IN	1,503,262	672	2,238

27	Virginia Beach, VA	1,394,439	527	2,647
28	Sacramento, CA	1,393,498	369	3,776
29	Kansas City, MO--KS	1,361,744	584	2,330
30	San Antonio, TX	1,327,554	408	3,257
31	Las Vegas, NV	1,314,357	286	4,597
32	Milwaukee, WI	1,308,913	487	2,688
33	Indianapolis, IN	1,218,919	553	2,205
34	Providence, RI--MA	1,174,548	504	2,332
35	Orlando, FL	1,157,431	453	2,554
36	Columbus, OH	1,133,193	398	2,849
37	New Orleans, LA	1,009,283	198	5,102
38	Buffalo, NY	976,703	367	2,664
39	Memphis, TN--MS--AR	972,091	400	2,431
40	Austin, TX	901,920	318	2,835
41	Bridgeport--Stamford, CT--NY	888,890	465	1,910
42	Salt Lake City, UT	887,650	231	3,847
43	Jacksonville, FL	882,295	411	2,149
44	Louisville, KY--IN	863,582	391	2,207
45	Hartford, CT	851,535	469	1,814
46	Richmond, VA	818,836	437	1,875
47	Charlotte, NC--SC	758,927	435	1,745
48	Nashville-Davidson, TN	749,935	431	1,741
49	Oklahoma City, OK	747,003	322	2,317
50	Tucson, AZ	720,425	291	2,473
51	Honolulu, HI	718,182	154	4,660
52	Dayton, OH	703,444	324	2,174
53	Rochester, NY	694,396	295	2,353
54	El Paso, TX--NM	674,801	219	3,080
55	Birmingham, AL	663,615	392	1,693
56	Omaha, NE--IA	626,623	226	2,768
57	Albuquerque, NM	598,191	224	2,671
58	Allentown--Bethlehem, PA--NJ	576,408	289	1,991
59	Springfield, MA--CT	573,610	309	1,857
60	Akron, OH	570,215	308	1,853
61	Sarasota--Bradenton, FL	559,229	270	2,068
62	Albany, NY	558,947	284	1,966
63	Tulsa, OK	558,329	261	2,136
64	Fresno, CA	554,923	139	4,003
65	Concord, CA	552,624	176	3,132
66	Raleigh, NC	541,527	320	1,694
67	Grand Rapids, MI	539,080	257	2,095
68	Mission Viejo, CA	533,015	137	3,894
69	New Haven, CT	531,314	285	1,862
70	McAllen, TX	523,144	314	1,667
71	Toledo, OH--MI	503,008	202	2,486
	Total	140,022,057	44,013	3,181

RANK BY LAND AREA

			Square	Population

Rank	Urbanized Area	Population	Miles	Density
1	New York--Newark, NY--NJ--CT	17,799,861	3,353	5,309
2	Chicago, IL--IN	8,307,904	2,123	3,914
3	Atlanta, GA	3,499,840	1,963	1,783
4	Philadelphia, PA--NJ--DE--MD	5,149,079	1,799	2,861
5	Boston, MA--NH--RI	4,032,484	1,736	2,323
6	Los Angeles--Long Beach--Santa Ana, CA	11,789,487	1,668	7,068
7	Dallas--Fort Worth--Arlington, TX	4,145,659	1,407	2,946
8	Houston, TX	3,822,509	1,295	2,951
9	Detroit, MI	3,903,377	1,261	3,094
10	Washington, DC--VA--MD	3,933,920	1,157	3,401
11	Miami, FL	4,919,036	1,116	4,407
12	Seattle, WA	2,712,205	954	2,844
13	Minneapolis--St. Paul, MN	2,388,593	894	2,671
14	Pittsburgh, PA	1,753,136	852	2,057
15	St. Louis, MO--IL	2,077,662	829	2,506
16	Tampa--St. Petersburg, FL	2,062,339	802	2,571
17	Phoenix--Mesa, AZ	2,907,049	799	3,638
18	San Diego, CA	2,674,436	782	3,419
19	Baltimore, MD	2,076,354	683	3,041
20	Cincinnati, OH--KY--IN	1,503,262	672	2,238
21	Cleveland, OH	1,786,647	647	2,761
22	Kansas City, MO--KS	1,361,744	584	2,330
23	Indianapolis, IN	1,218,919	553	2,205
24	Virginia Beach, VA	1,394,439	527	2,647
25	Providence, RI--MA	1,174,548	504	2,332
26	Denver--Aurora, CO	1,984,887	499	3,979
27	Milwaukee, WI	1,308,913	487	2,688
28	Portland, OR--WA	1,583,138	474	3,340
29	Hartford, CT	851,535	469	1,814
30	Bridgeport--Stamford, CT--NY	888,890	465	1,910
31	Orlando, FL	1,157,431	453	2,554
32	Riverside--San Bernardino, CA	1,506,816	439	3,434
33	Richmond, VA	818,836	437	1,875
34	Charlotte, NC--SC	758,927	435	1,745
35	Nashville-Davidson, TN	749,935	431	1,741
36	San Francisco--Oakland, CA	2,995,769	428	7,004
37	Jacksonville, FL	882,295	411	2,149
38	San Antonio, TX	1,327,554	408	3,257
39	Memphis, TN--MS--AR	972,091	400	2,431
40	Columbus, OH	1,133,193	398	2,849
41	Birmingham, AL	663,615	392	1,693
42	Louisville, KY--IN	863,582	391	2,207
43	Sacramento, CA	1,393,498	369	3,776
44	Buffalo, NY	976,703	367	2,664
45	Dayton, OH	703,444	324	2,174
46	Oklahoma City, OK	747,003	322	2,317
47	Raleigh, NC	541,527	320	1,694
48	Austin, TX	901,920	318	2,835

49	McAllen, TX	523,144	314	1,667
50	Springfield, MA--CT	573,610	309	1,857
51	Akron, OH	570,215	308	1,853
52	Rochester, NY	694,396	295	2,353
53	Tucson, AZ	720,425	291	2,473
54	Allentown--Bethlehem, PA--NJ	576,408	289	1,991
55	Las Vegas, NV	1,314,357	286	4,597
56	New Haven, CT	531,314	285	1,862
57	Albany, NY	558,947	284	1,966
58	Sarasota--Bradenton, FL	559,229	270	2,068
59	Tulsa, OK	558,329	261	2,136
60	San Jose, CA	1,538,312	260	5,914
61	Grand Rapids, MI	539,080	257	2,095
62	Salt Lake City, UT	887,650	231	3,847
63	Omaha, NE--IA	626,623	226	2,768
64	Albuquerque, NM	598,191	224	2,671
65	El Paso, TX--NM	674,801	219	3,080
66	Toledo, OH--MI	503,008	202	2,486
67	New Orleans, LA	1,009,283	198	5,102
68	Concord, CA	552,624	176	3,132
69	Honolulu, HI	718,182	154	4,660
70	Fresno, CA	554,923	139	4,003
71	Mission Viejo, CA	533,015	137	3,894

RANK BY DENSITY

Rank	Urbanized Area	Population	Square Miles	Population Density
1	Los Angeles--Long Beach--Santa Ana, CA	11,789,487	1,668	7,068
2	San Francisco--Oakland, CA	2,995,769	428	7,004
3	San Jose, CA	1,538,312	260	5,914
4	New York--Newark, NY--NJ--CT	17,799,861	3,353	5,309
5	New Orleans, LA	1,009,283	198	5,102
6	Honolulu, HI	718,182	154	4,660
7	Las Vegas, NV	1,314,357	286	4,597
8	Miami, FL	4,919,036	1,116	4,407
9	Fresno, CA	554,923	139	4,003
10	Denver--Aurora, CO	1,984,887	499	3,979
11	Chicago, IL--IN	8,307,904	2,123	3,914
12	Mission Viejo, CA	533,015	137	3,894
13	Salt Lake City, UT	887,650	231	3,847
14	Sacramento, CA	1,393,498	369	3,776
15	Phoenix--Mesa, AZ	2,907,049	799	3,638
16	Riverside--San Bernardino, CA	1,506,816	439	3,434
17	San Diego, CA	2,674,436	782	3,419
18	Washington, DC--VA--MD	3,933,920	1,157	3,401
19	Portland, OR--WA	1,583,138	474	3,340
20	San Antonio, TX	1,327,554	408	3,257
21	Concord, CA	552,624	176	3,132
22	Detroit, MI	3,903,377	1,261	3,094

23	El Paso, TX--NM	674,801	219	3,080
24	Baltimore, MD	2,076,354	683	3,041
25	Houston, TX	3,822,509	1,295	2,951
26	Dallas--Fort Worth--Arlington, TX	4,145,659	1,407	2,946
27	Philadelphia, PA--NJ--DE--MD	5,149,079	1,799	2,861
28	Columbus, OH	1,133,193	398	2,849
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63	Springfield, MA--CT	573,610	309	1,857
64	Akron, OH	570,215	308	1,853
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69	Raleigh, NC	541,527	320	1,694
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USA Urbanized Areas Over 500,000: 2000 Rankings

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RANK BY POPULATION

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43	Sacramento, CA	1,393,498	369	3,776
44	Buffalo, NY	976,703	367	2,664
45	Dayton, OH	703,444	324	2,174
46	Oklahoma City, OK	747,003	322	2,317
47	Raleigh, NC	541,527	320	1,694
48	Austin, TX	901,920	318	2,835

49	McAllen, TX	523,144	314	1,667
50	Springfield, MA--CT	573,610	309	1,857
51	Akron, OH	570,215	308	1,853
52	Rochester, NY	694,396	295	2,353
53	Tucson, AZ	720,425	291	2,473
54	Allentown--Bethlehem, PA--NJ	576,408	289	1,991
55	Las Vegas, NV	1,314,357	286	4,597
56	New Haven, CT	531,314	285	1,862
57	Albany, NY	558,947	284	1,966
58	Sarasota--Bradenton, FL	559,229	270	2,068
59	Tulsa, OK	558,329	261	2,136
60	San Jose, CA	1,538,312	260	5,914
61	Grand Rapids, MI	539,080	257	2,095
62	Salt Lake City, UT	887,650	231	3,847
63	Omaha, NE--IA	626,623	226	2,768
64	Albuquerque, NM	598,191	224	2,671
65	El Paso, TX--NM	674,801	219	3,080
66	Toledo, OH--MI	503,008	202	2,486
67	New Orleans, LA	1,009,283	198	5,102
68	Concord, CA	552,624	176	3,132
69	Honolulu, HI	718,182	154	4,660
70	Fresno, CA	554,923	139	4,003
71	Mission Viejo, CA	533,015	137	3,894

RANK BY DENSITY

Rank	Urbanized Area	Population	Square Miles	Population Density
1	Los Angeles--Long Beach--Santa Ana, CA	11,789,487	1,668	7,068
2	San Francisco--Oakland, CA	2,995,769	428	7,004
3	San Jose, CA	1,538,312	260	5,914
4	New York--Newark, NY--NJ--CT	17,799,861	3,353	5,309
5	New Orleans, LA	1,009,283	198	5,102
6	Honolulu, HI	718,182	154	4,660
7	Las Vegas, NV	1,314,357	286	4,597
8	Miami, FL	4,919,036	1,116	4,407
9	Fresno, CA	554,923	139	4,003
10	Denver--Aurora, CO	1,984,887	499	3,979
11	Chicago, IL--IN	8,307,904	2,123	3,914
12	Mission Viejo, CA	533,015	137	3,894
13	Salt Lake City, UT	887,650	231	3,847
14	Sacramento, CA	1,393,498	369	3,776
15	Phoenix--Mesa, AZ	2,907,049	799	3,638
16	Riverside--San Bernardino, CA	1,506,816	439	3,434
17	San Diego, CA	2,674,436	782	3,419
18	Washington, DC--VA--MD	3,933,920	1,157	3,401
19	Portland, OR--WA	1,583,138	474	3,340
20	San Antonio, TX	1,327,554	408	3,257
21	Concord, CA	552,624	176	3,132
22	Detroit, MI	3,903,377	1,261	3,094

23	El Paso, TX--NM	674,801	219	3,080
24	Baltimore, MD	2,076,354	683	3,041
25	Houston, TX	3,822,509	1,295	2,951
26	Dallas--Fort Worth--Arlington, TX	4,145,659	1,407	2,946
27	Philadelphia, PA--NJ--DE--MD	5,149,079	1,799	2,861
28	Columbus, OH	1,133,193	398	2,849
29	Seattle, WA	2,712,205	954	2,844
30	Austin, TX	901,920	318	2,835
31	Omaha, NE--IA	626,623	226	2,768
32	Cleveland, OH	1,786,647	647	2,761
33	Milwaukee, WI	1,308,913	487	2,688
34	Minneapolis--St. Paul, MN	2,388,593	894	2,671
35	Albuquerque, NM	598,191	224	2,671
36	Buffalo, NY	976,703	367	2,664
37	Virginia Beach, VA	1,394,439	527	2,647
38	Tampa--St. Petersburg, FL	2,062,339	802	2,571
39	Orlando, FL	1,157,431	453	2,554
40	St. Louis, MO--IL	2,077,662	829	2,506
41	Toledo, OH--MI	503,008	202	2,486
42	Tucson, AZ	720,425	291	2,473
43	Memphis, TN--MS--AR	972,091	400	2,431
44	Rochester, NY	694,396	295	2,353
45	Providence, RI--MA	1,174,548	504	2,332
46	Kansas City, MO--KS	1,361,744	584	2,330
47	Boston, MA--NH--RI	4,032,484	1,736	2,323
48	Oklahoma City, OK	747,003	322	2,317
49	Cincinnati, OH--KY--IN	1,503,262	672	2,238
50	Louisville, KY--IN	863,582	391	2,207
51	Indianapolis, IN	1,218,919	553	2,205
52	Dayton, OH	703,444	324	2,174
53	Jacksonville, FL	882,295	411	2,149
54	Tulsa, OK	558,329	261	2,136
55	Grand Rapids, MI	539,080	257	2,095
56	Sarasota--Bradenton, FL	559,229	270	2,068
57	Pittsburgh, PA	1,753,136	852	2,057
58	Allentown--Bethlehem, PA--NJ	576,408	289	1,991
59	Albany, NY	558,947	284	1,966
60	Bridgeport--Stamford, CT--NY	888,890	465	1,910
61	Richmond, VA	818,836	437	1,875
62	New Haven, CT	531,314	285	1,862
63	Springfield, MA--CT	573,610	309	1,857
64	Akron, OH	570,215	308	1,853
65	Hartford, CT	851,535	469	1,814
66	Atlanta, GA	3,499,840	1,963	1,783
67	Charlotte, NC--SC	758,927	435	1,745
68	Nashville-Davidson, TN	749,935	431	1,741
69	Raleigh, NC	541,527	320	1,694
70	Birmingham, AL	663,615	392	1,693
71	McAllen, TX	523,144	314	1,667

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Comment Letter No. 12

Kim F. Floyd
Conservation Chair
San Gorgonio Chapter Sierra Club
4079 Mission Inn Ave.
Riverside, CA 92501
kimffloyd@fastmail.fm

April 3, 2012

Comment No. 12-1

Thank you for the opportunity to comment on the RDEIR for the Lytle Creek Ranch Specific Plan. The Sierra Club believes this project is oversized and would result in excessive environmental degradation. We join in the objections to this project set forth in the comment letter submitted on behalf of Save Lytle Creek Wash. We request that the City seriously consider a smaller and less impactful alternative to the proposed project.

Response to Comment No. 12-1

This comment is noted for the record and will be forwarded to the decision makers. Please refer to Letter No. 10 for responses to the comments contained therein.

Ashley Rogers

From: Ashley Rogers
Sent: Thursday, May 10, 2012 1:49 PM
To: Ashley Rogers
Subject: FW: Comment on the RDEIR for the Lytle Creek Ranch Specific Plan

From: Gina Gibson [mailto:ggibson@rialtoca.gov]
Sent: Tuesday, April 03, 2012 08:50 AM
Subject: FW: Comment on the RDEIR for the Lytle Creek Ranch Specific Plan

From: Kim F Floyd [mailto:kimffloyd@fastmail.fm]
Sent: Tuesday, April 03, 2012 8:04 AM
To: Gina Gibson
Subject: Comment on the RDEIR for the Lytle Creek Ranch Specific Plan

Dear Ms. Gibson,

Thank you for the opportunity to comment on the RDEIR for the Lytle Creek Ranch Specific Plan. The Sierra Club believes this project is oversized and would result in excessive environmental degradation. We join in the objections to this project set forth in the comment letter submitted on behalf of Save Lytle Creek Wash. We request that the City seriously consider a smaller and less impactful alternative to the proposed project.

Regards, Kim Floyd
Conservation Chair
San Gorgonio Chapter Sierra Club
4079 Mission Inn Avenue
Riverside, CA 92501
(951) 684-6203
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1

Comment Letter No. 13

Joe Ayala
5879 Sycamore Ave.
Rialto, CA 92377
909.234.2884
ayalagolf@roadrunner.com

<u>Comment No. 13-1</u>

We simply want to be included in the overall plan.

<u>Response to Comment No. 13-1</u>

This comment is noted for the record and will be forwarded to the decision makers.

Lytle Creek Ranch Community Workshop
February 16, 2012

Joe Ayala 5879 Sycamore Avenue Rialto, CA 92377 909.234.2884 ayalagolf@roadrunner.com	We simply want to be included in the overall plan.

April 4, 2012

Comment Letter No. 14

Lynn Boshart

Comment No. 14-1

What is the density of Neighborhood IV?

Response to Comment No. 14-1

This comment, raised at a community meeting regarding the RPDEIR, does not refer to any of the analyses contained in the RPDEIR. In any event, as set forth in Table 1-1 of the RPDEIR, Neighborhood IV would contain 869 multifamily residential units and 180,689 square feet of commercial development. Table 1-2 of the RPDEIR sets forth a Conceptual Land Use Plan Summary for the Proposed Project, and contains the various density ranges by land use designations. Multi-family residential units would be developed with a density range of 25 to 35 dwelling units per acre. In addition, note that commercial development is set forth as "intensity" described by square feet, not as density, which is applied only to residential dwelling units.

Lytle Creek Ranch Community Workshop
February 16, 2012

Lynn Boshart	What is the density of Neighborhood IV?

April 4, 2012

Comment Letter No. 15

Gerald T. Braden
P. O. Box 64
Angelus Oaks, CA 92305-0064

Comment No. 15-1

I would like to submit comments on Revised Draft Environmental Impact Report for the Lytle Creek Ranch Specific Plan, here after referred to as the RDEIR. My comments are as follows:

DATA SETS/ASSESSMENTS

Data sets are essential to determining direct and indirect impacts. In the absence of existing data, various biologists are hired to survey a project site. Surveys vary in effort. At the least intensive, surveys consist of simple laundry lists of what was seen or otherwise detected. Biologists walk the site and record what they see (termed: walkover survey). Obviously not a very accurate accounting of biological resources as many species try to avoid detection, are cryptic, are active and observable seasonally or for certain times in a 24hr. period. In short, walkover surveys are the least accurate method at determining which species is present, but they are the least expensive and the most commonly used technique for identifying species presence. Walk over surveys cannot determine species' absence for obvious reasons. Depending on the threats to a species, the cost of anything more than a walk over survey may not be warranted. Do fence lizards warrant the same degree of accuracy in abundance and occurrence as SBKR? Of course not. This does not mean that more information is not useful, it simply means the cost is not justified.

At a more intensive level, survey efforts to compiled [sic] data sets may involve specific sampling designs, such as live-rodent trapping, bird points or transects, cover boards for reptiles and amphibians (collectively herps), or species specific U. S. Fish and Wildlife (FWS) and California Department of Fish and Game (CDFG) survey protocols in the case of threatened or endangered species. FWS and CDFG survey protocols are always required if a threatened or endangered species or its habitat is in the project area.

At an even more intensive sampling effort, and more expensive, specific species are targeted. In the case of SBKR it's more live trapping (presumably more traps), re-trapping locations (trapping success, varies, abundance varies with reproduction, animals move, etc.), seasonal trapping (abundance and occupation vary by annual season and among years. In short, more data are needed to assess impacts to SBKR due to its rarity and threat.

Response to Comment No. 15-1

The commentor states concerns about the biological surveys conducted for the Project. These matters are outside the scope of the RPDEIR; however, these issues were fully addressed in the DEIR. (See DEIR Volume I, Sections 4.5.3.2 and 4.5.5.1.) Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" with respect to cumulative impacts within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5.

Comment No. 15-2

So, in regards to the RDEIR why belabor the obvious? This is why. Accurate assessment of potentially significant biological and evaluation of mitigation strategies requires biological data. The more data the better the assessment and mitigation. In this case the RDEIR relies on data from previous EIRs, surveys specific to the project including walkover surveys and FWS/CDGF survey protocol results, CNDDB online data bases and focused data collected specific to SBKR. So what's the problem? Those were not the most complete nor accurate data sets available. Two key, accurate and extensive data sources were not utilized.

The first data source is simple, accessible and usually costs nothing. If one wants to know, with a very high degree of confidence, where a species of interest is known to have occurred, consult a museum. Museums for unknown reasons, possibly cultural biases, are not traditionally accessed when environmental documents are prepared. Whether by bias or not, this is a counterproductive and unnecessary omission. The entire vertebrate collection of the Museum of Vertebrate Zoology (MVZ) at UC Berkeley, as an example, is accessible online, at no cost to the user. If MVZ and similar resources had been consulted, amateurish errors, such as the following, would like not have been made in the RDEIR. The RDEIR sites Orange-throat Whiptail as probable on the proposed project site. There is no authenticated record of Orange-throated Whiptail north of the Santa Ana River, much less near or on the project site. Another example, the RDEIR sites Dulzura Kangaroo Rat as the only five-toed Kangaroo Rat occurring on the project area. Not true, the Pacific Kangaroo Rat, a five-toed kangaroo rat, also occurs in the project area. (The project site happens to be in the transition zone between the two species.) Two more examples, of the many more errors and omissions, are the California Glossy Snake and Greenest Tiger Beetle. Museum records document California Glossy Snake occurring on and adjacent to the proposed project site, but it is never mentioned. The Greenest Tiger Beetle is also know to occur in similar habitat as the project area, but in the Santa Ana River, yet is never mentioned. Why choose these last two species among many to highlight? To illustrate an important point. First, both these species are very strong candidates for listing as endangered or threatened due to habitat loss and precipitous declines in abundance. Yet neither of these species is on the RDEIR radar because the museum data bases were not used. Adding to the consternation, the RDEIR explicitly lays claim to identifying and consider species likely to be listed in the foreseeable near future. A task it has clearly failed at for these two species, and there are others. These failures and omission would not likely have occurred had museum data bases been queried.

Before going to the second unused data source, it is important to illustrate a critical distinction between museum data bases and the NDDB. Museum records of species occurrences are authenticated by scientific experts, thus errors in identification are exceedingly rare. When mistakes are made, or taxonomic changes occur, the mistakes can be corrected because there is a specimen for every record. In contrast, NDDB specimen occurrence records cannot be checked for accuracy because there are no specimens. Additionally, there is no qualification for submitting NDDB records. Anyone can submit an NDDB occurrence record, regardless of training or competency.

One might understand, though not excuse, the omission of museum data searches in the RDEIR. However, there can be no conceivable reason, by my reckoning, why the second omitted data base was overlooked. I am speaking of course of the data collected for the uncompleted San Bernardino Valley Multispecies Plan (Valley Plan). The Valley Plan was never finished, but the species occurrence and abundance data were collected. The data collection was financed by local municipalities (including the City of Rialto), San Bernardino County (SBCO), California Department of Fish and Game and U. S. Fish and Wildlife Service. The data were envisioned to be the empirical basis for determine reserve areas, species occurrences and abundances, defining long-term management plans, successes or failures of management plans and so forth. In short, the data sets are very comprehensive and robust. So why were Valley Plan data not used in the RDEIR? This is a significant deficiency as all species impacts analyses and mitigations extend from using the best available data. Valley Plan data were available, the data were not used in the RDEIR.

Response to Comment No. 15-2

The RPDEIR (Recirculated Portions of the Draft EIR) contains select revised portions of the original DEIR, in response to the Court Ruling, that replace only those corresponding portions of and/or sections in the DEIR. The RPDEIR does not replace the original DEIR in full, nor does it supersede any portions of the original DEIR that were not specifically supplemented, updated, or otherwise revised in the RPDEIR. In the context of the above comment, the commentor's reference to an RDEIR refers to the original DEIR and not the RPDEIR. Comments regarding the original DEIR are outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" with respect to cumulative impacts within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5. Issues addressed in this comment were fully addressed in the Draft EIR. (See DEIR Volume I, Sections 4.5.3.1, 4.5.3.2, and 4.5.5.1.)

Comment No. 15-3

RDEIR IDENTIFICATION OF SBKR IMPACTS

The RDEIR is unclear on how potential significant impacts to SBKR from the proposed project were identified. The RDEIR cites using live-trapping results to delineate occupied habitat. How were the results applied to such delineations? What were the distances between occupied (sites where SBKR were captured) and unoccupied (sites were SBKR were not captured) habitat? How were intervening distance interpolated? How large were they? Where SBKR densities and habitat quality considered? If so how? What percentage of the planning area was trapped? Was this sufficient to represent occupancy/un-occupancy? How so? How was suitable habitat identified? Were bench habitats considered suitable and/or trapped? All sites were not trapped the same years so how were normal fluctuations in abundance and occupancy dealt with? In short, what were the criteria used to delineate occupied and unoccupied SBKR habitat? Absent clarification of these questions, there is no meaningful way to assess neither the baseline conditions of the project site and surrounding area nor the direct and indirect project related impacts reported in the RDEIR. Neither is there a basis to assess the quality and suitability of the proposed mitigations. This is a serious and fundamental deficiency of the RDEIR.

The RDEIR states that it identified "...at least158.7 [sic] acres of land above the 100-year floodplain that support dense chamise chaparral, and do not currently support the SBKR..." by examination of current aerial photography. This a curious statement. Obviously, SBKR occupancy cannot be determined by aerial photography. Yet the assumption is made that these areas are not occupied, while in other areas the RDEIR states that the chamise chaparral islands in the active flood plain are critical SBKR refugia. So which is it? They are unoccupied and therefore available for deconstruction or they are occupied and important for SBKR recolonization after flood events?

Related to the previous comment, the RDEIR states "For purposes of this assessment, as an approach to identifying potentially suitable habitat for the SBKR, it is meaningful to consider only alluvial scrub that is both within active hydrological regimes and viable in the long-term as suitable habitat (including P-RAFSS)." FWS jurisdictional rights to define SBKR critical habitat aside, besides the two mentioned criteria how was SBKR critical habitat RDEIR redefined? Were terrace habitats (chamise and chaparral) include or excluded? By what criteria? How did the results of this re-definition compare to one utilizing critical habitat defined by FWS? Was the redefined critical habitat used in the SBKR regional analysis also? If so, how was this done? Were the RDEIR new definition criteria applied to the Santa Ana Wash in the regional analysis? If so, by definitions used in the RDEIR, much of the occupied SBKR habitat in the Santa Ana is no longer suitable due to the Seven Oaks Dam affects on hydrology of the River. Suspicious minds might understandably and reasonably conclude the RDEIR appears to treat chamise and chaparral benches according to their relative position in the document and positive perspective of the treatment. Clearly, the RDEIR is seriously deficient in resolving these apparent and repeated contradictions.

The RDEIR states recent trapping results coincident with the proposed project potentiates a more accurate definition of critical habitat for SBKR than the FWS SBKR Critical Habitat Designation. This too is a curious statement. The statement assumes that recent trapping results, occupied versus not, can determine what is critical habitat necessary for the recovery of the species and what is not. Suitable habitat for the vast majority of biological species is never fully occupied, including SBKR. So how exactly were negative trapping results used to redefine suitable habitat as well has critical unoccupied habitat required for the long-term survival of the species? The RDEIR here again, is deficient at providing validating data or discussions concerning its assertions and conclusions.

<u>Response to Comment No. 15-3</u>

See Response to Comment No. 15-2 above regarding the difference between the RPDEIR and the original DEIR. This comment addresses SBKR impacts at the Project location as discussed in the DEIR. This matter is outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" with respect to cumulative impacts within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5. Issues addressed in this comment were fully addressed in the

Draft EIR. (See DEIR Volume I, Sections 4.5.3.2, 4.5.5.1, and 4.5.5.2 and Mitigation Measure 5-7; also see DEIR Volume III (Part 1), Appendix III-D-B, Section 2.3.6 and pages 135 through 137 and 176 through 182.)

Furthermore, it should be noted that the Court Ruling rejected a claim that Mitigation Measure 5-7 would be ineffective to mitigate impacts to the SBKR to a less than significant level. The Court Ruling stated, in relevant parts:

> To the extent Petitioners are arguing that the mitigation measures [for the SBKR] are not supported by substantial evidence, they do not meet their burden on this issue.
>
> . . . .
>
> Petitioners argue, without any supporting evidence, that the project's impacts 'are so large as to be essentially unmitigable to a level of insignificance.' (See RPDEIR Volume V (Part 1), Appendix V-A, Court Ruling, pp. 49-50.)

As such, the comment is outside the scope of this RPDEIR.

Comment No. 15-4

PROJECT SBKR IMPACTS AND MITIGATION

Significant impacts to SBKR identified in the RDEIR from the proposed project are seriously understated. Proposed mitigations in the RDEIR to mitigate significant impacts to SBKR are critically inadequate. And, indirect impacts to high quality, high density SBKR habitat are not disclosed.

First, the DRDEIR proposes to constrict the existing Lytle Cr. channel by development in the wash and levy construction (seven mile revetment) along the length of the development. Placement of the levy will potentially significantly impact the current, essentially natural, hydrology of Lytle Cr. Wash. The hydrologic process that created and currently maintains high quality high density SBKR habitat. Yet the RDEIR presents no hydrologic study or assessment of the potential impacts.

Constricting the existing channel will increase scouring in the wash. After levy placement, the same volume of water will be forced through a narrower channel. Simple surface hydrology guarantees water velocities and associated channel scouring will increase, resulting in an increased scour zone. SBKR cannot utilize the scour zone for burrows, nor are there forage or shelter components. An increased scour zone will come at the expense of the remaining pioneer and intermediate AFSS habitats in the wash after levy placement. More precisely, high quality, high density, occupied SBKR habitat will likely be seriously degraded if not eliminated.

Levy placement will also diminish the ability of flows in the wash to meander through the channel in a reticulate pattern, as the channel width will be reduced. The meandering reticulate flow pattern is the very process that creates and renews high quality habitat for SBKR. After levy placement the opportunity for meandering flows comparable to the currently existing conditions will be irrevocably altered along the length of the levy. The ability of the hydrology to create and maintain quality SBKR habitat will likely be significantly diminished, if not eliminated.

Thus, this portion of the proposed mitigation to partially mitigate significant direct SBKR impacts to high quality, high occupancy SBKR habitat cannot be used as mitigation for two reasons; First, the proposed mitigation area will potentially be significantly impacted by the project. Second, and more critically, this portion of the proposed SBKR mitigation cannot be used as mitigation because it is a significant undisclosed and unmitigated indirect impact.

Response to Comment No. 15-4

See Response to Comment No. 15-2 above regarding the difference between the RPDEIR and the original DEIR. This comment addresses SBKR impacts at the Project location as discussed in the DEIR. This matter is outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" with respect to cumulative impacts within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5. Please also refer to Response to Comment No. 15-3 above for additional information regarding the Court Ruling's rejection of claims against mitigation measures designed to mitigate impacts to the SBKR to less than significant levels.

More specifically, with regard to the SBKR mitigation measures presented in the DEIR, these were developed in consultation with the biological resource consultants for the Project and the City. Secondary impacts to biological resources were described in DEIR Section 4.5.5.1. Also, hydrology and water quality analyses were provided in Appendix III-C of the DEIR, and the effects of surface water diversion on biological resources were provided in Appendix IV-E of the FEIR. Furthermore, the potential hydrological effects associated with the Project's proposed revetment would be consistent with the U.S. Army Corps of Engineers' conclusions regarding the similar revetment proposed as part of the Lytle Creek North Planned Development. As previously stated in Response I-9-13 of the FEIR, the U.S. Army Corps of Engineers found that "there would be no significant changes to the levels of inundation, the magnitude of streambed scour and variation, the duration of flooding, and localized velocities." Also refer to Response I-9-7 of the FEIR, which states that the toe-down of the revetments to be constructed has been designed to go below the worst-case scour depths so that the revetment is designed to maintain its integrity over the long-term without additional maintenance to address any future scouring.

Comment No. 15-5

Second, the proposed mitigation to offset significant project impacts to high quality high density SBKR by reclaiming and/or converting significant acreages of chamise dominated benches to pioneer and or intermediate high quality ASFF habitat is speculative at best, having a very high probability of failure.

These chamise dominate benches do not represent degraded or diminished SBKR habitat. They are naturally occurring climax habitats within the hydrologic regime. Chamise dominates these islands because evolved natural hydrologic, edaphic (soil) and biotic conditions dictate that chamise, and only chamise, dominates these benches. These areas are not degraded pioneer and intermediate AFSS to be reclaimed. They are naturally occurring successional communities created by fluvial processes. The edaphic and hydrologic conditions will not, cannot support pioneer and intermediate biotic components to any great extent or longevity because if they could, these floristic components would already dominate.

Additionally, the deconstruction and maintenance, in perpetuity, of formerly chamise dominated mature AFSS habitat into SBKR habitat, of even marginal suitability, has no convincingly successful precedent. To illustrate, deconstructing chamise dominated benches to suitable high quality SBKR habitat was a major mitigation component to offset significant impacts to SBKR from the Seven Oaks Dam on the Santa Ana River. Approved almost a decade ago, not one single acre of chamise habitat has been successfully converted to any SBKR habitat anywhere in the Santa Ana River.

A recent and closely monitored attempt to relocate SBKR and re-construct SBKR habitat in the Lytle Creek Wash, mitigation for the Lytle Creek North Development, washed away before the study was concluded. Preliminary results suggested a modicum of success at substantial management effort, involving heavy applications of herbicides (having unknown short or long-term incidental affects as these were not being monitored) and fire prescriptions. Most germane to the RDEIR, SBKR population increases were not appreciably enhanced. While there are experimental merits to the attempt, it completely failed as a mitigation.

The RDEIR states "On-site mitigation shall include restoration, creation, and preservation of approximately 34.5 acres of chamise chaparral within Neighborhood II above the 100-year floodplain that is immediately downstream of an contiguous with, the SBKR Conservation Area." Here the concept of re-creating SBKR habitat is extended to areas above the 100 - year floodplain, something that has never been successfully done, to areas that never were SBKR habitat, at least in the recent past. In these cases, the success of creating suitable pioneer and intermediate AFSS suitable for SBKR becomes even more unlikely to succeed if for no other reason than it never was SBKR habitat. At a minimum, long-term management of these sites will require long-term and intensive management.

To presuppose that anthropogenic manipulations can reconstruct, and maintain in prepetuity, [sic] the edaphic, biotic and hydrologic conditions suitable to pioneer and intermediate AFSS on these mature chamise dominated benches is not mitigation, it is experimentation. Any proposed actions to rehabilitate and/or construct SBKR habitat identified by the RDEIR is a misapplication of questionable management strategies as a substitute for natural fluvial systems. This is not substantive and meaningful mitigation for direct and indirect SBKR impacts, disclosed or undisclosed, from the proposed project.

<u>Response to Comment No. 15-5</u>

See Response to Comment No. 15-2 above regarding the difference between the RPDEIR and the original DEIR. This comment addresses SBKR impacts at the Project location as discussed in the DEIR. This matter is outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" with respect to cumulative impacts within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5. Please also refer to Response to Comment Nos. 15-3 and 15-4 above.

Comment No. 15-6

Third, preservation of unoccupied SBKR habitat upstream of the I-15 overpass, as proposed in the RDEIR, indirectly benefits SBKR by preserving the hydrology, but has no direct positive benefit for the animal. Aside for a few locations near the I-15 overpass, SBKR do not occupy, have not recently occupied, and are not likely to occupy this portion of Lytle Creek, regardless of any proposed reintroduction efforts. Repeated trapping events, most recently and intensely over the last ten years, and least recently by museum collecting expedition records, have failed to documented [sic] SBKR in this portion of Lytle Creek. By habitat suitability standards, cited in the RDEIR, and professional opinion of those who have worked extensively with the animal, the habitat in this reach is suitable for SBKR.

The lack of SBKR, both present and historic, is not due to any obvious barriers or lack of source population. SBKR have been recently documented adjacent to the I-15 overpass, both upstream and downstream. Thus, the I-15 is not likely a barrier. There is a large source population downstream of the I-15 overpass. Thus, dispersers are not likely a problem. The unoccupied habitat above the I-15 is well within the known dispersal distance of SBKR, documented at 1km. Thus, isolation is likely not a problem. Still, the animal is stubbornly absent. The evidence illustrates essential points:

1) The current habitat standards for SBKR, those cited in the RDEIR and often used by professionals, are correlational. Meaning, both the habitat standards and professional opinions correlate with SBKR occurrence, but they neither predict nor dictate either occupancy by SBKR or true habitat suitability for SBKR.

2) The evidence that this area of the wash has been unoccupied by SBKR for a long time strongly suggests the habitat is simply not suitable, regardless of habitat correlates and professional opinion. Simply put, we do not know all the biotic or abiotic conditions, historic or present, essential to SBKR. Attempts to introduce and establish SBKR in this portion of Lytle Creek, to any appreciable degree or persistence, has a very high probability of failure.

The absence of SBKR in the proposed mitigation area above the I-15 overpass, for no obvious reason, is not without precedent. SBKR occur in abundance at the confluence of Mill Creek and the Santa Ana River. Upstream of the confluence, SBKR are not known to occur on Mill Creek. There has been extensive trapping, there are no obvious barriers, there is an adjacent source population, and the habitat meets the suitability requirements delineated in the RDEIR as well as the judgment of experienced professionals. There are simply areas of apparently suitable habitat, by present knowledge, where SBKR do not occur for unknown reasons. No amount of habitat manipulation or animal introductions will change this fact. Preservation of unoccupied SBKR habitat upstream of the I-15 overpass, as proposed in the RDEIR, simply has no demonstrable mitigation value to partially offset significant direct impacts to SBKR from the proposed project.

Response to Comment No. 15-6

See Response to Comment No. 15-2 above regarding the difference between the RPDEIR and the original DEIR. This comment addresses SBKR impacts at the Project location as discussed in the DEIR. This matter is outside the scope of the RPDEIR. Please refer to Section 1.2 of this

Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" with respect to cumulative impacts within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5. Please also refer to Response to Comment Nos. 15-3 and 15-4 above.

Comment No. 15-7

Fourth, the RDEIR proposes to partially offset significant impacts to SBKR from the proposed project by enhancement of degraded SBKR habitat (exclusive of those dominated by chamise) and reintroduction of SBKR. The value of the proposed mitigation is marginal best because, here again, there is no precedence for either enhancement or reintroduction attempts being appreciably successful.

One of the most ambitious attempts at a multi-year, comprehensive and closely monitored attempt to enhance SBKR habitat occurred recently at the Redlands Sports Park. The plan had all the ingredients deemed necessary for a success. SBKR abundances and habitat quality were determined before and after habitat enhancement, enhancement prescriptions were applied, artificial kangaroo burrows were constructed, the enhanced habitat was formally and recently dominated by pioneer and intermediate AFSS, animals were re-trapped and relocated and animals were monitored for successive years. The plan failed. SBKR habitat did not appreciably, much less significantly, increase. The SBKR population did not increase, nor was there convincing evidence of successful reproduction, the gold standard of success. To reiterate, the plan failed. More germane to the RDEIR, it was accepted mitigation for the Redlands Sports Park, the same concept proposed by the RDEIR, and it failed.

Response to Comment No. 15-7

See Response to Comment No. 15-2 above regarding the difference between the RPDEIR and the original DEIR. This comment addresses SBKR impacts at the Project location as discussed in the DEIR. This matter is outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" with respect to cumulative impacts within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5. Please also refer to Response to Comment Nos. 15-3 and 15-4 above.

Comment No. 15-8

Fifth, presupposing conversion of chamise dominated habitats is at least marginally successful at establishing quality AFSS habitat, and that reclamation of degraded AFSS is successful, and that SBKR re-introductions are successful, these actions will not be adequate SBKR mitigation for the proposed project. It is important to recall that these mitigations are proposed to replace the high quality, high density SBKR habitat significantly, directly and indirectly impacted by the project. The probability that reconstruction and enhancement of SBKR habitat will result in comparable high quality, high density SBKR habitat are vanishingly low. Add to the equation that undisclosed and undefined impacts from channelization of the Lytle Creek Wash have yet to be disclosed or considered, and odds of mitigation resulting in habitat equivalent to that being lost become even lower.

Response to Comment No. 15-8

See Response to Comment No. 15-2 above regarding the difference between the RPDEIR and the original DEIR. This comment addresses SBKR impacts at the Project location as discussed in the DEIR. This matter is outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" with respect to cumulative impacts within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5. Please also refer to Response to Comment Nos. 15-3 and 15-4 above.

Comment No. 15-9

Sixth, the RDEIR directs that SBKR within the footprint shall be salvaged and translocated to newly enhanced or created habitat. Translocation of animals from a project footprint is an often proposed and implemented mitigation element. But does it work? The vast preponderance of evidence indicates this is meaningless mitigation. SBKR have been translocated, but rarely have there been follow-ups to determine if the animal survived. When there have been follow-ups, the majority of animals did not survive. In the very rare case were the translocated animals that did survive were monitored for three to five years, there was no evidence the translocated animals were reproducing. In short, no SBKR population of an appreciable size or longevity has been shown to result from the practice of translocation. Does this mean translocation should not be done? Of course not. When the choices are to leave an animal to certain death, or relocate an animal to an area where survival probability is low but greater than zero, the choice is clear. However, this does mean that translocation of SBKR as mitigation should in no way ever be considered to have substantive mitigation value.

Response to Comment No. 15-9

See Response to Comment No. 15-2 above regarding the difference between the RPDEIR and the original DEIR. This comment addresses SBKR impacts at the Project location as discussed in the DEIR. This matter is outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" with respect to cumulative impacts within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5. Please also refer to Response to Comment Nos. 15-3 and 15-4 above.

Comment No. 15-10

Seventh, the RDEIR proposes a variety of SBKR mitigations, e.g: [sic] enhancement, habitat reconstruction, habitat enhancement, creation of new populations through relocation and so forth. Given that these mitigation elements are deemed sufficient by the RDEIR to reduce otherwise significant impacts to non-significance, that is to offset the loss of high quality high density SBKR habitats, would it not be prudent, judicious, and cautious to determine that the mitigation strategies were successful in creating high quality, high occupancy habitats comparable to the ones lost before the existing habitat is lost? SBKR is, after all, a critically endangered species. There is no room for error or recourse if the mitigation elements fail. And failure is a likely probability for reasons previous [sic] discussed.

Response to Comment No. 15-10

See Response to Comment No. 15-2 above regarding the difference between the RPDEIR and the original DEIR. This comment addresses SBKR impacts at the Project location as discussed in the DEIR. This matter is outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" with respect to cumulative impacts within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5. Please also refer to Response to Comment Nos. 15-3 and 15-4 above.

Comment No. 15-11

REGIONAL SBKR IMPACTS AND MITIGATION

The RDEIR correctly states impacts to SBKR must be considered and mitigated to the level of non-significance on a regional basis such that FWS is not compelled to issue a Jeopardy Opinion on the project. Implicit in this RDEIR effort is an expectation and assurance the SBKR population in the planning area, after mitigations, will be viable. Yet there is no meaningful discussion in the RDEIR what defines "viable". Population viability is typically defined by a PVA (population viability analysis). No PVA has been done regionally for SBKR. Neither does the RDEIR present a PVA for SBKR populations in the planning area. To reiterate, the RDEIR provides no evidence or analysis to support the implied contention that there will be a viable SBKR population post construction impacts and mitigations.

The RDEIR is further deficient in a consideration or discussion of SBKR regional status and threats thereto. Meaningful SBKR populations are found in the Santa Ana River and tributaries, Cajon Creek, Lytle Creek, the San Jacinto River and nowhere else:

Long-term survival of SBKR populations in the Santa Ana is not assured due to the Seven Oaks Dam. The hydrology of the river has been permanently altered and mitigations unrealized. High water flows that otherwise would renew, create and rejuvenate SBKR habitat are no longer possible. Other impacts continue, such as non-mitigable impacts under FEMA to City Creek, un-mitigated flood control impacts, and undisclosed unconsidered impacts from the Santa Ana River Trail System. Additional impacts are likely pending approval of "Plan B" being formulated and affecting the Highland/Redland portions of the Santa Ana River. In short, long-term survival of SBKR in the Santa Ana River faces severe threats.

Long-term SBKR survival on the San Jacinto is even more questionable. The population here consists of a small isolated remnant in the San Jacinto Wash. Insipient habitat down-stream of the occupied area is consistently impacted by flood control practices. Existing and occupied habitat has recently been diminished by the repositioning of EMWD the percolation basins. Natural hydrologic events no longer exist due to high water dikes and urban/suburban encroachments. There is a very high probability the entire population will be extirpated by a single large flood event. There are no refugia for recolonization. This SKR population is at severe risk of extinction.

Long-term SBKR survival on Cajon Creek has better prospects but is in no way secure. Recent set asides of SBKR conservation lands, in perpetuity in the wash have removed development threats to the population. But, no meaningful long-term management practices or monitoring infrastructure nor central authority are in place to manage the Cajon Wash SBKR population. Thus, SBKR populations and habitat in these preserves are being impacted from upstream hydrologic manipulations, OHV enthusiasts, other recreational activities, exotic weed invasions, indirect impacts from Glen Helen Regional Park operational and improvement activities, and road improvements. The most recent of the later was the grading of an otherwise unused road in the wash to facilitate Glen Helen event access. In short, long-term SBKR persistence in Cajon Wash is nowhere near assured. And now, the long-term survival of the remaining significant SBKR population in Lytle Creek is threatened by the proposed project detailed by the RDEIR.

The RDEIR is deficient in discussing, recognizing, analyzing or mitigating the regional long-term threats to survival of SBKR from the proposed project. Rather than reducing regional impacts to a level of non-significance, the project, as proposed in the RDEIR, will likely significantly contribute to the regional impacts and decline of the species. Considering the regional threats collectively, the proposed project will likely jeopardize the long-term survival of SBKR.

Response to Comment No. 15-11

See Response to Comment No. 15-2 above regarding the difference between the RPDEIR and the original DEIR. This comment addresses SBKR impacts at the Project location as discussed in the DEIR. This matter is outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" with respect to cumulative impacts within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5. Issues addressed in this comment were fully addressed in the DEIR. Specifically, as described in Response I-9-20 included in the FEIR, the direct, indirect, and cumulative impacts to biological resources were fully and sufficiently analyzed in the DEIR on pages 4.5-9 through 4.5-163 and in the Biological Resource Assessment on pages 106 through 148, including tables and graphics. Those analyses considered both the Project Site as well as the southwestern San Bernardino County region. In addition, as set forth in Response I-9-6 in the FEIR, the proposed open space is both of sufficient size and adjacency to other permanently conserved habitat areas so as to be able to sustain these populations in perpetuity. The proposed open space is connected to several other significant conservation areas, making the total connected preserved conservation acreage (existing and proposed) in the area of Lytle Creek and Cajon Creek total in excess of 2,700 acres.

Please also refer to Response to Comment Nos. 15-3 and 15-4 above.

Comment No. 15-12

REGIONAL ANALYSYS OF IMPACTS TO SUITABLE HABITAT FOR SENSITVE WILDLIFE SPECIES

The RDEIR presents a regional analysis of impacts to suitable habitat for sensitive wildlife species. The analysis proceeds from identifying extant habitat found in the larger regional area, and then estimating percent of habitat impacted from the proposed project and in some cases, the regional losses the project impacts represent for some sensitive species. While the intent of the analysis is appropriate, the approach used is not. The results of analyses will vary depending on the size of the regional habitat considered. The larger the included regional area, the smaller the project impacts, and vice versa. So, the results will vary depending on how regionally boundaries are defined, which obscures the true regional impacts.

A second problem, animal and plant species are neither equally nor even distributed throughout the regional habitat, regardless how the regional habitat is defined. Basing the regional analyses on habitat makes a basic and incorrect assumption that they are. How can such an analyses provide meaningful results?

A third problem, the habitat based regional analysis also assumes that the preponderance of sensitive species' distributions occur in the defined regional habitat. This is an incorrect assumption. The assumption, to give a few examples, is false for Rufous-crowned Sparrow, Orange-throated whiptail, and burrowing Owl. The resulting error in the regional analyses for these and similar species is undefined. If could underestimate as well as overestimate the regional impacts. Either way, the habitat base regional species impacts analysis becomes nebulous and limited in value.

So what might have been a more constructive way to perform the analysis? Rather than habitat based, why not use the abundance or age classes ratios (to identify highly productive areas) of a target species in the regional area? Obviously one would need abundance and age class data for target species in the regional area. A difficult and labor intensive effort were it not for the fact those data already exist. Data from the defunct Valley Plan include multiple years of abundance and age class data for all sensitive species in the regional area at multiple locations in the regional planning area defined by the RDEIR. As previously mentioned, Valley Plan data could also fill in the "holes" in the inferior survey data collected and used for the proposed project. Some examples have been noted, here is another. The RDEIR elects not to apply a regional analysis to LAMP, presumably because LAPM data are insufficient. Had Valley Plan data been used, there would be sufficient data. The results would likely show that the proposed project will eliminate up to 20% of the habitat were LAPM is known to occur.

Why Valley Plan data are not used, either in the project related or regional impacts assessments, or in determining species' presences and abundances in the project area, is again unclear. Local municipalities (including the City of Rialto) as well as SBCO, FWS and CDFG paid for it. Valley Plan data would have been far superior, far more comprehensive and far more accurate than the habitat based approach used in the RDEIR.

Response to Comment No. 15-12

See Response to Comment No. 15-2 above regarding the difference between the RPDEIR and the original DEIR. This comment addresses SBKR impacts at the Project location as discussed in the DEIR. This matter is outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" with respect to cumulative impacts within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5. Please also refer to Response to Comment Nos. 15-3, 15-4, and 15-11 above.

Comment No. 15-13

SANTA ANA RIVER WHOOLLYSTAR

The RDEIR reports that the endangered Santa Ana River Whoollystar (*Eriastrum densifolium sanctorum*) does not occur in the project area, but rather the plants in question belong to the non-sensitive subspecies *Eriastrum densifolium elongatum*. The claim is based on significant differences in corolla length between the two subspecies. So of, let us say, four features measured and compared, the determination was made that because the plants on the project area are 25% different from *sanctorum* and 75% similar to *sanctorum*, the plants could not be the endangered *E. d. sanctorum*. A curious statement worth repeating. Because the plants were more similar to sanctorum, having differed from *sanctorum* by only one of many compared characteristics, the RDEIR concludes the plants on the project area could not be *E. d. sanctorum*? The logic escapes me.

Consider another perspective. The plants we are talking about are subspecies, not full species, meaning by the current biological species definition, were *E. d. sanctorum* and *E. d. elongatum* to cross pollinate, "breed", under natural conditions, they would produce fertile off spring and their offspring too would produce fertile offspring. Because these are subspecies able to reproduce under naturally occurring conditions, their progeny would have characteristics of both, which the plants in the project area do. So, when, geographically, does *E. d. sanctorum* distribution end and *E. d. elongatum* begin? The question cannot be answered because it is the wrong question. Because they are subspecies which freely exchange genetic information there is no distinct boundary between the subspecies, but rather a gradient of shared and unshared characteristics across the landscape. A condition confirmed by the study by Brunell and Reiseberg cited in the DREIR. So how then does/could one, with as much certainty as possible given the two plants in question are subspecies, determine if the plants in the project area deserve mitigation? One might do that exactly what the RDEIR did, but with the a more parsimonious interpretation of results. Specifically, compare characteristics and assign the plants to the subspecies with the most similar characteristics. In this case, the plants in the project area are more similar to *E. d. sanctorum*, not marginally but by the majority of characteristics examined. Nothing more can be said to assign the plants more definitively to one subspecies or the other absent extensive and expensive studies. Given the preponderance of characteristics and available evidence, the plants in question more closely affiliates with the endangered *E. d. sanctorum*, not *E. d. elongatum*. Ought not the plants be considered endangered? The RDEIR should treat the *Eriastrum densifolium* on the project site as endangered Santa Ana River Whoollystar and mitigate accordingly.

Response to Comment No. 15-13

See Response to Comment No. 15-2 above regarding the difference between the RPDEIR and the original DEIR. This comment addresses Woollystar impacts at the Project location in the Draft EIR. This matter is outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" with respect to cumulative impacts within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5. Issues addressed in this comment were fully addressed in FEIR Response III-177-3, which indicates that based on additional research and information provided by a recognized expert on woollystar, the woollystars on the Project Site are not the listed Santa Ana River woollystar subspecies. (See DEIR Volume I, pages 4.5-65 through 4.5-67 and 4.5-118 though 4.5-119; DEIR Volume III (Part 1), Appendix III-D-B, pages 13 through 14, pages 61 through 64, and Sub-Appendix B, Subspecies Identification of the Woollystar at the Lytle Creek Ranch Specific Plan Project Site; and FEIR Volume IV, Appendix IV-J.)

Comment No. 15-14

RAPTOR FORGING HABITAT IMPACT ASSESSMENT

The RDEIR assessment of impacts to raptor foraging is inadequate. The RDEIR determines that because upland habitat is poor raptor foraging habitat impacts are not significant. First, there is no citation to support this assertion. Raptors do utilized upland habitats for foraging. Their success may be less but nevertheless they do utilize upland habitats. Second, the RDEIR fails to recognize that upland habitats are a significant source of the raptor forage base; rabbits, hares, ground squirrels, small rodents and so forth. Obviously, affecting the raptor forage base will impact raptors.

Response to Comment No. 15-14

See Response to Comment No. 15-2 above regarding the difference between the RPDEIR and the original DEIR. This comment addresses raptor impacts at the Project location as discussed in the DEIR. This matter is outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" with respect to cumulative impacts within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5. Issues addressed in this comment were fully addressed in the EIR.

More specifically, as described in Response I-9-8 of the original FEIR, the DEIR examined the Project's direct, indirect, and cumulative impacts on those sensitive raptor species that were observed or have the potential to forage on the Project Site. (See DEIR Volume I, pages 4.5-120 through 4.5-134.) As explained in detail in the DEIR (pages 4.5-120 through 4.5-134), impacts to sensitive raptors and to raptor foraging habitat were found to be less than significant. The DEIR (page 4.5-155) also contains a cumulative analysis of the loss of raptor foraging habitat. The DEIR concluded: "The proposed project will add incrementally to the cumulative impacts to raptor foraging habitat within the BCISA [biological cumulative impact study area] but the impacts from the proposed project, while adverse, would not be cumulatively significant in light of the amount of habitat that remains available for this species in the BCISA and no mitigation is required or recommended." (See also Response to Comment No. I-9-8 in the FEIR Volume IV, as well as FEIR Volume IV, Appendix IV-C, May 5, 2010, PACE Technical Memorandum, pages 3 and 4.)

Comment No. 15-15

RDEIR IDENTIFICATION OF CORRIDORS AND CONECTIVITY IMPACTS

The RDEIR considers and addresses impacts to significant animal movement corridors on a false assumption. The RDEIR assumes that the majority of animals use pioneer and intermediate AFSS habitat for dispersal and movement corridors in the project area, discounting the impacts that development of upland habitats will potentiate. As an example, the RDEIR correctly points out that mule deer do not use pioneer and intermediate AFSS for movements (they actually avoid them due to lack of cover). As mule deer are the primary prey of mountain lion, won't interrupting mule deer connectivity logically affect mountain lion connectivity and diminish their available suitable habitat? Of course it would. What about other essential predator and prey relationships? Bobcat and rabbit? What about weasels, do they preferentially use intermediate or pioneer AFSS, or do they prefer more mature cover? A plethora of research has resoundingly shown that major predators are essential to the health of any ecosystem, yet the RDEIR does not comprehensively considered movement corridors for them, or their prey, in the proposed project. My point here is that, once again, there is an inconsistent application of logic by the RDEIR, in this case pertinent to assessing, much less redressing, project related impacts to movement corridors.

Response to Comment No. 15-15

See Response to Comment No. 15-2 above regarding the difference between the RPDEIR and the original DEIR. This comment addresses impacts on biological resources at the Project location as discussed in the DEIR. This matter is outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" with respect to cumulative impacts within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5.

In addition, as stated in Response III-147 in the original FEIR, the Lead Agency has concluded that all potentially significant environmental impacts of the Project relating to biological resources have been identified and analyzed in the EIR. Please also refer to Response to Comment No. 15-14, above, and Response No. I-9-8 in the FEIR for additional information regarding wildlife movement.

Comment No. 15-16

HEA ALTERNATIVE ASSESMENT AND MITIGATION OF RAFSS IMPACTS

The RDEIR proposes that HEA impact assessment to RAFSS may be substituted for ratio based mitigation estimates. HEA is not the proper tool for determining habitat mitigation equivalencies prior to their being impacted. The tool was developed to aid mitigation for oil spills after they occurred. On the surface the HEA appears appealing because it attempts to recognize habitat based on habitat value elements, such as quality, positioning the landscape, animal and plant resources values, not just the size of the habitat. But, as the saying goes, the devil is in the details. For example, a cogent argument can be made, has been made, that the corridor impacts from the proposed study are not being fully disclosed or mitigated. But what constitutes a high value corridor anyway? Experts will most assuredly disagree, depending on the frame of reference, meaning, are we talking about corridors for specific animals, group of animals, or corridors to maintain ecological components necessary to a healthy ecosystem, corridor widths, vegetative composition? The playing field gets very complicated very fast.

HEA is not necessary in the context used in the RDEIR. Ratio based mitigation ratios are not set in stone, as the RDEIR's exercise with SBKR habitat mitigations clearly demonstrates. Ratios in ratio based mitigation are guidelines, merely recommendations. Nor is there any *a priori* rule precluding the adjustment of mitigation ratios based on the habitat elements HEA purposes to consider. Simply put, enabling HEA procedures does nothing that ratio based mitigation doesn't already allow for. HEA only confuses the playing field.

Response to Comment No. 15-16

See Response to Comment No. 15-2 above regarding the difference between the RPDEIR and the original DEIR. This comment addresses RAFSS impacts at the Project location as addressed in the Draft EIR. This matter is outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" with respect to cumulative impacts within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5. Issues addressed in this comment were fully addressed in the Draft EIR. (See DEIR Volume I, Sections 4.5.3.2, 4.5.5.1, 4.5.5.2, and 4.5.5.3 and Mitigation Measure 5-1; also see DEIR Volume III (Part 1), Appendix III-D-B, Section 3.2 and pages 131 through 134, 140, 145 through148, and 149 though 175.)

Please also refer to Response to Comment Nos. 15-3 and 15-4 above.

Comment No. 15-17

MITIGATION OVERSIGHT AND MANAGEMENT

The RDEIR assigns authority to determine when applicants of project enabled by the proposed plan have met mitigation standards and requirements to the Development Services Director (Director). This potentiates a conflict of interest. The any city stands to benefit from developments within their jurisdiction as this adds to the city's tax base. The potential or at least perceive conflict of interest can be avoided by delegating authority to determine when mitigation standards have been met to an unbiased independent panel, disconnected and uninfluenced by the city.

While the RDEIR appoints an authority (the Director) for determining when applicants of projects enabled by the DREIR have met mitigation standards, no similar mechanism is established to determine when mitigation standards for the RDEIR itself have been met. This appears to be a significant omission as the preponderance of the mitigation is aimed at significant impacts to SBKR, an endangered species. Additionally, as a significant bulk of the SBKR mitigation requires habitat conversion, creation, rehabilitation, and SBKR reintroductions, all speculative and largely still experimental in nature, ought not there be a requirement that those mitigations first be done and deemed successful before existing high occupancy, high density SBKR habitat is irrevocably destroyed or otherwise significantly altered?

The RDEIR SBKR mitigation proposes to establish several SBKR preserves. Who will manage these preserves, in perpetuity? How will they be managed, in perpetuity? Who will assess and approve plans submitted for management and monitoring, in perpetuity? By what criteria will mitigations be deemed successful? Who will have that authority? What recourse will there be if mitigations are not successful? Simple signage, referenced in the RDEIR, is clearly not enough, as witnessed by OHV inroads, illegal dumping and unauthorized activities on SBKR preserve lands in Cajon Wash and the same problems plaguing the North Etiwanda RAFSS Preserve. Management by jurisdictional entities is problematic, due to conflict of interest entanglements. A third party, whose specialty is preservation and management, is the most appropriate and most commonly used entity, yet the RDEIR never mentions these groups. While the RDEIR requires that funds sufficient for long-term conservation and management be posted, at least for RAFSS mitigations, how will these funds be determined? How will the funds be managed? What contingencies are there for bankruptcy of a project applicant? In short, while the RDEIR proposes a wide variety of SBKR and other mitigations, both for the proposed plan and subsequent project applicants, the RDEIR fails in the details of how these mitigations will be managed and preserved in perpetuity.

This concludes my comments on the RDEIR. I hope the comments are constructive and prove useful in your evaluation of the adequacy of the RDEIR document. Thank you for the opportunity to comment.

Response to Comment No. 15-17

See Response to Comment No. 15-2 above regarding the difference between the RPDEIR and the original DEIR. This comment addresses mitigation measures for biological resource impacts at the Project location as discussed in the DEIR. This matter is outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" with respect to cumulative impacts within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5.

In any event, CEQA requires that mitigation measures be fully enforceable by permit conditions, agreements, or other measures, and that the public agency adopt a mitigation monitoring and reporting program (MMRP) to ensure compliance with mitigation measures during Project implementation. (See Public Resources Code, § 21081.6 and CEQA Guidelines, § 15097.) This Final RPEIR contains a revised MMRP for the Project (provided as Appendix VI-B herein), which includes all of the biological resources mitigation measures. Should the decision makers approve the Project and certify the Complete FEIR, they would also be required to adopt the revised MMRP, which identifies the entities responsible for providing compliance verification.

Comment No. 15-18

CURRICULUM VITAE

Gerald T. Braden
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Angelus Oaks, California 92305-0064
email-gtbraden@verizon.net

Education:

Bachelors of Arts - Environmental Studies. California State University San Bernardino, California. Graduated with Honors - 10 December, 1981

Bachelors of Arts - Physical Geography. California State University San Bernardino, California. Graduated with Honors - 10 December, 1981

Masters of Science - Biological Sciences. California State Polytechnic University, Pomona, California (CSPUP). Graduated with High Honors - 15 March 1991

Relevant Professional Work Experience:

Position: Independent Biological Consultant **From:** January 2010 **To:** Present
Employer: Gerald T. Braden/ Braden Biological Services

Activities: Independent biological consulting work. Surveys for land, shore and water birds, Desert Tortoise, reptiles, amphibians, Peninsular Bighorn Sheep and San Bernardino Kangaroo Rat. Consultations on threatened/endangered species, document reviews.

Position: Research Biologist/ Interim Curator **From:** October 1994 **To:** January 2010
Employer: San Bernardino County Museum/Biological Sciences Division

Responsibilities:

My primary responsibilities as a research biologist and interim curator were characterized by a high level of independence to design, perform, interpret, publish, and review original, professional, and scientific research using statistical, problem solving, personnel management, budget management, inter-agency coordination, and supervisory skills on a daily basis.

As interim curator I was singly accountable for all matters pertaining to the Biological Sciences Division. Responsibilities entail overseeing, augmenting, and maintaining regionally significant research collections of the herpetofauna, small mammals, avifauna, botanical, and invertebrate taxa of the Southwestern United States and northern Mexico. Duties entailed the collection, preparation, and preservation of scientific and tissue specimens to modern museum standards and practices. Duties also entail developing and maintaining research collaboration

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and strong working relationships with local universities and museum scientists. Duties also include maintaining hard and electronic copies of accession books, responding to requests, and dissemination of collections information to professional and amateur biologists, resource managers, educators, and the general public. Duties also included generating and managing a $400,000 annual budget (variable by year). Budget revenue was generated by contract solicitations and grant sources. Duties also included interfacing with museum visitors via tours, lectures, and disseminating information, exhibit and web module conception, design, and creation, consultation with other county departments, regulatory agencies, other museums, and academia pertaining to expertise, advice, environmental compliance, and general networking. Duties also included staff hiring, task assignments, work performance evaluations, and counseling.

As Research Biologist I was responsible for the development, implementation and supervision of Contract Field Studies program. The Contract Field Studies Program involved the conception, design, development, implementation, analysis, and reporting or manuscript write-up on original long-term field studies. Studies pertain to varied aspects of the distribution, life history, biology, and/or ecology of vertebrate taxa of the Southwestern United States. These studies involved the application of standard survey and sampling methodologies or the creation of new methodologies when warranted, and a strong capacity for independent problem solving and original thought. These studies also required a working knowledge of contemporary biological theories and paradigms as published in the primary scientific literature. Many of the contract field studies involve federal and state threatened or endangered species, therefore the studies required a working knowledge, understanding, and application of state and federal environmental laws such as the Endangered Species Act, Clean Water Act, National Environmental Policy Act, Federal Coordination Act, and California Environmental Quality Act.

In addition, the contract field studies involved the teaching, training and supervision of employees and contractors in standard scientific survey and data collection techniques, a variety of population sampling, estimation, persistence, area use and utilization models. Duties also required the application and interpretation of multivariate and probabilistic statistics, and the ability to effectively use major statistical and plotting software, such as SASS, BMDP, SigmaStat, and SigmPlot, in addition to the commonly used spreadsheet and databases software packages.

Contract field study duties also involved coordination among disparate jurisdictions with conflicting goals and missions. Jurisdictions included California Department of Fish and Game, Nevada Department of Fish and Wildlife, United States Geological Survey Biological Resources Division, United States Fish and Wildlife Service Ecological Services Offices, the United States Bureau of Land Management, the United States Bureau of Reclamation, Southern Nevada Water Authority and County departments.

Duties also included the hiring, training, coordination, and supervision of museum biologists, and coordination with the local universities to obtain highly qualified and motivated undergraduate and graduate students. Duties also entailed a contemporary working knowledge of the habitats and identification of the flora and fauna of the region, their historic and current distribution, species or taxa specific sampling techniques, and vegetation data collection techniques.

Position: Wildlife Biologist: **From:** May 1991 **To:** October 1994
Employer: U. S. Fish and Wildlife Service/Ecological Services

Responsibilities:

The federal wildlife biologist position was characterized by a high level of independence to provide guidance to federal, state, local, and private jurisdictions to facilitate compliance with the Endangered Species Act (ESA), Federal Coordination Act, National Environmental Policy Act, and Clean Water Act. The position was also characterized by a high level of independence to design and implement studies on threatened and endangered species to provide a scientific basis for endangered and threatened species survey protocols as well as management and recovery plans.

Foremost among these studies of threatened and endangered species studies were long-term life history, habitat/fitness, nest placement, parasitism, detection, and dispersal studies of the threatened California Gnatcatcher. The results of these studies included three primary literature publications and the development of the present day U. S. Fish and Wildlife California Gnatcatcher Survey Protocol. Other field studies involved protocol surveys for other listed species including Stephens' Kangaroo Rat, Light-footed Clapper Rail, Southwestern Willow Flycatcher, and Least Bell's Vireo.

In addition to the skills necessary to conceive, implement, and successfully complete a scientific study, these studies involved developing and maintaining partnerships among the FWS, University of California Riverside, San Bernardino County Museum, Riverside County Parks Department, Metropolitan Water District, and the private sector.

Other duties involving ESA guidance entailed working with jurisdictions to assure project compliance with the ESA and related environmental laws. Most often this involved providing guidance toward obtaining Threatened and Endangers Species take permits (Sections 10(a)1a, 10(a)1b, and 7) and advice on possible non-compliance (Section 9, illegal take) or other potential ESA and Clean Water Act violations. Not infrequently, these duties were performed in a highly charged emotional, often combative arena, which required substantial amounts of tact, diplomacy, creativity, and patience to arrive at constructive resolutions.

Position: Graduate Student **From:** Oct. 1987 **To:** Oct. 1991
Employer: Biological Sciences Department, California State Polytechnic University Pomona.

Responsibilities:

My thesis worked consisted of four years of study on the territory size, habitat use, den characteristics, and seasonal ranges of Black Bears (*Ursus americanus*) in the San Gabriel Mountains of Southern California. The work involved trapping bears by culvert traps and leg snares, administering tranquilizers, attaching radio collars, determining locations and den sites through telemetry, converting telemetry locations to territory and seasonal use-areas using multiple home range algorithms, data analysis, report writing, and professional presentations to scientific organizations and the general public. The work involved long hours alone in remote locations of the San Gabriel Mountains in all types of weather conditions. Because the bear project was on going, duties also included training subsequent graduate students in proper use of traps, snares, and telemetry, sedating wild bears, and home range analyses.

I also trained and assisted graduate students studying habitat use and territory utilization of coyote, raccoon, and opossums along urban-rural interfaces. Duties included the live capture of coyote, raccoons, and opossums as well as the determination of home ranges and territories for the same taxa using standard home-range algorithms. Independent of my graduate career I also studied age and growth patterns of California Walnut (*Juglans californica*) by analysis of tree ring growth data.

Position: Hydrologist **From:** ca. March 1981 **To:** October 1987
Employer: U.S. Geological Survey

Responsibilities:

The hydrologist position involved the collection, analysis, and reporting of surface flow and ground water data. Duties involved constructing, maintaining, and monitoring surface water gage stations and measuring surface water discharges at remote locations in the deserts, mountains, and coastal valleys of Southern California. These duties required a practical knowledge of standard construction techniques and equipment, surface water flow characteristics, hydrologic dynamics of current and historic flood events, the effects of varied geologic formations, soil types, and substrates on surface and subsurface flows, and the ability to work effectively under remote, hazardous, and unsupervised conditions under all extremes of weather. Analysis of surface and ground water data required a working knowledge of basic hydrological mathematics and principals. The position was a permanent federal government position with full benefits. I left the position to pursue an advanced degree in biological research.

Professional Memberships:

American Society of Mammalogists
American Society of Ichthyologists and Herpetologists
American Ornithologists' Union
Association of Field Ornithologists
Cooper Ornithological Society
Raptor Research Foundation
Wilson Ornithological Society
Society for the Study of Amphibians and Reptiles
Copeia

Awards and Citations:

Performance Award - U. S. Geological Survey: 1983.
Tim Brown Memorial - CSPUP 1990.
Durham Award - Southern California Academy of Sciences 1991.
Performance Award - U. S. Fish and Wildlife Service: Rating year 1993.
Performance Award - U. S. Fish and Wildlife Service: September 1993.
Performance Award - U. S. Fish and Wildlife Service: Rating year 1994.

Presentations

Presentation of original ornithological research at American Ornithologist and Cooper Ornithological Societies meetings.

Invited speaker on original research at specialized symposia such as:
- CalGnat 1994 at University of California Riverside, Coastal Sage Scrub Symposium 1995 at the San Diego Zoo

- Puente Hills Wildlife Corridors and Vanishing Habitats Symposium 1995 at California State University Fullerton 1995.

- The 1999 Annual Convention of Environmental Journalist speaking on "Science and Multispecies Habitat Conservation in Coastal Southern California".

- Semiannual Guest Lecturer at the Wildlife Ecology Graduate Student Seminar at California State Polytechnic University Pomona.

Activities

S Scientific Reviewer: Reviewer of original scientific studies submitted for publication to primary scientific societies, including The Wilson Bulletin, Journal of Field Ornithology, AUK, Condor, Journal of Wildlife Management, and The Journal of Canadian Zoology.

S Invited participant on the Science Consistency Review Panel for the USDA EIS Revised Land Management Plan for Southern California National Forests: October 26th and 27th, 2004

S Semi annually solicited for training USFS biologists on the occurrence and identification of sensitive birds and small mammals of the San Bernardino National Forest.

S Solicited for review, opinion, advice and consultation on the San Bernardino Kangaroo Rat, California Gnatcatcher, Southwestern Willow Flycatcher, and other federally listed or sensitive species and ecosystems of the Southwestern United States. Solicitors included but are not limited to U. S. Fish and Wildlife Service, U. S. Bureau of Reclamation, U. S. Bureau of land Management, U. S. Forest Service, U. S. Park Service, California Department of Fish Game, Nevada Department of Game and Fish, County of San Bernardino, Metropolitan Water District, Endangered Habitats League, Center for Biodiversity, Natural Heritage Institute.

- Expert Witness on California Gnatcatcher for the U. S. Department of Justice. DJ File Number 90-8-6-04239, United States of America v Granite Homes, INC.

Endangered/threatened/sensitive species experience

- California Gnatcatcher (*Polioptila californica californica*): Principal investigator on an eight-year study of the life history, habitat affinities, fitness, detection, nest monitoring and dispersal of CAGN in western Riverside. Developed the current FWS CAGN survey protocol. Two years of protocol surveys for the San Bernardino Valley Multi-species Plan. Multiple gray literature reports and three peer reviewed publications in primary ornithological journals. Invited review of FWS population modeling, protocols and policies pertaining to the species.

- Least Bell's Vireo (*Vireo bellii pusillus*): Five years of protocol surveys on the Santa Ana and Mojave Rivers and associated tributaries.

- Arizona Bell's Vireo (*Vireo bellii arizonae*): Five-years of surveys in the Lower Grand Canyon. Three years of surveys, nest monitoring, and habitat study on the Virgin River in Southern Nevada.

- Southwestern Willow Flycatcher (*Empidonax traillii extimus*): Nine years of study of the life history, distribution, habitat affinities, fitness, nest success, detection and dispersal of SWWF along the lower Colorado River and its tributaries. Six years of protocol surveys for the U. S. Forest Service. Multiple gray literature reports. Invited reviewer of FWS regulations, protocols and policies pertaining to the species.

- Yuma Clapper Rail (*Rallus longirostris yumanensis*): Yuma Clapper Rail surveys along the Virgin River in Southern Nevada (nine years). Multiple gray literature reports. FWS invited reviewer of current YCRA/BLRA survey protocol.

- Light-footed Clapper Rail (*Rallus longirostris levipes*): Two years of presence/absence protocol surveys at the Newport Back Bay.

- Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*): Yellow-billed Cuckoo surveys along the Virgin River in Southern Nevada (nine years). Incidental observations on the lower Colorado River (Virgin River south to the Mexican border, two years). Multiple gray literature reports.

- Stephens' Kangaroo (*Dipodomys stephensi*): Two years of protocol surveys in western Riverside County and Camp Pendleton.

- San Bernardino Kangaroo Rat (*Dipodomys merriami parvus*): Five years of protocol trapping for SBKR for the San Bernardino Valley Multi-species Plan and the U.S. Forest Service. Multiple gray literature reports. FWS invited reviewer of current SBKR survey protocol. FWS invited reviewer of Seven Oaks Dam BA.

- Desert *Tortoise (Gopherus agassizii)*: Relocation and radio telemetry study of Desert Tortoise in the west Mojave Desert in the late 1980's. A combined four years of Desert Tortoise surveys in the upper Coachella Valley and the eastern Mojave Desert.

Current Interests

- Pre-post fire comparisons of the small mammal community in Alluvial Fan Sage Scrub.
- Pre-post fire comparisons of the breeding season avian community in Alluvial Fan Sage Scrub
- Nest site selection, life history and habitat/fitness associations of the endangered Southwestern Willow Flycatcher.
- Southwestern Willow Flycatcher dispersal and site tenacity.
- Affects of water availability on the avian community in the lower Grand Canyon.
- Affects of water availability on the avian community along the Virgin River in Southern Nevada.
- Avian community responses to habitat modifications/reclamation along the Las Vegas Wash in southern Nevada.
- California Gnatcatcher Dispersal and site tenacity.
- Habitat/fitness relationships, dispersal, and community associations of the endangered San Bernardino Kangaroo Rat.
- The effects of Tamarisk on avian diversity in desert riparian systems.

Book Review:

Braden, G. T. 1997. Journal of Wildlife Management 83(3):130-131. Monitoring Bird Populations by Point Counts. C. J. Ralph, J. R. Sauer, and S. Droege. (Eds.) General Technical Report PSW-GTR-149. U. S. Department of Agriculture, iv + 181 pages.

Primary Literature Publications:

Braden, G. T. 1999. Does nest placement affect the fate or productivity of California Gnatcatcher nests? Auk 116:984-993.

Braden, G. T., R. L. McKernan, and S. M. Powell. 1997. Effects of nest parasitism by the brown-headed cowbird on nesting success of the California Gnatcatcher. Condor 99(4):

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858-865.

Braden, G. T., R. L. McKernan, and S. M. Powell. 1997. Association of within-territory vegetation characteristics and fitness components of California Gnatcatchers. Auk 114(4) 601-609.

Stubblefield, C. and **G. T. Braden**. 1994. Denning Characteristics of black bears in the San Gabriel Mountains of southern California. Cal. Academy of Sciences 93(1)30-37.

Alexander Sokoloff, R. F. Ferrone, J. D. Chaney, **J. Braden**, and R. J. Munoz. 1987. Linkage studies in *Tribolium castaneum* (Herbst). XII. A revision of linkage group II. Genome 29:26-33.

<u>Relevant Gray Literature Reports:</u>

Braden, G. T., L. Crew, and A. Miller. 2009. Avian diversity, vegetation composition and vegetation structure of the Las Vegas Wash: 2005 to 2009. San Bernardino County Museum, Biological Sciences Division, 2024 Orange Tree Lane Redlands, CA 92374. Prepared for the Las Vegas Wash Coordination Committee. November 2009. 75 pp.

Braden, G. T., M. Rathbun, T. Hoggan, A. Davenport, and K. Carter. 2009. The Status of Yuma Clapper Rail and Yellow-billed Cuckoo along portions of the Virgin River and Muddy River in Southern Nevada, with incidental observations of Southwestern Willow Flycatcher. 2008. Final. Report prepared for the Southern Nevada Water Authority by the Biological Sciences Division, San Bernardino County Museum, 2024 Orange Tree Lane, Redlands, California 92374. February 2009. 58 pp.

Braden, G. T., K. Carter, M. Rathbun, and T Hoggan. 2009. Occurrence, distribution, and abundance of vertebrate species on the Old Woman Mountains Preserve: 2004-2008. Revised Final. Biological Sciences Division, San Bernardino County Museum, 2024 Orange Tree Lane, Redlands CA 92374. Report to the Native American Lands Conservancy and the 29 Palms Band of Mission Indians. January 2009. 158 pp.

Braden, G. T and R. L. McKernan. 2006. Status, distribution, life-history, and habitat affinities of the Southwestern Willow Flycatcher along the lower Colorado River, Year 7 – 2002 Final Report-Revised. Report submitted to the U. S. Bureau of Reclamation, U. S. Fish and Wildlife Service and U. S. Bureau of Land Management. January 2006.

Braden, G. T., L. Crew, and A. Miller. 2005. Changes in avian breeding season diversity, microclimate, and habitat coincident with changes in surface water in a tamarisk dominated riparian habitat along the Virgin River in southern Nevada. Report submitted to Zane L. Marshall, Southern Nevada Water Authority, Las Vegas Nevada by the Biological Sciences Division, San Bernardino County Museum, Redlands, California.

Braden, G. T., K. Carter, M. Rathbun, and T. Hoggan. 2005. Occurrence, distribution and abundance of vertebrate species on the Old Woman Preserve: Spring 2004. Report to The Native American Lands Conservancy and The Twenty-nine Palms Band of Mission Indians by the Biological Sciences Division, San Bernardino County Museum, 2024 Orange Tree Lane, Redlands, CA 92374

Braden, G. T. and R. L. McKernan. 2000. A data based survey protocol and quantitative description of suitable habitat for the endangered San Bernardino Kangaroo Rat (*Dipodomys merriami parvus*). Biology Section, San Bernardino County Museum, Redlands, CA. June, 35 pp.

Braden, G. T. and R. L. McKernan. 1999. Possible effect of low level nest parasitism by the Brown-headed Cowbird (*Molothrus ater*) on the nest success of the Southwestern Willow Flycatcher (*Empidonax traillii extimus*) at sites monitored by the San Bernardino County Museum: A data review, progress report, and power's analysis. Report submitted to the U. S. Bureau of Reclamation, Lower Colorado River Region, Boulder City, Nevada, by the San Bernardino County Museum Biological Sciences Section, Redlands, California. December, 21 pp.

Braden, G. T., and R. L. McKernan. 1998. Nest stages, vocalizations, and survey protocols for the Southwestern Willow Flycatcher (*Empidonax traillii extimus*). Final Report submitted to the U. S. Bureau of Reclamation, Lower Colorado River Region, Boulder City, Nevada, by the San Bernardino County Museum Biological Sciences Section, Redlands, California. October, 36 pp.

Braden, G. T., and R. L. McKernan. 1998. Observations on nest cycles, vocalization rates, the probability of detection, and survey protocols for the Southwestern Willow Flycatcher (*Empidonax traillii extimus*). Report submitted to the U. S. Bureau of Reclamation, Lower Colorado River Region, Boulder City, Nevada, by the San Bernardino County Museum Biological Sciences Section, Redlands, California. March, 38 pp.

Braden, G. T. 1991. Home ranges, habitat use, and den characteristics of black bears in the San Gabriel Mountains of southern California. Master's Thesis, CSPUP.

Braden, G. T. R. L. McKernan, S. Love, and S. Powell. 1995. Nesting biology of the Coastal California Gnatcatcher (*Polioptila californica californica*) in western Riverside County: 1993-1994. San Bernardino County report to the Metropolitan Water District. 29 pp.

Braden, G. T. and Stacey L. Love. 1994. Dispersal and non-breeding season habitat use by the Coastal California Gnatcatcher (*Polioptila californica californica*) in western Riverside County. USFWS report to the Metropolitan Water District. 25 pp.

Braden, G. T. and Shawn Powell. 1994. Nesting biology of the Coastal California Gnatcatcher (*Polioptila californica californica*) in western Riverside County. USFWS report to the Metropolitan Water District. 35 pp.

Braden, G. T. and Shawn Powell. 1994. Breeding habitat use by *Polioptila californica* in western Riverside County. USFWS report to the Metropolitan Water District. 30 pp.

Braden, G. T. 1992. California Gnatcatchers (*Polioptila californica*) at three sites in western Riverside County. USFWS report to the Metropolitan Water District. 29 pp.

Carter. K. J., **G. T. Braden**, M. Rathbun, and T. Hoggan. 2006. Southwestern Willow Flycatcher, habitat suitability, and amphibian survey results for the San Bernardino National Forest: 2004. Final Report. Submitted to the San Bernardino National Forest by the Biological Sciences Division, San Bernardino County Museum, Redlands, California. January 2006.

Rathbun M., **G. T. Braden**, and K. J. Carter. 2004. Results of Southwestern Willow Flycatcher, Mountain Yellow-legged Frog, California Red-legged Frog, and Arroyo Toad surveys in the San Bernardino National Forest: 2003 Final Report. Report submitted to the San Bernardino National Forest by the Biological Sciences Division, San Bernardino County Museum, Redlands, California.

McKernan, R. L. **G. T. Braden**. 2002. Status, distribution, and habitat affinities of the Southwestern Willow Flycatcher along the lower Colorado River, Year 6 - 2001. Report submitted to the U. S. Bureau of Reclamation, U. S. Fish and Wildlife Service and U. S. Bureau of Land Management. May 2002.

McKernan, R. L. and **G. T. Braden**. 2001. Status, distribution, and habitat affinities of the Southwestern Willow Flycatcher along the lower Colorado River, Year 5 - 2000. Report submitted to the U. S. Bureau of Reclamation, U. S. Fish and Wildlife Service and U. S. Bureau of Land Management. May 2002.

McKernan, R. L. and **G. T. Braden**. 2001. Status, distribution, and habitat affinities of the Southwestern Willow Flycatcher along the lower Colorado River, Year 4 - 1999. Report submitted to the U. S. Bureau of Reclamation, U. S. Fish and Wildlife Service and U. S. Bureau of Land Management. February 2001.

McKernan, R. L., **G. T. Braden**, and E. A. Cardiff. 2002. Survey results: Status, distribution and habitat affinities of the Southwestern Willow Flycatcher in the San Bernardino National Forest: 2000 and 2001. Report submitted to the San Bernardino National Forest, September 2002. 61 pp.

McKernan, R. L., **G. T. Braden**, and E. A. Cardiff. 2000. Survey results: Status, distribution and habitat affinities of the Southwestern Willow Flycatcher in the San Bernardino National Forest, 1999. Report submitted to the San Bernardino National Forest, April 2000. 36 pp.

McKernan, R. L. and **G. T. Braden**. 1999. Status, distribution, and habitat affinities of the

Southwestern Willow Flycatcher along the lower Colorado River, Year 3 - 1998. Report submitted to the U. S. Bureau of Reclamation, U. S. Fish and Wildlife Service and U. S. Bureau of Land Management. March 1999.

References

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Response to Comment No. 15-18

This comment is noted for the record and will be forwarded to the decision makers.

Gerald T. Braden
P. O. Box 64
Angelus Oaks, CA 92305-0064

3 April, 2012

City of Rialto
Development Services Department
Planning & Business License Division
150 South Palm Avenue
Rialto, CA 92376-6487

re: Revised Draft Environmental Impact Report for the Lytle Creek Ranch Specific Plan.

Dear Development Services Department,

I would like to submit comments on Revised Draft Environmental Impact Report for the Lytle Creek Ranch Specific Plan, here after referred to as the RDEIR. My comments are as follows:

DATA SETS/ASSESSMENTS

Data sets are essential to determining direct and indirect impacts. In the absence of existing data, various biologists are hired to survey a project site. Surveys vary in effort. At the least intensive, surveys consist of simple laundry lists of what was seen or otherwise detected. Biologists walk the site and record what they see (termed: walkover survey). Obviously not a very accurate accounting of biological resources as many species try to avoid detection, are cryptic, are active and observable seasonally or for certain times in a 24hr. period. In short, walkover surveys are the least accurate method at determining which species is present, but they are the least expensive and the most commonly used technique for identifying species presence. Walk over surveys cannot determine species' absence for obvious reasons. Depending on the threats to a species, the cost of anything more than a walk over survey may not be warranted. Do fence lizards warrant the same degree of accuracy in abundance and occurrence as SBKR? Of course not. This does not mean that more information is not useful, it simply means the cost is not justified.

At a more intensive level, survey efforts to compiled data sets may involve specific sampling designs, such as live-rodent trapping, bird points or transects, cover boards for reptiles and amphibians (collectively herps), or species specific U. S. Fish and Wildlife (FWS) and California Department of Fish and Game (CDFG) survey protocols in the case of threatened or endangered species. FWS and CDFG survey protocols are always required if a threatened or endangered species or its habitat is in the project area.

At an even more intensive sampling effort, and more expensive, specific species are targeted. In the case of SBKR it's more live trapping (presumably more traps), re-trapping locations (trapping success, varies, abundance varies with reproduction, animals move, etc.), seasonal trapping (abundance and occupation vary by annual season and among years. In short, more data are needed to assess impacts to SBKR due to its rarity and threat.

So, in regards to the RDEIR why belabor the obvious? This is why. Accurate assessment of potentially significant biological and evaluation of mitigation strategies requires biological data. The more data the

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better the assessment and mitigation. In this case the RDEIR relies on data from previous EIRs, surveys specific to the project including walkover surveys and FWS/CDGF survey protocol results, CNDDB online data bases and focused data collected specific to SBKR. So what's the problem? Those were not the most complete nor accurate data sets available. Two key, accurate and extensive data sources were not utilized.

The first data source is simple, accessible and usually costs nothing. If one wants to know, with a very high degree of confidence, where a species of interest is known to have occurred, consult a museum. Museums for unknown reasons, possibly cultural biases, are not traditionally accessed when environmental documents are prepared. Whether by bias or not, this is a counterproductive and unnecessary omission. The entire vertebrate collection of the Museum of Vertebrate Zoology (MVZ) at UC Berkeley, as an example, is accessible online, at no cost to the user. If MVZ and similar resources had been consulted, amateurish errors, such as the following, would like not have been made in the RDEIR. The RDEIR sites Orange-throat Whiptail as probable on the proposed project site. There is no authenticated record of Orange-throated Whiptail north of the Santa Ana River, much less near or on the project site. Another example, the RDEIR sites Dulzura Kangaroo Rat as the only five-toed Kangaroo Rat occurring on the project area. Not true, the Pacific Kangaroo Rat, a five-toed kangaroo rat, also occurs in the project area. (The project site happens to be in the transition zone between the two species.) Two more examples, of the many more errors and omissions, are the California Glossy Snake and Greenest Tiger Beetle. Museum records document California Glossy Snake occurring on and adjacent to the proposed project site, but it is never mentioned. The Greenest Tiger Beetle is also know to occur in similar habitat as the project area, but in the Santa Ana River, yet is never mentioned. Why choose these last two species among many to highlight? To illustrate an important point. First, both these species are very strong candidates for listing as endangered or threatened due to habitat loss and precipitous declines in abundance. Yet neither of these species is on the RDEIR radar because the museum data bases were not used. Adding to the consternation, the RDEIR explicitly lays claim to identifying and consider species likely to be listed in the foreseeable near future. A task it has clearly failed at for these two species, and there are others. These failures and omission would not likely have occurred had museum data bases been queried.

Before going to the second unused data source, it is important to illustrate a critical distinction between museum data bases and the NDDB. Museum records of species occurrences are authenticated by scientific experts, thus errors in identification are exceedingly rare. When mistakes are made, or taxonomic changes occur, the mistakes can be corrected because there is a specimen for every record. In contrast, NDDB specimen occurrence records cannot be checked for accuracy because there are no specimens. Additionally, there is no qualification for submitting NDDB records. Anyone can submit an NDDB occurrence record, regardless of training or competency.

One might understand, though not excuse, the omission of museum data searches in the RDEIR. However, there can be no conceivable reason, by my reckoning, why the second omitted data base was overlooked. I am speaking of course of the data collected for the uncompleted San Bernardino Valley Multispecies Plan (Valley Plan). The Valley Plan was never finished, but the species occurrence and abundance data were collected. The data collection was financed by local municipalities (including the City of Rialto), San Bernardino County (SBCO), California Department of Fish and Game and U. S. Fish and Wildlife Service. The data were envisioned to be the empirical basis for determine reserve areas, species occurrences and abundances, defining long-term management plans, successes or failures of management plans and so forth. In short, the data sets are very comprehensive and robust. So why were Valley Plan data not used in the RDEIR? This is a significant deficiency as all species impacts analyses and mitigations extend from using the best available data. Valley Plan data were available, the data were not used in the RDEIR.

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RDEIR IDENTIFICATION OF SBKR IMPACTS

The RDEIR is unclear on how potential significant impacts to SBKR from the proposed project were identified. The RDEIR cites using live-trapping results to delineate occupied habitat. How were the results applied to such delineations? What were the distances between occupied (sites where SBKR were captured) and unoccupied (sites were SBKR were not captured) habitat? How were intervening distance interpolated? How large were they? Where SBKR densities and habitat quality considered? If so how? What percentage of the planning area was trapped? Was this sufficient to represent occupancy/un-occupancy? How so? How was suitable habitat identified? Were bench habitats considered suitable and/or trapped? All sites were not trapped the same years so how were normal fluctuations in abundance and occupancy dealt with? In short, what were the criteria used to delineate occupied and unoccupied SBKR habitat? Absent clarification of these questions, there is no meaningful way to assess neither the baseline conditions of the project site and surrounding area nor the direct and indirect project related impacts reported in the RDEIR. Neither is there a basis to assess the quality and suitability of the proposed mitigations. This is a serious and fundamental deficiency of the RDEIR.

The RDEIR states that it identified "...at least158.7 acres of land above the 100-year floodplain that support dense chamise chaparral, and do not currently support the SBKR..." by examination of current aerial photography. This a curious statement. Obviously, SBKR occupancy cannot be determined by aerial photography. Yet the assumption is made that these areas are not occupied, while in other areas the RDEIR states that the chamise chaparral islands in the active flood plain are critical SBKR refugia. So which is it? They are unoccupied and therefore available for deconstruction or they are occupied and important for SBKR recolonization after flood events?

Related to the previous comment, the RDEIR states "For purposes of this assessment, as an approach to identifying potentially suitable habitat for the SBKR, it is meaningful to consider only alluvial scrub that is both within active hydrological regimes and viable in the long-term as suitable habitat (including P-RAFSS)." FWS jurisdictional rights to define SBKR critical habitat aside, besides the two mentioned criteria how was SBKR critical habitat RDEIR redefined? Were terrace habitats (chamise and chaparral) include or excluded? By what criteria? How did the results of this re-definition compare to one utilizing critical habitat defined by FWS? Was the redefined critical habitat used in the SBKR regional analysis also? If so, how was this done? Were the RDEIR new definition criteria applied to the Santa Ana Wash in the regional analysis? If so, by definitions used in the RDEIR, much of the occupied SBKR habitat in the Santa Ana is no longer suitable due to the Seven Oaks Dam affects on hydrology of the River. Suspicious minds might understandably and reasonably conclude the RDEIR appears to treat chamise and chaparral benches according to their relative position in the document and positive perspective of the treatment. Clearly, the RDEIR is seriously deficient in resolving these apparent and repeated contradictions.

The RDEIR states recent trapping results coincident with the proposed project potentiates a more accurate definition of critical habitat for SBKR than the FWS SBKR Critical Habitat Designation. This too is a curious statement. The statement assumes that recent trapping results, occupied versus not, can determine what is critical habitat necessary for the recovery of the species and what is not. Suitable habitat for the vast majority of biological species is never fully occupied, including SBKR. So how exactly were negative trapping results used to redefine suitable habitat as well has critical unoccupied habitat required for the long-term survival of the species? The RDEIR here again, is deficient at providing validating data or discussions concerning its assertions and conclusions.

3

PROJECT SBKR IMPACTS AND MITIGATION

Significant impacts to SBKR identified in the RDEIR from the proposed project are seriously understated. Proposed mitigations in the RDEIR to mitigate significant impacts to SBKR are critically inadequate. And, indirect impacts to high quality, high density SBKR habitat are not disclosed.

First, the DRDEIR proposes to constrict the existing Lytle Cr. channel by development in the wash and levy construction (seven mile revetment) along the length of the development. Placement of the levy will potentially significantly impact the current, essentially natural, hydrology of Lytle Cr. Wash. The hydrologic process that created and currently maintains high quality high density SBKR habitat. Yet the RDEIR presents no hydrologic study or assessment of the potential impacts.

Constricting the existing channel will increase scouring in the wash. After levy placement, the same volume of water will be forced through a narrower channel. Simple surface hydrology guarantees water velocities and associated channel scouring will increase, resulting in an increased scour zone. SBKR cannot utilize the scour zone for burrows, nor are there forage or shelter components. An increased scour zone will come at the expense of the remaining pioneer and intermediate AFSS habitats in the wash after levy placement. More precisely, high quality, high density, occupied SBKR habitat will likely be seriously degraded if not eliminated.

Levy placement will also diminish the ability of flows in the wash to meander through the channel in a reticulate pattern, as the channel width will be reduced. The meandering reticulate flow pattern is the very process that creates and renews high quality habitat for SBKR. After levy placement the opportunity for meandering flows comparable to the currently existing conditions will be irrevocably altered along the length of the levy. The ability of the hydrology to create and maintain quality SBKR habitat will likely be significantly diminished, if not eliminated.

Thus, this portion of the proposed mitigation to partially mitigate significant direct SBKR impacts to high quality, high occupancy SBKR habitat cannot be used as mitigation for two reasons; First, the proposed mitigation area will potentially be significantly impacted by the project. Second, and more critically, this portion of the proposed SBKR mitigation cannot be used as mitigation because it is a significant undisclosed and unmitigated indirect impact.

Second, the proposed mitigation to offset significant project impacts to high quality high density SBKR by reclaiming and/or converting significant acreages of chamise dominated benches to pioneer and or intermediate high quality ASFF habitat is speculative at best, having a very high probability of failure.

These chamise dominate benches do not represent degraded or diminished SBKR habitat. They are naturally occurring climax habitats within the hydrologic regime. Chamise dominates these islands because evolved natural hydrologic, edaphic (soil) and biotic conditions dictate that chamise, and only chamise, dominates these benches. These areas are not degraded pioneer and intermediate AFSS to be reclaimed. They are naturally occurring successional communities created by fluvial processes. The edaphic and hydrologic conditions will not, cannot support pioneer and intermediate biotic components to any great extent or longevity because if they could, these floristic components would already dominate.

Additionally, the deconstruction and maintenance, in perpetuity, of formerly chamise dominated mature AFSS habitat into SBKR habitat, of even marginal suitability, has no convincingly successful precedent. To illustrate, deconstructing chamise dominated benches to suitable high quality SBKR habitat was a major mitigation component to offset significant impacts to SBKR from the Seven Oaks Dam on the Santa Ana River. Approved almost a decade ago, not one single acre of chamise habitat has been successfully converted to any SBKR habitat anywhere in the Santa Ana River.

A recent and closely monitored attempt to relocate SBKR and re-construct SBKR habitat in the Lytle Creek Wash, mitigation for the Lytle Creek North Development, washed away before the study was concluded. Preliminary results suggested a modicum of success at substantial management effort, involving heavy applications of herbicides (having unknown short or long-term incidental affects as these

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were not being monitored) and fire prescriptions. Most germane to the RDEIR, SBKR population increases were not appreciably enhanced. While there are experimental merits to the attempt, it completely failed as a mitigation.

The RDEIR states "On-site mitigation shall include restoration, creation, and preservation of approximately 34.5 acres of chamise chaparral within Neighborhood II above the 100-year floodplain that is immediately downstream of an contiguous with, the SBKR Conservation Area." Here the concept of re-creating SBKR habitat is extended to areas above the 100 - year floodplain, something that has never been successfully done, to areas that never were SBKR habitat, at least in the recent past. In these cases, the success of creating suitable pioneer and intermediate AFSS suitable for SBKR becomes even more unlikely to succeed if for no other reason than it never was SBKR habitat. At a minimum, long-term management of these sites will require long-term and intensive management.

To presuppose that anthropogenic manipulations can reconstruct, and maintain in prepetuity, the edaphic, biotic and hydrologic conditions suitable to pioneer and intermediate AFSS on these mature chamise dominated benches is not mitigation, it is experimentation. Any proposed actions to rehabilitate and/or construct SBKR habitat identified by the RDEIR is a misapplication of questionable management strategies as a substitute for natural fluvial systems. This is not substantive and meaningful mitigation for direct and indirect SBKR impacts, disclosed or undisclosed, from the proposed project.

Third, preservation of unoccupied SBKR habitat upstream of the I-15 overpass, as proposed in the RDEIR, indirectly benefits SBKR by preserving the hydrology, but has no direct positive benefit for the animal. Aside for a few locations near the I-15 overpass, SBKR do not occupy, have not recently occupied, and are not likely to occupy this portion of Lytle Creek, regardless of any proposed reintroduction efforts. Repeated trapping events, most recently and intensely over the last ten years, and least recently by museum collecting expedition records, have failed to documented SBKR in this portion of Lytle Creek. By habitat suitability standards, cited in the RDEIR, and professional opinion of those who have worked extensively with the animal, the habitat in this reach is suitable for SBKR.

The lack of SBKR, both present and historic, is not due to any obvious barriers or lack of source population. SBKR have been recently documented adjacent to the I-15 overpass, both upstream and downstream. Thus, the I-15 is not likely a barrier. There is a large source population downstream of the I-15 overpass. Thus, dispersers are not likely a problem. The unoccupied habitat above the I-15 is well within the known dispersal distance of SBKR, documented at 1km. Thus, isolation is likely not a problem. Still, the animal is stubbornly absent. The evidence illustrates essential points:

1) The current habitat standards for SBKR, those cited in the RDEIR and often used by professionals, are correlational. Meaning, both the habitat standards and professional opinions correlate with SBKR occurrence, but they neither predict nor dictate either occupancy by SBKR or true habitat suitability for SBKR.

2) The evidence that this area of the wash has been unoccupied by SBKR for a long time strongly suggests the habitat is simply not suitable, regardless of habitat correlates and professional opinion. Simply put, we do not know all the biotic or abiotic conditions, historic or present, essential to SBKR. Attempts to introduce and establish SBKR in this portion of Lytle Creek, to any appreciable degree or persistence, has a very high probability of failure.

The absence of SBKR in the proposed mitigation area above the I-15 overpass, for no obvious reason, is not without precedent. SBKR occur in abundance at the confluence of Mill Creek and the Santa Ana River. Upstream of the confluence, SBKR are not known to occur on Mill Creek. There has been extensive trapping, there are no obvious barriers, there is an adjacent source population, and the habitat meets the suitability requirements delineated in the RDEIR as well as the judgment of experienced professionals. There are simply areas of apparently suitable habitat, by present knowledge, where SBKR do not occur for unknown reasons. No amount of habitat manipulation or animal introductions will change this fact. Preservation of unoccupied SBKR habitat upstream of the I-15 overpass, as proposed in the RDEIR, simply has no demonstrable mitigation value to partially offset significant direct impacts to SBKR from the proposed project.

Fourth, the RDEIR proposes to partially offset significant impacts to SBKR from the proposed project by enhancement of degraded SBKR habitat (exclusive of those dominated by chamise) and reintroduction of SBKR. The value of the proposed mitigation is marginal best because, here again, there is no precedence for either enhancement or reintroduction attempts being appreciably successful.

One of the most ambitious attempts at a multi-year, comprehensive and closely monitored attempt to enhance SBKR habitat occurred recently at the Redlands Sports Park. The plan had all the ingredients deemed necessary for a success. SBKR abundances and habitat quality were determined before and after habitat enhancement, enhancement prescriptions were applied, artificial kangaroo burrows were constructed, the enhanced habitat was formally and recently dominated by pioneer and intermediate AFSS, animals were re-trapped and relocated and animals were monitored for successive years. The plan failed. SBKR habitat did not appreciably, much less significantly, increase. The SBKR population did not increase, nor was there convincing evidence of successful reproduction, the gold standard of success. To reiterate, the plan failed. More germane to the RDEIR, it was accepted mitigation for the Redlands Sports Park, the same concept proposed by the RDEIR, and it failed.

Fifth, presupposing conversion of chamise dominated habitats is at least marginally successful at establishing quality AFSS habitat, and that reclamation of degraded AFSS is successful, and that SBKR re-introductions are successful, these actions will not be adequate SBKR mitigation for the proposed project. It is important to recall that these mitigations are proposed to replace the high quality, high density SBKR habitat significantly, directly and indirectly impacted by the project. The probability that reconstruction and enhancement of SBKR habitat will result in comparable high quality, high density SBKR habitat are vanishingly low. Add to the equation that undisclosed and undefined impacts from channelization of the Lytle Creek Wash have yet to be disclosed or considered, and odds of mitigation resulting in habitat equivalent to that being lost become even lower.

Sixth, the RDEIR directs that SBKR within the footprint shall be salvaged and translocated to newly enhanced or created habitat. Translocation of animals from a project footprint is an often proposed and implemented mitigation element. But does it work? The vast preponderance of evidence indicates this is meaningless mitigation. SBKR have been translocated, but rarely have there been follow-ups to determine if the animal survived. When there have been follow-ups, the majority of animals did not survive. In the very rare case were the translocated animals that did survive were monitored for three to five years, there was no evidence the translocated animals were reproducing. In short, no SBKR population of an appreciable size or longevity has been shown to result from the practice of translocation. Does this mean translocation should not be done? Of course not. When the choices are to leave an animal to certain death, or relocate an animal to an area where survival probability is low but greater than zero, the choice is clear. However, this does mean that translocation of SBKR as mitigation should in no way ever be considered to have substantive mitigation value.

Seventh, the RDEIR proposes a variety of SBKR mitigations, e.g: enhancement, habitat reconstruction, habitat enhancement, creation of new populations through relocation and so forth. Given that these mitigation elements are deemed sufficient by the RDEIR to reduce otherwise significant impacts to non-significance, that is to offset the loss of high quality high density SBKR habitats, would it not be prudent, judicious, and cautious to determine that the mitigation strategies were successful in creating high quality, high occupancy habitats comparable to the ones lost before the existing habitat is lost? SBKR is, after all, a critically endangered species. There is no room for error or recourse if the mitigation elements fail. And failure is a likely probability for reasons previous discussed.

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REGIONAL SBKR IMPACTS AND MITIGATION

The RDEIR correctly states impacts to SBKR must be considered and mitigated to the level of non-significance on a regional basis such that FWS is not compelled to issue a Jeopardy Opinion on the project. Implicit in this RDEIR effort is an expectation and assurance the SBKR population in the planning area, after mitigations, will be viable. Yet there is no meaningful discussion in the RDEIR what defines "viable". Population viability is typically defined by a PVA (population viability analysis). No PVA has been done regionally for SBKR. Neither does the RDEIR present a PVA for SBKR populations in the planning area. To reiterate, the RDEIR provides no evidence or analysis to support the implied contention that there will be a viable SBKR population post construction impacts and mitigations.

The RDEIR is further deficient in a consideration or discussion of SBKR regional status and threats thereto. Meaningful SBKR populations are found in the Santa Ana River and tributaries, Cajon Creek, Lytle Creek, the San Jacinto River and nowhere else:

Long-term survival of SBKR populations in the Santa Ana is not assured due to the Seven Oaks Dam. The hydrology of the river has been permanently altered and mitigations unrealized. High water flows that otherwise would renew, create and rejuvenate SBKR habitat are no longer possible. Other impacts continue, such as non-mitigable impacts under FEMA to City Creek, un-mitigated flood control impacts, and undisclosed unconsidered impacts from the Santa Ana River Trail System. Additional impacts are likely pending approval of "Plan B" being formulated and affecting the Highland/Redland portions of the Santa Ana River. In short, long-term survival of SBKR in the Santa Ana River faces severe threats.

Long-term SBKR survival on the San Jacinto is even more questionable. The population here consists of a small isolated remnant in the San Jacinto Wash. Insipient habitat down-stream of the occupied area is consistently impacted by flood control practices. Existing and occupied habitat has recently been diminished by the repositioning of EMWD the percolation basins. Natural hydrologic events no longer exist due to high water dikes and urban/suburban encroachments. There is a very high probability the entire population will be extirpated by a single large flood event. There are no refugia for recolonization. This SKR population is at severe risk of extinction.

Long-term SBKR survival on Cajon Creek has better prospects but is in no way secure. Recent set asides of SBKR conservation lands, in perpetuity in the wash have removed development threats to the population. But, no meaningful long-term management practices or monitoring infrastructure nor central authority are in place to manage the Cajon Wash SBKR population. Thus, SBKR populations and habitat in these preserves are being impacted from upstream hydrologic manipulations, OHV enthusiasts, other recreational activities, exotic weed invasions, indirect impacts from Glen Helen Regional Park operational and improvement activities, and road improvements. The most recent of the later was the grading of an otherwise unused road in the wash to facilitate Glen Helen event access. In short, long-term SBKR persistence in Cajon Wash is nowhere near assured. And now, the long-term survival of the remaining significant SBKR population in Lytle Creek is threatened by the proposed project detailed by the RDEIR.

The RDEIR is deficient in discussing, recognizing, analyzing or mitigating the regional long-term threats to survival of SBKR from the proposed project. Rather than reducing regional impacts to a level of non-significance, the project, as proposed in the RDEIR, will likely significantly contribute to the regional impacts and decline of the species. Considering the regional threats collectively, the proposed project will likely jeopardize the long-term survival of SBKR.

REGIONAL ANALYSYS OF IMPACTS TO SUITABLE HABITAT FOR SENSITVE WILDLIFE SPECIES

The RDEIR presents a regional analysis of impacts to suitable habitat for sensitive wildlife species. The analysis proceeds from identifying extant habitat found in the larger regional area, and then estimating percent of habitat impacted from the proposed project and in some cases, the regional losses the project impacts represent for some sensitive species. While the intent of the analysis is appropriate, the approach used is not. The results of analyses will vary depending on the size of the regional habitat considered. The larger the included regional area, the smaller the project impacts, and vice versa. So, the results will vary depending on how regionally boundaries are defined, which obscures the true regional impacts.

A second problem, animal and plant species are neither equally nor even distributed throughout the regional habitat, regardless how the regional habitat is defined. Basing the regional analyses on habitat makes a basic and incorrect assumption that they are. How can such an analyses provide meaningful results?

A third problem, the habitat based regional analysis also assumes that the preponderance of sensitive species' distributions occur in the defined regional habitat. This is an incorrect assumption. The assumption, to give a few examples, is false for Rufous-crowned Sparrow, Orange-throated whiptail, and burrowing Owl. The resulting error in the regional analyses for these and similar species is undefined. If could underestimate as well as overestimate the regional impacts. Either way, the habitat base regional species impacts analysis becomes nebulous and limited in value.

So what might have been a more constructive way to perform the analysis? Rather than habitat based, why not use the abundance or age classes ratios (to identify highly productive areas) of a target species in the regional area? Obviously one would need abundance and age class data for target species in the regional area. A difficult and labor intensive effort were it not for the fact those data already exist. Data from the defunct Valley Plan include multiple years of abundance and age class data for all sensitive species in the regional area at multiple locations in the regional planning area defined by the RDEIR. As previously mentioned, Valley Plan data could also fill in the "holes" in the inferior survey data collected and used for the proposed project. Some examples have been noted, here is another. The RDEIR elects not to apply a regional analysis to LAMP, presumably because LAPM data are insufficient. Had Valley Plan data been used, there would be sufficient data. The results would likely show that the proposed project will eliminate up to 20% of the habitat were LAPM is known to occur.

Why Valley Plan data are not used, either in the project related or regional impacts assessments, or in determining species' presences and abundances in the project area, is again unclear. Local municipalities (including the City of Rialto) as well as SBCO, FWS and CDFG paid for it. Valley Plan data would have been far superior, far more comprehensive and far more accurate than the habitat based approach used in the RDEIR.

SANTA ANA RIVER WHOOLLYSTAR

The RDEIR reports that the endangered Santa Ana River Whoollystar (*Eriastrum densifolium sanctorum*) does not occur in the project area, but rather the plants in question belong to the non-sensitive subspecies *Eriastrum densifolium elongatum*. The claim is based on significant differences in corolla length between the two subspecies. So of, let us say, four features measured and compared, the determination was made that because the plants on the project area are 25% different from *sanctorum* and 75% similar to *sanctorum*, the plants could not be the endangered *E. d. sanctorum*. A curious statement worth repeating. Because the plants were more similar to *sanctorum*, having differed from sanctorum by only one of many compared characteristics, the RDEIR concludes the plants on the project area could not be *E. d. sanctorum*? The logic escapes me.

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Consider another perspective. The plants we are talking about are subspecies, not full species, meaning by the current biological species definition, were *E. d. sanctorum* and *E. d. elongatum* to cross pollinate, "breed", under natural conditions, they would produce fertile off spring and their offspring too would produce fertile offspring. Because these are subspecies able to reproduce under naturally occurring conditions, their progeny would have characteristics of both, which the plants in the project area do. So, when, geographically, does *E. d. sanctorum* distribution end and *E. d. elongatum* begin? The question cannot be answered because it is the wrong question. Because they are subspecies which freely exchange genetic information there is no distinct boundary between the subspecies, but rather a gradient of shared and unshared characteristics across the landscape. A condition confirmed by the study by Brunell and Reiseberg cited in the DREIR. So how then does/could one, with as much certainty as possible given the two plants in question are subspecies, determine if the plants in the project area deserve mitigation? One might do that exactly what the RDEIR did, but with the a more parsimonious interpretation of results. Specifically, compare characteristics and assign the plants to the subspecies with the most similar characteristics. In this case, the plants in the project area are more similar to *E. d. sanctorum*, not marginally but by the majority of characteristics examined. Nothing more can be said to assign the plants more definitively to one subspecies or the other absent extensive and expensive studies. Given the preponderance of characteristics and available evidence, the plants in question more closely affiliates with the endangered *E. d. sanctorum*, not *E. d. elongatum*. Ought not the plants be considered endangered? The RDEIR should treat the *Eriastrum densifolium* on the project site as endangered Santa Ana River Whoollystar and mitigate accordingly.

RAPTOR FORGING HABITAT IMPACT ASSESSMENT

The RDEIR assessment of impacts to raptor foraging is inadequate. The RDEIR determines that because upland habitat is poor raptor foraging habitat impacts are not significant. First, there is no citation to support this assertion. Raptors do utilized upland habitats for foraging. Their success may be less but nevertheless they do utilize upland habitats. Second, the RDEIR fails to recognize that upland habitats are a significant source of the raptor forage base; rabbits, hares, ground squirrels, small rodents and so forth. Obviously, affecting the raptor forage base will impact raptors.

RDEIR IDENTIFICATION OF CORRIDORS AND CONECTIVITY IMPACTS

The RDEIR considers and addresses impacts to significant animal movement corridors on a false assumption. The RDEIR assumes that the majority of animals use pioneer and intermediate AFSS habitat for dispersal and movement corridors in the project area, discounting the impacts that development of upland habitats will potentiate. As an example, the RDEIR correctly points out that mule deer do not use pioneer and intermediate AFSS for movements (they actually avoid them due to lack of cover). As mule deer are the primary prey of mountain lion, won't interrupting mule deer connectivity logically affect mountain lion connectivity and diminish their available suitable habitat? Of course it would. What about other essential predator and prey relationships? Bobcat and rabbit? What about weasels, do they preferentially use intermediate or pioneer AFSS, or do they prefer more mature cover? A plethora of research has resoundingly shown that major predators are essential to the health of any ecosystem, yet the RDEIR does not comprehensively considered movement corridors for them, or their prey, in the proposed project. My point here is that, once again, there is an inconsistent application of logic by the RDEIR, in this case pertinent to assessing, much less redressing, project related impacts to movement corridors.

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HEA ALTERNATIVE ASSESMENT AND MITIGATION OF RAFSS IMPACTS

The RDEIR proposes that HEA impact assessment to RAFSS may be substituted for ratio based mitigation estimates. HEA is not the proper tool for determining habitat mitigation equivalencies prior to their being impacted. The tool was developed to aid mitigation for oil spills after they occurred. On the surface the HEA appears appealing because it attempts to recognize habitat based on habitat value elements, such as quality, positioning the landscape, animal and plant resources values, not just the size of the habitat. But, as the saying goes, the devil is in the details. For example, a cogent argument can be made, has been made, that the corridor impacts from the proposed study are not being fully disclosed or mitigated. But what constitutes a high value corridor anyway? Experts will most assuredly disagree, depending on the frame of reference, meaning, are we talking about corridors for specific animals, group of animals, or corridors to maintain ecological components necessary to a healthy ecosystem, corridor widths, vegetative composition? The playing field gets very complicated very fast.

HEA is not necessary in the context used in the RDEIR. Ratio based mitigation ratios are not set in stone, as the RDEIR's exercise with SBKR habitat mitigations clearly demonstrates. Ratios in ratio based mitigation are guidelines, merely recommendations. Nor is there any *a priori* rule precluding the adjustment of mitigation ratios based on the habitat elements HEA purposes to consider. Simply put, enabling HEA procedures does nothing that ratio based mitigation doesn't already allow for. HEA only confuses the playing field.

MITIGATION OVERSIGHT AND MANAGEMENT

The RDEIR assigns authority to determine when applicants of project enabled by the proposed plan have met mitigation standards and requirements to the Development Services Director (Director). This potentiates a conflict of interest. The any city stands to benefit from developments within their jurisdiction as this adds to the city's tax base. The potential or at least perceive conflict of interest can be avoided by delegating authority to determine when mitigation standards have been met to an unbiased independent panel, disconnected and uninfluenced by the city.

While the RDEIR appoints an authority (the Director) for determining when applicants of projects enabled by the DREIR have met mitigation standards, no similar mechanism is established to determine when mitigation standards for the RDEIR itself have been met. This appears to be a significant omission as the preponderance of the mitigation is aimed at significant impacts to SBKR, an endangered species. Additionally, as a significant bulk of the SBKR mitigation requires habitat conversion, creation, rehabilitation, and SBKR reintroductions, all speculative and largely still experimental in nature, ought not there be a requirement that those mitigations first be done and deemed successful before existing high occupancy, high density SBKR habitat is irrevocably destroyed or otherwise significantly altered?

The RDEIR SBKR mitigation proposes to establish several SBKR preserves. Who will manage these preserves, in perpetuity? How will they be managed, in perpetuity? Who will assess and approve plans submitted for management and monitoring, in perpetuity? By what criteria will mitigations be deemed successful? Who will have that authority? What recourse will there be if mitigations are not successful? Simple signage, referenced in the RDEIR, is clearly not enough, as witnessed by OHV inroads, illegal dumping and unauthorized activities on SBKR preserve lands in Cajon Wash and the same problems plaguing the North Etiwanda RAFSS Preserve. Management by jurisdictional entities is problematic, due to conflict of interest entanglements. A third party, whose specialty is preservation and management, is the most appropriate and most commonly used entity, yet the RDEIR never mentions these groups. While the RDEIR requires that funds sufficient for long-term conservation and management be posted, at

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least for RAFSS mitigations, how will these funds be determined? How will the funds be managed? What contingencies are there for bankruptcy of a project applicant? In short, while the RDEIR proposes a wide variety of SBKR and other mitigations, both for the proposed plan and subsequent project applicants, the RDEIR fails in the details of how these mitigations will be managed and preserved in perpetuity.

This concludes my comments on the RDEIR. I hope the comments are constructive and prove useful in your evaluation of the adequacy of the RDEIR document. Thank you for the opportunity to comment.

Respectfully,

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Position: Independent Biological Consultant **From:** January 2010 **To:** Present
Employer: Gerald T. Braden/ Braden Biological Services

Activities: Independent biological consulting work. Surveys for land, shore and water birds, Desert Tortoise, reptiles, amphibians, Peninsular Bighorn Sheep and San Bernardino Kangaroo Rat. Consultations on threatened/endangered species, document reviews.

Position: Research Biologist/ Interim Curator **From:** October 1994 **To:** January 2010
Employer: San Bernardino County Museum/Biological Sciences Division

Responsibilities:

My primary responsibilities as a research biologist and interim curator were characterized by a high level of independence to design, perform, interpret, publish, and review original, professional, and scientific research using statistical, problem solving, personnel management, budget management, inter-agency coordination, and supervisory skills on a daily basis.

As interim curator I was singly accountable for all matters pertaining to the Biological Sciences Division. Responsibilities entail overseeing, augmenting, and maintaining regionally significant research collections of the herpetofauna, small mammals, avifauna, botanical, and invertebrate taxa of the Southwestern United States and northern Mexico. Duties entailed the collection, preparation, and preservation of scientific and tissue specimens to modern museum standards and practices. Duties also entail developing and maintaining research collaboration and strong working relationships with local universities and museum scientists. Duties also include maintaining hard and electronic copies of accession books, responding to requests, and dissemination of collections information to professional and amateur biologists, resource managers, educators, and the general public. Duties also included generating and managing a $400,000 annual budget (variable by year). Budget revenue was generated by contract solicitations and grant sources. Duties also included interfacing with museum visitors via tours, lectures, and disseminating information, exhibit and web module conception, design, and creation, consultation with other county departments, regulatory agencies, other museums, and academia pertaining to expertise, advice, environmental compliance, and general networking. Duties also included staff hiring, task assignments, work performance evaluations, and counseling.

As Research Biologist I was responsible for the development, implementation and supervision of Contract Field Studies program. The Contract Field Studies Program involved the conception, design, development, implementation, analysis, and reporting or manuscript write-up on original long-term field studies. Studies pertain to varied aspects of the distribution, life history, biology, and/or ecology of vertebrate taxa of the Southwestern United States. These studies involved the application of standard survey and sampling methodologies or the creation of new methodologies when warranted, and a strong capacity for independent problem solving and original thought. These studies also required a working knowledge of contemporary biological theories and paradigms as published in the primary scientific literature. Many of the contract field studies involve federal and state threatened or endangered species, therefore the studies required a working knowledge, understanding, and application of state and federal environmental laws such as the Endangered Species Act, Clean Water Act, National Environmental Policy Act, Federal Coordination Act, and California Environmental Quality Act.

In addition, the contract field studies involved the teaching, training and supervision of employees and contractors in standard scientific survey and data collection techniques, a variety of population sampling, estimation, persistence, area use and utilization models. Duties also required the application and interpretation of multivariate and probabilistic statistics, and the ability to effectively use major statistical and plotting software, such as SASS, BMDP, SigmaStat, and SigmPlot, in addition to the commonly used spreadsheet and databases software packages.

Contract field study duties also involved coordination among disparate jurisdictions with conflicting goals and missions. Jurisdictions included California Department of Fish and Game, Nevada Department of Fish and Wildlife, United States Geological Survey Biological Resources Division, United States Fish and Wildlife Service Ecological Services Offices, the United States Bureau of Land Management, the United States Bureau of Reclamation, Southern Nevada Water Authority and County departments.

Duties also included the hiring, training, coordination, and supervision of museum biologists, and coordination with the local universities to obtain highly qualified and motivated undergraduate and graduate students. Duties also entailed a contemporary working knowledge of the habitats and identification of the flora and fauna of the region, their historic and current distribution, species or taxa specific sampling techniques, and vegetation data collection techniques.

Position: Wildlife Biologist: **From:** May 1991 **To:** October 1994
Employer: U. S. Fish and Wildlife Service/Ecological Services

Responsibilities:

The federal wildlife biologist position was characterized by a high level of independence to provide guidance to federal, state, local, and private jurisdictions to facilitate compliance with the Endangered Species Act (ESA), Federal Coordination Act, National Environmental Policy Act, and Clean Water Act. The position was also characterized by a high level of independence to design and implement studies on threatened and endangered species to provide a scientific basis for endangered and threatened species survey protocols as well as management and recovery plans.

Foremost among these studies of threatened and endangered species studies were long-term life history, habitat/fitness, nest placement, parasitism, detection, and dispersal studies of the threatened California Gnatcatcher. The results of these studies included three primary literature publications and the development of the present day U. S. Fish and Wildlife California Gnatcatcher Survey Protocol. Other field studies involved protocol surveys for other listed species including Stephens' Kangaroo Rat, Light-footed Clapper Rail, Southwestern Willow Flycatcher, and Least Bell's Vireo.

In addition to the skills necessary to conceive, implement, and successfully complete a scientific study, these studies involved developing and maintaining partnerships among the FWS, University of California Riverside, San Bernardino County Museum, Riverside County Parks Department, Metropolitan Water District, and the private sector.

Other duties involving ESA guidance entailed working with jurisdictions to assure project compliance with the ESA and related environmental laws. Most often this involved providing guidance toward obtaining Threatened and Endangers Species take permits (Sections 10(a)1a, 10(a)1b, and 7) and advice on possible non-compliance (Section 9, illegal take) or other potential ESA and Clean Water Act violations. Not infrequently, these duties were performed in a highly charged emotional, often combative arena, which required substantial amounts of tact, diplomacy, creativity, and patience to arrive at constructive resolutions.

Position: Graduate Student **From:** Oct. 1987 **To:** Oct. 1991
Employer: Biological Sciences Department, California State Polytechnic University Pomona.

Responsibilities:

My thesis worked consisted of four years of study on the territory size, habitat use, den characteristics, and seasonal ranges of Black Bears (*Ursus americanus*) in the San Gabriel Mountains of Southern California. The work involved trapping bears by culvert traps and leg snares, administering tranquilizers, attaching radio collars, determining locations and den sites through telemetry, converting telemetry locations to territory and seasonal use-areas using multiple home range algorithms, data analysis, report writing, and professional presentations to scientific organizations and the general public. The work involved long hours alone in remote locations of the San Gabriel Mountains in all types of weather conditions. Because the bear project was on going, duties also included training subsequent graduate students in proper use of traps, snares, and telemetry, sedating wild bears, and home range analyses.

I also trained and assisted graduate students studying habitat use and territory utilization of coyote, raccoon, and opossums along urban-rural interfaces. Duties included the live capture of coyote, raccoons, and opossums as well as the determination of home ranges and territories for the same taxa using standard home-range algorithms. Independent of my graduate career I also studied age and growth patterns of California Walnut (*Juglans californica*) by analysis of tree ring growth data.

Position: Hydrologist **From:** ca. March 1981 **To:** October 1987
Employer: U.S. Geological Survey

Responsibilities:

The hydrologist position involved the collection, analysis, and reporting of surface flow and ground water data. Duties involved constructing, maintaining, and monitoring surface water gage stations and measuring surface water discharges at remote locations in the deserts, mountains, and coastal valleys of Southern California. These duties required a practical knowledge of standard construction techniques and equipment, surface water flow characteristics, hydrologic dynamics of current and historic flood events, the effects of varied geologic formations, soil types, and substrates on surface and subsurface flows, and the ability to work effectively under remote, hazardous, and unsupervised conditions under all extremes of weather. Analysis of surface and ground water data required a working knowledge of basic hydrological mathematics and principals. The position was a permanent federal government position with full benefits. I left the position to pursue an advanced degree in biological research.

Professional Memberships:

American Society of Mammalogists
American Society of Ichthyologists and Herpetologists
American Ornithologists' Union
Association of Field Ornithologists
Cooper Ornithological Society
Raptor Research Foundation
Wilson Ornithological Society
Society for the Study of Amphibians and Reptiles
Copeia

Awards and Citations:

Performance Award - U. S. Geological Survey: 1983.
Tim Brown Memorial - CSPUP 1990.
Durham Award - Southern California Academy of Sciences 1991.
Performance Award - U. S. Fish and Wildlife Service: Rating year 1993.
Performance Award - U. S. Fish and Wildlife Service: September 1993.
Performance Award - U. S. Fish and Wildlife Service: Rating year 1994.

Presentations

Presentation of original ornithological research at American Ornithologist and Cooper Ornithological Societies meetings.

Invited speaker on original research at specialized symposia such as:
- CalGnat 1994 at University of California Riverside, Coastal Sage Scrub Symposium 1995 at the San Diego Zoo

- Puente Hills Wildlife Corridors and Vanishing Habitats Symposium 1995 at California State University Fullerton 1995.

- The 1999 Annual Convention of Environmental Journalist speaking on "Science and Multispecies Habitat Conservation in Coastal Southern California".

- Semiannual Guest Lecturer at the Wildlife Ecology Graduate Student Seminar at California State Polytechnic University Pomona.

Activities

- Scientific Reviewer: Reviewer of original scientific studies submitted for publication to primary scientific societies, including The Wilson Bulletin, Journal of Field Ornithology, AUK, Condor, Journal of Wildlife Management, and The Journal of Canadian Zoology.

- Invited participant on the Science Consistency Review Panel for the USDA EIS Revised Land Management Plan for Southern California National Forests: October 26th and 27th, 2004

- Semi annually solicited for training USFS biologists on the occurrence and identification of sensitive birds and small mammals of the San Bernardino National Forest.

- Solicited for review, opinion, advice and consultation on the San Bernardino Kangaroo Rat, California Gnatcatcher, Southwestern Willow Flycatcher, and other federally listed or sensitive species and ecosystems of the Southwestern United States. Solicitors included but are not limited to U. S. Fish and Wildlife Service, U. S. Bureau of Reclamation, U. S. Bureau of land Management, U. S. Forest Service, U. S. Park Service,

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California Department of Fish Game, Nevada Department of Game and Fish, County of San Bernardino, Metropolitan Water District, Endangered Habitats League, Center for Biodiversity, Natural Heritage Institute.

- Expert Witness on California Gnatcatcher for the U. S. Department of Justice. DJ File Number 90-8-6-04239, United States of America v Granite Homes, INC.

Endangered/threatened/sensitive species experience

- California Gnatcatcher (*Polioptila californica californica*): Principal investigator on an eight-year study of the life history, habitat affinities, fitness, detection, nest monitoring and dispersal of CAGN in western Riverside. Developed the current FWS CAGN survey protocol. Two years of protocol surveys for the San Bernardino Valley Multi-species Plan. Multiple gray literature reports and three peer reviewed publications in primary ornithological journals. Invited review of FWS population modeling, protocols and policies pertaining to the species.

- Least Bell's Vireo (*Vireo bellii pusillus*): Five years of protocol surveys on the Santa Ana and Mojave Rivers and associated tributaries.

- Arizona Bell's Vireo (*Vireo bellii arizonae*): Five-years of surveys in the Lower Grand Canyon. Three years of surveys, nest monitoring, and habitat study on the Virgin River in Southern Nevada.

- Southwestern Willow Flycatcher (*Empidonax traillii extimus*): Nine years of study of the life history, distribution, habitat affinities, fitness, nest success, detection and dispersal of SWWF along the lower Colorado River and its tributaries. Six years of protocol surveys for the U. S. Forest Service. Multiple gray literature reports. Invited reviewer of FWS regulations, protocols and policies pertaining to the species.

- Yuma Clapper Rail (*Rallus longirostris yumanensis*): Yuma Clapper Rail surveys along the Virgin River in Southern Nevada (nine years). Multiple gray literature reports. FWS invited reviewer of current YCRA/BLRA survey protocol.

- Light-footed Clapper Rail (*Rallus longirostris levipes*): Two years of presence/absence protocol surveys at the Newport Back Bay.

- Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*): Yellow-billed Cuckoo surveys along the Virgin River in Southern Nevada (nine years). Incidental observations on the lower Colorado River (Virgin River south to the Mexican border, two years). Multiple gray literature reports.

- Stephens' Kangaroo (*Dipodomys stephensi*): Two years of protocol surveys in western Riverside County and Camp Pendleton.

- San Bernardino Kangaroo Rat (*Dipodomys merriami parvus*): Five years of protocol trapping for SBKR for the San Bernardino Valley Multi-species Plan and the U.S. Forest Service. Multiple gray literature reports. FWS invited reviewer of current SBKR survey protocol. FWS invited reviewer of Seven Oaks Dam BA.

- Desert *Tortoise (Gopherus agassizii)*: Relocation and radio telemetry study of Desert Tortoise in the west Mojave Desert in the late 1980's. A combined four years of Desert Tortoise surveys in the upper Coachella Valley and the eastern Mojave Desert.

Current Interests

- Pre-post fire comparisons of the small mammal community in Alluvial Fan Sage Scrub.
- Pre-post fire comparisons of the breeding season avian community in Alluvial Fan Sage Scrub
- Nest site selection, life history and habitat/fitness associations of the endangered Southwestern Willow Flycatcher.
- Southwestern Willow Flycatcher dispersal and site tenacity.
- Affects of water availability on the avian community in the lower Grand Canyon.
- Affects of water availability on the avian community along the Virgin River in Southern Nevada.
- Avian community responses to habitat modifications/reclamation along the Las Vegas Wash in southern Nevada.
- California Gnatcatcher Dispersal and site tenacity.
- Habitat/fitness relationships, dispersal, and community associations of the endangered San Bernardino Kangaroo Rat.
- The effects of Tamarisk on avian diversity in desert riparian systems.

Book Review:

Braden, G. T. 1997. Journal of Wildlife Management 83(3):130-131. Monitoring Bird Populations by Point Counts. C. J. Ralph, J. R. Sauer, and S. Droege. (Eds.) General Technical Report PSW-GTR-149. U. S. Department of Agriculture, iv + 181 pages.

Primary Literature Publications:

Braden, G. T. 1999. Does nest placement affect the fate or productivity of California Gnatcatcher nests? Auk 116:984-993.

Braden, G. T., R. L. McKernan, and S. M. Powell. 1997. Effects of nest parasitism by the brown-headed cowbird on nesting success of the California Gnatcatcher. Condor 99(4):

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858-865.

Braden, G. T., R. L. McKernan, and S. M. Powell. 1997. Association of within-territory vegetation characteristics and fitness components of California Gnatcatchers. Auk 114(4) 601-609.

Stubblefield, C. and **G. T. Braden**. 1994. Denning Characteristics of black bears in the San Gabriel Mountains of southern California. Cal. Academy of Sciences 93(1)30-37.

Alexander Sokoloff, R. F. Ferrone, J. D. Chaney, **J. Braden**, and R. J. Munoz. 1987. Linkage studies in *Tribolium castaneum* (Herbst). XII. A revision of linkage group II. Genome 29:26-33.

Relevant Grav Literature Reports:

Braden, G. T., L. Crew, and A. Miller. 2009. Avian diversity, vegetation composition and vegetation structure of the Las Vegas Wash: 2005 to 2009. San Bernardino County Museum, Biological Sciences Division, 2024 Orange Tree Lane Redlands, CA 92374. Prepared for the Las Vegas Wash Coordination Committee. November 2009. 75 pp.

Braden, G. T., M. Rathbun, T. Hoggan, A. Davenport, and K. Carter. 2009. The Status of Yuma Clapper Rail and Yellow-billed Cuckoo along portions of the Virgin River and Muddy River in Southern Nevada, with incidental observations of Southwestern Willow Flycatcher, 2008. Final. Report prepared for the Southern Nevada Water Authority by the Biological Sciences Division, San Bernardino County Museum, 2024 Orange Tree Lane, Redlands, California 92374. February 2009. 58 pp.

Braden, G. T., K. Carter, M. Rathbun, and T Hoggan. 2009. Occurrence, distribution, and abundance of vertebrate species on the Old Woman Mountains Preserve: 2004-2008. Revised Final. Biological Sciences Division, San Bernardino County Museum, 2024 Orange Tree Lane, Redlands CA 92374. Report to the Native American Lands Conservancy and the 29 Palms Band of Mission Indians. January 2009. 158 pp.

Braden, G. T. and R. L. McKernan. 2006. Status, distribution, life-history, and habitat affinities of the Southwestern Willow Flycatcher along the lower Colorado River, Year 7 – 2002 Final Report-Revised. Report submitted to the U. S. Bureau of Reclamation, U. S. Fish and Wildlife Service and U. S. Bureau of Land Management. January 2006.

Braden, G. T., L. Crew, and A. Miller. 2005. Changes in avian breeding season diversity, microclimate, and habitat coincident with changes in surface water in a tamarisk dominated riparian habitat along the Virgin River in southern Nevada. Report submitted to Zane L. Marshall, Southern Nevada Water Authority, Las Vegas Nevada by the Biological Sciences Division, San Bernardino County Museum, Redlands, California.

Braden, G. T., K. Carter, M. Rathbun, and T. Hoggan. 2005. Occurrence, distribution and abundance of vertebrate species on the Old Woman Preserve: Spring 2004. Report to The Native American Lands Conservancy and The Twenty-nine Palms Band of Mission Indians by the Biological Sciences Division, San Bernardino County Museum, 2024 Orange Tree Lane, Redlands, CA 92374

Braden, G. T. and R. L. McKernan. 2000. A data based survey protocol and quantitative description of suitable habitat for the endangered San Bernardino Kangaroo Rat (*Dipodomys merriami parvus*). Biology Section, San Bernardino County Museum, Redlands, CA. June, 35 pp.

Braden, G. T. and R. L. McKernan. 1999. Possible effect of low level nest parasitism by the Brown-headed Cowbird (*Molothrus ater*) on the nest success of the Southwestern Willow Flycatcher (*Empidonax traillii extimus*) at sites monitored by the San Bernardino County Museum: A data review, progress report, and power's analysis. Report submitted to the U. S. Bureau of Reclamation, Lower Colorado River Region, Boulder City, Nevada, by the San Bernardino County Museum Biological Sciences Section, Redlands, California. December, 21 pp.

Braden, G. T., and R. L. McKernan. 1998. Nest stages, vocalizations, and survey protocols for the Southwestern Willow Flycatcher (*Empidonax traillii extimus*). Final Report submitted to the U. S. Bureau of Reclamation, Lower Colorado River Region, Boulder City, Nevada, by the San Bernardino County Museum Biological Sciences Section, Redlands, California. October, 36 pp.

Braden, G. T., and R. L. McKernan. 1998. Observations on nest cycles, vocalization rates, the probability of detection, and survey protocols for the Southwestern Willow Flycatcher (*Empidonax traillii extimus*). Report submitted to the U. S. Bureau of Reclamation, Lower Colorado River Region, Boulder City, Nevada, by the San Bernardino County Museum Biological Sciences Section, Redlands, California. March, 38 pp.

Braden, G. T. 1991. Home ranges, habitat use, and den characteristics of black bears in the San Gabriel Mountains of southern California. Master's Thesis, CSPUP.

Braden, G. T. R. L. McKernan, S. Love, and S. Powell. 1995. Nesting biology of the Coastal California Gnatcatcher (*Polioptila californica californica*) in western Riverside County: 1993-1994. San Bernardino County report to the Metropolitan Water District. 29 pp.

Braden, G. T. and Stacey L. Love. 1994. Dispersal and non-breeding season habitat use by the Coastal California Gnatcatcher (*Polioptila californica californica*) in western Riverside County. USFWS report to the Metropolitan Water District. 25 pp.

Braden, G. T. and Shawn Powell. 1994. Nesting biology of the Coastal California Gnatcatcher (*Polioptila californica californica*) in western Riverside County. USFWS report to the Metropolitan Water District. 35 pp.

Braden, G. T. and Shawn Powell. 1994. Breeding habitat use by *Polioptila californica* in western Riverside County. USFWS report to the Metropolitan Water District. 30 pp.

Braden, G. T. 1992. California Gnatcatchers (*Polioptila californica*) at three sites in western Riverside County. USFWS report to the Metropolitan Water District. 29 pp.

Carter. K. J., **G. T. Braden**, M. Rathbun, and T. Hoggan. 2006. Southwestern Willow Flycatcher, habitat suitability, and amphibian survey results for the San Bernardino National Forest: 2004. Final Report. Submitted to the San Bernardino National Forest by the Biological Sciences Division, San Bernardino County Museum, Redlands, California. January 2006.

Rathbun M., **G. T. Braden**, and K. J. Carter. 2004. Results of Southwestern Willow Flycatcher, Mountain Yellow-legged Frog, California Red-legged Frog, and Arroyo Toad surveys in the San Bernardino National Forest: 2003 Final Report. Report submitted to the San Bernardino National Forest by the Biological Sciences Division, San Bernardino County Museum, Redlands, California.

McKernan, R. L. **G. T. Braden**. 2002. Status, distribution, and habitat affinities of the Southwestern Willow Flycatcher along the lower Colorado River, Year 6 - 2001. Report submitted to the U. S. Bureau of Reclamation, U. S. Fish and Wildlife Service and U. S. Bureau of Land Management. May 2002.

McKernan, R. L. and **G. T. Braden**. 2001. Status, distribution, and habitat affinities of the Southwestern Willow Flycatcher along the lower Colorado River, Year 5 - 2000. Report submitted to the U. S. Bureau of Reclamation, U. S. Fish and Wildlife Service and U. S. Bureau of Land Management. May 2002.

McKernan, R. L. and **G. T. Braden**. 2001. Status, distribution, and habitat affinities of the Southwestern Willow Flycatcher along the lower Colorado River, Year 4 - 1999. Report submitted to the U. S. Bureau of Reclamation, U. S. Fish and Wildlife Service and U. S. Bureau of Land Management. February 2001.

McKernan, R. L., **G. T. Braden**, and E. A. Cardiff. 2002. Survey results: Status, distribution and habitat affinities of the Southwestern Willow Flycatcher in the San Bernardino National Forest: 2000 and 2001. Report submitted to the San Bernardino National Forest, September 2002. 61 pp.

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McKernan, R. L. and **G. T. Braden**. 1999. Status, distribution, and habitat affinities of the

Southwestern Willow Flycatcher along the lower Colorado River, Year 3 - 1998. Report submitted to the U. S. Bureau of Reclamation, U. S. Fish and Wildlife Service and U. S. Bureau of Land Management. March 1999.

References

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Comment Letter No. 16

Maria Sonia Braganza
1245 W. Grove St.
Rialto, CA 92376
909.874.8473

Comment No. 16-1

We are looking forward for this progress very soon in our locality.

Response to Comment No. 16-1

This comment is noted for the record and will be forwarded to the decision makers.

Lytle Creek Ranch Community Workshop
February 16, 2012

Maria Sonia Braganza 1245 West Grove Street Rialto, CA 92376 909.874.8473	We are looking forward for this progress very soon in our locality.

April 4, 2012

Comment Letter No. 17

Tony Braganza
1245 W. Grove St.
Rialto, CA 92376
909.874.8473

Comment No. 17-1

I am really happy for the proposed project for the Lytle Creek. We are looking forward. [sic] This will not only bring prosperous [sic] for the City of Rialto but also make our City proud.

Response to Comment No. 17-1

This comment is noted for the record and will be forwarded to the decision makers.

Lytle Creek Ranch Community Workshop
February 16, 2012

Tony Braganza 1245 West Grove Street Rialto, CA 92376 909.874.8473	I am really happy for the proposed project for the Lytle Creek. We are looking forward. This will not only bring prosperous for the City of Rialto but also make our City proud.

April 4, 2012

Comment Letter No. 18

Mary Jaramillo
5635 Riverside Avenue
Rialto, CA 92377-3968

Comment No. 18-1

I have chosen to focus on the Transportation/Traffic "Sunnyvale" Analysis portion of the RDEIR. I continue to be concerned about the volume of traffic and related conditions primarily along Riverside Avenue. Riverside Avenue is the main artery running north and south alongside the proposed project, as well as the serving the only contiguous existing neighborhood to the project, El Rancho Verde.

Judge Gafkowski, in his decision, cited the commentary of Joe Chesley and Dave Maskell, which referred to increased traffic along Riverside Avenue during the construction period and after the project is completed. Their concerns concentrated on the the [sic] increase in traffic over the next twenty years on Riverside Avenue, and the capacity of the street system to withstand the added volume of increased vehicle trips. There was no current analysis status of Riverside Avenue, citing only 2007 data.

Response to Comment No. 18-1

It is noted that the reference in the comment to the “RDEIR” is incorrect and should reference the RPDEIR, as discussed further in Section 1.2 of this Final RPEIR. The RPDEIR contains select revised portions of the original DEIR in response to the Court Ruling that replace only those corresponding portions of and/or sections in the DEIR. The RPDEIR does not replace the original DEIR in full, nor does it supersede any portions of the original DEIR or analyses that were not specifically supplemented, updated, or otherwise revised in the RPDEIR. Comments regarding the original DEIR are outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City’s obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to “significant new information.”

As to the comment about the traffic data used, future (2030) traffic conditions were analyzed in the traffic impact analysis included with the original DEIR, which includes all traffic volume increases between the existing year (2007) and future year (2030) conditions. See Response to Comment No. 11-12 for additional discussion of this issue.

Comment No. 18-2

Since Neighborhoods 2, 3 and 4 begin on the north end close to the 1-15 and follow the path of Riverside Avenue south wrapping around to the east on Highland Avenue to Oakdale, these are the intersections I will be addressing. Some of these intersections, [sic] have plans for mitigation, some do not. Before I begin, I would like to express my opinion that the volume of existing traffic on Riverside Avenue has still been underestimated. For example, on a recent Thursday morning, I counted 10 diesel trucks pass my my [sic] Riverside Avenue home in a span of 20 minutes. It wasn't rush hour, 11:30 - 11:45 A.M.. I would have assumed that the cost of road maintenance would have been a factor in this report. Also not being a traffic engineer, I do not understand the method of Level of Service (LOS) for rating an intersection. How was this done? People were sent out from the City of Rialto Traffic Department to go through all the mentioned intersections and count the wait in seconds? What about the calibration of the traffic signals? As a lay person, who lives on Riverside Avenue, it makes more sense to count the vehicles going through the intersections and differentiate between autos and diesel trucks.

Response to Comment No. 18-2

The comment is noted for the record and will be forwarded to the decision makers. As to the comment regarding the number of trucks on Riverside Avenue between 11:30-11:45 A.M., the commentor is informed that this time period is outside of the traffic study periods required by City and County guidelines, which require the study of A.M. and P.M. peak hour periods. The peak periods used in the traffic study and "Sunnyvale" Analysis correspond to the following hours: 7:00 A.M. to 9:00 A.M. and 4:00 P.M. to 6:00 P.M., commonly referred to as the A.M. and P.M. peak hours.

With respect to the commentor's question regarding the of Level of Service methodology, the commentor is referred to the traffic impact analysis included in the original DEIR, which states:

> The methodology used in this study for the analysis and evaluation of traffic operations at each study intersection is based on procedures outlined in the Highway Capacity Manual (HCM2000), per San Bernardino County CMP guidelines. This methodology determines the operating characteristics of an intersection in terms of the "Level of Service" (LOS) provided for different levels of traffic volumes and other variables such as lane configurations and type of control. LOS describes the quality of service. Intersections with a LOS of A, B or C operate quite well. Typically, LOS D is the design level of service for many metropolitan street systems. LOS E represents volumes at or near the capacity of the facility, and might result in stoppages of momentary duration and fairly unstable flow. LOS F occurs when a facility is overloaded and is characterized by stop-and-go traffic with stoppages for a long duration. (See DEIR Volume II, Appendix II-A-F, p. 26.)

That same methodology was used in the "Sunnyvale" Analysis provided in the RPDEIR. As the "Sunnyvale" Analysis (provided in Appendix V-C-A to the RPDEIR Volume V (Part 2)) states:

> This 'Sunnyvale' analysis utilizes the same traffic analysis methodology used in the Traffic Study. Traffic volumes generated by the proposed development of the 2,447-acre master planned mixed-use community were assigned to the roadway network using a computerized transportation model which models (replicates) travel demand and traffic volumes. As recommended by the SanBAG staff, the East Valley Transportation Model (EVTM), which was developed by the City of San Bernardino, was used for the Traffic Study. (See RPDEIR Volume V (Part 2), Appendix V-C-A, p. 3.)

With respect to the comment regarding traffic counts, A.M. and P.M. counts were conducted by counting the turning movements at each study intersection. The Highway Capacity Manual (HCM2000) generally assumes that projects do not introduce an abnormal level of mixture of passenger vehicles and trucks. Therefore, according to standard procedures, trucks were not counted separately. (See also RPDEIR Volume V (Part 2), Appendix V-C-A, pp. 4-5.)

Comment No. 18-3

The following comments will be addressing Lytle Creek road coming off the mountain, and the intersections starting with the the [sic] I-15 On/Offramps [sic] at Sierra, and following the perimeter of the project south.

At the intersection of Lytle Creek Road and Glen Helen Parkway, mitigation has been completed to accommodate Rosena Ranch. My concern is with Lytle Creek Road as it continues past Glen Helen Parkway and runs along Neighborhood 4 and then up the mountain. Neighborhood 4 will be multi-unit homes, condominiums or apartments. This means a high volume of traffic exiting from the complex. Since the Lytle Creek Road side of the property is just a two way road, I still envision the residents who live across the street having difficulty exiting their driveways and the people coming down the mountain getting caught in a real bottleneck. In an emergency this could produce a dangerous situation. I did not see this mentioned in this document.

Response to Comment No. 18-3

Mitigation Measure 6-5, set forth in the original DEIR, requires the Project to widen and restripe Lytle Creek Road from Glen Helen Parkway to Sierra Avenue to provide two through lanes in each direction, and widen and restripe Glen Helen Parkway between Lytle Creek Road and Cajon Boulevard to provide two through lanes in each direction. With those roadway improvements, as well as intersection improvements required under both the “Sunnyvale” Analysis and the original traffic study, impacts would be less than significant at all study intersections along Neighborhood IV. The “Sunnyvale” Analysis determined that such improvements would not be required as a result of Project-related traffic. However, these improvements would be still required to mitigate cumulative traffic impacts to less than significant levels and are incorporated into the Project in the Mitigation Monitoring and Reporting Program (MMRP) provided in Appendix VI-B of this Final RPEIR.

Comment No. 18-4

Now, the I-15 On/Off ramps at Sierra Avenue is next. Extensive mitigation is planned with an added turn lane, re-striping and a traffic signal. This exact location was mentioned in a July 23, 2002 letter written by Congressman Gary G. Miller. In this correspondence to the U.S. Army Corps of Engineers, Los Angeles District, Congressman Miller supports the issuance of a Section 404 permit by the U.S. Army Corps of Engineers for the Lytle Creek North Project. Congressman Miller goes on to state that the proposed Lytle Creek North Project will contribute to the improvement of several roadways and intersections beyond the project's fail' share contribution. Included in these improvements, the Congressman cited were the I-15 ramps at Sierra Avenue. This work was never done. Now that same mitigation appears in the current project. What is the guarantee that it will ever be completed?

Response to Comment No. 18-4

The commentor expresses concerns regarding the timeline for implementation of mitigation measures for the I-15 On/Off Ramps at Sierra Avenue. The "Sunnyvale" Analysis determined that Project-related traffic could cause a potentially significant impact at both the I-15 Northbound On/Off Ramps and Sierra Avenue intersection (Study Intersection No. 12) and the I-15 Southbound On/Off Ramps and Sierra Avenue intersection (Study Intersection No. 13). (See RPDEIR Volume V (Part 1), Table 2.2-1 and page 2-115.) Thus, to mitigate the potentially significant impacts at those intersections to less than significant levels, the Project would be required to implement Mitigation Measure 6-4(a). That measure requires various intersection improvements to be completed when the level of Project development generates trip certain trip levels.

Accordingly, when Project-related development results in 272 A.M. peak hour trips or 281 P.M. peak hour trips, whichever occurs first, at the I-15 Northbound On/Off Ramps and Sierra Avenue intersection, the Applicant must cause to be completed the following improvement at that intersection:

> Improve Sierra Avenue to provide dual left-turn lanes and two through lanes in the northwest-bound direction and two through lanes and one free right-turn lane in the southeast-bound direction. Widen the Southbound off-ramp to accommodate one left-turn lane, one left/right-shared lane, and one right-turn lane. Install a traffic signal at this location. (RPDEIR Volume V (Part 1), p. 2-121.)

Similarly, when Project-related development results in 240 A.M. peak hour trips or 222 P.M. peak hour trips, whichever occurs first, at the I-15 Southbound On/Off Ramps and Sierra Avenue intersection, the Applicant must cause to be completed the following improvement at that intersection:

> Improve Sierra Avenue to provide dual left-turn lanes and two through lanes in the southeast-bound direction and two through lanes and one right-turn lane in the northwest-bound direction. Reconstruct the Northbound off-ramp to accommodate one left-turn lane, one left/through-shared lane, and one free right-turn lane. Install a traffic signal at this location. (RPDEIR Volume V (Part 1), p. 2-121.)

Comment No. 18-5

Riverside/Sierra Avenue, in the tables for both 2007 and 2011, was assigned an LOS F. On the final table 2.24 on p. 2-128, it is assigned a B after mitigation. No mitigation was mentioned in the RDEIR. In the original EIR, Sierra was to be widened and re-striped to provide dual left turn lanes in the southbound direction. Also there would be a free right turn onto Riverside Avenue and a traffic signal would be installed. Are these improvements still valid?

Response to Comment No. 18-5

The commenter asserts that the RPDEIR does not contain mitigation for potential traffic impacts at the intersection of Riverside Avenue and Sierra Avenue (Study Intersection No. 18). That is incorrect. The "Sunnyvale" Analysis determined that Project-related traffic would cause a potentially significant impact at that intersection. The RPDEIR explains that implementation of Mitigation Measure 6-4(a) would reduce that impact to a less than significant level. Accordingly, when Project-related development results in 258 A.M. peak hour or 247 P.M. peak at the Riverside Avenue and Sierra Avenue intersection, the Applicant must cause to be completed the following improvement at that intersection:

> Widen and restripe Sierra Avenue to provide dual left-turn lanes and two through lanes in the southbound direction. Improve the intersection to allow a free right-turn from Riverside Avenue onto Sierra Avenue. Install a traffic signal at this intersection. (RPDEIR, pp. 2-120 to 2-121.)

Comment No. 18-6

Riverside/Live Oak is an existing traffic signal intersection. In the original EIR it states it will be aligned opposite a proposed project roadway. In the RDEIR on Table 2.2-1 it has an LOS of D for the P.M.. This intersection does not appear again on Tables 2.2-3 or 2.2-4.

Riverside/ Alder received a LOS B rating in the original DEIR and does not appear on the Tables in the RDEIR.

Riverside/Locust appears as a LOS D for P.M. on Table 2.2-1 and also is not mentioned on any further Tables in the RDEIR.

Response to Comment No. 18-6

The "Sunnyvale" Analysis determined that Project-related traffic would not result in potentially significant impacts at the three intersections mentioned by the commentor. As the RPDEIR explains, "intersection operations at LOS D or better during the peak hour are generally acceptable under the City of Rialto's intersection impact policy…. For the "Sunnyvale" Analysis, a significant Project traffic impact would occur where the Project contributes 50 or more peak-hour trips at a location and where Project traffic would cause conditions to degrade below the City's goal of LOS D." (RPDEIR, p. 2-106.) Because Project-related traffic at the three identified intersections, as compared to existing (2007) conditions, would not exceed the significance threshold, less than significant impacts would result and no mitigation measures are required.

Comment No. 18-7

***** This next intersection is the one I am most concerned about, RiversideAve. [sic]/Linden Ave.. [sic] The plan for mitigation appears to be the same in the original EIR and the RDEIR. It calls for widening of the road and restriping to provide one left turn lane, one through lane, and one through right-shared lane ONLY in the north-west bound direction. Now according to the original EIR, it will be aligned opposite a proposed project roadway. Looking at the map, Linden is to be one of the main entrances into the project. Why haven't accommodations been made for a left turn lane coming south bound to enter the project? This will be a very busy intersection. Carter High School is on Linden. More than likely many of the residents coming out of the project will turn left and proceed down to Ayala and turn right to reach the I-210. Here, however is what troubles me the most, why isn't a TRAFFIC SIGNAL planned for Riverside Ave./Linden? How can this intersection safely function without one?

Response to Comment No. 18-7

The commentor is concerned with traffic at the intersection of Riverside Avenue and Linden Avenue (Study Intersection No. 22). The "Sunnyvale" Analysis determined that Project-related traffic could cause a potentially significant impact at that intersection. (See RPDEIR Volume V (Part 1), Table 2.2-1 and page 2-115.) Thus, to mitigate the potentially significant impact at that intersection to a less than significant level, the Project would be required to implement Mitigation Measure 6-4(a). That measure requires various intersection improvements to be completed when the level of Project development generates trip certain trip levels.

Accordingly, when Project-related development results in 250 A.M. peak hour trips or 210 P.M. peak hour trips at the Riverside Avenue and Linden Avenue intersection, the Applicant must cause to be completed the following improvement at that intersection:

> Widen and restripe to provide one left-turn lane, one through lane, and one through/right-shared lane in the northwest-bound direction.

The traffic modeling and analysis performed by Crain & Associates as part of the "Sunnyvale" analysis determined that with implementation of the improvements discussed above, the LOS at this intersection would be reduced to less than significant levels. No additional mitigation is required.

Comment No. 18-8

At this time I have to insert some more puzzling information. The original EIR planned for widening Riverside Avenue to two lanes Northbound and two lanes all the way south to Ayala from Sierra Avenue. Just north of Ayala, Riverside Avenue has to narrow to one lane. Why? The formation of the land juts out and makes two lanes impossible! Since this is just south of the Riverside Ave./Linden intersection, it seems problematic.

Response to Comment No. 18-8

The commentor appears to take issue with roadway widening mitigation proposed in the original DEIR to mitigate cumulative traffic impacts to less than significant levels. This matter is outside the scope of the RPDEIR. The Court Ruling did not require any changes to mitigation measures proposed to mitigate cumulative traffic impacts to less than significant levels. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information."

In any event, the RPDEIR explains that the Transportation/Traffic section in the original DEIR analyzed the operational impacts of the Project on a cumulative level. (See RPDEIR Volume V (Part 1), p. 2-104 to 2-105.) Though the Court Ruling obligated the City to conduct a traffic analysis of Project traffic compared to existing conditions (per the "Sunnyvale" decision), the cumulative impacts analysis set forth in the original DEIR remains valid under the Court Ruling. The cumulative impacts analysis incorporated forecasted traffic increases due to ambient growth and related projects through Year 2030 (the build-out year of the Project), and analyzed cumulative impacts on study area intersections, freeway segments, and the regional transportation system as a result of the Project. Under that analysis, it was determined that Mitigation Measure 6-5 would be required to mitigate roadway and intersection impact, and that by widening and restriping Riverside Avenue between Sierra Avenue and Ayala Drive to provide two through lanes in each direction, cumulative traffic impacts would be reduced to less than significant levels. No additional roadway widening mitigation at Riverside Avenue was identified or required.

The RPDEIR does not discuss Mitigation Measure 6-5 because the traffic consultant determined that under the "Sunnyvale" Analysis, the proposed roadway widening improvements were not required to mitigate Project-specific traffic impacts to less than significant levels. Nevertheless, because the cumulative traffic impacts analysis remains a component of the Project's overall traffic impact analysis, the road widening proposed under Mitigation Measure 6-5 would still be implemented. (See the MMRP provided in Appendix VI-B of this Final RPEIR, Mitigation Measure 6-5.)

Comment No. 18-9

Riverside Ave./Peach is not mentioned in either document. There is no Traffic Signal, only a stop sign. Many residents of the north end of the El Rancho Verde neighborhood use it as an entrance and exit. It is positioned right where Riverside Avenue begins to narrow.

Riverside Ave./Ayala is a well established intersection that handles a great volume of traffic.

Riverside Ave./Knollwood receives a [sic] LOS A. It has a Traffic Signal, but what I failed to see in either document was the fact that 10 months out of the year it is a crossing for the students attending Trapp ElementarySchool [sic], complete with a Crossing Guard.

Response to Comment No. 18-9

With respect to the intersection of Riverside Avenue and Peach Street, that intersection was not identified as a study intersection in either the original traffic impact analysis or the "Sunnyvale" Analysis. As the traffic study explained:

> For this Project, the study intersections and freeway segments were selected based on the identification of traffic volumes that would exceed County growth standards. According to the County growth standards, the study area must include all major intersections with 50 or more peak-hour project trips (two-way) and freeway segments with 100 or more peak-hour project trips (two-way) within a five-mile radius from the project site. Based on these standards, a total of 75

study intersections and 29 study freeway segments were selected for analyses. (DEIR, Appendix II-A-F, pp. 21, 26.)

Based on the above criteria, the Riverside Avenue and Peach Street intersection did not qualify and thus was not selected for study.

With respect to the comment regarding Riverside Avenue and Ayala Drive, the comment is noted for the record and will be forwarded to the decision makers. Riverside Avenue and Ayala Drive was identified as a study intersection in the traffic study and “Sunnyvale” Analysis. The “Sunnyvale” Analysis determined that Project-related traffic would not cause a significant impact at this intersection.

Finally with respect to the Riverside Avenue and Knollwood Avenue intersection, the traffic analysis took pedestrian activity into account in assessing potential impacts. Pedestrian activity during the peak hours at this intersection is not considered abnormal.

Comment No. 18-10

Riverside Avenue/Country Club in the RDEIR, on Table 2.2-1 is LOS B and C. It does not appear again on Tables 2.2-3 or 2.2-4. Riverside Ave./Country Club Drive is one of the entrances in to the project. At the present time, this intersection has a Traffic Signal. In the original information we received from the Lytle Creek Development Company, Country Club Drive was to be widened to two lanes in and out. To do this it was proposed that the median be reduced in size. I do not see any evidence in this document.

Response to Comment No. 18-10

The commentor is referred to Response to Comment No. 18-6 above. The “Sunnyvale” Analysis determined that Project-related traffic would not result in potentially significant impacts at the Riverside Avenue and Country Club Avenue intersection when compared to existing conditions.

The comment is noted for the record and will be forwarded to the decision makers.

Comment No. 18-11

After Country Club Drive there are two more intersections, Riverside Ave./Rowan and Riverside Ave./Shamwood. Both have no Traffic Signals only Stop signs and are used by the residents of El Rancho Verde for exiting and entering the neighborhood. With the added traffic this will become more difficult.

Response to Comment No. 18-11

Please refer to Response to Comment No. 18-9 above. The two intersections identified by the commentor were not included as study intersections in the traffic study or “Sunnyvale” Analysis as they did meet the required criteria.

Comment No. 18-12

The last intersection I am going to comment on is Highland/Oakdale, the southern most [sic] proposed entrance to the project. There is no Traffic Signal at Oakdale. It is a two way, residential street that I doubt could handle a heavy amount of traffic. Although it still remains on the map, there was no LOS analysis or any mitigation mentioned in either document. Even though it is an important entrance to the project, it appears to have been simply left out.

I sincerely hope that you will address these issues.

Response to Comment No. 18-12

Please refer to Response to Comment No. 18-9 above. The intersection identified by the commentor was not included as a study intersection in the traffic study or "Sunnyvale" Analysis as it did not meet the required criteria.

The comment is noted for the record and will be forwarded to the decision makers.

RECEIVED
APR - 2 2012
By

To: City of Rialto

From: Mary Jaramillo 5635 Riverside Avenue Rialto, CA 92377

Comments on the Lytle Creek Ranch Specific Plan RDEIR
Transportation/Traffic "Sunnyvale" Analysis

I have chosen to focus on the Transportation/Traffic "Sunnyvale" Analysis portion of the RDEIR. I continue to be concerned about the volume of traffic and related conditions primarily along Riverside Avenue. Riverside Avenue is the main artery running north and south alongside the proposed project, as well as the serving the only contiguous existing neighborhood to the project, El Rancho Verde.

Judge Gafkowski, in his decision, cited the commentary of Joe Chesley and Dave Maskell, which referred to increased traffic along Riverside Avenue during the construction period and after the project is completed. Their concerns concentrated on the the increase in traffic over the next twenty years on Riverside Avenue, and the capacity of the street system to withstand the added volume of increased vehicle trips. There was no current analysis status of Riverside Avenue, citing only 2007 data.

Since Neighborhoods 2,3 and 4 begin on the north end close to the I-15 and follow the path of Riverside Avenue south wrapping around to the east on Highland Avenue to Oakdale, these are the intersections I will be addressing. Some of these intersections, have plans for mitigation, some do not. Before I begin, I would like to express my opinion that the volume of existing traffic on Riverside Avenue has still been underestimated. For example, on a recent Thursday morning, I counted 10 diesel trucks pass my my Riverside Avenue home in a span of 20 minutes. It wasn't rush hour, 11:30 – 11:45 AM. I would have assumed that the cost of road maintenance would have been a factor in this report. Also not being a traffic engineer, I do not understand the method of Level of Service (LOS) for rating an intersection. How was this done? People were sent out from the City of Rialto Traffic Department to go through all the mentioned intersections and count the wait in seconds? What about the calibration of the traffic signals? As a lay person, who lives on Riverside Avenue, it makes more sense to count the vehicles going through the intersections and differentiate between autos and diesel trucks.

The following comments will be addressing Lytle Creek road coming off the mountain, and the intersections starting with the the I-15 On/Offramps at Sierra, and following the perimeter of the project south.

At the intersection of Lytle Creek Road and Glen Helen Parkway, mitigation has been completed to accommodate Rosena Ranch. My concern is with Lytle Creek Road as it continues past Glen Helen Parkway and runs along Neighborhood 4 and then up the mountain. Neighborhood 4 will be multi-unit homes, condominiums or apartments. This means a high volume of traffic exiting from the complex. Since the Lytle Creek Road side of the property is just a two way road, I still envision the residents who live across the street having difficulty exiting their driveways and the people coming down the mountain getting caught in a real bottleneck. In an emergency this could produce a dangerous situation. I did not see this mentioned in this document.

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Riverside/Sierra Avenue, in the tables for both 2007 and 2011, was assigned an LOS F. On the final table 2.24 on p. 2-128, it is assigned a B after mitigation. No mitigation was mentioned in the RDEIR. In the original EIR, Sierra was to be widened and re-striped to provide dual left turn lanes in the southbound direction. Also there would be a free right turn onto Riverside Avenue and a traffic signal would be installed. Are these improvements still valid?

Riverside/Live Oak is an existing traffic signal intersection. In the original EIR it states it will be aligned opposite a proposed project roadway. In the RDEIR on Table 2.2-1 it has an LOS of D for the PM. This intersection does not appear again on Tables 2.2-3 or 2.2-4.

Riverside/ Alder received a LOS B rating in the original DEIR and does not appear on the Tables in the RDEIR.

Riverside/Locust appears as a LOS D for PM on Table 2.2-1 and also is not mentioned on any further Tables in the RDEIR.

***** This next intersection is the one I am most concerned about, RiversideAve./Linden Ave.. The plan for mitigation appears to be the same in the original EIR and the RDEIR. It calls for widening of the road and re-striping to provide one left turn lane, one through lane, and one through/ right-shared lane ONLY in the north-west bound direction. Now according to the original EIR, it will be aligned opposite a proposed project roadway. Looking at the map, Linden is to be one of the main entrances into the project. Why haven't accommodations been made for a left turn lane coming south bound to enter the project? This will be a very busy intersection. Carter High School is on Linden. More than likely many of the residents coming out of the project will turn left and proceed down to Ayala and turn right to reach the I-210. Here, however is what troubles me the most, why isn't a TRAFFIC SIGNAL planned for Riverside Ave./Linden? How can this intersection safely function without one?

At this time I have to insert some more puzzling information. The original EIR planned for widening Riverside Avenue to two lanes Northbound and two lanes all the way south to Ayala from Sierra Avenue. Just north of Ayala, Riverside Avenue has to narrow to one lane. Why? The formation of the land juts out and makes two lanes impossible! Since this is just south of the Riverside Ave./Linden intersection, it seems problematic.

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Riverside Avenue/Country Club in the RDEIR, on Table 2.2-1 is LOS B and C. It does not appear again on Tables 2.2-3 or 2.2-4. Riverside Ave./ Country Club Drive is one of the entrances in to the project. At the present time, this intersection has a Traffic Signal. In the original information we received from the Lytle Creek Development Company, Country Club Drive was to be widened to two lanes in and out. To do this it was proposed that the median be reduced in size. I do not see any evidence in this document.

After Country Club Drive there are two more intersections, Riverside Ave./ Rowan and Riverside Ave./Shamwood. Both have no Traffic Signals only Stop signs and are used by the residents of El Rancho Verde for exiting and entering the neighborhood. With the added traffic this will become more difficult.

The last intersection I am going to comment on is Highland/Oakdale, the southern most proposed entrance to the project. There is no Traffic Signal at Oakdale. It is a two way, residential street that I doubt could handle a heavy amount of traffic. Although it still remains on the map, there was no LOS analysis or any mitigation mentioned in either document. Even though it is an important entrance to the project, it appears to have been simply left out.

I sincerely hope that you will address these issues.

Comment Letter No. 19

Albert Kelley
P.O. Box 844
Redlands, CA 92373
flow.ak@hotmail.com

Comment No. 19-1

The major non sequitar [sic] for the consideration of this project is the failure in any category to address cumulative impacts, those constructs of CEQA that must be addressed as opposed to Lytle and the City of Rialto using the poor rationalization of 'overriding considerations'. That any project would utilize that escape hatch lends itself to the inapproriateness [sic] of breadth and scope of project (and probably the process!) can only cause diminishment of quality of life for habitat loss and dweller alike, whether 2, 4-legged, or winged! Had the City had any mature planning in place (other than the 2200 home maximum in standing General Plan), you could have avoided such miscreant developers who've taken your souls over with their glaring white-inlays and slimy handshakes. The biological diversity list of the Cal-MatEIR [sic] project, the EIR for the El Rancho Golf Course as well as Vulcan mining bank ALL include Coastal Cactus Wren in their findings, but, is glaringly missing or referenced in any biological appendixes. [sic] That demonstrates the slovenly field techniques employed by the developer. Another misstep of developer agent is apparently speaking for Dr. Mark Brunnell on Wooly-Star findings; they are YOUR words, not his. Subspecies are also included and afforded protection, but consultant misses that one also. The channelization and increased rapidity of water (Venturi Effrect) [sic] will directly impact Vulcan Mitigation Bank, 210 Freeway, and Arroyo Valley High School. Are these collateral damage and part of overriding considerations? Combining with Global and US Drought Monitor, the sw will continue to experience moderate to severe drought and no other conclusion could be logically reached that habitat and life there won't be adversely affected. these [sic] are several of the cumulative impacts that you AND the courts must acknowledge. Thank you for allowing response and hope email doesn't get shut down like last EIR period!

Response to Comment No. 19-1

The commentor states concerns about the Project's cumulative impacts, including those related to biological resources and hydrology. These matters are outside the scope of the RPDEIR; however, these issues were fully addressed in the original DEIR. (See DEIR Volume I, Sections 4.5.5.3 and 4.4.5.3, respectively.) Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" with respect to cumulative impacts within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5.

Ashley Rogers

From: Ashley Rogers
Sent: Thursday, May 10, 2012 1:43 PM
To: Ashley Rogers
Subject: FW: Lytle Creek Ranch Development

From: Gina Gibson [mailto:ggibson@rialtoca.gov]
Sent: Monday, April 02, 2012 3:57 PM
Subject: FW: Lytle Creek Ranch Development

From: Al Kelley [mailto:flow.ak@hotmail.com]
Sent: Monday, April 02, 2012 12:56 PM
To: Gina Gibson; STEVE AND LIZ LOE
Subject: FW: Lytle Creek Ranch Development

From: flow.ak@hotmail.com
To: ggibson@rialto.gov; stevealoe@msn.com
Subject: Lytle Creek Ranch Development
Date: Mon, 2 Apr 2012 13:53:24 -0600

The major non sequitar for the consideration of this project is the failure in any category to address cumulative impacts, those constructs of CEQA that must be addressed as opposed to Lytle and the City of Rialto using the poor rationalization of 'overriding considerations'. That any project would utilize that escape hatch lends itself to the inapproriateness of breadth and scope of project (and probably the process!) can only cause diminishment of quality of life for habitat loss and dweller alike, whether 2, 4-legged, or winged! Had the City had any mature planning in place (other than the 2200 home maximum in standing General Plan), you could have avoided such miscreant developers who've taken your souls over with their glaring white-inlays and slimy handshakes. The biological diversity list of the Cal-MatEIR project, the EIR for the El Rancho Golf Course as well as Vulcan mining bank ALL include Coastal Cactus Wren in their findings, but, is glaringly missing or referenced in any biological appendixes. That demonstrates the slovenly field techniques employed by the developer. Another misstep of developer agent is apparently speaking for Dr. Mark Brunnell on Wooly-Star findings; they are YOUR words, not his. Subspecies are also included and afforded protection, but consultant misses that one also. The channelization and increased rapidity of water (Venturi Effect) will directly impact Vulcan Mitigation Bank, 210 Freeway, and Arroyo Valley High School. Are these collateral damage and part of overriding considerations? Combining with Global and US Drought Monitor, the sw will continue to experience moderate to severe drought and no other conclusion could be logically reached that habitat and life there won't be adversely affected. these are several of the cumulative impacts that you AND the courts must acknowledge. Thank you for allowing response and hope email doesn't get shut down like last EIR period! Gratefully, Albert Kelley POB 844, Redlands, Ca. 92373

1

Comment Letter No. 20

Marcia Lentz
5605 Larch Ave.
Rialto, CA 92377

Comment No. 20-1

I am focusing on the Traffic/Transportation Issues of the RDEIR, specifically the impact of this plan on the health of the citizens living in neighborhood 2,3, [sic] and 4.

I agree with Mrs. Jaramillo that the traffic analysis does not recognize the increase in current traffic on Riverside Avenue, specifically the abundance of large diesel trucks coming from and returning to the tile company and the cement company located above the El Rancho Verde neighborhood. On a Tuesday morning at approximately 8:00 am, I followed four large diesel trucks down Riverside Avenue as they entered the 210 freeway east. **I am very concerned about the children at Trapp Elementary school which is located on Riverside Avenue. How is diesel soot impacting their health while walking to and from school and when they are on the playground?**

Response to Comment No. 20-1

The commentor states concerns about the diesel soot impacts on elementary school children. This matter is outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a draft EIR due to "significant new information." The commentor offers no "significant new information" with respect to traffic emission impacts within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5. See Section 4.7, Air Quality, of the original DEIR, regarding the Proposed Project's mobile source air emissions and health risk effects.

This comment is noted for the record and will be forwarded to the decision makers.

Comment No. 20-2

As I stated in my response to the initial EIR our region has one of the poorest ratings for air quality. Data from the Environmental protection [sic] Agency state air pollution levels over the last three years rank San Bernardino/Riverside worst in the country with an average of 148 days per year.

A recent government health study published in a local newspaper states that diesel exhaust from trucks, buses portable generators and off road construction equipment is classified as a "probable carcinogen" but due to this studies [sic] results diesel exhaust will be examined by the International Agency for Research on Cancer, part of the World Health Organization at a June meeting to decide if diesel exhaust should be reclassified as a known carcinogen. The study further states that miners exposes [sic] to diesel engine exhaust are three times more likely to contract lung cancer and die and that a similar risk applies to people from smoggy urban areas such as Southern California who live near freeways or commute to work. **This would apply to the people living in the LCRSP Project area.**

Another study reported in the March 11, 2012,Press [sic] Enterprise newspaper found fine particles in the air increase the risk of a debilitating brain attack. Epidemiologists with the California Department off [sic] Public Health and collaborating organizations tracked more than 100,000 women, all current or former teachers and school administrators. They reported that older women living in places with higher levels of fine particle pollution including **diesel soot**, car exhaust, wood smoke, chemical compounds and microscopic airborne contaminants had a significantly increased risk for first time strokes. **Currently there are many seniors living in the area and the project is planning on creating a senior community.**

I previously documented that current statistics for this area demonstrate there already is an increase [sic] incidence of asthma and other respiratory diseases attributed to air quality and another study conducted by USC links the incidence of malignant brain tumors to air quality.

The health issues of this project will not go away after the construction phase which is projected to be 20 to 30 years, [sic] With the addition of 8407 dwelling units and 25,000 more residents, traffic in this area will continue to have a negative impact on the health of the Community. Why is this project moving forward knowing the risks?

<u>Response to Comment No. 20-2</u>

The commentor states concerns about air quality in the vicinity of the Project area. This matter is outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a draft EIR due to "significant new information." The commentor offers no "significant new information" with respect to traffic emission impacts within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5. See Section 4.7, Air Quality, of the original DEIR, regarding the Proposed Project's air pollution and health effects.

This comment is noted for the record and will be forwarded to the decision makers.

<u>Comment No. 20-3</u>

The RDEIR assumes that the 2020and [sic] 2030 standards for traffic /transportation [sic] and fuel use will be much improved thus negating concern. From a historic point of view this seems to be unrealistic since the Government has yet to agree on how to address many of these "green" issues.

<u>Response to Comment No. 20-3</u>

The commentor states concerns regarding operational air impacts in the vicinity of the Project area. This matter is outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a draft EIR due to "significant new information." The commentor offers no "significant new information" with respect to traffic emission impacts within the meaning of CEQA Section 21092.1 and CEQA

Guidelines Section 15088.5. See Section 4.7, Air Quality, of the original DEIR, regarding the Proposed Project's operational air impacts.

If the commentor is referring to the revised climate change analysis, then to the extent that traffic/transportation components of that analysis take credit for "'green' issues," such reliance is both fully appropriate and realistic. Indeed, such reliance is inherent in the definition of BAU that is part of the significance threshold approved by the Trial Court. See Ruling at 17 ("[T]he record supports the threshold of significance used….").

The RPDEIR adopts the definition of BAU developed and utilized by the California Air Resources Board in implementing Assembly Bill 32. The California Air Resources Board defines BAU as the greenhouse gases that would be emitted statewide in the absence of any greenhouse gas reduction measures discussed in its Climate Change Scoping Plan. In its Climate Change Scoping Plan, the California Air Resources Board compares the BAU greenhouse gas inventory it projected for the year 2020 (based on a 2002–2004 baseline period) to the greenhouse gases emitted statewide in 1990. The difference between these two inventories is the amount of greenhouse gas reductions that must be achieved for California to meet the mandate of Assembly Bill 32: returning to 1990 greenhouse gas emission levels by 2020. Once the amount of necessary greenhouse gas reductions was calculated, the California Air Resources Board crafted emission reduction measures responsive to the scope of the challenge facing the State. In sum, the California Air Resources Board's definition of BAU necessarily is static and, accordingly, the RPDEIR similarly utilizes a static definition of BAU. Notably, an emission reduction measure that will "much improve" the transportation related GHG emissions, AB 1493, is discussed in the Climate Change Scoping Plan and, like the other emission reduction measures, is relied upon by California Air Resources Board to meet the mandate of Assembly Bill 32. The California Air Resources Board did not find such reliance unrealistic. As such, it is both appropriate and realistic for the RPDEIR to take credit for AB 1493, and other "green" regulatory actions identified in the Climate Change Scoping Plan, vis-à-vis the BAU scenario.

This comment is noted for the record and will be forwarded to the decision makers.

RECEIVED
APR 03 2012
BY: Daniel Rosas

To: City of Rialto

From: Marcia Lentz
5605 Larch Avenue
Rialto, CA 92377

Subject: Lytle Creek Ranch Specific Plan RDEIR

I am focusing on the Traffic/Transportation Issues of the RDEIR, specifically the impact of this plan on the health of the citizens living in neighborhood 2,3, and 4.

I agree with Mrs. Jaramillo that the traffic analysis does not recognize the increase in current traffic on Riverside Avenue, specifically the abundance of large diesel trucks coming from and returning to the tile company and the cement company located above the El Rancho Verde neighborhood. On a Tuesday morning at approximately 8:00 am, I followed four large diesel trucks down Riverside Avenue as they entered the 210 freeway east. **I am very concerned about the children at Trapp Elementary school which is located on Riverside Avenue. How is diesel soot impacting their health while walking to and from school and when they are on the playground?**

As I stated in my response to the initial EIR our region has one of the poorest ratings for air quality. Data from the Environmental protection Agency state air pollution levels over the last three years rank San Bernardino/Riverside worst in the country with an average of 148 days per year.

A recent government health study published in a local newspaper states that diesel exhaust from trucks, buses portable generators and off road construction equipment is classified as a "probable carcinogen" but due to this studies results diesel exhaust will be examined by the International Agency for Research on Cancer, part of the World Health Organization at a June meeting to decide if diesel exhaust should be reclassified as a known carcinogen. The study further states that miners exposes to diesel engine exhaust are three times more likely to contract lung cancer and die and that a similar risk applies to people from smoggy urban areas such as Southern California who live near freeways or commute to work. **This would apply to the people living in the LCRSP Project area.**

Another study reported in the March11, 2012,Press Enterprise newspaper found fine particles in the air increase the risk of a debilitating brain attack. Epidemiologists with the California Department off Public Health and collaborating organizations tracked more than 100,000 women, all current or former teachers and school administrators. They reported that older women living in places with higher levels of fine particle pollution including **diesel soot**, car exhaust, wood smoke, chemical compounds and microscopic airborne contaminants had a significantly increased risk for first time strokes.
Currently there are many seniors living in the area and the project is planning on creating a senior community.

I previously documented that current statistics for this area demonstrate there already is an increase incidence of asthma and other respiratory diseases attributed to air quality and another study conducted by USC links the incidence of malignant brain tumors to air quality.

The health issues of this project will not go away after the construction phase which is projected to be 20 to 30 years, With the addition of 8407 dwelling units and 25,000 more residents, traffic in this area will continue to have a negative impact on the health of the Community. Why is this project moving forward knowing the risks?

The RDEIR assumes that the 2020and 2030 standards for traffic /transportation and fuel use will be much improved thus negating concern. From a historic point of view this seems to be unrealistic since the Government has yet to agree on how to address many of these "green" issues.

Comment Letter No. 21

Steve Loe
Biologist
33832 Nebraska St.
Yucaipa, CA 92399
steveloe@gmail.com

<u>Comment No. 21-1</u>

Need to deal with new designated critical habitat for San Bernardino Kangaroo habitat. Need a multi-species plan for the area that provides the most protection and still allows development. Please send a copy of the project disc.

<u>Response to Comment No. 21-1</u>

The commentor indicates concerns about newly designated critical habitat for the San Bernardino Kangaroo Rat (SBKR). This matter is outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" with respect to cumulative impacts within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5.

The original DEIR contains a discussion of the role of critical habitat designated by the United States Fish and Wildlife Service (USFWS) under the federal Endangered Species Act (ESA) and explains that this regulatory term/designation is intended "to guide the actions of federal agencies." (See Sections 4.5.2.1 and 4.5.3.2 of the DEIR Volume I.) The DEIR notes that for purposes of a proper analysis of the impacts of the Project on the SBKR through modifications and loss of SBKR habitat, the analysis took into consideration the information available about the species in the 2008 critical habitat designation rule (which incorporated information about the species and its habitat in the 2002 rule designating critical habitat that is currently in effect), but that a much more detailed and accurate habitat analysis was applied using more extensive, detailed and ground-verified information about habitat conditions on the Project site and in the surrounding area than was available simply by reference to whether the land was or was not designated by the USFWS as critical habitat. (See Section 4.5.5.1 of the DEIR Volume I.) Actual habitat conditions and functioning on the Project site and in the surrounding area were thus utilized in the DEIR analysis, which provided a more accurate analysis of impacts than simply calculating the number of acres designated by the USFWS as critical habitat being preserved and being impacted by the Project. The information, analysis, and conclusions regarding the impact of the Project on the SBKR (including indirect impacts to the species as a result of habitat loss and modification) were never dependent on the more broad-brushed critical habitat designation, intended to guide the actions of federal agencies. (See Sections 4.5.5.1 and 4.5.5.3 of the DEIR Volume I.)

The commentor has failed to establish the existence of "significant new information" with regard to SBKR critical habitat for another reason. Since certification of the EIR in 2010, no new information satisfying the standards of CEQA Section 21092.1 and CEQA Guidelines Section

15088.5 has been introduced. The only change with regard to SBKR critical habitat is that a federal district court has found that the USFWS acted "arbitrarily and capriciously" in adopting a revised designation of SBKR critical habitat in 2008. The effect of that judicial order was to automatically reinstate the critical habitat designation in effect prior to the revised designation made in 2008, until such time as the USFWS elects to re-propose modifications to the designation and complete the proper rule-making procedures. The biological information associated with the 2002 critical habitat designation was known and available in 2002 and at the time the City prepared and adopted the EIR for the Project. The EIR cited the 2008 revised critical habitat designation and rule (which included extensive information about the SBKR and its habitat, both what was known when it designated critical habitat in 2002 and when it revised the designation in 2008), and all of this information was considered in the overall CEQA analysis for the Project as part of the original EIR. (See reference to 73 Federal Regulation 20581 on page 4.5-134 of the DEIR Volume I). Thus, the fact that the USFWS and federal agencies must refer to the older 2002 critical habitat in conducting <u>their</u> activities (which does not take into consideration all of the additional information known about the SBKR and its habitat developed since 2002) has no bearing on calling into question the analysis and conclusion by the City of the Project's impact on the SBKR.

As for the request that a multi-species conservation plan be prepared, the City is entitled to pursue such a plan regardless of the Project. Multi-species conservation plans are typically broad-ranging in scope and geography and are not project-specific, and the development of such a plan falls outside of the scope of this Project. Moreover, this issue has little bearing on whether adequate mitigation has been proposed to address the biological impacts of the Project. As discussed in Section 4.5.5 of the original DEIR, such impacts would be less than significant after mitigation.

Lytle Creek Ranch Community Workshop
February 16, 2012

Steve Loe, Biologist 33832 Nebraska Yucaipa, CA 92399 909.435.5230 steveloe@gmail.com	Need to deal with new designated critical habitat for San Bernardino Kangaroo habitat. Need a multi-species plan for the area that provides the most protection and still allows development. Please send a copy of the project disc.

April 4, 2012

Comment Letter No. 22

Steve Loe
Biological Consultant
Certified Wildlife Biologist, TWS
steveloe01@gmail.com

Comment No. 22-1

Gina: Here are my comments regarding the Lytle Creek Ranch Project. I have been working with the City for over a year to try to gain understanding and recognition of the biological values and threats from the project. Several local biological experts and I asked to meet with the developer's and city's biologists, and were never accomodated. [sic] We even scheduled a meeting with them and Mike Storey and they never showed up. After an hour or so, Mike told us they weren't going to come meet with us after all. They were too busy.

Shortly after that, the project was approved without even giving the experts a chance to provide detailed input.

Response to Comment No. 22-1

The commentor's past requests to meet with the City regarding the Project are noted. Throughout the Project's environmental review process, opportunities for public review and comment have occurred in accordance with CEQA and the CEQA Guidelines, as summarized in Section 1.9 of the original DEIR, Response to Comment No. III-123-2 of the original Final EIR, and Section 1.3 of this Final RPEIR. It is also noted that the EIR includes a number of technical reports prepared by professional biologists and thus incorporates the input of "biological experts." This comment is noted for the record and will be forwarded to the decision makers.

Comment No. 22-2

In regards to the RDEIR, the information that myself and others have gathered from biological experts is new information. If you had dealt with it the last round and met with the biologists as requested, you could say this is old information. You did not, so this is new information. We still request a meeting to work with your biologists to understand what is really being proposed for habitat protection and how it is supposed to work. We also have some ideas that should be considered and discussed for better protection of species.

There is substantial new information since the circulation of the previous EIR that must be dealt with in a new decision.

The final Critical Habitat for the San Bernardino Kangaroo Rat (SBKR) is also a new situation that must be dealt with in the analysis and mitigation.

The final Critical Habitat for the Santa Ana Sucker and recent studies have documented the importance of gravel to Santa Ana sucker and the impacts of constraining the floodway with a new revetment on recruitment of sand for downstream SA sucker spawning has not been fully analyzed. Stopping the channel braiding through old sediments and picking up gravels will impact downstream sucker habitat. Cajon Wash and Lytle Creek are significant contributors of spawning gravel.

The Corps, Fish and Wildlife, Fish and Game, and the Water Quality Control Board have not approved the project as proposed and it is premature for you to approve a project that still has potential for significant changes based on biology and new information.

Response to Comment No. 22-2

The commentor indicates concerns about newly designated critical habitat for the San Bernardino Kangaroo Rat (SBKR). This matter is outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5. Please refer to Response to Comment No. 21-1 for further discussion.

Similarly, comments regarding the Santa Ana sucker are outside the scope of the RPDEIR and do not represent "significant new information" as defined in CEQA Section 21092.1 and CEQA Guidelines Section 15088.5. In any event, the Santa Ana sucker was addressed in Section 4.5, Biological Resources, of the original DEIR, and potential impacts are addressed in Section 4.5.5 therein. As discussed, the Santa Ana sucker is known to exist regionally but was neither observed nor is expected to occur within the LCRSP study area. The Project site was not designated as critical habitat for the Santa Ana sucker in the USFWS's most recent critical habitat designation for the species. As for the issue of sediment transport within Lytle Creek relative to Santa Ana suckers that may exist downstream of the Project site, the EIR explains why the Project is not expected to have any significant change to sediment transport dynamics or the amount of sediment transport occurring within Lytle Creek. (See June 30, 2010 PACE letter to Mike Story, Response 1, Response 8, Response 11; and May 5, 2010 PACE Technical Memorandum provided in Appendix IV-C of the FEIR Volume IV.)

With respect to the permits sought from the various resource agencies, this issue is also outside the scope of the RPDEIR. However, while permit approval will be necessary in order for the Project to ultimately be implemented, the City is entitled to approve the Project and certify the EIR prior to issuance of those permits. In particular, the CDFG typically requires certification of an EIR prior to issuance of a Section 1600 streambed alteration agreement.

Comment No. 22-3

Please let me know when the biological experts and I can meet with the City and proponent biological consultants. We would like a field trip so the City and proponent could explain their protection plan on the ground.

Response to Comment No. 22-3

The commentor's request to meet with the City regarding the Project is acknowledged. Please refer to Response to Comment No. 22-1 above. This comment is noted for the record and will be forwarded to the decision makers.

Comment No. 22-4

Please include these comments in the record along with the documents I submitted before that were not evaluated in the initial approval. I will send them in a separate e-mail.

- This project as proposed will make a permanent modification of the current geological and biological processes and functions that are unique to the Cajon/Lytle Creek confluence and alluvial fan. This will permanently affect the habitat for threatened, endangered species and species of special concern that are dependent upon the wash natural function. This has not been fully disclosed and analyzed.

Response to Comment No. 22-4

The commentor states concerns about the geologic, hydrologic, and biological impacts associated with the Project. These matters are outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5. However, these issues were addressed in the original DEIR. (See DEIR Volume I, Sections 4.3.5, 4.4.5, and 4.5.5 regarding impacts related to geology, hydrology, and biological resources, respectively.) This comment is noted for the record and will be forwarded to the decision makers.

Comment No. 22-5

- The loss a significant part of the largest remaining naturally functioning alluvial fan sage scrub/riversidean sage scrub habitat with its associated threatened, endangered species, and species of special concern, is significant and has not been acknowledged or mitigated to a large extent.

Response to Comment No. 22-5

The commentor states concerns about Project impacts to specific vegetation communities. These matters are outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5. However, these issues were addressed in the original DEIR. (See DEIR Volume I, Section 4.5.5.) This comment is noted for the record and will be forwarded to the decision makers.

Comment No. 22-6

- Analysis of effects and mitigation must include the function of the habitat and not just the acres. This is the largest remaining area with a hope of maintaining SBKR. It should not be compared to total acres in existence, but the analysis must focus on this area and its ability to support a viable population in perpetuity.

Response to Comment No. 22-6

The commentor states concerns about Project specific biological impacts and mitigation. These matters are outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5. However, these issues were addressed in the original DEIR, wherein there is extensive discussion of existing habitat, its suitability to support sensitive species, the results of field surveys performed on-site, etc. (See DEIR Volume I, Section 4.5, and specifically the impact analysis in Section 4.5.5.) In particular, Mitigation Measure 5-7 is designed to mitigate for impacts to the SBKR and includes measures that address on-site avoidance and preservation, off-site preservation and connectivity, refinement of mitigation program through consultation with USFWS, avoidance and minimization of direct mortality of individuals, minimization of indirect mortality of individuals, and long-term management of preserved habitat areas, and thus does not merely take habitat acreage into account. (See DEIR Volume I, Section 4.5.6.)

Furthermore, it should be noted that the Court Ruling rejected a claim that Mitigation Measure 5-7 would be ineffective to mitigate impacts to the SBKR to a less-than-significant level. The Court Ruling stated, in relevant parts:

> To the extent Petitioners are arguing that the mitigation measures [for the SBKR] are not supported by substantial evidence, they do not meet their burden on this issue.
>
> . . . .
>
> Petitioners argue, without any supporting evidence, that the project's impacts 'are so large as to be essentially unmitigable to a level of insignificance.' (RPDEIR Volume V (Part 1), Appendix V-A, Court Ruling, pp. 49-50.)

Comment No. 22-7

- It is premature for the City to approve the project until the permitting is complete.

Response to Comment No. 22-7

Please refer to Response to Comment No. 22-2 above.

Comment No. 22-8

- Cumulative impacts have not been adequately described as it relates to Riversidean Sage Scrub, Alluvial Fan Sage Scrub, and functioning species habitat.

Response to Comment No. 22-8

The commentor states concerns about Project cumulative impacts to specific vegetation communities. These matters are outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to “significant new information.” The commentor offers no “significant new information” within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5, nor is there any substantiation to the claim that the cumulative analysis provided in the original EIR was inadequate. These issues were thoroughly addressed in the original DEIR. (See DEIR Volume I, Section 4.5.5.3.)

Comment No. 22-9

- New information on cumulative impacts is available and must be used in a reanalysis. Some new items that must be addressed include; the inability of the release flows from Seven Oaks Dam being inadequate to maintain the function of the Santa Ana River habitat (including SBKR) for the long-term. The little bit of remaining San Jacinto River SBKR habitat has been severely altered. These are the two other larger areas that remain for SBKR and they are both seriously compromised.

Response to Comment No. 22-9

Please refer to Response to Comment No. 22-8, above. The issues raised in the comment do not directly relate to the analysis of cumulative impacts. CEQA Guidelines section 15130 states “a cumulative impact consists of an impact which is created as a result of the combination of the project evaluated in the EIR together with other projects causing related impacts.” The issues above are not associated with the related projects that were evaluated in the EIR. The commentor fails to cite to or provide any specific information regarding the Seven Oaks Dam, the Santa Ana SBKR population, and the San Jacinto River SBKR population. As such, the comment is speculation and is not substantial evidence under CEQA. (See CEQA Guidelines, § 15384.) Moreover, the EIR concluded that there would be a significant cumulative impact on the SBKR before mitigation. The proposed mitigation is focused on maintaining the long-term persistence of the SBKR population in the Lytle/Cajon creek system, which is a population separate from the Santa Ana and San Jacinto River populations.

In any event, the original DEIR and Biological Resources Assessment (Appendix III-D-B to the DEIR) undertook an extensive Project-specific and cumulative impact analysis of SBKR habitat in the Project study area, and incorporated appropriate measures to mitigate potential impacts to less than significant levels. Indeed, the Court Ruling rejected a claim that Mitigation Measure 5-7 would be ineffective to mitigate impacts to the SBKR to a less than significant level. Please refer to Response to Comment No. 22-6, above.

Comment No. 22-10

- The premise that AFSS and RSS habitat can be restored and created by man is not the case. Creating and maintaining functional SBKR and other dependent species habitat without alluvial influence has not been proven and should not be assumed to be possible. The analysis needs to reflect the inability to create or maintain habitat without water due to the new revetment.

Response to Comment No. 22-10

The commentor states concerns about Project cumulative impacts to specific vegetation communities. These matters are outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5.

The Court Ruling rejected a claim that Mitigation Measure 5-7 would be ineffective to mitigate impacts to the SBKR to a less-than-significant level. (See RPDEIR Volume V (Part 1), Appendix V-A, Court Ruling, pp. 48-51.) Indeed, the Court Ruling noted that the City was entitled to rely on expert opinion in concluding so, and noted mammalogist Dr. Michael J. O'Farrell has opined that such mitigation would be effective. Please also refer to Response to Comment No. 22-6. Furthermore, and contrary to the commentor's concern, the areas proposed for habitat restoration are not behind the revetment.

Comment No. 22-11

- AFSS and RSS habitat are a result of very large storms that occur in hundreds to thousands of year storms. What will the revetment do to the larger 200-1000 year events and the habitat. That needs to be fully disclosed.

Response to Comment No. 22-11

The commentor states concerns about Project cumulative impacts to specific vegetation communities. These matters are outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5.

In any event, the Biological Resources Assessment (BRA), provided as Appendix III-D-B to the original DEIR, did assess both periodic and highly intense storms and flooding, and the effect on RAFSS. As the BRA noted:

> Under the assumption or scenario that floods may become more frequent and more intense in the future, sensitive biological resources (both plant and animal species) within the LCRSP study area are already adapted to a dynamic flood regime due to the inherent nature of the alluvial fan system. In fact, the dominant plant community, Riversidean alluvial fan sage scrub, depends upon floods to maintain the pioneer, intermediate, and mature phases. Without scouring flood events, this community would not support the diverse vegetative stature and species composition it currently does.
>
> An additional consideration is the possibility that this scenario could result in floods that exceed the current 100-year floodplain limits (Figure 16, *Hydrologically Active RAFSS and SBKR Viable Constituent Elements*) or an expansion of the 100-year floodplain. Given the highly restricted distribution of Riversidean alluvial fan sage scrub and the associated and largely endemic

> sensitive species occurring within it (e.g. the San Bernardino kangaroo rat and slenderhorned spineflower), this could result in an unexpected benefit to these species. The expansion of the amount of Riversidean alluvial fan sage scrub within the Lytle Creek Wash system may occur if areas currently above the 100-year floodplain were exposed to more frequent flooding. *Although increased flood events could result in a reduction in the refugia habitat above the 100-year floodplain that is used by the San Bernardino kangaroo rat, it is not likely that a flood large enough to destroy all refugia within the Lytle/Cajon Wash system would occur*. On the contrary, catastrophic floods may increase the availability of suitable habitat for this species along the outer limits of the currently existing floodplain. (See DEIR Volume III (Part 1), Biological Resources Assessment, pp. 91-92, emphasis added. See also May 5, 2010, PACE Technical Memorandum, provided as Appendix IV-C, to the original FEIR Volume IV.)

Please also refer to Response to Comment No. 22-6, above.

Comment No. 22-12

- What will be the effect on the new community if there was a 200-1000 year flood event. It needs to be fully disclosed in lay person terms that a much larger than 100 year events formed this entire area and that one of these larger events could happen any future winter. The City must disclose what would happen in these types of alluvial fan floods and how that would affect residents and the environment. You are proposing to create an artificial system, so you must disclose the effects of the periodic massive flood.

Response to Comment No. 22-12

The commentor states concerns about Project cumulative impacts to specific vegetation communities. These matters are outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5. However, hydrology impacts were fully addressed in the DEIR, based on relevant methodologies and engineering standards set forth by the City, County, and State. (See DEIR Volume I, Section 4.4.)

Comment No. 22-13

- The reanalysis of the species and habitat protection alternatives and their infeasibility was not valid. The judge did not say go back and draft up some economic reason why the protection alternatives are infeasible so we don't have to deal with them. What has never been done is a serious look at ways to protect the habitat and still have a viable project. Just saying you must have everything proposed which is much more than the current entitlements or the entitlements when the property was purchased is not seriously looking for an enviromentally [sic] superior alternative. Please seriously look for a feasible alternative.

Response to Comment No. 22-13

The commentor implies that the RPDEIR did not contain a reasonable range of alternatives. However, the Court Ruling only required that the City revise the EIR's analysis of Habitat Avoidance Alternative 1 (Avoidance of SBKR/LBV-Occupied Habitat) and Habitat Avoidance Alternative 2 (Avoidance of RAFSS Areas). The Court Ruling did not require further analysis of the other alternatives to the Project that were evaluated in the original EIR, nor did it require the assessment of additional alternatives not previously analyzed in the EIR. Moreover, as described in Section 1.2 of this Final RPEIR, under current CEQA case law, claims unasserted or abandoned in the litigation are not subject to further review by the Court. A previous petition for writ of mandate against the City claimed that the original EIR failed to analyze a reasonable range of alternatives, and that claim was not pursued in substantive court briefing. Accordingly, this comment is outside the scope of the RPDEIR. The commentor is referred to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information."

Section 2.5.9 of the RPDEIR includes discussion of a variety of reasons why the alternatives are considered infeasible, including the failure to avoid or substantially lessen the Project's significant impacts (RPDEIR Section 2.5.9.1), financial infeasibility (RPDEIR Section 2.5.9.2), failure to meet key Project objectives (RPDEIR Section 2.5.9.3), and failure to satisfy key goals and policies of the General Plan (RPDEIR Section 2.5.9.4). Please refer to Response to Comment Nos. 22-6 and 22-10 above, and Response to Comment No. 7-4 for further discussion.

Comment No. 22-14

- The analysis and mitigation must disclose that the values at risk and planned for destruction are unique in this area. The biological effects are not an acre for acre effect or mitigation unless the acre is part of a large block of habitat capable of supporting a viable population of SBKR and other species of concern. A 10, or 50 or 100 acre patch of unconnected habitat will not support a viable population. Any habitat block that is no longer connected to periodic flows and floods will not even support the species in the long term.

I will submit additional comments and send attachments that still represent new information later tonite. [sic]

Response to Comment No. 22-14

Please refer to Response to Comment Nos. 22-6 and 22-10, above.

Ashley Rogers

From: Ashley Rogers
Sent: Thursday, May 10, 2012 1:45 PM
To: Ashley Rogers
Subject: FW: Lytle Creek Ranch RDEIR Comments

-----Original Message-----
From: Gina Gibson [mailto:ggibson@rialtoca.gov]
Sent: Tuesday, April 03, 2012 6:03 PM
Subject: FW: Lytle Creek Ranch RDEIR Comments

From: Steve Loe [steveloe01@gmail.com]
Sent: Tuesday, April 03, 2012 4:28 PM
To: Gina Gibson
Cc: Al Kelley; Steve Loe; Kathie P -FS Meyer
Subject: Lytle Creek Ranch RDEIR Comments

Gina: Here are my comments regarding the Lytle Creek Ranch Project. I have been working with the City for over a year to try to gain understanding and recognition of the biological values and threats from the project. Several local biological experts and I asked to meet with the developer's and city's biologists, and were never accomodated. We even scheduled a meeting with them and Mike Storey and they never showed up. After an hour or so, Mike told us they weren't going to come meet with us after all.They were too busy.
Shortly after that, the project was approved without even giving the experts a chance to provide detailed input.

In regards to the RDEIR, the information that myself and others have gathered from biological experts is new information. If you had dealt with it the last round and met with the biologists as requested, you
could say this is old information. You did not, so this is new
information. We still request a meeting to work with your biologists to understand what is really being proposed for habitat protection and how it is supposed to work. We also have some ideas that should be considered and discussed for better protection of species.

There is substantial new information since the circulation of the previous EIR that must be dealt with in a new decision.
The final Critical Habitat for the San Bernardino Kangaroo Rat (SBKR) is also a new situation that must be dealt with in the analysis and mitigation.

The final Critical Habitat for the Santa Ana Sucker and recent studies have documented the importance of gravel to Santa Ana sucker and the impacts of constraining the floodway with a new revetment on recruitment of sand for downstream SA sucker spawning has not been fully analyzed. Stopping the channel braiding through old sediments
and picking up gravels will impact downstream sucker habitat. Cajon Wash and Lytle Creek are significant contributors of spawning gravel.

The Corps, Fish and Wildlife, Fish and Game, and the Water Quality Control Board have not approved the project as proposed and it is premature for you to approve a project that still has potential for significant changes based on biology and new information.

Please let me know when the biological experts and I can meet with the City and proponent biological consultants. We would like a field trip so the City and proponent could explain their protection plan on the ground.

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Please include these comments in the record along with the documents I submitted before that were not evaluated in the initial approval. I will send them in a separate e-mail.

* This project as proposed will make a permanent modification of the current geological and biological processes and functions that are unique to the Cajon/Lytle Creek confluence and alluvial fan. This will permanently affect the habitat for threatened, endangered species and species of special concern that are dependent upon the wash natural function. This has not been fully disclosed and analyzed.
* The loss a significant part of the largest remaining naturally functioning alluvial fan sage scrub/riversidean sage scrub habitat with its associated threatened, endangered species, and species of special concern, is significant and has not been acknowledged or mitigated to a large extent.
* Analysis of effects and mitigation must include the function of the habitat and not just the acres. This is the largest remaining area with a hope of maintaining SBKR. It should not be compared to total acres in existence, but the analysis must focus on this area and its ability to support a viable population in perpetuity.
* It is premature for the City to approve the project until the permitting is complete.
* Cumulative impacts have not been adequately described as it relates to Riversidean Sage Scrub, Alluvial Fan Sage Scrub, and functioning species habitat.
* New information on cumulative impacts is available and must be used in a reanalysis. Some new items that must be addressed include; the inability of the release flows from Seven Oaks Dam being inadequate to maintain the function of the Santa Ana River habitat (including SBKR) for the long-term. The little bit of remaining San Jacinto River SBKR habitat has been severely altered. These are the two other larger areas that remain for SBKR and they are both seriously compromised.
* The premise that AFSS and RSS habitat can be restored and created by man is not the case. Creating and maintaining functional SBKR and other dependent species habitat without alluvial influence has not been proven and should not be assumed to be possible. The analysis needs to reflect the inability to create or maintain habitat without water due to the new revetment.
* AFSS and RSS habitat are a result of very large storms that occur in hundreds to thousands of year storms. What will the revetment do to the larger 200-1000 year events and the habitat. That needs to be fully disclosed.
* What will be the effect on the new community if there was a 200-1000 year flood event. It needs to be fully disclosed in lay person terms that a much larger than 100 year events formed this entire area and that one of these larger events could happen any future winter. The City must disclose what would happen in these types of alluvial fan floods and how that would affect residents and the environment. You are proposing to create an artificial system, so you must disclose the effects of the periodic massive flood.
* The reanalysis of the species and habitat protection alternatives and their infeasibility was not valid. The judge did not say go back and draft up some economic reason why the protection alternatives are infeasible so we don't have to deal with them. What has never been done is a serious look at ways to protect the habitat and still have a viable project. Just saying you must have everything proposed which is much more than the current entitlements or the entitlements when the property was purchased is not seriously looking for an enviromentally superior alternative. Please seriously look for a feasible alternative.
* The analysis and mitigation must disclose that the values at risk and planned for destruction are unique in this area. The biological effects are not an acre for acre effect or mitigation unless the acre is part of a large block of habitat capable of

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supporting a viable population of SBKR and other species of concern. A 10, or 50 or 100 acre patch of unconnected habitat will not support a viable population. Any habitat block that is no longer connected to periodic flows and floods will not even support the species in the long term.

I will submit additional comments and send attachments that still represent new information later tonite.

Steve Loe
Biological Consultant
Certified Wildlife Biologist, TWS
909-809-4726<tel:909-809-4726>

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Comment Letter No. 23

Steve Loe
Biological Consultant
Certified Wildlife Biologist, TWS
steveloe01@gmail.com

Comment No. 23-1

Gina: Additional Comments on the Lytle Creek Ranch Project RDEIR.

Please acknowledge these attached documents and requests for meetings and explain why the City never was able to pull together a biologist meeting. I officially request a meeting on the ground to review and understand design of revetment and protection of habitat and resources. Let me know when we can set up a meeting so I can involve local biological experts.

Response to Comment No. 23-1

The commentor's past requests to meet with the City regarding the Project are noted. Please refer to Response to Comment No. 22-1 regarding the opportunities for public review and input that have been afforded throughout the EIR process in accordance with CEQA.

Comment No. 23-2

[Attachment 1—City Council Meeting, June 22, 2010]

Good Evening City Staff and City Council:

My name is Steve Loe. I am a retired federal employee with 40 years of experience in natural resource management. As a Forest Service biologist and natural resource manager, I have been involved in management of Lytle Creek Wash for 30 years. I have worked with the County and regulatory agencies on Cajon and Lytle Creek habitat protection for 30 years. I provided input on the project in letters, testimony at the Planning Commission, and by direct communication with County Staff. I have asked repeatedly to meet with County Staff and the County Biological Consultant to work together to understand and discuss the biological ramifications and opportunities in the Wash. Apparently they have been too busy to meet and work on potential ways to improve the plan and EIR. I continue to think I have important input that is being ignored.

Response to Comment No. 23-2

The commentor's past requests to meet with the City regarding the Project are noted. Please refer to Response to Comment No. 22-1 regarding the opportunities for public review and input that have been afforded throughout the EIR process in accordance with CEQA.

Comment No. 23-3

I ask the City Council not to rush to judgment on this proposal. What the Council has before them to approve is only what the City and out-of-town developer think will make the most money, not a plan that is ready to approve at this time. The public, agencies, and residents have not been listened to and have really had no opportunity to influence the plan. The City's mind has been made up and all of the City's effort to date has been to justify the proposed project.

With the number of individual, citizen group and agency concerns regarding this proposal that have been expressed in writing and public testimony, it is obvious that this project does not yet have understanding and support of the affected parties. You can and have said that everything is great for everyone. It is not. There are huge outstanding issues that have been rolled under the carpet. These need to be openly dealt with before a project is approved:

Response to Comment No. 23-3

Please refer to Response to Comment No. 22-1 regarding the opportunities for public review and input that have been afforded throughout the EIR process in accordance with CEQA. Public comments have included the input of various public agencies, including those with jurisdiction over the Project; the comment letters are provided in Appendix IV-B of the original FEIR and throughout this section of the Final RPEIR (i.e., after each set of responses), and responses to those comments are provided in each respective EIR document.

The comment regarding "outstanding issues" is vague and unsubstantiated, and based on the date of the letter, is outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5.

Comment No. 23-4

- The extremely high value and uniqueness of the Lytle Creek Wash as plant and animal habitat has not been fully acknowledged and disclosed. The loss of these values (including Threatened and Endangered Species) with the project has been understated and under-mitigated.

Response to Comment No. 23-4

The commentor indicates concerns about Lytle Creek Wash and its habitat. These matters are outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5. However, these issues were thoroughly addressed in the original DEIR. (See DEIR Volume I, Section 4.5 and specifically Sections 4.5.5 and 4.5.6.)

Comment No. 23-5

- The value of the Wash to sand and gravel supplies, water quantity and quality, natural beauty, recreation and education has not been fully acknowledged and disclosed. The significant loss of these values with the project has been understated and under-mitigated.

<u>Response to Comment No. 23-5</u>

The commentor indicates concerns about various aspects of Lytle Creek Wash. These matters are outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5. However, these issues were thoroughly addressed in the original DEIR. (See DEIR Volume I, Sections 4.4, 4.5, 4.9, and 4.13.) Also refer to Response to Comment No. 22-2 regarding gravel in the Wash.

<u>Comment No. 23-6</u>

- The Alluvial Fan Task Force and its efforts to help agencies plan for management of alluvial fans has been ignored and trivialized by the City.

<u>Response to Comment No. 23-6</u>

The commentor indicates concerns about the Alluvial Fan Task Force. This matter is outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5.

In any event, the City is aware of the Alluvial Fan Task Force (a creation of Assembly Bill 2141 in 2004) and its guidance documents for development within alluvial fans. Those documents do not have a binding effect on any local government. Rather, it is the hope of the Task Force that individual cities and counties eventually will adopt some portion or variation of the recommendations; however, no city or county is compelled to do so. The City of Rialto's consideration of adopting the Task Force's recommendations, or any portion thereof, is a matter independent of the Project. (See July 6, 2010 Memo from Peter Lewandowski to Mike Story, § 4.4.)

Nonetheless, it should be noted that the EIR does recognize the location of the Project within an alluvial fan and analyzes issues associated with that location. The EIR adequately analyzes the issues of fire, flood, geology and soils, hydrology, and biological resources associated with the alluvial fan (to the extent these relate to the Project) and, where appropriate, provides mitigation measures to reduce impacts to below a level of significance. (See DEIR Volume I, Sections 4.3, 4.4, 4.5, and 4.9.)

<u>Comment No. 23-7</u>

- There are significant outstanding issues that have been raised by the agencies that will be making future decisions on the project before it can proceed. How can a project be approved prior to having buy-in by the agencies with connected decisions. The final project may look nothing like currently proposed.

Response to Comment No. 23-7

Please refer to Response to Comment No. 22-2 regarding the regulatory permits requested from the various resource agencies.

Comment No. 23-8

- Lytle Creek Wash really needs an interagency plan for management of the Wash which is a State, County, Federal and City resource. The City is trying to make the decision on the future of this invaluable resource by them selves [sic]. This is not right. There is a great need for a Coordinated Resource Management Plan and Habitat Conservation Plan for Lytle Creek Wash before project decisions can be made. It is the City's own Policy to do Habitat Conservation Planning for this area. Why is this being violated?

Response to Comment No. 23-8

The commentor indicates concerns about inter-agency management of Lytle Creek Wash. The City is entitled to pursue conservation plan(s) regardless of the Project. Such plans are typically broad-ranging in scope and geography and are not project-specific, and the development of such a plan falls outside of the scope of both the Project and the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5. Please refer to Response to Comment No. 22-1 regarding a multi-species plan.

Comment No. 23-9

- Restricting the Wash to the 100 year floodplain with a levee as proposed will greatly affect the natural function of the Wash. This has not been adequately disclosed or mitigated for. The Wash and its unique natural resources were created and maintained by much larger floods. Stopping the natural processes of larger floods and restricting them to a smaller area will have permanent adverse effects on the Wash and its resources. These effects have not been disclosed, analyzed and mitigated for.

Response to Comment No. 23-9

The commentor states concerns about the Lytle Creek Wash floodplain. This matter is outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5. However, hydrology impacts were fully addressed in the DEIR, based on relevant methodologies and engineering standards set forth by the City, County, and State. (See DEIR Volume I, Section 4.4.) Also refer to the PACE May 5, 2010 Technical Memorandum provided as Appendix IV-C of the FEIR Volume IV.

Comment No. 23-10

- The alternatives that would provide more protection to the Wash have been dismissed without serious analysis. The societal values of protection of the Wash by these alternatives have been understated and under-mitigated.

Response to Comment No. 23-10

The RPDEIR provides additional analysis of Habitat Avoidance Alternative 1 (Avoidance of SBKR/LBV-Occupied Habitat) and Habitat Avoidance Alternative 2 (Avoidance of RAFSS Areas), as directed by the Court Ruling. (See RPDEIR Volume V (Part 1), Section 2.5.)

The commentor implies that the EIR did not contain a reasonable range of alternatives. However, members of the public do not choose alternatives to a proposed project; that task is for the lead agency. "CEQA establishes no categorical legal imperative as to the scope of alternatives to be analyzed in an EIR." (*Citizens of Goleta Valley v. Board of Supervisors* (1990) 52 Cal.3d 553, 566.) The City is not legally obligated to analyze alternatives proposed by members of the public that are merely variations of alternatives already evaluated in the EIR. (See *Preservation Action Council v. City of San Jose* (2006) 141 Cal.App.4th 1336, 1358-59.)

The Court Ruling did not require further analysis of the other alternatives to the Project that were evaluated in the original EIR, nor did it require the assessment of additional alternatives not previously analyzed in the EIR. Moreover, the petition for writ of mandate filed against the City claimed that the original EIR failed to analyze a reasonable range of alternatives, and that claim was not pursued in substantive court briefing. Accordingly, this comment is outside the scope of the RPDEIR. The commentor is referred to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information."

Comment No. 23-11

If the City Council approves this project as currently proposed I will do everything in my power to:

- Make sure the final decision on how to manage the Wash is made by all of the public agencies responsible for the Wash and not just the City of Rialto.
- Work with residents, agencies and citizens to modify the project as it moves through the connected approval and permitting processes to better provide for existing residents and natural resources.
- Make sure the County, State and Federal agencies that have subsequent decisions on the project follow procedures and do their job in protecting the Wash.

In summary, I urge you not to approve this project at this time, but to put it on hold until a Coordinated Resource Management Plan and Habitat Conservation Plan can be developed to help design the final project. The City should provide some of the leadership in the development of these essential plans.

Response to Comment No. 23-11

Please refer to Response to Comment No. 22-2 regarding the regulatory permits requested from the various resource agencies. Refer to Response to Comment No. 22-1 regarding the opportunities for public review and input that have been and will continue to be afforded throughout the EIR process in accordance with CEQA. Refer to Response to Comment No. 23-8 above regarding conservation plan(s) for the Wash. This comment is noted for the record and will be forwarded to the decision makers.

Comment No. 23-12

[Attachment 2—Meeting with City of Rialto, July 6, 2010]

Attended by Mike Story, Steve Loe, Al Kelley, and Debbie

Mike Story said that the biologist and consultant were too busy responding to public comments to meet with us.

Said that he understood our concerns, but they were doing everything possible to be able to say they followed CEQA and met at least the minimum requirements. He acknowledged that some things have not been dealt with, but that they met the requirements of CEQA.

Response to Comment No. 23-12

Please refer to Response to Comment No. 22-1 regarding the opportunities for public review and input that have been afforded throughout the EIR process in accordance with CEQA.

Comment No. 23-13

Questions

- Explain to us what is being proposed to take care of the wash habitat and species.

Response to Comment No. 23-13

Please refer to Response to Comment No. 23-4 above.

Comment No. 23-14

- Help us understand the effects of constraining the wash forever to the 100 year floodplain and how that could possibly maintain all the species and processes currently supported by the wash which is largely created and maintained by greater than 100 year flood events.

Response to Comment No. 23-14

Please refer to Response to Comment No. 23-9 above.

Comment No. 23-15

- How could the constrained wash (100 yr. floodplain) ever maintain a habitat that is created and maintained by 200, 300, 400, 500 and thousand year events.

Response to Comment No. 23-15

Please refer to Response to Comment Nos. 23-4 and 23-9 above.

Comment No. 23-16

- Is there land somewhere in the City or adjacent that has been abandoned or City land that could be given to the developer in exchange for protecting the wash? Make it a win/win for the developer, the Wash and the City.

Response to Comment No. 23-16

This comment is outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5. Please also refer to Response to Comment 21-6.

Comment No. 23-17

- Did the developer or City's biologist consider the long-term value of the upper wash in light of global climate change and species population shifts? Forest Service has gone on record in Critical Habitat designation process stating that this is very important.

Response to Comment No. 23-17

The commentor indicates additional concerns about Lytle Creek Wash. These matters are outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5. However, these issues were addressed in the original DEIR. (See DEIR Volume I, Section 4.5 and specifically Section 4.5.3.1 therein; see also the Biological Resources Assessment, provided as Appendix III-D-B to the original DEIR Volume III (Part 1), Section 3.6.6.)

Comment No. 23-18

- How will the revetment be designed to allow things to move out of the wash when major flooding?

Response to Comment No. 23-18

Please refer to Response to Comment No. 23-9 above.

Comment No. 23-19

- Did the flood and revetment plan and analysis use wildlife habitat as a design criteria?

Response to Comment No. 23-19

These matters are outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5. Please refer to Response to Comment Nos. 23-4 and 23-9 above. Additionally, one of the overarching goals of the Project is stated in Project Objective A-2: Establish a conservation-based community through the creation of open space preservation areas that will provide functioning habitats for sensitive, threatened, and endangered species, preserve Lytle Creek and minimize impacts to its riparian and alluvial fan sage scrub habitats, while providing other wildlife benefits. (See DEIR Volume I, Section 2.3.2.)

Comment No. 23-20

- What is the situation with the City General Plan. Still using old plan, using new plan (Draft)? If using old plan, where is it available? Can we get a CD?

Response to Comment No. 23-20

Although this issue falls outside the scope of the Project and the RPDEIR and does not relate to CEQA, in December 2010, several months after the City originally approved the Project and certified the EIR, the City adopted an updated General Plan, which was only in draft form at the time of the Project's original approval. Project consistency with the current General Plan is provided in Section 2.5.8 of the RPDEIR. The General Plan is available in electronic format on the City's website.

Comment No. 23-21

- We need three copies of the BRA (Appendix III-D) as soon as possible.

- Need a copy of the Spencer and Goldsmith "Impacts of Free Ranging Cats on Wildlife at Suburban-Desert Interface" referenced in Resp. to Comments.

- Pacific Advance [sic] Civil Engineering "Hydrolic [sic] and Geomorphic Assessment of Lytle Creek SBKR Upland Habitat Conservation Area Erosion and Protection Plan", April 2007. Referenced in Resp. to comments.

- Need contact information for developer's biologist (Steve Nelson) to arrange a meeting.

Response to Comment No. 23-21

This comment is noted for the record and will be forwarded to the decision makers. To the extent that the commentor seeks documents subject to a Public Records Act request, the City requests that the commentor submit a "Records Request Form" to the City Clerk's Office. The form is available on the City's website at: http://www.ci.rialto.ca.us/documents/downloads/Records_Request_Form.pdf.

Comment No. 23-22

Concerns

- For the City, annexation and management of the Wash is a big thing and can't be handled as just a problem for a project that needs mitigation. An individual project cannot drive the decision on how we are going to manage the wash with multiple owners and jurisdictions.

Response to Comment No. 23-22

These matters are outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5.

Please also refer to Response to Comment No. 23-8 above. This comment is noted for the record and will be forwarded to the decision makers.

Comment No. 23-23

- There has to be a coordinated resource management plan (http://www.crmp.org/) multi-species management plan,or [sic] HCP (http://www.nmfs.noaa.gov/pr/pdfs/laws/hcp_handbook.pdf) developed for the wash. That plan will determine how the agencies can manage and develop the wash to maintain the biological values. Must be multi-species and coordinated with the resource agencies. City General Plan.

Response to Comment No. 23-23

These matters are outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5.

Please refer to Response to Comment No. 23-8 above. Also refer to Response to Comment No. 20-1 regarding a multi-species conservation plan.

Comment No. 23-24

- All of the agencies involved have legal and binding direction to place the management of wetlands, floodplains, Threatened and Endangered and imperiled species as a driving force in making decisions on these lands.

Response to Comment No. 23-24

These matters are outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5.

Please refer to Response to Comment No. 22-2 regarding the regulatory permits requested from the various resource agencies. This comment is noted for the record and will be forwarded to the decision makers.

Comment No. 23-25

- This project is not going to fly as currently designed and planned with the various regulatory and permitting agencies expressing concerns.

Response to Comment No. 23-25

These matters are outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5.

Please refer to Response to Comment No. 22-2 regarding the regulatory permits requested from the various resource agencies. This comment is noted for the record and will be forwarded to the decision makers.

Comment No. 23-26

- The City really needs to check out what the developer's biologist is presenting. They are evaluating and reporting the biology as best they can to support the project. The input you have gotten from other biologists that have been involved in the management of this area for a long time saying it is a huge deal and would change the Wash forever in a very detrimental way should be listened to.

Response to Comment No. 23-26

These matters are outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5.

Please refer to Response to Comment No. 22-1. This comment is noted for the record and will be forwarded to the decision makers.

Comment No. 23-27

[Attachment 3—August 14, 2010]

This project must be considered only as an alternative proposed by the city of Rialto which still has to be coordinated and co-planned by all regulatory and permitting agencies and property owners. This has not been done.

Response to Comment No. 23-27

These matters are outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5.

Please refer to Response to Comment No. 22-2 regarding the regulatory permits requested from the various resource agencies. Also refer to Response to Comment No. 22-1 regarding the opportunities for public review and input that have been afforded throughout the EIR process in accordance with CEQA. This comment is noted for the record and will be forwarded to the decision makers.

Comment No. 23-28

A cooperatively developd [sic] alternative that protects this nationally significant biological and geological area in its natural state, or at least near natural state, must be evaluated in all forthcoming decisions.

Response to Comment No. 23-28

These matters are outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5.

Please refer to Response to Comment No. 23-10, above, and Response to Comment No. 10-16 regarding the range of alternatives evaluated in the EIR, which the Court did not find to be inadequate. This comment is noted for the record and will be forwarded to the decision makers.

Comment No. 23-29

The biological analysis conducted for City project approval is [sic] has not been accepted by experts in biological functioning of the Wash. There is continuing dispute.

Response to Comment No. 23-29

These matters are outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5.

In any event, the list of discretionary actions, including land entitlements and permits, that are required in order for the Project to be approved and implemented, are listed in Section 2.15 of the original DEIR. Please refer to Response to Comment No. 22-2 regarding the regulatory permits requested from the various resource agencies. In addition, here, the City relied on various biological resources experts, including Steve Nelson at PCR Services Corporation, and Dr. Michael O'Farrell, a noted mammalogist and foremost authority on SBKR among other species, to assess the Project's potential biological resources impacts and to devise and recommend mitigation to reduce such impacts to less-than-significant levels.

Under CEQA, the City is legally entitled to choose among different expert opinions and is free to reject criticism from an expert or a regulatory agency on a given issue as long as its reasons for doing so are supported by substantial evidence. Please also refer to Response to Comment No. 22-6.

Comment No. 23-30

Changing the functioning of the wash through new levee (revetment) construction has not been analyzed and agreed to by all of the agencies that have some say in management of the wash.

Response to Comment No. 23-30

These matters are outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5.

Please refer to Response to Comment No. 23-9 above. Also refer to Response to Comment No. 22-2 regarding the regulatory permits requested from the various resource agencies. Hydrology impacts were fully addressed in the DEIR, based on relevant methodologies and engineering standards set forth by the City, County, and State. (See DEIR Volume I, Section 4.4.)

Comment No. 23-31

Private landowners affected by the City of Rialto decision have been adequately involved and almost all are against the project.

Response to Comment No. 23-31

Please refer to Response to Comment No. 22-1 regarding the opportunities for public review and input that have been afforded throughout the EIR process in accordance with CEQA.

In addition, please refer to Response to Comment Nos. 16-1, 17-1, and 26-1, which are letters of support from local residents. This comment is noted for the record and will be forwarded to the decision makers.

Comment No. 23-32

Project use of known biological information has been challenged by various agencies and biologists.

Response to Comment No. 23-32

These matters are outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5.

In addition, the comment is pure speculation and provides no evidence in support of the contention. "Argument, speculation, unsubstantiated opinion or narrative, [or] evidence which is clearly erroneous or inaccurate…does not constitute substantial evidence….Substantial evidence shall include facts, reasonable assumptions predicated on facts, and expert opinion supported by facts." (CEQA Guidelines, § 15384.)

Please refer to Response to Comment No. 22-1 regarding the technical reports prepared by professional biologists that have been prepared as part of the EIR. Also refer to Response to Comment No. 15-1 regarding data sources. This comment is noted for the record and will be forwarded to the decision makers.

Comment No. 23-33

The city did not provide for a meeting with City and Developer's biologists as requested by local, knowledgeable, biologists numerous times in the public involvement process for Lytle Creek Ranch.

Response to Comment No. 23-33

The commentor's past requests to meet with the City regarding the Project are noted. Please refer to Response to Comment No. 22-1 regarding the opportunities for public review and input that have been afforded throughout the EIR process in accordance with CEQA.

Comment No. 23-34

Project was approved because it met the desires of the City, but no one, including the County, State and Federal Government have not [sic] been included in the the [sic] decision.

Most of the residents affected are not Rialto Residents [sic]

Response to Comment No. 23-34

Please refer to Response to Comment No. 22-1 regarding the opportunities for public review and input that have been and will continue to be afforded throughout the EIR process in accordance with CEQA. In any event, the City has provided all responsible, trustee, and other agencies with jurisdiction over the Project with the RPDEIR. Those agencies were all given the opportunity to comment on the RPDEIR.

Also refer to Response to Comment No. 23-29 above regarding the discretionary actions required as part of the Project, and Response to Comment No. 22-2 regarding the regulatory permits requested from the various resource agencies. This comment is noted for the record and will be forwarded to the decision makers.

Ashley Rogers

From: Ashley Rogers
Sent: Thursday, May 10, 2012 1:45 PM
To: Ashley Rogers
Subject: FW: Lytle Creek Ranch RDEIR Comments

-----Original Message-----
From: Gina Gibson [mailto:ggibson@rialtoca.gov]
Sent: Tuesday, April 03, 2012 6:12 PM
Subject: FW: Lytle Creek Ranch RDEIR Comments

From: Steve Loe [steveloe01@gmail.com]
Sent: Tuesday, April 03, 2012 4:42 PM
To: Gina Gibson
Cc: Al Kelley; Steve Loe; Kathie P -FS Meyer
Subject: Re: Lytle Creek Ranch RDEIR Comments

Gina: Additional Comments on the Lytle Creek Ranch Project RDEIR.

Please acknowledge these attached documents and requests for meetings and explain why the City never was able to pull together a biologist meeting. I officially request a meeting on the ground to review and understand design of revetment and protection of habitat and resources. Let me know when we can set up a meeting so I can involve local biological experts.

Steve Loe
Biological Consultant
Certified Wildlife Biologist, TWS
909-809-4726<tel:909-809-4726>

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Steve A. Loe
Certified Wildlife Biologist
33832 Nebraska St.
Yucaipa, CA. 92399
909-809-4726

June 22, 2010

Re: Lytle Creek Ranch Specific Plan and EIR

Good Evening City Staff and City Council:

My name is Steve Loe. I am a retired federal employee with 40 years of experience in natural resource management. As a Forest Service biologist and natural resource manager, I have been involved in management of Lytle Creek Wash for 30 years. I have worked with the County and regulatory agencies on Cajon and Lytle Creek habitat protection for 30 years. I provided input on the project in letters, testimony at the Planning Commission, and by direct communication with County Staff. I have asked repeatedly to meet with County Staff and the County Biological Consultant to work together to understand and discuss the biological ramifications and opportunities in the Wash. Apparently they have been too busy to meet and work on potential ways to improve the plan and EIR. I continue to think I have important input that is being ignored.

I ask the City Council not to rush to judgment on this proposal. What the Council has before them to approve is only what the City and out-of-town developer think will make the most money, not a plan that is ready to approve at this time. The public, agencies, and residents have not been listened to and have really had no opportunity to influence the plan. The City's mind has been made up and all of the City's effort to date has been to justify the proposed project.

With the number of individual, citizen group and agency concerns regarding this proposal that have been expressed in writing and public testimony, it is obvious that this project does not yet have understanding and support of the affected parties. You can and have said that everything is great for everyone. It is not. There are huge outstanding issues that have been rolled under the carpet. These need to be openly dealt with before a project is approved:

- The extremely high value and uniqueness of the Lytle Creek Wash as plant and animal habitat has not been fully acknowledged and disclosed. The loss of these values (including Threatened and Endangered Species) with the project has been understated and under-mitigated.

- The value of the Wash to sand and gravel supplies, water quantity and quality, natural beauty, recreation and education has not been fully acknowledged and disclosed. The significant loss of these values with the project has been understated and under-mitigated.
- The Alluvial Fan Task Force and its efforts to help agencies plan for management of alluvial fans has been ignored and trivialized by the City.
- There are significant outstanding issues that have been raised by the agencies that will be making future decisions on the project before it can proceed. How can a project be approved prior to having buy-in by the agencies with connected decisions. The final project may look nothing like currently proposed.
- Lytle Creek Wash really needs an interagency plan for management of the Wash which is a State, County, Federal and City resource. The City is trying to make the decision on the future of this invaluable resource by them selves. This is not right. There is a great need for a Coordinated Resource Management Plan and Habitat Conservation Plan for Lytle Creek Wash before project decisions can be made. It is the City's own Policy to do Habitat Conservation Planning for this area. Why is this being violated?
- Restricting the Wash to the 100 year floodplain with a levee as proposed will greatly affect the natural function of the Wash. This has not been adequately disclosed or mitigated for. The Wash and its unique natural resources were created and maintained by much larger floods. Stopping the natural processes of larger floods and restricting them to a smaller area will have permanent adverse effects on the Wash and its resources. These effects have not been disclosed, analyzed and mitigated for.
- The alternatives that would provide more protection to the Wash have been dismissed without serious analysis. The societal values of protection of the Wash by these alternatives have been understated and under-mitigated.

If the City Council approves this project as currently proposed I will do everything in my power to:

- Make sure the final decision on how to manage the Wash is made by all of the public agencies responsible for the Wash and not just the City of Rialto.

- Work with residents, agencies and citizens to modify the project as it moves through the connected approval and permitting processes to better provide for existing residents and natural resources.
- Make sure the County, State and Federal agencies that have subsequent decisions on the project follow procedures and do their job in protecting the Wash.

In summary, I urge you not to approve this project at this time, but to put it on hold until a Coordinated Resource Management Plan and Habitat Conservation Plan can be developed to help design the final project. The City should provide some of the leadership in the development of these essential plans.

Steve A. Loe

Meeting with City of Rialto

Biology Meeting

7/6/2010

Attended by Mike Story, Steve Loe, Al Kelley, and Debbie

Mike Story said that the biologist and consultant were too busy responding to public comments to meet with us.

Said that he understood our concerns, but they were doing everything possible to be able to say they followed CEQA and met at least the minimum requirements. He acknowledged that some things have not been dealt with, but that they met the requirements of CEQA.

Questions

- Explain to us what is being proposed to take care of the wash habitat and species.
- Help us understand the effects of constraining the wash forever to the 100 year floodplain and how that could possibly maintain all the species and processes currently supported by the wash which is largely created and maintained by greater than 100 year flood events.
- How could the constrained wash (100 yr. floodplain) ever maintain a habitat that is created and maintained by 200, 300, 400, 500 and thousand year events.
- Is there land somewhere in the City or adjacent that has been abandoned or City land that could be given to the developer in

exchange for protecting the wash? Make it a win/win for the developer, the Wash and the City.

- Did the developer or City's biologist consider the long-term value of the upper wash in light of global climate change and species population shifts? Forest Service has gone on record in Critical Habitat designation process stating that this is very important.

- How will the revetment be designed to allow things to move out of the wash when major flooding?

- Did the flood and revetment plan and analysis use wildlife habitat as a design criteria?

- What is the situation with the City General Plan. Still using old plan, using new plan (Draft)? If using old plan, where is it available? Can we get a CD?

- We need three copies of the BRA (Appendix III-D) as soon as possible.

- Need a copy of the Spencer and Goldsmith "Impacts of Free Ranging Cats on Wildlife at Suburban-Desert Interface" referenced in Resp. to Comments.

- Pacific Advance Civil Engineering "Hydrolic and Geomorphic Assessment of Lytle Creek SBKR Upland Habitat Conservation Area Erosion and Protection Plan", April 2007. Referenced in Resp. to comments.

- Need contact information for developer's biologist (Steve Nelson) to arrange a meeting.

Concerns

- For the City, annexation and management of the Wash is a big thing and can't be handled as just a problem for a project that needs mitigation. An individual project cannot drive the decision on how we are going to manage the wash with multiple owners and jurisdictions.

- There has to be a coordinated resource management plan (http://www.crmp.org/)/multi-species management plan,or HCP (http://www.nmfs.noaa.gov/pr/pdfs/laws/hcp_handbook.pdf) developed for the wash. That plan will determine how the agencies can manage and develop the wash to maintain the biological values. Must be multi-species and coordinated with the resource agencies. City General Plan.

- All of the agencies involved have legal and binding direction to place the management of wetlands, floodplains, Threatened and Endangered and imperiled species as a driving force in making decisions on these lands.

- This project is not going to fly as currently designed and planned with the various regulatory and permitting agencies expressing concerns.

- The City really needs to check out what the developer's biologist is presenting. They are evaluating and reporting the biology as best they can to support the project. The input you have gotten from other biologists that have been involved in the management of this area for a long time saying it is a huge deal and would change the Wash forever in a very detrimental way should be listened to.

Steve A. Loe, Certified Wildlife Biologist
33832 Nebraska
Yucaipa, CA 92399
909-

Re: Lytle Creek Ranch Concept

To: Contacts

This project must be considered only as an alternative proposed by the city of Rialto which still has to be coordinated and co-planned by all regulatory and permitting agencies and property owners. This has not been done.

A cooperatively developd alternative that protects this nationally significant biological and geological area in its natural state, or at least near natural state, must be evaluated in all forthcoming decisions.

The biological analysis conducted for City project approval is has not been accepted by experts in biological functioning of the Wash. There is continuing dispute.

Changing the functioning of the wash through new levee (revetment) construction has not been analyzed and agreed to by all of the agencies that have some say in management of the wash.

Private landowners affected by the City of Rialto decision have been adequately involved and almost all are against the project.

Project use of known biological information has been challenged by various agencies and biologists.

The city did not provide for a meeting with City and Developer's biologists as requested by local, knowledgeable, biologists numerous times in the public involvement process for Lytle Creek Ranch.

Project was approved because it met the desires of the City, but no one, including the County, State and Federal Government have not been included in the the decision.

Most of the residents affected are not Rialto Residents

Comment Letter No. 24

Steve Loe
Biological Consultant
Certified Wildlife Biologist, TWS
steveloe01@gmail.com

Comment No. 24-1

I would again like to go on record as asking the City to require the proponent to do a Multi-species Plan and strategy for the Cajon/Lytle Creek confluence and both stream systems. This is the best long-term block of habitat remaining for SBKR and other flood dependent species. With all of the impacts here and elsewhere in the range of these species, a plan to protect the myriad of species is critical. Development should be designed around and to protect unique critical Natural Resources including wildlife and plants. If a multi-species plan cannot be developed as your general plan states you support, could you please explain why you aren't asking for one as a part of the development plan.

Response to Comment No. 24-1

The commentor indicates concerns about Lytle Creek, related impacts, and the Creek's protection. These matters are outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" with respect to cumulative impacts within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5.

Please refer to Response to Comment No. 21-1 for discussion of a multi-species conservation plan.

Comment No. 24-2

Also, in light of global climate change and the fact that periodic flooding is essential to creating new habitat, habitat outside of known occupied at this time can still be critical to the survival of the SBKR. SBKR is adapted to a changing environment which is sculpted periodically by water. Just because an area is not currently occupied in its current state, does not mean it won't become suitable following the ne23t major flooding. To provide for recovery, Critical Habitat must include both currently suitable and potentially suitable habitat for future conditions. Protecting only the occupied habitat at this time will hasten the eventual loss of the species as conditions will undoubtedly change over time. As climate changes, We [sic] are already seeing some upslope movement of species due to climate warming in parts of southern California. We need to protect upstream Critical Habitat even though it may not be currently occupied. Please correct any discussion that doesn't include the need to maintain future habitat as well as currently occupied as described in the Critical Habitat Designation. Habitat for recovery is important.

Response to Comment No. 24-2

The commentor indicates additional concerns about Lytle Creek Wash. These matters are outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5. However, these issues were addressed in the original DEIR. (See DEIR Volume I, Section 4.5 and specifically Section 4.5.3.1 therein; see also the Biological Resources Assessment, provided as Appendix III-D-B of original DEIR Volume III (Part 1), Section 3.6.6.) Also refer to Response to Comment No. 24-1 regarding critical habitat.

Comment No. 24-3

New information that wasn't included in the previously approved EIR was the lack of discussion and analysis of the effects on Speckled dace connectivity between Cajon Creek and Lytle Creek. This stream complex has the largest remaining population of Santa Ana speckled dace in the Santa Ana Watershed. It is important that connectivity be maintained between these two drainages so that dace may be able to mix at the confluence and move up the streams as flows recede. Please discuss the ramifications on dace occupancy and ability to move upstream as the flood water and winter flows subside with the new revetment that concentrates flows into a constricted flood channel. There are dace in the streams down to the project site during wet winters even though the lower streams go subsurface in the summer. This habitat complex is critical to the survival of SA speckled dace in the watershed. This needs to be discussed and evaluated in the recirculated EIR. We have recently lost populations of this species due to a lack of connectivity.

Response to Comment No. 24-3

The commentor indicates concerns about the speckled dace. This matter is outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5. However, the speckled dace was addressed in the DEIR. (See DEIR Volume I, Section 4.5, page 4.5-72.) The commentor does not provide any new information concerning the use of that portion of Lytle Creek within the Project site by the dace. The commentor merely states that "there are dace in the streams down to the project site during wet winters…." The commentor provides no data establishing that dace use the portion of Lytle Creek within the Project site or that dace in this region rely on intermingling at the Lytle/Cajon stream confluence to support populations of dace that may exist at the upper reaches of Lytle or Cajon Creeks. Nevertheless, the commentor's speculation regarding the possible effects of the Project on the dace's ability to move through the Project site (within Lytle Creek Wash), comingle with dace from Cajon Creek, and then migrate back upstream through the Project site (within Lytle Creek Wash) to portions of Lytle Creek upstream of the Project site overlooks the information in the EIR demonstrating that the LCRSP Project will not have any significant changes to waters flows within the existing braided creek system of Lytle Creek.

Additionally, the Project is not expected to significantly change the velocities or other fluvial dynamics of the water flows within this portion of Lytle Creek or downstream. Lytle Creek is expected to remain a braided system of dynamic, smaller channels within the wider Lytle Creek Wash throughout the reach of Lytle Creek adjacent to the Project site. The width of the Lytle Creek channel will not be significantly narrowed by the proposed project. The most significant feature affecting water volumes and velocities would be the constriction currently imposed by the CEMEX mining operations above the Lytle/Cajon confluence. (See May 5, 2010 PACE Technical Memorandum, provided as Appendix IV-C of the FEIR Volume IV; and June 30, 2010 PACE letter to Mike Story, Response 2: "[t]he results of this analysis also demonstrate in much more detail that the change in velocity and depth within this floodplain from the revetment construction for Lytle Ranch are relatively minor;" and Response 12.)

Ashley Rogers

From: Ashley Rogers
Sent: Thursday, May 10, 2012 1:46 PM
To: Ashley Rogers
Subject: FW: Lytle Creek Ranch Project Input

From: Gina Gibson [mailto:ggibson@rialtoca.gov]
Sent: Wednesday, April 04, 2012 7:31 AM
Subject: FW: Lytle Creek Ranch Project Input

From: Steve Loe [mailto:steveloe01@gmail.com]
Sent: Tuesday, April 03, 2012 8:29 PM
To: Gina Gibson; Al Kelley
Cc: Lynn Boshart
Subject: Lytle Creek Ranch Project Input

Gina:

I would again like to go on record as asking the City to require the proponent to do a Multi-species Plan and strategy for the Cajon/Lytle Creek confluence and both stream systems. This is the best long-term block of habitat remaining for SBKR and other flood dependent species. With all of the impacts here and elsewhere in the range of these species, a plan to protect the myriad of species is critical. Development should be designed around and to protect unique critical Natural Resources including wildlife and plants. If a multi-species plan cannot be developed as your general plan states you support, could you please explain why you aren't asking for one as a part of the development plan.

Also, in light of global climate change and the fact that periodic flooding is essential to creating new habitat, habitat outside of known occupied at this time can still be critical to the survival of the SBKR. SBKR is adapted to a changing environment which is sculpted periodically by water. Just because an area is not currently occupied in its current state, does not mean it won't become suitable following the next major flooding. To provide for recovery, Critical Habitat must include both currently suitable and potentially suitable habitat for future conditions. Protecting only the occupied habitat at this time will hasten the eventual loss of the species as conditions will undoubtedly change over time. As climate changes, We are already seeing some upslope movement of species due to climate warming in parts of southern California. We need to protect upstream Critical Habitat even though it may not be currently occupied. Please correct any discussion that doesn't include the need to maintain future habitat as well as currently occupied as described in the Critical Habitat Designation. Habitat for recovery is important.

New information that wasn't included in the previously approved EIR was the lack of discussion and analysis of the effects on Speckled dace connectivity between Cajon Creek and Lytle Creek. This stream complex has the largest remaining population of Santa Ana speckled dace in the Santa Ana Watershed. It is important that connectivity be maintained between these two drainages so that dace may be able to mix at the confluence and move up the streams as flows recede. Please discuss the ramifications on dace occupancy and ability to move upstream as the flood water and winter flows subside with the new revetment that concentrates flows into a constricted flood channel. There are dace in the streams down to the project site during wet winters even though the lower streams go subsurface in the summer. This habitat complex is critical to the survival of SA speckled dace in the watershed. This needs to be discussed and evaluated in the recirculated EIR. We have recently lost populations of this species due to a lack of connectivity.

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Thank you,

Steve Loe
Biological Consultant
Certified Wildlife Biologist, TWS
909-809-4726

Comment Letter No. 25

Steve Loe
Retired Federal Biologist
Public Land Owner
Certified Wildlife Biologist, TWS
steveloe01@gmail.com

Comment No. 25-1

I am very concerned that some of the friends and contacts I have made over the years in my Federal employment are going to get in big trouble over the way this project has been and is being evaluated and permitted through the various agencies. I am worried that some of them may even be held criminally responsible for some of the things that are going on. I am hearing rumors of groups and members of the public going to the press and the Attorney General. I am not sure what that means yet, but I will research it more.

I am very glad that there are Federal and State, at least, strong whistle-blowing regulations to help employees caught in these political messes. I encourage each of you to use this protection if things start heating up more than they already are. I have never seen a project where the public has tried so hard to have an influence over final project design to protect and benefit public resources and yet been so excluded from having meaningful input or influence. I have never seen a project where all alternatives to protect the environment were not an option because they didn't meet the proponent's bottom line on profit. I am naive, but I have never seen a project with so many ties to other regulatory processes and zoning and annexation, and special water companies, and politicians that are going on, without public disclosure of the links. I have never seen a project where so many FOIA and Record Requests have had to be made to find out what is really going on.

The way this project is being handled by local politicians and agencies makes me somewhat embarrassed of our government.

Response to Comment No. 25-1

The commentor expresses concerns regarding the Project approval, public permitting, and public review processes, including "rumors" and public records requests. These matters are outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5. Further, it is noted that opportunities for public review and comment have occurred throughout the Project's environmental review process in accordance with CEQA and the CEQA Guidelines, as summarized in Section 1.9 of the original DEIR, Response to Comment No. III-123-2 of the original Final EIR, and Section 1.3 of this Final RPEIR. Also refer to Response to Comment No. 22-1 regarding the opportunities for public review and input that have been afforded throughout the EIR process in accordance with CEQA. This comment is noted for the record and will be forwarded to the decision makers.

Comment No. 25-2

Because of where this project, [sic] sits (the largest remaining somewhat naturally functioning Riversidean Alluvial Fan Sage Scrub/San Bernardino Kangaroo Rat Critical Habitat [sic] that remains), If [sic] approved as planned, this will the most serious environmental modification in the region since construction of the Seven Oaks Dam. Permanent alteration of over 7 miles of the remaining floodplain by restricting the wash to an area between revetments will spell the eventual end of the San Bernardino kangaroo rat and potentially other species. Recent understanding of the situation below Seven Oaks Dam and in the San Jacinto River do not look promising for the K-Rat. Long-term viability in these habitats is problematic. The Cajon/Lytle Creek habitat complex is the most important habitat block remaining.

Response to Comment No. 25-2

The commentor expresses concerns regarding Riversidean Alluvial Fan Sage Scrub and SBKR habitat. These matters are outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5. Please refer to Response to Comment Nos. 21-1 and 22-5 for information regarding the critical habitat for the San Bernardino Kangaroo Rat as provided in the Draft EIR. In addition, please refer to Response to Comment No. 22-9 for information regarding Seven Oaks Dam.

Comment No. 25-3

Waters of the US will be significantly impacted as well as beneficial uses. Santa Ana Sucker and Santa Ana Speckled dace will be impacted by the constraining the wash to only a central channel. The wash must be allowed to function as it currently does in order to maintain habitat in the long-term. The Seven Oaks Dam was needed to protect millions downstream. This project is to allow the developer to make a profit on a new proposal that is far and above their current entitlements on the property, at the expense of a nationally significant biological resources.

Response to Comment No. 25-3

The commentor expresses concerns regarding the Santa Ana Sucker and Santa Ana Speckled dace. These matters are outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5. Please refer to Response to Comment Nos. 22-2 and 24-3 for information regarding the Santa Ana Sucker and Santa Ana Speckled dace as provided in the Draft EIR. In addition, please refer to Response to Comment No. 22-9 for information regarding Seven Oaks Dam.

Comment No. 25-4

In researching this project and all the political and agency ties and intertwined relationships, I have found multiple examples of conflicts of interest, or at least a substantial appearance of conflict) [sic] in the people assigned to the project in the various agencies and chosen for consulting work. This seems especially suspect because everything has been done for several years behind closed doors. It wasn't until relentless public digging and researching that all the schemes and underground planning that have been going on were exposed. Unknown financial links between agencies and politicians and developers appear to have been discovered.

Response to Comment No. 25-4

Please refer to Response to Comment No. 25-1, as well as Response to Comment No. 22-1 regarding the opportunities for public review and input that have been afforded throughout the EIR process in accordance with CEQA. As discussed, this matter is outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5. This comment is noted for the record and will be forwarded to the decision makers.

Comment No. 25-5

Data and conservation mapping paid for by the Fish and Wildlife Service and County funds in the failed SB County MSHCP are apparently not being used or included in analysis. Differing expert opinion is not being considered or even publicly acknowledged.

Response to Comment No. 25-5

The commentor expresses concerns regarding a multi-species plan and expert opinions. These matters are outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5. Please refer to Response to Comment No. 21-1 regarding a multi-species plan. Also refer to Response to Comment No. 22-1 regarding the opportunities for public review and input that have been afforded throughout the EIR process in accordance with CEQA. In addition, refer to Response to Comment No. 23-29 regarding the several biological resources experts that contributed to preparation of the EIR.

Comment No. 25-6

There has been an apparent attempt to avoid public disclosure and involvement in many cases by multiple agencies. Public involvement meetings with expert biologists have been scheduled to supposedly take serious biological input and then not even attended or rescheduled by the agencies or their consultants.

Response to Comment No. 25-6

Please refer to Response to Comment No. 25-1, as well as Response to Comment No. 22-1 regarding the opportunities for public review and input that have been afforded throughout the EIR process in accordance with CEQA. As discussed, this matter is outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5.

Comment No. 25-7

Repeated requests for an open species and habitat driven multi-species plan has been ignored for several years by the developer and City and never responded to. Then an older developer driven Conservation Strategy shows up that was developed to support the development as planned. Many of the Agencies have already been involved for several years in the Strategy without ever making it public.

Response to Comment No. 25-7

Please refer to Response to Comment Nos. 21-1 and 23-8 regarding a multi-species conservation plan. This matter is outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5.

Comment No. 25-8

Multiple field trips have been asked for too [sic] see what is really being proposed on the ground and we have been told it would be trespassing if we did it on our own. Field trips to see the project on the ground were requested and were never given by the developer or the agencies.

Response to Comment No. 25-8

Please refer to Response to Comment No. 25-1, as well as Response to Comment No. 22-1 regarding the opportunities for public review and input that have been afforded throughout the EIR process in accordance with CEQA. As discussed, this matter is outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5. Please also refer to Response to Comment No. 22-3. This comment is noted for the record and will be forwarded to the decision makers.

Comment No. 25-9

Attempts have been made by politicians to delist species to benefit developers. Secret meetings were planned and held it appears.

I believe the agencies better stop hiding things, having backdoor meetings, writing hidden plans, making backroom agreements, changing previous public commitments as a result of political pressure etc... There is a huge federal, state and county investment in protecting species and habitats that has been made to this point. Much of the work that was done is now being ignored for some new developer paid Conservation Strategy that is based more on the developer's proposal than it is on science. Any supposed Multi-Species Habitat Conservation Strategy better have the best biological information possible and that will require an open process sharing all available information and knowledge.

Response to Comment No. 25-9

Please refer to Response to Comment No. 25-1, as well as Response to Comment No. 22-1 regarding the opportunities for public review and input that have been afforded throughout the EIR process in accordance with CEQA. Also refer to Response to Comment No. 21-1 regarding a multi-species plan. As discussed, this matter is outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5. This comment is noted for the record and will be forwarded to the decision makers.

Comment No. 25-10

Many other projects with impacts on the Lytle/Cajon complex are not even being considered in evaluating the biological effect of this proposed project. Projects involving the Forest Service, San Bernardino County, Cal Trans, and others will all have an effect on the habitat and must be considered cumulatively. New information on Critical Habitat, problems with Seven Oaks Dam releases maintaining SB K-rat habitat, and the importance of gravel sources for Santa Ana sucker must be considered.

Response to Comment No. 25-10

Please refer to Response to Comment Nos. 22-8 and 22-9 regarding the EIR's cumulative analyses. This matter is outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5.

Comment No. 25-11

Many of us have been involved for many years in working toward a MSHCP for the San Bernardino Valley. The way this project is being handled is a slap in the face of those of us that have faithfully put our trust in the County and Fish and Wildlife Service to involve us in any Multi-species planning. We have been partners that have helped support County and Service. Why have we been left out of discussions and reviews of the developer proposed conservation strategy?

We have some real biologically based comment letters on this and the associated "mirror" development "Lytle Creek North (Now Rosena Ranch)" from the Fish and Game and Fish and Wildlife Service before they were put under so much pressure to approve a developer driven development plan and hidden "Conservation Plan", rather than a true openly developed species and ecosystem driven Multi-Species Habitat Conservation Plan.

Response to Comment No. 25-11

Please refer to Response to Comment No. 21-1 regarding a multi-species plan. This matter is outside the scope of the RPDEIR. Please refer to Section 1.2 of this Final RPEIR for a discussion of the scope of the RPDEIR, the City's obligation to respond to comments outside the scope of the RPDEIR, and the standards for recirculation of a Draft EIR due to "significant new information." The commentor offers no "significant new information" within the meaning of CEQA Section 21092.1 and CEQA Guidelines Section 15088.5. This comment is noted for the record and will be forwarded to the decision makers.

Comment No. 25-12

This is a very big deal, let's work together to do the right thing in an open process, or I am afraid that there may be ramifications to some of my friends and colleagues if the deceit and backdoor dealing continue. Reputation and Trust are very important, especially for government agencies. Please do what you can to make this an open process that we can all be proud of and not ashamed of.

Response to Comment No. 25-12

This comment is noted for the record and will be forwarded to the decision makers.

Ashley Rogers

From: Ashley Rogers
Sent: Thursday, May 10, 2012 1:48 PM
To: Ashley Rogers
Subject: FW: URGENT!!! Lytle Creek Ranch Development and Fish and Wildlife Protection

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From: Gina Gibson [mailto:ggibson@rialtoca.gov]
Sent: Wednesday, April 18, 2012 10:50 AM
Subject: FW: URGENT!!! Lytle Creek Ranch Development and Fish and Wildlife Protection

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From: Mike Story
Sent: Wednesday, April 18, 2012 8:20 AM
To: Gina Gibson
Subject: FW: URGENT!!! Lytle Creek Ranch Development and Fish and Wildlife Protection

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From: STEVE AND LIZ LOE [mailto:stevealoe@msn.com]
Sent: Wednesday, April 18, 2012 6:04 AM
To: Steve Business; amy minteer; Amy Minteer; Art Davenport; Kim Boss; Char Miller; Dan Silver; Dave Goodward@earthlink.net; Peter Lewendowski; Robin Maloney-Rames; rachel@iewaterkeeper.org; Frank Schiavone; Steve Farrell; Tom Keeneywk; lillie17@hpeprint.comu; Nancy Ferguson; regulatory.spl@spl01.usace.army.mil; Mike Story; Tom K Work
Subject: RE: URGENT!!! Lytle Creek Ranch Development and Fish and Wildlife Protection

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I am very concerned that some of the friends and contacts I have made over the years in my Federal employment are going to get in big trouble over the way this project has been and is being evaluated and permitted through the various agencies. I am worried that some of them may even be held criminally responsible for some of the things that are going on. I am hearing rumors of groups and members of the public going to the press and the Attorney General. I am not sure what that means yet, but I will research it more.

I am very glad that there are Federal and State, at least, strong whistle-blowing regulations to help employees caught in these political messes. I encourage each of you to use this protection if things start heating up more than they already are.. I have never seen a project where the public has tried so hard to have an influence over final project design to protect and benefit public resources and yet been so excluded from having meaningful input or influence. I have never seen a project where all alternatives to protect the environment were not an option because they didn't meet the proponent's bottom line on profit. I am naive, but I have never seen a project with so many ties to other regulatory processes and zoning and annexation, and special water companies,and politicians that are going on, without public disclosure of the links. I have never seen a project where so many FOIA and Record Requests have had to be made to find out what is really going on.

The way this project is being handled by local politicians and agencies makes me somewhat embarrassed of our government. Because of where this project, sits (the largest remaining somewhat naturally functioning Riversidean Alluvial Fan Sage Scrub/San Bernardino Kangaroo Rat Critical Habital that remains), If approved as planned, this will the most serious environmental modification in the region since construction of the Seven Oaks Dam. Permanent alteration of over 7 miles of the remaining floodplain by restricting the wash to an area between revetments will spell the eventual end of the San Bernardino kangaroo rat and potentially other species.

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Recent understanding of the situation below Seven Oaks Dam and in the San Jacinto River do not look promising for the K-Rat. Long-term viability in these habitats is problematic. The Cajon/Lytle Creek habitat complex is the most important habitat block remaining. Waters of the US will be significantly impacted as well as beneficial uses. Santa Ana Sucker and Santa Ana Speckled dace will be impacted by the constraining the wash to only a central channel. The wash must be allowed to function as it currently does in order to maintain habitat in the long-term. The Seven Oaks Dam was needed to protect millions downstream. This project is to allow the developer to make a profit on a new proposal that is far and above their current entitlements on the property, at the expense of a nationally significant biological resources.

In researching this project and all the political and agency ties and intertwined relationships, I have found multiple examples of conflicts of interest, or at least a substantial appearance of conflict) in the people assigned to the project in the various agencies and chosen for consulting work. This seems especially suspect because everything has been done for several years behind closed doors. It wasn't until relentless public digging and researching that all the schemes and underground planning that have been going on were exposed. Unknown financial links between agencies and politicians and developers appear to have been discovered.

Data and conservation mapping paid for by the Fish and Wildlife Service and County funds in the failed SB County MSHCP are apparently not being used or included in analysis. Differing expert opinion is not being considered or even publicly acknowledged.

There has been an apparent attempt to avoid public disclosure and involvement in many cases by multiple agencies. Public involvement meetings with expert biologists have been scheduled to supposedly take serious biological input and then not even attended or rescheduled by the agencies or their consultants.

Repeated requests for an open species and habitat driven multi-species plan has been ignored for several years by the developer and City and never responded to. Then an older developer driven Conservation Strategy shows up that was developed to support the development as planned. Many of the Agencies have already been involved for several years in the Strategy without ever making it public.

Multiple field trips have been asked for too see what is really being proposed on the ground and we have been told it would be trespassing if we did it on our own. Field trips to see the project on the ground were requested and were never given by the developer or the agencies.

Attempts have been made by politicians to delist species to benefit developers. Secret meetings were planned and held it appears.

I believe the agencies better stop hiding things, having backdoor meetings, writing hidden plans, making backroom agreements, changing previous public commitments as a result of political pressure etc... There is a huge federal, state and county investment in protecting species and habitats that has been made to this point. Much of the work that was done is now being ignored for some new developer paid Conservation Strategy that is based more on the developer's proposal than it is on science. Any supposed Multi-Species Habitat Conservation Strategy better have the best biological information possible and that will require an open process sharing all available information and knowledge.

Many other projects with impacts on the Lytle/Cajon complex are not even being considered in evaluating the biological effect of this proposed project. Projects involving the Forest Service, San Bernardino County, Cal Trans, and others will all have an effect on the habitat and must be considered cumulatively. New information on Critical Habitat, problems with Seven Oaks Dam releases maintaining SB K-rat habitat, and the importance of gravel sources for Santa Ana sucker must be considered.

Many of us have been involved for many years in working toward a MSHCP for the San Bernardino Valley. The way this project is being handled is a slap in the face of those of us that have faithfully put our trust in the County and Fish and Wildlife Service to involve us in any Multi-species planning. We have been partners that have helped support County and Service. Why have we been left out of discussions and reviews of the developer proposed conservation strategy?

We have some real biologically based comment letters on this and the associated "mirror" development "Lytle Creek North (Now Rosena Ranch)" from the Fish and Game and Fish and Wildlife Service before they were put under so much pressure to approve a developer driven development plan and hidden "Conservation Plan", rather than a true openly developed species and ecosystem driven Multi-Species Habitat Conservation Plan.

This is a very big deal, let's work together to do the right thing in an open process, or I am afraid that there may be ramifications to some of my friends and colleagues if the deceit and backdoor dealing continue. Reputation and Trust are very important, especially for government agencies. Please do what you can to make this an open process that we can all be proud of and not ashamed of.

Steve Loe
Retired Federal Biologist
Public Land Owner
Certified Wildlife Biologist, TWS

PS: I will forward this to my friends and contacts in my other e-mail account. Please read.

909-809-4726

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Steve Loe
Biological Consultant
Certified Wildlife Biologist, TWS
909-809-4726

Comment Letter No. 26

Richard Serrano
3938 White Ash Rd.
San Bernardino, CA 92407
rserrano891@juno.com

Comment No. 26-1

I believe it would have a positive impact.

Response to Comment No. 26-1

This comment is noted for the record and will be forwarded to the decision makers.

Lytle Creek Ranch Community Workshop
February 16, 2012

Richard Serrano 3938 White Ash Road San Bernardino, CA 92407 909.724.1640 Rserrano891@juno.com	I believe it would have a positive impact.

April 4, 2012