APPENDIX C

NOISE ANALYSIS METHODS AND CALCULATIONS

NOISE ANALYSIS METHODS AND CALCULATIONS

This appendix presents the methods and results for the analysis of the short-term (construction) and long-term (operational) noise impacts of the project.

C.1 Short-Term (Construction Impact)

For each construction activity defined in Section 4.1.1, a list of likely types and number of pieces of construction equipment, as well as estimates of hours per day and the percentages of time that each type of equipment would be in operation, were obtained from Table 2.1-2 in Section 2. Typical values for noise emissions (expressed as short-term noise exposures at 50 feet[1]) for the types of equipment to be used for the LA-RICS project were obtained mainly from the Federal Highway Administration's (FHWA) Roadway Construction Noise Model User's Guide.[2] These are shown in Table C.1-1. Table C.1-2 lists the different types of equipment that will be used for each construction activity.

Table C.1-1
Construction Equipment Noise Emission Characteristics

Equipment Type	Maximum Sound Level (dBA)[a]	Utilization Rate (%)	Source (see footnotes to table)
Aerial Man-lift	75	20	1
Concrete Saw	90	20	1
Concrete Truck	79	40	1
Crane, 25-ton	81	16	1
Drill Rig with Augers	84	20	1
Dump Truck	76	40	1
Flatbed Truck, 3-Ton	74	40	1
Generator, Portable	81	50	1
Mini Excavator @ 10 feet	99	40	2
Water Trailer @ 59.1 feet[b]	50	5	3

[a]Noise level at 50 feet, unless otherwise specified.
[b]Main noise source assumed to be the pump.

Sources:

1 U.S. Department of Transportation, Federal Highway Administration, *FHWA Roadway Construction Noise Model User's Guide*, FHWA-HEP-05-054, January, 2006.

2 "Mini Excavators, 308E2 CR SB. Specifications." Caterpillar (2014). http://www.cat.com/en_US/products/new/equipment/excavators/mini-excavators/18461067.html. Last accessed April 14, 2014.

3 "Noise Red Flag Tables." Canadian Ministry of Environment and Energy (1997), p. 83.

---

1 The reference distance was 50 feet unless otherwise specified.

2 U.S. Department of Transportation, Federal Highway Administration. FHWA Roadway Construction Noise Model User's Guide. John A. Volpe National Transportation Systems Center, Cambridge, Massachusetts, FHWA-HEP-05-054. January, 2006.

Table C.1-2
Assignment of Construction Equipment to Construction Activities

Construction Phase	Equipment Type	No. of Pieces	Hours/ Day	Days On Site
Demolition	Concrete Saw	1	7	1
	Dump Truck	1	3	1
	Mini Excavator	1	5	1
	500-Gallon Water Trailer	1	7	1
Site Preparation	Mini Excavator	1	5	1
Excavation	Drill Rig with Augers	1	3	2
	Mini Excavator/Loader/Backhoe	1	5	2
	500-Gallon Water Trailer	1	7	2
Pad Construction	Concrete Truck	1	4	2
Monopole and Equipment	3-Ton Flatbed Truck	1	3	2
	25-Ton Crane	1	6	1
	Aerial Man-Lift	1	6	6
	Portable Generator	1	6	10

Source: Assigned by UltraSystems, following guidance in CalEEMod Users Guide, Appendix D.

Construction Noise Estimation

In estimating noise exposures for construction equipment, it was assumed that the only attenuation would be by ground surface absorption. Existing or future noise barriers, such as sound walls, were not taken into account. The general equation for noise transmitted from a stationary source[3] to sensitive receivers over hard ground surfaces, such as paved roads, sidewalks, etc. is:

$$N_D = N_{ref} - 20 \log_{10} (D/D_{ref}) + 10 \log_{10} (U/100)$$

where

N_D = Noise level at distance D from a particular piece of equipment

N_{ref} = Noise level at reference distance

D = Distance from source to receiver

D_{ref} = Reference distance

U = Utilization rate, as a percentage

Log_{10} = Logarithm to the base 10

[3] Although construction equipment is mobile, it is normally treated as if it were a stationary source, with spherical spreading of sound energy, since movement is over a restricted area. Mobile sources usually consist of on road motor vehicles, trains, etc., which move linearly and have cylindrical spreading of sound energy.

For a soft ground surface, the following equation was used to calculate noise attenuation:

$$N_D = N_{ref} - 25 \log_{10} (D/D_{ref}) + 10 \log_{10} (U/100)$$

For n pieces of equipment, each with a noise exposure of L_i, the total noise exposure at a particular point is:

$$L_{tot} = 10 \log_{10} (10^{L_1/10} + 10^{L_2/10} + 10^{L_3/10} + \ldots + 10^{L_n/10})$$

Table C.1-3 shows the noise exposure at 50 feet for each phase, assuming a hard ground surface.

Table C.1-3
Maximum Hourly Average Noise Level at 50 Feet, by Construction Phase

Construction Phase	Hourly L_{eq} dBA at 50 Feet
Demolition - Concrete and Asphalt Cutting	83.0
Demolition - Other Activities	81.6
Site Preparation	81.0
Excavation - Drilling	77.0
Excavation - Soil Redistribution	81.0
Pad Construction	75.0
Monopole and Equipment - Haul Materials	70.0
Monopole and Equipment - Set Monopole	73.0
Monopole and Equipment - Install Equipment	69.5

Source: Calculated by UltraSystems

Redistribution of soil from excavation and drilling for the monopole foundation was chosen for the short-term analysis because it will occur at almost all sites, and may take more than one day; therefore, it will have a greater potential for “annoyance” by sensitive receptors. The one-hour average exposure at 50 feet would be approximately 81.0 dBA L_{eq}.

The 81.0-dBA value was used as N_{ref} to determine the value of N_D at various distances from the center of a hypothetical site. The center of the hypothetical site was chosen as it represents an average position of the future monopole, which is where the excavation and drilling activity would take place. The equation was also used iteratively to estimate the distance at which various exposure levels would occur.

C.2 Long-Term (Operational Impact)

The main potential noise sources associated with operations at each site will be the hum from some pieces of communications equipment, air conditioners for the communications system, the emergency generators, and routine facilities maintenance. The equipment housing walls that will encase the communications equipment will provide sufficient attenuation that communications equipment will not be audible to sensitive receivers near the sites. Noise from this equipment would have no impact on sensitive receptors and was not evaluated further. In addition, the noise from maintenance activities, which could include landscaping, routine site inspections, and occasional equipment repairs, would not be substantially different from current levels at the host facilities. This noise source was therefore not evaluated further.

The total equipment power output was assumed to be 12,500 watts, and the equipment was assumed to be distributed equally between four cabinets. Each cabinet would thus have to dissipate the heat equivalent of 3,125 watts. The inside minimum air temperature was assumed to be 64 degrees Fahrenheit. For a maximum heat load estimate, it was assumed that the outside temperature would be 100 degrees Fahrenheit. A method published by Ansari et al.[4] was used to estimate the air conditioning requirement. This value is about 1.5 tons for each of the four cabinets.[5] Typical noise ratings for refrigeration units with 1.5 tons capacity are 63 to 67 dBA.[6,7] The analysis conservatively assumed that the noise emissions from each of the four equipment cabinets would be 67 dBA.

A 35 kW (46.9-horsepower) emergency diesel generator would be installed, for backup power purposes, at 229 LTE sites,[8] and would operate intermittently. The emergency generator would be supplied with diesel fuel from an integrated, double-walled belly fuel tank, and would provide up to five days of power in the event of utility power outages. Generators rated below 50 horsepower do not need operating permits from the South Coast Air Quality Management District (SCAQMD). They do not have limits on the hours per year that they may be used.

Noise emissions from diesel generator sets vary greatly with size and design. Most new models have built-in attenuation. A review of specifications for 11 commercially available diesel generators ranging from 25 to 40 kW found noise ratings of 56 to 98 dBA at 23 feet.[9] The median noise rating was 66 dBA at 23 feet. This is equivalent to 59.3 dBA at 50 feet. Furthermore, the emergency generators at the LTE sites would be in solid wall enclosures, which would attenuate at least 10 dBA. The resulting noise emissions would be 49.6 dBA at 50 feet. This is comparable to the ambient noise at most locations. Generator noise was therefore not considered further.

Operating Noise Estimation

To provide a conservative analysis, the four air conditioners were assumed to be operating at the same time for 24 hours per day. The CNEL was calculated in these cases. The basic conversion from L_{eq} to CNEL is:

---

4 Ansari, F.A. et al. "A Simple Approach for Building Cooling Load Estimation," American Journal of Environmental Sciences 1(3):209-212, 2005.

5 A ton of refrigeration is equivalent to 12,000 British thermal units per hour.

6 "PC7, Classic & Classic Plus Series Specification." DENSO Corporation, Kariya, Japan. Internet URL: http://www.movincool.com/downloads/MovinCool_Overview_Specs.pdf.Accessed April 3, 2011.

7 These values assumed to have been determined by Air-Conditioning and Refrigeration Institute (ARI) Standard 270.

8 At two sites, an existing emergency generator would be used.

9 Devices reviewed include Cummins DSFAA, John Deere HJW 30 T6, Kipor KDE35E, Kohler 30REOZK4 and 40REOZK4, Kubota SQ-33, Kwiet DGK45C, PowerPro 25, Winco PSS30 and PSS40, and Winpower DR3014.

$$\text{CNEL} = 10 \log_{10} \left[(1/24) \sum_{i=1}^{24} 10^{[L_{eq}(h)_i + W_i]/10)} \right]$$

where

CNEL = 24-hour average L_{eq} with a 4.77-dBA penalty and 10-dBA penalty added during evening hours (7 p.m. to 10 p.m. and night hours (10 p.m. to 7 a.m.)

$L_{eq}(h)_i$ = L_{eq} for the *i*th hour

W_i = 0 dBA for day hours (7 a.m. to 7 p.m.)

W_i = $10 \log_{10}(3)$ = 4.77 dBA for evening hours (7 p.m. to 10 p.m.)

W_i = 10 dBA for night hours (10 p.m. to 7 a.m.)

Log_{10} = Logarithm to the base 10

Noise exposure resulting from air conditioner operation was calculated using the Air-Conditioning & Refrigeration Institute's (ACRI's) "Application of Sound Rating Levels of Outdoor Unitary Equipment,"[10] and the CNEL equation shown above. The ACRI method calculates noise attenuation with distance. It also takes into account noise losses from interaction with surrounding structures.

10 "1997 Standard for Application of Sound Rating Levels of Outdoor Unitary Equipment," Standard 275, Air-Conditioning and Refrigeration Institute, Arlington, Virginia. 1997.