APPENDIX E

Climate and Air Quality Impact Assessment

2006

APPENDIX E
CLIMATE AND AIR QUALITY IMPACT ASSESSMENT

Additional description of the methodologies for emissions estimation and impact analysis are provided in Appendix E, along with memoranda and information used to support the climate and air quality impact assessment in Chapter 10 of the Draft PEIR. The following attachments are included:

- Attachment E1. Tables to summarize the results of emissions estimation, comparison to relevant local air district significance thresholds, and predicted air quality impacts are provided in Attachment E1.
- Attachment E2. Details of the emissions calculations conducted for construction, operations, and general conformity applicability analysis are presented in Attachment E2.
- Attachment E3. A description of the MacDougall Method approach, assumptions, and results from prediction of playa dust (PM_{10}) emissions is provided in Attachment E3.
- Attachment E4. Constituents of potential concern in sediments and soils sampled at the Salton Sea, discussion of their potential to affect human health, and recommendations for future study are provided in a September 2005 draft technical memorandum in Attachment E4. This memorandum was not updated for the PEIR.
- Attachment E5. Additional discussion of potential mitigation measures and applicable regulatory requirements are provided in Attachment E5.
- Attachment E6. The Executive Summary from the Final Draft Technical Memorandum, Identify and Outline Measures to Control Playa Emissions, is provided as Attachment E6. For more information, the entire memorandum is included as part of Appendix H-3.
- Attachment E7. The Draft Technical Memorandum, Continued Evaluation of Playa Dust Emissions Models, is provided as Attachment E7. This work was conducted in the winter of 2005/2006 and spring of 2006. Results from use of the selected model are further described in Attachment E-3, mentioned previously.
- Attachment E8. The Draft Technical Memorandum, Ongoing Data Management and Air Quality Modeling Preparation, is provided as Attachment E8. This work was conducted in the winter of 2005/2006 and spring of 2006.
- Attachment E9. A Draft Technical Memorandum, Salton Sea Playa Salt Efflorescence Potential, is provided as Attachment E9.
- Attachment E10. A Draft Technical Memorandum, Brief Literature Search: the Effects of Dust/Saline Dust on Crops, is provided as Attachment E10.
- Attachment E11. A Draft Technical Memorandum, Description of Microclimate at the Salton Sea, is provided as Attachment E11.
- Attachment E12. A list of prior air quality technical reports prepared as part of the PEIR effort is provided as Attachment E12. Copies of these documents are available at http://www.saltonsea.water.ca.gov/.

The assumptions and limitations listed in the PEIR in Chapter 10 apply to the approaches, emissions estimates, and draft results presented in these Attachments. Please note that the reported values are estimates, and they include many sources of uncertainty. The reported values should be used only for comparison and evaluation of the project alternatives.

APPENDIX E, ATTACHMENT E1

Air Quality Emissions Summary Tables

2006

APPENDIX E, ATTACHMENT E1
AIR QUALITY EMISSIONS SUMMARY TABLES

Tables to summarize the results of emissions estimation, comparison to relevant local air district significance thresholds, and predicted air quality impacts are provided in Attachment E-1.

Table E1-1 summarizes emission estimates for construction in the Early Start Saline Habitat Complex (Early Start Habitat). Table E1-2 summarizes emissions estimates for the Peak Construction Year, assumed to occur in Phase I (initiation to 2020) for each of the alternatives. Also provided are the emissions estimates for the Peak Operations Year, assumed to occur in Phase IV (2040 to 2077). For the purposes of the PEIR, priority was placed on analysis of impacts associated with the nonattainment pollutants: PM_{10} and the ozone precursor, NO_x. In any future project-specific study, impacts associated with other criteria pollutants, and in some cases, HAPs, would need to be analyzed in greater detail.

Table E1-2 lists the following emissions estimates:

- Emissions associated with construction activities and material transport (fugitive dust and equipment exhaust emissions);
- Emissions associated with operations and maintenance (fugitive dust and equipment exhaust emissions); and
- Fugitive dust emissions from Exposed Playa Areas after implementation of Air Quality Management and control measures.

The significance thresholds used as rationale for the impacts described in the PEIR are also listed in the tables. Values presented in bold type exceed the listed thresholds, indicating the potential for significant impacts.

The assumptions and limitations listed in the PEIR in Chapter 10 apply to the results presented in these tables. Please note that these emissions estimates are estimates, and they include many sources of uncertainty. Results should be used only for comparison and evaluation of the alternatives.

Table E1-1
Summary of Emissions Estimates for the Early Start Habitat

Activity	Impact Source	Pollutant and Averaging Time	Significance Rationale	No Action Alternative-CEQA Conditions	No Action Alternative-Variability Conditions	Saline Habitat Complex I
				Emissions		
Early Start Habitat*						
Construction and operation of 2000 acres Saline Habitat Complex	Fugitive dust emissions from construction/maintenance (PM_{10})	PM_{10} Annual Average Daily (lb/day)	SCAQMD threshold for Construction: 150 lb/day	NA	NA	**673**
		PM_{10} Annual Emissions (ton/yr)	General conformity de minimis: 70 ton/yr	NA	NA	**89**
	Exhaust emissions from land- and marine-based construction/maintenance equipment (Diesel PM)	Diesel PM_{10} Annual Average Daily (lb/day)	SCAQMD threshold for Construction: 150 lb/day	NA	NA	**1.5**
		Diesel PM_{10} Annual Emissions (ton/yr)	General conformity de minimis: 70 ton/yr	NA	NA	**0.2**
	Exhaust emissions from land- and marine-based construction/maintenance equipment (NO_x)	NO_x Annual Average Daily (lb/day)	SCAQMD threshold for Construction: 100 lb/day	NA	NA	87
		NO_x Annual Emissions (ton/yr)	General conformity de minimis: 50 ton/yr	NA	NA	11

Emissions for Alternatives 2 through 8 would be the same as Alternative 1 for the Early Start Habitat.

NA = There would be no construction activities associated with the Early Start Habitat for the No Action Alternative.

* For PM_{10}, bolded values indicate that the sum of fugitive and diesel PM_{10} compared to the threshold would exceed the threshold even though the speciated values alone may not exceed the threshold.

Table E1-2
Summary of Emissions Estimates for Phase I and Phase IV

Impact Source	Pollutant and Averaging Time	Significance Rationale	No Action Alternative-CEQA Conditions	No Action Alternative-Variability Conditions	Saline Habitat Complex I	Saline Habitat Complex II	Concentric Rings	Concentric Lakes	North Sea	North Sea Combined	Combined North & South Lakes	South Sea Combined
			Emissions									
Phase I - Initiation to 2020 - Peak Construction Year												
Construction of Barriers, Perimeter Dikes, Saline Habitat Complex, Roadways, Canals/Basins, and AQM[a]												
Fugitive dust emissions from construction of project elements (PM_{10} and HAPs)[b]	PM_{10} Annual Average Daily (lb/day)	SCAQMD threshold for Construction: 150 lb/day	103	103	**747**	**1,389**	**2,554**	**560**	**3,327**	**17,677**	**21,313**	**19,436**
	PM_{10} Annual Emissions (ton/yr)	General conformity de minimis: 70 ton/yr	14	14	**99**	**183**	**337**	74	**439**	**2,333**	**2,813**	**2,565**
Exhaust emissions from material transport trucks, and land- and marine-based construction equipment	Diesel PM_{10} Annual Average Daily (lb/day)	SCAQMD threshold for Construction: 150 lb/day	0.7	0.7	1.7	**2.9**	**369**	**55**	**407**	**538**	**333**	**582**
	Diesel PM_{10} Annual Emissions (ton/yr)	General conformity de minimis: 70 ton/yr	0.1	0.1	**0.2**	**0.4**	**49**	7	**54**	**72**	**45**	**78**
Exhaust emissions from material transport trucks, and land- and marine-based construction equipment (NOx)	NO_x Annual Average Daily (lb/day)	SCAQMD threshold for Construction: 100 lb/day	47	47	95	**172**	**6,738**	**964**	**7,509**	**10,171**	**6,533**	**10,987**
	NO_x Annual Emissions (ton/yr)	General conformity de minimis: 50 ton/yr	6	6	13	23	**915**	**131**	**1,020**	**1,405**	**921**	**1,519**
Operation of Barriers, Lakes, Perimeter Dikes, Saline Habitat Complex, Roadways, Canals/Basins, Brine, AQM, during construction[c]												
Fugitive dust emissions from operation of vehicles and equipment used in maintenance (PM_{10} and HAPs)[b,d]	PM_{10} Annual Average Daily (lb/day)	SCAQMD threshold for Operations: 150 lb/day	1	1	**7.5**	**14**	**26**	**5.6**	**33**	**177**	**213**	**194**
	PM_{10} Annual Emissions (ton/yr)	General conformity de minimis: 70 ton/yr	0.1	0.1	**1**	**1.8**	3.4	**0.7**	**4.4**	**23**	**28**	**26**
Exhaust emissions from operation of vehicles and equipment used in maintenance[d]	Diesel PM_{10} Annual Average Daily (lb/day)	SCAQMD threshold for Construction: 150 lb/day	< 0.1	< 0.1	**< 0.1**	**< 0.1**	**3.7**	**0.6**	**4.1**	**5.4**	**3.3**	**5.8**
	Diesel PM_{10} Annual Emissions (ton/yr)	General conformity de minimis: 70 ton/yr	< 0.1	< 0.1	**< 0.1**	**< 0.1**	0.5	**< 0.1**	**0.5**	**0.7**	**0.5**	**0.8**
Fugitive dust emissions from exposed areas after implementation of AQM control measures (PM_{10} and HAPs)[b]	PM_{10} Annual Average Daily (lb/day)	SCAQMD threshold for Operations: 150 lb/day	78	74	**386**	**412**	**157**	**2,746**	**541**	**483**	**7,291**	**277**
	PM_{10} Annual Emissions (ton/yr)	General conformity: 70 ton/yr	14.2	13.5	**70**	**75**	29	**501**	**99**	**88**	**1,331**	**51**
Exhaust emissions from operation of vehicles and equipment used in maintenance[d]	NO_x Annual Average Daily (lb/day)	SCAQMD threshold for Operations: 55 lb/day	0.5	0.5	1.0	1.7	**67**	10	**75**	**102**	**65**	**110**
	NO_x Annual Emissions (ton/yr)	General conformity de minimis: 50 ton/yr	0.1	0.1	0.1	0.2	9.2	1.3	10	14	9	15
Phase IV - 2040 to 2077 - Peak Operation Year												
Operation of Barriers, Lakes, Perimeter Dikes, Saline Habitat Complex, Roadways, Canals/Basins, Brine, AQM, once constructed[c]												
Fugitive dust emissions from operation of vehicles and equipment used in maintenance (PM_{10} and HAPs)[b,e]	PM_{10} Annual Average Daily (lb/day)	SCAQMD threshold for Operations: 150 lb/day	**10**	**10**	**75**	**139**	**255**	**56**	**333**	**1,768**	**2,131**	**1,944**
	PM_{10} Annual Emissions (ton/yr)	General conformity de minimis: 70 ton/yr	**1.4**	**1.4**	**10**	**18**	**34**	**7.4**	**44**	**233**	**281**	**257**
Fugitive dust emissions from exposed areas after implementation of AQM control measures (PM_{10} and HAPs)[b]	PM_{10} Annual Average Daily (lb/day)	SCAQMD threshold for Operations: 150 lb/day	**796**	**756**	**1,077**	**1,248**	**1,803**[f]	**22,469**	**2,146**	**2,106**	**13,232**	**1,191**
	PM_{10} Annual Emissions (ton/yr)	General conformity de minimis: 70 ton/yr	**145**	**138**	**197**	**228**	**329**[f]	**4,101**	**391**	**384**	**2,415**	**217**

Table E1-2
Summary of Emissions Estimates for Phase I and Phase IV

Impact Source	Pollutant and Averaging Time	Significance Rationale	No Action Alternative-CEQA Conditions	No Action Alternative-Variability Conditions	Saline Habitat Complex I	Saline Habitat Complex II	Concentric Rings	Concentric Lakes	North Sea	North Sea Combined	Combined North & South Lakes	South Sea Combined
Exhaust emissions from operation of vehicles and equipment used in maintenance[e]	Diesel PM_{10} Annual Average Daily (lb/day)	SCAQMD threshold for Construction: 150 lb/day	**< 0.1**	**0**	**0.2**	**0.3**	**37**	**6**	**41**	**54**	**33**	**58**
	Diesel PM_{10} Annual Emissions (ton/yr)	General conformity de minimis: 70 ton/yr	**< 0.1**	**< 0.1**	**< 0.1**	**< 0.1**	**5**	**0.7**	**5**	**7**	**5**	**8**
Exhaust emissions from operation of vehicles and equipment used in maintenance[e]	NO_x Annual Average Daily (lb/day)	SCAQMD threshold or Operation: 55 lb/day	5	5	9	17	**674**	**96**	**751**	**1,017**	**653**	**1,099**
	NO_x Annual Emissions (ton/yr)	General conformity de minimis: 50 ton/yr	0.6	0.6	1.3	2.3	**92**	13	**102**	**141**	**92**	**152**

[a] For PM_{10}, bolded values indicate that the sum of fugitive and diesel PM_{10} compared to the threshold would exceed the threshold even though the speciated values alone may not exceed the threshold

[b] Analytical results indicate potentially significant levels of constituents of concern in the sediment and soil samples taken at the Salton Sea. Project-level analyses would need to do more detailed emissions estimation, exposure assessment, and health impact analyses than was possible in the timeframe of the PEIR.

[c] For PM_{10}, bolded values bolded values indicate that the sum of fugitive PM_{10} from O&M, diesel PM_{10} from O&M, and exposed areas compared to the threshold would exceed the threshold even though the speciated values alone may not exceed the threshold

[d] Assumed 1 percent of Phase I Peak Construction Year emissions estimates would be representative of annual emissions associated with operations and maintenance for project components in Phase I.

[e] Assumed 10 percent of Phase I Peak Construction Year emissions estimates would be representative of annual emissions associated with operations and maintenance for project components in Phase IV.

[f] If long term irrigation facilities were provided in Alternative 4, the fugitive dust emissions would be reduced. About 60,000 acre-feet/year of water has been allocated to Air Quality Management in Alternative 4.

APPENDIX E, ATTACHMENT E2

Emissions Estimates

2006

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APPENDIX E, ATTACHMENT E2
EMISSIONS ESTIMATES

CONSTRUCTION EMISSIONS

Construction activities would result in air emissions such as fugitive dust, and exhaust from the combustion of fossil fuels in equipment and vehicles. A screening level analysis of construction emissions was used to estimate the air quality impacts of the alternatives. This means that construction emissions were only calculated for the major components of the alternatives, and that emission calculations were focused on two pollutants, NO_x and PM_{10}. PM_{10} emissions estimates include both particulate emissions from diesel-fueled engines (termed diesel PM_{10}) and fugitive dust (fugitive PM_{10}). Project-level analyses would be required to include more detailed information to estimate emissions, and would need to include emissions of carbon monoxide (CO), oxides of sulfur (SO_x), volatile organic compounds (VOCs), and hazardous air pollutants (HAPS).

Emissions from construction were estimated for the following components of the alternatives (not all components apply to each alternative):

- Earthmoving to construct canals and Saline Habitat Complex;
- Rock transported and placed for the Barriers, Perimeter Dikes, and Saline Habitat Complex, including truck travel on unpaved roads;
- Gravel transported and placed for the Barriers, Perimeter Dikes, Saline Habitat Complex, and roads, including truck travel on unpaved roads;
- Dredging for construction of the Barriers and Perimeter Dikes;
- Disturbance of dry land to construct Saline Habitat Complex and roadways; and
- Disturbance of dry land to build out areas for Air Quality Management and water efficient vegetation.

Table E2-1 summarizes the material quantities and acreages for the listed components for each of the alternatives. These material quantities and acreages served as the basis for the construction emission calculations.[1] NO_x and diesel excavators PM_{10} emissions were estimated for exhaust from construction equipment (such as bulldozers and excavators), marine vessels (tugboats, barges, and dredges), and diesel-fueled trucks (haul trucks and water trucks). Uncontrolled and controlled fugitive PM_{10} emissions were calculated for soil disturbance and truck travel on unpaved roads.

For every alternative, construction emissions were calculated for an Early Start Habitat for construction of Saline Habitat Complex, and for a Peak Construction Year, which was assumed to occur between now and the year 2020 (in Phase I). The construction emissions reported in this attachment provide a means to compare the impacts of the alternatives and should not be considered comprehensive. As indicated previously, emissions from construction of these components were only calculated for NO_x, diesel PM_{10}, and fugitive PM_{10}. The following section describes the methodology used for the construction emission calculations.

[1] Table E2-21 lists the total material quantities estimated for the listed components, over the lifetime of the alternative. Assumptions used to derive the values in Table E2-1 for the Peak Construction Year, from the quantities in Table E2-21, are listed in Table E2-22.

Table E2-1
Summary of Quantities Used for Peak Year Construction Emission Calculations

Component	No Action Alternative	Alternative 1 – Saline Habitat Complex I	Alternative 2 – Saline Habitat Complex II	Alternative 3 – Concentric Rings	Alternative 4 – Concentric Lakes	Alternative 5 – North Sea	Alternative 6 – North Sea Combined	Alternative 7 – Combined North & South Lakes	Alternative 8 – South Sea Combined
Quantities used for Exhaust Emission Calculations									
Rock[a]									
Transported by Truck (cy/yr)	0	152,000	311,500	6,476,000	375,000	8,235,000	15,323,000	10,947,500	16,467,000
Placed by Truck (cy/yr)	0	152,000	311,500	647,600	37,500	981,000	5,920,400	4,807,900	6,469,000
Placed by Barge (cy/yr)	0	0	0	5,828,400	337,500	7,254,000	9,402,600	6,139,600	9,998,000
Gravel[b]									
Transported by Truck (cy/yr)	18,667	110,667	196,000	1,881,667	171,667	1,375,500	2,617,833	4,685,667	3,027,167
Placed by Truck (cy/yr)	18,667	110,667	196,000	409,667	171,667	377,100	1,529,833	4,212,067	1,727,967
Placed by Barge (cy/yr)	0	0	0	1,472,000	0	998,400	1,088,000	473,600	1,299,200
Sediment Dredged (cy/yr)	0	0	0	3,450,000	6,193,125	1,950,000	4,180,000	0	4,920,000
Other									
Soil – Habitat Berms and Contours (cy/yr)	2,525,000[c]	3,594,000	6,593,000	0	5,000,000	3,755,000	2,545,500	1,530,600	1,500,000
Soil - Water Efficient Vegetation (cy/yr)	807,000	807,000	807,000	807,000	0	807,000	807,000	0	807,000
Quantities Used for Fugitive Dust Calculations									
Disturbed Dry Land[d]									
Saline Habitat Complex (acres/yr)	1,000[c]	2,500	5,000	0	2,500	2,500	2,500	2,500	2,500
Water Efficient Vegetation (acres/yr)	2,000	4,000	4,000	4,000	0	4,000	4,000	0	4,000

Table E2-1
Summary of Quantities Used for Peak Year Construction Emission Calculations

Component	No Action Alternative	Alternative 1 – Saline Habitat Complex I	Alternative 2 – Saline Habitat Complex II	Alternative 3 – Concentric Rings	Alternative 4 – Concentric Lakes	Alternative 5 – North Sea	Alternative 6 – North Sea Combined	Alternative 7 – Combined North & South Lakes	Alternative 8 – South Sea Combined
Create Roads (acres/yr)	100	100	100	100	100	100	100	100	100
Travel on Unpaved Roads[e]									
Unpaved Roads (vehicle miles traveled/yr)	9,333	131,333	253,750	528,633	104,583	679,050	3,725,117	4,509,983	4,098,483

Notes

[a] Rock quantities represent rock used for the Barriers, Perimeter Dikes, or Saline Habitat Complex. Rock was assumed to be transported only by trucks and then placed by trucks, barges or both.

[b] Gravel quantities represent gravel used for the Barriers, Perimeter Dikes, Saline Habitat Complex, or roads. Gravel was assumed to be transported only by trucks and then placed by trucks, barges, or both.

[c] The peak construction year for the No Action Alternative occurs in an earlier year than assumed for the other alternatives, and would include soil disturbed to construct canals, therefore; the value represents soil for canals.

[d] Exhaust emissions from water trucks were estimated assuming watering every two hours, a surface area coverage rate of 2.9 acres/hr/truck, and the total acres disturbed in constructing habitat complex and roads.

[e] Vehicles miles traveled on unpaved roads were calculated only for the trucks placing rock or gravel, assuming trucks travel 5 miles one-way on unpaved roads. Emissions from entrained road dust for trips on paved roads to transport materials to the Sea were not estimated.

Methodology

Exhaust Emissions

NO_x and diesel PM_{10} emissions were estimated for exhaust from construction equipment (such as bulldozers), marine vessels (tugboats and dredges), and diesel-fueled trucks. Construction equipment were assumed to operate 8 hours per day and were categorized based on horsepower (hp) as large, medium, and small. Large construction equipment were assumed to represent equipment rated at 350 hp, medium construction equipment were assumed to represent equipment rated at 180 hp, and small construction equipment were assumed to represent equipment rated at 80 hp. The horsepower and load factors for each equipment category were obtained from URBEMIS2002, version 8.7.0. In addition, a material handling capacity (cubic yard [cy]/hr), from the 2005 National Construction Estimator guide, was assumed for each equipment category. Marine vessels were categorized by tugboat/barge combinations, large dredges, and small dredges. All marine vessels were assumed to operate 16 hours per day, because of the large volumes of materials to be moved and placed under some of the alternatives.

For construction equipment and marine vessels, emissions were calculated by multiplying the quantities (cy/yr) presented in Table E2-1 by derived emission factors (lb/cy), for an emission result of lb/yr. To simplify calculations, an average derived emission factor for large and small dredges was used to calculate emissions. The section below describes how the derived emission factors were obtained. For diesel-fueled trucks, emissions were calculated by dividing the quantities (cy/yr) in Table E2-1 by the assumed truck capacity of 20 cy, multiplying by the number of miles traveled to transport or place materials (assumptions to follow) to get vehicle miles traveled (VMT/yr), and then multiplying the vehicle miles traveled (VMT) by the EMFAC2002 emission factor (lb/VMT), to obtain an emission result in lb/yr. Trucks were assumed to travel 10 miles one-way to transport rock or gravel on paved roads and 5 miles one-way on unpaved roads to place the rock or gravel. The VMT used to calculate exhaust emissions for water trucks was based on a surface area coverage rate of 2.9 acres/hour/truck (SJVAPCD, 2003), a 2-hour watering interval, and the total acres disturbed in constructing habitat complex and roads.

Fugitive PM_{10} Emissions

Construction of the alternatives would result in air emissions in the form of fugitive PM_{10} from earthmoving activities, material transport, and truck travel on unpaved roadways. Fugitive PM_{10} emissions from unpaved roads were only calculated for material transport trucks and do not include worker travel or other equipment travel on unpaved or paved roads. Even with these limitations, travel on unpaved roadways was the predominant source of the estimated fugitive PM_{10} emissions.

Emission Factors

This section presents the emission factors and references used to calculate the exhaust and fugitive PM_{10} emissions from construction. The California Air Resources Board (ARB) Tier 4 emission standards for off-road vehicles and the United States Environmental Protection Agency (USEPA) Tier 2 marine vessel emissions standards were used to develop derived emission factors (CCR Title 13, Chapter 9 and USEPA, 2004). Derived emission factors were calculated by dividing the emission standards (g/hp hr) by a capacity factor (cy/hr) resulting in the derived emission factor in units of lb/cy. The South Coast Air Quality Management District (SCAQMD) table of Highest EMFAC2002 (version 2.2) emission factors (lb/vehicle mile traveled [VMT]) for on-road diesel trucks were used for truck emission calculations. Table E2-2 summarizes the emission factors used for both exhaust emission and fugitive PM_{10} emission calculations.

Emission factors from Appendix 9 of the SCAQMD CEQA Handbook, USEPA reference document AP-42 (Volume I, Fifth Edition) and the ARB Emission Inventory Processes Methodologies for Agricultural Land Preparation, were used to estimate fugitive PM_{10} associated with construction (SCAQMD, 1993; USEPA, 2006; and ARB, 2003). The grading emission factor from the Table A9-9 of the SCAQMD CEQA handbook was used to calculate fugitive PM_{10} emissions from the construction of Saline Habitat Complex, roadways, and Perimeter Dikes (SCAQMD, 1993). Fugitive PM_{10} emissions resulting from land preparation for planting water efficient vegetation was calculated using an agricultural tilling factor for seed grass (ARB, 2003). Fugitive PM_{10} from unpaved roads was calculated using the fugitive dust equation for unpaved industrial roads in the EPA AP-42, Chapter 13, Section 13.2.2 (USEPA, 2006). Variables for unpaved road dust were calculated using values for construction roads and construction equipment.

Table E2-2
Emission Factors

Emission Source	Emission Factor Units	Emission Factors		
		NO_x	Diesel PM_{10}	Fugitive PM_{10}
Large Size Construction Equipment	lb/cy	4.10E-03	5.46E-05	NA
Medium Size Construction Equipment	lb/cy	3.22E-03	4.29E-05	
Small Size Construction Equipment	lb/cy	2.01E-03	2.68E-05	
Tugboat/barge	lb/cy	1.93E-01	1.11E-02	
Dredge	lb/cy	2.30E-02	1.32E-03	
Diesel Trucks	lb/VMT	1.938E-02	4.38E-04	
Grading Surface (Saline Habitat Complex, roadway construction, Perimeter Dikes)	lb/day/acre	NA		26.4
Travel on Unpaved Roads*	lb/VMT			2.8
Surface Preparation for Water Efficient Vegetation	tons/year/acre			0.002

NA = Emission factor not applicable.

* EF for fugitive dust emission on unpaved industrial roads is based on 8.5 percent silt content and the average vehicle weight of 23.25 tons (USEPA, 2006).

Results

Tables E2-3 and E2-4 present the results of the construction emission calculations for the Peak Construction Year and the Early Start Habitat. Fugitive PM_{10} emissions were assumed to have the following control measures included:

- Saline Habitat Complex and roadway construction emissions were reduced by 74 percent assuming a 2-hour watering interval for exposed areas during construction (WRAP, 2004): and
- Unpaved road emissions were reduced by 55 percent assuming watering twice daily (WRAP, 2004).

Limitations of Study

Construction emissions were only estimated for construction of the large components for the alternatives. The following list details the types of emission sources that were not included as part of this analysis but should be considered for project-level analyses:

- Emissions generated by water trucks traveling on unpaved roads to refilling locations were not included in calculations of construction fugitive dust. In addition, exhaust emissions for this water truck travel were not estimated;
- Emissions of entrained road dust generated by trucks traveling on paved roads to transport construction materials (e.g., rock, gravel) from quarries to the Salton Sea were not included in calculations of construction fugitive dust;

Table E2-3
Summary of Peak Construction Year Emissions

	No Action Alternative– CEQA Conditions	No Action Alternative– Variability Conditions	Alternative 1 – Saline Habitat Complex I	Alternative 2 – Saline Habitat Complex II	Alternative 3 – Concentric Rings	Alternative 4 – Concentric Lakes	Alternative 5 – North Sea	Alternative 6 – North Sea Combined	Alternative 7 – Combined North & South Lakes	Alternative 8 – South Sea Combined
Emissions (ton/yr)										
NO_x	6	6	13	23	915	131	1,020	1,405	921	1,519
Diesel PM_{10}	0.1	0.1	0.2	0.4	49	7	54	72	45	78
Fugitive PM_{10} (with control)	13.6	13.6	99	183	337	74	439	2,333	2,813	2,565
Emissions (lb/day)										
NO_x	47	47	95	172	6,738	964	7,509	10,171	6,533	10,987
Diesel PM_{10}	0.7	0.7	1.7	2.9	369	55	407	538	333	582
Fugitive PM_{10} (with control)	103	103	747	1,389	2,554	560	3,327	17,677	21,313	19,436

[a] Emissions represent peak construction year for the No Action Alternative which would occur in an earlier year than that assumed for the other alternatives.

Table E2-4
Summary of Early Start Habitat Construction Emissions

Emissions (ton/yr)	
NO_x	11
Diesel PM_{10}	0.2
Fugitive PM_{10} (with control)	89
Emissions (lb/day)	
NO_x	87
Diesel PM_{10}	1.5
Fugitive PM_{10} (with control)	673

Early Start Habitat construction would be implemented as part of Alternatives 1, 2, 3, 4, 5, 6, 7, and 8.

- Emissions of fugitive dust from storage piles and material handling were not estimated;
- Emissions of fugitive dust generated by land-based construction equipment traveling on unpaved roads were not estimated;
- Exhaust and fugitive dust emissions generated by trucks used to haul miscellaneous construction-related materials, supplies, and resources, such as fencing and fuels, to the Salton Sea and construction sites were not estimated;
- Exhaust emissions from water trucks to control unpaved road dust for placement of materials were not estimated; and
- Emissions generated by employee commute vehicles were not included.

OPERATIONS EMISSIONS

The analysis of operations emissions was limited to two sources; operations and maintenance activities and wind erosion of Exposed Playa. Appendix E, Attachment E-3 describes how emissions were calculated for wind erosion of Exposed Playa. Operations and maintenance activities would include routine operations and maintenance of canals, berms, Perimeter Dikes, Saline Habitat Complex, and Barriers. A percentage method was used to estimate emissions from operations and maintenance activities for the alternatives. Operations and maintenance emissions were assumed to be a percentage of the Peak Construction Year emissions for Phase I and Phase IV, and emission calculations were again focused on two pollutants, NO_x and PM_{10}. This method required no information on proposed operations and maintenance activities; therefore, the operations emissions reported in this chapter are rough, order of magnitude estimates, to be used for comparisons of the alternatives. Project-level analyses would be required to utilize detailed information about operations and maintenance activities, and the emission calculations would need to include emissions of CO, SO_x, VOCs, and HAPS.

Methodology

Operation emissions were calculated for operations in Phase I during construction and a Peak Operations Year, assumed to occur in Phase IV, after construction is completed. For the purposes of the PEIR, in Phase I, an emissions level equivalent to 1 percent of the Peak Construction Year emissions estimates were assumed to be representative of annual emissions associated with operations and maintenance. For the purposes of the PEIR, an emissions level equivalent to 10 percent of Peak Construction Year emissions estimates was assumed to be representative of annual emissions associated with operations and maintenance for components in Phase IV (Peak Operations Year). This estimate was based on the assumption that the peak operations year would occur in the later phases of the alternatives, when periodically greater levels of operations and maintenance would be required for some of the large components, such as seepage control measures, repair of slumps in berms, or rock and gravel replacement. Tables E2-5 and E2-6 summarize the operations and maintenance emissions for Phase I and Phase IV.

GENERAL CONFORMITY

The general conformity rule prohibits any federal action that does not conform to the applicable air quality attainment plan or SIP. It is applicable only in areas designed as non-attainment or maintenance for NAAQS. General conformity applicability analysis requires quantification of direct and indirect, construction and operations emissions for the project, or federal action, and comparison of these emission levels to baseline emission levels.

Table E2-5
Summary of Operations Emissions for Phase I*

	No Action Alternative– CEQA Conditions	No Action Alternative– Variability Conditions	Alternative 1 – Saline Habitat Complex I	Alternative 2 – Saline Habitat Complex II	Alternative 3 – Concentric Rings	Alternative 4 – Concentric Lakes	Alternative 5 – North Sea	Alternative 6 – North Sea Combined	Alternative 7 – Combined North & South Lakes	Alternative 8 – South Sea Combined
Emissions (ton/yr)										
NO_x	0.1	0.1	0.1	0.2	9.2	1.3	10.2	14.1	9.2	15.2
Diesel PM_{10}	0.0009	0.0009	0.002	0.004	0.5	0.1	0.5	0.7	0.5	0.8
Fugitive PM_{10} (with control)	0.1	0.1	1.0	1.8	3.4	0.7	4.4	23.3	28.1	25.7
Emissions (lb/day)										
NO_x	0.5	0.5	1.0	1.7	67	10	75	102	65	110
Diesel PM_{10}	0.01	0.01	0.02	0.03	3.7	0.6	4.1	5.4	3.3	5.8
Fugitive PM_{10} (with control)	1.0	1.0	7.5	14	26	6	33	177	213	194

* Emissions assume 1 percent of the Phase I Peak Construction Year emissions estimates would be representative of annual emissions associated with operations and maintenance for components in Phase I.

Table E2-6
Summary of Operations Emissions for Phase IV* (Peak Operations Year)

	No Action Alternative– CEQA Conditions	No Action Alternative– Variability Conditions	Alternative 1 – Saline Habitat Complex I	Alternative 2 – Saline Habitat Complex II	Alternative 3 – Concentric Rings	Alternative 4 – Concentric Lakes	Alternative 5 – North Sea	Alternative 6 – North Sea Combined	Alternative 7 – Combined North & South Lakes	Alternative 8 – South Sea Combined
Emissions (ton/yr)										
NO_x	0.6	0.6	1.3	2.3	91.5	13.1	102	141	92	152
Diesel PM_{10}	0.01	0.01	0.02	0.04	4.9	0.7	5.4	7.2	4.5	7.8
Fugitive PM_{10} (with control)	1.4	1.4	10	18	34	7.4	44	233	281	257
Emissions (lb/day)										
NO_x	5	5	9	17	674	96	751	1,017	653	1,099
Diesel PM_{10}	0.1	0.1	0.2	0.3	37	6	41	54	33	58
Fugitive PM_{10} (with control)	10	10	75	139	255	56	333	1,768	2,131	1,944

* Emissions assume 10 percent of the Phase I Peak Construction Year emissions estimates would be representative of annual emissions associated with operations and maintenance for components in Phase IV.

A project is exempt from the conformity rule (presumed to conform) if the total net project related emissions increases pass two tests: they are less than the *de minimis* thresholds established by the conformity rule, and they are not regionally significant (emissions are regionally significant if they exceed 10 percent of the total regional emission inventory). A project that produces emissions that exceed conformity thresholds, or that is regionally significant, is required to demonstrate conformity with the SIP through mitigation or other accepted practices, such as dispersion modeling, comparison to SIP requirements, and possibly emission offsetting or revisions to the SIP to accommodate emissions.

The sum of construction and operations emissions was developed for each alternative for both the Peak Construction Year and the Peak Operations Year and compared to the comparable emissions estimated for the No Action Alternative under CEQA Conditions and Variability Conditions. The differences, or “net” emissions increases, were then compared to the applicable significance criteria (i.e., the general conformity de minimis thresholds and regionally significant emissions levels). Table E2-7 summarizes the net emissions increases for each alternative as compared to the No Action Alternative. Alternatives 1 though 8 assume inflows as predicted under No Action Alternative-Variability Conditions.

TABLE LIST

The following tables, listed below, support the construction emission calculations presented in Appendix E, Attachment E2.

REFERENCES

ARB (California Air Resources Board). 2003. Emission Inventory Processes Methodologies for Agricultural Land Preparation, Table 2a.

California Code of Regulations, Title 13, Ch. 9 Offroad Vehicles and Engines Pollution Control Devices, Article 4 Offroad Compression Ignition Engines and Equipment. April 20, 2005. (I got this from ARB website, http://www.arb.ca.gov/msprog/offroad/orcomp/documents.htm)

SJVUAPCD (San Joaquin Valley Unified Air Pollution Control District). 2003. Final BACM Technological and Economic Feasibility Analysis. March.

SCAQMD (South Coast Air Quality Management District). 1993. CEQA Air Quality Handbook, Table A9-9.

USEPA (United States Environmental Protection Agency). 2006. AP-42, Fifth Edition, Compilation of Air Pollution Emission Factors, Volume I: Stationary Point and Area Sources, Chapter 13.2.2. March.

USEPA (United States Environmental Protection Agency). 2004. Overview of EPA's Emission Standards for Marine Vessels. August.

WRAP (Western Area Governors' Association). 2004. *WRAP Fugitive Dust Handbook*. November.

Table E2-7
Summary of General Conformity Emissions for Phase I and Phase IV

Pollutant	Alternative 1 – Saline Habitat Complex I	Alternative 2 – Saline Habitat Complex II	Alternative 3 – Concentric Rings	Alternative 4 – Concentric Lakes	Alternative 5 – North Sea	Alternative 6 – North Sea Combined	Alternative 7 – Combined North & South Lakes	Alternative 8 – South Sea Combined
Phase I - Initiation to 2020 - Emissions Difference from No Action Alternative-CEQA Conditions(ton/yr)								
NO_x (ton/yr)	6	17	**918**	**126**	**1,024**	**1,413**	**924**	**1,528**
PM_{10} (ton/yr)	**142**	**233**	**391**	**555**	**569**	**2,490**	**4,190**	**2,693**
Phase I - Initiation to 2020 - Emissions Difference from No Action Alternative-Variability Conditions (ton/yr)								
NO_x (ton/yr)	6	17	**918**	**126**	**1,024**	**1,413**	**924**	**1,528**
PM_{10} (ton/yr)	**143**	**233**	**391**	**555**	**570**	**2,491**	**4,191**	**2,693**
Phase IV - 2040 to 2077 - Emissions Difference from No Action Alternative-CEQA Conditions (ton/yr)								
NO_x (ton/yr)	0.6	1.6	**91**	12.5	**101**	**140**	**92**	**151**
PM_{10} (ton/yr)	60	**100**	**221**	**3,962**	**294**	**478**	**2,554**	**335**
Phase IV - 2040 to 2077 - Emissions Difference from No Action Alternative-Variability Conditions (ton/yr)								
NO_x (ton/yr)	0.6	1.6	**91**	12.5	**101**	**140**	**92**	**151**
PM_{10} (ton/yr)	67	**107**	**228**	**3,969**	**302**	**486**	**2,561**	**342**

Note: Bolded values indicated exceedance of the de minimis thresholds of 70 ton/yr for PM_{10} and 50 ton/yr for NO_x. None of the estimated differences, or net emissions increases, would exceed 10 percent of the total regional emissions inventory. As presented in the PEIR, the ARB reports an annual average daily emissions rate of 55.4 ton/day, or about 20,220 ton/year, as the regional inventory for NO_x in the Salton Sea Air Basin. For PM_{10}, the ARB reports an annual average daily emissions rate of 262.3 ton/day, or about 95,740 ton/year.
Alternatives 1 though 8 assume inflows as predicted under No Action Alternative-Variability Conditions.

Tables

Table E2-14. Early Start Habitat Quantities (cubic yards) for Exhaust Emission Calculations

Values for Early Start Habitat	cubic yards/year
Rock cy/yr transported by truck	152,000
Rock cy/yr placed by barge	NA
Rock cy/yr placed by truck	152,000
Gravel cy/yr transported by truck	110,667
Gravel cy/yr placed by barge	NA
Gravel cy/yr placed by truck	110,667
Sediment cy/yr dredged	NA
Soil/Clay cy/yr graded	3,594,000
Soil cy/yr disturbed for AQ WEV	NA

Table E2-15. Land Based Equipment Exhaust Emission Calculations (Early Start Habitat)

	Emissions (ton/yr)		Emissions (lb/day)	
Equipment Type	**NOx**	**Diesel PM_{10}**	**NOx**	**Diesel PM_{10}**
Large Size Construction Equipment	3.7	0.049	27.9	0.4
Medium Size Construction Equipment	1.9	0.025	14.0	0.2
Small Size Construction Equipment	0.7	0.009	4.9	0.1
Tugboat/barge	NA	NA	NA	NA
Dredge	NA	NA	NA	NA
Haul Truck - Rock	2.2	0.05	16.7	0.38
Haul Truck - Gravel	1.6	0.04	12.2	0.28
Water Truck	0.4	0.010	3.4	0.08
TOTAL	10	0.18	79	1.4
Miscellaneous (add 10%)	1	0.02	8	0.1
GRAND TOTAL	11	0.20	87	1.5

Table E2-16. Land Based Construction Equipment Emission Factors

Equipment Type	URBEMIS2002 Equipment Type	Horsepower[a]	Load Factor[a]	Hours per Day	Material Handling (cy/hr)[b]	Emission Factors (g/hp-hr)[c]				Emission Factors (lb/hr)				Emission Factors (lb/cy)	
						NOx	PM_{10}	CO	ROG	NOx	PM_{10}	CO	ROG	NOx	PM_{10}
Large Size Equipment	Rubber Tired Dozer	352	0.59	8	125	1.12	0.01	1.94	0.14	0.51	0.01	0.89	0.06	0.004	5.463E-05
Medium Size Equipment	Excavator	180	0.58	8	80	1.12	0.01	1.94	0.14	0.26	0.00	0.45	0.03	0.003	4.291E-05
Small Size Equipment	Tractors/Loaders/Backhoe	79	0.465	8	45	1.12	0.01	1.94	0.14	0.09	0.00	0.16	0.01	0.002	2.684E-05

[a] Horsepower and load factor from URBEMIS2002, v. 8.7.0.

[b] Material handling rate from the 2005 National Construction Estimator, 53rd Edition

[c] Tier 4 emission factors for model year equipment for the year 2012, http://www.arb.ca.gov/msprog/ordiesel/ordiesel.htm accessed April 7, 2006, posted March 27, 2006.

Emission calculations assume an equal number of each equipment type operates each day except for land preparation for WEV which would only include small equipment.

Table E2-17. Marine Vessel Emission Factors - Tugboat/Barge

Marine Vessel Type	Horsepower (hp)	Load Factor	Material Handling	Material Density	Trips/day	Hours per Day	Material Handling	Emission Factor (lb/cy) NOx	PM	CO
Tugboat	4268	0.5	800	1.9	6	16	157.89	0.19	0.01	0.11

Horsepower from USEPA, Analysis of Commercial Marine Vessel Emissions and Consumption Data, February 2000

Assumes that 1 tugboat pushes around 1 barge and that a barge can handle 800 tons/trip, and make 6 trips per day.

Table E2-18. Marine Vessel Emission Factors - Dredges

Marine Vessel Type	Horsepower (hp)	Load Factor	Hours per Day	Material Handling	Emission Factor (g/cy)		
					NOx	PM	CO
Large Dredges	2560	0.5	16	1000	12.33	0.71	7.08
	840						
	400						
Small Dredges	465	0.5	16	200	8.52	0.49	4.89
	60				**Emission Factor (lb/cy)**		
Average of Large and Small Dredges Used for Calculations					2.30E-02	1.32E-03	1.32E-02

Dredge horsepower and handling capacity from Dixie Dredge Model Dredges, www.members.aol.com/dixiedredge/dixiehome.htm.

Assumed engine load of 50%.

Table E2-19. Marine Engine Emission Standards

Category	Power (kW)	Tier 2 Model Year	Emission Standards (g/kW-hr)			Emission Standards (g/hp-hr)		
			NOx[a]	PM	CO	NOx	PM	CO
C2	<3300	2007	8.7	0.5	5	6.49	0.37	3.73
	>3300	2007	9.8	0.5	5	7.31	0.37	3.73

[a] Assumes that HC+NOx emission standard is all NOx.

Source: USEPA, Regulatory Update, Overview of EPA's Emission Standards for Marine Engines, August 2004.

Table E2-20. Diesel Truck (Haul and Water) Emission Factors

Truck Capacity (cy)	Roundtrip Transport Distance (miles)	Roundtrip Placement Distance (miles)	Emission Factors (lb/mile)				
			NOx	PM_{10}	CO	ROG	SOx
20	20	10	0.0194	0.00044	0.0038	0.00081	4.62695E-05

Emission factors from the SCAQMD table of the most conservative EMFAC2002 emission factors for heavy-heavy duty diesel trucks, for the year 2012.

Table E2-21. Total Material Quantities Used for Construction Equipment, Marine Vessel, and Diesel Truck Emission Estimates

	1 Saline Habitat Complex I	2 Saline Habitat Complex II	3 Concentric Rings	4 Concentric Lakes (Imperial Group)	5 North Sea	6 North Sea Combined	7 Combined North & South Lakes (SSA)	8 South Sea Combined	No Action - CEQA	No Action - Variability
Total Material Quantities Moved (cubic yards)										
Rock (Import)										
Barrier	0	0	64,760,000	3,000,000	40,300,000	45,450,000	28,300,000	48,000,000		
Perimeter Dikes/ Sed Basins	710,000	710,000	470,000	490,000	470,000	30,540,000	26,140,000	33,950,000	710,000	710,000
Habitat Berms	3,040,000	6,230,000			3,500,000	2,500,000	1,190,000	1,540,000		
TOTAL ROCK	3,750,000	6,940,000	65,230,000	3,490,000	44,270,000	78,490,000	55,630,000	83,490,000	710,000	710,000
Gravel (Import)										
Barrier	0	0	18,400,000		6,240,000	6,800,000	2,960,000	8,120,000		
Perimeter Dikes/ Sed Basins	410,000	410,000	270,000	280,000	270,000	5,750,000	20,290,000	6,610,000	410,000	410,000
Habitat Berms	1,520,000	3,120,000		3,000,000	1,750,000	1,250,000	600,000	770,000		
Roadways	1,040,000	1,200,000	1,250,000	650,000	1,200,000	1,360,000	170,000	1,280,000	560,000	560,000
TOTAL GRAVEL	2,970,000	4,730,000	19,920,000	3,930,000	9,460,000	15,160,000	24,020,000	16,780,000	970,000	970,000
Dredging (from Sea)										
Barrier	0	0	13,800,000	49,545,000	3,900,000	4,250,000	0	5,080,000		
Perimeter Dikes						4,110,000	0	4,760,000		
TOTAL DREDGING	0	0	13,800,000	49,545,000	3,900,000	8,360,000	0	9,840,000	0	0
Soil/Clay										
Canals	5,260,000	4,670,000	5,010,000	4,670,000	7,770,000	7,700,000	2,910,000	7,390,000	5,050,000	5,050,000
Habitat Berms	28,450,000	57,580,000	0	0	31,670,000	23,350,000	12,220,000	14,000,000		
Habitat Contouring	43,430,000	74,280,000	0	100,000,000	43,430,000	27,560,000	18,392,000	16,000,000		
TOTAL SOIL/CLAY	77,140,000	136,530,000	5,010,000	104,670,000	82,870,000	58,610,000	33,522,000	37,390,000	5,050,000	5,050,000
Peak Construction Year, Phase I (Existing to 2020), Material Quanitities Moved (cubic yards/year)										
Rock cy/yr transported by truck	152,000	311,500	6,476,000	375,000	8,235,000	15,323,000	10,947,500	16,467,000	0	0
Rock cy/yr placed by barge	0	0	5,828,400	337,500	7,254,000	9,402,600	6,139,600	9,998,000	0	0
Rock cy/yr placed by truck	152,000	311,500	647,600	37,500	981,000	5,920,400	4,807,900	6,469,000	0	0
Gravel cy/yr transported by truck	110,667	196,000	1,881,667	171,667	1,375,500	2,617,833	4,685,667	3,027,167	18,667	18,667
Gravel cy/yr placed by barge	0	0	1,472,000	0	998,400	1,088,000	473,600	1,299,200	0	0
Gravel cy/yr placed by truck	110,667	196,000	409,667	171,667	377,100	1,529,833	4,212,067	1,727,967	18,667	18,667
Sediment cy/yr dredged	0	0	3,450,000	6,193,125	1,950,000	4,180,000	0	4,920,000	0	0
Soil/Clay cy/yr graded	3,594,000	6,593,000	0	5,000,000	3,755,000	2,545,500	1,530,600	1,500,000	2,525,000	2,525,000
Soil cy/yr disturbed for AQ WEV	807,000	807,000	807,000	0	807,000	807,000	0	807,000	807,000	807,000

Non-Peak Year										
Rock cy/yr transported by truck	152,000	311,500	0	0	175,000	125,000	59,500	77,000	0	0
Gravel cy/yr transported by truck	110,667	196,000	41,667	171,667	127,500	107,833	35,667	81,167	18,667	18,667
Transport										
Truck trips rock	7,600	15,575	0	0	8,750	6,250	2,975	3,850	0	0
Truck trips gravel	5,533	9,800	2,083	8,583	6,375	5,392	1,783	4,058	933	933
Total truck trips	13,133	25,375	2,083	8,583	15,125	11,642	4,758	7,908	933	933
	13,133	25,375	2,083	8,583	15,125	11,642	4,758	7,908	933	933
Peak Year										
Rock cy/yr transported by truck	152,000	311,500	6,476,000	375,000	8,235,000	15,323,000	10,947,500	16,467,000	0	0

Table E2-21. Total Material Quantities Used for Construction Equipment, Marine Vessel, and Diesel Truck Emission Estimates (continued)

Gravel cy/yr transported by truck	110,667	196,000	1,881,667	171,667	1,375,500	2,617,833	4,685,667	3,027,167	18,667	18,667
	13,133	25,375	417,883	27,333	480,525	897,042	781,658	974,708	933	933
Rock										
Dam Perm	0	0	6,476,000	375,000	8,060,000	15,198,000	10,888,000	16,390,000	0	0
Other	152,000	311,500	0	0	175,000	125,000	59,500	77,000	0	0
Dam Daily Trips	0	0	17,742	1,027	22,082	41,638	29,830	44,904	0	0
Other Daily Trips	576	1,180	0	0	663	473	225	292	0	0
Gravel										
Dam Perm	0	0	1,840,000	0	1,248,000	2,510,000	4,650,000	2,946,000	0	0
Other	110,667	196,000	41,667	171,667	127,500	107,833	35,667	81,167	18,667	18,667
Dam Daily Trips	0	0	5,041	0	3,419	6,877	12,740	8,071	0	0
Other Daily Trips	419	742	158	650	483	408	135	307	71	71
Total	50	96	1,147	84	1,332	2,470	2,147	2,679	4	4

Table E2-22. Peak Construction Year Assumptions

Variable	**Assumption**
Rock (Imported)	
Barrier	Assumed rock for Barrier transported 100% by truck 10 miles one way on paved roads. Assumed 90% of rock placed by barge and 10% of rock placed by truck. For truck placement, assumed trucks travel 5 miles one way on unpaved roads. For Alternatives 5,6,7,and 8, assumed 1/5 of rock volume moved in peak year. For Alternative 3, assumed 1/10 of rock volume moved in peak year. For Alternative 4, assumed 1/8 of rock volume moved in peak year. Barriers would not be constructed for the No Action Alternative, Alternative 1, or Alternative 2.
Perimeter Dikes/ Sedimentation Basins	Assumed rock for Perimeter Dikes transported 100% by truck 10 miles one way on paved roads. Assumed 20% of rock placed by barge and 80% of rock placed by truck. For truck placement, assumed trucks travel 5 miles one way on unpaved roads. For Alternatives, 6,7, and 8, assume 1/5 of rock volume moved in peak year. For all other alternatives, assumed Perimeter Dikes/Sedimentation Basins would not be constructed in peak year.
Saline Habitat Complex	Assumed rock for Saline Habitat Complex transported 100% by truck 10 miles one way on paved roads. Assumed 100% of rock placed by truck. For truck placement, assumed trucks travel 5 miles one way on unpaved roads. For Alternatives 1,2,5,6,7, and 8 assumed 1/20 of rock volume moved in peak year. Saline Habitat Complex would not be construted for the No Action Alternative, Alternative 3, or Alternative 4.
Gravel (Imported)	
Barrier	Assumed gravel for Barrier transported 100% by truck 10 miles one way on paved roads. Assumed 80% of gravel placed by barge and 20% of gravel placed by truck. For truck placement, assumed trucks travel 5 miles one way on unpaved roads. For alternatives 5,6,7,and 8, assumed 1/5 of gravel volume moved in peak year. For Alternative 3, assumed 1/10 of gravel volume moved in peak year. For Alternative 4, no gravel would be used. A Barrier would not be constructed for the No Action Alternative, Alternative 1, or Alternative 2.
Perimeter Dikes/ Sedimentation Basins	Assumed gravel for Perimeter Dikes transported 100% by truck 10 miles one way on paved roads. Assumed 100% of gravel placed by truck. For truck placement, assumed trucks travel 5 miles one way on unpaved roads. For Alternatives, 6,7, and 8, assume 1/5 of gravel volume moved in peak year. For all other alternatives, assumed gravel for perimeter dikes/sedimentation basins would not be constructed in peak year.
Saline Habitat Complex	Assumed gravel for Saline Habitat Complex transported 100% by truck 10 miles one way on paved roads. Assumed 100% of gravel placed by truck. For truck placement, assumed trucks travel 5 miles one way on unpaved roads. For Alternatives 1,2,5,6,7, and 8 assumed 1/20 of gravel volume moved in peak year. Saline Habitat Complex would not be constructed for the No Action Alternative or Alternative 3.
Roadways	Assumed gravel for roadway construction transported 100% by truck 10 miles one way on paved roads. Assumed 100% of gravel placed by truck. For truck placement, assumed trucks travel 5 miles one way on unpaved roads. For all alternatives, assumed 1/30 of the gravel volume moved in peak year.
Dredging (from Salton Sea)	
Barrier and Perimeter Dikes	For Alternatives 5,6, and 8, assumed 1/2 of the sediment volume would be dredged in the peak year. For Alternative 3, assumed 1/4 of the sediment volume would be dredged in the peak year. For Alternative 4, assumed 1/8 of the sediment volume would be dredged in the peak year. For Alternative 7, assumed 1/5 of the sediment volume would be dredged in the peak year
Material	
Canals	Peak construction for No Action Alternative occurs in an earlier year than was assumed for the other alternatives, so construction of canals was only included with the No Action Alternative.
Saline Habitat Complex	Assumed 1/20 of the of the total material volume was worked by a mix of large, medium, and small construction equipment.
Water Efficient Vegetation	Assumed 1,000 acres per year and top 6 inches of soil disturbed for land preparation for water efficient vegatation.

APPENDIX E, ATTACHMENT E3

Evaluation of Playa Dust Emissions (PM_{10})

2006

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APPENDIX E, ATTACHMENT E3
EVALUATION OF PLAYA DUST EMISSIONS (PM_{10})

INTRODUCTION

Under alternatives being considered in the PEIR, currently wet or flooded areas at the Salton Sea could become dry and exposed, and thereby become sources of windblown dust. Emissions during high wind events are of particular concern. Particulate matter is a regulated air pollutant that must be considered in evaluating air quality impacts from the alternatives. To support the PEIR, a tool and modeling process were developed to estimate dust emissions in the form of particulate matter less than 10 microns in aerodynamic diameter (PM_{10}) from future Exposed Playa areas at the Salton Sea.

The tool selected was based on the "Empirical Method for Determining Fugitive Dust Emissions from Wind Erosion of Vacant Land", commonly referred to as the "MacDougall Method" (MacDougall and Uhl, 2003). This section discusses the methods, approaches and assumptions that were used in developing the specific tool and modeling process. Results from use of the tool provide preliminary estimates of playa dust emissions before and after implementation of Air Quality Management and control measures for the various alternatives analyzed in the PEIR.

MACDOUGALL METHOD

There is no agreed upon method to estimate PM_{10} emissions or wind blown dust, and there are many uncertainties and limitations associated with the available tools and methods. The MacDougall Method is a tool used to estimate particulate matter emissions that relies heavily on emission factors developed through use of wind tunnel and/or Portable In-Situ Wind Erosion Laboratory (PI-SWERL) study results. The MacDougall Method was developed to estimate dust emissions from land with little or no vegetation. Such lands may have the ability to form a crust, which can minimize dust emissions. Other available methods for dust emissions estimation are not able to take into account the ability of soils to form a crust. The method relies on actual field measurements of soil with and without crust to estimate PM_{10} emissions. Soils with varying crust strengths or stabilities may also be studied.

A wind tunnel is a chamber used to simulate wind conditions and to track releases of pollutants such as particulate matter. Wind tunnels usually operate in laboratories, but a portable version is available and was used in September 2005 for measurements at the Salton Sea. The wind tunnel is large and cumbersome, so a more portable method was developed. The PI-SWERL, developed at the Desert Research Institute (DRI), is a device used to measure particulate emissions in the field. The PI-SWERL is portable and can easily be moved from one location to another. The PI-SWERL was operated side by side with the portable wind tunnel at the Salton Sea sampling locations in September 2005, and has since been used to take measurements at the same study locations in January and March 2006. The results of the side by side comparison were used to help estimate PM_{10} emissions during the PI-SWERL sampling events.

The availability of wind tunnel and/or PI-SWERL results for the type of vacant land being assessed must be considered when deciding to use the MacDougall method for a given application. When wind tunnel and/or PI-SWERL results are available or when wind testing can be completed, several parameters must be evaluated to appropriately apply the wind tunnel results to a given vacant land area. These parameters include:

- threshold wind velocities;
- wind events;

- land type reservoirs; and
- rain/humidity events.

Applying the MacDougall Method to the potential Exposed Playa involves determining the meteorological data set to consider, wind tunnel and/or PI-SWERL studies to apply, and categorizing the Exposed Playa based on the parameters listed above. The methods, approaches, and assumptions related to each of these elements are discussed in the following subsections.

Developing a Meteorological Data Set

The MacDougall Method requires the meteorological parameters of wind speed, precipitation, and relative humidity at the area being evaluated to predict the amount of dust that may be generated by wind erosion. A meteorological data set was developed for the Salton Sea watershed using year 2002 data from two 10-meter[1] surface meteorological stations, the Niland and Indio stations, within the Salton Sea study area. The Niland station is operated by the Imperial County Air Pollution Control District (ICAPCD) and the Indio station is operated by the South Coast Air Quality Management District (SCAQMD). The Indio station is located in the north portion of the study area, and the Niland station is located in the south portion of the study area. Based on the data available at the time of the analysis, a decision was made to relate the measured shear velocity data to wind speeds measured at 10 meters.

Calculating and Identifying Emission Factors Based on PI-SWERL Results

The MacDougall method relies on an understanding of the land type and reservoir capacity. The best method to derive such information is from field measurements in the study area. A field testing program was conducted by DRI along the shoreline of the Salton Sea, at accessible locations where Exposed Playa currently exists. DRI performed co-located wind tunnel and PI-SWERL tests in September 2005, and additional "PI-SWERL only" tests in January 2006 (Etyemezian, 2006a). Tests were also conducted in March 2006, but results were not available at the time of preparation of this report.

Preliminary draft PI-SWERL data collected at 13 sites during the September 2005 and 15 sites during the January 2006 test periods were used in the current analysis (Etymezian, 2006). Finalized results for the September and January tests were not available at the time of preparation of the PEIR, nor were the March 2006 results available. The draft PI-SWERL data consisted of shear velocities [meters per second (m/s)], and PM_{10} emission factors [milligrams per square meter second (mg/m^2*s)]. The preliminary draft data from September 2005 and January 2006 used in this analysis are presented in Appendix E3A. Each of the DRI PI-SWERL data points was grouped, based on the location of the test.

In order to relate the shear velocity measured by DRI in the PI-SWERL sampling events to an equivalent 10 meter wind speed, the aerodynamic roughness factor, z_0, is needed. Information on the z_0 value for the Salton Sea area was not available at the time of this analysis. Because Owens dry lakebed has conditions considered similar to conditions that may occur at Salton Sea, information from ongoing studies at Owens Lake was used to estimate emissions at Salton Sea. The Owens Lake mean z_0 of 0.000462 meters (Nickling and Brown, 2001) was used to correct the Salton Sea data, using the Prandtl-von Karman equation:

$$U_{10\ meters} = [u^*/K] \text{ x 1n } [(10 \text{ meters})/z_0 \text{ meters})]$$

where K is a dimensionless constant = 0.4 and u* is the shear velocity measured by DRI.

[1] The height of meteorological monitoring stations above ground surface is designated in metric units. Ten meters is about 32.8 feet.

Once the wind speed was corrected to 10 meters, the wind speed was converted from m/s to miles per hour (mph).Finally, the emission factors, measured by DRI in the PI-SWERL tests in mg/m^2-s, were converted to tons per acre-hour (ton/ac-hr).To illustrate, a sample calculation using the PI-SWERL location A-100 is shown in Table E3-1.

Table E3-1
Sample Calculation of Correction of PI-SWERL Data to 10 meters

Given: u* = [(0.306697 m/s) and EF = (0.004262 mg/m^2 sec).

Using the formula presented above and the data from Appendix E3B for location A100-1:

$U_{10\ meters}$ = [(0.306697 m/s)/0.4] x ln [(10 meters/0.000462 meters)]

= [0.7667 m/s] x ln (2.1645 x 10^5) = 0.7667 m/s x 9.9825

= 7.654 meters/sec.

= (7.654 m/s) x (0.0006214 miles/meter) x (3600 sec/hour)

= (7.654 m/s) x 2.23692 = 17.122 miles per hour.

The emissions factor EF is similarly converted to tons/acre x hour as shown below:

EF = (0.004262 mg/m^2 sec) x(1.1023113x10^{-9} tons/mg)x(3600 sec/hr)/2.4710538x10^{-4} Ac/m^2.

= 4.262 x 10^{-3} x 0.016059 = 6.8444 x 10^{-5} tons/acre - hour.

In order to analyze the data further, the PI-SWERL emissions data for each test location were organized by wind speed at 10 meters. The spreadsheet providing this information is presented in Appendix E3C. Separate tables were generated for the September 2005 data and the January 2006 data. Organizing the data in this fashion allowed the calculation of the average, or mean, emission factor and standard deviation at each wind speed measured.

The term “stable playa” is used describe conditions where wind blown dust is least likely to occur. The term “unstable playa” is used to describe conditions where wind blown dust is more likely to occur. These conditions are defined more fully later in this report.

Based on the above calculations, the mean emission factors at wind speeds in increments of 5 mph, from 15 to 45 mph, were derived. These were the emission factors used in the emissions calculations, presented in Table E3-2, below.

Table E3-2
Average PM_{10} Emission Factors for Stable and Unstable Playa Conditions Based on DRI Measurements at the Salton Sea

Stable Playa Conditions		Unstable Playa Conditions	
$U_{10\ meters}$ (mph)	Emission Factor (Tons/acre - hour)	$U_{10\ meters}$ (mph)	Emission Factor (Tons/acre - hour)
15	7.2424 E-05	15	1.0560 E-04
20	1.0300 E-04	20	7.0425 E-04
25	3.2053 E-04	25	3.8038 E-04
30	2.0207 E-04	30	1.2238 E-03
35	9.2007 E-04	35	7.4520 E-03
40	1.9845 E-04	40	1.3353 E-02
45	7.4128 E-03	45	1.2945 E-02

Categorizing Exposed Playa Conditions

In order to apply the MacDougall Method to future conditions at the Salton Sea, it is crucial to first categorize the potential Exposed Playa based on crust formation, threshold wind velocities, land type reservoirs, wind events and rain events/humidity. These factors are discussed further in the following subsections.

Establishing Stable Crust versus Unstable Crust Conditions

The formation of a salt crust on the Exposed Playa can significantly affect wind erosion emission rates, as observed at Owens Lake (Nickling and Brown, 2001). When the crust is relatively hard, as observed in summer and fall months, the crust protects the underlying surface of soil, and remains intact, preventing particles from becoming airborne until very high wind velocities occur. During the winter and early spring months, the crust across the playa is generally softened by more frequent rains, or by lower temperatures and higher humidity. The softer crust can no longer protect the underlying surface to the same degree as the more stable crust, and particles become airborne under relatively lower wind speeds.

The ICAPCD requires that open areas have a stabilized surface in accordance with Rule 804. The Exposed Playa area would constitute an open area under the ICAPCD rules. A specific test has been established by ICAPCD for determining the presence of a stable surface (Rule 800, Appendix B). The test is commonly referred to as the “Ball Drop Test”. ICAPCD has jurisdiction over areas of the Salton Sea where playa may become exposed in the future, so the open area rules and requirements would be applicable. As part of the PI-SWERL testing completed by DRI, ball drop and/or cone penetrometer tests were conducted at the site of each PI-SWERL measurement to test crust strength and stability. During the September 2005 testing, the cone penetrometer tests indicated the playa crust was probably strong enough to pass the ball drop test (Etyemezian, 2006b), although this test was not conducted during the September sampling period. The September 2005 data were classified as representing stable surface, or playa conditions, in accordance with ICAPCD rules. When the PI-SWERL testing was completed in January of 2006, the crusts had softened, likely due to conditions of higher humidity and lower temperatures, and in most cases, the crust was not strong enough to pass the ball drop test. The January 2006 test data were therefore considered representative of unstable surfaces as defined by ICAPCD.

For purposes of estimating particulate emissions using the MacDougall Method tool and modeling process, it was assumed that for the months April through November, Exposed Playa is in a stable crust condition. For the remaining four months (December, January, February and March), the Exposed Playa is assumed to be in an unstable crust condition. These assumptions were based on the DRI September 2005 and January 2006 PI-SWERL data, as well as observations by local residents of the area, who reported differences in the appearance of the salt crust during the early spring (Etyemezian, 2006). Visitors to the Salton Sea in January reported that the salt crust appeared “soft” and “puffy”, indicating that the playa was in an unstable condition (Dickey, 2006). Anecdotal observations of crust conditions in late March indicated that crusts appeared “harder” and more stable than in January 2006.

Identifying Threshold Wind Velocities

Particles become airborne when the wind speed at the land surface reaches a velocity which allows the particles to become loosened from the underlying materials. This is referred to as the “threshold wind velocity”. For purposes of this analysis, a wind event was defined as the time period when winds reach the threshold wind velocities, separated by at least a day before a new wind event is defined. Based on the PI-SWERL data collected at all sites in September 2005 and January 2006, the average emission factors were divided into “brackets” of wind speed velocities, as shown in Table E3-3. The lower number in this “bracket” was taken to represent the wind velocity “threshold”. At each higher wind speed threshold, emission rates increased for Exposed Playa. Emissions were also calculated differently depending on whether the wind event occurred during a “stable crust condition” month (April through November), or during one of the remaining four “unstable crust condition” months. Based on Owens Lake methodologies and assumptions approved by EPA Region 9 for the Imperial County fugitive dust emissions inventory, conservative best estimates were used to assume duration of emissivity under stable and unstable conditions. If the playa was assumed to be in a stable crust condition, only the first hour of each wind event exceeding the designated threshold of 25 mph was considered. If the playa was assumed to be in an unstable condition, the total number of hours that each wind event exceeded the designated threshold of 15 mph was considered. This is discussed further in the next subsection.

Table E3-3
PM_{10} Derived Emission Factors Based on Wind Data from the Niland Weather Station

	Months with Stable Playa Conditions			Months with Unstable Playa Conditions		
$U_{10\ meter}$ Increment (mph)	Year 2002 Total Event Hours Niland Station	Emission Factor (Tons/acre - hour)	Emission Factor (Tons/acre)	Year 2002 Total Event Hours Niland Station	Emission Factor (Tons/acre - hour)	Emission Factor (Tons/acre)
15 - 20	—	7.2424 E-05	0	93	1.0560 E-04	9.82 E-03
20 - 25	—	1.0300 E-04	0	67	7.0425 E-04	4.72 E-02
25 - 30	16	3.2053 E-04	5.13 E-03	19	3.8038 E-04	7.23 E-03
30 - 35	3	2.0207 E-04	6.06 E-04	1	1.2238 E-03	1.22 E-03
35 - 40	0	9.2007 E-04	0	0	7.4520 E-03	0
40 - 45	0	1.9845 E-04	0	0	1.3353 E-02	0
45 - 50	0	7.4128 E-03	0	0	1.2945 E-02	0
		TOTAL	**5.74 E-03**		**TOTAL**	**6.55 E-02**
TOTAL (STABLE PLUS UNSTABLE) EMISSION FACTOR (tons/acre):						**7.12 E-02**

For stable conditions, the threshold velocity of 25 mph was derived by observing the data presented in Appendix E3C. These data show that no emissions were measured until the wind speed attained 17 mph. Even at 17 mph, emissions were not observed in all samples, and emissions that were measured were low. Higher and more consistent emissions were observed as the wind speeds reached and exceeded 25 mph, therefore this value was selected as the threshold for stable playa.

For unstable playa, the January PI-SWERL data indicated no emissions would occur at wind speeds below 15-17 mph, however the emission factors increase at wind speeds of 17 mph and above, at a much higher rate than emissions observed for stable playa. For example, for stable playa, the emission factor at 30 mph was 2.0207×10^{-04} tons/acre-hour, whereas for unstable playa, the emission factor was much higher (1.2238×10^{-03} tons/acre-hour). Above 30 mph, emissions increased at a rapid rate. Emissions for unstable playa were always observed to be greater than for stable playa, except at very high wind speeds (i.e., greater than 55 mph). Wind speeds above 35 mph were not found in the meteorological data set, and as a result, issues associated with emissions under high wind speed conditions were not encountered.

In summary, it was assumed that for stable crust conditions, playa became emissive at wind speeds of 25 mph. For unstable crust conditions, it was assumed that playa became emissive at wind speeds of 15 mph.

Estimating Land Type Reservoirs and Wind Events

Different land types have different soil characteristics and different tendencies to release particulate matter that may become airborne. The particulates below surface that are available to become airborne under high wind conditions are described as a reservoir. Vacant land does not have an endless reserve of fugitive dust. Depending on whether the vacant land is undisturbed or has been disturbed by vehicles or other mechanisms, the vacant land will have loose soil particles on the surface. Once the wind begins to blow at a rate sufficient to entrain loose soils and blown them away, the same area of land has no remaining particulate matter to emit because the soil particles are too large and too heavy to become airborne. The emission of particles is attributed to the piece of land from which they were emitted. Particles already emitted from other pieces of land will continue to move with the wind and cross several other pieces of land before coming to rest. A particulate reservoir must be assumed for each land type. Some soils have a high percentage of silt or small particles and the reservoir of small particles is quite large; other soils are more gravelly and the reservoir of airborne particles is very small.

Generally, land that has a stable crust or a very shallow reservoir will emit most of the available particulate matter within the first hour after winds exceed the threshold velocity. Land that has an unstable crust is typically indicative of a deeper reservoir that will continue to emit particulate matter for several hours, generally as long as wind speeds exceed the threshold velocity.

As noted in the Owens Lake wind tunnel studies (Nickling and Brown, 2001), the Exposed Playa will form a crust. Available temperature and humidity data supported the assumption that December, January, February, and March would be months when unstable crusts are present, and April through November would be months having stable crust conditions. When stable crust conditions are present, the MacDougall Method assumes that the land is emissive only during the first hour of each wind event. When unstable crust conditions are present, the MacDougall Method assumes that the land is emissive during the entire wind event, whenever wind speeds exceed the threshold velocity. A wind event, as defined above, occurs during periods where wind speeds exceeded 25 mph under stable crust conditions, or 15 mph under unstable crust conditions.

Evaluating Rain and Humidity Events

Salt crusts present on saline playas are known to absorb moisture from the air when the relative humidity is high and the temperature is relatively low, particularly after wintertime precipitation events. This absorbed moisture softens the salt crust, causing the surface to become more emissive. This is just the opposite of what one would expect under non-saline soil conditions.

The MacDougall Method assumes that while measurable rain (greater than 0.01 inches) is occurring, the soils are not emissive. For soils without a salt crust, the method assumes that enough moisture will be retained in the soil to keep the soil stable for at least one day after the rain event. For soils with a salt crust, the number of days after a rain event during which the land is considered emissive is adjusted based on temperature. If the temperature remains below 60 °F, the area is considered not crusted for five days after the measurable rainfall, and then weakly crusted thereafter. If temperatures are above 60 °F, the area is considered non-emissive the day of the rain event and the first day following the rain event, and durably crusted thereafter. Durably crusted soil passes the ball drop test and weakly crusted soil does not.

There are no precipitation data available from either of the two meteorological stations that were used for wind data at the Salton Sea; namely at the weather stations at Indio and Niland. Precipitation data were available at other weather stations, such as the CIMIS stations at Calipatria, CA (on the south side of the Salton Sea) and at Oasis, CA (on the northwest side of the Salton Sea, nearest the Indio weather station).

For the Calipatria data, of the 10 different days in 2002 on which measurable rainfall was recorded, only two of those events occurred during the four months in which the soil was considered emissive (December, January, February and March). On the January 25, 2002 event, only 0.01 inch of rain was measured during just one hour. The temperature at the time was 43.3°F; however, the temperature rose to over 60°F later that same day. For the March 22, 2002 event, only 0.01 inch of rain was recorded during just one hour and the temperature at the time was 83°F. Thus, the MacDougall Method considered the soil as emissive for the day of the rainfall plus the next day only.

Examination of the Oasis precipitation data for the same days indicated that no rain was measured at all on either of those two days. Rainfall in the Salton Sea is apparently very localized. In addition, the Oasis data indicated daily measured rainfall virtually every day from August 1 through September 27, 2002, with little to no corresponding decrease in solar radiation. The data indicated that the weather station was probably measuring drift from irrigation spraying, because the hour interval for which during which the precipitation was recorded was the same for virtually every day.

It was decided to not consider individual precipitation events or humidity as factors in the MacDougall Method at this time, due to the lack of reliable precipitation data, the limited number of annual precipitation events that might reduce emissivity, the lack of consistency of rain events over the entire Salton Sea, and the limited available information on the relationships of precipitation and humidity to potential emissivity of Exposed Playa at the Salton Sea.

Calculation of Total Event Hours

As discussed above, for each wind event that occurs during the months of April through November, when playa conditions have been assumed to be stable, only the first hour during which the wind speed exceeded the threshold velocity of 25 mph was considered as a wind event. During the winter months of December through March, when playa conditions have been assumed to be unstable, the total number of hours during which the wind exceeded the threshold wind speed of 15 mph was considered as a wind event.

The total number of event hours was calculated by summing up all the hours within the calendar year that constituted a wind event. Total event hours for each of the two meteorological stations were calculated.

Calculation of Overall Emissions Factor for Exposed Playa

As discussed in the previous subsection, the total number of event hours for each of the 5 mph increments was determined. The total number of event hours were then multiplied by the emission factor for that wind increment. Care was taken in sorting the hourly wind speed data by considering only those wind speeds within the 5 mph increment, so that no double-counting of a wind speed data point could occur for more than one increment.

No wind speeds reported for the Indio meteorological station exceeded the 15 mph threshold during months when playa have been assumed to be unstable, and no reported data exceeded the 25 mph threshold during the months when the playa have been assumed to be under stable conditions. Therefore, under these assumptions, no emissions were predicted for the northern portions of the Salton Sea represented by the Indio meteorological station data. As a result, all predicted emissions would result from exposed acres in the southern portion of the Sea, represented by the Niland meteorological station data.

Table E3-3 lists the total event hours for the Niland station, the incremental emission factors in tons/acre-hour, and the emission factors in tons/acre which were derived from multiplying the total event hours by the emissions factor for each increment of wind speed. The total emission factor (tons/acre) is the sum of the individual incremental emission factors.

PLAYA EMISSIONS ESTIMATES

Determining Areas of Exposed Playa

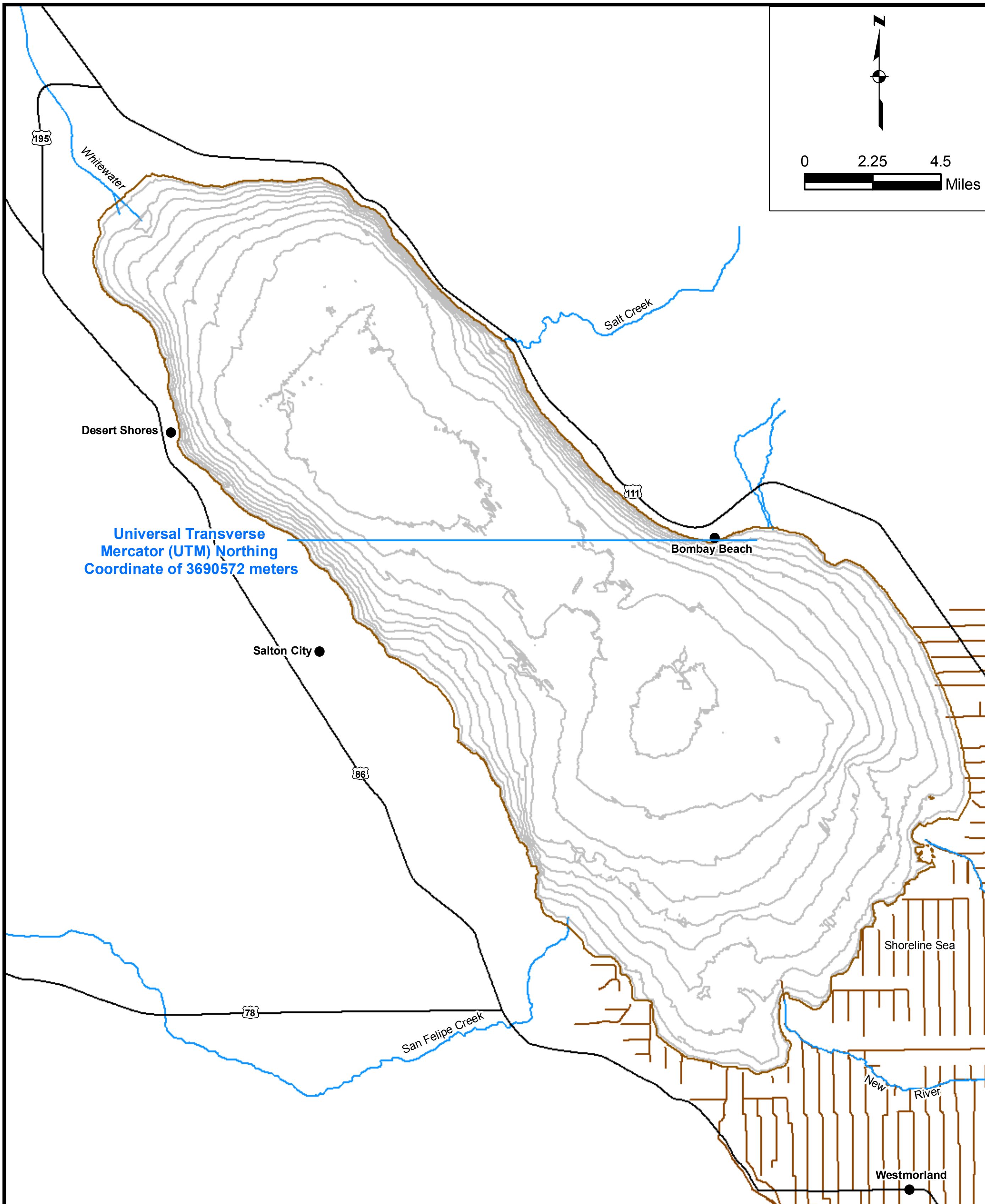
Results from modeling of the water resources available under each alternative were used to predict acres of Exposed Playa area under the various alternatives and phases analyzed in the PEIR. To support the emissions calculations, the total Exposed Playa Area predicted for each alternative was hypothetically divided into north and south portions, by estimating the area north or south of a line corresponding to the Universal Transverse Mercator (UTM) northing coordinate of 3690572 meters. (From the eastern Salton Sea shoreline at Bombay Beach, this line runs east to a point midway between Desert Shores and Salton City on the western shoreline, see Figure E3-1.) The meteorological data from Indio in the north and Niland in the south were used to support the calculations for the north and south portions of the Exposed Playa, respectively. Each acre of Exposed Playa estimated for each alternative was classified as either stable or unstable based on the months of the year during which wind events occurred. Once the emission factors were developed, and the total number of event hours calculated from the respective meteorological data, the number of acres in each stability category was multiplied by the appropriate emissions factor and by the number of emissive event hours.

Based on GIS mapping data, the total area of the Salton Sea was measured and is shown in Table E3-4. A breakdown of the acreages was performed based on the hypothetical division of the Salton Sea into northern and southern portions. The meteorological data for the Niland data were used to estimate emissions for the area of the Salton Sea south of the UTM northing coordinate of 3690572 meters. The data from the Niland station indicate wind speeds exceeded 35 mph at times during 2002 and the predominant wind direction was from the west. As stated in the previous subsection, no emissions were predicted for the northern portions of the Salton Sea represented by the Indio meteorological station.

Table E3-4
Measured Acreage of the Southern and Northern Portions of the Salton Sea

Location	Surface Area (km^2)	Surface Area (acres)
Southern Portion of Salton Sea	591	146,000
Northern Portion of Salton Sea	348	86,000
Total Area of Salton Sea	939	232,000

The United States Geological Survey (USGS) personnel have completed an analysis of winds measured around the Salton Sea. Wind speeds and directions collected at 10 meters at California Air Resources Board sites and wind speed and direction collected at 2 meters at CIMIS sites were used in the analysis (Chavez, 2006). While 2 meter wind data cannot be directly compared with 10 meter wind data, the USGS analysis confirmed that higher wind speeds occur in the southern Salton Sea area. The USGS data also showed that the wind speed and direction in the southwest portion of the Salton Sea were very similar to that in the southeast portion of the Salton Sea. For this reason, although 10 meter wind data were available from a meteorological station in Westmoreland, the Niland data were used for the entire southern portion of the sea. The Niland station was closer to the Salton Sea, and measurements for Niland have been reported to be more representative of wind conditions at the Salton Sea.



LEGEND

- ● Towns and Cities
- Highways
- Rivers/Streams

FIGURE E3-1
HYPOTHETICAL LINE USED TO DIVIDE NORTH AND SOUTH PORTIONS OF THE SALTON SEA TO SUPPORT PLAYA DUST EMISSIONS CALCULATIONS

SAC \\GLACIER\SACGIS\SALTON_SEA\GIS\MXDS\AIR_QUALITY\FIGUREE3-1_NORTH_SOUTH_LIINE.MXD FIGUREE3-1_NORTH_SOUTH_LIINE.PDF 6/28/2006 15:05:13

Determining Types and Acres of Exposed Playa Based on Alternatives and Phases

The PEIR evaluates environmental impacts and benefits for eight alternatives. In addition, the no action alternative must be considered under CEQA.

For purposes of the PEIR, the following assumptions form the basis of the air quality impact analysis for Exposed Playa:

- A monitoring program would be established to determine emissivity of the playa as water recedes;
- Based on experience in similar environments, it is expected that a substantial portion of Exposed Playa would not be emissive and would be transitioned to long term monitoring. If monitoring later determines that an area has become emissive, it would be subject to control measures;
- Portions of the Exposed Playa would be emissive; and these emissive conditions may be seasonal;
- Emissive areas would be stabilized by one or more methods, such as water-efficient vegetation, surface wetting, or dry measures, such as gravel cover. A range of dust control measures have been and would continue to be evaluated, until significant questions regarding dust control on Salton Sea playa have been resolved. Measures requiring little or no water would be preferred, due to the many competing needs for water. No options would be eliminated from consideration unless proven infeasible or ineffective. Implemented controls would be monitored for their effectiveness and adaptively managed;
- If control is needed, water-based control measures, such as water-efficient vegetation, would be implemented on up to 50 percent of the Exposed Playa area. For each alternative, the Exposed Playa area is defined as the area exposed above the high water level of the Brine Sink at its lowest elevation in Phase IV; and
- Other Exposed Playa area would either be non-emissive or controlled by other means. For the purposes of the PEIR, it has been assumed that 30 percent of the Exposed Playa area under each alternative would be nonemissive. If emissive, the remaining Exposed Playa area would employ other dust control measures (other Air Quality Management), such as stabilization with brine, chemical stabilization, gravel, or some other method from the open “tool box.”

These assumptions are further discussed and documented in Appendix H-3 to the PEIR.

Results from modeling of the water resources available under each alternative were used to predict acres of Exposed Playa area under the various alternatives and phases analyzed in the PEIR.

The total exposed acreages for each of the alternatives have been assigned to three types of exposed acres to allow emissions estimation. These types of exposed acres are nonemissive, acres assumed to implement water efficient vegetation, and acres assumed to implement Other Air Quality Management. Two of the alternatives, Alternatives 4 and 7, have exposed areas without identified control measures, and for the purposes of emissions estimation, these acres have been assumed to be “uncontrolled”. Alternative 7 also has an area designated as Protective Salt Flat.

The number of acres in each of these categories were evaluated for each of the alternatives, during two future phases: Phase I (2006-2020) and Phase IV (2040-2078). Phases II and III were not analyzed at this time, because analysis of the early and late phases provided "book ends" to the range of playa emissions that might be expected over time, under each alternative.

Table E3-5 presents the acreages that would be exposed in the northern and southern portions of the Salton Sea, and the total acreages exposed, for each alternative during both Phases I and IV. This table also includes the acreages that would be exposed above -235 feet msl and below -249 feet msl in the No Action Alternative, under CEQA and Variability Conditions. In the table, these acreages are designated as "Landowners Responsible" areas, because compliance with applicable local regulations for dust control would be the responsibility of the landowners. These acreages are not included in the analysis of impacts of the No Action Alternative, because they would be exposed by projects not related to the Quantification Settlement Agreement.

Table E3-6 presents the northern and southern acreages that would be exposed in Phase I, as assigned to each type of exposed acres. Table E3-7 presents the northern and southern acreages that would be exposed in Phase IV, as assigned to each type of exposed acres. The northern acreages are reported for informational purposes only because emissions were not calculated for the northern area, based on the assumptions used in this analysis (see above subsection, Calculation of Overall Emissions Factor for Exposed Playa).

Assumptions Summary / Calculating Playa Emissions for Each Alternative and Phase

The following assumptions, described in detail in the previous subsections, were applied to the calculation of emissions for each alternative and each phase year:

- Indio meteorological station wind data are representative of the northern Salton Sea area;
- Niland meteorological station wind data are representative of the southern Salton Sea area;
- Playa exhibits stable crust conditions eight months of the year (April through November),
- Playa exhibits unstable crust conditions four months of the year (December, January, February, and March);
- Stable playa becomes emissive at a wind speed velocity threshold of 25 mph;
- Unstable playa becomes emissive at a wind speed velocity threshold of 15 mph;
- Stable playa is only considered emissive during the first hour of each wind event within a 24 hour period; and
- Unstable playa is considered to be emissive throughout an entire wind event.

As indicated previously, no wind speeds reported for the Indio meteorological station exceeded the 15 mph threshold during months when playa have been assumed to be unstable, and no reported data exceeded the 25 mph threshold during the months when the playa have been assumed to be under stable conditions. Therefore, under these assumptions, no emissions were predicted for Exposed Playa in the northern portions of the Sea Bed, represented by Indio meteorological station data. As a result, all predicted emissions would result from Exposed Playa in the southern portion of the Sea Bed, represented by the Niland meteorological station data.

Table E3-5
Summary of North, South, and Total Exposed Playa Areas by Alternative (Acres)

Alternatives	Phase I (Existing-2020) North Sea South Sea Total Sea	Phase II (2020-2030) North Sea South Sea Total Sea	Phase III (2030-2040) North Sea South Sea Total Sea	Phase IV (2040-2078) North Sea South Sea Total Sea	Comments
No Action Alternative–CEQA Conditions	800 3,200 4,000	—	—	9,400 37,600 47,000	Assumes 20 percent of the total exposed area is in the north portion and 80 percent in the south portion of the Salton Sea.
No Action Alternative–CEQA Conditions, Areas Considered Landowners' Responsibility	4,800 11,200 16,000	—	—	5,800 13,000 18,800	Assumes 31 percent of the total exposed area is in the north portion and 69 percent in the south portion of the Salton Sea.
No Action Alternative–Variability Conditions	1,000 3,000 4,000	—	—	11,280 35,720 47,000	Assumes 24 percent of the total exposed area is in the north portion and 76 percent in the south portion of the Salton Sea.
No Action Alternative–Variability Conditions, Areas Considered Landowners' Responsibility	4,800 11,200 16,000	—	—	12,240 38,760 51,000	Assumes 29 percent of the total exposed area is in the north portion and 71 percent in the south portion of the Salton Sea.
Alternative 1 – Saline Habitat Complex I	12,000 18,000 83,000	—	—	33,200 49,800 83,000	Assumes 40 percent of the total exposed area is in the north portion and 60 percent in the south portion of the Salton Sea.
Alternative 2 – Saline Habitat Complex II	10,800 19,200 30,000	—	—	33,000 58,000 91,000	Assumes 36 percent of the total exposed area is in the north portion and 64 percent in the south portion of the Salton Sea.
Alternative 3 – Concentric Rings	4,000 8,000 12,000	—	—	42,000 84,000 126,000	Assumes 33 percent of the total exposed area is in the north portion and 67 percent in the south portion of the Salton Sea.
Alternative 4 – Concentric Lakes	5,800 10,200 16,000	—	—	46,100 81,900 128,000	Assumes 36 percent of the total exposed area is in the north portion and 64 percent in the south portion of the Salton Sea.
Alternative 5 – North Sea	4,800 25,200 30,000	—	—	18,900 99,100 118,000	Assumes 16 percent of the total exposed area is in the north portion and 84 percent in the south portion of the Salton Sea.
Alternative 6 – North Sea Combined	7,500 22,500 30,000	—	—	32,800 98,200 131,000	Assumes 25 percent of the total exposed area is in the north portion and 75 percent in the south portion of the Salton Sea.

Table E3-5
Summary of North, South, and Total Exposed Playa Areas by Alternative (Acres)

Alternatives	Phase I (Existing-2020) North Sea South Sea Total Sea	Phase II (2020-2030) North Sea South Sea Total Sea	Phase III (2030-2040) North Sea South Sea Total Sea	Phase IV (2040-2078) North Sea South Sea Total Sea	Comments
Alternative 7 – Combined North & South Lakes	3,300 26,700 30,000	—	—	11,300 91,700 103,000	Assumes 11 percent of the total exposed area is in the north portion and 89 percent in the south portion of the Salton Sea.
Alternative 8 – South Sea Combined	17,000 13,000 30,000	—	—	73,000 55,000 128,000	Assumes 57 percent of the total exposed area is in the north portion and 43 percent in the south portion of the Salton Sea.

Table E3-6
Types of Exposed Playa Areas by Alternative for Phase I (Acres)

Alternatives	Total Acres North Sea South Sea Total Sea	Nonemissive North Sea South Sea Total Sea	Water Efficient Vegetation North Sea South Sea Total Sea	Other Air Quality Management North Sea South Sea Total Sea	Uncontrolled North Sea South Sea Total Sea	Protective Salt Flat North Sea South Sea Total Sea	Comments
No Action Alternative–CEQA Conditions	800 3,200 4,000	200 800 1,000	400 1,600 2,000	200 800 1,000	—	—	Assumes 30 percent Nonemissive, 50 percent Water Efficient Vegetation, & 20 percent Other Air Quality Management
No Action Alternative–CEQA Conditions, Areas Considered Landowners' Responsibility	4,800 11,200 16,000	1,488 3,312 4,800	—	3,472 7,728 11,200	—	—	Assumes 30 percent Nonemissive, & 70 percent Other Air Quality Management
No Action Alternative–Variability Conditions	1,000 3,000 4,000	240 760 1,000	480 1,520 2,000	240 760 1,000	—	—	Assumes 30 percent Nonemissive, 50 percent Water Efficient Vegetation, & 20 percent Other Air Quality Management
No Action Alternative–Variability Conditions, Areas Considered Landowners' Responsibility	4,800 11,200 16,000	1,488 3,312 4,800	—	3,472 7,728 11,200	—	—	Assumes 30 percent Nonemissive, & 70 percent Other Air Quality Management
Alternative 1 – Saline Habitat Complex I	12,000 18,000 83,000	3,600 5,400 9,000	6,000 9,000 15,000	2,400 3,600 6,000	—	—	Assumes 30 percent Nonemissive, 50 percent Water Efficient Vegetation, & 20 percent Other Air Quality Management
Alternative 2 – Saline Habitat Complex II	10,800 19,200 30,000	3,240 5,760 9,000	5,400 9,600 15,000	2,160 3,840 6,000	—	—	Assumes 30 percent Nonemissive, 50 percent Water Efficient Vegetation, & 20 percent Other Air Quality Management

Table E3-6
Types of Exposed Playa Areas by Alternative for Phase I (Acres)

Alternatives	Total Acres North Sea South Sea Total Sea	Nonemissive North Sea South Sea Total Sea	Water Efficient Vegetation North Sea South Sea Total Sea	Other Air Quality Management North Sea South Sea Total Sea	Uncontrolled North Sea South Sea Total Sea	Protective Salt Flat North Sea South Sea Total Sea	Comments
Alternative 3 – Concentric Rings	4,000 8,000 12,000	1,320 2,680 4,000	1,980 4,020 6,000	660 1,340 2,000	—	—	Assumes 30 percent Nonemissive, 50 percent Water Efficient Vegetation, & 20 percent Other Air Quality Management
Alternative 4 – Concentric Lakes	5,800 10,200 16,000	1,800 3,200 5,000	—	—	3,960 7,040 11,000	—	Assumes 30 percent Nonemissive and 70 percent With No Control (Uncontrolled). If long term irrigation facilities were included in this alternative for 35 percent of the area, the area with No Control would be reduced to 35 percent
Alternative 5 – North Sea	4,800 25,200 30,000	1,440 7,560 9,000	2,400 12,600 15,000	960 5,040 6,000	—	—	Assumes 30 percent Nonemissive, 50 percent Water Efficient Vegetation, & 20 percent Other Air Quality Management
Alternative 6 – North Sea Combined	7,500 22,500 30,000	2,250 6.750 9,000	3,750 11,250 15,000	1,500 4,500 6,000	—	—	Assumes 30 percent Nonemissive, 50 percent Water Efficient Vegetation, & 20 percent Other Air Quality Management
Alternative 7 – Combined North & South Lakes	3,300 26,700 30,000	990 8,010 9,000	—	—	2,310 18,690 21,000	0 0 0	Assumes 30 percent Nonemissive, 70 percent Uncontrolled, & 0 percent Protective Salt Flat in this Phase
Alternative 8 – South Sea Combined	17,000 13,000 30,000	5,130 3,870 9,000	8,550 6,450 15,000	3,420 2,580 6,000	—	—	Assumes 30 percent Nonemissive, 50 percent Water Efficient Vegetation, & 20 percent Other Air Quality Management

Table E3-7
Types of Exposed Playa Areas by Alternative for Phase IV (Acres)

Alternatives	Total Acres North Sea South Sea Total Sea	Nonemissive North Sea South Sea Total Sea	Water Efficient Vegetation North Sea South Sea Total Sea	Other Air Quality Management North Sea South Sea Total Sea	Uncontrolled North Sea South Sea Total Sea	Protective Salt Flat North Sea South Sea Total Sea
No Action Alternative–CEQA Conditions	9,400 37,600 47,000	2,800 11,200 14,000	4,800 19,200 24,000	1,800 7,200 9,000	—	—
No Action Alternative–CEQA Conditions, Areas Considered Landowners' Responsibility	5,800 13,000 18,800	1,740 3,900 5,640	—	4,060 9,100 13,160	—	—
No Action Alternative–Variability Conditions	11,280 35,720 47,000	3,360 10,640 14,000	5,760 18,240 24,000	2,160 6,840 9,000	—	—
No Action Alternative–Variability Conditions, Areas Considered Landowners' Responsibility	15,000 36,000 51,000	4,500 10,800 15,300	—	10,500 25,200 35,700	—	—
Alternative 1 – Saline Habitat Complex I	33,200 49,800 83,000	10,000 15,000 25,000	16,400 24,600 41,000	6,800 10,200 17,000	—	—
Alternative 2 – Saline Habitat Complex II	33,000 58,000 91,000	9,720 17,280 27,000	16,560 29,440 46,000	6,480 11,520 18,000	—	—
Alternative 3 – Concentric Rings	42,000 84,000 126,000	12,540 25,460 38,000	20,790 42,210 63,000	8,250 16,750 25,000	—	—
Alternative 4 – Concentric Lakes*	46,100 81,900 128,000	13,680 24,320 38,000	—	—	32,400 57,600 90,000	—
Alternative 5 – North Sea	18,900 99,100 118,000	5,600 29,400 35,000	9,440 49,560 59,000	3,840 20,160 24,000	—	—

Table E3-7
Types of Exposed Playa Areas by Alternative for Phase IV (Acres)

Alternatives	Total Acres North Sea South Sea Total Sea	Nonemissive North Sea South Sea Total Sea	Water Efficient Vegetation North Sea South Sea Total Sea	Other Air Quality Management North Sea South Sea Total Sea	Uncontrolled North Sea South Sea Total Sea	Protective Salt Flat North Sea South Sea Total Sea
Alternative 6 – North Sea Combined	32,800 98,200 131,000	9,750 29,250 39,000	16,500 49,500 66,000	6,500 19,500 26,000	—	—
Alternative 7 – Combined North & South Lakes	11,300 91,700 103,000	1,320 10,680 12,000	—	—	3,080 24,920 28,000	3,000 60,000 63,000
Alternative 8 – South Sea Combined	73,000 55,000 128,000	21,660 16,340 38,000	36,480 27,520 64,000	14,820 11,180 26,000	—	—

* If long term irrigation facilities were included in this alternative, the uncontrolled area would be reduced and the irrigated vegetation would be increased.

To estimate fugitive dust emissions associated with Exposed Playa areas after implementation of Air Quality Management, the following control measures were assumed:

- 30 percent of Exposed Playa area would not be emissive (nonemissive);
- 50 percent would use Air Quality Management such as water efficient vegetation; and
- 20 percent would use Other Air Quality Management measures.

For each alternative except 4 and 7, the total acres were divided into these three categories: nonemissive, water efficient vegetation, and Other Air Quality Management. For alternatives 4 and 7, it was assumed 30 percent of the Exposed Playa area without any control measures identified was non-emissive and 70 percent was uncontrolled. Alternative 7 also has an area designated as Protective Salt Flat.

Assumptions were also made for the control efficiencies that might be achieved for the various types of control measures. These assumptions include many sources of uncertainty, and project-level analyses would need to develop additional information on the actual control efficiencies that would be achieved in practice. For the purposes of the PEIR, the assumed efficiencies were used consistently in analysis of the alternatives to allow comparison and evaluation of the resulting emission estimates.

Nonemissive areas were assumed to be 100 percent controlled. Water efficient vegetation was assumed to have a control efficiency of 95 percent, and Other Air Quality Management was assumed to have a control efficiency of 85 percent. Protective Salt Flat was also assumed to have a control efficiency of 85 percent. For areas with no identified control measures, emissions were assumed to be uncontrolled (0 percent control efficiency).

Results

Table E3-8 presents the emission estimates predicted by the MacDougall Method for each alternative in Phase I (2006-2020) without implementation of control measures and Air Quality Management, referred to as “uncontrolled” emissions. Table E3-9 presents the uncontrolled emission estimates for each alternative in Phase IV (2040-2078). Table E3-10 presents the predicted emissions for Phase I, after implementation of control measures and Air Quality Management, applying the control efficiencies described above for each type of exposed area. Emissions estimates that take into account the assumed control measures and control efficiencies are referred to as “controlled” emissions. Table E3-11 presents the controlled emissions for Phase IV.

As required under local air district regulations and requirements, landowners would implement dust control for any exposed areas outside of the study area that should become emissive (e.g., any areas above -235 feet mean sea level (msl) or below -249 feet msl in the No Action Alternative). Dust control measures implemented by landowners would not likely be 100 percent effective in reducing fugitive dust emissions from these exposed areas, resulting in additional emissions not covered by the IID Water Conservation and Transfer Project Mitigation Monitoring and Reporting Plan or the alternatives. In Tables E3-8 and E3-9, “uncontrolled” emissions estimated for those areas designated as “Landowners’ Responsibility” represent emissions before control, and therefore do not reflect emissions reductions that would be achieved with implementation of dust control measures by landowners. “Controlled” emissions have also been estimated for these “Landowners’ Responsibility” areas, as presented in Tables E3-10 and E3-11, assuming levels of control similar to those assumed for the alternatives.

In each case, emissions were estimated in tons per year. These emissions rates were averaged over 365 days per year, and the reported values in pounds per day (lbs/day) represent annual average daily emissions. Peak daily emissions would be expected to be much higher when unstable conditions and wind events occur.

The Excel spreadsheet used to calculate each of the above emission estimates is presented in Appendix E3D.

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Table E3-8
Predicted PM_{10} Emissions from Exposed Playa Areas Without Implementation of Control Measures by Alternative for Phase I (tons/year)*

Alternatives	Nonemissive	Water Efficient Vegetation	Other Air Quality Management	Uncontrolled	Protective Salt Flat	Uncontrolled Emissions (tons/year)	Uncontrolled Emissions (lbs/day)*
No Action Alternative–CEQA Conditions	57	114	57	—	—	228	1,248
No Action Alternative–CEQA Conditions, Areas Considered Landowners' Responsibility	236	—	550	—	—	786	4,307
No Action Alternative–Variability Conditions	54	108	54	—	—	216	1,186
No Action Alternative–Variability Conditions, Areas Considered Landowners' Responsibility	236	—	550	—	—	786	4,307
Alternative 1 – Saline Habitat Complex I	384	641	256	—	—	1,281	7,022
Alternative 2 – Saline Habitat Complex II	410	683	273	—	—	1,367	7,490
Alternative 3 – Concentric Rings	191	286	95	—	—	572	3,136
Alternative 4 – Concentric Lakes	228	—	—	501	—	729	3,995
Alternative 5 – North Sea	538	897	359	—	—	1,794	9,830
Alternative 6 – North Sea Combined	481	801	320	—	—	1,602	8,777
Alternative 7 – Combined North & South Lakes	570	—	—	1,331	0	1,901	10,415
Alternative 8 – South Sea Combined	276	459	184	—	—	918	5,032

* Emissions were estimated in tons per year. These emissions rates were averaged over 365 days per year, and the reported values in pounds per day (lbs/day) represent annual average daily emissions. Peak daily emissions would be expected to be much higher when unstable conditions and wind events occur.

Table E3-9
Predicted PM_{10} Emissions from Exposed Playa Areas Without Implementation of Control Measures by Alternative for Phase IV (tons/year)[a]

Alternatives	Nonemissive	Water Efficient Vegetation	Other Air Quality Management	Uncontrolled	Protective Salt Flat	Uncontrolled Emissions (tons/year)	Uncontrolled Emissions (lbs/day)
No Action Alternative–CEQA Conditions	797	1,367	513	—	—	2,677	14,667
No Action Alternative–CEQA Conditions, Areas Considered Landowners' Responsibility	278	—	648	—	—	926	5,071
No Action Alternative–Variability Conditions	757	1,299	487	—	—	2,543	13,934
No Action Alternative–Variability Conditions, Areas Considered Landowners' Responsibility	769	—	1,794	—	—	2,563	14,044
Alternative 1 – Saline Habitat Complex I	1,068	1,751	726	—	—	3,545	19,426
Alternative 2 – Saline Habitat Complex II	1,230	2,096	820	—	—	4,146	22,719
Alternative 3 – Concentric Rings	1,813	3,005	1,192	—	—	6,010	32,931
Alternative 4 – Concentric Lakes[b]	1,731	—	—	4,101	—	5,832	31,956
Alternative 5 – North Sea	2,093	3,528	1,435	—	—	7,056	38,666
Alternative 6 – North Sea Combined	2,082	3,524	1,388	—	—	6,995	38,326
Alternative 7 – Combined North & South Lakes	760	—	—	1,774	4,271	6,806	37,292
Alternative 8 – South Sea Combined	1,163	1,959	796	—	—	3,918	21,471

[a] Emissions were estimated in tons per year. These emissions rates were averaged over 365 days per year, and the reported values in pounds per day (lbs/day) represent annual average daily emissions. Peak daily emissions would be expected to be much higher when unstable conditions and wind events occur.

[b] If long term irrigation facilities were included in this alternative, the uncontrolled area would be reduced and the irrigated vegetation would be increased..

Table E3-10
Predicted PM_{10} Emissions from Exposed Playa Areas After Implementation of Control Measures by Alternative for Phase I (tons/year)*

Alternatives	Nonemissive	Water Efficient Vegetation	Other Air Quality Management	Uncontrolled	Protective Salt Flat	Controlled Emissions	Controlled Emissions (lbs/day)
Control Efficiency	100%	95%	85%	0%	85%		
No Action Alternative–CEQA Conditions	0	5.7	8.5	—	—	14.2	78
No Action Alternative–CEQA Conditions, Areas Considered Landowners' Responsibility	0	—	83	—	—	83	452
No Action Alternative–Variability Conditions	0	5.4	8.1	—	—	13.5	74
No Action Alternative–Variability Conditions, Areas Considered Landowners' Responsibility	0	—	83	—	—	83	452
Alternative 1 – Saline Habitat Complex I	0	32	38	—	—	70	386
Alternative 2 – Saline Habitat Complex II	0	34	41	—	—	75	412
Alternative 3 – Concentric Rings	0	14	15	—	—	29	157
Alternative 4 – Concentric Lakes	0	—	—	501	—	501	2,746
Alternative 5 – North Sea	0	45	54	—	—	99	541
Alternative 6 – North Sea Combined	0	40	48	—	—	88	483
Alternative 7 – Combined North & South Lakes	0	—	—	1,331	0	1,331	7,291
Alternative 8 – South Sea Combined	0	23	28	—	—	51	277

* Emissions were estimated in tons per year. These emissions rates were averaged over 365 days per year, and the reported values in pounds per day (lbs/day) represent annual average daily emissions. Peak daily emissions would be expected to be much higher when unstable conditions and wind events occur.

Table E3-11
Predicted PM_{10} Emissions from Exposed Playa Areas After Implementation of Control Measures by Alternative for Phase IV (tons/year)[a]

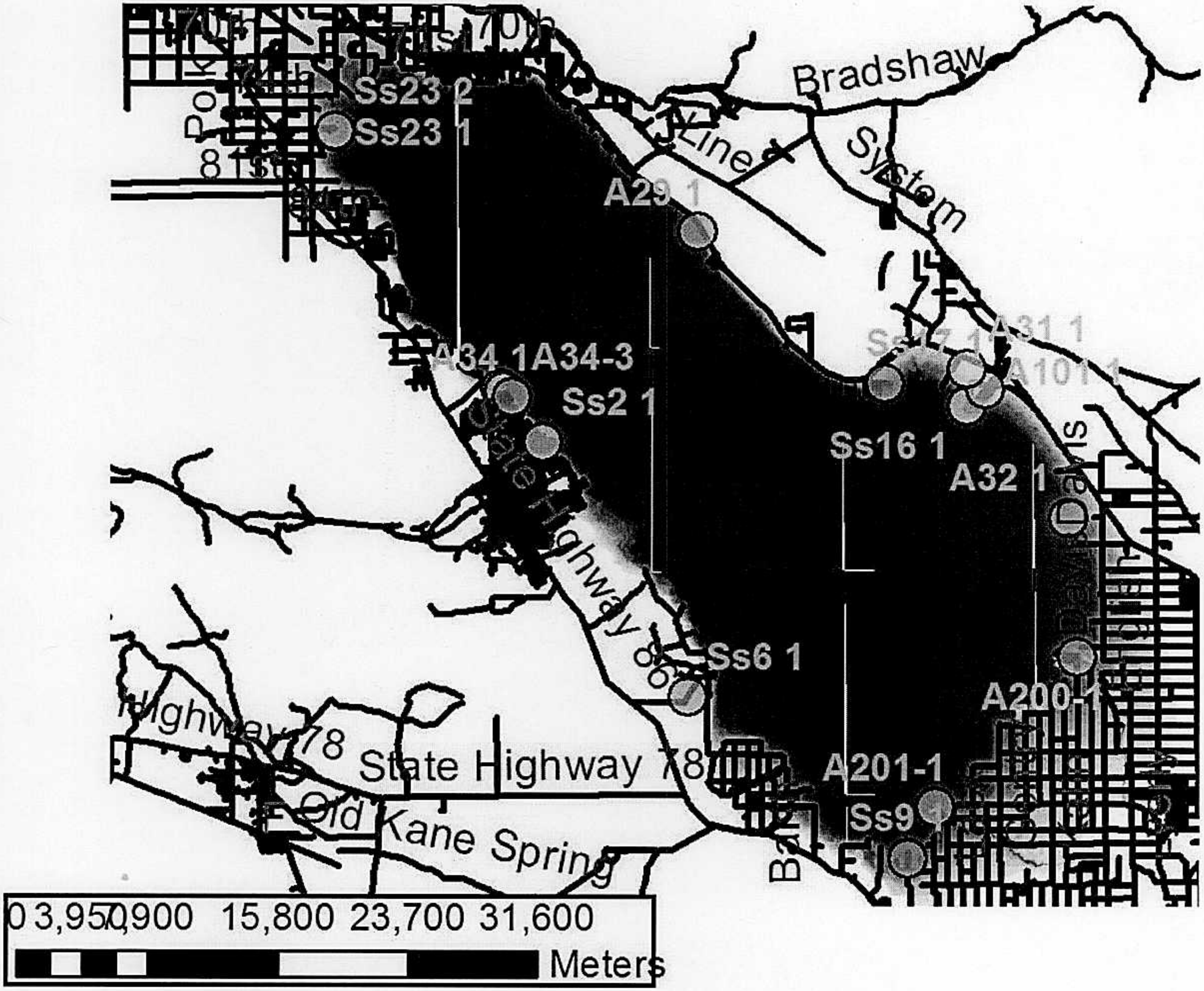
Alternatives	Non-emissive	Water Efficient Vegetation	Other Air Quality Management	Uncontrolled	Protective Salt Flat	Controlled Emissions	Controlled Emissions (lbs/day)
Control Efficiency	100%	95%	85%	0%	85%		
No Action Alternative–CEQA Conditions	0	68	77	—	—	145	796
No Action Alternative–CEQA Conditions, Areas Considered Landowners' Responsibility	0	—	97	—	—	97	532
No Action Alternative–Variability Conditions	0	65	73	—	—	138	756
No Action Alternative–Variability Conditions, Areas Considered Landowners' Responsibility	0	—	269	—	—	269	1,475
Alternative 1 – Saline Habitat Complex I	0	88	109	—	—	197	1,077
Alternative 2 – Saline Habitat Complex II	0	105	123	—	—	228	1,248
Alternative 3 – Concentric Rings	0	150	179	—	—	329	1,803
Alternative 4 – Concentric Lakes[a]	0	—	—	4,101	—	4,101	22,469
Alternative 5 – North Sea	0	176	215	—	—	391	2,146
Alternative 6 – North Sea Combined	0	176	208	—	—	384	2,106
Alternative 7 – Combined North & South Lakes	0	—	—	1,774	641	2,415	13,232
Alternative 8 – South Sea Combined	0	98	119	—	—	217	1,191

[a] Emissions were estimated in tons per year. These emissions rates were averaged over 365 days per year, and the reported values in pounds per day (lbs/day) represent annual average daily emissions. Peak daily emissions would be expected to be much higher when unstable conditions and wind events occur.

[b] If long term irrigation facilities were included in this alternative, the uncontrolled area would be reduced and the irrigated vegetation would be increased.

ATTACHMENT E3, APPENDIX A

Preliminary Draft DRI PI-SWERL Data Used in This Analysis (September 2005 and January 2006)



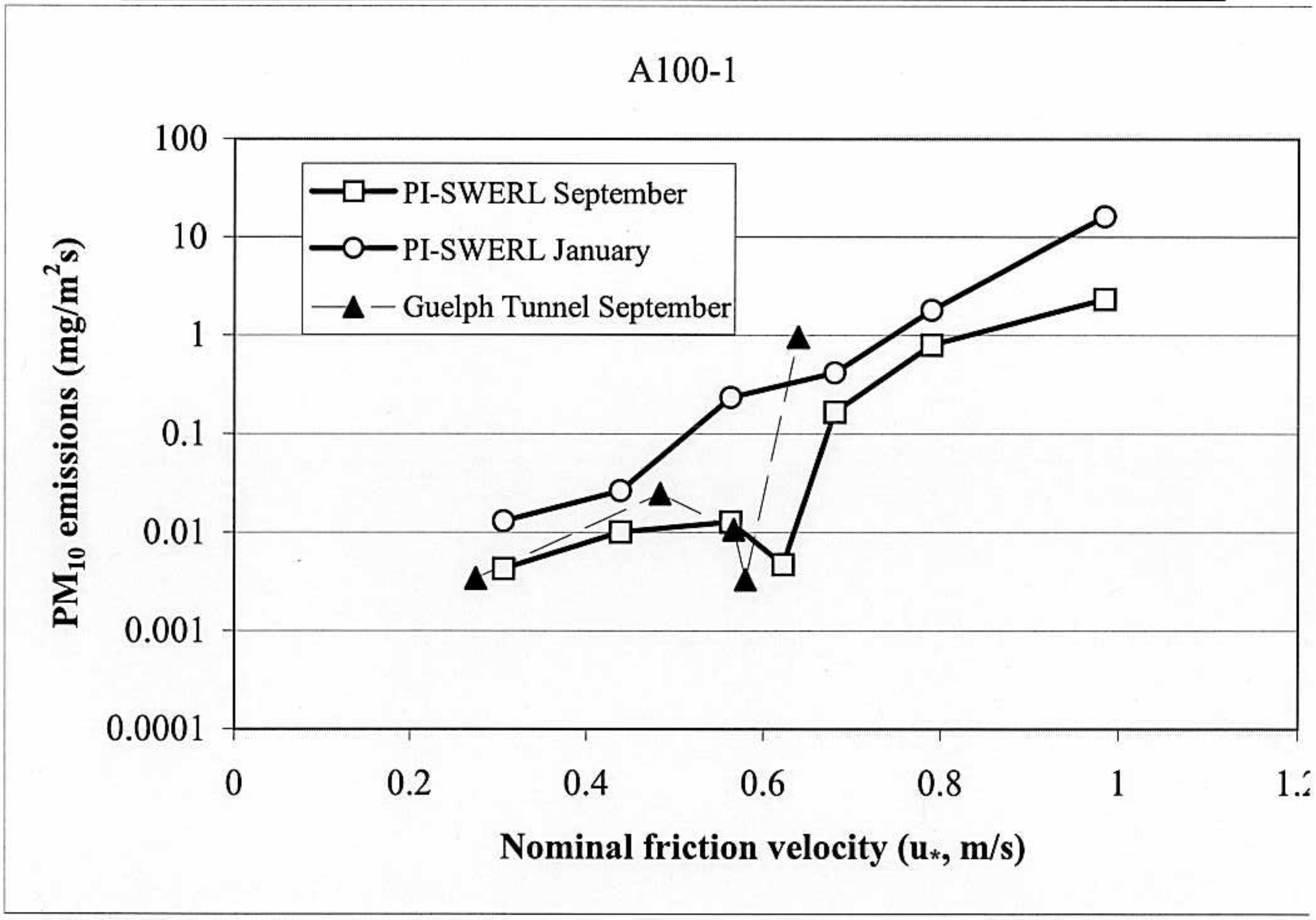
Bradshaw
Line
System
Ss23 2
Ss23 1
A29 1
A31 1
A101 1
A34 1A34-3
Ss2 1
Ss16 1
A32 1
State Highway 86
Ss6 1
A200-1
A201-1
Ss9
Highway 78
State Highway 78
Old Kane Spring
Davis
0 3,950 7,900 15,800 23,700 31,600
Meters

Site	Lat_dd	Lon_dd	WT_PI
A100 1	33.3527	-115.973	WT+PI
A100 2	33.3516	-115.971	WT+PI
A101 1	33.3502	-115.656	WT+PI
A29 1	33.4399	-115.843	PI
A31 1	33.3618	-115.667	WT+PI
A32 1	33.2781	-115.602	PI
A34 1	33.3479	-115.966	WT+PI
A34 2	33.3476	-115.966	WT+PI
Ss16 1	33.341	-115.668	WT+PI
Ss17 1	33.3542	-115.721	PI
Ss2 1	33.3231	-115.946	WT+PI
Ss23 1	33.4974	-116.08	None
Ss23 2	33.4982	-116.08	None
Ss6 1	33.1805	-115.852	PI
Ss9 1	33.0895	-115.71	PI
A34-3	33.3484	-115.965	PI
A200-1	33.2004	-115.597	PI
A201-1	33.1174	-115.691	PI

A100-1

September	PI-SWERL							
	u*	0.306697	0.438439	0.563069	0.622618	0.680271	0.789729	0.984148
	mg/m2s	0.004262	0.010071	0.012769	0.004737	0.166337	0.799438	2.333499
	Guelph Tunnel							
	u*	0.2752	0.4832	0.5664	0.58	0.6392		
	Etotal	0.003409	0.024609	0.010685	0.003303	0.95658		

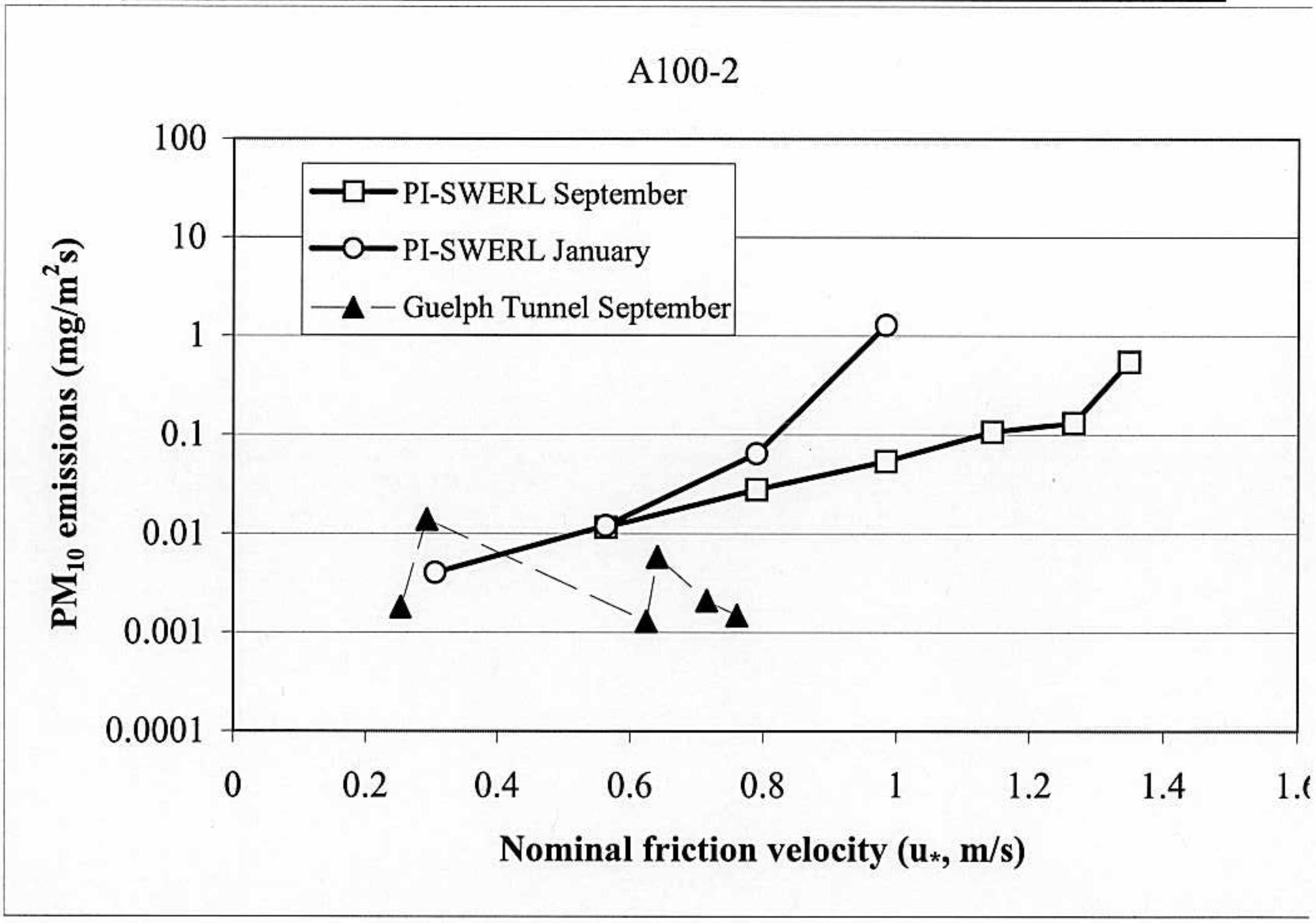
January	PI-SWERL						
	u*	0.306697	0.438439	0.563069	0.680271	0.789729	0.984148
	mg/m2s	0.012962	0.026377	0.233343	0.415108	1.802995	16.2185



A100-2

September	PI-SWERL						
	u*	0.563069	0.789729	0.984148	1.143792	1.266131	1.348631
	mg/m2s	0.011561	0.027782	0.053617	0.107075	0.131818	0.547457
	Guelph Tunnel						
	u*	0.2536	0.294	0.6244	0.6408	0.7152	0.7608
	Etotal	0.001806	0.013909	0.001299	0.005807	0.0021	0.00148

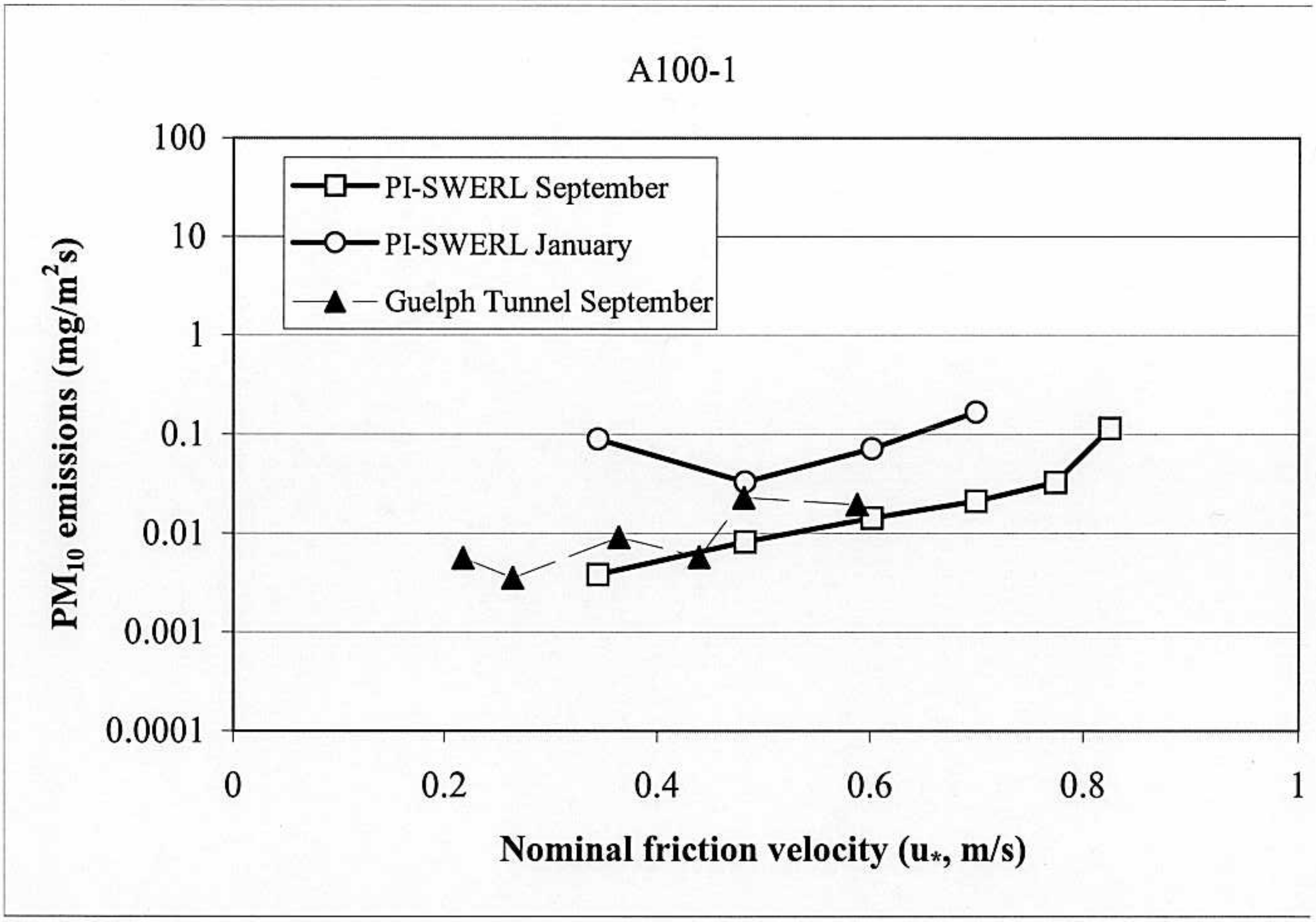
January	PI-SWERL				
	u*	0.306697	0.563069	0.789729	0.984148
	mg/m2s	0.004013	0.01204	0.064003	1.27918



A100-1

September	PI-SWERL						
	u*	0.344237	0.482808	0.601667	0.699267	0.77406	0.824497
	mg/m2s	0.003811	0.008194	0.014197	0.021066	0.0325	0.11419
	Guelph Tunnel						
	u*	0.2176	0.2644	0.364	0.4396	0.4816	0.588
	Etotal	0.005597	0.003521	0.009083	0.005742	0.02283	0.019417

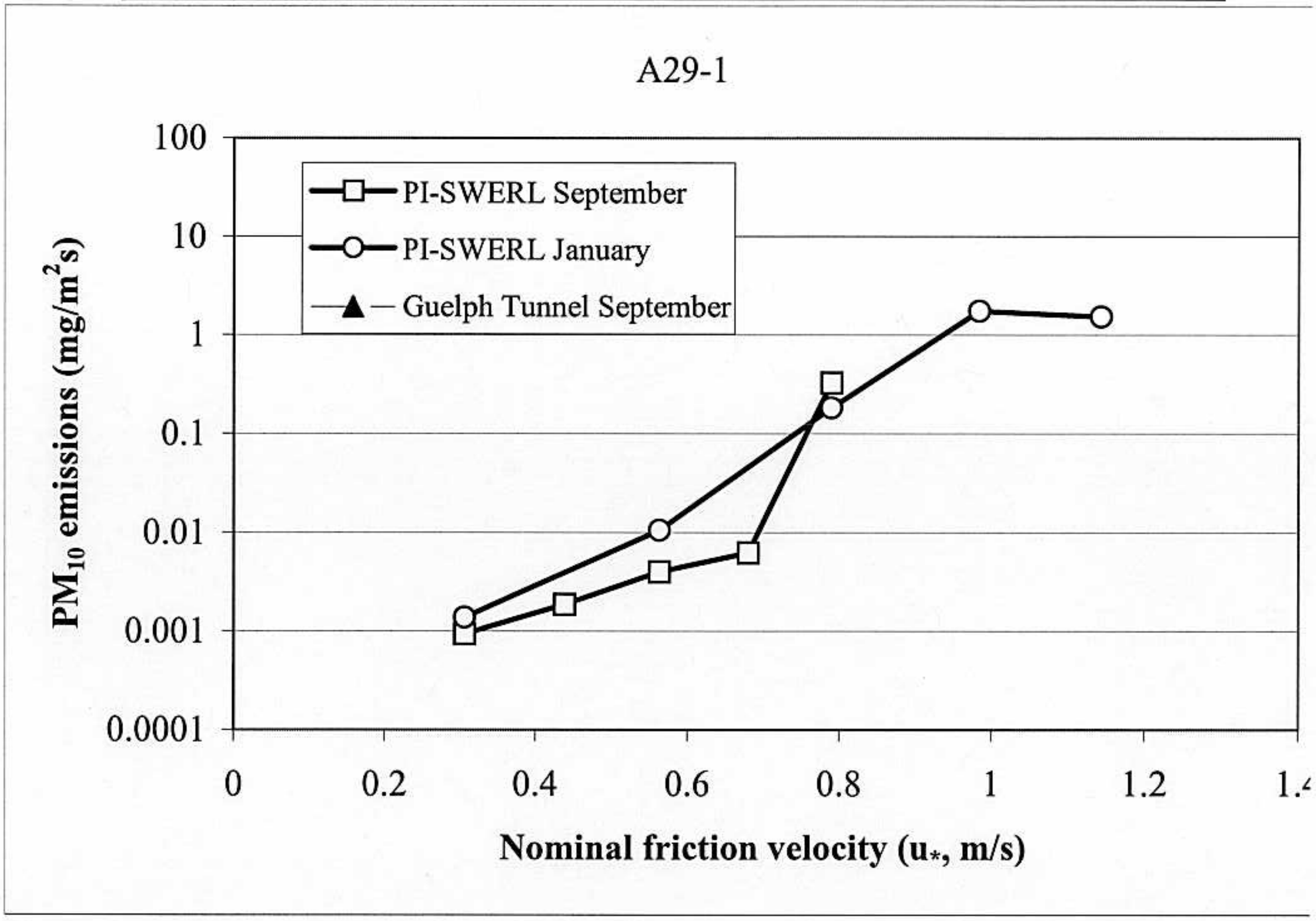
January	PI-SWERL				
	u*	0.344237	0.482808	0.601667	0.699267
	mg/m2s	0.088669	0.032851	0.070955	0.166197



A29-1

September	PI-SWERL					
	u*	0.306697	0.438439	0.563069	0.680271	0.789729
	mg/m2s	0.000936	0.001871	0.004001	0.006201	0.327037
	Guelph Tunnel					
	u*	(m/s)				
	Etotal	(mg/m2s)				

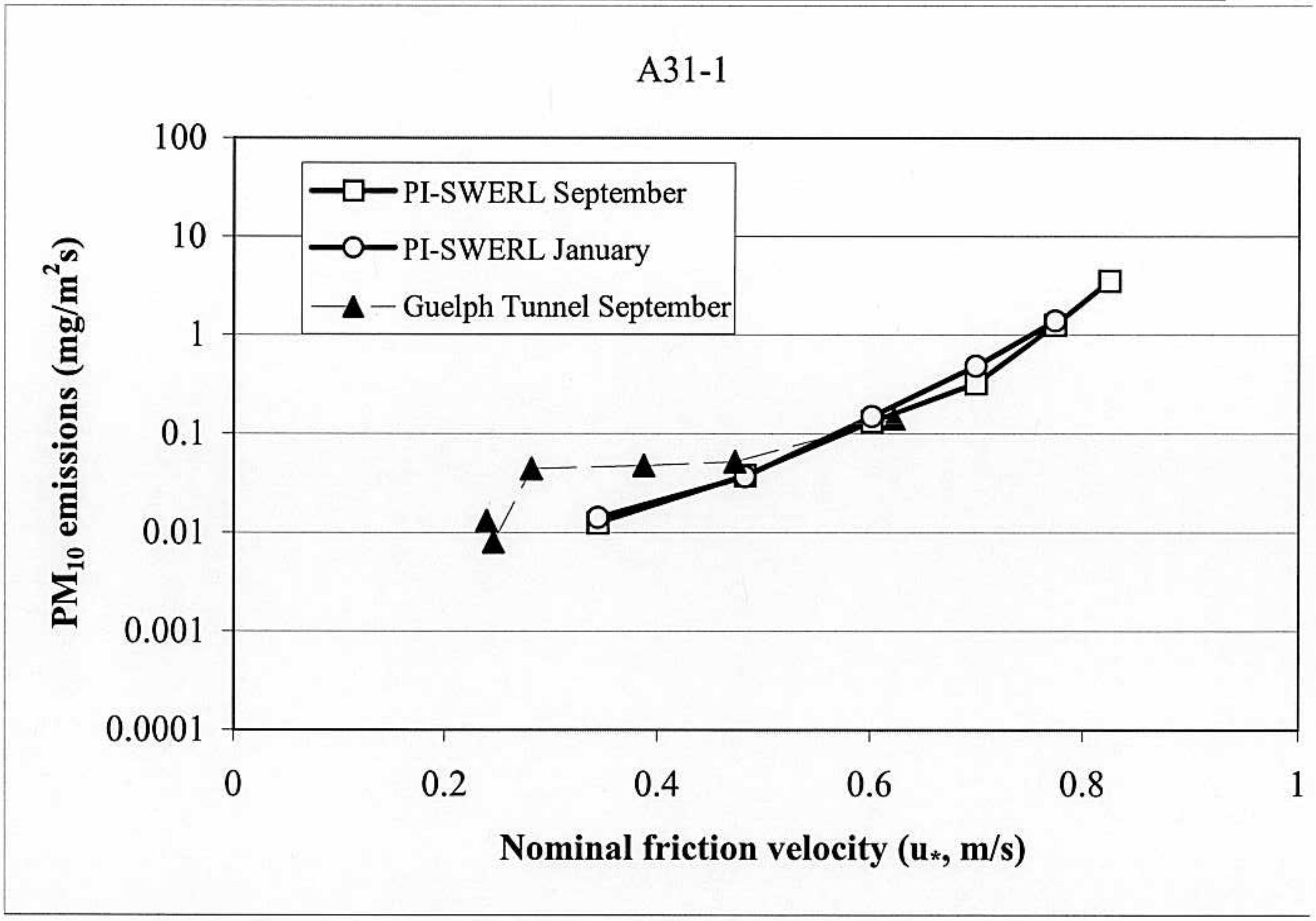
January	PI-SWERL					
	u*	0.306697	0.563069	0.789729	0.984148	1.143792
	mg/m2s	0.001377	0.0105	0.182312	1.746093	1.531208



A31-1

September	PI-SWERL						
	u*	0.344237	0.482808	0.601667	0.699267	0.77406	0.824497
	mg/m2s	0.012442	0.03768	0.132651	0.322007	1.256856	3.517852
	Guelph Tunnel						
	u*	0.2396	0.246	0.282	0.3876	0.4732	0.6224
	Etotal	0.013096	0.008005	0.0442	0.047416	0.051855	0.141903

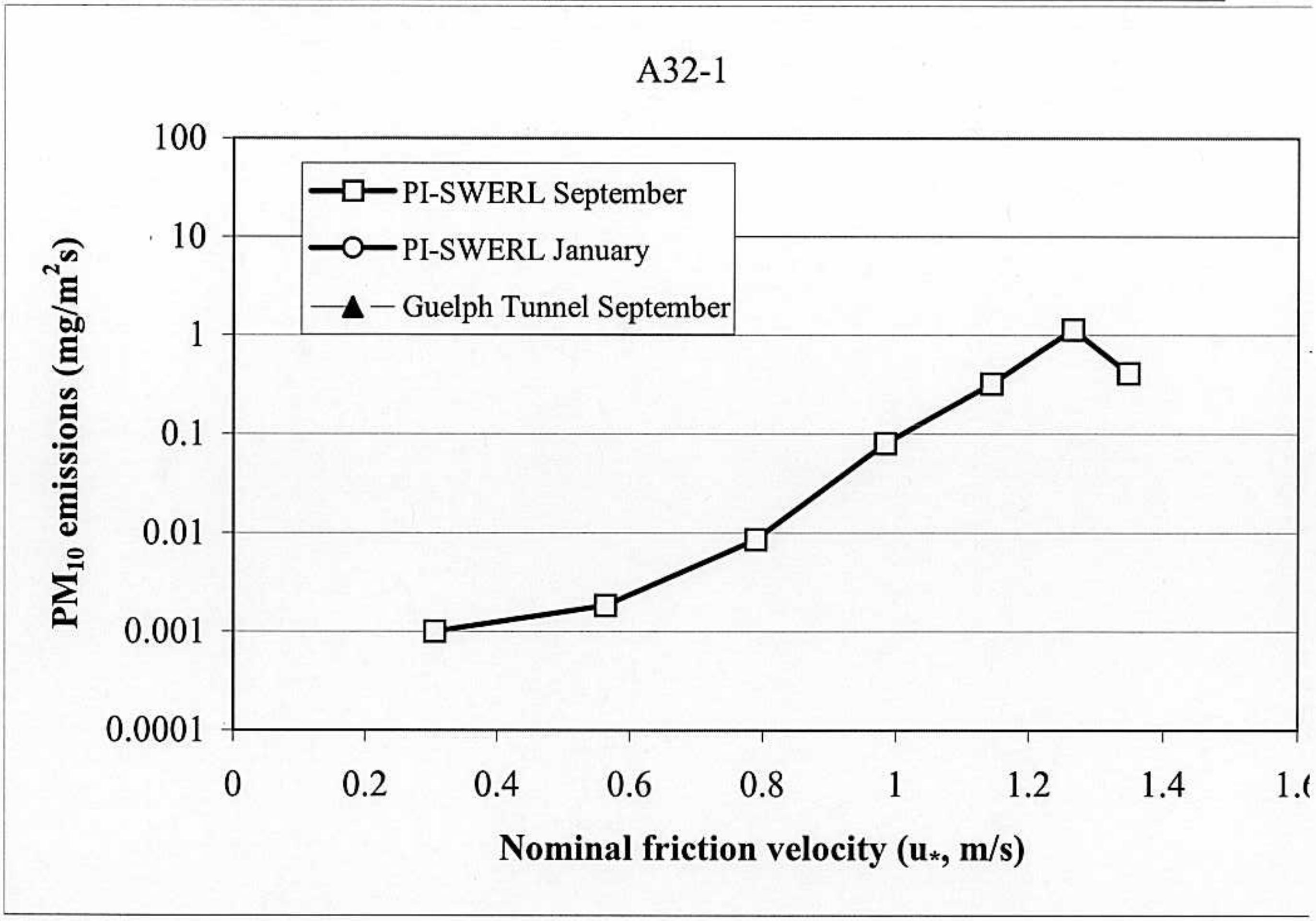
January	PI-SWERL					
	u*	0.344237	0.482808	0.601667	0.699267	0.77406
	mg/m2s	0.014077	0.036666	0.149131	0.480935	1.392457



A32-1

September	PI-SWERL								
	u*		0.306697	0.563069	0.789729	0.984148	1.143792	1.266131	1.348631
	mg/m2s		0.001002	0.001839	0.008524	0.080008	0.321232	1.135228	0.409643
	Guelph Tunnel								
	u*	(m/s)							
	Etotal	(mg/m2s)							

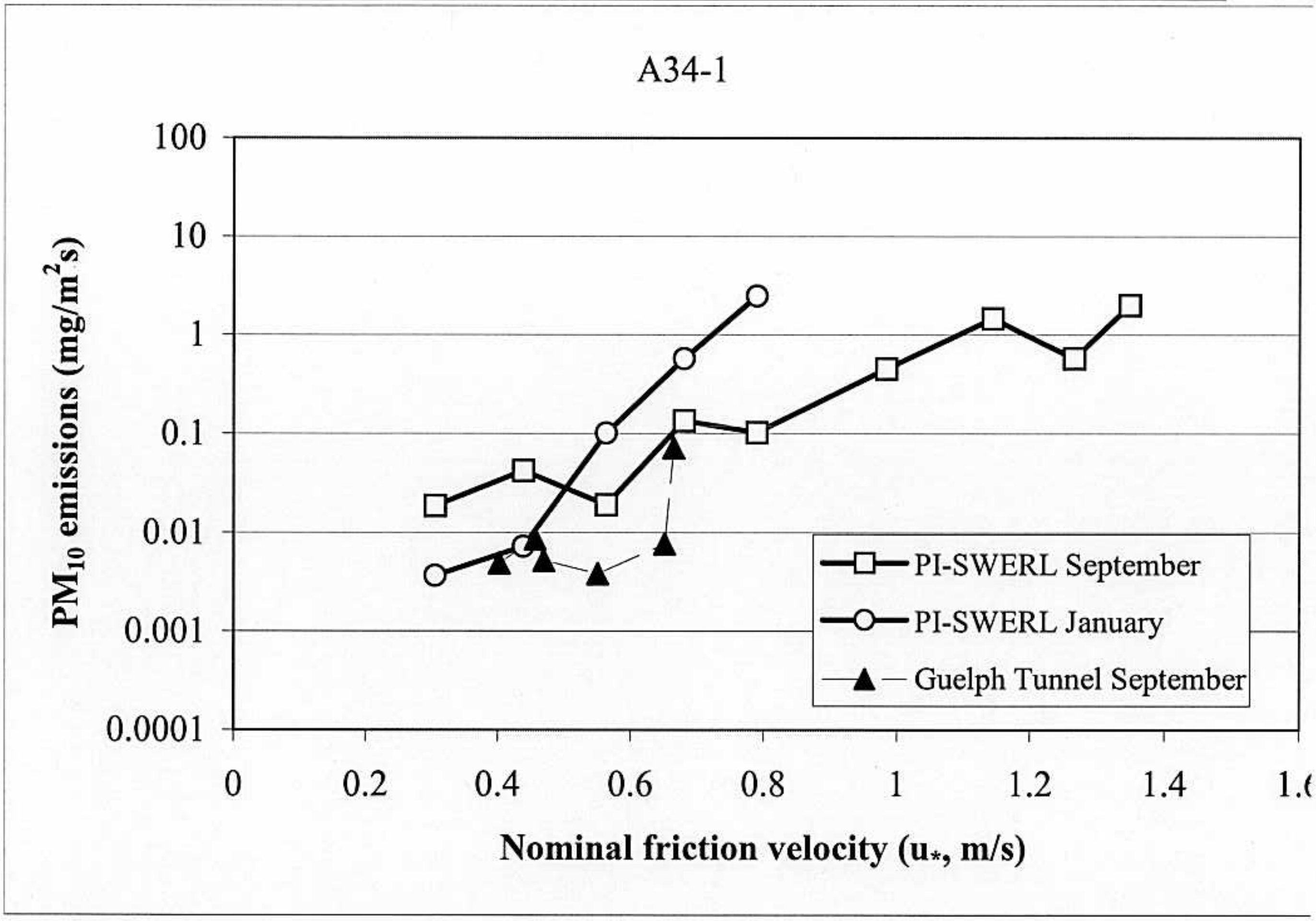
January	PI-SWERL	
	u*	
	mg/m2s	



A34-1

September	PI-SWERL							
	u*	0.306697	0.438439	0.563069	0.680271	0.789729	0.984148	1.143792
	mg/m2s	0.018578	0.041981	0.018936	0.134122	0.101982	0.452057	1.464934
	Guelph Tunnel							
	u*	0.4024	0.456	0.4692	0.5504	0.6512	0.6644	
	Etotal	0.004921	0.008618	0.005193	0.003824	0.00765	0.071685	

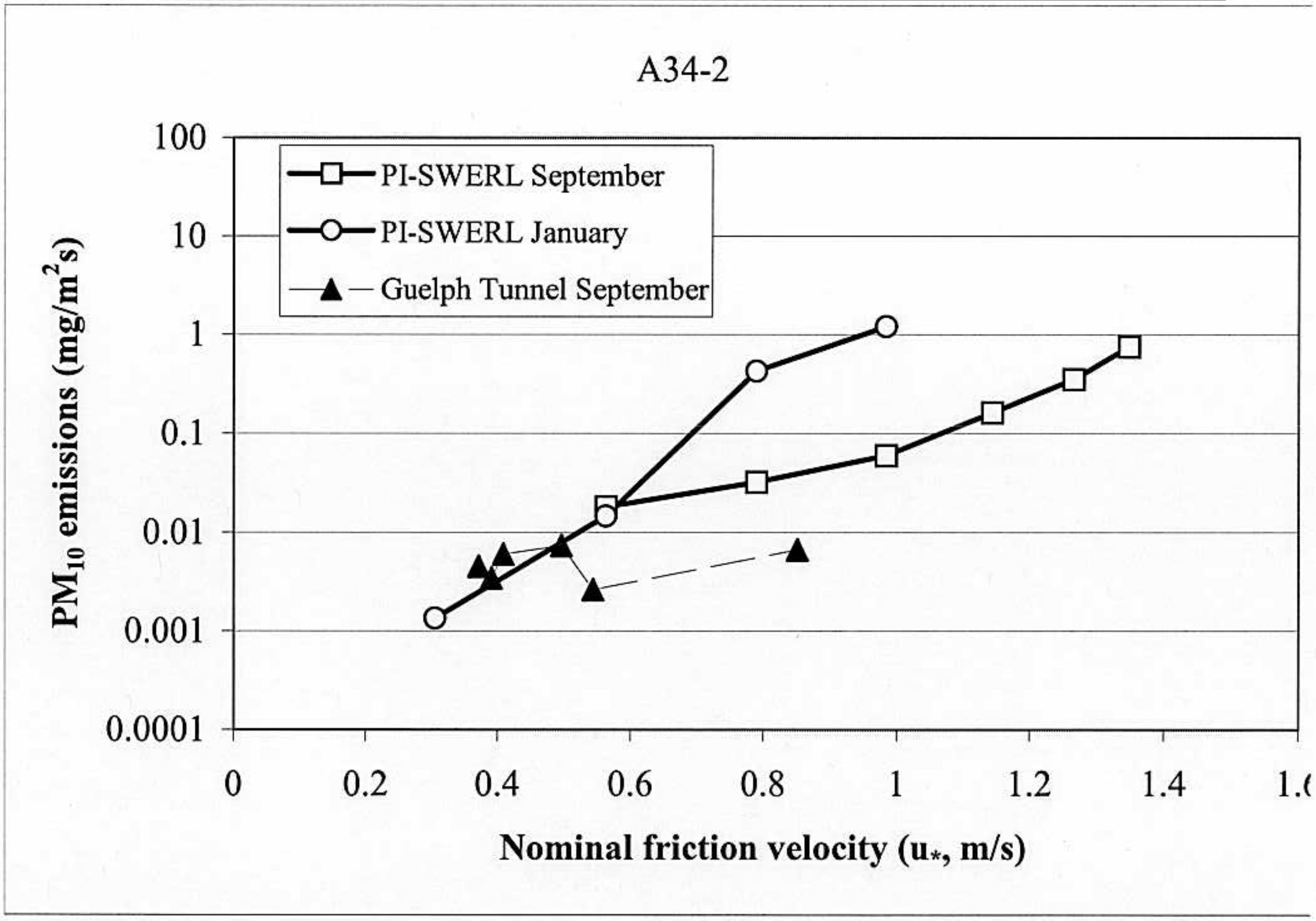
January	PI-SWERL					
	u*	0.306697	0.438439	0.563069	0.680271	0.789729
	mg/m2s	0.003643	0.007207	0.100904	0.571618	2.472314



A34-2

September	PI-SWERL						
	u*	0.563069	0.789729	0.984148	1.143792	1.266131	1.348631
	mg/m2s	0.017998	0.032021	0.059517	0.162011	0.350744	0.75366
	Guelph Tunnel						
	u*	0.3716	0.3908	0.4088	0.4968	0.544	0.8516
	Etotal	0.004535	0.003451	0.005979	0.007299	0.002618	0.006657

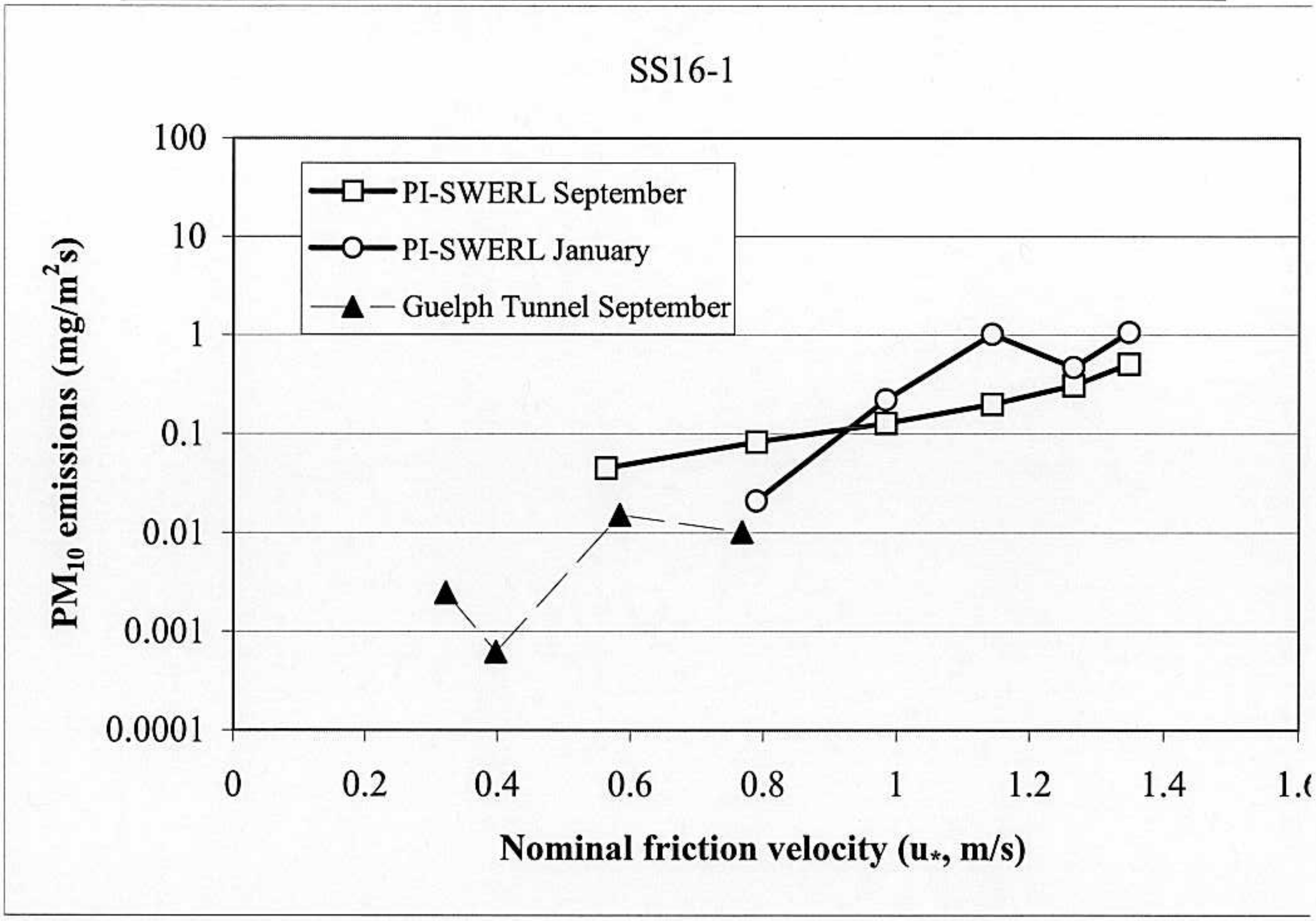
January	PI-SWERL				
	u*	0.306697	0.563069	0.789729	0.984148
	mg/m2s	0.001344	0.014585	0.426841	1.204327



SS16-1

September	PI-SWERL						
	u*	0.563069	0.789729	0.984148	1.143792	1.266131	1.348631
	mg/m2s	0.044928	0.082523	0.127724	0.199461	0.308232	0.508177
	Guelph Tunnel						
	u*	0.3228	0.398	0.584	0.7684		
	Etotal	0.002474	0.000621	0.015128	0.010138		

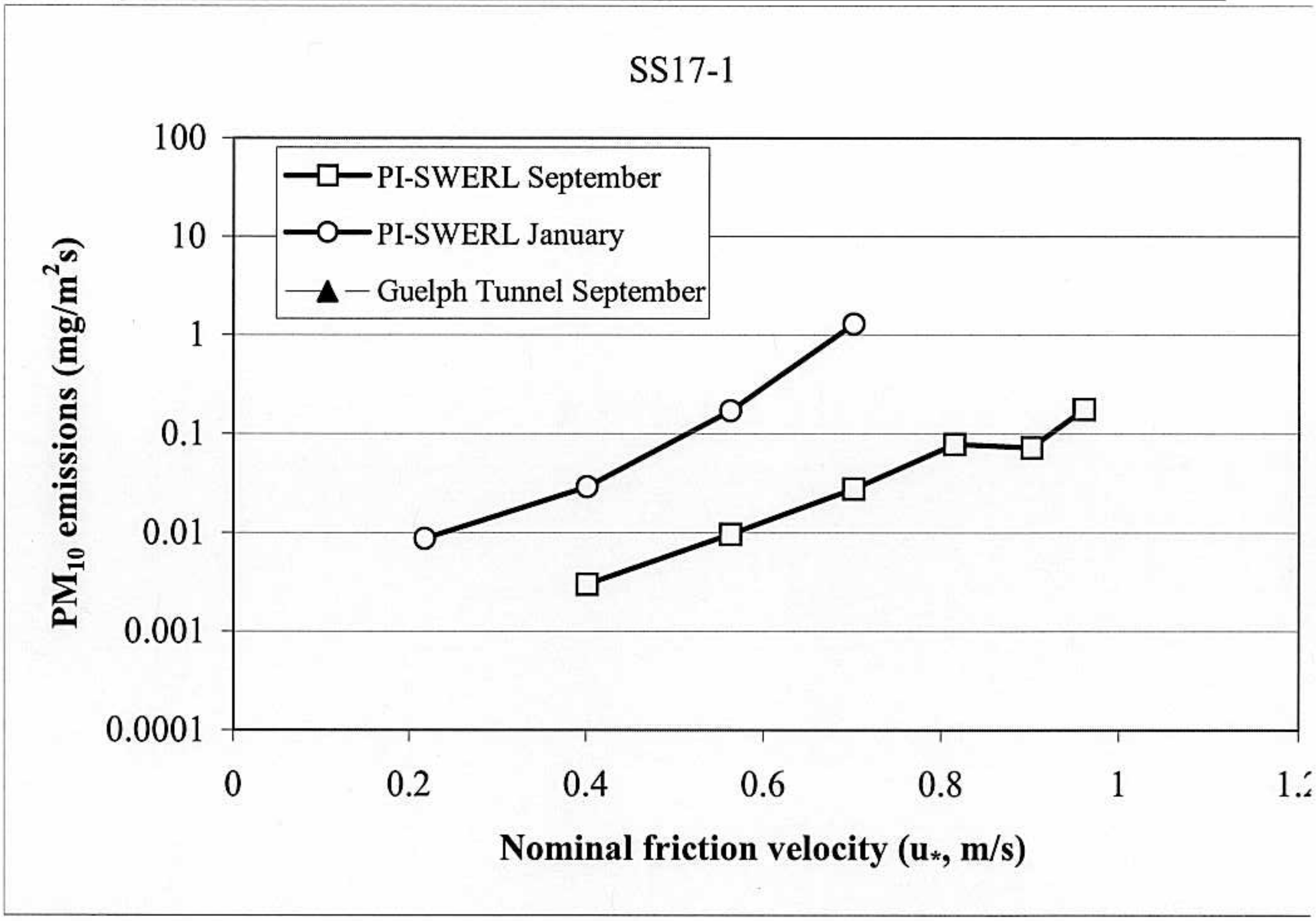
January	PI-SWERL					
	u*	0.789729	0.984148	1.143792	1.266131	1.348631
	mg/m2s	0.02094	0.220891	1.014254	0.467518	1.066129



SS17-1

September	PI-SWERL						
	u*	0.401358	0.562922	0.701505	0.8153	0.902503	0.96131
	mg/m2s	0.002989	0.009584	0.02765	0.078439	0.072055	0.17697
	Guelph Tunnel						
	u*	(m/s)					
	Etotal	(mg/m2s)					

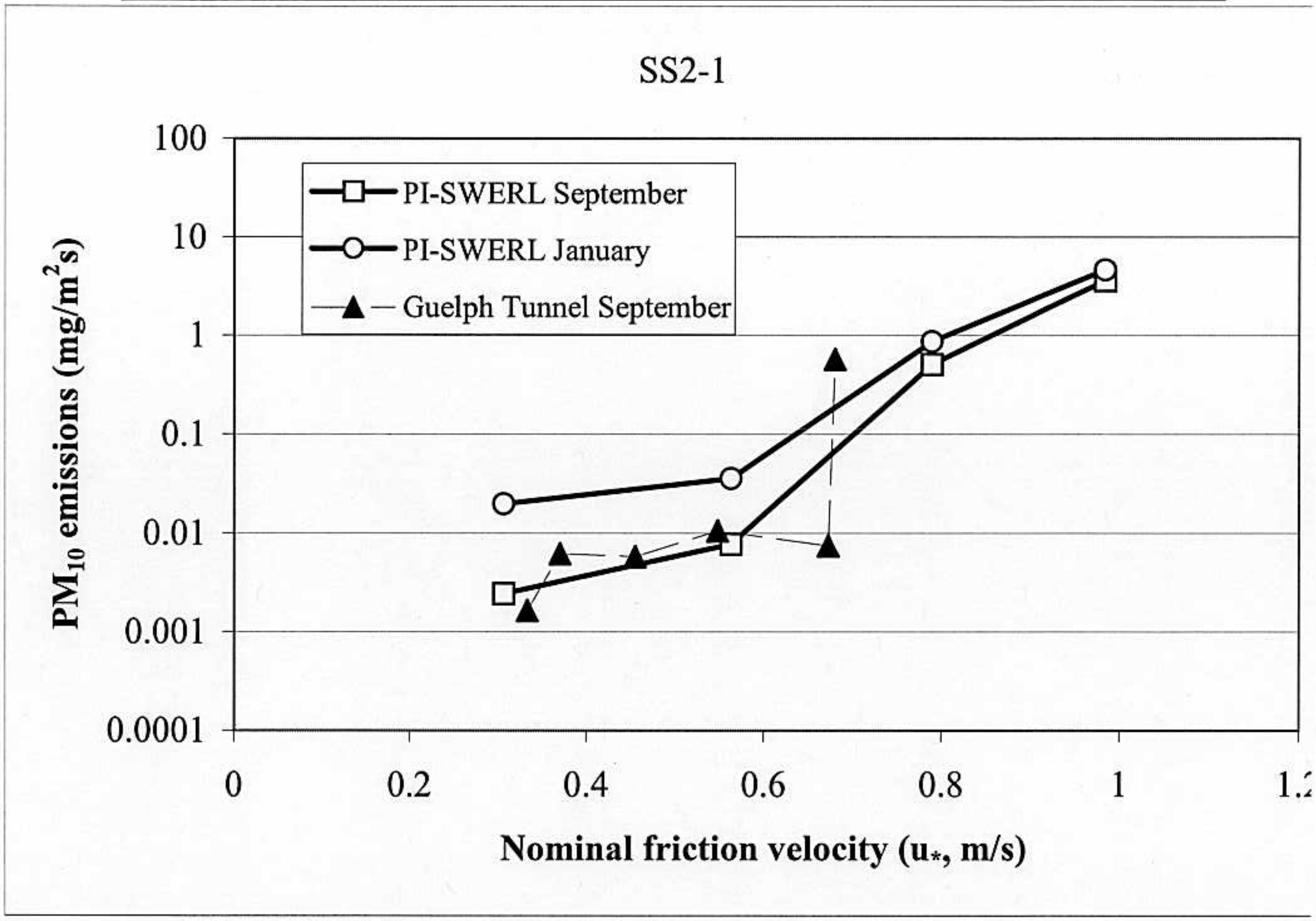
January	PI-SWERL				
	u*	0.218615	0.401358	0.562922	0.701505
	mg/m2s	0.008691	0.028816	0.170363	1.286506



SS2-1

September	PI-SWERL						
	u*	0.306697	0.563069	0.789729	0.984148		
	mg/m2s	0.002431	0.007709	0.509218	3.592612		
	Guelph Tunnel						
	u*	0.3332	0.3704	0.4552	0.548	0.6732	0.6804
	Etotal	0.001646	0.006183	0.005773	0.010502	0.0074	0.570032

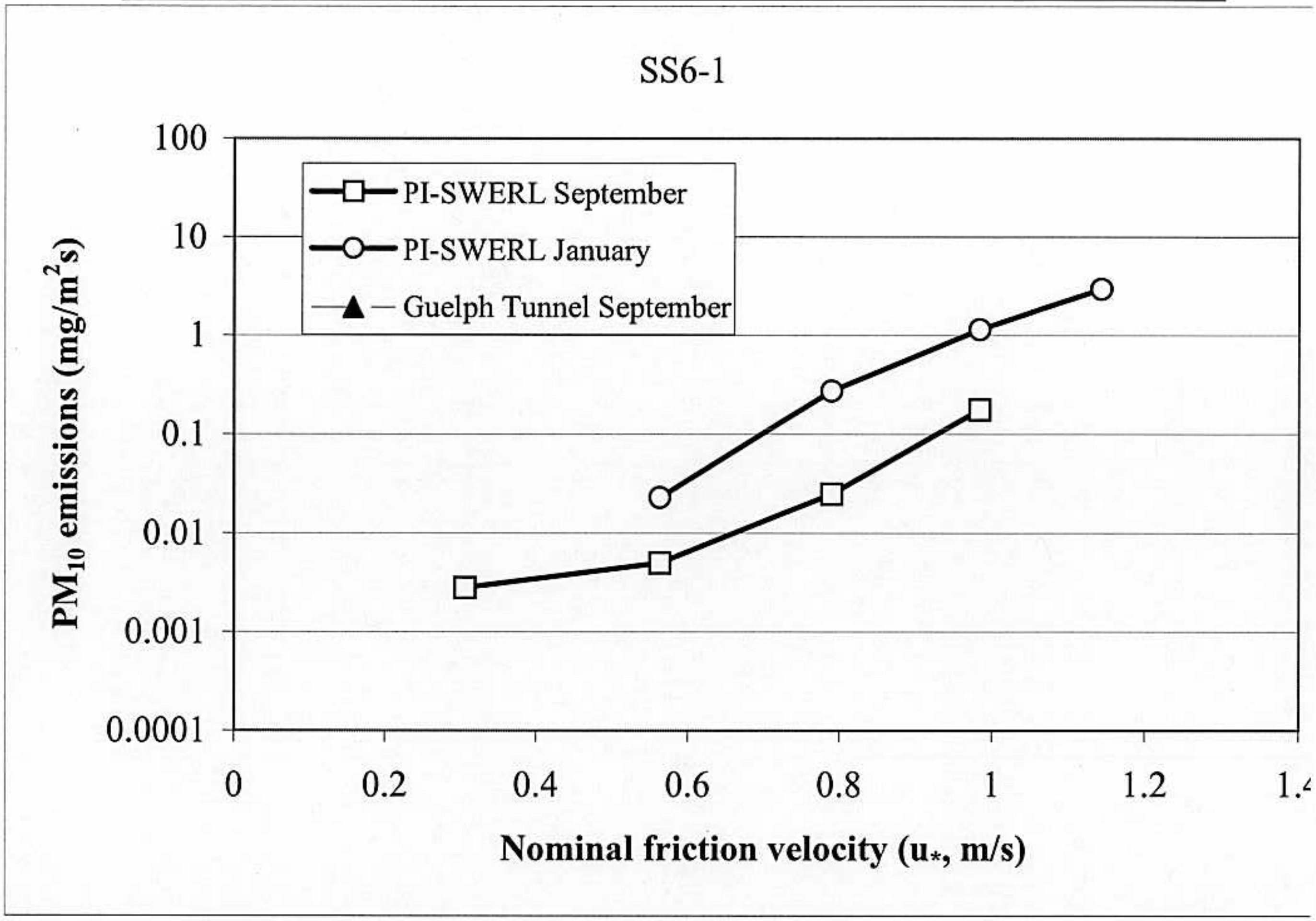
January	PI-SWERL				
	u*	0.306697	0.563069	0.789729	0.984148
	mg/m2s	0.019735	0.035421	0.865852	4.616558



SS6-1

September	PI-SWERL					
	u*		0.306697	0.563069	0.789729	0.984148
	mg/m2s		0.002803	0.004983	0.024765	0.176562
	Guelph Tunnel					
	u*	(m/s)				
	Etotal	(mg/m2s)				

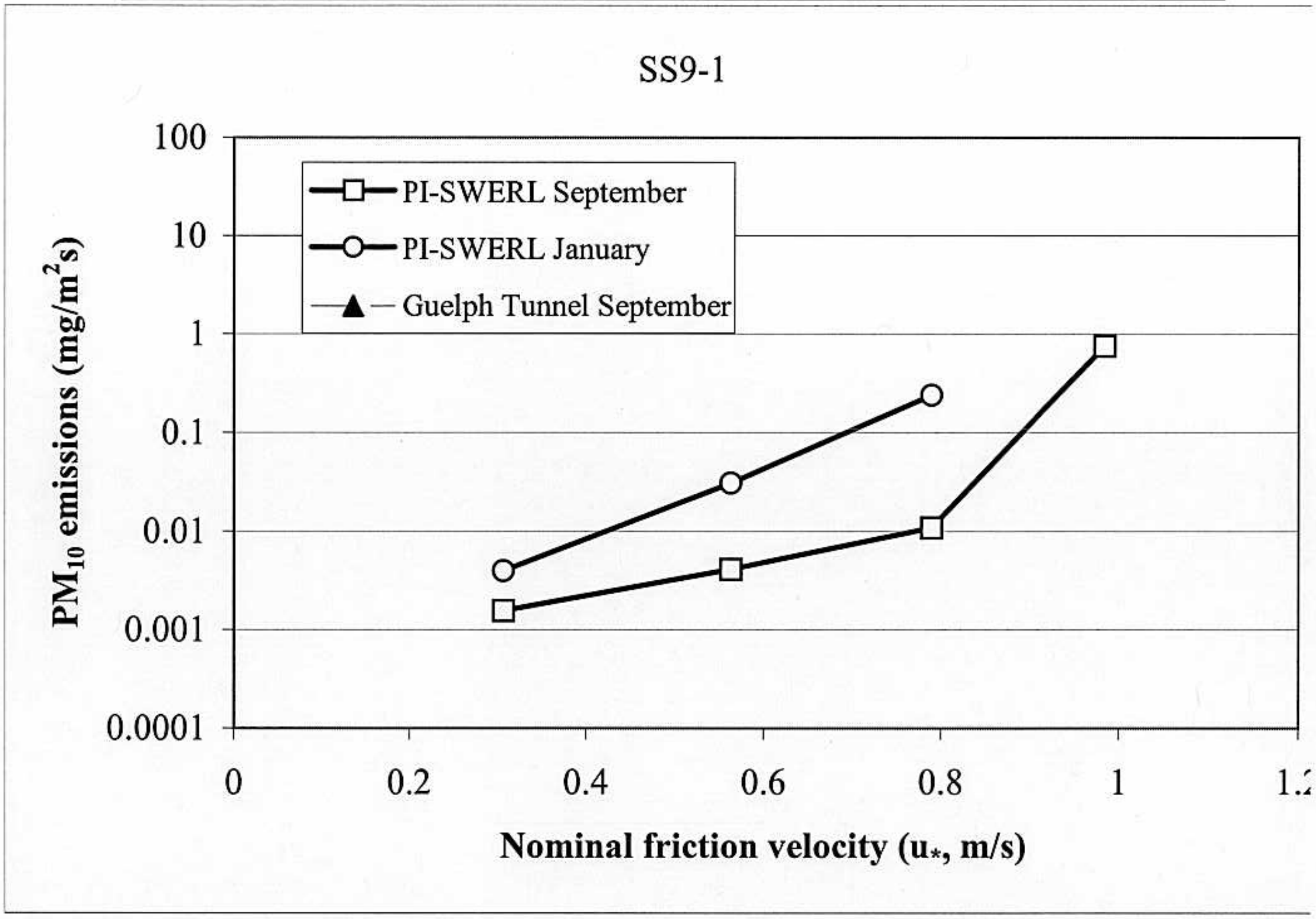
January	PI-SWERL				
	u*	0.563069	0.789729	0.984148	1.143792
	mg/m2s	0.022788	0.273367	1.143777	2.942844



SS9-1

September	PI-SWERL				
	u*	0.306697	0.563069	0.789729	0.984148
	mg/m2s	0.001557	0.004102	0.010839	0.752862
	Guelph Tunnel				
	u*	(m/s)			
	Etotal	(mg/m2s)			

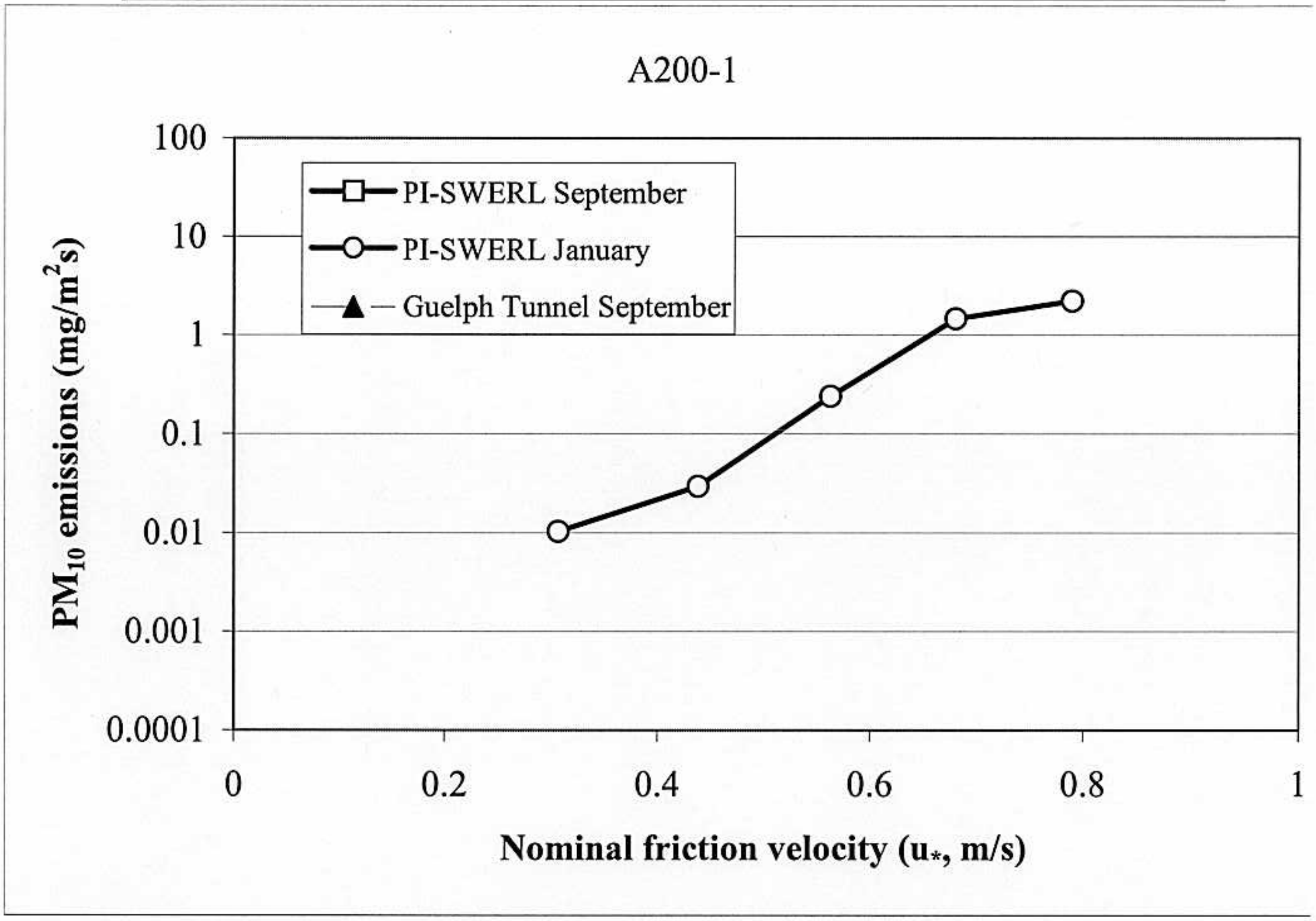
January	PI-SWERL			
	u*	0.306697	0.563069	0.789729
	mg/m2s	0.00397	0.030615	0.239203



A200-1

September	PI-SWERL						
	u*						
	mg/m2s						
	Guelph Tunnel						
	u*	(m/s)					
	Etotal	(mg/m2s)					

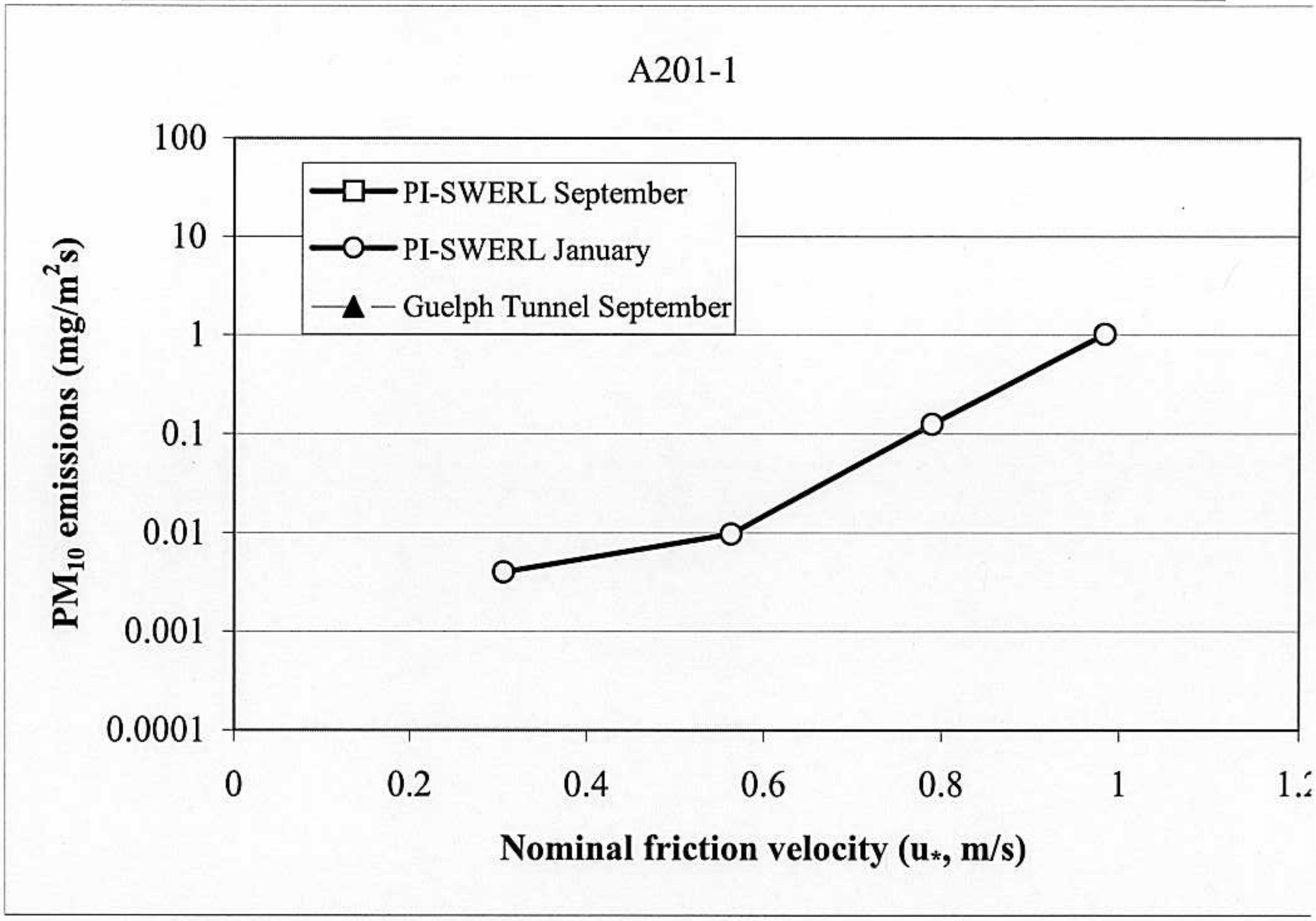
January	PI-SWERL					
	u*	0.306697	0.438439	0.563069	0.680271	0.789729
	mg/m2s	0.010293	0.029442	0.239371	1.457093	2.2118



A201-1

September	PI-SWERL					
	u*					
	mg/m2s					
	Guelph Tunnel					
	u*	(m/s)				
	Etotal	(mg/m2s)				

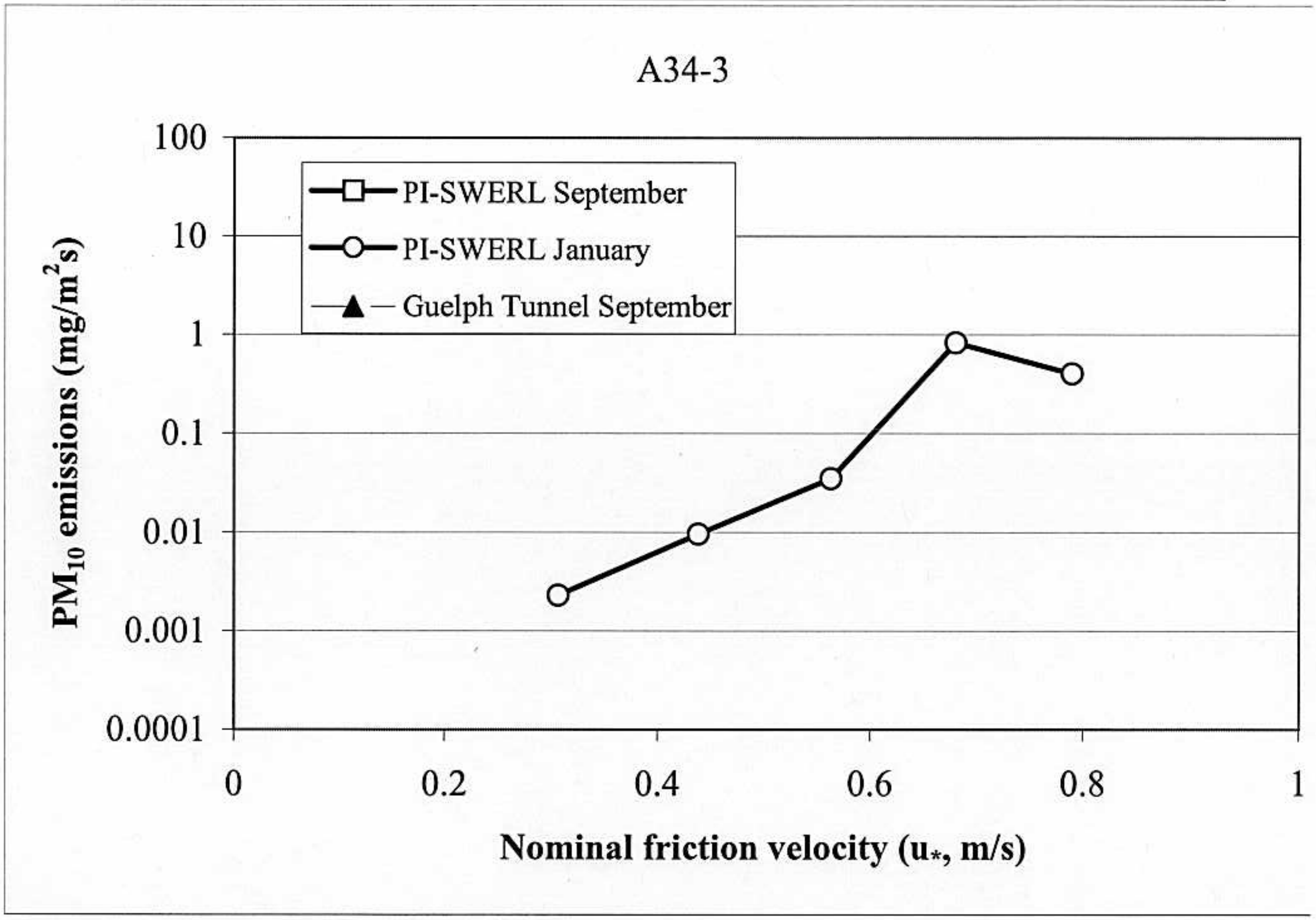
January	PI-SWERL					
	u*	0.306697	0.563069	0.789729	0.984148	
	mg/m2s	0.004001	0.009696	0.124903	1.013792	



A34-3

September	PI-SWERL					
	u*					
	mg/m2s					
	Guelph Tunnel					
	u* (m/s)					
	Etotal (mg/m2s)					

January	PI-SWERL					
	u*	0.306697	0.438439	0.563069	0.680271	0.789729
	mg/m2s	0.002301	0.009576	0.034841	0.829496	0.402516



ATTACHMENT E3, APPENDIX B

Calculation of PI-SWERL Emission Factors for 10-meter Wind Speeds (Stable and Unstable Playa Conditions)

	Stable Playa					
PI-SWERL LOCATION	MEAN AERODYNAMIC ROUGHNESS, Z_0 (meters)	SHEAR VELOCITY, u* (met/sec)	SEPTEMBER 2005 EMISSIONS (mg/m2s)	EQUIVALENT 10 MET WIND SPEED, $U_{10\ met}$ (met/sec)	EQUIVALENT 10 MET WIND SPEED, $U_{10\ met}$ (miles per hour)	SEPTEMBER 2005 EMISSIONS (tons/acre x hour)
A100-1	4.62E-04	0.306697	0.004262	7.654	17.122	6.8443E-05
	4.62E-04	0.438439	0.010071	10.942	24.476	1.6173E-04
	4.62E-04	0.563069	0.012769	14.052	31.434	2.0506E-04
	4.62E-04	0.622618	0.004737	15.538	34.758	7.6071E-05
	4.62E-04	0.680271	0.166337	16.977	37.977	2.6712E-03
	4.62E-04	0.789729	0.799438	19.709	44.087	1.2838E-02
	4.62E-04	0.984148	2.333499	24.561	54.941	3.7474E-02
		Averages:	**0.475873286**			
A100-2	4.62E-04	0.306697	N/A	7.654	17.122	N/A
	4.62E-04	0.563069	0.011561	14.052	31.434	1.8566E-04
	4.62E-04	0.789729	0.027782	19.709	44.087	4.4615E-04
	4.62E-04	0.984148	0.053617	24.561	54.941	8.6104E-04
	4.62E-04	1.143792	0.107075	28.545	63.853	1.7195E-03
	4.62E-04	1.266131	0.131818	31.598	70.683	2.1169E-03
	4.62E-04	1.348631	0.547457	33.657	75.288	8.7916E-03
		Averages:	**0.146551667**			
A101-1	4.62E-04	0.344237	0.003811	8.591	19.217	6.1201E-05
	4.62E-04	0.482808	0.008194	12.049	26.953	1.3159E-04
	4.62E-04	0.601667	0.014197	15.015	33.588	2.2799E-04
	4.62E-04	0.699267	0.021066	17.451	39.037	3.3830E-04
	4.62E-04	0.77406	0.0325	19.318	43.212	5.2192E-04
	4.62E-04	0.824497	0.11419	20.576	46.028	1.8338E-03
		Averages:	**0.032326333**			
A29-1	4.62E-04	0.306697	0.000936	7.654	17.122	1.5031E-05
	4.62E-04	0.438439	0.0018711	10.942	24.476	3.0048E-05
	4.62E-04	0.563069	0.004001	14.052	31.434	6.4252E-05
	4.62E-04	0.680271	0.006201	16.977	37.977	9.9582E-05
	4.62E-04	0.789729	0.327037	19.709	44.087	5.2519E-03
	4.62E-04	0.984148	N/A	24.561	54.941	N/A
	4.62E-04	1.143792	N/A	28.545	63.853	N/A
		Averages:	**0.06800922**			
A31-1	4.62E-04	0.344237	0.012442	8.591	19.217	1.9981E-04
	4.62E-04	0.482808	0.03768	12.049	26.953	6.0510E-04
	4.62E-04	0.601667	0.132651	15.015	33.588	2.1302E-03
	4.62E-04	0.699267	0.322007	17.451	39.037	5.1711E-03
	4.62E-04	0.77406	1.256856	19.318	43.212	2.0184E-02
	4.62E-04	0.824497	3.517852	20.576	46.028	5.6493E-02
		Averages:	**0.879914667**			
A32-1	4.62E-04	0.306697	0.001002	7.654	17.122	1.6091E-05
	4.62E-04	0.563069	0.001839	14.052	31.434	2.9533E-05
	4.62E-04	0.789729	0.008524	19.709	44.087	1.3689E-04
	4.62E-04	0.984148	0.080008	24.561	54.941	1.2848E-03
	4.62E-04	1.143792	0.321232	28.545	63.853	5.1587E-03
	4.62E-04	1.266131	1.135228	31.598	70.683	1.8231E-02
	4.62E-04	1.348631	0.409643	33.657	75.288	6.5785E-03
		Averages:	**0.279639429**			
A34-1	4.62E-04	0.306697	0.018578	7.654	17.122	2.9834E-04
	4.62E-04	0.438439	0.041981	10.942	24.476	6.7417E-04
	4.62E-04	0.563069	0.018936	14.052	31.434	3.0409E-04
	4.62E-04	0.680271	0.134122	16.977	37.977	2.1539E-03
	4.62E-04	0.789729	0.101982	19.709	44.087	1.6377E-03
	4.62E-04	0.984148	0.452057	24.561	54.941	7.2596E-03
	4.62E-04	1.143792	1.464934	28.545	63.853	2.3525E-02
	4.62E-04	1.266131	0.575611	31.598	70.683	9.2437E-03
	4.62E-04	1.348631	1.986424	33.657	75.288	3.1900E-02
		Averages:	**0.532736111**			
A-34-2	4.62E-04	0.306697	N/A	7.654	17.122	N/A
	4.62E-04	0.563069	0.017998	14.052	31.434	2.8903E-04
	4.62E-04	0.789729	0.032021	19.709	44.087	5.1423E-04
	4.62E-04	0.984148	0.059517	24.561	54.941	9.5578E-04
	4.62E-04	1.143792	0.162011	28.545	63.853	2.6017E-03
	4.62E-04	1.266131	0.350744	31.598	70.683	5.6326E-03
	4.62E-04	1.348631	0.75366	33.657	75.288	1.2103E-02
		Averages:	**0.229325167**			

	Stable Playa					
PI-SWERL LOCATION	MEAN AERODYNAMIC ROUGHNESS, Z_0 (meters)	SHEAR VELOCITY, u* (met/sec)	SEPTEMBER 2005 EMISSIONS (mg/m2s)	EQUIVALENT 10 MET WIND SPEED, $U_{10\ met}$ (met/sec)	EQUIVALENT 10 MET WIND SPEED, $U_{10\ met}$ (miles per hour)	SEPTEMBER 2005 EMISSIONS (tons/acre x hour)
SS16-1	4.62E-04	0.563069	0.044928	14.052	31.434	7.2150E-04
	4.62E-04	0.789729	0.082523	19.709	44.087	1.3252E-03
	4.62E-04	0.984148	0.127724	24.561	54.941	2.0511E-03
	4.62E-04	1.143792	0.199461	28.545	63.853	3.2031E-03
	4.62E-04	1.266131	0.308232	31.598	70.683	4.9499E-03
	4.62E-04	1.348631	0.508177	33.657	75.288	8.1608E-03
		Averages:	**0.211840833**			
SS17-1	4.62E-04	0.218615	N/A	5.456	12.204	N/A
	4.62E-04	0.401358	0.002989	10.016	22.406	4.8000E-05
	4.62E-04	0.562922	0.009584	14.048	31.426	1.5391E-04
	4.62E-04	0.701505	0.02765	17.507	39.162	4.4403E-04
	4.62E-04	0.8153	0.078439	20.347	45.515	1.2597E-03
	4.62E-04	0.902503	0.072055	22.523	50.383	1.1571E-03
	4.62E-04	0.96131	0.17697	23.991	53.666	2.8420E-03
		Averages:	**0.061281167**			
SS2-1	4.62E-04	0.306697	0.002431	7.654	17.122	3.9039E-05
	4.62E-04	0.563069	0.007709	14.052	31.434	1.2380E-04
	4.62E-04	0.789729	0.509218	19.709	44.087	8.1775E-03
	4.62E-04	0.984148	3.592612	24.561	54.941	5.7694E-02
		Averages:	**1.0279925**			
SS6-1	4.62E-04	0.306697	0.002803	7.654	17.122	4.5013E-05
	4.62E-04	0.563069	0.004983	14.052	31.434	8.0022E-05
	4.62E-04	0.789729	0.024765	19.709	44.087	3.9770E-04
	4.62E-04	0.984148	0.176562	24.561	54.941	2.8354E-03
	4.62E-04	1.143792	N/A	28.545	63.853	N/A
		Averages:	**0.05227825**			
SS9-1	4.62E-04	0.306697	0.001557	7.654	17.122	2.5004E-05
	4.62E-04	0.563069	0.004102	14.052	31.434	6.5874E-05
	4.62E-04	0.789729	0.010839	19.709	44.087	1.7406E-04
	4.62E-04	0.984148	0.752862	24.561	54.941	1.2090E-02
		Averages:	**0.19234**			
A200-1	4.62E-04	0.306697	N/A	7.654	17.122	N/A
	4.62E-04	0.438439	N/A	10.942	24.476	N/A
	4.62E-04	0.563069	N/A	14.052	31.434	N/A
	4.62E-04	0.680271	N/A	16.977	37.977	N/A
	4.62E-04	0.789729	N/A	19.709	44.087	N/A
		Averages:				
A201-1	4.62E-04	0.306697	N/A	7.654	17.122	N/A
	4.62E-04	0.563069	N/A	14.052	31.434	N/A
	4.62E-04	0.789729	N/A	19.709	44.087	N/A
	4.62E-04	0.984148	N/A	24.561	54.941	N/A
		Averages:				
A34-3	4.62E-04	0.306697	N/A	7.654	17.122	N/A
	4.62E-04	0.438439	N/A	10.942	24.476	N/A
	4.62E-04	0.563069	N/A	14.052	31.434	N/A
	4.62E-04	0.680271	N/A	16.977	37.977	N/A
	4.62E-04	0.789729	N/A	19.709	44.087	N/A
		Averages:				

Assumptions and Notes:

Z_0 = mean aerodynamic roughness length for Owens Lake data, page 20, Table 6.1, for Lake (w/o feed), "PM10 DUST EMISSIONS AT OWENS LAKE, CA 2001 (Final)" = 4.62 E-04 meters.

$U_{10\ met}$ is the equivalent 10 meter wind speed computed by using the Prandtl-von Karman equation:

$$U10\ met = (u^*/\kappa) \times \ln(10\ met/Z_0)$$

Wind Speed (miles per hour) = 2.23692 x wind speed (meters per second)

Emissions (tons/acre x hour) = 0.016059 x Emissions (mg/m^2 sec)

			Unstable Playa				
PI-SWERL LOCATION	PI-SWERL LOCATION	MEAN AERODYNAMIC ROUGHNESS, Z_0 (meters)	SHEAR VELOCITY, u* (met/sec)	JANUARY 2006 EMISSIONS (mg/m2s)	EQUIVALENT 10 MET WIND SPEED, $U_{10\ met}$ (met/sec)	EQUIVALENT 10 MET WIND SPEED, $U_{10\ met}$ (miles per hour)	JANUARY 2006 EMISSIONS (tons/acre x hour)
A100-1	**A100-1**	4.62E-04	0.306697	0.012962	7.654	17.122	2.0816E-04
		4.62E-04	0.438439	0.026377	10.942	24.476	4.2359E-04
		4.62E-04	0.563069	0.233343	14.052	31.434	3.7473E-03
		4.62E-04	0.622618	N/A	15.538	34.758	N/A
		4.62E-04	0.680271	0.415108	16.977	37.977	6.6662E-03
		4.62E-04	0.789729	1.802995	19.709	44.087	2.8954E-02
		4.62E-04	0.984148	16.2185	24.561	54.941	2.6045E-01
				3.118214167			
A100-2	**A100-2**	4.62E-04	0.306697	0.004013	7.654	17.122	6.4445E-05
		4.62E-04	0.563069	0.01204	14.052	31.434	1.9335E-04
		4.62E-04	0.789729	0.064003	19.709	44.087	1.0278E-03
		4.62E-04	0.984148	1.27918	24.561	54.941	2.0542E-02
		4.62E-04	1.143792	N/A	28.545	63.853	N/A
		4.62E-04	1.266131	N/A	31.598	70.683	N/A
		4.62E-04	1.348631	N/A	33.657	75.288	N/A
				0.339809			
A101-1	**A101-1**	4.62E-04	0.344237	0.088669	8.591	19.217	1.4239E-03
		4.62E-04	0.482808	0.032851	12.049	26.953	5.2755E-04
		4.62E-04	0.601667	0.070955	15.015	33.588	1.1395E-03
		4.62E-04	0.699267	0.166197	17.451	39.037	2.6690E-03
		4.62E-04	0.77406	N/A	19.318	43.212	N/A
		4.62E-04	0.824497	N/A	20.576	46.028	N/A
				0.089668			
A29-1	**A29-1**	4.62E-04	0.306697	0.001377	7.654	17.122	2.2113E-05
		4.62E-04	0.438439	N/A	10.942	24.476	N/A
		4.62E-04	0.563069	0.0105	14.052	31.434	1.6862E-04
		4.62E-04	0.680271	N/A	16.977	37.977	N/A
		4.62E-04	0.789729	0.182312	19.709	44.087	2.9277E-03
		4.62E-04	0.984148	1.746093	24.561	54.941	2.8041E-02
		4.62E-04	1.143792	1.531208	28.545	63.853	2.4590E-02
				0.694298			
A31-1	**A31-1**	4.62E-04	0.344237	0.014077	8.591	19.217	2.2606E-04
		4.62E-04	0.482808	0.0366666	12.049	26.953	5.8883E-04
		4.62E-04	0.601667	0.149131	15.015	33.588	2.3949E-03
		4.62E-04	0.699267	0.480935	17.451	39.037	7.7233E-03
		4.62E-04	0.77406	1.392457	19.318	43.212	2.2361E-02
		4.62E-04	0.824497	N/A	20.576	46.028	N/A
				0.41465332			
A32-1	**A32-1**	4.62E-04	0.306697	N/A	7.654	17.122	N/A
		4.62E-04	0.563069	N/A	14.052	31.434	N/A
		4.62E-04	0.789729	N/A	19.709	44.087	N/A
		4.62E-04	0.984148	N/A	24.561	54.941	N/A
		4.62E-04	1.143792	N/A	28.545	63.853	N/A
		4.62E-04	1.266131	N/A	31.598	70.683	N/A
		4.62E-04	1.348631	N/A	33.657	75.288	N/A
A34-1	**A34-1**	4.62E-04	0.306697	0.003643	7.654	17.122	5.8503E-05
		4.62E-04	0.438439	0.007207	10.942	24.476	1.1574E-04
		4.62E-04	0.563069	0.100904	14.052	31.434	1.6204E-03
		4.62E-04	0.680271	0.571618	16.977	37.977	9.1796E-03
		4.62E-04	0.789729	2.472314	19.709	44.087	3.9703E-02
		4.62E-04	0.984148	N/A	24.561	54.941	N/A
		4.62E-04	1.143792	N/A	28.545	63.853	N/A
		4.62E-04	1.266131	N/A	31.598	70.683	N/A
		4.62E-04	1.348631	N/A	33.657	75.288	N/A
				0.6311372			
A-34-2	**A-34-2**	4.62E-04	0.306697	0.001344	7.654	17.122	2.1583E-05
		4.62E-04	0.563069	0.014585	14.052	31.434	2.3422E-04
		4.62E-04	0.789729	0.426841	19.709	44.087	6.8546E-03
		4.62E-04	0.984148	1.204327	24.561	54.941	1.9340E-02
		4.62E-04	1.143792	N/A	28.545	63.853	N/A
		4.62E-04	1.266131	N/A	31.598	70.683	N/A
		4.62E-04	1.348631	N/A	33.657	75.288	N/A
				0.41177425			

			Unstable Playa				
PI-SWERL LOCATION	PI-SWERL LOCATION	MEAN AERODYNAMIC ROUGHNESS, Z_0 (meters)	SHEAR VELOCITY, u* (met/sec)	JANUARY 2006 EMISSIONS (mg/m2s)	EQUIVALENT 10 MET WIND SPEED, $U_{10\ met}$ (met/sec)	EQUIVALENT 10 MET WIND SPEED, $U_{10\ met}$ (miles per hour)	JANUARY 2006 EMISSIONS (tons/acre x hour)
SS16-1	**SS16-1**	4.62E-04	0.563069	N/A	14.052	31.434	N/A
		4.62E-04	0.789729	0.02094	19.709	44.087	3.3628E-04
		4.62E-04	0.984148	0.220891	24.561	54.941	3.5473E-03
		4.62E-04	1.143792	1.014254	28.545	63.853	1.6288E-02
		4.62E-04	1.266131	0.467518	31.598	70.683	7.5079E-03
		4.62E-04	1.348631	1.066129	33.657	75.288	1.7121E-02
				0.5579464			
SS17-1	**SS17-1**	4.62E-04	0.218615	0.008691	5.456	12.204	1.3957E-04
		4.62E-04	0.401358	0.028816	10.016	22.406	4.6276E-04
		4.62E-04	0.562922	0.170363	14.048	31.426	2.7359E-03
		4.62E-04	0.701505	1.286506	17.507	39.162	2.0660E-02
		4.62E-04	0.8153	N/A	20.347	45.515	N/A
		4.62E-04	0.902503	N/A	22.523	50.383	N/A
		4.62E-04	0.96131	N/A	23.991	53.666	N/A
		4.62E-04		**0.373594**			
SS2-1	**SS2-1**	4.62E-04	0.306697	0.019735	7.654	17.122	3.1692E-04
		4.62E-04	0.563069	0.035421	14.052	31.434	5.6883E-04
		4.62E-04	0.789729	0.865852	19.709	44.087	1.3905E-02
		4.62E-04	0.984148	4.616558	24.561	54.941	7.4137E-02
				1.3843915			
SS6-1	**SS6-1**	4.62E-04	0.306697	N/A	7.654	17.122	N/A
		4.62E-04	0.563069	0.022788	14.052	31.434	3.6595E-04
		4.62E-04	0.789729	0.273367	19.709	44.087	4.3900E-03
		4.62E-04	0.984148	1.143777	24.561	54.941	1.8368E-02
		4.62E-04	1.143792	2.942844	28.545	63.853	4.7259E-02
				1.095694			
SS9-1	**SS9-1**	4.62E-04	0.306697	0.00397	7.654	17.122	6.3754E-05
		4.62E-04	0.563069	0.030615	14.052	31.434	4.9165E-04
		4.62E-04	0.789729	0.239203	19.709	44.087	3.8414E-03
		4.62E-04	0.984148	N/A	24.561	54.941	N/A
				0.091262667			
A200-1	**A200-1**	4.62E-04	0.306697	0.010293	7.654	17.122	1.6530E-04
		4.62E-04	0.438439	0.029442	10.942	24.476	4.7281E-04
		4.62E-04	0.563069	0.239371	14.052	31.434	3.8441E-03
		4.62E-04	0.680271	1.457093	16.977	37.977	2.3399E-02
		4.62E-04	0.789729	2.2118	19.709	44.087	3.5519E-02
				0.7895998			
A201-1	**A201-1**	4.62E-04	0.306697	0.004001	7.654	17.122	6.4252E-05
		4.62E-04	0.563069	0.009696	14.052	31.434	1.5571E-04
		4.62E-04	0.789729	0.124903	19.709	44.087	2.0058E-03
		4.62E-04	0.984148	1.013792	24.561	54.941	1.6280E-02
				0.288098			
A34-3	**A34-3**	4.62E-04	0.306697	0.002301	7.654	17.122	3.6952E-05
		4.62E-04	0.438439	0.009576	10.942	24.476	1.5378E-04
		4.62E-04	0.563069	0.034841	14.052	31.434	5.5951E-04
		4.62E-04	0.680271	0.829496	16.977	37.977	1.3321E-02
		4.62E-04	0.789729	0.402516	19.709	44.087	6.4640E-03
				0.255746			

Assumptions an(Assumptions and Notes:

Z_0 = mean aerodynamic roughness length for Owens Lake data, page 20, Table 6.1, for Lake (w/o feed), "PM10 DUST EMISSIONS AT OWENS LAKE, CA 2001 (Final)" = 4.62 E-04 meters.

$U_{10\ met}$ is the equivalent 10 meter wind speed computed by using the Prandtl-von Karman equation:

$$U10\ met = (u^*/\kappa) \times \ln(10\ met/Z_0)$$

Wind Speed (miles per hour) = 2.23692 x wind speed (meters per second)

Emissions (tons/acre x hour) = 0.016059 x Emissions (mg/m^2 sec)

ATTACHMENT E3, APPENDIX C

PI-SWERL Emissions Estimates Organized by Wind Speed Corrected to 10 meters

PI-SWERL EMISSIONS (tons/acre x hour) ORGANIZED BY WIND SPEED (mph) CORRECTED TO 10 METERS

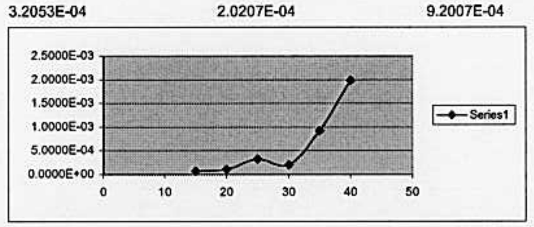
Stable Playa

PI-SWERL LOCATION	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)
	12.204	17.122	19.217	22.406	24.476	26.953	31.426	31.434	33.588	34.758	37.977	39.037
A100-1		6.8443E-05			1.6173E-04			2.0506E-04		7.6071E-05	2.6712E-03	
A100-2		N/A						1.8566E-04				
A101-1			6.1201E-05			1.3159E-04			2.2799E-04			3.3830E-04
A29-1		1.5031E-05			3.0048E-05			6.4252E-05			9.9582E-05	
A31-1			1.9981E-04			6.0510E-04			2.1302E-03			5.1711E-03
A32-1		1.6091E-05						2.9533E-05				
A34-1		2.9834E-04			6.7417E-04			3.0409E-04			2.1539E-03	
A-34-2		N/A						2.8903E-04				
SS16-1								7.2150E-04				
SS17-1	N/A			4.8000E-05			1.5391E-04					
SS2-1		3.9039E-05						1.2380E-04				
SS6-1		4.5013E-05						8.0022E-05				
SS9-1		2.5004E-05						6.5874E-05				
A200-1		N/A			N/A			N/A			N/A	
A201-1		N/A						N/A				
A34-3		N/A			N/A			N/A			N/A	
SUM	0.0000E+00	5.0697E-04	2.6101E-04	4.8000E-05	8.6595E-04	7.3669E-04	1.5391E-04	2.0688E-03	2.3582E-03	7.6071E-05	4.9247E-03	5.5094E-03
MEAN	0.0000E+00	7.2424E-05	1.3050E-04	4.8000E-05	2.8865E-04	3.6835E-04	1.5391E-04	2.0688E-04	1.1791E-03	7.6071E-05	1.6416E-03	2.7547E-03
S.D.	0.0000E+00	9.3837E-05	9.8009E-05	0.0000E+00	3.4030E-04	3.3483E-04	0.0000E+00	2.0444E-04	1.3451E-03	0.0000E+00	1.3602E-03	3.4173E-03
MAX.	0.0000E+00	2.9834E-04	2.0000E-04	4.8000E-05	6.7417E-04	6.0510E-04	1.5391E-04	7.2150E-04	2.1302E-03	7.6071E-05	2.6712E-03	3.3830E-04
MIN.	0.0000E+00	1.5031E-05	6.1201E-05	4.8000E-05	3.0048E-05	1.3159E-04	1.5391E-04	2.9533E-05	2.2799E-04	7.6071E-05	9.9582E-05	5.1711E-03

PI-SWERL LOCATION	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)
	39.162	43.212	44.087	45.515	46.028	50.383	53.666	54.941	63.853	70.683	75.288
A100-1			1.2838E-02					3.7474E-02			
A100-2			4.4615E-04					8.6104E-04	1.7195E-03	2.1169E-03	8.7916E-03
A101-1		5.2192E-04			1.8338E-03						
A29-1			5.2519E-03					N/A	N/A		
A31-1		2.0184E-02			5.6493E-02						
A32-1			1.3689E-04					1.2848E-03	5.1587E-03	1.8231E-02	6.5785E-03
A34-1			1.6377E-03					7.2596E-03	2.3525E-02	9.2437E-03	3.1900E-02
A-34-2			5.1423E-04					9.5578E-04	2.6017E-03	5.6326E-03	1.2103E-02
SS16-1			1.3252E-03					2.0511E-03	3.2031E-03	4.9499E-03	8.1608E-03
SS17-1	4.4403E-04			1.2597E-03		1.1571E-03	2.8420E-03				
SS2-1			8.1775E-03					5.7694E-02			
SS6-1			3.9770E-04					2.8354E-03	N/A		
SS9-1			1.7406E-04					1.2090E-02			
A200-1			N/A								
A201-1			N/A					N/A			
A34-3			N/A								
SUM	4.4403E-04	2.0706E-02	3.0900E-02	1.2597E-03	5.8327E-02	1.1571E-03	2.8420E-03	1.2251E-01	3.6208E-02	4.0174E-02	6.7534E-02
MEAN	4.4403E-04	1.0353E-02	3.0900E-03	1.2597E-03	2.9163E-02	1.1571E-03	2.8420E-03	1.3612E-02	7.2417E-03	8.0347E-03	1.3507E-02
S.D.	0.0000E+00	1.3903E-02	4.3321E-03	0.0000E+00	3.8650E-02	0.0000E+00	0.0000E+00	2.0248E-02	8.7354E-03	6.4734E-03	1.0873E-02
MAX.	4.4403E-04	2.0184E-02	1.2838E-02	1.2597E-03	5.6493E-02	1.1571E-03	2.8420E-03	5.7694E-02	5.1587E-03	1.8231E-02	3.1900E-02
MIN.	4.4403E-04	5.2192E-04	1.3689E-04	1.2597E-03	1.8338E-03	1.1571E-03	2.8420E-03	8.6104E-04	1.7195E-03	2.1169E-03	8.7916E-03

mph	17	20	25	30	35	40	45
tons/acre x hr	7.2424E-05	1.0300E-04	3.2053E-04	2.0207E-04	9.2007E-04	1.9845E-03	7.4128E-03

15	7.2424E-05
20	1.0300E-04
25	3.2053E-04
30	2.0207E-04
35	9.2007E-04
40	1.9845E-03
45	7.4128E-03



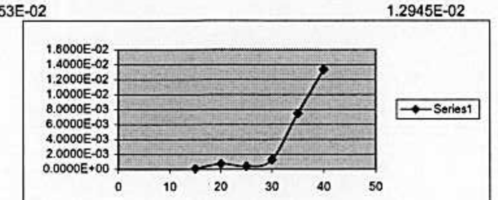
Unstable Playa

PI-SWERL LOCATION	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)
	12.204	17.122	19.217	22.406	24.476	26.953	31.426	31.434	33.588	34.758	37.977	39.037
A100-1		2.0816E-04			4.2359E-04			3.7473E-03		N/A	6.6662E-03	
A100-2		6.4445E-05						1.9335E-04				
A101-1			1.4239E-03			5.2755E-04			1.1395E-03			2.6690E-03
A29-1		2.2113E-05			N/A			1.6862E-04			N/A	
A31-1			2.2606E-04			5.8883E-04			2.3949E-03			7.7233E-03
A32-1		N/A						N/A				
A34-1		5.8503E-05			1.1574E-04			1.6204E-03			9.1796E-03	
A-34-2		2.1583E-05						2.3422E-04				
SS16-1								N/A				
SS17-1	1.3957E-04			4.6276E-04			2.7359E-03					
SS2-1		3.1692E-04						5.6883E-04				
SS6-1		N/A						3.6595E-04				
SS9-1		6.3754E-05						4.9165E-04				
A200-1		1.6530E-04			4.7281E-04			3.8441E-03			2.3399E-02	
A201-1		6.4252E-05						1.5571E-04				
A34-3		3.6952E-05			1.5378E-04			5.5951E-04			1.3321E-02	
SUM	1.3957E-04	1.0220E-03	1.6500E-03	4.6276E-04	1.1659E-03	1.1164E-03	2.7359E-03	1.1950E-02	3.5344E-03	0.0000E+00	5.2566E-02	1.0392E-02
MEAN	1.3957E-04	1.0220E-04	8.2500E-04	4.6276E-04	2.9148E-04	5.5819E-04	2.7359E-03	1.0863E-03	1.7672E-03	0.0000E+00	1.3142E-02	5.1961E-03
S.D.	0.0000E+00	9.2053E-05	8.4702E-04	0.0000E+00	1.8274E-04	4.3328E-05	0.0000E+00	1.4007E-03	8.8772E-04	0.0000E+00	7.3685E-03	3.5740E-03
MAX.	1.3957E-04	3.1692E-04	1.4239E-03	4.6276E-04	4.7281E-04	5.8883E-04	2.7359E-03	3.8441E-03	2.3949E-03	0.0000E+00	2.3399E-02	2.6690E-03
MIN.	1.3957E-04	2.1583E-05	2.1031E-04	4.6276E-04	1.1574E-04	5.2755E-04	2.7359E-03	1.5571E-04	1.1395E-03	0.0000E+00	6.6662E-03	7.7233E-03

PI-SWERL LOCATION	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)	EQUIVALENT 10 MET WIND SPEED, U_{10} met (miles per hour)
	39.162	43.212	44.087	45.515	46.028	50.383	53.666	54.941	63.853	70.683	75.288
A100-1			2.8954E-02					2.6045E-01			
A100-2			1.0278E-03					2.0542E-02	N/A	N/A	N/A
A101-1		N/A			N/A						
A29-1			2.9277E-03					2.8041E-02	2.4590E-02		
A31-1		2.2361E-02			N/A						
A32-1			N/A					N/A	N/A	N/A	N/A
A34-1			3.9703E-02					N/A	N/A	N/A	N/A
A-34-2			6.8546E-03					1.9340E-02	N/A	N/A	N/A
SS16-1			3.3628E-04					3.5473E-03	1.6288E-02	7.5079E-03	1.7121E-02
SS17-1	2.0660E-02			N/A		N/A	N/A				
SS2-1			1.3905E-02					7.4137E-02			
SS6-1			4.3900E-03					1.8368E-02	4.7259E-02		
SS9-1			3.8414E-03					N/A			
A200-1			3.5519E-02								
A201-1			2.0058E-03					1.6280E-02			
A34-3			6.4640E-03								
SUM	2.0660E-02	2.2361E-02	1.4593E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	4.4071E-01	8.8137E-02	7.5079E-03	1.7121E-02
MEAN	2.0660E-02	2.2361E-02	1.2161E-02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	5.5089E-02	2.9379E-02	7.5079E-03	1.7121E-02
S.D.	0.0000E+00	0.0000E+00	1.4243E-02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	8.5566E-02	1.6031E-02	0.0000E+00	0.0000E+00
MAX.	2.0660E-02	2.2361E-02	3.9703E-02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	7.4137E-02	4.7259E-02	7.5079E-03	1.7121E-02
MIN.	2.0660E-02	2.2361E-02	3.3628E-04	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.6280E-02	1.6288E-02	7.5079E-03	1.7121E-02

mph	15	20	25	30	35	40	45	55
tons/acre x hr	1.0560E-04	7.0425E-04	3.8038E-04	1.2238E-03	7.4520E-03	1.3353E-02	1.2945E-02	5.5089E-02

15	1.0560E-04
20	7.0425E-04
25	3.8038E-04
30	1.2238E-03
35	7.4520E-03
40	1.3353E-02
45	1.2945E-02



ATTACHMENT E3, APPENDIX D

Exposed Playa Emissions Estimates

Exposed Playa Emissions Phase 1 (2006 - 2020)
Salton Sea

Total South Sea Acreages	Total North Sea Acreage	Niland EF (South)	Indio EF (North)
146,000.00	86,000.00	7.12E-02	0

Phase 1 (2006-2020) - Alternative 1: Saline Habitat Complex I

Total Exposed Playa Acres	30% NE	50% WEV	20% Other
30,000	9,000	15,000	6,000

Assume 40% of Total Exposed Acreages is in North Portion of Sea & 60% in South Portion of Sea.

Playa Location/Type	Exposed Playa Area (ac)	EF (ton/ac-yr)	Uncontrolled Emissions (tpy)	Uncontrolled Emissions (lb/day)	Control Efficiency*	Controlled Emissions (tpy)	Controlled Emissions (lb/day)
North NE	3,600	0	0.00	0.00	1.00	0.00	0.00
South NE	5,400	7.12E-02	384.43	2106.48	1.00	0.00	0.00
North WEV	6,000	0	0.00	0.00	0.95	0.00	0.00
South WEV	9,000	7.12E-02	640.72	3510.80	0.95	32.04	175.54
North Other	2,400	0	0.00	0.00	0.85	0.00	0.00
South Other	3,600	7.12E-02	256.29	1404.32	0.85	38.44	210.65
TOTAL:	**30,000**	**TOTALS:**	**1281.44**	**7021.60**	**TOTALS:**	**70.48**	**386.19**

* Control Efficiency derived in the PEIR.

Phase 1 (2006-2020) - Alternative 2: Saline Habitat Complex II

Total Exposed Playa Acres	30% NE	50% WEV	20% Other
30,000	9,000	15,000	6,000

Assume 36% of Total Exposed Acreages is in North Portion of Sea & 64% in South Portion of Sea.

Playa Location/Type	Exposed Playa Area (ac)	EF (ton/ac-yr)	Uncontrolled Emissions (tpy)	Uncontrolled Emissions (lb/day)	Control Efficiency*	Controlled Emissions (tpy)	Controlled Emissions (lb/day)
North NE	3,240	0	0.00	0.00	1.00	0.00	0.00
South NE	5,760	7.12E-02	410.06	2246.91	1.00	0.00	0.00
North WEV	5,400	0	0.00	0.00	0.95	0.00	0.00
South WEV	9,600	7.12E-02	683.44	3744.86	0.95	34.17	187.24
North Other	2,160	0	0.00	0.00	0.85	0.00	0.00
South Other	3,840	7.12E-02	273.37	1497.94	0.85	41.01	224.69
TOTAL:	**30,000**	**TOTALS:**	**1366.87**	**7489.71**	**TOTALS:**	**75.18**	**411.93**

* Control Efficiency derived in the PEIR.

Phase 1 (2006-2020) - Alternative 3: Concentric Rings

Total Exposed Playa Acres	30% NE	50% WEV	20% Other
12,000	4,000	6,000	2,000

Assume 33% of Total Exposed Acreages is in North Portion of Sea & 67% in South Portion of Sea.

Playa Location/Type	Exposed Playa Area (ac)	EF (ton/ac-yr)	Uncontrolled Emissions (tpy)	Uncontrolled Emissions (lb/day)	Control Efficiency*	Controlled Emissions (tpy)	Controlled Emissions (lb/day)
North NE	1,320	0	0.00	0.00	1.00	0.00	0.00
South NE	2,680	7.12E-02	190.79	1045.44	1.00	0.00	0.00
North WEV	1,980	0	0.00	0.00	0.95	0.00	0.00
South WEV	4,020	7.12E-02	286.19	1568.16	0.95	14.31	78.41
North Other	660	0	0.00	0.00	0.85	0.00	0.00
South Other	1,340	7.12E-02	95.40	522.72	0.85	14.31	78.41
TOTAL:	**12,000**	**TOTALS:**	**572.38**	**3136.32**	**TOTALS:**	**28.62**	**156.82**

* Control Efficiency derived in the PEIR.

Phase 1 (2006-2020) - Alternative 4: Concentric Lakes

Total Exposed Playa Acres	30% NE	70% Uncontrolled	0% Other
16,000	5,000	11,000	0

Assume 36% of Total Exposed Acreages is in North Portion of Sea & 64% in South Portion of Sea.

Playa Location/Type	Exposed Playa Area (ac)	EF (ton/ac-yr)	Uncontrolled Emissions (tpy)	Uncontrolled Emissions (lb/day)	Control Efficiency*	Controlled Emissions (tpy)	Controlled Emissions (lb/day)
North NE	1,800	0	0.00	0.00	1.00	0.00	0.00
South NE	3,200	7.12E-02	227.81	1248.29	1.00	0.00	0.00
North Uncontrolled	3,960	0	0.00	0.00	0.00	0.00	0.00
South Uncontrolled	7,040	7.12E-02	501.19	2746.23	0.00	501.19	2746.23
North Other	0	0	0.00	0.00	0.85	0.00	0.00
South Other	0	7.12E-02	0.00	0.00	0.85	0.00	0.00
TOTAL:	**16,000**	**TOTALS:**	**729.00**	**3994.51**	**TOTALS:**	**501.19**	**2746.23**

* Control Efficiency derived in the PEIR.

Phase 1 (2006-2020) - Alternative 5: North Sea

Total Exposed Playa Acres	30% NE	50% WEV	20% Other
30,000	9,000	15,000	6,000

Assume 16% of Total Exposed Acreages is in North Portion of Sea & 84% in South Portion of Sea.

Playa Location/Type	Exposed Playa Area (ac)	EF (ton/ac-yr)	Uncontrolled Emissions (tpy)	Uncontrolled Emissions (lb/day)	Control Efficiency*	Controlled Emissions (tpy)	Controlled Emissions (lb/day)
North NE	1,440	0	0.00	0.00	1.00	0.00	0.00
South NE	7,560	7.12E-02	538.21	2949.07	1.00	0.00	0.00
North WEV	2,400	0	0.00	0.00	0.95	0.00	0.00
South WEV	12,600	7.12E-02	897.01	4915.12	0.95	44.85	245.76
North Other	960	0	0.00	0.00	0.85	0.00	0.00
South Other	5,040	7.12E-02	358.80	1966.05	0.85	53.82	294.91
TOTAL:	**30,000**	**TOTALS:**	**1794.02**	**9830.25**	**TOTALS:**	**98.67**	**540.66**

* Control Efficiency derived in the PEIR.

Exposed Playa Emissions Phase 1 (2006 - 2020)
Salton Sea

Phase 1 (2006-2020) - Alternative 6: North Sea Combined

Total Exposed Playa Acres	30% NE	50% WEV	20% Other
30,000	9,000	15,000	6,000

Assume 25% of Total Exposed Acreages is in North Portion of Sea & 75% in South Portion of Sea.

Playa Location/Type	Exposed Playa Area (ac)	EF (ton/ac-yr)	Uncontrolled Emissions (tpy)	Uncontrolled Emissions (lb/day)	Control Efficiency*	Controlled Emissions (tpy)	Controlled Emissions (lb/day)
North NE	2,250	0	0.00	0.00	1.00	0.00	0.00
South NE	6,750	7.12E-02	480.54	2633.10	1.00	0.00	0.00
North WEV	3,750	0	0.00	0.00	0.95	0.00	0.00
South WEV	11,250	7.12E-02	800.90	4388.50	0.95	40.05	219.43
North Other	1,500	0	0.00	0.00	0.85	0.00	0.00
South Other	4,500	7.12E-02	320.36	1755.40	0.85	48.05	263.31
TOTAL:	**30,000**	**TOTALS:**	**1601.80**	**8777.00**	**TOTALS:**	**88.10**	**482.74**

* Control Efficiency derived in the PEIR.

Phase 1 (2006-2020) - Alternative 7: Combined North & South Lakes

Total Exposed Playa Acres	30% NE	70% Uncontrolled	Protected Salt Flat
30,000	9,000	21,000	0

Assume 11% of Total Exposed Acreages is in North Portion of Sea & 89% in South Portion of Sea.

Playa Location/Type	Exposed Playa Area (ac)	EF (ton/ac-yr)	Uncontrolled Emissions (tpy)	Uncontrolled Emissions (lb/day)	Control Efficiency*	Controlled Emissions (tpy)	Controlled Emissions (lb/day)
North NE	990	0	0.00	0.00	1.00	0.00	0.00
South NE	8,010	7.12E-02	570.24	3124.61	1.00	0.00	0.00
North Uncontrolled	2,310	0	0.00	0.00	0.00	0.00	0.00
South Uncontrolled	18,690	7.12E-02	1330.56	7290.77	0.00	1330.56	7290.77
North Protected Salt Flat	0	0	0.00	0.00	0.85	0.00	0.00
South Protected Salt Flat	0	7.12E-02	0.00	0.00	0.85	0.00	0.00
TOTAL:	**30,000**	**TOTALS:**	**1900.81**	**10415.38**	**TOTALS:**	**1330.56**	**7290.77**

* Control Efficiency derived in the PEIR.

Phase 1 (2006-2020) - Alternative 8: South Sea Combined

Total Exposed Playa Acres	30% NE	50% WEV	20% Other
30,000	9,000	15,000	6,000

Assume 57% of Total Exposed Acreages is in North Portion of Sea & 43% in South Portion of Sea.

Playa Location/Type	Exposed Playa Area (ac)	EF (ton/ac-yr)	Uncontrolled Emissions (tpy)	Uncontrolled Emissions (lb/day)	Control Efficiency*	Controlled Emissions (tpy)	Controlled Emissions (lb/day)
North NE	5,130	0	0.00	0.00	1.00	0.00	0.00
South NE	3,870	7.12E-02	275.51	1509.64	1.00	0.00	0.00
North WEV	8,550	0	0.00	0.00	0.95	0.00	0.00
South WEV	6,450	7.12E-02	459.18	2516.07	0.95	22.96	125.80
North Other	3,420	0	0.00	0.00	0.85	0.00	0.00
South Other	2,580	7.12E-02	183.67	1006.43	0.85	27.55	150.96
TOTAL:	**30,000**	**TOTALS:**	**918.37**	**5032.15**	**TOTALS:**	**50.51**	**276.77**

* Control Efficiency derived in the PEIR.

Phase 1 (2006-2020) - Alternative 10: No Action - CEQA Conditions

Total Exposed Playa Acres	30% NE	50% WEV	20% Other
4,000	1,000	2,000	1,000

Assume 20% of Total Exposed Acreages is in North Portion of Sea & 80% in South Portion of Sea.

Playa Location/Type	Exposed Playa Area (ac)	EF (ton/ac-yr)	Uncontrolled Emissions (tpy)	Uncontrolled Emissions (lb/day)	Control Efficiency*	Controlled Emissions (tpy)	Controlled Emissions (lb/day)
North NE	200	0	0.00	0.00	1.00	0.00	0.00
South NE	800	7.12E-02	56.95	312.07	1.00	0.00	0.00
North WEV	400	0	0.00	0.00	0.95	0.00	0.00
South WEV	1,600	7.12E-02	113.91	624.14	0.95	5.70	31.21
North Other	200	0	0.00	0.00	0.85	0.00	0.00
South Other	800	7.12E-02	56.95	312.07	0.85	8.54	46.81
TOTAL:	**4,000**	**TOTALS:**	**227.81**	**1248.29**	**TOTALS:**	**14.24**	**78.02**

* Control Efficiency derived in the PEIR.

Phase 1 (2006-2020) - Alternative 11: No Action - Variability Assumptions

Total Exposed Playa Acres	30% NE	50% WEV	20% Other
4,000	1,000	2,000	1,000

Assume 24% of Total Exposed Acreages is in North Portion of Sea & 76% in South Portion of Sea.

Playa Location/Type	Exposed Playa Area (ac)	EF (ton/ac-yr)	Uncontrolled Emissions (tpy)	Uncontrolled Emissions (lb/day)	Control Efficiency*	Controlled Emissions (tpy)	Controlled Emissions (lb/day)
North NE	240	0	0.00	0.00	1.00	0.00	0.00
South NE	760	7.12E-02	54.11	296.47	1.00	0.00	0.00
North WEV	480	0	0.00	0.00	0.95	0.00	0.00
South WEV	1,520	7.12E-02	108.21	592.94	0.95	5.41	29.65
North Other	240	0	0.00	0.00	0.85	0.00	0.00
South Other	760	7.12E-02	54.11	296.47	0.85	8.12	44.47
TOTAL:	**4,000**	**TOTALS:**	**216.42**	**1185.87**	**TOTALS:**	**13.53**	**74.12**

* Control Efficiency derived in the PEIR.

Phase 1 (2006-2020) - No Action - Variability & CEQA/Landowners Responsible

Total Exposed Playa Acres	30% NE	70% AQM Other	0% Other
16,000	4,800	11,200	0

Assume 31% of Total Exposed Acreages is in North Portion of Sea & 69% in South Portion of Sea.

Playa Location/Type	Exposed Playa Area (ac)	EF (ton/ac-yr)	Uncontrolled Emissions (tpy)	Uncontrolled Emissions (lb/day)	Control Efficiency*	Controlled Emissions (tpy)	Controlled Emissions (lb/day)
North NE	1,488	0	0.00	0.00	1.00	0.00	0.00
South NE	3,312	7.12E-02	235.79	1291.98	1.00	0.00	0.00
North AQM Other	3,472	0	0.00	0.00	0.85	0.00	0.00
South AQM Other	7,728	7.12E-02	550.17	3014.61	0.85	82.52	452.19
North Other	0	0	0.00	0.00	0.85	0.00	0.00
South Other	0	7.12E-02	0.00	0.00	0.85	0.00	0.00
TOTAL:	**16,000**	**TOTALS:**	**785.95**	**4306.58**	**TOTALS:**	**82.52**	**452.19**

* Control Efficiency derived in the PEIR.
AQM = Air Quality Management
NE = nonemissive
WEV = water efficient vegetation

Exposed Playa Emissions Phase 4 (2041 - 2078)

Total South Sea Acreages	Total North Sea Acreage	Niland EF (South)	Indio EF (North)
146,000.00	86,000.00	7.12E-02	0

Phase 4 (2041-2078) - Alternative 1: Saline Habitat Complex I

Total Exposed Playa Acres	30% NE	50% WEV	20% Other
83,000	25,000	41,000	17,000

Assume 40% of Total Exposed Acreages is in North Portion of Sea & 60% in South Portion of Sea.

Playa Location/Type	Exposed Playa Area (ac)	EF (ton/ac-yr)	Uncontrolled Emissions (tpy)	Uncontrolled Emissions (lb/day)	Control Efficiency*	Controlled Emissions (tpy)	Controlled Emissions (lb/day)
North NE	10,000	0	0.00	0.00	1.00	0.00	0.00
South NE	15,000	7.12E-02	1067.87	5851.34	1.00	0.00	0.00
North WEV	16,400	0	0.00	0.00	0.95	0.00	0.00
South WEV	24,600	7.12E-02	1751.30	9596.19	0.95	87.57	479.81
North Other	6,800	0	0.00	0.00	0.85	0.00	0.00
South Other	10,200	7.12E-02	726.15	3978.91	0.85	108.92	596.84
TOTAL:	**83,000**	**TOTALS:**	**3545.32**	**19426.44**	**TOTALS:**	**196.49**	**1076.65**

* Control Efficiency derived in the PEIR.

Phase 4 (2041-2078) - Alternative 2: Saline Habitat Complex II

Total Exposed Playa Acres	30% NE	50% WEV	20% Other
91,000	27,000	46,000	18,000

Assume 36% of Total Exposed Acreages is in North Portion of Sea & 64% in South Portion of Sea.

Playa Location/Type	Exposed Playa Area (ac)	EF (ton/ac-yr)	Uncontrolled Emissions (tpy)	Uncontrolled Emissions (lb/day)	Control Efficiency*	Controlled Emissions (tpy)	Controlled Emissions (lb/day)
North NE	9,720	0	0.00	0.00	1.00	0.00	0.00
South NE	17,280	7.12E-02	1230.18	6740.74	1.00	0.00	0.00
North WEV	16,560	0	0.00	0.00	0.95	0.00	0.00
South WEV	29,440	7.12E-02	2095.87	11484.22	0.95	104.79	574.21
North Other	6,480	0	0.00	0.00	0.85	0.00	0.00
South Other	11,520	7.12E-02	820.12	4493.83	0.85	123.02	674.07
TOTAL:	**91,000**	**TOTALS:**	**4146.18**	**22718.79**	**TOTALS:**	**227.81**	**1248.29**

* Control Efficiency derived in the PEIR.

Phase 4 (2041-2078) - Alternative 3: Concentric Rings

Total Exposed Playa Acres	30% NE	50% WEV	20% Other
126,000	38,000	63,000	25,000

Assume 33% of Total Exposed Acreages is in North Portion of Sea & 67% in South Portion of Sea.

Playa Location/Type	Exposed Playa Area (ac)	EF (ton/ac-yr)	Uncontrolled Emissions (tpy)	Uncontrolled Emissions (lb/day)	Control Efficiency*	Controlled Emissions (tpy)	Controlled Emissions (lb/day)
North NE	12,540	0	0.00	0.00	1.00	0.00	0.00
South NE	25,460	7.12E-02	1812.53	9931.67	1.00	0.00	0.00
North WEV	20,790	0	0.00	0.00	0.95	0.00	0.00
South WEV	42,210	7.12E-02	3004.98	16465.66	0.95	150.25	823.28
North Other	8,250	0	0.00	0.00	0.85	0.00	0.00
South Other	16,750	7.12E-02	1192.45	6533.99	0.85	178.87	980.10
TOTAL:	**126,000**	**TOTALS:**	**6009.97**	**32931.32**	**TOTALS:**	**329.12**	**1803.38**

* Control Efficiency derived in the PEIR.

Phase 4 (2041-2078) - Alternative 4: Concentric Lakes

Total Exposed Playa Acres	30% NE	70% Uncontrolled	0% Other
128,000	38,000	90,000	0

Assume 36% of Total Exposed Acreages is in North Portion of Sea & 64% in South Portion of Sea.

Playa Location/Type	Exposed Playa Area (ac)	EF (ton/ac-yr)	Uncontrolled Emissions (tpy)	Uncontrolled Emissions (lb/day)	Control Efficiency*	Controlled Emissions (tpy)	Controlled Emissions (lb/day)
North NE	13,680	0	0.00	0.00	1.00	0.00	0.00
South NE	24,320	7.12E-02	1731.37	9486.97	1.00	0.00	0.00
North Uncontrolled	32,400	0	0.00	0.00	0.00	0.00	0.00
South Uncontrolled	57,600	7.12E-02	4100.62	22469.13	0.00	4100.62	22469.13
North Other	0	0	0.00	0.00	0.85	0.00	0.00
South Other	0	7.12E-02	0.00	0.00	0.85	0.00	0.00
TOTAL:	**128,000**	**TOTALS:**	**5831.99**	**31956.10**	**TOTALS:**	**4100.62**	**22469.13**

* Control Efficiency derived in the PEIR.
If long-term irrigation facilities were included, these emissions would be reduced.

Phase 4 (2041-2078) - Alternative 5: North Sea

Total Exposed Playa Acres	30% NE	50% WEV	20% Other
118,000	35,000	59,000	24,000

Assume 16% of Total Exposed Acreages is in North Portion of Sea & 84% in South Portion of Sea.

Playa Location/Type	Exposed Playa Area (ac)	EF (ton/ac-yr)	Uncontrolled Emissions (tpy)	Uncontrolled Emissions (lb/day)	Control Efficiency*	Controlled Emissions (tpy)	Controlled Emissions (lb/day)
North NE	5,600	0	0.00	0.00	1.00	0.00	0.00
South NE	29,400	7.12E-02	2093.02	11468.62	1.00	0.00	0.00
North WEV	9,440	0	0.00	0.00	0.95	0.00	0.00
South WEV	49,560	7.12E-02	3528.24	19332.82	0.95	176.41	966.64
North Other	3,840	0	0.00	0.00	0.85	0.00	0.00
South Other	20,160	7.12E-02	1435.22	7864.20	0.85	215.28	1179.63
TOTAL:	**118,000**	**TOTALS:**	**7056.48**	**38665.63**	**TOTALS:**	**391.69**	**2146.27**

* Control Efficiency derived in the PEIR.

Phase 4 (2041-2078) - Alternative 6: North Sea Combined

Total Exposed Playa Acres	30% NE	50% WEV	20% Other
131,000	39,000	66,000	26,000

Assume 25% of Total Exposed Acreages is in North Portion of Sea & 75% in South Portion of Sea.

Playa Location/Type	Exposed Playa Area (ac)	EF (ton/ac-yr)	Uncontrolled Emissions (tpy)	Uncontrolled Emissions (lb/day)	Control Efficiency*	Controlled Emissions (tpy)	Controlled Emissions (lb/day)
North NE	9,750	0	0.00	0.00	1.00	0.00	0.00
South NE	29,250	7.12E-02	2082.34	11410.11	1.00	0.00	0.00
North WEV	16,500	0	0.00	0.00	0.95	0.00	0.00
South WEV	49,500	7.12E-02	3523.97	19309.41	0.95	176.20	965.47
North Other	6,500	0	0.00	0.00	0.85	0.00	0.00
South Other	19,500	7.12E-02	1388.23	7606.74	0.85	208.23	1141.01
TOTAL:	**131,000**	**TOTALS:**	**6994.54**	**38326.25**	**TOTALS:**	**384.43**	**2106.48**

* Control Efficiency derived in the PEIR.

Exposed Playa Emissions Phase 4 (2041 - 2078)

Phase 4 (2041-2078) - Alternative 7: Combined North & South Lakes

Total Exposed Playa Acres	30% NE	70% Uncontrolled	Protective Salt Flat
40,000 (+63,000 salt flat)	12,000	28,000	63,000

Assume 11% of Total Exposed Acreages is in North Portion of Sea & 89% in South Portion of Sea.
Assume 3,000 acres of protective salt flat is in the north, and 60,000 acres of protective salt flat is in the south portion of the Sea.

Playa Location/Type	Exposed Playa Area (ac)	EF (ton/ac-yr)	Uncontrolled Emissions (tpy)	Uncontrolled Emissions (lb/day)	Control Efficiency*	Controlled Emissions (tpy)	Controlled Emissions (lb/day)
North NE	1,320	0	0.00	0.00	1.00	0.00	0.00
South NE	10,680	7.12E-02	760.32	4166.15	1.00	0.00	0.00
North Uncontrolled	3,080	0	0.00	0.00	0.00	0.00	0.00
South Uncontrolled	24,920	7.12E-02	1774.09	9721.02	0.00	1774.09	9721.02
North Salt Flat	3,000	0	0.00	0.00	0.85	0.00	0.00
South Salt Flat	60,000	7.12E-02	4271.47	23405.32	0.85	640.72	3510.80
TOTAL:	**103,000**	**TOTALS:**	**6805.88**	**37292.49**	**TOTALS:**	**2414.81**	**13231.82**

* Control Efficiency derived in the PEIR.

Phase 4 (2041-2078) - Alternative 8: South Sea Combined

Total Exposed Playa Acres	30% NE	50% WEV	20% Other
128,000	38,000	64,000	26,000

Assume 57% of Total Exposed Acreages is in North Portion of Sea & 43% in South Portion of Sea.

Playa Location/Type	Exposed Playa Area (ac)	EF (ton/ac-yr)	Uncontrolled Emissions (tpy)	Uncontrolled Emissions (lb/day)	Control Efficiency*	Controlled Emissions (tpy)	Controlled Emissions (lb/day)
North NE	21,660	0	0.00	0.00	1.00	0.00	0.00
South NE	16,340	7.12E-02	1163.27	6374.06	1.00	0.00	0.00
North WEV	36,480	0	0.00	0.00	0.95	0.00	0.00
South WEV	27,520	7.12E-02	1959.18	10735.25	0.95	97.96	536.76
North Other	14,820	0	0.00	0.00	0.85	0.00	0.00
South Other	11,180	7.12E-02	795.92	4361.20	0.85	119.39	654.18
TOTAL:	**128,000**	**TOTALS:**	**3918.37**	**21470.50**	**TOTALS:**	**217.35**	**1190.94**

* Control Efficiency derived in the PEIR.

Phase 4 (2041-2078) - Alternative 10: No Action - CEQA Conditions

Total Exposed Playa Acres	30% NE	50% WEV	20% Other
47,000	14,000	24,000	9,000

Assume 20% of Total Exposed Acreages is in North Portion of Sea & 80% in South Portion of Sea.

Playa Location/Type	Exposed Playa Area (ac)	EF (ton/ac-yr)	Uncontrolled Emissions (tpy)	Uncontrolled Emissions (lb/day)	Control Efficiency*	Controlled Emissions (tpy)	Controlled Emissions (lb/day)
North NE	2,800	0	0.00	0.00	1.00	0.00	0.00
South NE	11,200	7.12E-02	797.34	4369.00	1.00	0.00	0.00
North WEV	4,800	0	0.00	0.00	0.95	0.00	0.00
South WEV	19,200	7.12E-02	1366.87	7489.71	0.95	68.34	374.49
North Other	1,800	0	0.00	0.00	0.85	0.00	0.00
South Other	7,200	7.12E-02	512.58	2808.64	0.85	76.89	421.30
TOTAL:	**47,000**	**TOTALS:**	**2676.79**	**14667.35**	**TOTALS:**	**145.23**	**795.78**

* Control Efficiency derived in the PEIR.

Phase 4 (2041-2078) - Alternative 11: No Action - Variability Assumptions

Total Exposed Playa Acres	30% NE	50% WEV	20% Other
47,000	14,000	24,000	9,000

Assume 24% of Total Exposed Acreages is in North Portion of Sea & 76% in South Portion of Sea.

Playa Location/Type	Exposed Playa Area (ac)	EF (ton/ac-yr)	Uncontrolled Emissions (tpy)	Uncontrolled Emissions (lb/day)	Control Efficiency*	Controlled Emissions (tpy)	Controlled Emissions (lb/day)
North NE	3,360	0	0.00	0.00	1.00	0.00	0.00
South NE	10,640	7.12E-02	757.48	4150.55	1.00	0.00	0.00
North WEV	5,760	0	0.00	0.00	0.95	0.00	0.00
South WEV	18,240	7.12E-02	1298.53	7115.23	0.95	64.93	355.76
North Other	2,160	0	0.00	0.00	0.85	0.00	0.00
South Other	6,840	7.12E-02	486.95	2668.21	0.85	73.04	400.23
TOTAL:	**47,000**	**TOTALS:**	**2542.95**	**13933.98**	**TOTALS:**	**137.97**	**755.99**

* Control Efficiency derived in the PEIR.

Phase 4 (2041-2078) - No Action - Variability/Landowners Responsible

Total Exposed Playa Acres	30% NE	70% AQM Other	0% Other
51,000	15,300	35,700	0

Assume 29% of Total Exposed Acreages is in North Portion of Sea & 71% in South Portion of Sea.

Playa Location/Type	Exposed Playa Area (ac)	EF (ton/ac-yr)	Uncontrolled Emissions (tpy)	Uncontrolled Emissions (lb/day)	Control Efficiency*	Controlled Emissions (tpy)	Controlled Emissions (lb/day)
North NE	4,500	0	0.00	0.00	1.00	0.00	0.00
South NE	10,800	7.12E-02	768.88	4213.07	1.00	0.00	0.00
North AQM Other	10,500	0	0.00	0.00	0.85	0.00	0.00
South AQM Other	25,200	7.12E-02	1794.01	9830.21	0.85	269.10	1474.53
North Other	0	0	0.00	0.00	0.85	0.00	0.00
South Other	0	7.12E-02	0.00	0.00	0.85	0.00	0.00
TOTAL:	**51,000**	**TOTALS:**	**2562.90**	**14043.28**	**TOTALS:**	**269.10**	**1474.53**

* Control Efficiency derived in the PEIR.

Phase 4 (2041-2078) - No Action - CEQA/Landowners Responsible

Total Exposed Playa Acres	30% NE	70% AQM Other	0% Other
18,800	5,640	13,160	0

Assume 31% of Total Exposed Acreages is in North Portion of Sea & 69% in South Portion of Sea.

Playa Location/Type	Exposed Playa Area (ac)	EF (ton/ac-yr)	Uncontrolled Emissions (tpy)	Uncontrolled Emissions (lb/day)	Control Efficiency*	Controlled Emissions (tpy)	Controlled Emissions (lb/day)
North NE	1,740	0	0.00	0.00	1.00	0.00	0.00
South NE	3,900	7.12E-02	277.65	1521.35	1.00	0.00	0.00
North AQM Other	4,060	0	0.00	0.00	0.85	0.00	0.00
South AQM Other	9,100	7.12E-02	647.84	3549.81	0.85	97.18	532.47
North Other	0	0	0.00	0.00	0.85	0.00	0.00
South Other	0	7.12E-02	0.00	0.00	0.85	0.00	0.00
TOTAL:	**18,800**	**TOTALS:**	**925.49**	**5071.16**	**TOTALS:**	**97.18**	**532.47**

* Control Efficiency derived in the PEIR.
AQM = Air Quality Management
NE = nonemissive
WEV = water efficient vegetation

APPENDIX E, ATTACHMENT E4

Constituents of Potential Concern in Sediments and Soils, and Their Potential to Affect Human Health

September 2005

(Not Updated for the PEIR)

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APPENDIX E, ATTACHMENT 4
CONSTITUENTS OF POTENTIAL CONCERN IN SEDIMENTS AND SOILS, AND THEIR POTENTIAL TO AFFECT HUMAN HEALTH

EXECUTIVE SUMMARY

In compliance with legislation enacted in 2003 and 2004, the California Resources Agency is preparing a Salton Sea Ecosystem Restoration Plan (ERP) and accompanying Programmatic Environmental Impact Report (PEIR). Under future restoration alternatives being considered for the Salton Sea, currently wet or flooded areas could become dry and exposed and, thereby, become sources of windblown dust. Some constituents contained within the near-shore sediments and soils are of concern because of their potential to adversely affect human health through human exposure to fugitive dust or volatile emissions. Human exposure routes could include inhalation (breathing), ingestion (eating), or dermal contact (skin contact) with the constituents of concern.

As part of the PEIR, air quality and potential human health impacts will be evaluated for the No Action Alternative, program alternatives (not yet identified), and cumulative conditions. The purpose of this memorandum is to:

- Sort and analyze sampling data collected as part of Task Orders No. 13 and 20 to confirm the presence or non-presence of those constituents identified as posing potential human health concerns.
- Review sampling data to evaluate the concentrations of constituents of potential concern.
- Evaluate the possible level of human exposure to constituents of potential concern.
- Evaluate the potential health effects associated with possible levels of human exposure.
- Make recommendations for additional research or analysis needed prior to detailed health risk assessment.

This technical memorandum interprets the results reported for the sampling and analysis of constituents of potential concern in sediments and soil. It also includes a preliminary assessment of the potential to affect human health, and provides recommendations for further study and health risk assessment. In addition, to support human exposure assessment, a search of the scientific literature and a review of regulatory agency guidance were conducted to better understand the appropriate action levels, or levels of concern, both current and pending, for each relevant constituent for the inhalation, ingestion, and dermal exposure pathways.

This memorandum lists chemical constituents or pathogens in Salton Sea sediments and soils that could adversely affect human health. Information on the concentrations of these constituents in Salton Sea sediments and soils was generated from sampling data obtained under Task Orders No. 13 and 20. This memorandum also provides a preliminary evaluation of the potential for adverse human health effects due to possible exposure to the sediments and soils. The potential health effects evaluated include incremental lifetime cancer risk, non-cancer health effects from chronic (long-term) exposure, and non-cancer health effects from acute (short-term) exposure.

The process of evaluating health effects includes three components: exposure assessment, hazard assessment, and risk characterization.[1] Exposure assessment identifies potential pathways by which exposure could occur; characterizes the potentially exposed populations; and estimates the magnitude, frequency, and duration of exposure. Hazard assessment evaluates the toxicity of the chemicals of potential concern, and the magnitude of exposure and adverse effects. Risk characterization integrates the exposure and hazard assessments to estimate the potential risks to human health from exposure to the chemicals of potential concern at specified locations. In the current study, the chemicals of potential concern comprise the fugitive dust and volatile emissions that may be emitted from soils and sediments in the Salton Sea area under ERP alternatives.

The direct inhalation exposure pathway is evaluated based on maximum ambient concentrations of particulate matter (PM) measured in the region over the last 10 years. The oral exposure pathway is evaluated based on maximum observed and calculated ingestion of soil provided by U.S. Environmental Protection Agency (EPA) guidance and independent studies. Dermal exposure is addressed only briefly and requires further study.

Results of this initial study show that cancer risk from the inhalation pathway may outweigh the relative cancer risk from the oral pathway, and that potentially high levels of chromium may account for the majority of the estimated inhalation cancer risk. This result is based on the conservative assumption that 50 percent of the total chromium found in the samples is the carcinogenic form of chromium (i.e., hexavalent chromium). This result would be greatly improved by further study to speciate the chromium and determine the actual percentage of hexavalent chromium in the soil and sediment sampled at the Salton Sea.

Results of this initial study also show that for non-cancer adverse health effects, those from chronic (long-term) exposure outweigh those from acute (short-term) exposure to constituents of potential concern.

Additional refinement to the techniques used in this memorandum will be required to more accurately assess potential health impacts. Recommended refinements include additional research into the bioavailability of constituents of potential concern, as well as emissions estimation and screening-level dispersion modeling to estimate potential ambient concentrations of constituents in populated areas near the Salton Sea.

This preliminary draft technical memorandum provides health risk assessment information relative to the ERP and PEIR. It is the first in a series of memoranda on the potential human health effects associated with exposure to airborne constituents of potential concern. It addresses only constituents of potential concern found in sediments and soils around the Salton Sea, whereas, to the extent feasible, the ERP and PEIR will quantify and assess the significance of all potential exposure routes and human health impacts associated with the No Action Alternative and other project alternatives.

BACKGROUND

In compliance with legislation enacted in 2003 and 2004, the California Resources Agency is preparing a Salton Sea ERP and accompanying PEIR. The study area for the PEIR is the Salton Sea watershed. The U.S. portion of the Salton Sea watershed is located in four counties (Imperial, Riverside, San Bernardino, and San Diego), under the jurisdiction of the following four local air quality agencies: the Imperial County Air Pollution Control District (ICAPCD), the San Diego Air Pollution Control District (SDAPCD), the South Coast Air Quality Management District (SCAQMD), and the Mojave Desert Air Quality Management District (MDAQMD).

[1] In each case, the current study provides only a preliminary assessment. Recommendations for further study are provided.

Under future restoration alternatives being considered for the Salton Sea, currently wet (or flooded) areas could become dry and exposed and, thereby, become sources of windblown dust. Construction may also occur in exposed areas, resulting in fugitive dust. Some constituents contained within the near-shore sediments and soils are of concern because of their potential to adversely affect human health. The potential impacts could result from human exposure to fugitive dust containing these constituents, or from human exposure to volatile or semi-volatile emissions from exposed or disturbed areas. Potential human exposure routes include inhalation (breathing), ingestion (eating), or dermal contact (skin contact) with the constituents of concern.

As part of the PEIR, air quality and potential human health impacts will be evaluated for the No Action Alternative, program alternatives (not yet identified), and cumulative conditions. To evaluate the alternatives relative one to another, a uniform set of analytical tools will be developed. To evaluate the significance of potential impacts, significance criteria will be identified and applied. In some local air districts, in addition to other air quality-related thresholds, significance criteria for proposed emissions sources have been established for health risks associated with human exposure to airborne toxic air contaminants (TACs).

To evaluate ERP impacts and compare to risk-based significance criteria, and to respond to comments regarding potential human and ecological health risks received during the scoping process, the California Department of Water Resources (DWR) has issued several task orders for sampling and analysis of biota, soils, and sediments around the Salton Sea. Task Orders No. 13 and 20 focus on collection of samples and analysis of these samples for selenium and other constituents of potential concern.

Task Order No. 19, Subtask 3.01, identified the constituents of potential concern for sampling and analysis in soil and sediment. Those constituents are elements or compounds that have not only the potential to be present in water, soil, or sediment at the Salton Sea, but also have the potential to be ingested or become airborne, enter a human exposure pathway, and result in adverse health effects.

This memorandum, prepared under Task Order No. 19, Subtask 3.02, interprets the results reported for the sampling and analysis of constituents of potential concern in sediments and soil. It also includes a preliminary assessment of the potential to affect human health, and provides recommendations for further study and health risk assessment. In addition, to support human exposure assessment, a search of the scientific literature and a review of regulatory agency guidance were conducted to better understand the appropriate action levels, or levels of concern, both current and pending, for each relevant constituent or pathogen for the inhalation, ingestion, and dermal exposure pathways.

Review of Existing Data to Develop a List of Constituents of Potential Concern

As part of Subtask 3.01, a list of chemical constituents or pathogens likely to be present in Salton Sea sediments and soils was developed by reviewing literature, risk assessments performed for previous projects in the Salton Sea area, and water sampling data collected by the California Regional Water Quality Control Board from the New River. Examination of New River water sampling data was deemed appropriate, as the New River feeds into the Salton Sea and constituents in the New River water could migrate into the sediments and soils around the Salton Sea.

The initial list of constituents of potential concern identified from these sources was screened to include only those that could become airborne, result in human exposures, and adversely affect human health. Potential health impacts are divided into two classes: cancer causing (carcinogenic), and non-carcinogenic. Non-carcinogenic, or non-cancer, adverse health effects include such maladies as impairment of the central nervous system and loss of organ function due to cell death. Cancerous maladies are limited to the formation of specific types of tumors. Carcinogenic effects are caused by chronic (of long-term duration) exposure to cancer-causing toxicants. Non-cancer health effects may be caused by either chronic or acute (of short duration) exposure.

Table 1 lists the chemical compounds found in soil or sediment samples and the corresponding potential for carcinogenic (cancer) effects and non-carcinogenic (non-cancer) acute and chronic effects.

Table 1
Chemical Compounds Found in Soil or Sediment Samples and Their Potential for Cancer or Non-Cancer Health Effects

Chemical Name	Potential for Cancer Effects	Potential for Non-Cancer Effects
Acenaphthene		X
Acenaphthylene		X
Aldrin	X	X
alpha-Hexachlorocyclohexane	X	X
Aluminum		X
Aniline	X	X
Anthracene		X
Antimony Compounds		X
PCB	X	X
Arsenic	X	X
Barium		X
Benz(A)anthracene	X	
Benzo(A)pyrene	X	
Benzo(B)fluoranthene	X	
Benzoic Acid		X
Benzyl Alcohol		X
Beryllium	X	X
beta- Hexachlorocyclohexane	X	X
BIS(2-Chloroethyl)Ether (Dichloroethyl ether)	X	
Butylbenzylphthalate		X
2-Chlorophenol		X
4-Chloro-3-methylphenol		X
4-Chloroaniline		X
Cadmium	X	X
Chromium	X	X
Chrysene	X	
Cobalt		X
Copper		X
1,2-Dichlorobenzene		X
1,2-Diphenylhydrazine	X	
1,3-Dichlorobenzene		X
2,4-Dichlorophenol		X
2,4-dimethyphenol		X
2,4-Dinitrophenol	X	X
2,4-Dinitrotoluene	X	
3,3-Dichlorobenzidine	X	
4,4’-DDD	X	X
4,4’-DDE	X	X
4,4’-DDT	X	X
Di(2-ethylhexyl)phthalate (DEHP)	X	X

Table 1
Chemical Compounds Found in Soil or Sediment Samples and Their Potential for Cancer or Non-Cancer Health Effects

Chemical Name	Potential for Cancer Effects	Potential for Non-Cancer Effects
Dibenz(A,H)anthracene	X	
Dieldrin	X	X
Diethylphthalate		X
Dimethylphthalate		X
Di-n-butylphthalate		X
Di-n-octylphthalate		X
Endosulfan I		X
Endrin		X
Fluoranthene		X
Fluorene		X
Heptachlor	X	X
Heptachlor epoxide	X	X
Hexachlorobenzene	X	X
Hexachlorobutadiene	X	X
Hexachlorocyclohexane	X	X
Hexachlorocyclopentadiene		X
Hexachloroethane	X	X
Indeno(1,2,3-C,D)pyrene	X	
Isophorone		X
Lead	X	
2-Methylnaphthalene		X
Magnesium		X
Manganese	X	X
Mercury	X	X
Methoxychlor		X
Molybdenum		X
2-Nitrophenol		X
3-Nitroaniline		X
Naphthalene	X	X
Nickel	X	X
N-nitrosodimethylamine	X	
N-nitrosodi-n-propylamine	X	
N-nitrosodiphenylamine	X	
o-Cresol		X
OM Selenium Plus Residue Selenium		X
p-Cresol		X
p-Dichlorobenzene	X	X
Pentachlorophenol	X	X
Phenanthrene		X
Phenol		X
Pyrene		X
Se/chloride ratio		X
Selenium		X
Silver		X
Sodium		X

Table 1
Chemical Compounds Found in Soil or Sediment Samples and Their Potential for Cancer or Non-Cancer Health Effects

Chemical Name	Potential for Cancer Effects	Potential for Non-Cancer Effects
1,2,4-Trichlorobenzene		X
1,2,4-Trichlorobenzene		X
2,4,5-Trichlorophenol		X
2,4,6-Trichlorophenol	X	
Thallium		X
Toxaphene	X	
Vanadium (fume or dust)		X
Zinc		X

Note: For chemicals without any designation, no data are available.

Table 1 is not an exhaustive list of all constituents included in the sampling programs, but includes only those constituents known to cause cancer or non-cancer adverse health affects. The Appendix lists the health effect values (e.g., cancer potency factors and reference exposure levels [RELs]) published by both the California Office of Environmental Health Hazard Assessment (OEHHA) and the U.S. EPA for each of the constituents found in the soil or sediment samples.

Review of Sampling Data to Evaluate Concentrations of Constituents of Potential Concern

As part of Task Orders No. 13 and 20, soil and sediment samples were collected from various locations around the Salton Sea. The samples were collected according to a collection plan that divided the Salton Sea and surrounding area into four quadrants: northeast (NE), northwest (NW), southeast (SE), and southwest (SW). The collected samples were sent to certified laboratories for analysis and validation of results.

Additionally, as part of Task Orders No. 13 and 20, samples previously taken at the Salton Sea by Agrarian Research Inc., for the U.S. Geological Survey (USGS) Salton Sea Science Office were analyzed for non-organic constituents of potential concern. These results were included in the dataset. For the purposes of this task order, the USGS samples are referred to as archived samples. Details of the sampling and analysis plans and summaries of analytical results are included in the reports prepared for Task Orders No. 13 and 20.

To determine which of the constituents are likely to pose the highest level of concern for either cancer or non-cancer effects, the following calculations were performed for both inhalation and soil ingestion pathways:

- The concentration of each constituent in each sample was multiplied by its published cancer potency factor. This multiplication product gives the relative cancer weight of a single constituent in a single sample. The highest (and the mean) sampled constituent concentrations for the five constituents with the largest cancer weights are listed in Table 2.
- The relative cancer weight was scaled to yield a cancer risk value, by assuming that the soil or sediment sample (with the listed constituent concentration) would be present in the air as inhalable particulate matter at an ambient concentration of 100 micrograms/cubic meter [$\mu g/m^3$]) of PM. It is further assumed that humans would breathe this air for 70 years. Other conservative assumptions made in estimating these cancer risk values are discussed below. The corresponding

single-sample contributions to estimated cancer risks are listed for constituents in Table 2. Also listed are the mean cancer risks for each of the constituents across all samples.[2]

- The concentration of each constituent in each sample was divided by its chronic or acute REL. The resultant hazard quotient gives the relative non-cancer weight of a single constituent in a single sample. The highest (and the mean) sampled constituent concentrations for the five constituents with the largest hazard quotient are listed in Table 2.
- The relative hazard quotient for each constituent in each sample was scaled to yield a value assuming that the soil or sediment sample with the listed constituent concentration would be present in the air as inhalable particulate matter at an ambient concentration of 100 $\mu g/m^3$ of PM. Soil ingestion assumptions are discussed in the following. The corresponding single-sample hazard quotients are listed for constituents in Table 2. Also listed are the mean hazard quotients for each of the constituents across all samples.[3]

The cancer risk values and hazard indexes presented in Table 2 are derived from accepted and conservative assumptions used by both OEHHA and EPA in their risk assessment guidelines. Notably, in the inhalation exposure pathway, the cancer and non-cancer chronic values assume that individuals are continuously exposed to the particular constituent of concern in soil/sediment as PM with an ambient concentration of 100 $\mu g/m^3$ for 24 hours a day, 7 days a week, over a 70-year lifetime. For the soil ingestion pathway, the health effects values assume ingestion of 25 milligrams (mg) of soil per kilogram (kg) of body weight per day, every day, for 70 years. Further, the health factors used to generate cancer risk and non-cancer hazard indexes are derived from animal studies or epidemiological studies, and are at least two orders of magnitude more conservative than the factors actually observed in the studies.

The results presented suggest that for exposures to soil at a level of 100 $\mu g/m^3$ of PM in ambient air, the potential cancer impact from the inhalation pathway significantly outweighs the potential cancer impact from the soil ingestion pathway. Further, the results in Table 2 indicate that chromium is the key constituent that contributes to the potential inhalation cancer risk for the inhalation pathway. The analytical method employed for chromium in the soil and sediment samples obtained in Salton Sea Task Orders No. 13 and 20 (EPA method SW-6010B) tested for total chromium and did not speciate the types of chromium in each sample. The inhalation cancer risk presented in Table 2 is based on the conservative assumption that 50 percent of the total chromium found in the samples is the carcinogenic form of chromium (i.e., hexavalent chromium). Until recently, OEHHA used the assumption that 7 percent of naturally occurring chromium is hexavalent chromium; however, OEHHA is reconsidering its findings based on recent sampling studies completed by the California Department of Health Services (DHS) on well water and surface waters. The results of those studies indicate that the percentage of hexavalent chromium in total chromium may range anywhere from 0 to 100 percent, with a bias that surface water samples have shown no detectable hexavalent chromium. The latest sampling data from DHS are available from DHS Division of Drinking Water and Environmental Management (DHS, 2005). The inhalation cancer risk result presented in Table 2 would be greatly improved through further analysis to speciate the chromium and determine the actual percentage of hexavalent chromium in the soils and sediment samples from the area around the Salton Sea.

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[2] The values are expressed as worst plausible excess lifetime cancer risks that might be predicted under the extremely conservative assumptions used in this initial study. For example, a value reported as 53 x 10^{-6} in Table 2 indicates an incremental lifetime cancer risk of 53 per 1 million individuals, or 53 in 1 million. Results of a detailed risk assessment would typically be compared to significance criteria established by the regulatory agency. For example, the SCAQMD lists a significance criterion of 1 x 10^{-6} for projects without toxics best available control technology (TBACT) and 10 x 10^{-6} for projects with TBACT.

[3] To estimate the potential for non-cancer health effects from more than one substance, OEHHA suggests using a hazard index approach (OEHHA, 2003). To calculate a hazard index, substances are grouped according to the 'target organs' they affect. Then, the average exposure concentration of each substance for the appropriate time period, either long term, or 1-hour, is divided by its REL to obtain a 'hazard quotient.' The hazard quotients for all substances within each target organ group, including both inhalation and non-inhalation exposure pathways, are summed to obtain a single hazard index. A hazard index of 1.0 or greater indicates a potential health hazard may exist, and a more in-depth study may be needed (OEHHA, 2003).

Hazard index data presented in Table 2 are substantially less than 1. These values are relatively low and may provide a preliminary indication that cancer-related health effects will outweigh non-cancer health effects.

Table 2
Constituents with the Largest Potential for Health Effects, as Determined by Weighting of Concentrations and Risk Values

Potential Cancer Effects—Inhalation Pathway*					
		Highest and Mean Sampled Concentrations for the Five Constituents with the Largest Cancer Weights		**Estimated Sample Cancer Risk at 100 µg/m^3 of PM***	
Soil Constituent	**Units**	**Highest**	**Mean**	**At Highest Concentration**	**At Mean Concentration**
Chromium	mg/kg	17.7	7.1	133 x10^{-6}	53 x10^{-6}
N-Nitrosodimethylamine	µg/kg	14,000*	3,500	6.4 x10^{-6}	1.6 x10^{-6}
Arsenic	mg/kg	11	3.7	3.7 x10^{-6}	1.2 x10^{-6}
N-Nitroso-di-n-propylamine	µg/kg	14,000*	3,500	2.8 x10^{-6}	0.71 x10^{-6}
Dibenzo(a,h)anthracene	µg/kg	14,000*	3,500	1.7 x10^{-6}	0.43 x10^{-6}
Potential Non-Cancer Chronic Effects—Inhalation Pathway					
		Highest and Mean Sampled Concentrations for the Five Constituents with the Largest Hazard Quotients		**Estimated Sample Hazard Index at 100 µg/m^3 of PM***	
Soil Constituent	**Units**	**Highest**	**Mean**	**At Highest Concentration**	**At Mean Concentration**
Manganese	mg/kg	518	196	.259	0.10
Nickel	mg/kg	62	11	0.12	0.02
Arsenic	mg/kg	11	3.7	0.04	0.01
Pentachlorophenol	µg/kg	70,000*	17,200	0.04	0.01
Cadmium	mg/kg	3.9	0.33	0.02	0.002
Potential Non-Cancer Acute Effects—Inhalation Pathway					
		Highest and Mean Sampled Concentrations for the Five Constituents with the Largest Hazard Quotients		**Estimated Sample Hazard Index at 100 µg/m^3 of PM1**	
Soil Constituent	**Units**	**Highest**	**Mean**	**At Highest Concentration**	**At Mean Concentration**
Arsenic	mg/kg	11	3.7	5.9E-03	2.0E-03
Nickel	mg/kg	62	10.9	1.0E-03	1.8E-04
Vanadium	mg/kg	36	13.3	1.2E-04	4.4E-05
Copper	mg/kg	24	8.2	2.4E-05	8.2E-06
Mercury	mg/kg	0.05	0.01	2.8E-06	8.1E-07

Table 2
Constituents with the Largest Potential for Health Effects, as Determined by Weighting of Concentrations and Risk Values

Potential Cancer Effects—Soil Ingestion Pathway					
		Highest and Mean Sampled Concentrations for the Five Constituents with the Largest Cancer Weights		Estimated Sample Cancer Risk Assuming Ingestion of 25 mg Soil per kg Body Weight per Day*	
Soil Constituent	Units	Highest	At Mean Concentration	At Highest Concentration	At Mean Concentration
Arsenic	mg/kg	11	3.7	1.7 $x10^{-10}$	5.6 $x10^{-11}$
Lead	mg/kg	15	4.9	1.3 $x10^{-12}$	4.2 $x10^{-13}$
bis(2-Ethylhexyl)phthalate	µg/kg	14,000*	3,500	1.2 $x10^{-12}$	3.0 $x10^{-13}$
Aroclor-1232	µg/kg	140*	56	9.8 $x10^{-14}$	3.9 $x10^{-14}$
Aroclor-1242	µg/kg	140*	56	9.8 $x10^{-14}$	3.9 $x10^{-14}$
Potential Non-Cancer Chronic Effects—Soil Ingestion Pathway					
		Highest and Mean Sampled Concentrations for the Five Constituents with the Largest Hazard Quotients		Estimated Sample Cancer Risk Assuming Ingestion of 25 mg Soil per kg Body Weight per Day*	
Soil Constituent	Units	Highest	Mean	At Highest Concentration	At Mean Concentration
Selenium, total	µg/kg	300	6.1	.60	0.01
Hexachlorobenzene	µg/kg	14,000*	3,500	.46	0.12
Aluminum	mg/kg	15,400	6,000	.46	0.18
Arsenic	mg/kg	11	3.7	.46	0.12
2,4-Dinitrophenol	µg/kg	70,000*	17,200	0.35	0.09

Notes: Estimated values are for individual constituents in different samples and should not be summed.
$\mu g/m^3$ micrograms/cubic meter
mg/kg milligrams/kilogram
µg/kg micrograms/kilogram
* These values are at the reporting limit for the sample. These compounds have been detected in the Salton Sea, but the levels of detection were below the reporting limit so the reporting limit has been used for this analysis.

Potential Human Exposure Levels and Preliminary Hazard and Risk Assessment

Previous studies (Le Blanc, et al., 2004; Schroeder, 2004) indicate that organic constituents found in the Salton Sea soils and sediments have likely been chemically adsorbed onto soils and sediments and do not readily move into equilibrium with the aqueous environment on the Salton Sea bed. Our sampling results also show that surface soils near the lake contain similar concentrations of constituents to the submerged sediment samples. This similarity in composition suggests that the constituents remain adsorbed and do not desorb or evaporate in the dry environment just above the shoreline. If the constituents are bound, as this evidence suggests, human exposure to constituents of potential concern is closely related to exposure to soil particles, or particulate matter from soil or sediment.

As humans in the region are exposed to windblown dust through inhalation, ingestion, or skin contact, they may be exposed to soils that contain the constituents of concern (also referred to as ‘contaminated soils’). The specific desorption rates of the constituents in these soils when introduced to biological systems are unknown. If the adsorbed compounds have a greater affinity for soil than for biological tissues, it is likely that the adsorbed compounds will remain bound to the soil and they will not desorb into exposed tissue (gut, lung linings, or skin). In that event, contaminated soil would have a reduced health impact. In fact, a large body of research has shown that many potentially hazardous organic compounds in soil become tightly bound with soil through physical and chemical processes. This research is reviewed in the following section.

One method to evaluate the worst-case situation for exposure to these constituents is to assume a high average value for the concentration of contaminated soil, as particulate matter, in the Salton Sea ambient air, and assume that the entire quantity of adsorbed constituents is released upon contact with biological tissues.

The historic annual average concentrations of PM in the Salton Sea Air Basin, as reported by the California Air Resources Board (ARB), are shown in the Table 3, and can be used as a basis for determining worst-case annual average ambient concentrations.

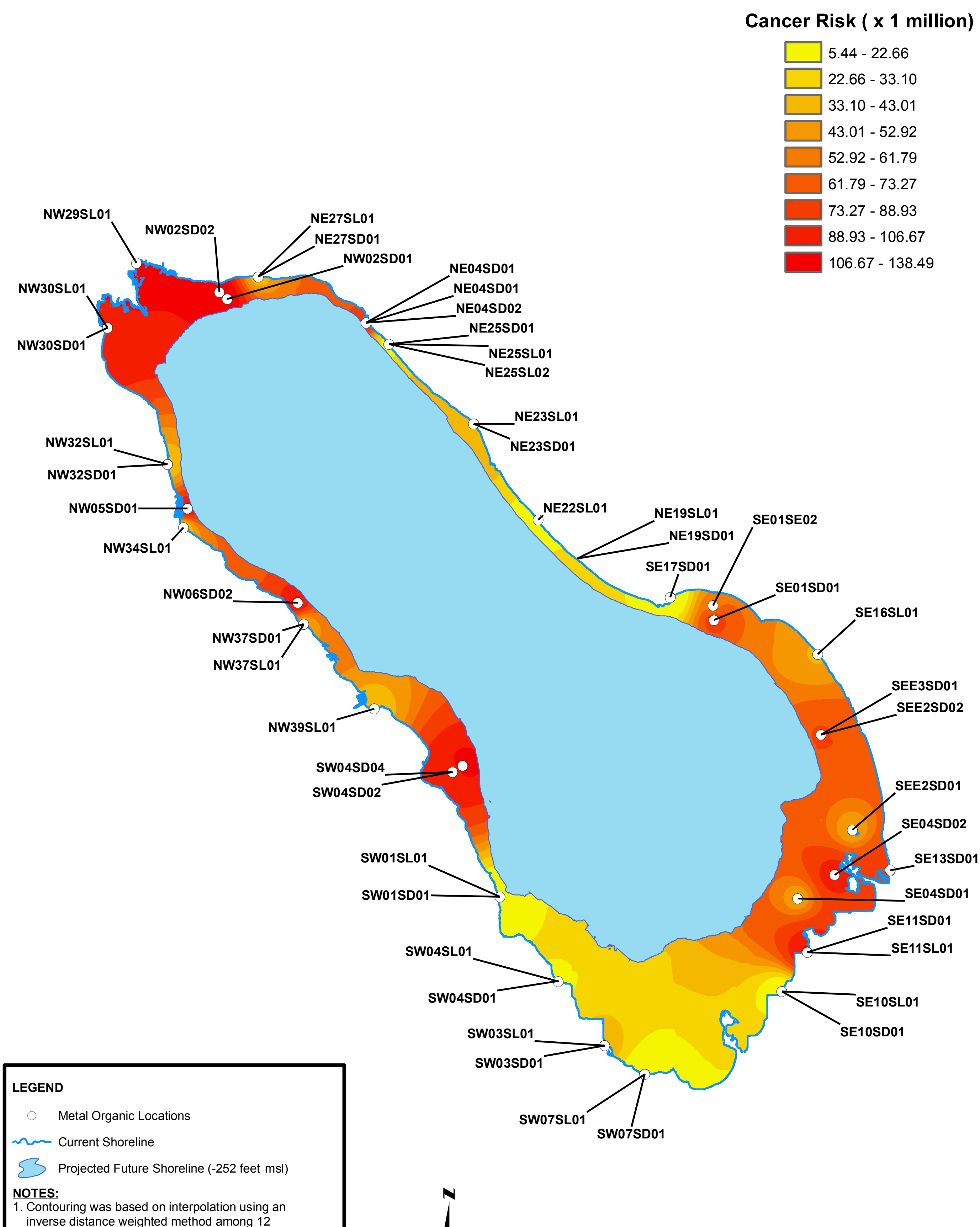
Table 3
Salton Sea Air Basin PM_{10} Annual and 3-Year Average Ambient Concentrations (µg/m3)

Year	Annual Average	3-year Average
2004	60.3	81
2003	79.7	87
2002	80.9	87
2001	87.1	87
2000	84.8	85
1999	79.0	79
1998	66.6	67
1997	77.7	78
1996	73.6	74
1995	72.0	72
1994	48.3	53
1993	52.6	69
1992	47.5	80
1991	69.1	80
1990	80.3	80

Note: PM_{10} refers to particulate matter less than 10 microns in aerodynamic diameter. Most of the PM measured in the Salton Sea Air Basin is PM_{10}, due to the high contribution of fugitive dust to ambient concentrations. In this document, the terms PM and PM_{10} are used synonymously.

The highest annual average level of PM emissions was 87.1 $\mu g/m^3$ in the year 2001. Figures E4-1 and E4-2 illustrate the results of an evaluation for cancer risk with the following conservative assumptions:

1. The annual average value for the concentration of contaminated soil, as PM, in the Salton Sea ambient air is 100 $\mu g/m^3$. The cancer risks have been estimated for hypothetical persons exposed to contaminated soil from an illustrated location. This level of exposure persists 24 hours a day, 7 days a week, for a 70-year lifetime.
2. For each sampling point with risks illustrated in the Figures, the contaminated soil from the sampling point makes up the entire quantity of PM to which a hypothetical person is exposed.
3. Upon inhalation, the entire quantities of the COPCs in the inhaled, contaminated soil completely desorb from the soil PM into the airspace surrounding the biological tissues of the exposed person's lungs, and contribute to the estimated risks.



LEGEND

○ Metal Organic Locations

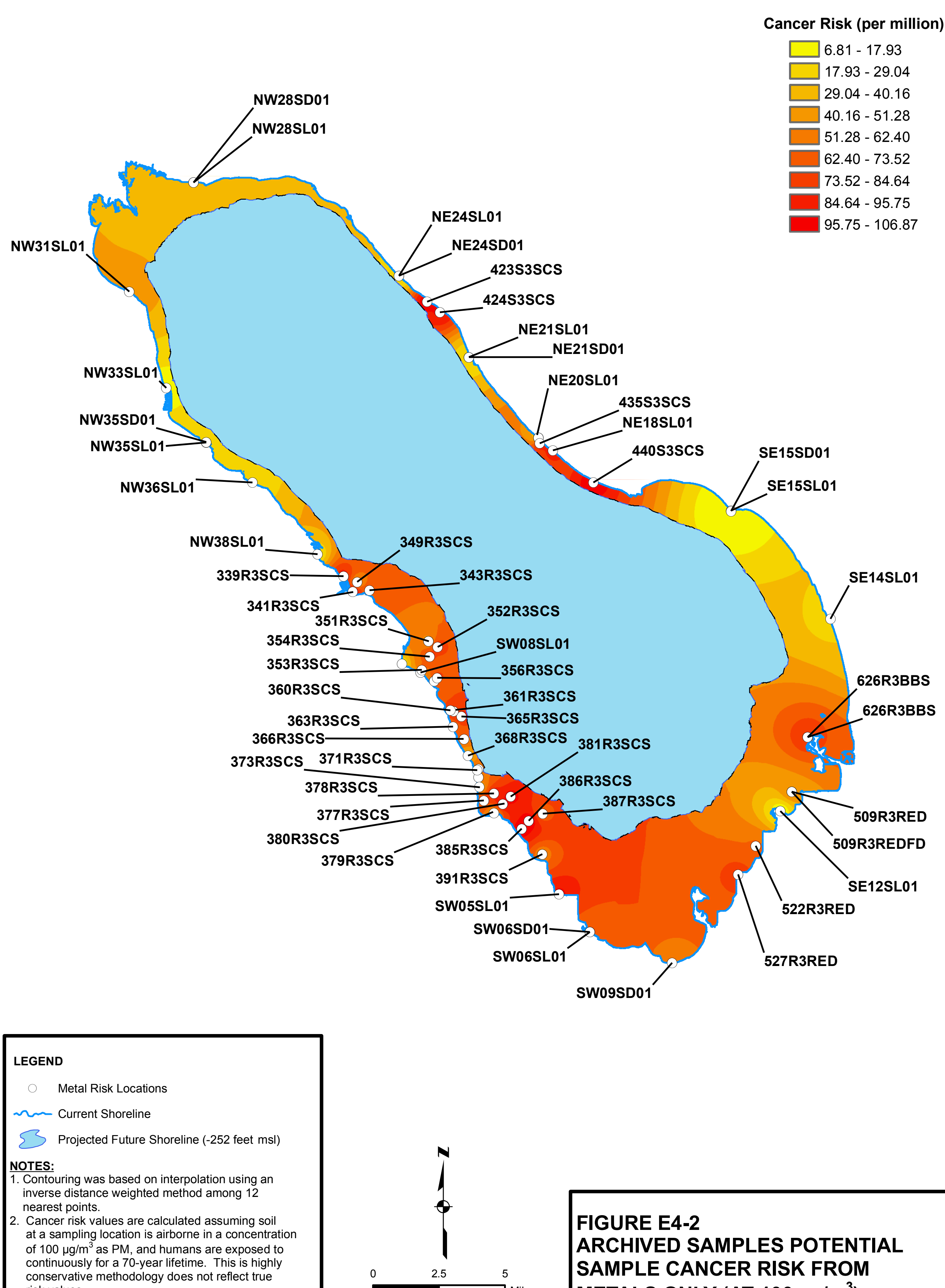
Current Shoreline

Projected Future Shoreline (-252 feet msl)

NOTES:
1. Contouring was based on interpolation using an inverse distance weighted method among 12 nearest points.
2. Cancer risk values are calculated assuming soil at a sampling location is airborne in a concentration of 100 μg/m^3 as PM, and humans are exposed to contaminated soil in ambient air at this level for a 70-year lifetime. These levels of risk likely represent an unrealistically high level. This highly conservative methodology does not reflect true risk values.

FIGURE E4-1
POTENTIAL CANCER RISK FROM METALS AND ORGANICS
(AT 100 μg/m^3)

SAC \\GLACIER\SACGIS\SALTON_SEA\GIS\MXDS\PEIR\FIGUREE4_1_AIRRISK.MXD FIGUREE4-1.PDF 6/15/2006 15:46:30



LEGEND

- Metal Risk Locations
- Current Shoreline
- Projected Future Shoreline (-252 feet msl)

NOTES:

1. Contouring was based on interpolation using an inverse distance weighted method among 12 nearest points.
2. Cancer risk values are calculated assuming soil at a sampling location is airborne in a concentration of 100 µg/m^3 as PM, and humans are exposed to continuously for a 70-year lifetime. This is highly conservative methodology does not reflect true risk values.

FIGURE E4-2
ARCHIVED SAMPLES POTENTIAL SAMPLE CANCER RISK FROM METALS ONLY (AT 100 µg/m^3)

SAC \\GLACIER\SACGIS\SALTON_SEA\GIS\MXDS\PEIR\FIGUREE4_2_AIRRISK.MXD FIGUREE4-2_AIRRISK.PDF 6/15/2006 15:47:56

4. Fifty percent of all chromium detected in each sample is the carcinogenic form, hexavalent chromium.
5. If a constituent was detected in any sample at the Salton Sea, each sample was assumed to contain that substance at the reporting limit for that constituent in the sample, whether or not that constituent was actually detected in the individual sample.

Depicted in the figures are the approximate cancer risk values if the contaminated soil in that location is airborne in a concentration of 100 $\mu g/m^3$ as PM, and humans are exposed to contaminated soil in ambient air at this level for a 70-year lifetime. This highly conservative methodology does not reflect true risk values.

Figure 1 shows potential cancer risk for recent samples that were analyzed for both metal and organic constituents. Figure 2 shows potential cancer risk for archived samples that were only analyzed for metals. It is noteworthy that the weighted cancer levels for the metal samples are distributed in a manner that is spatially consistent with the samples that contain both metals and organics. This observation suggests that the organic constituents are bound to the soils, remaining co-located with the metal contaminants.

The cancer risks reported in this analysis assume a human exposure level equivalent to the highest recorded annual average concentration of PM (approximately 100 $\mu g/m^3$) for 24 hours a day, 7 days a week, over a 70-year lifetime, and the risk levels are also based on the assumption that all of the PM is composed of contaminated soils. These conservative assumptions lead to risk values, presented in this memo, substantially above a threshold of significance of 10 in 1 million, which has been adopted by many California air quality management districts.

To consider possible acute effects, the worst-case PM concentrations in the Salton Sea area were compared with dust storm conditions in three studies (Cohn, et al., 2003; Draxler, et al., 2001; and Chan, et al., 2003). Results show the highest hourly PM readings around the Salton Sea region over the last 10 years to be 800 $\mu g/m^3$. The values in the studies showed the highest 1-hour average PM during dust storms in Reno, Nevada, approached 500 $\mu g/m^3$; in Australia, the values approached 600 $\mu g/m^3$; and in Iraq, the concentration of PM approached 2,000 $\mu g/m^3$. Recent air monitoring data around Owens Lake in California show even higher un-mitigated 1-hour average concentrations of PM_{10} approaching 50,000 $\mu g/m^3$. Table 2 shows the highest sampled constituent contributes to a hazard index at values approaching only 6×10^{-3} if ambient soil PM concentrations are 100 $\mu g/m^3$. The threshold of significance for a hazard index adopted by many California air quality management districts is a value of 1. If the ambient levels approach the levels recorded at Owens Lake, it is possible that the acute hazard index could approach or exceed a value of 1, indicating the need for additional study of potential acute health effects.

To estimate cancer and non-cancer health risk more accurately, emissions estimation and dispersion modeling will be required to more closely estimate the exposure of humans to contaminated soil as ambient PM in the Salton Sea area. As a first step, a screening-level assessment could be performed with screening meteorology that would predict the worst-case concentrations in populated regions at a distance from the lake. More accurate estimates would require the use of a sophisticated dispersion model and inputs to that model that would include accurate emission factors for exposed playa, as well as validated meteorological data for the Salton Sea Air Basin.

Literature Search to Identify Parameters for Constituents of Potential Concern

Literature searches were conducted to identify recent information related to exposure to contaminated soil as particulate matter, constituents of potential concern present at the Salton Sea, and typical dust and wind conditions that represent the upper bounds of exposure at the Salton Sea. Extensive searches resulted in limited information regarding soils exposure in the Salton Sea Air Basin. Two risk assessments have been performed in recent years, but they followed ingestion of fish and are not relevant to this task.

Recent research from the National Environmental Policy Institute has resulted in the guidance document Assessing the Bioavailability of Organic Chemicals in Soil for Use in Human Health Risk Assessments. That document details procedures for estimating the quantity of toxic compounds that may remain bound to soils and reduce the impact of such soils on human health. Further investigations in related studies may provide useful guidance for the development of protocols to quantify human exposure and health risk around the Salton Sea.

A literature search was also conducted to determine the likely concentration of particulate matter in the ambient air around the Salton Sea. This search identified three studies performed during dust storms in desert terrain. As mentioned earlier, one study took place in Reno, where the highest PM value Approached 500 $\mu g/m^3$ (Cohn, et al., 2002). Another study was in the Australian desert, where the highest ambient PM level was close to 600 $\mu g/m^3$ (Chan, et al., 2003). The third study was from Iraq, where the highest ambient PM level was closer to 2,000 $\mu g/m^3$ (Draxler, et al., 2001).

Recommendations and Conclusions

This initial study suggests that there are potentially significant levels of constituents of concern in the sediment and soil samples taken from the region around the Salton Sea. Because of the constituents' spatial uniformity and consistency, additional sampling may not be required to further characterize soils for risk assessment purposes. A conservative evaluation of upper-bound cancer risk does not discount the possibility of significant human health impacts, but rather suggests that further study is warranted. First steps to further study should include:

- Re-analyze sediment and soil samples to obtain an accurate measure of hexavalent chromium
- Establish a screening-level dispersion modeling protocol that will allow more accurate upper-bound estimates of exposure and corresponding health impacts to nearby populated regions
- Investigate the feasibility of incorporating into the risk assessment protocol the complex nature of physical and chemical adsorption of toxic compounds to the soils and sediments

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APPENDIX

Table of Risk Assessment Health Factors

Appendix
Table of Risk Assessment Health Factors [1,2]

CAS	Substance	Non Cancer			Cancer		
		Acute Inhalation (µg/m^3)	Chronic Inhalation (µg/m^3)	Chronic Oral (mg/kg/day)	Inhalation Cancer Potency Factor (mg/kg-day)	Inhalation Unit Risk (µg/m^3)	Oral Slope Factor (mg/kg-day)
83-32-9	Acenaphthene			6.00E-02			
208-96-8	Acenaphthylene			7.10E-03			
309-00-2	Aldrin			3.00E-05		4.90E-03	
319-84-6	alpha-hexachlorocyclohexane		1.00E+00	3.00E-04	4.00E+00	1.10E-03	
7429-90-5	Aluminum			3.30E-01			
62-53-3	Aniline		1.00E+00		5.70E-03	1.60E-06	
120-12-7	Anthracene			3.00E-01			
7440-36-0	Antimony Compounds		2.00E-01				
12674-11-2	Aroclor-1016[3]		1.20E+00	2.00E-05	7.00E-02	5.70E-04	7.00E-02
11104-28-2	Aroclor-1221[3]		1.20E+00	2.00E-05	7.00E-02	5.70E-04	7.00E-02
11141-16-5	Aroclor-1232[3]		1.20E+00	2.00E-05	7.00E-02	5.70E-04	7.00E-02
53469-21-9	Aroclor-1242[3]		1.20E+00	2.00E-05	7.00E-02	5.70E-04	7.00E-02
12672-29-6	Aroclor-1248[3]		1.20E+00	2.00E-05	7.00E-02	5.70E-04	7.00E-02
11097-69-1	Aroclor-1254[3]		1.20E+00	2.00E-05	7.00E-02	5.70E-04	7.00E-02
11096-82-5	Aroclor-1260[3]		1.20E+00	2.00E-05	7.00E-02	5.70E-04	7.00E-02
7440-38-2	Arsenic	1.90E-01	3.00E-02	3.00E-04	1.20E+01	3.30E-03	1.50E+00
7440-39-3	Barium			2.00E-01			
56-55-3	Benz(a)anthracene				3.90E-01	1.10E-04	
50-32-8	Benzo(a)pyrene				3.90E+00	1.10E-03	
205-99-2	Benzo(b)fluoranthene				3.90E-01	1.10E-04	
207-08-9	Benzo(k)fluoranthene				3.90E-01	1.10E-04	
65-85-0	Benzoic Acid			4.40E+00			
100-51-6	Benzyl Alcohol			1.40E+00			
7440-41-7	Beryllium		7.00E-03	2.00E-03	8.40E+00	2.40E-03	
319-85-7	beta- Hexachlorocyclohexane		1.00E+00		4.00E+00	1.10E-03	
111-44-4	Bis(2-chloroethyl)ether (Dichloroethyl ether)				2.50E+00	7.10E-04	
85-68-7	Butylbenzylphthalate			2.00E-01			

Appendix
Table of Risk Assessment Health Factors [1,2]

CAS	Substance	Non Cancer			Cancer		
		Acute Inhalation (μg/m³)	Chronic Inhalation (μg/m³)	Chronic Oral (mg/kg/day)	Inhalation Cancer Potency Factor (mg/kg-day)	Inhalation Unit Risk (μg/m³)	Oral Slope Factor (mg/kg-day)
59-50-7	4-Chloro-3-methylphenol			2.00E-02			
106-47-8	4-Chloroaniline			4.00E-03			
95-57-8	2-Chlorophenol		1.80E+01				
7440-43-9	Cadmium		2.00E-02	5.00E-04	1.50E+01	4.20E-03	
7440-47-3	Chromium			2.00E-02	5.10E+03	1.50E-01	
218-01-9	Chrysene				3.90E-02	1.10E-05	
7440-48-4	Cobalt			5.00E-03			
7440-50-8	Copper	1.00E+02	2.40E+00	3.80E-02			
95-50-1	1,2-Dichlorobenzene			9.00E-02			
122-66-7	1,2-Diphenylhydrazine					2.20E-04	
541-73-1	1,3-Dichlorobenzene			8.60E-02			
120-83-2	2,4-Dichlorophenol			3.00E-03			
105-67-9	2,4-dimethyphenol			2.00E-02			
51-28-5	2,4-Dinitrophenol			2.00E-03			
121-14-2	2,4-Dinitrotoluene				3.10E-01	8.90E-05	
91-94-1	3,3-Dichlorobenzidine				1.20E+00	3.40E-04	
72-54-8	4,4'-DDD			3.00E-03		7.00E-05	
72-55-9	4,4'-DDE			7.00E-04		9.70E-05	
50-29-3	4,4'-DDT			5.00E-04		9.70E-05	
117-81-7	Di(2-ethylhexyl)phthalate (DEHP)		7.00E+01		8.40E-03	2.40E-06	8.40E-03
53-70-3	Dibenz(a,h)anthracene				4.10E+00	1.20E-03	
60-57-1	Dieldrin			5.00E-05		4.60E-03	
84-66-2	Diethylphthalate			8.00E-01			
131-11-3	Dimethylphthalate			1.00E+01			
84-74-2	Di-n-butylphthalate			1.20E-01			
117-84-0	Di-n-octylphthalate			1.80E-02			
959-98-8	Endosulfan I			6.00E-03			

Appendix
Table of Risk Assessment Health Factors [1,2]

CAS	Substance	Non Cancer			Cancer		
		Acute Inhalation (µg/m³)	Chronic Inhalation (µg/m³)	Chronic Oral (mg/kg/day)	Inhalation Cancer Potency Factor (mg/kg-day)	Inhalation Unit Risk (µg/m³)	Oral Slope Factor (mg/kg-day)
72-20-8	Endrin			3.00E-04			
206-44-0	Fluoranthene			4.00E-02			
86-73-7	Fluorene			4.00E-02			
76-44-8	Heptachlor			5.00E-04		1.30E-03	
1024-57-3	Heptachlor epoxide			1.30E-05		2.60E-03	
118-74-1	Hexachlorobenzene		2.80E+00	3.00E-04	1.80E+00	5.10E-04	
87-68-3	Hexachlorobutadiene			7.80E-02		2.20E-05	
58-89-9	Hexachlorocyclohexane		1.00E+00	3.00E-04	1.10E+00	3.10E-04	1.10E+00
77-47-4	Hexachlorocyclopentadiene		2.40E-01				
67-72-1	Hexachloroethane			1.00E-03		4.00E-06	
193-39-5	Indeno(1,2,3-C,D)pyrene				3.90E-01	1.10E-04	
78-59-1	Isophorone		2.00E+03				
7439-92-1	Lead				4.20E-02	1.20E-05	8.50E-03
91-57-6	2-Methylnaphthalene			4.00E-03			
7439-95-4	Magnesium			1.10E+01			
7439-96-5	Manganese		2.00E-01	1.40E-01		5.00E-05	
7439-97-6	Mercury	1.80E+00	9.00E-02	3.00E-04		3.00E-04	
72-43-5	Methoxychlor			5.00E-03			
7439-98-7	Molybdenum			5.00E-03			
88-75-5	2-Nitrophenol			2.00E+00			
99-09-2	3-Nitroaniline			2.80E-03			
91-20-3	Naphthalene		9.00E+00		1.20E-01	3.40E-05	
7440-02-0	Nickel	6.00E+00	5.00E-02	7.60E-02	9.10E-01	2.40E-04	
62-75-9	N-Nitrosodimethylamine				1.60E+01	4.60E-03	
621-64-7	N-Nitrosodi-n-propylamine				7.00E+00	2.00E-03	
86-30-6	N-Nitrosodiphenylamine				9.00E-03	2.60E-06	
95-48-7	o-Cresol		6.00E+02				

Appendix
Table of Risk Assessment Health Factors [1,2]

CAS	Substance	Non Cancer			Cancer		
		Acute Inhalation (µg/m³)	Chronic Inhalation (µg/m³)	Chronic Oral (mg/kg/day)	Inhalation Cancer Potency Factor (mg/kg-day)	Inhalation Unit Risk (µg/m³)	Oral Slope Factor (mg/kg-day)
7782-49-2	OM Selenium Plus Residue Selenium			5.00E-03			
106-44-5	p-Cresol		6.00E+02				
106-46-7	p-Dichlorobenzene		8.00E+02		4.00E-02	1.10E-05	
87-86-5	Pentachlorophenol		2.00E-01		1.80E-02	5.10E-06	
85-01-8	Phenanthrene			7.10E-03			
108-95-2	Phenol	5.80E+03	2.00E+02				
129-00-0	Pyrene			3.00E-02			
7782-49-2/16887-00-6	Se/chloride ratio			5.00E-03			
7782-49-2	Selenium[4]		2.00E+01	5.00E-03			
7782-49-2_D	Selenium, dissolved[4]		2.00E+01	5.00E-03			
7782-49-2_Leachate	Selenium, Leachate[4]		2.00E+01	5.00E-03			
7440-22-4	Silver			5.00E-03			
7440-23-5	Sodium			3.40E+01			
120-82-1	1,2,4-Trichlorobenzene			1.00E-02			
120-82-1	1,2,4-Trichlorobenzene			1.00E-02			
95-95-4	2,4,5-Trichlorophenol			1.00E-01			
88-06-2	2,4,6-Trichlorophenol				7.00E-02	2.00E-05	
7440-28-0	Thallium			6.70E-05			
8001-35-2	Toxaphene					3.20E-04	
7440-62-2	Vanadium (fume or dust)	3.00E+01					
7440-66-6	Zinc		3.50E+01	3.00E-01			

Notes
1 Blank cells indicate no data is available.
2 Data from OEHHA or EPA IRIS (Integrated Risk Information System). (http://www.epa.gov/iris/subst/index.html)
3 From OEHHA, PCB (Polycholorinated Byphenayls)
4 From OEHHA, Selenium Compound values.

APPENDIX E, ATTACHMENT E5

Additional Discussion of Potential Mitigation Measures

2006

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APPENDIX E, ATTACHMENT E5
ADDITIONAL DISCUSSION OF POTENTIAL MITIGATION MEASURES

The primary focus of the mitigation measures described in this attachment would be control of fugitive dust emissions from construction or operation of the alternatives evaluated in the PEIR. Construction of the alternatives or other related development would result in air emissions in the form of fugitive and windblown dust from earthmoving and excavation activities, construction material transport and storage, and vehicle travel on roadways. Control of fugitive dust from these sources can be accomplished by a variety of management practices.

Figures E5-1 through E5-3 show bar graphs of the estimated emissions (in tons/year) of fugitive PM_{10}, diesel PM_{10}, and NO_x emissions from sources evaluated for each of the alternatives in the Peak Construction Year. Figure E5-1 shows that emissions from unpaved roads are the major contributor to fugitive PM_{10} emissions. Figure E5-2 and E5-3 show that the major contributors to diesel PM_{10} and NO_x emissions are barges and the tugboats that move them. The construction emission analysis was completed using documented emission factors for fugitive dust and exhaust emissions, and is provided in more detail in Attachment E2.

This attachment discusses a wide variety of control and mitigation measures. Based on results of calculations for this analysis, mitigation measures to reduce unpaved road dust and barge exhaust emissions would provide the greatest overall reductions in emissions. A different method (other than diesel trucks and barges) could be used to transport and place construction materials such as rock and gravel, and this would greatly reduce unpaved road dust (PM_{10}), and barge exhaust emissions (NO_x, diesel PM_{10}). One example of another method that could be considered for material movement and placement would be use of electric, covered conveyor systems.

The Salton Sea is primarily located in two counties, Imperial County and a portion of the Riverside County. For air quality, Imperial County is under the local jurisdiction of the Imperial County Air Pollution Control District (ICAPCD) and Riverside County is under the local jurisdiction of the South Coast Air Quality Management District (SCAQMD). The ICAPCD regulates fugitive dust emissions under Regulation VIII, Rules 800 through 806. The SCAQMD regulates fugitive dust under Regulation IV, Rule 403. In this discussion, control measures were considered those measures required to comply with ICAPCD and SCAQMD rules, and mitigation measures were considered additional measures to reduce emissions beyond those required to comply with the air district rules. The control and mitigation measures presented in this attachment are divided into the following categories:

- Limitations of Control Measures
- Required Control Measures for Fugitive Dust - Controls that are required by air district rules and regulations
- Quantifiable Mitigation Measures for Fugitive Dust - Mitigation measures beyond what is required by air district regulations and rules
- Additional General Practice Mitigation for Fugitive Dust - Qualitative practices which can be implemented on a programmatic level to mitigate impacts.
- Mitigation Measures for Exhaust Emissions (NO_x and diesel PM_{10})

Limitations of Control Measures

Information on the control effectiveness of control and mitigation measures is listed for measures where it was available. The effectiveness of mitigation measures is largely based upon the activity to be mitigated, and may not be additive in nature. The actual effectiveness of several mitigation measures implemented as part of a mitigation package can be neutral, exhibiting no change in the effectiveness of the individual measures. Or the effectiveness of multiple measures may be synergistic, that is, complementary to the extent that the combined effects are greater than the sum of the individual effects. Or the effectiveness of multiple measures may be non-complementary, when the measures reduce the effects of one another when combined.

Required Control Measures

To minimize impacts to air quality during all phases of construction and operations and maintenance, the control measures contained in the following ICAPCD and SCAQMD Rules would be required in the project-level analyses. The Rules are briefly summarized below but should be reviewed in their entirety before being applied. Current versions of these rules are available on the air district websites; http://imperialcounty.net/ag/Departments/Air%20Pollution.htm and www.aqmd.gov/rules/index.html.

Imperial County Air Pollution Control District

Rule 800 – General Requirements for Control of Fine Particulate Matter (PM_{10})

The requirements of this Rule 800 apply to any Active Operation, and/or man-made or man-caused condition or practice capable of generating Fugitive Dust (PM_{10}). Rule 800 has general requirements for acceptable types of chemical/organic materials that may be used to stabilize soil and contains the test methods for determination of Visible Dust Emissions (VDE) Opacity, and determination of stabilization which includes; determination of silt content on unpaved roads and unpaved traffic areas, determination of threshold friction velocity (TFV), determination of flat vegetative cover, determination of standing vegetative cover, and the rock test method.

Rule 801 – Construction and Earthmoving Activities

Rule 801 applies to any construction and other earthmoving activities, including, but not limited to, land clearing, excavation related to construction, land leveling, grading, cut and fill grading, erection or demolition of any structure, cutting and filling, grading, leveling, trenching, loading or unloading of bulk materials, demolishing, drilling, adding to or removing bulk of materials from open storage piles, weed abatement through disking, back filling, travel on-site and travel on access roads to and from the site. This rule requires that activities limit VDE to 20 percent opacity and that all persons who own or operate a construction site of 10 acres or more in size for residential developments or 5 acres or more for non-residential developments shall submit a Dust Control Plan to the air pollution control officer (APCO). In addition, the rule lists the Best Available Control Measures for Fugitive Dust (PM_{10}).

Rule 802 – Bulk Materials

Rule 802 applies to the outdoor handling, storage, and transport of bulk materials, including, but not limited to, earth, rock, silt, sediment, sand, gravel, soil, fill, aggregate materials, dirt, mud debris, and other organic and/or inorganic consisting of or containing particulate matter with five percent or greater silt content. This rule requires that bulk material handling, bulk material storage, material transport, and haul truck activities limit VDE to 20 percent opacity.

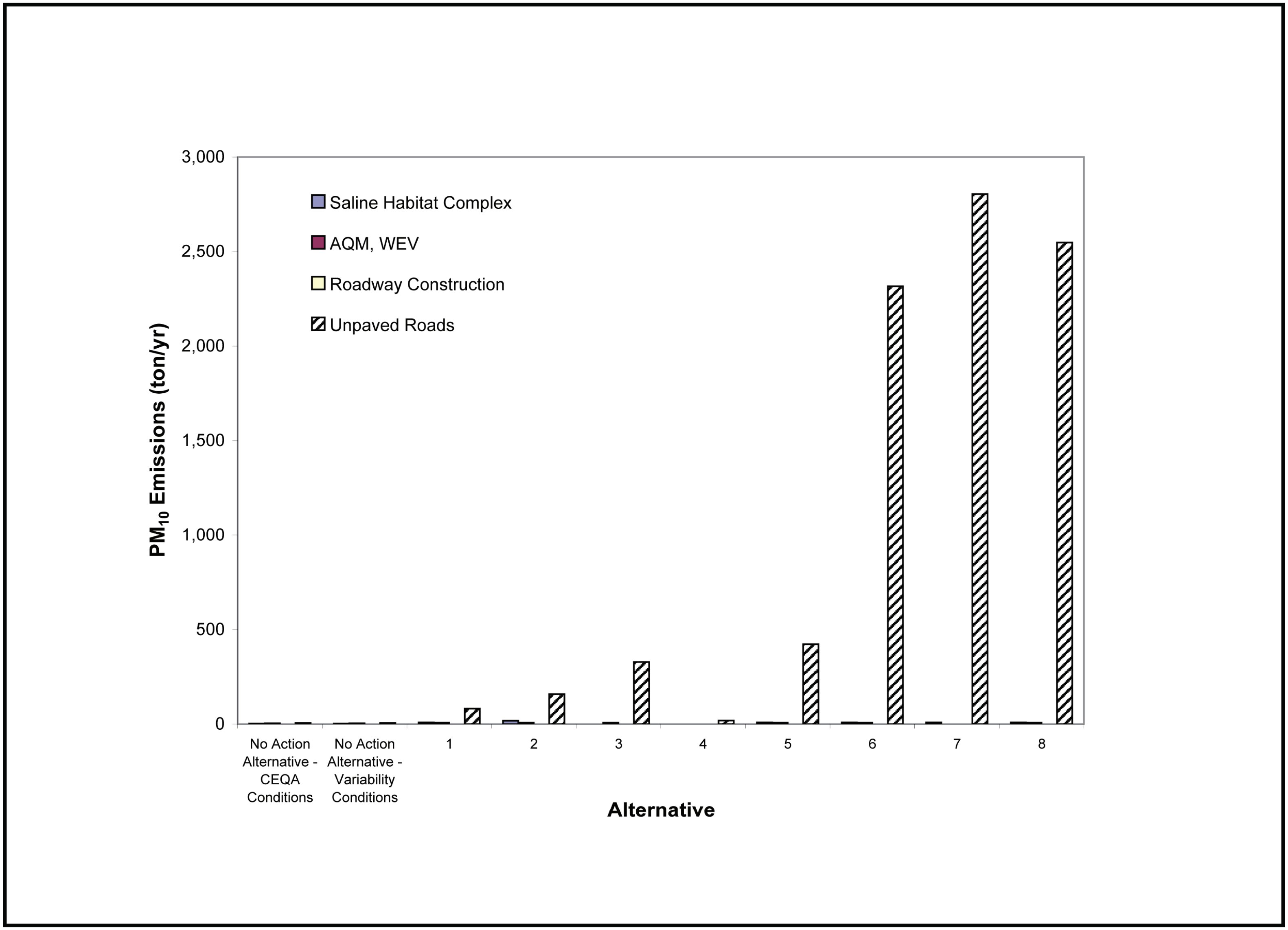

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FIGURE E5-1
PEAK CONSTRUCTION YEAR FUGITIVE PM_{10} EMISSIONS

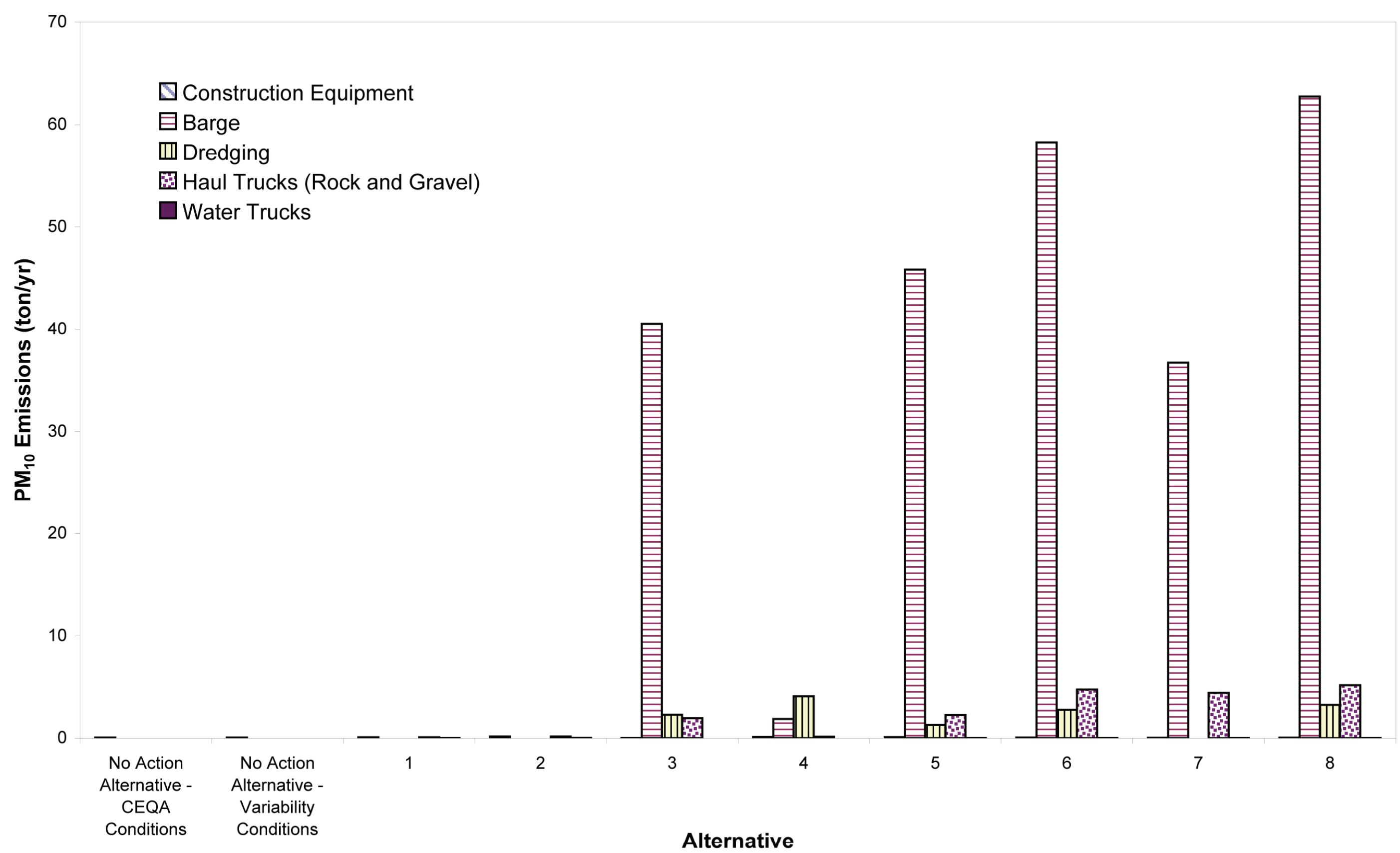

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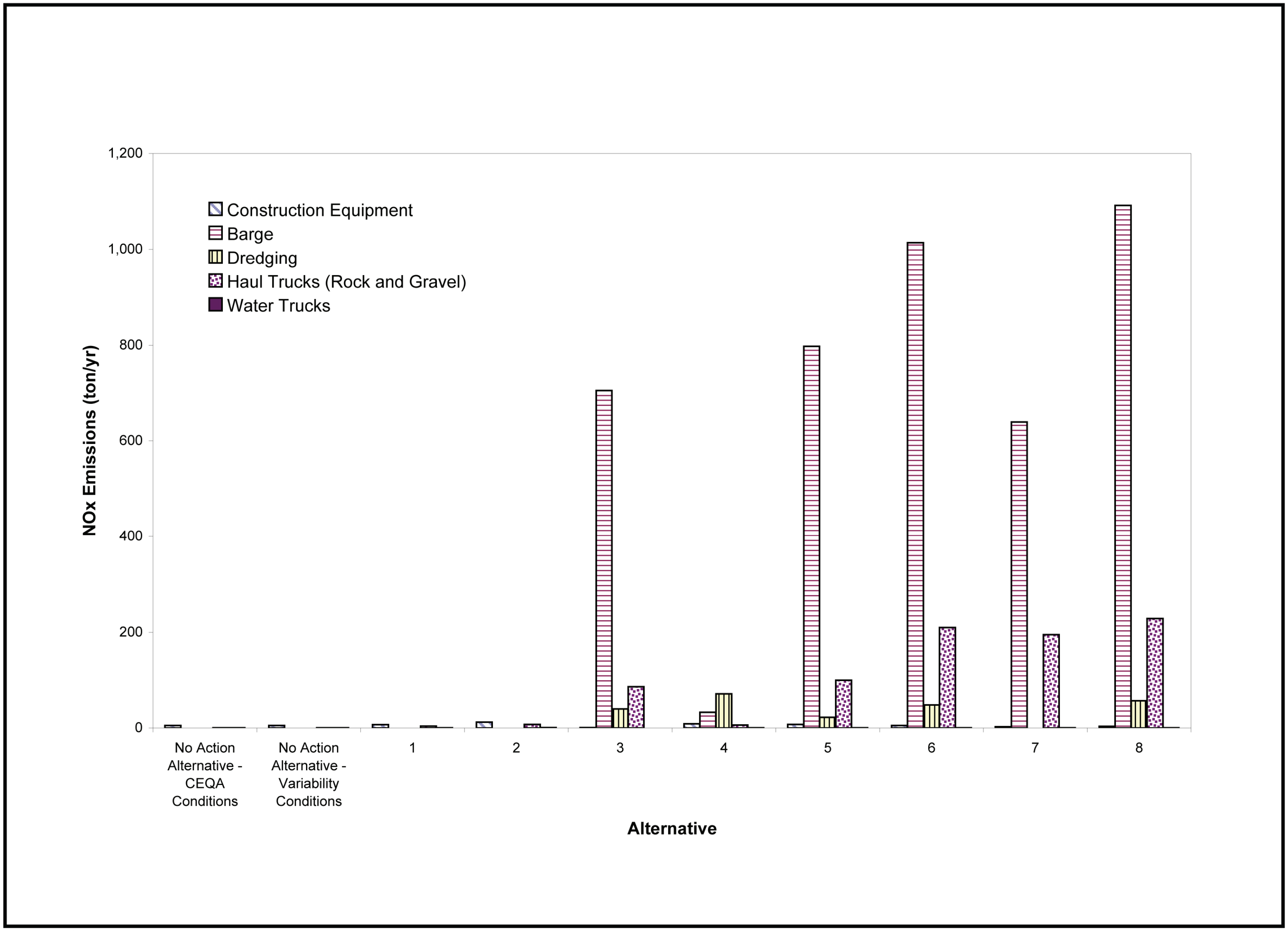
FIGURE E5-2
PEAK CONSTRUCTION YEAR DIESEL PM_{10} EMISSIONS BY SOURCE



ES112005003SAC figure_E5-3.ai 10-10-06 tdaus

FIGURE E5-3
PEAK CONSTRUCTION YEAR NO_X EMISSIONS BY SOURCE

Rule 803 – Carry-out and Track-out

Rule 803 applies to all sites that are subject to Rule VIII where track-out or carry-out has occurred or may occur on paved public roads or the paved shoulders of a paved public road. This rule requires that any person who causes the deposition of bulk material by carrying-out or tracking-out onto a paved road surface shall comply with preventing or mitigating this deposition.

Rule 804 – Open Areas

Rule 804 applies to any open area having 0.5 acres or more within urban areas; or 3.0 acres or more within rural areas; and contains at least 1,000 square feet of disturbed surface area. This rule requires that any person who owns or otherwise has jurisdiction over an open area shall comply with the conditions of a stabilized surface and limit VDE to 20 percent opacity. In addition, unauthorized vehicle use in open areas shall be prevented by posting "No Trespassing" signs.

Rule 805 – Paved and Unpaved Roads

Rule 805 applies to any new or existing public or private paved or unpaved road, road construction project, or road modification project. This rule contains Best Available Control Measures (BACM) for fugitive dust from unpaved roads, canal roads, unpaved traffic areas, and new or modified paved roads.

Rule 806 – Conservation Management

Rule 806 applies to agricultural operation sites located within the Imperial County. This rule contains the Conservation Management Practices (CMP) for fugitive dust, including a requirement to prepare a CMP plan.

South Coast Air Quality Management District

Rule 403 – Fugitive Dust

Rule 403 applies to any activity or man-made condition capable of generating fugitive dust. Table 1 of Rule 403 summarizes the BACM for fugitive dust by source category and Table 2 of Rule 403 summarizes the BACM for large operations. In addition, the Rule 403 Implementation Handbook is available to assist with complying with Rule 403. For example, the handbook contains test methods, vendors for dust suppressants, and guidance for large operations.

Next Steps

The following lists of measures are termed "Next Steps" because these measures may not be required by ICAPCD or SCAQMD rules but could be implemented to further control fugitive dust and exhaust emissions. Mitigation measures are listed in Section 7 of the ICAPCD CEQA Air Quality Handbook (ICAPCD, 2005) and Chapter 11 of the SCAQMD CEQA Air Quality Handbook (SCAQMD, 1993). These mitigation measures, in addition to mitigation measures from other sources, are briefly summarized below, and control efficiencies are provided if available. Both the ICAPCD handbook and the SCAQMD handbook should be reviewed in their entirety before selecting mitigation measures for project-level analyses.

Source Category: Earthmoving Activities and Exposed Areas

- Water at least twice daily or otherwise stabilize all active construction areas (ICAPCD, 2005)
  - 61 percent efficient for a 3.2-hour watering interval (WRAP, 2004).
  - 74 percent for a 2.1-hour watering interval (WRAP, 2004).

  - Increasing soil moisture from 1.4 percent to 12 percent for earthmoving, provides a 69 percent control efficiency (WRAP, 2004). Increasing soil moisture has also been estimated to be around 30 percent effective (SJVAPCD, 2003).
  - Watering frequently enough to keep soil moist enough so visible plumes are eliminated has shown to be between 34 percent and 68 percent effective (SCAQMD, 1993).
  - When areas are watered at least twice daily the control efficiency is about 50 percent depending upon type of operation, soil, and wind exposure (MBUAPCD, 2004).
  - The control efficiency of water was estimated to be 68.5 percent with two water trucks spraying a 12.5 acre area every 2.5 hours (SJVAPCD, 2003);
- Apply non-toxic soil stabilizers to inactive construction areas (previously graded areas inactive for ten days or more) (ICAPCD, 2005). The estimated control efficiency ranges from 30 percent to 65 percent according to the SCAQMD CEQA Handbook (SCAQMD, 1993). The control efficiency is about 84 percent for dust suppressants (SJVAPCD, 2003) and has also been estimated to be about 80 percent efficient on inactive construction areas (MBUAPCD, 2004);
- Establish vegetation on all previously disturbed areas as quickly as possible (ICAPCD, 2005). The control efficiency increases with more densely planted ground cover and ranges from 15-49 percent in control efficiency (SCAQMD, 1993). This has also been estimated to be 5-99 percent effective based on planting plan (MBAPCD, 2004); and/or
- Applying and maintaining gravel on unpaved open areas or roads is about 46 percent efficient (SJVAPCD, 2003) and has also been shown to be about 84 percent efficient when used to stabilize an open area (WRAP, 2004).

General Requirements

  - The entire site shall be pre-watered for 48-hrs prior to clearing and grubbing (ICAPCD, 2005b);
  - Reduce the amount of the disturbed area where possible (ICAPCD, 2005b), this can be done by phasing construction (ICAPCD, 2005a);
  - Construct and maintain wind barriers in conjunction with water or chemical stabilization (ICAPCD, 2005a);
  - Apply water or chemical stabilization to unpaved haul/access roads and unpaved traffic areas (ICAPCD, 2005a);
  - Restrict vehicular access to the area by fencing or signage (ICAPCD, 2005a); and/or
  - Suspend all excavating and grading operations when wind speeds exceed 25 mph as instantaneous gusts (SCAQMD, 1993).

Source Category: Bulk Material Handling

- Pre-moisten, prior to transport, materials that have silt content of 5 percent or greater. Water all materials with silt content of 5 percent or greater with a spray bar or cover trucks hauling dirt, sand, or loose materials (ICAPCD, 2005b). Provides about 50 percent control efficiency (ICAPCD, 2005a);
- Continuously spraying the storage area with water will increase the moisture content of the material by a factor of about two, which provides an emission reduction efficiency around 62 percent (WRAP, 2004);

- All trucks hauling dirt, sand, soil, or other lose material will be covered or should maintain at least two feet of freeboard. This has been shown to be 7 percent to14 percent effective. (SCAQMD, 1993);
- Cover bulk materials stored outdoors with tarps, plastic, or other suitable material and anchor that prevents the cover being removed by wind. Cover of inactive storage piles, has been up to 90 percent effective (MBUAPCD, 2004);
- Utilize a 3-side structure with a height at least equal to the height of the storage pile and with less than 50 percent porosity or if utilizing fences and wind barriers apply water or chemical stabilizers (ICAPCD, 2005a). Emission reductions can be up to 75 percent (SJVUAPCD, 2003 and WRAP, 2004); and/or
- Enclose, cover, water twice daily or apply non-toxic soil binders to exposed piles with 5 percent or greater silt content. The control efficiency ranges from 30 percent to 74 percent (SCAQMD, 1993).

General Requirements

- If trucks are not covered, they should maintain at least 6” of freeboard when traveling on public roads (ICAPCD, 2005a and ICAPCD, 2005b);
- Protect from wind erosion by sheltering or enclosing the operation and transfer line (ICAPCD, 2005a);
- Haul trucks should be used so that no spillage and loss of bulk material can occur from holes or other openings in the cargo compartment’s floor, side, and/or tailgate (ICAPCD, 2005a); and/or
- The cargo compartment of all haul trucks will be cleaned and/or washed at delivery site after removal of bulk material (ICAPCD, 2005a).

Source Category: Carry-out and Track-out Operations

For all sites with access to a paved roads and with 150 or more average vehicle trips per day, or 20 or more average vehicle trips per day by vehicles with three or more axles:

- Install one or more Track-Out Prevention Devices or wash down system at access points where unpaved traffic surfaces adjoin paved roads. Estimated reduction in 80 percent of trackout emission when track-out devices are installed (SJVUAPCD, 2003);
- Maintain paving for a distance of 50 or more consecutive feet at access points where unpaved roads adjoin paved roads. Control efficiencies are estimated at 60 percent emission reduction (ICAPCD, 2005a). Paving access roads at least 100 feet is about 92.5 percent efficient (SCAQMD, 1993);
- Maintain chemical stabilization for a distance of 50 or more consecutive feet at access points where unpaved roads adjoin paved roads. Control efficiencies are estimated at 60 percent emission reduction (ICAPCD, 2005a);
- Maintain at least 3 inches depth of gravel (gravel silt content < 5 percent) for a distance of 50 or more consecutive feet at access points where unpaved roads adjoin paved roads. Control efficiencies are estimated at 60 percent (ICAPCD, 2005a). The control efficiency of a 60 foot or a 25 foot long gravel bed has been estimated at 46 percent (SJVUAPCD, 2003), (WRAP, 2004);

- Sweeping streets at the end of the day if visible soil material is carried onto adjacent public paved roads has been shown to be 25-60 percent efficient (ICAPCD, 2005a), (SJVUAPCD, 2003), (ICAPCD, 2005b). Sweeping streets can be up to 34 percent effective at reducing fugitive dust emissions (SMAQMD, 2004); and/or

- Practices such as installing wheel washers where vehicles enter and exit unpaved roads onto paved roads, or washing off trucks and any equipment leaving the site each trip, range from 40-70 percent efficient (SCAQMD, 1993). When installed at the entrance of construction sites, wheel washers have been shown to be 50 percent effective (SMAQMD, 2004).

Source Category: Travel on Unpaved Roads

- Paving roads has been shown to be 99 percent efficient (WRAP, 2004). It has also been estimated to be 92.5 percent effective on roads with traffic volume of more than 50 daily trips by construction equipment or 150 total daily trips for all vehicles (SCAQMD, 1993). Paving all roads at construction sites would be 90 percent effective (SMAQMD, 2004);

- Applying chemical dust suppressant to provide stabilization is estimated to be 85 percent efficient (SJVUAPCD, 2003). When applied at regular intervals of 2 weeks to 1 month, it has been 80 percent efficient (WRAP, 2004). Dust suppressants, such as polymer emulsions, have been shown to be about 84 percent effective for actively disturbed areas;

- Applying and maintaining gravel, recrushed/recycled asphalt or other material with a silt content less than 5 percent to the depth of at least three inches is estimated to provide a control efficiency of about 46 percent (SJVUAPCD, 2003);

- Applying water three times daily on all unpaved access roads, parking areas, and staging areas at construction sites has been shown to be about 45-85 percent efficient (ICAPCD, 2005b), SCAQMD, 1993). Implementing watering twice a day for industrial unpaved roads is about 55 percent efficient (WRAP, 2004). Applying water to disturbed soils at the end of each day of cleanup is about 10 percent efficient for a 14-hour watering interval (WRAP, 2004); and/or

- Limiting traffic speeds on all unpaved roads to 15 mph or less is 40-70 percent efficient (SCAQMD, 1993). It has also been estimated to provide a 57 percent control efficiency when uncontrolled vehicle speed averages 35 mph (WRAP, 2004).

General Requirements

- Permanent road closure (ICAPCD, 2005a);
- Restrict unauthorized vehicle access (ICAPCD, 2005a);
- Stockpile triploid grass carp in canals to reduce maintenance vehicle trips along canals to remove aquatic weeds (ICAPCD, 2005a);
- Install remote control delivery gates to eliminate manual gate operation by maintenance personal along canal banks (ICAPCD, 2005a);
- Implement silt removal program to delay grading of spoil piles deposited along canal banks after cleaning operations until the next cleaning operation to eliminate excess vehicle trips (ICAPCD, 2005a);
- Convert open canals to pipeline (ICAPCD, 2005a); and/or
- Line canals to eliminate maintenance for silt/ weed control (ICAPCD, 2005a).

Agricultural tilling mitigation measures

- Limited activity during a high-wind event (wind greater than 25 mph) provides a 1 to 5 percent control efficiency (WRAP, 2004);
- Revegetation of fallow agricultural lands by direct seeding provides a 91 to 99 percent control efficiency (WRAP, 2004); and/or
- Surface roughening with rocks and soil aggregates provides a 15 to 64 percent control efficiency (WRAP, 2004).

General Requirements

- Increase watering frequency when wind speeds exceed 15 mph (ICAPCD, 2005b);
- An operational water truck should be onsite at all times (SJVUAPCD, 2003);
- All transfer processes involving a free fall of soil or other particulate matter should be operated to minimize dust emissions (SJVUAPCD, 2003);
- Source improvement related to work practices; reducing drop height (WRAP, 2004);
- Load/unload performed downwind of the pile (WRAP, 2004); and/or
- No open burning of vegetative waste or other legal or illegal burn materials may be conducted at the project site. It is unlawful to haul waste materials offsite for disposal by open burning (SJVUAPCD, 2003).

Fugitive Dust Mitigation from Paved and Unpaved Roads

- Pave shoulders between 4 and 8 feet wide, emissions reduction depends significantly on the type of traffic the road is exposed to and the material on the road, but is estimated about 42 percent (SJVUAPCD, 2003 and WRAP, 2004);
- Pave interior roads (30 foot wide, 100 foot long, with 3 inches of asphalt). The average efficiency of interior paved roads in reducing trackout is about 42 percent (SJVUAPCD, 2003);
- Water unpaved parking lots and limit speed to 5 mph. Over an 8-hr watering period the control efficiency was estimated at 18 percent. More frequent watering will result in higher costs and more efficient controls (SJVUAPCD, 2003) and/or
- Implement street sweeping program vacuum units (14-day frequency) for local streets is from 7 to 16 percent efficient, and for arterial/collector streets is from 11 to 26 percent efficient (WRAP, 2004).

General Requirements

- Avoid watering programs that confound trackout problems (WRAP, 2004);
- Wet sweeping of public thoroughfares (FRAQMD, 2003);
- Paved streets will be swept frequently if soil material has been carried onto adjacent paved public thoroughfares from the project site;
- Limit the number of cars by instituting a busing program for employees to and from the site (WRAP, 2004); and/or
- All roadways, driveways, sidewalks, etc. to be paved should be completed as soon as possible. In addition, building pads should be laid as soon as possible after grading unless seeding or soil binders are used (ICAPCD, 2005b).

Next Steps for Exhaust Emissions (NO_x and diesel PM_{10})

Heavy Duty Equipment Construction Equipment

Implementing the following practices can reduce the exhaust emissions from construction vehicles.

- Use PutiNO$_x$ emulsified diesel fuel in existing engines, reduces NO_x by 14 percent and PM_{10} by 63 percent (SMAQMD, 2004);
- Modify engine with ARB verified retrofit, up to 25 percent NO_x reduction and up to 85 percent PM_{10} reduction (SMAQMD, 2004);
- Repower with current standard diesel technology, reduces NO_x up to 91 percent and PM_{10} by up to 60 percent (SMAQMD, 2004); and/or
- Repower with clean natural gas / lean natural gas to reduce NO_x up to 73 percent and reduce PM_{10} by 75 to 80 percent (SMAQMD, 2004).

Qualitative Measures

The exhaust emissions from construction equipment can be reduced by implementing the following mitigation measures:

- Configure construction parking to minimize traffic interference (SCAQMD, 1993);
- Provide temporary traffic control during all phases of construction activities to improve traffic flow, such as providing a flag person to direct traffic and ensure safe movements off the site (SCAQMD, 1993);
- Schedule off-site cut-and-fill transport and other construction activities to off-peak hours (SCAQMD, 1993); and/or
- Develop a construction traffic management plan that includes: rescheduling good movements for off-peak hours, rerouting construction trucks off congested streets, consolidating truck deliveries, and providing dedicated turn lanes for movement of construction trucks and equipment on and off site (SCAQMD, 1993).

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SCAQMD. (South Coast Air Quality Management District). 1993. CEQA Air Quality Handbook, Table A9-9.

SMAQMD. (Sacramento Metropolitan Air Quality Management District). 2004. CEQA Guide to Air Quality Assessment. July.

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APPENDIX E, ATTACHMENT E6

Identify and Outline Measures to Control Playa Emissions (Executive Summary)

2006

APPENDIX E, ATTACHMENT E6
IDENTIFY AND OUTLINE MEASURES TO CONTROL PLAYA EMISSION (EXECUTIVE SUMMARY)

The main focus of this technical memorandum is the development of dust control approaches for future Exposed Playa Areas at the Salton Sea. Other air quality issues, such as emissions of fugitive dust (PM_{10}) from Exposed Playa, and dust and exhaust emissions from construction and operations and maintenance of facilities associated with the alternatives, are addressed in Chapter 10 of the Programmatic Environmental Impact Report (PEIR), with supporting information provided in Appendix E.

The alternatives would involve varying amounts and configurations of exposed Salton Sea Bed (called "playa"). Under the alternatives, the playa would be either developed for some land use (e.g., wildlife refuge, brine storage) or managed to limit dust emissions. Where no other land use is specified, Exposed Playa would be specified for Air Quality Management, a land use in which the main purpose of facilities and land management is to control dust emissions. Air Quality Management could take the form of either long term monitoring (for stable areas) or dust control (for areas that require it). The rationale for and configuration of these facilities, as presented here, provides design criteria and operations requirements to incorporate Air Quality Management into the alternatives.

Under the State Water Resources Control Board (SWRCB) Order and the Imperial Irrigation District (IID)'s Water Conservation and Transfer Project Mitigation, Monitoring, and Reporting Program, (MMRP) (IID, 2003; SWRCB, 2002), potential air quality impacts from exposed Salton Sea playa must be monitored and mitigated by implementing the following four steps:

1. Restrict future access. Minimize disturbance of natural crusts and soil surfaces in exposed shoreline areas;
2. Research and monitoring. Conduct research to find effective and efficient dust control measures for the Exposed Playa, and monitor the surrounding air quality;
3. Emission reduction credits. If monitoring results indicate exposed areas are emissive, create or purchase offsetting emissions reductions; and
4. Dust control measures. To the extent that offsets are not available, implement dust control measures on the emissive parts of the Exposed Playa.

The term "emissive" refers to a land surface's tendency to emit sufficient dust to cause or contribute to an air quality violation. "Non-emissive" is used to describe surfaces that do not emit sufficient dust to cause or contribute to air quality violations.

All restoration alternatives must contain Air Quality Management actions related to this four-step process. In coordination with landowners and stakeholders, access to Exposed Playa will be controlled to avoid disturbance and resulting emissions. In concert with the MMRP, a research program focusing on development of cost effective, water efficient, and adaptive Air Quality Management has been initiated and will continue. In the long run, results of this effort will guide the Air Quality Management approaches implemented at the Salton Sea.

Regional air quality management districts are responsible for identification and planning to address air quality problems, including issues such as particulate matter that might be emitted from the future playa. Approaches developed in this technical memorandum have been reviewed with these agencies and are generally consistent with air quality laws and ordinances, as well as the districts' planning processes. Plans have also been discussed with the California Air Resources Board and the U.S. Environmental

Protection Agency, and reviewed by technical specialists from the Desert Research Institute and by numerous and diverse stakeholders.

A range of dust control measures (DCMs) have been and will continue to be evaluated. DCMs requiring little or no water are preferred because of the high demand and resulting high cost for water in Southern California. Although many DCMs are under consideration at this time, no similar area with high emissions rates has been stabilized without water. Water and capital requirements for Air Quality Management under the alternatives are therefore based on water efficient, but not necessarily water-free, dust control technology.

For the purposes of the PEIR, assumptions and contingencies were developed that form the basis of Air Quality Management for Exposed Playa under the alternatives. The approach represents a reasonable "worst-case" analysis, applied to all alternatives, including the No Action Alternative.

While a broad range of means for stabilizing Exposed Playa will be considered in future research and may ultimately be implemented, air quality regulatory agencies favor a placeholder (engineering analysis based on a specific technology) approach as part of the PEIR. To the extent possible, a placeholder technology should have been proven feasible and effective at a large scale. Sufficient resources for its implementation should be incorporated into the alternatives, along with contingencies. The approach also must achieve this goal as efficiently as possible.

In addition to placeholder technologies, this technical memorandum identifies a number of land stabilization and dust control approaches, representing a wide range of capital costs, operations costs, and water requirements. Some approaches have been proven at a large scale, while others are in early stages of development. Many of the identified approaches, and many combinations of them, could be implemented within the resource allocations made for the placeholder technology.

Based on anticipated requirements and performance criteria, three temporary and three permanent Air Quality Management approaches are identified and developed in greater detail. If other more desirable technologies meeting the essential performance criteria are identified later, project-specific planning and implementation may incorporate these approaches, in lieu of the placeholder technologies employed in the alternatives. In this way, adequate resources and contingencies are reserved for the avoidance of air quality impacts of restoration alternatives, while allowing for incorporation of new knowledge.

Temporary approaches in the PEIR include sand fences (or other linear sand capture features, such as moat and row), surface treatment (with stabilizing agents), and control of traffic. These measures would be applied where permanent approaches are not feasible (e.g., areas that have not yet been sufficiently dewatered to allow for construction).

Permanent approaches in the PEIR include water efficient vegetation (likely salt- and drought-tolerant native shrubs and/or grasses), stabilization with brine (wetting and replenishment of salt on unstable surfaces to create a stable salt crust), and control of traffic. The permanent approaches used for planning would each require 1.2 feet of irrigation per year[1] or less. Water efficient vegetation may also require extensive subsurface drainage.

Table E6-1 summarizes the temporary and permanent DCMs recommended for Air Quality Management, based on performance criteria.

[1] Depth of water applied annually, about 1 foot of which is inflow to Salton Sea.

Table E6-1
Select Dust Control Measures

DCM	Basic Concept	Constraints, Requirements, Advantages, Effectiveness	Preliminary Finding for Large-Scale Implementation at Salton Sea
Temporary Dust Control Measures			
Surface Treatment (Chemical Treatment and Stabilization Products)	Increases adhesion between surface soil particles	• Unproven over large areas • Long term performance and environmental issues • Potential environmental issues (depends on material and environment) • Frequent re-application can lead to high cost	Potentially feasible for temporary control, especially for reduction in road/berm watering frequency.
Sand Fences	Capture mobile sand	• Requires periodic removal and disposal of trapped sand • Long term maintenance difficult and expensive	Potentially feasible for temporary control of small areas.
Control of Traffic	Restrict unwanted traffic from Exposed Playa	• Land ownership and jurisdictions must be respected and coordinated • Legitimate public access must be allowed • Large land areas involved • Large potential benefit at relatively low cost • Also applies to construction and operations traffic	Essential for large areas of playa; need to maintain necessary access while limiting playa disturbance.
Permanent Dust Control Measures			
Stabilization with brine	Spread brine to form stable salt crust	• Uncertain crust stability • Not proven effective • Attractive for areas flooded seasonally by brine pond • Outside the brine pond, would likely require an oversized system for highly emissive periods • May cause ponding that could mobilize selenium into the food chain for birds	Potentially feasible, especially for playa surface immediately adjacent to brine pond. Further research required to confirm effectiveness and to refine requirements.
Water efficient vegetation	Establish irrigated vegetative cover to reduce surface wind velocity	• Considerable infrastructure and operations effort required • Proven feasible and effective at Owens Lake • Water demand approx. 33 percent of seasonal surface wetting, 16 percent of open water	Proven DCM, but high capital and O&M cost; need to resolve performance specification issues and plan additional time for implementation.
Control of Traffic	See Control of Traffic, above, under Temporary Dust Control Measures		

The Next Steps considered in Chapter 10 could also include monitoring of Exposed Playa, as follows:

- Regional meteorological and aerometric monitoring;
- Intensive monitoring of newly exposed areas;
- Less intensive, long term monitoring of areas deemed "stable" (that is, minimally or non-emissive surface);
- Monitoring of Air Quality Management facilities' compliance with dust control performance specifications (such as percent vegetative cover) and effectiveness in controlling potential dust sources; and
- Feedback of monitoring results into the Air Quality Management process to guide design and adaptive management of Air Quality Management facilities.

As a result of monitoring feedback and results of dust control research and development, Air Quality Management could be adaptively managed. For example:

- A smaller area than that assumed may require irrigation, either because larger areas of the playa are stable, or because more water efficient DCMs (such as gravel blanket) prove effective and implementable. In this case, additional water, previously allocated for Air Quality Management, would be available for other purposes, such as habitat; and
- Additional water (in excess of assumptions in alternatives) may be required for Air Quality Management, if more water efficient measures prove ineffective or infeasible in some areas. In this case, supplementary environmental documentation for the allocation of this water supply would be required.

Note: A complete version of this memorandum is provided as Appendix H-3.

APPENDIX E, ATTACHMENT E7

Continued Evaluation of Playa Dust (PM_{10}) Emissions Models

2006

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APPENDIX E, ATTACHMENT E7
CONTINUED EVALUATION OF PLAYA DUST (PM_{10}) EMISSIONS MODELS

This technical memorandum describes the development of the MacDougall Method for use in estimating dust emissions from future Exposed Playa Areas.

BACKGROUND

Two models were identified to estimate dust emissions, in the form of particulate matter less than 10 microns in aerodynamic diameter (PM_{10}), from future Exposed Playa Areas at the Salton Sea. These models, the Wind Erosion Prediction System (WEPS) and the MacDougall Method, were further evaluated under Task Order SS0405-3573-17. The tool selected was based on the Empirical Method for Determining Fugitive Dust Emissions from Wind Erosion of Vacant Land, commonly referred to as the MacDougall Method (MacDougall and Uhl, 2003). Ongoing emissions modeling has focused on the MacDougall Method because it requires less input data and because Imperial County used the MacDougall Method to support the fugitive dust (PM_{10}) emissions inventory used in its Regulation VIII rule development process. Based on input from the Air Quality Working Group, no further development of the WEPS model has been undertaken at this time. During future environmental studies and research on playa dust emissions control, WEPS or a similar tool may prove useful to predict dust emissions rates and evaluate control efficiencies for the control measures proposed.

The MacDougall Method uses the dominant factors known to affect generation of dust emissions from vacant lands, such as Exposed Playa, to estimate particulate emissions over large areas. The dominant factors are climate (wind speed, temperature, humidity, and precipitation), land surface conditions (soil texture, crust development, strength of crust, and crust texture), and land use (e.g., wildlife refuge, wetlands habitat, lakes, saline habitat, or infrastructure). For the purposes of the PEIR, the land use of the Exposed Playa was assumed to be vacant and undisturbed, with no public access allowed.

This technical memorandum presents results from the following:

- Meteorological data development, selection of sites for test runs of MacDougall Method emissions estimates, and extraction of appropriate meteorological data for these sites;
- Development of salt crust stability/timing information from available literature and information to incorporate into the MacDougall Method;
- Emissions estimates using the MacDougall Method for a test case using site-specific meteorological data for specific soils; and
- Development of refinements for alternatives analysis.

DEVELOPMENT OF METEOROLOGICAL DATA

Site Selection

The California Department of Water Resources (DWR), the California Air Resources Board (ARB), and two California air districts, the South Coast Air Quality Management District (SCAQMD) and the Imperial County Air Pollution Control District (ICAPCD), operate meteorological monitoring stations near the Salton Sea. The locations of these stations are illustrated in Figure E7-1. Meteorological monitoring stations operated by DWR through the California Irrigation Management Information System (CIMIS) collect data to support irrigation and agriculture. Data are collected at a height of 2 meters to better measure evaporation rates. At this height, wind speed data may reflect surface influences, and cannot be used for emission factor development. Meteorological monitoring stations operated by air districts are sited and operated consistent with stringent air quality guidelines developed by the U.S. Environmental Protection Agency (USEPA). Meteorological data are collected at a height of 10 meters to allow for unobstructed wind flow. Air districts do not collect precipitation and other hydrologic data.

To characterize meteorological conditions at the Salton Sea and to support development of emissions estimates, wind data from the air district-operated stations at Indio to the north and Niland to the south are considered most representative of the study area. For humidity and precipitation, hydrologic data from CIMIS stations at Oasis to the north, Palo Verda to the south, and Calipatria to the southeast are considered part of the most relevant available data set.

Data Availability

To assist in the air quality evaluations, the most recent data were considered. Data from 2001 through 2005 were used, although data are available at most locations beginning in the early 1990s.

Data on wind speed and direction are collected by the air agencies and are available through the USEPA from the Technology Transfer Network Air Quality System (AQS) site or through the air districts directly. Data available from the AQS have been through quality control checks, and missing or invalid data have been identified or removed. However, not all data appear to be available on the AQS site, and some data were obtained directly from Imperial County.

For Niland, complete wind data are available for 2001, 2002, and 2004. For Westmorland, complete data are available for 2002, 2003, and 2004. For Indio, complete data are available for 2001, 2002, 2003, and 2004. A comparison of the 2002 data to the data from 2001 through 2004 shows 2002 to be a typical year. Table E7-1 compares data from 2002 to the longer data period at each station. Figures E7-2 through E7-7 show the wind roses for 2002 and the composite years for each site.

Significant differences among the measurement sites are evident. North of the Salton Sea, Indio shows a strong predominance of winds from the northwest, reflecting the terrain of the Coachella Valley. The average wind speed is 4.9 miles per hour (2.22 meters per second), but winds seldom exceed 20 miles per hour (8.9 meters per second). At Westmorland, south of the Salton Sea, winds are predominantly from the southeast with a strong secondary direction from the west. Wind speeds average 4.2 miles per hour (1.87 meters per second), with the strongest winds from the west and northwest. Winds exceed 20 miles per hour less than 1 percent of the year. At Niland, southeast of the Salton Sea, winds are predominately from the southeast, reflecting the terrain of the Imperial Valley, with flow toward the Salton Sea. The wind speed averages 6.9 miles per hour (3.12 meters per second). The highest winds are from the west. Winds exceed 20 miles per hour about 4 percent of the year. Because the Westmorland data exhibit patterns inconsistent with the other data sets and because of siting questions for this station, wind data from the Westmorland station were not used to support the emissions estimates.

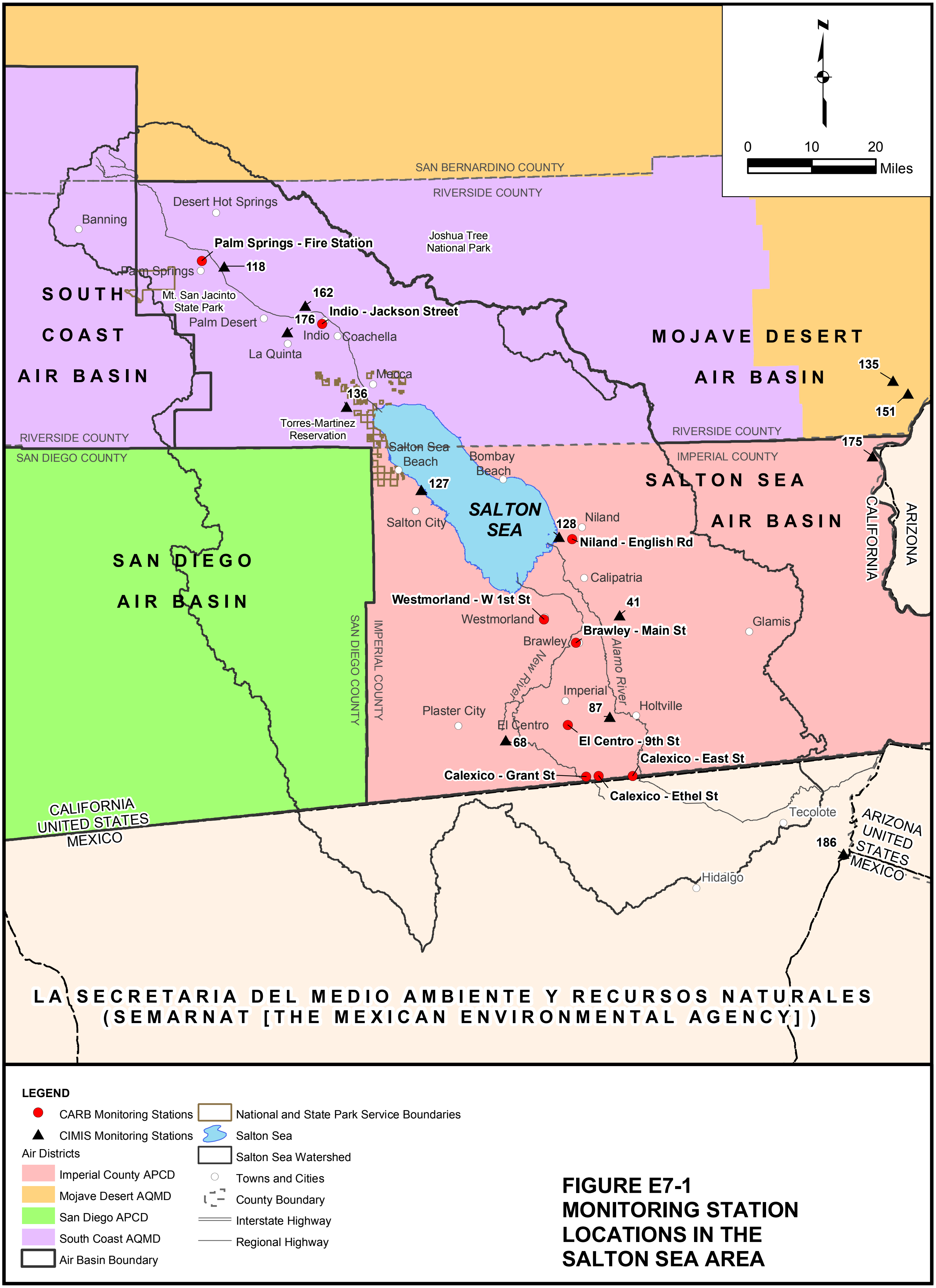
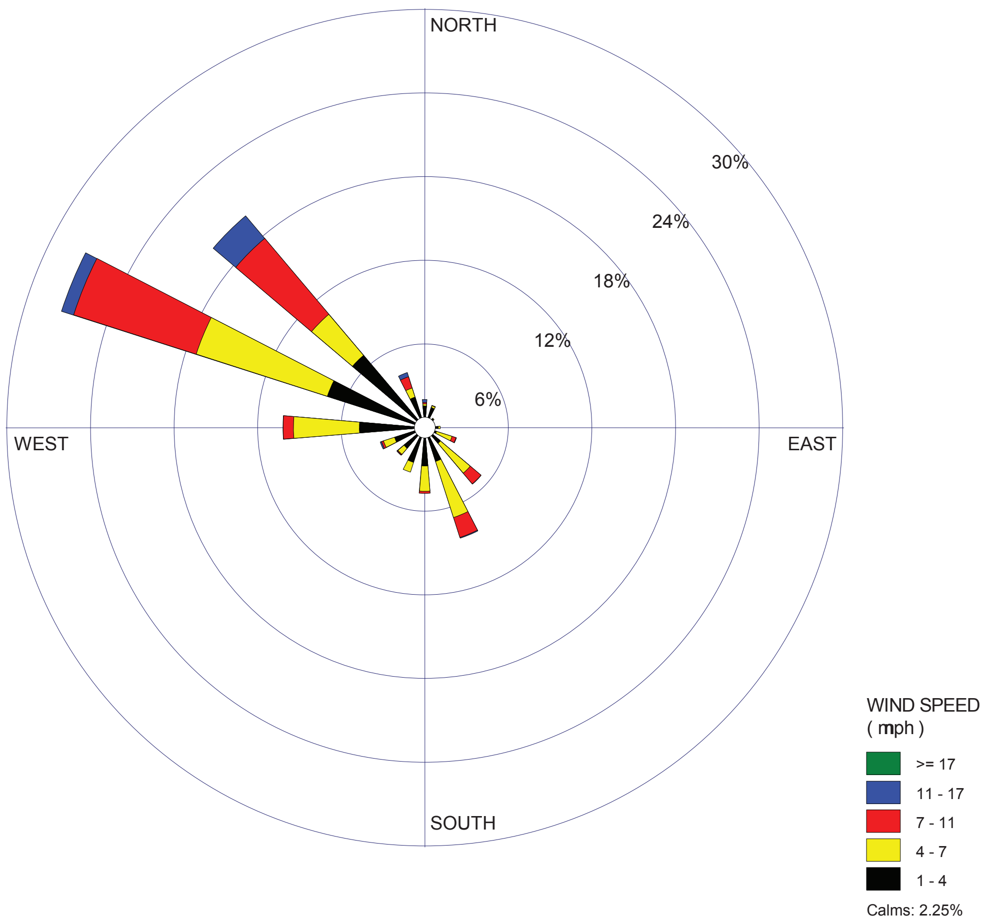


**FIGURE E7-1
MONITORING STATION
LOCATIONS IN THE
SALTON SEA AREA**

WIND ROSE PLOT:
Indio Windrose
Year 2002

DISPLAY:
Wind Speed
Direction (blowing from)



COMMENTS:

DATA PERIOD:
2002
Jan 1 - Dec 31
00:00 - 23:00

CALM WINDS:
2.25%

TOTAL COUNT:
8323 hrs.

AVG. WIND SPEED:
4.74 mph

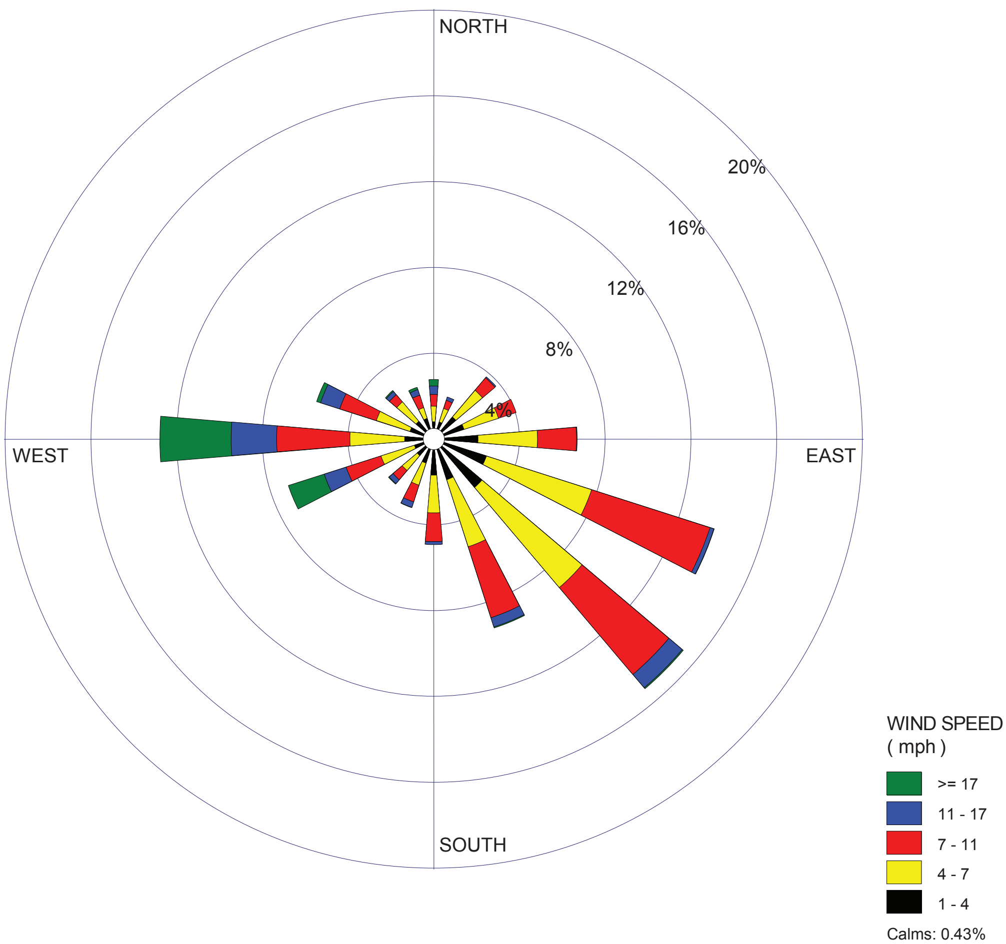
DATE:
7/3/2006

WRPLOT View - Lakes Environmental Software

FIGURE E7-2
INDIO 2002 WIND ROSE

WIND ROSE PLOT:
Niland Windrose
Year 2002

DISPLAY:
Wind Speed
Direction (blowing from)



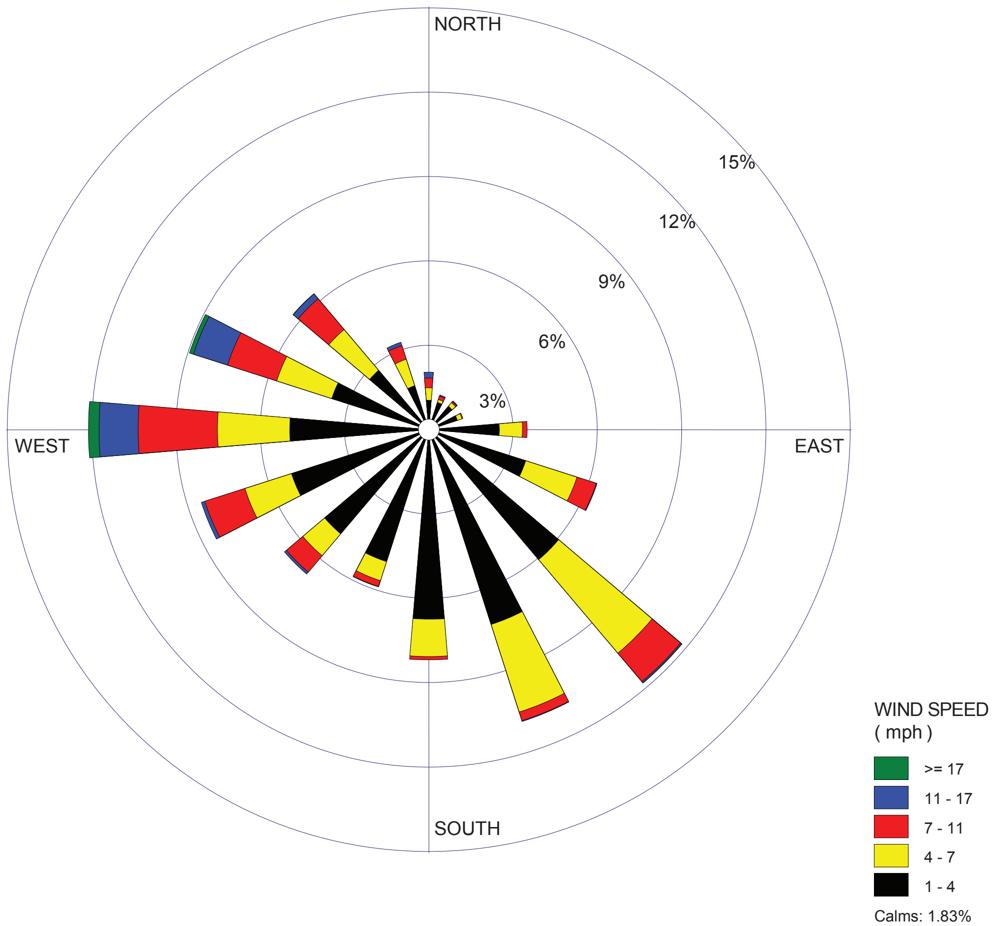
COMMENTS:	DATA PERIOD: 2002 Jan 1 - Dec 31 00:00 - 23:00	
	CALM WINDS: 0.43%	TOTAL COUNT: 8407 hrs.
	AVG. WIND SPEED: 7.00 mph	DATE: 7/3/2006

WRPLOT View - Lakes Environmental Software

FIGURE E7-3
NILAND 2002 WIND ROSE

WIND ROSE PLOT:
Westmorland Windrose
Year 2002

DISPLAY:
Wind Speed
Direction (blowing from)



COMMENTS:

DATA PERIOD:
2002
Jan 1 - Dec 31
00:00 - 23:00

CALM WINDS:
1.83%

TOTAL COUNT:
7742 hrs.

AVG. WIND SPEED:
4.08 mph

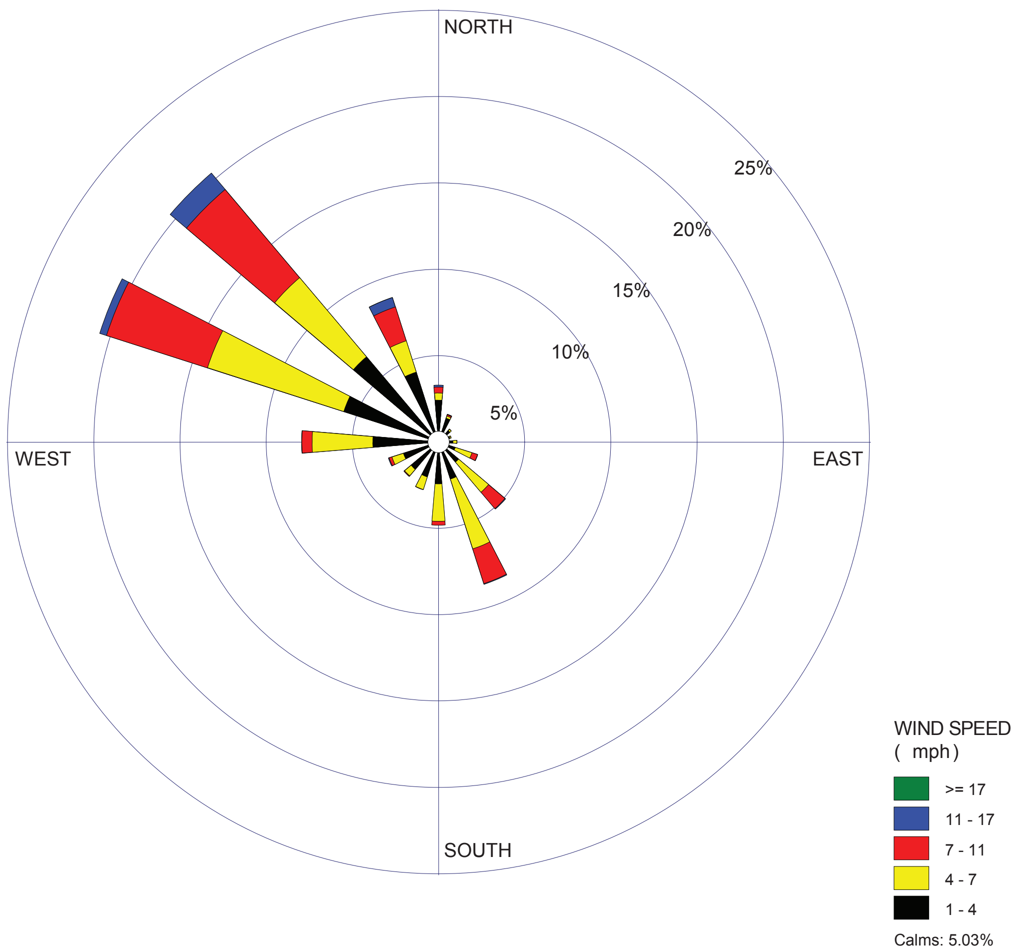
DATE:
7/3/2006

WRPLOT View - Lakes Environmental Software

FIGURE E7-4
WESTMORLAND 2002 WIND ROSE

WIND ROSE PLOT:
Indio Composite Windrose
Year 2001, 2002, 2003 and 2004

DISPLAY:
Wind Speed
Direction (blowing from)

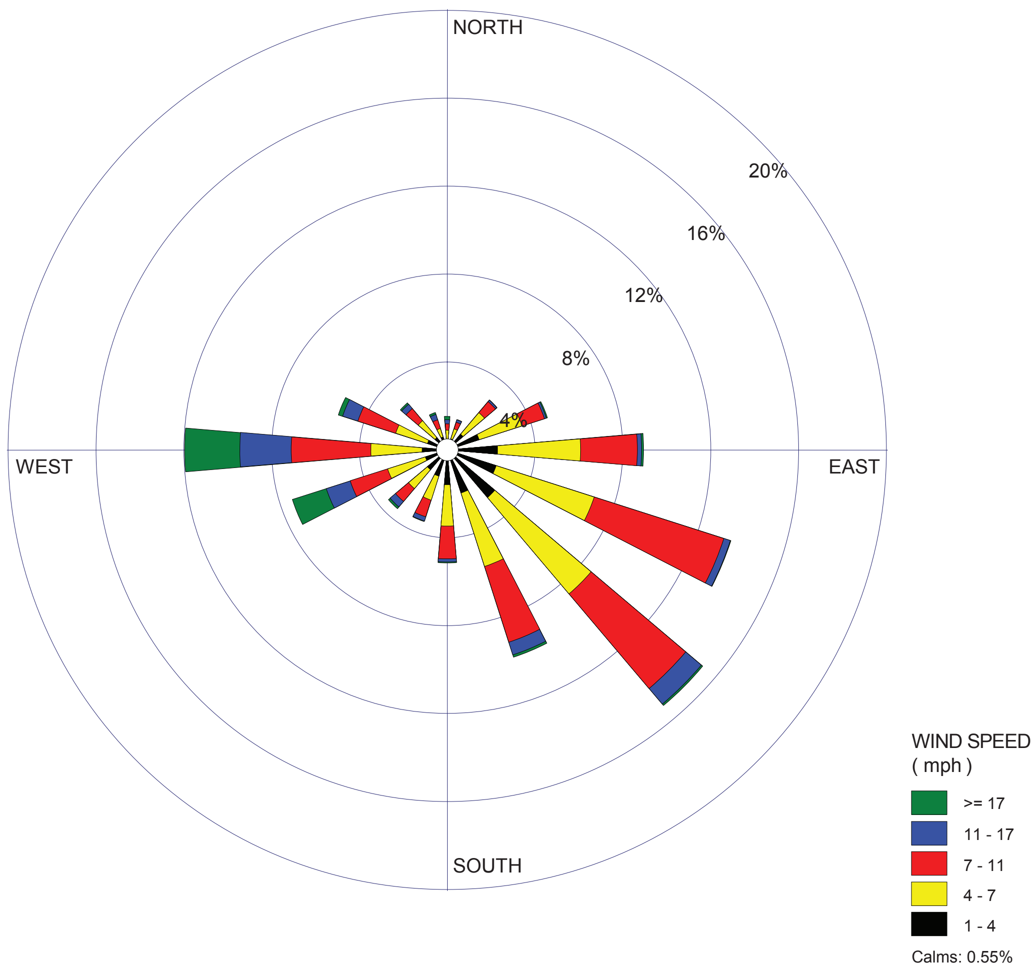


COMMENTS:	DATA PERIOD: 2001 2001 2002 2004 Jan 1 - Dec 31 00:00 - 23:00	
	CALM WINDS: 5.03%	TOTAL COUNT: 32307 hrs.
	AVG. WIND SPEED: 4.50 mph	DATE: 7/3/2006

WRPLOT View - Lakes Environmental Software

FIGURE E7-5
INDIO COMPOSITE WIND ROSE

WIND ROSE PLOT: Niland Composite Windrose Year 2001, 2002 and 2004	DISPLAY: Wind Speed Direction (blowing from)



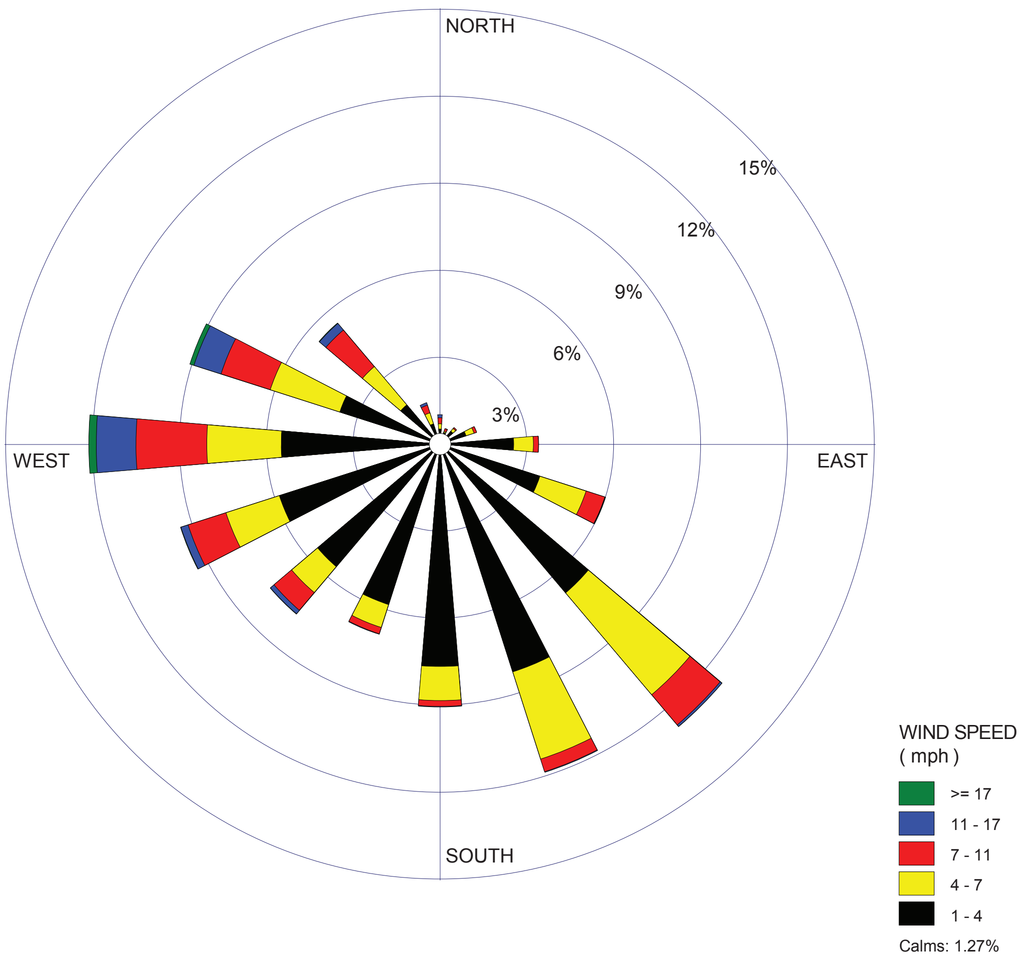
COMMENTS:	DATA PERIOD: 2001 2002 2004 Jan 1 - Dec 31 00:00 - 23:00	
	CALM WINDS: 0.55%	TOTAL COUNT: 25338 hrs.
	AVG. WIND SPEED: 7.06 mph	DATE: 7/3/2006

WRPLOT View - Lakes Environmental Software

FIGURE E7-6
NILAND COMPOSITE WIND ROSE

WIND ROSE PLOT:
Westmorland Composite Windrose
Year 2002, 2003 and 2004

DISPLAY:
Wind Speed
Direction (blowing from)



COMMENTS:	DATA PERIOD: 2002 2003 2004 Jan 1 - Dec 31 00:00 - 23:00	
	CALM WINDS: 1.27%	TOTAL COUNT: 23813 hrs.
	AVG. WIND SPEED: 4.03 mph	DATE: 7/3/2006

WRPLOT View - Lakes Environmental Software

FIGURE E7-7
WESTMORLAND COMPOSITE WIND ROSE

Table E7-1
Annual and Composite Wind Speed and Direction Measured at Selected Monitoring Stations

Stations	Years	Average Wind Speed (m/s)	Average Wind Speed (mph)	Percent of Time per Year When Wind Speeds Exceed 20 mph	Predominant Wind Direction (Percentage)
Indio	2002	2.22	4.9	<0.01	WNW (27.3) NW (19.9)
Indio	2001, 2002, 2004	2.07	4.6	0.05	WNW (20.63) NW (20.60)
Westmorland	2002	1.87	4.2	0.22	W (12.1) SE (11.8)
Westmorland	2002-2004	1.85	4.1	0.13	SE (12.7) W (12.1)
Niland	2002	3.12	6.9	4.0	SE (15.21) ESE (13.7)
Niland	2001-2004	3.14	7.0	3.5	SE (15.21) ESE (13.5)

m/s = meters per second
mph= miles per hour

CRUST FORMATION

Available Literature and Information

The formation of a salt crust on exposed playa can significantly affect wind erosion emission rates (Nickling and Brown, 2001). Based on observations in the Salton Sea area, when a crust is relatively hard (summer/fall months), the crust protects the underlying surface of soil and remains intact, preventing particles from becoming airborne until relatively high wind velocities occur. During the winter-early spring rains, the crust across the playa is generally softened by more frequent rains, or by the low temperatures and high humidity. The softer crust can no longer protect the surface to the same degree as more stable crust during the summer/fall.

The SCAQMD and the ICAPCD have jurisdiction over areas of the Salton Sea where playa may become exposed in the future. As one example of the types of air quality regulations that may apply to future Exposed Playa Areas, these areas are likely to fall under the open area definition in the ICAPCD rules. ICAPCD requires that open areas have a stable surface. The ball drop test is used by ICAPCD to determine the presence of a stable surface or crust.

The Desert Research Institute (DRI) under contract with DWR, is testing soil characteristics and wind erodability at the Salton Sea. At various locations around the Salton Sea, a one-time wind tunnel test has been co-located with Portable In-Situ Wind Erosion Laboratory (PI-SWERL) testing. In addition, periodic PI-SWERL tests are being conducted over several seasons. This information will be used to support the MacDougall Method and its use in calculation of playa dust emissions.

Assumptions were made as to future conditions that might be expected for playa surfaces at the Salton Sea. Based on ball drop test results, meteorological data on temperature and humidity, and observations by local residents of the area, the MacDougall Method will assume that for April through November, Exposed Playa will be in a stable crust condition. For the remaining 4 months (December, January, February, and March), the Exposed Playa will be assumed to exhibit unstable crust conditions.

Salton Sea Playa Salt Efflorescence Potential

Inflow to the Salton Sea will decrease through a combination of measures, exposing shallow-sloped playas whose subsurface may contain saline water. Playas containing saline water are prone to a salt efflorescence (growth of [often very fine] salt crystals on the surface of the playa) and to salt transformations (which can render playa surfaces extremely friable and susceptible to high rates of wind erosion). Dust emissions from friable playa and efflorescent salts on the Owens Lake playa have raised concern about similar emissions from the future Salton Sea playa.

The specific conditions on the Salton Sea playa are not known with sufficient detail to forecast daily potential for wind erosion, nor are predictive tools at this level of detail available. However, general conditions support the possibility that efflorescence and loosening of the crusted surface would occur and that dust could form from salt and loosened sediments during the right combination of climatic conditions.

Field observations of salt efflorescence, surface loosening, and wind erosion rates on the Salton Sea playa appear to be the only way to establish the extent to which salt transformations will actually increase susceptibility to wind erosion. Anecdotal reports of dust from the Salton Sea playa have not been systematically evaluated. However, these reports suggest that efflorescence and changes in crust friability, generally corresponding to expected climatic triggers, do occur (DRI, 2006).

Important Parameters Related to Crust Formation and Emissions Estimation

The dominant factors known to affect generation of PM_{10} dust emissions from Exposed Playa are:

- Land Use (e.g., wildlife refuge, wetlands habitat, lakes, saline habitat, or infrastructure);
- Climatic Factors (wind speed, temperature, humidity, and precipitation); and
- Land Surface Conditions (soil texture, crust development, strength of crust, and crust texture).

Use of the MacDougall Method for emissions estimates requires analyses of the following parameters:

- Land-type reservoirs;
- Threshold wind velocities; and
- Rain/humidity effects.

Estimating Land-Type Reservoirs

Most vacant land does not have an endless reserve of fugitive dust. Once the loose soils have been entrained and blown away, the same area of land has no more particulate matter to emit. Inter-area transport of particulates is the only method that keeps events going when there is a crust on the soil surface. Particles emitted from a neighboring parcel of land may move and settle on a nearby parcel, but generally no breach of the surface crust occurs.

Thus, land with a crust will have a shallow reservoir. Fugitive dust will be emitted within the first hour after winds exceed the threshold velocity. Land with no crust or with a disturbed crust, or with an erosive surface, will emit particulates for longer periods, perhaps for as long as the wind speeds exceed the threshold velocity.

Data from the Owens Lake wind tunnel studies (Nickling and Brown, 2001) show that when a crust is present, the soil surface is protected. When a stable crust is present, the MacDougall Method assumes that the land will be considered emissive only during the first hour of the wind event. When there is no crust present, or the crust is disturbed or softened, the sand creeping over the surface will erode the surface and result in an ongoing reservoir of particulate emissions. It was conservatively assumed that as long as an area was exposed and not crusted, emissions would continue throughout the duration of the wind event.

Estimating Threshold Wind Velocities

A wind event is defined as the time period when winds reach the threshold friction velocities, separated by at least a day before a new wind event is defined. The DRI PI-SWERL data will be used to develop the threshold friction velocities, which in turn will be used to define wind events in the meteorological data set. To calculate the number of wind events in a given interval of wind speed, if the playa is stable, the first hour will be assumed emissive. For unstable playa, all the hours during which the wind speed exceeds the threshold wind velocity will be assumed emissive.

Determining Rain and Humidity Events

Salt crusts on saline playas absorb moisture from the air when the relative humidity is high and the temperature is low, particularly after wintertime precipitation events. This absorbed moisture softens the crust, causing the soil to become more emissive. This is just the opposite of what is expected under non-saline soil conditions.

The MacDougall Method assumes that while measurable rain occurs, the soils are not emissive. For soils without a salt crust, the method assumes that enough moisture will be retained in the soil to keep the soil stable for at least 1 day after the rain event. For soils with a salt crust, the number of days after a rain event during which the land is considered emissive is adjusted based on temperature. If temperatures remain below 60 °F, the area will be considered not crusted for 5 days after the measurable rainfall and weakly crusted thereafter. If temperatures are above 60 °F, the area will be considered non-emissive the day of the rain event and the first day following the rain event, and durably crusted thereafter.

Precipitation data were not available from the three meteorological stations considered for wind data at the Salton Sea,(the weather stations at Indio, Westmorland, and Niland). Precipitation data were available at CIMIS weather stations in the area, such as at Calipatria (near the Niland weather station), Palo Verda (near Westmorland), and Oasis (on the northwest side of the Salton Sea, nearest the Indio weather station).

Area of Exposed Playa

U.S. Geological Survey (USGS) personnel have completed an analysis of winds measured around the Salton Sea. Wind speeds and directions collected at 10 meters at ARB sites and at 2 meters at CIMIS sites were used in the analysis (Chavez, et al., 2006). While 2-meter wind data cannot be directly compared with 10-meter wind data, the USGS analysis confirmed that higher wind speeds occur in the southern Salton Sea area. The USGS data also showed that the wind speeds and directions in the southwest portion of the Salton Sea are similar to those in the southeast portion of the Salton Sea. For this reason, and others previously listed, the 10-meter wind data from the Westmorland station were not used. Rather, the Niland data were used to represent conditions for the entire southern portion of the Salton Sea. The Niland station is closer to the Salton Sea, and measurements for Niland have been reported to be more representative of wind conditions at the Salton Sea.

TEST CASE

The MacDougall method uses site specific emissions information such as that derived from the PI-SWERL to estimate emissions in conjunction with a number of factors. Since Salton Sea PI-SWERL data were not available at the time of this test, and no other representative information is available, similar data collected at Owens Lake were used as the most representative data available. While these data are expected to be different than the site specific information when it becomes available, it provides a way to test the method and to conduct quality assurance checks on the methodology and other information used in the analysis.

Using the Owens Lake emission factors and the meteorological data from Indio and Niland, emissions were estimated assuming the entire lakebed had stable crust conditions and for the entire lakebed assuming unstable crust conditions. Emissions were found to range from about 7 tons per year assuming the entire lakebed exhibited stable crust conditions to 174 tons per year assuming the entire lakebed exhibited unstable crust conditions. Further refinements to the method and to the available data will be provided in the PEIR.

Reference: Playa Emission Estimation Presentation at March 14, 2006 Salton Sea Advisory Committee Meeting, MacDougall and Entyemezian

REFINEMENTS FOR ALTERNATIVES ANALYSIS

Development of emissions using the MacDougall method requires incorporation of a number of site-specific variables. These data will be developed in part using the data collected by DRI through the wind tunnel and PI-SWERL tests underway at the Salton Sea. Based upon the availability and quality of that data, the following site specific information will be used to refine the estimate of playa emissions at Salton Sea.

- Threshold wind velocity and emission factors for a number of wind speed categories;
- Emission factors at a number of locations, so different emission factors can be applied to different areas;
- Emission factors at a number of wind speed categories and locations during stable crust and unstable crust conditions;
- Time periods during which stable crust conditions and unstable crust conditions will be assumed;
- Refinements from examination of temperature, humidity, and rainfall conditions; and
- Calculation of total hours where wind speeds exceed threshold velocities.

These refinements will be incorporated into MacDougall Method to develop emissions estimates and support the analysis of alternatives in the PEIR.

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Nickling, W. G. and L.J. Brown. 2001. PM_{10} Dust Emissions at Owens Lake, California. Prepared for Great Basin Unified Air Pollution Control District by Wind Erosion Laboratory, University of Guelph, Guelph, Ontario, Canada.

APPENDIX E, ATTACHMENT E8

Ongoing Data Management and Air Quality Management and Air Quality Modeling Preparation

2006

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APPENDIX E, ATTACHMENT E8
ONGOING DATA MANAGEMENT AND AIR QUALITY MODELING PREPARATION

Early work on available data and data management resulted in a report titled, Identification of Data Gaps, part of the Unified Executive Summary and Appended Final Air Quality Technical Memoranda Prepared to Support the Salton Sea Ecosystem Restoration Programmatic Environmental Impact Report (PEIR), completed in February 2005 (California Department of Water Resources [DWR], 2005a). That report is referred to as the Data Gaps report in this technical memorandum. The Data Gaps report provided an initial list of available data and identified data gaps to be investigated and filled to support the PEIR.

Follow-on work was summarized in the technical memorandum *Evaluate, Identify Gaps, and Provide Management of Current Aerometric Monitoring Data Collection Efforts* (DWR, 2005b). That report is referred to as the Data Update Report. It updated the ongoing development and maintenance of the air quality monitoring and meteorological database, and identified, evaluated, and interpreted new aerometric monitoring data. It also presented information on ongoing aerometric monitoring data collection efforts being conducted by others in support of the PEIR.

This technical memorandum updates the development of the air quality monitoring and meteorological database and presents the details of the preparation of AERMOD-ready meteorological data sets and revised CALMET meteorological wind field data. It also describes or interprets aerometric monitoring data received from the following studies:

- Data sets obtained and updated for this report;
- Acoustic modeling of seafloor sediments studies being conducted by the U.S. Geological Survey Flagstaff Office (USGS Flagstaff) and U.S. Bureau of Reclamation in Boulder City, and its consultant, Quester Tangent Corporation;
- Correlations of PM_{10} monitoring results and meteorological data for stations north and south of the Salton Sea being conducted by USGS Flagstaff;
- Wind tunnel tests to evaluate the potential emissivity of recently exposed sediments being conducted by the Desert Research Institute (DRI); and
- Correlations of data received from new 10-meter meteorological stations collocated at the site of three 2-meter CIMIS meteorological stations.

ONGOING DATA MANAGEMENT

Since the preparation of the PEIR began, a database was envisioned that would contain all the aerometric data available in the Salton Sea watershed. Compilation of data began at the onset of efforts for the Data Gaps report. A database has now been designed, and the import procedures initiated. At this point, the database has been populated with meteorological and particulate matter data. Once completed, this database will be available for review and use by the California Resources Agency and, with its approval, other interested parties.

Database Design and Structure

The database is designed to collect data from state and federal agencies, process the data into a uniform format, and have a user interface that enables data retrieval using a geographic information system (GIS) interface. The product of the retrieval will be an Excel worksheet containing the data requested.

As shown in Figure E8-1, each raw data set (Raw Data Sources) will be extracted according to a fixed algorithm that can be used to update the database through time (Raw Data Extraction). Each extracted data set will be used to populate (Population Process) a raw data table identified by the agency that provided the data, the data averaging period (hourly, daily) if it varies, and the measurement method if it varies for each parameter. Prior to retrieval, each data set requested will move through a quality control process to standardize the data for units and quality assurance (QC). Data sets from multiple agencies for the same monitoring station will be merged into one data set (tblProcessData). A retrieve data view (View) will allow the user to retrieve the data (Retrieve Process).

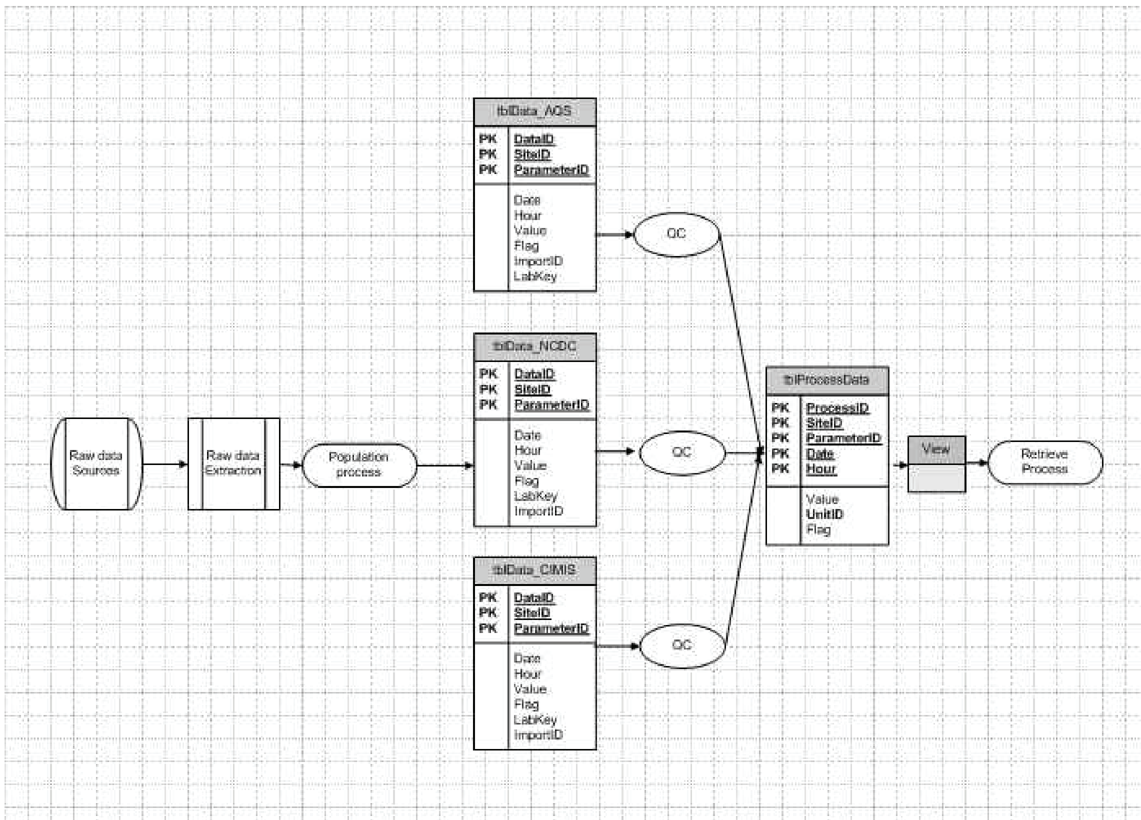


FIGURE E8-1
DATABASE FLOW DIAGRAM

Fifteen tables and one ARCGIS view make up the structure of the database. ARCGIS is the comprehensive name for the current suite of GIS products produced by ESRI. The tables and view are listed in Tables E8-1 and E8-2, respectively.

Table E8-1
Database Tables

Table Name	Columns	Description
tblSource	5	Names of agencies providing data
tblSite	15	Names of monitoring sites
tblParameter	6	Names of parameters
tblCategory	2	Parameter categories
tblFrequency	2	Data collection frequency
tblUnit	4	Contains all units used in data sets
tblImport	5	Records population history
tblData_[SOURCE]	11	Hourly data from individual sources
tblData_Temp	11	Temporary raw data table
tblProcess Site	2	Holds data from all sources as individual sites prior to quality procedures and standardization
tblProcessData	8	Holds data for retrieval by user

Table E8-2
ARCGIS View

View Name	Columns	Description
vRetrieveData	9	Provides user interface

Quality Assurance Considerations

Aerometric monitoring stations in the Salton Sea watershed area are operated by local air districts, DWR, the National Park Service, and the National Weather Service (NWS). Each of those organizations has established its own data quality objectives to collect data of acceptable quality, and each follows its own procedures to meet its objectives. Data being collected and established in the database include quality parameters, when available.

The database quality assurance procedure will involve the following three steps:

1. Screening data;
2. Replacing missing data (inserting flags for missing data); and
3. Standardizing units of measurement.

The first step will check each value against a range of valid values and check the variation of values over time against a standard. For example, meteorological data will be screened against the criteria listed in Table E8-3.

Table E8-3
Screening Criteria for Meteorological Data

Variable	Unit	Criteria
Average Wind Speed	Meters per second (m/sec)	Wind speed is greater than 0 m/sec and less than 25 m/sec. Wind speed varies by no more than 0.1 m/sec for 3 consecutive hours.
Maximum Wind Gust	m/sec	Wind gust is greater than average wind speed. Wind gust is less than 26.82 m/sec (60 mph).
Average Wind Direction	Degrees from	Wind direction is greater than 0 and less than 360 degrees. Wind direction varies by no more than 1 degree over 3 consecutive hours. Wind direction varies by no more than 10 degrees over 6 consecutive hours.

The second step will replace each missing data value as defined by the source agency with a NULL or blank. A flag of "M" will follow the value. When retrieving the data, the user will have the option to specify a number such as "999" to replace the missing data.

The third step will replace all units for a parameter to a common unit. For example, wind speed will be reported in meters per second. If the raw data are in knots, the data will be converted to meters per second. This step will also convert time frequencies less than an hour to an hourly value.

User Interface

Upon opening the database, the user will view a map showing the sites for which the database has data (Figure E8-2). The user will click the "Salton Sea" command button on the top toolbar to bring up a form with monitoring station locations (sites) in the Salton Sea area. After choosing the sites desired (Figure E8-3), the user will click on the "Next" button to bring up a form for choosing the parameters and time periods desired (Figure E8-4). Alternatively, the user can select a location on the site map and then click the "Salton Sea" command button. The site(s) for that location will appear in the form for choosing sites. After choosing the parameters and time periods desired, the user will click on the "Export to Excel" button to retrieve data (Figure E8-5). The data will appear in an Excel worksheet and will be available to the user.

AERMET METEOROLOGICAL DATA PROCESSING

To facilitate future air dispersion modeling that might be needed near the Salton Sea, the AERMOD model will likely be used. The AERMOD model has been promulgated by USEPA in its *Guideline on Air Quality Modeling* (USEPA, 2006) as the standard model for most purposes, including the transport of pollutants to downwind distances (up to 50 kilometers [km]) over which steady-state conditions can be assumed. AERMOD can be run with area sources and point sources and is a logical selection for modeling the types of sources associated with Salton Sea restoration alternatives.

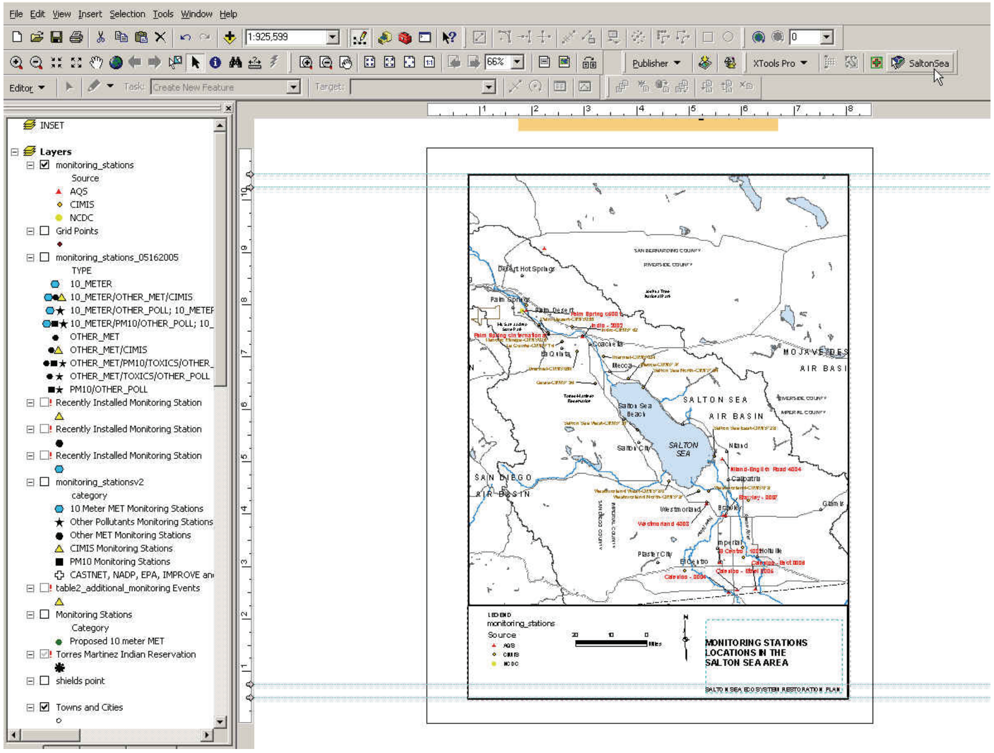


FIGURE E8-2
USER INTERFACE – OPENING SCREEN

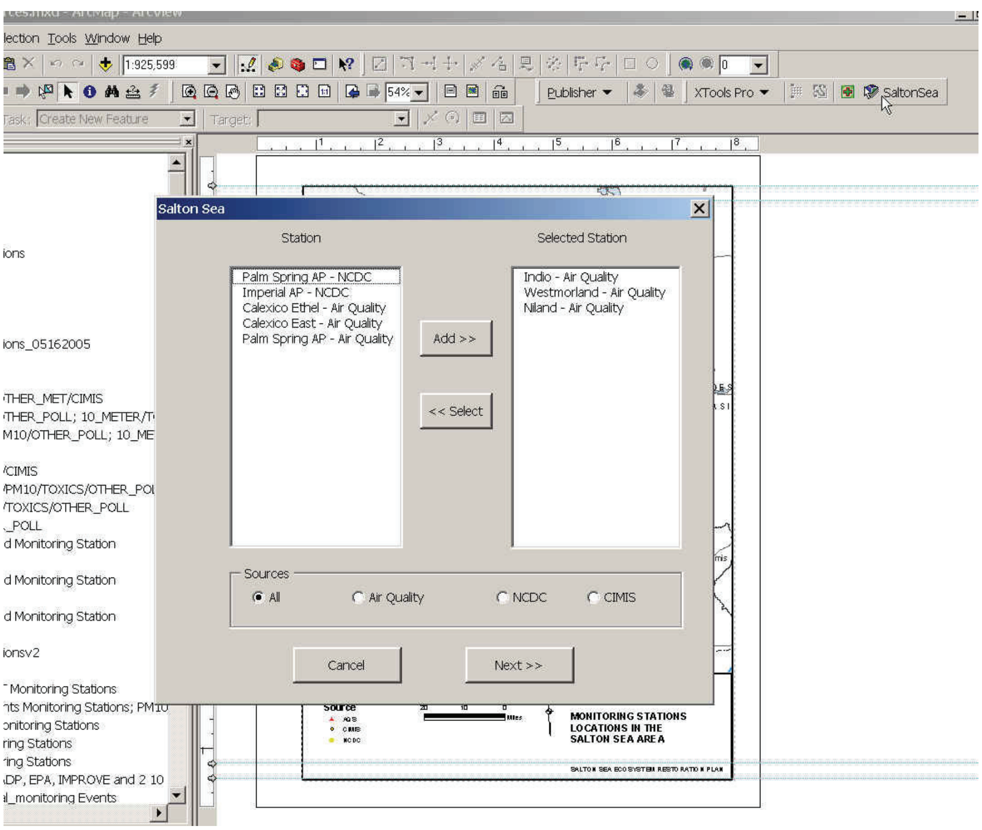


FIGURE E8-3
SITE FORM

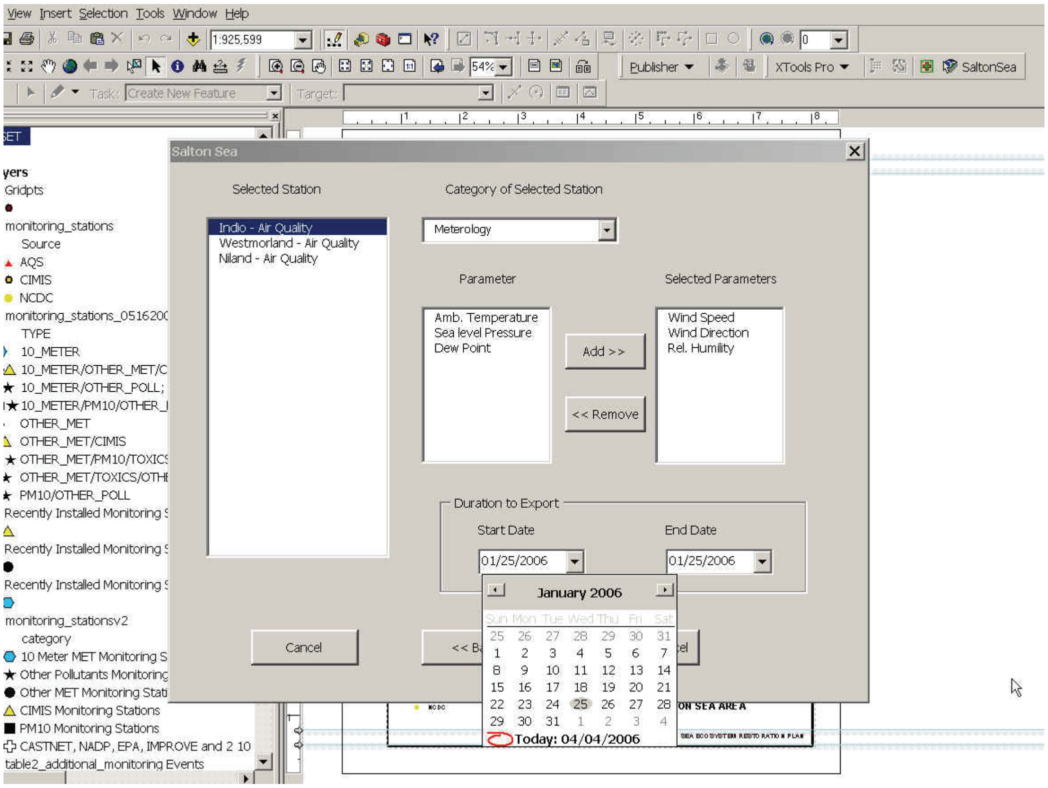


FIGURE E8-4
PARAMETER AND TIME PERIOD FORM

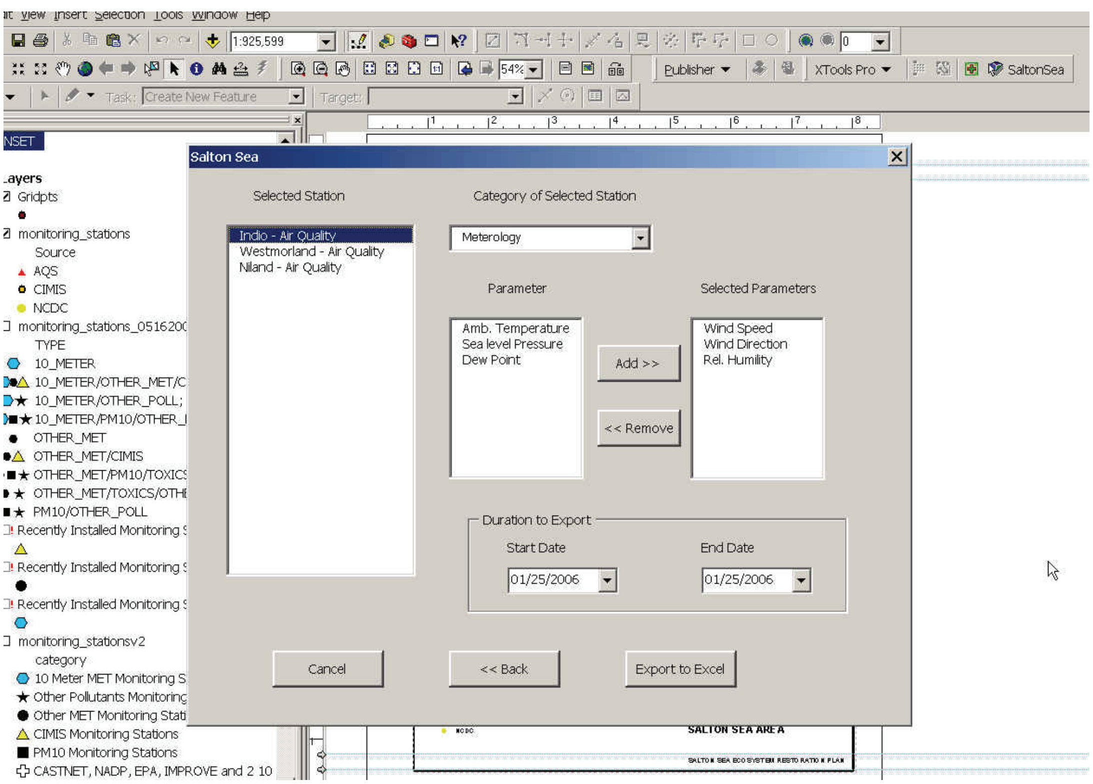


FIGURE E8-5
READY FOR EXPORT

AERMOD-ready meteorological files were prepared for several locations considered representative of the area immediately surrounding the Salton Sea. The meteorological preprocessor module of AERMOD, AERMET, was used to generate the files. AERMET Version 4.30 was used to prepare the meteorological files.

The AERMET module is a three-stage processing routine. The first stage involves extracting data from three sources (onsite data, NWS surface data, and NWS upper air data) and subjecting it to quality assurance checks in the form of acceptable data ranges. The second stage merges data into a single data file. The third stage establishes the boundary layer parameters from the merged data and generates the two meteorological files read by AERMOD: (1) a file of the hourly boundary layer parameters, and (2) a file that includes the wind speed, direction, temperature, and, if multi-level data are included in the onsite data file, the standard deviation of the fluctuating components of the wind at multiple levels.

Calculations of the boundary layer parameters depend on the surface conditions at the meteorological measurement site. Obstacles to wind flow, surface moisture, and reflectivity affect the calculation and are quantified by the assignment of three variables: surface albedo, Bowen ratio, and surface roughness length. These site-specific variables can be assigned to vary by wind direction sector for areas where land use around the area to be modeled varies appreciably. The surface characteristics preprocessing program AERSURFACE was used to assign these parameters using USGS 1-degree land-use data files to determine the predominant land-use category, by sector, within a 10-kilometer radius of the meteorological data sites at Niland, Westmorland, and Indio. AERSURFACE has been developed by USEPA to automate the selection of land use within a user-specified radius of a given coordinate. The USGS land-use data must first be processed with the MAKEGEO preprocessing program from the CALMET model. Currently, AERSURFACE will only present the annual average land use and will write out the values by 30-degree sectors. Table E8-4 presents the albedo, Bowen ratio, and surface roughness length, by sector.

Table E8-4
AERMET Surface Characteristics

Sector (degrees)	Albedo	Bowen Ratio	Surface Roughness Length (m)
00-30	0.25	1.02	0.1019
30-60	0.24	1.01	0.0803
60-90	0.24	1.01	0.0954
90-120	0.22	1.02	0.1498
120-150	0.18	1.04	0.2928
150-180	0.18	1.02	0.2362
180-210	0.18	1	0.2057
210-240	0.19	0.99	0.1799
240-270	0.2	1.02	0.1997
270-300	0.22	1.08	0.2797
300-330	0.2	1.07	0.2791
330-360	0.23	1.04	0.1635

The three sites near the Salton Sea that meet USEPA criteria for use in modeling and with acceptable data completeness are Indio to the north, Westmorland to the south, and Niland to the southeast. To support the PEIR, the most complete meteorological data from the last 5 years were processed using surface data from the three sites. Available data are summarized in Table E8-5 for each site and year. AERMET requires that NWS surface data be used. NWS data are available from the Imperial County Airport for use with the Niland and Westmorland data, and the Palm Springs Regional Airport for use with the Indio data. Upper air data from Desert Rock, Nevada, were used as the closest and most appropriate upper air data for all sites.

AERMET was run with the option to substitute data from the NWS stations for data missing from the onsite data files.

Table E8-5
AERMET Meteorological Source Data

Onsite Data*	Years	NWS Surface Data	NWS Upper Air Data
Niland	2001, 2002, 2004	Imperial County Airport	Desert Rock
Indio	2001, 2002, 2003, 2004	Palm Springs Regional Airport	Desert Rock
Westmorland	2001, 2002, 2003, 2004	Imperial County Airport	Desert Rock

* Source of data for Niland and Westmorland is the Imperial County Air Pollution Control District. Source of data for Indio is the South Coast Air Quality Management District.

CALMET METEOROLOGICAL DATA PROCESSING

CALMET is the meteorological preprocessor component of the CALPUFF air model (http://www.src.com/calpuff/calpuff1.htm). As reported in the Data Update Report, a preliminary CALMET wind field was developed for the Salton Sea area. Comments received on the draft Data Update Report and further evaluation of data have resulted in development of a revised CALMET wind field. CALMET Version 5.53a was used to prepare the wind fields.

Fugitive dust emission estimates require the use of meteorological parameters such as wind speed, temperature, humidity, and precipitation at specific geographic locations to predict the amount of dust generated by wind erosion. The wind fields developed for the Salton Sea watershed domain were used to create meteorological data sets to support the emissions estimation models.

Although the current objective is to use the CALMET data to create surface wind data sets at a number of locations, a three-dimensional database was created for future use. The lowest level of the wind field, 0 to 20 meters, was extracted to develop the surface data sets.

The use of CALMET to provide data to model particulate matter emissions rates addresses several complex physical processes that affect the Salton Sea. These complex processes include the meteorology in the area, as well as the processes associated with particle migration. There is not significant experience using CALMET with data from the Pennsylvania State University/National Center for Atmospheric Research Mesoscale Model – Generation 5 (MM5) to develop wind fields in this type of environment for this type of situation. While CALMET has been used with MM5 data for the development of wind fields in places without abundant meteorological data, its use is not widely accepted.

CALMET includes a diagnostic wind field generator containing objective analysis and parameterized treatments of slope flows, kinematic terrain effects, terrain blocking effects, and a divergence minimization procedure. It also contains a micrometeorological model for overland and over-water boundary layer conditions. Output from CALMET is used as input to the CALPUFF transport and dispersion model.

The CALMET program applies a two-step approach to generate the modeling domain wind field. The first step reads the observational upper air data and generates an initial wind field. This approach uses a routine to adjust the data for terrain effects (kinematic effects, slope flows, blocking conditions). The second step applies an objective analysis and a data-smoothing approach to refine the initial wind field. This step uses the surface data and results in the development of the final wind field.

CALMET also has the option to incorporate gridded prognostic wind fields (MM5) to the analysis, which may better represent regional wind conditions and slope/valley circulations. The gridded prognostic data can be introduced into CALMET in three ways:

1. As a replacement for the initial wind field, which is referred to in CALMET as the initial guess wind field;
2. As a replacement for the Step 2 wind field; or
3. As a way to consider the prognostic data as “observations data” from a surface meteorological station.

For this analysis, MM5 data were used as the initial guess wind field.

CALMET Modeling Domain

The Salton Sea is in an arid area of southern California. The lake is about 35 miles long and 15 miles wide. The lake surface average elevation is about 227 feet below mean sea level. The watershed area that feeds the Salton Sea extends from Riverside County to Mexico, and from the Mojave Desert to San Diego County. The area encompasses portions of Riverside, San Diego, and Imperial counties. Major terrain features include the Coachella Valley to the northwest and the Imperial Valley to the southeast. The Santa Rosa Mountains to the west and the Chocolate Mountains to the east form barriers to air flow and affect the climate and the winds in the area.

A number of FORTRAN computer programs are needed to extract data from large databases and convert the data into formats suitable for input to CALMET. The input data from a number of sources are defined below.

CALMET uses the meteorological grid to determine the spatial variability and effect of meteorological conditions and terrain on calculated pollutant concentrations. The southwest corner of the meteorological grid defines the grid starting point.

The modeling domain developed for this analysis is the geographic area that encompasses the Salton Sea watershed and is defined below.

The domain is a three-dimensional box, with horizontal dimensions extending 196 kilometers in the east-west (x) direction and 209 kilometers in the north-south (y) direction. The grid cell spacing in the horizontal plane is 1 kilometer. The vertical dimension of the domain has 10 layers defined by the following heights (kilometers): 20, 40, 80, 160, 300, 600, 1,000, 1,500, 2,200, and 3,000.

The coordinate system used to define the grid is Universal Transverse Mercator (UTM). The southwest corner of the three-dimensional grid is the origin of the modeling domain and is at 504,042 UTM east and 3,572,072 UTM north in UTM Zone 11.

CALMET Data Inputs

Meteorological data inputs to CALMET included three-dimensional prognostic meteorological data, as well as data from surface meteorological stations and precipitation stations throughout the domain. The following data sets were used in the CALMET runs:

- Terrain elevations for each grid cell in the surface layer were obtained from the USGS website, in the form of Digital Elevation Maps (DEM) files. The 1-degree DEM data for the modeling domain grid were extracted using CALPUFF’s terrain preprocessor program, TERREL;

- Land-use data were also obtained from the USGS website in the Composite Theme Grid (CTG) format. The resolution of the files is 1:250000. Currently, all land-use parameter values are based only on annual averaged values;
- Land-use values were processed into the correct format using CALPUFF's preprocessor CTGCOMP, which puts data into a compressed format for use by CTGPROC, which extracts the land-use parameters at each of the predefined grid cells in the domain;
- All of the processed land-use parameters were combined with the terrain information via CALPUFF's preprocessor MAKEGEO in a GEO.DAT file for input to CALMET;
- MM5 prognostic data for 2002 were used to establish the initial guess wind field. The MM5 data have a 36-kilometer resolution. These data were adjusted to account for terrain influences to create a Step 1 wind field. The MM5 data were derived from a data set that was developed for the Western Regional Air Partnership (WRAP), by ENVIRON International Corporation (WRAP, 2004);
- Surface meteorological data were obtained for nine stations from USEPA Region 9, except for data for the Palm Springs Regional Airport and Imperial County Airport, which were obtained from the National Climatic Data Center (NCDC);
- Precipitation data from 13 stations within the modeling domain were obtained from the NCDC; and
- CALMET uses observation data from surface and precipitation stations to provide additional data near the stations chosen to blend with the Step 1 wind field data to compute the Step 2 wind field. Upper air observational data were not used in this analysis. Both the distance of the nearest stations from the Salton Sea watershed and the difference in land use and terrain influences led to the determination that the upper air data in the MM5 data would be more representative of local conditions.

Figure E8-6 shows the modeling domain established for this analysis, the terrain, and the locations of the additional meteorological station data used. The input variables selected for running CALMET are in Appendix A.

Differences in the current analysis and the TO No. 17 analysis include:

- Change in year of analysis from 2003 to 2002;
- Change in TERRAD, the variable that defines the distance for influence of terrain, from 10 kilometers to 20 kilometers;
- Change in surface and precipitation stations based on data completeness of individual stations for 2002 vs 2003; and
- Change in radius of influence for interpolation of precipitation data from 100 to 200 kilometers.

NEW AEROMETRIC MONITORING DATA

Updated Data Sets

Air quality and meteorological data available near the Salton Sea are described in Table E8-6. All data shown in this table have been updated for this task. Table E8-6 notes the status of updates and includes the following fields:

- Source of data;
- Station identification number;
- Station name;
- Years the station was in operation;
- Location of station (latitude, longitude, elevation); and
- Type of data (meteorological, air quality).

Table E8-7 details the type of meteorological and air quality data available at each site. Websites and references for the data are listed in the References section of this document.

CASTNET, RAWS, NADP, and IMPROVE data from Joshua Tree National Park were not updated for this task. The station distance from the Salton Sea region and the time-consuming nature of data retrieval precluded data collection.

Also, data have not yet been collected on the Torres Martinez Indian Reservation.

Acoustic Modeling of Seafloor Sediments

USGS Flagstaff, the U.S. Bureau of Reclamation in Boulder City, and consultant Quester Tangent Corporation have completed a mapping project of Salton Sea bottom characteristics using dual frequency acoustics (USGS, 2006a). The project detected and mapped Salton Sea bottom surface characteristics that may indicate potential new dust sources within the Salton Sea as the water level is lowered. Little is known about the airborne suspension potential of sediments in the Salton Sea. A map showing surface characteristics may prove useful in assigning dust emissivity coefficients to areas that may be exposed in the future.

The acoustic survey consisted of 3 million acoustic returns starting at 5 feet of water depth and covered 138,557 acres through interpolation. The survey found that about 30 percent of the area had particles of fine particle size, indicating high relative vulnerability; about 37 percent of the area had particles of intermediate particle size, indicating moderate relative vulnerability; and about 33 percent of the area had particles of coarse particle size, indicating low relative vulnerability. Additional details of the analysis can be obtained from USGS.

PM_{10} and Meteorological Data from Stations North and South of the Salton Sea

USGS Flagstaff and Reclamation have completed a study of wind characteristics and PM_{10} emissions using data collected by the California Air Resources Board (ARB) and CIMIS meteorological stations (USGS, 2006b). The study used data from 2000 and 2002 to study wind characteristics around the Salton Sea and evaluate potential correlations between monitored wind characteristics and measured PM_{10} levels in the area. Correlations may prove useful in estimating potential air quality impacts associated with dust emissions that might result from a lower Salton Sea water level.

The primary parameters used in the analysis were wind speed and wind direction. Wind speed and direction are recorded hourly at the ARB and CIMIS stations. PM_{10} data were used when available as a general indicator of air quality. Hourly PM_{10} data were available for only one ARB site for the 2 years examined. Because of the lack of historical hourly PM_{10} data, detailed analyses and correlation with wind data were not possible.

USGS and Reclamation found a possible correlation between elevated PM_{10} levels and winds blowing from the northwest, with a secondary correlation with winds blowing from the southeast. A weak correlation was found between PM_{10} and wind speeds greater than 10 miles per hour (mph).

Wind Tunnel Tests at the Salton Sea

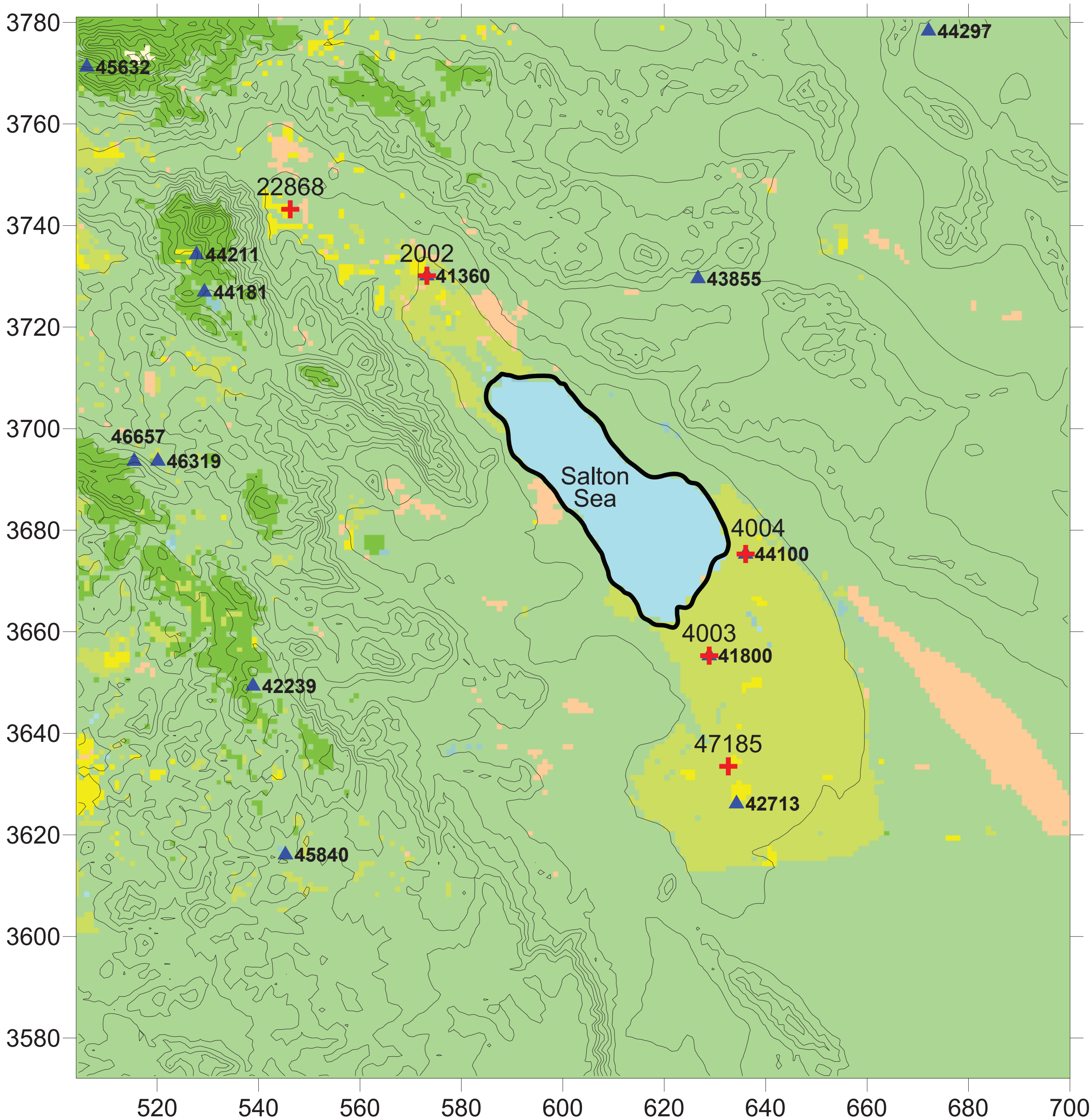
DRI has conducted several rounds of testing at the Salton Sea to provide onsite data for dust emissivity estimation and soil characterization (DWR, 2006; DRI, 2006). Wind erodibility and soil tests were conducted between September 19 and October 2, 2005. Tests were also conducted between January 23 and January 27, 2006, and March 20 and March 23, 2006. An interim report summarizing the 2005 field measurement campaign was submitted on January 3, 2006, and preliminary results from the January testing were presented and discussed at the March 14, 2006, Air Quality Working Group meeting.

Soil analyses included crust stability, albedo (reflectivity), water content, particle size distribution, carbonate content, electrical conductivity and pH, organic matter content, salt and ion content, and aggregate analysis. These data are needed for emissions modeling and potential dispersion modeling.

Wind erodibility indexes were measured using the Portable In-Situ Wind Erosion Laboratory (PI-SWERL), a DRI-developed technology. This technology allows for rapid, repeatable measurements needed for numerous sites and varying measurement frequencies. To interpret data from the PI-SWERL in terms of traditional wind tunnel measures, such as threshold friction speeds, the PI-SWERL was collocated with the University of Guelph field wind tunnel at some sites during the 2005 measurement campaign.

Results from the 2005 campaign show some sites have higher emissivity (6 milligrams per meter squared second) than others (0.1 milligrams per meter squared second). The high values are not clustered geographically, and high and low values are sometimes located next to each other. The maximum values appear midway on both the east and west sides of the Salton Sea.

In general, preliminary data from the January 2006 campaign indicate that the emissivities measured by the PI-SWERL technology in January 2006 were greater than those measured in fall 2005, but crust strength declined at most of the sites. Preliminary data from the March campaign show that the crust restabilized from the January campaign and the emissivities declined.



LEGEND

Precipitation Station

Surface Station

FIGURE E8-6
SALTON SEA CALMET MODELING DOMAIN

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Table E8-6
Summary of Monitoring Sites

			Location			Type of Data			
Source	Site ID	Site Name	Latitude	Longitude	Elevation m	Meteorological	Air Quality	Years Station in Operation	Date Data Updated Through
AQS	AIRS0003	Brawley - Main Street #1	32.98	-115.53	-13		x	1993-2003	NU
AQS	AIRS0004	Calexico - Grant Street	32.67	-115.52	NA	x	x	1991-Present	Sep-05
AQS	AIRS0005	Calexico - Ethel	32.68	-115.48	6	x	x	1994-Present	Sep-05
AQS	AIRS0006	Calexico - East	32.68	-115.39	10	x	x	1996-Present	Sep-05
AQS	AIRS0007	Brawley - Main Street #2	32.98	-115.54	-13		x	2004-Present	Sep-05
AQS	AIRS0012	Banning-Airport	33.92	-116.86	473	x	x	1995-Present	Sep-05
AQS	AIRS1003	El Centro - 9th Street	32.79	-115.56	9	x	x	1986-Present	Sep-05
AQS	AIRS2002	Indio - Jackson Street	33.71	-116.21	-4	x	x	1983-Present	Sep-05
AQS	AIRS4003	Westmorland	33.03	-115.62	-32	x	x	1993-Present	Sep-05
AQS	AIRS4004	Niland-English Road	33.21	-115.54	-54	x	x	1996-Present	Sep-05
AQS	AIRS5001	Palm Springs Fire Station	33.82	-116.48	171	x	x	1971-Present	Sep-05
AQS	AIRS9002	Joshua Tree National Park	34.07	-116.39	1,244	x	x	1993-Present	Sep-05
NCDC	COOP040983	Borrego Desert Park	33.23	-116.42	245	x		1942-Present	NU
NCDC	COOP044224/KIPL	Imperial County AP	32.83	-115.58	-20	x		1962-Present	Oct-05
NCDC	COOP044259	Indio US Date Garden	33.72	-116.22	-6	x		2004	NU
NCDC	COOP045502	Mecca	33.57	-116.08	-55	x		2004-Present	NU
NCDC	COOP048892/KTRM	Palm Springs Thermal AP	33.63	-116.17	-34	x		1950-2003	NU
NCDC	KPSP	Palm Springs International Airport	33.82	-116.50	128	x		1998-Present	Oct-05
NCDC - Precip	COOP41860	Indio Coachella	33.41	-116.10	-6	x		1948-1950	NU
NCDC - Precip	COOP42139	Crawford Ranch	32.53	-116.17	140	x		1948-1985	NU
NCDC - Precip	COOP42239	Cuyamaca	32.59	-116.35	431	x		1931-Present	NU
NCDC - Precip	COOP42709	El Capitan Dam	32.53	-116.49	56	x		1935-Present	NU
NCDC - Precip	COOP42713	El Centro 2 Ssw	32.46	-115.34	-3	x		1932-Present	NU
NCDC - Precip	COOP43855	Hayfield Pump Plant	33.42	-115.38	127	x		1933-Present	NU
NCDC - Precip	COOP43899	Hemet Reservoir	33.40	-116.40	405	x		1948-1961	NU
NCDC - Precip	COOP43914	Henshaw Dam	33.14	-116.46	251	x		1942-Present	NU
NCDC - Precip	COOP44181	Hurkey Creek Park	33.41	-116.41	408	x		1939-Present	NU
NCDC - Precip	COOP44208	Idyllwild 1 Ne	33.45	-116.42	501	x		1951-1952	NU
NCDC - Precip	COOP44211	Idyllwild Fire Dept	33.45	-116.42	500	x		1944-Present	NU
NCDC - Precip	COOP44297	Iron Mountain	34.08	-115.08	86	x		1935-Present	NU
NCDC - Precip	COOP44412	Julian	33.05	-116.36	392	x		1949-1994	NU
NCDC - Precip	COOP44415	Julian Manzanita Ran	33.04	-116.38	392	x		1931-1949	NU
NCDC - Precip	COOP44418	Julian Wynola	33.06	-116.39	339	x		1949-1988	NU
NCDC - Precip	COOP45162	Lower Otay Reservoir	32.37	-116.56	50	x		1949-1992	NU
NCDC - Precip	COOP45632	Mill Creek Intake	34.05	-116.56	459	x		1948-Present	NU
NCDC - Precip	COOP45840	Morena Dam	32.41	-116.31	286	x		1948-Present	NU

Table E8-6
Summary of Monitoring Sites

			Location			Type of Data			
Source	**Site ID**	**Site Name**	**Latitude**	**Longitude**	**Elevation m**	**Meteorological**	**Air Quality**	**Years Station in Operation**	**Date Data Updated Through**
NCDC - Precip	COOP45965	Mount Laguna Caa Ap	32.52	-116.25	577	x		1948-1950	NU
NCDC - Precip	COOP46319	Oak Grove R S	33.23	-116.47	255	x		1953-Present	NU
NCDC - Precip	COOP46657	Palomar Mtn Obs	33.23	-116.50	516	x		1942-Present	NU
NCDC - Precip	COOP48893	Thermal Fire Stn 39	33.38	-116.10	-11	x		1972-Present	NU
NCDC - Precip	COOP49447	Warner Springs	33.17	-116.38	296	x		1931-1978	NU
CIMIS	CIMIS017	El Centro	32.85	-115.45	-26	x		1982-1987	NU
CIMIS	CIMIS018	Westmorland	33.08	-115.61	-59	x		1982-1986	NU
CIMIS	CIMIS024	Thermal	33.63	-116.11	-37	x		1982-1986	NU
CIMIS	CIMIS025	Rancho Mirage	33.76	-116.42	73	x		1982-1985	NU
CIMIS	CIMIS041	Calipatria/Mulberry	33.04	-115.42	-34	x		1983-Present	Mar-06
CIMIS	CIMIS050	Thermal	33.65	-116.24	-9	x		1986-1999	NU
CIMIS	CIMIS055	Palm Desert	33.73	-116.38	61	x		1987-1994	NU
CIMIS	CIMIS068	Seeley	32.76	-115.73	12	x		1987-Present	Mar-06
CIMIS	CIMIS072	Palo Verde	33.39	-114.72	70	x		1987-2000	NU
CIMIS	CIMIS087	Meloland	32.81	-115.45	-15	x		1989-Present	Mar-06
CIMIS	CIMIS118	Cathedral City	33.84	-116.48	119	x		1995-Present	Mar-06
CIMIS	CIMIS127	Salton Sea West	33.33	-115.95	-69	x		1994-Present	Mar-06
CIMIS	CIMIS128	Salton Sea East	33.22	-115.58	-69	x		1994-Present	Mar-06
CIMIS	CIMIS136	Oasis	33.52	-116.15	4	x		1997-Present	Mar-06
CIMIS	CIMIS141	Mecca	33.54	-115.99	-55	x		1998-Present	Mar-06
CIMIS	CIMIS154	Salton Sea North	33.5	-115.92	-61	x		1998-2003	NU
CIMIS	CIMIS162	Indio	33.75	-116.26	12	x		1999-Present	Mar-06
CIMIS	CIMIS175	Palo Verde II	33.39	-114.73	70	x		2001-Present	Mar-06
CIMIS	CIMIS176	La Quinta	33.69	-116.31	13	x		2000-Present	Mar-06
CIMIS	CIMIS180	Westmorland West	33.12	-115.8	-66	x		2001-2003	NU
CIMIS	CIMIS181	Westmorland North	33.08	-115.66	-61	x		2004-Present	Mar-06
CIMIS	CIMIS185	UC-Mex	32.41	-115.2	12	x		2002-2003	NU
CIMIS	CIMIS186	UC-San Luis	32.49	-114.83	15	x		2002-2004	NU
Torres-Martinez		Torres-Martinez	N/A	N/A	N/A	x		2002-Present	NU

Notes:
AQS Air Quality System
CIMIS California Irrigation Management Information System
NCDC National Climatic Data Center
NU Not updated
Stations in italics are no longer in operation.

Table E8-7
List of Parameters

Source	AQS												NCDC						NCDC-Precip	CIMIS	
Site Name	Brawley #1	Calexico-Grant	Calexico-Ethel	Calexico-East	Brawley #2	Banning	El Centro	Indio	Westmor-land	Niland	Palm Springs	Joshua Tree	Borrego Desert Park	Imperial County Airport	Indio US Date Garden	Mecca	Thermal Airport	Palm Springs Airport	All Sites	All Sites	Torres-Martinez
Site ID	AIRS0003	AIRS0004	AIRS0005	AIRS0006	AIRS0007	AIRS0012	AIRS1003	AIRS2002	AIRS4003	AIRS4004	AIRS5001	AIRS9002	COOP040983	COOP044224	COOP044259	COOP045502	COOP048892	KPSP	All Sites	All Sites	
MET																					
Air Temperature		H	H	H		H	H		H	H		H	D	D	D	D	H	H		H	H
Barometric Pressure			H			H												H			
Evapotranspiration															D					H	
Precipitation												H	D	D	D	D	H	H	H	H	H
Relative Humidity			H			H						H								H	H
Solar Radiation			H			H						H								H	
Wind Direction		H	H	H		H	H	H	H	H	H	H						H		H	H
Wind Speed		H	H	H		H	H	H	H	H	H	H						H		H	H
Gaseous Criteria Pollutants																					
O_3		H	H	H		H	H	H	H	H	H	H									
CO			H	H			H				H										
NO_2			H	H		H	H				H										
SO_2			H	H							H										
Particulates																					
PM_{10}	D	H	H	H	D	D	H	H	H	H	D										
$PM_{2.5}$	D	H	H	H	D		H	H			D										
Ammonium	D	D	D	D			D		D												
Carbon (Organic and Elemental)	D			D					D												
Chlorides	D	D	D	D			D	D	D		D										
Chlorine	D	D	D				D														
Nitrates	D	D	D	D		D	D	D	D		D										
Nitrites																					
Sulfates	D	D	D	D		D	D	D	D		D										
Toxic Pollutants																					
Metals		D	D				D														
VOCs			D			D					D										
PAHs			D																		
PAMs						D															

Notes:

H-Hourly, D-Daily, W-Weekly, M-Monthly

Measurement heights of wind speed and wind direction:

AQS, CASTNET, and NCDC sites Palm Springs and Imperial County - 10-meter

CIMIS and all other NCDC sites - 2-meter

RAWS - 6-meter

Torres Martinez - 3, 15 and 45 meter

CIMIS Meteorological Stations

Background

DWR operates the CIMIS, a network of more than 120 automated weather stations in California. CIMIS was developed in 1982 by the DWR and the University of California at Davis to assist California's irrigators manage water resources efficiently. In the Salton Sea basin, DWR operates 12 CIMIS stations.

The CIMIS stations measure wind speed, wind direction, temperature, relative humidity, soil temperature, solar radiation, and precipitation. Because CIMIS was developed to support irrigation and agricultural interests in the State, the wind speed and wind direction data are collected at a height of 2 meters. Standard height for wind speed and wind direction measurements is 10 meters to minimize interference from obstacles and the ground surface.

The CIMIS data represent a long-term data source. Because of interest in wind conditions at the Salton Sea and to windblown dust concerns, data at a 10-meter height are preferred.

The Data Gaps report recommended that 10-meter meteorological stations be collocated at three 2-meter stations to gather additional information for use in the PEIR. The three 10-meter stations are:

- Salton Sea East, operating CIMIS Station 128, on the southeastern Salton Sea shoreline;
- Salton Sea West, operating CIMIS Station 127, on the western shoreline; and
- Salton Sea North, operating CIMIS Station 154 with invalid 2-meter data, on the northern shoreline. Wind flow at this station is obstructed at the 2 meter level.

Salton Sea East and Salton Sea West became fully operational at the end of July and beginning of August 2005. Data from these two stations were merged for this study. Data for Salton Sea North were collected but not used.

A large tree and a small building near the Salton Sea West site were identified as potential obstructions to wind measurements at that site. DWR used a building wake effect algorithm to determine if trimming the tree would eliminate these wind effects. ARB reviewed that analysis and determined that the building did not affect 10-meter data and trimming the tree would eliminate the wind effects at 10 meters. ARB concluded that the station meets the siting criteria if the tree is cut to a height of 20 feet, which DWR has done. The siting criteria are defined in *Meteorological Monitoring Guidance for Regulatory Modeling Applications* (USEPA, 2000).

Data collected at the 2-meter level will likely still be influenced by these obstructions, and should not be used.

Available Data

The wind speeds measured at CIMIS Stations 127 and 128 were evaluated. Hourly data were acquired for July 26, 2005, to January 15, 2006, with more than 8,000 data pairs available. As shown in Figures E8-7 and 8, the winds speeds varied greatly, with the wind speed at 10 meters being typically higher than the wind speed at 2 meters.

Methodology for Development of a Predictive Equation

To develop a predictive equation for wind speeds at 10 meters based on 2-meter measurements, four modeling approaches were evaluated: simple linear regression, regression using log-transformed values, vector-adjusted linear regression, and application of a power law equation.

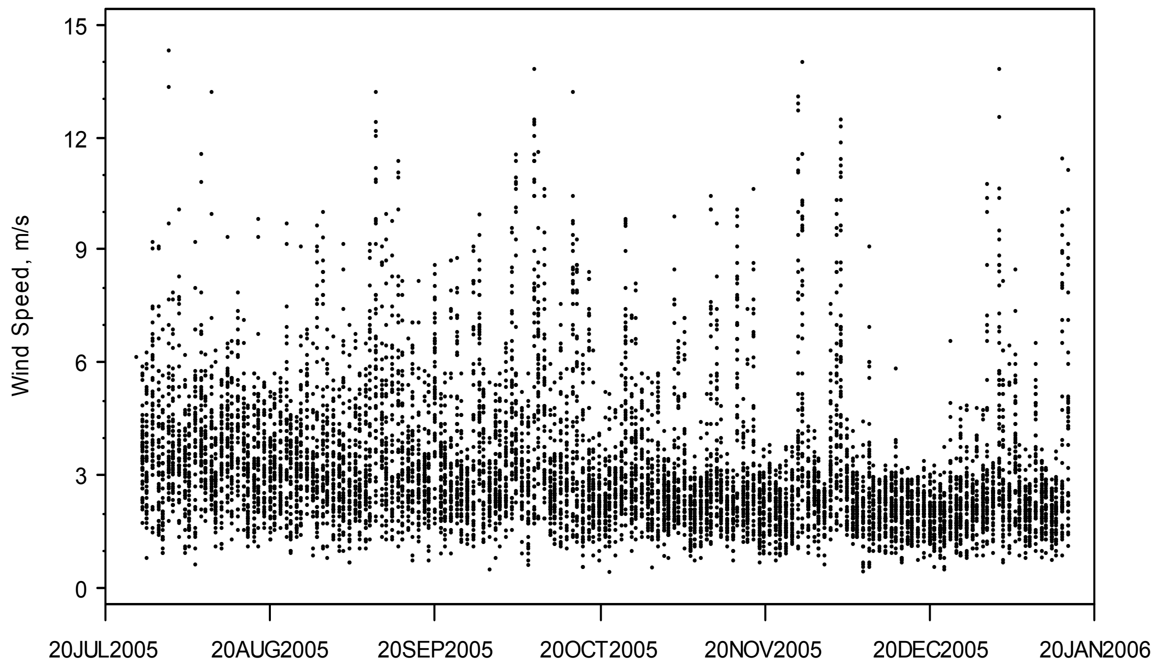

FIGURE E8-7
10-METER WIND SPEED VERSUS TIME

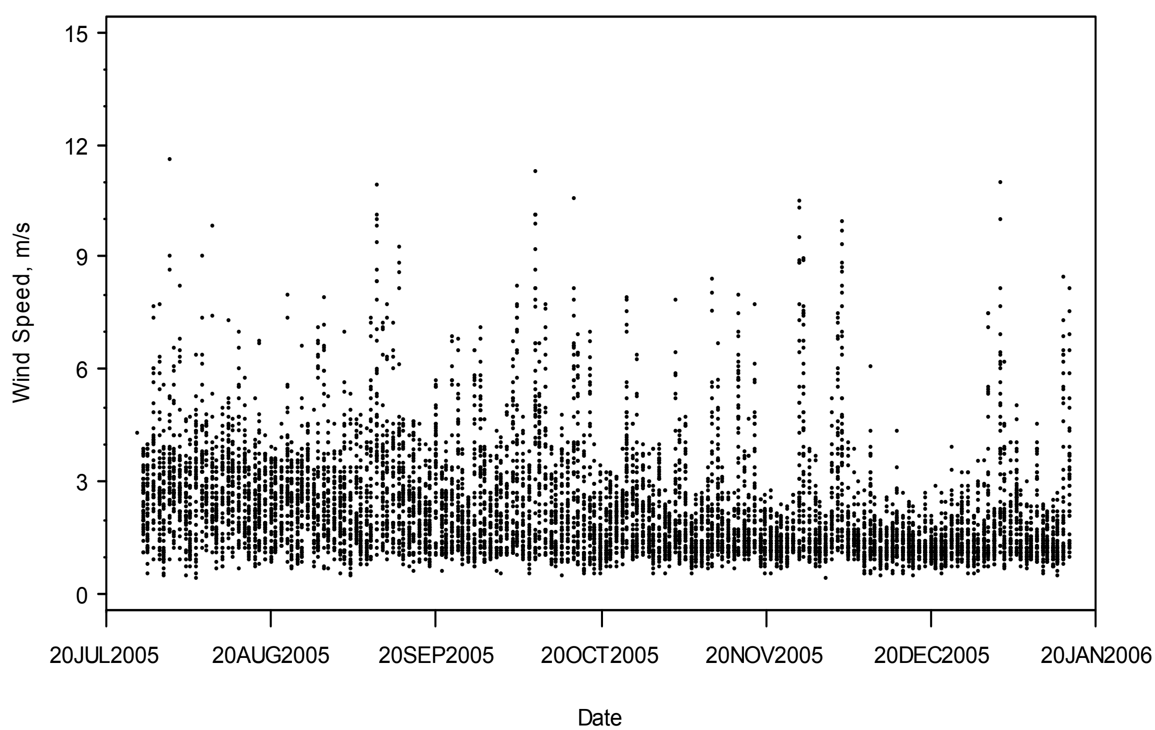

FIGURE E8-8
2-METER WIND SPEED VERSUS TIME

Simple Linear Regression

Simple linear regression attempts to model one parameter (in this case, the 10-meter wind speed) with another parameter (in this case, the 2-meter wind speed) via the equation:

$$y = \beta_1 x + \beta_0$$

or

Wind Speed (10 m) = Regression Coefficient * Wind Speed (2 m) + Intercept

The regression coefficient and intercept are optimized in linear regression via least squares estimation so that the sum of squares of the residuals (the differences between the predicted and actual 10-meter wind speeds) is minimized.

Data for each height and station were merged based on the date and hour they were measured and evaluated via regression analysis. The resulting statistics are presented in Table E8-8. Along with the least square estimates, the R^2 and the standard deviation of residuals are presented. The R^2, a common measure of goodness of fit, is often described as the proportion of total error described by the model. The standard deviation of residuals measures the variability in the residuals (deviations between actual and predicted wind speeds).

Table E8-8
Regression Statistics for Simple Linear Regression

Station	Regression Coefficient	Intercept	R^2	Standard Deviation of Residuals
127	1.27	0.238	0.912	0.563
128	1.21	0.568	0.900	0.562
Combined	1.23	0.423	0.903	0.561

These statistics are shown for Stations 127 and 128 individually and for the combined data set of both stations. The differences between the individual statistics and the combined statistics appear minor. Because the goal is to produce a standard prediction model (not one for individual stations), ensuing statistical evaluations were performed on the combined data set.

The goodness of fit of the combined data set can also be visualized in a plot of the data (Figure E8-9). In this figure, the actual 10-meter wind speeds are plotted against the predicted 10-meter wind speeds. Thus, the solid straight line does not represent a predicted line, but rather the line along which predicted points would fall if there were perfect fit (essentially the actual speeds plotted against themselves).

The residuals (differences between actual and predicted speeds) were then plotted in a histogram (Figure E8-10). Overlaid on this histogram is the expected normal curve, assuming the residuals are normally distributed. The distribution of residuals is different from the normal curve, but the differences are not due to skewness in the residuals. That is, the distribution of residuals appears fairly symmetrical. This symmetry suggests that a transformation of the data is not necessary. Nevertheless, a logarithmic transformation of the data was pursued to ensure completeness.

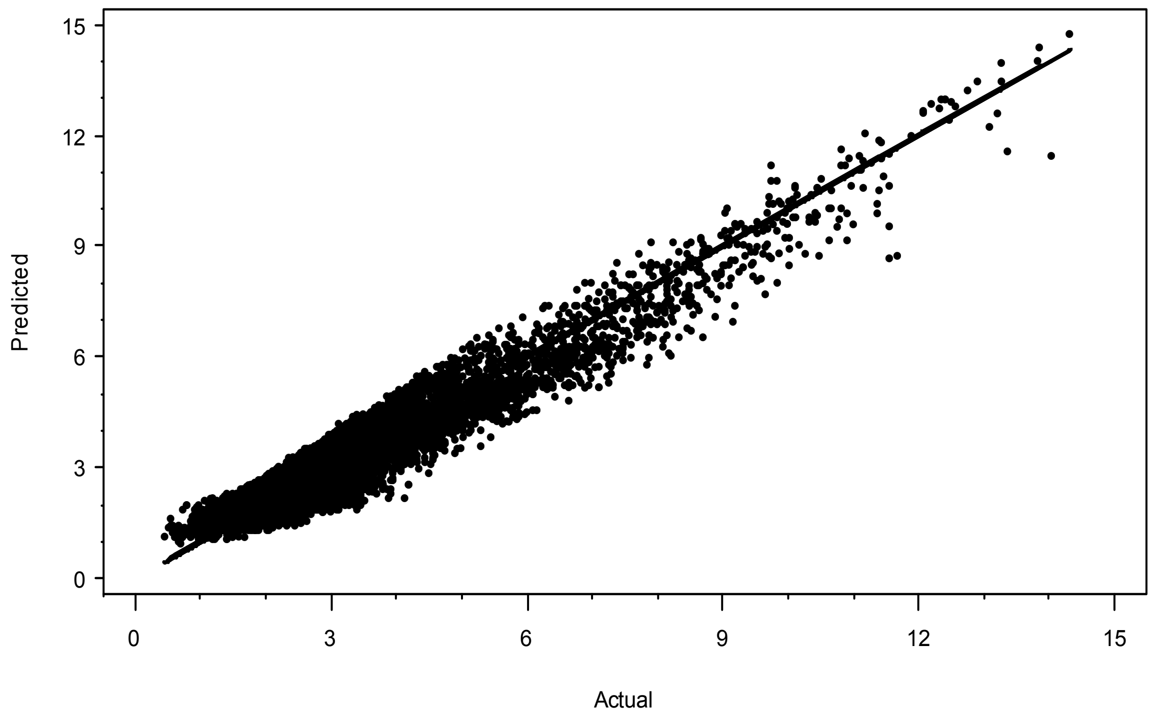

FIGURE E8-9
PREDICTED 10-METER WIND SPEED VERSUS ACTUAL USING SIMPLE LINEAR REGRESSION

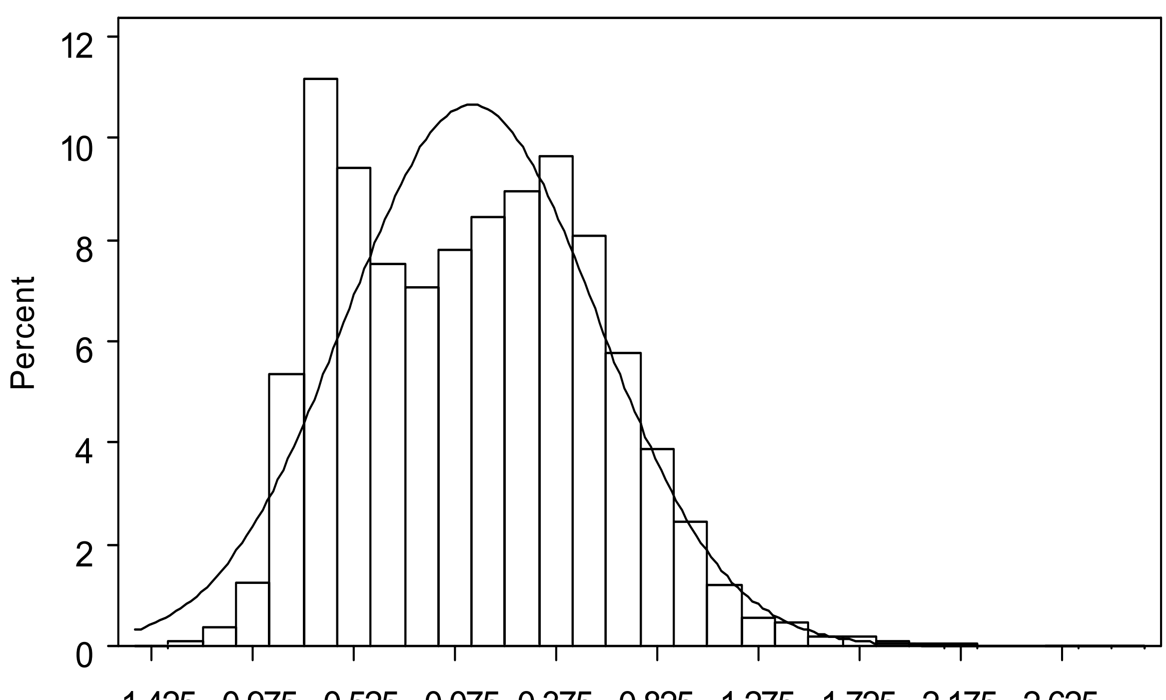

FIGURE E8-10
HISTOGRAM OF RESIDUALS FOR SIMPLE LINEAR REGRESSION

Log-Transformed Regression Analysis

Log transformation can be applied to data prior to regression analysis followed by inverse-log transformation to place the results back into the original units. In this study of wind speeds, the regression equation is:

Wind Speed (10 m) = exp { Regression Coefficient * ln[Wind Speed (2 m)] + Intercept }

Where ln = *natural logarithm* and exp = *exponential* (e^x). The resulting statistics are presented in Table E8-9. Along with the least square estimates, the R^2 and the standard deviation of residuals are presented.

Table E8-9
Regression Statistics for Log-Transformed Regression

Regression Coefficient	Intercept	R^2	Standard Deviation of Residuals
0.845	0.477	0.897	0.591

The R^2 value and standard deviation of residuals in Table E8-9 are based on the wind speeds after they have been placed inverted back into the original units. Neither of these values shows improved fit for the log-transformed regression over simple linear regression presented above.

The predicted and actual 10-meter wind speeds are shown in Figure E8-11. Although the appearance of fit is similar to Figure E8-9 (simple linear regression), there is a consistent underestimation of the highest wind speeds, although the underestimation is slight.

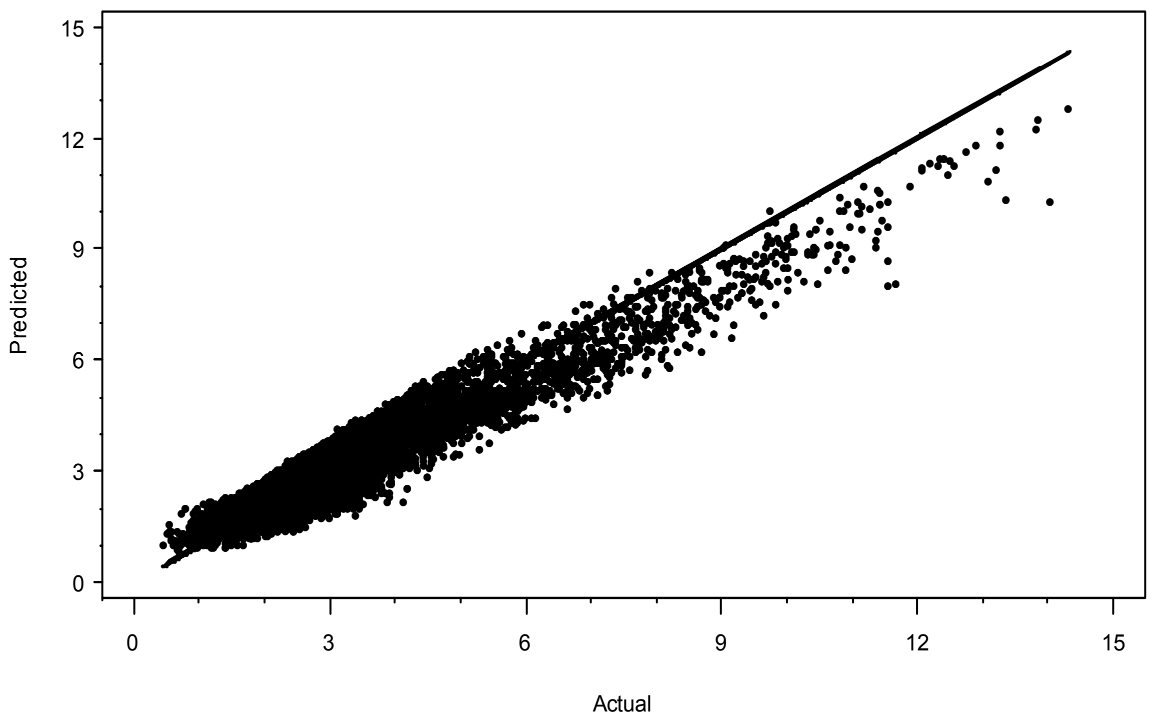

FIGURE E8-11
PREDICTED 10-METER WIND SPEED VERSUS ACTUAL USING LOG-TRANSFORMED REGRESSION

Vector-Adjusted Regression

USEPA's guidance on meteorological modeling (USEPA, 2000) presents a vector-adjustment strategy to convert wind speed into north and east vectors, based on the wind speed and wind direction. These conversions are shown below:

$$V_n = -\frac{1}{N}\Sigma u_i(\cos\theta_i) \quad V_e = -\frac{1}{N}\Sigma u_i(\sin\theta_i)$$

where u = wind speed and θ = angle of the wind vector. The wind speeds at 2 and 10 meters were converted into vectors so that V_n and V_e represent the magnitudes of the north-south (positive toward north) and east-west component (positive toward east). These were modeled separately for the available data with the predicted values used to convert back into a wind speed using the following equation:

$$WindSpeed = (V_e^2 + V_n^2)^{1/2}$$

Theoretically, such an approach might help improve the predicted wind speed if differing wind direction is an important effect in the 2-meter versus 10-meter data.

The predicted versus actual results using this approach are presented in Figure E8-12 with the goodness of fit statistics presented in Table E8-10. These results reveal that this approach does not offer an improved prediction over simple linear regression. It is not entirely clear how a vector-adjusted approach would be used to predict unknown 10-meter wind speeds (because the wind direction would probably not be known), but this evaluation does not offer a reason to pursue it.

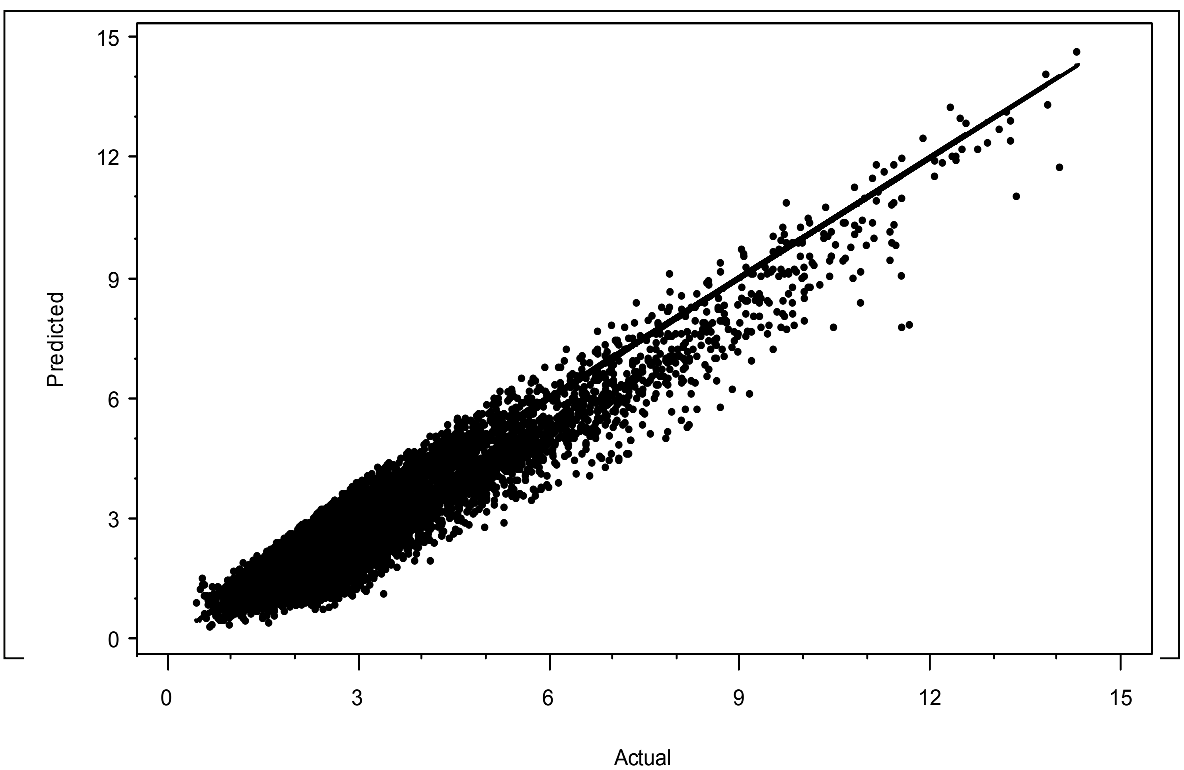

FIGURE E8-12
PREDICTED 10-METER WIND SPEED VERSUS ACTUAL USING VECTOR-ADJUSTED REGRESSION

Table E8-10
Goodness of Fit Statistics for Vector-Adjusted Regression

R^2	Standard Deviation of Residuals
0.891	0.597

Power-Law Equation

Another approach in the guidance on meteorological modeling (USEPA, 2000) makes use of the power-law equation, shown below:

$$U_z = U_r (Z / Z_r)^p$$

Where U_z = the wind speed at height Z, U_r = the wind speed at reference height r, Z_r = the reference height, and p = the power-law exponent. For our evaluation, this equation can be written as:

$$WS_{10} = WS_2 (10/2)^p$$

To calculate the power-law exponent for our evaluation, the following equation can be used:

$$p = \frac{\ln(WS_{10}) - \ln(WS_2)}{\ln(10) - \ln(2)}$$

The distribution of p values for the data is shown in Table E8-11. As shown, the mean and median are close to one another, indicating that the distribution is fairly symmetric, as shown in Figure E8-13. Based on this evaluation, a p value of 0.23 was used in the application of the power-law equation.

Table E8-11
Summary Statistics for Power-Law Exponent

Percentiles										
1st	5th	10th	25th	50th (Median)	75th	90th	95	99th	Mean	Standard Deviation
0.007	0.049	0.064	0.113	0.224	0.327	0.419	0.468	0.544	0.231	0.136

The predicted versus actual results using the power-law model are presented in Figure E8-14 with the goodness of fit statistics presented in Table E8-12. These statistics indicate values similar to the simple linear regression approach but with a higher standard deviation of residuals. The standard deviation of residuals (residuals are the differences between actual and predicted speeds) is 0.635 meter per second for the power-law model and 0.561 meter per second for the simple linear regression approach. Thus, there is about a 13 percent larger standard deviation of residuals with the power-law approach than with the simple linear regression method. By itself, such a difference may not be substantial enough to give simple linear regression a notable advantage over the power-law approach.

However, as shown in Figure E8-13, the more elevated wind speeds are consistently underestimated as they were with the log-transformed regression. This might be a more important concern (than the larger standard deviation of residuals) depending on the interest in good correlation at higher speeds.

Table E8-12
Goodness of Fit Statistics for Power-Law Model

R^2	Standard Deviation of Residuals
0.903	0.635

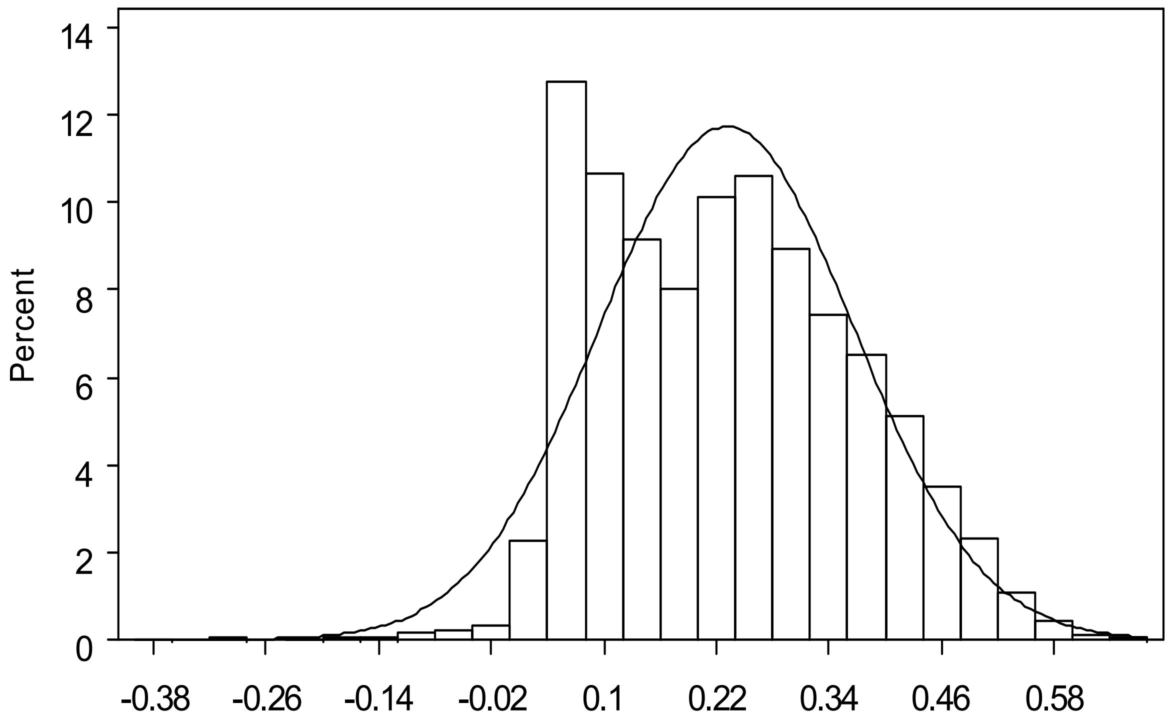

FIGURE E8-13
POWER LAW EXPONENT DISTRIBUTION. MEAN P = 0.231

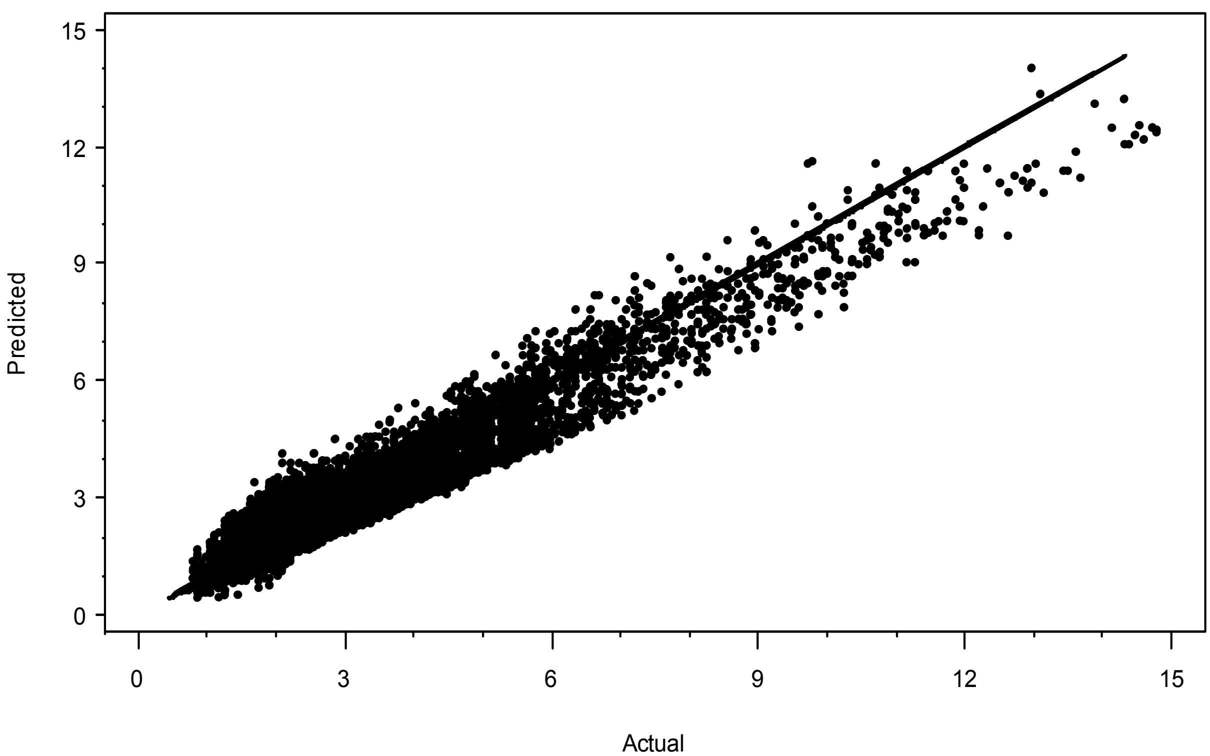

FIGURE E8-14
PREDICTED 10-METER WIND SPEED VERSUS ACTUAL USING POWER-LAW EQUATION

On the other hand, the power-law model may offer more flexibility. The USEPA guidance (2000) suggests the same power-law exponent may be valid to predict wind speed at a variety of heights, with all wind speeds measured at the same reference height (2 meters for this study). Data from Stations 127 and 128 are available only at heights of 2 and 10 meters; data do not exist at these stations to validate that a single power-law equation could effectively model a variety of heights.

Comparison of Various Models

The four approaches evaluated in this memorandum are listed in Table E8-13. All of the models appear to offer credible prediction of the 10-meter wind speeds. Nonetheless, the simple linear regression approach offers the highest R^2 value and lowest standard deviation of residuals.

Table E8-13
Goodness of Fit Statistics for Various Models

Modeling Approach	R^2	Standard Deviation of Residuals
Simple Linear Regression	0.903	0.561
Log-Transformed Regression	0.897	0.591
Vector-Adjusted Regression	0.891	0.597
Power-Law Equation	0.903	0.635

The log-transformed regression approach did not offer an improved fit over the simple linear regression. The histogram of residuals from the simple linear regression approach did not appear skewed, so resorting to a modeling approach based upon an assumption of a skewed distribution is not needed.

Similarly, the goodness of fit statistics for the vector-adjusted approach does not offer an advantage over simple linear regression. Thus, the extra complexity of pursuing this approach is not warranted.

Many believe that the relationship between height and wind speed is an exponential correlation, but this does not affect the type of regression used to model predict wind speeds at one height from another. In that pursuit, we are considering only two heights (2 and 10 meters in this study) and whether the wind speed is increasing exponentially with height does not affect the regression analysis.

It may, however, have impact if the power-law equation is used. This approach can be used to predict a single height (i.e., 10 meters) from a reference height (i.e., 2 meters), but it can also theoretically be applied to predict wind speeds at multiple heights if one believes the power-law exponent is constant across the height range of interest. Data available in this study focus only on two heights, so this consistency across heights cannot currently be evaluated. The power-law goodness of fit statistics are similar to the simple linear regression approach, although the residuals appear somewhat larger as evidenced by the increased standard deviation shown in Table E8-13. The potential improved flexibility of this model, however, may outweigh lesser fit with the data available for building the model.

However, the power-law equation slightly underestimates the more elevated wind speeds. This could become a more substantial issue if faster wind speeds need to be predicted.

It is also prudent in model building to use subsequent data to test a model after developing it. Such data offer further information on the difference of fits between the simple linear regression and power-law equation approaches. If subsequent data include wind speeds at heights other than 2 and 10 meters, the suitability of the power-law equation with one constant exponent across a height range could be tested.

This analysis has been based on a limited duration of data covering about one half of a year. Additional analyses are recommended following collection of a complete year of data.

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ATTACHMENT E8, APPENDIX A

CALMET Input Variables

CALMET Input File Summary

Variable	Description	Value
INPUT GROUP 0 - Input and Output File Names		
GEO.DAT	Name of geophysical data file	GEO1km.DAT
SURF.DAT	Name of surface data file	SURF.DAT
PRECIP.DAT	Name of precipitation data file	PRECIP.DAT
NUSTA	Number of upper air data sites	0
UPn.DAT	Names of NUSTA upper air data files	upn.dat
INPUT GROUP 1 - General run control parameters		
IBYR	Beginning year	2002
IBMO	Beginning month	1
IBDY	Beginning day	1
IBHR	Beginning hour	1
IBTZ	Base time zone	8
IRLG	Number of hours to simulate	8736
IRTYPE	Output file type to create (must be 1 for CALPUFF)	1
LCALGRD	Are w-components and temperature needed?	T
INPUT GROUP 2 - Technical Options **Grid control parameters**		
NX	Number of east-west grid cells	196
NY	Number of north-south grid cells	209
DGRIDKM	Grid spacing	1
PMAP	Map Projection	UTM
XORIGKM	Southwest grid cell X coordinate	504.042
YORIGKM	Southwest grid cell Y coordinate	3,572.072
XLAT0	Southwest grid cell latitude	32.29
YLAT0	Southwest grid cell longitude	116.95
IUTMZN	UTM Zone	11
LLCONF	When using Lambert Conformal map coordinates, rotate winds from true north to map north?	NA
XLAT1	Latitude of 1st standard parallel	NA
XLAT2	Latitude of 2nd standard parallel	NA
RLONO	Longitude used if LLCONF = T	NA
RLATO	Latitude used if LLCONF = T	NA
NZ	Number of vertical layers	10
ZFACE	Vertical cell face heights (NZ+1 values)	0, 20, 40, 80, 160, 300,600, 1000, 1500, 2200, 3000
INPUT GROUP 3 - Output Options		
LSAVE	Save met data fields in an unformatted file?	T
IFORMO	Format of unformatted file (1 for CALPUFF)	1
INPUT GROUP 4 - Meteorological data options		
NSSTA	Number of stations in SURF.DAT file	5
NPSTA	Number of stations in PRECIP.DAT file	13
ICLOUD	Is cloud data to be input as gridded fields? (0 = No)	0

CALMET Input File Summary

Variable	Description	Value
IFORMS	Format of surface data (2 = formatted)	2
IFORMP	Format of precipitation data (2 = formatted)	2
IFORMC	Format of cloud data (2 = formatted)	2
INPUT GROUP 5 - Windfield Options and Parameters		
IWFCOD	Generate winds by diagnostic wind module? (1 = Yes)	1
IFRADJ	Adjust winds using Froude number effects? (1 = Yes)	1
IKINE	Adjust winds using kinematic effects? (0 = No)	0
IOBR	Use O'Brien procedure for vertical winds? (0 = No)	0
ISLOPE	Compute slope flows? (1 = Yes)	1
IEXTRP	Extrapolate surface winds to upper layers? (-4 = use similarity theory and ignore layer 1 of upper air station data)	1
ICALM	Extrapolate surface calms to upper layers? (0 = No)	0
BIAS	Surface/upper-air weighting factors (NZ values)	0,0,0,0,0,0,0,0,0,0
IPROG	Using prognostic or MM-FDDA data? (0 = No)	14
LVARY	Use varying radius to develop surface winds?	F
RMAX1	Max surface over-land extrapolation radius (km)	36
RMAX2	Max aloft over-land extrapolation radius (km)	50
RMAX3	Max over-water extrapolation radius (km)	500
RMIN	Minimum extrapolation radius (km)	0.1
RMIN2	Distance (km) around an upper air site where vertical extrapolation is excluded (Set to -1 if IEXTRP = +/-4)	4
TERRAD	Radius of influence of terrain features (km)	20
R1	Relative weight at surface of Step 1 fields and obs	5
R2	Relative weight aloft of Step 1 field and obs	5
DIVLIM	Maximum acceptable divergence	5.00E-06
NITER	Max number of passes in divergence minimization	50
NSMTH	Number of passes in smoothing (NZ values)	2, 4, 4, 4, 4, 4, 4, 4, 4, 4
NINTR2	Max number of stations for interpolations (NA values)	10*5
CRITFN	Critical Froude number	1
ALPHA	Empirical factor triggering kinematic effects	0.1
IDIOPT1	Compute temperatures from observations (0 = True)	0
ISURFT	Surface station to use for surface temperature (between 1 and NSSTA)	3
IDIOPT2	Compute domain-average lapse rates? (0 = True)	0
IUPT	Station for lapse rates (between 1 and NUSTA)	0
ZUPT	Depth of domain-average lapse rate (m)	200
IDIOPT3	Compute internally initial guess winds? (0 = True)	0
IUPWND	Upper air station for domain winds (-1 = 1/r**2 interpolation of all stations)	-1
ZUPWND	Bottom and top of layer for 1st guess winds (m)	1, 1000
IDIOPT4	Read surface winds from SURF.DAT? (0 = True)	0
IDIOPT5	Read aloft winds from UPn.DAT? (0 = True)	0

CALMET Input File Summary

Variable	Description	Value
INPUT GROUP 6 - Mixing Height, Temperature, & Precipitation Parameters		
CONSTB	Neutral mixing height B constant	1.41
CONSTE	Convective mixing height E constant	0.15
CONSTN	Stable mixing height N constant	2400
CONSTW	Over-water mixing height W constant	0.16
FCORIOL	Absolute value of Coriolis parameter	1.0E-04
IAVEXZI	Spatial averaging of mixing heights? (1 = True)	1
MNMDAV	Max averaging radius (number of grid cells)	1
HAFANG	Half-angle for looking upwind (degrees)	30
ILEVZI	Layer to use in upwind averaging (between 1 and NZ)	1
DPTMIN	Minimum capping potential temperature lapse rate	0.001
DZZI	Depth for computing capping lapse rate (m)	200
ZIMIN	Minimum over-land mixing height (m)	50
ZIMAX	Maximum over-land mixing height (m)	3000
ZIMINW	Minimum over-water mixing height (m)	100
ZIMAXW	Maximum over-water mixing height (m)	3000
IRAD	Form of temperature interpolation (1 = 1/r)	1
TRADKM	Radius of temperature interpolation (km)	100
NUMTS	Max number of stations in temperature interpolations	5
IAVET	Conduct spatial averaging of temperature? (1 = True)	1
TGDEFB	Default over-water mixed layer lapse rate (K/m)	-0.0098
TGDEFA	Default over-water capping lapse rate (K/m)	-0.0045
JWAT1	Beginning landuse type defining water	999
JWAT2	Ending landuse defining water	999
NFLAGP	Method for precipitation interpolation (2 = 1/r**2)	2
SIGMAP	Precip radius for interpolations (km)	200
CUTP	Minimum cut off precip rate (mm/hr)	0.01
INPUT GROUP 7 - Surface meteorological station parameters		
SSn	NSSTA input records for surface stations	5
INPUT GROUP 8 - Upper air meteorological station parameters		
USn	NUSTA input records for upper-air stations	NA
INPUT GROUP 9 - Precipitation station parameters		
PSn	NPSTA input records for precipitation stations	13

APPENDIX E, ATTACHMENT E9

Salton Sea Playa Salt Efflorescence Potential

2006

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APPENDIX E, ATTACHMENT E9
SALTON SEA PLAYA SALT EFFLORESCENCE POTENTIAL

Inflow to the Salton Sea will decrease through a combination of measures, exposing shallow-sloped playas whose subsurface may contain saline water. Playas containing saline water are prone to a salt efflorescence (growth of [often very fine] salt crystals on the surface of the playa) and to salt transformations (which can render playa surfaces extremely friable and susceptible to high rates of wind erosion). Dust from friable playa and efflorescent salts on the Owens Lake playa have raised concern about similar emissions from Salton Sea playa.

The specific conditions on the Salton Sea playa are not known with sufficient detail to forecast the daily potential for wind erosion, nor are predictive tools at this level of detail available. However, general conditions support the possibility that efflorescence and loosening of the crusted surface would occur and that dust could form from salt and loosened sediments during the right combination of climatic conditions. Chemical modeling and laboratory experiments are inadequate for forecasting dust formation. Predictions about salt sequences that form in a submerged brine pool or artificial salt pond are not predictive of salt efflorescence or of the dust formation potential on the playa. Table E9-1 presents names and formulas for selected salts.

Table E9-1
Names and Formulas for Selected Salts

Mineral Name	Formula	Chemical Name
Anhydrite	$CaSO_4$	Calcium sulfate
Bloedite	$MgSO_4 \cdot Na_2SO_4 \cdot 4H_2O$	Magnesium sodium sulfate
Epsomite	$MgSO_4 \cdot 7H_2O$	Magnesium sulfate heptahydrate
Glauberite	$Na_2SO_4 \cdot CaSO_4$	Sodium calcium sulfate
Gypsum	$CaSO_4 \cdot 2H_2O$	Calcium sulfate dehydrate
Halite	NaCl	Sodium chloride
Kieserite	$MgSO_4 \cdot H_2O$	Magnesium sulfate monohydrate
Labile Salt	$2Na_2SO_4 \cdot CaSO_4 \cdot 2H_2O$	—
Mirabilite	$Na_2SO_4 \cdot 10H_2O$	Sodium sulfate decahydrate
Penta Salt	$5CaSO_4 \cdot Na_2SO_4 \cdot 3H_2O$	—
Bicarbonate of Soda	$NaHCO_3$	Sodium bicarbonate
Soda Ash	Na_2CO_3	Sodium carbonate
Trona	$Na_2CO_3 \cdot NaHCO_3 \cdot 2H_2O$	Sodium sesquicarbonate
Thermonatrite	$Na_2CO_3 \cdot H_2O$	Sodium carbonate monohydrate
Thenardite	Na_2SO_4	Sodium sulfate
-	$Na_2CO_3 \cdot 7H_2O$	Sodium carbonate heptahydrate
Washing Soda	$Na_2CO_3 \cdot 10H_2O$	Sodium carbonate decahydrate

Field observations of salt efflorescence, surface loosening, and wind erosion rates on the Salton Sea playa appear to be the only way to establish the extent to which salt transformations will actually increase susceptibility to wind erosion. Anecdotal reports of dust from the Salton Sea playa have not been systematically evaluated. However, these reports seem to suggest that efflorescence and changes in crust friability, generally corresponding to expected climatic triggers, do occur as suggested above. Wind erosion rates measured concurrently with a seasonally fragile physical condition of this playa peaked around January, and exhibited low erosion rates in late summer (DRI, 2006). Climatic conditions preceding the January observations, although somewhat cool and moist, were not outside of the range commonly observed during the wintertime in the region. This suggests that, if conditions observed in January 2006 resulted from climatically driven salt transformations, such conditions might recur with reasonable frequency.

SALTON SEA CHEMISTRY AND EVAPORITE MINERALS

Salton Sea salinity is comprised primarily (in descending concentration) of chloride, sodium, sulfate, calcium, magnesium, and bicarbonate. When the Salton Sea becomes sufficiently concentrated, four minerals are predicted to form in the submerged brine pool: gypsum ($CaSO_4 \cdot 2H_2O$), glauberite ($Na_2SO_4 \cdot CaSO_4$), halite (NaCl), and bloedite ($MgSO_4 \cdot Na_2SO_4 \cdot 4H_2O$).

Comparison of the Salton Sea and Owens Lake (see Table E9-4 and related text) showed that brine geochemistry differs significantly, with Owens Lake having a significantly higher proportion of inorganic carbon (carbonate and bicarbonate) and the Salton Sea having proportionately higher sulfate. The geochemical conditions at Owens Lake do not directly reflect the salt efflorescence and dust formation potential of the Salton Sea playa, but the higher proportion of sulfate in the Salton Sea raises the potential for sodium sulfate salt blooms on the playa.

The concentrations of dissolved ions at the Salton Sea's Bertram Station between 1995 and 2001 fluctuated somewhat during the period, but were closely enough clustered to be evaluated as average values. Average ionic concentrations from 1995 through 2001 that were used in the following evaluations are provided in Table E9-2.

Table E9-2
Average Ionic Concentrations at the Salton Sea's Bertram Station (1995-2001)

	Chloride	Sodium	Sulfate	Calcium	Magnesium	Bicarbonate	Potassium
Concentration (mg/L)	17,228	11,097	8,635	1,455	1,215	191	160
Standard Deviation (mg/L)	1,419.5	2,206.7	2,678.2	395.8	343.5	11.9	145.9

The ionic composition of Salton Sea water was compared with 37 liquid-solid phase combinations reported in a symposium proceedings (Susarla and Sanghavi, 1993) to identify the composition that would best predict the final (submerged pool) brine-salt equilibrium condition after Salton Sea water evaporation. The brine with ionic ratios most closely resembling water in the Salton Sea would result in precipitation of anhydrite ($CaSO_4$), glauberite, halite, and bloedite, according to the published report. However, application of the "Marshall and Slusher" model (Marshall and Slusher, 1968) to Salton Sea water, with its lower sulfate-to calcium ratio, showed that gypsum would be the stable calcium sulfate mineral after evaporation, instead of anhydrite.

Salts formed in the brine pool due to evaporation are not necessarily the minerals that will form as efflorescent deposits on the playa or salt crystals within the playa crust. Three of the four salts predicted in the brine pool are known to effloresce under suitable relative humidity, temperature, and soil texture conditions (Hamdi-Aissa, et al., 1998; Hamdi-Aissa, et al., 2004; Rodriguez-Navarro, 2000; Rinjiers, 2004; Schreiber and Tabakh, 2000; Zhender and Arnold, 1989). The salts that effloresce are halite, bloedite, and gypsum. There were no clear indications that glauberite effloresces on saline playas, but one investigation reported glauberite efflorescence in marine aerosols. The potential also exists for glauberite to transform into sodium and calcium sulfate efflorescences as a result of weathering, so glauberite could have significance in a playa setting.

The mineral forms of salts occurring on the playa cannot be predicted with any certainty; weathering, rainfall, antecedent conditions, rate of drying, and capillary structure all affect the types, sequences, occurrences, and durations of salt "blooms" that can occur on the playa. However, because the Salton Sea has a higher relative sulfate concentration than Owens Lake, glauberite that might form on the playa or remain after the shoreline recedes could weather into other mineral forms, such as sodium sulfate, which could effloresce.

PLAYA SALT EFFLORESCENCE

General Efflorescence Mechanism

The formation of salt efflorescence on playas of saline bodies as reported in scientific literature has been under investigation with growing insight into the underlying mechanisms. It appears that many salts can effloresce under suitable conditions, including the familiar sodium sulfate (Rodriguez-Navarro et al., 2000) and sodium carbonate/bicarbonate salts (Niaz et al., 2003), as well as gypsum and halite (common salt or sodium chloride) (Clarke and Paine, 2004; Schreiber and Tabakh, 2000; Hamdi-Aissa et al., 1998; Bąbel, 2004).

A general description of the underlying mechanism of efflorescence was illustrated by Zhender and Arnold in an article published in 1989. Four phases of crystallization were identified, the final two phases leading directly to efflorescence (see Appendix E9A). The first two phases describe progressive liquid evaporation and salt precipitation with progressive drying. The third stage is characterized by (sodium nitrate) salt surfaces having lost much of the initial free moisture, but still being moderately humid with no microscopically visible solution film. Interstitial solution remains, however, and columnar crystals grow vertically from the substrate as the solution continues to evaporate. In the fourth (final) stage, whiskers grow on the slightly humid, nearly dry surface. Initially the whiskers grow as relatively thick, bent, or curled crystals. Finally, thin, straight whiskers grow vertically from the nearly dry surface as more-or-less perfect crystals. This last growth occurs at the base of the whisker, thinning out at the base as the crystal extends upward.

The third and fourth phases of salt efflorescence rely on progressively drying salt deposits, but drying surfaces are usually fed by a subsurface capillary system that allows growth of whiskers to significant length (Hamdi-Aissa et al., 1998). Wider fissures in the substrate favor growth of efflorescent formations (Zehnder and Arnold, 1989; Last and Ginn, 2005; Rijniers, 2004), with smaller pores causing a reduction in water evaporation rate and a greater degree of salt supersaturation within the pores (Rijniers, 2004).

Specific Salts

The previous discussion is general and shows that salt efflorescence is possible for many types of salts under suitable environmental conditions. Brief descriptions of the four salts predicted to form in the brine pool are provided below.

Gypsum

Gypsum is relatively insoluble and is typically one of the first precipitates to form (along with calcium carbonate) during evaporative concentration of brine pools. Published accounts lack detail about the gypsum efflorescence mechanism(s) in a playa setting (Merry and Fitzpatrick, 2005; Hamdi-Aissa et al., 1998; Babel, 2004), but gypsum easily transforms to anhydtite (anhydrous calcium sulfate) in a hot desert playa environment (Hamdi-Aissa et al., 2004), where the ground surface temperature can far exceed the ambient air temperature.

Although no information on the mechanism of gypsum efflorescence was found, one paper reported that 6 months after scraping the top soil from one site, newly-formed efflorescences of gypsum and other minerals were observed (Hamdi-Aissa et al., 1998). No information about temperature or relative humidity was provided.

Glauberite

Information about the calcium-sodium-sulfate–water system (Linke, 1958b) suggests that glauberite could undergo interconversion between a rather large number of mineral forms such as labile salt ($2Na_2SO_4 \cdot CaSO_4 \cdot 2H_2O$), penta salt ($5CaSO_4 \cdot Na_2SO_4 \cdot 3H_2O$), thenardite ($Na_2SO_4$), and mirabilite ($Na_2SO_4 \cdot 10\ H_2O$) under suitable climatic conditions. Thenardite and mirabilite effloresce under suitable conditions and are discussed further below.

There were no clear indications that glauberite effloresces on saline playas, but one investigation reported glauberite efflorescence in marine aerosols (Chabas and Lefèvre, 2000). Since glauberite could weather to form sodium and calcium sulfate, which can efflorescence, glauberite could be an indirect source of dust from the Salton Sea playa.

Halite

Sodium chloride (halite) in bulk or massive form is stable as a solid when the relative humidity (RH) is below ~75 percent at 68°F under controlled laboratory conditions. Above 75 percent RH, sodium chloride transforms to a salt solution (Rijniers, 2004). In a porous structure with ~7 nanometer (nm) cells, the salt picks up water at a significantly lower RH than the bulk salt, and supersaturated halite solution can form in the pores.

In a hot, arid environment, the actual ground surface temperature can be substantially higher than the ambient air temperature, so the RH at the soil surface will be reduced and evaporation will increase, making it difficult to compare field and laboratory test conditions.

Anecdotally, halite and gypsum efflorescences were common on slopes and playas with cracking clays of high salt content after evidence of moisture from rain or snowmelt had evaporated at a field test site near Hanksville, Utah in 2003 (Clarke and Pain, 2004). Specific climatic conditions were not reported.

Schreiber and Tabakh (2000) reported that above 65 percent RH, halite can form, but that its stability is tenuous. Below 65 percent RH, the solid is preserved but only when the RH falls below ~35 percent does evaporation continue with the formation of other salts. Halite can form fine dendritic whiskers and crusts on drying on the surface of marginal salt flats fed by capillary rise of subsurface brine.

Relative humidity and air temperature data for areas surrounding the Salton Sea were obtained for three stations from the California Irrigation Management Information Service (CIMIS). The data, consisting of 5-year averages, are given in Table E9-3. The average relative humidity generally falls into the range where halite will precipitate, and marginally into the range where evaporation can continue, so that other salts begin to crystallize. Two additional factors increase the probability that ongoing crystallization will occur. First, the values in Table E9-3 are monthly averages; higher temperatures and lower relative humidities will occur over shorter time intervals than the monthly average. Second, ground surface temperatures on sunny days will be significantly hotter than the ambient air temperature, enhancing evaporation and reducing the relative humidity below values in Table E9-3. Consequently, evaporation will continue, making efflorescence likely.

Bloedite

Bloedite and other minerals occur as powdery efflorescence in relatively damp parts of the playa on a shallow saline lake of the Oaurgla depression in the Algerian Sahara (Hamdi-Aissa et al., 1998). Bloedite reportedly occurs in combination with halite, gypsum, thenardite, glauberite, and other sulfate-chloride minerals (Merry and Fitzpatrick, 2005; Fitzpatrick et al., 2005; Hamdi-Aissa et al., 1998). The relationships between mineral forms are depicted in phase diagrams in King et al. (2004) (Appendix E9B) and supported by tabulated solubility data in Linke (1958a).

No specific climatic information about formation of bloedite efflorescences was found during the review, so direct applicability to the Salton Sea could not be verified.

Table E9-3
Summary Data for 5-day Moving Averages of Climatic Data
(from or corrected to Brawley, CA, 1983-2004)

Month	Temperature (°F)				Relative Humidity (%)			
	Ave	Min	Max	Std Dev	Ave	Min	Max	Std Dev
Jan	54.1	44.8	63.4	3.6	61.8	39.6	87.1	8.8
Feb	57.0	42.8	70.5	4.3	59.6	28.1	79.9	9.2
Mar	62.3	50.8	76.7	4.9	56.7	20.8	81.2	10.1
Apr	67.3	53.0	78.6	5.1	54.0	35.4	73.2	7.7
May	75.3	60.6	89.6	5.3	47.6	23.9	63.4	7.5
Jun	82.8	68.6	94.2	4.5	41.3	23.6	65.1	7.7
Jul	89.3	79.6	97.1	3.1	45.7	20.8	70.2	9.0
Aug	90.4	81.6	98.0	3.3	48.9	28.1	74.1	9.0
Sep	85.4	68.3	95.9	5.1	48.2	26.5	81.3	8.9
Oct	74.8	58.7	87.7	5.7	49.3	33.5	75.4	8.5
Nov	61.9	49.3	76.6	5.4	55.7	36.7	88.5	8.8
Dec	53.2	41.5	62.0	3.9	61.2	30.8	90.7	10.0

Source: University of California Statewide Integrated Pest Management Program and California Irrigation Management Information System

Thenardite and Mirabilite

Thenardite and mirabilite precipitation from bulk brine was not predicted from the initial Salton Sea water composition at the Bertram Station. However, weathering and other mechanisms occurring on the playa are expected to alter the mineral sequence and have a high potential to produce Phase 3 and Phase 4 (see Appendix E9A) efflorescences on the playa.

Photomicrographs of sodium sulfate crystals (Rodriguez-Navarro et al., 2000) illustrate the efflorescent salt morphologies (Appendix E9C) described above in the section titled “Efflorescence Mechanism.” The photomicrographs also show a special characteristic of sodium sulfate and several other minerals that are frequently associated with dust formation: alternation between higher-density thenardite (specific gravity 2.664) and lower-density mirabilite (specific gravity 1.464) produces highly porous particulate matrix (including these salt crystals and other particulate matter in which it is entrained) that is loose, friable, and susceptible to wind erosion.

Thenardite typically does not precipitate at temperatures below ~90°F; however, when brine occurs in porous materials such as playa surfaces, thenardite precipitation can occur, concurrently with mirabilite, which is normally the favored crystalline form below 90°F. Once sodium sulfate precipitates, mirabilite will dehydrate to form thenardite when the RH falls below 71 percent (at a temperature of 68°F). Thenardite will rehydrate back to mirabilite when the RH rises above 71 percent (again, at a temperature of 68°F; Rodriguez-Navarro et al., 2000).

The alternation between phases is accompanied by changes in particle density. With thenardite as the starting material (specific gravity of 2.664), the size of the crystal expands during hydration to low density mirabilite to accommodate the waters of hydration. During subsequent dehydration, the skeletal crystal retains its shape, probably with some fine particle dislocation, but upon rehydration, structural changes occur again during transformation back to mirabilite, with increased dust formation potential. Phase diagrams of the relationship between thenardite and mirabilite as functions of temperature and relative humidity are shown in Appendix E9D (Rodriguez-Navarro et al., 2000).

This mechanism appears to apply to several other salts that are frequently associated with efflorescence, including sodium carbonate (anhydrous specific gravity, 2.532; decahydrate specific gravity, 1.44) and magnesium sulfate (monohydrate specific gravity, 2.517; heptahydrate specific gravity, 1.636).

Comparison of Salton Sea with Owens Lake

The seasonally emissive nature of the Owens Lake playa has been attributed at least partially to the friability caused by alternating formation of sodium sulfate salts (thenardite and mirabilite; Saint-Amand, 1986). Comparison of the mole percentages of anions in the Salton Sea and in Owens Lake brine, surface drainage and groundwater (Table E9-4) shows that the proportion of sulfate in the Salton Sea is 2.3 to 3 times higher than Owens Lake. Sodium sulfate dust and other dust (eroded from the friable crust and underlying sediments) is reported at Owens Lake. Therefore, the Salton Sea, with up to 3 times the sulfate relative to other anions, is reasonably likely to form comparable efflorescent sulfate salts, and to exhibit salt transformations and associated crust friability, all of which can lead to elevated rates of airborne particulate emissions.

Table E9-4
Mole Percentages of Anions in the Salton Sea and Owens Lake

Anion	Salton Sea	Owens Lake		
		Brine Pool[a]	Groundwater[b]	Surface Drainage[c]
Cl	83.9	73.5	50.6	71.6
SO_4	15.5	5.7	5.1	6.7
HCO_3	0.5	2.7	42.3	5.5
CO_3	—	18.1	—	14.7
$B(OH)_4$	—	—	2.1	1.2
NO_3	—	—	—	0.2

[a] Great Basin Unified Air Pollution Control District samples, March 2000.
[b] Great Basin Unified Air Pollution Control District piezometers at 4- and 10-foot depths, April 1993.
[c] Great Basin Unified Air Pollution Control District research sites, Oct 1998 through March 2000.

CONCLUSIONS

1. Crystallized salt sequences occurring in evaporating pools are not predictive of salts that occur in a playa setting. Brine pools lack the pore structure, weathering, and mineral reworking that occur on a saline playa.

2. Most commonly occurring salts exhibit efflorescence under suitable conditions. The typical morphology of these salts is elongated whiskers that form when the last of the liquid film is evaporating.

3. Several salts undergo additional morphological and density transformations in response to temperature and relative humidity. These salts appear more likely to greatly increase friability of playa surfaces, under suitable (cool and moist) climatic conditions, increasing dust emissions potential.

4. Sodium sulfate minerals are among those most likely to form dust during the aforementioned climatic conditions. Sodium sulfate salts are likely to appear as efflorescences in Salton Sea playas, and within the alternately hard and more friable playa crust, based on available information.

5. Sodium sulfate efflorescence is reasonably likely to occur on the Salton Sea playa, because similar salts are known at Owens Lake, which has a significantly lower proportion of sulfate-to-other anions than the Salton Sea.

6. There are no known predictive models for dust-forming efflorescent minerals. Laboratory tests similarly do not replicate the range of field conditions or long-term environmental exposures to which efflorescent salts would be exposed.

7. The most definitive means for investigating efflorescence and dust-forming potential is field monitoring of representative areas of the playa.

ATTACHMENT E9, APPENDIX A

Crystallization Sequence of Sodium Nitrate on a Porous Substrate

ATTACHMENT E9, APPENDIX A
CRYSTALLIZATION SEQUENCE OF SODIUM NITRATE ON A POROUS SUBSTRATE

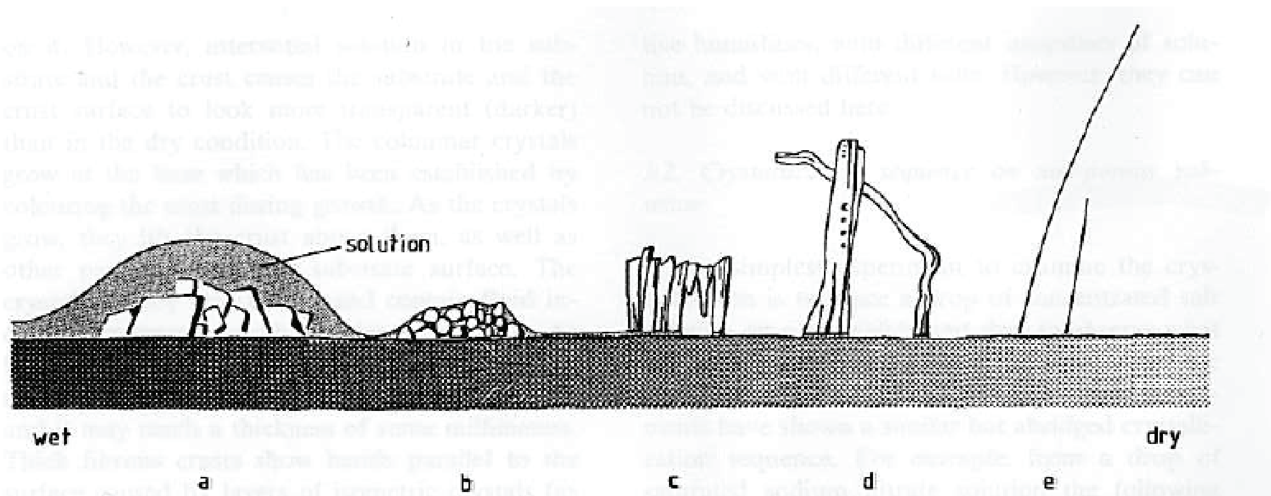


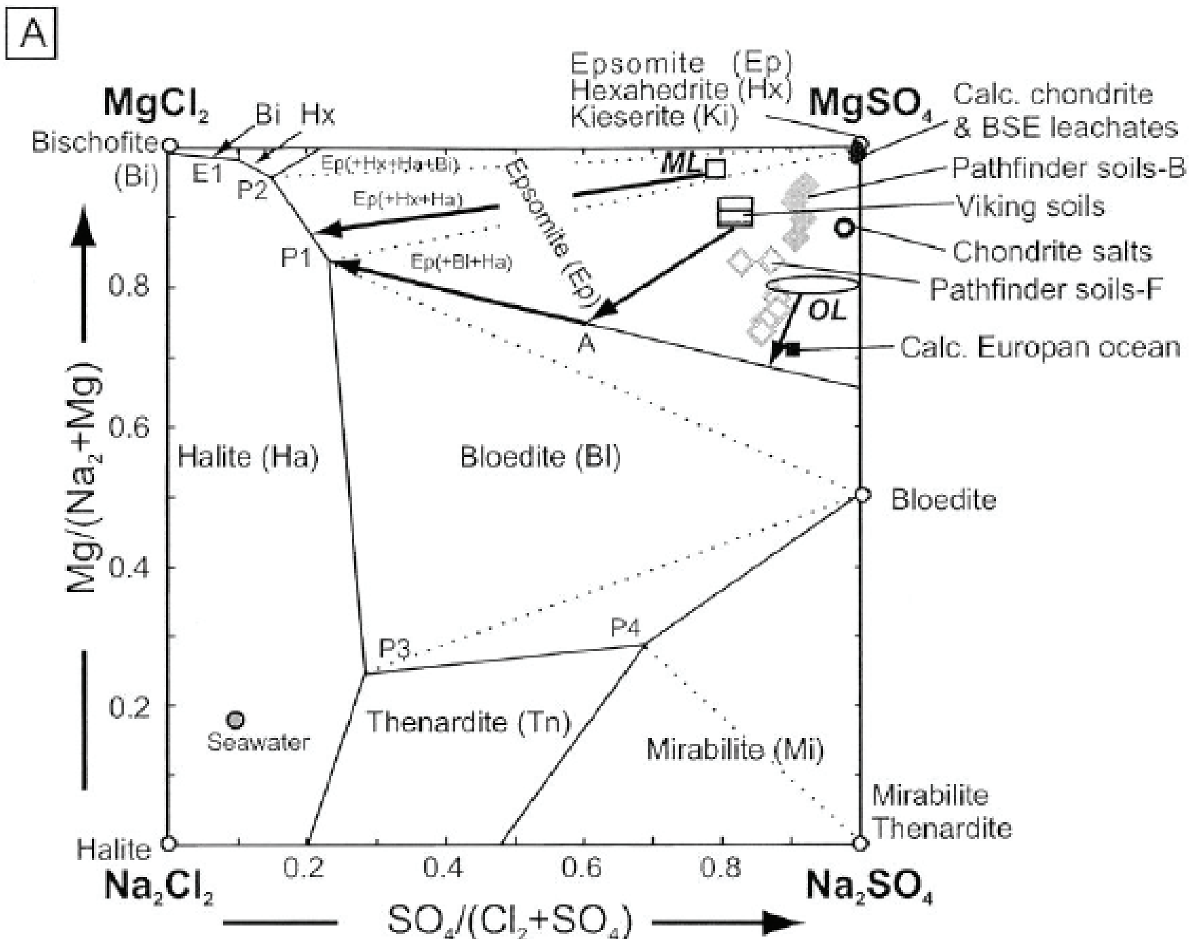
Fig. 2. Crystallization sequence of sodium nitrate on a porous substrate. The synoptical sketch corresponds to the evolution from wet to dry surface (see text).

Phase 1 is '*a*' in the figure; Phase 2 is shown as crystals in '*b*'; Phase 3 is '*c*'; Phase 4 shown as '*d*' and '*e*' (Zhender and Arnold, 1989).

ATTACHMENT E9, APPENDIX B

Relationship Between Bloedite, Thenardite, and Mirabilite

ATTACHMENT E9, APPENDIX B
RELATIONSHIP BETWEEN BLOEDITE, THENARDITE, AND MIRABILITE



From King et al., 2004.

The figure shows the relationship between bloedite, and thenardite and mirabilite – two sodium sulfate crystal forms. Units are mole fraction, as shown on each axis.

ATTACHMENT E9, APPENDIX C

Sodium Sulphate ESEM Micrographs

ATTACHMENT E9, APPENDIX C
SODIUM SULPHATE ESEM MICROGRAPHS

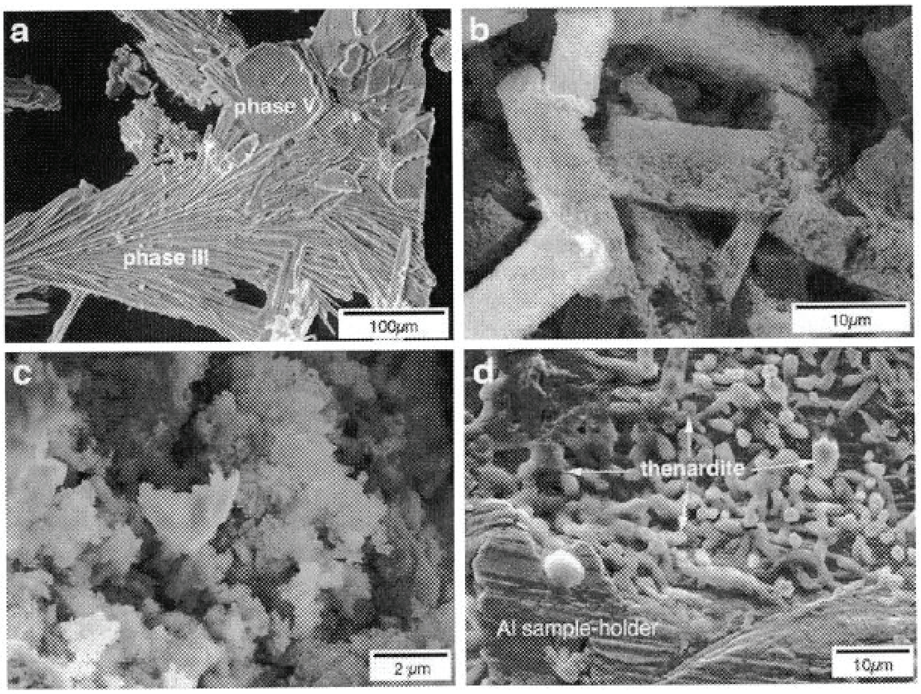


Fig. 4. Sodium sulfate ESEM micrographs. (a) Thenardite crystals precipitated on glass slides. (b) Thenardite aggregates formed after dehydration of pre-existing mirabilite crystals (ESEM dynamic study). (c) Detail of thenardite crystals formed after dehydration of mirabilite. (d) Thenardite crystals precipitated directly from solution on the Al sample holder in the ESEM.

(from Rodriguez—Navarro, et al, 2000)

ATTACHMENT E9, APPENDIX D

Na_2SO_4 – H_2O Temperature vs. Concentration Diagram

ATTACHMENT E9, APPENDIX D
NA_2SO_4 – H_2O TEMPERATURE VS. CONCENTRATION DIAGRAM

1528 C. Rodriguez-Navarro et al. / Cement and Concrete Research 30 (2000) 1527–1534

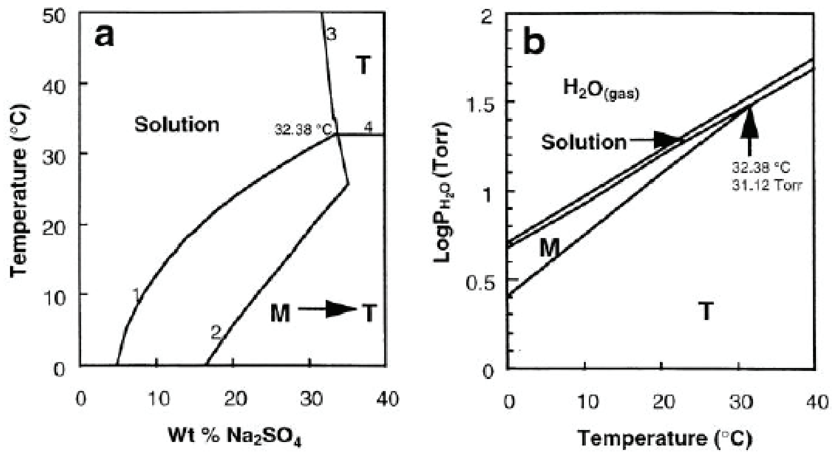


Fig. 1. The system, $Na_2SO_4-H_2O$. (a) Temperature vs. concentration diagram (M = mirabilite; T = thenardite; 1 = solubility curve for $Na_2SO_4 \cdot 10H_2O$; 2 = solubility curve for $Na_2SO_4 \cdot 7H_2O$; 3 = solubility curve for Na_2SO_4; 4 = $Na_2SO_4/Na_2SO_4 \cdot 10H_2O$ boundary). (b) *P*/*T* phase diagram for the system, $Na_2SO_4-H_2O$. Data sources: Refs. [16,19,20].

(from Rodriguez-Navarro et al., 2000)

APPENDIX E, ATTACHMENT E10

Brief Literature Search: The Effects of Dust/Saline Dust on Crops

2006

APPENDIX E, ATTACHMENT E10
BRIEF LITERATURE SEARCH: THE EFFECTS OF DUST/SALINE DUST ON CROPS

A brief literature search was conducted to identify scientific findings on the effects of dust and saline dust on agricultural crops. Very limited information was found, and no documents specific to the Salton Sea were identified. A summary of the information sources that were found is presented below.

THE EFFECT OF DUST ON PLANTS

Summary

There appear to be several references in the literature of public agencies and other sources to the "clogging" action that dust has on plant pores or stomata. However, no scientific literature proving this effect was identified. Main points from the sources listed below include the following:

- Dust settling on plant leaves can decrease light penetration, block stomata, and decrease gas exchange and water loss (respiration and transpiration).
- Heavy dust can reduce photosynthesis.
- Different plants may have different sensitivities to dust.
- Dust coating on plants may affect the normal action of pesticides and other agricultural chemicals applied as sprays to foliage.

Individual Articles

L. Morgan. Undated. The Growing Edge.
http://www.growingedge.com/magazine/current_issue/view_article.php3?AID=170530

Fine particles of sand, soil, dust and other debris are another aspect of air quality which concerns many growers. Wind-blown dust can settle on plant foliage and cut down the amount of light penetration on the leaf surface and can also block stomata and slow rates of gas exchange and water loss.

Heavy dust can severely reduce plant photosynthesis. It's most commonly a problem in greenhouse plant rows boarding vents and in open-sided structures. One of the most effective ways of preventing dust contamination is the use of windbreaks outside the cropping area which trap the dust particles before they are blown into the cropping area. Use of insect mesh screens or roll down plastic sides also help prevent airborne dust and grit from entering the growing space.

Notes: Dr. Lynette Morgan is a regular contributor to The Growing Edge. She holds a Ph.D. in Vegetable Production from Massey University, New Zealand.

USDA Agricultural Research Service, Research Programs, Air Quality. Particulate Emissions from Wind Erosion problem statement.
http://ars.usda.gov/research/programs/programs.htm?np_code=203&docid=317&page=3

Deposition of transported dust on crops hinders processing and decreases yield and value.

Farmer, A.M. 1993. The effects of dust on vegetation—a review. Environ Pollut. 79(1):63-75. English Nature, Northminster House, Peterborough, PE1 1UA, UK.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=15091915&itool=iconabstr&query_hl=2&itool=pubmed_docsum

Abstract: An increase in quarrying, open-cast mining and road traffic suggest that dust deposition onto vegetation may be increasing. This review describes the physical and chemical characters of a range of dust types. The effects of dust on crops, grasslands, heathlands, trees and woodlands, arctic bryophyte and lichen communities are identified. Dust may affect photosynthesis, respiration, transpiration and allow the penetration of phytotoxic gaseous pollutants. Visible injury symptoms may occur and generally there is decreased productivity. Most of the plant communities are affected by dust deposition so that community structure is altered. Epiphytic lichen and Sphagnum dominated communities are the most sensitive of those studied. However, there have been very few detailed studies on natural and semi-natural systems and some dust types are also very understudied. Recommendations for future research are made in order to overcome this deficiency.

Griffiths, H. 2003. Effects of Air Pollution on Agricultural Crops. Ontario Ministry of Agriculture, Food and Rural Affairs Factsheet. http://www.omafra.gov.on.ca/english/crops/facts/01-015.htm#particulate

Particulate matter such as cement dust, magnesium-lime dust and carbon soot deposited on vegetation can inhibit the normal respiration and photosynthesis mechanisms within the leaf. Cement dust may cause chlorosis and death of leaf tissue by the combination of a thick crust and alkaline toxicity produced in wet weather. The dust coating also may affect the normal action of pesticides and other agricultural chemicals applied as sprays to foliage. In addition, accumulation of alkaline dusts in the soil can increase soil pH to levels adverse to crop growth.

DUST FROM SALINIZED AREAS

Summary

While it seems to be commonly accepted that saline dust can harm crops, no scientific information sources were identified providing evidence of this phenomenon. Few studies that examined specific types of particulate matter, such as saline dust, and their effects on crops were identified. Dust such as cement dust from operations such as construction and mining has been studied briefly. Main points from the information sources that were found include the following:

- Salt crusts vary in their chemical composition and in their potential to erode and be carried by wind.
- Haloyphytic (salt-loving) bacteria may be carried from saline environments to other environments over considerable distances through erosion and deposition.

Individual Articles

**Street, K. 2004. (International Centre for Agricultural Research in the Dry Areas)
Racing Against Time to Save Our Green Gold. Issues 69, December 2004, Food Security
http://issues.control.com.au/issues2004/69f1.shtml**

Saline dust storms are listed as an indirect cause of genetic erosion through effects on plant ecosystems. No further explanation is given.

**Reheis et al., 2003. Health Effects of Dust from Owens (dry) Lake, California. Potential Health Hazards of Owens Lake Dust. USGS.
http://esp.cr.usgs.gov/info/sw/swdust/owens.html**

Mineral dusts from the desiccated playa of Owens Lake, Calif., contain elevated concentrations of many metals known to have toxic effects. To assess the element sources and possible hazards to humans, other animals, and plants, we are (1) analyzing trace-element contents of the fine-grained mineral and soluble fractions of deposited dust, playa sediment, and aerosol samples collected during dust storms, and (2) repeating these analyses by extracting the same samples using solutions that are surrogates for human lung and gastric fluids.

Dusts and aerosols are strongly enriched in sulfate from soluble sodium sulfate in playa sediment: elemental S concentrations in saline dust events can be as much as 10 percent by weight. Potentially toxic elements in the <50 µm fraction of deposited dust include (conc. in ppm): As (10-50), Cr (17-56), Cu (<22), Mo (0.5-3), Ni (<16), Pb (50-400), Sb (6-14), Th (10-16), and U (3-8). Leach tests of the dusts using water and simulated lung fluids (20:1 fluid:dust by wt., 24 hr mixing) show these metals are quite soluble and bioavailable (i.e., dissolved As, Mo, and U as much as 2700, 650, and 170 g/L, respectively).

Dust-deposition rates of some metals and sulfates in Owens Valley equal or exceed rates in industrialized areas of the world. Much Owens Lake dust is <10 µm in diameter, and SEM studies reveal abundant submicron particles. Given composition, size, and deposition rates (1991-1998 average of 150 $g/m^2/yr$ of fine dust at one site), a large fraction of these metals could be transported hundreds of kilometers and easily respired. Terminal lake basins such as Owens Valley could be globally important sources of metal-bearing dusts. The health and ecological effects of soluble alkaline sulfate aerosols are poorly known but of potential concern.

Galloway J.N., Thornton J.D., Norton S.A., Volchok H.L., and McLean R.A.N., 1982, Trace metals in atmospheric deposition: A review and assessment: Atmos. Envir., v. 16, p. 1677-1700.

Hageman, P.L., and Briggs, P.H., 2000, A simple field leach test for rapid screening and qualitative characterization of mine waste dump material on abandoned mine lands: Proceedings, Fifth International Conference on Acid Rock Drainage (ICARD2000), May 21-24, 2000, Denver, Colorado, published by Society for Mining, Metallurgy, and

Exploration Inc., Littleton, Colorado, Vol. II, p. 1463-1475.

Hinkley T.K., Lamothe P.A., Wilson S.A., Finnegan D.L., and Gerlach T.M., 1999B, Metal emissions from Kilauea, and a suggested revision of the estimated worldwide metal output by quiescent degassing of volcanoes: Earth and Planet. Sci. Lett., v. 170, p. 315-325.

Reheis, M.C., 1997, Dust deposition downwind of Owens (dry) Lake, 1991-1994: Preliminary findings: Jour. Geophys. Res., 102(D22), p. 25999-26008.

Reheis, M.C., Budahn, J.R., and Lamothe P.L., 1999, Elemental analyses of modern dust in southern Nevada and California: U.S. Geological Survey Open-File Report 99-0531.

Reheis, M.C., Budahn, J.R., and Lamothe, P.L., in press, Geochemical evidence for diversity of dust sources in the southwestern U.S.: Geochimica et Cosmochimica Acta.

Akinobu Echigo, Miki Hino, Tadamasa Fukushima, Toru Mizuki, Masahiro Kamekura, and Ron Usami. Endospores of halophilic bacteria of the family Bacillaceae isolated from non-saline Japanese soil may be transported by Kosa event (Asian dust storm). Saline Systems, in press (2005). http://www.sciencedaily.com/releases/2005/10/051020091138.htm

Bacteria found in soil around Tokyo are not indigenous to the area. A study published in the open access journal Saline Systems reveals a large proportion of salt-loving bacteria in non-saline soil around Tokyo. The researchers suggest that dust storms may have carried the bacteria from their natural habitats in China.

Arieh, S., Zobeck, T., Poberezsky, L. and Argaman, E. The PM10 and PM2.5 Dust Generation Potential of Soils/Sediments in the Southern Aral Sea Basin, Uzbekistan

Submitted to: Journal of Arid Environments
Publication Type: Peer Reviewed Journal
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Publication Date: N/A

Technical Abstract: Enormous dust storms have become common in the area of the Aral Sea in Central Asia due to exposure of large portions of the former sea bed, resulting from the extensive desiccation. The objective of this study was to assess the contribution of the major soil/sediment surfaces in the Southern Aral Sea Basin to the dust generation potential of the region. The exposed surfaces include wetlands in the delta close to the Amu Darya River bed; with transitions to Solonchak soils commonly with a salt crust; Takyr and Takyr-like soils exhibiting a fine-grained crust more removed from the river bed; and shallow, stony soils on the more elevated terrain and Solonchak-like soils on exposed Aral Sea bed.

Eight crusts and soils/sediments from 7 sites representative of these surfaces, were sampled in the field and their major characteristics (particle size distribution, organic carbon, carbonate, and salt content) that are related to dust generation were determined. The PM_{10} and $PM_{2.5}$ dust generation potential of the materials was accepted as a general indicator for their dust generation capability, and was determined in the laboratory using the Lubbock Dust Generation, Analysis and Sampling System. The highest amount of PM10 dust (579.3 mg.m-3) was generated from the Takyr crust material. The lowest, by one Solonchak salt crust material (39.6 mg.m-3). Salt crusts from the desiccated Aral Sea bottom generated intermediate amounts of dust. Salt crusts seem to generate much lower PM10 dusts, possibly due to dense interlocking matrix of the salt crystallites forming the crust.

The results of these determinations indicate that the Takyrs and Takyr-like soils, roughly of an extent of over 1 million ha in the Southern Aral Sea Basin, constitute the surfaces with the highest potential for being the source for the severe dust storms of the area. Second to the Takyr soils, the Solonchaks and Solonchak-like soils contribute highly saline dust.

APPENDIX E, ATTACHMENT E11

Description of Microclimate at the Salton Sea

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APPENDIX E, ATTACHMENT E11 DESCRIPTION OF MICROCLIMATE AT THE SALTON SEA

The valley that comprises the Salton Sea Air Basin is divided into two parts: the Imperial Valley to the south and the Coachella Valley to the north. The climate of this area is common in the desert areas of the southwest U.S., and is characterized by extreme aridity, high summer temperatures, and marked diurnal swings in temperature. Average annual precipitation is slightly less than 3 inches on the valley floor and about 40 inches at the crests of the San Jacinto Mountains. Maximum summer temperatures commonly exceed 104 degrees Fahrenheit, and winter minimums are seldom below 32 degrees Fahrenheit.

Near the shore of the Salton Sea, the large body of water moderates the extreme desert climate by creating its own local climate or microclimate. The most notable features of the local microclimate is the Salton Sea's moderating effect on temperature and the creation of localized wind patterns, or lake breezes, caused by the differential heating of the land and water surface.

The Salton Sea also has a seasonal effect on local temperature. Large lakes such as the Salton Sea can retain heat during the cooler months of the year, and influence near shore temperatures. Conversely, the Salton Sea causes a slight cooling affect near shore during warmer months. This moderating affect on temperature occurs even without the aid of the more noticeable lake breeze effect. Productive farmland nearest the shore line can benefit from the moderating affects of temperature which can extend growing seasons.

Lake breezes are produced from the differential heating of land and water surfaces and are more pronounced near large water bodies, such as the Salton Sea, that have marked temperature differences compared to the adjacent land. Onshore breezes are created during the day when the land heats more quickly than the adjacent water surface, causing the air over the land to rise and cooler air over the water to move in over the land. At night, the circulation is reversed as the water retains heat while the land cools quickly. Because the temperature differences between the water and land surfaces are what drive the lake breeze circulation, winds are typically strongest during the day close to the shoreline and diminish with distance inland. Through the diurnal lake breeze circulation, a pronounced affect on temperatures near the shoreline can be experienced as cool air moves on shore during the day.

Local meteorological parameters other than temperature and wind are also affected by the Salton Sea, although their effect on the local climate is less evident. These parameters are important to understand, and a discussion of these parameters is used to evaluate the effects that alternatives may have on the local microclimate.

The parameters that affect microclimate are defined below.

Evapotranspiration is defined as the amount of water vapor that evaporates from the earth's surface to the air, and the amount of water vapor that is transported (transpired) from a plant's leaf surface to the air.

Relative humidity is defined as the amount of water vapor present in air expressed as a percent of the possible amount of water vapor that could be present in air.

Temperature is defined as how hot or cold the air is at 2 meters above ground.

Precipitable moisture/precipitable water is defined as the amount of water vapor that is present in air and has the potential to fall to the ground as rain over a localized area.

Precipitation/rainfall is defined as the amount of rain that is actually measured by a gauge at a certain location.

Wind speed and direction is defined as the horizontal movement of air.

Vegetation is defined as living plants, trees, shrubs, grasses, and ground covers.

EFFECT OF ALTERNATIVES ON INDIVIDUAL PARAMETERS

Under most alternatives, shallower depths, smaller water surfaces, and higher salinity would result. These changes would affect all of the microclimate parameters defined above, and in particular, would affect the climate of the near shore areas which experience more moderate temperatures and are influenced by lake breezes.

By reducing water surfaces and inflow to the Sea, less water is available for microclimatic interactions in the atmosphere. Evapotranspiration would be diminished, but any noticeable climatic affect from a reduction in evapotranspiration would not be pronounced in such an arid climate. Changes in vegetation would likely result from the construction of components and dust control measures. Changes in vegetative cover would also affect evapotranspiration.

Under the alternatives, the interaction between the water surface, irrigated farmland, and sunlight would result in changes to other microclimate parameters as follows:

- Relative humidity – would decrease because less water vapor would be formed or present;
- Temperature – beyond the near shore temperature effects described above, effects would vary over farmland because water acts as an insulator and reduced inflow would result in less water to cover the ground. Dry ground absorbs heat from sunlight faster than water surfaces, thereby increasing air temperatures during daylight hours. Because the ground does not insulate as well as water, temperatures could drop faster at night. This would result in larger diurnal temperature swings, with higher temperatures during the day and potentially lower temperatures at night;
- Evapotranspiration – would decrease due to reduced moisture and surface area. Presently the average annual evapotranspiration rate is 71.34 inches per year, based on data collected from one station (Brawley Station) for the past 22 years. Changes to the extremely arid local climate would be unnoticeable due to decreased evapotranspiration under the alternatives;
- Salinity – As salinity increases, vapor pressure in the water decreases, resulting in a decrease in the evaporation rate. This effect would be negligible compared with the change in evaporation from a smaller water surface;
- Precipitable Moisture/Precipitable Water – would not change or would decrease negligibly due to the arid climate. The source of water vapor capable of reacting with sunlight and the atmosphere would decrease, however, changes precipitable water would be negligible compared with the available moisture transported to the area in weather systems that affect the region;
- Rainfall – would not change or would decrease negligibly because the available moisture in weather systems that affect the region and cause rainfall is not derived from local evaporation;
- Vegetation – would increase under alternatives where plants are used in Air Quality Management, or dust control, or where native vegetation or agricultural crops are encouraged to grow. However, native vegetation in some areas immediately adjacent to the Salton Sea may decrease, because less moisture would be available to sustain plant growth; and
- Wind speed and direction – other than changes to the lake breeze effect described above, changes to wind speed and direction would have an undetermined effect, due to other parameters that may cause either increases or decreases in the atmospheric processes that change wind speed. In some

cases, wind speed would decrease because water surfaces are smoother then land and the increased surface roughness of dry ground would act to slow air moving across the surface. Similarly, wind speed would be reduced in areas where more vegetation is planted. Conversely, wind speed would increase in areas where existing vegetation dies due to decreased water or water vapor availability.

Although the predicted effects on each individual parameter are described, these changes cannot be quantified, because of limited information about individual parameters and the local microclimate near the Sea. Therefore, the combined effects of the defined weather parameters on local microclimate cannot be quantified but are likely to be most pronounced nearest the existing shoreline.

APPENDIX E, ATTACHMENT E12

Prior Air Quality Technical Reports

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APPENDIX E, ATTACHMENT 12
PRIOR AIR QUALITY TECHNICAL REPORTS

Copies of documents are available at http://www.saltonsea.water.ca.gov/

1. *Initial Draft Report for Existing Baseline Conditions*, issued August 27, 2004. Air Quality and Climate Section, pp 2-56 to pp 2-77.
2. Unified Executive Summary and Appended Final Air Quality Technical Memoranda Prepared to Support the Salton Sea Ecosystem Restoration Plan Programmatic Environmental Impact Report (PEIR), issued February 2005.
3. Final Salton Sea Air Quality Work Outline, Final Draft issued February 2005.
4. Identification of Data Gaps, issued February 2005.
5. Identify Potential Emissions Sources, Significance Criteria, and Analytical Tools and Methods, Final Draft issued February 2005.
6. Soil/Sediment Emissivity Assessment, Final Draft issued February 2005.
7. Draft Responses to Comments on Items 2 through 6, issued March 2005.
8. *Identify and Outline Measures to Control Playa Emissions* - Draft issued on June 10, 2005. For Final Draft version, please see Appendix H, Attachment H-3.
9. Outline Control Measures for Non-Playa Emissions - Final Draft issued on November 18, 2005.
10. Evaluate, Identify Gaps, and Provide Management of Current Aerometric Monitoring Data Collection Efforts - Final Draft issued on October 24, 2005.
11. *Air Quality Conditions for the No Action Alternative and Analyze Potential Variability* - Draft issued on May 16, 2005. For Final Draft version, please see Chapter 10 in the PEIR.
12. *Constituents of Potential Concern in Sediments and Soils, and Their Potential to Affect Human Health*, issued on September 16, 2005.
13. *Continued Evaluation of Playa Dust Emissions Models* – Please see Appendix E, Attachment E7.
14. *Refine Emissions Estimation Tools for Non-Playa Emission Sources* – Please see Appendix E, Attachment E2.
15. *Ongoing Data Management and Air Quality Modeling Preparation* – Please see Appendix E, Attachment E8.
16. Draft Outline for Four-Year Plan for Air Quality Management (AQM) Research and Development, Draft Outline issued on January 5, 2006.