Appendix AQ-2
SS AQMP Overview

SALTON SEA AIR QUALITY MITIGATION PROGRAM OVERVIEW

PREPARED BY FORMATION ENVIRONMENTAL, AUGUST 2024

The Salton Sea Air Quality Mitigation Program (SS AQMP) was developed by IID to provide a comprehensive, science-based, adaptive approach to address air quality mitigation requirements associated with the Quantification Settlement Agreement (QSA) and the water conservation and transfers under the QSA. It is important to understand that current and future exposed Salton Sea playa is anticipated to be a new source of PM_{10} dust emissions, however, until the playa is exposed, the location, frequency and magnitude of future emissions are unknown. It is also important to note that the timing and location of playa exposure is a function of the Sea floor bathymetry and the Sea's response to inflows, salt loads, and evaporation rates. While models have been developed to predict future playa exposure (rate and extent), these models (like all models) have uncertainty regarding future conditions and the Sea's response. Therefore, the objective and structure of the SS AQMP is specifically designed to be adaptive and proactively detect, locate, assess and identify options to mitigate dust emissions from exposed Salton Sea playa *as it occurs, regardless of timing, rate, and extent of playa exposure*. Each component of the program is used to proactively identify, prioritize, and guide implementation of dust control measures on exposed Salton Sea playa now and into the future (IID 2016).

The main components of the SS AQMP include 1) an annual Emissions Monitoring Program to estimate emissions and to identify areas of exposed playa for proactive dust control, 2) an annual Proactive Dust Control Plan with recommendations and design for site-specific dust control measures, and 3) implementation of dust control measures to prevent PM_{10} dust source areas from becoming significant sources of dust emissions, and also scaling and adapting dust control measures to efficiently achieve control at a larger scale as playa exposure accelerates. The annual Emissions Monitoring Program is designed to work in tandem with the development of the annual Proactive Dust Control Plan and subsequent implementation of dust control measures. Sites for dust control measures are identified by IID on an annual basis in the Proactive Dust Control Plan. This approach allows for effective, targeted use of resources on areas that require proactive dust control to protect the public health of communities near and around the Salton Sea. **Figure 1** is an infographic summarizing the main components of the SS AQMP and highlighting the extensive work completed to implement dust control measures strategically and effectively at the Salton Sea. Each component of the SS AQMP is further described in the following sections.

1. EMISSION ESTIMATE

Under the SS AQMP, the Salton Sea Emissions Monitoring Program is conducted, which estimates and monitors emissions and identifies areas of exposed playa for proactive dust control. Each annual PM_{10} emissions estimate is compiled in a report that is located at https://saltonseaprogram.com/aqm/team-documents.php. The Emissions Monitoring Program also identifies the location and magnitude of emissions in the desert area adjacent to the Salton Sea (to the west). Emissions from the desert open area to the west of the Salton Sea is the single largest source of PM_{10} in the Salton Sea Air Basin (ICAPCD

2018) and are important because they are upwind of the playa, making it difficult to determine (isolate) dust generated from the playa versus dust generated from the desert. In addition, these desert areas contain an unlimited supply of sand that is transported (aeolian and fluvial processes) toward the Salton Sea and impacts the fragile playa surfaces, thus increasing the emissions potential of exposed playa (in specific locations where it comes onto the playa). The emission estimate program includes four key steps (**Figure 1**):

a. **Map Playa Exposure**. Playa exposure is monitored continuously and mapped at the end of each year, when the Salton Sea is at the lowest point of the hydrologic cycle. Analysis includes use of satellite imagery, USGS water surface elevation data, and high-resolution bathymetric data. It is important to note the timing and location of playa exposure is a function of the Sea floor bathymetry and the Sea's response to inflows, salt loads, and evaporation rates. While models have been developed to predict future playa exposure, these models have uncertainty regarding future conditions. Therefore, the SS AQMP monitors actual playa exposure routinely regardless of what was projected to be exposed. This ensures that playa is characterized appropriately and monitored for potential emissions.

b. **Characterize Surfaces**. Playa and desert surfaces are characterized throughout each wind season (November through June) to provide a better understanding of the type, location, and extent of surfaces vulnerable to erosion and emissions. Each surface is tested for emissions throughout the wind season using a Portable in-situ Wind ERosion Laboratory (PI-SWERL). Emissions potential is highly variable, but is driven by surface type, surface moisture, and the presence of loose surface sand. Overall, playa surfaces dominated by coarser textured (Sandy) soils have more predictable emissions. In contrast, emissions from playa surface with finer textured, clay soils have less predictable emissions because of sensitivity to environmental influences on salt crust formation. For example, precipitation events, groundwater depth, diurnal temperature changes, and relative humidity can cause playa surface characteristics to change, increasing or decreasing the potential for erosion/emissions. Vegetative cover (an important surface characteristic) is also quantified using high-resolution imagery. Vegetative cover reduces emissions potential of exposed playa by sheltering and sand capture. Natural vegetation expansion continues to be prevalent in many locations around the Salton Sea. Since the 2017/2018 emissions estimate, vegetated playa has increased from approximately 3,610 acres (~20% of exposed playa) to approximately 7,738 acres (~25% of exposed playa) documented in the 2022/2023 emissions estimate (IID 2024a). This represents a gradual increase in relative and absolute vegetation cover as playa exposure has increased through time.

c. **Model Wind Conditions.** Weather variables, like wind speed and wind direction, play a pivotal role in emission from the playa. IID and other agencies maintain numerous point weather observation stations in and around the air basin. IID uses these data to parameterize the Weather Research and Forecasting Model (WRF) to estimate wind speed and direction across the entire basin. These data demonstrate the winds are spatially variable across the Salton Sea, with the northern portions of the Salton Sea experiencing significantly lower wind speeds as compared to the Western and Southern portions of the playa that experience much higher and more frequent high wind events.

d. **Estimate Emissions.** Using the data described above, hourly, daily, and annual emissions are estimated for the playa and desert regions. The estimated annual emissions (unmitigated, or uncontrolled) from the playa was documented in the 2022/2023 emissions estimate as roughly 320 tons/year (0.88 tons/day) as compared to over 30,267 tons/year (83 tons/day) from the adjacent desert area (west of the Salton Sea). These values are consistent with previous emission estimates and demonstrate the playa emissions are significantly lower than the adjacent desert emissions. To put this into perspective, unmitigated playa emissions account for less than 1% of all emissions in the air basin (IID 2024a). When considering dust control implementation described in the following section, this number drops to less than 0.5% of the total emissions in the Salton Sea Air Basin on an annual basis.

   When the 2022/2023 playa emissions are aggregated with the previous four emissions estimates to develop five-year average annual emissions estimates, results demonstrate that a relatively small percentage of the playa is responsible for the majority of playa emissions. Approximately 20% of the playa is responsible for nearly 73% of playa emissions as shown in **Figure 2**. These playa areas are identified as “high priority playa” and have existing or planned Dust Control Measures (DCMs), which will mitigate the majority of the estimated emissions. Existing field studies and planned DCMs cover an area of about 16,780 acres, including 7,580 acres implemented, 1,219 acres in active construction, and 7,987 acres planned (IID 2024b). These existing field studies and planned DCMs are in playa areas that contribute 71.6% (of the five-year average annual emissions estimate (IID 2024b). This approach allows effective use of resources to help protect the public health of communities near and around the Salton Sea.

   Spatially, nearly 90% of all emissions occur along the western and southern portions of the Salton Sea. This is due to many factors, including soil conditions, wind speeds, and fetch distance of exposed playa in these areas. Importantly, emissions in the north end of the Sea are very small, accounting for less than 1.5% of all emissions from the playa (IID 2024a). This is due mainly to the air flow and wind speeds in this region of the playa, which are typically lower than the threshold for erosion as compared to other areas around the Sea (e.g. western and southern).

e. **Evaluate Dust Composition.** Dust composition is a specific concern regarding the current and future exposed playa. Specifically, the degree to which contaminants (e.g., salt, pesticides, selenium, and other metals) present in the soil / sediment matrix will also be present in the playa dust (Vogl and Henry, 2002; Frie et al., 2017) is the main concern. Elevated levels of cadmium, copper, molybdenum, nickel, zinc, and selenium have been observed in Salton Sea soil sediments; and the accumulation of metals and pesticides in playa environments (e.g., arsenic in Owens Lake and Ash Meadows) can increase PM toxicity and exacerbate health risks (Frie et al., 2017; Reheis et al., 2009; Breit et al., 2009). To evaluate this health risk, the elemental composition of playa dust and sediment and whether it is unique from native desert material has been the focus of multiple investigations (Vogl and Henry, 2002, Xu et al. 2016, Frie et al. 2017, 2019, Biddle et al 2023 as well as the IID AQMP. Specifically, IID has collected numerous gravimetric filter samples of PM_{10} induced by a small wind tunnel (the PI-SWERL) across seven playa and six desert sites and analyzed them for a suite of 51 elemental compounds using XRF. The advantage of these "direct" aerosol samples (compared to bulk PM sampled from a monitoring station) is that the PM_{10} accumulated on each filter is a direct representation of the dust each specific playa surface type may generate. This compares to other methods where numerous dust sources (open areas, agriculture, playa, desert, etc.) contribute to the dust collected on the filter and analyzed for toxic constituents. Findings indicate that concentrations of toxic metals were either below the method detection limit, or if above detection limits, were indistinguishable between the playa and desert domains (i.e. similar to background soil conditions for the surround natural desert landscape). This finding is consistent with other studies (Frie et al., 2017, 2019) where playa samples were enriched with elements associated with sodium, chlorine, magnesium, sulfur, and phosphorus; while desert samples were enriched with mineral elements (e.g., aluminum, iron, silicon), but were not enriched with toxic metals relative to the background conditions associated with the desert soils.

Current analyses of aerosol and sub-aerial soil samples from the playa and desert surrounding the Salton Sea suggest that until PM contaminant concentrations begin to exceed California EPA reference exposure levels, the principal health concern is the amount of PM being emitted rather than the composition (Frie et al., 2017). The disconnect between the sediment-driven aquatic toxicity and PM human toxicity is likely driven by different pathways (Frie et al., 2017). The main concern regarding sub-aqueous sediment toxicity is its ability to bioaccumulate. PM toxicity does not compound through bioaccumulation but is rather a function of the size and composition of the PM as well as the mechanism of salt crust formation through evaporative processes. The playa surfaces vulnerable to aeolian erosion and dispersion were originally dried Salton Sea sediment but have since formed salt crust structures through the evapoconcentration of shallow groundwater and the formation of evaporite minerals as well as the aeolian and fluvial superposition of desert-derived sediment. These factors are likely responsible for the discrepancy between the toxic elements observed in Salton Sea soil sediment and the lack thereof observed in playa and desert PM and soil samples.

The concept that playa dust (PM_{10}) is exceptionally high in toxic metals is not supported by the current body of research. However, the playa has been identified as an anthropogenic source of atmospheric dust that is expected to increase in areal extent, exposing different portions of previously submerged Salton Sea sediment that has been shown to have elevated levels of toxic contaminants in some areas. Sediments with elevated levels of organic carbon, metal, and metalloid contaminants appear to be concentrated in the relatively deeper, northern sub-basin within net depositional zones (Anderson et al., 2008; Vogl and Henry, 2002). It is not anticipated that these deeper portions of the Salton Sea will be exposed (they will remain submerged). However, the SS AQMP will continue to consider scientific findings and actively characterize the elemental composition of PM samples collected from playa surfaces as environmental settings evolve.

As described above, the Emission Monitoring Program provides the scientific data to inform prioritization and implementation of dust mitigation activities under the SS AQMP. To that end, an open and transparent peer review process was completed to ensure that the methods and data used for the Annual Emissions Estimates are based on sound and defensible science. The independent peer review of the Emissions Estimates methodology and results was conducted in Spring 2021, consistent with EPA's peer review guidelines (Peer Review Handbook 4th Edition, 2015). Reviewers were charged with providing feedback on each component of the emission estimate workflow, including any important improvements to the methods and an overall assessment regarding the scientific appropriateness of the current methods to meet the goal of identifying high priority playa areas for dust mitigation implementation under the SS AQMP. The peer reviewers agreed that the emissions estimate approach is scientifically rigorous and achieves the objectives of the program.

2. PLAN AND DESIGN

The overall goal of the SS AQMP is to keep playa emissions at low levels, even as playa exposure accelerates, through implementation of targeted, proactive dust control measures on priority playa areas. The success of the proactive dust control strategy requires the development and testing of a range of dust control measures that can be quickly implemented, adequately maintain a stabilized surface, and prevent the spread of emission source areas as playa is exposed. This approach provides flexibility for implementing effective dust control measures when and where they are needed. The annual Proactive Dust Control Plan describes recommendations for site specific dust control measures based on rigorous evaluation of the surface characteristics and emission potential. Each annual Proactive Dust Control Plan is located at https://saltonseaprogram.com/aqm/team-documents.php. This evaluation considers soil suitability, the availability of water resources, other planned stakeholder projects, and more (**Figure 1**):

a. **Assess Soil Suitability.** Planning for implementation of dust control measures requires information on the soil subsurface conditions, particularly soil texture, salinity, and depth to water. More specifically, certain dust control measures are suitable for fine-texture clay soils and not suitable for sandy soils. Sandy soils require more water intensive methods and therefore need to be understood (spatial location) so water resources can be developed for irrigation. Due to the expansive nature of the exposed playa, high-throughput soil survey methods are employed to characterize soil conditions as playa exposure occurs. To-date over 1,600 soil cores (5 feet depth) have been collected, analyzed, and documented to guide dust control implementation at the Salton Sea as shown in **Figure 3**. In addition, significant aquatic coring in the future exposed playa has also been completed to help guide planning of dust control with stakeholder agencies. (**Figure 3**).

b. **Assess Water Availability.** Water availability is another main driver of dust control measure suitability and selection. Where surface water resources exist, there is a water source for establishment of water efficient shrub vegetation. Where water resources do not exist, IID has developed sustainable groundwater resources for the initial establishment of vegetation for sites along the western and eastern portions of the playa (e.g. Salton City and Bombay Beach).

c. **Test / Develop Dust Control Measures.** The SS AQMP has and continues to test numerous types of dust control measures around the Salton Sea. In particular, methods that can be quickly implemented are preferred and provide emission reductions while longer term strategies (if needed) can be developed (e.g. water resources). Currently, IID is constructing and testing different vegetation-based dust control measures, surface roughening, stabilization with non-erodible elements, sand fencing, and surface stabilizers (e.g. biogrout).

d. **Consider Stakeholder Projects.** In addition to IID's SS AQMP, the Salton Sea Management Program (SSMP) Dust Suppression Action Plan (DSAP) was developed by the California Natural Resources Agency (CNRA) to fulfill its obligations under the California State Water Resources Control Board Order WR 2017-0134, Condition #24. Dust suppression project sites are identified in the SSMP DSAP, including those close to residential populations (North Shore and Bombay Beach) to benefit communities (CNRA 2020) and cover playa that is identified by IID as priority for dust control implementation. Under the SSMP DSAP, other factors related to the feasibility of implementation of dust suppression projects were also considered: permitting, access authorization, and water supply for certain suppression methods. IID routinely coordinates with the State to ensure resources are efficiently used and targeted at priority playa areas. This includes sharing the annual emission estimates as well as coordination on dust control implementation.

3. Dust Control Implementation and Monitoring

As described previously, approximately 20% of the playa is responsible for nearly 73% of playa emissions. These playa areas are identified and tracked yearly as "high priority playa" and are targeted for dust control implementation. It is important to note that these priority playa areas already have existing or planned Dust Control Measures (DCMs), which will mitigate the majority of the estimated emissions. Existing field studies and planned DCMs from both the State of California and IID cover an area of about 16,780 acres, including 7,580 acres implemented, 1,219 acres in active construction, and 7,987 acres planned (**Figure 2**) (IID 2024b). These existing field studies and planned DCMs are in playa areas that contribute 71.6% of the five-year average annual emissions estimate (IID 2024b). This approach allows effective use of resources to help protect the public health of communities near and around the Salton Sea.

Dust control performance monitoring is essential for measuring dust control effectiveness over time after implementation. Surface roughening and vegetation establishment are the primary dust mitigation measures implemented as a part of the SS AQMP. Effective performance monitoring includes multiple lines of evidence to balance the strengths and weaknesses of individual methodologies. By pursuing multiple lines of evidence, a clear and readily interpretable assessment of dust control performance can be achieved. Results are used to guide operations and maintenance activities including management, augmentation, or replacement of DCMs in order to maintain a stabilized surface.

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FIGURE 1. SS AQMP INFOGRAPHIC DESCRIBING THE 3 MAIN COMPONENTS OF THE PROGRAM AND THE STEPS IID TAKES TO EFFECTIVELY IMPLEMENT DUST CONTROL AT THE SALTON SEA.

FIGURE 2. PM_{10} EMISSIONS POTENTIAL (LEFT) AND EXISTING AND PLANNED DUST CONTROL LOCATED IN AREAS THAT CONTRIBUTE 73% OF THE FIVE-YEAR AVERAGE ANNUAL EMISSIONS ESTIMATE (RIGHT)

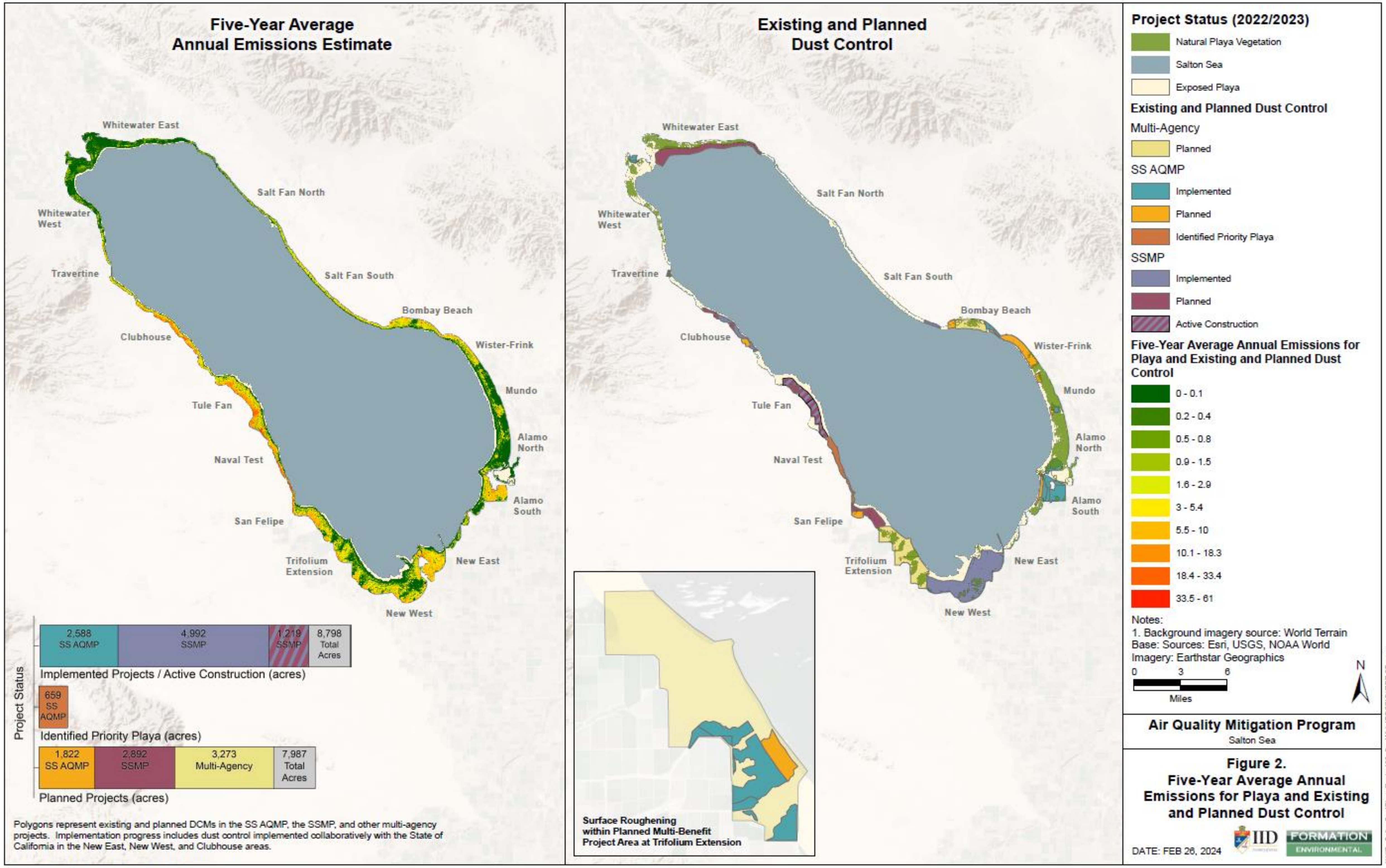

FIGURE 3. SUB-AQUEOUS AND TERRESTRIAL SOIL CORING LOCATIONS (LEFT PANEL) AND SOIL TYPE (RIGHT PANEL)