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TREASURE ISLAND
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Geomatrix

March 13, 2008
Project 4850.005.3

Mr. James B. Sullivan
Mr. Charles Perry
Mr. Scott Anderson
Department of the Navy
Base Realignment and Closure
Program Management Office West
1455 Frazee Road, Suite 900
San Diego, CA 92108-4310

Subject: Comments on January 2008 Draft Addendum 3 to Final Work Plan, In Situ Anaerobic Bioremediation Pilot Study, Site 24 and Site 21 Naval Station Treasure Island San Francisco, California

Dear Mr. Sullivan, Mr. Perry and Mr. Anderson:

On behalf of the Treasure Island Development Authority (TIDA), Geomatrix Consultants, Inc. (Geomatrix), has reviewed the January 4, 2008 Draft Addendum 3 to Final Work Plan In Situ Anaerobic Bioremediation Pilot Study, Site 24 and Site 21, Naval Station Treasure Island, San Francisco, California (Draft Work Plan Addendum 3). Geomatrix did not independently evaluate the accuracy of data presented in the report; however, discrepancies noted are identified herein. This letter contains a brief summary of the document, as well as general and specific comments.

SUMMARY

This document is the third addendum to the Final Work Plan for conducting in situ bioremediation pilot treatability studies at Installation Restoration (IR) Sites 24 and 21. At both sites, injection of dehalococcoides containing microbial consortium (SDC-9) with substrate medium is being used to treat chlorinated ethenes in groundwater. The Site 24 Pilot Treatability Study was initiated in the presumed source area in 2003 and expanded to encompass what is presumed to be the entire dissolved groundwater plume in 2005. The Site 21 Pilot Treatability Study was initiated in 2005.

At Site 24, the Draft Work Plan Addendum 3 proposes additional work in the source area, including (1) additional investigation of potential presence of dense non-aqueous phase liquids (DNAPLs), (2) installation of a permeable reactive barrier (PRB) immediately downgradient of the presumed source area, and (3) possible installation of additional treatment systems such as electrical resistance heating, enhanced solubilization and bioremediation and/or bioaugmentation. The Draft Work Plan Addendum 3 also proposes additional work

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downgradient of the Site 24 source area including (1) further characterization of the dissolved plume in the vicinity of Buildings 99, 96 and the tennis courts, (2) expanded treatment of the dissolved plume, and (3) continued analysis of the effectiveness of the treatability study. At Site 21, the Draft Work Plan Addendum 3 proposes additional injections of substrate and SDC-9.

GENERAL COMMENTS

- ***Presentation of Data Collected to Date.*** The document does not provide a sufficient evaluation of the data collected to date to allow a reader to assess whether the proposed additional activities are appropriate. Although some information has been presented at BRAC Closure Team (BCT) meetings in PowerPoint presentations, a technical document containing a thorough presentation of the results to date has not been prepared for BCT review. As such, we are not able to assess whether the proposed additional activities are appropriate.

- ***The Description of Many Proposed Activities is Vague.*** Details on data interpretation (i.e., how DNAPL is identified) and remediation design (e.g., injection volumes) are not discussed. Additionally, the analytical suite for performance monitoring is not defined adequately. Please see the Specific Comments below for many other examples where additional information is needed for clarification. In general, the Work Plan does not provide sufficient details and supporting information about the work that is to be implemented to allow us to evaluate the adequacy of the proposed work.

- ***Evaluation of Underground Storage Tank Area and Subsurface Utilities as Potential Source Areas.*** The document proposes to conduct a source area investigation in the vicinity of EW-4, including the location of a former underground storage tank (UST) area. This UST area was not previously identified in the October 2003 Final Facility-wide UST Summary Report or the August 2004 Final UST Summary Report Update. Please explain how the Navy came to know about the presence of these USTs and why they had not been identified in the earlier UST Summary Reports. In addition, information presented in the Draft Remedial Investigation (RI) Report for Site 24 suggests that chemicals may have been discharged to the sanitary sewer located inside Building 99 and exiting Building 99 to the southeast. Additionally, samples collected from wells near sanitary sewers generally show higher chlorinated ethene concentrations (wells EW-6 and EW-10, Figure 5) than other wells. Consistent with our comments on the Draft Site 24 RI Report, we believe that subsurface utilities should be evaluated to assess whether they have affected the distribution of contaminants in the

subsurface, either as a direct source (resulting from past chemical discharge) or by creating preferential pathways.

- ***Evaluation of Individual Volatile Organic Compounds (VOCs).*** Data presented in this report only show total VOC concentrations. When the pilot treatability studies were initiated in 2003, the BCT agreed to use 100 micrograms per liter (□g/L) total VOCs for purposes of assessing the effectiveness of the studies. However, the BCT has not yet established cleanup goals for individual VOCs in groundwater. As we have suggested at previous BCT meetings, we believe it is prudent to present and evaluate data for individual VOCs (e.g., vinyl chloride) to better assess whether the treatment technologies could be a final remedy for these sites.

SPECIFIC COMMENTS ON TEXT

- ***Section 1.1, Technical Basis and Project Background, Page 1-3.*** The first bullet of the text on page 1-3 states, "The use of direct-push injection points (Site 24 BioBarrier Wells and Site 21 Injection Points) is a viable and cost-effective method of distributing small to moderate amounts of substrate and DHC microbes within a zone of influence with a radius of approximately 10 to 15 feet." Our calculations indicate that the volume required to achieve a radius of influence (equidistant from the injection location) of 10 feet assuming an effective porosity of 0.25, is approximately 580 gallons per foot of targeted depth interval. Although we agree that direct-push injections are inexpensive, large volumes of fluid injection (about 5,800 gallons for 10 feet thickness and 10 feet radius of influence) would be required for effective distribution. If small volumes of fluid are to be injected, how will the injected amendments be evenly distributed throughout the target area and depth?

- ***Section 1.1, Technical Basis and Project Background, Page 1-3.*** The third bullet under the conclusions from the Expanded Treatability Study at Site 24 and the direct injections at Site 21 states, "A PRB using EHC® is effective at reducing concentrations of chlorinated ethenes to below 100 micrograms per liter (□g/L)." Please provide the data from these studies that supports this statement. The effectiveness of a PRB relies not only on the media emplaced, but also on the hydraulic performance of the system, the contaminant discharge across the alignment, and careful construction (emplacement) methods (to ensure the emplaced media is more permeable than aquifer sediments). Residence time and influent concentration (based on groundwater flow velocity and maximum plume concentration) are key factors in the design of the PRB,

in conjunction with the compound specific degradation rate for the emplaced treatment media. These site specific factors should be considered as part of the PRB design.

- ***Section 2.1, Potential Source Area, Page 2-2.*** The text states, "ESB is considered most applicable if DNAPL is distributed throughout the aquifer as small residual globules distributed through the aquifer matrix. ERH is considered most applicable if DNAPL occurs in the aquifer as pools or as large residual bodies distributed through the aquifer matrix." The document should provide references to support these statements unless they are simply opinions provided by the authors of the report, in which case, a basis for the opinion should be provided. Also, it may be difficult to establish whether pools of DNAPL or widespread globules exist in the subsurface. This information appears to be an important decision criterion for choosing one of these two technologies. What if both globules and pools of DNAPL exist?

- ***Section 2.1.1, DNAPL Investigation, Page 2-2.*** The text states, "Data from nearby wells IEW5 (former EW5), IEW6 (former EW6), and EIW5 (former IW5) do not strongly suggest that DNAPL will be found in the UST area." It is unclear which data supports this statement. Please provide more detail and discussion.

- ***Section 2.1.1, DNAPL Investigation, Page 2-2.*** The text states, "The Tetra Tech Remedial Investigation of the site shows cross sections in which the Bay Mud occurs at a depth of 35 feet. Tetra Tech considered this to be a laterally continuous confining unit. Shaw's data did not confirm this. Although clayey lenses were observed, they appear to be discontinuous, and therefore do not constitute a lower confining layer at least down to 35 feet." It is not clear whether Shaw has concluded (1) that no continuous confining layer of Bay Mud exists or (2) that a continuous confining layer might occur at a depth greater than 35 feet. Given the likely importance of Bay Mud as a low permeability, continuous layer for preventing downward contaminant migration, Shaw should consider extending their DNAPL investigation to depths where Bay Mud is expected to be encountered, to confirm the absence or presence of this important hydrogeologic unit.

- ***Section 2.1.1.1, Membrane Interface Probe Study, Page 2-4.*** The text states, "...the depth will be ***up to*** 35 feet bgs, which is slightly deeper than the depth of the Bay Mud." Geomatrix recommends that the depth of the MIP investigation should be ***at least*** 35 feet, especially since Shaw indicates in Section 2.1.1 that Bay Mud was not encountered at this depth. Shaw should be prepared to extend the investigation below 35 feet based on the real-time chemical and lithologic information as it is available in

the field. For example, it would not be helpful to terminate an MIP boring at 35 feet if the detector response(s) indicated that high VOCs were present at 35 feet bgs (and likely deeper). Additionally, the document should discuss procedures for preventing vertical mobilization of DNAPL if it is encountered at a shallow depth. Finally, the document should include a description of the method for identifying Bay Mud with the MIP technology.

- ***Section 2.1.1.1, Membrane Interface Probe Study, Page 2-4.*** Figure three shows only two initial locations for using the MIP technology and the text indicates that "the total number of MIP locations is anticipated to be up to a total of 30 locations." While we understand the need for flexibility for expanding the study based on real-time data, we believe that additional initial locations should be identified in this work plan. Additionally, the text states, "If a possible DNAPL source is detected using MIP technology...". The document should include a discussion of the criteria that will be used to identify DNAPL using the MIP and how many confirmation soil and groundwater samples will be collected for comparison with the MIP results.

- ***Section 2.1.1.2 FLUTe® Study and Section 2.1.1.3 Soil Sampling.*** The text indicates that borings will be drilled to conduct FLUTe® and soil sampling, however, no information is provided about the number of borings to be drilled, their location, or the depth to which borings will be drilled. Please provide this information or explain how decisions will be made to identify boring locations and depths during the DNAPL investigation.

- ***Section 2.1.1.4, Monitoring Well Installation, Page 2-4.*** A discussion of the drilling methods for monitoring well installation and methods for minimizing vertical mobilization of DNAPL (if present) should be included in this section. On page 2-5 of the same section, the text states, "Analysis of samples may include: VOCs, dissolved gases, sulfate, alkalinity and ferrous iron." Since this document is a Work Plan Addendum, we request that it specify the analyte list for the baseline monitoring. Stating that samples <u>may</u> be analyzed for various constituents provides no meaningful information.

- ***Section 2.1.2, Installation of a PRB System, Page 2-5.*** The conceptual design involves 10 injection locations to a depth of 35 feet bgs where 36,300 pounds of a granular compound (EHC) is injected over five-foot depth intervals at 15-foot spacing "to create a PRB that stretches a linear distance of 150 feet..." It seems very unlikely that a continuous PRB can be installed by injecting a granular substance into the

subsurface at discrete locations. There are many other PRB installation methods that would provide a much higher likelihood of success, in terms of passive treatment and mass discharge reduction, compared to the proposed approach. Figure 4 shows the "PRB System" in plan view as a series of EHC injection locations where cylinders of EHC material appear to be adjoining to form a continuous wall of reactive material across the dissolved plume. We calculate the soil mass for these cylinders to be approximately 9,420,000 lbs, based on the volume of ten cylinders with a height of 30 feet and radius of 10 feet, and a dry density for sand of 100 pounds per cubic foot. The design EHC weight of 36,300 pounds represents less than 0.5% by weight of the soil contained within the boundaries of the circles shown in Figure 4, which is approximately four times less than the vendor recommended mass of EHC for constructing a "PRB System" by injection at a chlorinated solvent site. (http://www.adventusgroup.com/pdfs/EHC/EHC%20mechanisms%20requirements.pdf). Although additional information and justification for the design of the PRB system would be useful for this Addendum, the available limited information suggests that the PRB system would not be effective at limiting dissolved chlorinated ethene migration. In addition, a discussion of the detailed performance monitoring network for demonstrating the effectiveness of the "PRB System" would be useful in this section.

- ***Section 2.1.3.1 Electrical Resistance Heating (ERH).*** The text states that the ERH "array will have a radius of influence of approximately 25 to 30 feet..." Please provide the supporting documentation for this statement. The text indicates that this system has been used by the Navy at Alameda Point. Was the technology successful at this site?

- ***Section 2.1.3.3, In Situ Bioremediation, Pages 2-7 and 2-8.*** The operation of the injection and circulation program (i.e. the amendment delivery method) is unclear. There is no explanation for the volume of lactic acid and SDC-9 to be added to groundwater, and how many pore volumes of the treatment zone are to be circulated through the system, and at which wells. We recognize that it is important to have flexibility in operation of the bioremediation system such that performance enhancing modifications can be implemented as data become available. However, this document should clearly describe the starting conditions and present the supporting design calculations. In addition, the text states, "During Stage 1, groundwater samples will be collected monthly from up to five wells and may be analyzed for alkalinity, sulfate, and dissolved arsenic." This statement could be interpreted to be suggesting that, at a minimum, one groundwater sample will be collected per month but the sample may not be analyzed for anything. The same language is used in Section 2.1.3.4 and 2.2.1.1.

- ***Section 2.1.3.4 Source Area Groundwater Sampling.*** The text indicates that there will be "***up to*** four consecutive quarters of post-treatment groundwater sampling of ***up to*** five wells in the source area." As written, this requirement could be satisfied if one well is sampled once. We recommend that in both cases the words "up to" be replaced with "a minimum of." We believe that it is essential for monitoring to be conducted for a sufficient period to time to confirm that rebound does not occur.

- ***Section 2.2, Site 24 Dissolved Plume Area, Figure 5.*** The text in this section states that the downgradient plume "contains relatively higher concentrations of more reduced compounds including TCE, DCE, and VC." It would be helpful to present figures that show individual VOC concentrations to support this statement (see general comments above). On a related note, Figure 5 shows plume contours for total VOCs, but it does not present any of the data that were used to develop the contours. On figure showing iso-concentration contours, please present the data that were used to develop the contours. Additionally, note 1 of Figure 5 indicates that the "100 □g/L chlorinated ethenes plume is conservative because it includes areas around injection wells even though their total chlorinated ethenes concentration is less than 100 □g/L." Chemical concentrations for post-injection samples from the injection wells will be biased low because these wells were flooded with amendment-containing water, and therefore, it is misleading to suggest that the plume contour is conservative based on the results of the injection wells. The injection wells should not be used for monitoring the dissolved plume.

- ***Section 2.2.1.1 Delineation using Temporary Wells.*** Please provide the rationale for why temporary wells are not required west of location TW-23.

- ***Section 2.2.1.2, Reconfigure Injection and Extraction Wells, Page 2-10.*** The text in the first paragraph states, "Phase 1 of the expanded TS demonstrated that the radial distribution well layout provided better substrate distribution than the two-well loop system used in the pilot TS (source area). The reconfiguration of the injection and extraction wells is based on the results of the Phase 1 system operation." Please provide the analysis of the Phase 1 data that is cited to support the reconfiguration. Also, the text in this paragraph indicates that "degradation decreased away from the injection wells." How far away was effective degradation observed? Please provide the supporting data. Additionally, this section indicates that wells formerly used as injection wells will be used as extraction wells in the Phase 2 dissolve plume in situ bioremediation program. Geomatrix would like to point out that, under this scenario, all post-startup samples collected from extraction and injection wells will be from

wells that have received injected substrate and therefore these samples will likely indicate "best case" reduction of chlorinated ethenes. To better monitor the effectiveness of the in situ bioremediation program, additional monitoring wells should be installed in areas where direct injection of substrate did not occur, to ensure adequate effectiveness throughout the entire plume. Finally, please identify the locations of the four additional extraction wells discussed in the last paragraph of this section.

- ***Section 2.2.2, Phase 2 Treatment, Page 2-12.*** The text states that "upon adequate distribution of the substrate, the recirculation systems will be stopped and the microbes will be allowed to degrade the VOCs." How will it be determined that "adequate distribution" has occurred?

- ***Section 2.2.3, Phase 2 Monitoring, Page 2-12.*** In general, the monitoring program discusses what "may" be monitored, which is not appropriate for a Work Plan (as discussed previously). The minimum frequency, locations and analytes that will be part of the monitoring program should be listed, as more sampling locations, analytes, and increase the frequency can be added as needed. In addition, the proposed frequency of the monitoring appears insufficient (four and eight months into Stage 2). The performance of the in situ bioremediation program will be difficult to assess in terms of concentration versus time with only two data points at the end of Stage 2.

- ***Section 3.0, Page 3-1.*** The data presented on Figure 9 do not support the conclusion (paragraph 2) that the plume is deepest in the middle and shallower away from the middle. Additionally, the text states "the recirculation system involves upfront engineering, fabrication, and installation costs that make it cost-prohibitive for use in smaller treatment areas such as Site 21." We disagree with this statement, especially since the work done previously at Site 24 does not appear to have involved much upfront engineering and fabrication (i.e. the injection system is portable). It appears that Shaw intends to simply inject substrate into the subsurface without assessing how effective the distribution will be.

- ***Section 3.0, Figure 7—Site 21 Total VOCs Total Chlorinated Ethenes.*** A note on Figure 7 states, "VOC Cleanup Level: 100 □g/L". We do not believe that cleanup levels have been established by the BCT.

- ***Section 3.0, Figure 9—Direct Injection Plan.*** Figure 9 shows the proximity of existing monitoring wells to proposed direct injection points. Many of the exiting

monitoring wells are within less than 10 feet of planned injection points (21-MW-03A 21-MW08A&B, 21-MW-9A&B, 21-MW10A&B, 21-MW-14). During direct injection programs at many sites, injected fluid has often been observed to emanate from nearby monitoring wells suggesting that the wells act as a preferential pathway for the pressurized fluid to migrate through the subsurface. Once this happens, the affected monitoring well cannot provide reliable performance monitoring data because the injected fluid may persist in the filter pack and vicinity of the well for a substantial time period. We expect that this could happen at Site 21, and the data from the monitoring program will not be representative of average groundwater conditions within the treatment zone, and will falsely provide the impression of a successful remediation program. Therefore, we recommend that the Work Plan include monitoring well data from new wells to be installed in a transect at the downgradient edge of the injection area after the injection program is completed. The new wells should be constructed with short, depth-discrete well screens to assess both vertical and lateral distribution of amendment and chlorinated ethenes, and the effects of treatment on the discharge of chlorinated ethenes to the Bay.

- ***Section 3.0, Second Bullet, page 3-1.*** The text states, "DHC microbes are present in the aquifer but have difficulty dechlorinating beyond the cis-1,2-DCE stage, possibly because of substrate limitations. Bioaugmentation with cultured SDC-9 might help jump-start the process..." Please provide the data to support the statement that dechlorination beyond cis-I,2-DCE is not occurring. If substrate limitation is the reason for incomplete dechlorination, why not just add more substrate?

- ***Section 3.1, Injection of Substrate and SDC-9, page 3-2.*** The text states, "Work performed under Addendum 2 demonstrated that EHC®, a proprietary remediation product of Adventus Group, can be injected using direct-push technology and, with dispersion over time, has a radius of influence of 10 feet." This statement seems to suggest that Shaw believes that each injection will evenly distribute the remediation compound through the entire target depth interval to a radial distance of 10 feet from the point of injection, and that their remediation program has been designed (at least conceptually) based on this belief. Please discuss the Addendum 2 data that supports this belief. Will any confirmatory soil borings or other activities (other than monitoring long screened wells) be completed to readily and inexpensively assess the distribution of amendment after or during the injection program? The document also indicates that dispersion, a time dependent process, will result in distribution of the substrate. Has this process been modeled? Lateral dispersion is generally very small at most sites, and the timeframe required for diffusion to distribute biologically active compounds is

likely too long to allow for several feet of migration (the substrate may be consumed before it diffuses far enough). The document should provide a technical basis that includes calculations and assumptions with respect to groundwater flow rates, hydrodynamic dispersion, and injection volumes, before finalizing the injection program.

- ***Section 3.1, Injection of Substrate and SDC-9, page 3-2.*** The text states, "Based on results from the Site 24 TS about 650 milligrams per liter of lactic acid will be required to reduce the concentrations of chlorinated ethenes as well as other electron acceptors." We interpret this statement to mean that sufficient lactic acid will be added such that the final treatment zone pore volume has an in situ concentration of at least 650 mg/L (as opposed to an injection fluid concentration). If the plan is to rely on dispersion to distribute amendment, what injection concentration is required to achieve an in situ concentration of 650 mg/L throughout the entire treatment zone Clarification on whether the 650 mg/L is an average in situ concentration, or injection fluid concentration, is needed.

- ***Section 3.1, Injection of Substrate and SDC-9, page 3-3.*** A discussion of the injection strategy is presented, but no discussion on the injection volume per location and total mass of substrate and SDC-9 is provided. These important details need to be added so the reader can assess the relative impact that this program may have on groundwater quality. Figure 9 shows overlapping circles that imply complete and even radial distribution of injection fluid from each injection point, where Figure 10 shows even vertical distribution from each injection point. The document should provide a plan to confirm that this even lateral and vertical distribution is occurring at several injection locations,

- ***Section 3.1, Injection of Substrate and SDC-9, page 3-3.*** A discussion of the injection sequence is presented, where the sequence of injection from below the plume upwards, and from the perimeter towards the center is being proposed to prevent lateral and vertical spreading of the plume. The document indicates that using water extracted from nearby monitoring wells will create a "re-circulation effect." However, a conclusion from Site 24 was that re-circulation did not provide plume containment. Also, if the makeup water is extracted and placed in a tank, and water levels recover somewhat within the treatment area, then the injection of the temporarily stored and amended makeup water will result in a hydraulic mound, which could cause vertical and lateral migration, regardless of the sequence of injection.

- ***Section 3.2, Makeup Water Extraction, page 3-3.*** The document proposes to extract "Makeup Water" from nearby extraction wells for amendment addition prior to re-injection at direct injection locations. This scenario will artificially increase the likelihood that injection fluid is preferentially pulled towards each monitoring well, giving the appearance of effective delivery because each well could show the beneficial effects of the injection even if substantial portions of the treatment zone are not affected by the injection program. For this reason, additional monitoring wells or depth-discrete confirmatory groundwater sampling is required, in place of monitoring wells that are used to extract water for nearby injection locations.

SPECIFIC COMMENTS ON SAMPLING AND ANALYSIS PLAN (APPENDIX B)

- ***Section 2.1 Stating the Problem.*** The City of San Francisco is included in the list of agencies that provide regulatory support and oversight. Please remove the City from this list.

- ***Section 2.3, Identifying Information Inputs, Page 2-2.*** The first bullet states "Observation of presence or absence of DNAPL by Membrane Interface Probe..." It is unclear in this statement how the MIP will be used to determine whether or not DNAPL exists.

- ***Section 2.5, Developing the Analytical Approach, Page 2-3.*** The last bullet on this page states "If MIP and FLUTe™ system indicate pools or large ganglia of DNAPLs..." It is unclear in this statement how the MIP or FLUTe™ system will be used to determine whether or not DNAPL exists as ganglia or pools. Upon encountering DNAPL, it is very likely that the MIP components would be saturated and required some recovery time before proceeding. Furthermore, if the presence of DNAPL is indicated with MIP in real time, it may be prudent to terminate the MIP boring to prevent vertical mobilization of DNAPL.

- ***Section 2.5, Developing the Analytical Approach, Page 2-4.*** The first bullet of this page states "If concentration of chlorinated ethenes in soil samples are in the high (>1000 mg/kg) range, then presence of DNAPL will be confirmed." For PCE and TCE, concentrations < 1,000 mg/kg could also indicate DNAPL, depending on the soil organic carbon conditions and porosity. We recommend the document provide a basis for the 1000 mg/kg criterion or recalculate the value for each chlorinated ethene based on soil organic content and porosity.

- ***Section 3.1.1, Soil Sampling, Page 3-1.*** We recommend that the document include confirmation soil sampling at several locations over the full range of MIP responses to provide a qualitative comparison of MIP response and chemical concentration.

Sincerely yours,
GEOMATRIX CONSULTANTS, INC.

Peter J. Bennett, PG #7902
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Gary R. Foote, PG #5044
Principal Geologist

PJB\GRF\nji

Attachments

cc: Mr. Jack Sylvan, City and County of San Francisco
Mr. Michael Tymoff, City and County of San Francisco
Ms. Mirian Saez, Treasure Island Development Authority
Mr. Marc McDonald, Treasure Island Development Authority
Mr. Ryan Miya, Cal EPA Department of Toxic Substances Control
Ms. Christine Katin, U.S. Environmental Protection Agency
Ms. Agnes Farres, Cal EPA Regional Water Quality Control Board

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