Quality Assurance Project Plan for Environmental Reconnaissance of the Salton Sea

Sediment Contaminants

December 11, 1998
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Prepared for
Salton Sea Research Management Committee

QUALITY ASSURANCE PROJECT PLAN FOR ENVIRONMENTAL RECONNAISSANCE OF THE SALTON SEA:

- **SEDIMENT CONTAMINANTS**

Part of the NEPA/CEQA Process for the Salton Sea Restoration Project

Prepared for the
Salton Sea Research Management Committee

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A3 PROJECT / TASK ORGANIZATION

On behalf of the Bureau of Reclamation and the Salton Sea Science Subcommittee, LFR Levine·Fricke (LFR) has prepared this project-specific Quality Assurance Project Plan (QAPP) for activities associated with the environmental reconnaissance of sediment contaminants for the Salton Sea ("the Site") located in Imperial and Riverside counties, California.

This QAPP has been prepared using guidelines detailed in the following document:

- EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations. EPA QA/R-5. United States Environmental Protection Agency Quality Assurance Division, Washington, DC 20460. External Review Draft Final, October 1998.

The Quality Assurance (QA) and Quality Control (QC) procedures detailed in this QAPP are designed so that the technical data generated during investigative activities at the Site are precise, unbiased, accurate, complete, and representative of actual field conditions. QA is defined as an integrated system of management activities involving planning, implementation, documentation, assessment, reporting, and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the client. QC is defined as the overall system of technical activities that measure the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer. QC includes the operational techniques and activities that are used to fulfill requirements for quality.

The LFR project team and management structure provides for direct and constant operational responsibility and the integration of QA activities. The project management, field operations, quality assurance, and analytical laboratory responsibilities are outlined below. Table 1 outlines the project organization and lines of communication among all project participants.

Project Management and Team

The project manager (principal investigator) is Doug Lipton, Ph.D., who is responsible for all aspects of the sediment study. Dr. Lipton will be responsible for implementing the project and will have the authority to commit the necessary resources to meet the project objectives and requirements in accordance with this QAPP. Other project manager functions include the following:

- directing field activities
- oversight of sampling and data collection
- oversight of data assessment and validation

- statistical analysis and report preparation

The administrative project manager is Richard A. Vogl, R.G., C.H.G., C.E.G., R.E.A., who is responsible for overall coordination of the project, manpower, and schedule. Mr. Vogl is also responsible for confirmation of adherence to budget deadlines and deliverables.

The project assistant managers (co-investigators) are Roger Leventhal, P.E.; Steven Beadle, Ph.D., R.G., C.H.G., C.E.G.; and Martin Hamann, R.G., C.H.G., who are responsible for peer review and field sampling activities to ensure that the field teams maintain proper sampling and decontamination procedures in collecting samples and proper labeling and shipping procedures for samples being sent to the analytical laboratory for analysis. Responsibilities include:

- Direct supervision of field personnel.
- Following procedures related to field activities outlined in this QAPP.
- Compliance with the data quality objectives (DQOs).

The quality assurance officer (QAO) for field operations and laboratory analysis is Richard Vogl. He is responsible for maintaining quality assurance for the field operations and the analyses performed in support of this project, and for reviewing and approving the QAPP. These responsibilities include:

- Review and approval of QA/QC procedures and documents generated in support of project activities.

- Oversight of the assessment of the data and determination of the usability of the data generated to meet project requirements, as necessary.

Communication

LFR will communicate project status to the Salton Sea Research Management Committee (SSRMC) via one interim progress report and a final report. In addition, informal technical exchange will be necessary to assure that SSRMC is informed about important site activities and that LFR staff fully understand the SSRMC's views regarding each key program activity. Informal exchanges will include the following:

- Conference telephone calls between a representative of Tetra Tech, SSRMC, and LFR's project manager to discuss key project activities, preliminary observations, and significant changes in activities that may be anticipated. Also, a representative of LFR will attend monthly Salton Sea Science Subcommittee meetings.

- Technical exchange meetings at agreed-upon locations, at project milestones, to update parties on project progress and to discuss important technical issues are also acceptable if necessary.

A4 PROBLEM DEFINITION / BACKGROUND

Salton Sea is the largest lake in California with current measurements at 35 miles long and 15 miles wide with a maximum depth of 50 feet. It is approximately 278 feet below mean sea level and its salinity is 44 parts per thousand (ocean water is 34.9 parts per thousand), according to the Salton Sea National Wildlife Refuge. The Sea has a surface coverage of 240,000 acres and a watershed of 8,360 square miles. It has no outlets and lies in an area with only 2.3 inches of rain a year with temperatures reaching 120° Fahrenheit. The lake is polymictic, with distinctive differences in thermo-haline stratification between northern and southern basins (Cook et al. 1998). A greater strength of stratification in the northern basin occurs when hypolimnion temperatures remain constant and epilimnion temperatures rise dramatically, resulting in exchange of hypolimnetic north-south waters.

Sources of pollution into the Sea are from the maquiladoras in Mexicali, Mexico, agricultural runoff in Mexicali Valley, and runoff in Imperial Valley. Drainage from the 500,000 acres of heavily watered and fertilized growing fields of Imperial Valley has kept the Sea from total evaporation while loading it with nitrates, pesticides, toxic levels of the element selenium, and salt leached from the soil. The salinity continues to increase with a present rate of approximately 0.8 parts per thousand per year. The pollution that constantly plagues the New River makes it an acute, life-threatening health risk to humans and animals. Furthermore, this pollution collects in the Salton Sea and threatens all wildlife dependent on this ecosystem, including at least 380 species having been reported with either threatened or endangered status within the area of the Sea.

Besides salts and selenium, Imperial Valley drainage carries high levels of nitrogen and phosphorus, which have caused a eutrophic environment in the Sea. Phytoplankton, such as the algal dinoflagellates, have turned the water reddish brown with an awful stench after they die and decompose.

Some of the chemicals known to exist in the rivers feeding into the Salton Sea are DDT, dicholomethane, polychlorinated biphenyls, and pesticides. Previous studies of the bottom sediment revealed organochlorine pesticide residues of DDE in concentrations of 110 micrograms per kilogram (μg/kg) at Trifolium Drain 1 (Eccles 1979), a minimum of 0.1 milligrams per kilogram (mg/kg) detected in the Whitewater River upstream from Highway 111 (Setmire & Stroud 1990), and 3.3 mg/kg for composite samples.

This investigation is being conducted to strengthen the limited current information on the Salton Sea's bottom sediment, specifically, to evaluate trace elements and anthropogenic organic compounds and their residues at a full range of depths and distances from the Sea inflows and provide physical characterization data of the Sea's sediment.

Since 1994, the Salton Sea Authority has considered two solutions for the high salinity of the Sea. The first involves diverting fresh water into the Sea from the Colorado River in years of high flow plus piping out saline water from the Sea 45 miles south to the Laguna Salada in Mexico for an estimated cost of $110 million. The second solution is to build a saline drainoff from Imperial Valley

by diking off one end of the Salton Sea while maintaining a freshwater flow into the other part for an estimated cost of $100 million. This study will aid the decision that the Authority has to make on these issues.

A5 PROJECT / TASK DESCRIPTION

The proposed study revolves around a phased, nonseasonal sampling work schedule that will be accomplished during the winter. Table 2 outlines the schedule of milestones and products expected. The phased approach will allow for the refinement and subsequent additional investigation of areas of concern. Phase I will consist of preliminary sampling of sediment. Phase II sampling will focus on the significant areas of interest identified during Phase I.

All related existing data and studies will be compiled, reviewed, and synthesized to ensure that there is no duplication of past efforts. This existing data will be evaluated for quality and incorporated into our report if the data are determined to be representative.

Phase I will consist of samples from 48 sites throughout the Sea, with particular focus on the deltaic fans located at the mouths of the four Sea inlets. The New, Alamo, and Whitewater rivers will be sampled at their mouths and a half mile upstream. Salt Creek will be sampled at its mouth because of its location next to the Salton Sea State Park. A soil profile using a corer will be performed at six of the 48 sites. These samples may identify potential sources of high contamination or uncharacteristic physical and chemical data that may require additional evaluation. These samples will also be used to identify the vertical profile of sediment types and potential contaminants. The locations of the proposed sampling sites were selected to provide representative coverage of the Salton Sea. Previous studies by Setmire (1979, 1984), Setmire et al. (1993), Setmire & Stroud (1990), and U.S. Geological Survey ensure that the samples collected by LFR will be complementary to existing known data on baseline contaminants.

Phase II sampling will occur at 25 sampling sites. It will include 10 sediment cores and 15 grab samples and will focus on the significant areas of concern identified during the Phase I sampling. The exact location of sampling sites for Phase II will be selected based on the Phase I results. Approximately 10 percent of the total sample number will be collected as duplicate samples during

each phase. In addition, one equipment blank will be collected per day to verify sampling equipment decontamination procedures.

A6 QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

This QAPP is designed so that the data collected during all phases of work are valid, reliable, appropriate, and complete. The work tasks, which include project planning, field activities, sample analyses, sample and data handling, and data evaluation and interpretation, should be of such quality as to allow complete fulfillment of the project's objectives. To achieve the required quality assurance standards, quality control measures are developed for both field and laboratory procedures within a data quality objective (DQO) process.

The DQO process is a strategic planning approach based on scientific methods to prepare data collection activities. It is a systematic approach for defining the pertinent criteria for a sampling program including:

- Where to collect samples
- How to collect samples
- Tolerable levels of decision errors
- How many samples to collect

Thereby, the DQO process assures that the type, quantity, and quality of environmental data used to evaluate the attainment of the remediation standards are appropriate for the intended use. According to EPA documents, DQOs are developed using a seven-step process: (a) state the problem; (b) identify decisions that address the problem; (c) identify inputs to the decision; (d) identify the boundaries; (e) develop decision rules; (f) specify limits on decision error tolerances; and (g) optimize the design of the data collection program. The following numbers present the seven-step DQO development process that will be implemented during sampling activities.

(a) Problem statement: The problem at the Site is to collect significant and defensible data on the concentrations of contaminants in the bottom sediment of the Salton Sea, specifically, to evaluate metals (including selenium), anthropogenic organic compounds, and their residues at a full range of depths and distances from the Sea inflows and provide physical characterization data of the Sea's sediment. The data collected will be used to assist in preparation of the EIR/EIS.

(b) Decisions to address problem: Decisions that will address the problem include identifying representative lake bottom sediment sampling sites and incorporating sediment analytical data with historic contaminant levels.

(c) Inputs to decision: Inputs for decision making include field observations and sediment analytical results.

(d) Boundaries: For the Site, boundaries for data collection are based on the surface water borders of the Salton Sea and 6 feet below the water-sediment interface. Exceptions to this definition include the sampling sites within the four main tributaries of the Salton Sea outlined in the proposal for investigating sediment contaminants (LFR 1998).

(e) Decision rule: If refusal occurs during sediment core sampling, a different location will be selected within a 5-foot radius of the original location. If refusal occurs at the second sampling site, a third location will be selected within a 5-foot radius. If refusal occurs again, the deepest of the three cores will be selected for laboratory analysis.

(f) Decision error limits: Decision error limits are based on the use of general observations of site conditions during the time of sampling.

(g) Data collection program: The sediment sampling component of data to be collected during this investigation consists of field and laboratory data. The field investigation includes the depth to bottom sediment from surface water at each sampling location and the latitude and longitude of each sampling site recorded on a hand-held global positioning system (GPS). Laboratory analysis of the methods outlined in Section B4 will generate sediment quality data.

QA will be applied throughout the entire sampling so that the data collected are of known and acceptable quality. Analytical laboratories will be required to conform to EPA guidelines and will be certified by the EPA for performing the analytical methods being performed. Measurement procedures will be in accordance with EPA regulations and guidelines. Deviations from approved plans will be documented and justified. Deviations from the sampling procedures will be documented on field logs and the reason for the deviation recorded. Adherence to approved procedures will be verified during system audits.

The quality of the measurement data generated will be assessed for precision, accuracy, representativeness, comparability, and completeness (PARCC) based on adherence to the sampling procedures described in Section B, and available external measures of quality (e.g., standard engineering practice, analysis of trip blanks, duplicates, etc.). The sampling activities will be in accordance with applicable EPA guidance documents and accepted LFR standard practices.

The laboratory project managers are responsible for ensuring that all laboratory work is performed in accordance with guidelines established by the EPA. The certified laboratory will be responsible for maintaining strict QA/QC programs compliant with requirements of the laboratory QAPP for all instrument preparations and analytical procedures employed during this project. In addition, the

laboratory is responsible for supplying clean sample bottles, preservatives, coolers, chain-of-custody forms, and seals. Responsibilities of the laboratories include:

- acting as a liaison between the project manager and laboratory technical staff
- monitoring workloads and ensuring availability of resources
- analytical report preparation overview
- technical guidance of analytical groups
- interaction with LFR's QAO, as needed, to complete the data assessments
- reporting deficiencies to LFR's project manager

Laboratory results will be evaluated for accuracy, precision, completeness, consistency, and representativeness of the measured media. Since the precision and accuracy of any data obtained will depend upon the type of measurement and the sample media (solid or liquid), performance standards are site- and measurement-specific. The inherent variability in lithology and geology, including the geochemistry of most geologic media, will be taken into consideration in developing data acceptance criteria based on historical QC data. Thus, data acceptance criteria will be updated following each round of QC data acquisition.

Precision, Accuracy, and Completeness Criteria

The initial QA objective (goal) for data precision, expressed as relative percent difference (RPD) of field duplicate samples, is arbitrarily set at 50 percent or less. The initial QA objective for accuracy, expressed as spike recovery percent (SRP) for analytical data, is 50 to 150 percent. Initial laboratory QA objectives for precision and accuracy are based on those outlined in the EPA Contract Laboratory Program (CLP).

It should be noted that there is no scientific basis for these initial QA goals for precision and accuracy of field data. Hence, these goals may not be used as data acceptance criteria. Thus, the initial precision and accuracy obtained for field data will be used to assess the appropriateness of the initial QA goals until statistically based acceptance criteria are developed from quality-control sample results of significant quantities of data.

Subsequent acceptance criteria will be derived from historical QC data (if the data pool size is at least 10), using control limits that will be updated with new QC data as these data become available. Other acceptance criteria may be derived for duplicate samples containing constituents at very low concentrations (less than 10 times the analytical detection limits) because of the inherent variability of results near the detection limit.

Data completeness is evaluated by comparing requested analyses with reported analyses and assessing the sufficiency of the data reported in fulfilling project objectives. For the former, the target completion rate is 100 percent, while the latter will be qualitatively assessed.

In order for the data collected to be comparable to both previous and subsequent data, standardized procedures will be followed during field sampling activities, laboratory analyses, and data evaluation and interpretation. Whenever procedures change from one sampling round to another or within a sampling episode, historical data will be evaluated in light of recent data before data compilation and interpretation. To obtain data that are representative of the media being evaluated, strict technical and management practices will be followed.

A7 SPECIAL TRAINING REQUIREMENTS / CRITERIA

Investigation of sediment contaminants in the Salton Sea requires strict devotion to providing accurate and precise analytical laboratory data. LFR will ensure that the utmost in sample integrity and quality is maintained to provide the SSRMC with meaningful data. The QA/QC plan of LFR will ensure that all field and laboratory staff are trained on Good Laboratory Procedures (GLP) in compliance with the Environmental Protection Agency and FIFRA's Good Laboratory Practice Standards, Final Rule [OPP-300165A; FRL-3518-2], RIN 2070-AB68. Furthermore, samples will be analyzed in a timely manner consistent with applicable analytical protocols to ensure data integrity. These GLP's will ensure that the utmost in field documentation, sample integrity, and quality is maintained to provide meaningful data. The field quality assurance program is a systematic process that, together with the laboratory and data storage quality assurance programs, ensures a high degree of reliability and confidence in the data collected for an environmental survey.

A8 DOCUMENTATION AND RECORDS

Sample Identification

All samples will be identified and labeled at the time of collection. Sample identification will follow a specific format to ensure that all sample numbers are unique. The sample identification format will be as follows:

Site Samples

Grab samples will have the prefix GB, followed by the site number, followed by the depth, followed by the six-digit date.

Example: GB4-2-111098

Core samples will have the prefix CR, followed by the site number, followed by the depth, followed by the six-digit date.

Example: CR4-2-111098

Duplicate Samples

Duplicate samples will have the same as above, followed by "-0."

Example: GB4-2-111098-0 or CR4-2-111098-0

Equipment Blank Samples

Equipment blank samples will have the prefix EB, followed by the six-digit date.

Example: EB4-111098

Sample Transfers

Strict chain-of-custody protocol will be followed throughout all sample transfers. A chain-of-custody document will be completed in triplicate. One copy will accompany the samples to the laboratory, one will be retained by the sampler, and the third will be forwarded to the LFR data management system.

SECTION B MEASUREMENTS / DATA ACQUISTION ELEMENTS

B1 SAMPLING PROCESS DESIGN (EXPERIMENTAL DESIGN)

The sampling process revolves around a phased, nonseasonal work schedule that will be accomplished during the winter. The phased approach will allow for the refinement and subsequent additional investigation of areas of concern. Phase I will consist of preliminary sampling of sediment from 48 sites throughout the Sea, with particular focus on the deltaic fans located at the mouths of the four Sea inlets. The New, Alamo, and Whitewater rivers will be sampled at their mouths and a half-mile upstream. Salt Creek will be sampled at its mouth because of its location next to the Salton Sea State Park. A soil profile using a corer will be performed at six of the 48 sites. These samples may identify potential sources of high contamination or uncharacteristic physical and chemical data that may require additional evaluation. These samples will also be used to identify the vertical profile of sediment types and potential contaminants. Phase II sampling will consist of 25 sampling sites and include 10 sediment cores and 15 grab samples and focus on the significant areas of concern identified during the Phase I sampling.

Two types of sample stations in the Sea are located at near-shore and in deeper waters. The near-shore site samples will reflect information on a relatively short time scale with influences associated with inflow velocities of heavier particles and run-off contaminants. Deep stations located over the deepest points of the lake provide seasonal, longer time-frame information about the water column, such as conditions associated with silt/clay suspension.

Bottom sediment studies will be conducted from a boat furnished by LFR. Samplers for bottom sediment include use of a modified Birge-Ekman-style box sediment sampler and the AMS soft

sediment corer. The bottom sediment should consist of predictable soil compositions (Quaternary deposits of lacustrine silts and clays) based on previous reports by Setmire & Stroud (1990). The locations of the proposed sampling sites were selected to provide representative coverage of the Salton Sea. Previous studies by Setmire (1979, 1984), Setmire & Stroud (1990), Setmire et al. (1993), and the U.S. Geological Survey will be reviewed to ensure that the samples collected by LFR will be complementary to existing known data on baseline contaminants.

Laboratory analysis of the sediment will be done at the Apollo Analytics Laboratory, located in Irvine, California. Apollo is certified by California EPA for the test methods being conducted. Samples collected in the field will be stored on ice and delivered to the laboratory daily and remain at a constant temperature of at least 4 degrees Celsius. Each sediment sample will be analyzed for volatile organic compounds using EPA Method 8260, semivolatile organics using EPA Method 8270, chlorinated pesticides and PCBs using EPA Method 8080, organophosphate and nitrogen pesticides using EPA Method 8140, and chlorinated herbicides using EPA Method 8150B. Total inorganic metals, consisting of the California Code of Regulations (CCR) 17 metals series, including antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, selenium, silver, thallium, vanadium, and zinc, will be analyzed using EPA Method 7000S. A complete list of all compounds for these analyses is included in Attachment 3. Additionally, all of the samples, except for the duplicates and blanks, will be evaluated in the laboratory for particle size using sieves for the coarse-grained materials and a hydrometer for the fine-grained materials. Samples will be delivered to the laboratory daily. Chemical analysis of the Phase I sediments will indicate significant areas of interest and assess the limits of contamination in the Salton Sea. Phase II sampling will return to areas of concern. The field procedures for sampling of sediment quality for metals and anthropogenic organic compounds are described below.

B2 SAMPLING METHODS REQUIREMENTS

Bottom sampling will be performed from either a 10-horsepower, 15-foot boat or a 120-horsepower, 20-foot boat. For safety and efficiency, sampling activities will be performed by a minimum of two people. Correct positioning of the boat will be accomplished by an LFR team member in charge of the hand-held GPS communicating latitude and longitude with the captain of the boat. Samplers for bottom sediment include use of a modified Birge-Ekman-style box sediment sampler and the AMS soft sediment corer. The modified Birge-Ekman-style box sediment sampler

is stainless steel and 6"x6"x6" in size. Stainless steel is less likely to corrode or affect metal concentrations in sediment samples. The apparatus has flaps on the top that open during descent (allowing water to flow through) and close during ascent (maintaining the sample during retrieval). A messenger activates the shovel-like jaws from the surface. The sediment is subsampled through the top flaps to identify acceptable recovery of sediment.

The core samples will be collected using an AMS stainless steel, soft sediment sampler that will produce a 2-inch-diameter by 6-foot-long core. The corer can take up to 6 feet of undisturbed samples from soft sediment provided that rocks or dense materials are not encountered. In the cored samples, each core will be described continuously and the top, 2-foot zone, 4-foot zone, and the bottom of each core will be analyzed.

Water depth measurements will be taken to ensure adequate cable length for operation of the samplers and proper execution. This important consideration will control the speed of entry of the sampler into the sediment, increasing its recovery and decreasing any shock waves.

For each grab sample using the stainless steel Birge-Ekman sampler, one sediment sample will be retained for chemical analysis. Sediment samples will be transferred directly from the sampling equipment into the laboratory-grade, clean glass jars using a stainless steel trowel. Using only nitrile-gloved hands, the threads of the jar will be cleaned and the jar capped and sealed. The jar will then be labeled and stored in a chilled cooler on board pending delivery to the analytical laboratory. Strict chain-of-custody protocol will be followed throughout all phases of the sample handling process.

Sediment samples obtained while using the stainless steel corer will be collected from a boring advanced to approximately 6 feet below ground surface with samples for laboratory analyses taken at 1.5-foot intervals. Cored samples are lithologically described and classified using the Unified Soil Classification System. A lithologic log is prepared for each boring with photographs to document collection. Boring and logging are performed under the direction of an LFR, GLP-trained, California Registered Geologist. As with the grab samples, these samples will be transferred to a laboratory-grade, clean glass jar using a stainless steel trowel. The labeled jar is then stored in a chilled cooler on board pending delivery to the analytical laboratory with a chain-of-custody form.

To ensure consistent sample location identification, all sampling sites will be identified using a hand-held, standard GPS equipment. This will enable us to go back to the same site and be at the proper location.

To reduce the potential for cross contamination between borings, soil sampling equipment will be scrubbed with a laboratory-grade, nonphosphate detergent and double-rinsed with distilled water between sampling intervals.

Duplicate sediment samples will be collected from approximately 10 percent of the total sample number. These samples will be used for assessing the reproducibility of analytical procedures. In addition, approximately one equipment blank will also be collected per day to verify sampling equipment decontamination procedures. The equipment blank sample will be labeled with the prefix

EB, followed by the six-digit date. Section B5 describes the duplicate and blank samples in more detail. The duplicate and blank samples will be submitted with sediment samples to Apollo Analytics daily.

In the event that a failure in the sampling occurs, the LFR QAO will be responsible for corrective action. Under normal circumstances, this corrective action will normally consist of resampling.

B3 SAMPLE HANDLING AND CUSTODY REQUIREMENTS

To link each reported datum with its associated sample, sample custody and documentation procedures have been established. The sample custody pathway for this project is summarized in the flow chart in Figure 1. Three separate, interlinking documentation and custody procedures—for field, office, and laboratory—are described. The chain-of-custody (COC) forms, which are central to these procedures, will be attached to all samples and their associated data throughout the tracking process.

Field Custody Procedures

Field documentation will include sample labels, lithologic logs, field activities logbook, and COC/analyses request forms. These documents will be completed using indelible ink. Any corrections to the document will be made by drawing a line through the error and entering the correct value, without obliterating the original entry. Persons correcting the original document will initial any changes made.

These documents are described in detail in the following sections.

Sample Labels

Sample labels will be completed for all samples collected and attached to the sample container. The label is made of a waterproof material backed with a water-resistant adhesive. This sample label, to be filled out using waterproof ink, will contain at least the following information: date, time, sampling location, sample number, sampler's name, and the analyses to be conducted. A copy of a LFR sample label is shown in Attachment 1.

Lithologic Log

All sediments encountered during collection will be examined and described by the on-site geologist or engineer, who will maintain a complete record of these descriptions. Sediments will be described in accordance with the Unified Soil Classification System.

Field Activities Logbook

A field log will be used to record daily field activities. The field geologist or engineer will be responsible for making sure that a copy of the field log is sent to the project file as soon as each sampling round is completed. Field log entries will include the following:

- field person's name
- date and time of field log entries
- location of activity
- personnel present in the project area
- sampling and measurement methods
- total number of samples collected
- sample numbers
- sample distribution (laboratory)
- field observations, comments

Chain-of-Custody/Analysis Request Form

The COC form will be prepared for groups of samples collected at a given location on a given day. A COC will be prepared in quadruplicate and will accompany every shipment of samples to the respective analytical laboratories.

Two of the four copies (white and green) will accompany the samples to the analytical laboratory. The pink copy will be kept in LFR's QA/QC file, while the yellow copy will be retained for the sampler's record. The COC form makes provision for documenting sample integrity and the identity of any persons involved in sample transfer (see Attachment 2 for a sample COC/analysis request form). Other information entered on the COC includes the following:

- project name and number
- field logbook number
- COC serial number

- project location
- sample numbers
- sampler/recorder's signature
- date and time of collection
- collection location
- sample type
- analyses requested
- inclusive dates of possession
- name of person receiving the sample
- laboratory sample number
- date of sample receipt
- address of analytical laboratory

In order to maintain the integrity of the samples during transit, ice packs will be used with all samples collected. The ice packs will decrease the potential contamination of samples by melted ice if the cooler shifts during transit. The samples will be packed upright in the cooler with at least two times as much ice pack weight as the total volume of the samples. The samples that are most likely to deteriorate will be closest to the ice packs. Proper laboratory COC forms will be enclosed in a sealed plastic bag and taped to the inside lid of the cooler.

Samples will be shipped in such a manner that no more than 24 hours will elapse from the time of shipment to the time of receipt by the analytical laboratory. The method of shipment may include hand delivery by the field personnel, laboratory courier, or commercial shipping services (such as UPS or Federal Express). The method of sample shipment will be noted on the COC form. In any event, the cooler will be sealed with heavy-duty packing tape to reduce the possibility of it accidentally opening and to prevent tampering with the samples.

Office Documentation Procedures

Samples and data will be tracked and archived at LFR's Irvine, California office. LFR's Data Management Group (DMG) is responsible for ensuring that correct management practices are followed for proper documentation and for linking all samples with data. The project file will be used in data tracking and documentation, as discussed below.

In addition to several other documents (e.g., work orders, proposals, sampling plans, assessment reports, and correspondence), the field log, COC forms, and sampling information forms are all stored in the project file. This system provides a common location for all information that will be

required in data evaluation and interpretation and report preparation. The file is organized for easy retrieval and long-term storage of information. The LFR Administrative Project Manager will be responsible for maintaining the project file.

Laboratory Custody Procedures

The laboratory will designate a sample custodian who will accept custody of the shipped samples and check that the information on the sample labels match that on the COC form(s). The custodian will then enter the appropriate data into the laboratory's sample tracking system. The custodian will use the sample number on the sample label or assign a unique laboratory number to each sample. As a record of sample receipt, the analytical laboratory will mail a copy of the COC form, with the assigned laboratory numbers, to the sampler. The custodian will then transfer the sample(s) to the proper analyst(s) or store the sample(s) under refrigeration until they are extracted and analyzed.

Laboratory personnel are responsible for the care and custody of samples from the time they are received until the sample is exhausted or disposed of. Material remaining after completion of the requested analyses will be stored until the end of the investigation (or specific phase of work). Disposal of unused samples must comply with all applicable federal, state, and local environmental regulations. All data sheets and laboratory records will be retained as permanent documentation.

B4 ANALYTICAL METHODS REQUIREMENTS

The designated primary analytical laboratory is Apollo Analytics Laboratories, located in Costa Mesa, California. Apollo is accredited and/or registered as an environmental laboratory pursuant to the provisions of the California Environmental Laboratory Improvement Act of 1988 (Health and Safety Code, Division 1, Part 2, Chapter 7.5, commencing with Section 1010) by the California Department of Health Services, Environmental Laboratory Accreditation Program. If the status of any of these laboratories' accreditation changes, or if overall unsatisfactory performance is noted, an alternate accredited analytical laboratory may perform the analyses required. Apollo is certified by California EPA for the test methods being conducted to include the following:

- Volatile organic compounds will be analyzed by EPA Method 8260. Semivolatile organic compounds will be analyzed by EPA Method 8270.

- Chlorinated pesticides and PCBs will be analyzed by EPA Method 8080. Organophosphate and nitrogen pesticides will be analyzed by EPA Method 8140. Chlorinated herbicides will be analyzed by EPA Method 8150B.

- Total inorganic metals, consisting of the California Code of Regulations (CCR) 17 metals series, including antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, selenium, silver, thallium, vanadium, and zinc, will be analyzed using EPA Method 7000S.

A complete list of all compounds for these methods is included in Attachment 3.

The laboratory will be required to document the QA/QC procedures, as referenced in SW-846, Chapter 1, Quality Control, which apply to the samples, such as blanks, replicates, spikes, and instrument calibration data.

There are four commonly used detection or quantitation limits: instrument detection limit (IDL), method detection limit (MDL), sample quantitation limit (SQL), and practical quantitation limit (PQL).

IDL: The minimum amount of an analyte that can be identified using an individual instrument. The laboratory usually determines the IDL by calculating the standard deviation of the results of seven replicate spike sample analyses and multiplying by 3.

MDL: The minimum amount of an analyte that can be identified using a specific method. The laboratory usually determines the MDL by calculating the standard deviation of the results of seven replicate spike sample analyses and multiplying by 3. The MDL is an ideal detection limit when there is no background laboratory contamination and the sample to be analyzed is a clean sample free of matrix effects. When MDLs are defined within a particular method, they are determined using reagent water as a sample. Also known as the method quantitation limit, this limit is not sample-specific and does not vary with any sample preparation or dilutions required for each sample analyzed.

SQL: The minimum amount of an analyte that can be identified using a specific method and instrument, taking into account sample dilutions required for the method as well as for matrix effects or high compound concentrations, and the IDL and MDL information. The laboratory may elevate the SQL because of known method problems, such as blank contamination, or on the basis of the laboratory's experience with the method. The SQL is the most common "detection limit" or "reporting limit" referred to in laboratory reports.

PQL: The minimum amount of an analyte that can be reliably identified within specified limits of precision and accuracy during routine laboratory operations. The PQL is defined in "Test Methods for Evaluating Solid Waste." PQLs represent goals for each analytical laboratory and are generally higher than a laboratory's expected sample quantitation limits.

The detection limits for soil samples may increase, however, with analyte dilution due to a relatively high concentration of an individual compound. The reported method detection limit for each analyte will not be greater than the PQL reported in EPA SW-846. Each laboratory will report actual detection limits obtained during chemical analyses.

Additionally, all of the samples, except for the duplicates and blanks, will be evaluated in the laboratory for particle size, using sieves for the coarse-grained materials and a hydrometer for the fine-grained materials. These limited physical analyses will be conducted by a qualified materials testing laboratory according to ASTM method D422 for grain size/sieve analysis.

B5 QUALITY CONTROL REQUIREMENTS

Field and laboratory QC checks will be used to evaluate laboratory analytical procedures. The QC checks will involve introduction of control samples into the sample analysis stream in an effort to evaluate the accuracy and precision of the sampling and analysis program.

Field QC Checks

Field QC checks will entail field collection of control samples to be introduced to the laboratory as blind samples. Blanks and duplicates are the two sample types to be used, and samples will be identified in the field logbook according to type.

Field blanks will be collected immediately before collecting field samples by pouring organic-free deionized water into the sediment sampler and filling the appropriate sample containers with this water. At least one field blank will be collected (but not necessarily analyzed) for each day of sampling. Blanks immediately analyzed will include the first day's, the fourth day's, and the final day's of sampling for both Phase I and Phase II. Additional field blanks may be collected at the sampler's discretion. The sampler, after consultation with the Project Manager, may instruct the laboratory either to analyze such additional samples or to hold them for possible analysis later, pending initial results. If initial results from a sample collected following a field blank indicate detectable concentrations of constituents, and if a sample contains unexplainable concentrations of constituents, the field blank sample will be analyzed.

One trip blank per type of analysis requested will be included in each sample shipping container sent or delivered to the laboratory. Trip blanks will be prepared by the primary laboratory using organic-free deionized water supplied in appropriate prefilled sample containers, or they may be prepared by the sampler using laboratory-supplied organic-free deionized water. Apollo will analyze at least one trip blank per sampling event as a check for possible contamination of the sample bottles and/or the organic-free deionized water used for field blanks.

A minimum of one duplicate sample per analysis every two days of field sampling (or approximately 10 percent) will be collected. Additional duplicate samples may be collected and submitted to the laboratories with instructions to hold the samples for possible analysis later (if, for example, analytical results for the one duplicate set indicate poor precision).

Laboratory QC Checks

The types of laboratory QC samples that may be analyzed include reagent or method blanks, calibration blanks, split duplicates, laboratory control standards and laboratory control standard duplicates, matrix spikes, and matrix spike duplicates.

Reagent or method blanks are samples prepared from distilled, deionized water that has been treated with all of the reagents and manipulations (i.e., digestions or extractions) to which samples are subjected. Positive results in the reagent or method blank may indicate either contamination of the chemical reagents or the glassware and other implements used to store or prepare the sample and resulting solutions.

Calibration blanks are samples prepared from distilled, deionized water that are directly introduced into an instrument without having been treated with reagents appropriate to the analytical method used to analyze samples. Positive results in the calibration blank may indicate contamination of an instrument or of the water used in the laboratory.

Matrix spikes and matrix spike duplicates are samples prepared using the batch sample matrix (i.e., sediment) and adding a predetermined quantity of target compounds. Following analysis, percent recovery of the "spikes" and the relative percent difference of the two spikes are calculated.

Control samples are samples of a well-characterized matrix (such as blank water or sand) that are spiked with certain target parameters and analyzed at approximately 10 percent of the sample load to establish method-specific control limits.

Laboratory quality control checks will be conducted as follows. Duplicates, spikes (matrix or similar type), and blanks (reagent and method) will be analyzed on at least 10 percent of the total samples submitted for analysis. A method blank is performed for either every 20 samples or every batch of samples analyzed, whichever is more frequent. Surrogates and internal standards are added to each individual sample when applicable. Spikes are conducted on the matrix in the case of water samples, but are conducted on the method blank in the case of soil samples. Soil matrix may be conducted at the laboratory's discretion.

B6 INSTRUMENT / EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE REQUIREMNTS

Equipment operation will be routinely checked to minimize breakdowns in the field. Calibration procedures described in Section B7 will check the proper functioning of field instrumentation. Nonfunctional equipment will be removed from service and this information entered into the daily field log. The equipment will be repaired or replaced and the time and date of its return to service also noted in the log.

B7 INSTRUMENT CALIBRATION AND FREQUENCY

During the investigation, field data will be gathered on specific activities related to single sampling events. The protocols for field personnel, described below, are designed so that field measurements, if made by different individuals, are consistent and reproducible. Standard equipment calibration procedures for each instrument are also described.

Field sampling, measuring, and test equipment for bottom sampling will include the use of a hand-held GPS, modified Birge-Ekman-style box sediment sampler, an AMS soft sediment corer, and water depth measurements will be taken by a calibrated plumb line. The modified Birge-Ekman-style box sediment sampler is stainless steel and 6"x6"x6" in size. The apparatus has flaps on the top that open during descent and close during ascent. The shovel-like jaws are activated from the surface by a messenger. The AMS soft sediment corer is stainless steel and collects a 2-inch-diameter by 6-foot-long core, provided that rocks or dense materials are not encountered.

Field Calibration Procedures

Global Positioning System

Calibration of the GPS instrument will be performed as specified by the manufacturer. However, calibration according to the manufacturer is not required for instrument use.

Modified Birge-Ekman-Style Box Sediment Sampler

Preventative maintenance and cleaning will be performed on the sampler after each day.

The sediment sampler will be used to collect sediment only and has no other calibration requirements.

AMS Soft Sediment Corer

Preventative maintenance and cleaning will be performed on the sampler after each day.

The sediment corer will be used to collect sediment only and has no other calibration requirements.

Calibrated Plumb Line

Water depth measurements will be taken by calibrated plumb line and verified by a boat-mounted depth finder. Calibration of the boat-mounted depth finder will be performed by using the calibrated plumb line to verify its accuracy.

A log book will be maintained in the LFR files that will contain maintenance data for each piece of sampling equipment, including time and date of the previous maintenance, who performed the maintenance, and how it was performed.

Laboratory Calibration Procedures

Calibration of laboratory instruments is necessary to ensure that the analytical system is operating correctly and functioning at the proper sensitivity to meet established detection limits. Each instrument is calibrated with standard solutions appropriate for the type of instrument and the linear range established for the analytical method. The Standard Operating Procedures (SOP) for analyses for many of the chemicals of concern are contained in “Test Methods for Evaluating Solid Waste” (EPA SW 846, 3d ed., 1986) and “Methods for Chemical Analyses of Water and Waste” (EPA-600/4-79-020, revised Nov. 1986). Daily calibration checks and standards for relevant constituents must fall within the laboratory control limits.

For EPA Methods 8240/8260 and 8270 analyses using a combined gas chromatograph/mass spectrometer (GC/MS) method, the mass calibration standard will be analyzed daily (or every 12 hours) to demonstrate that the instrument meets the standard mass spectra abundance criteria.

Whenever any action is taken that may affect the tuning parameter of the instrument (e.g., source cleaning or other maintenance), the mass calibration must be checked, regardless of the 12-hour time period. Mass calibration criteria must be met before any analysis (standards, blanks, or samples) using EPA protocols may be performed.

For metals analysis (EPA Method Series 7000S) using atomic absorption and inductively coupled plasma, spectrophotometers will be calibrated daily, or at least once per batch of samples.

B8 INSPECTION / ACCEPTANCE REQUIREMENTS FOR SUPPLIES AND CONSUMABLES

Sample containers may vary with each type of analytical parameter. Container types and materials are selected to be nonreactive with the particular analytical parameter tested. All sampling jars will be provided by Apollo Analytics in a sealed container and will have already passed batch quality control inspection. Final inspection of such containers will be the responsibility of the on-site quality assurance officer.

Starting in the field, investigators will follow necessary precautions to protect samples from contamination and deterioration to ensure the quality of data generated in a laboratory.

B9 DATA ACQUISTION REQUIREMENTS (NONDIRECT MEASUREMENTS)

LFR will collect significant and defensible data on the concentrations of current contaminants in the bottom sediment of the Salton Sea. We will specifically evaluate metals (including selenium) and

anthropogenic organic compounds and their residues at a full range of depths and distances from the Sea inflows. Furthermore, LFR will provide physical characterization data of the Sea's sediment. However, in order to accomplish a meaningful, defensible evaluation of the bottom sediment, a synthesis of previous investigations pertinent to the study is necessary. This review of past results will avoid duplicate efforts and offer a historical timeline to evaluate change. Data such as historic sampling locations, mean sea level, concentrations within the bottom sediment of all contaminants in question, and other contractor data revealing water quality. All sources of data must originate from work plans with quality assurance plans and acceptable quality controls.

After all current data are assembled, the results will be compared with the existing data from the Sea for a synthesis of information. These results will then be compiled in a spatial information database both at LFR and at the University of Redlands Salton Sea Database program.

B10 DATA MANAGEMENT

Data collected during all phases of the project will be checked, validated, and reduced before inclusion in reports. The sequence for processing analytical data is shown on a flow chart in Figure 2. Field data will be appropriately checked, validated, and included in the project database before data reduction and QA/QC evaluations.

As shown in Figure 2, data tracking, transfer, reformatting, and analysis can be performed electronically. This procedure eliminates human transcription errors, in addition to providing hands-on data retrieval, manipulation, and evaluation capabilities. An LFR staff member will check that these data are correct before they are reduced and reported. When electronic data transfer is not possible, two different LFR staff members will input reported laboratory data to separate databases. The two databases will be compared and any differences will be resolved. They are then added to the master database, reduced, and reported. Key data that cannot be validated will be brought to the attention of the Project Manager. All reported results ultimately are stored in the project database along with actual copies of laboratory reports being stored in LFR.

Field and analytical data will be reviewed by task leaders for precision, accuracy, and completeness (as relevant), prior to entry into the project database. Procedures and relevant equations for calculating precision, accuracy, and completeness are provided in Section D. Project data will be stored in the electronic database for access by authorized project staff. A draft report of the new data for entry will be prepared by the database manager and reviewed against original input by staff designated by the respective task leaders. Any comments or required revisions will be noted on the draft report and are incorporated prior to entry into the secured database proper. Access to the secured database will require Project Manager authorization.

Field measurement data will be validated by senior personnel by checking procedures used in the field and comparing current measurements with historical data. Data validation involves specific procedures for evaluating and/or calculating data precision, accuracy, and completeness. These field quality assurance steps, as well as for the laboratory analytical data, are covered in detail in Section D2.

Data required from this study will be analyzed for immediate use by the SSRMC and all other contractors. Ensuring the quality of the data includes the use of instrumentation in the laboratories, which are fully automated and computerized. In the Apollo Analytics GC and GC/MS laboratories, each analytical system has a dedicated computer for data acquisition, and data reduction using Hewlett-Packard Chemstation software running under a Window NT network. The HP Chemstation allows calculation of quality control sample results in real time analysis. This provides better quality data and faster turnaround times. The software also allows maximum flexibility in data reduction and archiving to meet the client's requirements. To monitor samples throughout, Apollo has developed a unique sample tracking system using Microsoft Access and Excel software to track progress throughout the analytical pipeline. Work lists, sample holding times, and turnaround commitments are carefully reviewed daily to meet requirements. In addition, the software offers flexibility in producing customized report formats and creation of database files.

LFR's Data Management Group will validate analytical data after they have been entered into the project database and before they are used in any reports or calculations. If suspect laboratory performance is evident, either in the precision or accuracy evaluations or detectable chemical concentrations in field blank samples, the QAO will notify the laboratory and the laboratory will take the appropriate corrective action, such as reextraction and reanalysis of samples or detailed review of spectra or chromatograms. The QAO will also make recommendations to the Project Manager as to any additional action that LFR should take, such as resampling or modification of the sampling or analytical protocol. The Project Manager will then decide what additional action, if any, will be taken.

SECTION C ASSESSMENT / OVERSIGHT ELEMENTS

C1 ASSESSMENT AND RESPONSE ACTIONS

Field personnel will participate in periodic internal performance and system audits conducted by the Project Manager and/or QAO. Internal audits by the QAO will also include evaluation of QC data and validation of all data collected at every phase of the investigation in the Project Area. Internal laboratory performance and system audits will be conducted according to the specifications of the individual analytical laboratories.

Contract laboratory performance and procedures will be externally audited by the QAO, in addition to other external audits that are required of the laboratories for their DTSC State certification or enlistment in various programs.

Internal Audits

Field Personnel Performance

The Project Manager, QAO, or their designee will randomly observe field staff to ascertain adherence to the sampling protocols described in this QAPP and will conduct at least one field inspection during the execution of the work activities for each new major phase of work. Deviations from the defined field protocols, as stated in this QAPP, or any procedures that might compromise the quality of data obtained in the field, will be reported by the field staff to the Project Manager, who will decide what appropriate action to take.

The sediment collection program will be audited once for each new phase of work. These field audits will focus on whether the sampling procedures described in this document have been followed. The QAO or Project Manager will observe operations and review selected documentation of the field activities. The results of each field audit will be summarized in the report for that phase of work.

System Audits

The QAO or designee will perform annual (or as required) system audits to evaluate the following:

- the appropriateness of the sampling for the project area and the intended project objectives
- the effect of the sampling location on the representativeness of sediment sampled from the subsurface
- the effect of sampling protocols on data quality and validity
- the significance of sample custody and handling methods for sample integrity
- sample and data tracking and documentation procedures in data validation, field sampling, and analytical methodologies
- the appropriateness of the chemical analysis method
- the sufficiency and appropriateness of quality control checks for ensuring data quality

The QAO or designee will prepare a summary of the system audit for presentation to the Project Manager.

Quality Control Check Programs

The Data Management Group is responsible for validating all data by following the evaluation steps described in Section D and summarized in Figure 2.

Laboratory Performance Audits

Each laboratory must follow an internal audit procedure comparable to that of the primary laboratory. This entails the following:

- weekly walk-through by the laboratory's QAO and Safety Officer
- monthly system audit conducted by the laboratory's QAO
- quarterly audits conducted by the laboratory's Corporate Vice President of Quality Assurance
- when there is a problem, special audits by the laboratory's QAO or other appropriate laboratory personnel

External Laboratory Audits

The Salton Sea Science Subcommittee, Quality Assurance Manager will audit the analytical laboratories if applicable, or when unresolvable problems are identified in the laboratory results. All contract laboratories will undergo auditing through mandatory blind sample analyses, as required by regulatory agencies. The audit will include inspection of control charts associated with the instrument and for the compounds analyzed, review of documentation procedures, review of overall facilities and instrumentation, and a general evaluation of a laboratory's capability to perform analyses to quality control standards. The Salton Sea Science Subcommittee, Quality Assurance Manager will prepare an audit report to submit to the Project Manager.

If questionable data are detected by the QA/QC program procedures, corrective action may be required. Criteria for determining when corrective action is required for chemical analyses are discussed in Section D1. Corrective action in such a case might include analyzing additional blank or duplicate samples, if available; rechecking laboratory calculations and chromatograms; resampling; modifying the sampling and/or analytical protocol; or other measures. The QAO will make recommendations for corrective action to the Project Manager, who will decide what action, if any, will be taken.

C2 REPORTS TO MANAGEMENT

The Project Manager may request that a report be made on the performance of sample collection and data quality, calculations, or drawings. The report may include:

- Assessment of measurement data accuracy, precision, and completeness
- Results of performance audits
- Results of systems audits
- Identification of significant QA problems and recommended solutions

Sampling and field measurement data quality information may be summarized and included with the raw data as appropriate in an interim report. The LFR Project Manager will prepare and issue a QA summary upon completion of the phased work schedule. These reports will be submitted using metric units for all measurements to remain homogenous with the other investigators format.

SECTION D DATA VALIDATION AND USABILITY

D1 DATA REVIEW, VALIDATION, AND VERIFICATION REQUIREMENTS

This section summarizes the QA/QC protocol for assessing the validity of the reported chemical data. Also included are diagnostic procedures for identifying possible sources of errors and appropriate corrective actions for data validation.

Data Validation Procedures

LFR's QAO will evaluate chemical data using quantitative statistical tests, qualitative assessment, and professional judgment so that the data received are representative of actual field conditions. The analytical results will first be checked for completeness, including the analytical method sensitivity (reported detection limit) from one sampling round to another and for an entire sampling plan. Thereafter, blanks, duplicates, and spikes (quality control samples) will be evaluated for contamination, data precision, and data accuracy, respectively.

Using a database management system, sample results will be compiled and summarized for relevant compounds and those found at concentrations above their detection limits. Where direct electronic data transfer is not used in data compilation, hard copies of the summarized data will be used as a source for manual data entry. All data will be manually entered by two different LFR staff members, the two data files will be compared electronically, and any discrepancies will be investigated and edited for errors during formatting.

Data completeness will be tracked and checked with an analysis completion form. The completion of all analyses requested in the chain-of-custody form and additional analyses request forms will be checked by tracking the status of each sample being analyzed. Tracking will be maintained until all samples have been analyzed and the results have been reported by the analytical laboratory and received by LFR's QAO. In addition, the detection limits reported for all data will be screened for possible unacceptably high limits and consistency from one sampling round to another.

Sample results reported for samples analyzed past recommended holding times will be considered invalid and will not be used for quantitative purposes other than for duplicate sample comparisons. These results may be evaluated qualitatively to aid in evaluating confirmed "hot spots" but will not be included in the database.

QA/QC Evaluation and Data Validation

Both the field and laboratory quality control samples will be evaluated to assess the representativeness of results for the sampling region. Blank samples will be used to determine if and where any field samples may have been contaminated and the significance of any such contamination. Duplicate samples will be used to assess the precision of the analytical procedure as well as the inherent variability within the sampling region. Simple statistical parameters and qualitative indicators will be used in validating data.

Control Sample Types

Blanks

Blanks are good indicators of possible outside sample contamination. Samples can be contaminated before, during, and after field sampling. Often this results from container contamination before field sampling has begun. After field sampling, samples may be contaminated during shipping and sample custody before and during laboratory chemical analysis. To isolate the stage at which sample contamination may have occurred, up to three types of blank samples may be analyzed: trip blank, field blank, and laboratory blank (method or VOA blank). Trip blanks consist of organic-free deionized water in sample containers prepared either by the laboratory or the sampler before sampling in the field. Field blank water samples consist of organic-free deionized water that is passed through or over the sampling equipment and then collected in the sample container. Laboratory blanks, otherwise called method blanks, are laboratory-grade water used in preparing the standards or samples.

Duplicates

Duplicates are samples used to estimate data precision and the variability within the sampling region. There are two types: field duplicates and laboratory splits. Field duplicates are samples collected from the same sampling location, following the same sampling protocol, one after the other. Duplicate samples may be submitted to one laboratory as long as they are blindly labeled for intralaboratory comparison, or one of the duplicate samples may be sent to a designated quality control laboratory for interlaboratory comparison. Laboratory splits are samples divided into two halves by the laboratory before analysis.

Spikes

Spike sample results allow the accuracy of the analytical methodologies to be assessed. Laboratory spikes (known amounts of the compounds of interest added to a sample) may be conducted on matrix solutions and/or laboratory blanks. Surrogate spikes (compounds similar in composition and structure to the compounds of interest but are not normally found in the environment) may be added as applicable to samples to allow evaluation of matrix effects or preparatory effects.

QA Criteria and Evaluation Procedures for Control Samples

Quality control sample data will be comprehensively evaluated for contamination, accuracy, and precision, as discussed below.

Evaluation of QC Data

Blanks

Data from blank samples will be evaluated along with the data for those samples with which the blanks are associated. The maximum detectable concentration of each compound of any associated blank will be used in the evaluation of the data.

If the blank contains detectable concentrations of common laboratory contaminants (methylene chloride, acetone, toluene, and bis(2-ethylhexyl)phthalate), the sample results will only be considered positive detections if the concentrations exceed 10 times the maximum amount detected in any blank. The sample results will be flagged as "suspect" in the database.

If the blank contains detectable concentrations of chemicals that are not considered common laboratory contaminants, the sample results will only be considered positive detections if the concentrations exceed five times the maximum amount detected in any blank. The sample result will be flagged as "suspect" in the database. Under no circumstances will any sample result be deleted from the database for blank-related problems.

Duplicates and Spikes

Spike results will be evaluated for accuracy and expressed as spiked percent recovery (SPR) for each spike compound. The SPR is the difference in concentration between the total concentration in the spike sample and the original concentration in the sample divided by the actual spike concentration added to the sample. The SPR will be computed on a compound-by-compound basis for spiked sample data. For surrogate spikes, the laboratory will generate control limits within which the SPR must fall. Other steps for the data validation procedure are explained below.

Duplicate results will be statistically evaluated for data precision, using the relative percent difference (RPD) values computed from the raw data reported. RPD is the difference in concentrations between field duplicates and laboratory splits, divided by their average concentration, expressed as a percentage. The standard deviation for groups of duplicate data will be computed. One of the following statistical testing and acceptance criteria will be selected and applied:

- Preselected upper warning and control limits (UWL and UCL, respectively) and lower warning and control limits (LWL and LCL) will be used to assess sediment data when

historical sediment control data for the site under investigation are insufficient. The warning limits are cautionary indicators that results should be closely evaluated before data validation. Control limits indicate poor data quality. The preselected UWL and UCL are based on those imposed for the EPA contract laboratory program. For duplicate results expressed as RPD, the only applicable limits, the UWL and UCL, are set at 50 percent and 100 percent, respectively, except when compounds are detected near the reporting limit. For surrogate or spike percent recovery, the UWL and UCL are set at 125 percent and 150 percent, respectively. Hence, the LWL and LCL are 75 percent and 50 percent, respectively.

- The UWL, UCL, LWL, and LCL are computed from the historical quality control duplicate and spike data. The control limits (CLs) are ideally at the 95 percent confidence interval for a one-tailed normal distribution for duplicate results expressed as RPD and for a two-tailed normal distribution for spike results expressed as SPR. The CL value for half of a bell-shaped curve is 2.77 of the standard deviation or standard error, depending on the applicable parameter. It will, however, be approximated as three times the standard deviation for statistical testing. The warning limits (WLs) are two-thirds of the UCL, hence twice the standard deviation.

- Other tests for statistical significance, such as Student's t-test, F-test, or chi-test, will be selected and applied, as appropriate.

D2 VALIDATION AND VERIFICATION METHODS

Data collected during all phases of the project will be validated and verified before inclusion in reports. The sequence for processing analytical data is shown on a flow chart in Figure 2. Field data will be appropriately checked, validated, and included in the project database before data reduction and QA/QC evaluations.

As shown in Figure 2, data tracking, transfer, reformatting, and analysis can be performed electronically. This procedure eliminates human transcription errors, in addition to providing hands-on data retrieval, manipulation, and evaluation capabilities. An LFR staff member will check that these data are correct before they are reduced and reported. When electronic data transfer is not possible, two different LFR staff members will input reported laboratory data to separate databases. The two databases will be compared and any differences will be resolved, added to the master database, reduced, and reported. Key data that cannot be validated will be brought to the attention of the Project Manager. All reported results ultimately are stored in the project database along with actual copies of laboratory reports being stored in LFR project files.

Field and analytical data will be reviewed by task leaders for precision, accuracy, and completeness (as relevant) prior to entry into the project database. Project data will be stored in the electronic database for access by authorized project staff. A draft report of the new data for entry will be

prepared by the database manager and reviewed against original input by staff designated by the respective task leaders. Any comments or required revisions will be noted on the draft report and are incorporated prior to entry into the secured database proper. Access to the secured database will require Project Manager authorization.

Senior personnel will validate data obtained from field measurements by checking procedures used in the field and comparing current measurements with historical data. To allow comparison of data from different sampling episodes, results will have to be reported in the same units. The units for the various parameters are identified below.

- Sediment sample depths will be reported to the top of each 0.5-meter sampling interval.
- Elevations of all sample sites will be surveyed and referenced to mean sea level.
- Locations of sampling sites will be located on site maps using GPS/GIS technology.
- Lithologic sample descriptions will be consistent with the Unified Soil Classification System and geologic nomenclature.

Laboratory Analytical Data

Calculations conducted by analytical laboratories in converting raw data to reported results will be readily available for inspection. Senior laboratory personnel must check the accuracy and correctness of any data reported by the laboratory before the laboratory reports the results.

LFR's QA Officer will validate analytical data after they have been entered into the project database and before they are used in any reports or calculations. Data validation involves specific procedures for evaluating and/or calculating data precision, accuracy, and completeness.

If suspect laboratory performance is evident, either in the precision or accuracy evaluations or detectable chemical concentrations in field blank samples, the QAO will notify the laboratory and the laboratory will take the appropriate corrective action, such as re-extraction and re-analysis of samples or detailed review of spectra or chromatograms. The QA Officer will also make recommendations to the Project Manager as to any additional action that LFR should take, such as re-sampling or modification of the sampling or analytical protocol. The Project Manager will then decide what additional action, if any, will be taken.

D3 RECONCILIATION WITH USER REQUIREMENTS

LFR is prepared to forward its preliminary findings and laboratory data to the SSRMC once the data have been verified and prior to the completion of our summary report. We anticipate that a

single report will be prepared upon the conclusion of all sampling associated with this aspect of the study. Our report will include the following items at a minimum:

- A description and synthesis of previous investigations pertinent to the study.
- A description of the locations of each sample location.
- The rationale for the various sample parameters collected and laboratory analyses completed.
- A description of the sampling methods used and an explanation for any instances where sampling methods were modified from the standard protocols.
- Results of the sampling. Results will include a discussion of the sediment identified, contaminant concentration, locations, observations on depths, etc. Statistical interpretations of the data will also be made.
- A description of the Quality Assurance Project Plan (QAPP). Data will be evaluated against the plan to ensure that data presented are accurate, statistically significant, and defensible. Any instances where data do not meet the objectives of the plans will also be noted.
- A thorough peer review by all investigators involved with the project.
- Conclusions and findings regarding the study. Recommendations, as appropriate, may be provided.
- Appropriate figures, tables, and appendices with laboratory data, chain-of-custody documents, field data sheets, sampling protocols, analytical protocols, statistical protocols, etc.
- All data will be submitted in a GIS-compatible format according to the metadata standards set forth by the Federal Geographic Data Committee.

LFR will prepare a draft document for review by the SSRMC. Upon the concurrence of the SSRMC, LFR will incorporate any required changes and submit its report as final.

REFERENCES

Cook, C., Huston, D., Jensen, M., Orlob, G., Schladow, S. 1998. Internal Dynamics of a Large Saline Lake: Field Investigation and Monitoring of the Salton Sea, California, 1998 Ocean Sciences Meeting, AGU and ASLO.

Eccles, L.A. 1979. Pesticide residues in agricultural drains, southeastern desert area, California. U.S. Geological Survey Water Resources Investigation Report 79-16, 60 pp.

Levine·Fricke·Recon Inc. 1998. Proposal for Environmental Reconnaissance of the Salton Sea: Sediment Contaminants.

Setmire, J. [et al.]. 1993. Detailed study of water quality, bottom sediment, and biota associated with irrigation drainage in the Salton Sea area, California, 1988-90. Prepared in cooperation with the California Regional Water Quality Control Board, Colorado River Basin Region. Sacramento, Calif.: U.S. Geological Survey; 93-4014, 102 p.

Setmire, J., & Stroud, R. 1990. Reconnaissance investigation of water quality, bottom sediment, and biota associated with irrigation drainage in the Salton Sea area, California, 1986-87. [Sacramento, Calif.]: Dept. of the Interior, U.S. Geological Survey; 89-4102, 68 p.

Setmire, J. 1984. Water quality in the New River from Calexico to the Salton Sea, Imperial County, California; Prepared in cooperation with the California Department of Water Resources. Washington, D.C.: U.S. Government Printing Office; Alexandria, Va., 42 p.

Setmire, J. 1979. Water-quality conditions in the New River, Imperial County, California. Prepared in cooperation with the California Regional Water Quality Control Board--Colorado River Basin Region. Menlo Park, Calif. : Water Resources Division, U.S. Geological Survey, 79-86, 63 p.

United States Environmental Protection Agency. 1986. Test Methods for Evaluating Solid Waste, EPA SW 846, Third Edition. November.

————. 1986. Methods for Chemical Analyses of Water and Waste. EPA-600/4-79-020. Revised November.

————. 1988. Interim Final Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA. OSWER Directive 9355, 3-01. October.

ATTACHMENT 1

Sample Label

ATTACHMENT 2

Chain-of-Custody Form

ATTACHMENT 3

EPA Laboratory Sample Method Analytes