United States Environmental Protection Agency, Region 9
Emergency Response Section
Generic Data Quality Objectives Process Document
for
Soil and Mercury Vapor Sampling

Cordero Mercury Mine Site

Removal Assessment of Two Roadway Areas

Data Quality Objectives (DQO) Process Document
Objective Outputs

Contract: EP-S5-08-01
TDD No.: TO2-09-10-06-0002
Job No.: 002693.2094.01RA

STEP 1.
THE PROBLEM

Background
The site is the subject of a United States Environmental Protection Agency (U.S. EPA) Region IX Emergency Response Section Removal Assessment. The site consists of two locations: a public road approximately 1,600 feet long and 30 feet wide located at 111 North Road, and a privately owned residential driveway approximately 160 feet long and 30 feet wide, both located on the Paiute-Shoshone Indian Reservation, Fort McDermitt, Nevada. The width of the roadways was estimated at 30 feet.. The public road is located approximately 5.2 miles east-southeast of Fort McDermitt, and 10.5 miles east from the Cordero Mine, which operated as a mercury mine between 1935 and the 1980s. The driveway is located near the intersection of South Road and State Highway 95, approximately 11 miles south of Fort McDermitt. The public road is a dirt road which connects the Paiute Shoshone Indian Reservation administration office with their municipal landfill. It has been suspected that mercury-contaminated waste rock material from the Cordero Mine was utilized in the construction of the road and the driveway.

Based on conditions described above, the U.S. EPA is concerned about the possibility of exposure of mercury-contaminated dust to human health and the environment as a result of site use. The objectives discussed herein are for the length and width of the site suspected of containing mine waste.

Planning Team
Mr. Tom Dunkelman, U.S. EPA FOSC
Mr. Brian Milton, E2 Consulting Engineers Inc., (E2) Superfund Technical Assessment and Response Team (START), Project Manager
Mr. Adam Smith, Ecology and Environment, Inc., (E & E) Superfund Technical Assessment and Response Team (START), Project Team Member

Mr. Howard Edwards, E & E START, Quality Assurance Officer
Mr. Duane Masters, Sr., Paiute Shoshone Tribal Environmental Coordinator

The names and affiliations of the actual field team will be documented in the field logbook.

Conceptual Site Model

- The mediums of concern are soil, specifically roadbed materials, and ambient air above the roadways.
- The principal Contaminant of Primary Concern (COPC) is mercury; both inorganic salts and elemental mercury vapor.
- The road bed material contains elevated concentrations of the COPC which originated as waste rock from a mercury mining operation (Cordero Mine).

Exposure Scenario

- Concerns based on current conditions include (1) direct exposure of human and/or environmental receptors (e.g. invertebrates, mammals, reptiles, plants, migratory birds) to contaminants in road bed material, and (2) exposure of receptors through ingestion by inhalation to vapors and particulate matter (dust) that contain mercury above health-protective concentrations.

Resources

The current START budget for objective planning and development of a U.S. EPA-approved Sampling and Analysis Plan (SAP) is approximately $8,000.

The available budget for the Removal Assessment currently allocated to the START is $28,000. Other budget constraints on U.S. EPA resources for this project have not been specified. The primary decision-maker for the project is Federal On-Scene Coordinator (FOSC) Tom Dunkelman.

Roles and Responsibilities

- The U.S. EPA FOSC will be the primary decision-maker and will direct the project, specify tasks, and ensure that the project is proceeding on schedule and within budget. Additional duties include coordination of all preliminary and final reporting and communication with the START Project Manager and U.S. EPA Quality Assurance (QA) Office.
- Brian Milton, the START Project Manager, will coordinate with the planning team to develop objectives and complete an approved SAP.
- Howard Edwards, START QA Officer, will oversee development and preparation of the SAP and other START deliverables. Mr. Edwards will provide overall project quality assurance and, if necessary, audit functions.
- START will be responsible for implementation of the SAP, coordination of project tasks, coordination of field sampling, project management, and completion of all preliminary and final reporting.
- The START has arranged for the U.S. EPA Region IX Laboratory in Richmond, California to perform the confirmation sample analysis.
- START or a START contractor will be responsible for data validation.

Other Considerations and Constraints Related to Problem and Resources

- Soil analyses available for assessment are not always useful for determining disposal and remediation requirements and costs. Additional waste testing of excavated soil is usually necessary to determine disposal requirements.

- Contamination not found during the soil investigation might be revealed during excavation activities.

STEP 2.
THE DECISION

Principal Study Questions

It is suspected that mercury mine waste was used in the construction of a public road and a private driveway on the Paiute Shoshone Indian Reservation. It appears as though no samples have been collected from either roadway.

Primary Study Question #1: Does mercury-contaminated soil exist at or above the site-specific action level within the top 18 inches of the roadways?

Primary Study Question #2: What is the spatial distribution of mercury within the roadways?

Primary Study Question #3: Are there mercury vapors currently, or is there a potential for mercury vapors to emanate from, the roadway at concentrations that are above the applicable action levels?

Secondary Study Question #1: Based on the answers to the primary questions, what is the rough estimated volume of soil with contamination that exceeds the action level?

Actions that Could Result from the Resolution of Study Questions

If the new data suggests that mercury concentrations in the roadway are at or above the project action level; then the site will be considered as needing additional study and/or remediation.

If the new data suggests that mercury concentrations in the roadway are below the action level; then the site will not be considered as needing removal or remediation.

If the new data suggests that there is mercury concentrations in portions of the roadway that are at or above the project action level; then associated roadway sections will be considered as needing additional study and/or remediation.

If the new data suggests that mercury concentrations in the roadway are at levels around the action level, then the site may be considered as needing additional study.

Decision Statements (Directives)

Determine whether mercury concentrations in soil in the top 18-inches of roadway, and mercury vapor concentrations in ambient air above the roadway, exceed the project action levels in order to determine whether the site needs remediation/removal, additional study, or no further action.

STEP 3.
DECISION INPUTS

Environmental data required to resolve the decision statements

- Total mercury data for soils between 0 and 1.5 feet bgs.
- Mercury vapor concentrations in the breathing zone above the road, and in nearby ambient air.
- Sample location data.

Sources for Study Information

- Visual survey data and global positioning system (GPS) data
- Field analysis of roadway soil samples for total mercury.
- Laboratory analysis of roadway soil samples for total mercury.
- Field analysis of mercury vapor

Information Needed to Establish Action Level

- Information on whether mercury is in elemental form or mercury salts.
- Information on expected and/or potential exposure pathways to receptors.
- Information on expected and or actual duration of potential exposure.

- Several benchmarks exist that could be used as project action levels

    - EPA Region 9 industrial soil RSL for elemental mercury.
    - EPA Region 9 industrial soil RSL for inorganic mercury salts, including mercury oxides and mercury sulfides.
    - EPA Region 9 residential soil RSL for elemental mercury.
    - EPA Region 9 residential soil RSL for inorganic mercury salts, including mercury oxides and mercury sulfides.
    - ASTDR action level for mercury vapor in a residential and/or industrial scenario

Collection methods

Soil samples can be collected using a trowel, disposable scoop, power auger, hand auger, or shovel.

Mercury vapor concentrations can be measured directly using a mercury vapor analyzer, or by placing soil in a sealed bag and mixing it, then measuring the vapor phase mercury concentrations in the head space inside the bag.

Measurement methods

Collected soil samples can be analyzed to determine COPC concentrations using the following definitive US EPA SW-846 method; U.S. EPA Method 7471A for total mercury or the non-definitive U.S. EPA Method 6200 for total mercury.

Mercury vapor analysis and/or mercury speciation methods can be used to establish whether mercury is in elemental form or as an inorganic mercury salt (ionic). Specifically, a Lumex® Model 915+ Mercury Vapor Analyzer could be used to measure vapor-phase mercury concentrations.

Confirm that appropriate analytical methods exist to provide the necessary data:

For soil analysis, the definitive U.S. EPA method has sufficient sensitivity, accuracy, precision, and other quality parameters to generate necessary data, provided the data are not needed within a critical timeframe.

The non-definitive has sufficient sensitivity, accuracy, precision and other quality parameters to generate necessary data, except if the action level is for residential elemental mercury. Data can be generated in periods close to real time.

Mercury vapor analysis and/or mercury speciation methods are semi-quantitative, but are appropriate to provide the necessary data.

STEP 4.
STUDY BOUNDARIES

Define the Population Being Studied
The roadway materials within the site boundary, and the ambient air above and nearby the roadway, are the populations being studied

Spatial Boundary of Investigation
The boundary of the investigation is the roadway and driveway area specified in the site map. However, it will also be necessary to establish background concentrations of mercury vapor in ambient air and soil near, but not at, the suspected areas of impact.

Temporal Boundary of Investigation
The decisions will apply to determinations of risk associated with long-term exposure to contaminated surface soil and/or mercury vapor from direct exposure. However, decisions may also apply to short-term (acute) exposure to contaminated soil or vapor due to future development activities.

Inorganic mercury salts in soil or roadway material are environmentally persistent and migrate slowly, so the concentration of mercury in roadway material generally does not vary greatly over time. Elemental mercury is less environmentally persistent and will migrate as a vapor and as a dense liquid. Given the age of the roadway, elemental mercury would not be expected to be present at elevated concentrations in shallow and/or exposed surface materials. Given the location and relative inaccessibility of potential contamination, threats to the environment, surface water, and existing communities are not expected to be immediate or imminent. However, the migration of airborne particulate matter containing inorganic mercury salts and mercury vapor is dependent upon weather conditions and roadway use. Increased roadway use would be expected to increase the potential for exposure to mercury laden dust and, if present, mercury vapor.

Thus, the following assessment time-frame has been proposed:
- The SAP will be submitted to U.S. EPA FOSC by September 1, 2010, and should be reviewed and revised by September 13, 2010, the first day of proposed work.

- Sample collection will take place following SAP approval by the U.S. EPA.
- Preliminary data should be available approximately 3 weeks from the date of sample delivery to the laboratory.
- Data packages and final data should be reported to project management approximately 5 weeks after sample delivery to the laboratory.
- Laboratory data should be evaluated following U.S. EPA Region 9 Tier 2 guidance. Evaluated data should be reported to project management approximately 6-7 weeks after sample delivery to the laboratory.
- Decision statement resolutions are expected to occur approximately 6-7 weeks after sampling and should take place prior to development decisions.

Scale of decision-making

The scale of decision-making will cover the entire delineated site area (e.g. all the roadways). If mercury in specific locations and samples are found at concentrations that are significantly lower than at other sample locations, those locations and the corresponding soil may be considered separate decision units.

Constraints on Data Collection

- The turnaround times on data are always estimated and cannot be assured. Sample and system problems may indiscriminately increase data turnaround times.
- Definitive data will undergo a U.S. EPA Region 9 Tier 2 validation review prior to final reporting. Problems identified during this review may initiate additional data reviews, which will increase the time needed before data are finalized.
- Specific data may be qualified or rejected based on the results of the data review process.
- Civil constraints such as site access agreements, tribal requirements, and permit requirements may exist and, if so, will need to be addressed prior to sampling.

STEP 5.
DECISION RULE

Statistical Parameter

The geographic distribution of contamination and the range of contaminant concentrations define the statistical population of interest. In order to locate a contamination hot spot of a specific size, it will be necessary to consider an individual sampling data point (which is not a statistical parameter) as representing the contaminant concentration at a specific location.

Action Levels

The proposed action levels for the study will be 310 mg/kg or 230 mg/kg, which are the respective regional screening levels (RSLs) for industrial and residential exposure scenarios (i-RSL) for inorganic mercury for industrial soil. However, START field teams will also utilize a Lumex 915+ Mercury Vapor Analyzer (Lumex®) to screen mercury vapor in ambient air in the breathing zone above the roadways, and in the headspace of soil sample containers. The U.S. EPA will consider screening results from the Lumex® to determine the presence or absence of elemental mercury vapors and whether a lower action level is warranted, (e.g. the 34 mg/kg residential RSL for elemental mercury).

The RSL for industrial and residential soil were proposed as the site-specific removal assessment action levels because the RSLs are based on exposure risks which, for industrial soil, is typically an 8-hour day. The RSLs for residential soil is determined using a continuous 24-hour exposure scenario.

Decision Rules

- If the data indicate that a soil sample at a specific location has a mercury concentration above the applicable action level, then it will be assumed that there is a contamination hot-spot and that area, and the associated area will be considered in need of remediation or additional study/assessment.

- If the data indicate that a sample at a specific location has a mercury concentration below the action level, then it will be assumed that there is not a contamination hot-spot and the associated area will not be considered as in need of remediation or additional study.

STEP 6.
LIMITS ON DECISION ERRORS

Range of the Parameters of Interest

For all investigation areas the range of interest for mercury concentration that could effect decision is between ½ the action level and twice the action level. Quantitatively precise and accurate determinations of contaminant concentrations that are significantly above the action level are not necessary.

The Null Hypothesis or Baseline Condition

The COC concentrations in soil and ambient air exceed the applicable action levels.

Alternative Hypothesis

The COC concentrations in soil and soil vapor are less than the applicable action levels.

Table 2 - DECISION ERRORS
Cordero Mine Site
Fort McDermitt, Nevada

E & E Project No.: 002693.2094.01RA TDD No.: TO2-09-10-06-0002

Decision Error	Deciding that the sample concentration exceeds the action level when it does not.	Deciding that the sample concentration does not exceed the action level when it does.
True Nature of Decision Error	The sample concentrations are either not representative or are biased high.	The sample concentrations are either not representative or are biased low.
The Consequence of Error	Areas of soil represented by the sample will undergo additional investigation or may be immediately excavated or treated. Each situation would cost the EPA, Region 9, additional resources of time, money, and manpower.	The community could be directly exposed to COCs in areas of contaminated soil. Exposure would be an imminent threat to human health and the environment.
Which Decision Error Has More Severe Consequences near the Action Level?	**LESS SEVERE** to human health, but with appreciable economic consequences	**MORE SEVERE** because the contaminated soil may pose risks to human health and/or the environment.
Error Type Based on Consequences	**False Negative Decision** A decision that the soil contaminant concentrations are greater than the action level when they actually are not.	**False Positive Decision** A decision that the soil contaminant concentrations are less than the action level when they actually are greater.

Definitions
False Negative Decision = A false negative decision error occurs when the null hypothesis is not rejected when it is false.
False Positive Decision = A false positive decision error occurs when the null hypothesis is rejected when it is true.
See the EPA document titled, *Guidance for the Data Quality Objective Process*, Chapter 6, (EPA QA/G-4) for additional guidance regarding decision error.

Decision Error Limits Goals

For this project the goal is to locate a circular mercury contamination hot-spot that has a radius greater than 120 feet with a probability of 95 % (0.95).

If all the samples through out the entire site are found to have mercury levels either above or below the action level, then Table 3.

Table 3 - Decision Error Limits Goals (Soil) **Cordero Mine Site** E & E Project No.: 002693.2094.01RA TDD No.: TO2-09-10-06-0002		
True Concentration of Sample (% of Action Level)	**Typical Decision Error Probability Goals (Based on Professional Judgment)**	**Type of Decision Error**
0 -75	Less than 5%	False negative
75--100	Gray area[1]	False negative
100-125	Less than 5%	False positive
> 125	Less than 1%	False positive
If the coefficient of variability is 30 % the required number of samples is expected to be 21 samples.		
2010 ecology & environment, inc.		

STEP 7.
DESIGN FOR OBTAINING DATA

<u>Specific Design Optimization</u>

Based on the project's goals and objectives, the START Planning Team considered the following design elements as necessary to achieve DQOs:

- Collection and analysis of soil samples for mercury
- Generation of data that will indicate the geographical distribution of contamination (GPS data)
- Systematic representative soil sampling over the entire delineated area

A systematic sample design is the most appropriate sampling design that will meet the project objective. The systematic sampling will be divided into two approaches. The first approach will occur along the length of the public road. The sampling will begin at the west side of the public road at the intersection with North Road and collect one sample from 0-0.5 feet bgs. At the direction of the FOSC, additional subsurface soil samples would be collected from 0.5-1.0 feet bgs, and/or from 1.0-1.5 feet bgs at each surface sampling location. The sample team will travel 200 feet north and collect samples from the middle of the roadway using the method described above The sample team will travel 200 feet north to the east side of the roadway and collect three samples from the east side. The sample team will then travel 200 feet and return to the middle of the road to collect the next set of samples. The back-and-forth pattern of roadway soil sampling will extend the 1,630-foot length of the road. Approximately 24 samples will be collected using this approach. Figures 4-1a and 4-1b of the SAP show the approximate number and locations of the samples

For a single point sample in a grid sector of 200 ft^2 by 30 ft^2, the algorithm used to calculate the probability of a hit (which makes possible the calculation of the hot spot size or the number of samples) was developed by Singer and Wickman (1969) and Singer (1972) with refinements by Davidson (1995). For this design, the smallest hot spot that could be detected was calculated based on the given grid size and other parameters.

The inputs to the algorithm that result in the smallest hot spot that could be detected are:

Parameter	**Description**	**Value**
Inputs		
	Probability of detection	**95%**
Grid Type	**Grid pattern (Square, Triangular or Rectangular)**	**Rectangular**
Grid Size	**Spacing between samples**	**200 feet by 30 feet**
Grid Area	**Area represented by one grid**	**4,000 ft^2**
Sample Type	**Point samples**	**Points**
Hot Spot Shape	**Hot spot height to width ratio**	**1**
Outputs		
Hot Spot Size	**Length of hot spot semi-major axis**	**97 feet**

The second approach will be along the private driveway. The second approach will be similar to the first; however the interval between each sample location will be 40 feet rather than 200 feet. The sample team will begin at the west side of the driveway at the intersection of S Road and continue the back-and-forth pattern, collecting three samples at the aforementioned depths every 20 feet. Approximately 12 samples will be collected using this approach.

Samples will be collected from the surface to 0.5 feet bgs, from 0.5-1.0 feet bgs, and from 1.0-1.5 bgs. Three samples per location will be collected. Samples will be homogenized in a stainless steel bowl and then placed into the appropriate sample containers using stainless steel sampling scoops. Samples will be collected using disposable plastic scoops and placed in a 4-ounce jar in preparation for analysis. Samples will be placed in coolers and chilled with ice to 4^{o} C for storage and shipping.

For a single point sample in a grid sector of 40 ft^2 by 30 ft^2, the algorithm used to calculate the probability of a hit (which makes possible the calculation of the hot spot size or the number of samples) was developed by Singer and Wickman (1969) and Singer (1972) with refinements by Davidson (1995). For this design, the smallest hot spot that could be detected was calculated based on the given grid size and other parameters.

The inputs to the algorithm that result in the smallest hot spot that could be detected are:

Parameter	**Description**	**Value**
Inputs		
	Probability of detection	**95%**
Grid Type	**Grid pattern (Square, Triangular or Rectangular)**	**Rectangular**
Grid Size	**Spacing between samples**	**40 feet by 30 feet**
Grid Area	**Area represented by one grid**	**1,200 ft^2**
Sample Type	**Point samples**	**Points**
Hot Spot Shape	**Hot spot height to width ratio**	**1**
Outputs		
Hot Spot Size	**Length of hot spot semi-major axis**	**21.4 feet**

Approximately 4 background samples will be collected during the sampling event from areas not expected to have been impacted by mine waste. Background sample locations will be determined in the field by the START during the event based on observed and reported historical wind conditions. Duplicates, equipment blanks, and other appropriate quality assurance/quality control samples should be collected and are specified in the SAP. Data review, independent of the laboratory, should be performed on all analytical data that may be used in decision-making. The GPS coordinates (latitude and longitude) of each sampling location will be determined and documented during sampling.

Analysis:
All soil samples collected will be analyzed for the COPC by the following methods:

- U. S. EPA Method 7471A for Mercury.

If it is expected that the site is to become a U.S. EPA funded removal project, then EPA method 6200 may also be warranted.

In order to document whether mercury vapor is present in the roadway, the roadway, and soil samples can be screened in the field using the Lumex® 915.

Decision Error Minimization

In order to meet the decision limit error goal stated in step 6 of this DQO, all single point samples must have 10 % duplicate analysis and data should not be qualified.

Data from individual sample locations
The decision-maker should consider data uncertainty when making decisions using sampling data and associated estimated values from a single location. An individual data value reported below the action level may be biased low, while a data value reported above the action level may be biased high. The probability of decision error increases when COPC concentrations are near the action level due to both data uncertainty and data bias. Data that exceeds the action level by several times will likely not be in error.

For any reported COPC concentrations near the method detection limit, the uncertainty is relatively large, increasing the probability of decision error.

There are insufficient data to determine with any confidence whether any single sampling location can represent a larger area. Therefore, it is unknown whether data from any individual sample location in a search grid is representative of the entire grid sector. Thus the decision-maker should consider discrete data points as potentially not representative of any greater area.

Contamination Distribution Map
Data from sampling locations can be used to create a contaminant distribution map. The mapped COPC concentrations within an area should generally be based on the sample data from that area and the sample data from adjacent locations, particularly if discrete sample data are being used. The generated map model could be used to estimate the concentration of contamination throughout the property. The decision-maker should consider the data source and statistical sophistication of the distribution map prior to making decisions based on the map. The uncertainty for estimated data (data based on extrapolations and interpolations) is typically greater than for actual data. Therefore the probability of a decision error is greatly increased when extrapolated data are used.

General requirement for generating usable data

All activities and documentation related to the project should proceed under a Quality Management Plan (QMP). All sampling, analytical and quality assurance activities will proceed under a U.S. EPA-approved SAP. A record of sampling activities and deviation from the SAP must be documented in a bound field log book. Prior to sample collection, all project sampling personnel will review relevant sampling procedures and relevant quality assurance and control (QA/QC) requirements for selected analytical methods.