Data Quality Objectives for Great Salt Lake Project 5: Predictions of Selenium Accumulation in ***Artemia franciscana*** under Conditions Realistic for the Populations Residing in the Great Salt Lake

Step	DQO Guidance of Purpose and Outputs of Step	Great Salt Lake Project
1. Problem Statement	**Purpose:** Clearly define the problem that requires new environmental data so that the focus of the study will be clear and unambiguous. **Outputs From This Step** • A concise description of the problem. • A list of the planning team members and identification of the decision maker. • A summary of available resources and relevant deadlines for the study.	**Problem:** The current water quality standard for Great Salt Lake (GSL) is based on a limited data set of correlations between selenium concentrations in GSL water and *Artemia franciscana* (brine shrimp). While a dietary threshold for birds of about 5 mg Se/kg (DW) seems well supported, the influence of dietary versus waterborne selenium on shrimp selenium concentrations and the kinetics of selenium uptake and loss are less well documented. The detailed conceptual model of selenium cycling in the GSL (Bill Johnson et al., CWECS, University of Utah) identified linkages for trophic transfer of selenium within food webs from water to particulate matter (seston) to the dominant zooplankton species *Artemia franciscana.* With respect to that model, this project will provide information concerning linkages from water column selenium to phytoplankton (algae) (Pathway 39) and from algae to *Artemia* (Pathway 18). The <u>main objective</u> of this project is to provide reliable predictions of selenium accumulation in *Artemia franciscana* under conditions realistic for the populations residing in the GSL. This general objective will be addressed by pursuing the following <u>specific objectives</u>: 1) Determine the influence of salinity on selenium uptake and feeding rate by *Artemia fransiscana*; 2) Determine selenium uptake rates in *Artemia franciscana* from dissolved selenium concentrations in artificial GSL water (uptake kinetics); 3) Determine dietary selenium intake and subsequent selenium assimilation efficiency in *Artemia franciscana* fed a diet of selenium-loaded algae cells (*Dunaliella viridis*); 4) Determine selenium elimination rates from *Artemia franciscana* following selenium accumulation from elevated ambient concentrations; 5) Model selenium accumulation in *Artemia franciscana* based on the results from objectives 1-3 to provide predictions of selenium accumulation during realistic exposure scenarios; 6) Determine the "knee" of the dissolved selenium accumulation rate curve in *Artemia franciscana;* and 7) Investigate possible regulation of selenium accumulation in *Artemia franciscana* during prolonged exposure to selenium. **Planning team members:** Dr. Martin Grosell (Principal investigator), Dr. David Buckwalter (Project advisor) with ultimate decision authority by Utah Department of Environmental Quality, considering input by the GSL Steering Committee and GSL Science Panel. **Resources:** A total budget of $150,464 is provided for this project. Experimental laboratory facilities and a full-time laboratory research associate are available for the project in the Grosell laboratory at the University of Miami. Currently cultures of both *Artemia franciscana* and GSL algae *Dunaliella viridis* are maintained at the University of Miami. Dr. Grosell possesses radioisotope training, licensing, and relevant equipment to perform the outlined selenium accumulation and depuration studies. To the extent required, GSL water samples will be collected and shipped to University of Miami by Utah Division of Water Quality. In addition, speciation analyses of selenium from GSL algae samples and selected samples collected during this overall project will be performed by Brad Marden. The collection and shipment of GSL water as well as analyses of algae or other field samples (including speciation analyses) are not part of the present project or cost. **Deadlines:** Refer to page 9 of the work plan for a projected project progress

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2. Decision Statements	**Purpose**: Define the decision(s) that will be resolved using data to address the problem. **Approach**: Identify the key question that the study attempts to address and alternative actions that may be taken, depending on the answer to the key study question. **Outputs From This Step** • A statement of the decision that must be resolved using data in order to address or solve the problem. • A list of possible actions or outcomes that would result from each resolution of the decision statement. *Note from EPA guidance on DQO: If the principal study question is not obvious and specific alternative actions cannot be identified, then the study may fall in the category of exploratory research, in which case this particular step of the DQO Process may not be needed.*	**Decisions:** The overall purpose of the present project is to provide predictions of selenium concentrations in GSL brine shrimp as a function of selenium concentrations in the GSL water and algae. **Possible outcomes:** The ultimate goal of the present project is to model selenium concentrations in the shrimp based on measured selenium concentrations in algae and waters of the GSL. The model developed from the experiments outlined in the workplan will allow for prediction of algae and water selenium concentrations that will result in threshold selenium concentrations. From these predictions, the principal route of selenium uptake for accumulation will be identified. Selenium criteria can be developed from these predictions with shrimp selenium accumulation (avian dietary exposure) as the target endpoint for modeling and criteria development.
3. Inputs to the Decision	**Purpose**: The purpose of this step is to identify the informational inputs that will be required to resolve the decision, and to determine which inputs require environmental measurements. **Activities** • Identify the information that will be required to resolve the decision. • Determine the sources for each item of information identified. • Identify the information that is needed to establish the action level for the study. • Confirm that appropriate field sampling techniques and analytical methods exist to provide the necessary data. **Outputs From This Step** • A list of informational inputs (including sources and potential action levels) needed to resolve the decision. • The list of environmental variables or characteristics that will be measured.	**Informational inputs:** Influence of salinity on selenium uptake by brine shrimp from the water Influence of salinity on brine shrimp feeding rate and thereby dietary exposure Selenium uptake rates at different waterborne selenium concentrations Selenium intake and assimilation efficiency by shrimp fed a selenium-loaded diet of *Dunaliella viridis* Selenium elimination rates by brine shrimp **Variables/characteristics to be measured:** ^{75}Se accumulation from water and feeding rates at different salinities (100 and 160 parts per thousand) ^{75}Se accumulation kinetics over a wide range of relevant selenium concentrations to identify uptake rates and the “knee” of the selenium uptake curve ^{75}Se ingestion via a ^{75}Se-loaded diet consisting of *Dunaliella viridis* and subsequent assimilation efficiency ^{75}Se depuration/elimination rates from brine shrimp with ^{75}Se accumulated from the water and the diet

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4. Study Boundaries	**Purpose**: Specify the spatial and temporal circumstances that are covered by the decision. **Activities** • Define the domain or geographic area within which all decisions must apply. • Specify the characteristics that define the population of interest. • When appropriate, divide the population into strata that have relatively homogeneous characteristics. • Define the scale of decision making. • Determine when to collect data. • Determine the time frame to which the study data apply. • Identify any practical constraints on data collection. **Outputs From This Step** • Characteristics that define the domain of the study. • A detailed description of the spatial and temporal boundaries of the decision. • A list of any practical constraints that may interfere with the study.	**Spatial:** This project consists strictly of laboratory experiments/measurements. Test media are of a chemical composition mimicking the composition of the GSL as best as possible. For this reason, data collected as part of this project and conclusions based on the resulting data with respect to water quality criteria ought to apply only to the GSL or water of very similar water chemistry. **Temporal:** The maximum period of experimentation and data collection for the present project is 8 months starting from project notice to proceed. Projected progress is outlined in the workplan. **Practical constraints on data collection:** No practical constraints are anticipated. Possible limitations may be associated with isotope supply and temporary interruption of the project may result from hurricanes during the late summer and early fall 2007.
5. Decision Rules	**Purpose**: The purpose of this step is to integrate the outputs from previous steps into a single statement that describes the logical basis for choosing among alternative actions. **Activities** • Specify the parameter that characterizes the population of interest. • Specify the action level for the study. • Combine the outputs of the previous DQO steps into an "if...then..." decision rule that defines the conditions that would cause the decision maker to choose among alternative actions. **Outputs From This Step** • An "if...then..." statement that defines the conditions that would cause the decision maker to choose among alternative courses of action.	If the results from the initial specific objective reveal an effect of salinity, the Science Panel will be presented with a decision to make for an appropriate salinity at which to perform remaining experiments. When selenium uptake rates from water and algae are determined and combined with elimination/excretion rates in a model (objective 5), the model will allow for predictions of brine shrimp selenium concentrations as a function of water and algae selenium concentrations and exposure time. From the model predictions, determinations of “safe” selenium concentrations in water and algae can be assessed based on the avian dietary threshold of choice. Although not expected, information in addition to that which will be obtained as part of the present project may be required for successful modeling of brine shrimp selenium concentrations. In such case, recommendations for further studies will be provided to the Science Panel.

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6. Tolerable Limits on Decision Rules	**Purpose**: Specify the decision maker's acceptable limits on decision errors, which are used to establish appropriate performance goals for limiting uncertainty in the data. **Activities** • Determine the possible range of the parameter of interest. • Define both types of decision errors and identify the potential consequences of each. • Specify a range of possible parameter values where the consequences of decision errors are relatively minor (gray region). • Assign probability values to points above and below the action level that reflect the acceptable possibility for the occurrence of decision errors. • Check the limits on decision errors to ensure that they accurately reflect the decision maker's concern about the relative consequences for each type of decision error. **Outputs From This Step** • The decision maker's acceptable decision error rates based on a consideration of the consequences of making an incorrect decision.	Determination of radioactivity of ^{75}Se is associated with limited variation due to low analytical errors. As part of the isotopic approach total selenium concentrations will be determined in stock solutions (note that there will be no matrix effect) using graphite furnace atomic absorption (GFAA). For both these measurements UDWQ's quality assurance plan will be followed to the extent relevant for the present project. The ultimate tool developed from this project is the model to predict selenium concentrations in brine shrimp. Each of the model parameters is associated with errors that sum to give total possible uncertainty associated with the model predictions. The potential error of each parameter will be assessed by comparing the modeled results to the measured values and the combined potential error of the model will be determined as the sum of these errors associated with individual input parameters. Thus, predicted selenium accumulations in brine shrimp can be associated with a "confidence interval". For this investigation, in general, the measurement quality objectives for ^{75}Se are about +/- 10% and +/-20% for total selenium analysis using GFAA.
7. Optimization of the Sampling Design	**Purpose**: Identify the most resource-effective sampling and analysis design for generating data that are expected to satisfy the DQOs. **Activities** • Review the DQO outputs and existing environmental data. • Translate the information from the DQOs into a statistical hypothesis. • Develop general sampling and analysis design alternatives. • For each design alternative, formulate the mathematical expressions needed to solve the design problems. • For each design alternative, select the optimal sample size that satisfies the DQOs. • Select the most resource-effective design that satisfies all of the DQOs. • Document the operational details and theoretical assumptions of the selected design in the Sampling and Analysis Plan. **Outputs From This Step** • The most resource-effective design for the study that is expected to achieve the DQOs, selected from a group of alternative designs generated during this step.	For details about experimental design, biological replication and specific methodologies please refer to the work plan and the SOPs (to be) developed for the present project.