

## *CV-SALTS Initial Conceptual Model Technical Services*

### **Scope of Work**

The following is a detailed description of the scope of work and corresponding budget that will be completed over the next six months in conjunction with CV-SALTS. Any changes to the scope of work will require Executive Committee approval and adjustments to the project budget. The scope of work addresses all of the elements requested in the CV-SALTS Request for Qualifications. Tasks within this scope of work will be initiated after a notice to proceed has been received from the CV-SALTS Executive Director and/or Technical Program Manager.

The elements that are included within this scope of work are outlined below and discussed in additional detail in the following section of this exhibit.

- Task 1 - Management and Coordination Activities
- Task 2 - ICM Workplan Development
- Task 3 - Data Development
- Task 4 - Establish Management Zones
- Task 5 - Establish Methods for Salt and Nitrate Water Quality Analyses
- Task 6 - Complete High Level Salt and Nitrate Analyses for Central Valley
- Task 7 - Salt and Nitrate Analyses in Selected Subareas of the Central Valley
- Task 8 - Prepare Initial Conceptual Model Report

### **TASK 1. MANAGEMENT AND COORDINATION ACTIVITIES**

Management and coordination activities will be employed to maintain a clear focus on the assignments, to clearly communicate progress on the necessary technical information, and to apply the knowledge gained most effectively. Given the compressed schedule and budget, it will be important to track progress closely and support the sharing of information and advice needed to complete the studies most effectively. The subtasks include the following:

#### **Task 1.1 – Coordination Meetings**

The LWA Team Project Manager (PM) will be responsible for coordinating the technical activities and regularly communicating with the CV-SALTS Technical Program Manager (TPM) to discuss technical work status, major discussion items in upcoming Technical Committee meetings, and/or near-term plans. The PM will periodically attend meetings to share progress and discuss strategic direction. The PM as well as other Team members may participate in Executive Committee meetings as needed. The Senior Advisors will assist with “big picture” discussions to lay the overall path to a feasible Salt and Nitrate Management Plan (SNMP). Regular conference calls/meetings will be held to keep the project on schedule and to ensure that there are clear lines of communication. It is anticipated that the coordination may include periodic calls/meetings with the Technical Committee, the Technical Program Manager, the Executive Director, and/or presentations to the Executive Committee as needed.

At the outset of the project, we strongly suggest a meeting with the Technical or Executive Committee or a subset thereof, to achieve the following: (1) review and comment on the proposed organizational and communication structure, and (2) develop an overall project schedule and identify key work products leading toward completion of the SNMP by May 2014.

In addition, the LWA Team also recommends a full day workshop in the fall to present and discuss the deliverables associated with Tasks 3-5. Given the timeframe in which the subsequent tasks need to be completed and the importance of deliverables, a workshop will allow the Technical Committee and/or Executive Committee members the ability to walk through the documents and ask key questions in a

timely manner. The Project Management Plan identified within Task 2 will outline the recommended coordination meetings that should occur and the frequency at which they should occur.

***Deliverables<sup>1</sup>:***

- *Six (6) Conference Calls – LWA Team & CV-SALTS*
- *Three (3) In-Person Meetings*
- *One (1) Full Day Workshop*

**Task 1.2 – GIS/Data Management Policy**

The LWA Team will coordinate priorities, share data with, and use the GIS layers developed pursuant to the GIS Basin Planning Technical Services RFQ throughout the ICM project. The GIS workplan will contain GIS standards, data exchange protocol, data confidentiality, and data archival procedures.

***Deliverables:***

- *Coordination with the GIS Technical Services to develop a GIS/Database Management Policy*
- *Draft & Final GIS/Database Management Policy*

**Task 1.3 – As Needed Support**

The LWA Team will, on an as needed basis and based on the applicable hourly rates, coordinate with and/or provide additional technical and/or regulatory support for other CV-SALTS technical projects or analyses. The LWA Team members' involvement in many of the CV- SALTS projects provides a unique opportunity to provide insight and support.

**Task 1.4 – Data Management**

The work products will be maintained in an accessible format and location and evaluated by the team experts on Basin Plan amendments for completeness. A critical review of the work products and guidance by Strategic Advisors on this team will provide the necessary assurances that the criteria for a Basin Plan amendment have been met.

***Deliverables:***

- *Ongoing coordination with the GIS Technical Services*
- *Ongoing review of deliverables by Strategic Advisors*

**Task 1.5 – Monthly Progress Reports**

On a monthly basis the LWA Team (via the PM) will provide a written monthly progress report to document the project progress on a task-by-task basis. The monthly reports will document the work completed to date, the upcoming work to be completed, and any project concerns that need to be communicated. This information will be shared on an ongoing basis during regularly scheduled conference calls and/or other meetings. This will be incorporated into the Project Management Plan identified within Task 2.

***Deliverables:***

- *Written monthly progress reports in Microsoft Word or PDF formats*
- *Monthly Invoices*

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<sup>1</sup> If it is determined that there should be a greater role for the PM or other LWA Team members, the LWA Team can respond as needed.

## **TASK 2. WORKPLAN DEVELOPMENT**

The first task to be completed will be for the LWA Team to, based on the scope of work within this proposal, and the initial meeting with the CV-SALTS Selection Committee, develop a detailed Workplan that describes the approach, milestones, and deliverables that will be used to develop the ICM and to complete Tasks 3-8 described below. The Workplan will be based on the scope of work provided in the proposal and captured within this Scope of Work and will include a specific Project Management Plan (PMP) section.

The PMP will be incorporated into the text of the Workplan as well as the schedule and will specifically identify items such as:

- What communication methods will be used internally as well as with CV-SALTS
- Who will be the specific points of contact within the Team and within CV-SALTS
- What meetings will be held and when they will be held
- How the QA/QC within the team will be managed
- What reports will be provided and when they will be provided
- What procedure(s) will be used to obtain reviews and approvals for the project deliverables
- How the overall project schedule and budget will be tracked

It is anticipated that the Workplan will be developed shortly after the execution of the contract, and that it will be approved by the Executive Committee. The LWA Team will participate in an official kickoff meeting and move forward with Tasks 3-8 after approval of the Workplan.

### ***Deliverables:***

- *Draft Workplan (incorporating the PMP)*
- *Final Workplan (incorporating the PMP)*

## **TASK 3. DATA DEVELOPMENT**

The purpose of data development is to provide appropriate inputs and checks for the conceptual modeling effort. Thus, the exact nature of data needs will depend to some extent on the modeling approach. Although this scope describes a modeling approach, this will be finalized in collaboration with CV-SALTS, and final decisions on data needs will follow. A final, detailed approach to data development will be provided in the Workplan. What is described here is an initial description of resources and approaches to this task. This principle applies to descriptions of Tasks 3 through 8 in this scope.

### **3.1. Review CV-SALTS Geodatabase and Mapping Activities**

Geodatabases developed to date by CV-SALTS (e.g., the BUOS Project work products) will be reviewed relative to anticipated project requirements. A database framework that will accommodate data that are in-hand, along with those to be assembled under this task, along with needed source and data quality documentation, will be designed and documented to provide a usable, efficient repository. Subdivisions of the Central Valley that will be built into the ICM and later analyses will be incorporated at the earliest possible date so that data adequacy in these areas can be evaluated.

### ***Deliverables:***

- *Documentation of database framework within the Data Summary Report*

### 3.2. Identify Data Sources and Data Types Required for Project

A draft data source list will be developed, reviewed with the Technical Committee, and finalized based on comments received. Data inputs to the conceptual model must satisfy the needs of a coarse-scale analysis illustrated by the puzzle/GIS graphic employed in the CV-SALTS process. Another guiding principle is the need to develop input data with an eye to future phases and refinements. Future work and needs should be borne in mind during Phase 1, and the stage should be set for more detailed work, to the extent practicable. This will be done, for example, by employing field- or sub-section-level land cover data and water/salt/nutrient balances, and then summing them to coarser-level elements for regional SNMP analyses. Since field- and sub-section-level land cover data are readily available, and since their analysis is more straightforward than analysis of larger land units, it is both better and easier to do this work at the field or sub-section level of detail. This sets the stage for future, more detailed analyses by NOT aggregating land cover data during the development of the ICM.

#### ***Deliverables:***

- *Draft data source list to Technical Committee for review*
- *Final data source list that incorporates comments received*

### 3.3. Gather and Compile Data, Create Source Record

Data from the source list will be compiled into the database framework, along with source and quality metadata. Data requirements for the ICM work will be met to the maximum extent possible not only with existing data, but with data already compiled for similar analyses. This is the only feasible way to meet the schedule goals, and to control the budget, for the ICM data development. Where further refinement seems to be useful or necessary, these opportunities and needs will be identified and called out clearly in documentation of methodology.

Data for most of the Central Valley have been compiled in CVHM and during the course of several previous efforts in which the LWA Team has been heavily involved, including work for CV-SALTS, the Drinking Water Policy Technical Working Group, DairyCARES, Irrigated Lands coalitions, and for groups developing SNMP's in other watersheds. In addition, other entities (e.g., UC Davis in the course of the recent SBX2-1 nitrate study, Kings River Water Management District in the course of the recent IRWMP) have invested heavily in developing land cover and other data for specific geographies, and this work can be drawn upon to complete and improve input data.

The main land and water data needs are listed below. Data are available primarily in CVHM and WARMF databases (which can be used whether or not WARMF is employed for any modeling purpose). Collectively, WARMF databases cover 7,160,571 acres of the Central Valley, or about 56% of the Central Valley.

#### Primary land and water data requirements:

##### Water supply

- Surface water deliveries (location, volume, and quality)
- Groundwater pumping (location, volume, and quality). LSCE and PlanTierra have compiled substantial Central Valley groundwater quality databases for other efforts, and their use may save significant time for this project.
- Irrigation methods (based on DWR data by detailed analysis unit [DAU])
- Irrigation rates by land cover class (based on DWR applied water rates by DAU). Note that these data are preferable to CIMIS for estimating applied water.

Climate and hydrology - CVHM contains substantial climatic data and hydrologic simulation capability.

#### Land cover and hydrography

- Hydrography is crucial to understanding how water and constituents are routed through the watershed (National Hydrographic Database)
- Land cover classes. Management regimes will be classified at the field or sub-section level into groups, each of which contains land that is relatively homogeneous from the standpoint of management parameters important to water, salt, and nutrient balances.
- Land cover mapping in CVHM and WARMF databases, and by DWR, USGS, cities, counties, regional councils of governments, and for the Dairy general permit can each be drawn upon in the areas where they contribute the most useful detail.

#### Subsurface characteristics

- Soils (vertical hydraulic conductivity, drainage), USDA/NRCS
- Depth to groundwater, DWR, USDA/NRCS
- Average annual groundwater recharge

#### Applied materials

- Fertilizer and amendment sales quantities by county from Fertilizer Research and Education Program data
- Recommended and common application rates from literature (e.g., UC Cooperative Extension)
- Ranges of gaseous loss rates from literature

#### Uptake

- Evapotranspiration (CIMIS and other DWR data by DAU)
- Nutrients (crop tonnages from county Agricultural Commissioner's reports; nutrient concentrations of removed tonnage from plant tissue literature)

#### Ambient water quality

- Surface water from irrigation districts, USGS, CDEC, SWAMP, ILRP, DWR, studies
- Shallow groundwater from the USGS, SWRCB Geotracker, dairy, domestic, and monitoring wells, as well as compilations of same from Irrigated Lands coalitions and DairyCARES
- Deep/other groundwater from the USGS, DPH, dairy, and other agricultural wells

#### Point sources (These are contained in the WARMF database produced for Central Valley Drinking Water Policy Work Group)

- POTW and industrial outfalls (from permits)
- Land application (from permits)

#### Nonpoint sources

- Leaching water and constituents from land cover classes, considering precipitation, irrigation (amount and quality), recharge, fertilization (amount of N and total non-volatile salinity), plant uptake, soil N dynamics (e.g., gaseous losses). Dairy land application will be based on Dairy Program data, and handled here, since it is so closely integrated with forage cropping systems. Exported manure will be assumed to be applied at agronomic rates unless there is evidence to the contrary.
- Stormwater flows (quantity and quality)

Again, sources of data required for the ICM analyses are at least partially developed for all of the major categories, and many are compiled into common database frameworks as input to CVHM and WARMF.

**Deliverables:**

- *Compilation of data (and documentation of data source and metadata) from the Task 3.3 source list into the database framework (developed in Task 3.1)*
- *Documentation of any data refinements needed*

### **3.4. QA/QC and Convert Data**

Compiled data will be checked and screened for quality through data summaries, exploratory statistics, and the like. Data passing quality control screens will be converted to formats and data structures required for model inputs.

### **3.5. Identify and Report on Data Gaps**

Where data for needed inputs are lacking, these would be identified. One of the goals of this step would be to work around data gaps where possible, especially for conceptual modeling. Critical data gaps would be identified and prioritized; non-critical data gaps would be documented along with action items to work around them and/or address them in later phases. In this way, efforts to gather and organize data that are not readily available will be minimized and/or deferred to facilitate completion of work on-time and within budget.

**Deliverables:**

- *Documentation of critical and non-critical data gaps and potential solutions to Technical Committee for review*
- *Final data gaps and solutions documentation that incorporates comments received*

### **3.6. Address Data Gaps as Needed**

Data gaps deemed critical will be addressed immediately (pursuant to available budget) while work that can be achieved with data in-hand proceeds. No effort beyond that described in Subtask 3.5 will be expended on non-critical data gaps.

### **3.7. Data Summary per Management Zone**

A draft data summary report (overall and by Management Zone) will be prepared and reviewed with the Technical Committee, then finalized based on comments received.

**Deliverables:**

- *Draft Data Summary Report*
- *Final Data Summary Report*

## **TASK 4. ESTABLISH MANAGEMENT ZONES**

The purpose of this task is to delineate and recommend Management Zones that will provide the basis for implementation of the ICM and completion of analyses in subsequent tasks. There are four subtasks associated with this task. As described below, the “initial”, or ICM, Management Zones are proposed to be hydrologically based to expediently satisfy the objectives outlined in the RFQ. In Task 4, the factors that will be considered for delineating Phase 2 Management Zones for the SNMP Master Plan are described.

#### **Task 4.1 – Draft Management Zone Alternatives for the ICM and the Phase 2 SNMP**

This subtask will identify different ways of defining Management Zones for the purposes of CV-SALTS policy discussions, and the requirements for the Central Valley-wide Salt and Nitrate Management Plan.

For purposes of the ICM, and particularly to expedite completion of the high-level analyses requested in this RFQ, it is proposed that the Management Zones be hydrologically based. DWR has defined 21 Subregions as water supply planning areas and has compiled substantial information on water deliveries and diversions for these subregions. This substantial effort and contribution toward understanding the hydrology of the Central Valley was recognized by the USGS and incorporated in the USGS Central Valley Hydrologic Model (CVHM, 2009 version). The USGS refers to the 21 previously identified areas as “water balance subregions.” The USGS is currently working on another version of the CVHM which is anticipated to be released in December 2012 (in this proposal, the updated version is also referred to as “CVHM2”). The 2012 version is understood to include some re-discretization of subregions and will incorporate 78 subregions in the San Luis and Delta-Mendota Water Authority (SLDMWA) and 32 in the Delta area. For purposes of the high level analyses of interest for the ICM, it is proposed that the current 21 DWR/CVHM subregions serve as the initial Management Zones.

This task will explore alternatives for otherwise delineating Management Zones for the Phase 2 SNMP and also for purposes of future local planning efforts. Some alternatives to the DWR Subregions utilized by the USGS CVHM groundwater flow model include the following:

- DWR-defined groundwater basins and subbasins as defined in Bulletin 118,
- Broader scaled zones for example Integrated Regional Management Plan regions, and
- Smaller scaled zones on a more political basis that would consider future local interests on the district/city/county level.

#### ***Deliverables:***

- *Information from this subtask will be included within the ICM Management Zones Recommendation Memo*

#### **Task 4.2 – Evaluate Management Zone Alternatives**

The different delineation methods of defining Management Zones will be evaluated for appropriateness for the Phase 2 SNMP and the data needs will be outlined for each method. The data availability, the value of the data with respect to the scale or size of the Management Zones, a discussion of the ability to refine or subdivide the management zone areas in the future for more regionalized management plans, and the consideration of political or regulatory implications will be examined.

#### ***Deliverables:***

- *Information from this subtask will be included within the ICM Management Zones Recommendation Memo*

#### **Task 4.3 – Stakeholder Outreach**

The approach for Management Zones for application for the ICM would be presented and described as a part of the workshop that will be held pursuant to Subtask 1.1. During the workshop the items that will specifically be discussed include the definition of, and criteria relating to, Management Zones for

application as part of future Phase 2 SNMP efforts. In addition, input from CV-SALTS management and stakeholders would be received and synthesized to develop consensus regarding suitable criteria to define the Phase 2 SNMP Management Zones. It is anticipated that the criteria would allow for some flexibility in the scale of the zones depending on stakeholder needs.

A summary of the comments received and how they were addressed would be prepared in conjunction with the memorandum for Task 4.4.

***Deliverables:***

- *Information from this subtask will be included within the ICM Management Zones Recommendation Memo*

**Task 4.4 – ICM Management Zones and Recommendations for Phase 2 Management Zones**

A Memorandum will be prepared that summarizes the findings of this task, including a summary of the Phase 1 ICM Management Zone approach that is proposed to be based on the 21 CVHM Subregions designated in the 2009 version of the USGS CVHM model. The Memorandum will describe the criteria proposed for evaluating and delineating Management Zones for the Phase 2 SNMP Master Plan. The Memorandum will include comments received from the stakeholder outreach effort, and it will provide a focused look at the rationale for selecting the preferred Management Zone delineation method. The preferred Management Zone delineation method will then be employed as part of the Phase 2 SNMP (i.e., refinement of the ICM Management Zones). Additionally, the preferred Management Zone delineation method could be employed in the future by local entities/stakeholders that wish to incorporate additional details and data specific to local planning efforts and needs in their areas.

***Deliverables:***

- *Preparation of technical memorandum that summarizes the findings of Tasks 4.1-4.3*

**TASK 5. ESTABLISH METHODS FOR SALT AND NITRATE WATER QUALITY ANALYSES**

The purpose of this task is to develop methods for utilizing and analyzing groundwater data and estimating groundwater/surface water interaction in order to answer data analysis questions at different geographic scales for future tasks. There are three subtasks associated with this task, resulting in the determination of a preferred method of analysis.

**Task 5.1 – Determine Methods to Estimate Ambient Groundwater Quality**

For the entire Central Valley, an assessment of available salt and nitrate groundwater data will be performed to determine methods of estimating ambient groundwater quality. This assessment will include analysis of the occurrence of bias in the datasets, which can be introduced as a result of:

- Frequency of data collection (infrequent sample collection may result in outlier values being taken as representative values);
- Locations of data points (for example, data may be concentrated on regulated facilities and public water supply systems, and lacking coverage for irrigation/domestic groundwater sources);
- Vertical distribution of groundwater quality (although several sources can be identified as “shallow” (Geotracker Regulated Facility Monitoring Wells; USGS queried wells <100 feet in depth; Geotracker GAMA domestic wells; etc.) and “deep” (DPH Public Water Supply Wells; agricultural wells from the Dairy dataset; USGS queried wells >100 feet in depth; etc.), there is

- uncertainty associated with some datasets;
- The coverage of sample data during a particular time period may present bias if certain areas lack data during recent times;
- The source of the data would also be considered if there are some questionable measurements and insufficient quality control or quality assurance (QA/QC), though most of the above-mentioned data sources are reliable, such that field and laboratory methods are expected to be of little concern.

Ambient salt and nitrate groundwater quality would be assessed on a subregion (ICM Management Zone) scale for purposes of Task 6 using GIS mapping techniques and statistical methods to determine representativeness. Salt and nitrate data with relatively higher spatial resolution would be used in Task 7. Salt and nitrate groundwater quality would also be assessed on a vertical spatial scale to establish, as possible given available and accessible data attributes (e.g., well construction, well depth, etc.), the ambient quality for relatively shallower and relatively deeper parts of the aquifer system.

**Deliverables:**

- *Information from this subtask will be included within the ICM Methodologies Recommendation Memo*

**Task 5.2 – Develop Data/Decision Matrix**

This subtask involves preparation of a matrix that would focus on the groundwater data compiled and synthesized as part of Task 5.1. Specifically, such factors as data availability and spatial density by Management Zone would be summarized along with the degree to which the data can be differentiated by well completion within the aquifer system (i.e., relatively shallower or deeper well depths). It is beyond the scope of this analysis to attempt to link well construction information (i.e, beyond well depths, as available) to wells that have groundwater quality data. Temporal data would be broadly assessed to identify the period of available historical water quality records for each Management Zone. With a preliminary understanding of the degree to which groundwater quality conditions can be assessed with some level of spatial and temporal resolution, the potential applicability of the data for large-scale resource decision-making or smaller scale decisions will be evaluated. In addition, in preparation for Task 6, the LWA Team will recommend assessment criteria that would be used to assist in identifying hotspots as well as prioritization criteria that would be used to identify high priority areas/subregions.

**Deliverables:**

- *Prepare matrix to summarize groundwater data compiled and synthesized in Task 5.1*
- *Recommendation of assessment criteria to identify hotspots and high priority areas/subregions*
- *Information from this subtask will be included within the ICM Methodologies Recommendation Memo*

**Task 5.3 – Establish Water, Salt, and Nitrate Balance Calculation Methods**

This subtask involves developing analysis methods for calculating water, salt, and nitrate balances for surface water and groundwater. The method to assess salt and nitrate balances for surface water is proposed to utilize WARMF for analyses at the Management Zone scale. The existing WARMF models will be used without modification to minimize the required time and expense. Constituent concentrations in the lower soil layer simulated by WARMF will be combined with recharge rates from CVHM to determine loading to the groundwater aquifers in each Management Zone. WARMF also includes transformational loads tracking formation and decay of nitrate.

For purposes of calculating salt and nitrate in groundwater, the method developed as part of this task would be crafted to address the objectives outlined in Task 6. Specifically, the method established for groundwater purposes would be applied by identifying which Management Zones are achieving balance (i.e., steady state) with respect to water, salt, and/or nitrate. The method would also be used to preliminarily identify the rate of salt and nitrate accumulation or depletion on a Management Zone scale. Additionally, the methods would assess at a high level the assimilative capacity of the upper portion of the aquifer system based on recharge water quality inputs from results of previous WARMF runs, linking the surface water and groundwater components through the root zone. Approaches for assimilative capacity analysis would be further piloted/demonstrated as part of Task 6.

Once ambient salt and nitrate groundwater concentrations are defined for each of the proposed 21 ICM Management Zones, the applied mass and volume loading variables would be employed as inflows and outflows to the Management Zone. This will be done using CVHM's water budget output for the upper portion of the unconfined aquifer (mostly CVHM layers 1 and 2, and sometimes layer 3 in areas where depths to water are greater) on a Management Zone scale. For purposes of the ICM, it is assumed that mixing of applied water would first occur at the water table within approximately the upper 100 feet of saturated material.

CVHM's flow budget would provide volumes of water that inflow or outflow into each Management Zone according to the following:

- Inflows: Recharge (deep percolation), Horizontal Groundwater Inflow, Vertical Groundwater Inflow from below (vertical upward gradient from deeper to shallower parts of the aquifer system), and Stream Leakage into the zone (in places of losing streams).
- Outflows: Pumpage from the shallow aquifer portion, Horizontal Groundwater Outflow, Vertical Groundwater Outflow to underlying aquifer units (vertical downward gradient from shallower to deeper parts of the aquifer system), and Stream Leakage into surface water courses (in places of gaining streams).

Concentrations for each constituent (salt and nitrate) in groundwater beneath each ICM Management Zone (CVHM Subregion) would be computed for a 20-year simulation period (to include the hydrologic water year types covered by such a period), where successive years of integrated input from prior year calculations are applicable. The 20- year simulation is based on an anticipation of data availability for other inputs for the entire Central Valley; although, land cover would be held constant for the simulation period. Computations would be done for the upper portion of the unconfined aquifer.

***Deliverables:***

- *Develop a technical memorandum summarizing the findings of Tasks 5.1 -5.2 that describes:*
  - *The planned methods for determining ambient groundwater quality for each ICM Management Zone, and*
  - *The methodology for calculating water, salt, and nitrate balances for surface water and groundwater.*

**TASK 6. COMPLETE HIGH-LEVEL SALT AND NITRATE ANALYSES FOR CENTRAL VALLEY**

The purpose of this task is to perform a high-level analysis of salt and nitrate conditions throughout the Central Valley in order to address basic questions developed by the Technical Committee as summarized in Attachment 2 to the *Conceptual Model Summary Description*. Findings of this task will be provided in the report prepared as a part of Task 8.

### **Task 6.1 – Salt and Nitrate Source and Transport**

The efforts under this subtask include the following:

- Apply methods from Task 5 to determine ambient water quality.
- Using the methodology described in Task 5, the water, salt and nitrate budgets will be developed on an ICM Management Zone scale. These will be collectively used to describe the pattern of movement of these parameters in the Central Valley.
- Using the methodology described in Task 5, overall water budgets will be developed for each Management Zone from the beginning of the 20-year simulation period (baseline) to the end of the period. This approach will also be used to identify where water is entering and leaving the Central Valley.
- Using the methodology described in Task 5, overall salt and nitrate trends will be assessed from the beginning of the 20-year simulation period (baseline) to the end of the period. This approach will also be used to identify where major sources of salt and nitrate are occurring (i.e., at the Management Zone scale) and where there is salt and/or nitrate entering and leaving the Central Valley.
- The overall rate of salt and nitrate movement in the Central Valley will be determined on an ICM Management Zone scale. Simulated salt and nitrate concentrations would be plotted for the 20-year period.

### **Task 6.2 – Management Zone Specific Analysis**

The methodology described in Task 5 will also be used to evaluate the difference in mass of salt and nitrate in the ICM Management Zones from the beginning of the simulation period to the end of the 20-year simulation period. Specifically, this will illustrate on an ICM Management Zone scale where the Zones are in balance (steady state), accumulating or depleting with respect to salt and nitrate, and also the rate at which accumulation and/or depletion may be occurring.

Although the RFQ expressed interest in analysis of the *rate of change* in salt and nitrate concentration in the vadose zone, it is recommended that this be deferred until such time as other analytical tools are developed that provide an improved linkage between simulation of solute concentrations and relevant mechanisms governing transport through the vadose zone and infiltration to groundwater.

Such enhancements would provide for the direct simulation of long-term effects of historical and future agricultural practices on the salinity of the root zone and underlying groundwater. There has not yet been funding to implement these enhancements, but to the extent such actions may occur in parallel efforts, such a tool would greatly enhance work conducted for CV-SALTS during the Phase 2 SNMP Master Plan.

In the interim, previous WARMF work could be employed in two ways. One is to employ WARMF data in a simplified salt and nutrient loading assessment. The second would be to use output from previous WARMF model runs to characterize water quality at the base of the root zone of each irrigated land cover class. Under the latter option, soil processes in WARMF would capture root-zone subsurface processes such as plant uptake, gaseous loss of N, etc. The LWA Team is open to selecting between these options flexibly after consulting with the Technical Committee. Water balance processes would be handled exclusively in CVHM.

### **Task 6.3 – Preliminary Salt and Nitrate Assessment**

The results of Tasks 6.1 and 6.2 would be used to summarize salt and nitrate hotspots (elevated levels of these constituents) on the Management Zone scale for the Central Valley. The input data from WARMF and the land cover analysis would be used to assess the primary drivers within the ICM

Management Zones that have hotspots and/or accumulating trends. Salt and nitrate assessment criteria would be developed in collaboration with the Technical Committee, incorporating the development of appropriate beneficial uses and water quality objectives for salt and nitrate from other ongoing CV-SALTS technical work.

The above information would be used to identify a preliminary ranking of and prioritization of ICM Management Zones for management activities. This information will be used to identify areas where more detailed assessment should occur to determine where focused regulatory oversight is most warranted.

### **Analysis (Incorporated into the Task 8 Report)**

The results of Task 6.1 – 6.3 will be incorporated into the Task 8 Draft Report and will include the water, salt, and nitrate analyses conducted for each Management Zone (21 CVHM Subregions) in the Central Valley. The information will include:

- Water, salt and nitrate budgets for a period of approximately 20 years (simulation period)
- Water salt and nitrate transport in the Central Valley for a period of approximately 20 years (simulation period)
- Overall trends in salt and nitrate concentrations will be summarized for each Management Zone
- Overall salt and nitrate masses for a 20-year period will be summarized for each Management Zone (i.e., salt and nitrate in balance, accumulating, or depleting on a Management Zone scale).
- “Hotspots” will be displayed on a Management Zone scale for the entire Central Valley
- A description will be provided concerning the accuracy of the information developed for the high level/low resolution ICM analyses (this will also be related to the additional level of resolution that will be used in Task 7 for the two prototypes and corresponding analyses for those areas)
- A preliminary ranking and prioritization of Management Zones will be prepared for the purpose of identifying where more detailed assessments should occur.

### **Deliverables:**

- *Information developed from Task 6 will be incorporated into Task 8 Draft Report*

## **TASK 7. SALT AND NITRATE ANALYSES IN SELECTED SUBAREAS OF THE CENTRAL VALLEY**

The purpose of this task is to develop prototype templates for the use of the data analysis methods developed under Task 5 to characterize salt and nitrate at a management-level scale. Water quality results would be generated for the selected preliminary subarea(s). The preliminarily subareas identified are 1) Merced/Stanislaus and 2) Kings River.

The prototypes will provide the foundation and methods that can be applied to the future development of a Salt and Nitrate Management Plan for the entire Central Valley (Phase 2 SNMP Master Plan). Tasks 5 and 6 propose to use the CVHM model to evaluate salt and nitrate occurrence and movement at the “Conceptual or 30,000-foot” scale of analysis. Task 7 would develop the above prototypes to illustrate the additional level of detail that will be important for the Phase 2 SNMP Master Plan scale of analysis. The USGS Modesto model, proposed to serve as the prototype for Stanislaus/Merced, would not only serve as a Phase 2 SNMP Master Plan prototype; with its much smaller (approximately 1/4 mile square) cells, it could also serve as a local-level prototype. At the local level, salt and nitrate

sources, as well as refined inflow and outflow details may be added in the future. This local level would have a finer-scale of analysis (i.e., smaller model grid cells and/or variable cell dimensions across the area of analysis). As described below, the Kings Subbasin, based on two proposed ICM Management Zones (or CVHM Subregions), would serve as the other prototype.

Results of this task will be provided in a Subarea Analysis Memorandum.

### **Task 7.1 – Establish Geographical Boundaries**

The boundaries for the focused, smaller-scale (selected subarea) analyses will be based on the vision of the Executive Committee, and depend on areas meeting criteria for appropriate and available data to complete the analysis.

- For the Merced/Stanslaus subarea, it is proposed that the regional USGS model created for the greater Modesto area (containing most of Stanislaus County and a portion of northern Merced County) be used as the Stanislaus/Merced prototype. Specifically, this Modesto model was used as part of the CV-SALTS Pilot Study and would be utilized as part of Task 7 to address additional questions related to salt and nitrate transport, including assessment of concentrations in different parts of the aquifer system. The WARMF model as applied for the Pilot Study can be used to provide root zone constituent concentrations for calculations of recharge loading and the fraction of nitrate formed and decayed by chemical reactions within the soil.
- The Kings River area (Kings Subbasin) would be pursued for this more focused analysis, in which the boundaries would most likely coincide with the Kings River Conservation District (KRCD) Boundary, as the KRCD maintains an extremely thorough hydrologic dataset. Preliminarily, the salt and nitrate analyses for the ICM would focus on use of CVHM, particularly Subregions 16, 17, and part of 15 that overlie the Kings Subbasin. An Integrated Surface Groundwater Model (IGSM) has been developed for the KRCD. Water budgets for the IGSM will be compared to those from CVHM Subregions 16, 17, and part of 15. To achieve agreement for purposes of the ICM, gross adjustments may be made to selected parameters as needed. There is no existing WARMF application for the Kings River watershed, but root zone simulations from the neighboring Tule River watershed can be used as a reference. Sections of the Tule River watershed can be matched with sections of the Kings River watershed with similar irrigation water quality and land use to provide the concentration component needed to calculate recharge loading and the fractions of nitrate formed and decayed by chemical reactions.

### **Task 7.2 – Characterize Key Subareas**

The surface and groundwater hydrology, hydrogeology, land cover (primary agricultural activities, wildlands, urban land uses, etc.), locations of POTWs, and municipal water sources (surface water intakes or wells) would be characterized using a combination of the GIS/Database Development Project and groundwater flow model documentation. Some of this information, such as locations of POTWs and municipal water sources, is anticipated to be available from other work being conducted for the Phase 2 GIS BUOS. For purposes of the ICM prototype templates, this mapping would be coordinated with other aspects of this task. However, as further discussed below, the prototypes would focus on major sources of salt and nitrate already incorporated in the Modesto area model (which was the basis of the CV-SALTS Pilot Model for the Modesto area) and planned to be developed for the Kings Subbasin (Task 3).

Salt and nitrate data with relatively higher spatial resolution as available from Task 3 for the Kings Subbasin or as previously compiled for the Modesto area would be used in the Task 7.5 analyses.

### **Task 7.3 – Identify Major Sources and Sinks of Salt and Nitrate**

An analysis of ambient groundwater and surface water quality in conjunction with surface applications of salt and nitrate will lead to the identification of major sources and sinks of salt and nitrate within each subarea. Areas with high concentrations of salt and/or nitrate, or where application rates are out of balance with recharge rates, will be identified as sources. Sinks of salt and/or nitrate will be interpreted based on a combination of hydrology, groundwater flow directions, and groundwater/surface water quality. The results of this task will also include a comparison to the results of Task 6.2.

### **Task 7.4 – Identify Zones of High, Low, and Moderate Groundwater Quality**

GIS mapping techniques will be used to categorize zones where the groundwater is considered to be of high quality (low concentrations of salt and nitrate), low quality (high concentrations of salt and/or nitrate), and moderate quality within the selected subarea(s). The mapping will include depiction of higher to lower quality within the relatively shallower part of the aquifer system and the relatively deeper part of the aquifer system.

### **Task 7.5 – Establish and Quantify Transport Patterns**

To identify the transport patterns of the major sources and sinks of salt and nitrate in the subarea(s), the use of a new model code, called MODPATH-OBS, is proposed. This new USGS code has been used internally (not yet published) and advances the particle tracking capabilities of the existing MODPATH module, allowing chemical concentrations to be tracked with flow. The code may be publicly available by August 2012. If not, verbal communications with applicable USGS personnel have indicated that the code would be provided for use in a “beta testing” capacity. The MODPATH-OBS program requires input files compatible with the original MODPATH module, used in the CV-SALTS Salt and Nitrate Sources Pilot Implementation Study Report (LWA et al., 2010) for the Modesto Pilot Study Area.

The use of particle tracking with concentrations will allow for identification of areas within the subarea that either contribute or remove salt and nitrate from groundwater as well as the rate of salt and nitrate transport from these areas.

The salt and nitrate data with relatively higher spatial resolution for the shallower and deeper parts of the aquifer system, as developed in Task 3 (including for the Kings Subbasin and as previously compiled for the Modesto area) would be used in the analyses of transport patterns. This analysis would include evaluation of the concentration trends and transport of salt and nitrate within the upper model layers for each prototype. The results would preliminarily assess the concept of assimilative capacity in a part of the aquifer system that provides actual or probable beneficial uses. The zone of influence of major sources and sinks would also be illustrated. It is anticipated that the concepts of assimilative capacity, zones of influence, and the “boundary of the zone of influence” would be further examined in the Phase 2 SNMP Master Plan.

Considering results from a twenty-year simulation period of surface water/ groundwater quality along with an estimated rate of transport, it will be possible to determine what areas are improving in quality, degrading in quality, or remaining stable at a SNMP Master Plan/local scale (i.e., a denser model grid as compared to the analyses in Task 6 at the ICM Management Zone scale). Groundwater discharge influences on surface water quality would be estimated for parts of the subareas where known discharges have been previously identified as being significant. Further analysis of these influences, and comparison of simulated to measured results, would be recommended for the Phase 2 SNMP Master Plan.

## Task 7.6 Subarea Analysis Memo

A Memorandum containing the more focused analysis on the subarea/prototype area scale (Tasks 7.1 – 7.5) will be prepared, including a detailed section describing the methodology and results of the salt and nitrate analysis for each prototype area.

- A map containing the selected subarea boundaries will be included.
- A map that shows zones within the subarea where groundwater quality is of high, low, or moderate quality will be included.
- A map showing where the groundwater quality is improving, degrading, or remaining stable will be included.
- Linkages to and data needs for the Phase 2 SNMP Master Plan will be discussed. The source loads and land cover analyses conducted as part of Task 3, along with the compilation of other existing data, consist mostly of information at a coarser level of discretization (i.e., catchment scale in many cases). This means the CVHM flow model (updated version in December 2012) would have cell sizes at 1-square mile or smaller, but the loading would be at a coarser scale. The results of Task 6, along with additional prioritization of the Management Zones in Phase 2, would inform the additional data needs for the Phase 2 SNMP Master Plan, including details necessary for regulatory and resource management decisions.
- The Memorandum would describe further data needs and/or recommended analyses relating to the concepts of assimilative capacity, zone of influence, and the “boundary of the zone of influence” that would be conducted as part of the Phase 2 SNMP Master Plan.

### **Deliverables:**

- *Draft technical memorandum*
- *Final technical memorandum incorporating comments*

## TASK 8. PREPARE INITIAL CONCEPTUAL MODEL REPORT

The LWA Team will critically review the technical documents and then interpret and incorporate the results of the project tasks into the Initial Phase Conceptual Model Draft Report (Report).

The Report will summarize the relevant findings from each of the tasks that have been completed and will provide recommendations for the development of the Phase 2 SNMP Master Plan and the Final Phase Central Valley SNMP. The Report will specifically address the following (in addition to other information):

- The assumptions that were used to develop the ICM and the data analysis methods;
- How well conserved nitrogen was assumed/found to be in the systems modeled;
- How CVHM and/or other models were used to support the calculation of the loads;
- The level of accuracy, completeness and confidence of the results;
- Consistency with results of the CV-SALTS pilot study and other source work; and
- How the results have been validated or will need to be validated by local stakeholders.

Other recommendations that may be included to support the Phase 2 SNMP include:

- Refine conceptual model and salt and nitrate loads, i.e., use higher resolution, updated CVHM2 along with MODPATH-OBS to develop salt and nitrate concentration-based analysis;
- Assess sustainable salt and nitrate balances (i.e., apply future scenarios for high priority Management Zones);
- Identify potential large-scale management practices and projects for analysis (i.e., coordinate with illustrations of Water Resources Management strategies being included in the California Water Plan Update 2013 to demonstrate benefits of conjunctive use strategies or other resource management approaches);

- Incorporate changes to Beneficial uses and WQOs based on prototypes (i.e., apply results of Phases 1 and Phase 2 GIS BUOS to prototypes included in the ICM work and also other high priority Management Zones); and
- Prepare Central Valley Assessment (i.e., synthesize all work efforts from the ICM, and Phases 1 and 2 GIS BUOS to identify guidelines for CV-wide planning and recommendations for local efforts to refine source loading estimates, etc.)

***Deliverables:***

- *Prepare Draft Report*
- *Prepare Final Report incorporating comments*