

## **KNOWLEDGE GAINED SUBCOMMITTEE**

### **SUPPORTING DOCUMENTS**

**for**

**November 10, 2011 Technical Advisory Committee Meeting**

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# A Recommended Approach to Salt and Nutrient Management Plan Development in the Central Valley

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**Submitted to the CV-SALTS Knowledge Gained Committee on October 18, 2011**

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In responding to the request to provide markups on the “Framework document” (*A Framework for Salt and Nitrate Source Identification Studies, July 28, 2011 version*), the listed contributors have had a series of discussions regarding the overall approach to Salt and Nutrient Management Plan development in the Central Valley. Those discussions have led to the formulation of a recommended approach that is intended to be cost-effective, efficient, and consistent with the Recycled Water Policy requirements and other Salt and Nutrient Management Planning efforts in California. This brief discussion highlights the major elements of that concept and provides a context for comments offered separately on the Framework document.

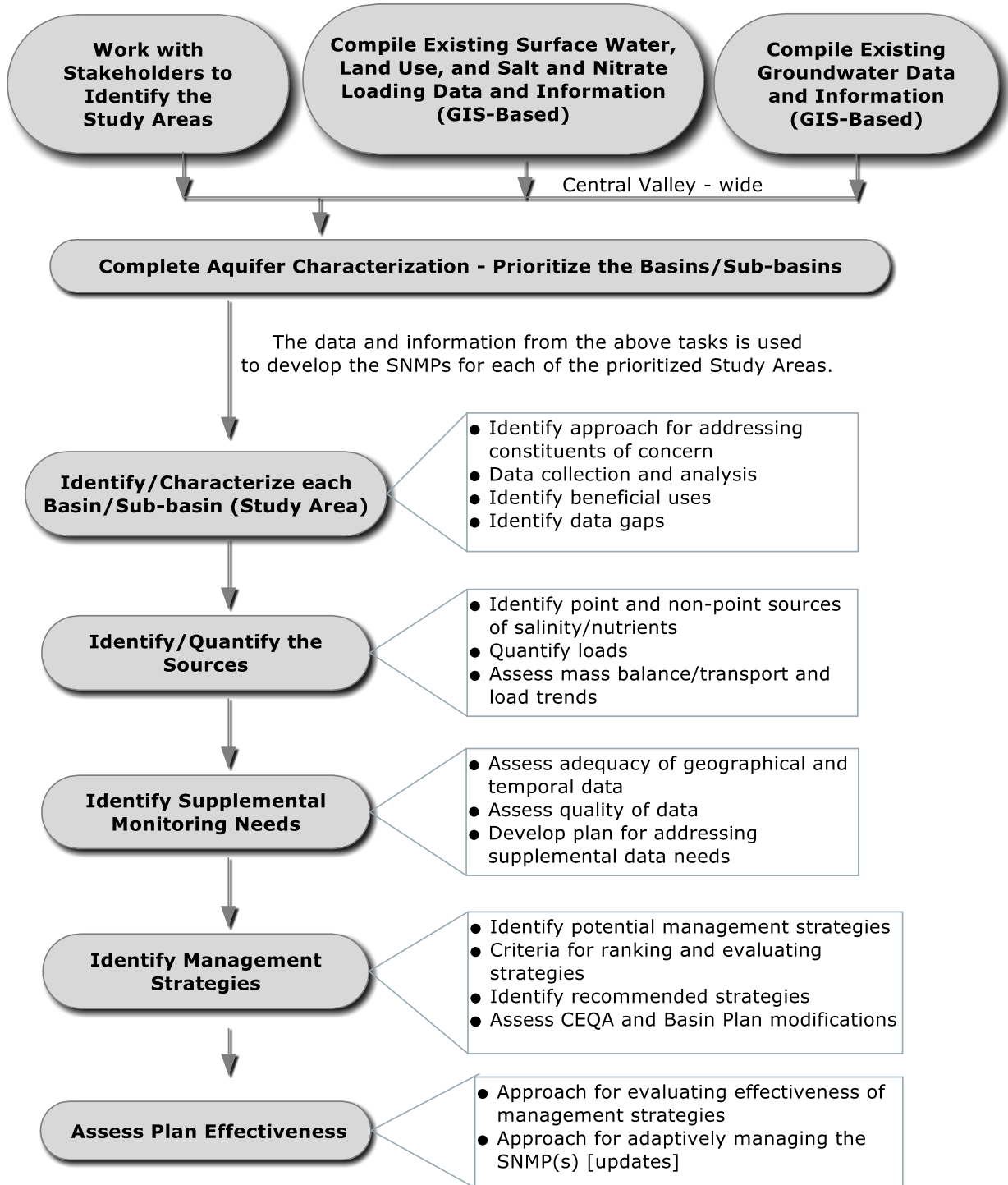
The recommended first steps in the development of Salt and Nutrient Management Plans in the Central Valley are (1) to identify candidate study area boundaries based on a multi-faceted approach involving identification of existing planning entities and political boundaries, assembly and review of available mapping layers depicting watersheds and groundwater basins/sub-basins, and, most importantly, direct outreach to stakeholders in candidate study areas; (2) to assemble and map readily available land use information in GIS-format on a valley-wide basis in the Sacramento, San Joaquin and Tulare Basins, building off prior efforts, as described in the attached document prepared by John Dickey; and (3) to assemble and map readily available groundwater basin information for the Sacramento, San Joaquin and Tulare basins, building off work performed by Luhdorff and Scalmanini, and others, to characterize aquifers and depict various groundwater attributes, including known problem areas, depth-dependent groundwater quality, depth to groundwater, soil permeability, and recharge potential. These steps can and should be performed in parallel to economize on time.

The information developed in these first steps should then be used to finalize study area boundary determinations as a critical next step. With the study area delineations established, the information developed in these first steps should be used in combination with existing GIS layers depicting beneficial uses and existing water quality objectives and criteria in the Central Valley (developed by Kennedy Jenks for CV-SALTS), to develop information needed to implement a Salt and Nutrient Management Planning

effort following the general guidelines established in the San Diego region (see attached flow diagram)[Ref: Welch, M.R. 2010. *Proposed Guidelines for Salt and Nutrient Management Planning in the San Diego Region (9)*. Prepared for Southern California Salinity Coalition and San Diego County Water Authority.]

The planning guidelines should be appropriately modified to reflect the conditions in the Central Valley and the requirements of CV-SALTS. The guidelines should be used to categorize basins/subbasins (and the associated aquifers) and study areas in the Central Valley using a tiered approach and to prioritize resource allocations to support Salt and Nutrient Management Planning in the Central Valley.

**Recommended Approach for the Development of  
Salt and Nutrient Management Plans (SNMPs) in Central Valley**



**Adapted from the *Proposed Guidelines for Salinity/Nutrient Management Planning in the San Diego Region (9)* document.**

# MEMO



**From:** John Dickey/PlanTierra  
**To:** File  
**Date:** October 17, 2011  
**Subject:** Conceptual Modeling of Salt and Nutrient Loads

At the Technical Advisory Committee meeting on September 29, 2011, I suggested an alternative to a non-spatial (or grossly-spatial) spreadsheet model of salt and nutrient balance as an Initial Study to define salt and nitrate sources and loads in a given Study area. The purpose of this memo is to summarize that suggestion in writing so that it may be fully considered by the Knowledge Gained committee.

The initial method for developing salt and nutrient loads for CV Salts should meet several criteria, including the following:

1. Employ readily available, existing data so that new or challenging data procurement and/or collection effort does not become an impediment.
2. Employ tools that are widely available so that they can be used by diverse, yet technically proficient groups.
3. Be sufficiently detailed and explicit to provide an accurate first cut at the size, intensity, nature, and location of sources, and therefore be readily checked by inspection and critical analysis with alternative tools.
4. Employ software that lends itself to structured, documented, repeatable analyses.
5. Provide a jump-start for more detailed analyses that might follow by providing data in formats that are needed by more sophisticated, mechanistic analytical tools. This is not only efficient; it breeds consistency and comparability among analyses. Inputs might be refined and enriched to provide mechanistic model inputs, but most of the load characterization needed as input to these models would be complete.
6. To the extent possible, methods should be informed by experience in other watersheds, including those developing salt and nutrient management plans in California.

The GIS-based approach I described, like the spreadsheet model, requires an inventory of sources, but employs land-use data, documented information regarding land management (irrigation, nutrient and salt loads), and waste loads (land application or discharge of salt and nutrient loads). The main difference is that instead of a list of loads associated with a geographic subarea, one begins with a much more detailed map from a QC'd data source, classified into a broadly recognized set of land uses. For example, the California Department of Water Resources maps land use every few years in field-by-field detail, with each individual field placed into one of a couple of hundred land use classes. Counties often do the same sort of mapping. Land use classes can be readily consolidated into groups that, from the standpoint of salt and nutrient management, are similar. The detail is not a detriment, since mapping exists in database format, and can be summarized into broader units by means of database or GIS queries.

Where a single data source proves inadequate, others may be employed. Two examples are wastewater discharges and animal waste loads. Both are documented by the Regional Boards in the form of permit documents, and have comparable spatial attributes that facilitate their incorporation into a GIS-based approach. These data contain far more detailed information regarding these important sources than DWR and county-level land use data, and thus are an ideal complement.

Parameters (hydraulic, salt, and nutrient loads, rates of uptake and other losses) can be developed for each land use class, and applied by means of queries. Water, salt, and nutrient balances can equally be performed by

calculations in these queries. Since the data are both spatial and in database format, the means by which results are obtained are documented in the tables, queries, and GIS layers.

The finished product can be developed in a number of ways, but generally has the following components:

- Land use and other waste load geospatial data (a map)
- Classification of land use and waste loads (a legend for the map)
- Loading parameters (hydraulic, salt, and nutrient input-output quantities for the classes in the legend)
- Queries that produce water, salt, and nutrient balance results for areas of interest (calculations)
- Reports that summarize input data and query results (tables and figures, summary or otherwise, according to needs)

The GIS-based approach meets all of the listed criteria, and is superior in most respects to spreadsheet models of salt and nutrient loading. The major drawback of the GIS-based approach is that, like spreadsheet models, it lacks a priori peer review and does not incorporate sophisticated or spatial modeling transport and transformation processes that are available in mechanistic models.

Thus, at a minimum, GIS-based approaches should be considered an equal alternative to those depending on calculations mostly done in spreadsheets or workbooks containing spreadsheets. I recommend that GIS-based approaches be considered in preference to the use of any spreadsheet model due to their superiority, as follows (numbered according to the criteria listed above):

1. DWR land use, water quality permit, irrigation, fertilization, irrigation water quality, estimated fate and transport, and other salt load (e.g., gypsum application) data are generally available.
2. GIS software and capable practitioners are widely available, employed by all major agencies and counties in Region 5.
3. Field-by-field, permit-by-permit information (for major permits and dairies) is quite detailed, but readily summarized in a GIS database.
4. GIS is a database format, employing documented tables of data and explicit queries and reports that any capable practitioner can review and duplicate.
5. GIS source inventories exactly like those described above are available for Region 5, having been developed as mechanistic model inputs for the Drinking Water Policy Working Group effort.
6. GIS-based conceptual models have been developed for areas of the Central Valley and the North Bay for this exact purpose.

Even if spreadsheet models are used, mechanistic models will eventually require that geospatial inputs be developed. Where the information and capability exists, why not begin by organizing load data linked to readily available geographic information, since this provides a more robust conceptual model? When/if mechanistic tools are used, the conceptual analysis can be employed directly as model input, so that the conceptual and detailed analyses will be more consistent with conceptual work, less costly, and more rapid.

In the event that a spreadsheet model is employed, the limitations imposed by the lack of geographic context should be stated clearly, and the resulting uncertainty recognized explicitly. If the spreadsheet model is used to develop a sub-basin salt and water budget, the inputs should be documented in such a way that they can be related to spatial elements in later analytical steps. Given the drawbacks of the spreadsheet approach, its application (if any) should be limited to high-level, sub-basin summaries. But again, these would be more robust in the first place if produced as roll-up summaries of the GIS-based analysis described previously, or of mechanistic modeling that employs GIS-based inputs.

1. **Study area/scale:** The Framework suggests “Initial Studies” use a clearly defined study area. While no specific scale is given for the Initial Studies, it is indicated the area include natural hydrological boundaries such as watersheds or groundwater basins. It is stated that a key objective of the initial study is to develop water budgets and salt and nitrate mass balances that are complete and include an **“accounting of all components in sufficient detail to identify potential management strategies”**. It is further stated that the Initial Studies develop salt/nitrate loads and mass balances where all “salt/nitrate sources, sinks, and concentrators are identified with appropriate quantitative, location, and associated land use data.” And, it is suggested that Final Studies *may* include determining “current and legacy salt/nitrate sources that are causing or have caused beneficial use impairment and establish the salt/nitrate load contribution of each source.”

Based on the indicated objectives for Initial Studies, the **study area for any Final Study would necessarily need to be the same as for the Initial Study** for time and resource expediency. More importantly, **in order to develop an accounting method with sufficient detail to identify potential management strategies, spatial and temporal objectives need to be specified and met in the Initial Study**. A sufficient level of detail would then enable further analysis as part of a “Final Study” to determine whether current/legacy loading have contributed to specific beneficial use impairment due to specific salt/nitrate source loading.

There are two types of studies compared in Table 1 in the Framework document. The Turlock study has a “gross” working scale, i.e., the entire subbasin is treated as the unit of analysis. The Pilot Study represents three area study areas (Modesto, Tule River and Yolo) each of which is comprised of many catchments, or subunits of analysis, defined based on the characteristics of both the watershed (physical features for major and minor surface water courses and use of the WARMF accounting tool to track all air, surface (soil and surface water), and near subsurface processes (surface water/groundwater interface and interface with deeper groundwater) and groundwater flow models in each of the three areas. The number of catchments in each area is: Modesto (55), Tule River (51), and Yolo (41). Accordingly, use of the WARMF accounting tool for organizing data and simulating processes allows initial and future **analyses with appropriate quantitative source/sink location and land and water use information to enable linkage of these processes to potential or actual impairment and to identify source/sink location-specific management strategies. Such analyses are not meaningful when the unit of analysis is too large**, i.e., basin/subbasins and no differentiation within those areas of the processes and source loading, and meaningful management strategies cannot be developed.

2. **Constituents of analysis:** The Framework places **equal significance on an accounting of salt and nitrate loads and mass balance determinations**. The Pilot Study approach addresses this objective for Initial Studies whereas the Turlock Study approach does not, or at least not in its current form. Additionally, the data collected and input into the WARMF accounting tool include many more constituents than simply TDS and nitrate. Rather, WARMF includes the suite of general minerals composing TDS, and also nutrients, biological constituents and other parameters which can play important roles in the analysis of source- and location-specific processes when tracking potential pollutants through a watershed from source areas.
3. **Temporal: Temporal considerations play a significant role when considering water to salinity/nutrient relationships and mass loading** (e.g., during different water year types, or seasonal water/wastewater flow variability, etc.). **Temporal considerations are, therefore, also important for the development of meaningful management strategies**. The Pilot Study data include daily or hourly meteorological parameters. These parameters were also based on stations located nearest to each of the catchments. The Pilot Study approach also included a 10- year

simulation period that incorporated average, dry, and wet water years. The Pilot Study also provided a comparative analysis between wet and dry water year types to test the sensitivity of the results to the water year type. The Turlock Study did not address temporal variability.

4. **Projected salinity/nitrate concentration trends: Two important factors are necessary** to make this analysis meaningful, including the **data representing the portion of the surface water or groundwater system to which the projection is being compared** and the **unit of analysis used to make the projection**. The Pilot Study described the sources of data and whether the data (e.g. groundwater data) allowed for differentiation of groundwater quality in different parts of the aquifer system. The Turlock Study did not describe efforts to differentiate the groundwater quality data obtained from different wells in the Subbasin. The Pilot Study used an approach for the Yolo study area for projecting concentration trends that was based on a shallow or upper portion of the aquifer system. While both studies employed a “mixing model”, the Yolo study employed one linked to data output from the WARMF model and also the CVHM MODFLOW model which varied temporally based on 10-year hydrologic data record for each catchment analyzed. The Turlock Study employed a mixing model that used the entire volume of groundwater contained in storage in the subbasin and assumed “instantaneous and uniform” mixing of all the groundwater in storage (23 MAF) with the salt mass load estimated for the entire subbasin. The Turlock Study approach is not meaningful as such mixing is highly unrealistic. Therefore, this approach is not a useful tool to project concentrations in the upper part of the aquifer system; it also does not allow differentiation by area of the affect of different land and water uses (i.e., potential management strategies) on groundwater quality. Therefore, it is not suitable for an Initial Study. The Yolo study area approach provides for a reasonable approach to an **analysis of the assimilative capacity of an area by catchment or collection of catchments**. The Turlock study approach is not suitable for analysis of assimilative capacity as it would overestimate the mass-dilution capacity by using the full volume of groundwater in storage.
5. **Priority areas of analysis:** The Framework does not suggest simpler and more expedient approaches to identifying priority regions for Salt and Nutrient Management Planning. **Existing groundwater quality data have been mapped for the entire Central Valley that show concentration changes with time and also by area with the more sensitive land use/geologic settings being associated with elevated constituent concentrations for TDS and nitrate.** These basic data are available to help guide and expedite the implementation of more detailed studies of the type that the Framework categorizes as Follow-Up Studies. The **greater spatial and temporal differentiation is required for meaningful salt and nitrate management planning** on the Central Valley scale that leads to timely completion of studies that inform the Basin Plan amendments.