

Attachment 5: Work Plan

PROJECT PURPOSE, GOALS, AND OBJECTIVES

The goals of this project: Upgrades, Calibration, and Application of Zone 7's Groundwater Model for Groundwater and Salt Management are:

Goal 1: Calibrate the model to effectively simulate current and future conditions.

Goal 2: Use the model for ongoing groundwater and salt management.

Goal 3: Use the model for optimizing conjunctive use, i.e., groundwater storage, production and recharge.

As discussed in Attachment 4, the project supports goals and objectives of the Zone 7 Groundwater Management Plan and Bay Area Integrated Regional Management Plan.

DESCRIPTION OF WORK

The proposed scope of work is divided into four main tasks. The tasks and their subtasks are:

Task 1: Revise and Add Model Features

Subtask 1A: Re-layer the model

Subtask 1B: Incorporate streams, lakes and arroyos

Subtask 1C: Update water balance and salt budget through 2012

Task 2: Calibrate the Model and Validate Model Code

Subtask 2A: Add new calibration data

Subtask 2B: Calibrate the model

Subtask 2C: Validate model code with comparison to USGS code

Task 3: Model Scenarios with Optimization

Subtask 3A: Develop baseline scenario

Subtask 3B: Perform optimization run

Subtask 3C: Run model scenarios

Task 4: Review, Reporting, and Project Management

Subtask 4A: Peer review

Subtask 4B: Produce model report

Subtask 4C: Project management

A detailed description of the work items to be performed for each task is presented below.

TASK 1: REVISE AND ADD MODEL FEATURES

SUBTASK 1A. RE-LAYER MODEL

The layering of the model will be modified to achieve two outcomes. The first purpose is to address possible salt migration delays due to clay overburden area in the southwestern portion of the basin. Zone 7 staff identified this as an important process that should be addressed in the updated model. The second purpose is to add the necessary refinement for salt transport modeling. Accurate salt transport modeling generally requires more model layers than groundwater flow modeling. Layers that represent the basin's gross hydrostratigraphy may be too thick to accurately represent the depth variation of salt concentrations.

In 2004, a hydrostratigraphic framework for the Western Basin was developed using sequence stratigraphic techniques (Figuers and Ehman, 2004). Zone 7 extended this framework during its Hydrostratigraphic Investigation of the Aquifer Recharge Potential for Lakes C and D (Zone 7, 2011 funded partially by the Local Groundwater Assistance Grant Program 2008-2009). This framework shows the extent of the clay overburden area that may retard salt migration. Zone 7 staff will use the sequence boundaries to help define model layer elevations. HydroMetrics WRI will review and revise the model layer elevations to facilitate numerical convergence.

In order to add the necessary refinement for salt transport modeling, Zone 7 staff will compile, review and summarize salt concentrations by elevation. Zone 7 staff and HydroMetrics WRI will identify elevations where the greatest changes in salt concentrations occur and define model layers to be able to simulate those vertical changes in salt concentrations. HydroMetrics WRI will also adjust the model layer elevations for numerical considerations.

The model layer elevations will be imported into the Groundwater Vistas groundwater model graphical user interface (GUI). For quality assurance purposes, maps and cross-

sections of model layer elevations will be output from Groundwater Vistas for comparison with the model-independent maps and cross-sections used to define layer elevations.

SUBTASK 1B. INCORPORATE STREAMS, LAKES, AND ARROYOS INTO THE MODEL

Streams (arroyos) and lakes (former gravel pits known as Chain of Lakes) are likely important features for moving salt into and around the basin. The current model does not explicitly simulate stream routing or lake water budgets. Zone 7 is currently funding software development that will add the capability to simulate transport as well as flow in the streams and lakes packages. This will allow direct simulation of flow and transport interactions between the groundwater and surface water features.

HydroMetrics WRI will implement the MODFLOW packages for streams (SFR2, Niswonger and Prudic, 2005) and lakes (LAK3, Merritt and Konikow, 2000) in the Zone 7 model including locations, elevations, geometry, and inflows. HydroMetrics WRI will implement the new MT3DMS transport capabilities by assigning background concentrations and influent concentrations to the model. Time-varying data from 1974 through 2012 will be included.

SUBTASK 1C. UPDATE WATER BALANCE AND SALT BUDGET THROUGH 2012

The current version of the model includes water balance and salt budget data through 2004. The model will be updated with data through 2012. Zone 7 staff will meet with members of the TRVG to collect updated data for the model. With review from HydroMetrics WRI, Zone 7 staff will compile and format the updated data sets for pumping, recharge, and salt loading estimates for input into the model. Zone 7 staff has recently revised the recharge estimates based on mapping of land use and soil types in preparation for this task.

Water balance and salt budget data will be imported into the Groundwater Vistas GUI. For quality assurance purposes, the simulated water balance and salt budget from the calibrated model will be graphed and compared to the input data sets for water balance and salt budget information.

TASK 2: CALIBRATE AND VALIDATE MODEL CODE

SUBTASK 2A. INCLUDE NEW CALIBRATION DATA

New data for model calibration will be added to the model. Some of these data have been collected since the last calibration in 2004, and some are added to calibrate new improvements to the model, such as the streams and lakes package. New data to be compiled by Zone 7 staff for comparison to model results are:

- 2004-2012 groundwater level data from monitoring wells,
- 2004-2012 salt concentration data from monitoring wells,
- 1974-2012 salt concentrations at extraction wells,
- New aquifer test data (e.g., transmissivity) from three recently installed wells,
- 1974-2012 streamflow data and
- 1979-2012 lake level data.

The calibration data will be imported into Groundwater Vistas so model results can be compared to observed data within Groundwater Vistas. Graphs of observed data will be produced as part of Subtask 2B, and Zone 7 staff will compare the graphs of measured data to available report graphs as part of a quality assurance procedure for the calibration data input.

SUBTASK 2B. CALIBRATE FLOW AND TRANSPORT MODEL

The flow and transport model will be calibrated to groundwater level elevations, salt concentrations, streamflow and lake level data, and other data added in Subtask 1B. HydroMetrics WRI will use Parameter Estimation (PEST) software to calibrate hydrologic parameters that vary over the basin area. Calibration will be judged on both visual inspection of groundwater hydrographs and chemographs; as well as statistical analysis of model results. Calibration will continue until both Zone 7 staff and the consultant staff agree that the model results are adequate for running simulations to evaluate alternatives for groundwater and salt management. The calibrated model and a summary of calibration results will be provided to the peer reviewer for his comments. The peer reviewer's comments will be addressed and, where appropriate, incorporated into the final calibrated model.

SUBTASK 2C. VALIDATE FLOW MODEL CODE WITH USGS CODE

In order to utilize the software capabilities currently being developed that will allow simulation of salt transport in streams and lakes, specialized versions of MODFLOW 2000 (MF2K-SSPA, Bedekar et al., 2011) will be used for the Zone 7 groundwater model.

Although MF2K-SSPA is not the official USGS version of MODFLOW (Harbaugh et al., 2000), it was developed in collaboration with the developers of the official USGS code MODFLOW-NWT (Niswonger et al, 2011). To validate use of MF2K-SSPA, the USGS code MODFLOW-NWT will be used on equivalent flow model input and flow results from the two codes will be compared.

TASK 3: SIMULATE MANAGEMENT ALTERNATIVES WITH OPTIMIZATION

SUBTASK 3A. BASELINE SCENARIO

Zone 7 will develop a scenario to use as a baseline for applying the model to evaluate groundwater and salt management alternatives. Prior to developing a scenario, Zone 7 staff will meet with the Tri-Valley Retail Group to introduce the upgrades of the model, collect input data for the baseline scenario, and discuss management alternatives to simulate. The baseline scenario will be developed using the hydrology from 1974-2012, but keeping constant current conditions such as land use, existence of surface water features such as the Chain of Lakes, and current pumping patterns. Zone 7 staff will update the recharge estimates based on current land use and estimate pumping based on current patterns for importation into the model. HydroMetrics WRI will review these estimates and implement the existing surface water features in the streams and lakes packages.

Water balance and salt budget data will be imported into the Groundwater Vistas GUI. For quality assurance purposes, the simulated water balance and salt budget from the baseline scenario model will be graphed and compared to the input data sets for water and salt budget information.

SUBTASK 3B. INITIAL OPTIMIZATION RUN

Zone 7 will develop a groundwater management alternative for optimization. Pumping and recharge in the basin will be optimized to achieve basin management objectives. An example of optimization would be to maximize salt removal from the basin while maintaining groundwater levels above a benchmark such as historic lows. HydroMetrics WRI will develop the optimization procedure to demonstrate model capabilities using the optimization software SOMOS (Systems Simulation/Optimization Laboratory, 2004). Part of this task is training of Zone 7 staff so they will be able to use the model for future optimization runs to guide groundwater and salt management.

Intermediate model runs created as part of the optimization run will be saved and reviewed for quality assurance purposes.

SUBTASK 3C. RUN MANAGEMENT ALTERNATIVE SIMULATIONS

Zone 7 will apply the model to two additional groundwater and salt management alternatives to provide a general understanding of the ability of management actions to meet basin management objectives. Zone 7 staff will define the water and salt budget information for the alternatives and create the model input files to simulate those alternatives. HydroMetrics WRI will review the model input files and evaluate the output from the model.

Water and salt budget data will be imported into the Groundwater Vistas GUI. For quality assurance purposes, simulated water and salt budgets from the baseline scenario model will be graphed and compared to the input data sets for water and salt budget information.

TASK 4: REVIEW, REPORTING AND PROJECT MANAGEMENT

SUBTASK 4A. PEER REVIEW

Mr. Zafer Demir, a groundwater modeling expert from Lawrence Livermore National Laboratory, has been slated to provide peer review for the model. If Mr. Demir should become unavailable to conduct the peer review, another groundwater modeling expert with equivalent qualifications will be selected to conduct the peer review. After completing calibration, Zone 7 will provide the model files and documentation of model upgrades and calibration to the peer reviewer. The peer reviewer will have a meeting with Zone 7 staff and HydroMetrics WRI to provide comments. Where appropriate, comments will be addressed with changes to the model or in the report. The peer reviewer will also be provided the draft review for written comment. Where appropriate, comments will be incorporated into the final report. A summary of comments and responses will be provided as an appendix to the final report.

SUBTASK 4B. MODEL REPORT

Articulate and thorough model reports serve as both a record of the model's development, and as reference documents for future model users. At a minimum, the model documentation should include the information outlined by authors such as Anderson and Woessner (1992), and the Murray-Darling Basin Commission (2000). HydroMetrics WRI will provide Zone 7 with a draft model report. The documentation will include a discussion of data adequacy, provide suggestions for strengthening the existing data set, and present guidelines for regularly updating and improving the model. The report will document the upgrades to the model, the calibration, and the results of the management alternative scenarios including the initial optimization run.

The report will include necessary components for submission as a final report to the DWR.

An electronic draft of the modeling report will be provided to Zone 7 staff and the peer reviewer for their comments. HydroMetrics WRI will incorporate all comments into the draft final report as appropriate. DWR will receive an electronic copy of the draft final report. Zone 7 staff will meet with DWR staff to discuss DWR's review of the report and DWR's will be incorporated into the final report. Zone 7 will produce and distribute electronic and hard copies of the final report, including the copies to DWR as the final grant report.

SUBTASK 4C. PROJECT MANAGEMENT

Zone 7 will perform project management tasks as discussed in Performance of the Project below. This task includes preparation of four quarterly reports for submission to DWR to update the status of project progress. This task also includes any DWR requirements for project close-out, including a final meeting between DWR and Zone 7 staff.

PERFORMANCE OF THE PROJECT

SCHEDULE AND BUDGET MANAGEMENT

The budget for this project will be tracked at two levels: Zone 7 will track budgets in its internal accounting system, and HydroMetrics WRI will track its portion of the budget independently. Budgets and schedules will be updated monthly based on the consultants' monthly invoices and Zone 7 timesheets. Budget and schedule management is additionally tied to the quarterly reporting plan. The quarterly reports will identify progress to date, compare actual progress with the anticipated schedule, identify where the schedule and budget have slipped, and propose methods for addressing problems with budget or schedule.

ONGOING USE

The model will be used regularly by Zone 7 staff and to optimize pumping and artificial recharge. It would also be used to simulate the effects of particular management actions, such as changing the source/quality of recharge water, redistributing pumping from wells, assessing well master plan siting of wells, and maintaining groundwater elevations above historical lows.

The model is planned to be updated every seven to ten years. This ensures the model remains calibrated to recent data and takes advantage of new and improved modeling

packages that may be published by the USGS. The ongoing modeling work and future upgrades conducted by Zone 7 staff would be funded from their Groundwater Group budget.

INFORMATION DISSEMINATION

Draft reports will be provided to the Tri-Valley Retail Group (Dublin San Ramon Services District [DSRSD], City of Livermore, City of Pleasanton and the California Water Service Company [CWS]), and made available to the public for comment. Final reports will be provided to the stakeholders to be used as reference during groundwater management and salt and nutrient management activities.

Upon completion, the project report will be made available on Zone 7's website at: <http://www.zone7water.com/publications-reports/water-reportsplanning-documents>

PROJECT DELIVERABLES

As outlined in the Scope of Work, the project deliverables will include the following:

Quarterly Reports. Given the expected project schedule of 15 months, four quarterly progress reports required by DWR will be prepared and submitted. The reports will demonstrate that the project is proceeding as planned, and that the grant funding is being expended in accordance with the grant requirements. The reports will include a description of progress made for the reported quarter, an update on the budget for each project task, an update on the status of each project task, and a description of work expected to be completed by the end of next quarter.

Draft and Final Report. The draft report will document the model upgrades, calibration, and groundwater and salt management application. Approaches to various aspects of the model will be documented, but much of the model documentation will be provided by figures and tables. Specific figures and tables on model upgrades that will be included in the report are:

- Cross-section and plan figures showing changes to model layering
- Maps showing characteristics of streams and lakes
- Tables and figures showing water balance components

Specific figures and tables on calibration that will be included in the report are:

- Hydrographs and chemographs comparing model results of groundwater levels, stream flows, lake levels, and salt concentrations with observed data

- Graphs of observations vs. simulated results and observations vs. calibration error
- Contour and flood maps of simulated results vs. observed data
- Model calibration statistics

Specific figures and tables on application of the model to groundwater and salt management that will be included in the report are:

- Figures and tables showing model simulation assumptions
- Hydrographs and chemographs showing simulation results
- Contour and flood maps of simulation results
- Figures and tables showing optimized results

ENVIRONMENTAL COMPLIANCE

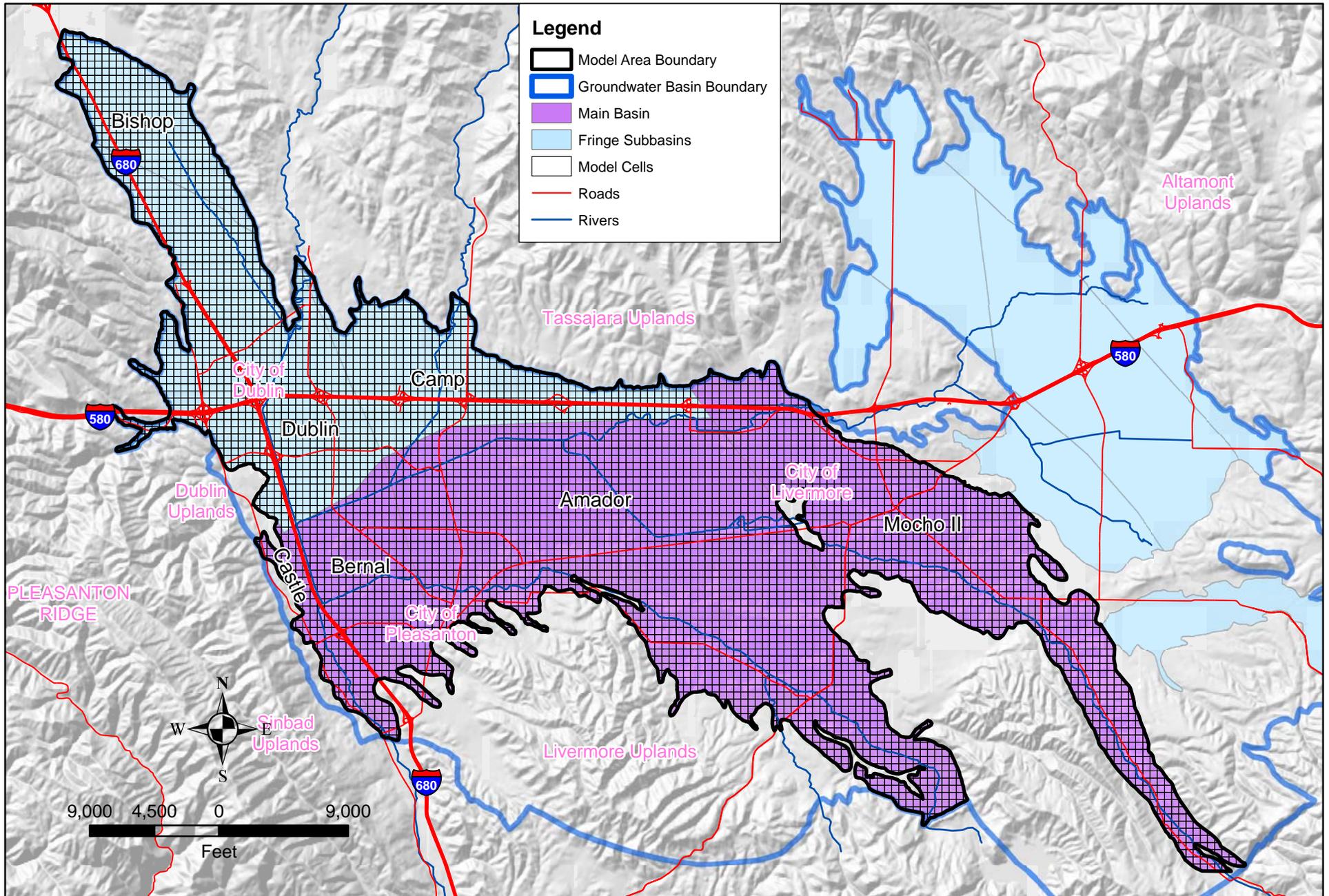
The proposed project will update Zone 7's existing model, and as such, no environmental permits are anticipated to be required for the proposed project. The proposed activities would not have a direct or reasonably foreseeable indirect physical change in the environment. As a result, the proposed activities would not be considered a project under and be subject to the California Environmental Quality Act (CEQA).

Following the completion of the proposed project, the updated model may be used for Zone 7's update of its Salt Nutrient Management Plan and GWMP. Any environmental permitting and/or CEQA obligations required for, or as a result of, the plans will be completed for these efforts.

REFERENCES

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- Harbaugh, A.W., E.R. Banta, M.C. Hill, and M.G. McDonald. 2000. MODFLOW-2000, the U.S. Geological Survey modular ground-water model -- the Ground-Water Flow Process: U.S. Geological Survey, Reston, VA, variously p.

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- Niswonger, R.G. S. Panday, and M. Ibaraki. 2011. MODFLOW-NWT, A Newton Formulation for MODFLOW-2005: U.S. Geological Survey Techniques and Methods, Book 6, Chap. A37, 44 p.
- Niswonger, R.G. and D.E. Prudic., 2005, Documentation of the Streamflow-Routing (SFR2) Package to include unsaturated flow beneath streams--A modification to SFR1: U.S. Geological Survey Techniques and Methods, Book 6, Chap. A13, 47 p.
- Systems Simulation/Optimization Laboratory. 2004. User's Manual for Web and Standard SOMOS Versions. Utah State University. 2004.
- Zheng, C. 2010. MT3DMS v5.3 Supplemental User's Guide, Technical Report to the U.S. Army Engineer Research and Development Center, Department of Geological Sciences, University of Alabama, 51 p.
- Zone 7 Water Agency. 2011. Hydrostratigraphic Investigation of the Aquifer Recharge Potential for Lakes C and D, Livermore, CA.



ZONE 7 WATER AGENCY
 100 North Canyons Parkway, Livermore, CA

DRAWN: TR

REVIEWED: MK, GK, CT

File: E:\PROJECTS\LGAGrantStudy2012-Model\FigAtt5-1-ModelArea.mxd

**MODEL AREA AND GRID
 LIVERMORE VALLEY
 GROUNDWATER BASIN**

Scale: 1" = 9,000'

Date: July 12, 2012

FIGURE Att5-1