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List of Abbreviations

ASTM American Society for Testing and Materials
BC Brown and Caldwell
BCDWRC Butte County Department of Water and Resource Conservation
CEQA California Environmental Quality Act
CSU California State University
DWR California Department of Water Resources
GIS Geographic Information System
IRWM Integrated Regional Water Management
IS/MND Initial Study/Proposed Mitigated Negative Declaration
LTA Project Lower Tuscan Aquifer Monitoring, Recharge, and Data Management Project
MND Mitigated Negative Declaration
TSC Technical Steering Committee
Section 1
Introduction

This report is being submitted as the Third Quarter 2011 Quarterly Report concerning activities completed for the Lower Tuscan Aquifer Monitoring, Recharge, and Data Management Project (LTA Project). This Quarterly Report is intended to meet the requirements of Attachment Two Section A2.3 of the County of Butte Contract Number 18050 dated January 31, 2010 between Butte County and Brown and Caldwell (BC). The purpose of the Quarterly Reports are to provide the Butte County Department of Water and Resource Conservation (BCDWRC) and the Public progress reports on activities completed during the quarter, a summary of initial findings, and an estimate of activities that will be completed during the next quarter. The LTA Project consists of seven tasks as follows:

Task 1 – California Environmental Quality Act (CEQA) Initial Study
Task 2 – Technical Steering Committee
Task 3 – Development of Geographic Information System (GIS) Geodatabase
Task 4 – Aquifer Recharge Assessment
Task 5 – Installation of Groundwater Monitoring Wells
Task 6 – Aquifer Performance Testing
Task 7 – Public Outreach

The Tuscan Aquifer system, a regional aquifer of the Sacramento Valley Groundwater Basin, is among the principal water bearing units in Butte County. For this project, the Tuscan Formation has been divided into four units, labeled A through D, as defined by Helly and Hardwood (1985). Units A and B define the LTA, the subject of this study, and units C and D define the Upper Tuscan Aquifer. The approximate extent of the LTA within the project boundaries is shown on Figure 1-1.

1.1 LTA Project Purpose

Butte County has been awarded grant funds from the California Department of Water Resources (DWR) through Proposition 50 (Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002) for implementation of the LTA Project. Included as part of Proposition 50, is the Integrated Regional Water Management (IRWM) Grant Program. Butte County is administering the LTA Project in partnership with the Northern Sacramento Valley Integrated Regional Water Management Group, previously the Four County Group.
Butte and Tehama Counties, California

General Lower Tuscan Aquifer Project Area

Legend
- Proposed Reaches
- Existing Monitoring Wells
- Existing Performance Wells
- Proposed Monitoring Wells
- Infiltrometer Test Locations
- Stream Gauging Locations
- Study Streams
- Lower Tuscan Outcrops
- Approx. Buried Tuscan Extent

Figure 1-1

0 1 2 4 6 8 10 Miles
1:316,800 1 inch = 5 miles

S:\Butte County\138604_Lower_Tuscan_Aquifer_Inv\ARCMAPS\FIGURES\Quarterly Reports\2010Q1\Overview.mxd
The LTA Project grant application included a scientific investigation that is to develop data and analytic tools to improve the understanding of the aquifer. Specifically, the LTA Project is a scientific field investigation that seeks to improve the scientific understanding of the properties of the LTA system including:

- The physical parameters affecting percolation of surface water to the LTA.
- The interaction between surface water and the LTA.
- Recharge contributions from other aquifers to the LTA.
- Measurements of standard aquifer properties and their variability.
- Identification of natural recharge areas under current hydrologic conditions.
- Identification of recharge areas under increase utilization.
- How additional pumping may impact the aquifer and surface water.

In addition, the project includes development of a comprehensive GIS Geodatabase to store data collected during the duration of the project. As part of the GIS Geodatabase, the project also includes development of a field data collection tool that will improve quality of data collected in the field to be incorporated into the Geodatabase. Finally, the project includes a public outreach program that will heighten public awareness and understanding of the aquifer.

1.2 Report Format

As stated above, the purpose of the Quarterly Reports is to provide the BCDWRC and the public progress reports on activities completed during the quarter, a summary of initial findings, and an estimate of activities that will be completed during the next quarter. As such, the format of this report has been developed based on activities completed during the Quarter. For the Third Quarter 2011, activities have been conducted for Tasks 1 through 7 stated in the introduction. The activities discussed in this report cover the period from July 1, 2011 to September 30, 2011. An updated schedule showing the progress of the project is provided on Figure 1-2.
## Lower Tuscan Aquifer Monitoring, Recharge, and Data Management Project

### Project Milestones

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### Milestones and Tasks Summary

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<td>Final Comprehensive Report</td>
<td>2010-08-01</td>
<td>2010-08-31</td>
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*Figure 1-2*
Section 2

CEQA Initial Study

BCDWRC, acting as the California Environmental Quality Act (CEQA) Lead Agency, has determined that the proposed LTA Project would not have a significant effect on the environment pursuant to CEQA. Because the Lead Agency finds no substantial evidence that the project or any of its aspects may cause a significant impact on the environment with mitigation, a Proposed Mitigated Negative Declaration (MND) was prepared. BC with teaming partner Galloway Consulting were responsible for preparation of the CEQA Initial Study/Proposed Mitigated Negative Declaration (IS/MND). The IS/MND was approved by the Butte County Board of Supervisors on July 13, 2010. A copy of the IS/MND and response to comments can be found at the project website listed below.


A summary of activities conducted for this task during the Third Quarter 2011 and planned activities for Fourth Quarter 2011 are presented in the following Sections.

2.1 Activities Completed - Third Quarter 2011

On July 13, 2011, the archeologist observed the installation of temperature gradient wells along Big Chico Creek. After completion of this inspection, a letter report, summarizing the mitigation measures conducted for the project was prepared and submitted to Butte County. This report, dated September 7, 2011, provides a brief summary of field activities for all LTA tasks and a verification that no direct or indirect impacts to sensitive natural communities or plant, wildlife, and fish species and their associated habitat occurred during field work. A copy of this report is provided in Appendix A.

2.2 Planned Activities - Fourth Quarter 2011

Submission of the September 7, 2011 mitigation measures letter report completes the CEQA task for this project.
Section 3

Technical Steering Committee

A Technical Steering Committee (TSC) has been formed to provide input and recommendations to help guide the progress of the project and the quality of the data. The TSC is comprised of qualified scientists selected from within the Four County area and includes representatives from State and local agencies, the academic community and various special districts throughout the Northern Sacramento Valley. The TSC meets on an as needed basis throughout the duration of the project and will act solely in an advisory capacity to Butte County and the BC Project Team. A list of the TSC members and the organization they represent are in the Table 3-1.

<table>
<thead>
<tr>
<th>TSC Member</th>
<th>Organization</th>
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</thead>
<tbody>
<tr>
<td><strong>Four County Group Members</strong></td>
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</tr>
<tr>
<td>Vickie Newlin</td>
<td>BCDWRC</td>
</tr>
<tr>
<td>Allan Fulton</td>
<td>Tehama County</td>
</tr>
<tr>
<td>Lester Messina</td>
<td>Glenn County, Department of Agriculture</td>
</tr>
<tr>
<td>Steve Hackney</td>
<td>Colusa County, Planning and Building Department</td>
</tr>
<tr>
<td>Dan Peterson</td>
<td>Water Resources, Sutter County Department of Public Works</td>
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<tr>
<td><strong>External TSC Members</strong></td>
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<tr>
<td>Joe Connell</td>
<td>University of California Cooperative Extension</td>
</tr>
<tr>
<td>Brendon Flynn</td>
<td>Pacific Farms &amp; Orchards</td>
</tr>
<tr>
<td>Dr. Steffan Mehl</td>
<td>California State University (CSU) Chico</td>
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<tr>
<td>Dr. Todd Greene</td>
<td>CSU Chico</td>
</tr>
<tr>
<td>Benn Pennock</td>
<td>Glenn Colusa Irrigation District</td>
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<tr>
<td>Ted Trimble</td>
<td>Western Canal Water District</td>
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<tr>
<td>Kelly Stanton</td>
<td>DWR, Northern District</td>
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<tr>
<td>Tracy McReynolds</td>
<td>Department of Fish and Game</td>
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<tr>
<td>John Lane</td>
<td>Chico Environmental Science and Planning</td>
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<tr>
<td>Mark Kimmelshue</td>
<td>Armco</td>
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<tr>
<td>Dr. Lev Kavvas</td>
<td>Hydraulic Research Laboratory, California Hydrologic Research Laboratory</td>
</tr>
<tr>
<td>Carol Perkins</td>
<td>Butte Environmental Council</td>
</tr>
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</table>
3.1 Activities Completed - Third Quarter 2011

A meeting to discuss the initial results of aquifer tests completed at the Esquon Ranch and Hackett property was conducted on August 16, 2011 with DWR staff. A TSC meeting was conducted on September 16, 2011. The objective of the TSC meeting was to provide a project status update and share initial/preliminary results of field activities completed during the Spring/Summer 2011 field season. A copy of the presentation slides prepared for this meeting are included in Appendix B.

3.2 Planned Activities - Fourth Quarter 2011

No TSC meetings are anticipated during Fourth Quarter 2011. The next anticipated TSC meeting should be occur during the First Quarter 2012 to discuss results of analysis of the recently completed aquifer tests and assessments of existing aquifer tests conducted over the project area.
Section 4

GIS Geodatabase

As stated in Section 1, the project includes development of a comprehensive GIS Geodatabase to store data collected during the duration of the project. This system is an important tool for the BCDWRC to monitor conditions in the groundwater basin and promote education regarding the local water resources and will allow qualification and quantification of surface water and groundwater properties from the LTA Project area including:

- Aquifer transmissivity and hydraulic conductivity;
- Aquifer storage values (storativity or specific yield);
- Surface water and groundwater temperature;
- Streambed and soil infiltration capacities;
- Monitoring well location and construction;
- Extraction well location, construction, yield, drawdown and specific capacity.

As part of this task, the BC Project Team also developed a field data collection tool that will improve the quality of the data collected in the field to be incorporated into the geodatabase.

4.1 Activities Completed - Third Quarter 2011

During the Third Quarter 2011, stream gauging data and aquifer test data as discussed in Sections 5 and 7 were added to the geodatabase.

4.2 Planned Activities - Fourth Quarter 2011

During the Fourth Quarter 2011, data will be collected during this period using the field tool as discussed in the other sections.
Section 5
Aquifer Recharge Assessment

The aquifer recharge assessment is intended to gain a better understanding of the flow pathways by which surface water enters the subsurface and recharges the LTA. Three subtasks have been identified to assess the potential for recharge from surface water sources: Subtask 1 – Soil Infiltration Testing; Subtask 2 – Stream Gauging; and Subtask 3 – Stream-Aquifer Temperature Gradient Evaluation.

The soil infiltration testing (Subtask 1) will be performed at 10 locations (Figure 1-1). Each test location will include the performance of basic geologic outcrop mapping in the immediate vicinity of the test location. One double-ring infiltrometer test will be performed at each of the ten proposed sites following American Society for Testing and Materials (ASTM) Standard D-3385-03. The stream gauging task (Subtask 2) was intended to provide estimates of discharge, and potential recharge to the LTA, from 6 primary streams within the drainage basin overlying and intersecting the LTA. These streams included: Antelope Creek, Mill Creek, Deer Creek, Big Chico Creek, Butte Creek, and Little Dry Creek (Figure 1-1). However, due to access issues, the stream gauging task will only be conducted from five streams: Mill Creek, Big Chico Creek, Butte Creek, Deer Creek, and Little Dry Creek. As indicated below, access to Deer Creek was granted in June 2011. If access is granted at a later date to Antelope Creek, then stream gauging activities will be conducted at this stream as appropriate.

The Stream-aquifer interaction task (Subtask 3) includes three components which relate to the ability for the stream channels to act as primary recharge conduit to the LTA. The three tasks to be implemented here include a temperature gradient evaluation, slug testing of shallow piezometers, and seepage meter evaluation. Details of each of these tasks are presented in the Draft IS/MND. To assess the viability of these tests for future use, these tests will initially only be conducted at Mill Creek, Big Chico Creek, and Butte Creek. If the tests are successful, then these tests will be conducted on Little Dry Creek and if access is granted at a later date, on Antelope Creek and Deer Creek.

5.1 Completed Third Activities Quarter 2011

On August 4 and 5, 2011, the BC team performed the three remaining infiltrometer tests at locations designated SI-DR-3, -6, and -8 (Figure 1-1). Copies of the infiltration plots for each of these tests are provided in Appendix C. A summary of the infiltration tests collected to date are summarized on Figure 5-1. The BC team also submitted soil samples collected from each of the completed infiltrometer tests for grain size analysis. Appendix C presents the laboratory reports for the completed grain size analysis.

The BC team conducted two stream gauging events during July and September 2011 on Mill Creek, Deer Creek, Big Chico Creek, and Butte Creek. No flows were observed in Little Dry Creek during both of these periods. It was also observed that high flows between the July and September 2011 events removed the staff gauge from the upper station at Mill Creek. During the September 2011 gauging event at this station, the stage measurement was collected using a tape measure from the top of the pipe (see Figure 5-2) used to secure the staff gauge and house the pressure transducers. This measurement will be corrected after installing a new staff gauge at the site. The data collected from the stream gauging events will be used to develop ratings curves for each station. An example of the initial rating curve developed for the upper Butte Creek station is shown on Figure 5-3.
Figure 5-1. Summary of Infiltration Results. Red indicates recently completed tests.

Figure 5-2. Initial Ratings Curve for Upper Station on Butte Creek.
During the September 2011 stream gauging event, the BC team installed temperature probes into the shallow piezometers installed at Mill Creek (Figure 5-4). At Big Chico Creek, the temperature probe wells could not be installed due to drilling refusal within the cemented material in the area. The deepest depth penetrated in this area was three feet immediately adjacent to the creek. Observations indicated that the borehole was dry suggesting that water is not moving from the creek to the groundwater.

![Figure 5-3. Missing Staff Gauge from Upper Mill Creek](image1)

![Figure 5-4. Temperature Probes Attached to Pipe Prior to Installation in Well](image2)

### 5.2 Planned Activities – Fourth Quarter 2011

As discussed in the Second Quarter 2011 Quarterly Report and the September 16, 2011 TSC meeting, the results from the infiltrometer test conducted at LTA-SI-DR5 were questionable due to the presence of abundant organic material. As such, the BC team will conduct an additional test near Hicks Lane and Landmark Drive. The BC team will also conduct another round of stream gauging, download pressure transducers at each gauge location, and prepare each location for the upcoming winter months.
Section 6

Installation of Groundwater Monitoring Wells

Over the past few years, dedicated groundwater monitoring infrastructure (monitoring wells) have been installed in the Northern Sacramento Valley, which has contributed to a better understanding and quantification of the region. The LTA Project includes the installation of additional monitoring wells to further contribute to groundwater monitoring databases. The purpose of this task is to:

- Establish a reliable baseline of hydrogeologic data,
- Fill data gaps,
- Measure drawdown during aquifer performance tests,
- Monitor groundwater recharge, and
- Evaluate well performance and pumping impacts.

Dedicated groundwater monitoring wells provide data regarding the depths of different aquifers. Small diameter PVC pipes with perforations at varying depths were placed near existing production well and measurements of groundwater depth and quantity will be made at different times to assess local groundwater recharge and recovery. The newly installed monitoring wells cannot be used for or retrofitted for groundwater extraction or production of water. Once the monitoring project is complete, the monitoring wells will be integrated into the cooperative DWR-BCDWRC groundwater monitoring network.

6.1 Activities Completed - Third Quarter 2011

During the Third Quarter 2011, the BC team completed preparation of the geologic boring logs and well completion diagrams. Copies of these logs as submitted to the DWR are provided in Appendix D.

6.2 Planned Activities - Fourth Quarter 2011

All planned field activities for this task have been completed. During the Fourth Quarter 2011, the BC team will prepare and submit the Field Investigation Report summarizing the procedures used and results for the installation of the groundwater monitoring wells.
Section 7
Aquifer Performance Testing

This task consists of two subtasks, a review of existing aquifer performance testing and the performance of up to three aquifer performance tests. Up to six detailed reviews of existing aquifer performance tests will be conducted. The review will include the evaluation of test design, test implementation, the data collected during the test, and the analysis of the test data. If the analysis of the data is found to be inconsistent with industry standards the data will be re-analyzed to verify results.

Aquifer performance testing will be conducted on three existing production wells. The locations of these wells are shown on Figure 1-1. Newly installed groundwater monitoring wells MW-MT-1 and MW-HKT-1 will be used as observation wells during two of these tests. An existing groundwater monitoring well installed by the DWR (see Figure 1-1) will be used as an observation well during the third aquifer test. The production wells to be utilized are existing groundwater pumping wells and are connected to irrigation distribution systems. The water extracted will be used as part of existing irrigation practices and distributed according to normal operating conditions at each location. These tests will be compliant with the Regional Water Quality Control Board General Discharge Permit, where applicable and no additional permitting would be required.

7.1 Activities Completed - Third Quarter 2011

During Third Quarter 2011, the BC team continued to monitor water levels at the Esquon Ranch and Hackett properties and begin analysis of the aquifer tests conducted at each of these sites. The BC team also conducted a second test at the Hackett property from September 16, 2011 through September 19, 2011. This test was conducted using another irrigation well located on the property that appears to be completed within the zone screened by MW-HP-1-Deep.

Due to cooler temperatures in the area, irrigation of the orchards at M&T Ranch did not allow operation of the planned pumping wells for the aquifer test at this site for more than a two day period. As such, the aquifer test at this site has not been conducted. The current plan is to conduct this test during the Summer 2012 or switch the test to the CSU site.

Figure 7-1. Pumping Well Used for Additional Test at the Hackett Property
7.2 Planned Activities - Fourth Quarter 2011

During the Fourth Quarter 2011, the BC Project Team will conduct the aquifer test at the M&T Ranch or CSU ranch if pumping wells will be used for at least a 4 to 5 day continuous period. In addition, the BC team will: continue to monitor water levels at the Esquo Ranch and Hackett properties through the irrigation season; continue analysis of the completed aquifer tests; and begin analysis of existing aquifer tests conducted throughout the project area.

Figure 7-2. Setup for Measuring Flow Rates of Pumping Wells during Aquifer Tests
Section 8
Public Outreach

The purpose of the public outreach task is to educate regional and county decision makers and the public about the aquifer investigation’s objectives, progress, and results. Public outreach as part of the LTA Project will primarily consist of stakeholder and public meetings, with support in the form of quarterly reports, a website, and newsletters. This website would provide a means of sharing the project schedule, status, and outreach materials with the public and stakeholders. The website will be updated monthly and can contain content such as: project schedule, CEQA documentation, quarterly reports, meeting minutes, outreach meeting schedules, project data, newsletters, and links to other related websites.

8.1 Activities Completed - Third Quarter 2011

During the Third Quarter 2011, the BC Project Team finalized and submitted the Second Quarter 2011 Quarterly Report and issued a newsletter outlining the progress of the project. Copies of these reports can be seen on the project website shown below.


In addition, a public workshop was conducted on September 29, 2011. The primary objectives of this workshop were to provide an overview of the project objectives and scope, present a summary of work completed and project challenges, discuss the next steps for the project, and allow for questions and answers. A copy of the presentation slides used at the workshop are provided in Appendix B.

8.2 Planned Activities - Fourth Quarter 2011

A copy of this quarterly report will be included on the project website shown above. In addition, the BC Team will present an update for the project to the Butte County Water Commission on November 2, 2011.