Memo

To: Courtney Howard

From: Mike Cornelius

Date: August 21, 2013

Re: Paso Robles Groundwater Basin 1997 to 2013 Difference Map Description

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INTRODUCTION

The purpose of this technical memorandum (TM) is to describe the approach used to develop the Generalized Difference in Spring Groundwater Elevations 1997 to 2013 Map dated August 21, 2013 (1997-2013 Difference Map) for the Paso Robles Groundwater Basin (Basin).

A map titled Difference in Spring Groundwater Elevation 1997 to 2009 (1997 to 2009 Map) was included in the Paso Robles Groundwater Basin Management Plan (GMP) as Figure 3-3. The GMP was adopted by the San Luis Obispo County Flood Control and Water Conservation District (District) in March 2012. The 1997 to 2009 Map has been used to identify those areas that have experienced the groundwater level declines in the Basin.

At the August 6, 2013 meeting of the District, the Board requested that the 1997 to 2009 Map be updated with groundwater information through 2013. The revised map would benefit the Board when they conduct the August 27 public hearing to consider an Urgency Ordinance for the Basin. In response to this request, the initial DRAFT 1997-2013 Difference Map was provided to County's Public Works staff on August 14 so it could be incorporated into the staff's report associated with the August 27, 2013, Board Agenda Packet, Item No. 13. GEI continued its normal quality control (QC) accuracy checking processes after submitting the DRAFT 1997 to 2013 Difference Map to county staff. During the QC process, an erroneous data point (a data point having transposed numbers) was discovered that had contributed to the enlarged area of groundwater decline in the Shandon Subarea. The 1997-2013 Difference Map has now been revised and finalized after completing the QC process. It is presented in Figure 1.

This TM provides a description of how the 1997 to 2013 Different Map was developed and addresses the following items:

- Groundwater Level Monitoring Network
- Map Development Methodology
- QA/QC Procedures

GROUNDWATER LEVEL MONITORING NETWORK

The District has been monitoring groundwater levels in the Basin for over 40 years. In 2003, an evaluation of the monitoring network was completed to evaluate the efficiency and effectiveness of the District's Monitoring Program. Since that time additional monitoring wells have been added, so

there are currently about 160 wells included in the monitoring network in the San Luis Obispo County portion of the Basin. These wells are observed primarily by County Public Works employees with the remaining wells are monitored by local municipal water company employees who forward the data to the County's Public Works Department for inclusion in the monitoring program database. Additionally, three wells located in the Monterey County portion of the Basin are monitored by the Monterey County Water Resources Agency.

Table 1 summarizes the available data in available in the County's Groundwater Level Database for selected years by subarea. It should be noted that there is no data available for the Bradley or North Gabilan subareas. The lack of data in these areas prevents the development of groundwater level mapping in these areas.

As shown in Table 1, there are a total of 160 wells in the monitoring network with observations in one of the three years. While the number of wells currently being monitored has increased from 89 in 1997 to 160 by 2013, only 82 wells include observations in both Spring 1997 and Spring 2013.

Table 1 – Groundwater Monitoring Data in the Paso Robles Groundwater Basin for Selected Years

Subarea	Current Number of Monitoring Wells (1)	Spring 1997 Observations	Spring 2009 Observations	Spring 2013 Observations	Spring 1997 and Spring 2013 Observations
Atascadero Subbasin	47	25	42	42	24
Creston Subarea	16	12	16	15	12
Estrella Subarea	48	27	45	43	25
San Juan Subarea	15	8	12	12	5
Shandon Subarea	23	16	22	22	15
South Gabilan	1	1	1	1	1
TOTAL	**160**	**89**	**138**	**135**	**82**

(1) This includes only wells with observations for the years listed, and does not include other monitoring wells that do not have observations for the years being considered.

MAP DEVELOPMENT METHODOLOGY

The 1997 to 2013 Difference Map was developed using only groundwater-level data from spring 1997 and spring 2013. The spring monitoring cycle generally represents higher groundwater levels compared to summer or fall monitoring because:

- Winter and spring rains have recharged the groundwater basin.
- Increased groundwater pumping associated with summer agricultural, recreational, or residential uses has generally not started for the year.

The following steps were needed to develop the 1997 to 2013 Difference Map (Figure 1):

Step 1: Develop Spring 1997 Groundwater Elevation Map - The Spring 1997 Groundwater Elevation Map serves as the baseline condition for determining the magnitude of the change in groundwater levels. This was developed using the spring 1997 water level data.

- The water surface elevations at each well were used in ArcGIS to interpolate a generalized surface. To create the surface, an interpolation method was used that assumes that values closer together are more alike than values farther apart, so each measured point has a local influence that diminishes with distance. Interpolation factors were used to try to reduce the noise between the points.
- Wells that were identified as "pumping" (in use) or otherwise having questionable or non-stable elevation readings were not used to create the surface.
- Additionally, because of the faults in the area, a barrier line (along the main fault running almost north-south between Paso Robles and Atascadero) accounted for the significant differences in groundwater elevations on either side of the fault.

Step 2: Develop Spring 2013 Groundwater Elevation Map - This map plots the spring 2013 water level data.

- The approach is the same as described above for the spring 1997 surface.
- As shown in Table 1, there are many more wells available for the 2013 compared to the 1997 surface.

Step 3: Create Generalize Groundwater Elevation Difference Map - This map was created by subtracting the elevations 2013 groundwater level surface from the 1997 surface.

- The two groundwater elevation surfaces described in Steps 1 and 2 were subtracted (1997 from 2013) to calculate the difference between the two surfaces.
- Areas where the 2013 surface was lower elevation than the 1997 surface would result in a negative value (decline in groundwater elevations are shown as yellow or red on Figure 1).
- Areas where the 2013 surface was higher elevation than the 1997 surface would result in a positive value (increase in groundwater elevations are shown in blue shading on Figure 1.

Interpretation of Groundwater Level Maps

The groundwater elevation maps are developed based upon the best available data. It is our opinion that the available data provides a fair representation of the groundwater levels in the Basin, but it should be acknowledged that common data limitations exist including:

- The geographic distribution of data points.
- The number of observations for the selected period under consideration.
- The number and distribution of data points for different years (when developing a groundwater level difference map).

- The hydrogeologic setting – The more complex the hydrogeology, the more data required to develop a groundwater elevation map.

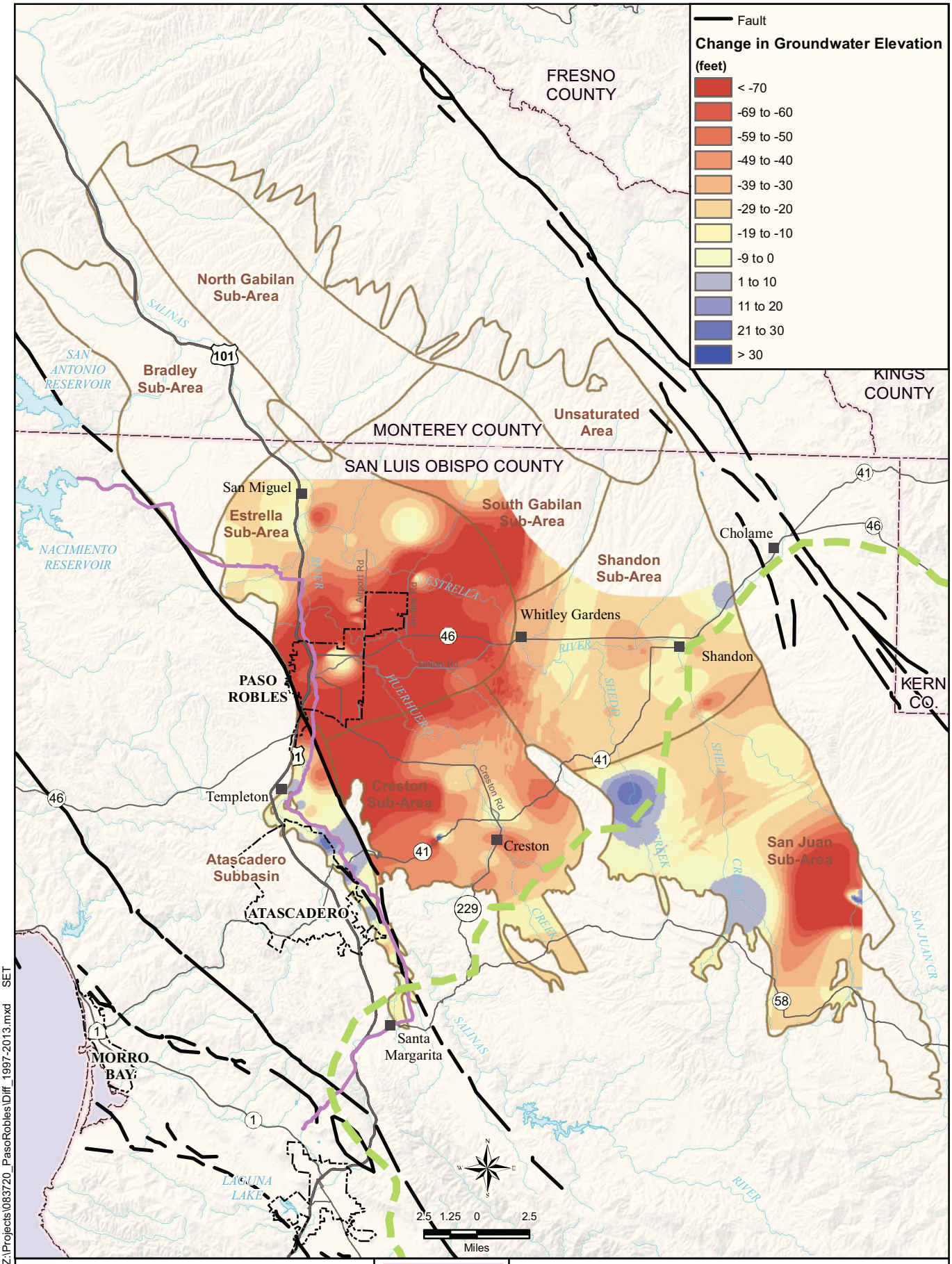
QA/QC PROCEDURES

The standard QA/QC procedures GEI uses are designed to account for human error in analysis and map production as well as to catch errors in the data itself. The preliminary steps include:

- Spot check observations in areas that have bulls-eye patterns to understand their occurrence.
- Check individual well hydrographs in areas to compare trends in data to fill data gaps.
- Conduct surface interpolation processes multiple times to ensure identical results and no accidental changes (human error) in variables or data sources.
- Make sure new data results are displayed in the same manner (on the map) as the previous results to allow easier comparison. This includes using the same color scheme and scale as the original map.

Secondary steps include:

- Check every data point in both years for correct reference elevation point values and correctly calculated water surface elevation values.
- Re-check that data points used were not pumping, noted as unreliable readings, etc.
- Recreate surfaces when any errors or issues were found during the above steps and then repeat the steps with the new surfaces.



Paso Robles Groundwater Basin
In San Luis Obispo County

San Luis Obispo County, California

GEI Consultants

GENERALIZED DIFFERENCE IN SPRING GROUND-WATER ELEVATIONS BETWEEN 1997 - 2013

AUGUST 2013 FIGURE 1

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