APPENDIX F
ASSESSMENT OF PRINCIPAL AQUIFERS

APPENDIX F – ASSESSMENT OF PRINCIPAL AQUIFERS

This section provides a detailed hydrogeologic assessment of potential principal aquifers. It provides both historic definition of aquifers and current information to assess the number of principal aquifers.

The definition of principal aquifers must be supported by the geologic conditions, differences in groundwater levels, and water quality. The following sections provide a detailed discussion of aquifer conditions to demonstrate that the aquifers within the North American Subbasin can be considered to be one principal aquifer. Definitions of principal aquifers in adjacent subbasins are also included.

Historic Definition of Aquifers

The geologic units described above were grouped and separated into two aquifers, an Upper and Lower aquifer, by DWR for the North American Conjunctive Use Program (1997). "The division between the two aquifers is inexact, due to the difficulty in accurately determining the formation contacts". Figures 4-9 through 4-11 in Section 4.9 of the GSP show the extent of the principal aquifers on the geologic sections.

The Upper aquifer was defined as the upper 200 to 300 feet of the aquifer system. It includes the Quaternary Alluvium, Modesto, Riverbank, and Laguna Formations and consists of generally thin and laterally discontinuous sands and gravels separated by thick sequences of clay. Groundwater in the Upper aquifer occurs under generally unconfined conditions. It should be noted on the geologic sections that portions of the Mehrten Formation in the eastern portion of the Subbasin would also be included in the Upper aquifer.

The Lower aquifer was defined as extending from about 200 to 300 feet below ground surface to the base of freshwater. It consists of Mehrten Formation sediments. It should be noted that in the eastern portion of the Subbasin the Upper aquifer includes the Mehrten Formation as it raises to ground surface.

Geologic Conditions

There are no regionally extensive fine-grained layers in the subsurface that were identified by previous studies or during the development of the geologic profiles or by historic references that could be used to separate and define principal aquifers.

There may be a confining bed in the deeper portions of the Mehrten Formation that is not being used for water supply in the NASb. Groundwater under the confining bed typically has dissolved gases and manganese concentrations above the MCL. It was partially identified near Roseville, but only a few other wells in the area have been drilled deep enough, so the full extent is unknown.

Groundwater Levels

Nested monitoring wells provide some of the highest quality data and groundwater levels in the various penetrated aquifers. Figure F-1 shows the location of nested and clustered wells in the NASb along with selected wells to illustrate groundwater levels in the different aquifers. Appendix J contains hydrographs for all of the nested and clustered wells in the Subbasin and sorted by DWR's definition of the aquifers.

Figure F-1 shows that for the most part, groundwater levels in the DWR-defined aquifers are similar, with the maximum difference in levels being 23 feet and those wells only present in the western portion of the subbasin. In the western portion, groundwater levels in the upper portions of the Mehrten Formation track similar to those in the Laguna Formation. Greater groundwater level differences are present in the deeper portions of the Mehrten Formation. The amount of separation of water levels between some zones indicates increasing confinement and isolation with depth (DWR, 1977). Other than for the western portion of the Subbasin, there is not a significant difference in groundwater levels between the two aquifers and does not suggest two separate aquifers.

Although there are head differences between the aquifers, wells in the areas are responding in a similar manner, to pumping and effects of recharge. Figure F-2 shows the head differences across the subbasin at nested or clustered wells and illustrates the similar trends in the aquifers suggesting they are interconnected.

The hydrographs show that groundwater levels in the Upper and Lower aquifers have similar trends, indicating that the aquifers are connected and are not separate. There is a slight lag time of the responses in the Lower aquifer.

Groundwater Gradients

The groundwater gradients are similar between the Upper and Lower aquifers except for on the east side. The gradients in the Upper aquifer are steeper from the east than in the Lower aquifer potentially due to groundwater recharge effects being greater in the Upper aquifer than in the Lower aquifer. Table F-1 provides the gradients by aquifers.

Table F-1. Groundwater Gradients

Aquifers	Groundwater gradients (ft/ft)			
	West	East	North	South
Upper	0.001	0.06	0.001	0.002
Lower	0.002	0.002	0.001	ND

Aquifer Hydraulic Characteristics

Aquifer hydraulic characteristics can best be determined by pumping a well and measuring the drawdown in observation well(s), but this only provides information at a single location in a 342,000-acre basin. The basis of the aquifers are from DWR's SVSim model which uses textural classifications to estimate hydraulic characteristics to simulate groundwater hydraulic characteristics on a basin wide scale. The principal aquifers defined by DWR were not based on hydraulic characteristics of sediments. Aquifer tests with this elevated level of testing could not be located.

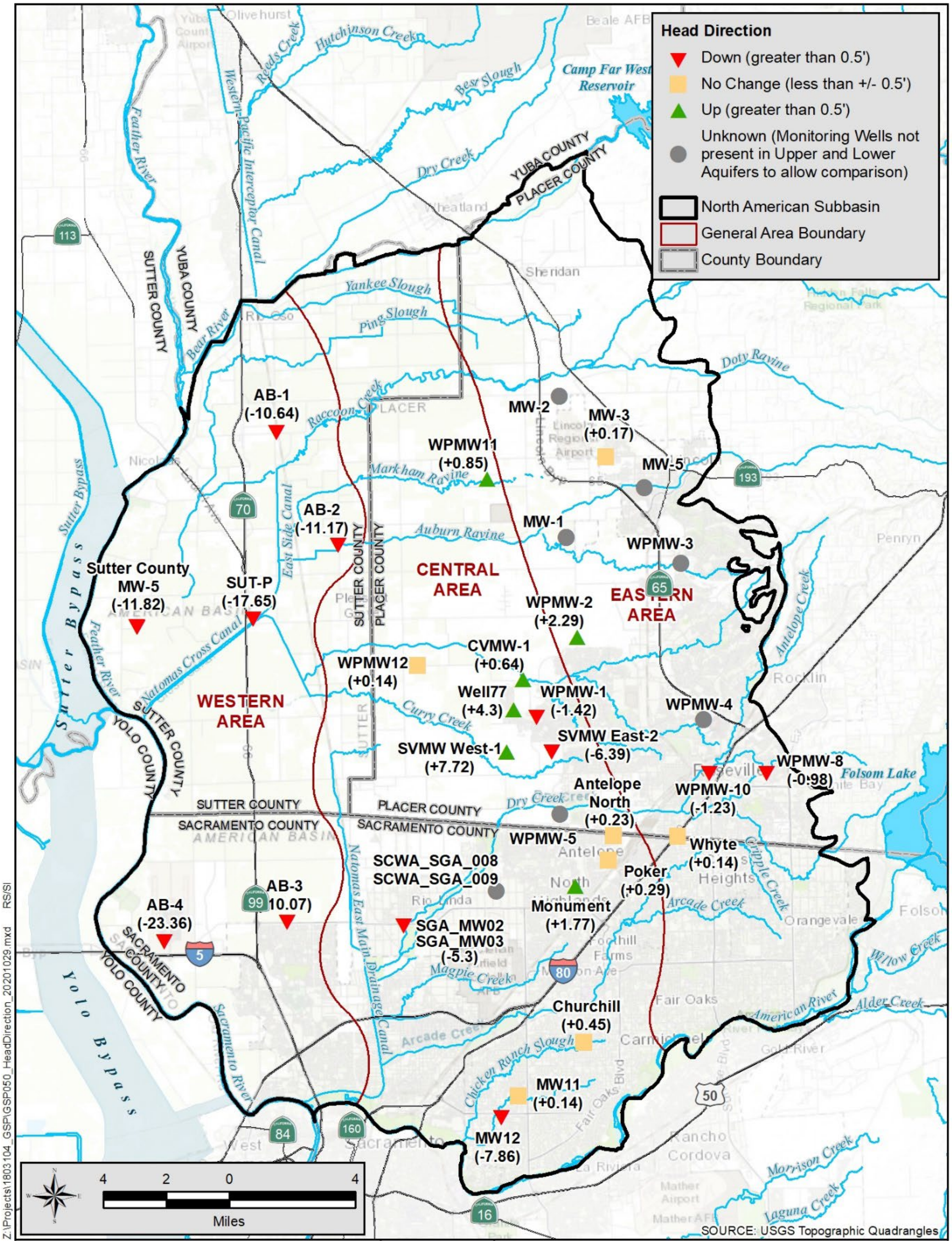

Figure F-1 Vertical Gradients Upper to Lower Aquifer – Fall 2019

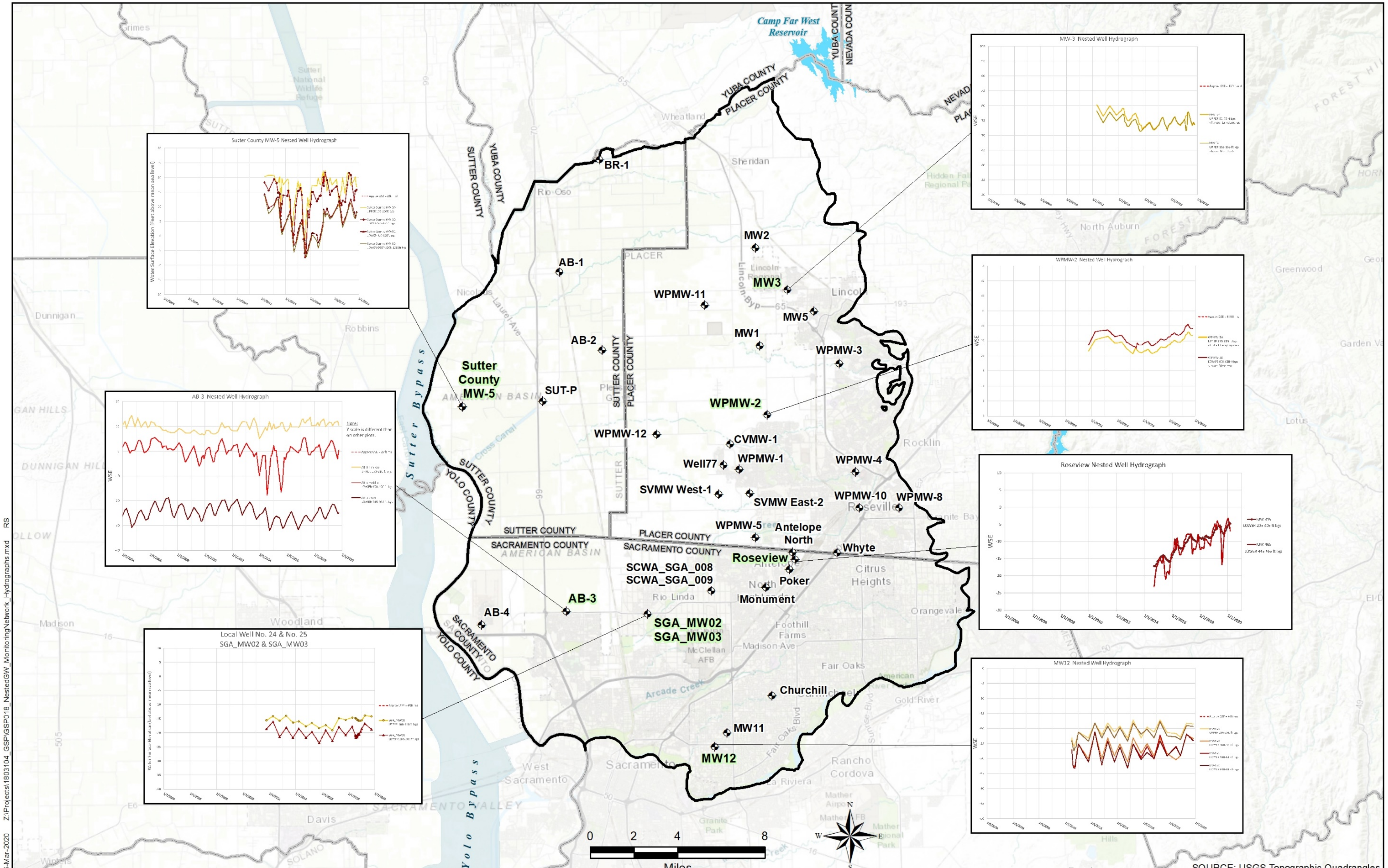

Figure F-2 Groundwater Level Trends

This page intentionally left blank.

General Water Quality

Figures F-3 and F-4 illustrate the distribution of total dissolved solids (TDS), a measure of the salt content, by the two DWR-identified aquifers in the central and western portion of the Subbasin and adjacent subbasins based on water quality sampling of depth-discrete monitoring wells that allowed vertical profiling of the groundwater quality in the various aquifers (GEI, 2020). The figures show that good quality water (green color and each ring representing one to three monitoring wells within the same aquifer) is present in the central portions of the Subbasin but poorer quality water (browns and reds) are present in the western portions of the Subbasin. Figure F-5 shows the distribution of the water quality in the subsurface by principal aquifers. The figure shows that water quality does not distinguish the DWR-defined principal aquifers.

Figures F-3 and F-4 show that high TDS groundwater is present along the western edge of the NASb. Figure F-5 shows the water quality in the western area is highly variable and not consistent by aquifer. Near surface groundwater, near the Feather River, contains high concentrations of TDS, along with elevated levels of chloride and nitrate, and its shallow depth suggests that it has been affected by agriculture. Underlying the near surface poor quality water is better quality water, but it also changes and varies with depth. There is also poor-quality water underlying the freshwater bearing aquifers, below the base of freshwater.

Number of Principal Aquifers

Based on the discussion above, there is not sufficient evidence to define two separate and distinct principal aquifers. Therefore, for the purposes of this GSP, the NASb only contains one principal aquifer.

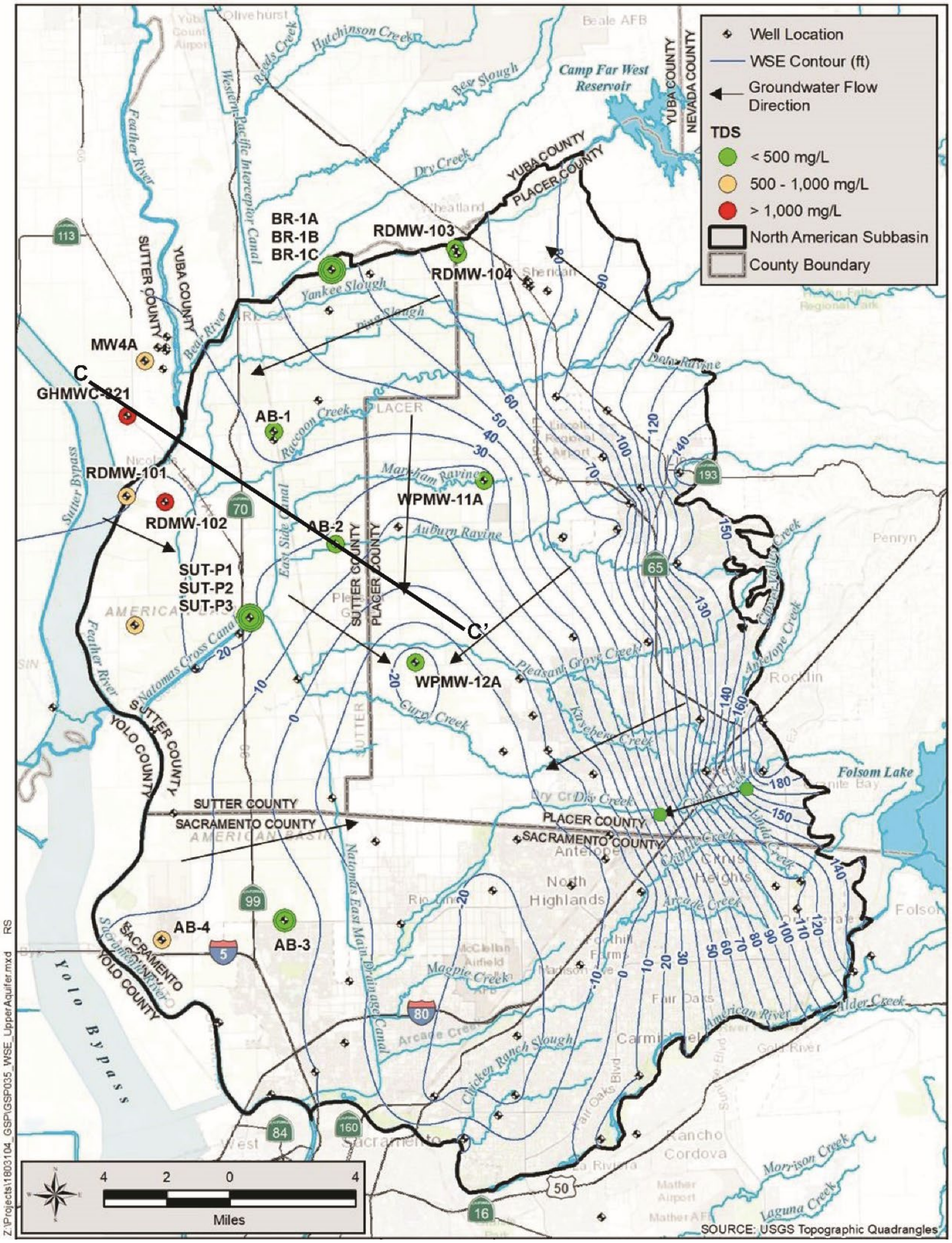

Figure F-3 Groundwater Quality Distribution Upper Aquifer

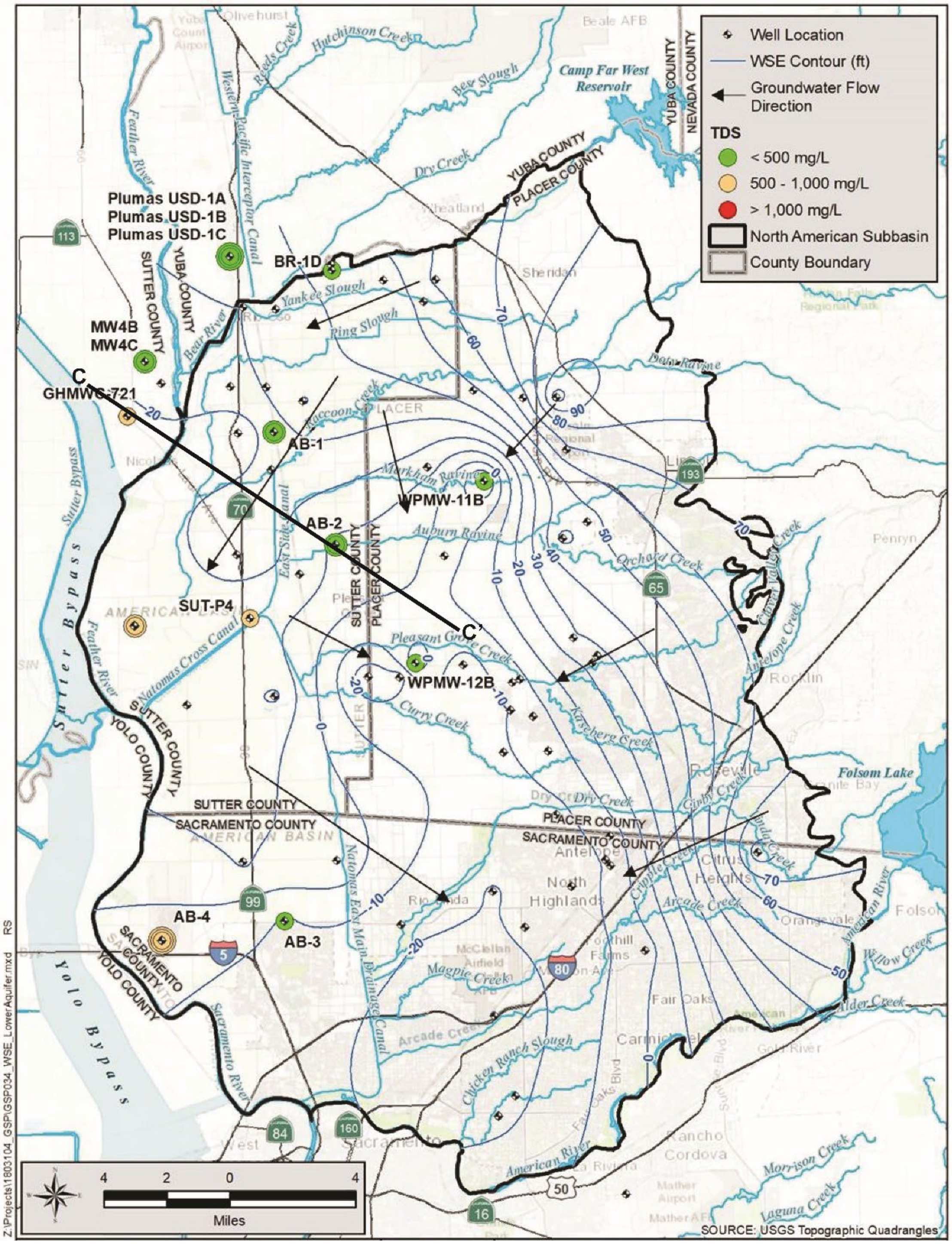

Figure F-4 Groundwater Quality Distribution Lower Aquifer

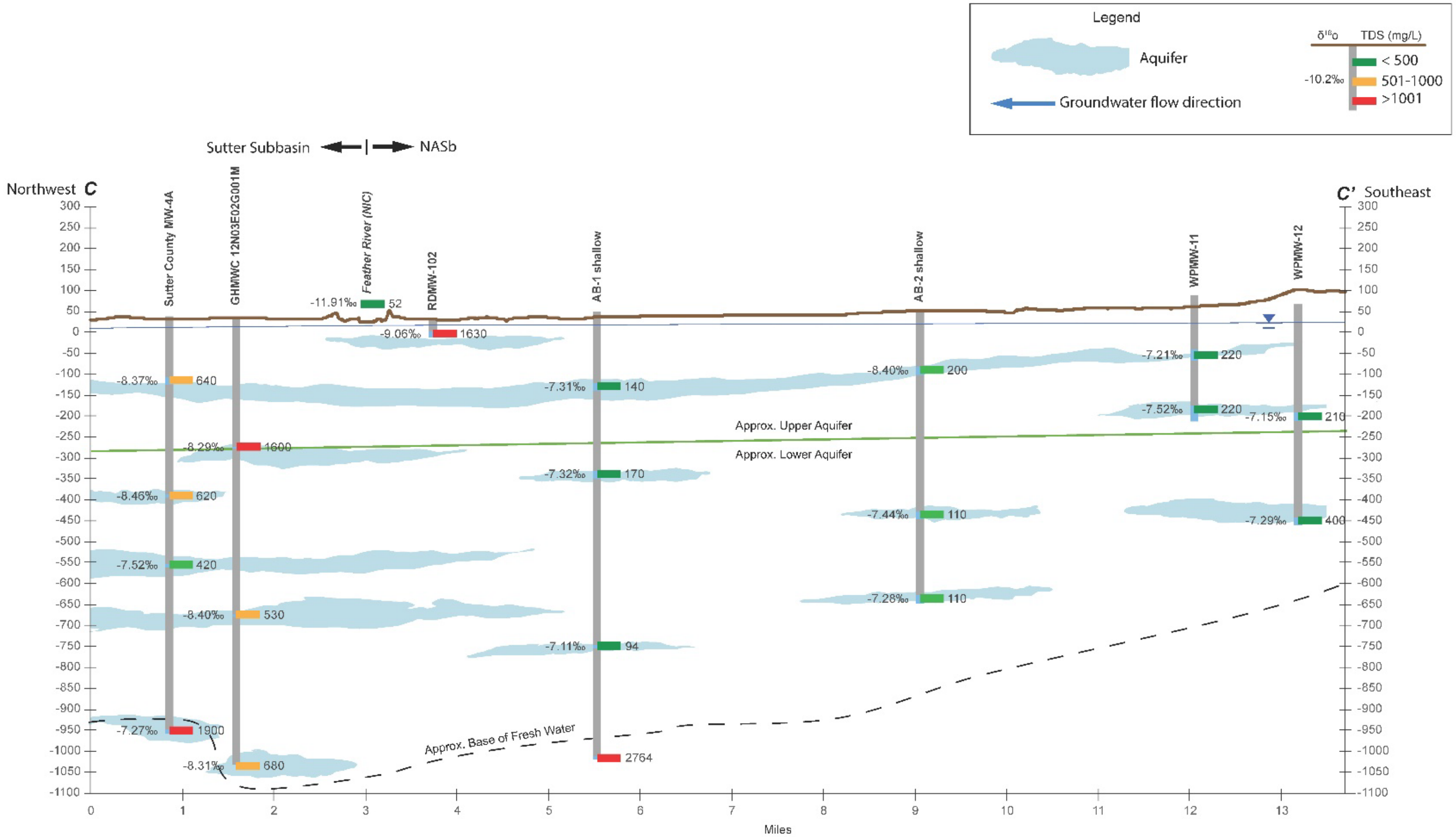

Figure F-5: Groundwater Quality Profile C-C'