Appendix D. Sediment Texture and Other Soil Data

This appendix describes the sediment texture of the aquifer system in the Restoration Area. The contents of this appendix describe the:

- Importance of sediment texture for managing seepage,
- Sediment texture models developed in the Restoration Area,
- Data used to develop the models, and
- Additional available soil texture/type data.

D.1 Importance of Sediment Texture

The sediments making up the aquifer system in the Restoration Area are composed of a heterogeneous mix of recent river channel deposits, recent flood plain deposits, and older continental deposits. The texture of these sediments ranges from coarse-grained gravels to fine-grained clays, and the distribution of these textures can have a strong influence on the hydrogeology.

For example, an unpublished study of the central part of the west side of San Joaquin Valley, which is close to the Restoration Area, showed a high correlation between shallow sediment texture and the tile drainage network (Figure D-1), and presumably an equally high correlation to the need for drainage. Figure D-1 shows the sediment texture of the upper 15 feet of the Grasslands Drainage Area and vicinity, overlain by the tile drain network in blue (unpublished data, Phillips).

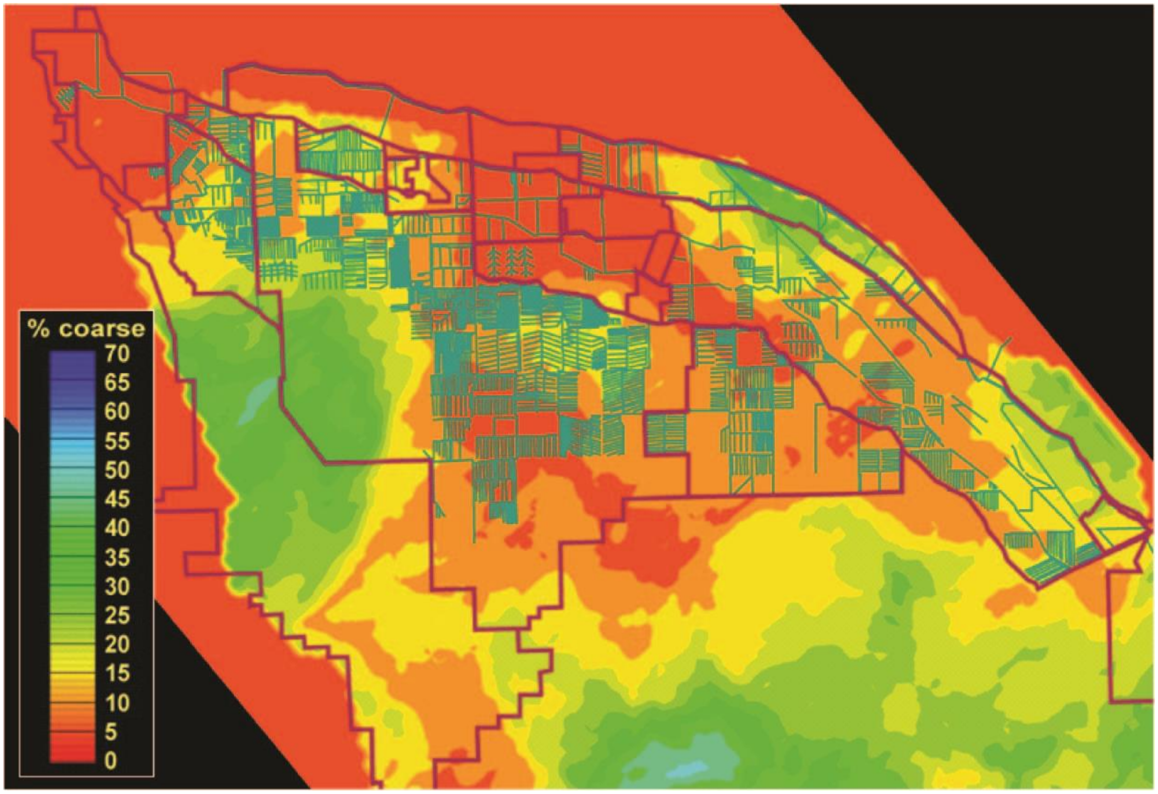

Figure D-1.
Sediment texture and tile drains

Also, as discussed in Appendix C, the shallow water table is sensitive to groundwater pumping, but it is not equally sensitive in all areas. This variability is likely controlled partly by sediment texture and its distribution. Thus, it is important to characterize the sediment texture of the aquifer system in the Restoration Area.

D.2 Sediment Texture Models

Sediment texture models are a type of hydrologic framework model used to characterize the materials that make up an aquifer. This subsection discusses a sediment texture model previously developed in 2009 for a groundwater model of the entire Central Valley (Faunt, 2009) and also for a model developed specifically to support the SJRRP (Traum, 2014). The sediment texture information used to derive these models includes lithologic data from drillers' logs and from core samples taken during SJRRP drilling.

D.2.1 Central Valley Sediment Texture Model

A regional sediment texture model for the entire Central Valley was developed in support of the USGS Central Valley Hydrologic Model (Faunt, 2009). Figure D-2 shows the location of the drillers' logs that were used to generate the Central Valley texture model within the Restoration Area, and the derived texture values for each model cell. The high density of drillers' logs data shown in the northern part of the study area represents the useful logs culled from the set of all available logs for that area, done as part of a subregional study to the north (Burow and others, 2004). The data presented in Figure D-2 represent only a subset of the available good-quality lithologic logs in the study area.

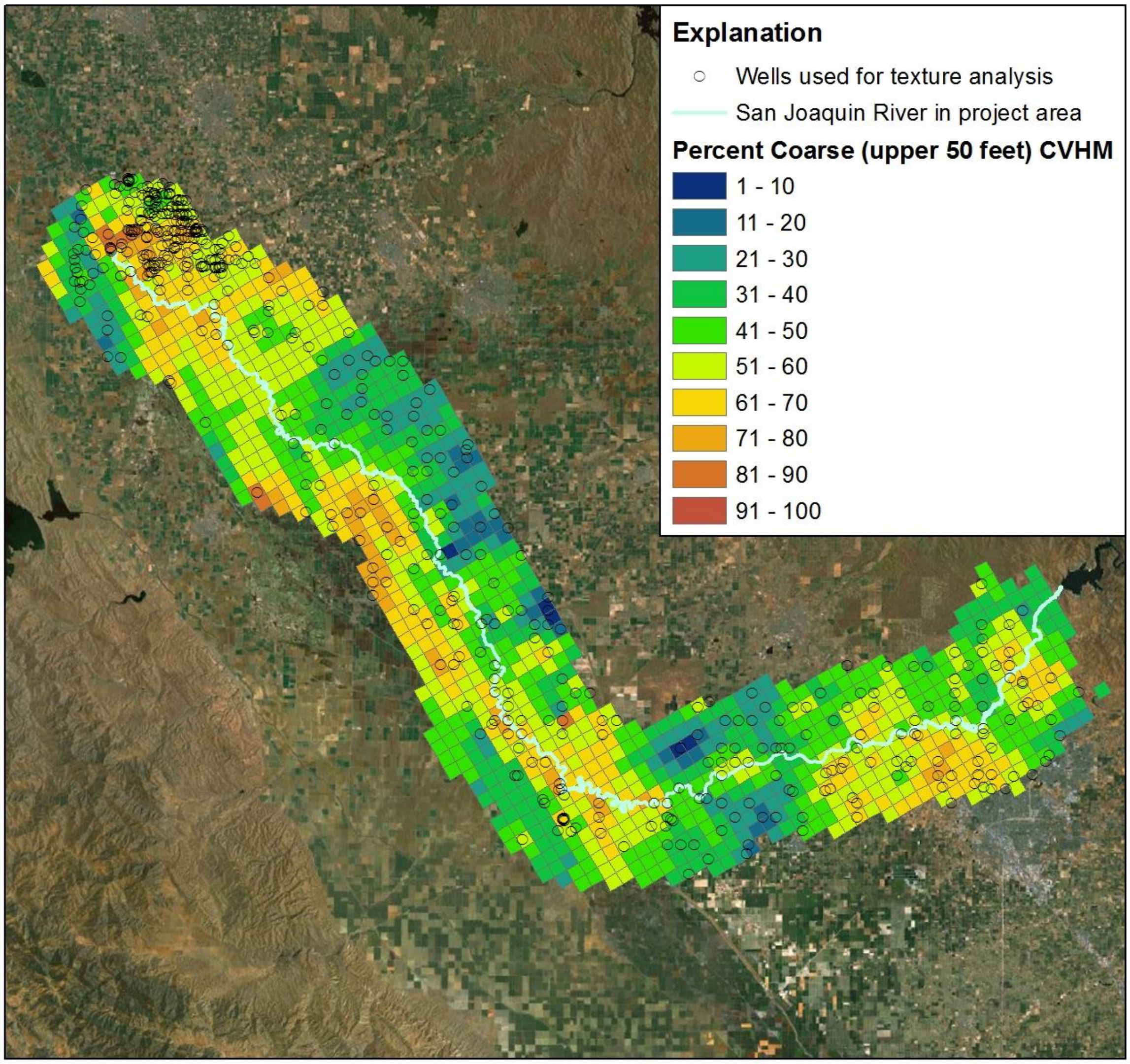

Figure D-2.
Percent of Coarse-Grained Sediments in the Restoration Area

Each square in Figure D-2 is one square mile representing a cell in the USGS Central Valley Hydrologic Model (CVHM, Faunt 2009). Small circles represent locations associated with lithologic logs used to determine sediment texture; large areas with no wells are highly uncertain. The higher concentration of logs at the northern end is associated with the southern tip of a more detailed study of sediment texture (Burow and others, 2004).

D.2.2 SJRRP Sediment Texture Model

A refined sediment texture model was developed for the Restoration Area. This refined texture model has been used in the development of the San Joaquin River Restoration Program Groundwater model (SJRRPGW) to support analyses for the SJRRP (Traum, 2014). The refined sediment texture model can also be used for other drainage or seepage analyses.

The refined sediment texture model was developed using Transition Probability Geostatistical Software (TProGS) (Carle, 1996), a geostatistical method that uses transition probabilities (the probability of transitioning from one sediment texture to another) to interpolate, or fill the gaps, between data points. Sediment texture was grouped into four geologic categories (facies) which include: gravel, sand, muddy sand, and clay, as shown in Figure D-3, which represents one of many equally probable distributions, or realizations, of sediment texture.

The TProGS model was developed using lithologic data from 616 drillers' logs and a small number of core samples representing the Restoration area. From the drillers' log database used to generate the Central Valley texture model, 402 well logs within the Restoration Area were selected for use in the refined texture model, and 214 additional wells (some with core samples) were digitized and added to the database.

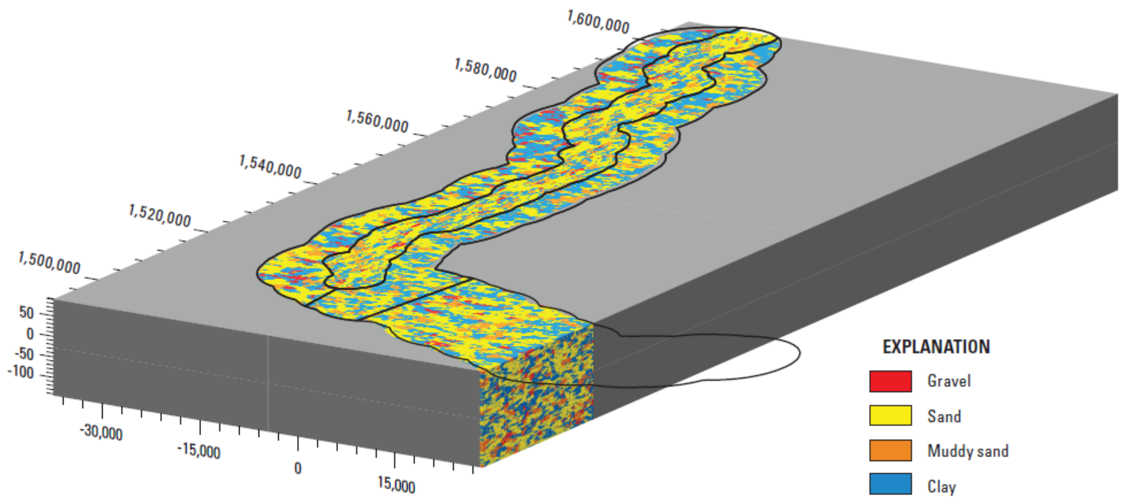

Figure D-3.
Example Sediment Texture Distribution for the Restoration Area

D.2.3 Benefit of Local-Scale Model vs. Regional-Scale Texture Model

The level of detail in the regional model shown in Figure D-2 is certainly useful for developing a better understanding of the hydrology in the Restoration Area. However, the method used by Faunt (2009) averages the texture for 50-foot thick layers over a one mile square grid cell. In contrast, the local-scale TProGS model uses a one meter vertical scale (15 times refined) and a horizontal grid size of 1/8 mile by 1/8 mile (8 times refined).

A 50-foot thickness may be inadequate for evaluating local vulnerability to seepage effects. For example, a profile with 10 feet of clay overlying 40 feet of gravel would, when averaged, appear to be a course-grained unit. However, in reality, the first 10 feet of clay could present a drainage problem.

As another example, a regional scaled model cross-section might be configured as shown in Figure D-4, where the colors represent different sediment categories.

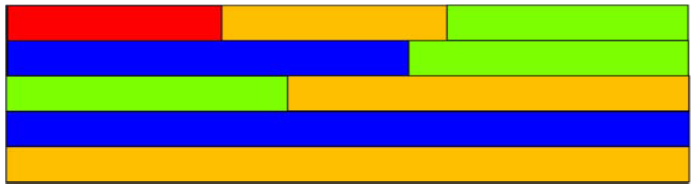

Figure D-4.
Example Sediment Texture in a Regional-Scale Model

In a local-scaled model, the same dataset might be used to generate a configuration as shown in Figure D-5.

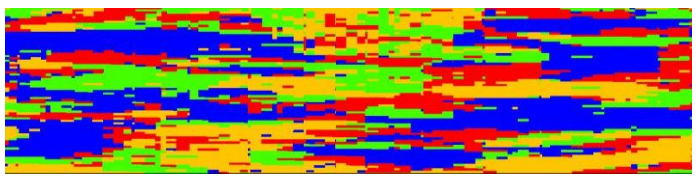

Figure D-5.
Example Sediment Texture in a Local-Scale Model

The local-scale configuration allows for more three-dimensional interconnections than a less heterogeneous, less realistic regional configuration.

D.3 NRCS Soil Data

The Natural Resources Conservation Service (NRCS) has developed GIS data layers that show soil classifications and, in some cases, the slopes of the land. The NRCS's Soil Survey Geographic (SSURGO) database typically contains information regarding soil groups, water capacity, soil reaction, electrical conductivity, and frequency of flooding; yields for cropland, woodland, rangeland, and pastureland; and limitations affecting recreational development, building site development, and other engineering uses.

Figures D-6 through D-9 show the NRCS soil classification data plotted for Reaches 3 and 4A. The data can be shown at a more "zoomed in" scale during analysis of a certain area or property. This data is also available along the other reaches of the river. These figures are shown for illustrative purposes. The other NRCS data types mentioned above can also be plotted spatially, similar to the soil classification in these figures.

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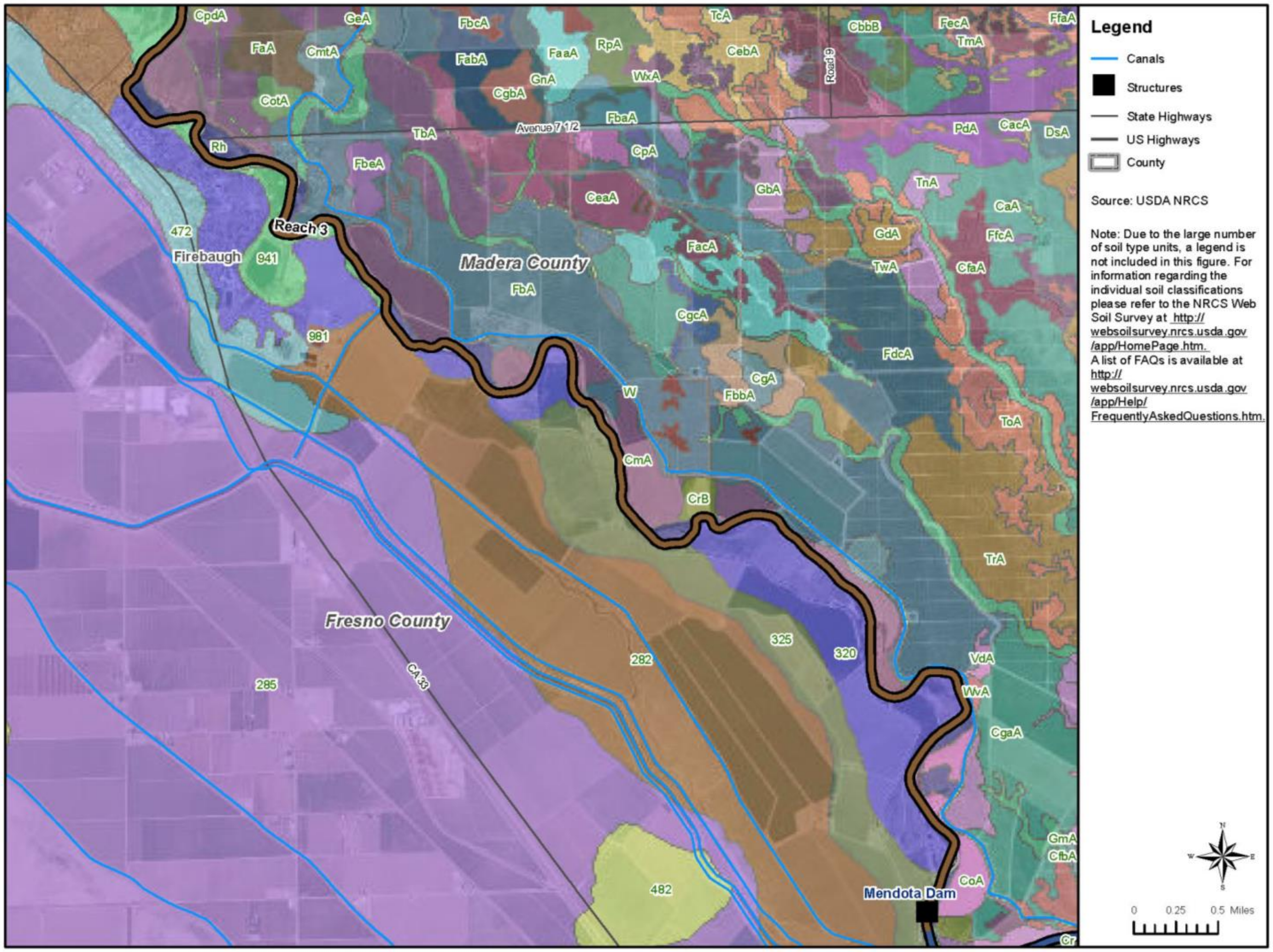

Figure D-6.
NRCS Soil Classification (Map 1 of 4)

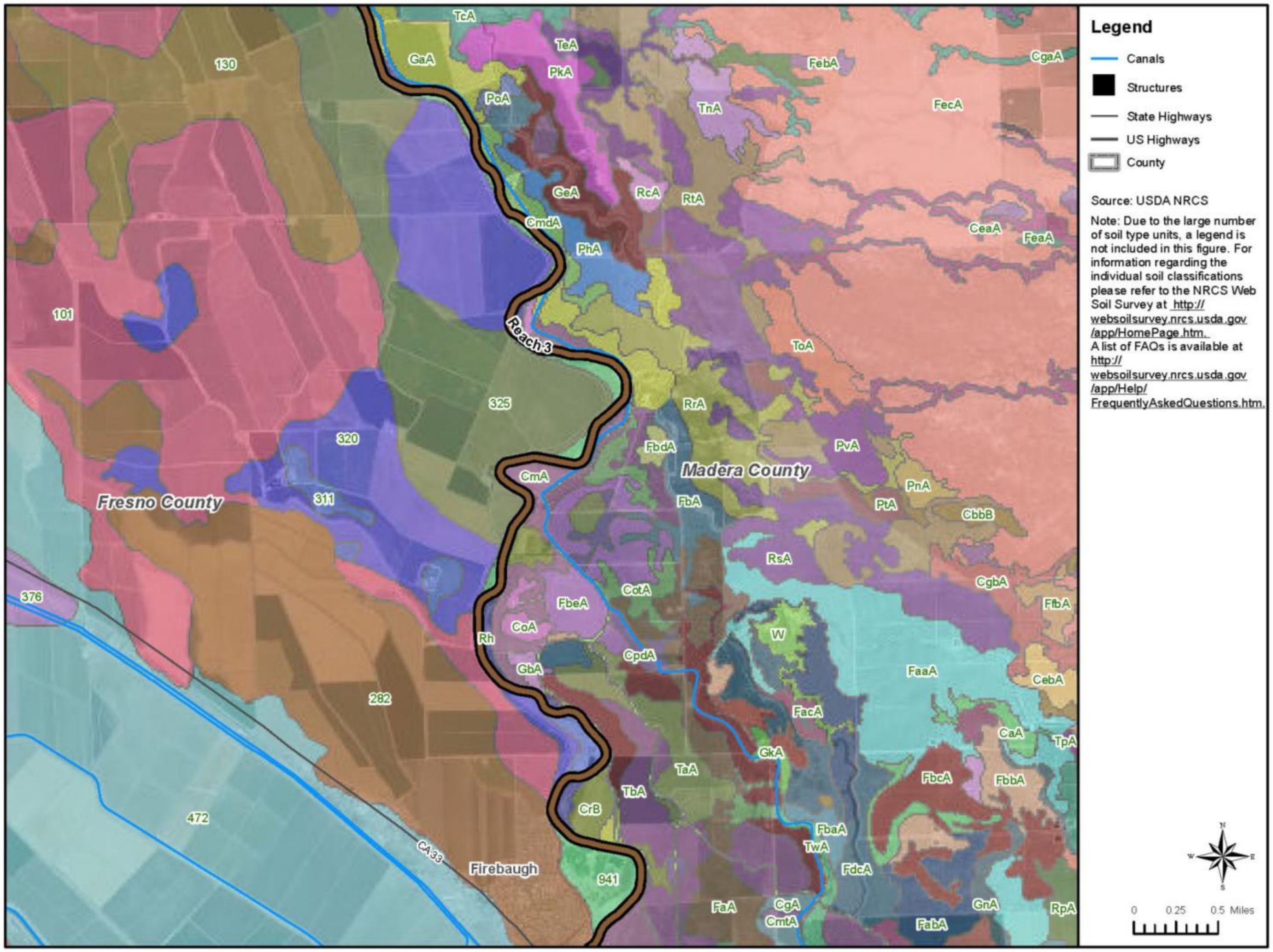

Figure D-7.
NRCS Soil Classification (Map 2 of 4)

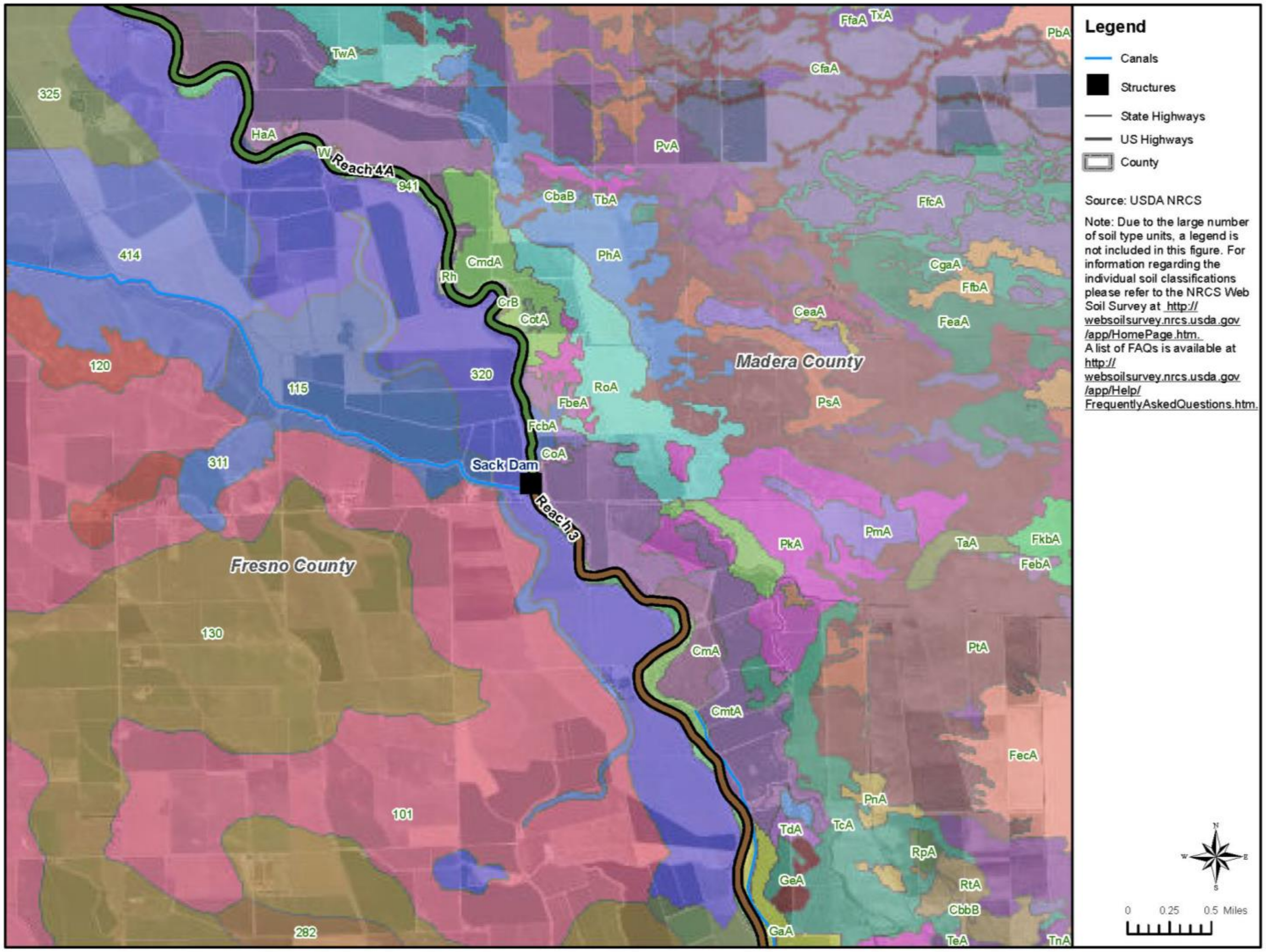

Figure D-8.
NRCS Soil Classification (Map 3 of 4)

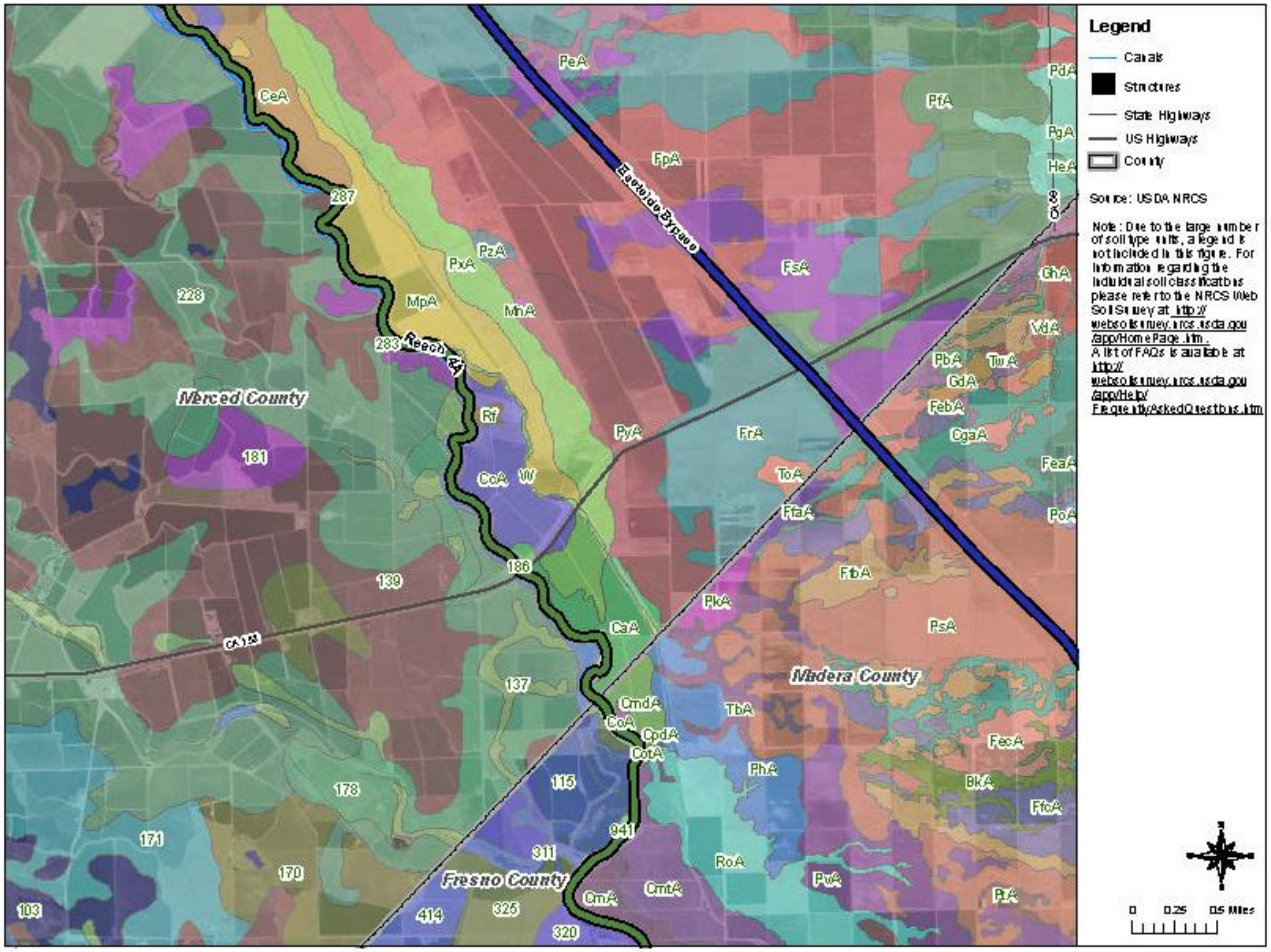

Figure D-9.
NRCS Soil Classification (Map 4 of 4)

D.4 Geomorphology

As part of the Non-Urban Levee Evaluation (NULE) program, DWR has completed a review of surficial geology in the Reach 3 and 4A area (DWR 2011). Their analysis included a review of historical surficial geologic mapping and NRCS mapping. Additional detail on DWR's analysis is provided in DWR 2011. Figures D-10 through D-14 show the resulting "susceptibility" of geologic units to levee underseepage. These results are a combination of geologic unit and soil type (per NRCS). Table D-1 (from DWR 2011) shows the correlation between geologic unit and susceptibility of underseepage.

Table D-1.
Susceptibility to Levee Underseepage

Geologic Symbol	Unit Name	Susceptibility Rating
Rob	Recent overbank deposits	Very High
Rsc	Recent stream channel deposits	Very High
Rch	Recent channel deposits: includes currently active and previous (historical) abandoned channel locations	Very High
Rcs	Recent crevasse splay deposits Very High 0.2 <1 Hob Holocene overbank deposits, High 5 10 Hch Holocene channel deposits	High
Qdc	Holocene to Recent Dos Palos Alluvium, channel deposits	Very High
Qdt	Holocene to Recent Dos Palos Alluvium, terrace levee, point bar, abandoned channel deposits	Very High
Qdb	Holocene to Recent Dos Palos Alluvium overbank deposits	High
Qdb/Qmb	Late Pleistocene to Recent overbank deposits comprised of Dos Palos alluvium and Modesto formation sediments	Moderate
Qpf	Early Holocene to Recent Patterson Alluvium, middle and lower fan deposits, Coast range derived	High
Qhal	Holocene flooplain /terrace deposits	High
Qmu	Late Pleistocene Modesto formation, upper member (lower fans, floodplains: fine grained deposits)	Moderate

Source: DWR 2011

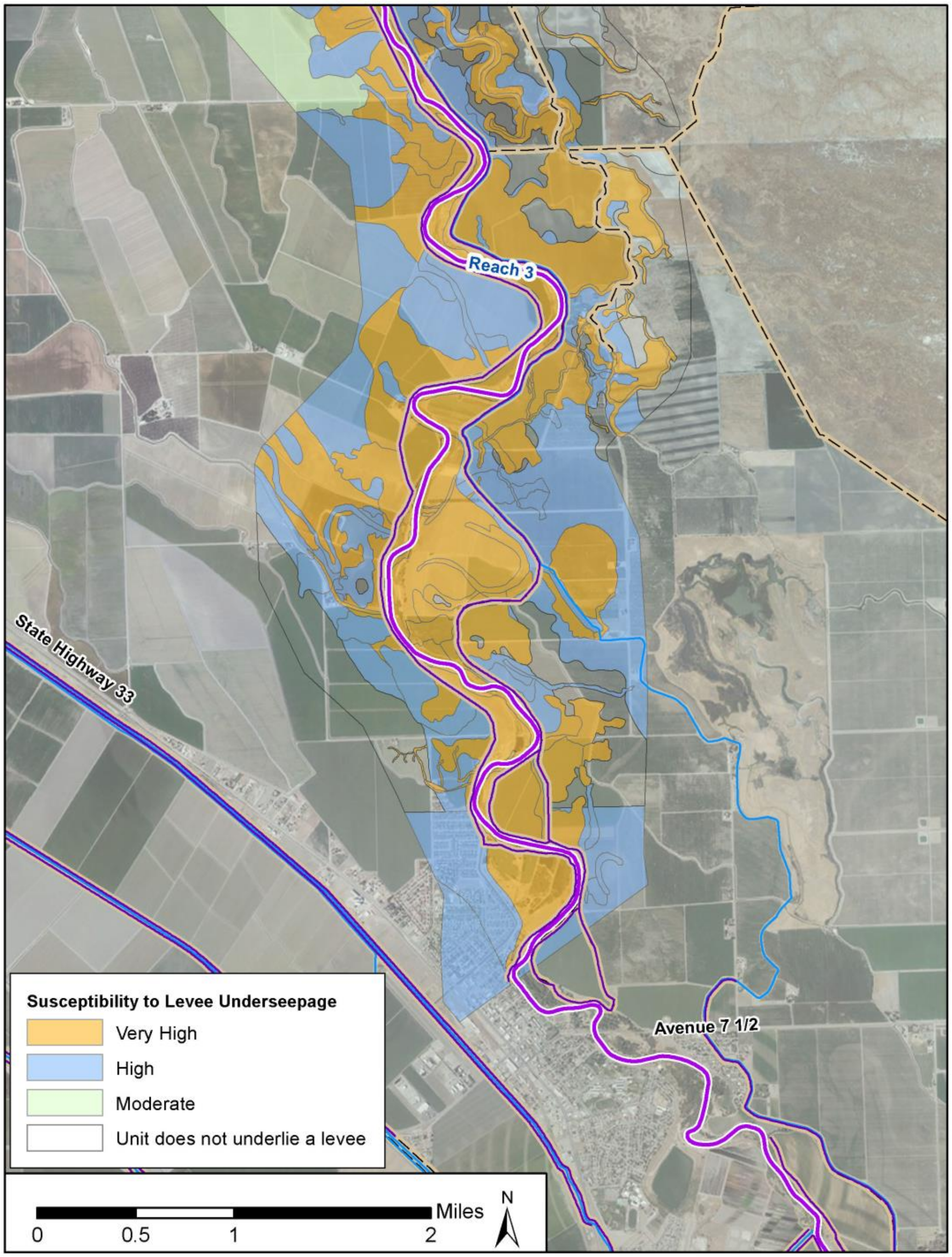

Figure D-10.
NULE Analysis of Susceptibility to Levee Underseepage (Map 1 of 5)
(Source: DWR 2011)

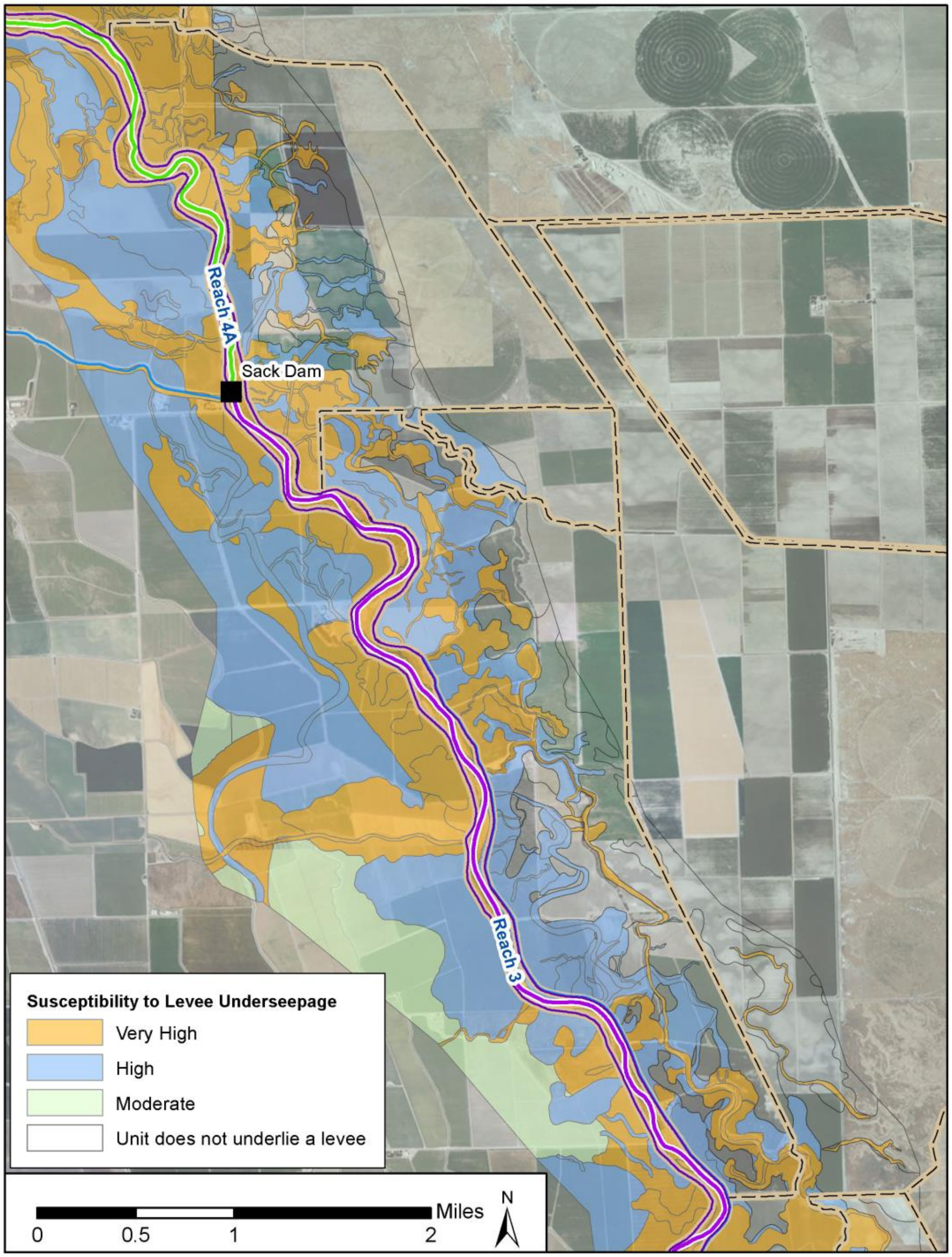

Figure D-11.
NULE Analysis of Susceptibility to Levee Underseepage (Map 2 of 5)
(Source: DWR 2011)

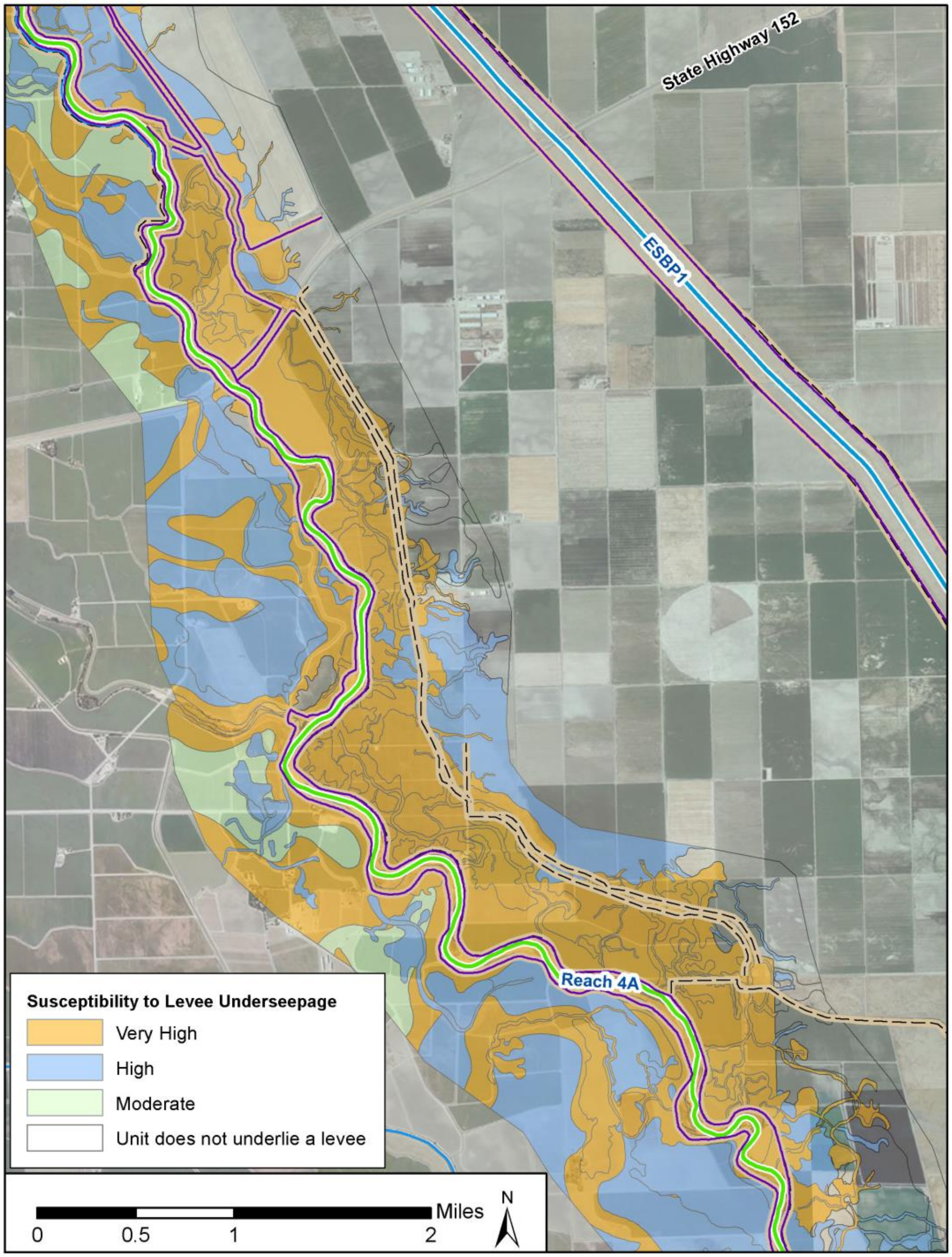

Figure D-12.
NULE Analysis of Susceptibility to Levee Underseepage (Map 3 of 5)
(Source: DWR 2011)

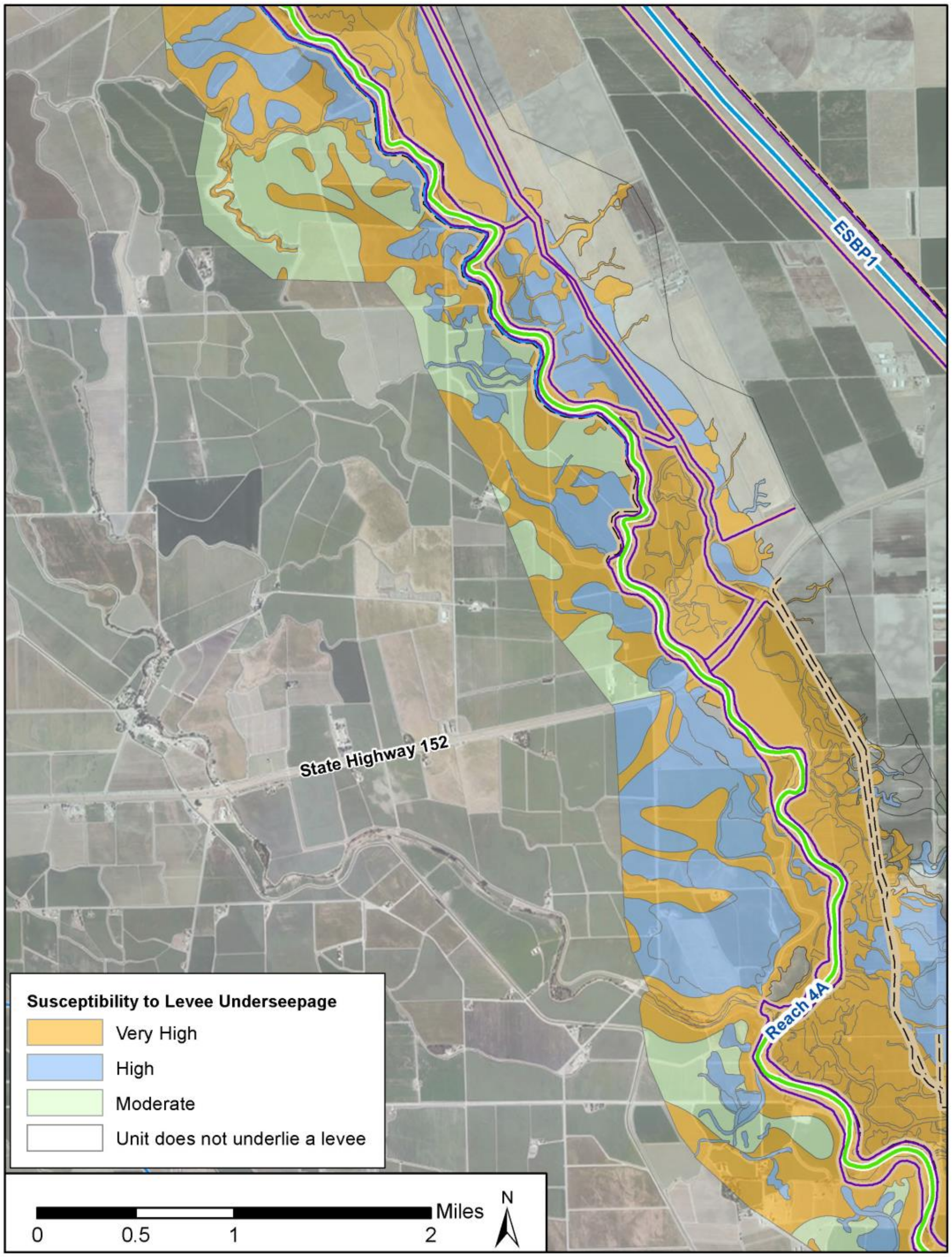

Figure D-13.
NULE Analysis of Susceptibility to Levee Underseepage (Map 4 of 5)
(Source: DWR 2011)

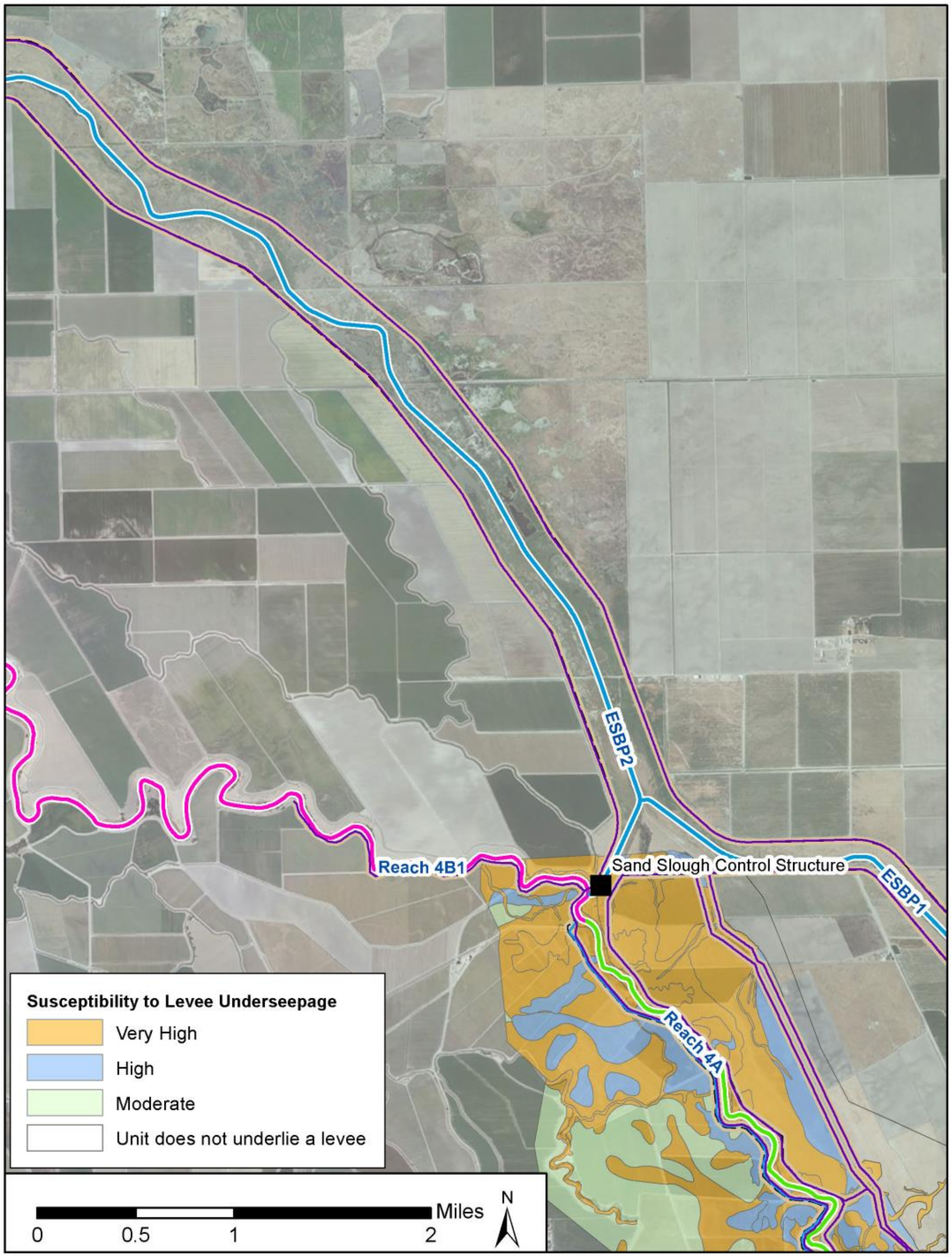

Figure D-14.
NULE Analysis of Susceptibility to Levee Underseepage (Map 5 of 5)
(Source: DWR 2011)

D.5 Geologic Cross-Sections

The SJRRP has developed several cross-sections along Reaches 1 through 5 depicting the geology of the area. The cross-sections were developed using the drilling logs from the monitoring wells that have been installed as part of the SJRRP. Where available, the cross-sections also utilize the geologic information developed from the shallow hand-augered salinity borings. The geologic cross-sections are provided in Attachment 1 to Appendix D.