Appendix B

Reach 2A and Reach 2B Update San Joaquin River In-channel Capacity Analysis

September 2017

Reach 2A and 2B Update - San Joaquin River In-channel Capacity Analysis

September 12, 2017

1. INTRODUCTION

An in-channel capacity evaluation of the San Joaquin River and the Eastside and Mariposa Bypasses between Friant Dam and the confluence with the Merced River was previously conducted in 2013 and 2015 by the California Department of Water Resources (DWR) and Tetra Tech (DWR, 2013, DWR, 2015 and Tetra Tech, 2015a). The focus of the work was to:

1. Determine the in-channel capacity of each reach, defined as the highest flow that can be conveyed through the reach where the water-surface elevation does not exceed the landside (or outside) ground elevation near the base of the levee for any part of the reach.

2. Determine the approximate length of left- and right-bank levee for each reach where the water-surface elevation of an in-channel flow of 2,000 cfs exceeds the landside ground elevation near the base of the levee.

3. Determine the approximate length of left- and right-bank levee for each reach where the water-surface elevation of an in-channel flow of 4,500 cfs exceeds the landside ground elevation near the base of the levee.

At this time, only limited data remain available regarding characteristics and performance criteria (including Factor of Safety) for levees along Reaches 2A and 2B. To provide information that can be used by the Bureau of Reclamation (Reclamation) to limit the release of Interim and Restoration flows, as necessary, to prevent damages prior to sufficient data becoming available to determine the Factor of Safety, and to prioritize future data collection and analysis activities, landside ground elevations near the base of the levees were determined and compared to computed water-surface elevations over a range of flows. The evaluation was conducted using the HEC-RAS 1-D steady-state hydraulic models developed by Tetra Tech for the San Joaquin River Restoration Program (SJRRP), and was based purely on the comparison of water surface and landside ground elevations independent of levee characteristics.

The results in Reaches 2A and 2B have been updated to reflect the impact of recent subsidence. This memorandum summarizes the methods and results of the updated in-channel capacity analysis for these reaches, and represents an update to Appendix C of the Channel Capacity Report 2015 Restoration Year (DWR, 2015). All results herein shall supersede those presented in Appendix C (DWR, 2015).

2. METHODOLOGY AND ASSUMPTIONS

The in-channel capacity analysis specifically focused on identifying the maximum discharge that can be conveyed through each reach where the water-surface elevation does not exceed the landside (outside) ground elevation near the base of the levee (i.e., in-channel flow capacity), and included an estimate of the length along the levee where outside ground elevations are exceeded by water-surface elevations at 2,000 and 4,500 cfs. The 2,000- and 4,500-cfs flows represent the potential low and high range of flows that may be needed to achieve the Restoration goal of the Settlement Agreement.

2.1. River Reach Extent

The in-channel capacity was evaluated for each area that is bounded by levees in Reaches 2A and 2B, (**Figure 1**). Setback levees may eventually be constructed in Reach 2B as part of the SJRRP, but because Restoration Flow releases will be routed through this reach prior to construction, capacity of the outside ground along the levees upstream from the direct impacts of Mendota Pool was evaluated. The upstream 3.9 miles of Reach 2A does not contain project levees and was therefore excluded from this evaluation.

2.2. Hydraulic Models and Topographic Data

The hydraulic model for the study reach is based primarily on 2008 LiDAR mapping, and 2009-2011 bathymetry, where available (Tt-MEI, 2012). However, surveys conducted in November 2016 by Provost and Pritchard suggest that subsidence has lowered elevations in these reaches (**Figure 2**). Some scatter exists between the points of the surveyed reaches. To a limited degree, the scatter could result from the variability in the proximity of the data collected to the reference cross sections, but most likely indicate variability in the 2008 LiDAR mapping surface in which the models are based (Tetra Tech, 2013), changes in the ground as a result of grading/filling on the levees or adjacent lands, and potentially varying degrees of non-uniform subsidence. The specific variations were not critical to this effort and were not investigated. A trend line was fit through the data to represent the primary trend of the subsidence in Reaches 2A and 2B since 2008. The models were adjusted to reflect between 1.5 and 1.8 feet in Reach 2B and between 0.4 and 1.5 feet in Reach 2A since 2008 (Figure 2).

2.3. Outside Ground Elevations

Elevations of land protected by and adjacent to the levees (outside ground) were previously developed for the 2013 in-channel capacity assessment based on the 2008 LiDAR data incorporated into the updated hydraulic model. Elevations were initially identified at each model cross section primarily through inspection of the cross-section profiles and verified through review of the aerial photography and contour mapping (2008 LiDAR).

For the updated analysis, the outside ground elevations were adjusted to account for the subsidence indicated by the November 2016 surveys, and used to re-evaluate the in-channel capacity.

3. RESULTS

Computed water-surface profiles were compared to the outside ground elevations adjacent to both the left and right levees along both reaches. The in-channel flow capacity was determined to be the highest flow rate through the reach where the water-surface elevation does not exceed the outside ground elevation for any part of the reach. Approximate lengths of each site where the outside ground elevations are overtopped by the water-surface elevations associated with a local discharge of 2,000 and 4,500 cfs were then estimated from the available mapping, topography at adjacent cross sections, and the actual length along the levee as indicated in aerial photography.

Generally, the impact of subsidence in the 11-mile-long Reach 2A that runs from Gravely Ford to the Chowchilla Bypass Bifurcation Structure has been relatively minor compared to other reaches. However, because the downstream end of the reach has subsided about 1 foot more than the upstream end of the reach, the in-channel capacity is reduced from the last analysis (DWR, 2015). The in-channel capacity of this reach is now approximately 1,500 cfs (reduced from the previous estimate of 1,630 cfs) and is limited by the ground elevation on the right side of the river at XS 580452 (**Figures 3 and 4**). At 2,000 cfs, the length where water-surface elevations exceed ground elevations is less than a half mile (approximately 2,100 feet) along the levees on both sides of the river (**Figure 5**). At 4,500 cfs the distance where the water surface elevations exceed the ground elevations is 2.7 miles (14,200 feet) along the left levee and 2.1 miles (10,900 feet) (**Table 2**) along the right levee (**Figure 6**). All of these areas are within the 4 miles immediately upstream from the Bifurcation structure. It is important to note, however, that capacities in this reach were also computed based on a separate Geotechnical Condition Report (GCR) of the Gravelly Ford Study Area (Tetra Tech, 2015b) that determined an acceptable elevation of flow along the levees. The result of the GCR Priority 1 levee evaluations of maximum flows showed that, when considering levee seepage and stability, allowable flows in Reach 2A before and after adjusting for subsidence are over 6,000 cfs throughout the entire reach. Because capacities based on the additional levee information are greater than indicated by the in-channel capacity analysis described above, the GCR results supersede the results from this in-channel capacity update. However, future subsidence could reduce the capacity to less than 6,000 cfs.

Table 2. Summary of in-channel capacity discharge and approximate length of levee in Reach 2B where the outside ground elevation is below the water-surface elevation at 2,000 and 4,500 cfs.

Reach	Levee Side	Discharge Capacity[1] (cfs)	Length of Levee at 2,000 cfs (ft)	Length of Levee at 4,500 cfs (ft)
Reach 2A	Left	1,900	2,100	14,200
Reach 2A	Right	1,500	2,180	10,900
Reach 2B (Entire Reach)[2]	Left	0[4]	15,100	51,300
Reach 2B (Entire Reach) [2]	Right	0[4]	10,900	40,400
Reach 2B (Excluding Mendota Pool)[3]	Left	1,210	3,090	36,000
Reach 2B (Excluding Mendota Pool) [3]	Right	1,670	3,430	25,500

[1]Capacity based on outside ground elevations.

[2]Entire reach including Mendota Pool.

[3]Portion of reach above influence of Mendota Pool (upstream of Sta 4765+00).

[4]Pool elevation exceeds outside ground elevations

Reach 2B is approximately 11 miles long and extends from the Chowchilla Bypass Bifurcation Structure downstream to Mendota Dam. Outside ground elevations along the lower portion of this reach (downstream from approximately Sta 4765+00) are generally lower than the normal pool elevation at Mendota Dam. The existing flow capacity was also evaluated for the reach upstream from the influence of the pool.

Outside ground elevations in the lower portion of Reach 2B (downstream from approximately Sta 4765+00) are generally lower than the normal pool elevation at Mendota Dam. Therefore, when considering the entire reach, including Mendota Pool, and the criteria defined in this study the capacity along both sides of the channel is 0 cfs (**Figures 7 and 8**). At a local discharge of 2,000 cfs, water-surface elevations exceed the outside ground elevations over approximately 2.8 miles (15,000 feet) along the left levee and 1.9 miles (10,240 feet) along the right levee (Table 2, **Figure 9**). At 4,500 cfs[1], the length where water-surface elevations exceed ground elevations along the left levee increases to about 9.7 miles (51,200 feet), and the length along the right levee increases to about 7.6 miles (40,400 feet) (**Figure 10**). If only the portion of the reach upstream from the influence of the pool is considered, the highest local discharge in which the water surface is at or below the outside ground elevation is now about 1,210 cfs along the left levee and 1,670 cfs along the right levee (Table 2) (increased from the previous estimate of 1,550 cfs along the right levee and 1,120 cfs along the left levee). In this portion of the reach, water-surface elevations at 2,000 cfs exceed the outside ground elevations along 3,090 feet of levee on the left side of the channel and 3,430 feet along the right levee. At a local flow of 4,500 cfs, the lengths increase significantly to 6.8 miles (36,000 feet) along the left levee and 4.8 miles (25,500 feet) along the right levee.

4. REFERENCES

California Department of Water Resources, 2015. San Joaquin River In-channel Capacity Analysis: Appendix C to the Channel Capacity Report 2015 Restoration Year, September.

Tetra Tech (dba Mussetter Engineering, Inc.), 2012. San Joaquin River Reaches 1B, 2A, 2B, 3 and 4B1 One-dimensional HEC-RAS Steady-state Hydraulic Model Bathymetry Updates. Review Draft technical memorandum prepared for the California Dept. of Water Resources, Fresno, California, January 31.

Tetra Tech Inc., 2013. San Joaquin River and Bypass System 1-D Steady State HEC-RAS Model Documentation, Draft technical memorandum prepared for the California Dept. of Water Resources, Fresno, California, June.

Tetra Tech, 2014. San Joaquin River and Bypass System 1-D Steady State HEC-RAS Model Documentation, Draft technical memorandum prepared for the California Dept. of Water Resources, Fresno, California, March.

Tetra Tech, 2015a. San Joaquin River In-channel Capacity Analysis, Technical memorandum prepared for the California Dept. of Water Resources, Fresno, California, August.

[1] In-channel capacity results for 4,500 cfs in Reach 2B are included. However, model results show that 4,500 cfs will also overtop portions of the existing levees, indicating that 4,500 cfs cannot be conveyed in Reach 2B under existing conditions.

Tetra Tech, 2015b. Levee Capacity Evaluation of Geotechnical Gravelly Ford (Reach 2A) Study Area, Technical memorandum prepared for the California Dept. of Water Resources, Fresno, California, August.

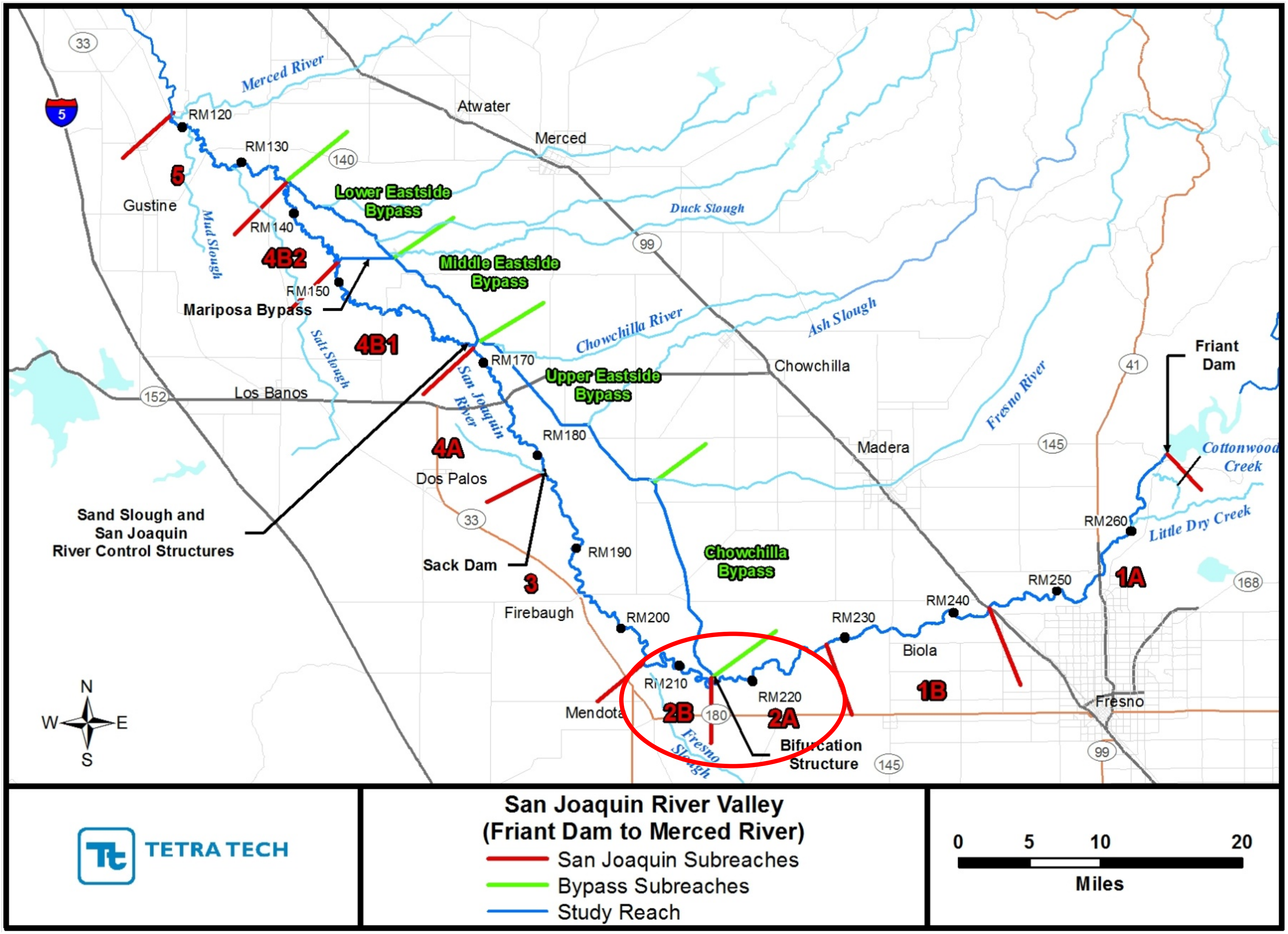

Figure 1. Map of the San Joaquin River Restoration Project Reach showing the location of Reach 2A and 2B.

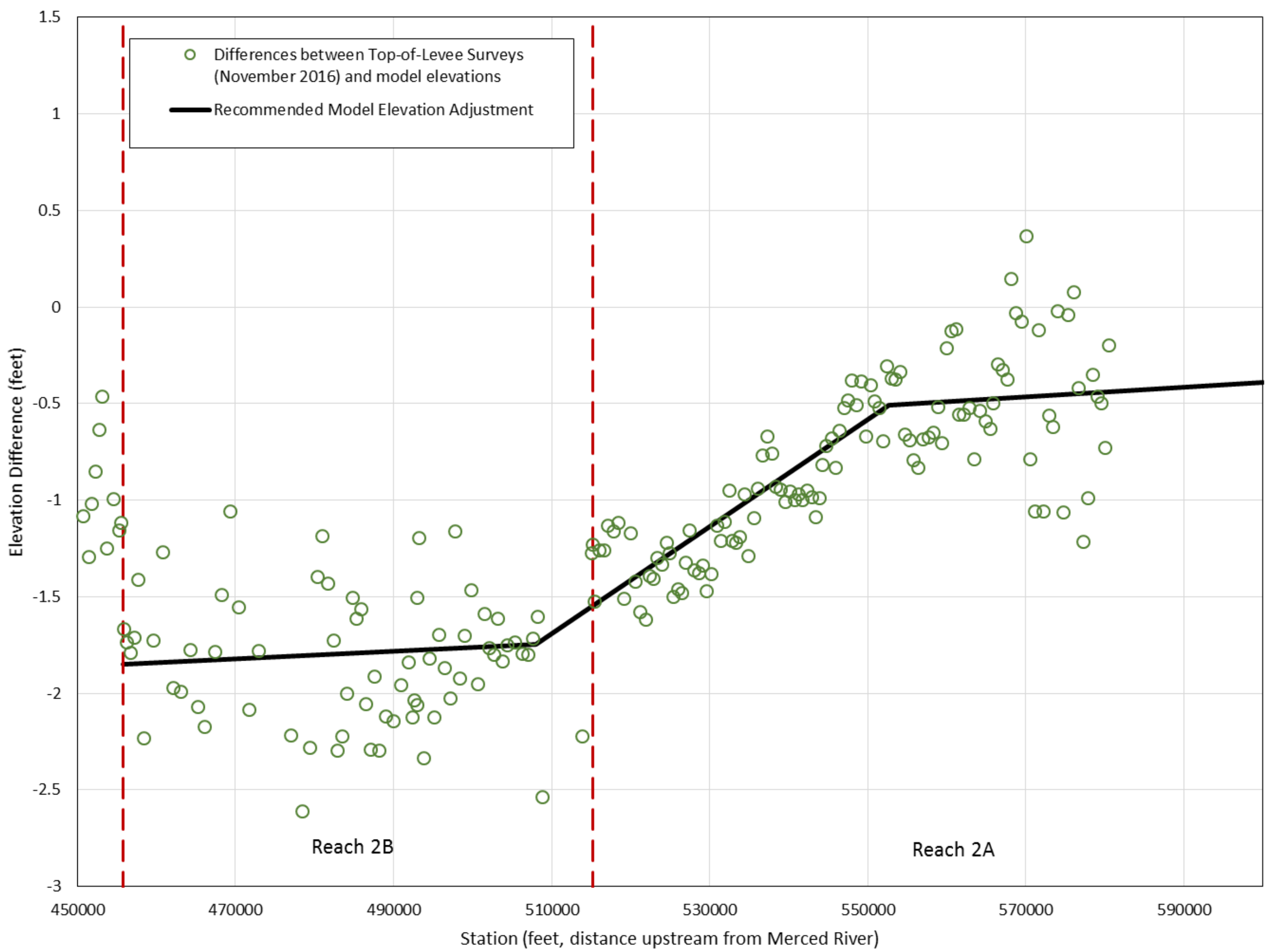

Figure 2. Differences between the November 2016 ground surveys and the 2008 LiDAR elevations indicated in the hydraulic model and 2008 model elevations. Negative values indicate that elevations have decreased from 2008 to 2017. Note: Stationing indicated in figure is based on river stationline.

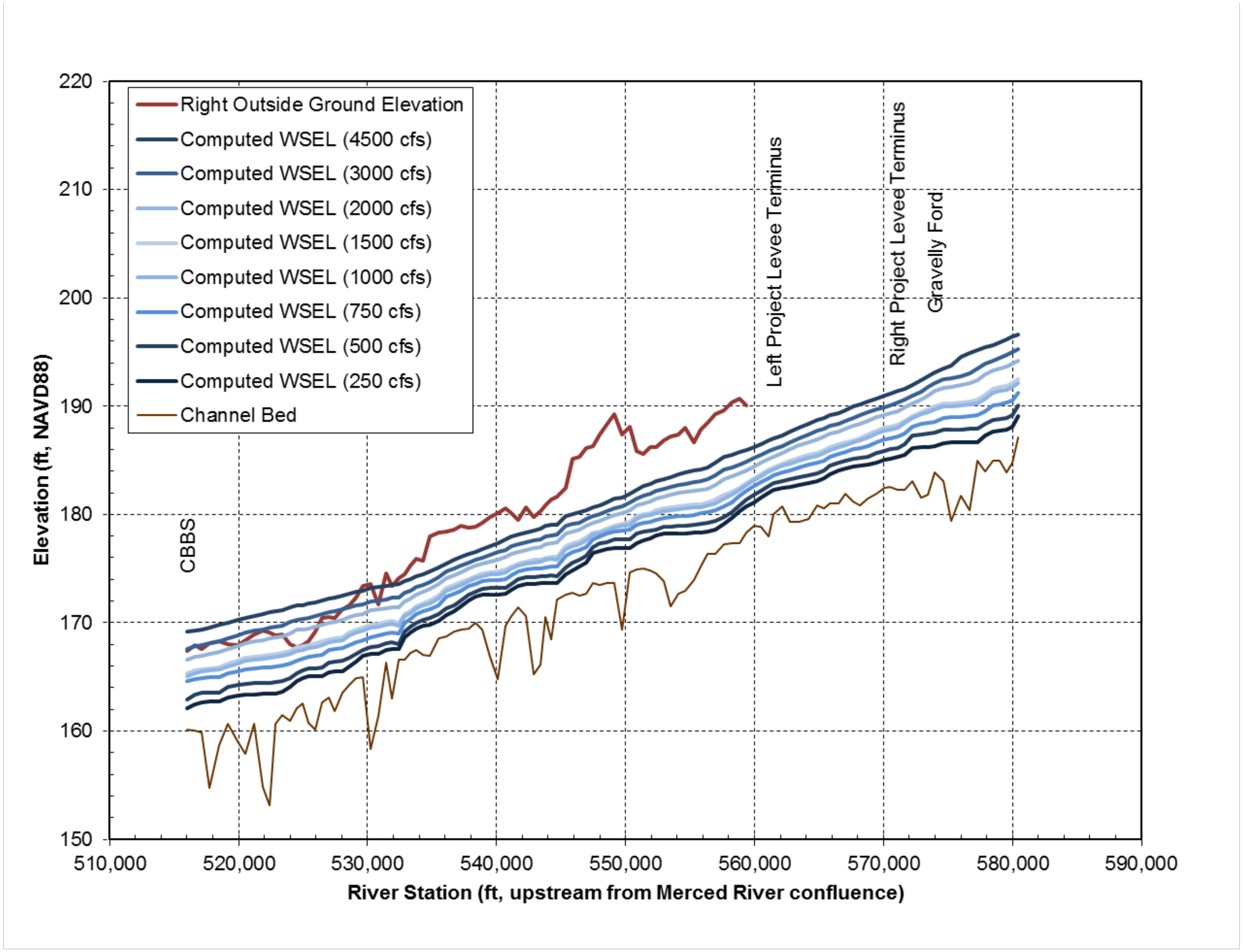

Figure 3. Comparison of outside ground elevation with computed water-surface elevations along right levee in Reach 2A.

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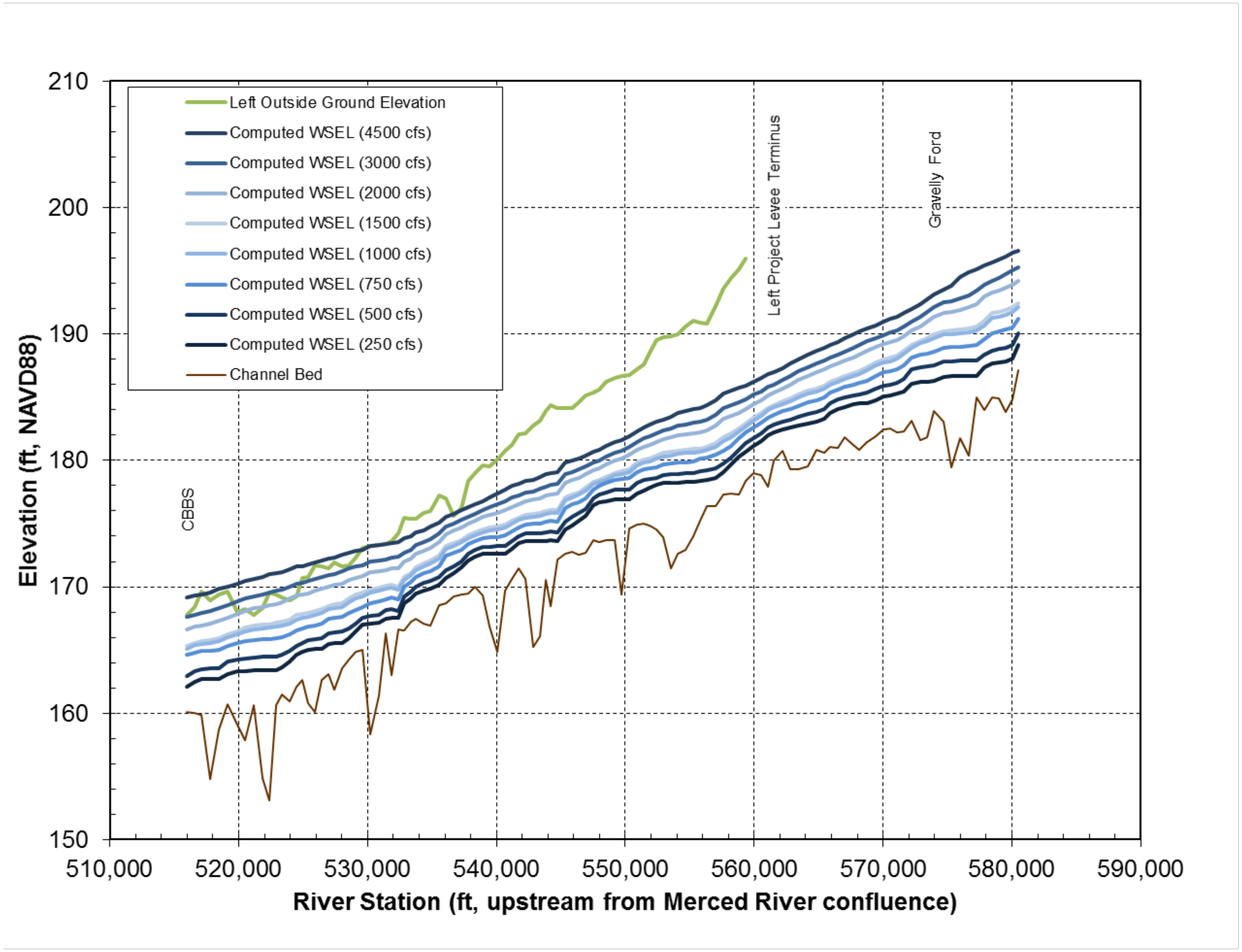

Figure 4. Comparison of outside ground elevation with computed water-surface elevations along left levee in Reach 2A.

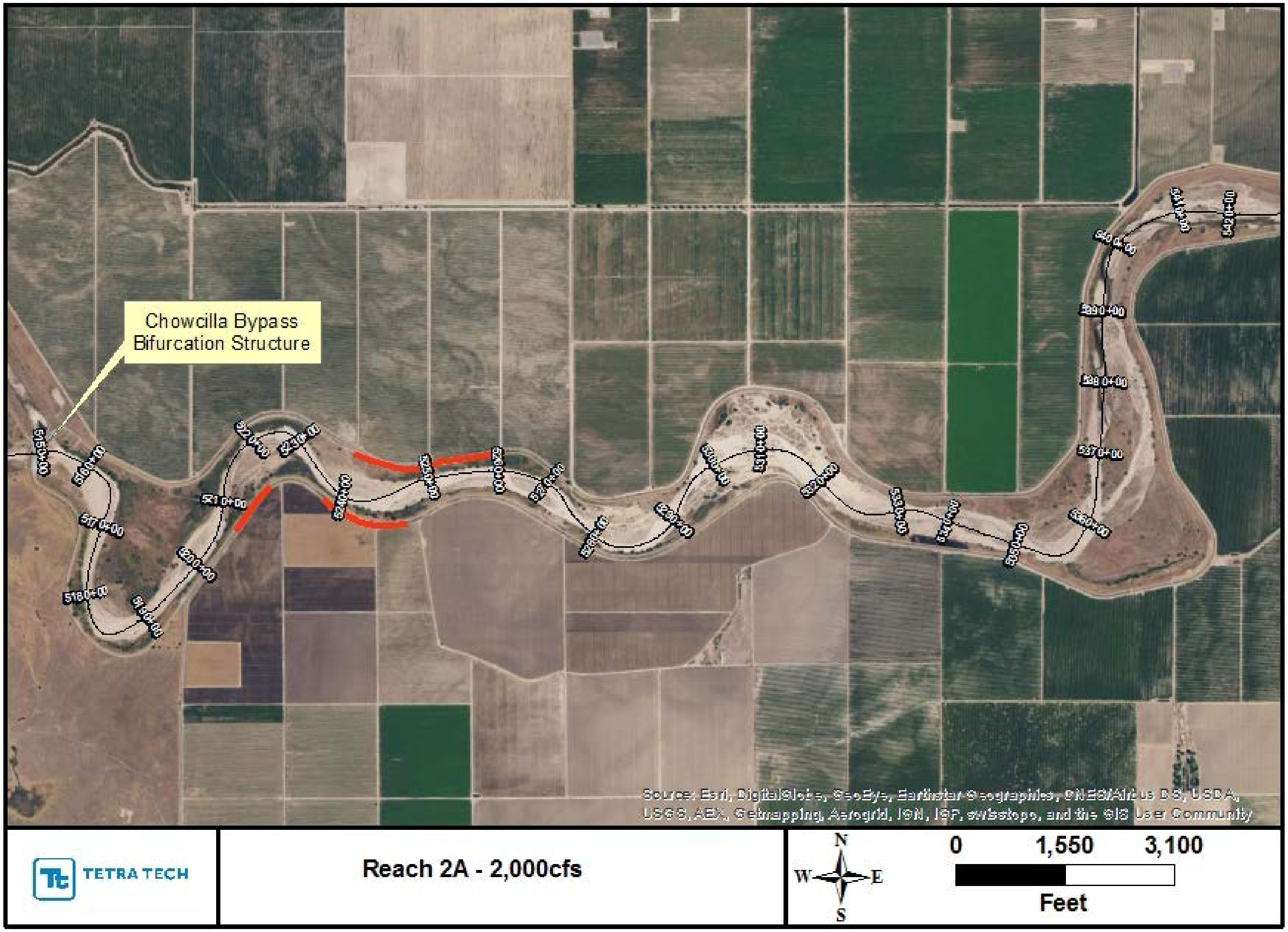

Figure 5. Portions of levee in Reach 2A where the 2,000-cfs water-surface elevation is above the outside ground elevation.

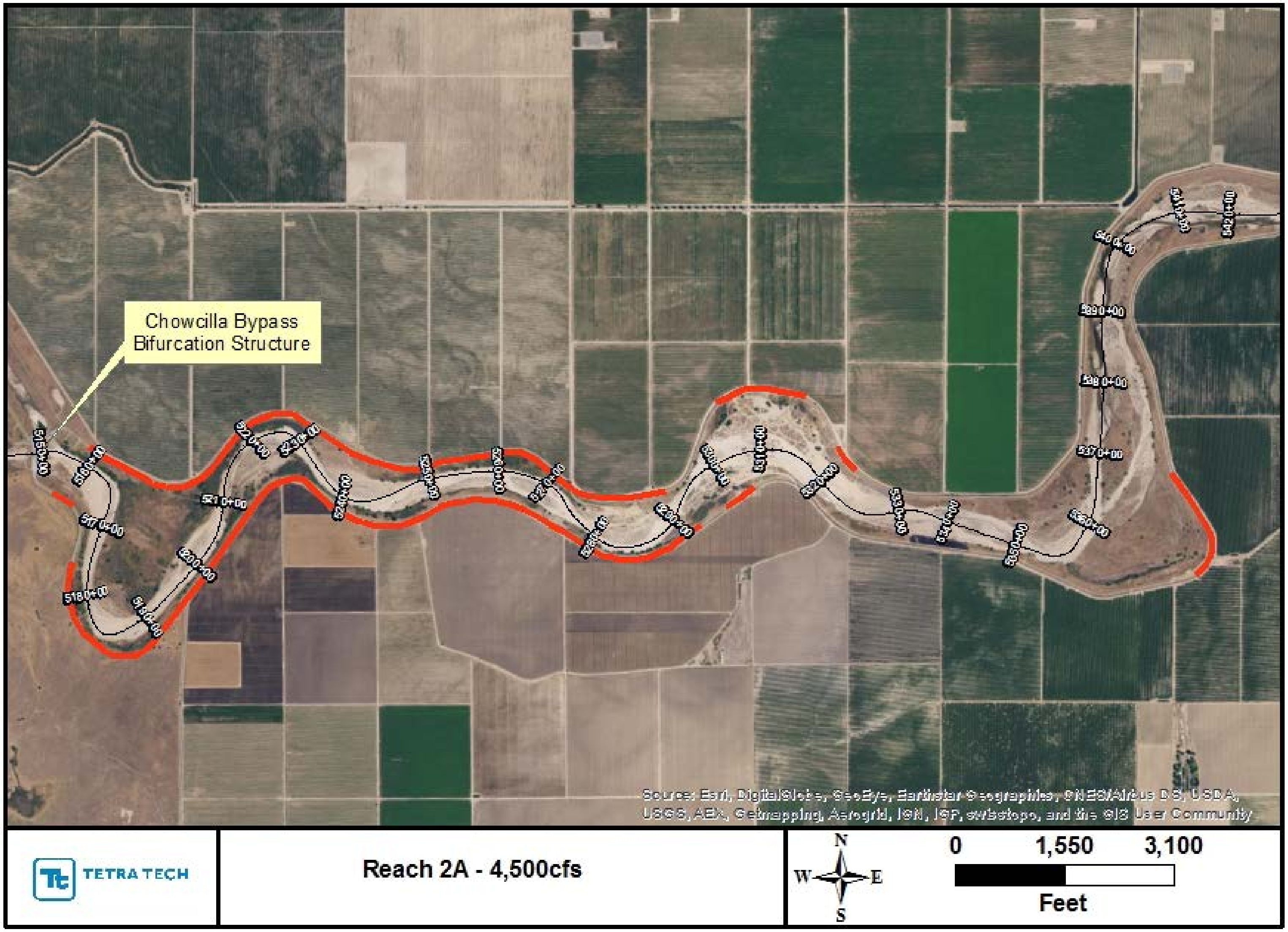

Figure 6. Portions of levee in Reach 2A where the 4,500-cfs water-surface elevation is above the outside ground elevation.

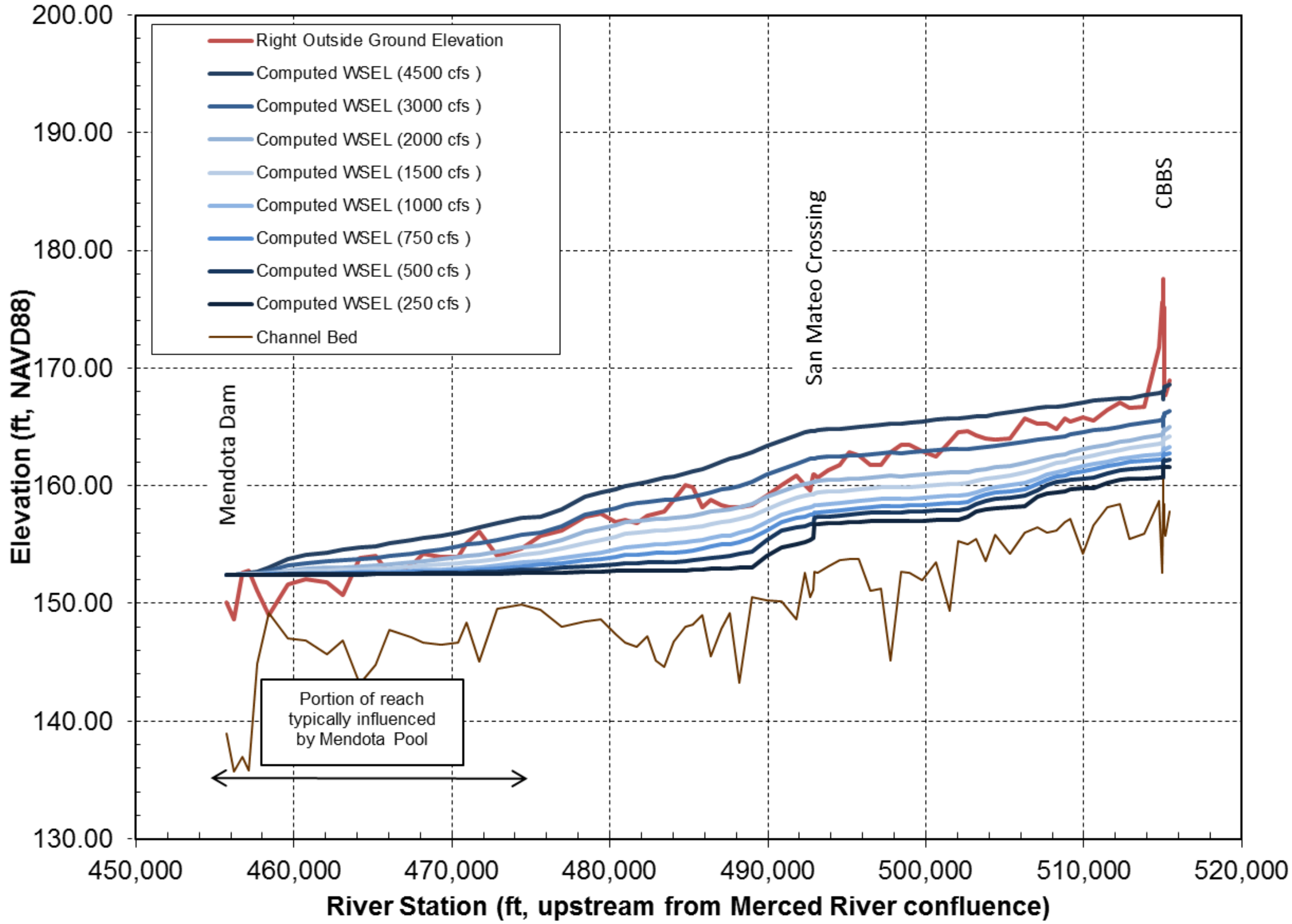

Figure 7. Comparison of outside ground elevation with computed water-surface elevations along right levee in Reach 2B.

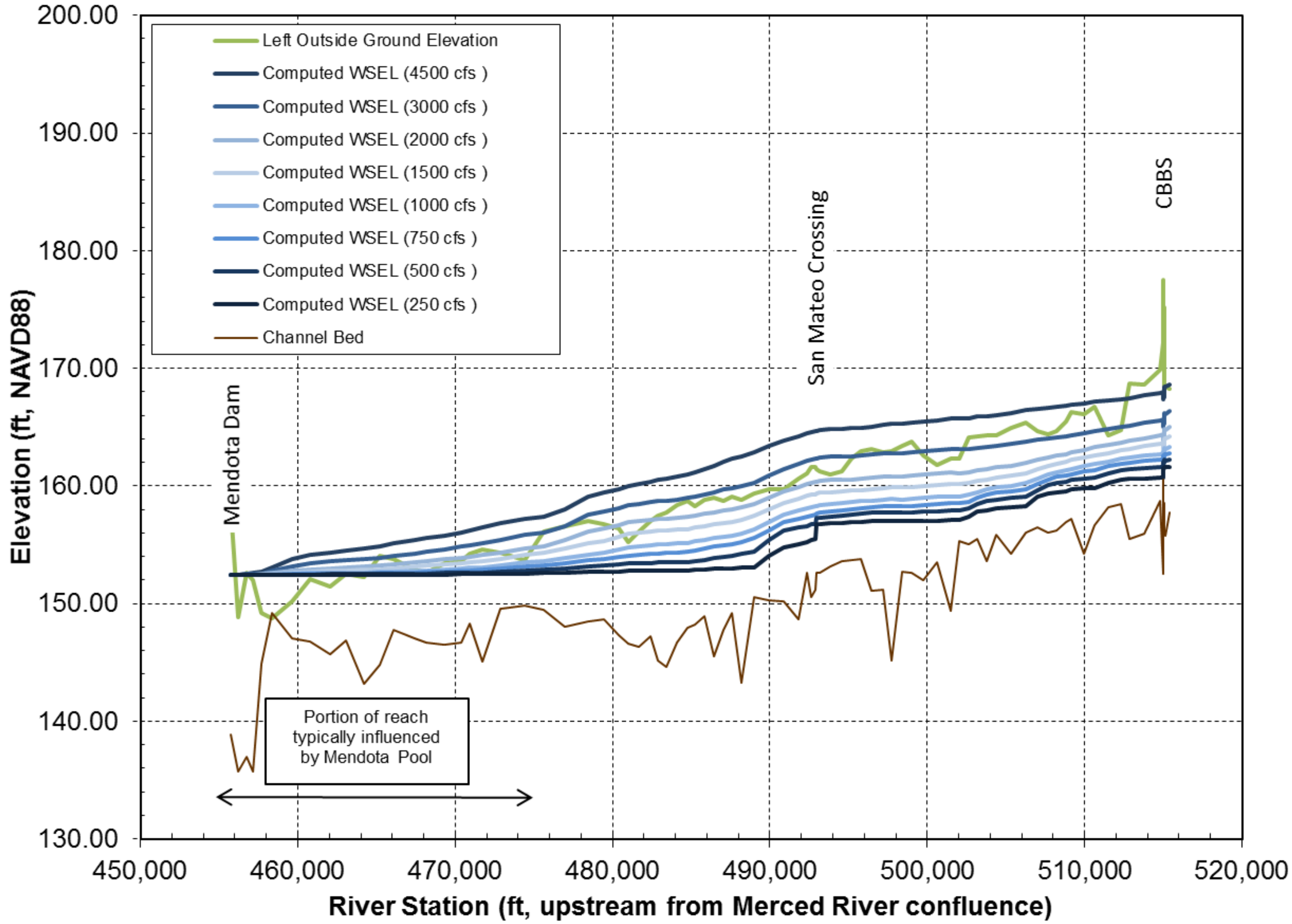

Figure 8. Comparison of outside ground elevation with computed water-surface elevations along left levee in Reach 2B.

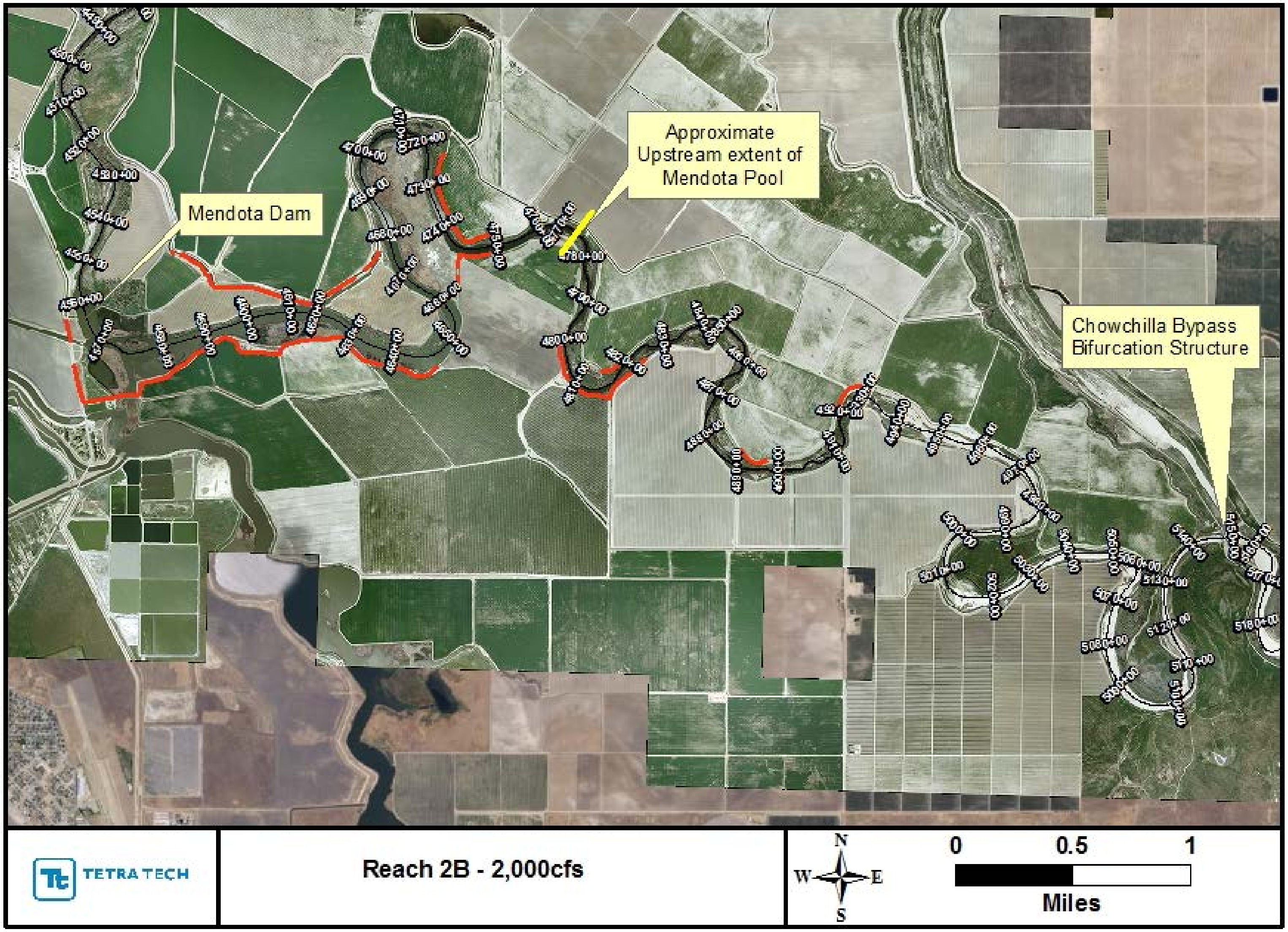

Figure 9. Portions of levee in Reach 2B where the 2,000-cfs water-surface elevation is above the outside ground elevation.

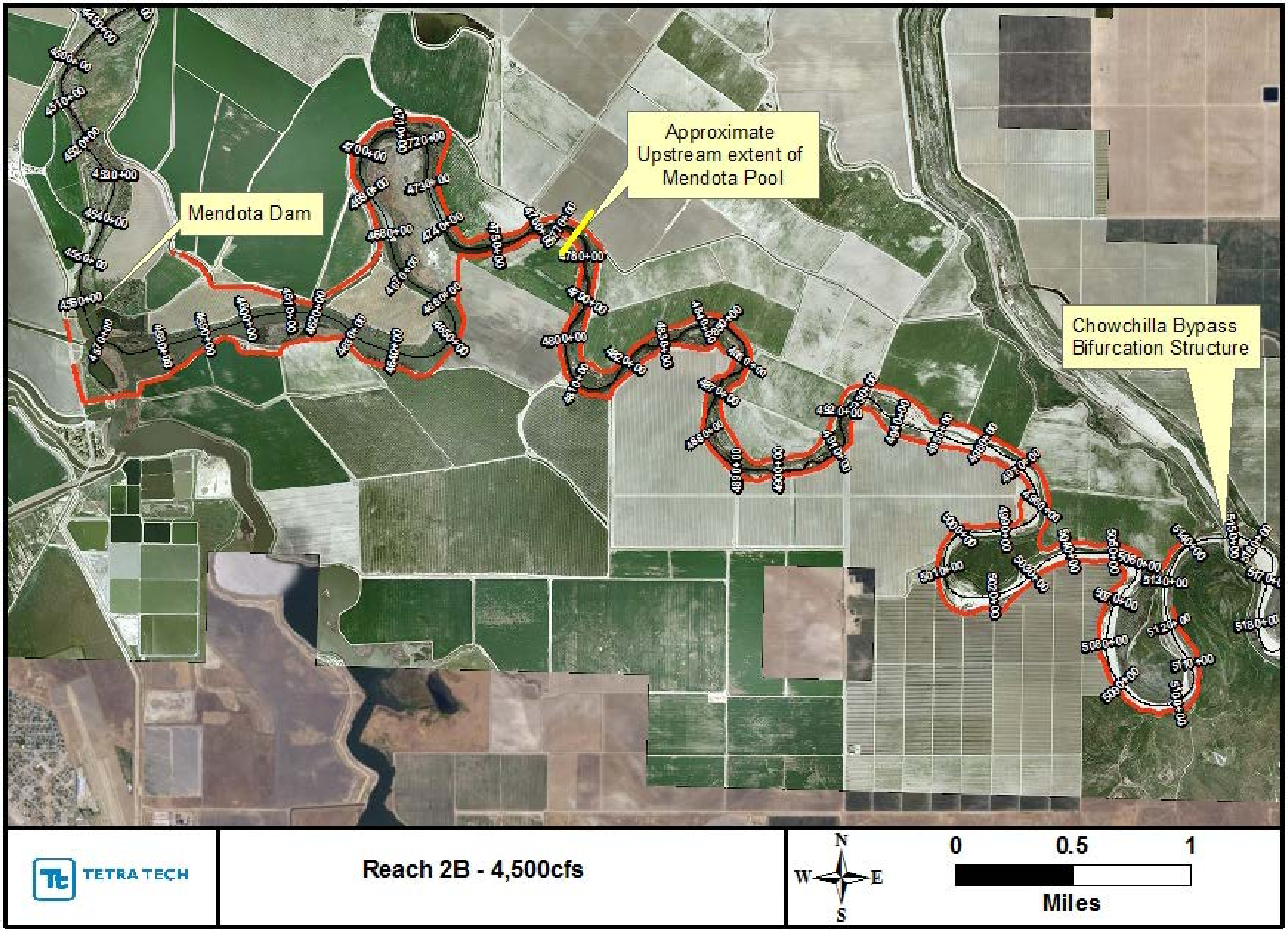

Figure 10. Portions of levee in Reach 2B where the 4,500-cfs water-surface elevation is above the outside ground elevation.