Conceptual Design Technical Memo

Paradise Cut Expansion Project

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Prepared for:

SACRAMENTO - SAN JOAQUIN DELTA CONSERVANCY
A California State Agency

SAN JOAQUIN COUNTY RESOURCE CONSERVATION DISTRICT

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1. Introduction

The purpose of this document is to refine the Paradise Cut Expansion Project plan described in the 2017 Update of the Central Valley Flood Protection Plan (DWR 2017). The Department of Water Resources (DWR) relied upon public input to develop the Paradise Cut Expansion Project in the Central Valley Flood Protection Plan (CVFPP) with the understanding that substantial additional design work would be necessary before the plan could be implemented. American Rivers, together with the San Joaquin County Resource Conservation District (SJCRCD), retained and directed consultants to refine the design in a manner that maximizes flood-stage reduction benefits, minimizes adverse hydraulic impacts, and lowers implementation costs. American Rivers and Environmental Science Associates (ESA) identified a variety of options for refining the design, and MBK Engineers developed and ran a hydraulic model to evaluate the hydraulic benefits and impacts of various configurations.

The refined design proposed in this document is not the final design for expanding Paradise Cut. Rather, it is still an early step in the design process that will be further refined when the project moves through the environmental compliance and permitting process to comply with the California Environmental Quality Act, the National Environmental Policy Act, Section 408 of the Rivers and Harbors Act, and other applicable laws. The refined design described in this document, however, will provide the basis for describing the benefits of the project, quantifying adverse hydraulic impacts on downstream areas, estimating implementation costs, and identifying permitting issues that will need to be addressed before the project can be implemented.

The SJCRCD and American Rivers made a concerted effort to obtain input on the design from agencies, the local community, and their technical consultants. The SJCRCD and American Rivers hosted well-attended meetings of both landowners and state and local agencies in the summer of 2018 to explain the project, discuss design challenges, and obtain suggestions. American Rivers provided state and local engineers an opportunity to review and comment on a detailed report describing the hydraulic model (MBK 2018), and later met with these engineers to describe the alternatives formulation process, the hydraulic modeling plan, and obtain input on assessment criteria. In January of 2019, the SJCRCD and American Rivers convened a second set of meetings with the local community and agency representatives to present preliminary results and receive input from stakeholders.

2. Objectives

The 2017 Update of the Central Valley Flood Protection Plan prioritizes multi-benefit flood management projects that reduce flood risk and improve habitat for fish and wildlife. The Paradise Cut Expansion Project is a multi-benefit flood management project designed to achieve the several flood and ecosystem objectives described below. The preponderance of technical analysis described in this document focuses on maximizing the flood risk reduction alternatives because all of the alternatives considered have significant and roughly equal ecosystem benefits.

Flood Risk Reduction Objectives

1. Reduce flood risk to people and property in the South Delta.
    a. Substantially reduce flood stage on the mainstem San Joaquin River between Mossdale and Stockton. Specifically, the project seeks to provide a substantial reduction in flood stage on the mainstem San Joaquin River between Vernalis and Stockton for the design event.
    b. Reduce flood risk for agricultural producers in the South Delta region.

   c. Avoid any increase in flood risk during the design event, particularly along Old River and Grant Line Canal.
   d. Substantially increase flood conveyance capacity of the lower San Joaquin River floodway.
2. Create and preserve the opportunity to incrementally expand the conveyance capacity of the lower San Joaquin River floodway to adapt to increases in peak run-off that are projected to occur over the next few decades as the climate changes.
3. Reduce maintenance costs and conflicts with listed species.
4. Maintain consistency with regional flood management plans (i.e., the Central Valley Flood Protection Plan).

Ecosystem Restoration Objectives

1. Increase habitat restoration opportunities upstream of Paradise Weir without adversely affecting flood management. Preserve and enhance habitat for Swainson's hawk and other species that forage in seasonal agriculture.
2. Reestablish woody vegetation along the west bank of the San Joaquin River upstream of Paradise Weir for riparian brush rabbit, riparian song birds, and other species.

3. Alternatives Formulation and Evaluation Process

American Rivers and the consultant team including MBK Engineers and ESA developed a range of alternatives to advance the project objectives, respond to public input, and evaluate how the project could be implemented in a phased manner to respond to changing hydrologic conditions over the next few decades. Each alternative consists of multiple elements and most of these elements were individually modeled to determine their individual impact. The four alternatives presented in **Table 1** and described below summarize a wide range of options evaluated and reveals the most interesting results. The full range of iterations evaluated with different model runs is described and shown in **Appendix C**.

Table 1: Description of Alternatives

Alternative Name	**Alternative Description**
CVFPP	Option M-ag from the 2017 update of the Central Valley Flood Protection Plan (Figure 2)
Modified CVFPP	CVFPP plus 5 miles of dredging in Old River and Grant Line Canal and with adjustments in setback levee configuration (Figure 4)
Minimum Viable Project (MVP)	Modified CVFPP without levee setback along the western edge of the bypass expansion area south of Deuel Vocational Institute (DVI) and with 250 foot opening at eastern UPRR crossing instead of 500 foot opening (Figure 5)
Potential Maximum Project (PMP)	MVP with 500 foot openings at all rail and highway crossings and major new setback levee along the northern end of Paradise Cut (Figure 6).

The logic of the four alternatives in **Table 1** builds upon the extensive planning and modeling performed by DWR for the 2017 Update of the CVFPP. The modeling team started with the CVFPP conceptual design described as Option M-Ag in the CVFPP appendix, the San Joaquin Basin Wide Feasibility Study (DWR 2016), and hereafter referred to as "CVFPP." To address local concerns with the CVFPP design, we developed the "Modified CVFPP" alternative, which entailed some adjustments in the proposed levee setback alignments and added dredging in Old River and Grant Line Canal. Then, we significantly scaled back the Modified CVFPP by reducing expensive elements – we eliminated the proposed 1.5 mile-long setback levee south of Deuel Vocational Institution (DVI) and halved the size of the proposed, new railroad trestle on the eastern UPRR track - to evaluate an alternative we named the Minimum Viable Project (MVP). Lastly, to evaluate the hydraulic benefits of expanding the MVP in the future to accommodate very large floods, we created the Potential Maximum Project (PMP) alternative, which altered the MVP design to include three new 500 foot bridges on the railroad and highway infrastructure and 2.5 miles of levee setback on the northern end of Paradise Cut.

Each alternative was evaluated under three different hydrologic and levee breach scenarios (**Table 2**). The levee breach assumptions are often unrealistic and can significantly influence the model results. The 1997 levee breach assumptions are the most realistic because they are based on what actually occurred in 1997. The 100-year with climate change assumption that levees overtop but do not breach represents a worst case scenario that may be useful for informing land use decisions, but is not useful for predicting how the system will actually respond. The design event assumption that levees will not fail is probably incorrect, but it does provide potentially useful information about how hydraulics will change if the system performs as originally intended.

Table 2: Hydrology and Levee Breach Assumptions

Hydrologic Scenario	Discharge at Vernalis (cfs)	Levee Breach Assumptions
Design Flood	52,000	No levee breaches
1997 Flood*	110,000	Levee breaches and relief cuts same as 1997 event except where levees have been significantly improved (i.e. super levees) or are assumed to be improved as part of the project.
100-Year (1% AEP) plus climate change**	235,000	Levees overtop but do not breach.

*76,000 cfs estimate at Vernalis gauge plus estimated 35,000 cfs that bypassed gauge.

** 116,000 cfs in the river and 120,000 cfs on the floodplain.

We used a variety of quantitative assessment criteria (**Table 3**) to evaluate the hydraulic and environmental performance of the alternatives relative to the flood risk reduction and environmental objectives described above. Although we considered all criteria in **Table 3**, we focused on the following five items:

- Peak flood stage reduction in the urbanizing reach between Paradise Weir and Howard Road
- Peak flood stage increase on Grant Line Canal and Old River downstream of Paradise Cut.
- Peak flood velocity (cross sectional average) on Grant Line Canal and Old River downstream of Paradise Cut.
- Presence or absence of expensive infrastructural elements as a surrogate for cost.
- Freeboard: the extent to which stage reductions or increases significantly changed available freeboard

Environmental criteria were not determinative because all alternatives had similar configurations, and the environmental performance is largely determined by the configuration.

Table 3: Assessment Criteria

Flood Stage Reduction Along water surface profiles reported along four pathways: 1. Mainstem San Joaquin River from Vernalis to Stockton Deepwater Ship Channel 2. Paradise Cut from Paradise Weir to Salmon Slough 3. Old River from the San Joaquin Confluence to Clifton Court 4. Grant Line Canal At key locations: Paradise Weir, Highway 5, Head of Old River, Tracy Avenue
Freeboard Along water surface profiles reported along four pathways: 1. Mainstem San Joaquin River from Vernalis to Stockton Deepwater Ship Channel 2. Paradise Cut from Paradise Weir to Salmon Slough 3. Old River from the San Joaquin Confluence to Clifton Court 4. Grant Line Canal
Discharge (cubic feet per second) At key locations and all flow splits: Vernalis, SJ at new weir, PC at new weir, SJ at Paradise weir, PC at Paradise Weir, SJ downstream of Old River, Head of Old River, Old River downstream of Paradise Cut, Grant Line Canal
Cost New infrastructure (levees, bridges, weirs) Land Acquisition Mitigation costs Operations and Maintenance Costs
Habitat Acres of Riparian habitat (songbirds, brush rabbit) Linear feet of Shaded Riverine aquatic Acres of seasonal agricultural habitat (Swainson's hawk, other avian species)

4. Conceptual Design Alternatives Description and Analysis

The alternatives identified in **Table 1** are described in detail below along with information on their hydraulic performance.

The hydraulic performance of each alternative is reported in a series of charts that depict stage and velocity results of four distinct pathways (see **Figure 1**):

1) San Joaquin River from Vernalis to Stockton Deepwater Ship Channel
2) Paradise Cut from Paradise Weir to Salmon Slough
3) Old River from the San Joaquin Confluence to Clifton Court
4) Grant Line Canal

CVFPP

The Central Valley Flood Protection Plan (CVFPP 2017) includes the Paradise Cut Expansion Project as one of several recommended actions on the San Joaquin River to improve flood risk management and provide ecosystem benefits. DWR reviewed a series of scenarios to expand Paradise Cut and recommended Option M-ag, which consists of a new 1,000 foot weir and associated levee setback upstream of the existing Paradise Cut weir, installation of setback levees along Paradise Cut, and the east railroad trestle expanded by 500 feet (see **Figure 2)**. According the CVFPP, this configuration would reduce peak stage by 2 feet on the San Joaquin at the Mossdale Bridge and increase riparian and wetland habitat by about 500 acres.

The current hydraulic modeling was done using a modified version of the San Joaquin River Basin HEC-RAS model developed by DWR for the Central Valley Floodplain Evaluation and Delineation (CVFED) project. The model was originally reduced to the San Joaquin River and distributaries downstream of the Stanislaus River by Peterson Brustad Inc. (PBI) for the cities of Lathrop and Manteca (PBI 2014), and was subsequently refined to improve representation of Paradise Cut, Old River, and Grant Line Canal (MBK 2018). The model, which was developed with topography and bathymetry collected in 2008-2010, was further refined based on bathymetric data collected in Old River between Middle River and Tracy Boulevard by the South Delta Water Agency in June 2018.

CVFPP with Dredging

In a series of outreach meetings in 2018-19, local stakeholders - including farmers, reclamation district representatives, and agency staff - repeatedly requested that the project include dredging as part of its hydraulic modeling and conceptual design. The modeling team responded to this request by modeling 2 vertical feet of dredging along a 5 mile section of Old River and Grant Line Canal (see **Figure 3)**. The dredging scenario was undertaken to determine the sensitivity of the model hydraulics to dredging, and is not necessarily the recommended location and extent of any future dredging.

A comparison of the CVFPP and CVFPP with Dredging indicates that dredging, as modeled, would lower flood stage a maximum of between 1.5and 2inches for both the design and 1997 flood events on Old River between the west end of Stewart Tract and upstream of Tracy Blvd and on Grant Line Canal upstream of Tracy Blvd (**Charts 1-4**).

Dredging has other benefits that make it desirable to include as part of the larger project. First, local stakeholders point out that excessive sedimentation already negatively affects their irrigation intake pumps as well as navigation on South Delta waterways. They feel that increased flood water due to the Paradise Cut expansion project may bring increased sedimentation and add to their problems. A sediment control plan (that includes dredging) to improve irrigation intakes and navigation may be the key to gaining local support for this project, even though it may have little hydraulic impact on flood stage.

Secondly, the state will need to mitigate for negative downstream hydraulic impacts due to increased flood stage and velocity from the project. Multiple local stakeholders have asserted that the downstream levees are high enough to avoid levee overtopping but narrow and erodible and therefore prone to failure due to increased hydrostatic pressure or velocity. They point out that using the spoils from dredging to reinforce the landside toe of the levee would strengthen vulnerable levees and decrease costs of importing soils.

Restrictions on dredging in the Delta require substantial permitting and mitigation. However, in this location along Old River and Grant Line Canal, the aquatic habitat value is limited due to the nearby water delivery pumps that entrain and kill fish. Project proponents may be able to convince agency staff that flood risk reduction and ecosystem enhancement benefits from this project and related endeavors outweigh any potential damage done to a reach of the river system that is essentially a death trap for fish.

In summary, dredging may be an important piece of the larger project because it could ensure local support and potentially provide material to strengthen downstream levees, thereby reducing costs. Support for dredging from agencies will likely be difficult to obtain but may be gained by presenting a larger picture of ecosystem restoration and flood risk reduction.

Modified CVFPP

The modeling team changed the following elements of the CVFPP original design to create the Modified CVFPP (see **Figure 4**):

- Included dredging as set out in the previous section
- Realigned the River Islands levee on the right bank of Paradise Cut to reflect their design
- Reduced the setback levee at Kisst Dairy to avoid the high costs and impact associated with moving a dairy facility
- Removed the setback levee at Bend 16 from the design

The hydraulic impact from these changes is not even detectable during the 1997 event in the San Joaquin River (see **Chart 5**), and therefore the constrictions at the Kisst dairy facility and Bend 16 do not affect the flood stage reduction benefits on the mainstem San Joaquin. On Paradise Cut, water surface elevation does increase between I-5 and the confluence with Old River by up to 3/10 of a foot in the 1997 flood (see **Chart 6**). On both Old River and Grant Line Canal, the Modified CVFPP has minimal impacts of up to 2/10 foot reduction in flood stage due to dredging (see **Charts 7-8** and previous **Charts 1-4**).

In summary, the Modified CVFPP does not affect flood stage reduction in the San Joaquin River, has minimal stage reductions in Old River and Grant Line Canal, and increases flood stage in Paradise Cut by up to 3.5 inches, with the most impacted areas between I-5 and Bend 16, and just downstream of the Paradise Road crossing.

Minimum Viable Project

The modeling team then modeled the hydraulic performance of the project with the following alterations to the Modified CVFPP design (see **Figure 5**):

- No setback levee south of Deuel Vocational Institute
- Reduced east railroad opening expansion from 500 feet to 250 feet

Both of these modifications, together named the Minimum Viable Project (MVP), were predicted to reduce costs and downstream hydraulic impacts, and therefore make the project more likely to be built. In comparison with the Modified CVFPP, the MVP alterations had almost no hydraulic impact on flood stage reduction in the San Joaquin or in Old River (see **Charts 9-10**). The MVP very slightly reduced flood stage on Paradise Cut and Grant Line Canal during the 1997 flood (see **Charts 11-12**), which presumably results from a smaller opening through the east rail road crossing.

In summary, the MVP has an equivalent hydraulic impact on the San Joaquin River as the Modified CVFPP, which itself was equivalent to the CVFPP design. Therefore, the MVP has an equal amount of flood stage reduction benefits on the San Joaquin River as the CVFPP, and equivalent or smaller impacts downstream on Paradise Cut, Old River and Grant Line Canal. Since the MVP is presumed to cost less than the CVFPP design due to less setback levee construction and a smaller opening under the eastern railroad crossing, the MVP is preferable to the CVFPP. A cost estimate during the next phase of analysis will quantify the costs savings associated with the MVP relative to the CVFPP.

Potential Maximum Project

The SJBWFS, an appendix to the 2017 CVFPP Update, predicts that peak flood flows on the San Joaquin River will increase significantly due to climate change. Under these projections, a 200-year flood with climate change could double the volume of the 1997 flood.

To determine whether it was possible to accommodate this future scenario, the modeling team modeled a Potential Maximum Project (PMP), which alters the modified CVFPP configuration to include the following elements (see **Figure 6**):

- Include original CVFPP setbacks at Kisst dairy and Bend 16
- Add setback downstream of Bend 16
- Expand openings by 500 feet under east railroad, 1-5,205, and west railroad
- Expand upper weir opening to 2,000 ft
- No setback levee at Deuel Vocational Institute

In comparison with the MVP in both the design and 1997 flood events, the PMP:

- Reduces flood stage on the San Joaquin River during the Design Flood by about ¾ of a foot, for a total of 2.75 feet of flood reduction (see **Chart 13**).
- Reduces flood stage on the San Joaquin River during the1997 Flood by up to one foot, for a total of 4 feet of flood reduction (see **Chart 14**).
- Reduces flood stage on Paradise Cut upstream of the railroad and highway crossings by up to one foot in the design flood and 1.5 feet in the 1997 flood, which is due to the 500 foot openings that allow more water through (see **Charts 15-16**).
- For both design and 1997 floods, increases flood stage downstream of the highway and railroad crossings by up to a foot on Paradise Cut (see **Charts 15-16**) and up to 3/10 of a foot on Old River and Grant Line Canal (see **Charts 17-20**).

In order to determine if the PMP will provide significant flood relief during larger flood events, the performance of the MVP and the PMP were also evaluated in the 100 year flood event with climate change. In comparison with existing conditions in the San Joaquin River, the MVP reduced flood stage by up to 1 foot, and the PMP reduced flood stage by up 1.5 feet (see **Chart 20**). Due to the increased width in the openings across Paradise Cut, the PMP reduces flood stage in Paradise Cut by 1.25 feet relative to the MVP (see **Chart 21**). Downstream on Old River and Grant Line Canal, the PMP results in a slight state increase relative to the MVP (see **Charts 22-23**).

The results for both the PMP and MVP under the 100-year with climate change event are problematic. If the model assumptions are correct, the predicted flood volume is so large that even relatively significant modifications to Paradise Cut will not be enough to prevent large scale flooding in the region. Although both the PMP and MVP lower flood stage relative to the existing bypass configuration, these reductions do not prevent widespread flooding according to the model. Equally troubling, the model predicts a two foot stage increase in Old River for the 100 year event, which would be difficult if not impossible to mitigate. The last result is circumspect because the pattern of stage increase on Old River is significantly different then the pattern predicted for the 1997 and design events. In both of those events, the stage increase was greatest between Paradise Cut and Tracy Blvd and then tapered-off toward Clifton Court on both Old River and Grant Line Canal, but for the 100 year event, the stage increase is substantially greater downstream of Tracy Blvd but only on Old River.

The model results for the 100-year plus climate change scenario are not an accurate prediction of what will occur. The general prediction of widespread inundation may be correct, but the results are largely an artifact of an unrealistic, controlling assumption – levees that overtop do not breach. This levee breach assumption may be useful, and in fact is required, for informing land use planning decisions, but is not an accurate prediction of how the system will actually function during a large event. In the real world, levees will breach before they overtop, and a relief cut will form, or be created by humans, to allow peak flood waters to spread out and flow across broad floodplains, which would lower regional flood stages substantially and could significantly attenuate flood peaks. More realistic assumptions regarding how levees and flow paths will change are difficult to model, but recent advancements in two-dimensional modeling should enable flood managers to better predict how flood waters will move during unprecedented, extreme events.

Modeling results for the 1997 and design event are much more reliable and indicate that both the MVP and the PMP have substantial stage reduction benefits. Although the PMP produces greater flood stage reduction benefits, the amount of effort and expense involved in obtaining easements for additional setback levees and constructing large openings under the highway and railroads would substantially increase the implementation costs of the PMP relative to the MVP.

5. Preferred Conceptual Design: Minimum Viable Project Details

The Minimum Viable Project is the preferred design because it produces relatively large flood stage reduction benefits with a smaller level of effort and cost. It equals or exceeds the stage reduction benefits of the CVFPP and Modified CVFPP configurations, but with substantially less infrastructure. Although it does not provide the stage reduction benefits of the PMP, it can be expanded over time to achieve these benefits without any stranded investments if future decision makers decide the extra investment is warranted. The following section provides more information regarding the MVP including changes to flood routing, freeboard, velocity, and habitat.

For review, the MVP configuration (see **Figure 5**) consists of the following alterations to the original CVFPP design.

- Includes some dredging on Old River and Grant Line Canal
- Realigns the River Islands levee on the right bank of Paradise Cut to reflect their design
- Reduces the setback levee at Kisst Dairy to avoid the high costs and complications associated with moving or retiring a dairy facility
- Removes the setback levee at Bend 16 from the design
- Removes the setback levee south of Deuel Vocational Institute
- Reduces east railroad opening expansion from 500 feet to 250 feet

Flood Routing

Expanding Paradise Cut lowers flood risk because it both increases total flood conveyance at a constrained reach of the lower San Joaquin River and routes flood waters away from the urbanizing reach of the San Joaquin between Highway 5 and French Camp Slough. **Figures 7-8** show how the MVP changes peak flow routing during the design event. The MVP increases peak flows routed down Paradise Cut by forty-five percent and decreases peak flows in the mainstem San Joaquin at all flow splits downstream of the proposed new weir. The MVP increases peak flow in Old River and Grant Line Canal downstream of Paradise Cut, but counterintuitively these increases are much less than one might expect. Although the MVP increases the amount flowing down Paradise Cut toward Old River and Grant Line canal by forty-five percent, it decreases the amount flowing to this area from the head of Old River by seventeen percent. The net result is an eight to nine percent increase in peak flows along the lower reaches of Old River and Grant Line Canal under the design event.

Freeboard

Freeboard, the vertical difference between flood stage and the top of the levee, is depicted in **Charts 23-2**6. The left and right levee crowns are plotted against existing conditions and the Minimum Viable Project.

Although increased flood volumes and stage downstream of Paradise Cut are perhaps the biggest permitting and implementation challenge to expanding Paradise Cut, **Charts 25-26** show that freeboard along Old River and Grant Line Canal under the MVP is mostly greater than five feet during the 1997 scenario. Under the MVP, the maximum freeboard reduction (six inches on Grant Line Canal at Tracy Blvd under the 1997 scenario) amounts to a seven percent reduction in the seven feet of freeboard currently available Along most of Old River and Grant Line Canal, the MVP reduces freeboard by less than five percent. Any increase in stage or velocity is problematic for downstream landowners and residents, but the stage increases are small compared to the amount of freeboard available. Although the decrease in freeboard is numerically small, it will incrementally increase pressure on the levees and would have to be adequately mitigated.

The levees along twelve miles of the San Joaquin River between Paradise Weir and Airport Way have the most limited freeboard in the study area and are therefore more vulnerable to levee overtopping than the levees along Old River and Grant Line Canal (see **Chart 23**). The MVP doubles freeboard along ten miles of the right bank levee under the 1997 event. Under the design event, the MVP increases freeboard by 20 to 50 percent along this 10 mile reach.

Along Paradise Cut, the MVP doesn't change freeboard significantly except for a half mile reach upstream of Highway 5 where minimum freeboard is reduced from 4 feet under existing conditions to 2 feet under the MVP (see **Chart 24**).

Although the freeboard graphs indicate that the region upstream of Paradise Cut is much more vulnerable to overtopping than the region downstream of Paradise Cut, freeboard is not the only levee integrity factor to consider. Levee failure can occur due to piping (seepage) through the levee cross section or erosion by high velocity waters. If failure due to piping is the main concern, then flood stage is a better metric because piping is a function of hydrostatic pressure, which is largely determined by stage.   All other factors being equal, however, a levee with less freeboard is more likely to fail from piping. Where erosion is the primary concern, velocity is the most useful indicator of vulnerability. Velocity can be a function of stage, but freeboard is irrelevant.

Velocity

During stakeholder outreach meetings, community members requested modeling of water velocity along vulnerable levees, particularly along Old River and Paradise Cut downstream of Paradise Cut. The model generates cross-sectional average velocity predictions, which are useful for identifying major changes in velocity, but very limited for determining what type of impacts that major increases in velocities may cause. Velocity changes on the channel margins are most problematic for levee and bank erosion and stability, but the average cross sectional velocity could change significantly without changing channel margin velocities, particularly where channel margins are vegetated. Nevertheless, the following analyses offer some interesting information regarding the potential impacts of the proposed project.

Charts 27-30 plot projected velocity changes for the MVP along all four study reaches under both the 1997 and design events. In summary, velocities decrease slightly along the San Joaquin River downstream of the new proposed weir and along the upper 13 miles of Old River. Immediately upstream of the new weir, velocities spike thirty percent during the 1997 event for a short reach. Velocities increase slightly, less than ten percent, downstream of Tracy Blvd along the lower six miles of Old River and Grant Line Canal, but remain relatively unchanged in the reach between Tracy Blvd and Paradise Cut. Along Paradise Cut, velocities change fairly dramatically and unevenly with some major increases at bridge openings but significant decreases in other reaches.

The velocity spike upstream of the new weir could result in significant channel stability problems. The velocity spike appears to result from a significant steepening in the water surface profile. The new weir apparently lowers flood stage so significantly that it steepens the water surface gradient immediately upstream of the new weir. Excavation of a two hundred food wide levee breach on the Consumnes floodplain in 2013 caused a similar velocity spike leading to substantial bed scour upstream of the breach. Additional analysis is definitely necessary to determine if the new weir could substantially change upstream velocities and channel form.

The velocity spikes in Paradise Cut could also be problematic. Three of the four spikes are associated with bridge crossings. The upper two could be managed by armoring the channel underneath Highway 5 and the western railroad crossing. The spike associated with Paradise Road could be a result of the River Islands levee configuration, which constricts the channel at Paradise Cut. The fourth spike is two miles downstream of the western rail crossing and may be a result of the widening of the proposed Paradise Cut at this location. Further analysis and design is necessary to avoid or mitigate these spikes.

Velocity increases on lower Old River and Grant Line Canal appear to be far less problematic. Absolute values are significantly lower than the spikes predicted on the mainstem and Paradise Cut (max 4 to 4.7 ft/sec vs. 7 to 8.5 ft/sec). Relative increases are also much smaller (up to 10 percent increases vs. 30 to 40 percent increases). Nevertheless, more analysis is still needed. Existing velocities may already be a problem, and if so, any increases would require mitigation.

Habitat Potential

The Minimum Viable Project includes the protection and creation of potentially valuable habitat for key South Delta species, including Swainson's hawk, riparian brush rabbit, and riparian song birds. Although the project will not create frequently inundated floodplain on Paradise Cut for salmon, it will also not increase diversion of juvenile salmon to the Old River corridor where they could be entrained into the state and federal water export facilities. The new weir will only be activated during extreme events (10% annual exceedance probability), minimizing the frequency during which juvenile salmon could be routed to the pumps. Although some juvenile salmon will be routed toward the export pumps in these extreme events, entrainment is not a large problem during extreme outflow events and juvenile mortality does not limit the population during wet years. Although the bypass will not directly impact or benefit salmon, it will un-constrain the San Joaquin channel upstream and downstream to allow the potential for juvenile salmon habitat enhancements that may otherwise be prohibited due to perceived encroachment on flood conveyance capacity.

Figure 9 shows the potential habitat that would be available as part of the MVP design. The project would provide approximately 2,570 acres of Swainson's hawk habitat, 810 acres of restored riparian habitat, 29 acres of enhanced riparian habitat, 83 acres (equivalent to 3.5 linear miles) of shaded riverine aquatic habitat, and 41 acres of managed native grassland. Below is a description of the specific habitat needs for each of the species.

Swainson's Hawk is a threatened migratory species that lives in the Central Valley March through September to breed and raise its young. Because most of their historical foraging habitat of grass and shrub land has been converted to urban development and agricultural uses, Swainson's hawk now depends on the frequent mowing, harvesting, disking and irrigation associated with annual agriculture to flush out their prey. Swainson's hawk almost exclusively uses tall trees in riparian habitats to build their large stick nests and raise their young. The hawks, with an average life span of 12 to 16 years, have a high fidelity to nesting areas, including returning young. Studies show most nests are in valley oaks and cottonwoods, and less frequently in walnuts, sycamores, willows, locusts, conifers, and eucalyptus. However, the reports indidate that tree availability, size and proximity to foraging habitat, rather than the tree species itself, drive the Swainson's hawk nesting tree selection (Stillwater Sciences et al, 2017).

Riparian song birds, including special status species such as Least Bell's vireo, song sparrow, yellow-breasted chat, yellow-billed cuckoo, and yellow warbler, need a diverse riparian habitat including variable tree heights, presence/absence of snags and bare ground. According to Stillwater Science's research (Stillwater Sciences 2017), riparian vegetation is considered the most critical habitat for conservation and recovery of California's resident and neotropical migrant bird species. Changes in the structure and composition of riparian vegetation can increase the capacity and habitat quality of riparian areas for bird species (Stillwater Sciences et al, 2017).

Riparian brush rabbit live in riparian oak forests with a dense understory of wild roses, grapes and blackberries. The rabbit has been sighted along Paradise Cut, and is believed to have been washed down from Caswell State Park during a large flood event. The rabbit needs suitable riparian habitat and safety from flood events (higher ground refugia) in order to continue to survive in the area.

Arboreal Debris Rack

Several local stakeholders have reported that large woody debris causes flood waters to dangerously back-up at bridge crossings, particularly the eastern rail crossing. The new opening in the eastern rail crossing should reduce this problem, but debris is still likely to be a problem. American Rivers proposes addressing this problem by planting rows of trees across the expanded bypass and perpendicular to the flow of water to serve as natural debris racks that would block downstream movement of any large woody debris before they reach bridge crossings. The tree rows are located along existing roads for ease of maintenance (see **Figure 10**). This design has the added benefit of incorporating potentially valuable habitat for local and migratory species. We did not model this concept in the hydraulic analysis, but if the design is of interest to the landowners (probably facilitated by economic incentives) additional modeling would be a necessary next step.

6. Summary and Next Steps

The design concepts and analysis presented in this document are not the final designs for Paradise Cut. Significant additional analysis by the state and federal government is legally required before the project can be implemented. The Minimum Viable Project (MVP) conceptual design identified and analyzed in this document, however, will form the basis for additional analysis on the costs and permitting challenges of implementing the project. Over the next several months, American Rivers and the SJCRCD will work with consultants to estimate the costs of implementing the MVP and identify the steps necessary to complete environmental compliance and permitting steps.

The analysis leading to the MVP as the preferred conceptual design identified two major cost saving measures that do not reduce the flood stage reduction benefits of the proposed project: 1) halve the span of a new railroad trestle from 500 feet to 250 feet; and 2) eliminate 1.5 miles of a new set-back levee. Future cost estimating analysis will quantify the costs savings, if any, associated with these changes. Equally important, however, analysis of the Potential Maximum Project (PMP) indicates that constructing expensive new bridges across other highway and rail crossings is not necessary to achieve significant stage reduction benefits.

Despite the potential cost saving associated with the MVP, the project will still require significant infrastructure or property acquisition costs, some of which were not considered as part of the 2017 CVFPP cost estimate. These costs include:

- Acquisition of additional flood easements over the expanded inundation area that would result from foregoing construction of the 1.5 mile setback levee south of Duel Vocational Facility.
- Construction of a new setback levee against the eastern railroad embankment.
- Downstream measures, including dredging and levee reinforcement, to mitigate the adverse hydraulic impacts of the project could involve extensive permitting costs and negotiations.

The analysis of both the MVP and PMP suggest new questions and design ideas. First and foremost, further analysis should examine whether the MVP could be further refined to reduce implementation costs and maximize stage reduction benefits. In particular, the opening through the eastern rail crossing might be further limited without substantially reducing the flood stage reduction benefits of the project and the existing weir might be widened to provide more flood stage reduction benefits.

The analysis in this memo focuses on changes to peak flood stage and velocity. Subsequent analysis should evaluate how the project reduces flood stage during the entire flood hydrograph. The numerical model results produced by this analysis could be queried to compare flood stage over several days at key locations such as Highway 5 and Tracy Blvd. Further analysis of how to expand the scope of the PMP may be warranted to identify whether it is possible to accommodate the extreme events that may result as the climate changes.

Finally, the design analysis did *not* identify a promising strategy for reducing the project's adverse hydraulic impact on Old River and Grant Line Canal, a major concern of local residents. Substantial public engagement resulted in changes to the conceptual design to address local suggestions including dredging of five miles of channel. Most of these changes did not reduce the benefits of the project and dredging incrementally reduced the downstream impacts on Old River and Grant Line Canal. American Rivers and SJCRCD have applied for additional grant funds to identify and evaluate other strategies for avoiding or mitigating these downstream impacts.

7. References

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Appendix A: Figures

Figure 1: Study Reaches

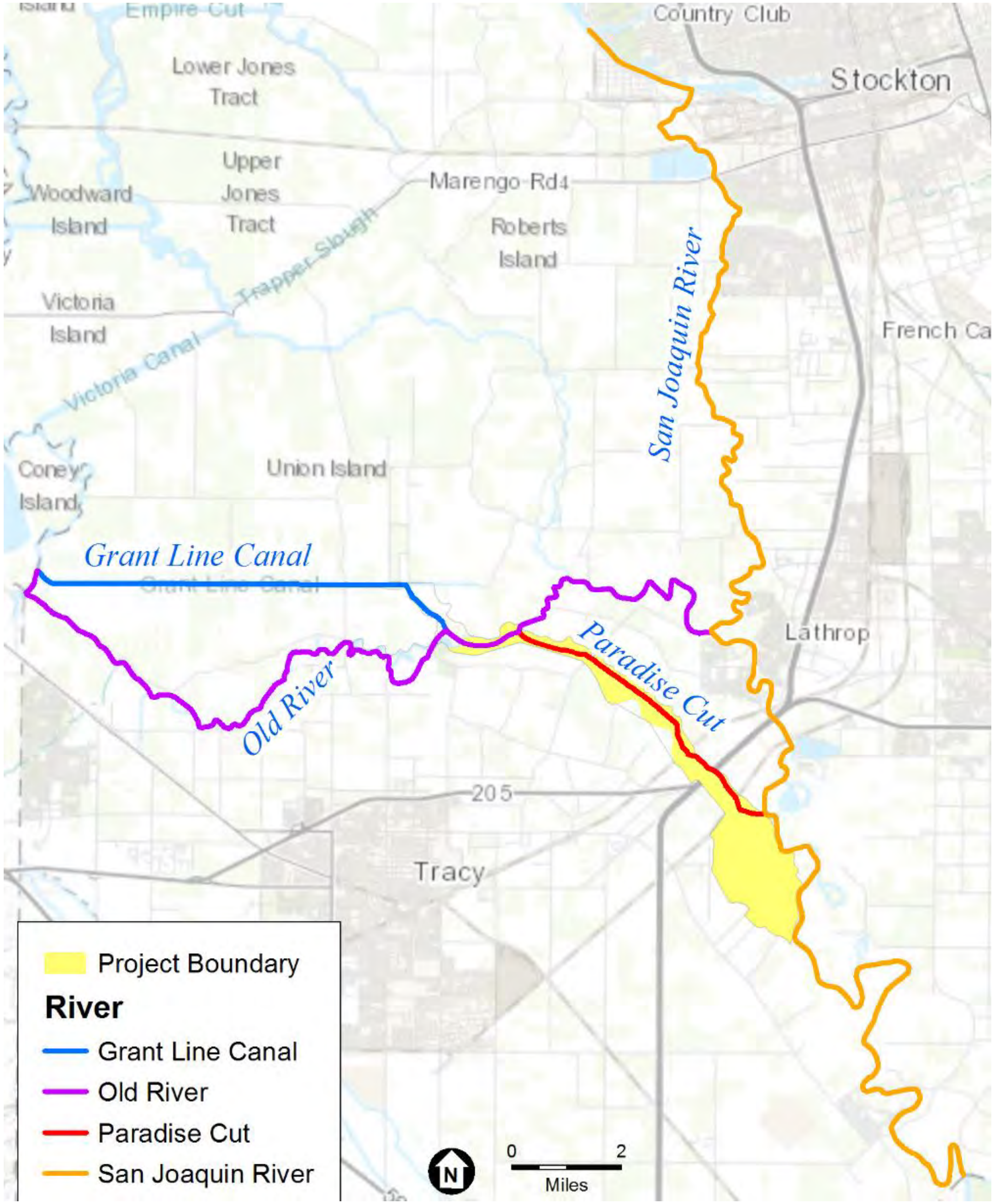


Figure 2: CVFPP Conceptual Plan

Figure 3: CVFPP with Dredging

Figure 4: Modified CVFPP

Figure 5: Minimum Viable Project

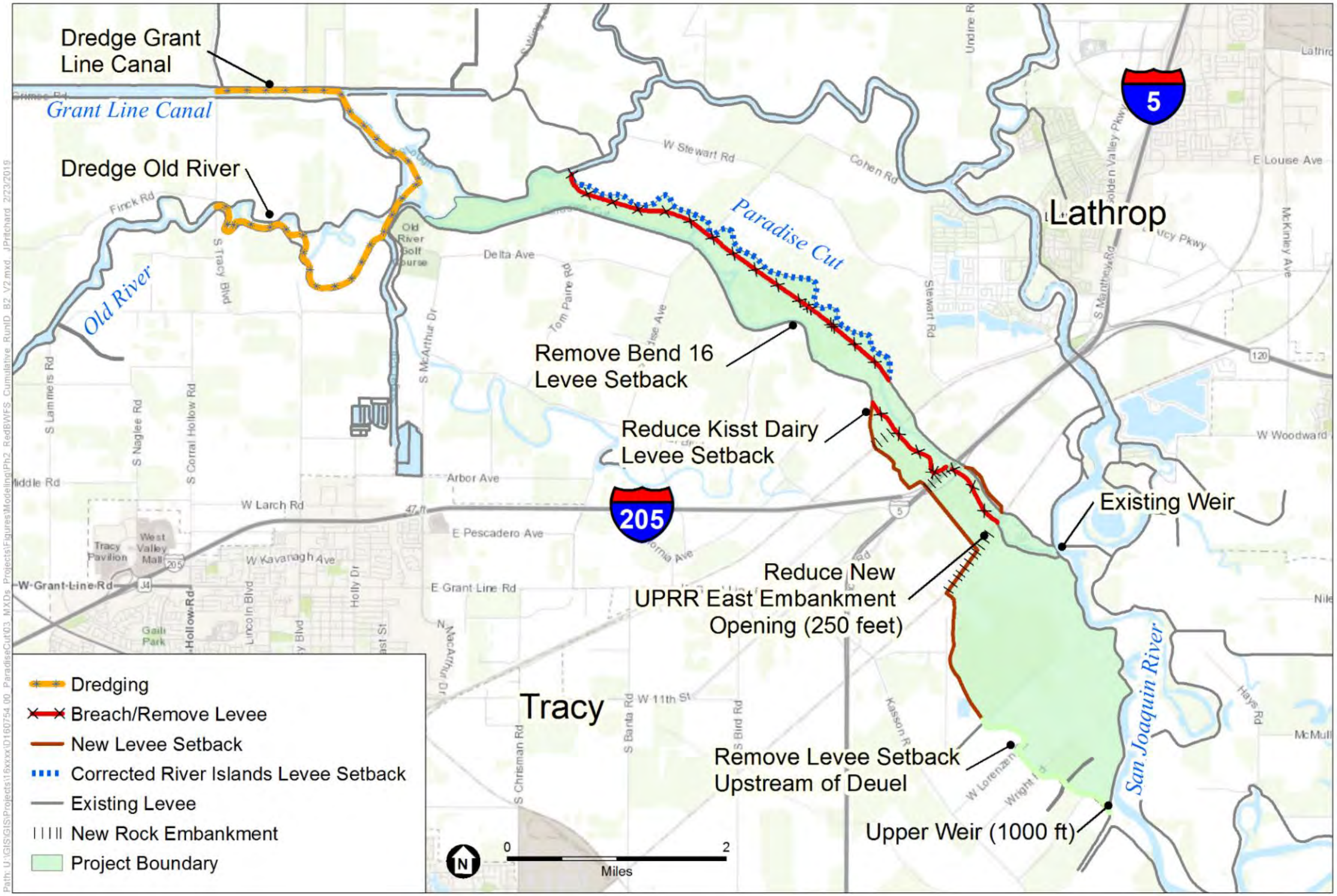


Figure 6: Potential Maximum Project

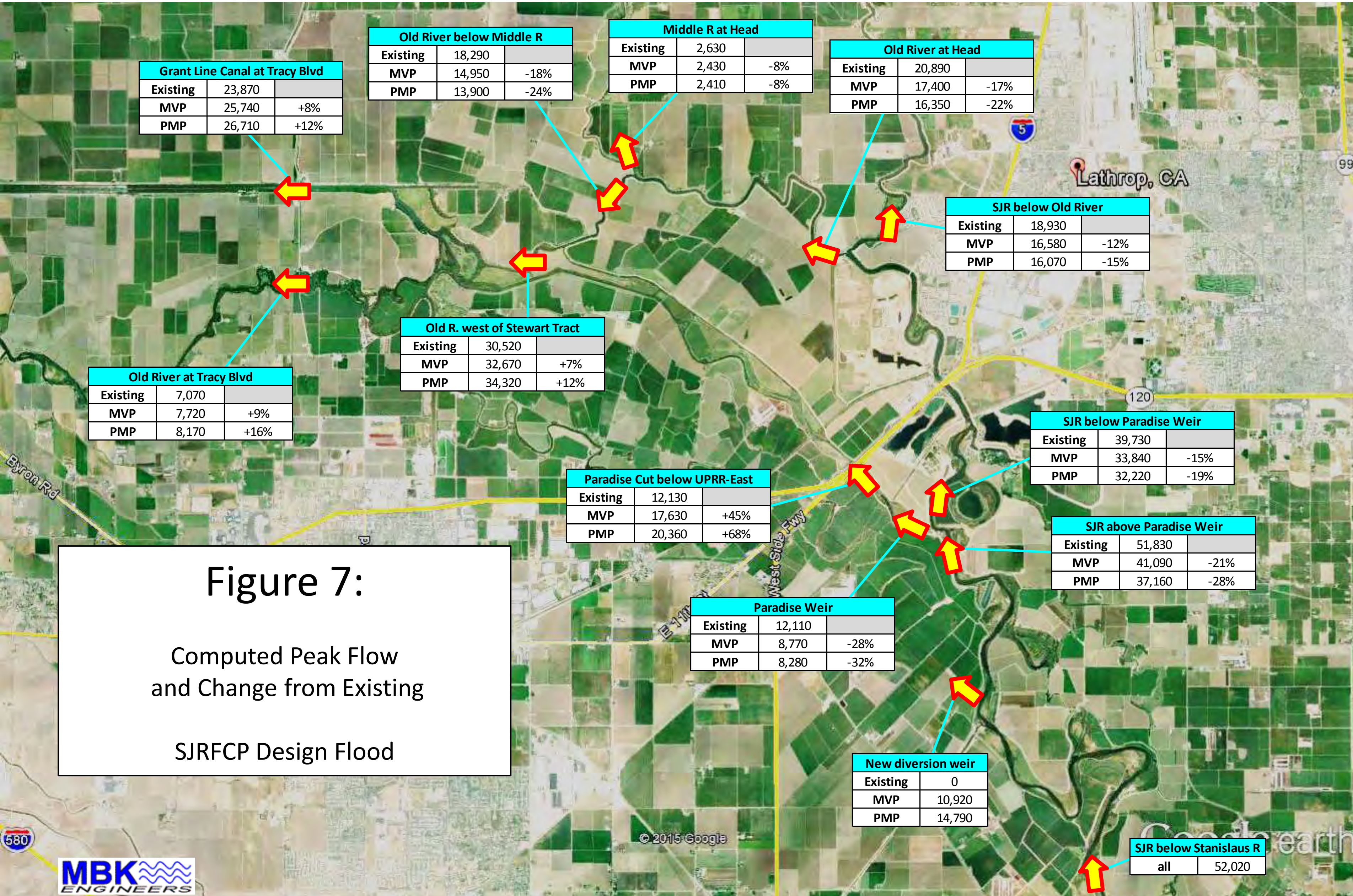


Figure 7:

Computed Peak Flow
and Change from Existing

SJRFCP Design Flood

Grant Line Canal at Tracy Blvd		
Existing	23,870	
MVP	25,740	+8%
PMP	26,710	+12%

Old River below Middle R		
Existing	18,290	
MVP	14,950	-18%
PMP	13,900	-24%

Middle R at Head		
Existing	2,630	
MVP	2,430	-8%
PMP	2,410	-8%

Old River at Head		
Existing	20,890	
MVP	17,400	-17%
PMP	16,350	-22%

SJR below Old River		
Existing	18,930	
MVP	16,580	-12%
PMP	16,070	-15%

Old R. west of Stewart Tract		
Existing	30,520	
MVP	32,670	+7%
PMP	34,320	+12%

Old River at Tracy Blvd		
Existing	7,070	
MVP	7,720	+9%
PMP	8,170	+16%

SJR below Paradise Weir		
Existing	39,730	
MVP	33,840	-15%
PMP	32,220	-19%

Paradise Cut below UPRR-East		
Existing	12,130	
MVP	17,630	+45%
PMP	20,360	+68%

SJR above Paradise Weir		
Existing	51,830	
MVP	41,090	-21%
PMP	37,160	-28%

Paradise Weir		
Existing	12,110	
MVP	8,770	-28%
PMP	8,280	-32%

New diversion weir	
Existing	0
MVP	10,920
PMP	14,790

SJR below Stanislaus R	
all	52,020

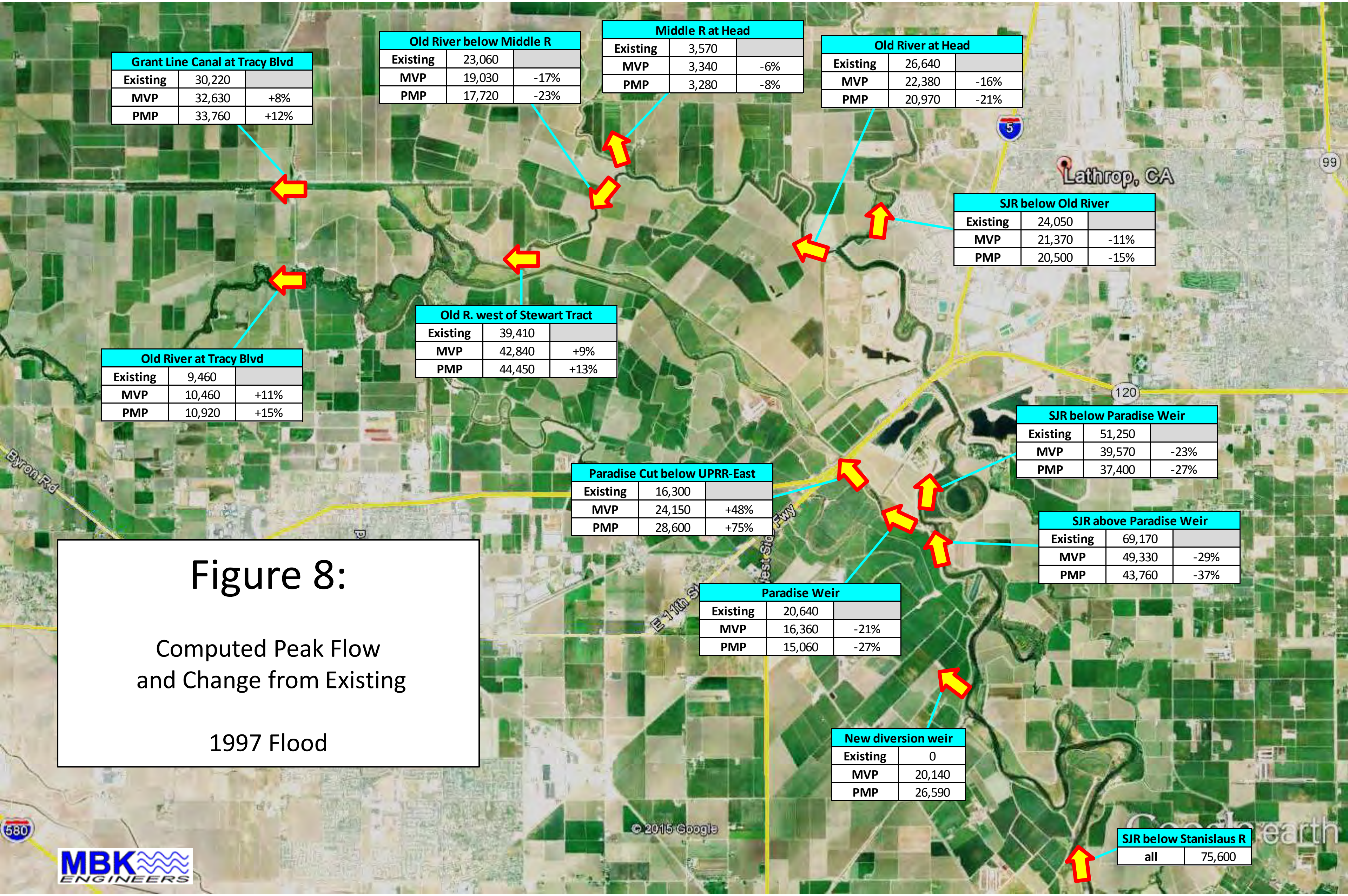


Figure 8:

Computed Peak Flow
and Change from Existing

1997 Flood

Figure 9: Habitat Enhancement Conceptual Elements

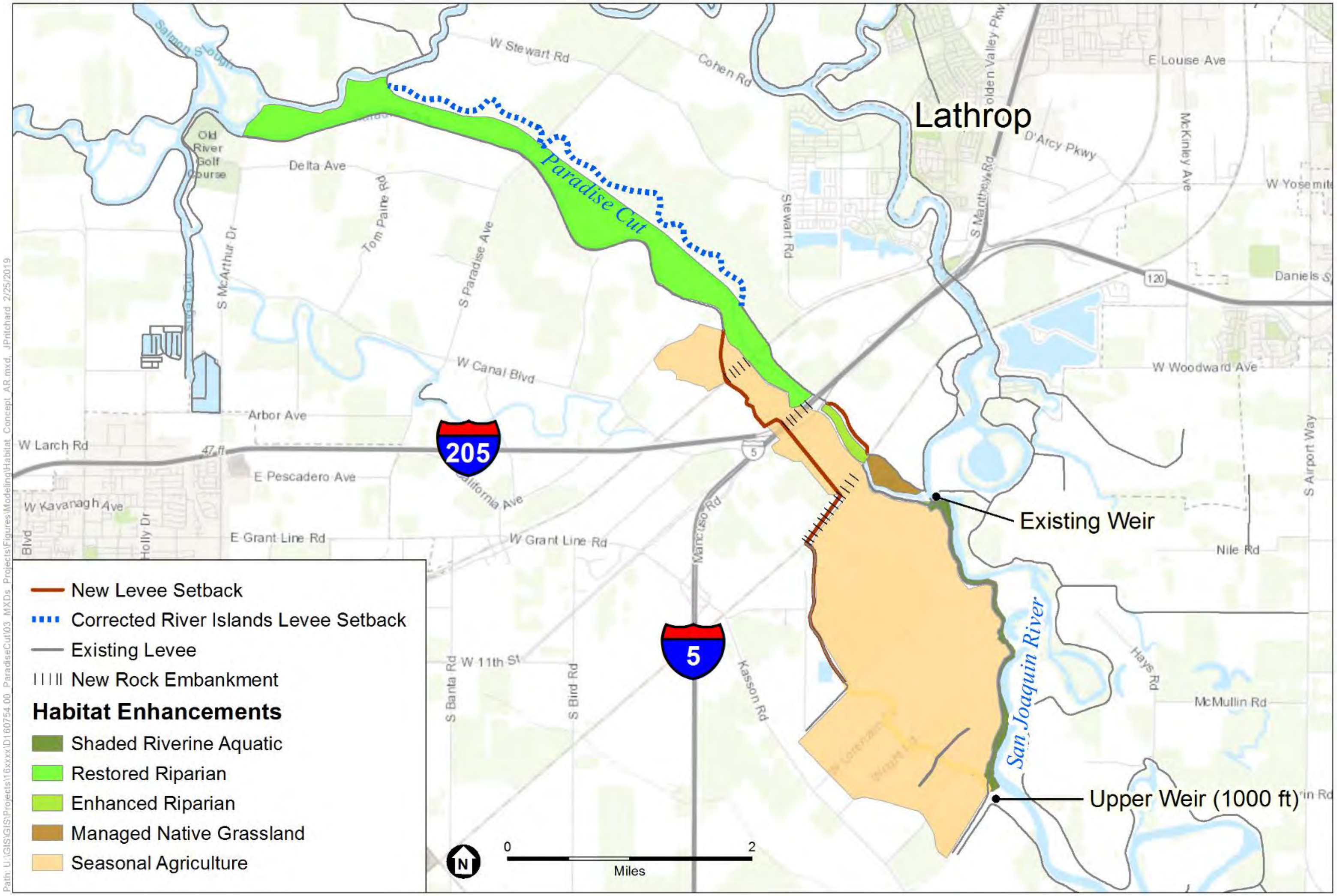
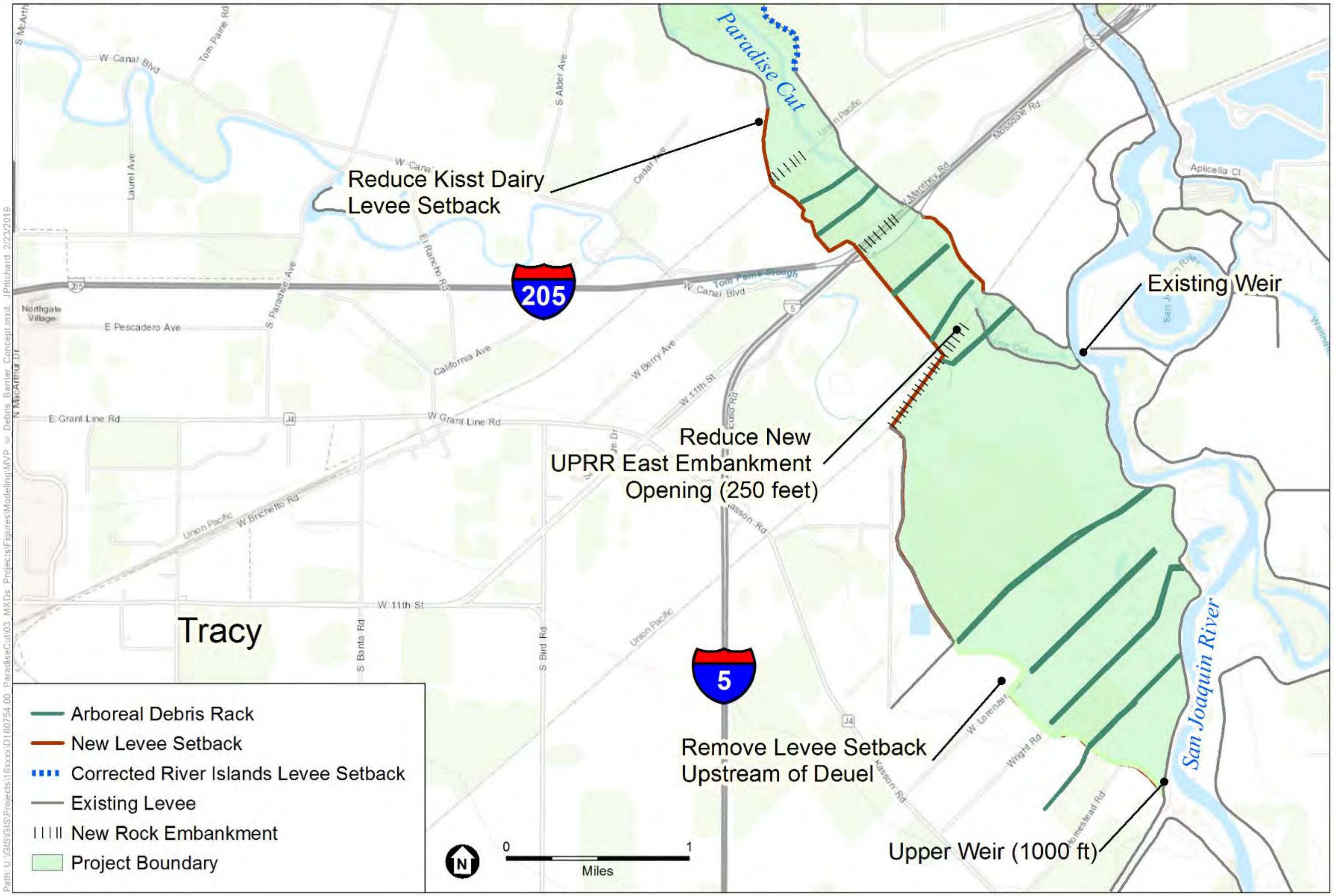
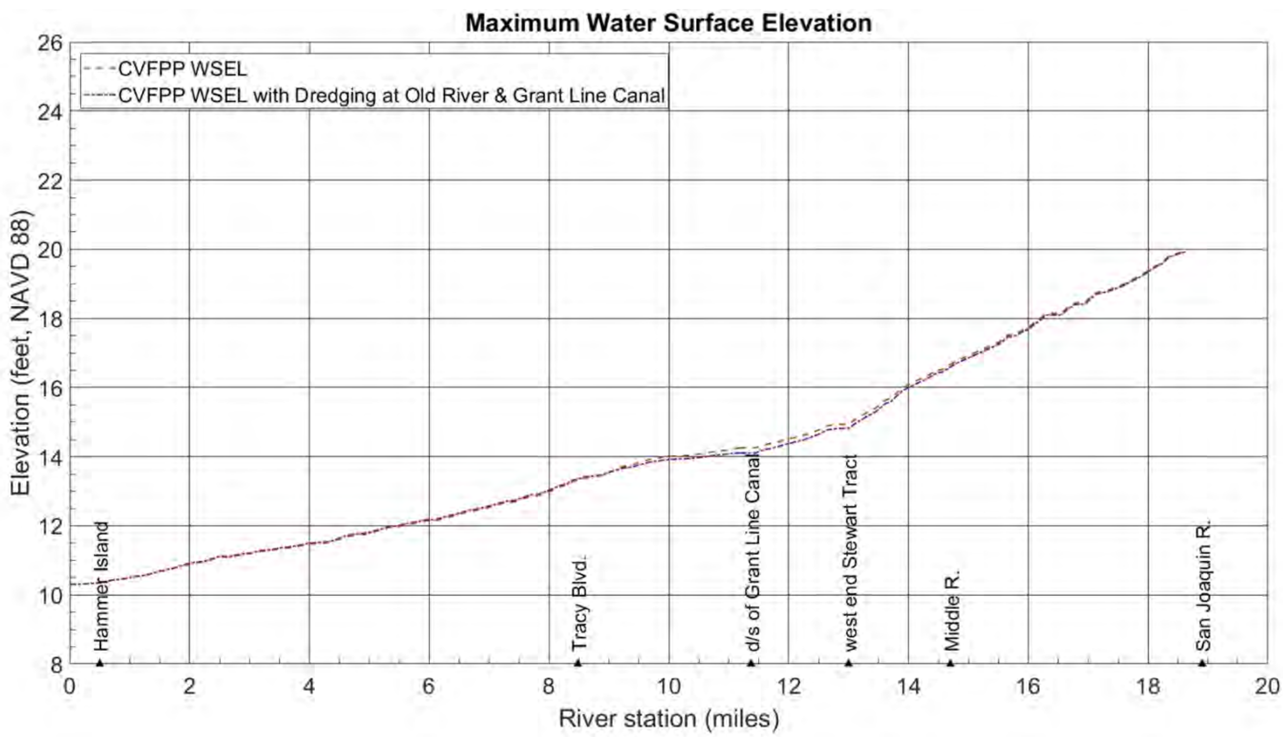


Figure 10: Arboreal Debris Rack Concept



Appendix B: Charts

Chart 1: CVFPP vs. CVFPP with Dredging
Old River at Design Flood



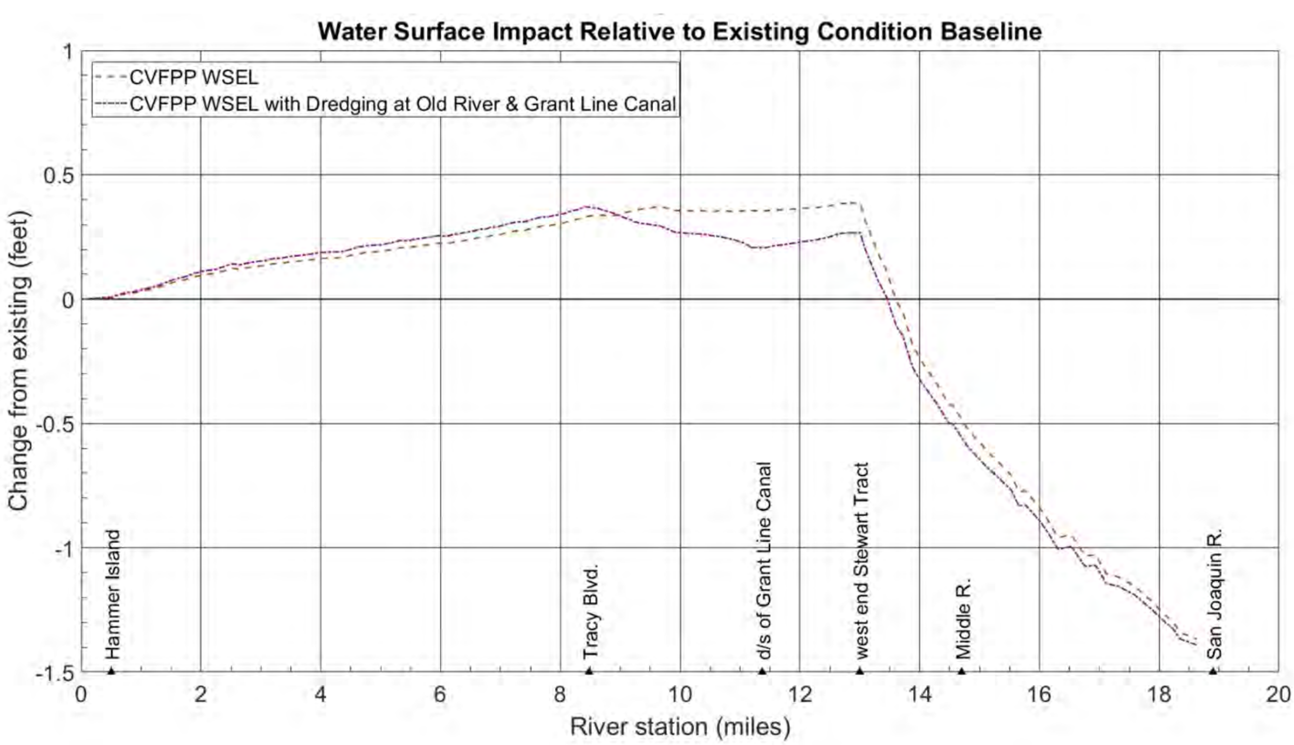
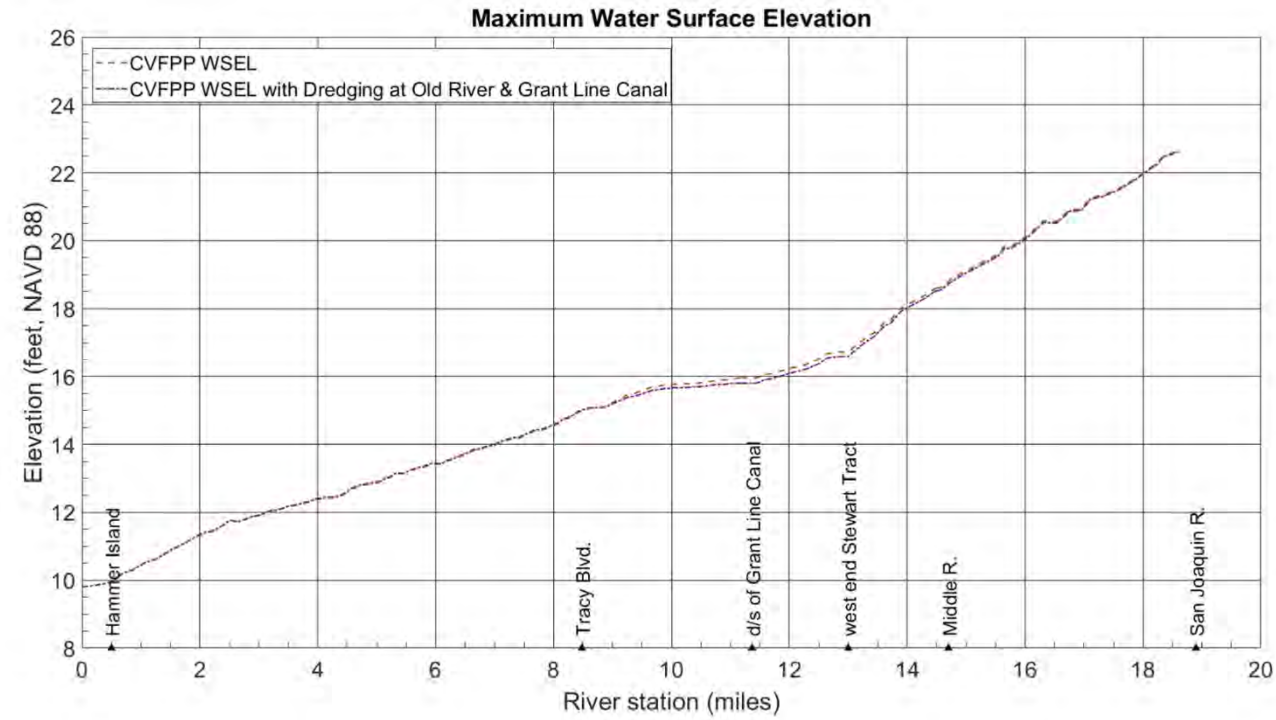


Chart 2: CVFPP vs. CVFPP with Dredging Old River at 1997 Flood



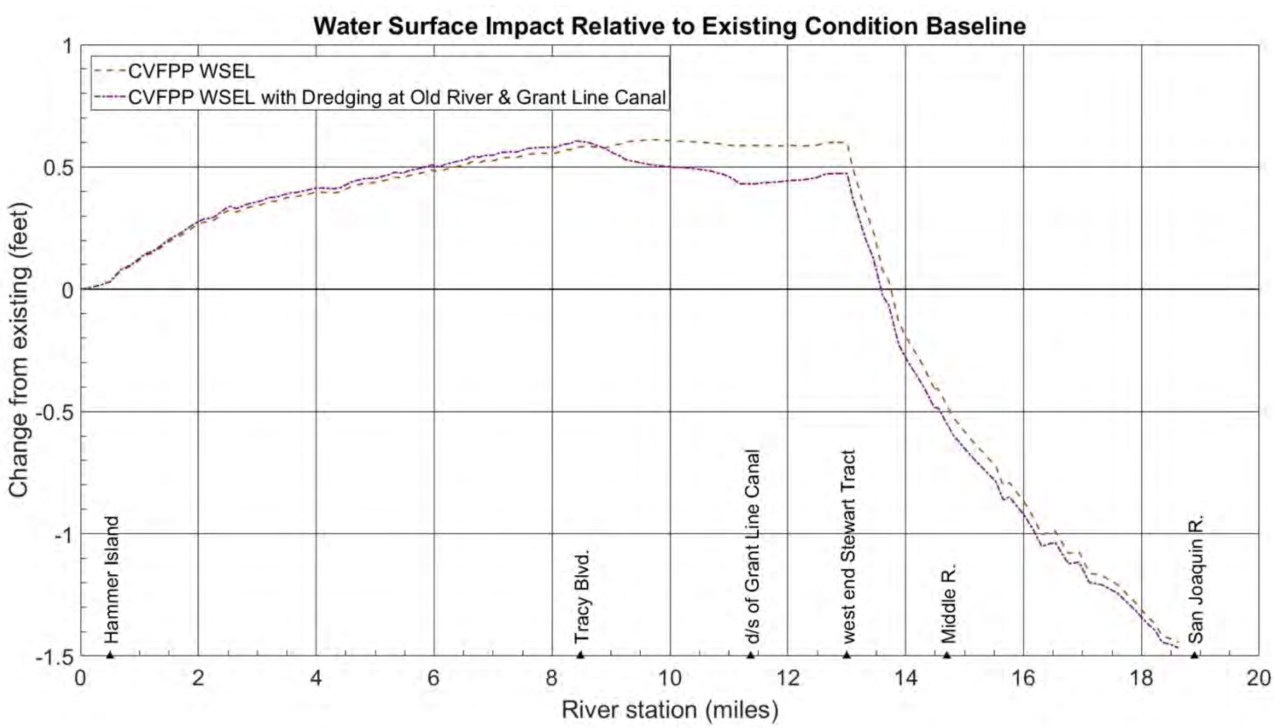
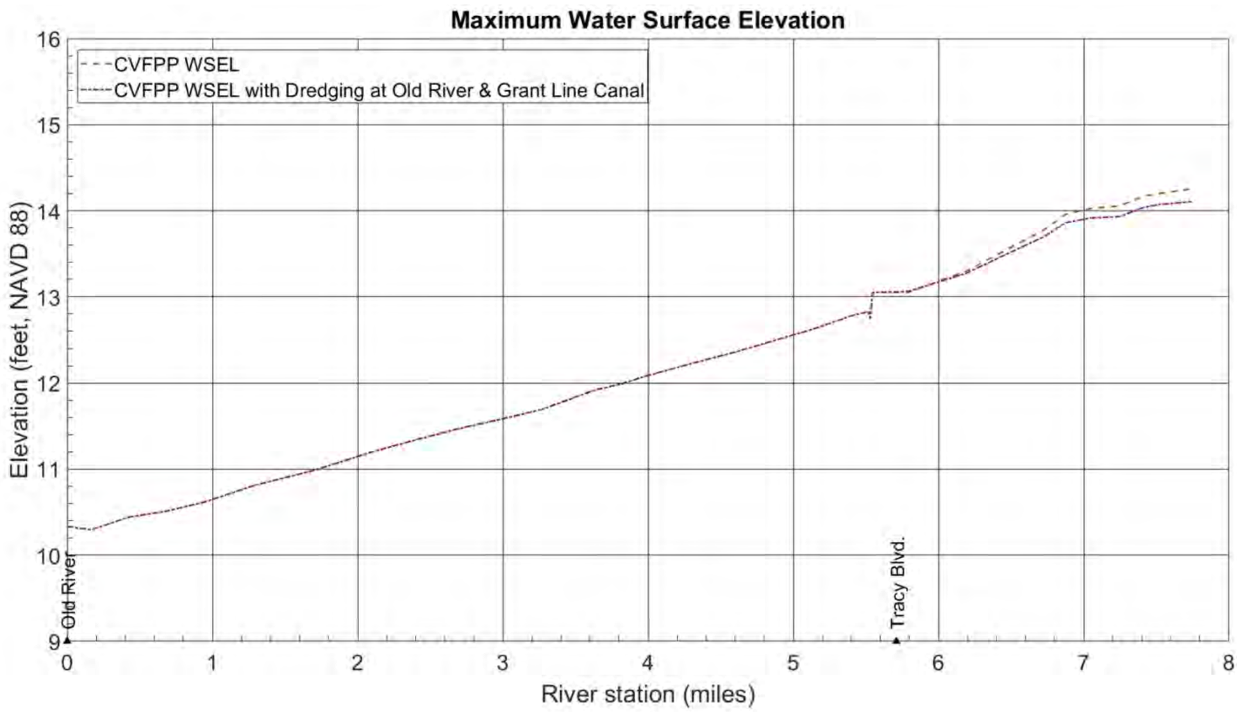


Chart 3: CVFPP vs. CVFPP with Dredging Grant Line Canal at Design Flood



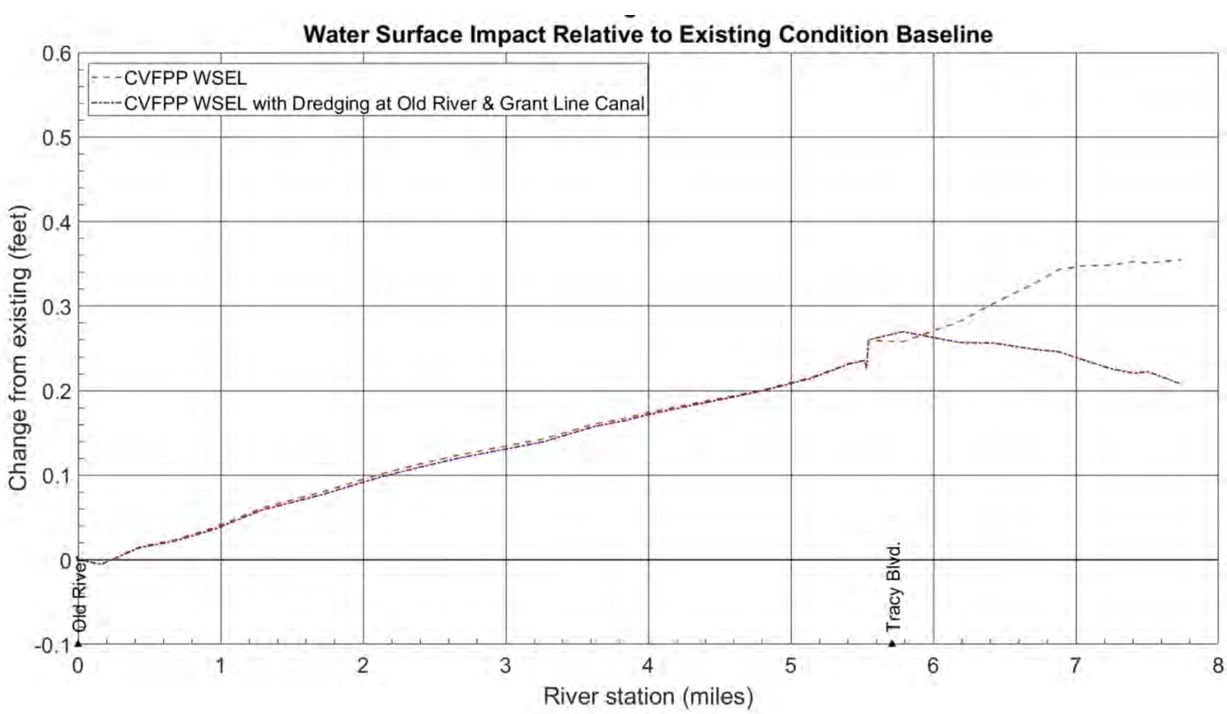
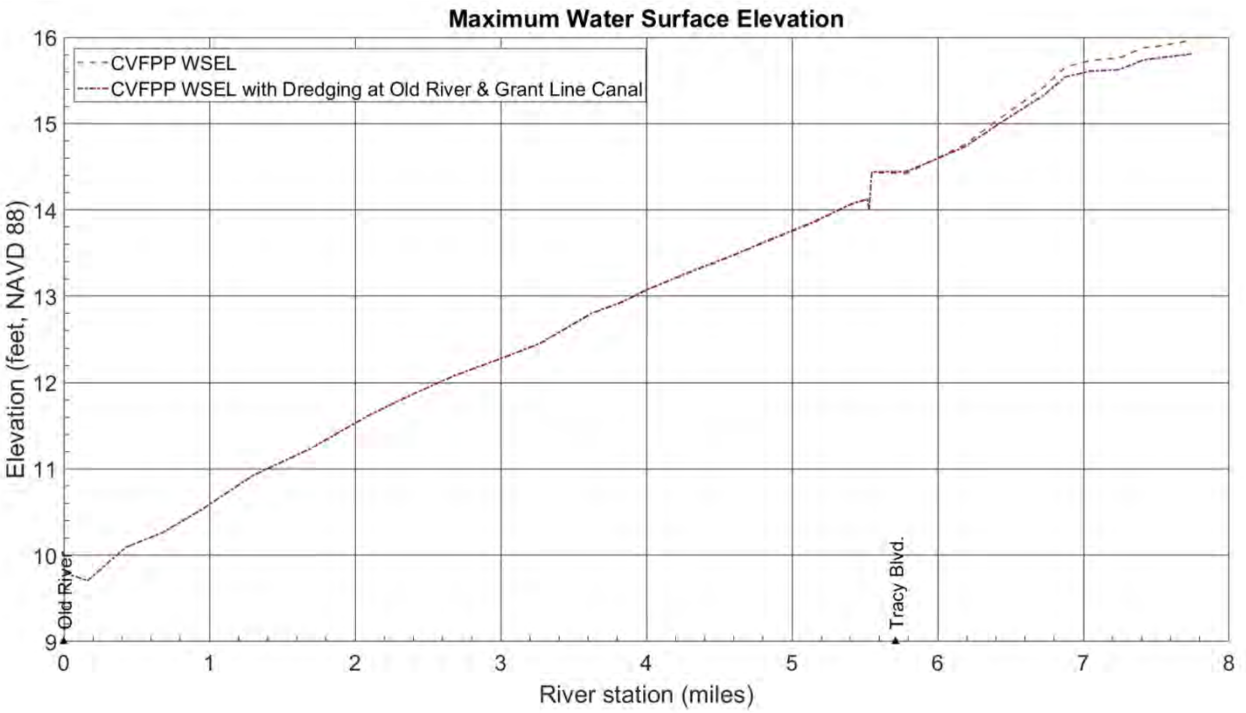


Chart 4: CVFPP vs. CVFPP with Dredging
Grant Line Canal at 1997 Flood



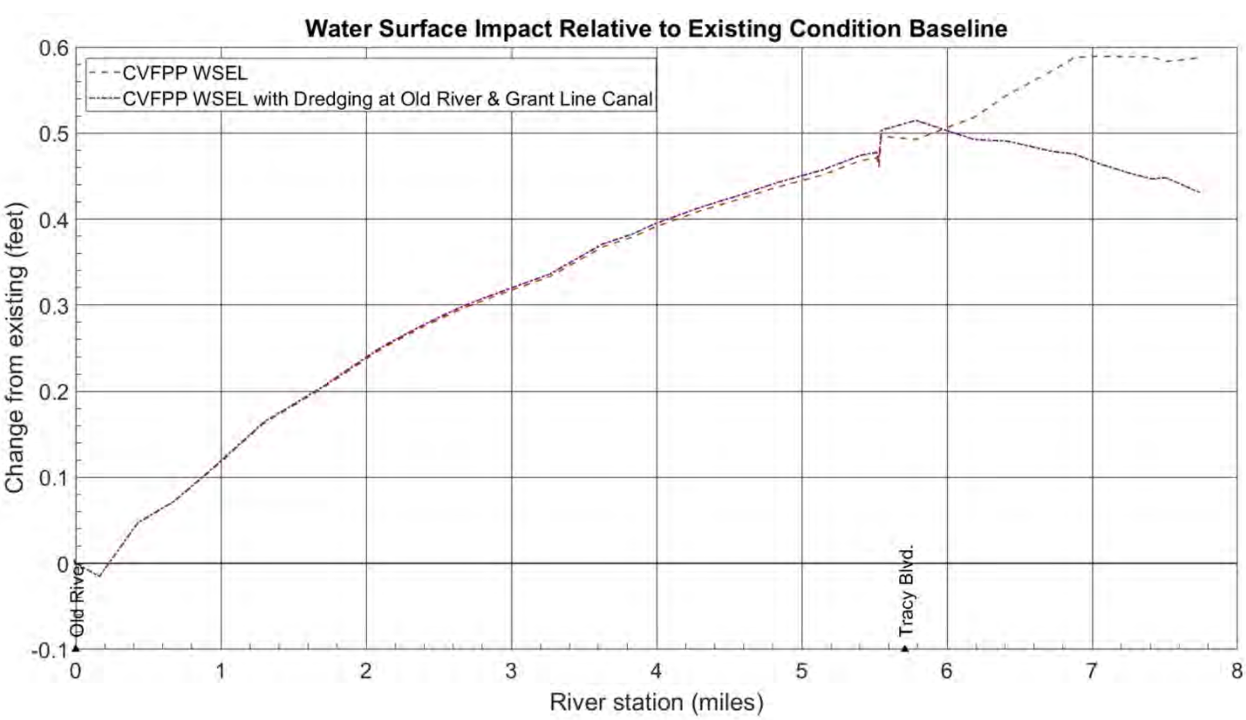
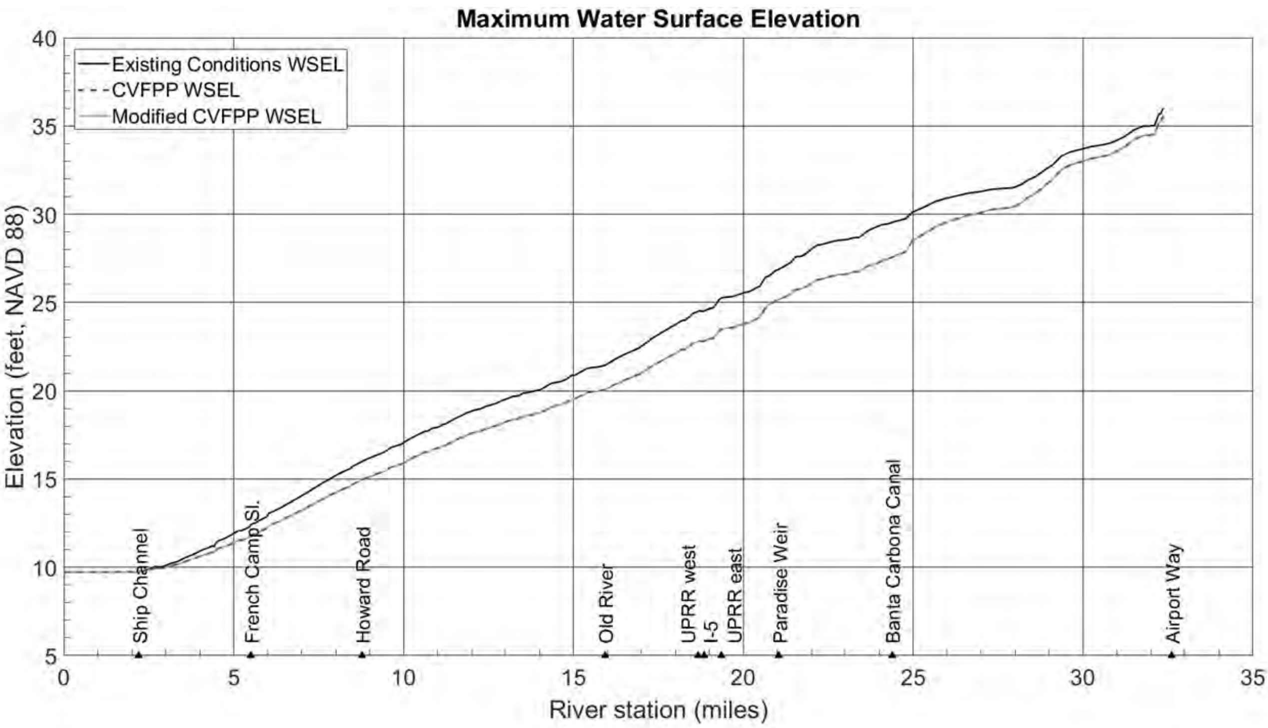


Chart 5: CVFPP vs. Modified CVFPP
San Joaquin River at 1997 Flood



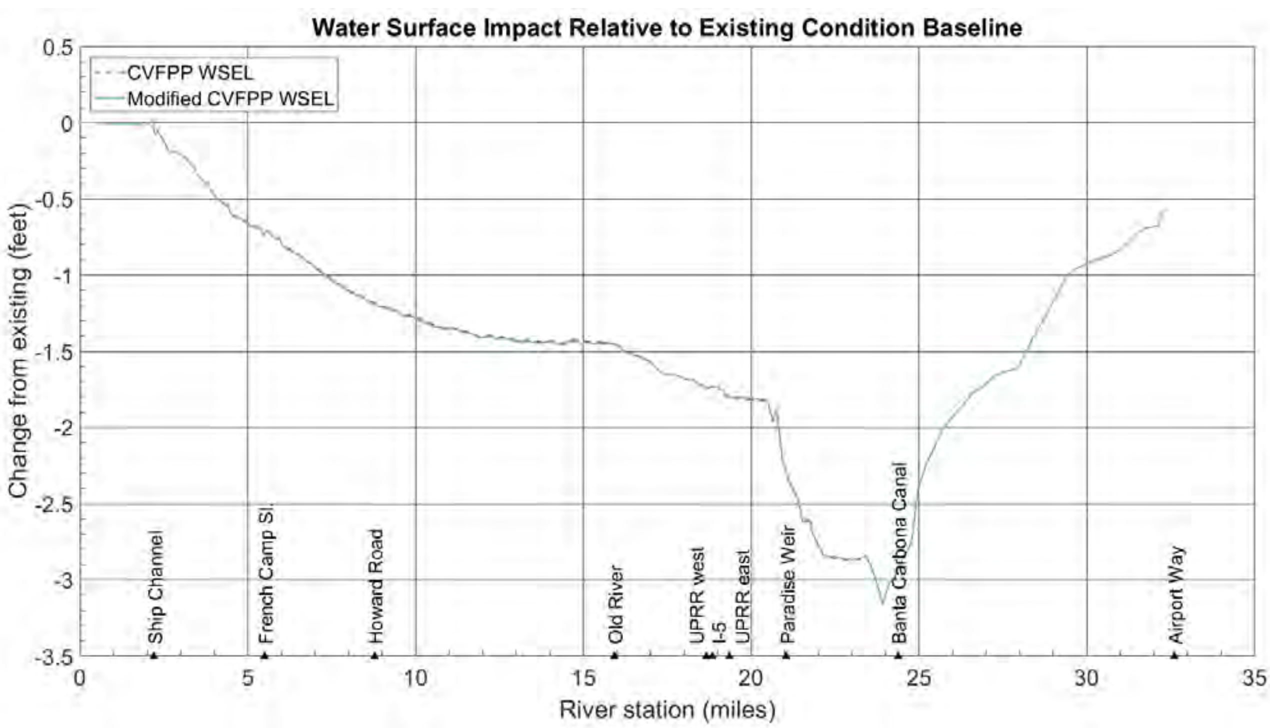
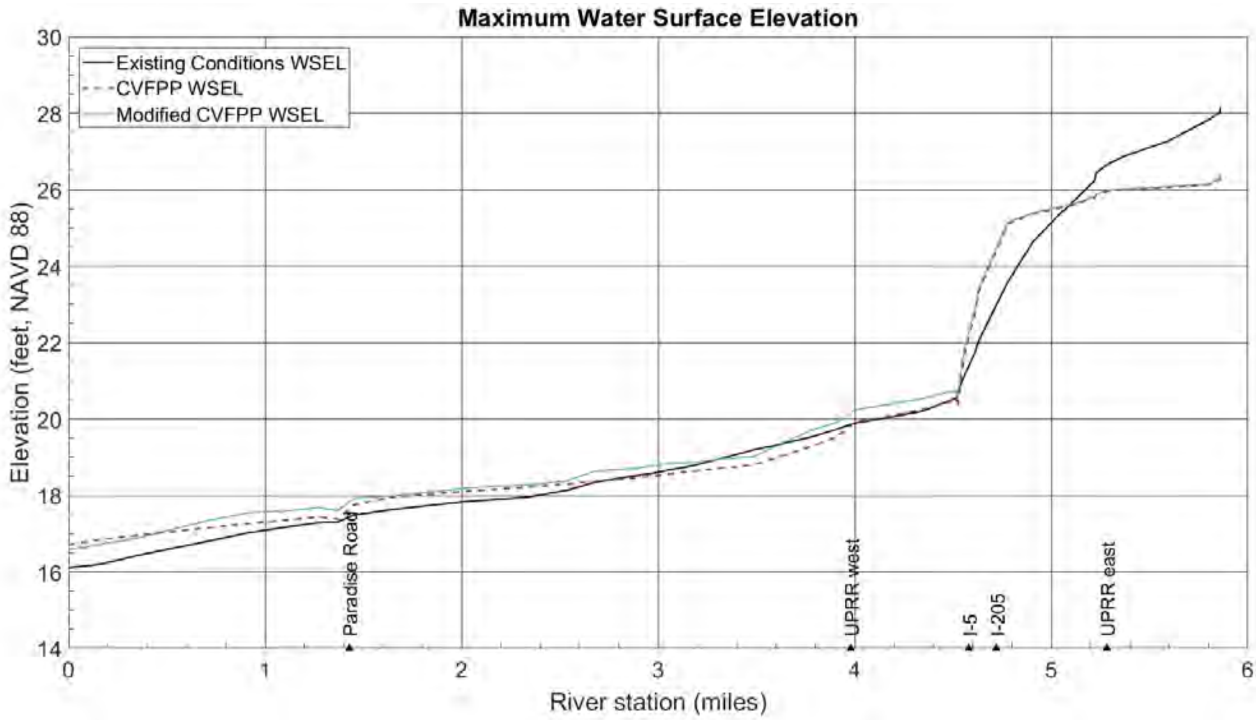


Chart 6: CVFPP vs. Modified CVFPP
Paradise Cut at 1997 Flood



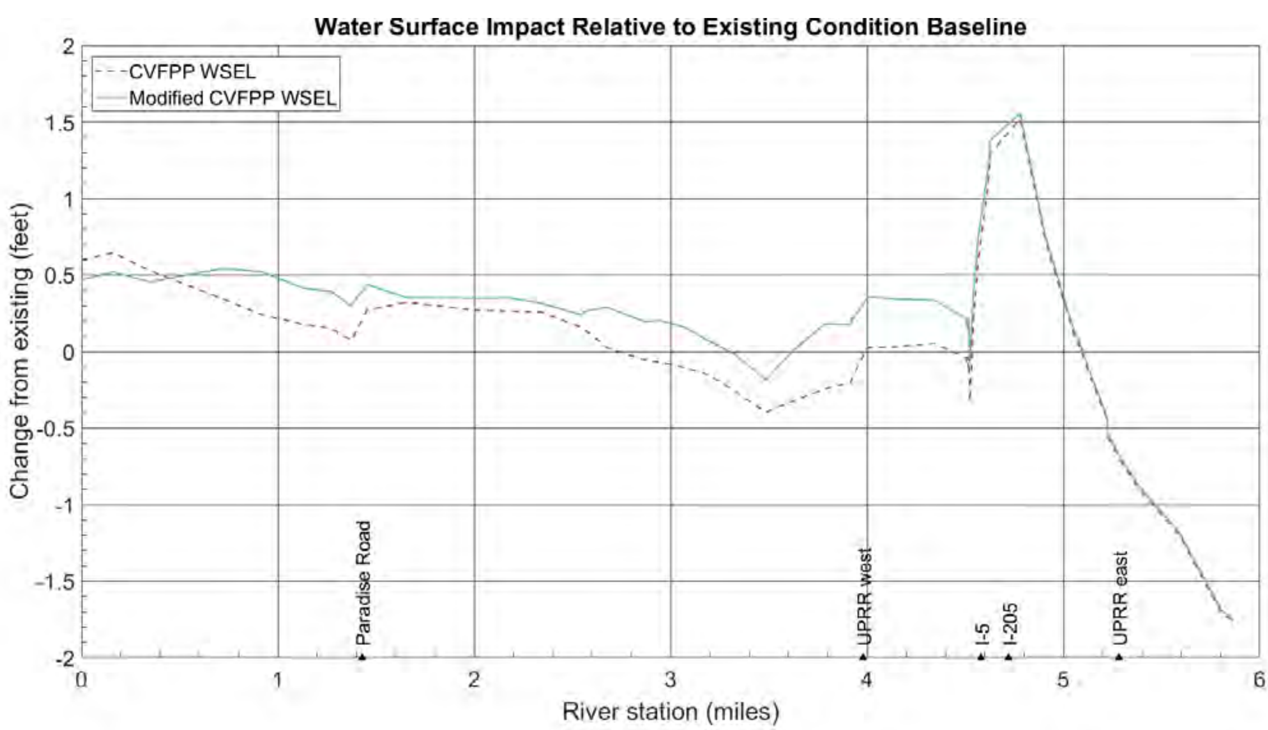
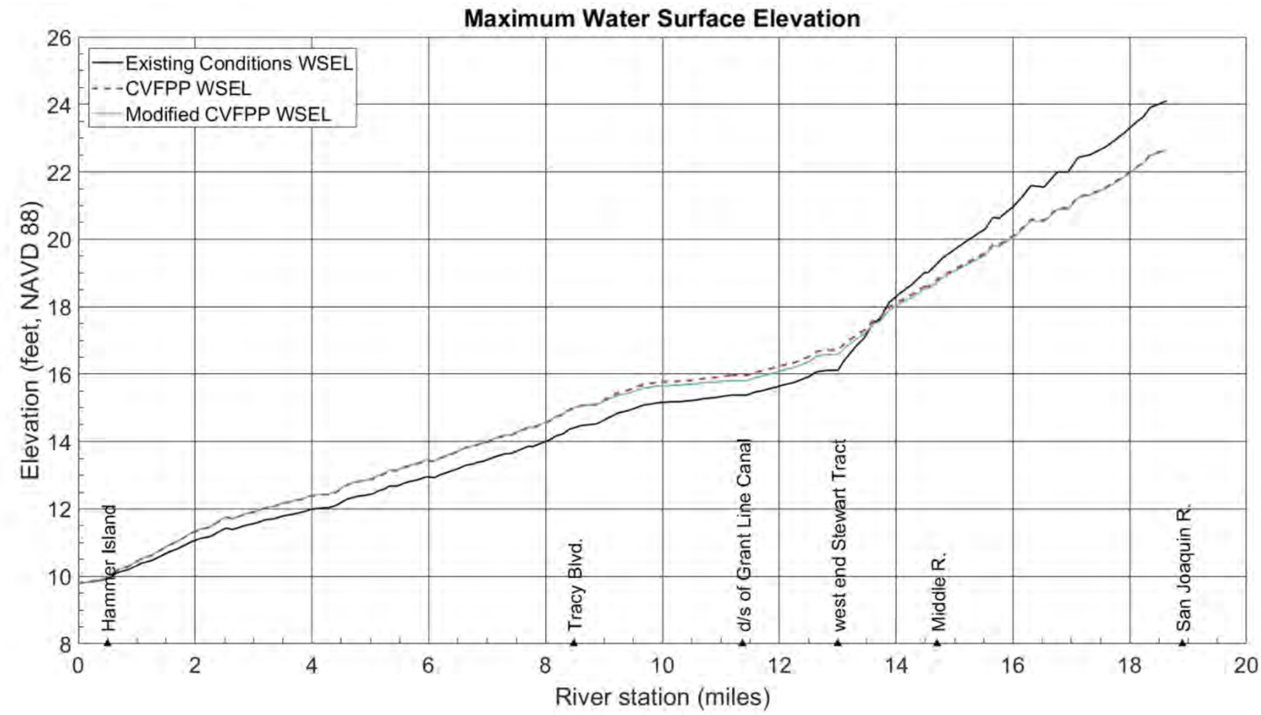


Chart 7: CVFPP vs. Modified CVFPP
Old River at 1997 Flood



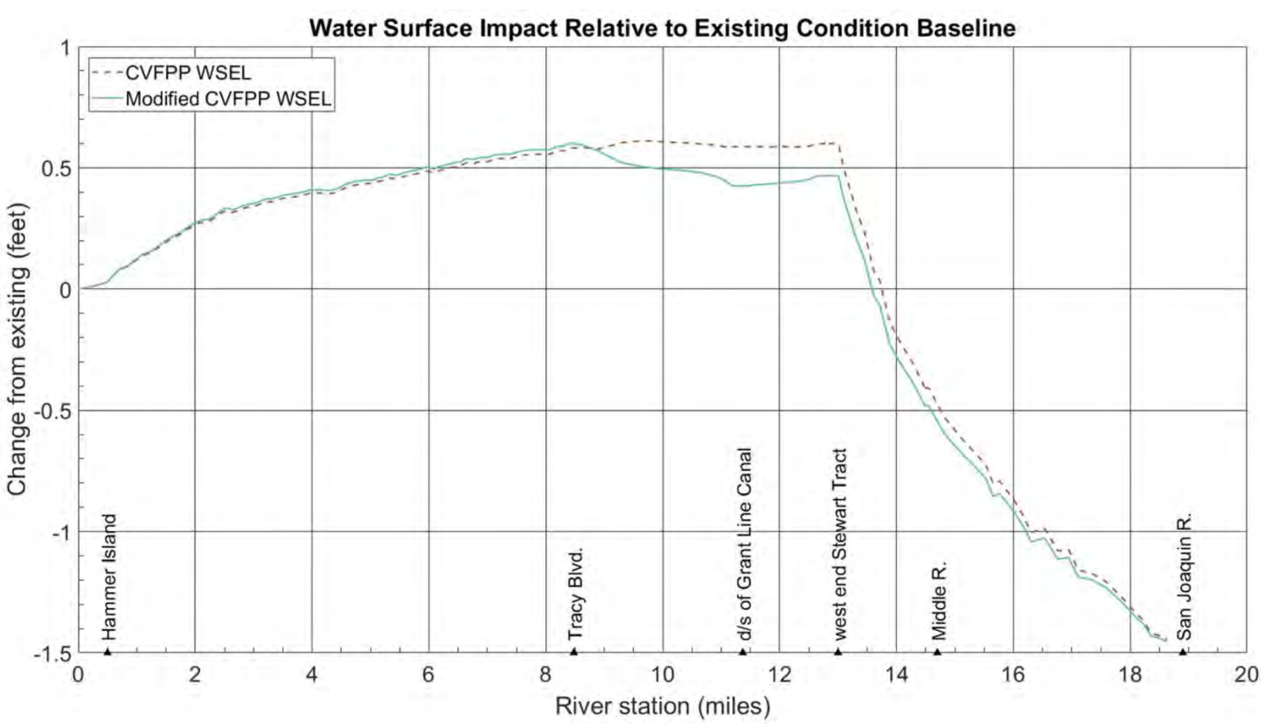
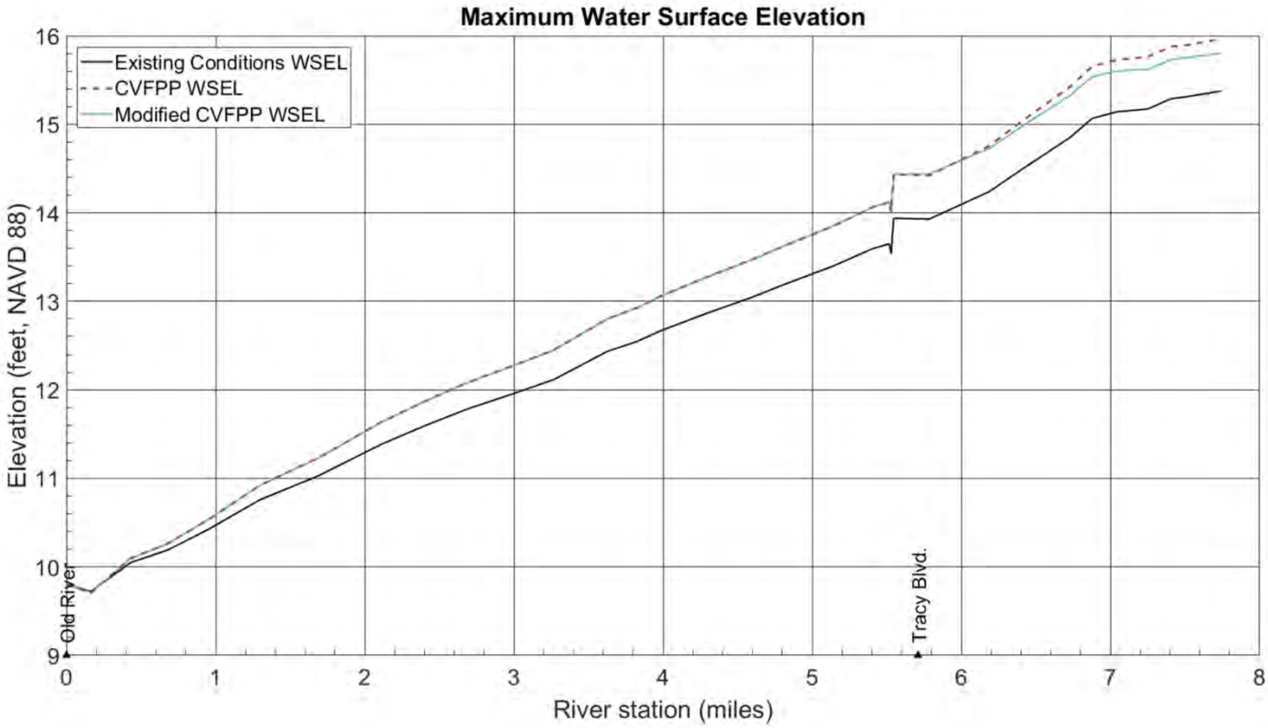


Chart 8: CVFPP vs. Modified CVFPP
Grant Line Canal at 1997 Flood



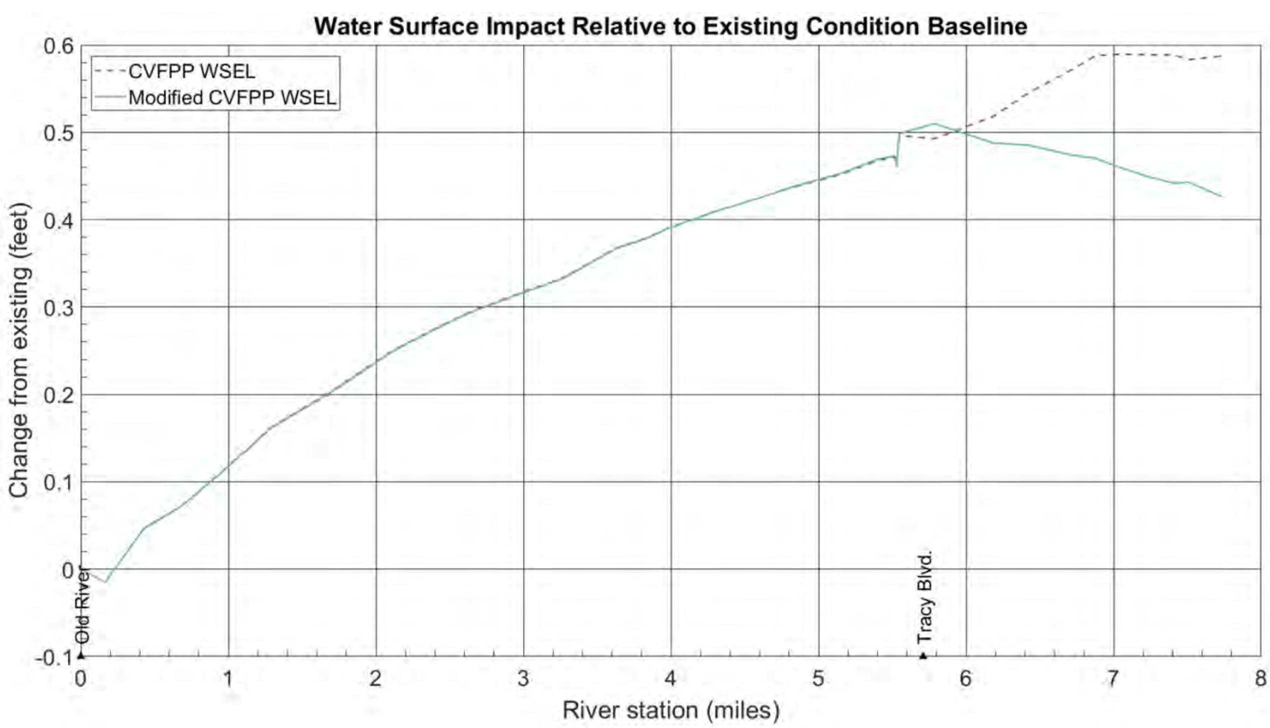
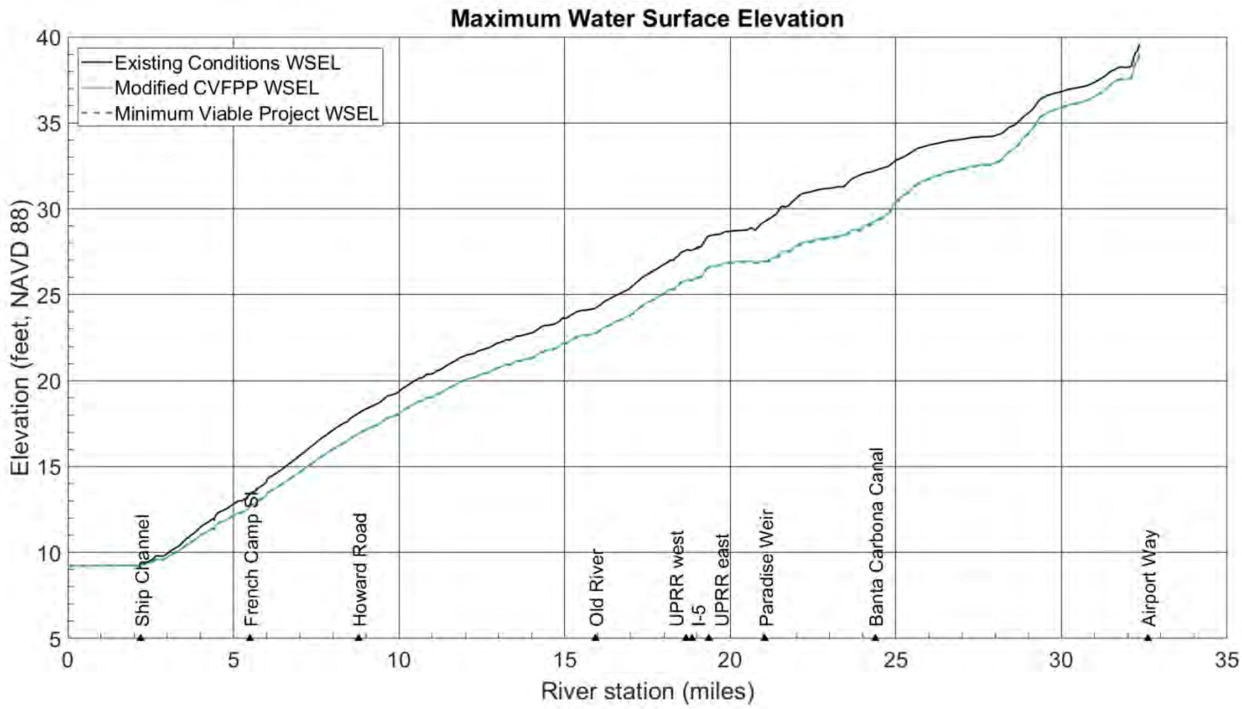


Chart 9: Modified CVFPP vs Minimum Viable Project
San Joaquin River at 1997 Flood



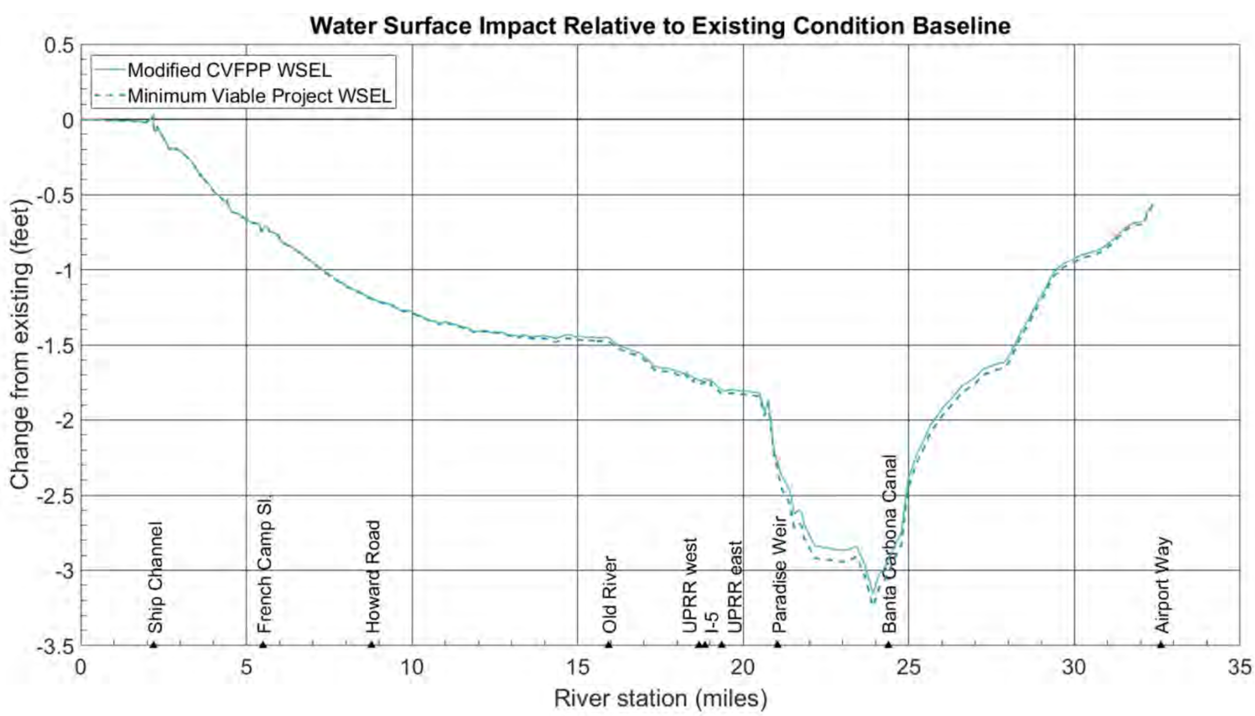
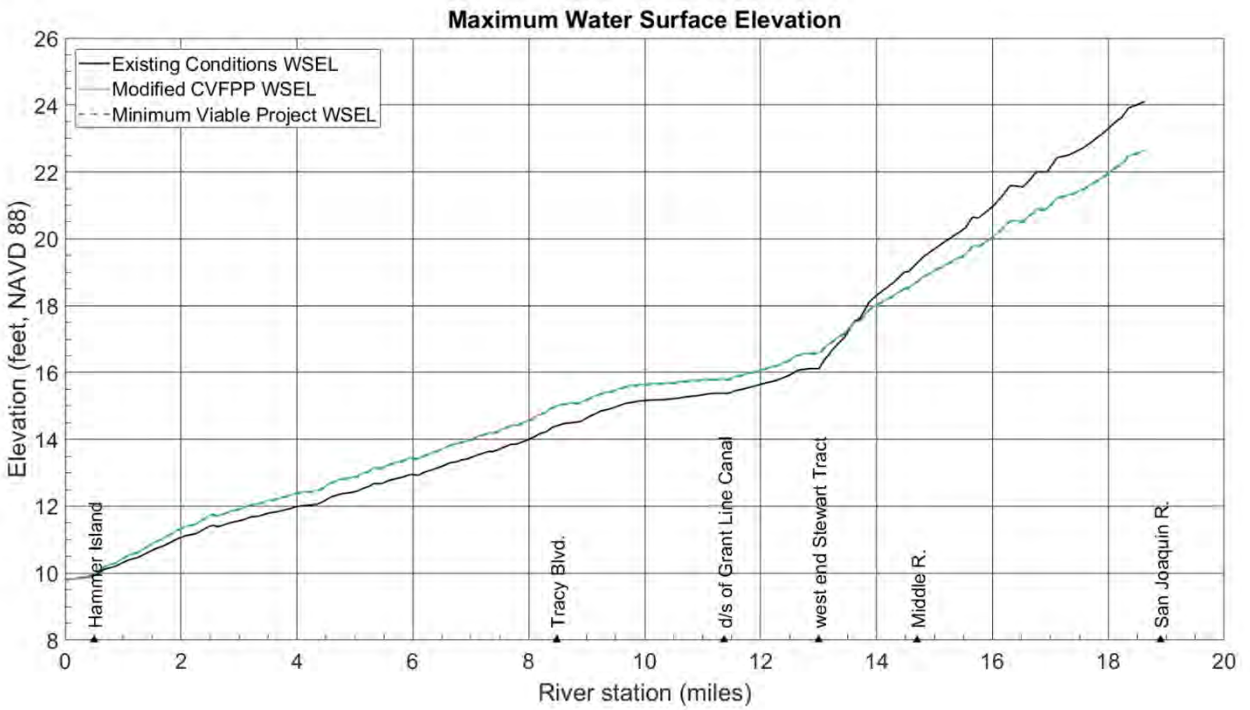


Chart 10: Modified CVFPP vs Minimum Viable Project
Old River at 1997 Flood



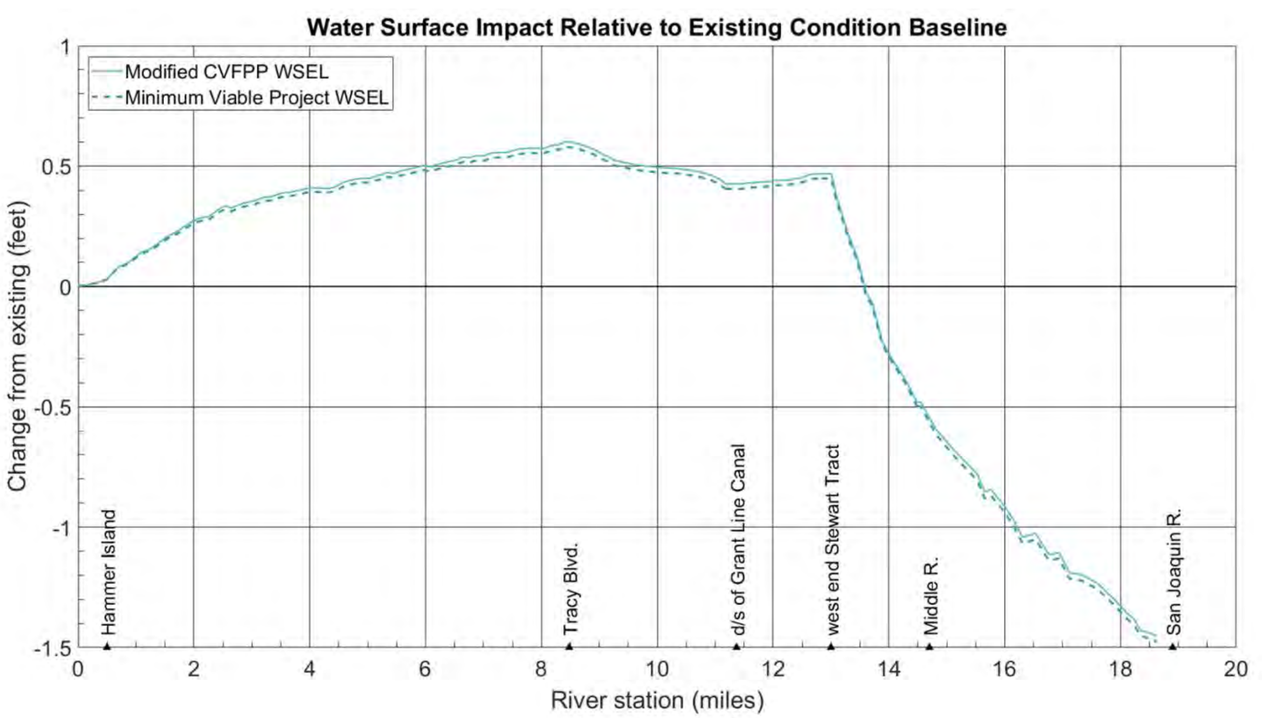
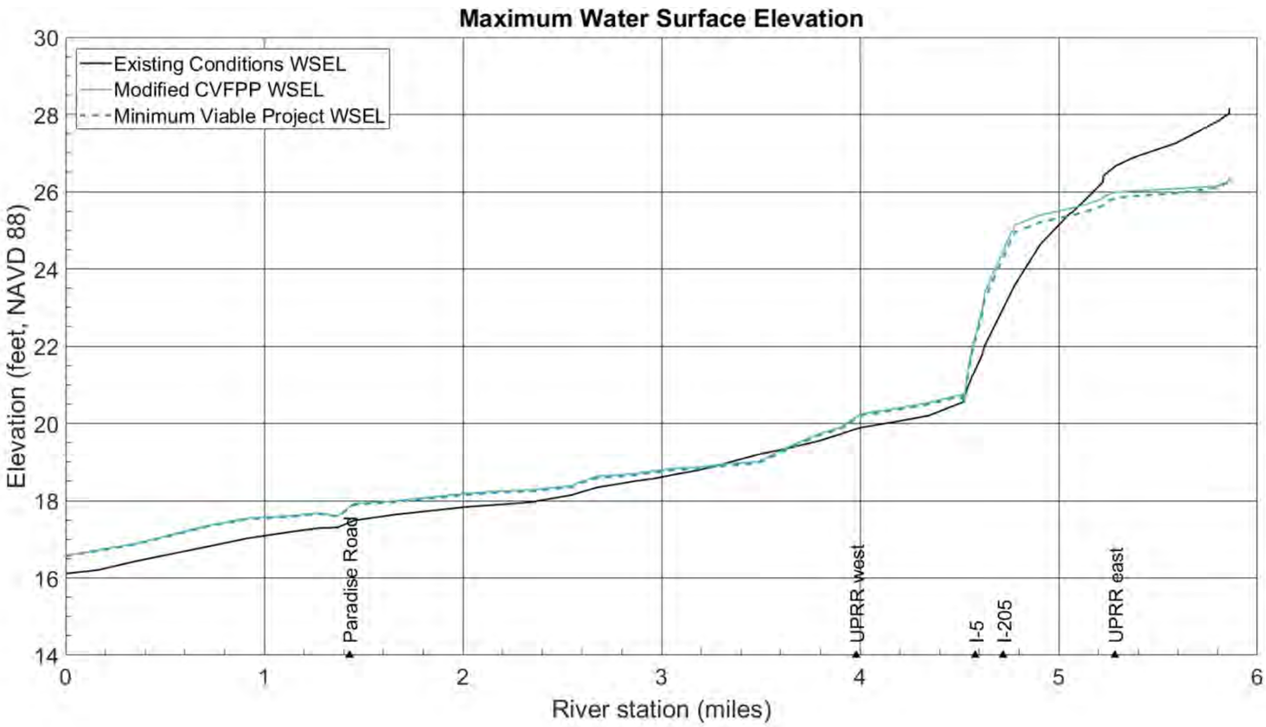


Chart 11: Modified CVFPP vs Minimum Viable Project Paradise Cut at 1997 Flood



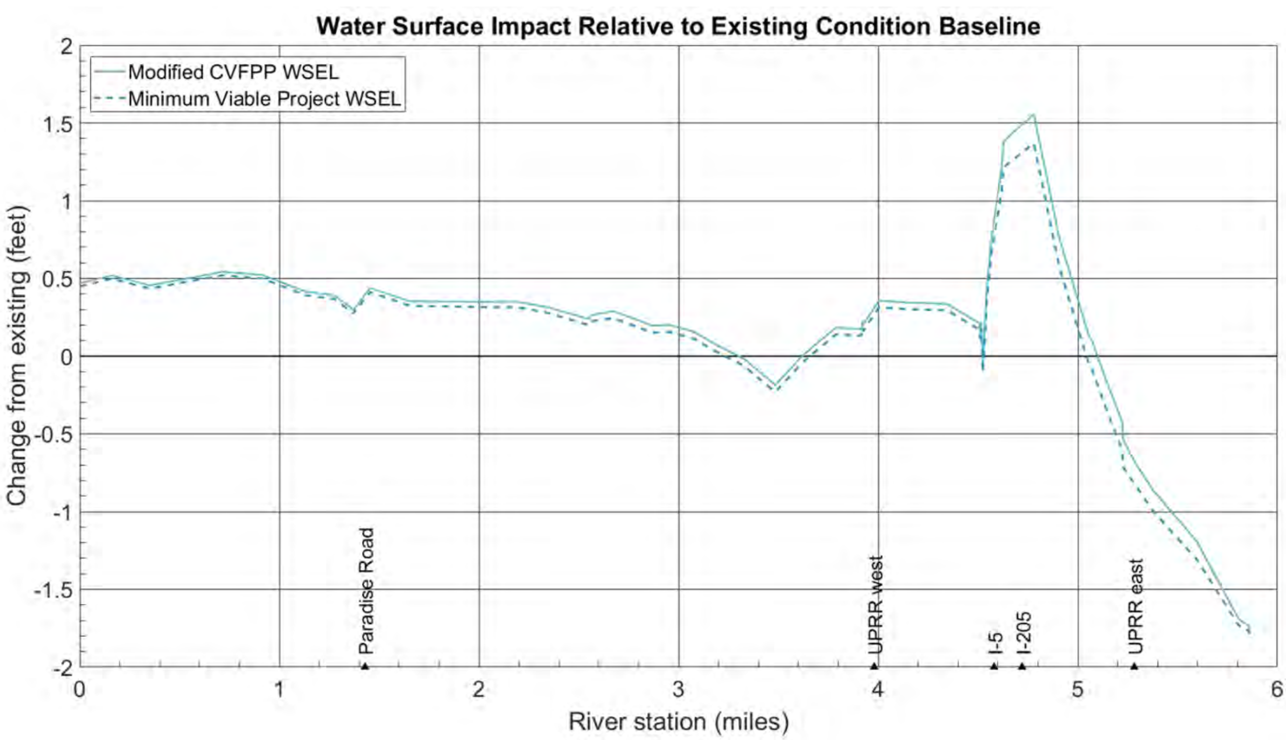
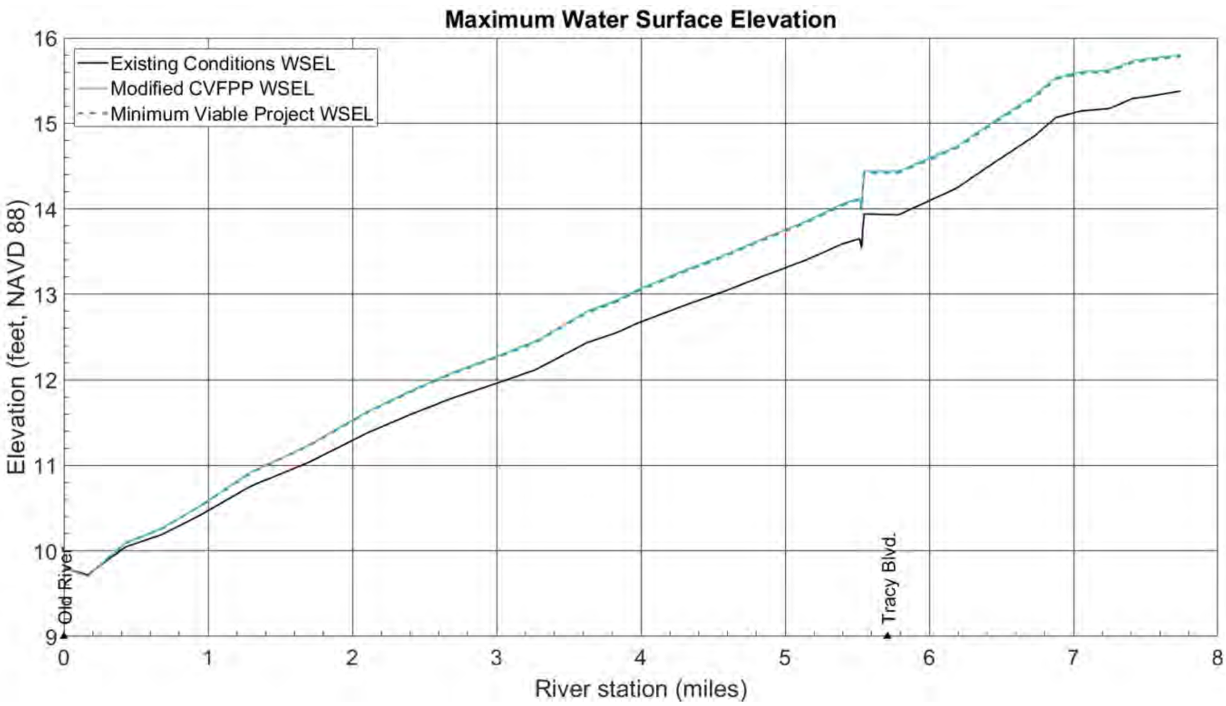


Chart 12: Modified CVFPP vs Minimum Viable Project
Grant Line Canal at 1997 Flood



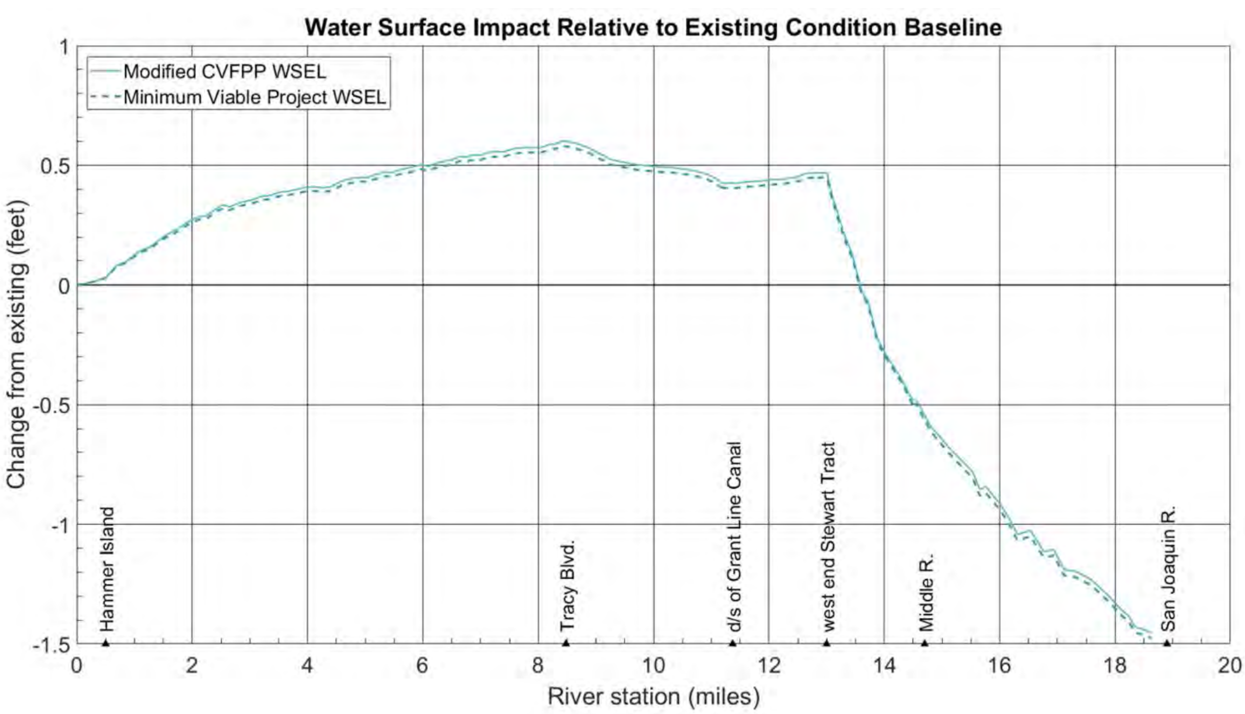
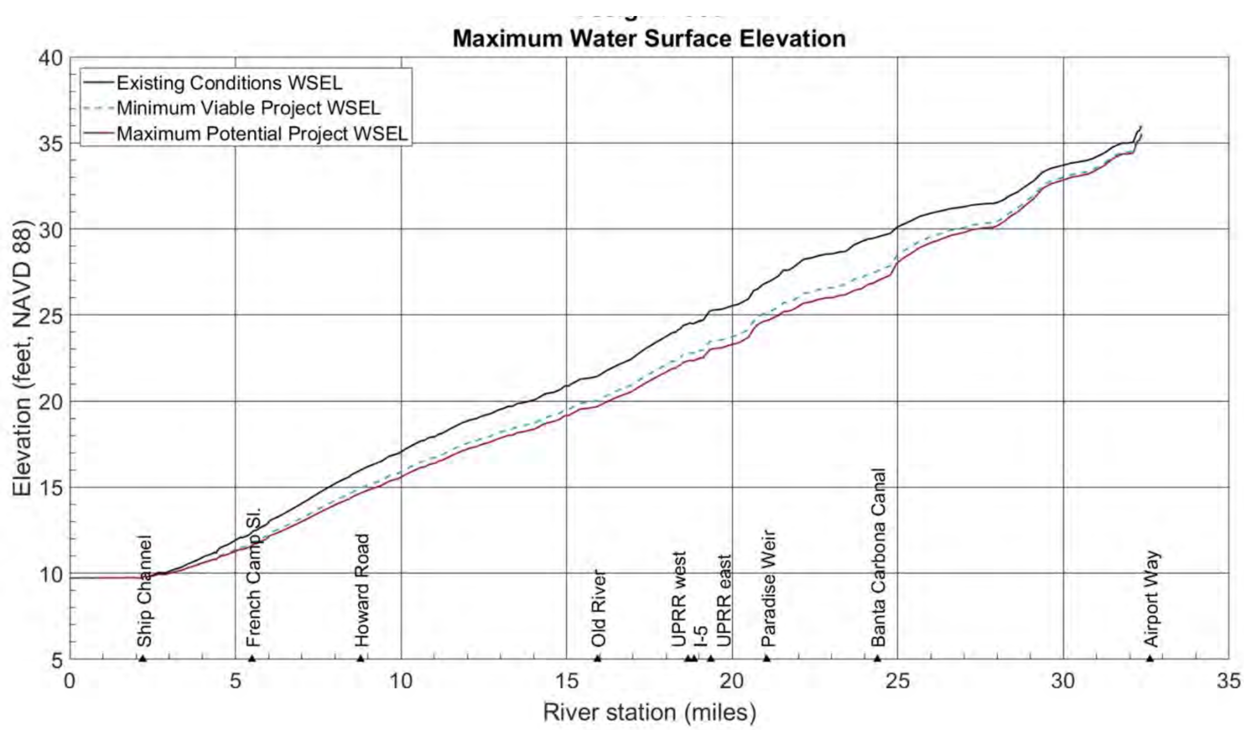


Chart 13:
Potential Maximum Project vs. Minimum Viable Project
San Joaquin River at Design Flood



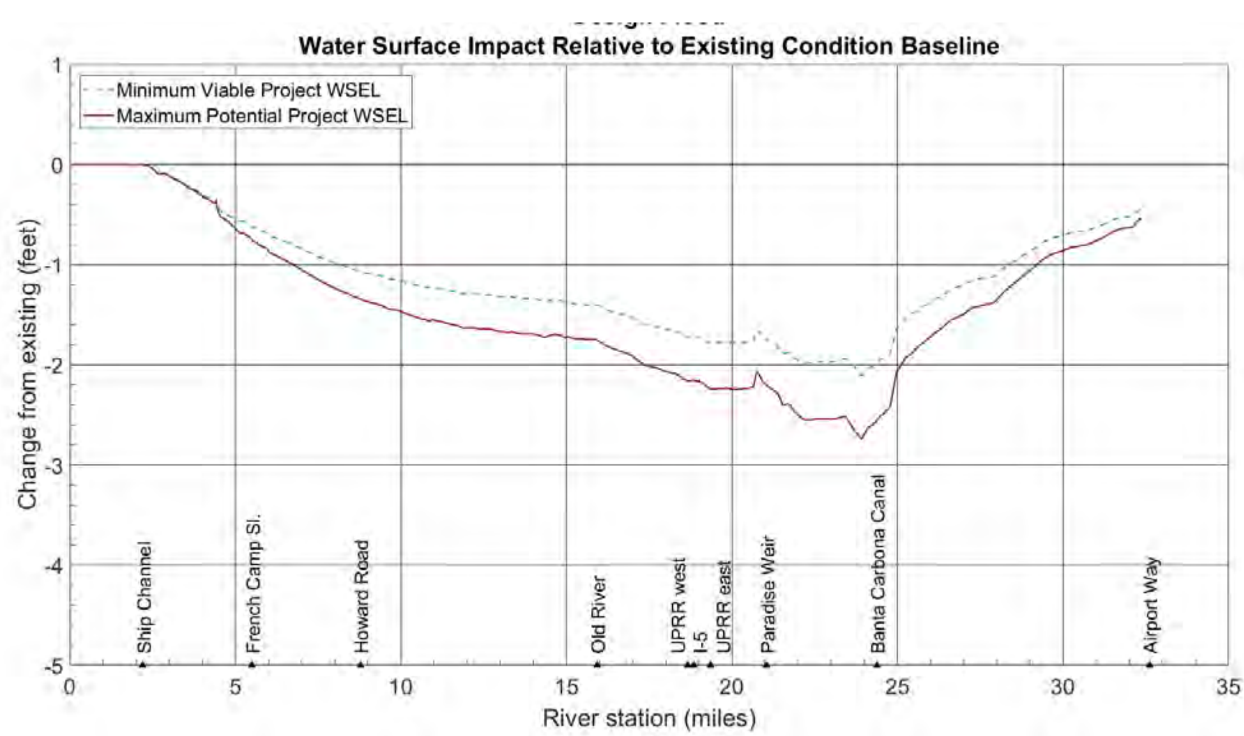
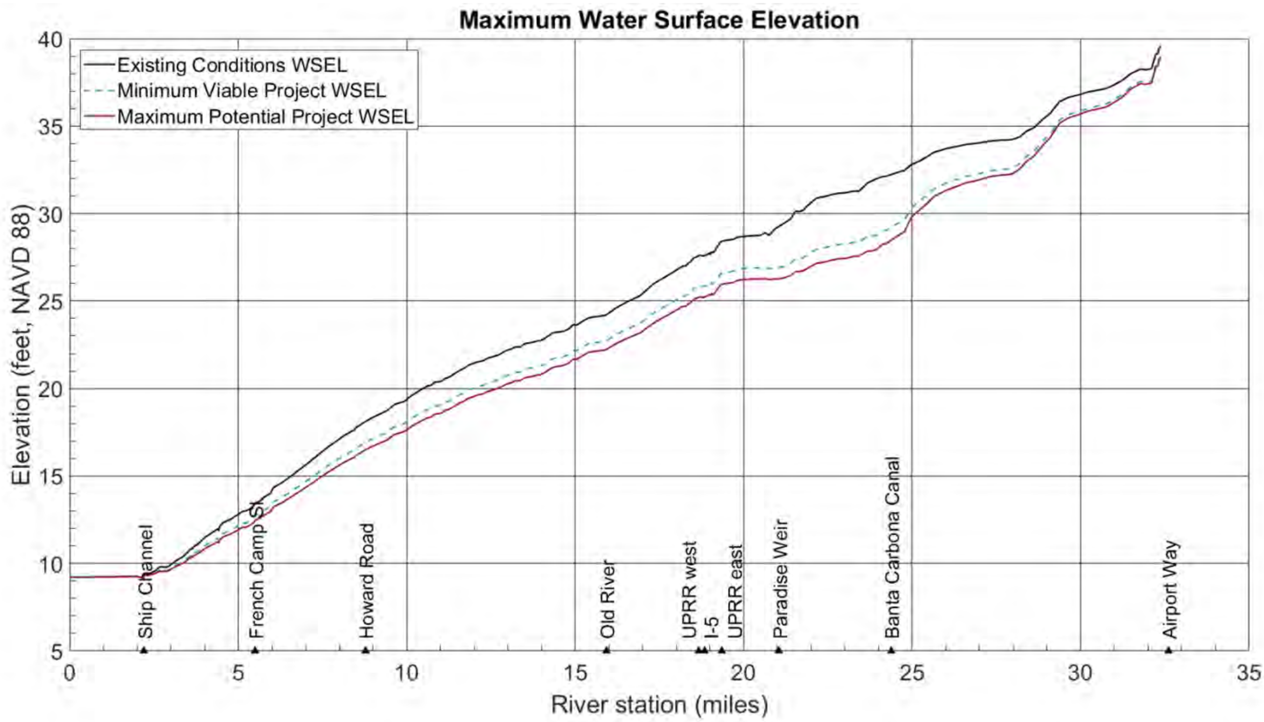


Chart 14:
Potential Maximum Project vs. Minimum Viable Project
San Joaquin River at 1997 Flood



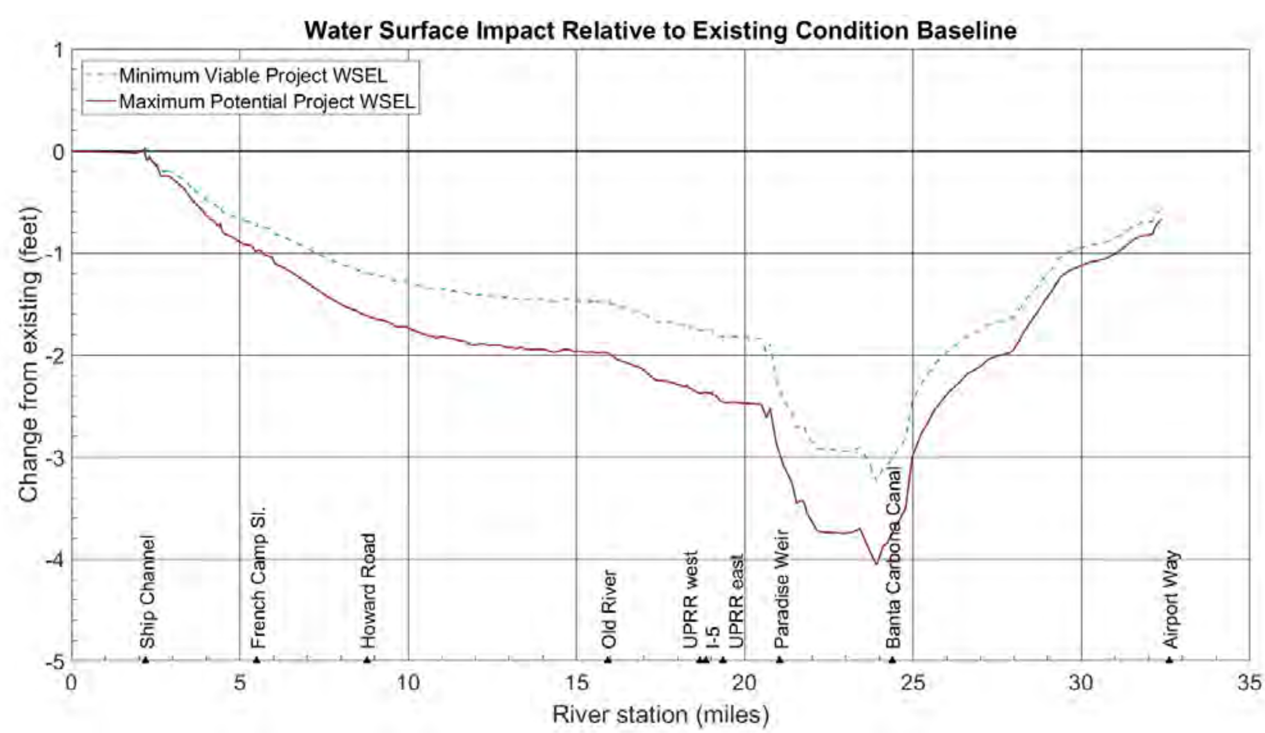
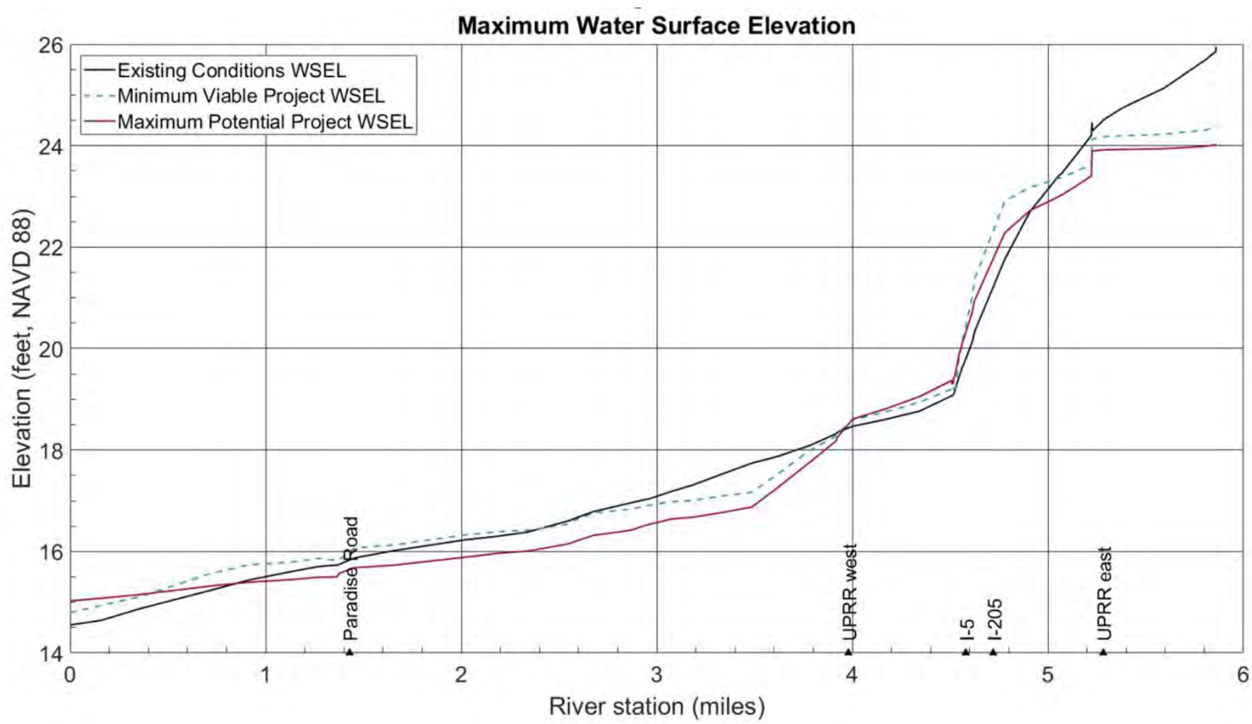


Chart 15:
Potential Maximum Project vs. Minimum Viable Project
Paradise Cut at Design Flood



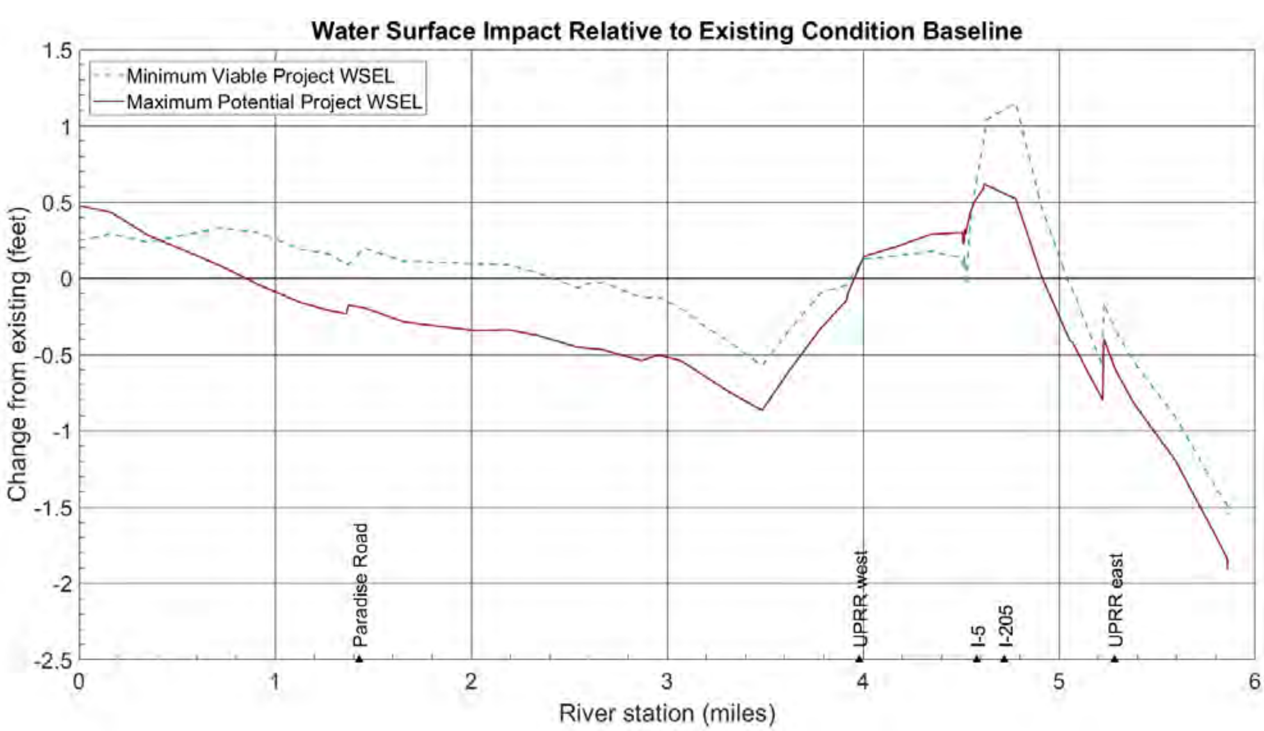
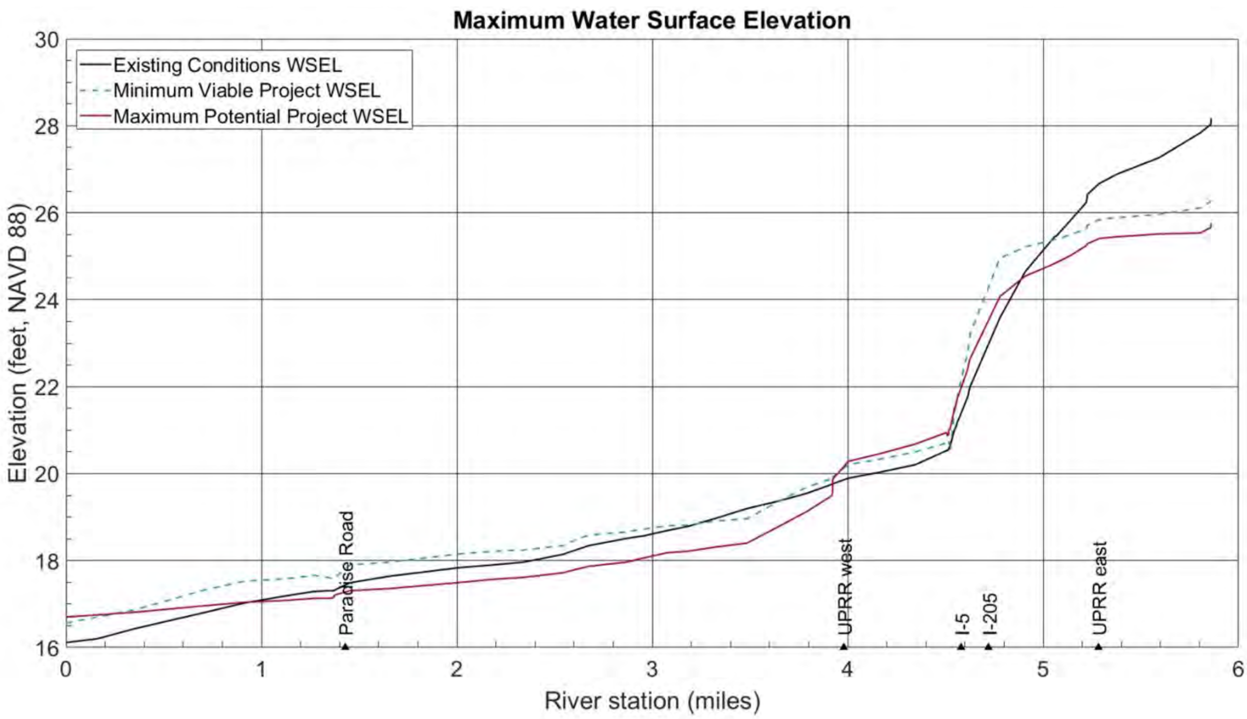


Chart 16:
Potential Maximum Project vs. Minimum Viable Project
Paradise Cut at 1997 Flood



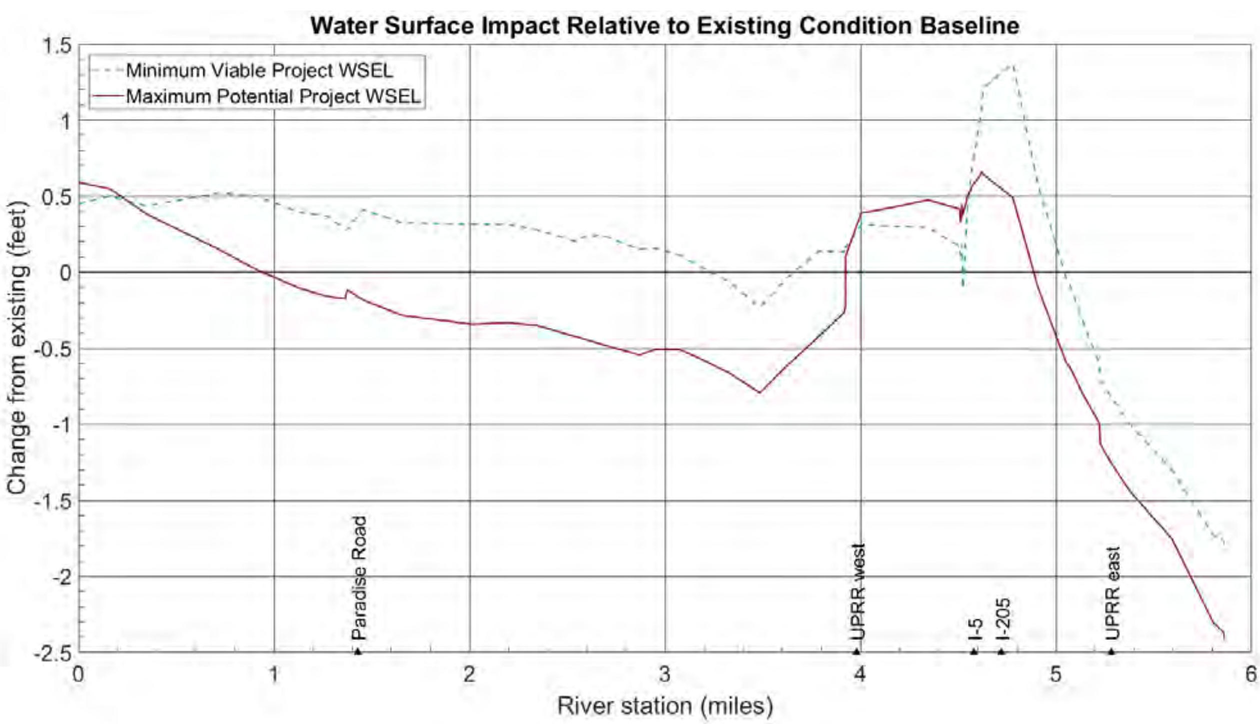
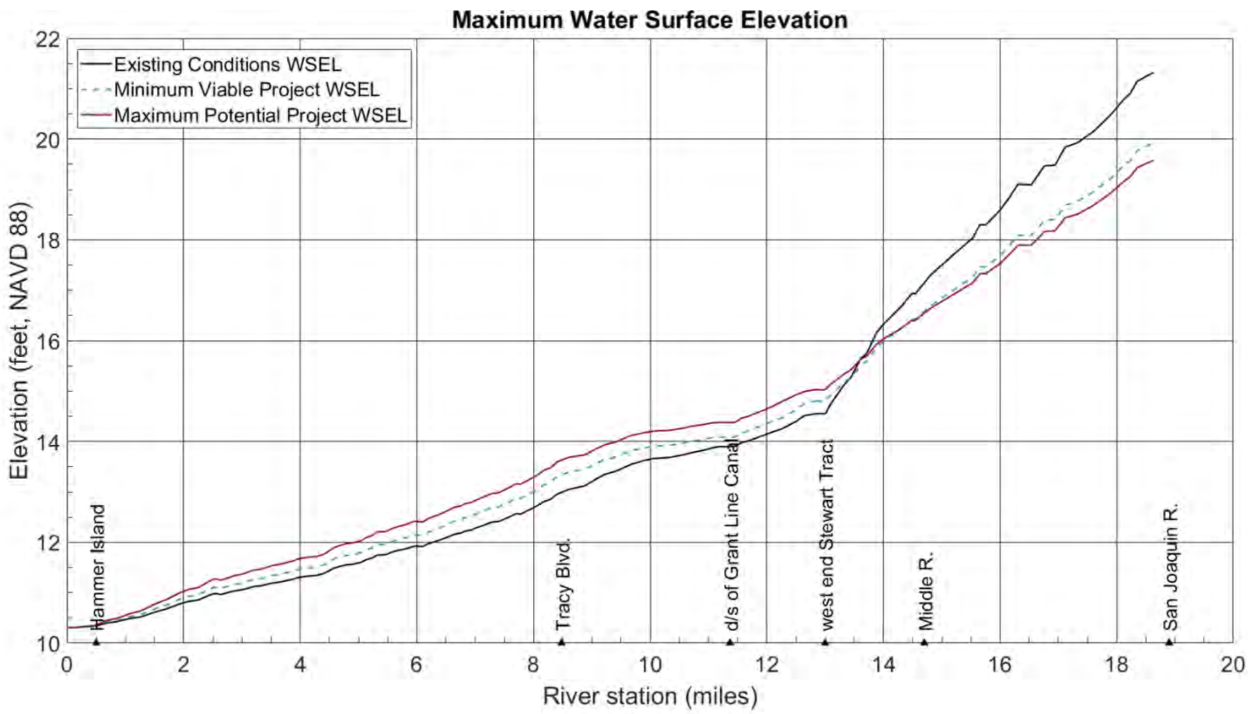


Chart 17:
Potential Maximum Project vs. Minimum Viable Project
Old River at Design Flood



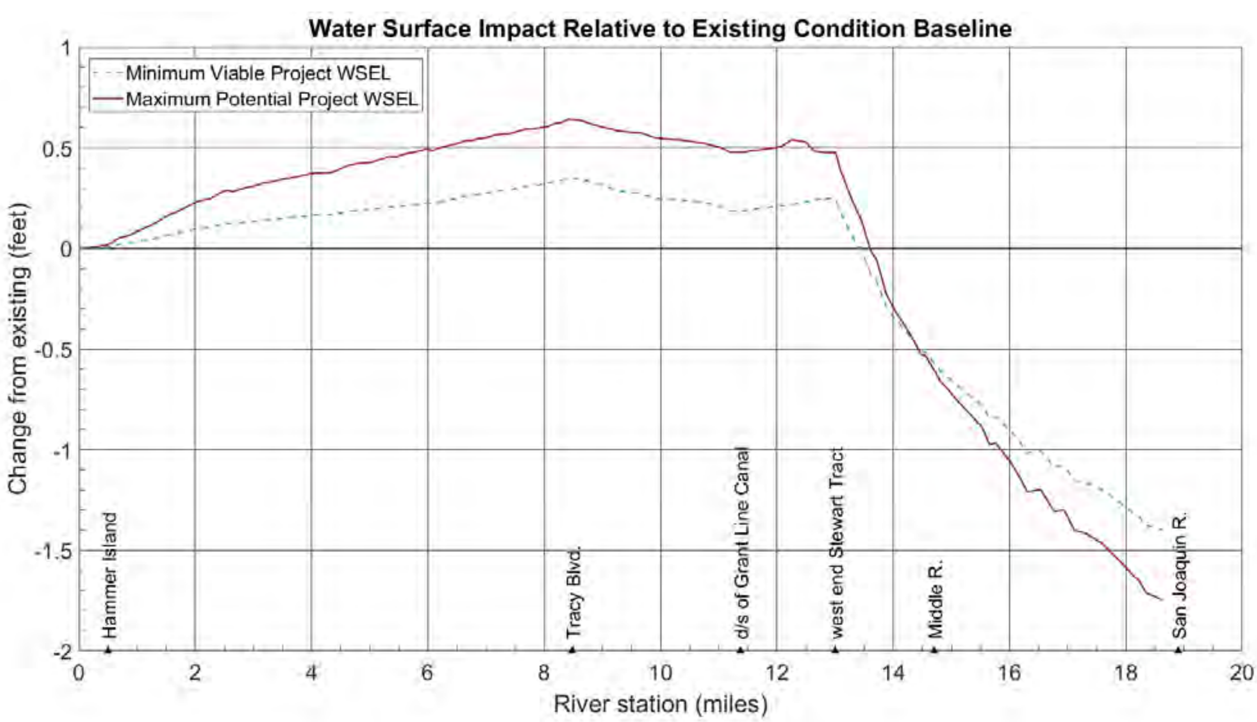
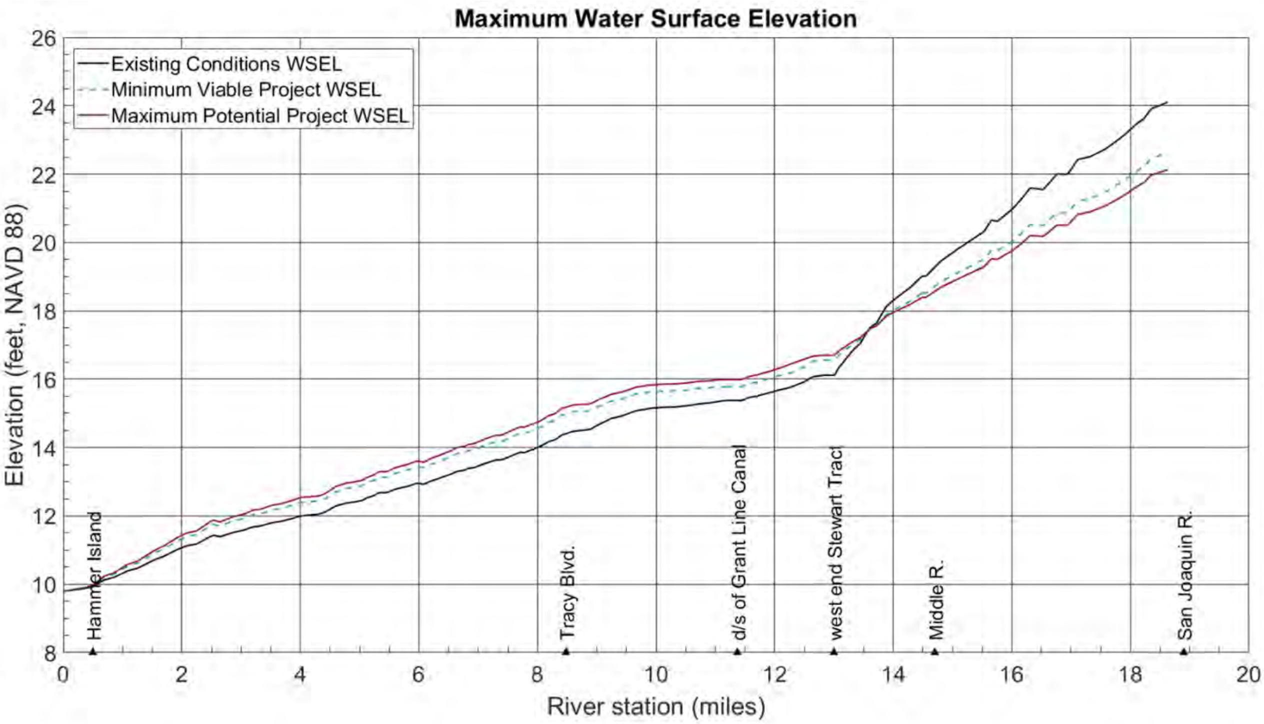


Chart 18:
Potential Maximum Project vs. Minimum Viable Project
Old River at 1997 Flood



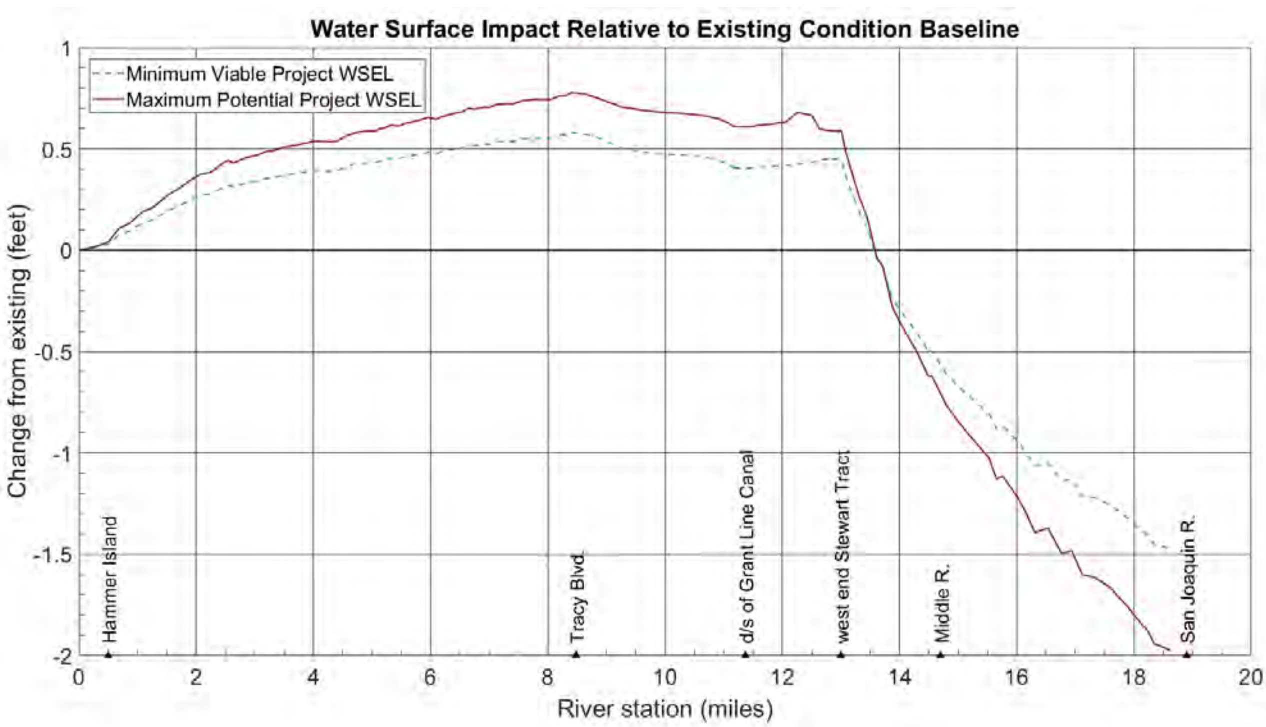
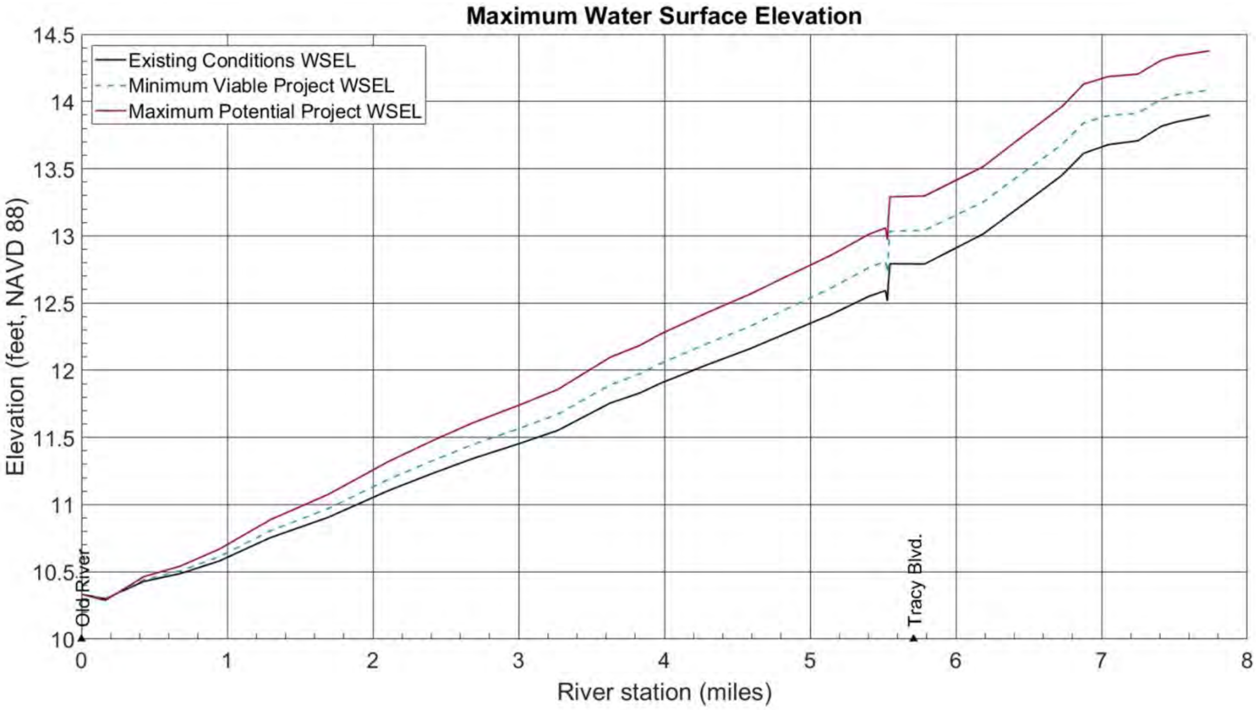


Chart 19:
Potential Maximum Project vs. Minimum Viable Project
Grant Line Canal at Design Flood



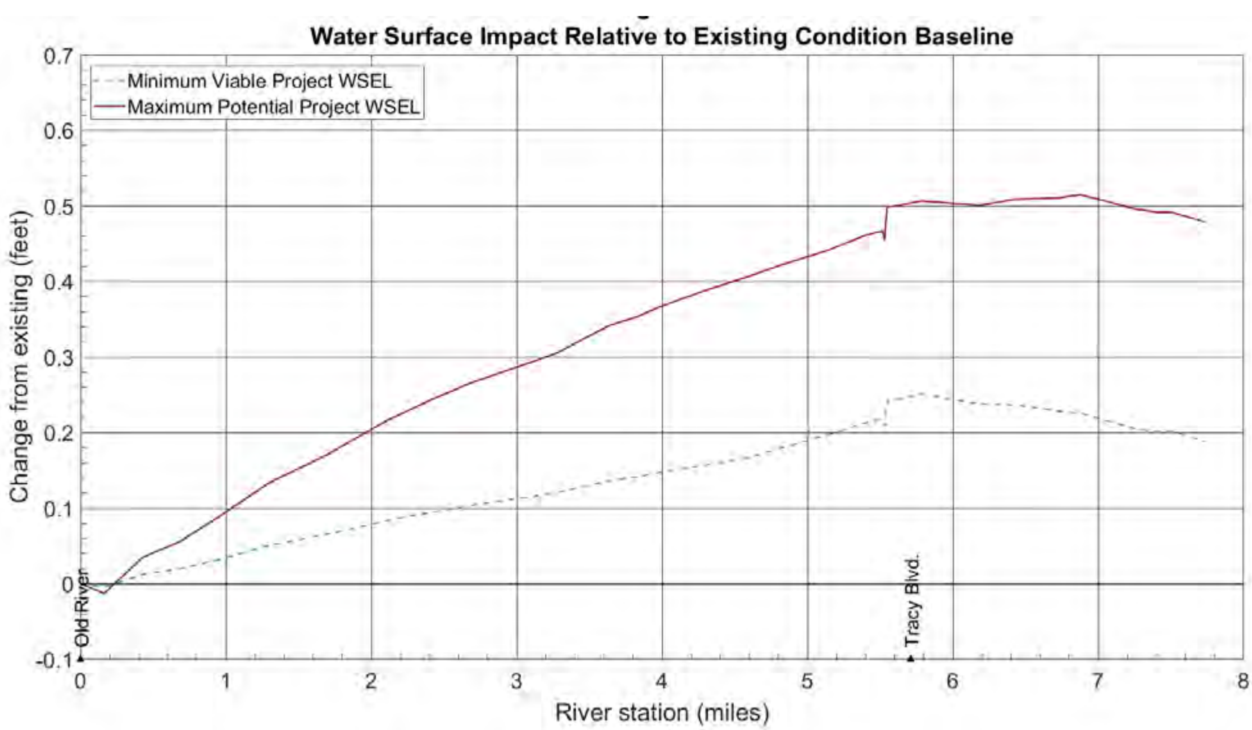
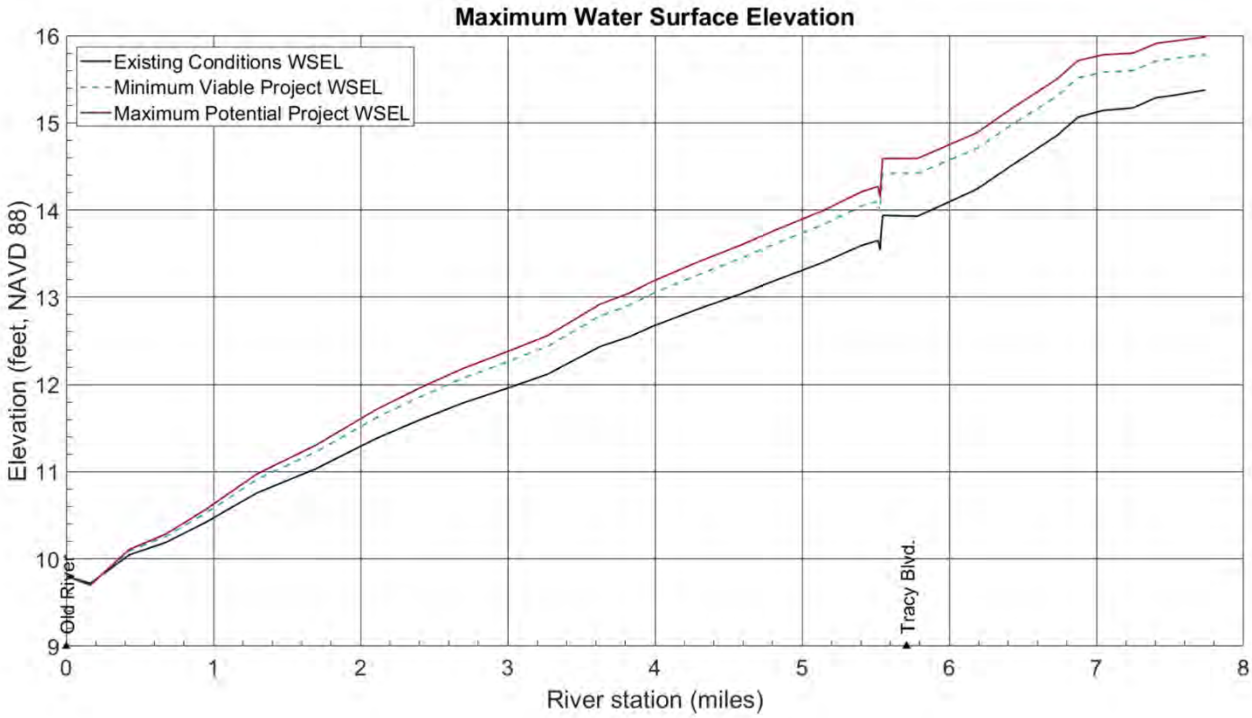


Chart 20:
Potential Maximum Project vs. Minimum Viable Project
Grant Line Canal at 1997 Flood



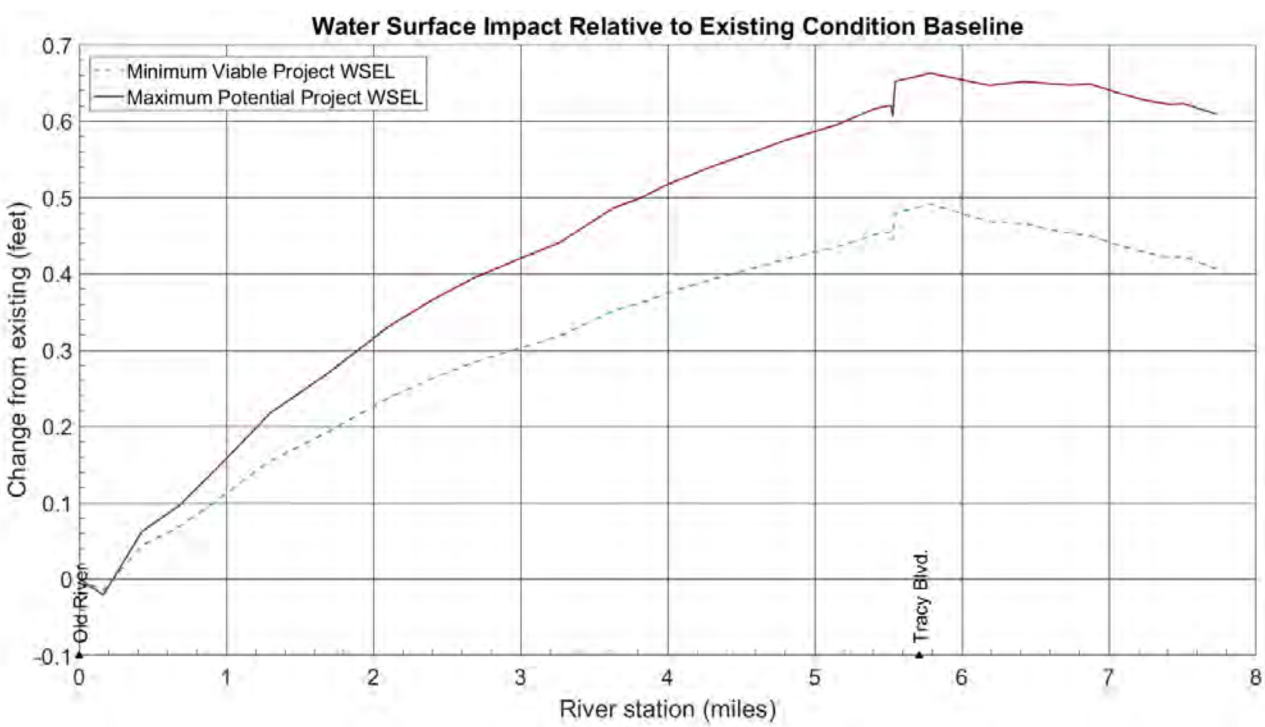
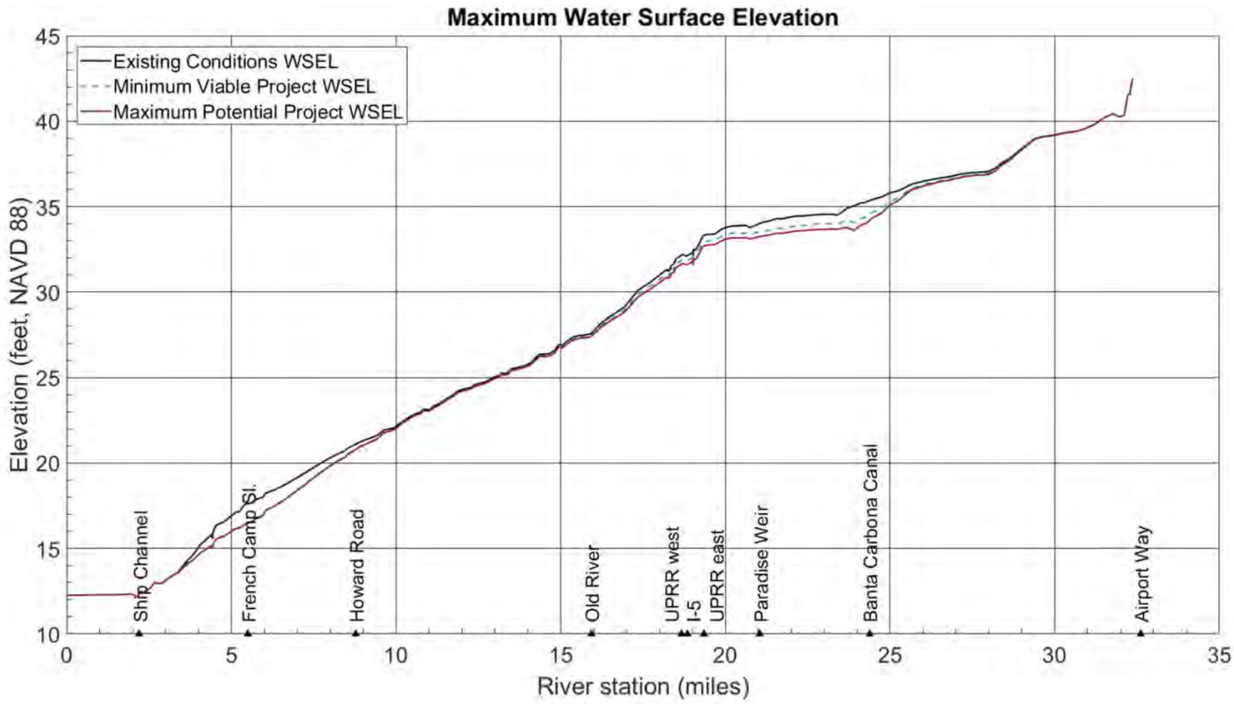


Chart 20:
Potential Maximum Project vs. Minimum Viable Project
San Joaquin River at 100-yr Flood with Climate Change



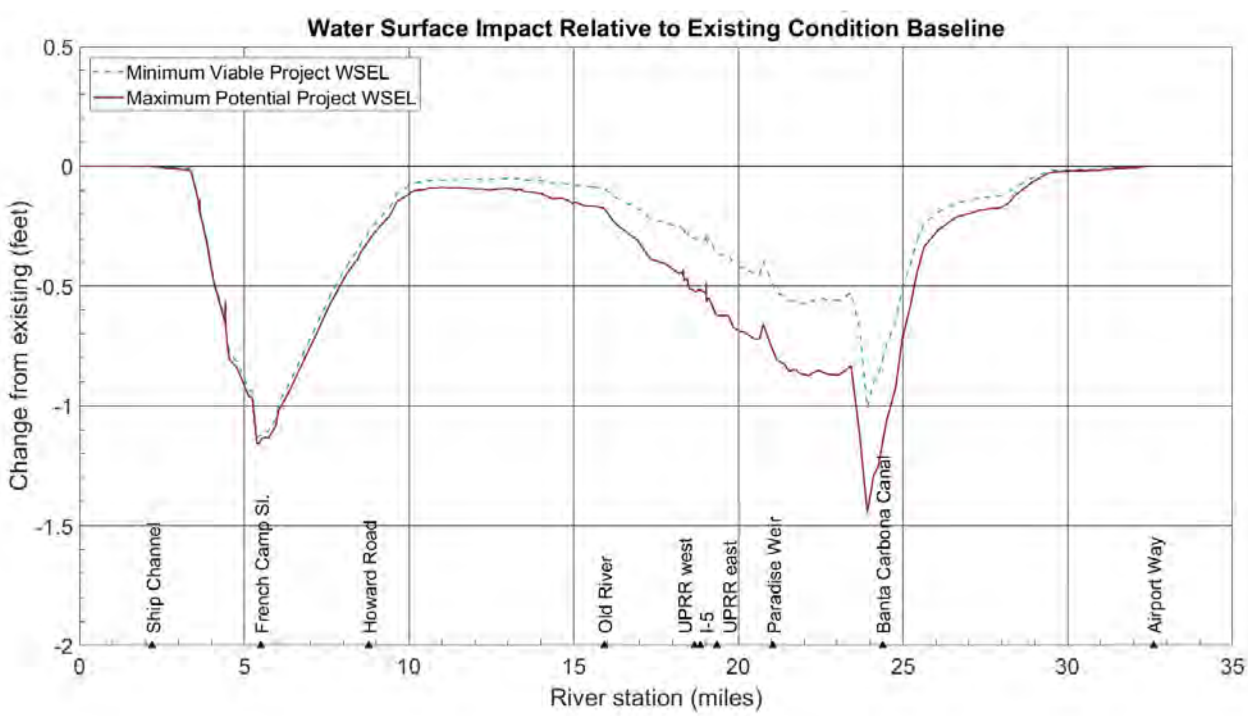
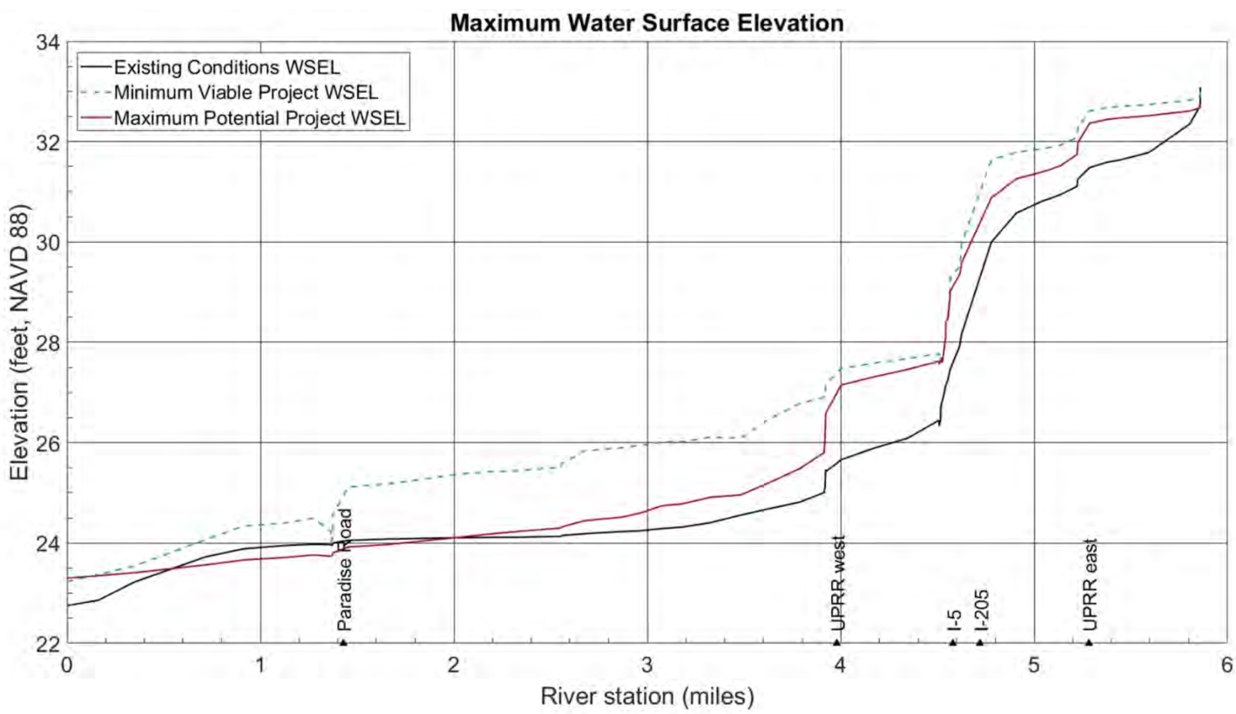


Chart 21:
Potential Maximum Project vs. Minimum Viable Project
Paradise Cut at 100-yr Flood with Climate Change



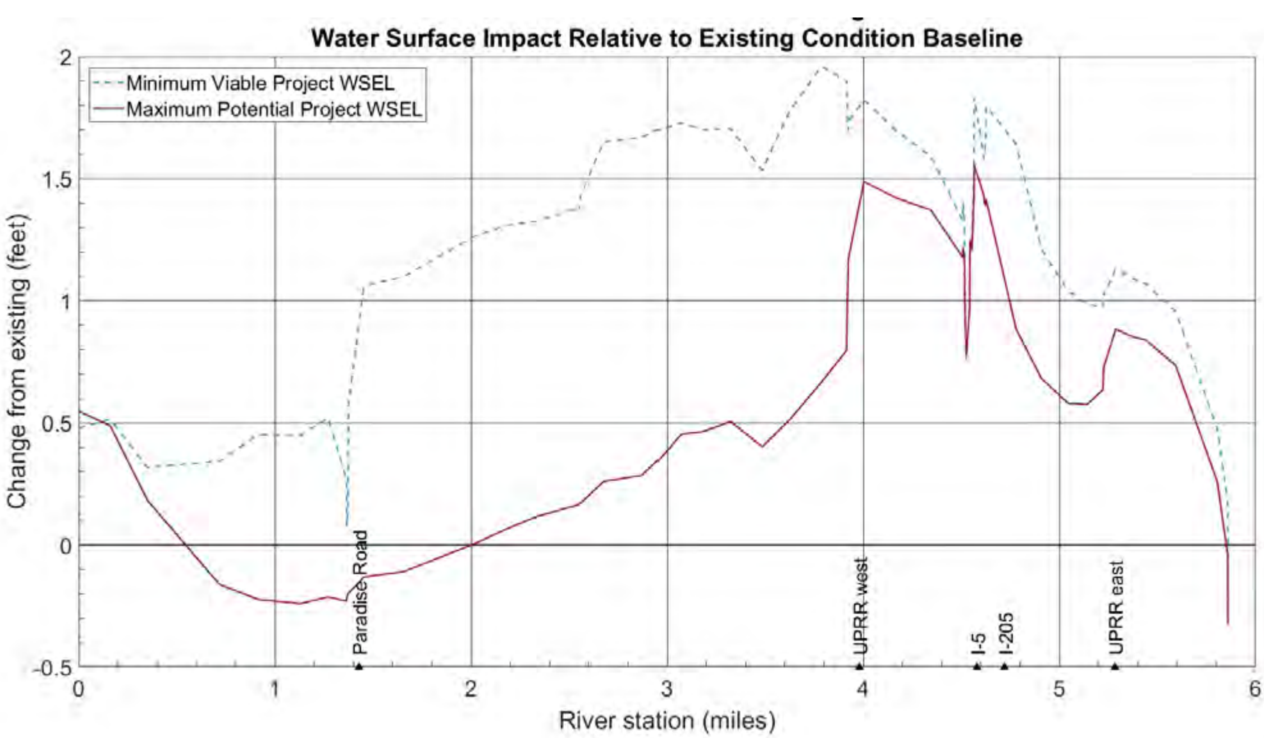
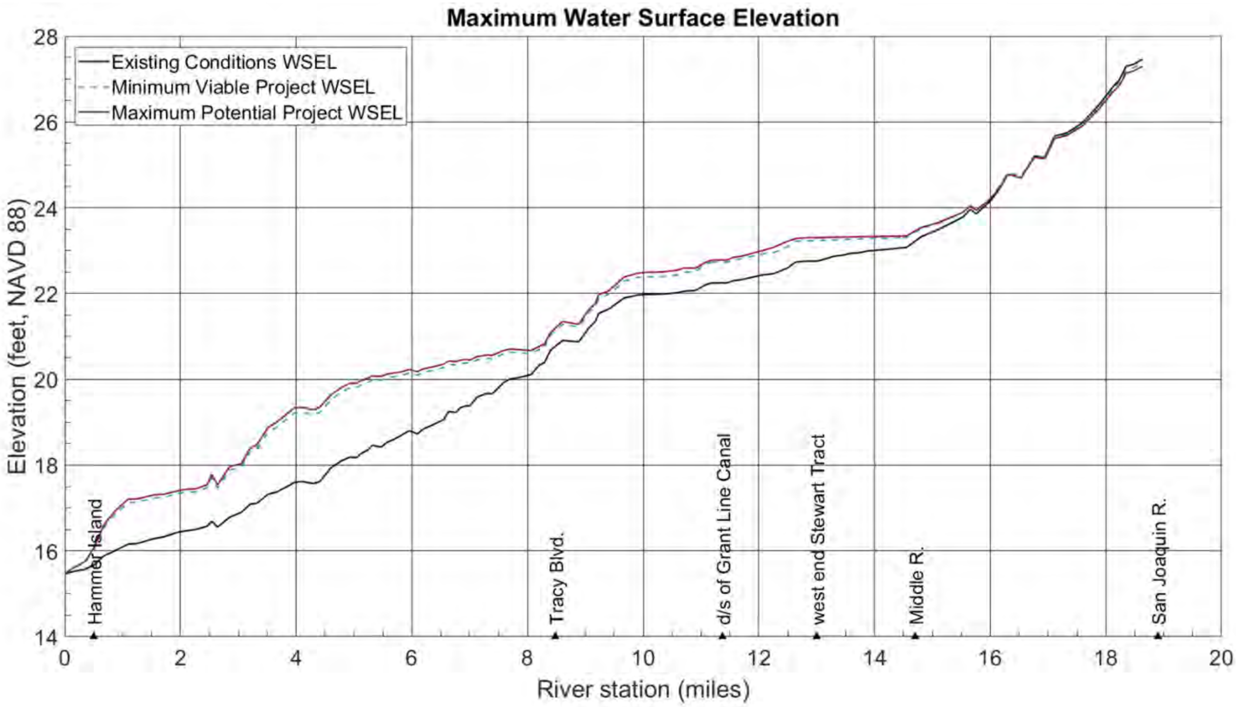


Chart 22:
Potential Maximum Project vs. Minimum Viable Project
Old River at 100-yr Flood with Climate Change



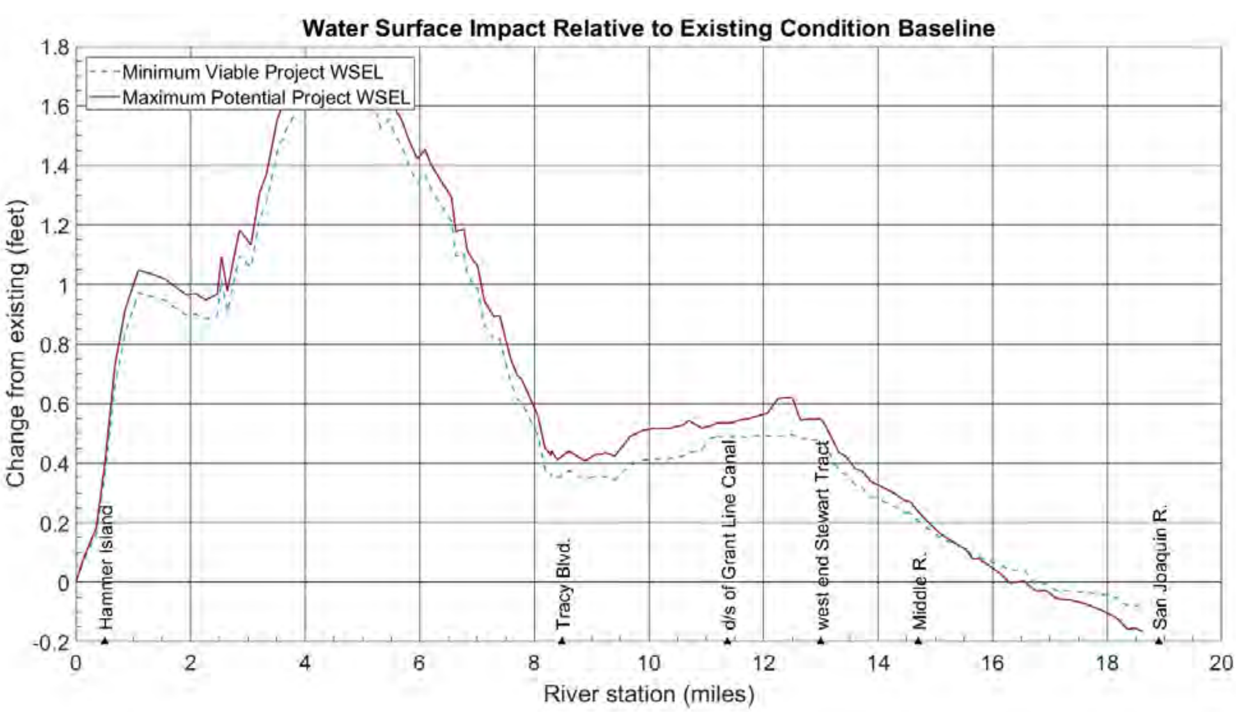
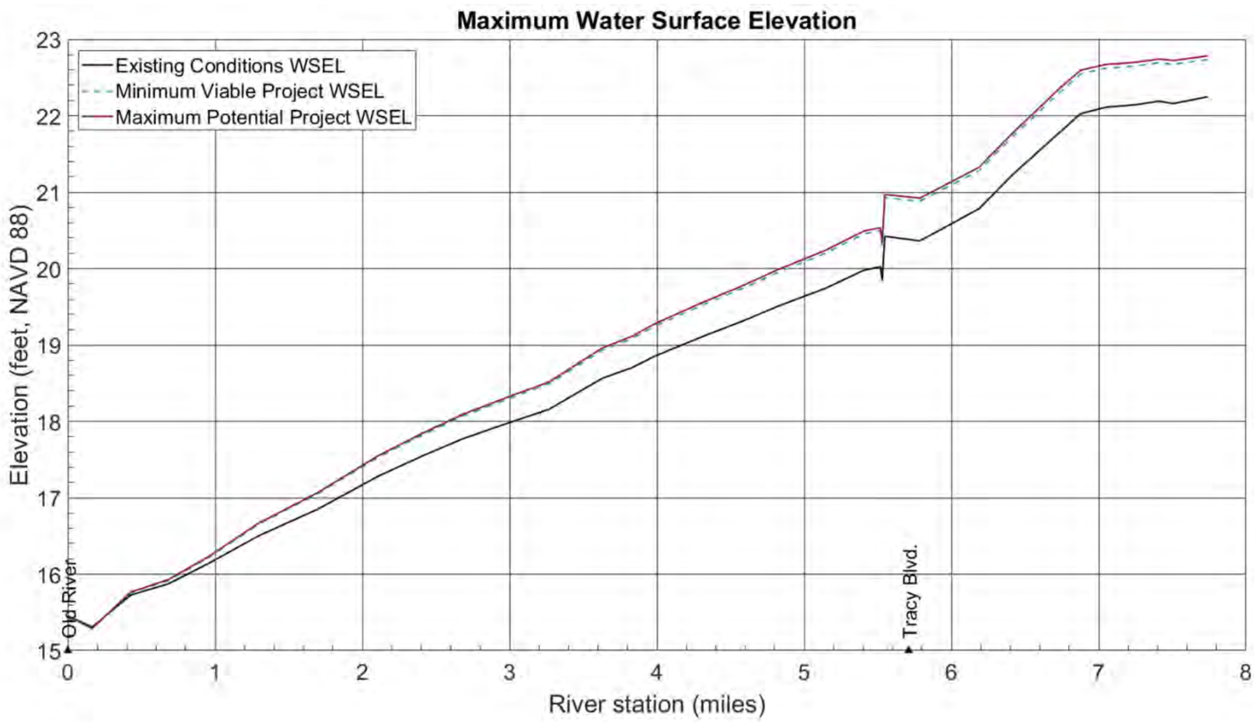


Chart 22:
Potential Maximum Project vs. Minimum Viable Project
Grant Line Canal at 100-yr Flood with Climate Change



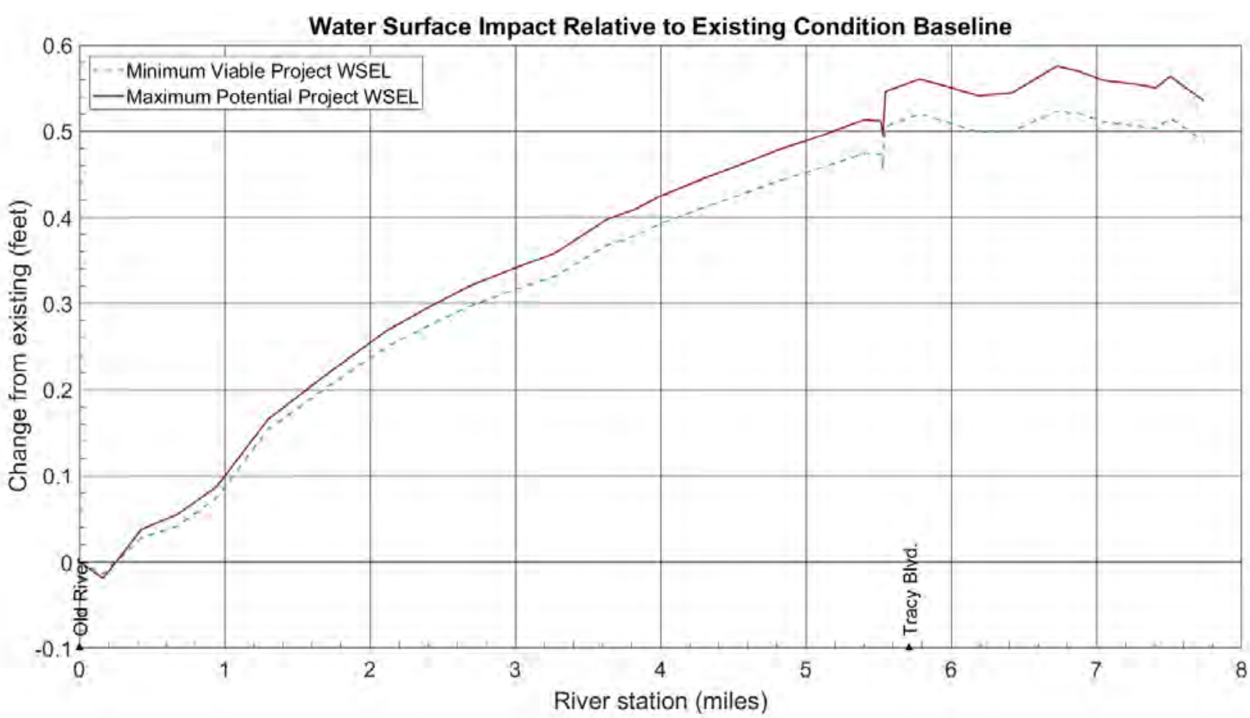
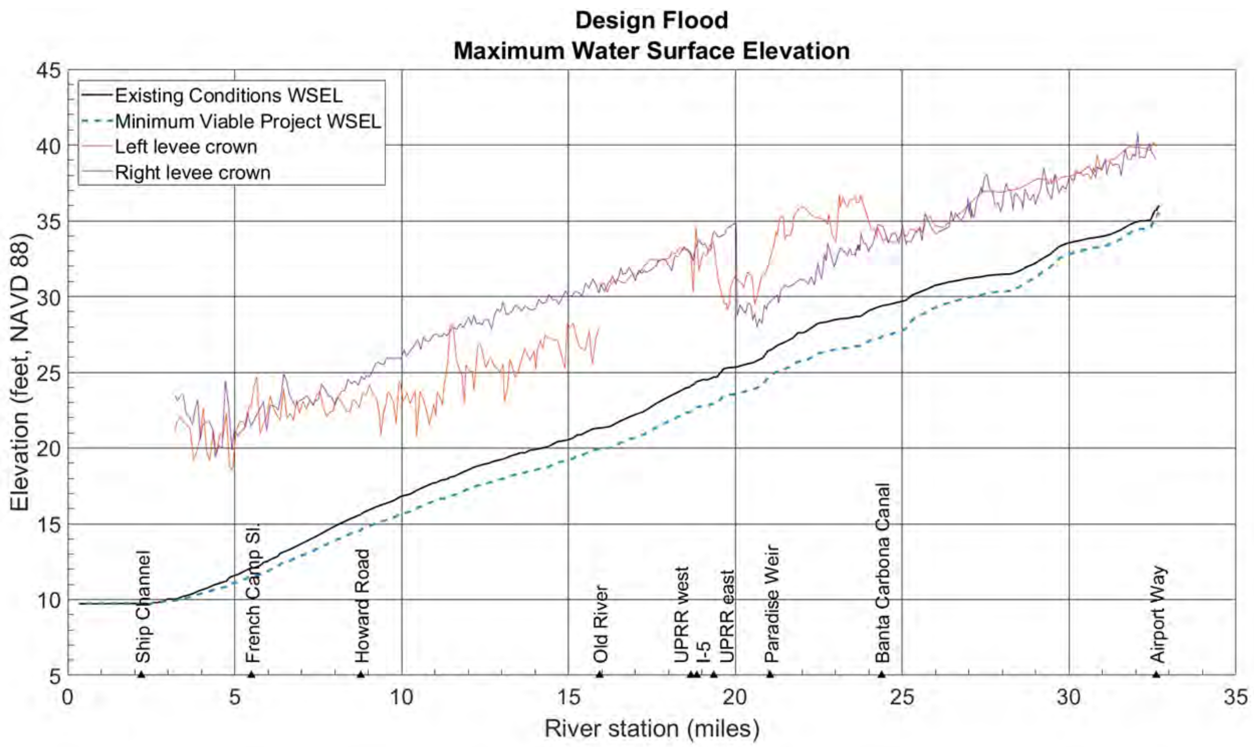


Chart 23: Top of Levees
Minimum Viable Project vs Existing Conditions
San Joaquin River



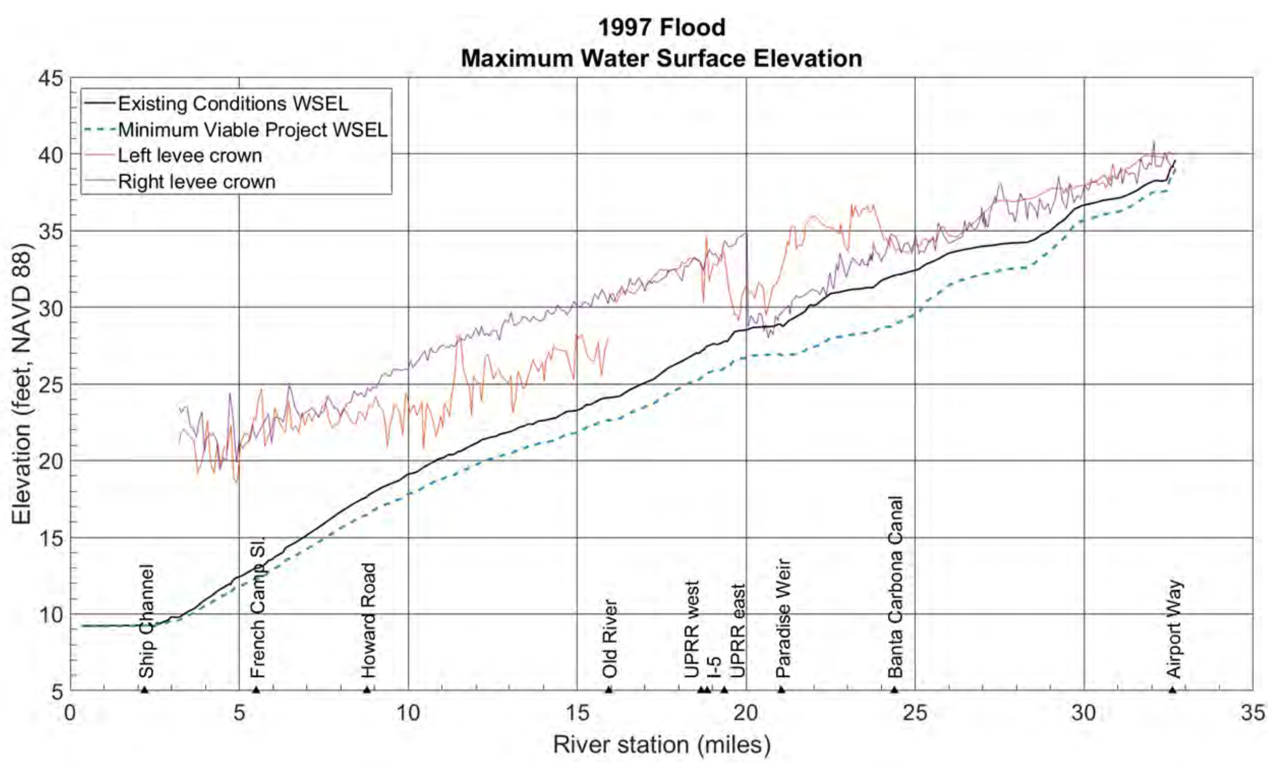
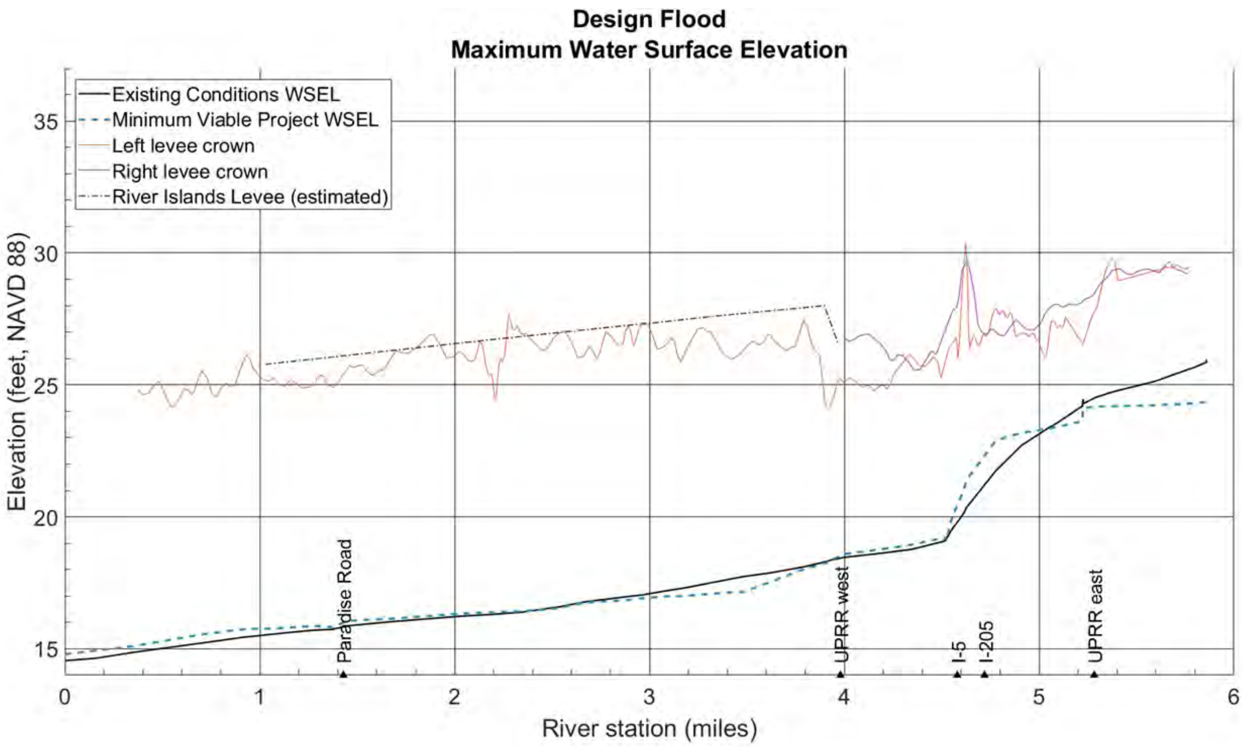


Chart 24: Top of Levees
Minimum Viable Project vs Existing Conditions
Paradise Cut



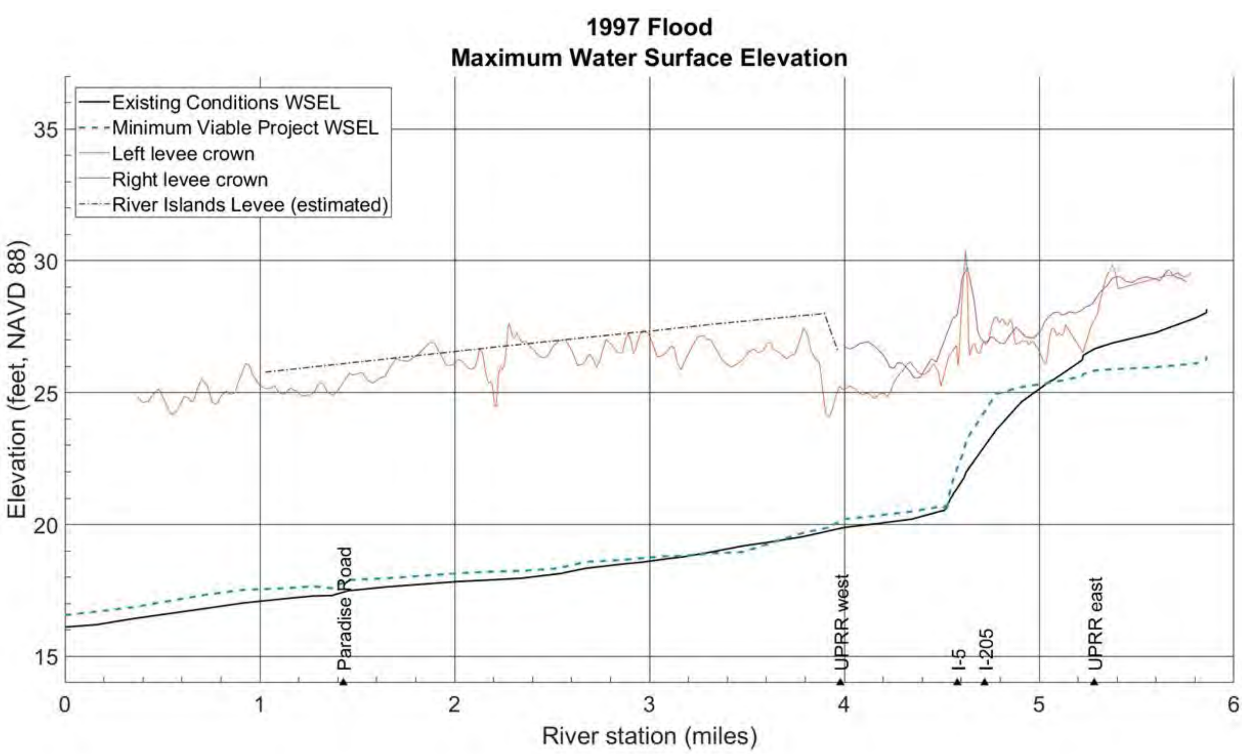
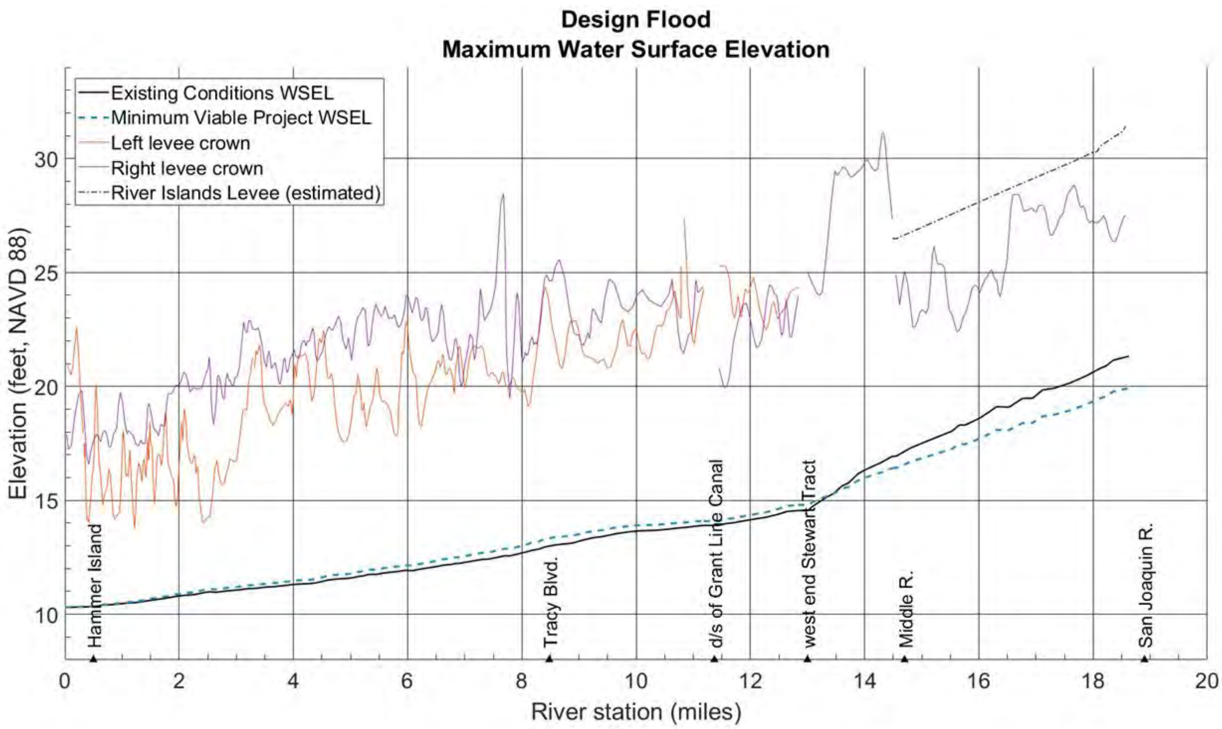


Chart 25: Top of Levees
Minimum Viable Project vs Existing Conditions
Old River



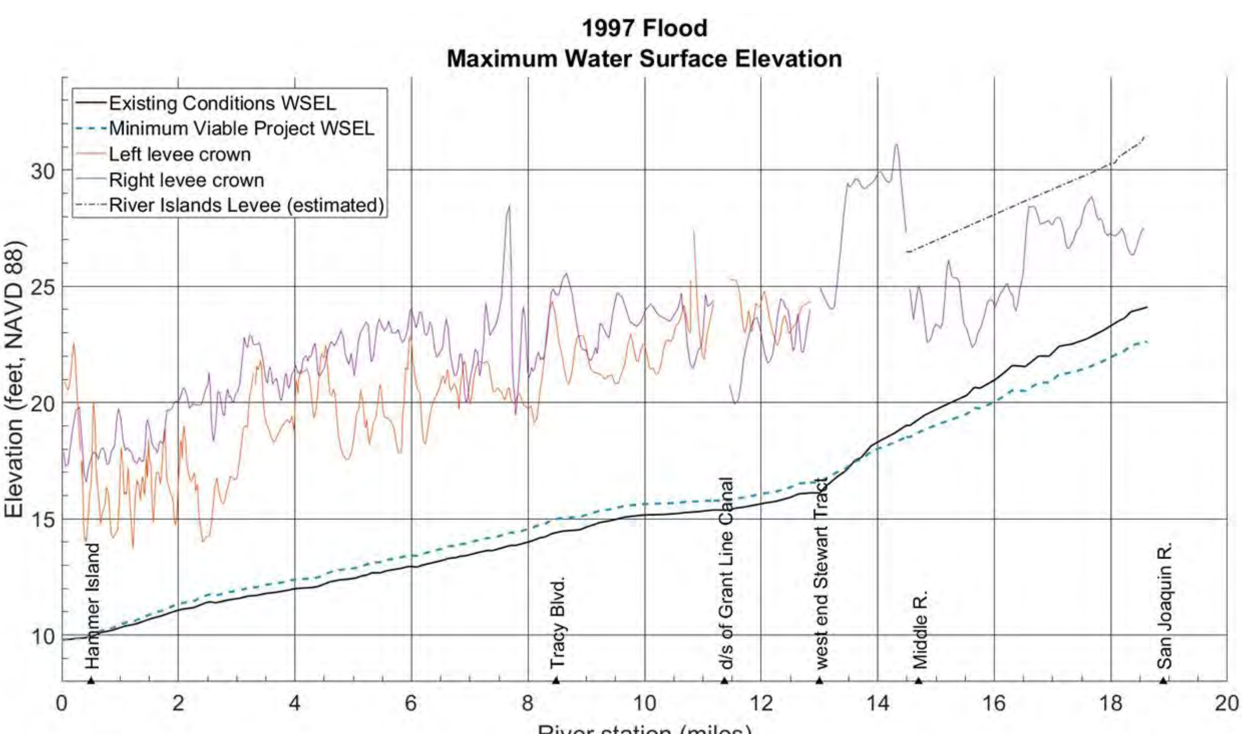
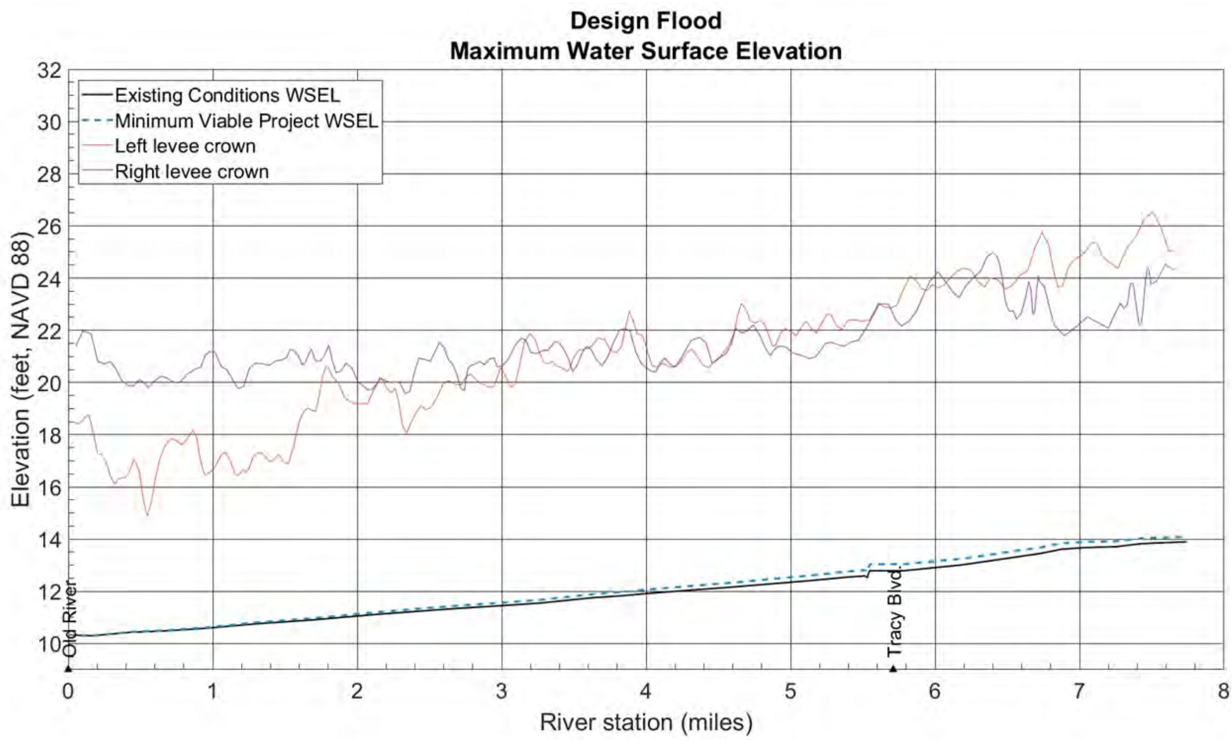


Chart 26: Top of Levees
Minimum Viable Project vs Existing Conditions
Grant Line Canal



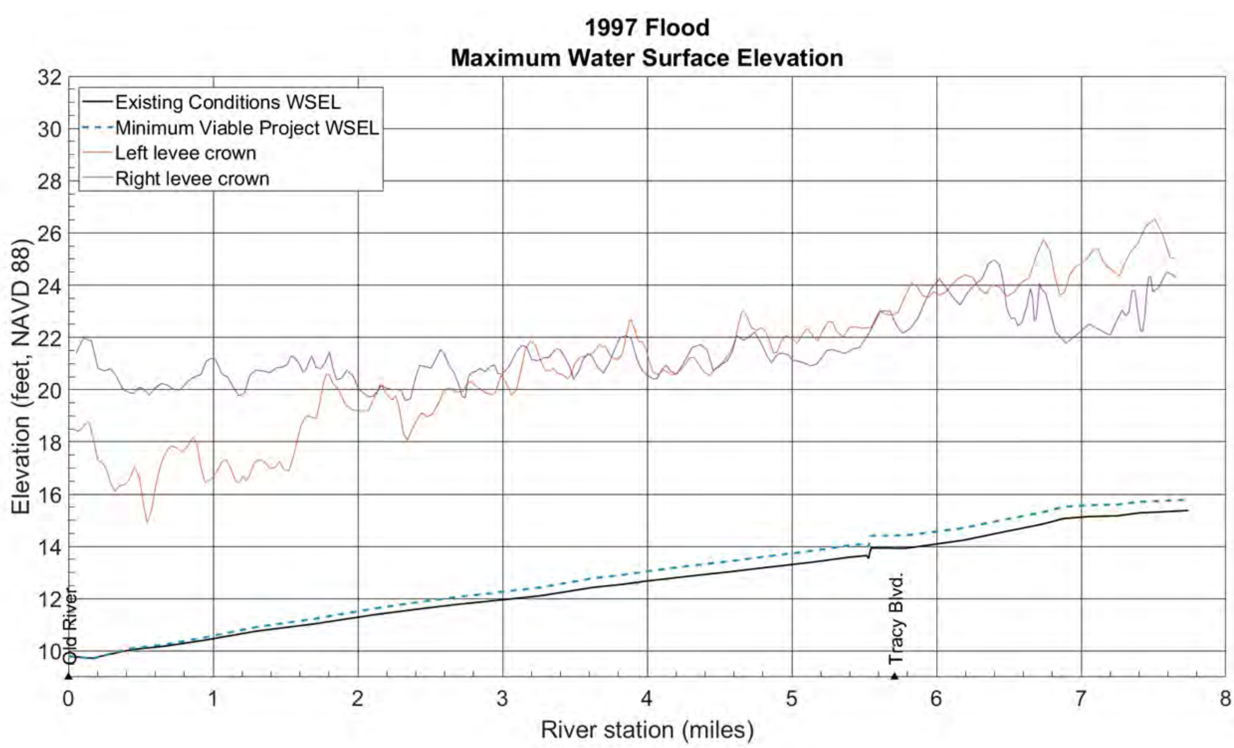
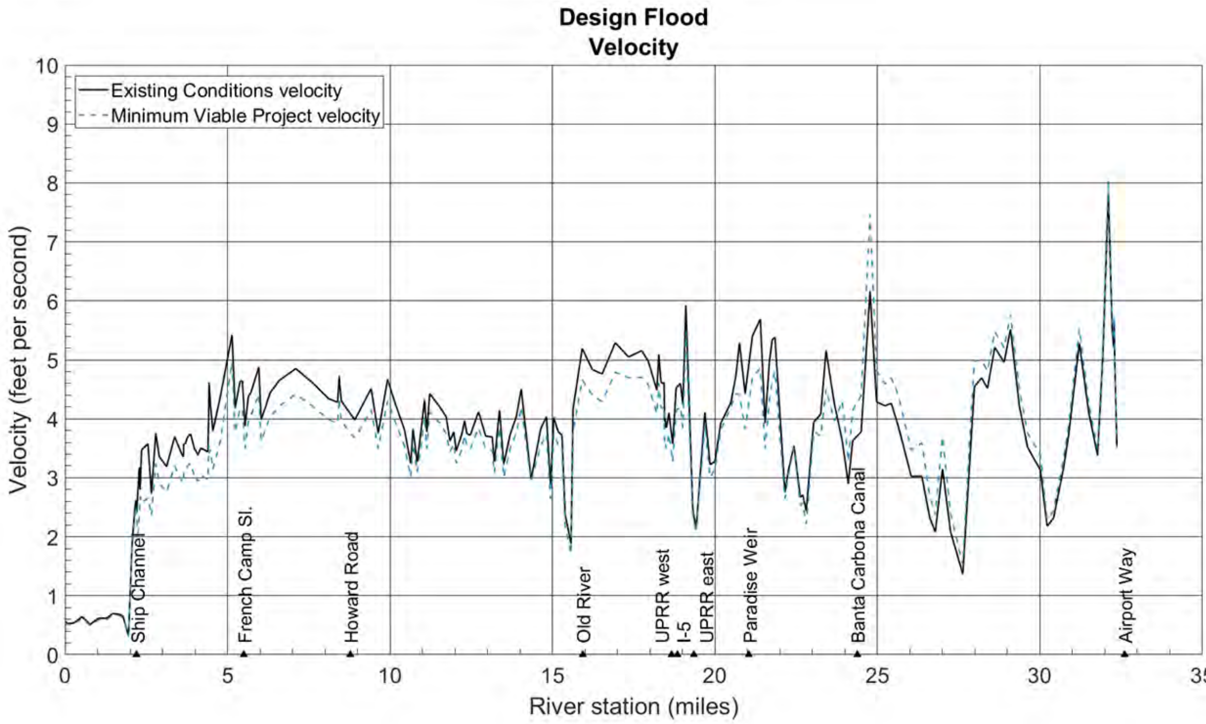


Chart 27: Velocity
Minimum Viable Project vs Existing Conditions
San Joaquin River



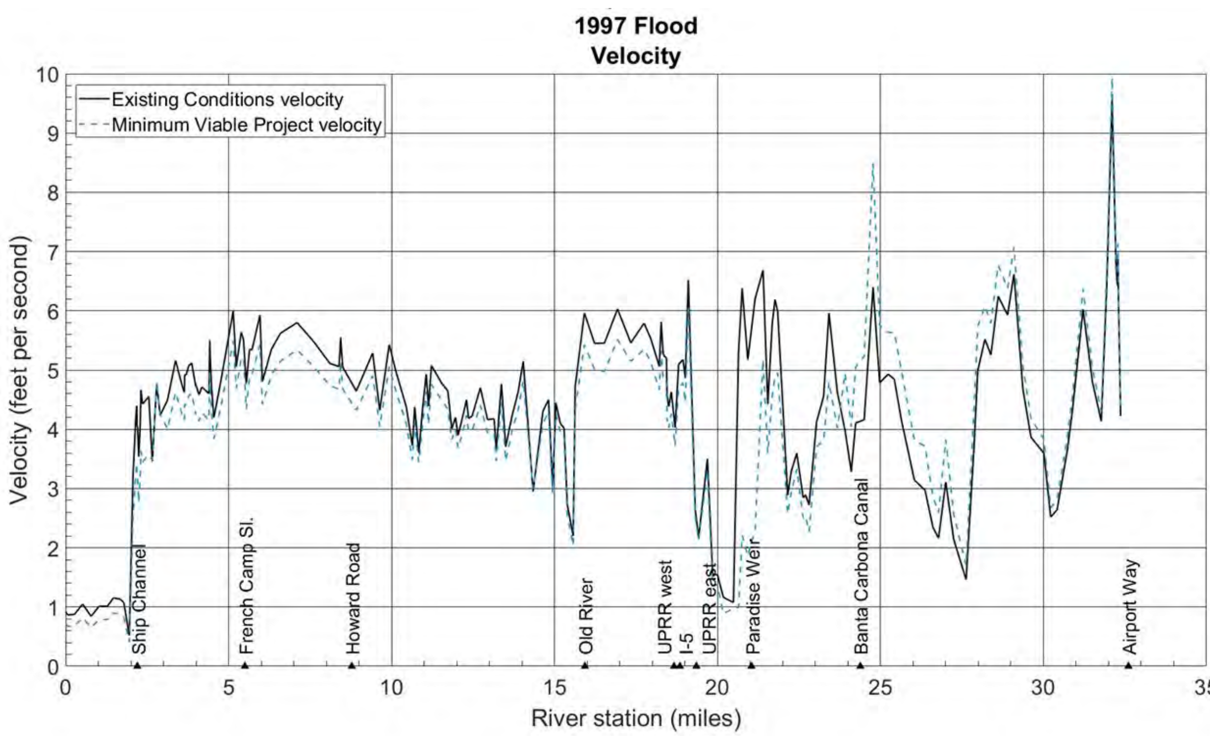
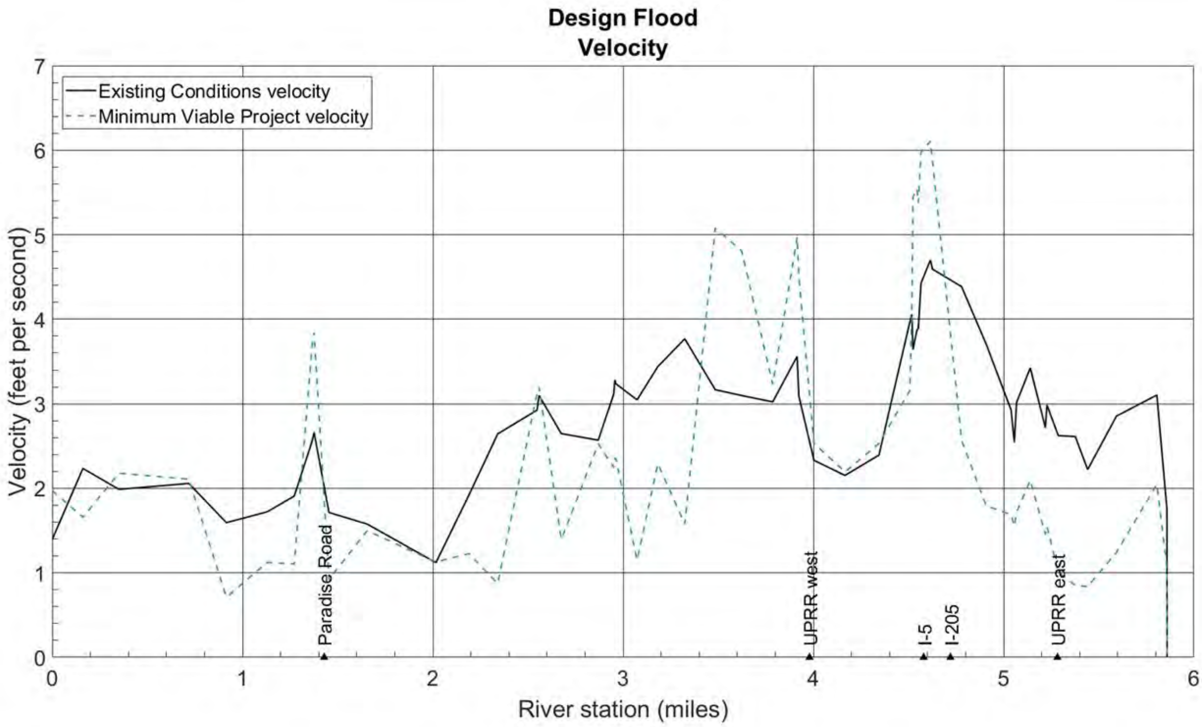


Chart 28: Velocity
Minimum Viable Project vs Existing Conditions
Paradise Cut



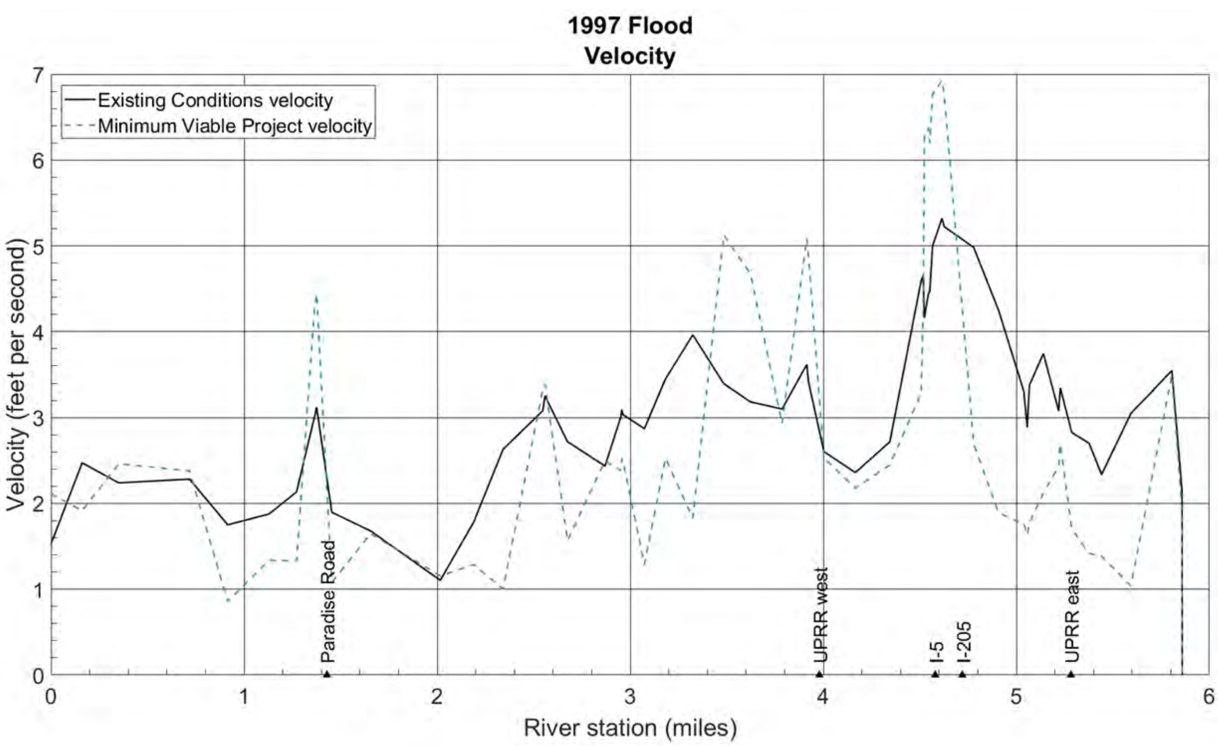
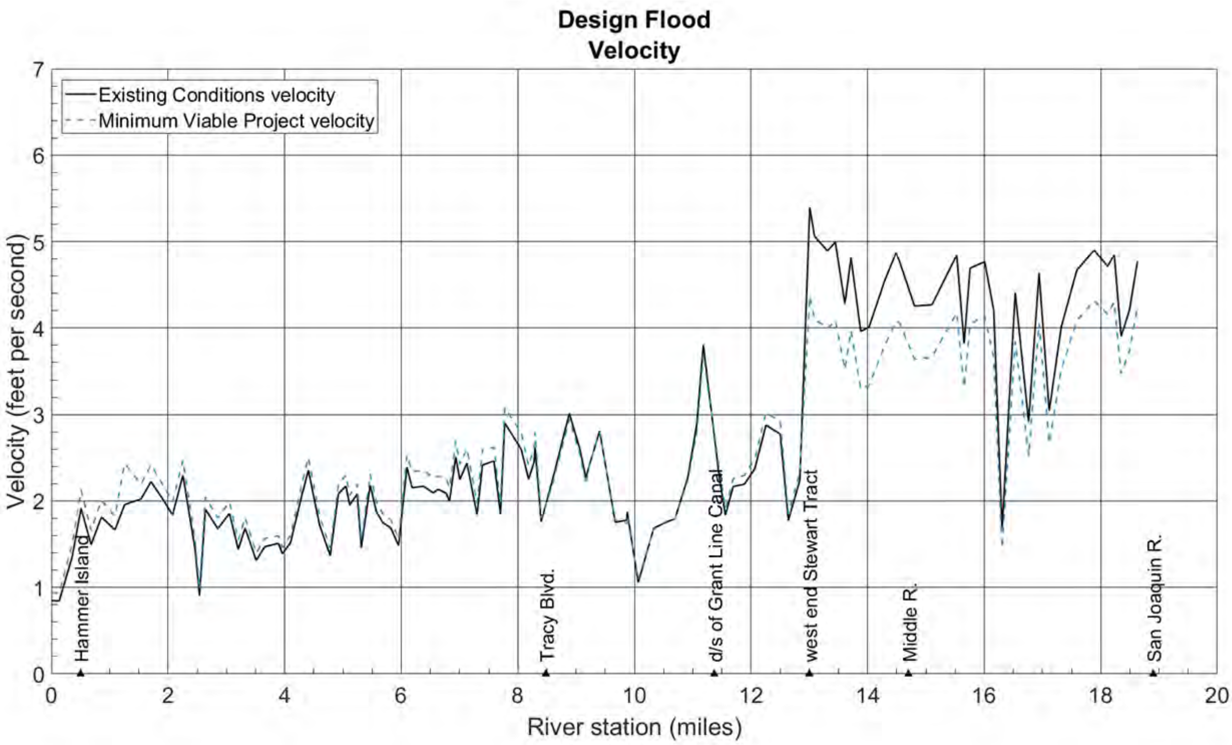


Chart 29: Velocity
Minimum Viable Project vs Existing Conditions
Old River



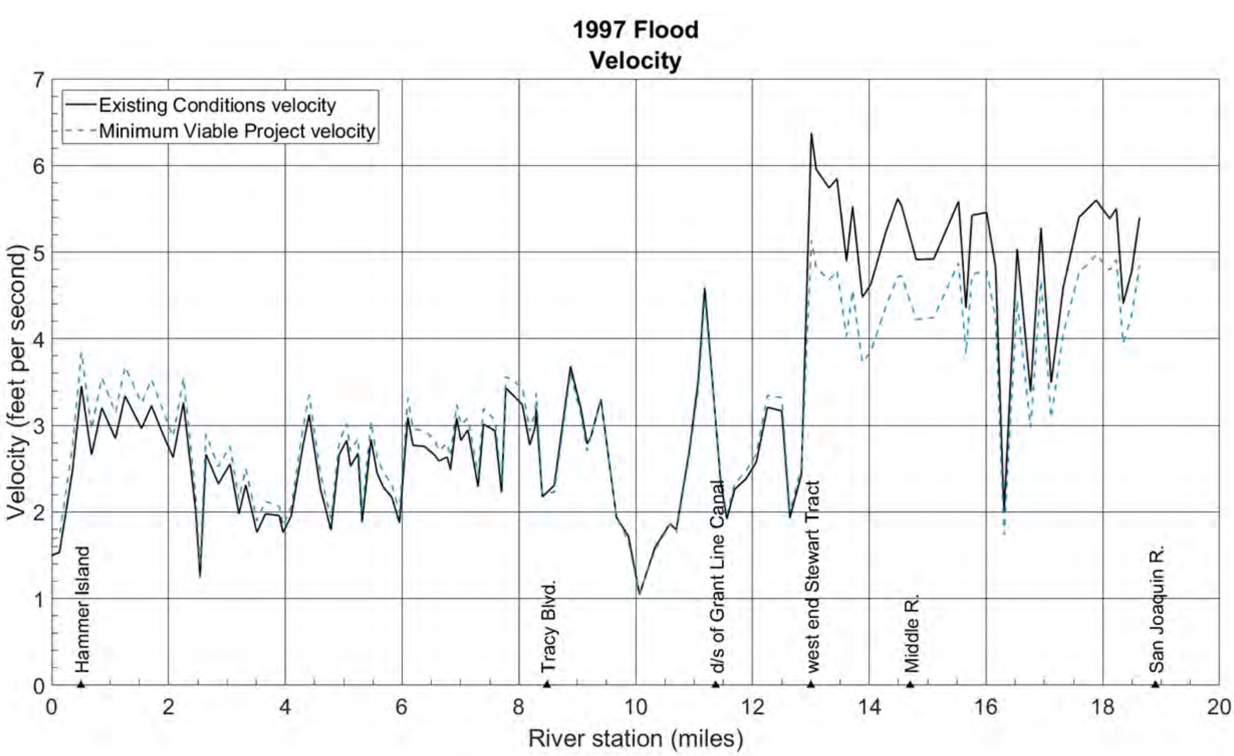
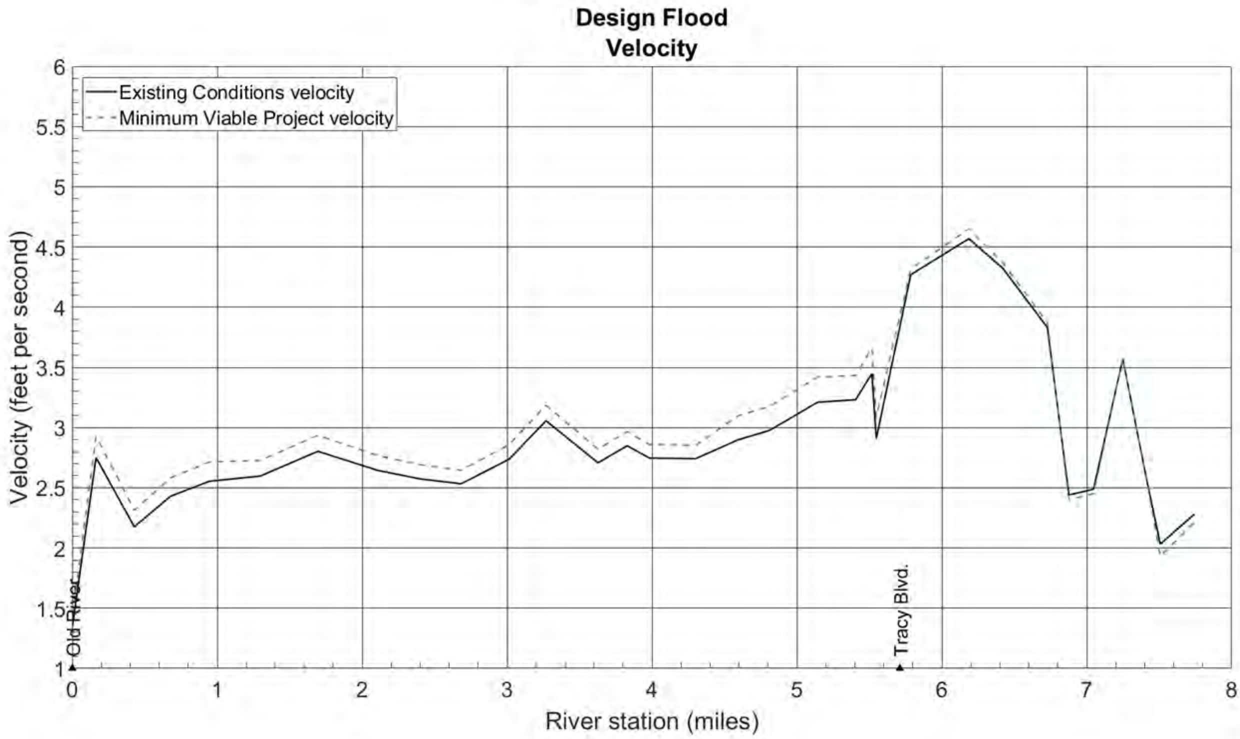
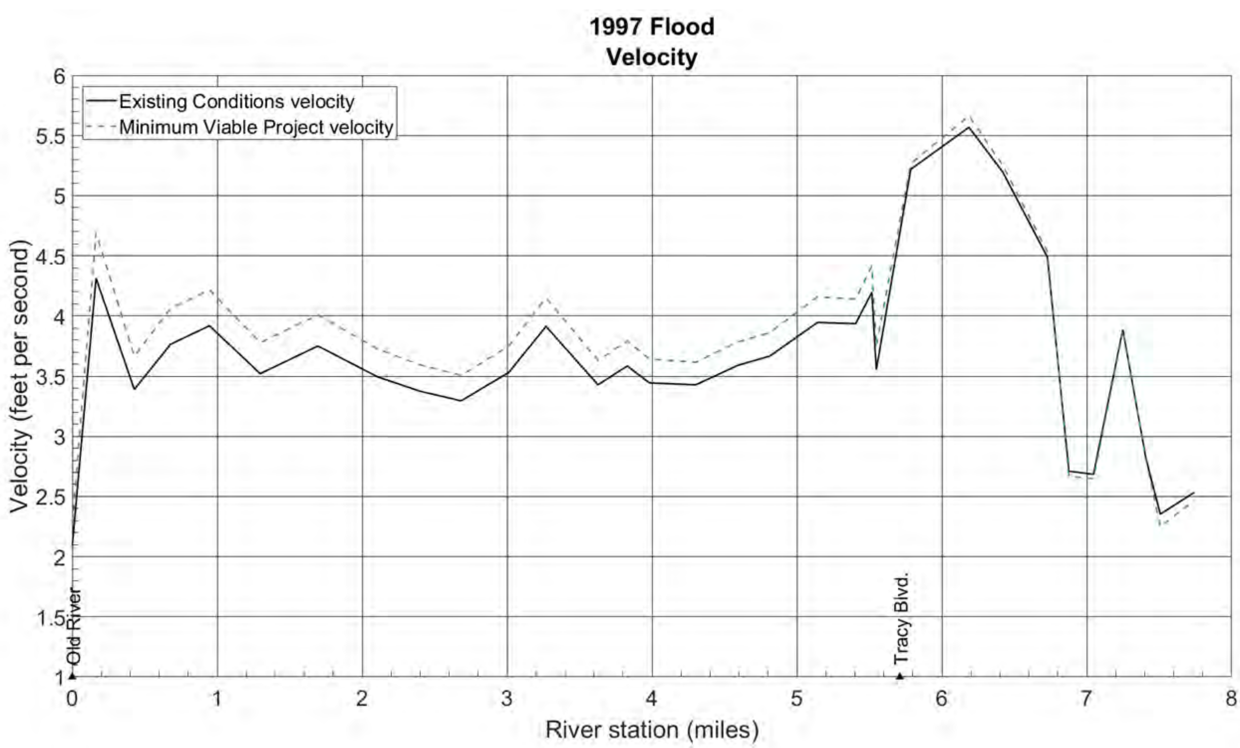


Chart 30: Velocity
Minimum Viable Project vs Existing Conditions
Grant Line Canal





Appendix C: Modeling Table and Additional Charts

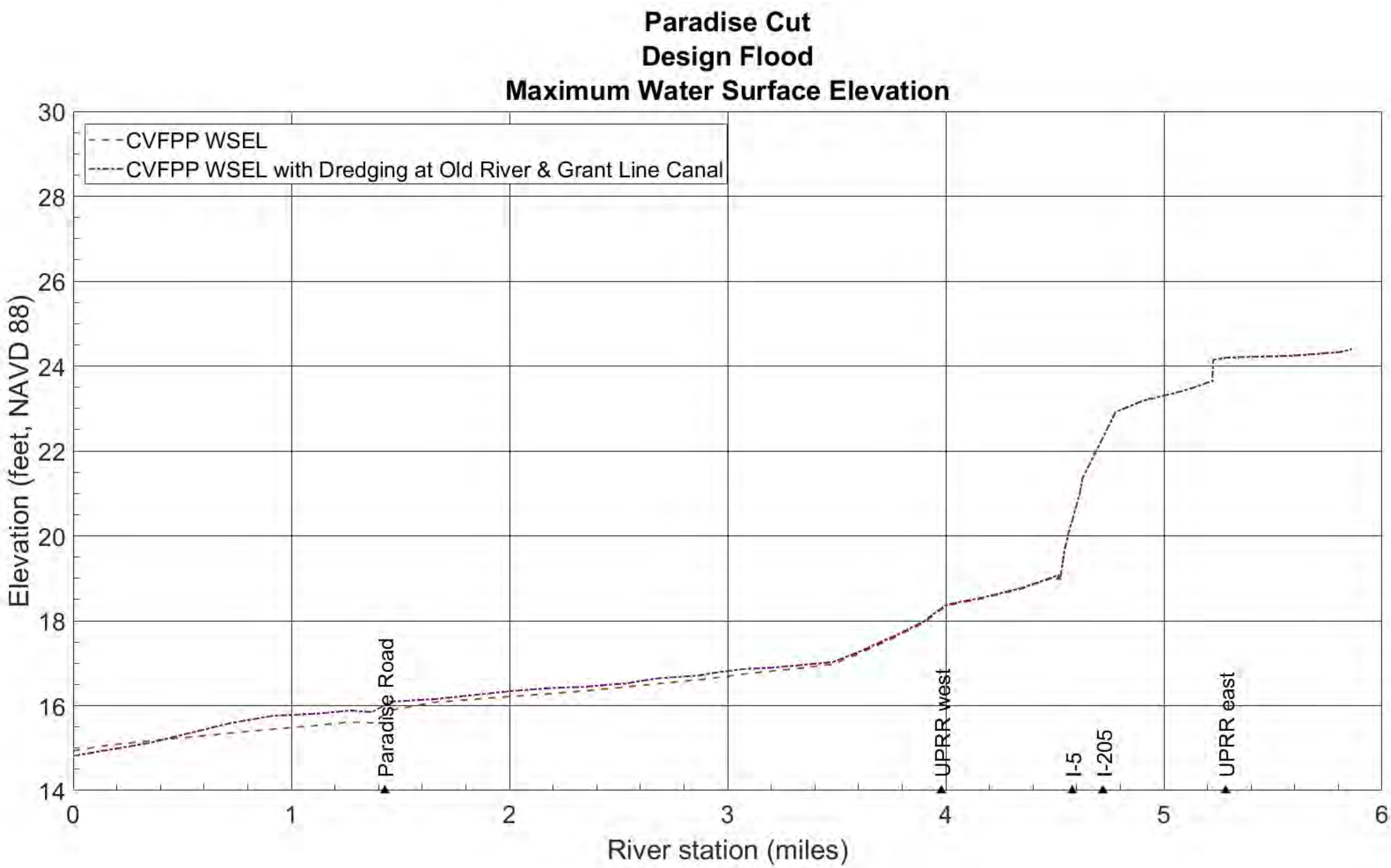
This appendix contains the following:

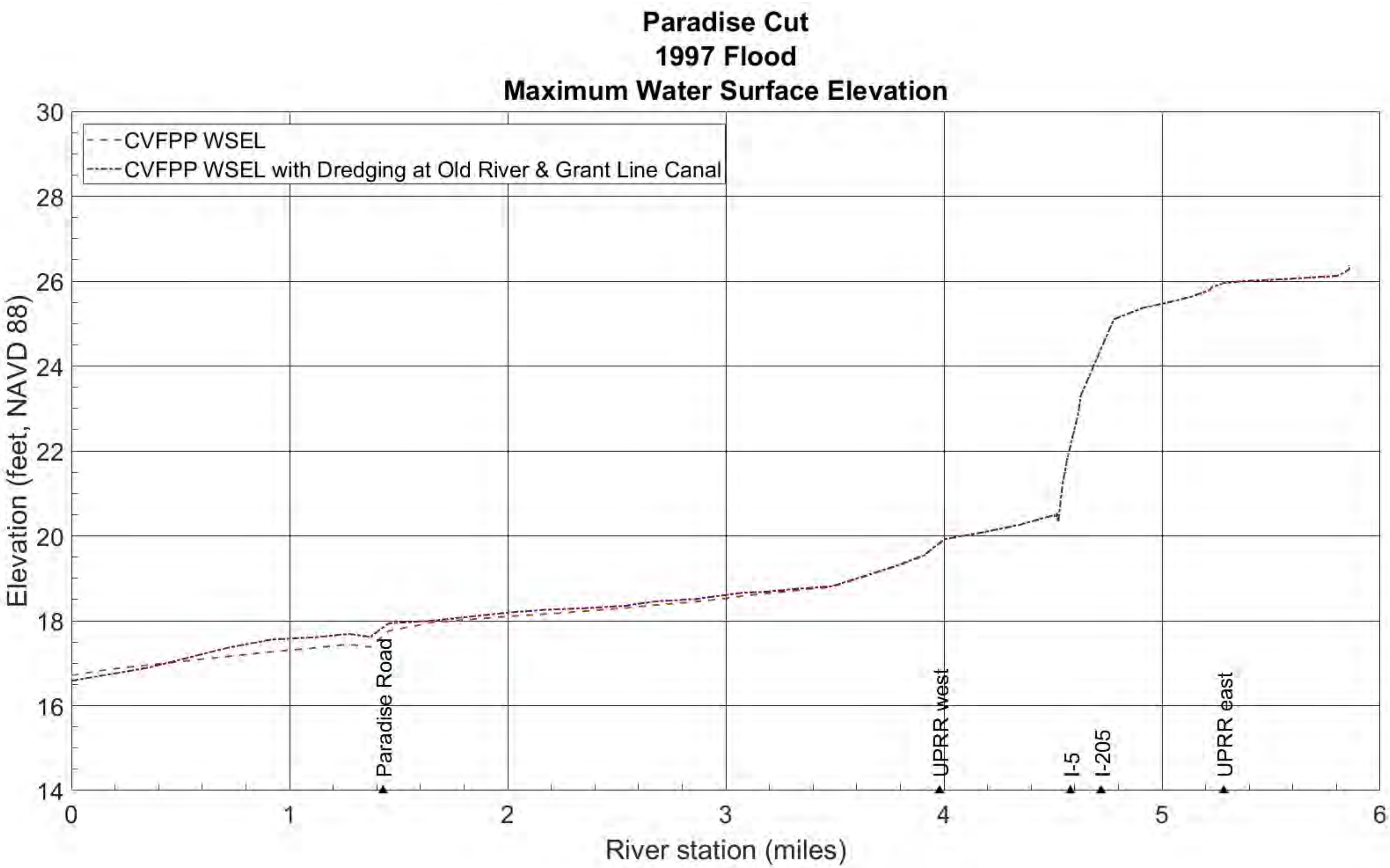
- Model run table
- Model run charts
  - Chart Group 1: CVFPP vs CVFPP with Dredging
  - Chart Group 2: Modified CVFPP vs CVFPP
  - Chart Group 3: MVP vs Modified CVFPP
  - Chart Group 4: Expensive MVP vs MVP
  - Chart Group 5: MVP Velocity
  - Chart Group 6: PMP vs MVP
  - Chart Group 7: MVP vs Crown of Levees

Model Run Table

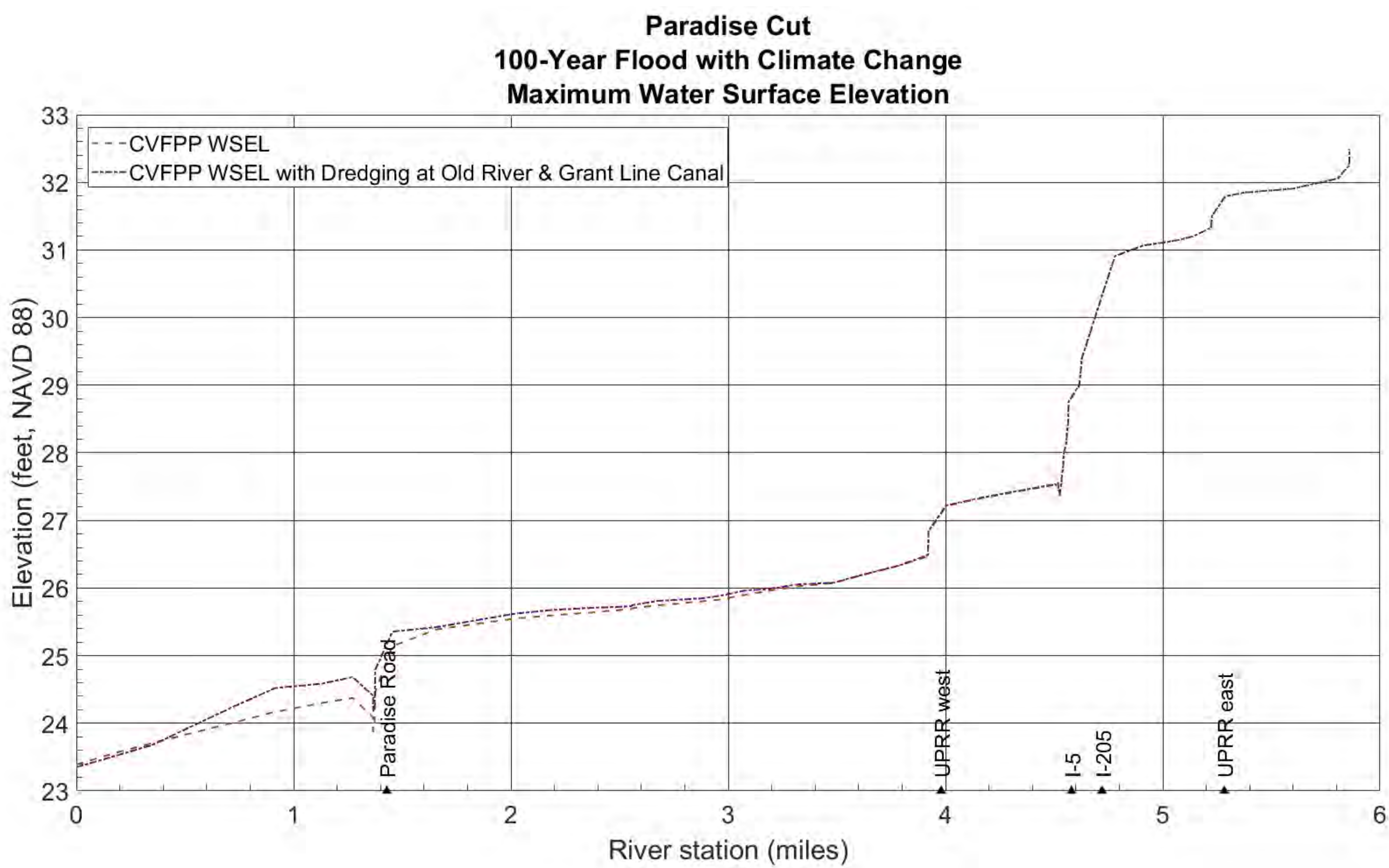
		Weir Widths		Levee Setbacks						Bathymetry	Dredging	Additional Structure Widths		
RunID	Run Name	Paradise Cut Weir	Upper Weir	Addition of River Islands Setback	Levee Setback at Kisst Dairy	Levee Setback at Bend 16	Levee setback, left bank of Pcut downstream of Bend 16	Levee Setback from Upper Weir to UPRR east, left bank, Rkm 93-97	Partial Levee Removal from P-Cut Weir to UPRR east, left bank, km 0-1		Dredge Old River and Grant Line Canal	UPRR East (1)	I-5	UPRR West (2)
Phase 1														
0a	Existing Conditions (extg model bathymetry)	200 ft	---	---	---	---	---	---	---	CVFED	--	None	15 ft	None
0b	Existing Conditions (updated model bathymetry)	200 ft	---	---	---	---	---	---	---	SDWA 2018 & CVFED	--	None	15 ft	None
1	SJR BWFS (Option M-ag)	200 ft	1000 ft	Straight	Yes	Yes	No	Enhance back-levee	No	SDWA 2018 & CVFED	No	500 ft	None	None
2	SJR BWFS (Option M-ag), rev. RI Levee	200 ft	1000 ft	Revised	Yes	Yes	No	Enhance back-levee	No	SDWA 2018 & CVFED	No	500 ft	None	None
3	SJR BWFS (Option M-ag), Realigned Kisst Setback	200 ft	1000 ft	Revised	No	Yes	No	Enhance back-levee	No	SDWA 2018 & CVFED	No	500 ft	None	None
4	SJR BWFS (Option M-ag), No Bend 16 Setback	200 ft	1000 ft	Revised	Yes	No	No	Enhance back-levee	No	SDWA 2018 & CVFED	No	500 ft	None	None
5	SJR BWFS (Option M-ag), Dredging @ Old River/Grant Line	200 ft	1000 ft	Revised	Yes	Yes	No	Enhance back-levee	No	SDWA 2018 & CVFED	Yes	500 ft	None	None
6	SJR BWFS (Option M-ag), cumulative runs 2-5	200 ft	1000 ft	Revised	No	No	No	Enhance back-levee	No	SDWA 2018 & CVFED	Yes	500 ft	None	None
Phase 2														
A	Phase 1 Scenario 6 without setback levee south of Deuel	200 ft	1000 ft	Revised	No	No	No	Enhance; None US of Deuel	No	SDWA 2018 & CVFED	Yes	500 ft	None	None
B1	Phase 1 Scenario 6 with UPRR East opening width reduced from 500 ft to 250 ft	200 ft	1000 ft	Revised	No	No	No	Enhance back-levee	No	SDWA 2018 & CVFED	Yes	250 ft	None	None
B2	Phase 2 Scenario A with UPRR East opening width reduced from 500 ft to 250 ft	200 ft	1000 ft	Revised	No	No	No	Enhance; none US of Deuel	No	SDWA 2018 & CVFED	Yes	250 ft	None	None
C1	Phase 1 Scenario 6 with upper weir width increased from 1000 ft to 2000 ft	200 ft	2000 ft	Revised	No	No	No	Enhance back-levee	No	SDWA 2018 & CVFED	Yes	500 ft	None	None
C2	Phase 2 Scenario A with upper weir width increased from 1000 ft to 2000 ft	200 ft	2000 ft	Revised	No	No	No	Enhance; None US of Deuel	No	SDWA 2018 & CVFED	Yes	500 ft	None	None
C3	Phase 2 Scenario B1 with upper weir width increased from 1000 ft to 2000 ft	200 ft	2000 ft	Revised	No	No	No	Enhance back-levee	No	SDWA 2018 & CVFED	Yes	250 ft	None	None
C4	Phase 2 Scenario B2 with upper weir width increased from 1000 ft to 2000 ft	200 ft	2000 ft	Revised	No	No	No	Enhance; None US of Deuel	No	SDWA 2018 & CVFED	Yes	250 ft	None	None
D1	Modify RR and Hwy Crossings cumulatively (500ft)	200 ft	2000 ft	Revised	No	No	No	Enhance back-levee	No	SDWA 2018 & CVFED	Yes	500 ft	500 ft	500 ft
D2	Modify RR and Hwy Crossings cumulatively (500ft)	200 ft	2000 ft	Revised	No	No	No	Enhance; None US of Deuel	No	SDWA 2018 & CVFED	Yes	500 ft	500 ft	500 ft
E	Setback levee at Kisst Dairy (Option M-ag configuration)	200 ft	2000 ft	Revised	Yes	No	No	Enhance; None US of Deuel	No	SDWA 2018 & CVFED	Yes	500 ft	500 ft	500 ft
F	Setback levee at Bend 16 (Option M-ag configuration)	200 ft	2000 ft	Revised	Yes	Yes	Yes	Enhance; None US of Deuel	No	SDWA 2018 & CVFED	Yes	500 ft	500 ft	500 ft
G	Setback levee on left bank downstream of Bend 16	200 ft	2000 ft	Revised	Yes	Yes	Yes	Enhance; None US of Deuel	No	SDWA 2018 & CVFED	Yes	500 ft	500 ft	500 ft
E through G	Combines D2 plus E through G (MPP)	200 ft	2000 ft	Revised	Yes	Yes	Yes	Enhance; None US of Deuel	No	SDWA 2018 & CVFED	Yes	500 ft	500 ft	500 ft
Final configuration														
MVP	Minimum Viable project	200 ft	1000 ft	Revised	No	No	No	Enhance; none US of Deuel	No	SDWA 2018 & CVFED	Yes	250 ft	None	None
MPP	Maximum Project potential	200 ft	2000 ft	Revised	Yes	Yes	Yes	Enhance; None US of Deuel	No	SDWA 2018 & CVFED	Yes	500 ft	500 ft	500 ft

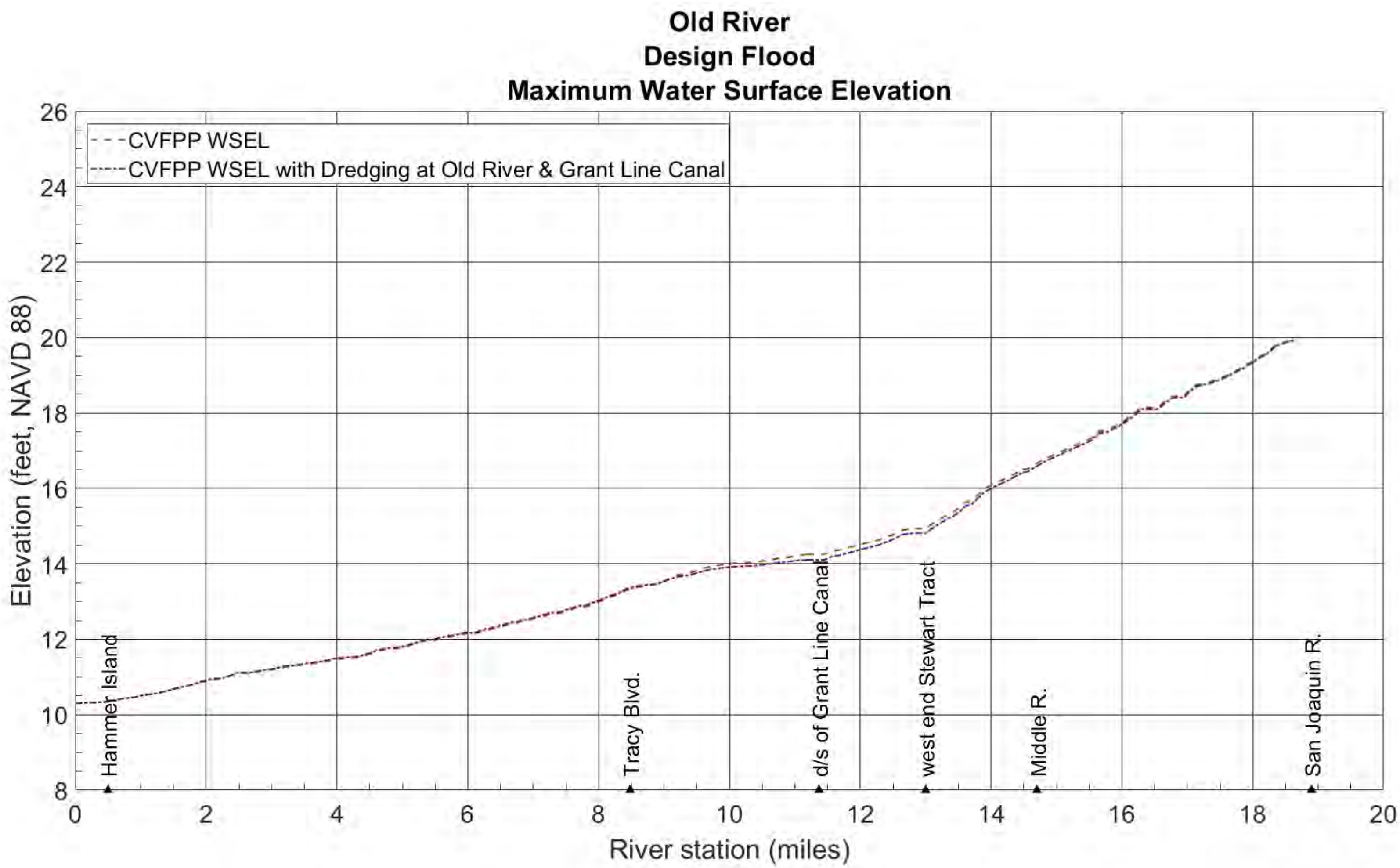
Chart Group 1a
CVFPP vs CVFPP with Dredging
water surface elevations


Paradise Cut
Design Flood
Maximum Water Surface Elevation
CVFPP WSEL
CVFPP WSEL with Dredging at Old River & Grant Line Canal
Elevation (feet, NAVD 88)
River station (miles)
Paradise Road
UPRR west
I-5
I-205
UPRR east
30
28
26
24
22
20
18
16
14
0
1
2
3
4
5
6

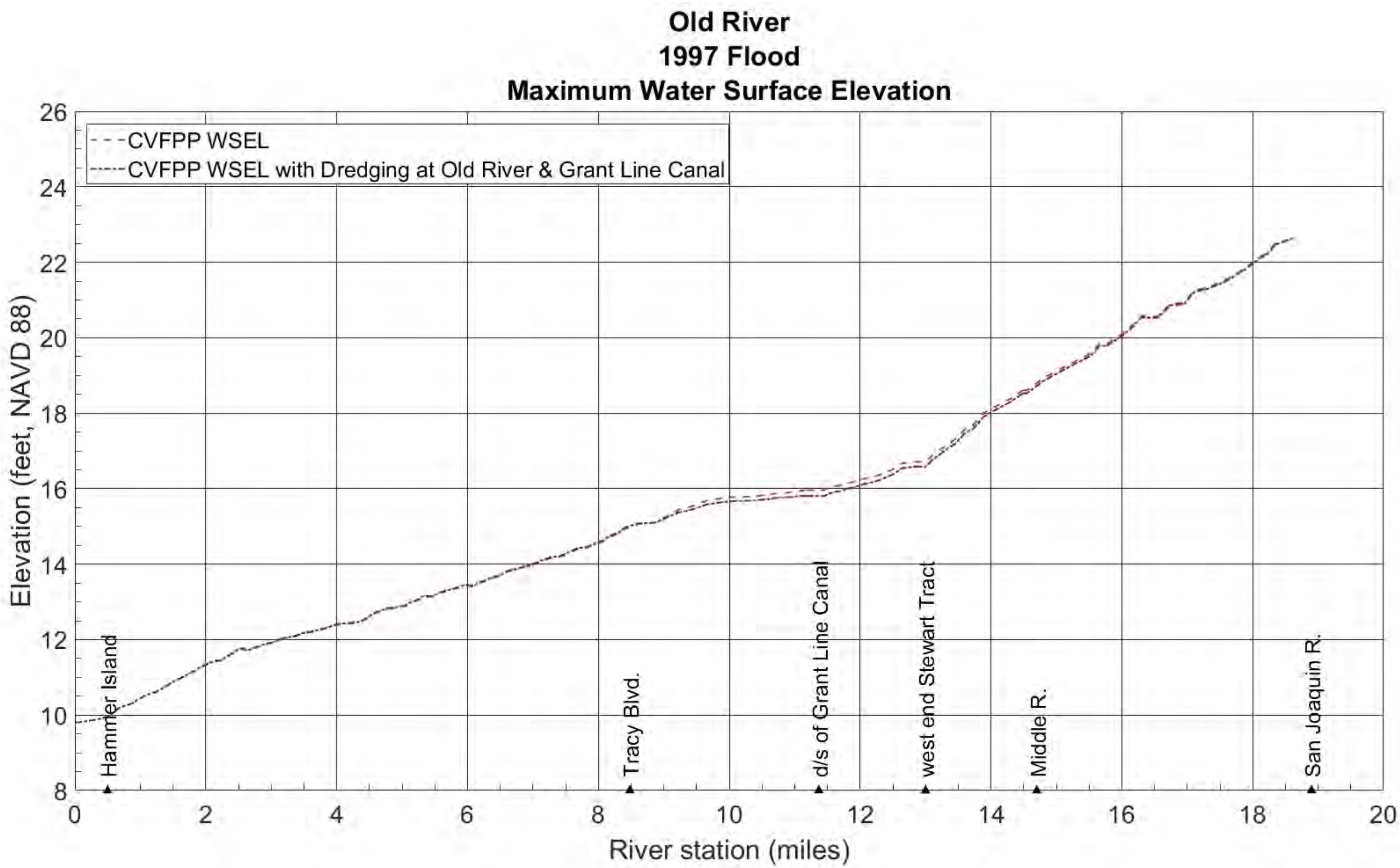


Paradise Cut
1997 Flood
Maximum Water Surface Elevation
CVFPP WSEL
CVFPP WSEL with Dredging at Old River & Grant Line Canal
Elevation (feet, NAVD 88)
30
28
26
24
22
20
18
16
14
Paradise Road
UPRR west
I-5
I-205
UPRR east
0
1
2
3
4
5
6
River station (miles)

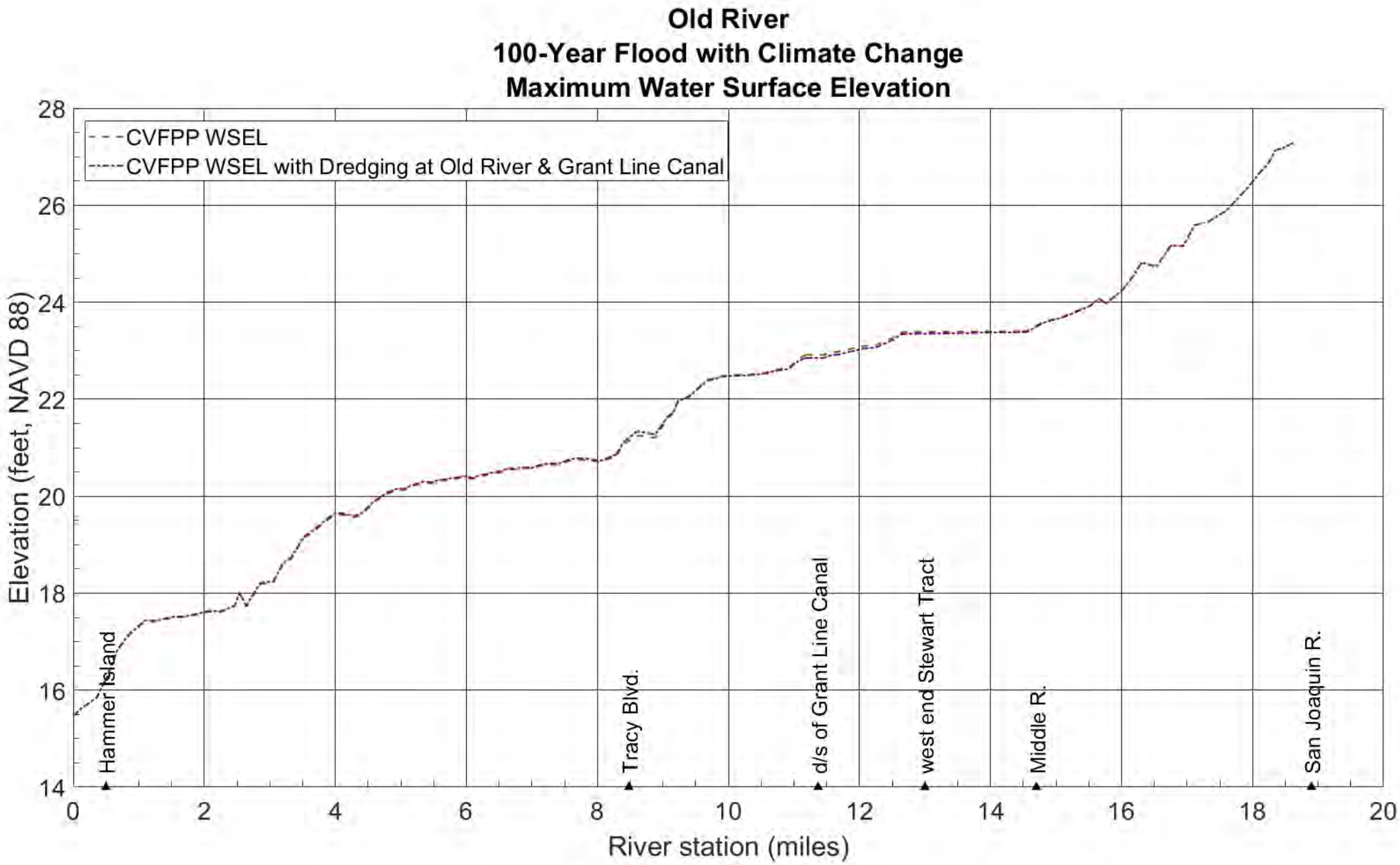

Paradise Cut
100-Year Flood with Climate Change
Maximum Water Surface Elevation
CVFPP WSEL
CVFPP WSEL with Dredging at Old River & Grant Line Canal
Elevation (feet, NAVD 88)
River station (miles)
Paradise Road
UPRR west
I-5
I-205
UPRR east
33
32
31
30
29
28
27
26
25
24
23
0
1
2
3
4
5
6

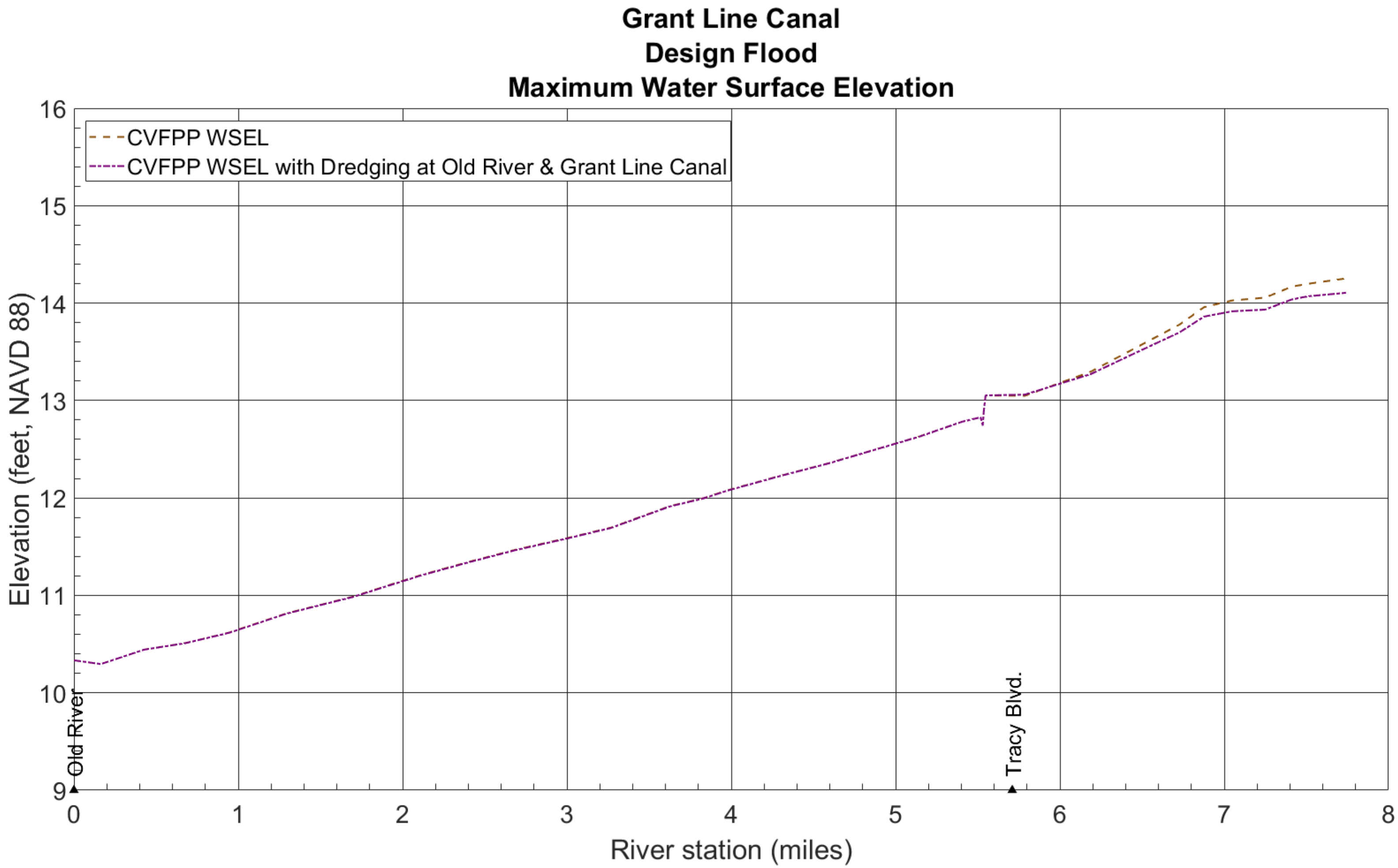


Old River
Design Flood
Maximum Water Surface Elevation
CVFPP WSEL
CVFPP WSEL with Dredging at Old River & Grant Line Canal
Elevation (feet, NAVD 88)
River station (miles)
Hammer Island
Tracy Blvd.
d/s of Grant Line Canal
west end Stewart Tract
Middle R.
San Joaquin R.
8
10
12
14
16
18
20
22
24
26
0
2
4
6
8
10
12
14
16
18
20

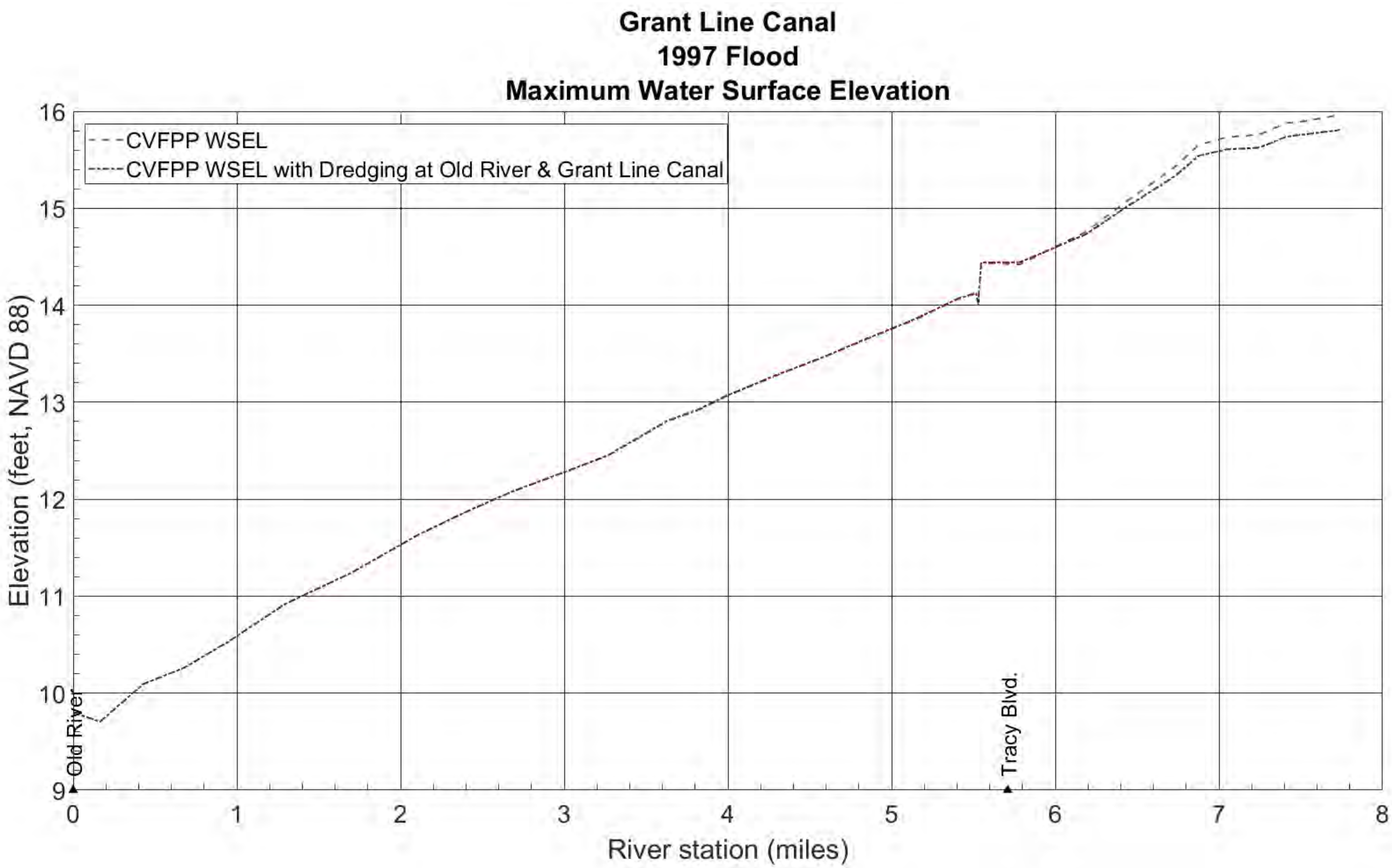


Old River
1997 Flood
Maximum Water Surface Elevation
CVFPP WSEL
CVFPP WSEL with Dredging at Old River & Grant Line Canal
Elevation (feet, NAVD 88)
River station (miles)
26
24
22
20
18
16
14
12
10
8
0
2
4
6
8
10
12
14
16
18
20
Hammer Island
Tracy Blvd.
d/s of Grant Line Canal
west end Stewart Tract
Middle R.
San Joaquin R.


Old River
100-Year Flood with Climate Change
Maximum Water Surface Elevation
CVFPP WSEL
CVFPP WSEL with Dredging at Old River & Grant Line Canal
Elevation (feet, NAVD 88)
River station (miles)
Hammer Island
Tracy Blvd.
d/s of Grant Line Canal
west end Stewart Tract
Middle R.
San Joaquin R.
14
16
18
20
22
24
26
28
0
2
4
6
8
10
12
14
16
18
20



Grant Line Canal
Design Flood
Maximum Water Surface Elevation
CVFPP WSEL
CVFPP WSEL with Dredging at Old River & Grant Line Canal
Elevation (feet, NAVD 88)
16
15
14
13
12
11
10
9
0
1
2
3
4
5
6
7
8
River station (miles)
Old River
Tracy Blvd.


Grant Line Canal
1997 Flood
Maximum Water Surface Elevation
CVFPP WSEL
CVFPP WSEL with Dredging at Old River & Grant Line Canal
Elevation (feet, NAVD 88)
River station (miles)
Old River
Tracy Blvd.
16
15
14
13
12
11
10
9
0
1
2
3
4
5
6
7
8

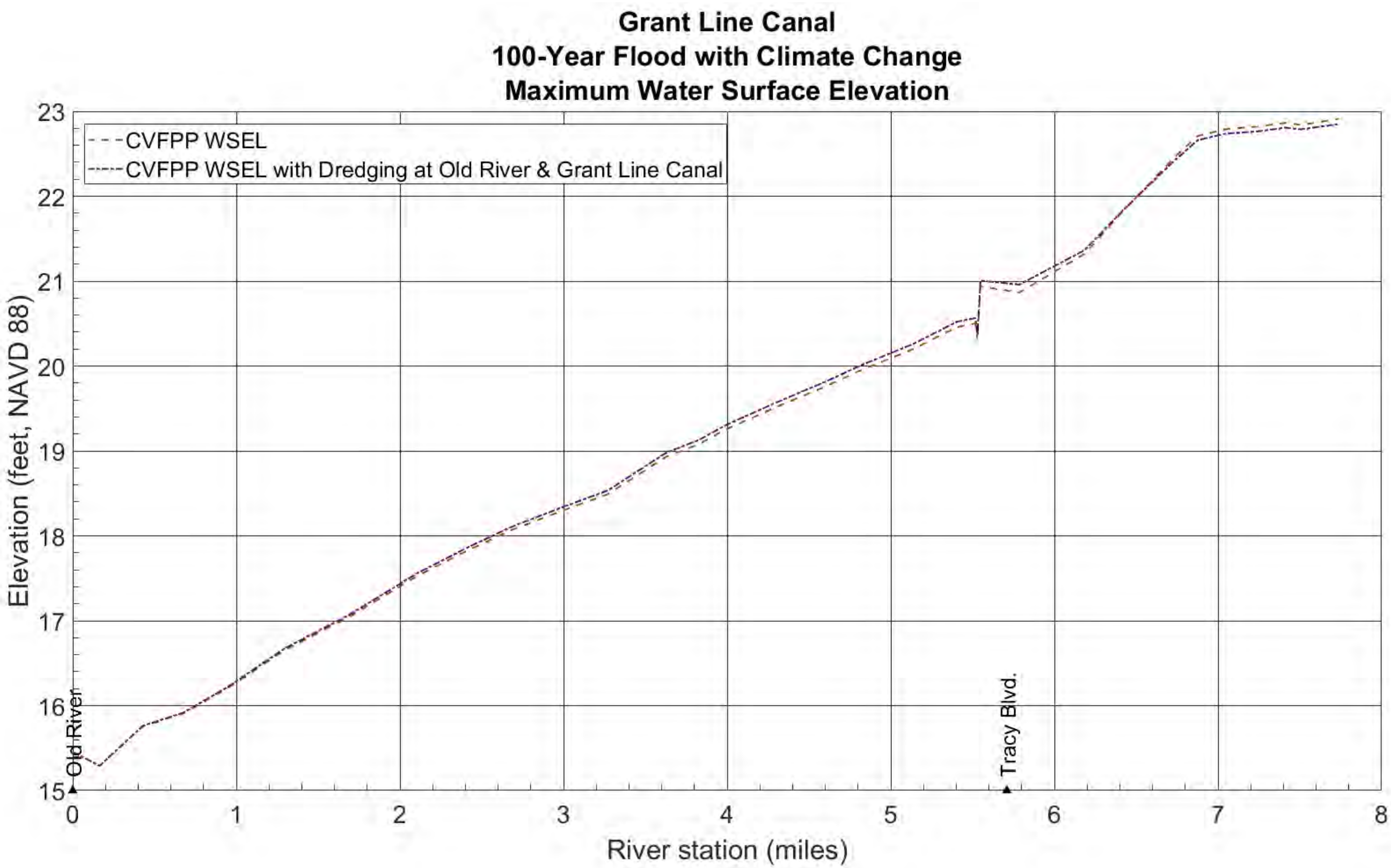
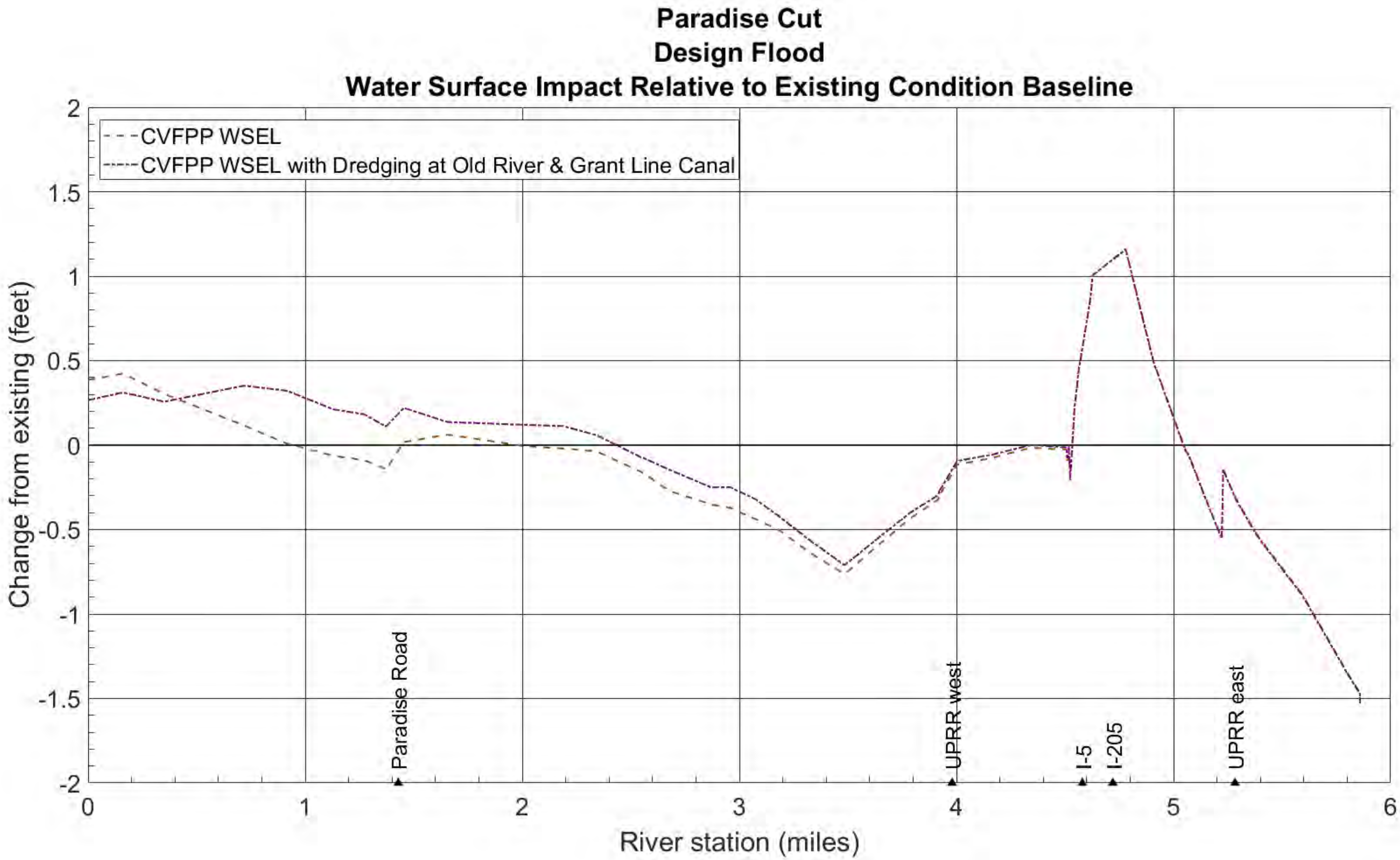
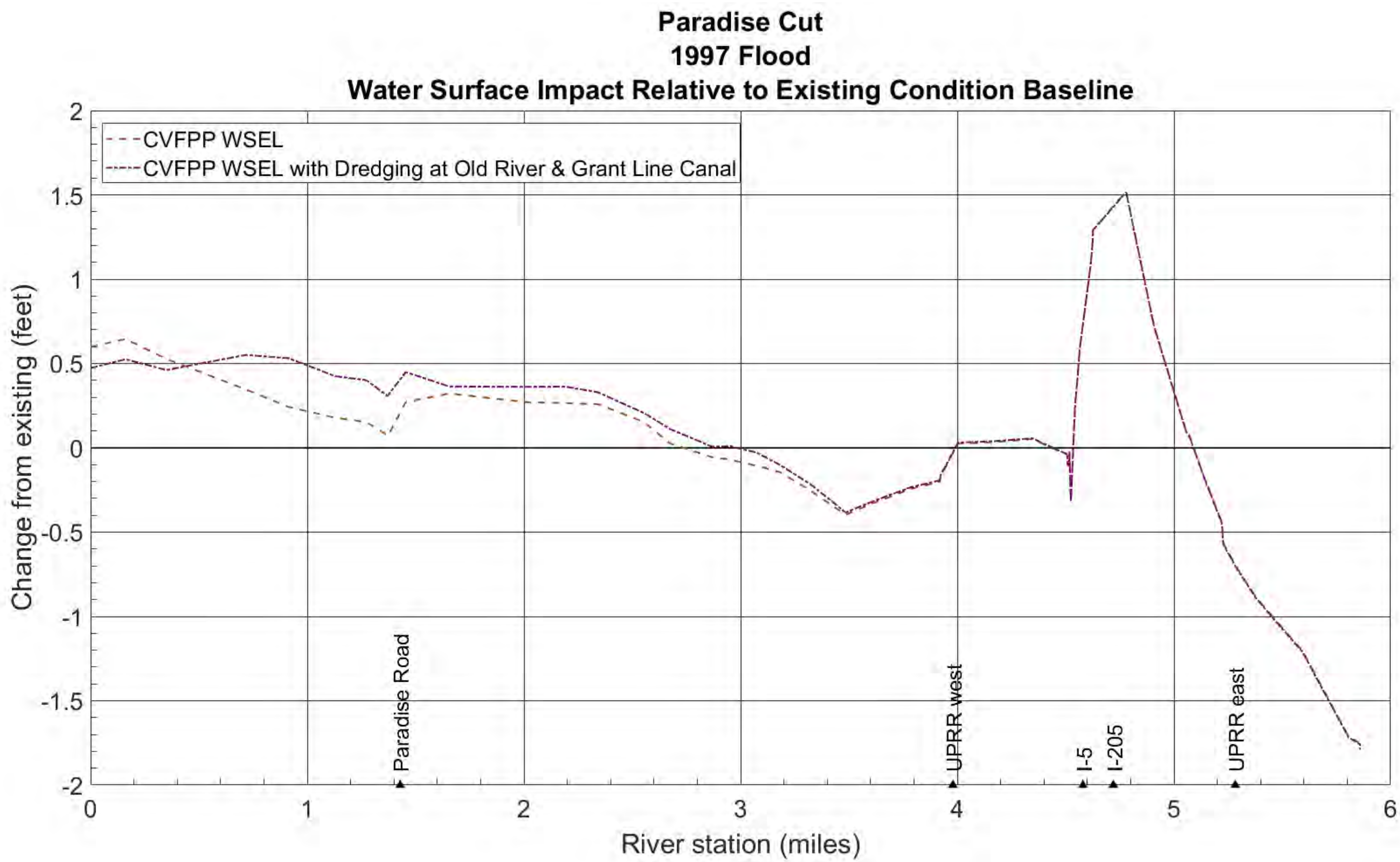

Grant Line Canal
100-Year Flood with Climate Change
Maximum Water Surface Elevation
CVFPP WSEL
CVFPP WSEL with Dredging at Old River & Grant Line Canal
Elevation (feet, NAVD 88)
River station (miles)
Old River
Tracy Blvd.
23
22
21
20
19
18
17
16
15
0
1
2
3
4
5
6
7
8

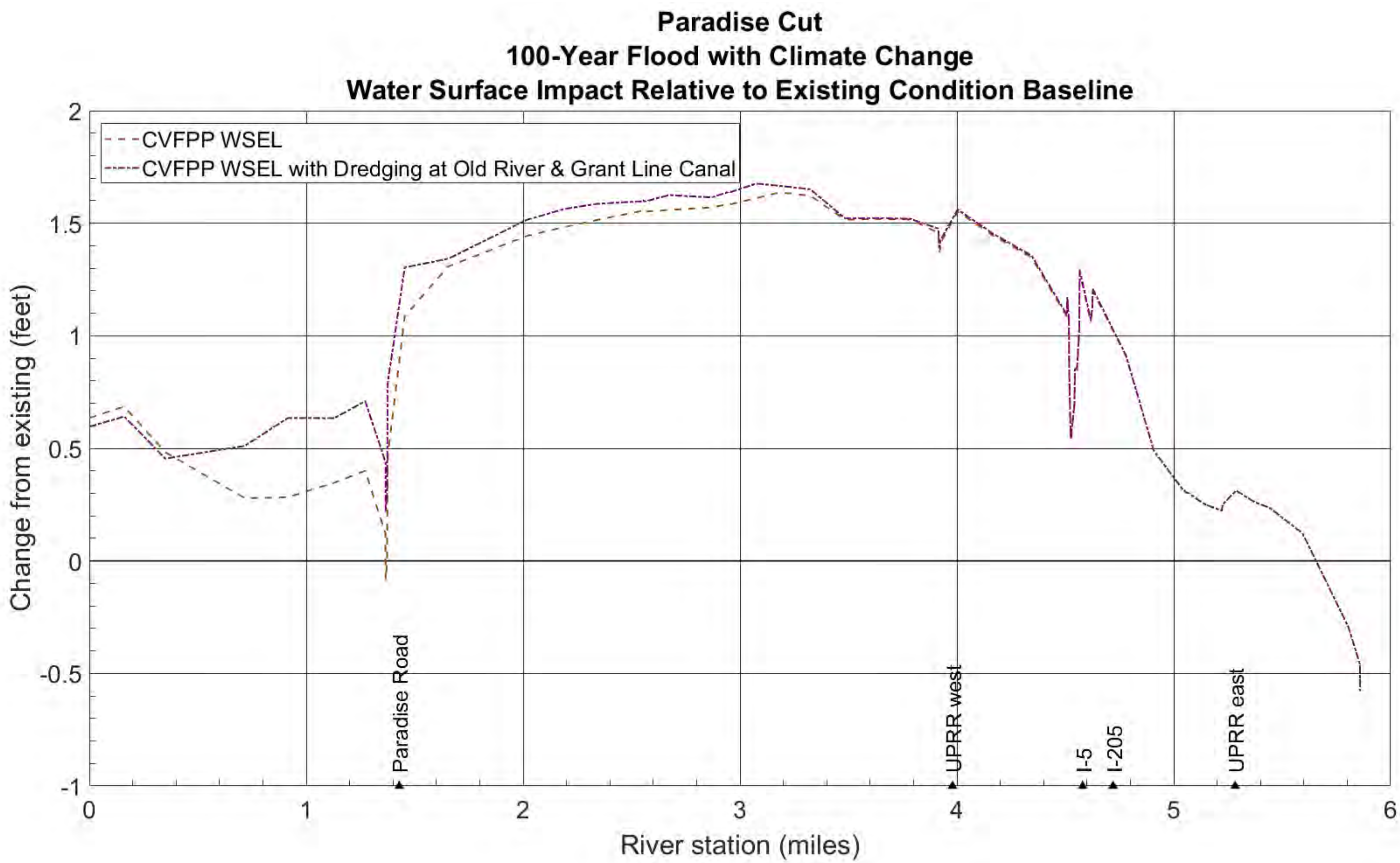
Chart Group 1b
CVFPP vs CVFPP with Dredging
relative difference

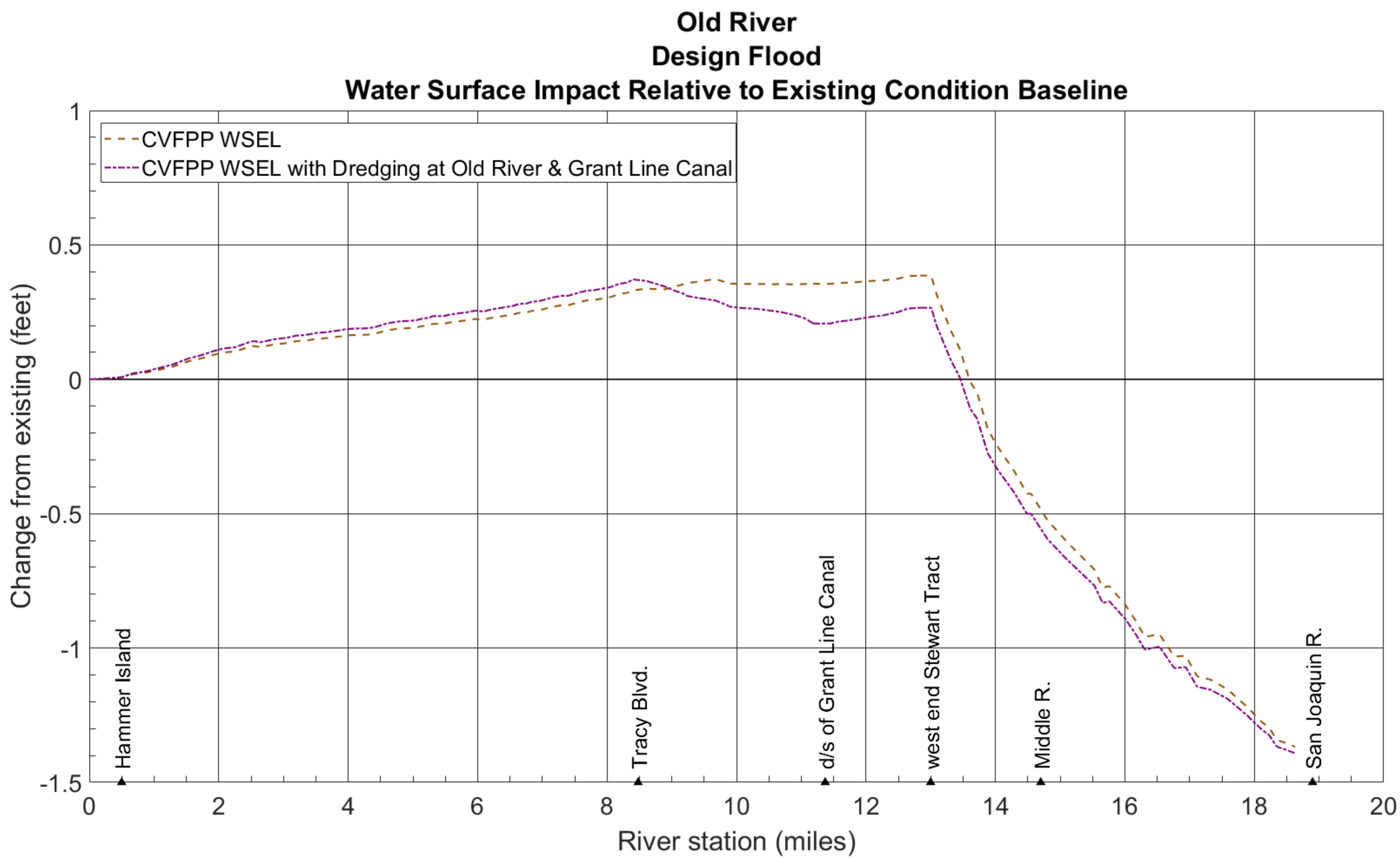


Paradise Cut
Design Flood
Water Surface Impact Relative to Existing Condition Baseline
CVFPP WSEL
CVFPP WSEL with Dredging at Old River & Grant Line Canal
Change from existing (feet)
River station (miles)
Paradise Road
UPRR west
I-5
I-205
UPRR east
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
0
1
2
3
4
5
6



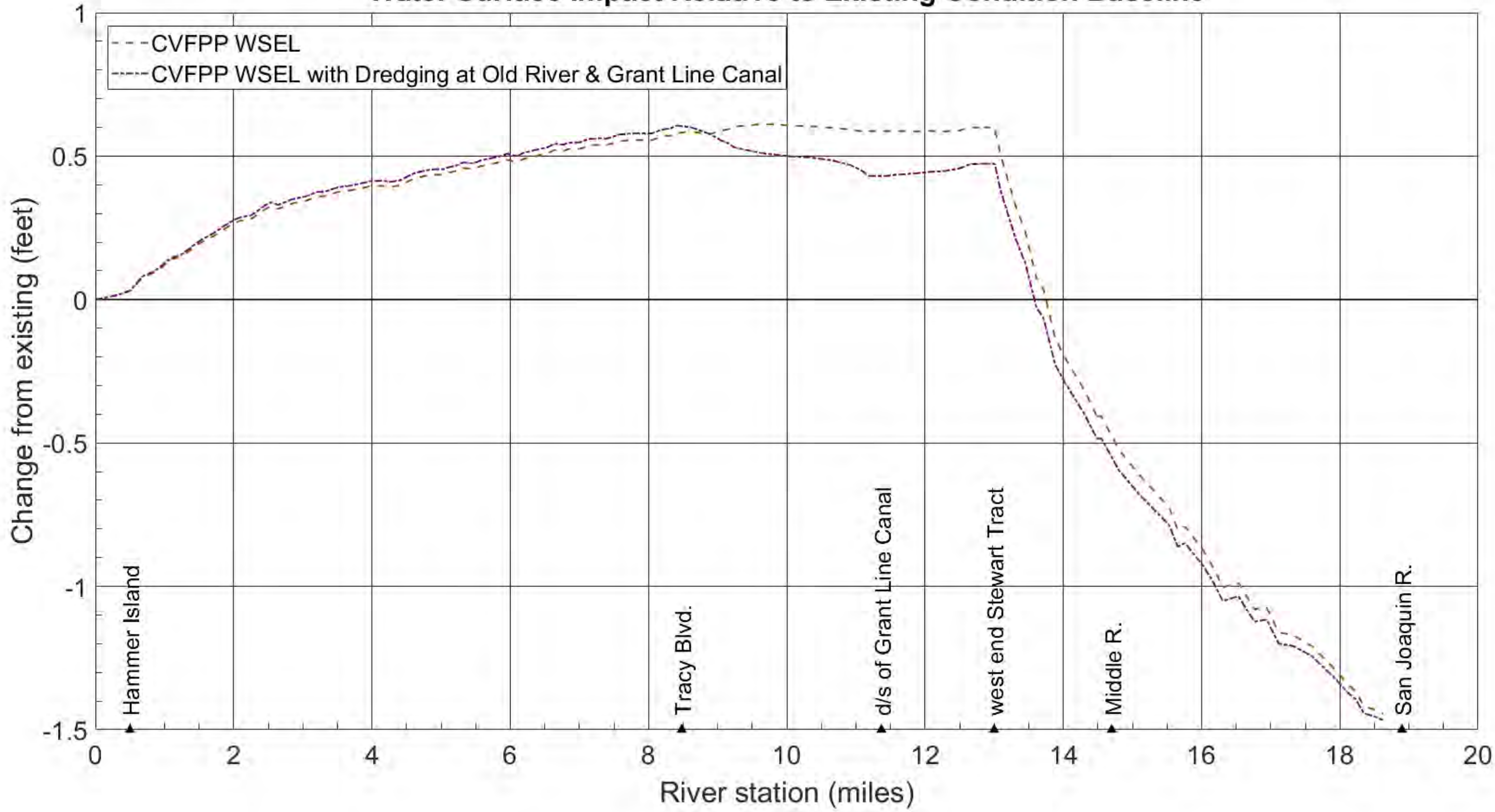
Paradise Cut
1997 Flood
Water Surface Impact Relative to Existing Condition Baseline
CVFPP WSEL
CVFPP WSEL with Dredging at Old River & Grant Line Canal
Change from existing (feet)
River station (miles)
Paradise Road
UPRR west
I-5
I-205
UPRR east
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
0
1
2
3
4
5
6

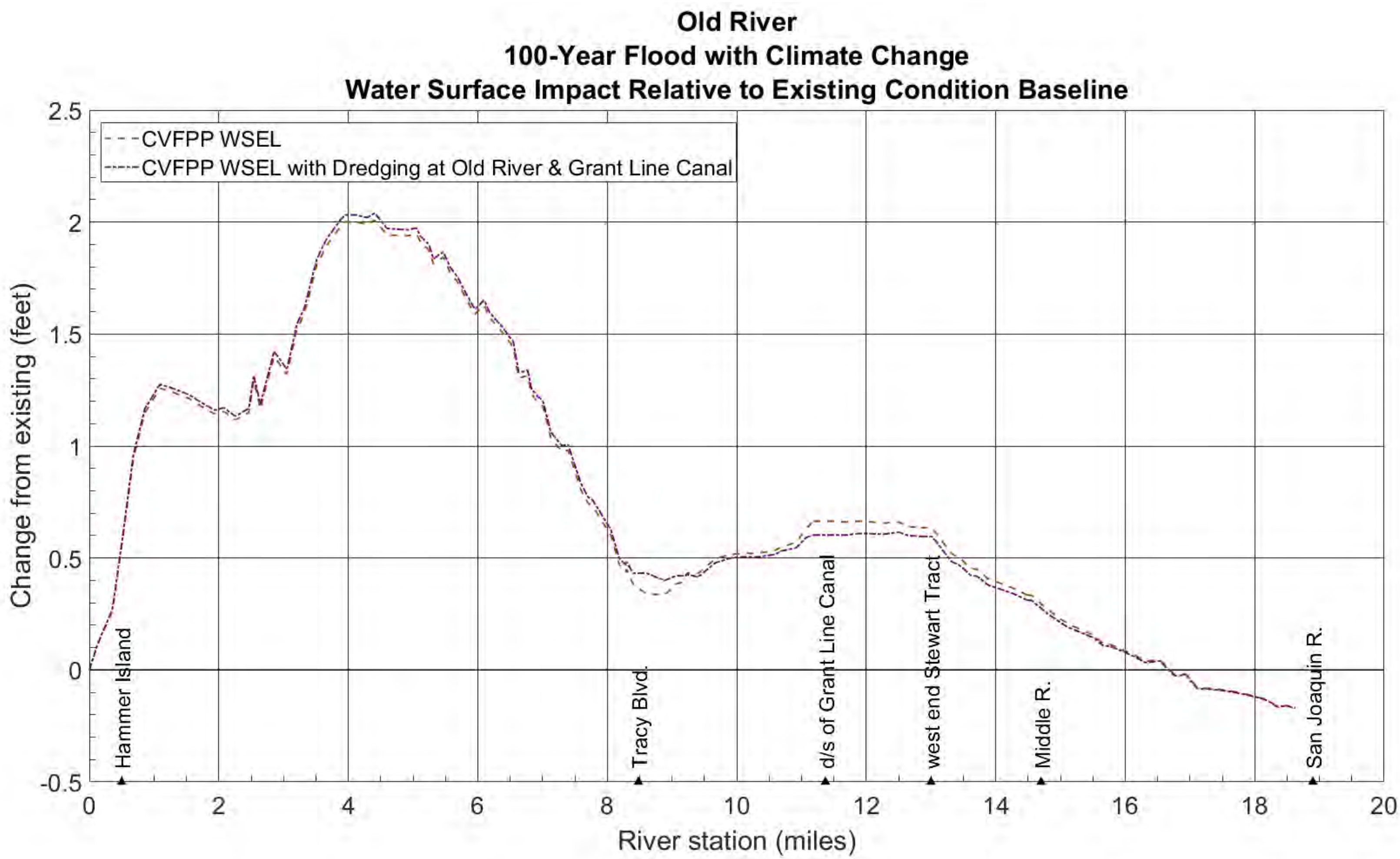

Paradise Cut
100-Year Flood with Climate Change
Water Surface Impact Relative to Existing Condition Baseline
CVFPP WSEL
CVFPP WSEL with Dredging at Old River & Grant Line Canal
Change from existing (feet)
2
1.5
1
0.5
0
-0.5
-1
Paradise Road
UPRR west
I-5
I-205
UPRR east
0
1
2
3
4
5
6
River station (miles)

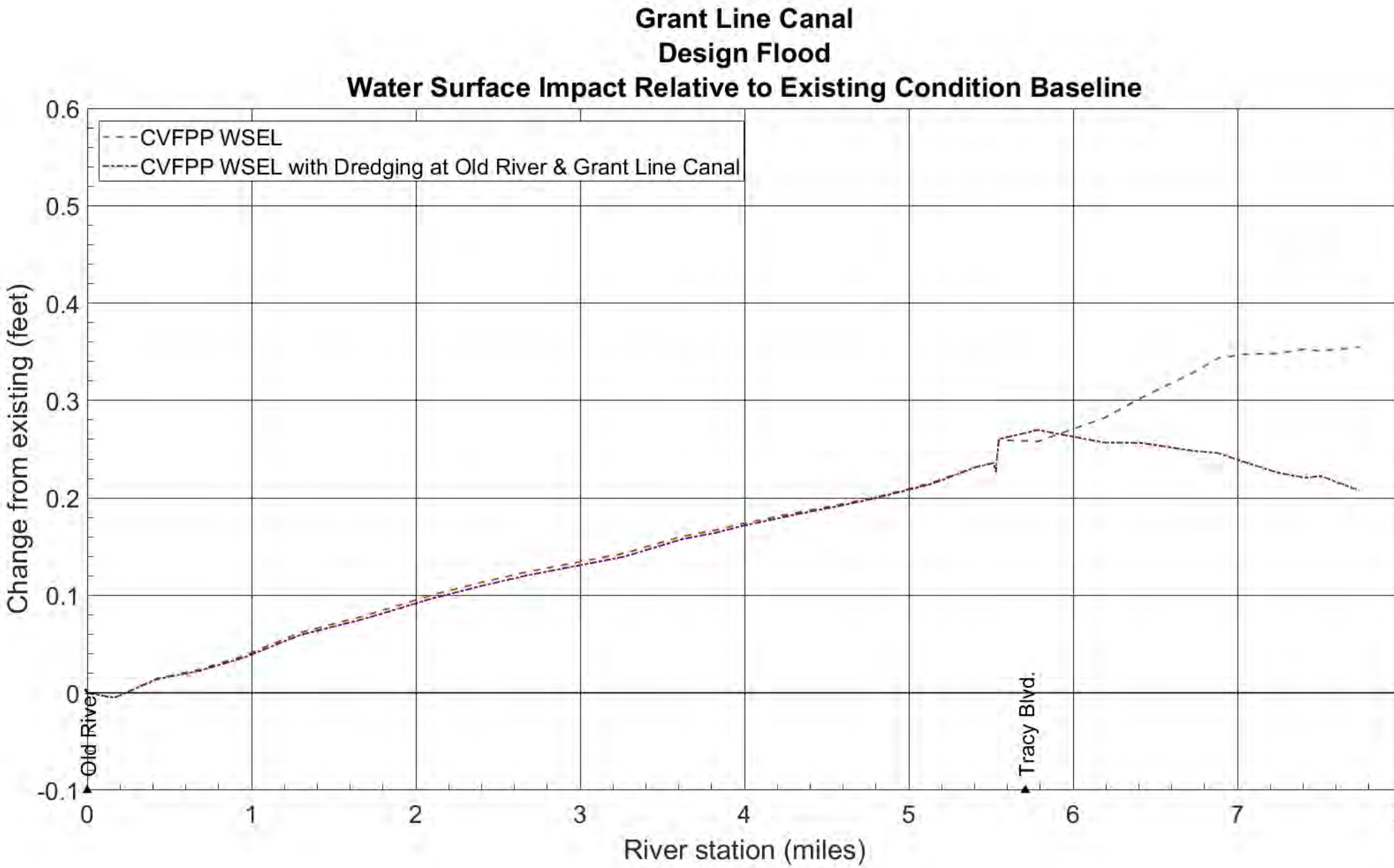


Old River
Design Flood
Water Surface Impact Relative to Existing Condition Baseline
CVFPP WSEL
CVFPP WSEL with Dredging at Old River & Grant Line Canal
Change from existing (feet)
River station (miles)
Hammer Island
Tracy Blvd.
d/s of Grant Line Canal
west end Stewart Tract
Middle R.
San Joaquin R.
1
0.5
0
-0.5
-1
-1.5
0
2
4
6
8
10
12
14
16
18
20

Old River
1997 Flood
Water Surface Impact Relative to Existing Condition Baseline

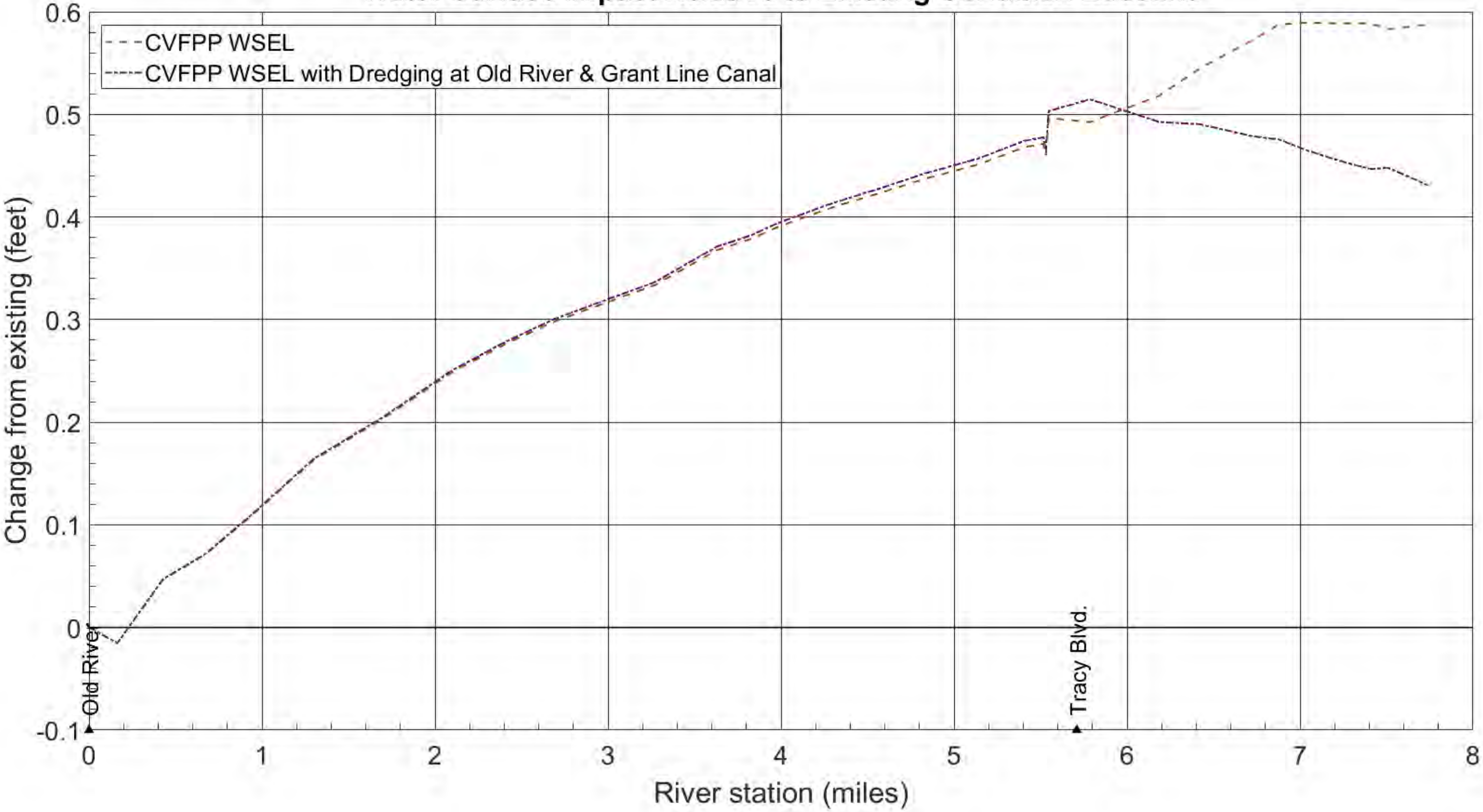



Old River
100-Year Flood with Climate Change
Water Surface Impact Relative to Existing Condition Baseline
CVFPP WSEL
CVFPP WSEL with Dredging at Old River & Grant Line Canal
Change from existing (feet)
River station (miles)
Hammer Island
Tracy Blvd.
d/s of Grant Line Canal
west end Stewart Tract
Middle R.
San Joaquin R.
2.5
2
1.5
1
0.5
0
-0.5
0
2
4
6
8
10
12
14
16
18
20



Grant Line Canal
Design Flood
Water Surface Impact Relative to Existing Condition Baseline
CVFPP WSEL
CVFPP WSEL with Dredging at Old River & Grant Line Canal
Change from existing (feet)
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
0
1
2
3
4
5
6
7
8
River station (miles)
Old River
Tracy Blvd.

Grant Line Canal
1997 Flood
Water Surface Impact Relative to Existing Condition Baseline



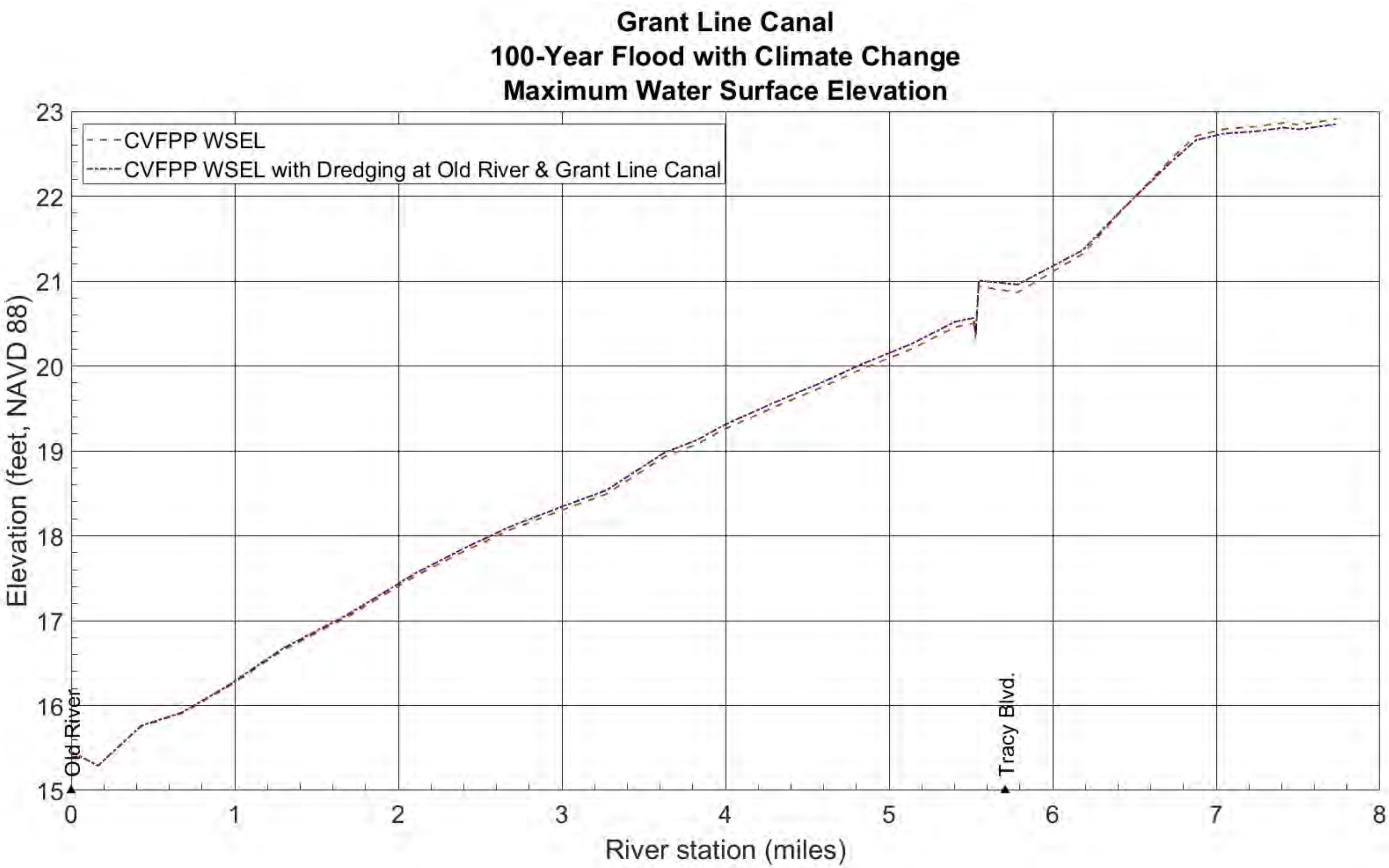
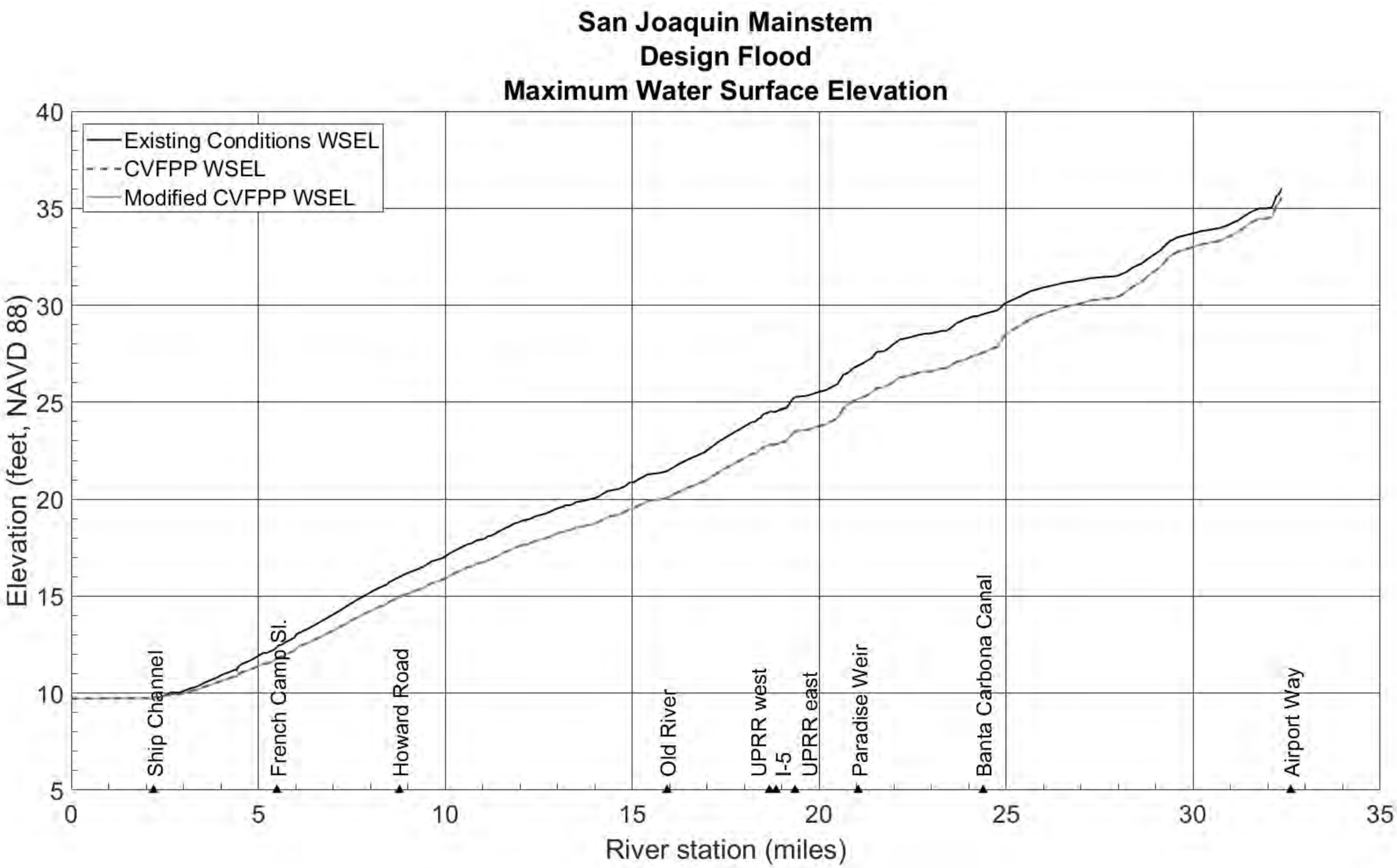
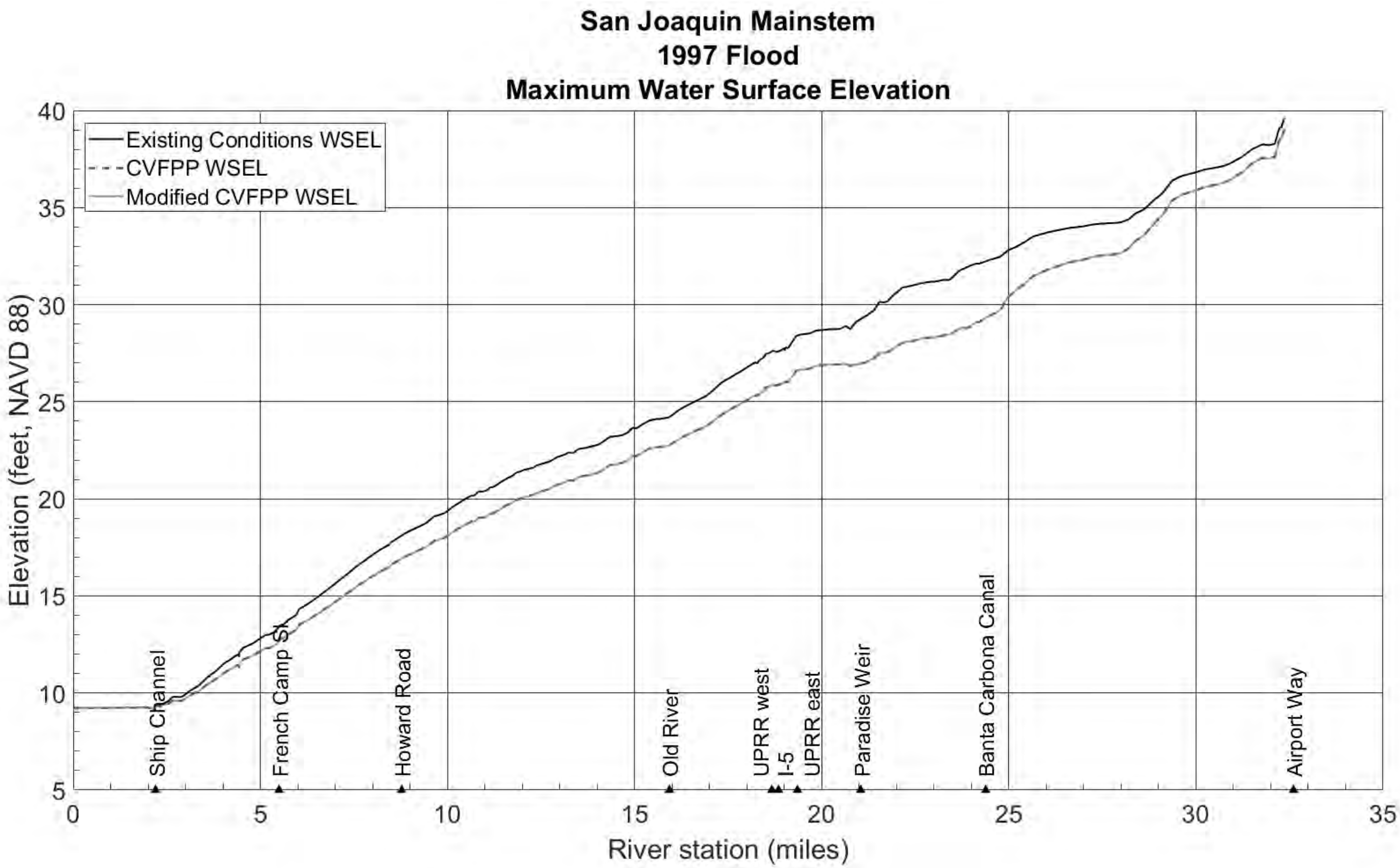
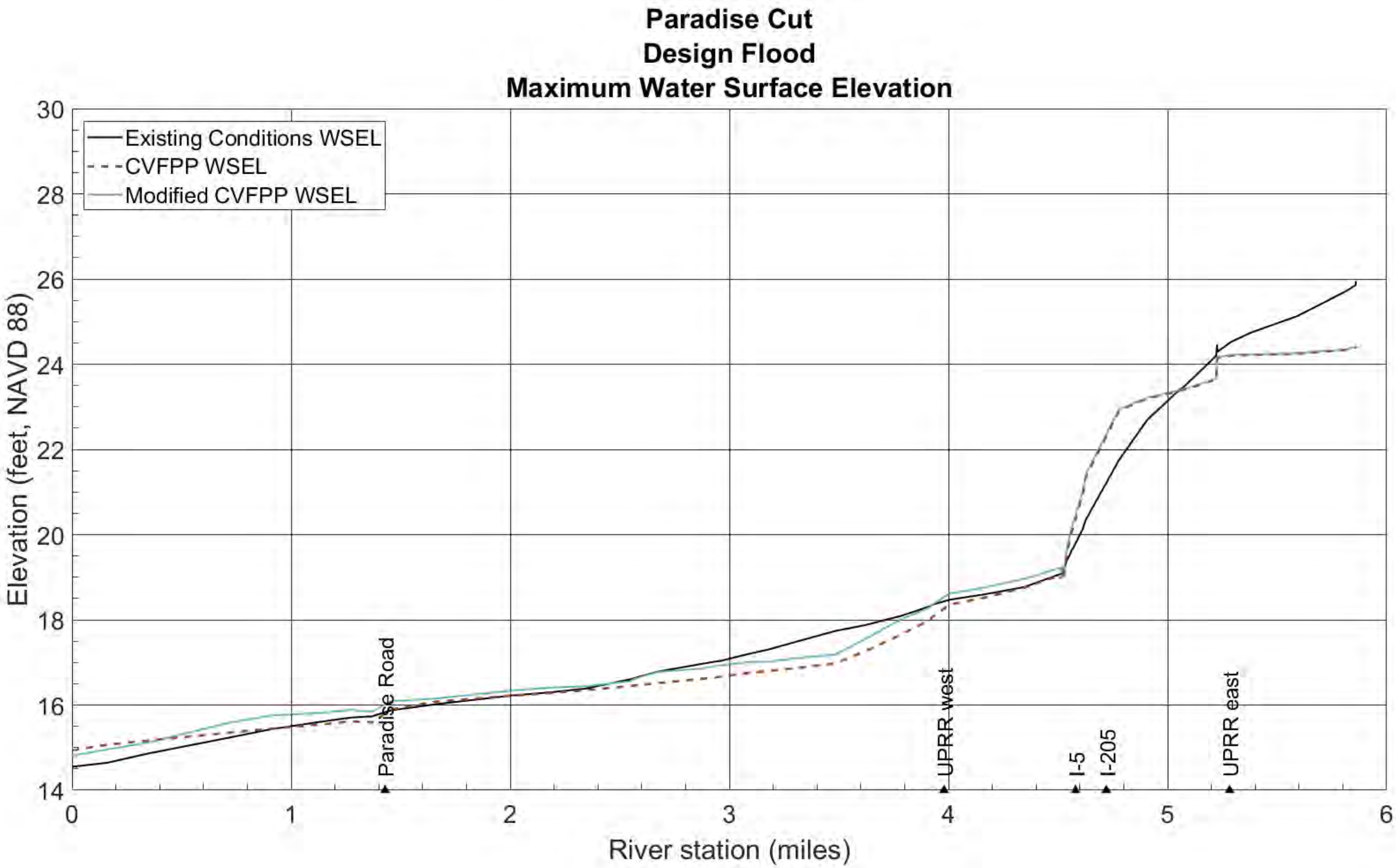

Grant Line Canal
100-Year Flood with Climate Change
Maximum Water Surface Elevation
CVFPP WSEL
CVFPP WSEL with Dredging at Old River & Grant Line Canal
Elevation (feet, NAVD 88)
River station (miles)
Old River
Tracy Blvd.
15
16
17
18
19
20
21
22
23
0
1
2
3
4
5
6
7
8

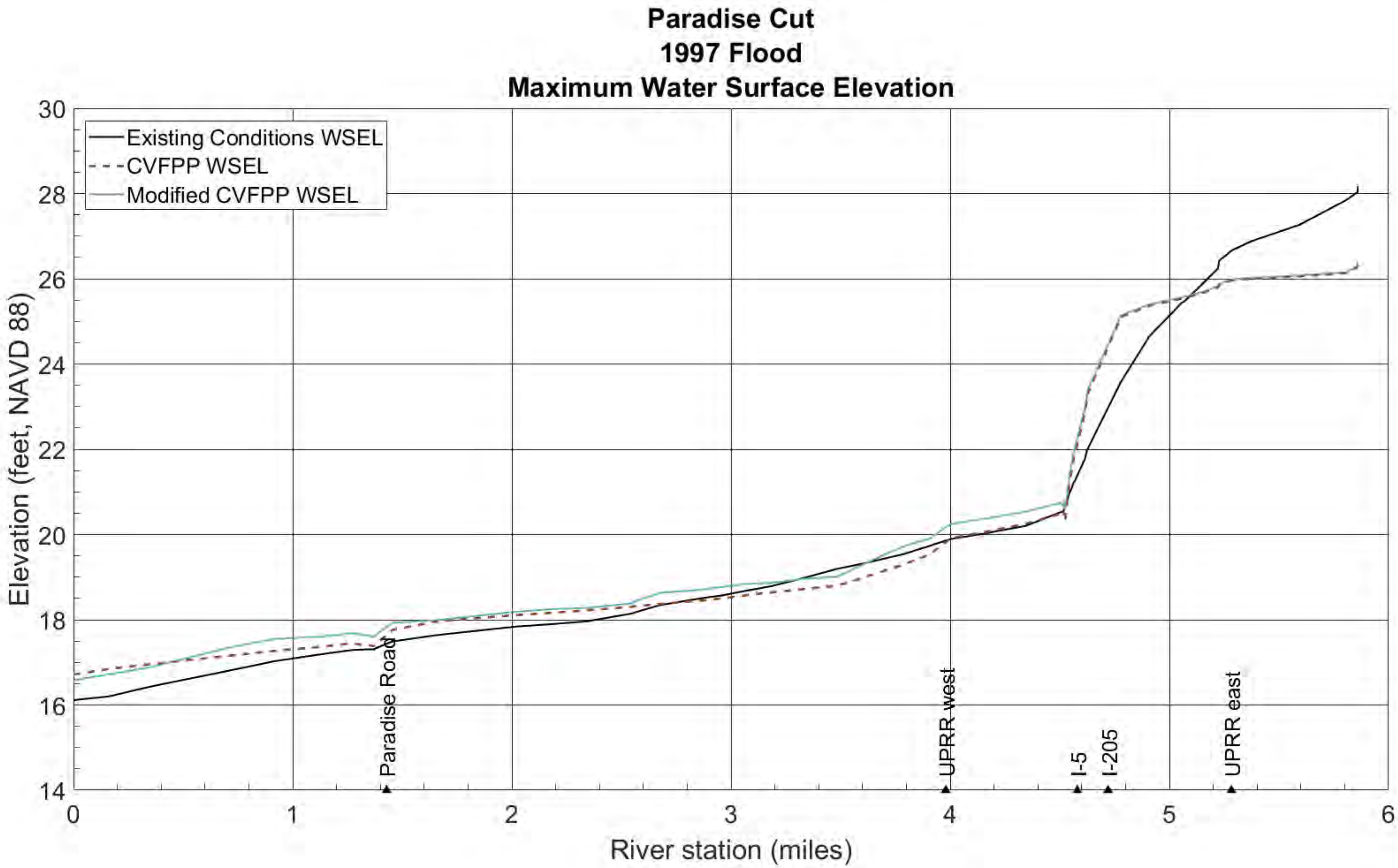
Chart Group 2a
Modified CVFPP vs CVFPP
water surface elevation



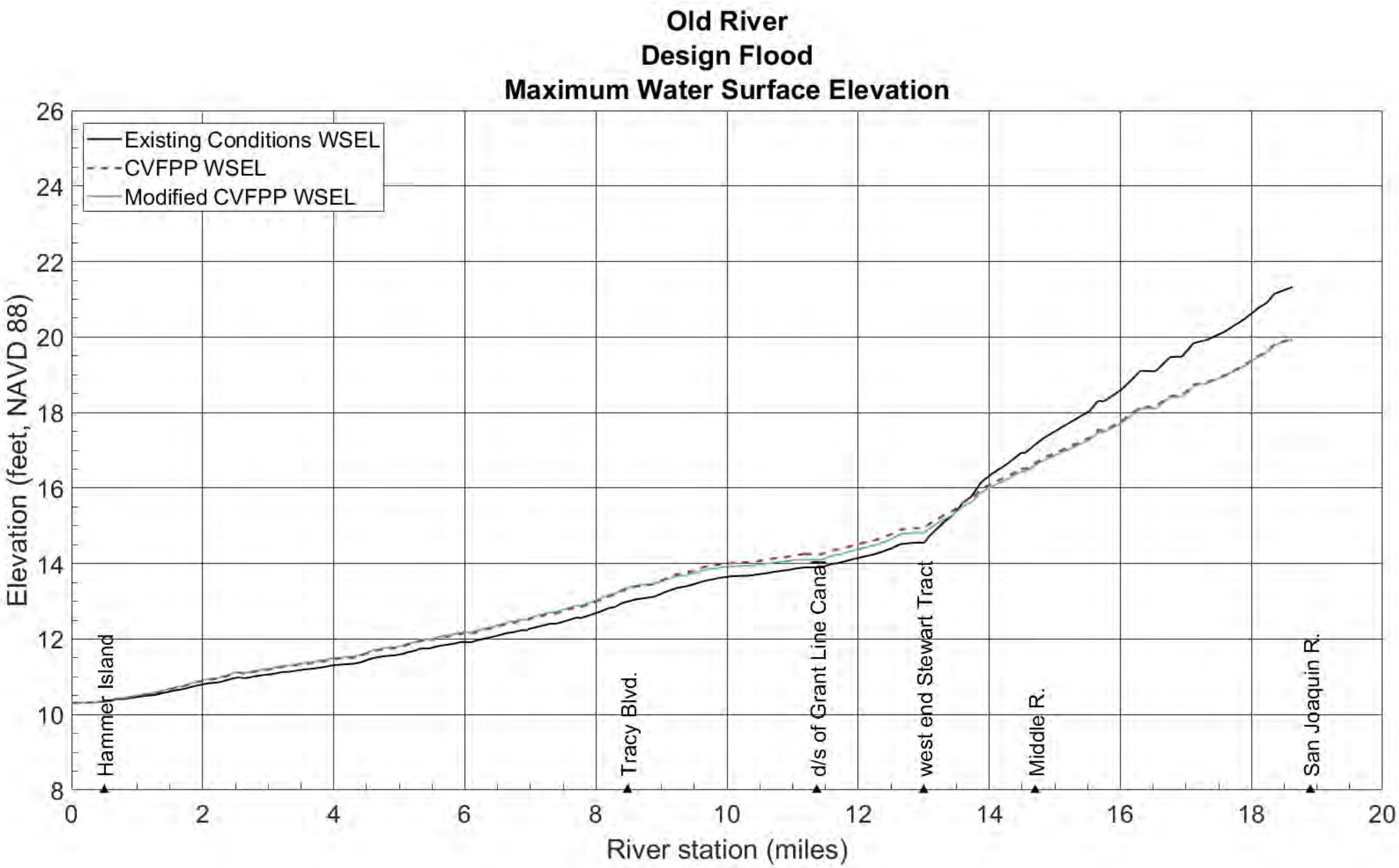
San Joaquin Mainstem
Design Flood
Maximum Water Surface Elevation
Existing Conditions WSEL
CVFPP WSEL
Modified CVFPP WSEL
Elevation (feet, NAVD 88)
River station (miles)
Ship Channel
French Camp Sl.
Howard Road
Old River
UPRR west
I-5
UPRR east
Paradise Weir
Banta Carbona Canal
Airport Way
40
35
30
25
20
15
10
5
0
5
10
15
20
25
30
35

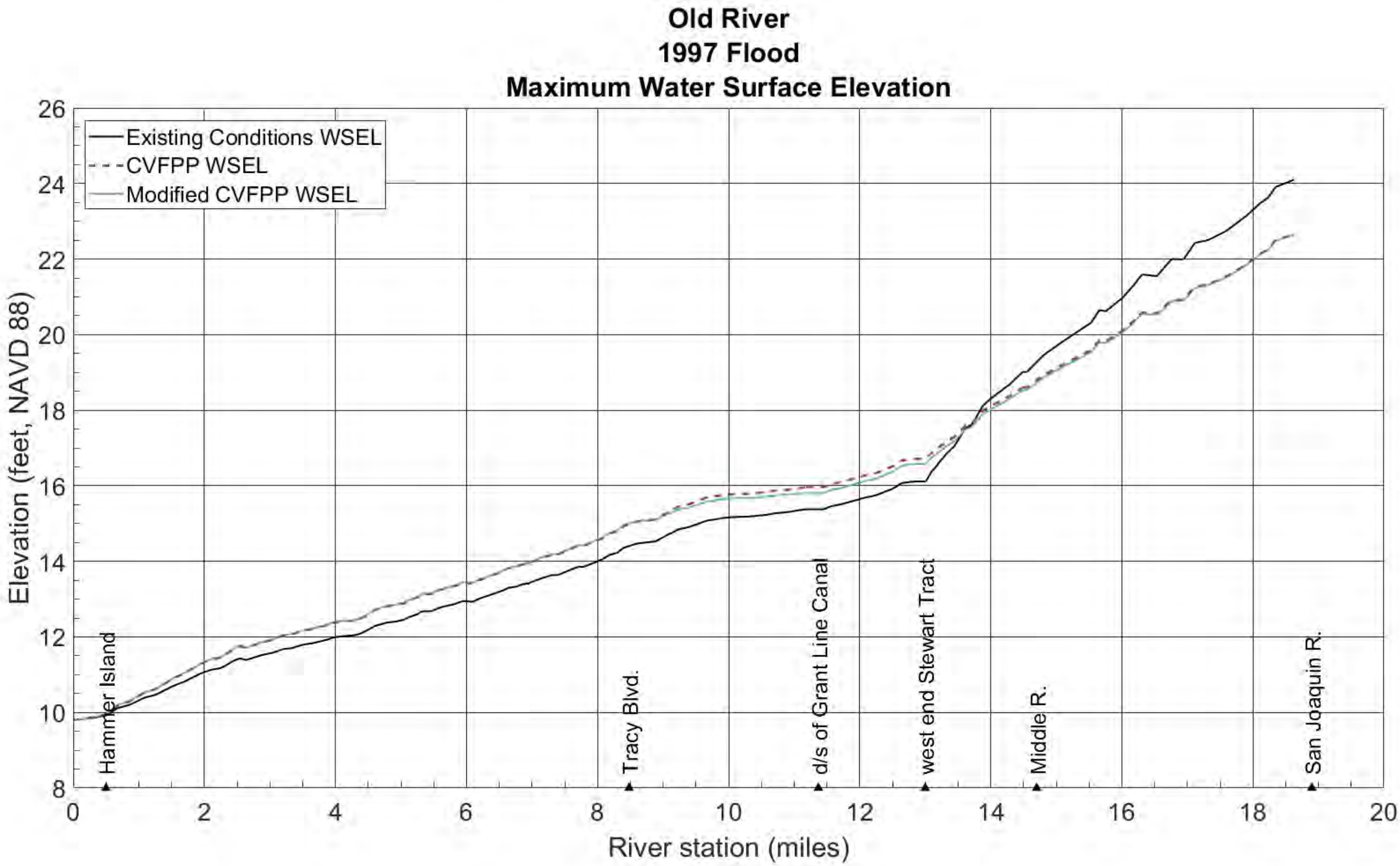

San Joaquin Mainstem
1997 Flood
Maximum Water Surface Elevation
Existing Conditions WSEL
CVFPP WSEL
Modified CVFPP WSEL
Elevation (feet, NAVD 88)
River station (miles)
Ship Channel
French Camp Sl
Howard Road
Old River
UPRR west
I-5
UPRR east
Paradise Weir
Banta Carbona Canal
Airport Way
40
35
30
25
20
15
10
5
0
5
10
15
20
25
30
35


Paradise Cut
Design Flood
Maximum Water Surface Elevation
Existing Conditions WSEL
CVFPP WSEL
Modified CVFPP WSEL
Elevation (feet, NAVD 88)
30
28
26
24
22
20
18
16
14
Paradise Road
UPRR west
I-5
I-205
UPRR east
0
1
2
3
4
5
6
River station (miles)

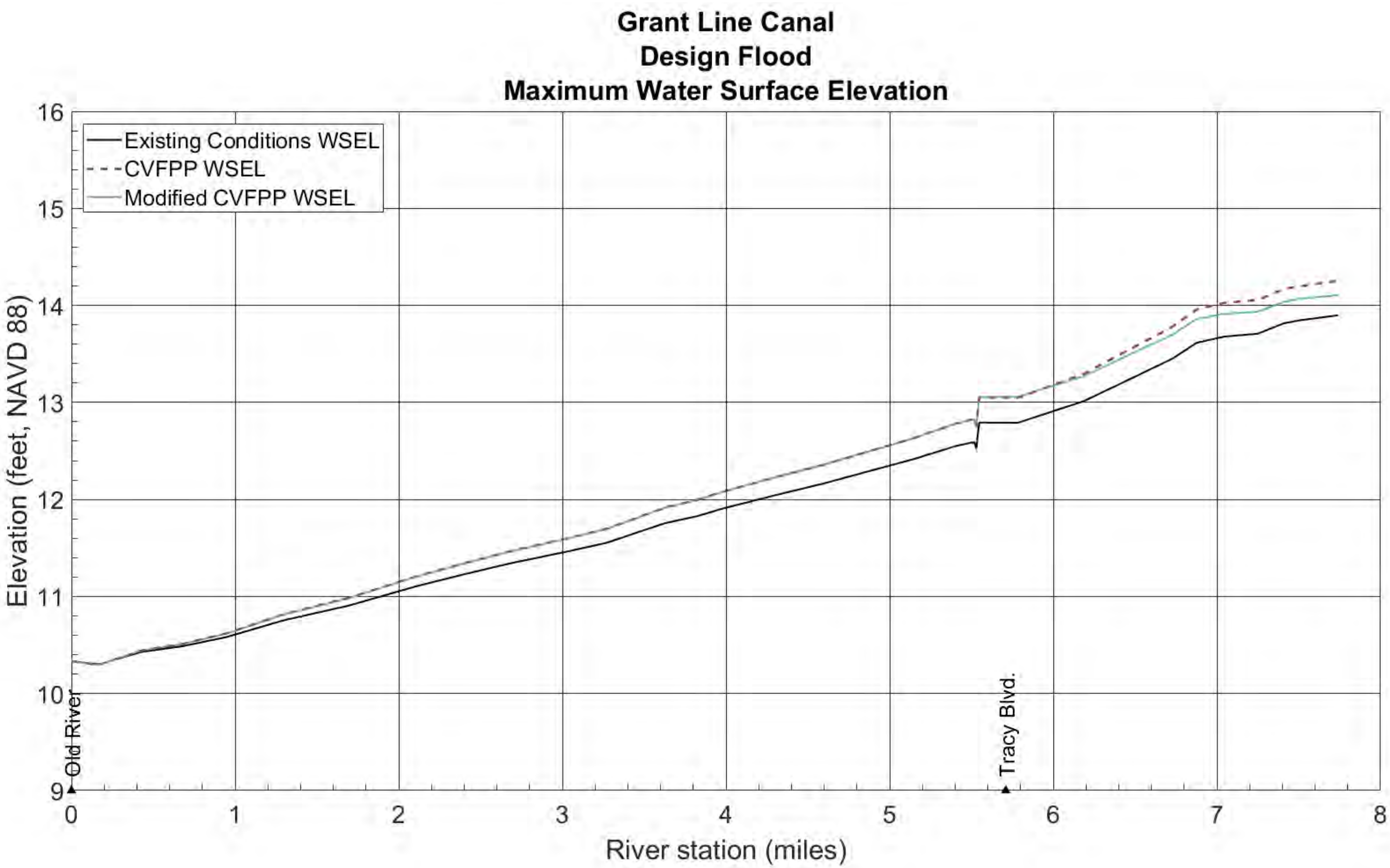


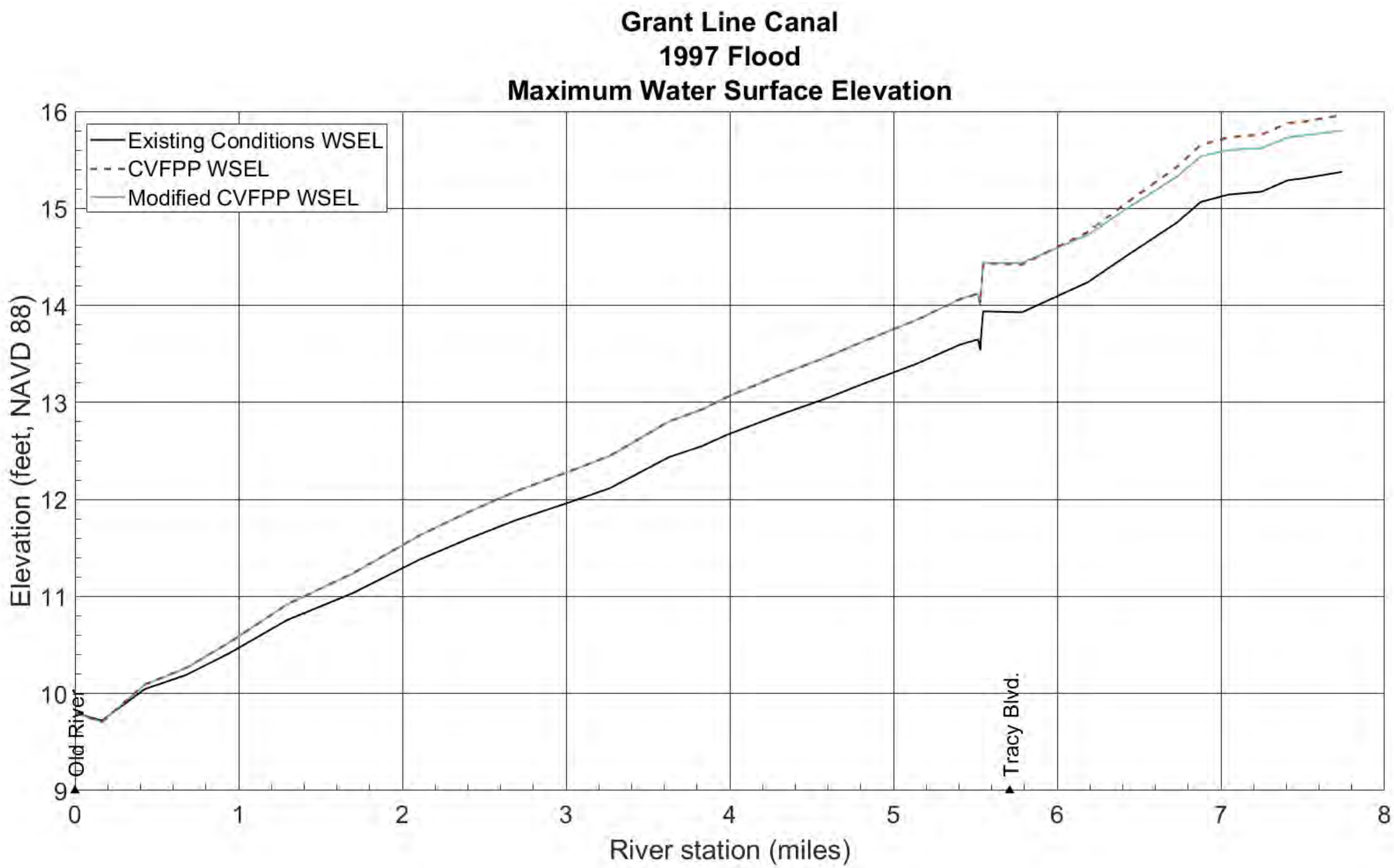
Paradise Cut
1997 Flood
Maximum Water Surface Elevation
Existing Conditions WSEL
CVFPP WSEL
Modified CVFPP WSEL
Elevation (feet, NAVD 88)
30
28
26
24
22
20
18
16
14
0
1
2
3
4
5
6
River station (miles)
Paradise Road
UPRR west
I-5
I-205
UPRR east


Old River
Design Flood
Maximum Water Surface Elevation
Existing Conditions WSEL
CVFPP WSEL
Modified CVFPP WSEL
Elevation (feet, NAVD 88)
River station (miles)
Hammer Island
Tracy Blvd.
d/s of Grant Line Canal
west end Stewart Tract
Middle R.
San Joaquin R.
26
24
22
20
18
16
14
12
10
8
0
2
4
6
8
10
12
14
16
18
20



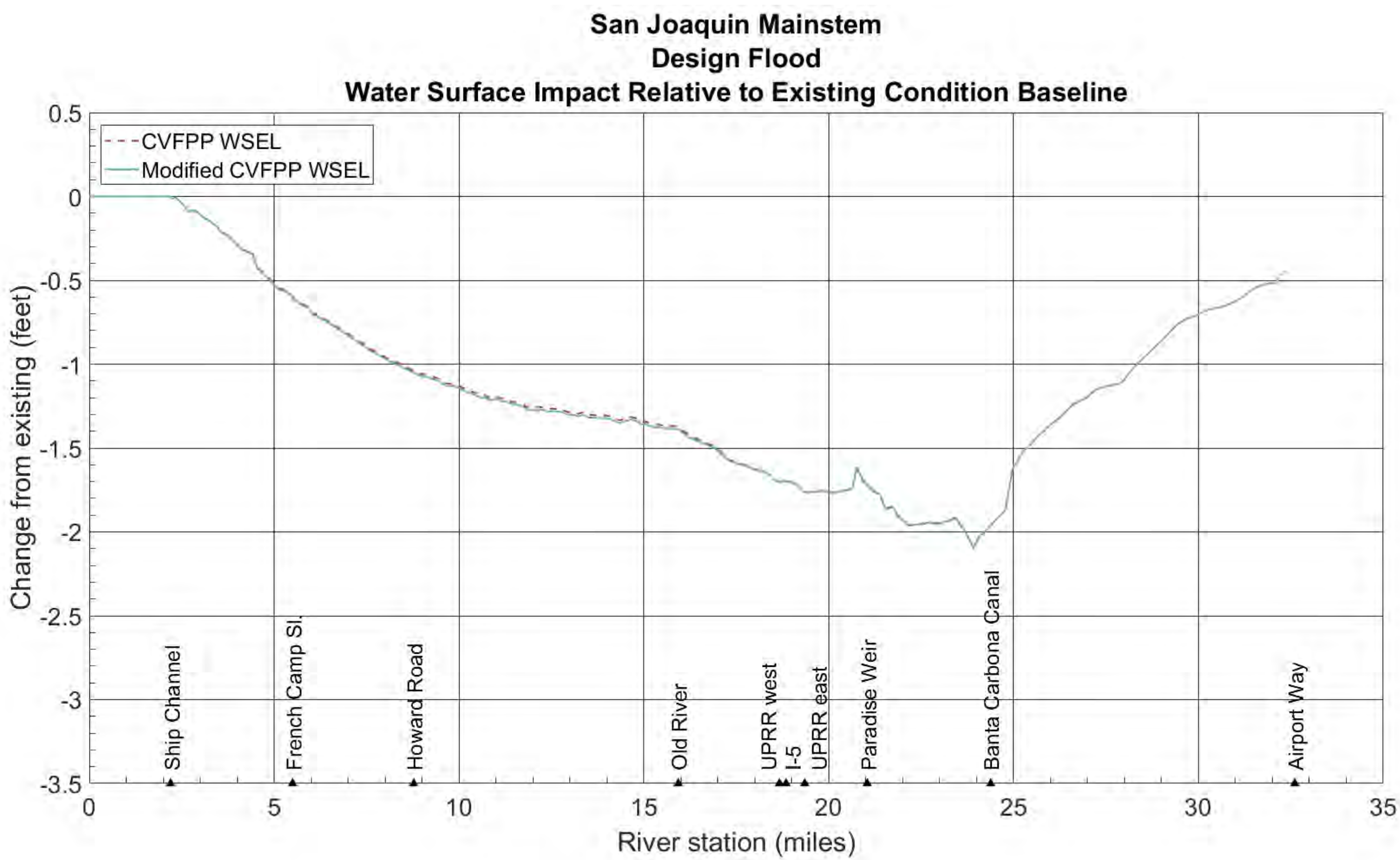
Old River
1997 Flood
Maximum Water Surface Elevation
Existing Conditions WSEL
CVFPP WSEL
Modified CVFPP WSEL
Elevation (feet, NAVD 88)
River station (miles)
Hammer Island
Tracy Blvd.
d/s of Grant Line Canal
west end Stewart Tract
Middle R.
San Joaquin R.
8
10
12
14
16
18
20
22
24
26
0
2
4
6
8
10
12
14
16
18
20


Grant Line Canal
Design Flood
Maximum Water Surface Elevation
Existing Conditions WSEL
CVFPP WSEL
Modified CVFPP WSEL
Elevation (feet, NAVD 88)
River station (miles)
Old River
Tracy Blvd.
16
15
14
13
12
11
10
9
0
1
2
3
4
5
6
7
8

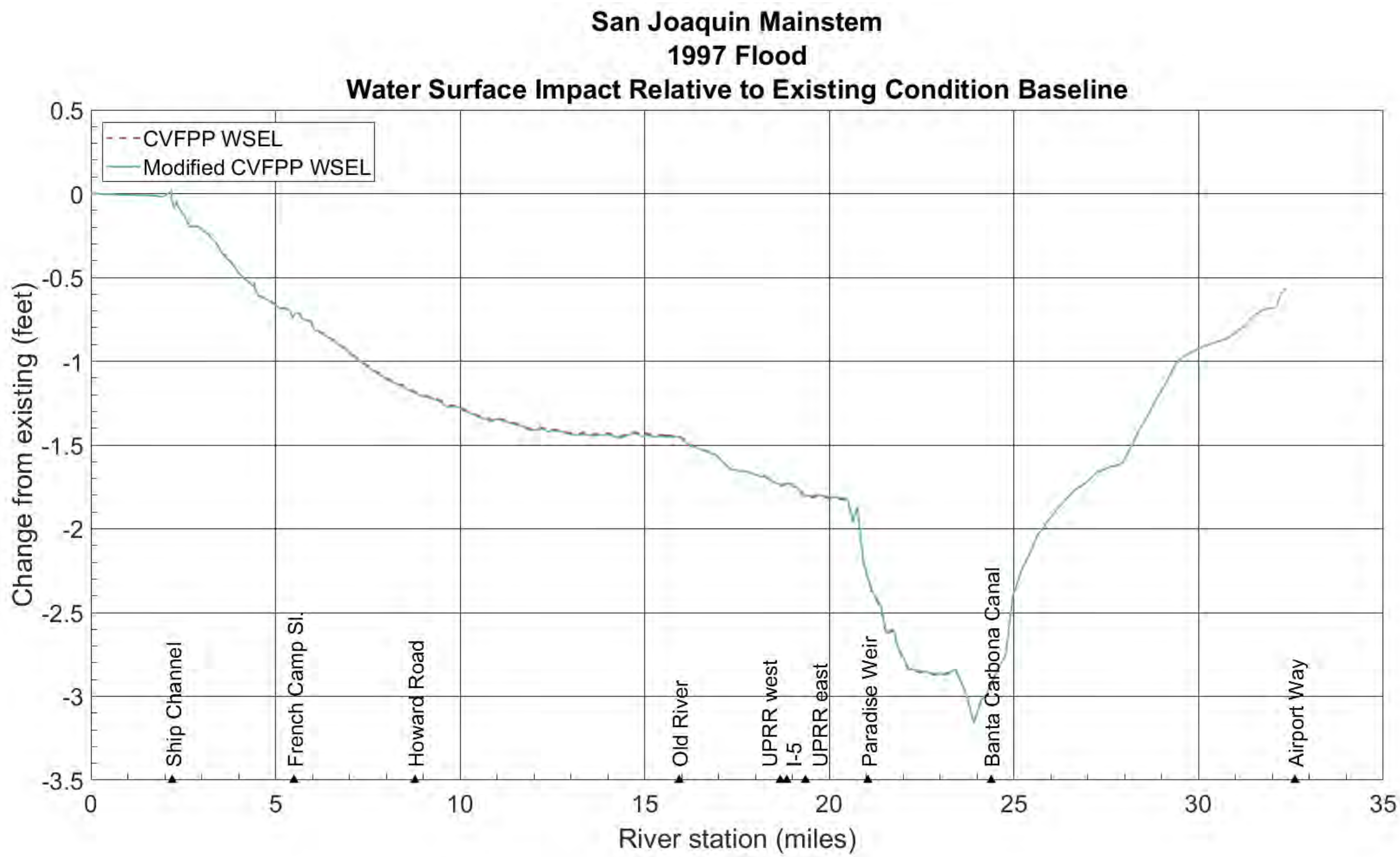


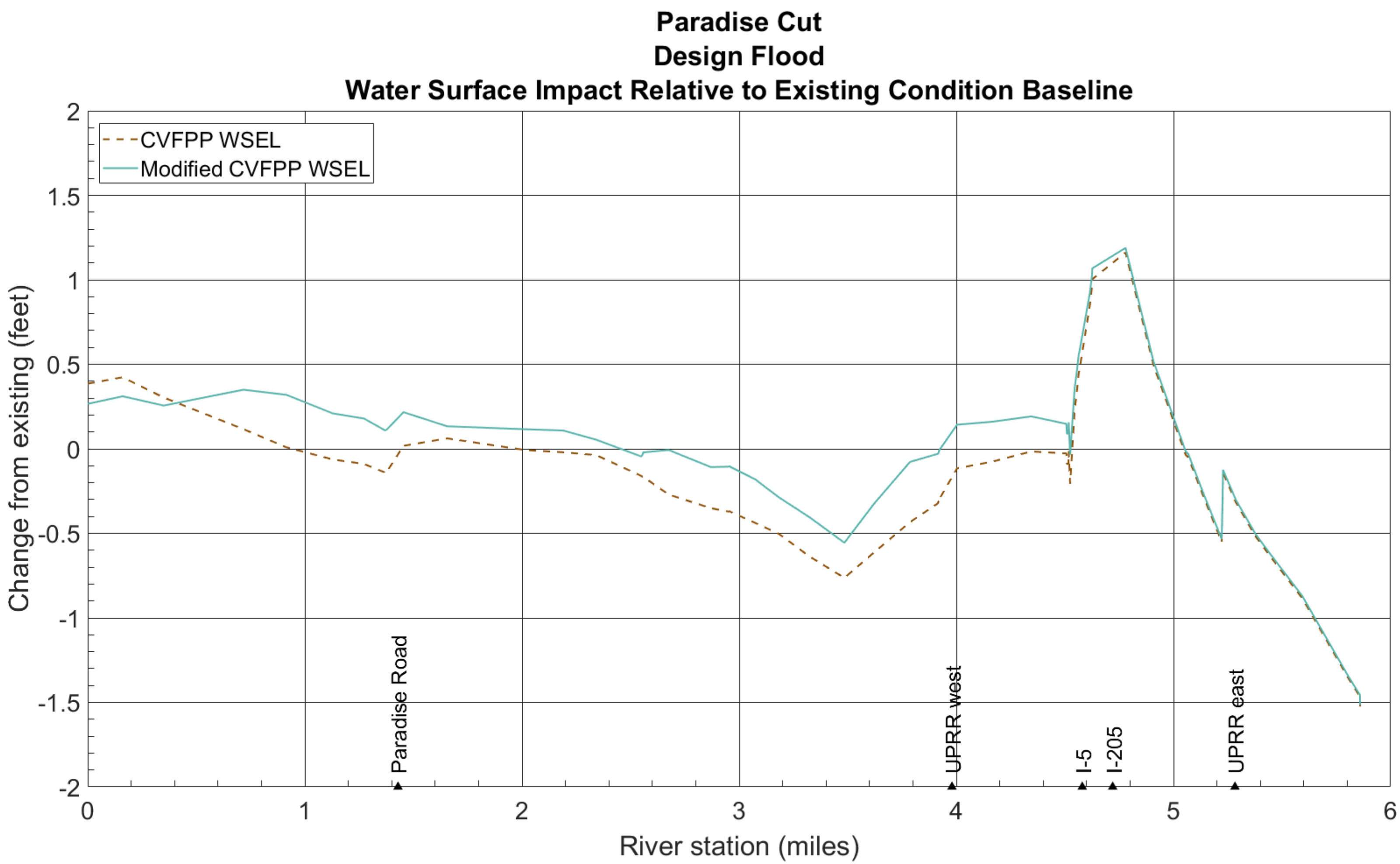
Grant Line Canal
1997 Flood
Maximum Water Surface Elevation
Existing Conditions WSEL
CVFPP WSEL
Modified CVFPP WSEL
Elevation (feet, NAVD 88)
River station (miles)
Old River
Tracy Blvd.
16
15
14
13
12
11
10
9
0
1
2
3
4
5
6
7
8

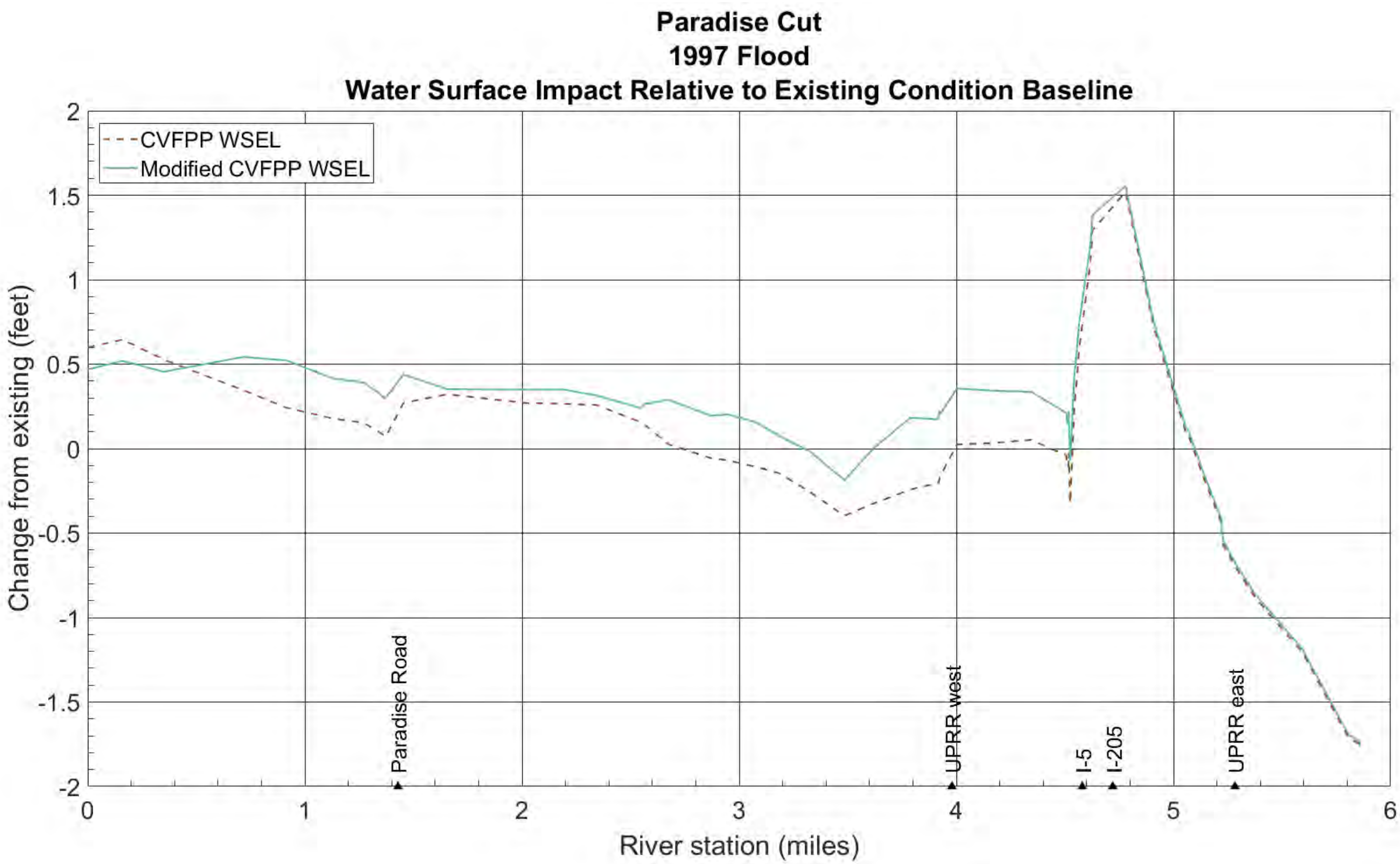
Chart Group 2b
Modified CVFPP vs CVFPP
relative difference



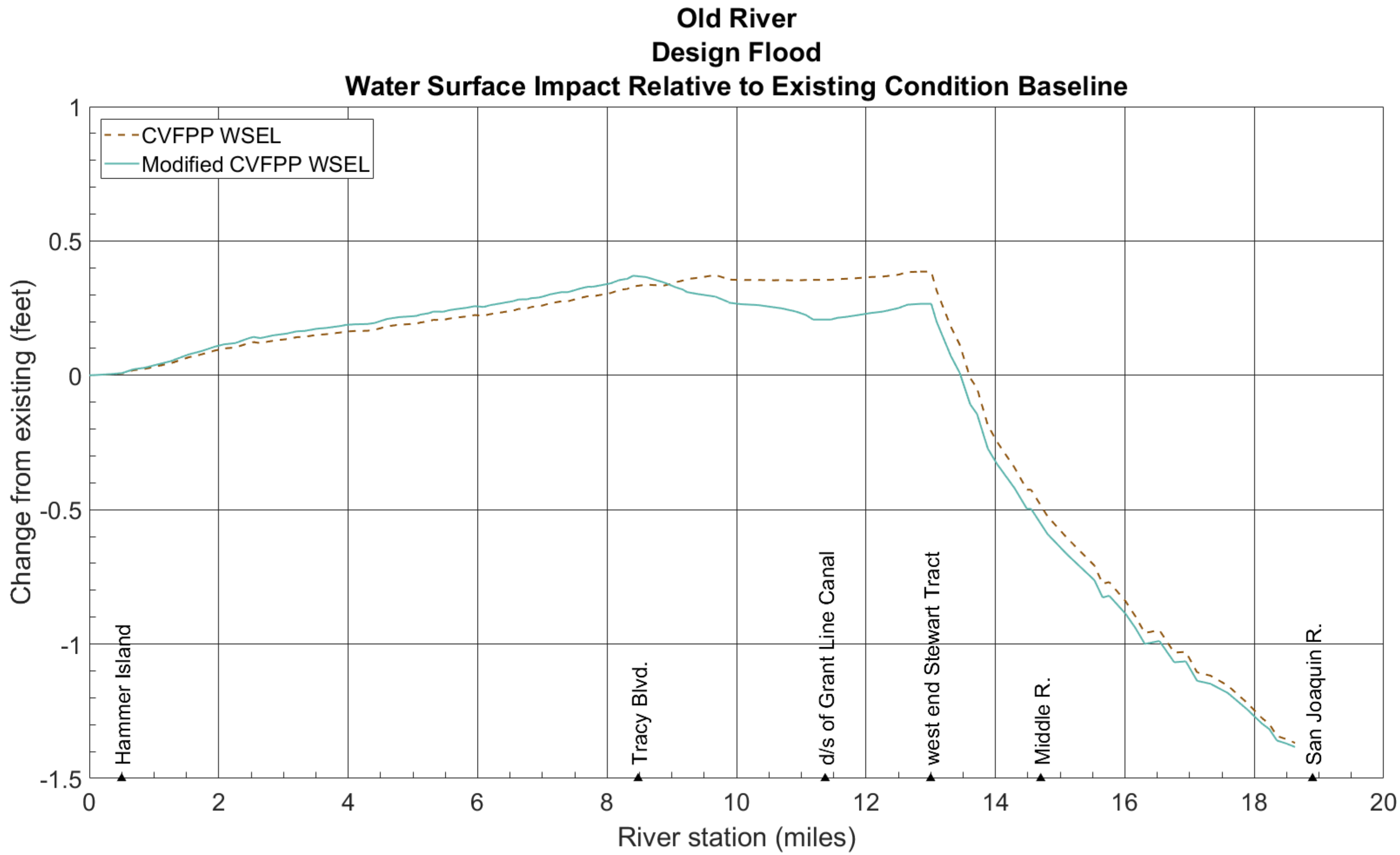
San Joaquin Mainstem
Design Flood
Water Surface Impact Relative to Existing Condition Baseline
CVFPP WSEL
Modified CVFPP WSEL
Change from existing (feet)
River station (miles)
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
0
5
10
15
20
25
30
35
Ship Channel
French Camp Sl.
Howard Road
Old River
UPRR west
I-5
UPRR east
Paradise Weir
Banta Carbona Canal
Airport Way

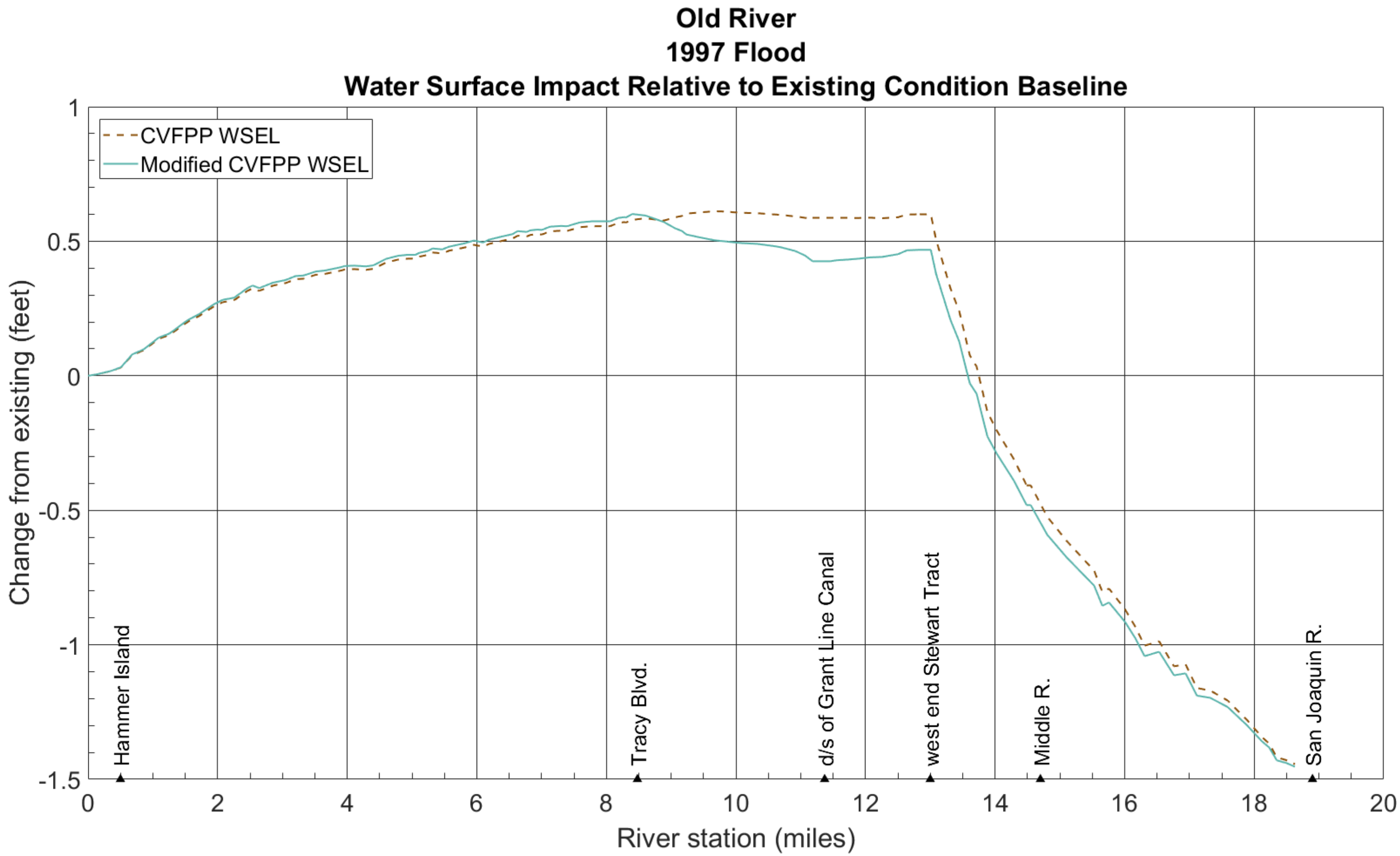

San Joaquin Mainstem
1997 Flood
Water Surface Impact Relative to Existing Condition Baseline
CVFPP WSEL
Modified CVFPP WSEL
Change from existing (feet)
River station (miles)
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
0
5
10
15
20
25
30
35
Ship Channel
French Camp Sl.
Howard Road
Old River
UPRR west
I-5
UPRR east
Paradise Weir
Banta Carbona Canal
Airport Way

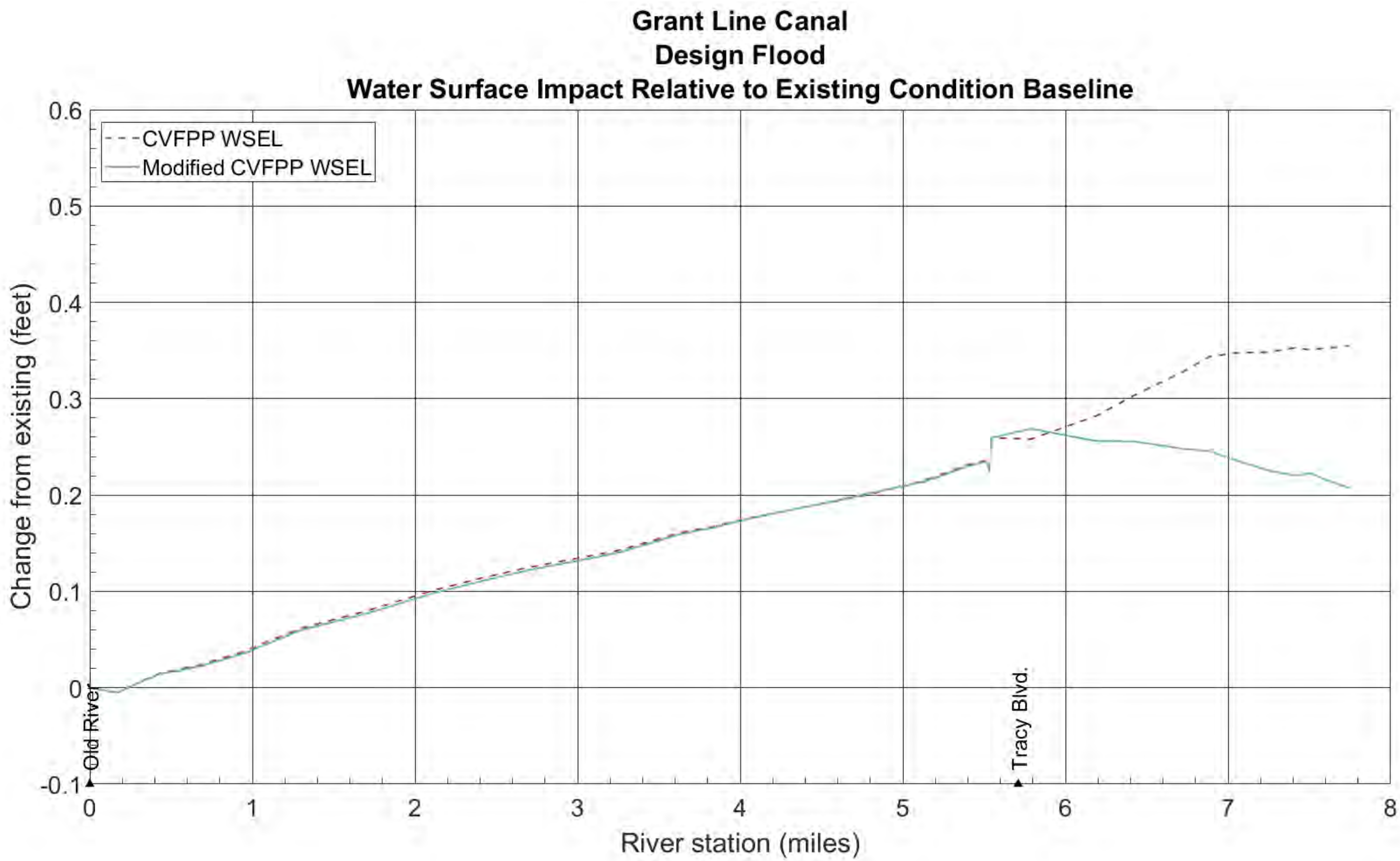

Paradise Cut
Design Flood
Water Surface Impact Relative to Existing Condition Baseline
CVFPP WSEL
Modified CVFPP WSEL
Change from existing (feet)
River station (miles)
Paradise Road
UPRR west
I-5
I-205
UPRR east
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
0
1
2
3
4
5
6



Paradise Cut
1997 Flood
Water Surface Impact Relative to Existing Condition Baseline
CVFPP WSEL
Modified CVFPP WSEL
Change from existing (feet)
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
Paradise Road
UPRR west
I-5
I-205
UPRR east
0
1
2
3
4
5
6
River station (miles)


Old River
Design Flood
Water Surface Impact Relative to Existing Condition Baseline
CVFPP WSEL
Modified CVFPP WSEL
Change from existing (feet)
River station (miles)
1
0.5
0
-0.5
-1
-1.5
0
2
4
6
8
10
12
14
16
18
20
Hammer Island
Tracy Blvd.
d/s of Grant Line Canal
west end Stewart Tract
Middle R.
San Joaquin R.


Old River
1997 Flood
Water Surface Impact Relative to Existing Condition Baseline
CVFPP WSEL
Modified CVFPP WSEL
Change from existing (feet)
1
0.5
0
-0.5
-1
-1.5
0
2
4
6
8
10
12
14
16
18
20
River station (miles)
Hammer Island
Tracy Blvd.
d/s of Grant Line Canal
west end Stewart Tract
Middle R.
San Joaquin R.


Grant Line Canal
Design Flood
Water Surface Impact Relative to Existing Condition Baseline
CVFPP WSEL
Modified CVFPP WSEL
Change from existing (feet)
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
Old River
Tracy Blvd.
0
1
2
3
4
5
6
7
8
River station (miles)

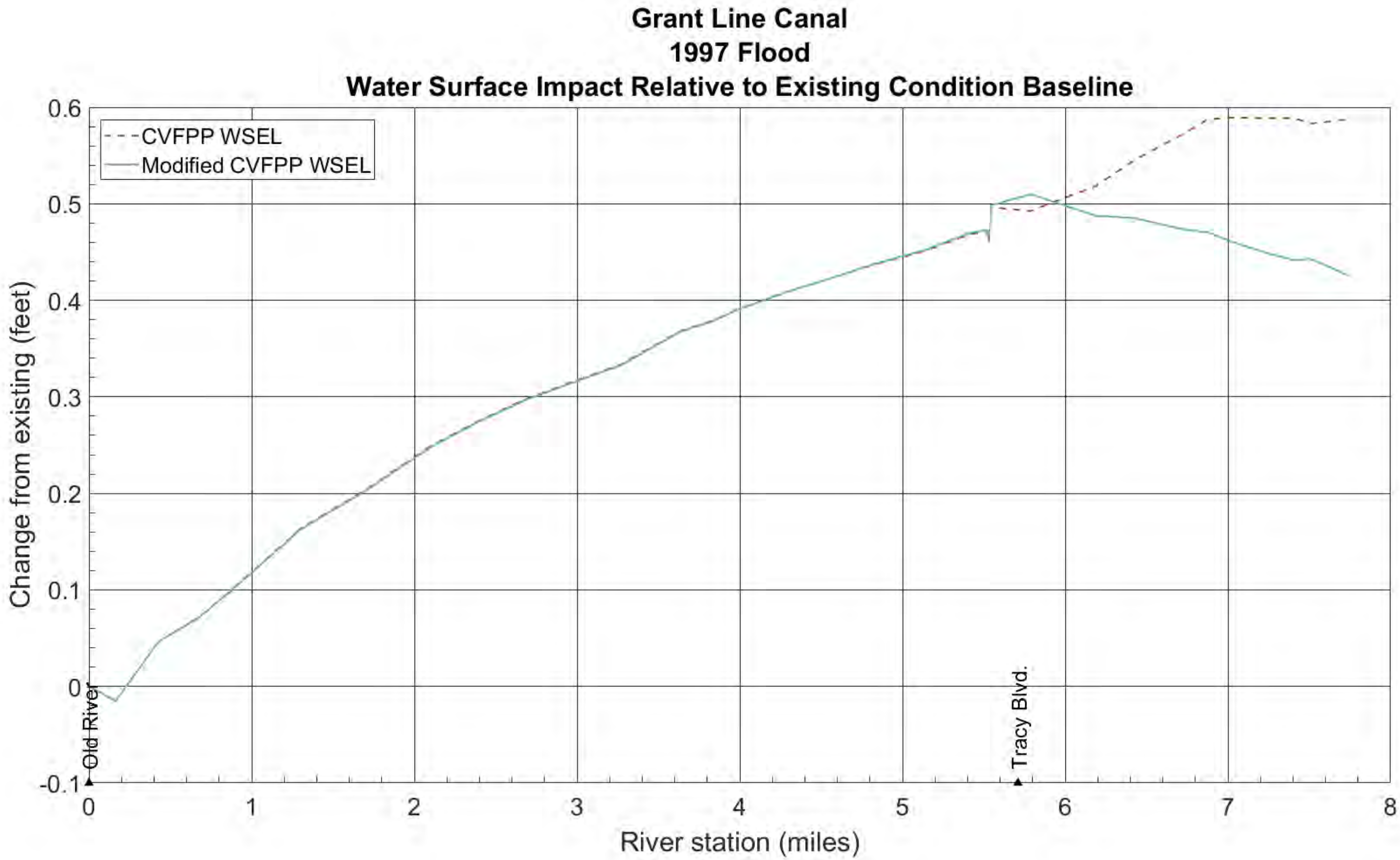
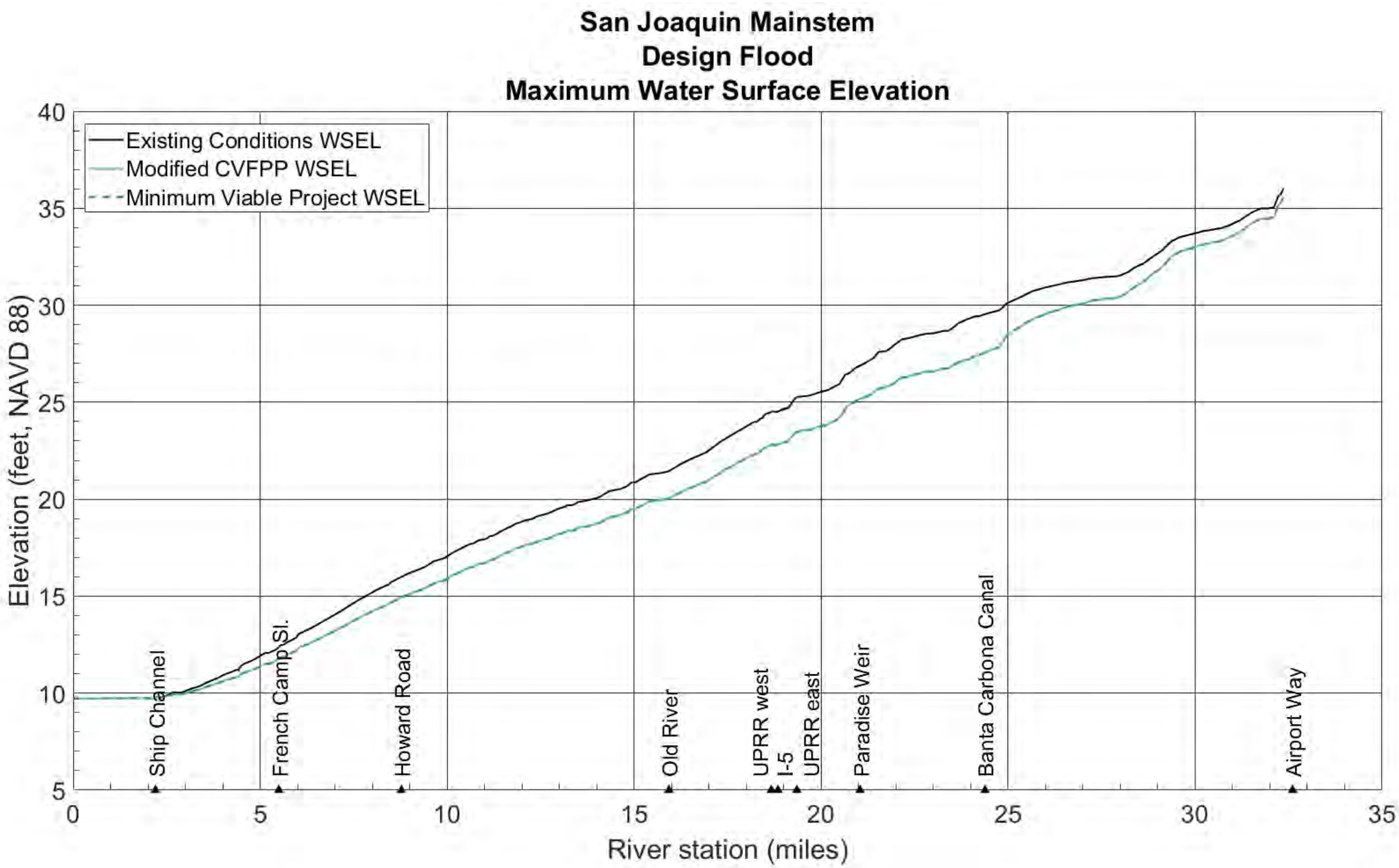
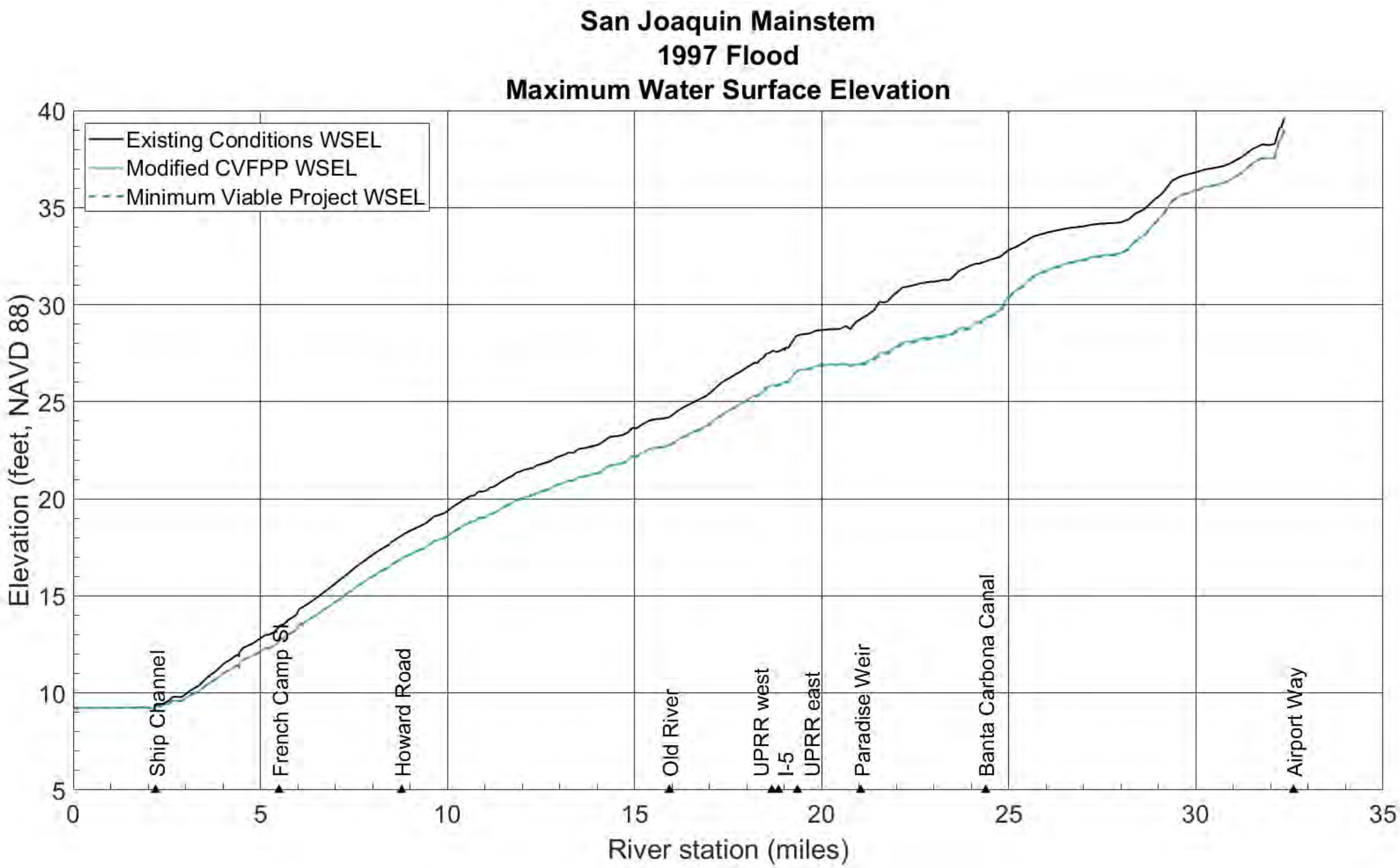
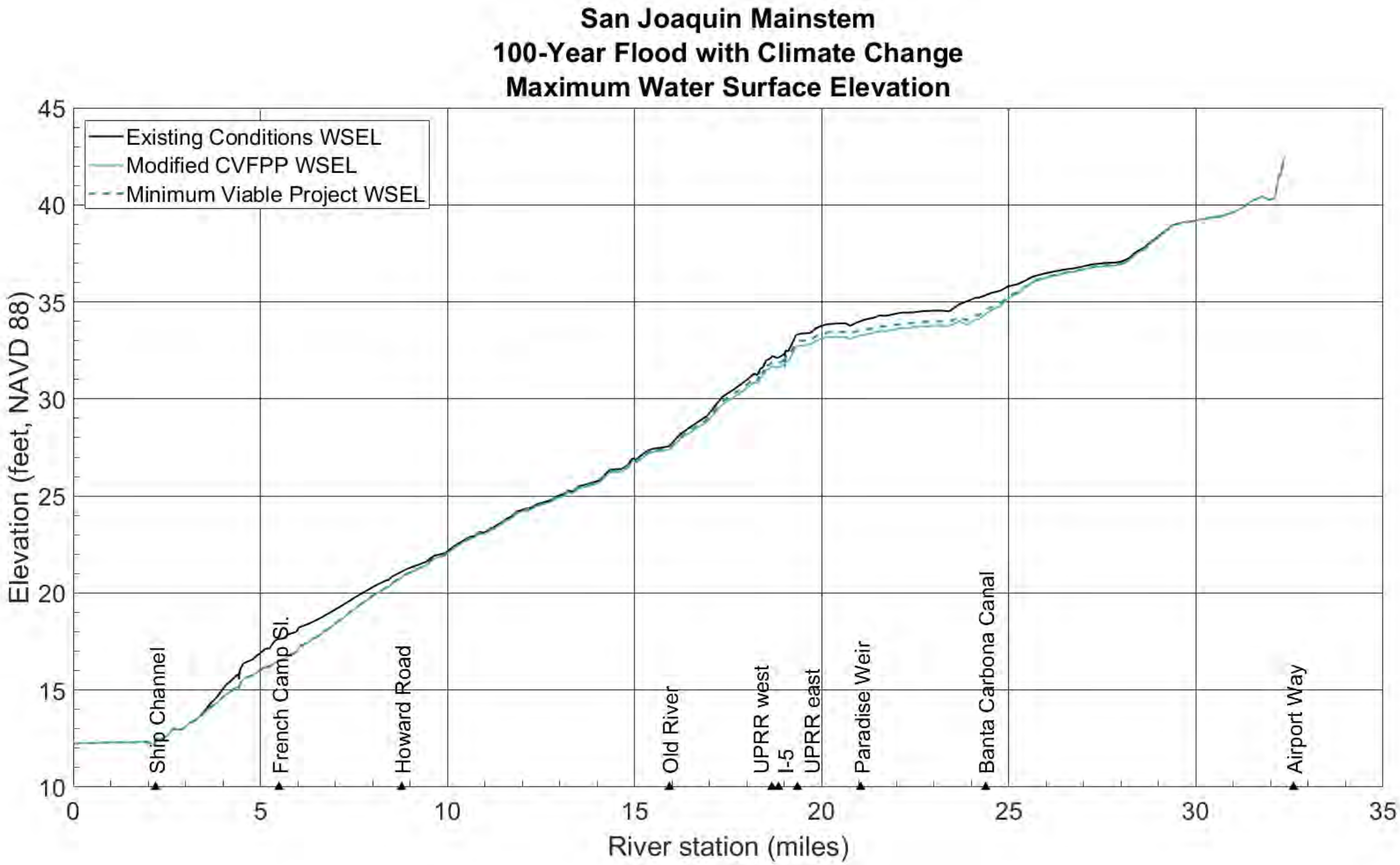

Grant Line Canal
1997 Flood
Water Surface Impact Relative to Existing Condition Baseline
CVFPP WSEL
Modified CVFPP WSEL
Change from existing (feet)
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
Old River
Tracy Blvd.
0
1
2
3
4
5
6
7
8
River station (miles)

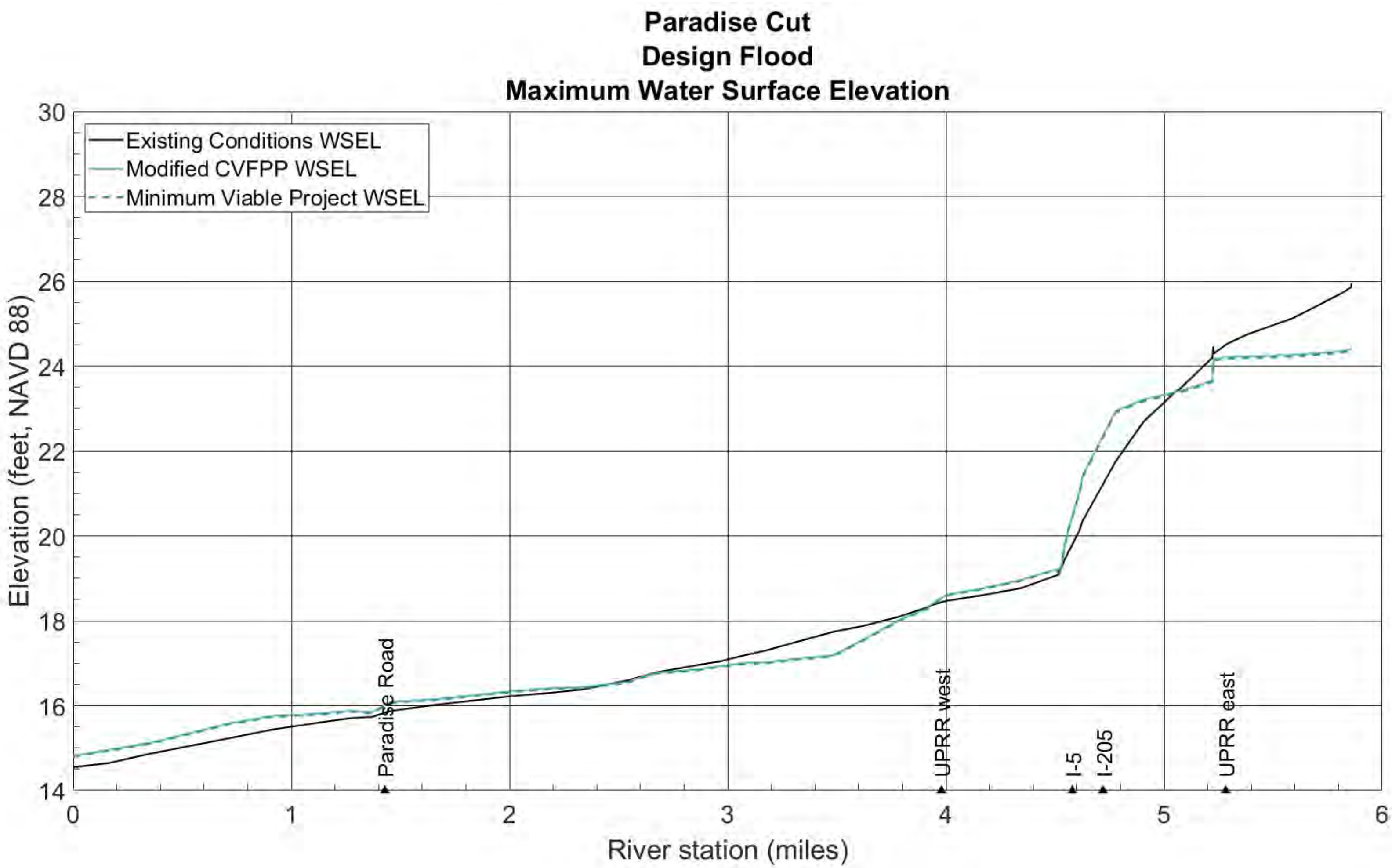
Chart group 3a
MVP vs Modified CVFPP
water surface elevation


San Joaquin Mainstem
Design Flood
Maximum Water Surface Elevation
Existing Conditions WSEL
Modified CVFPP WSEL
Minimum Viable Project WSEL
Elevation (feet, NAVD 88)
River station (miles)
Ship Channel
French Camp Sl.
Howard Road
Old River
UPRR west
I-5
UPRR east
Paradise Weir
Banta Carbona Canal
Airport Way
40
35
30
25
20
15
10
5
0
5
10
15
20
25
30
35

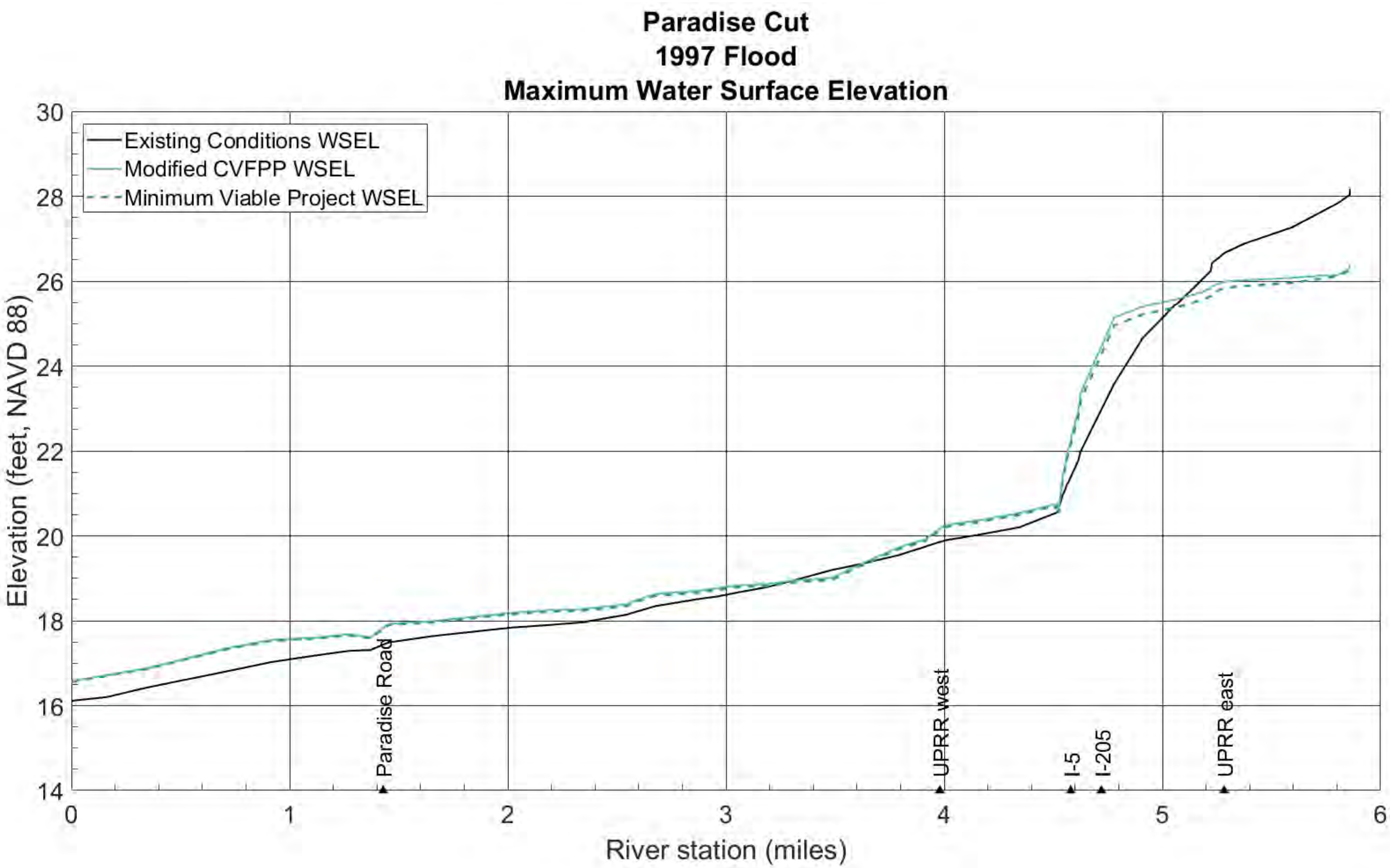


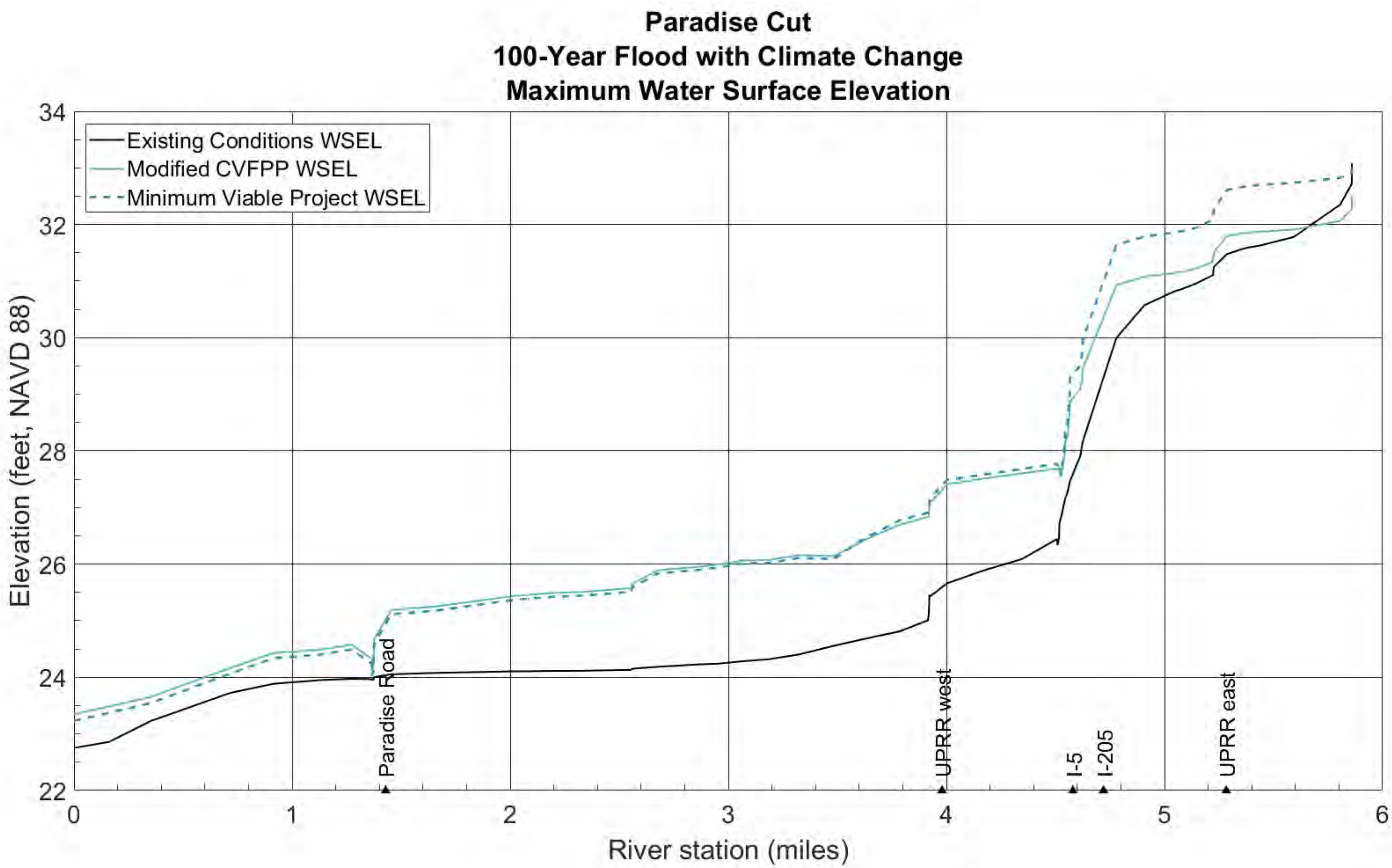
San Joaquin Mainstem
1997 Flood
Maximum Water Surface Elevation
Existing Conditions WSEL
Modified CVFPP WSEL
Minimum Viable Project WSEL
Elevation (feet, NAVD 88)
River station (miles)
Ship Channel
French Camp Sl
Howard Road
Old River
UPRR west
I-5
UPRR east
Paradise Weir
Banta Carbona Canal
Airport Way
0
5
10
15
20
25
30
35
40

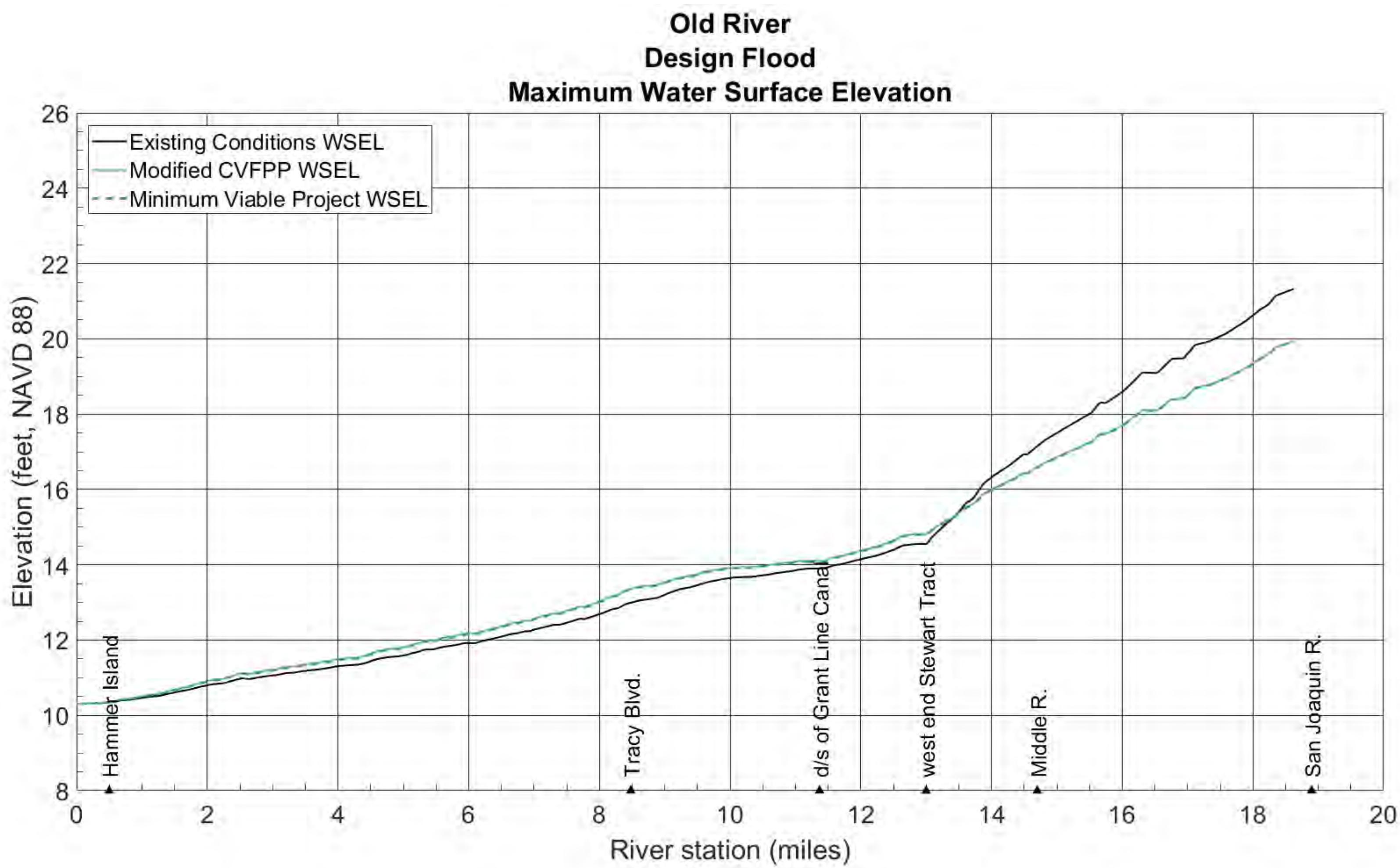

San Joaquin Mainstem
100-Year Flood with Climate Change
Maximum Water Surface Elevation
Existing Conditions WSEL
Modified CVFPP WSEL
Minimum Viable Project WSEL
Elevation (feet, NAVD 88)
River station (miles)
Ship Channel
French Camp Sl.
Howard Road
Old River
UPRR west
I-5
UPRR east
Paradise Weir
Banta Carbona Canal
Airport Way
45
40
35
30
25
20
15
10
0
5
10
15
20
25
30
35

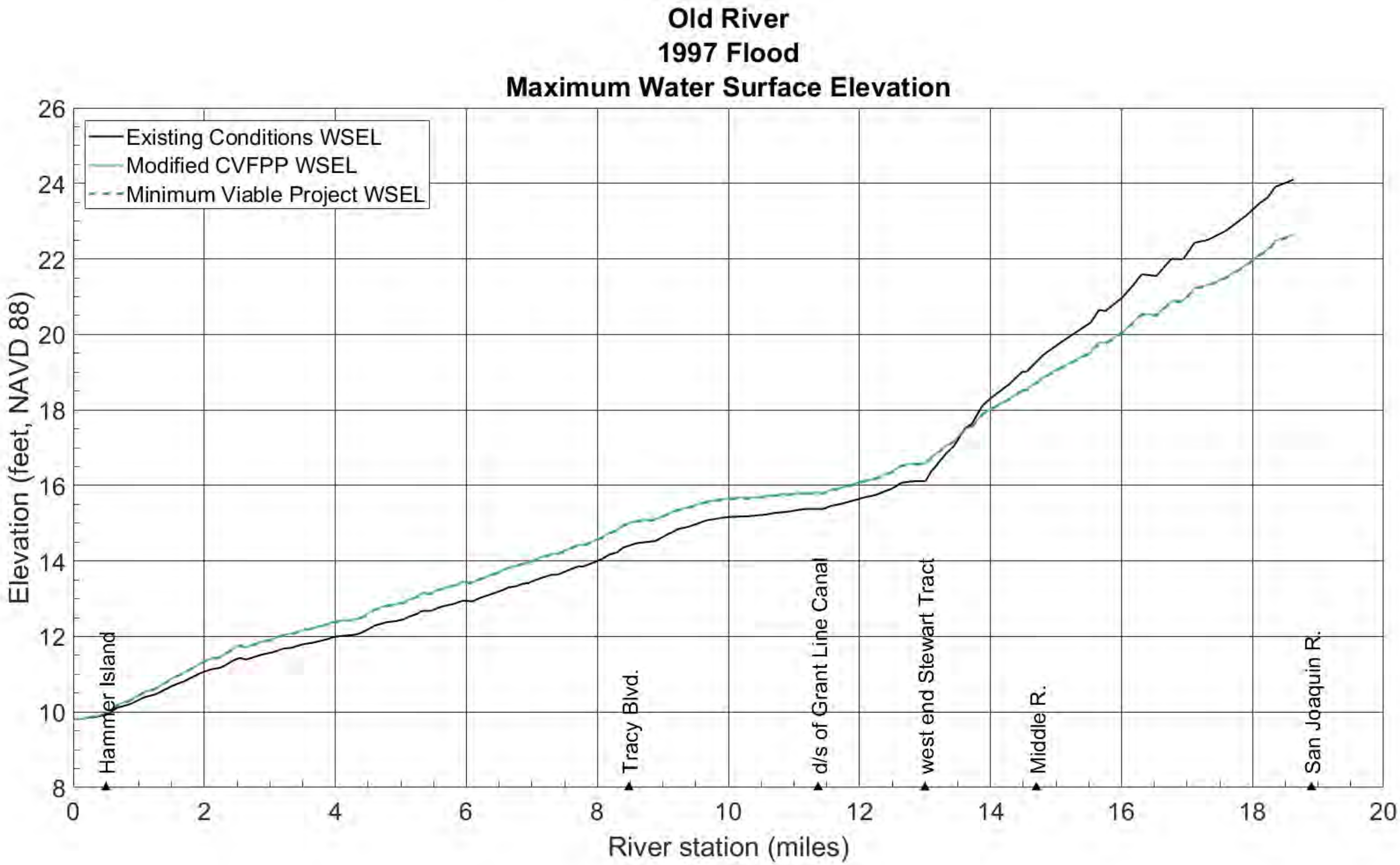


Paradise Cut
Design Flood
Maximum Water Surface Elevation
Existing Conditions WSEL
Modified CVFPP WSEL
Minimum Viable Project WSEL
Elevation (feet, NAVD 88)
River station (miles)
Paradise Road
UPRR west
I-5
I-205
UPRR east
30
28
26
24
22
20
18
16
14
0
1
2
3
4
5
6

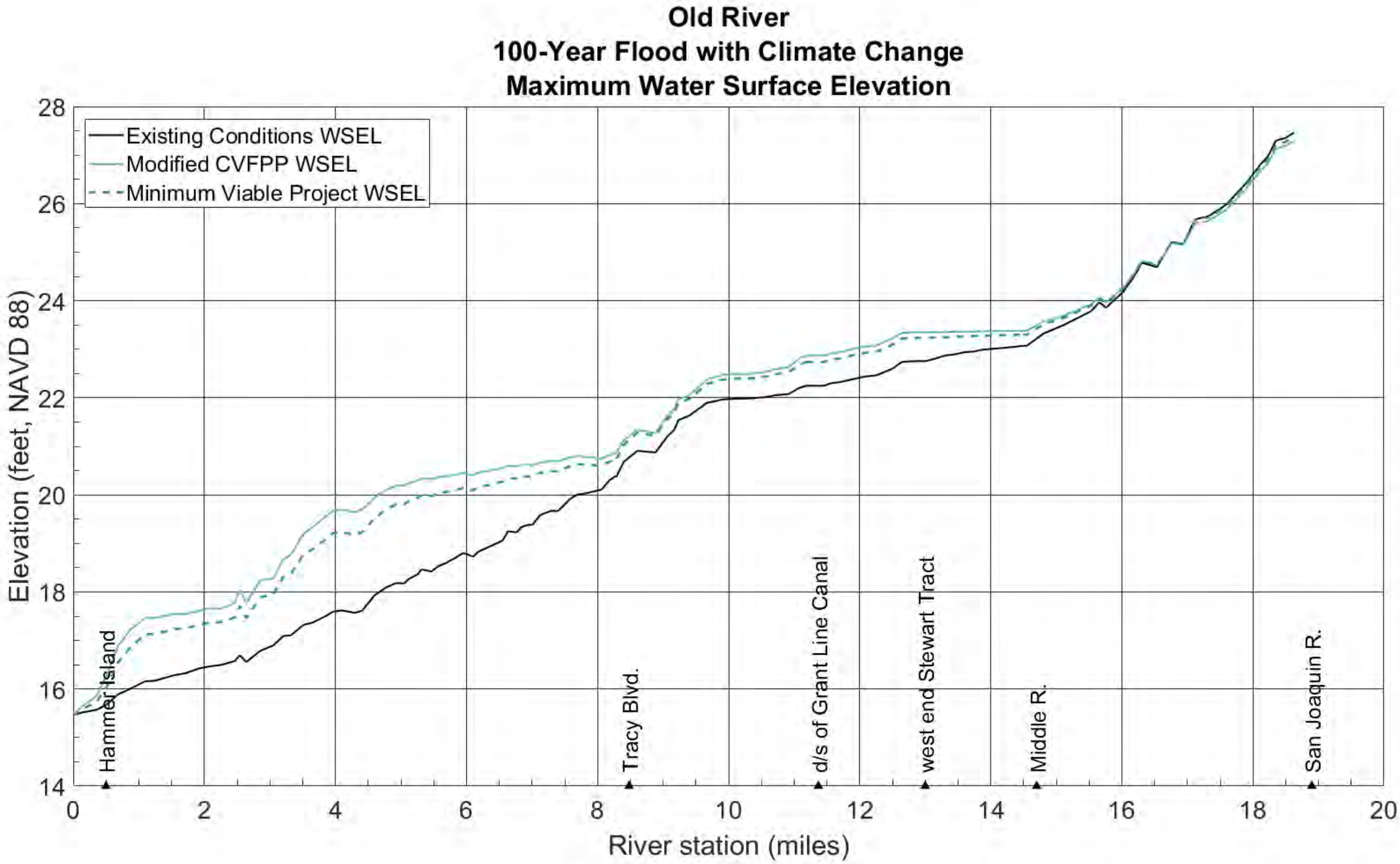

Paradise Cut
1997 Flood
Maximum Water Surface Elevation
Existing Conditions WSEL
Modified CVFPP WSEL
Minimum Viable Project WSEL
Elevation (feet, NAVD 88)
River station (miles)
Paradise Road
UPRR west
I-5
I-205
UPRR east
30
28
26
24
22
20
18
16
14
0
1
2
3
4
5
6

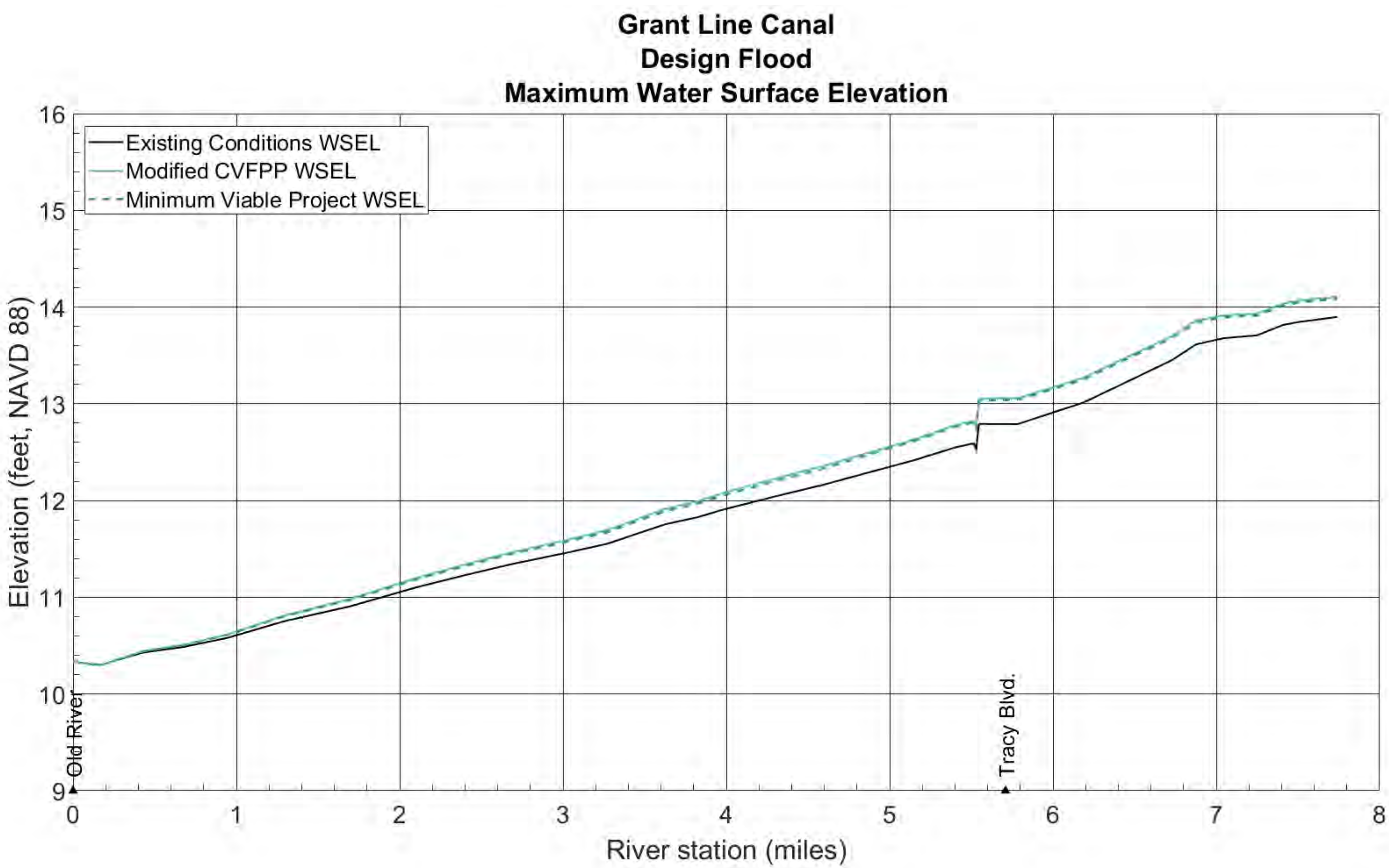

Paradise Cut
100-Year Flood with Climate Change
Maximum Water Surface Elevation
Existing Conditions WSEL
Modified CVFPP WSEL
Minimum Viable Project WSEL
Elevation (feet, NAVD 88)
River station (miles)
34
32
30
28
26
24
22
0
1
2
3
4
5
6
Paradise Road
UPRR west
I-5
I-205
UPRR east

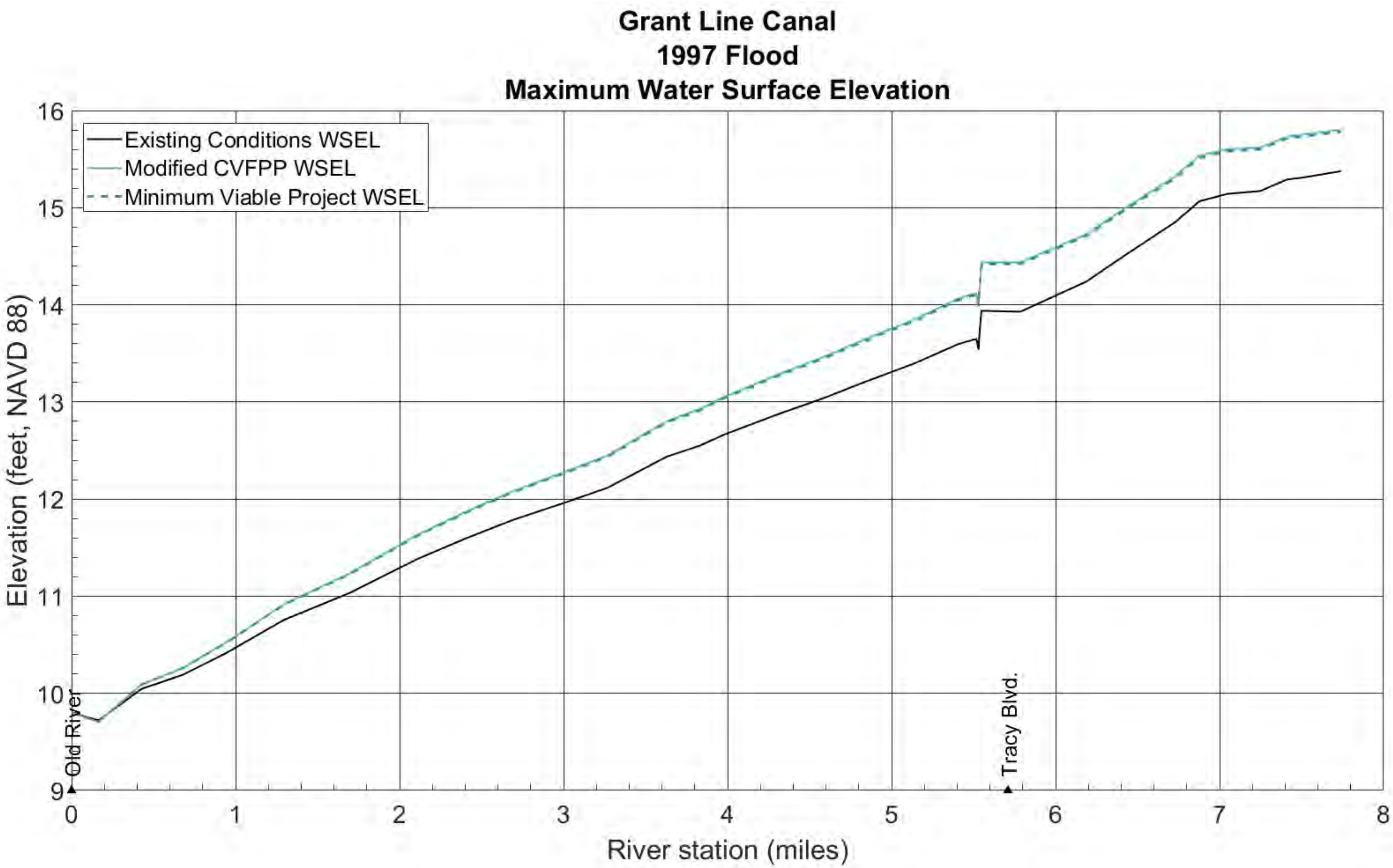

Old River
Design Flood
Maximum Water Surface Elevation
Existing Conditions WSEL
Modified CVFPP WSEL
Minimum Viable Project WSEL
Elevation (feet, NAVD 88)
River station (miles)
Hammer Island
Tracy Blvd.
d/s of Grant Line Canal
west end Stewart Tract
Middle R.
San Joaquin R.
26
24
22
20
18
16
14
12
10
8
0
2
4
6
8
10
12
14
16
18
20



Old River
1997 Flood
Maximum Water Surface Elevation
Existing Conditions WSEL
Modified CVFPP WSEL
Minimum Viable Project WSEL
Elevation (feet, NAVD 88)
River station (miles)
Hammer Island
Tracy Blvd.
d/s of Grant Line Canal
west end Stewart Tract
Middle R.
San Joaquin R.
26
24
22
20
18
16
14
12
10
8
0
2
4
6
8
10
12
14
16
18
20


Old River
100-Year Flood with Climate Change
Maximum Water Surface Elevation
Existing Conditions WSEL
Modified CVFPP WSEL
Minimum Viable Project WSEL
Elevation (feet, NAVD 88)
River station (miles)
Hammer Island
Tracy Blvd.
d/s of Grant Line Canal
west end Stewart Tract
Middle R.
San Joaquin R.
28
26
24
22
20
18
16
14
0
2
4
6
8
10
12
14
16
18
20


Grant Line Canal
Design Flood
Maximum Water Surface Elevation
Existing Conditions WSEL
Modified CVFPP WSEL
Minimum Viable Project WSEL
Elevation (feet, NAVD 88)
River station (miles)
Old River
Tracy Blvd.
16
15
14
13
12
11
10
9
0
1
2
3
4
5
6
7
8



Grant Line Canal
1997 Flood
Maximum Water Surface Elevation
Existing Conditions WSEL
Modified CVFPP WSEL
Minimum Viable Project WSEL
Elevation (feet, NAVD 88)
River station (miles)
Old River
Tracy Blvd.
16
15
14
13
12
11
10
9
0
1
2
3
4
5
6
7
8

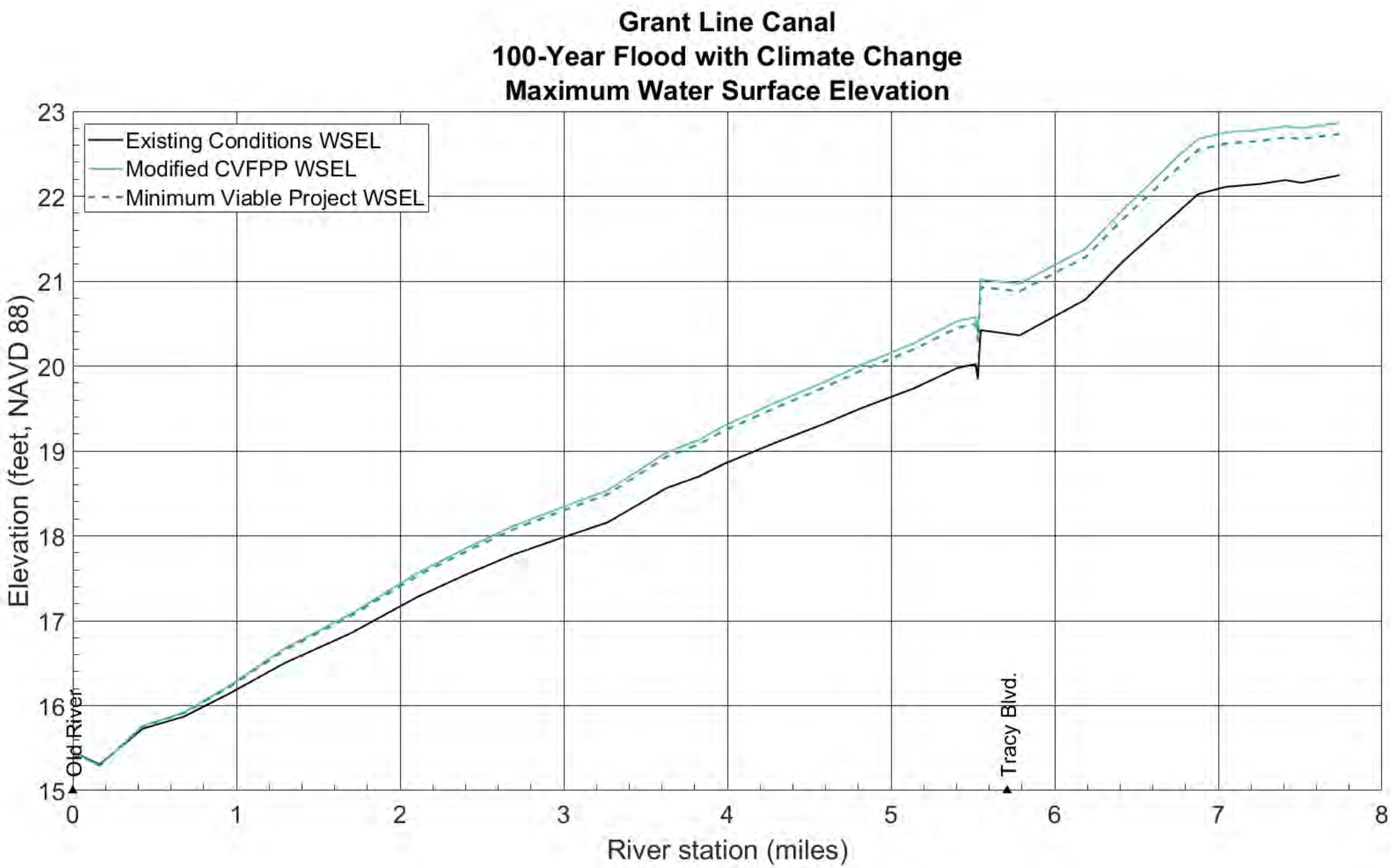
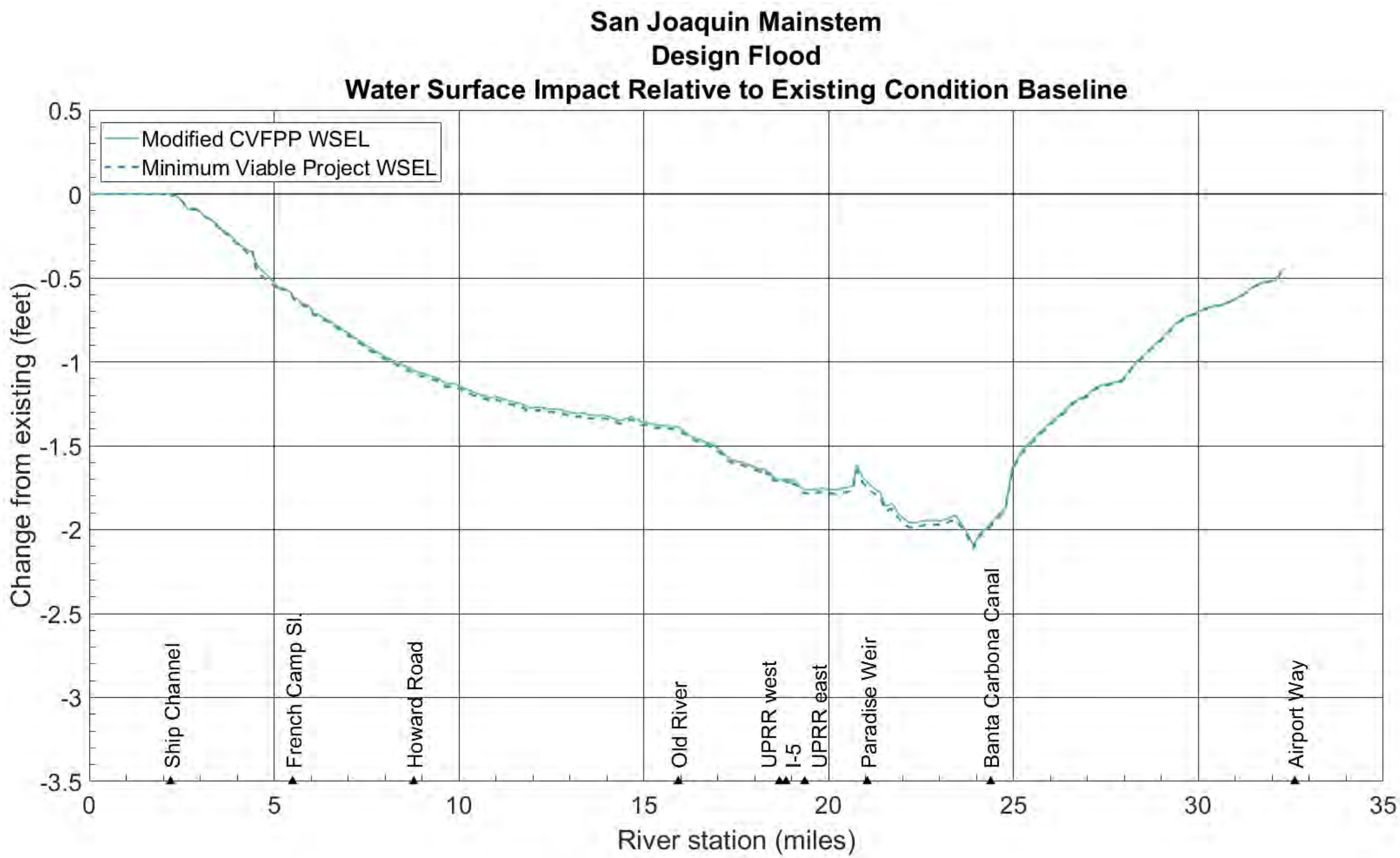
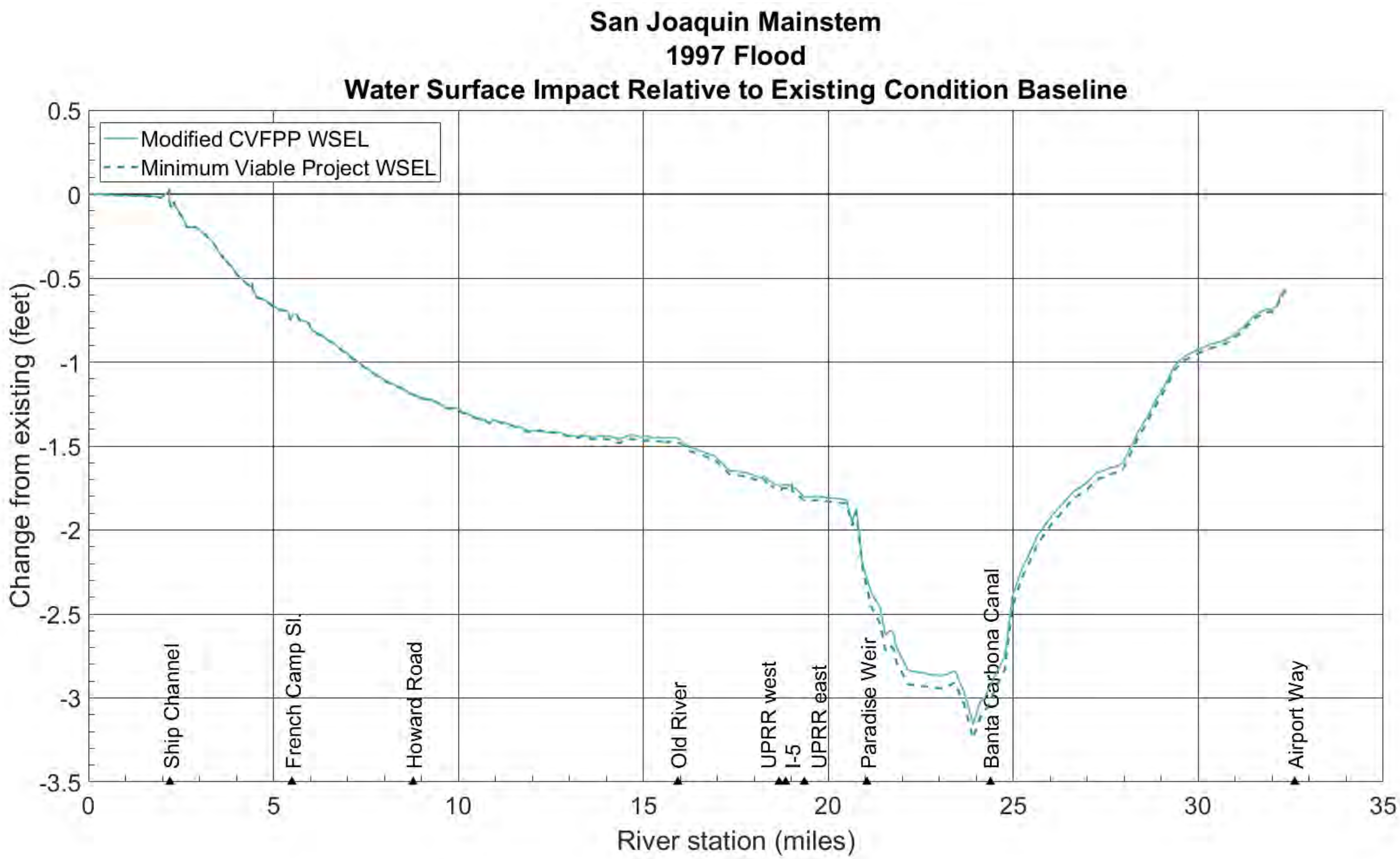
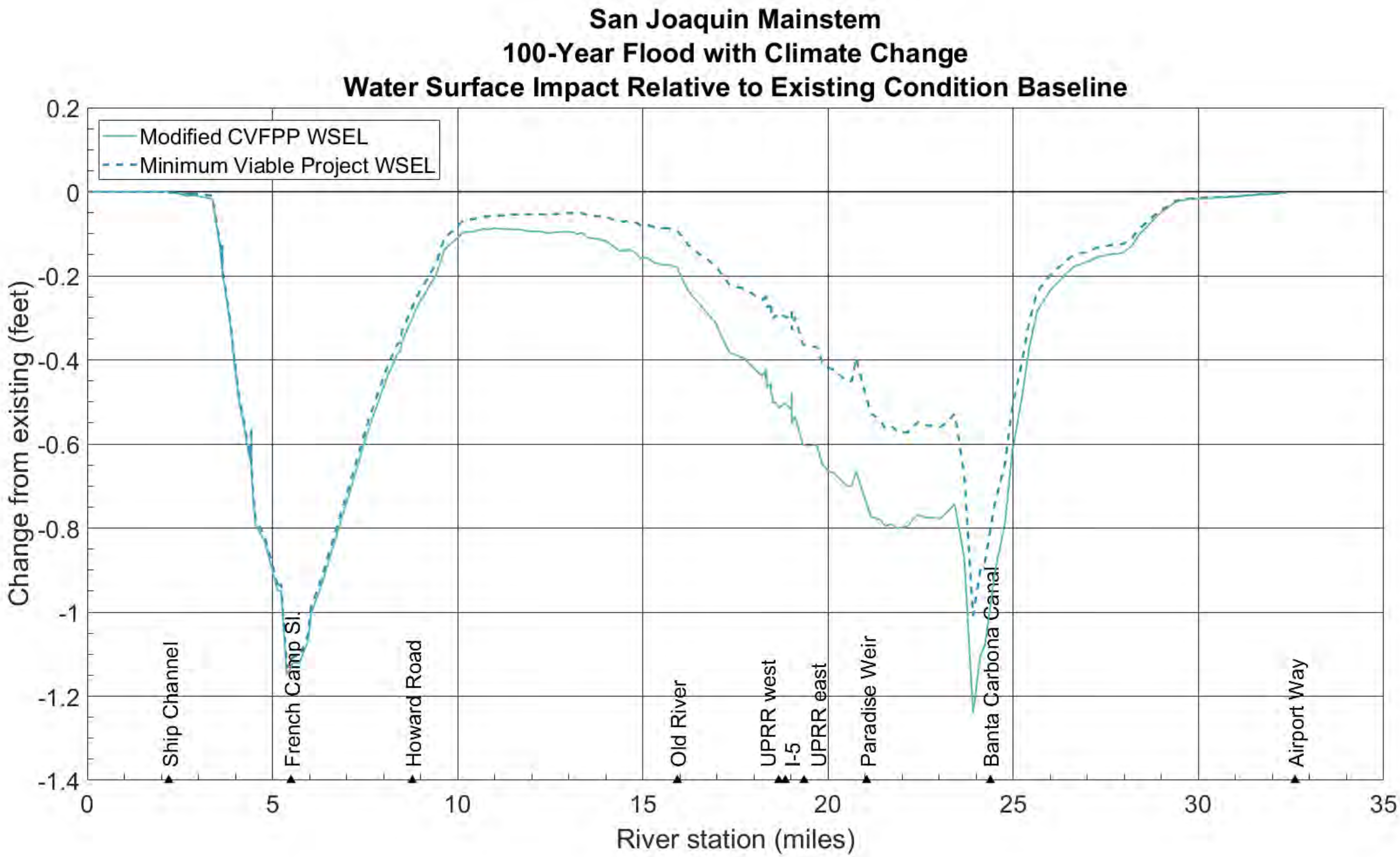
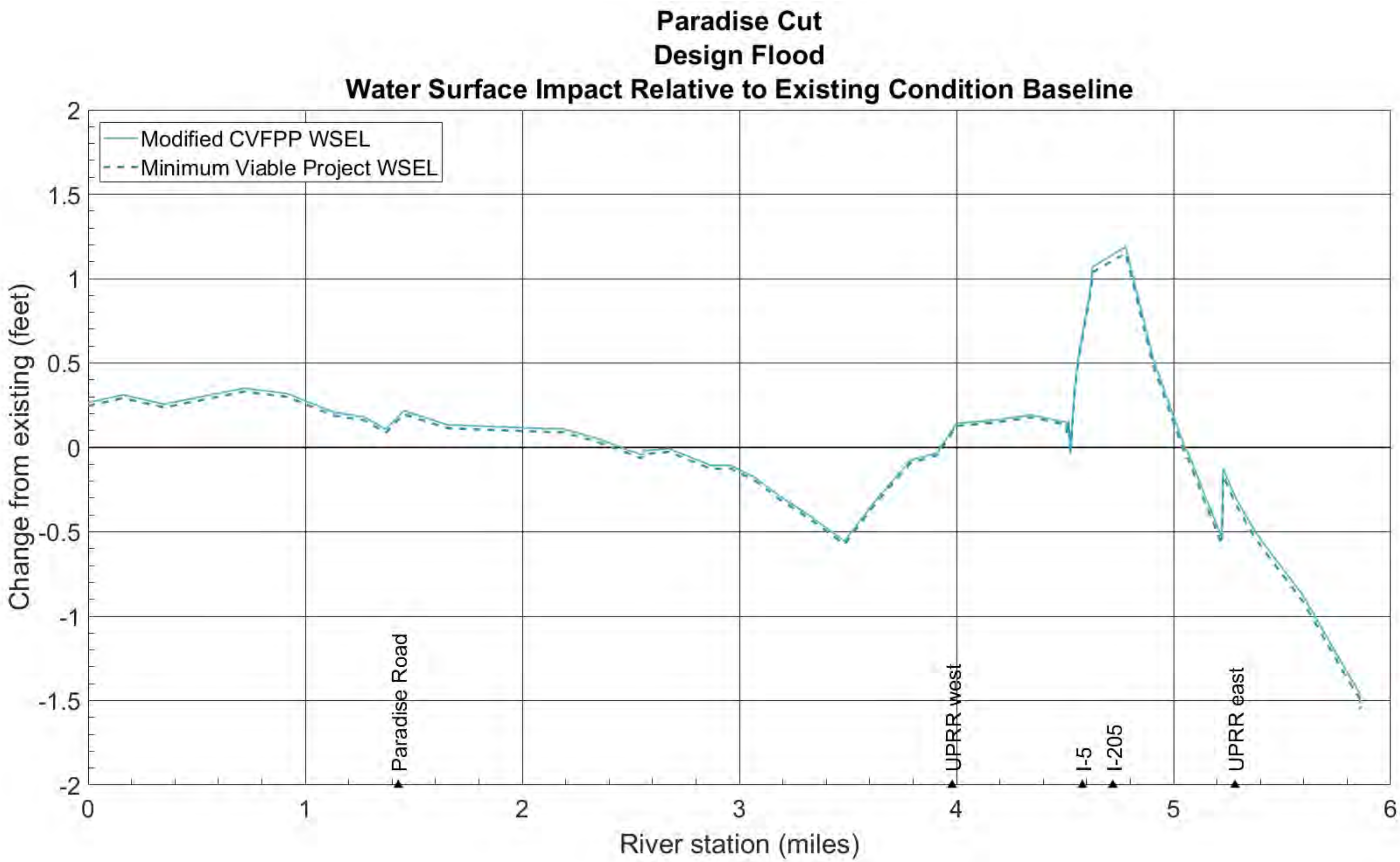

Grant Line Canal
100-Year Flood with Climate Change
Maximum Water Surface Elevation
Existing Conditions WSEL
Modified CVFPP WSEL
Minimum Viable Project WSEL
Elevation (feet, NAVD 88)
River station (miles)
Old River
Tracy Blvd.
23
22
21
20
19
18
17
16
15
0
1
2
3
4
5
6
7
8

Chart group 3b
MVP vs Modified CVFPP
relative difference

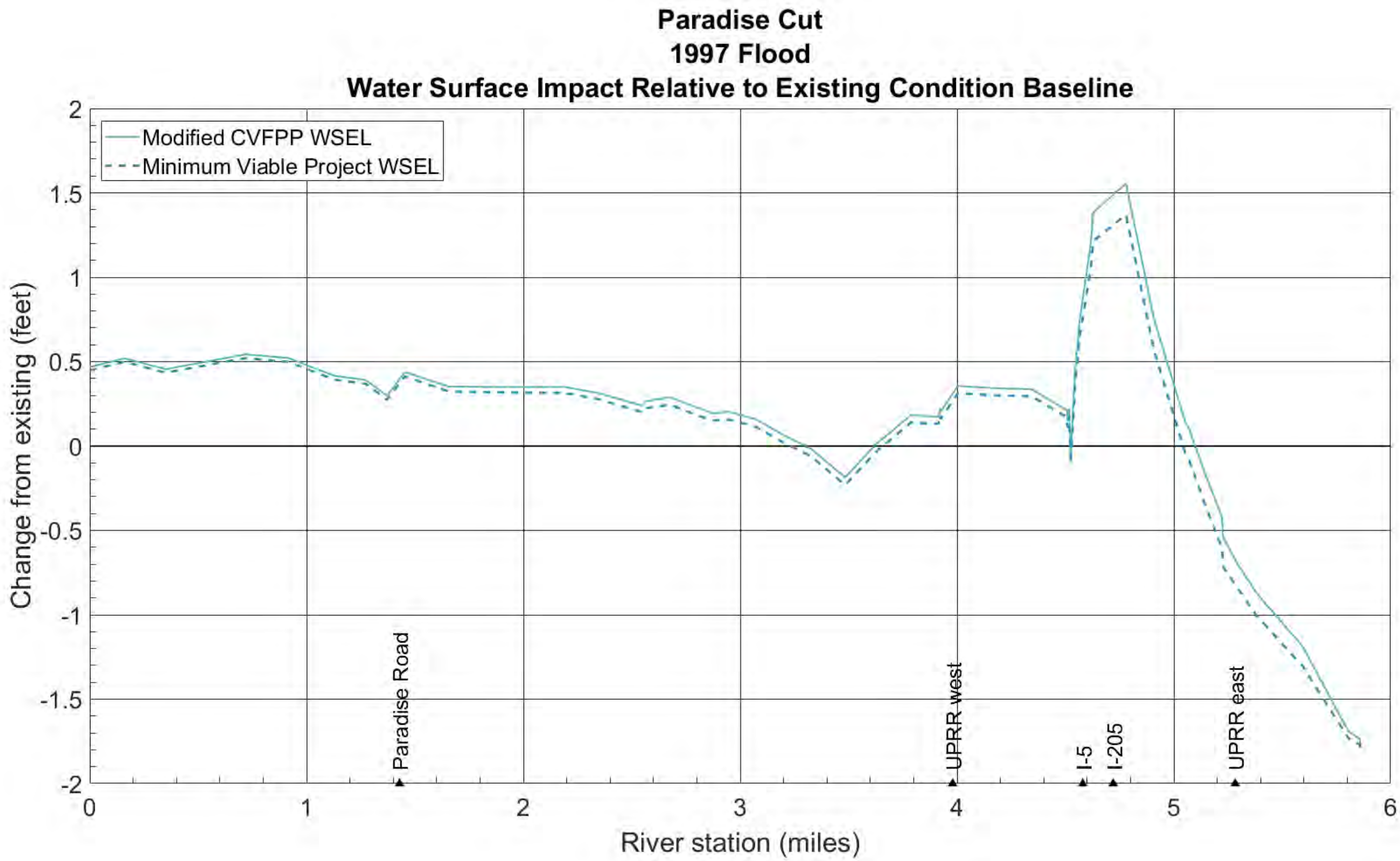

San Joaquin Mainstem
Design Flood
Water Surface Impact Relative to Existing Condition Baseline
Modified CVFPP WSEL
Minimum Viable Project WSEL
Change from existing (feet)
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
Ship Channel
French Camp Sl.
Howard Road
Old River
UPRR west
I-5
UPRR east
Paradise Weir
Banta Carbona Canal
Airport Way
0
5
10
15
20
25
30
35
River station (miles)


San Joaquin Mainstem
1997 Flood
Water Surface Impact Relative to Existing Condition Baseline
Modified CVFPP WSEL
Minimum Viable Project WSEL
Change from existing (feet)
River station (miles)
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
0
5
10
15
20
25
30
35
Ship Channel
French Camp Sl.
Howard Road
Old River
UPRR west
I-5
UPRR east
Paradise Weir
Banta Carbona Canal
Airport Way

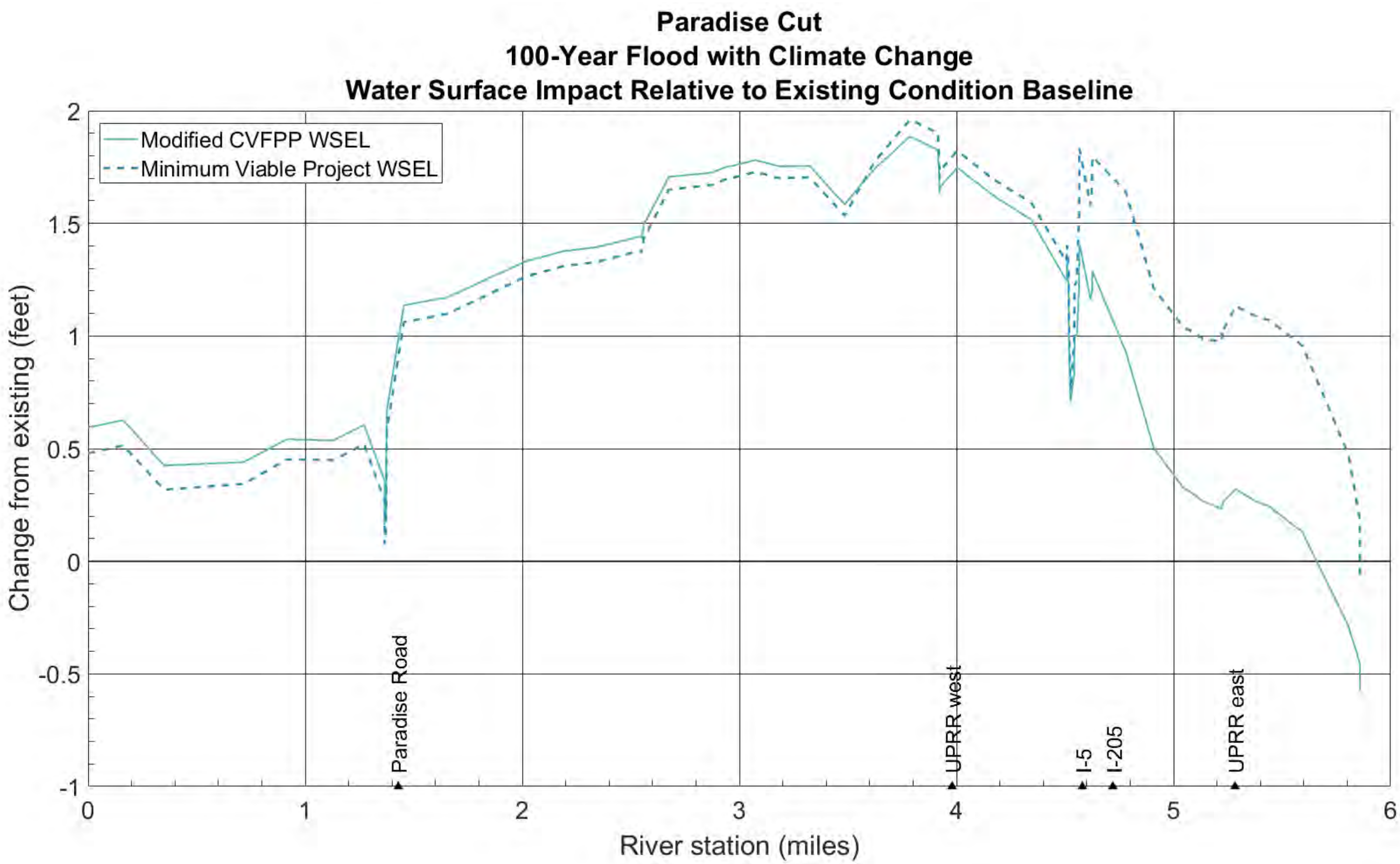

San Joaquin Mainstem
100-Year Flood with Climate Change
Water Surface Impact Relative to Existing Condition Baseline
Modified CVFPP WSEL
Minimum Viable Project WSEL
Change from existing (feet)
River station (miles)
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.4
0
5
10
15
20
25
30
35
Ship Channel
French Camp Sl.
Howard Road
Old River
UPRR west
I-5
UPRR east
Paradise Weir
Banta Carbona Canal
Airport Way



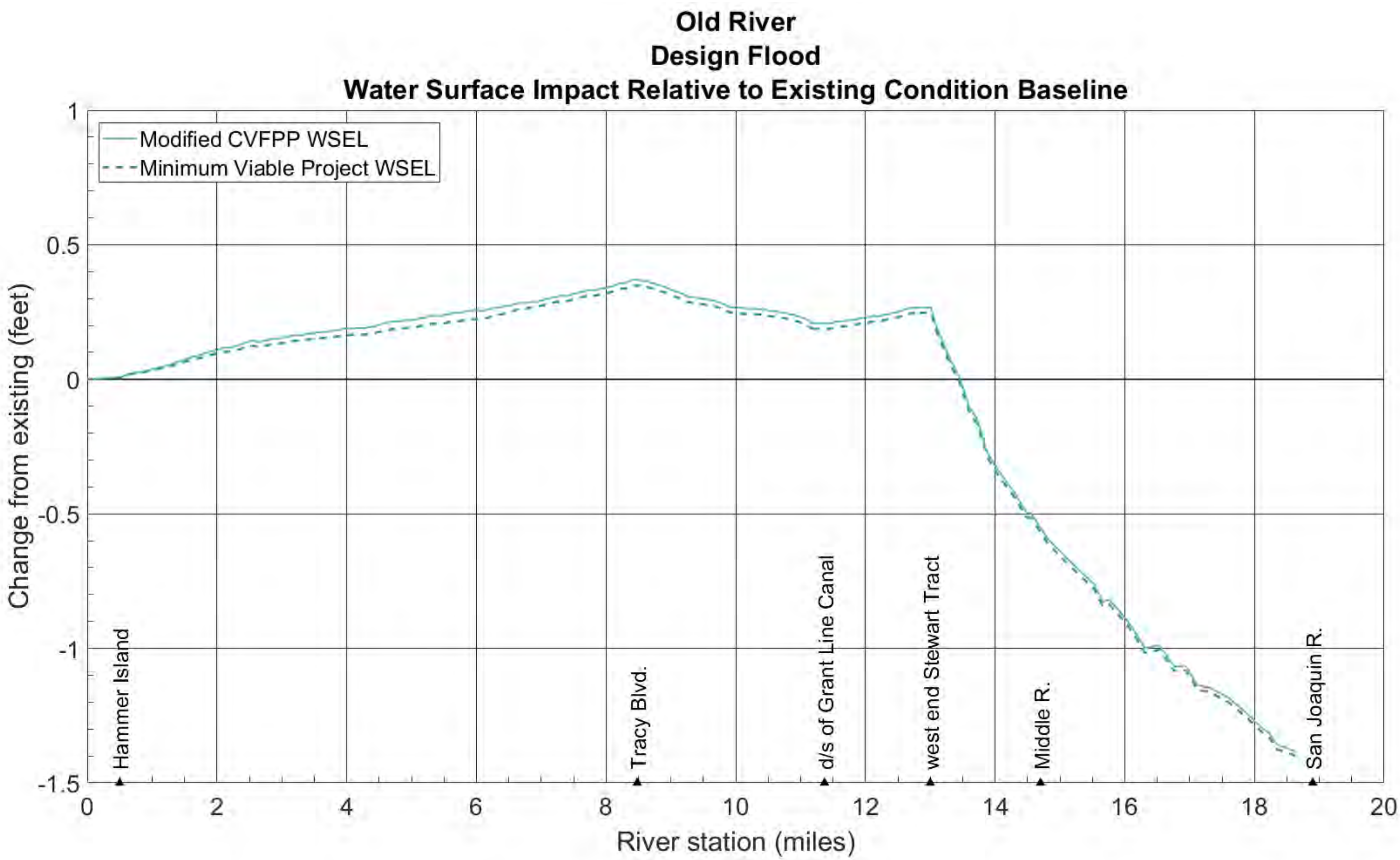
Paradise Cut
Design Flood
Water Surface Impact Relative to Existing Condition Baseline
Modified CVFPP WSEL
Minimum Viable Project WSEL
Change from existing (feet)
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
Paradise Road
UPRR west
I-5
I-205
UPRR east
0
1
2
3
4
5
6
River station (miles)



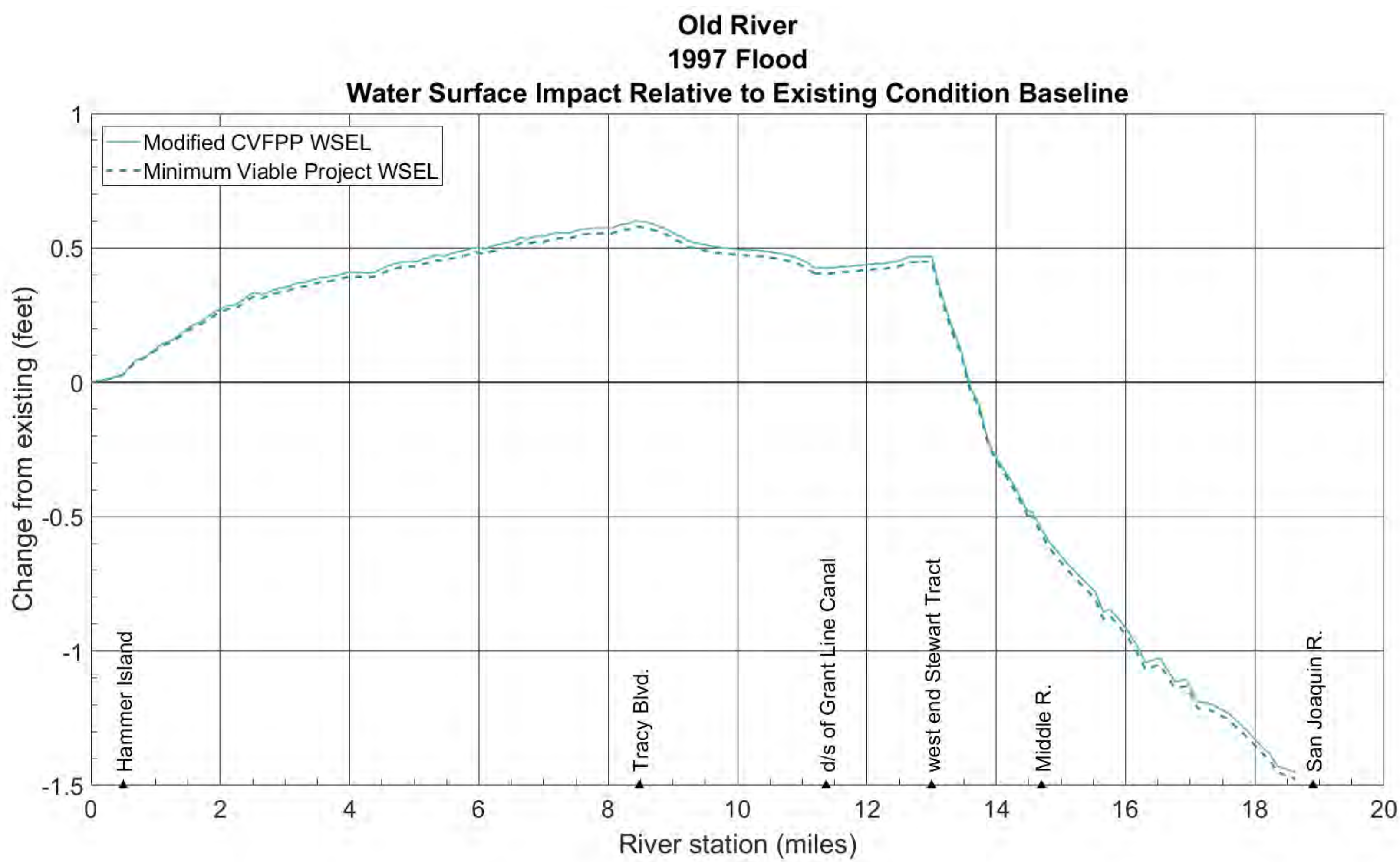
Paradise Cut
1997 Flood
Water Surface Impact Relative to Existing Condition Baseline
Modified CVFPP WSEL
Minimum Viable Project WSEL
Change from existing (feet)
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
0
1
2
3
4
5
6
River station (miles)
Paradise Road
UPRR west
I-5
I-205
UPRR east

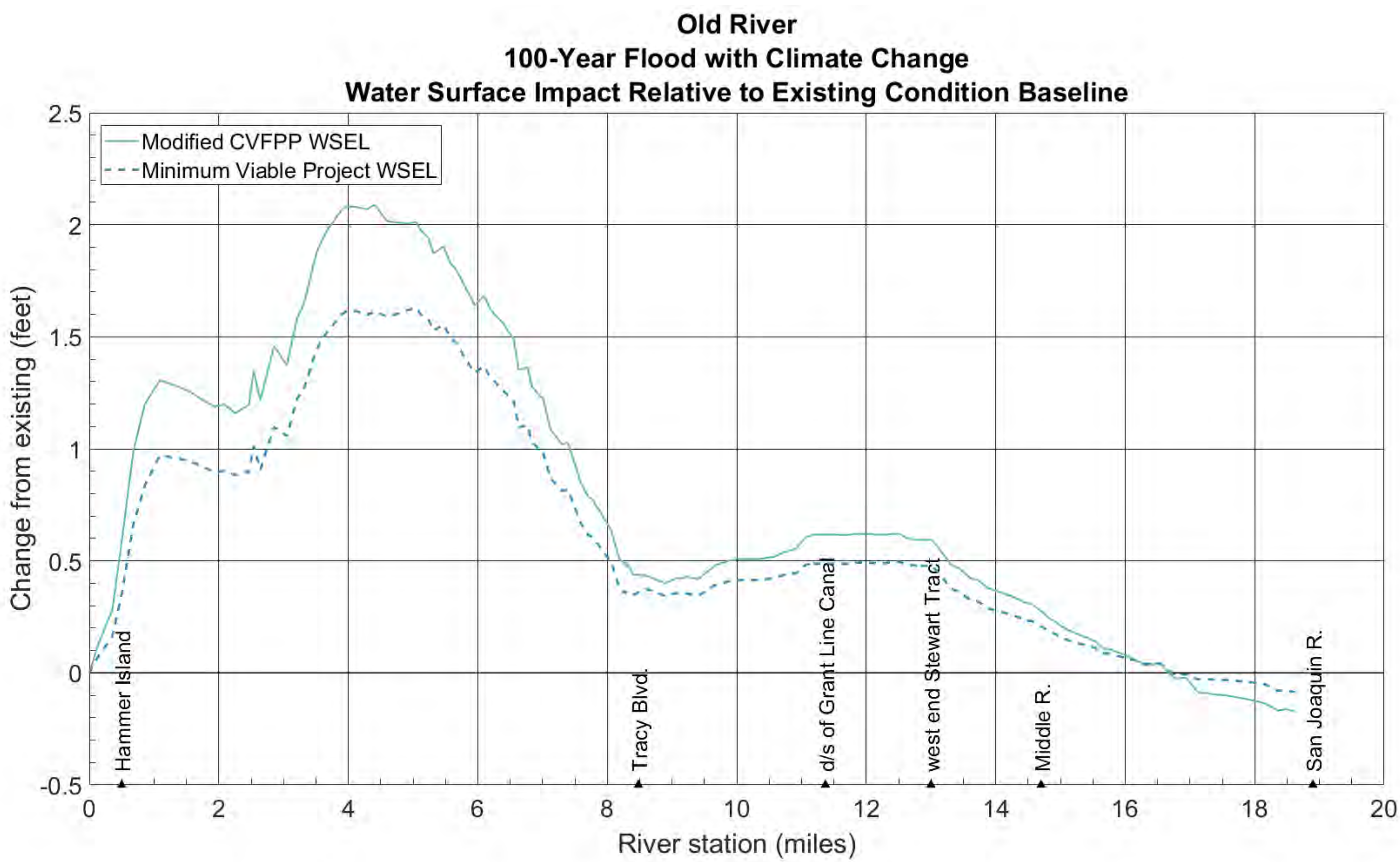


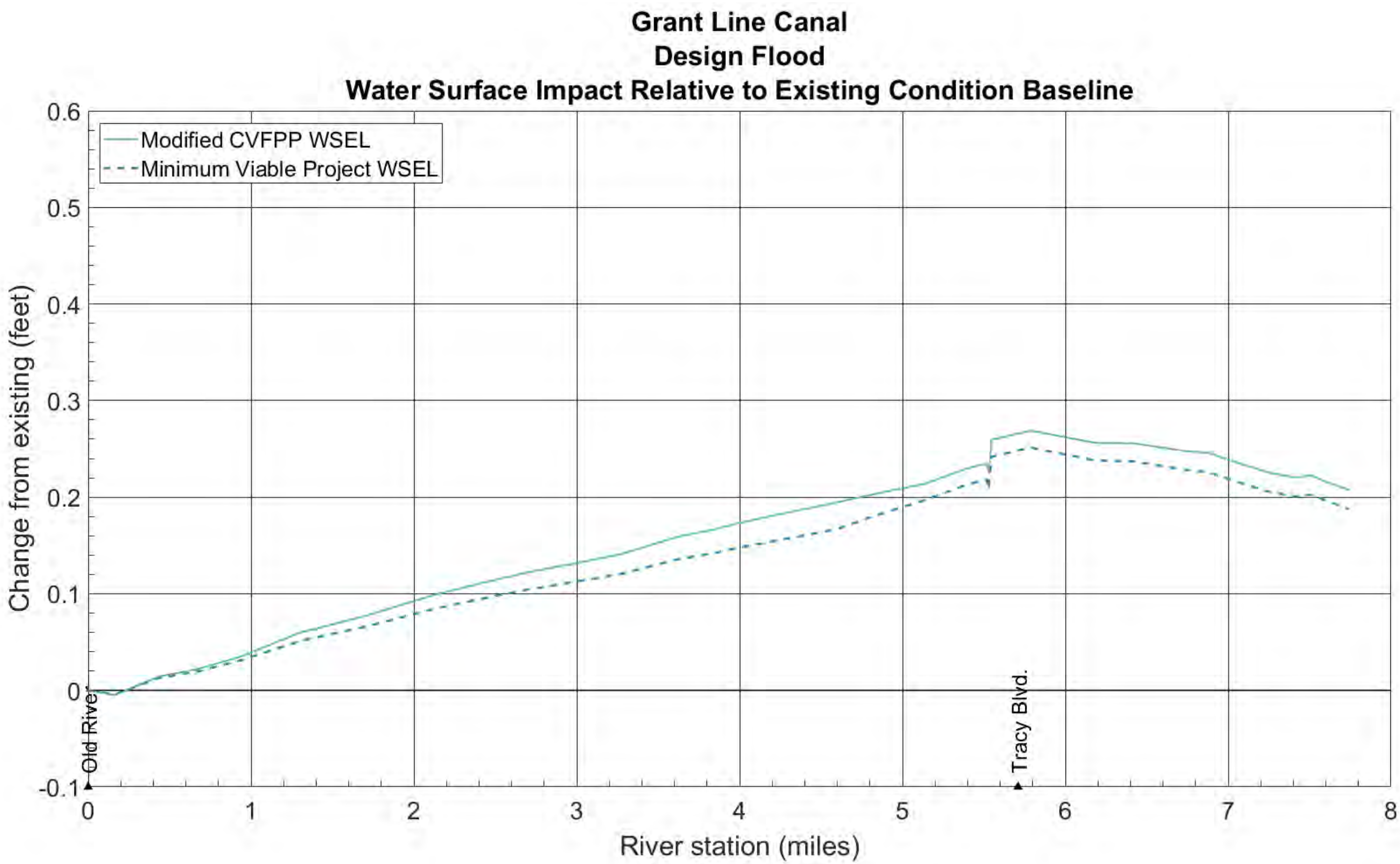
Paradise Cut
100-Year Flood with Climate Change
Water Surface Impact Relative to Existing Condition Baseline
Modified CVFPP WSEL
Minimum Viable Project WSEL
Change from existing (feet)
2
1.5
1
0.5
0
-0.5
-1
Paradise Road
UPRR west
I-5
I-205
UPRR east
0
1
2
3
4
5
6
River station (miles)



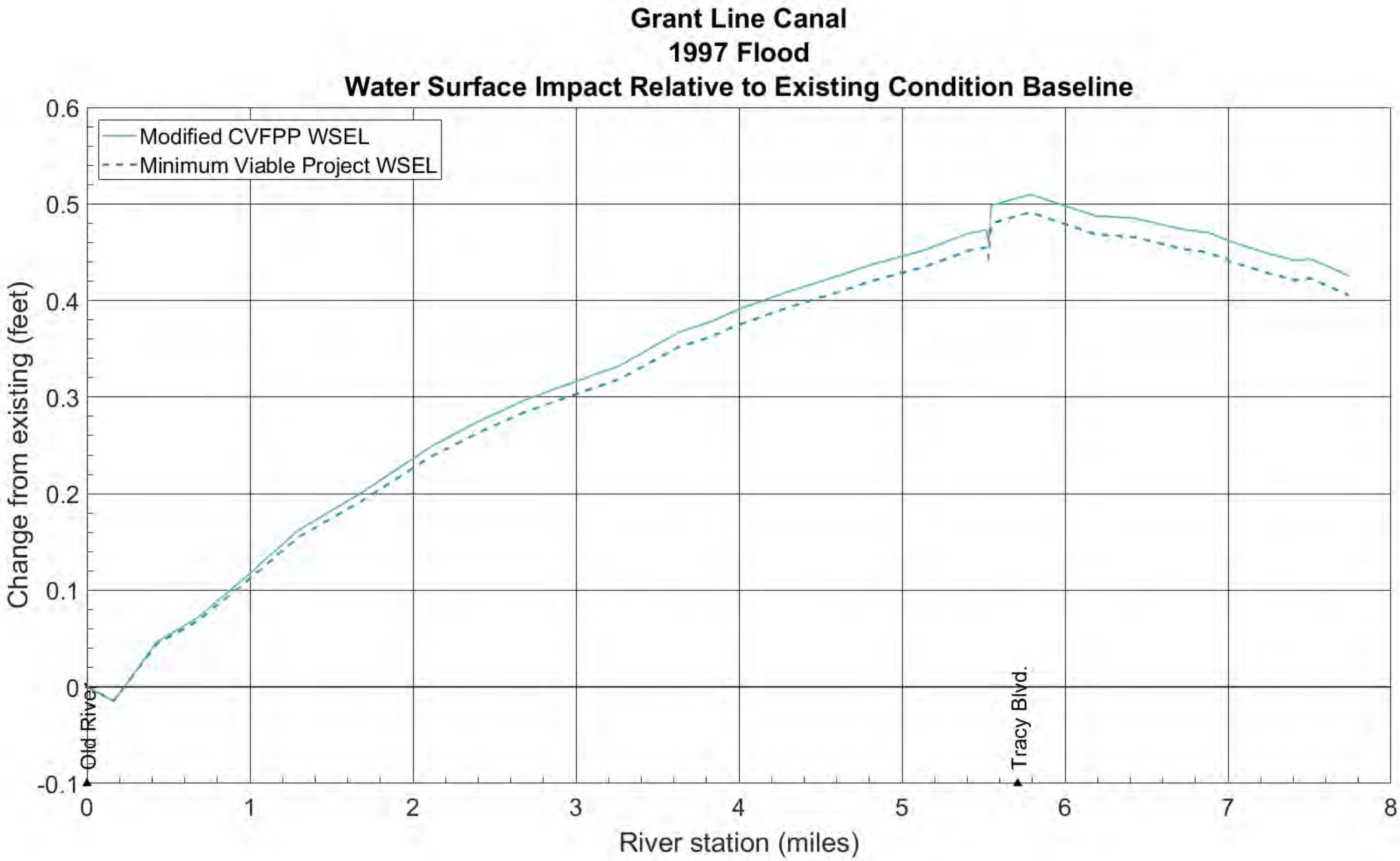
Old River
Design Flood
Water Surface Impact Relative to Existing Condition Baseline
Modified CVFPP WSEL
Minimum Viable Project WSEL
Change from existing (feet)
1
0.5
0
-0.5
-1
-1.5
Hammer Island
Tracy Blvd.
d/s of Grant Line Canal
west end Stewart Tract
Middle R.
San Joaquin R.
0
2
4
6
8
10
12
14
16
18
20
River station (miles)


Old River
1997 Flood
Water Surface Impact Relative to Existing Condition Baseline
Modified CVFPP WSEL
Minimum Viable Project WSEL
Change from existing (feet)
River station (miles)
Hammer Island
Tracy Blvd.
d/s of Grant Line Canal
west end Stewart Tract
Middle R.
San Joaquin R.
1
0.5
0
-0.5
-1
-1.5
0
2
4
6
8
10
12
14
16
18
20


Old River
100-Year Flood with Climate Change
Water Surface Impact Relative to Existing Condition Baseline
Modified CVFPP WSEL
Minimum Viable Project WSEL
Change from existing (feet)
River station (miles)
Hammer Island
Tracy Blvd.
d/s of Grant Line Canal
west end Stewart Tract
Middle R.
San Joaquin R.
2.5
2
1.5
1
0.5
0
-0.5
0
2
4
6
8
10
12
14
16
18
20



Grant Line Canal
Design Flood
Water Surface Impact Relative to Existing Condition Baseline
Modified CVFPP WSEL
Minimum Viable Project WSEL
Change from existing (feet)
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
0
1
2
3
4
5
6
7
8
River station (miles)
Old Rive
Tracy Blvd.


Grant Line Canal
1997 Flood
Water Surface Impact Relative to Existing Condition Baseline
Modified CVFPP WSEL
Minimum Viable Project WSEL
Change from existing (feet)
River station (miles)
Old River
Tracy Blvd.
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
0
1
2
3
4
5
6
7
8

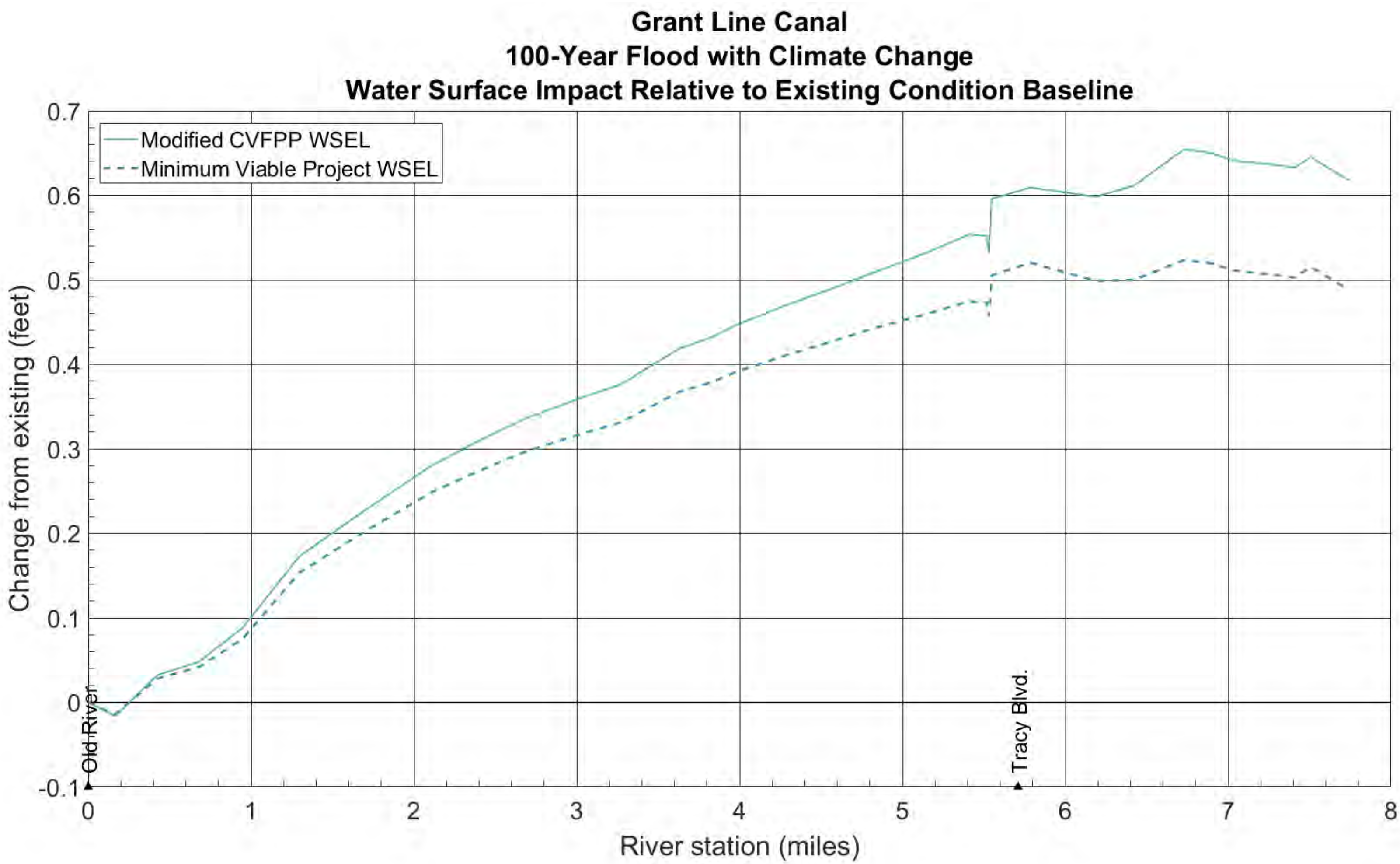
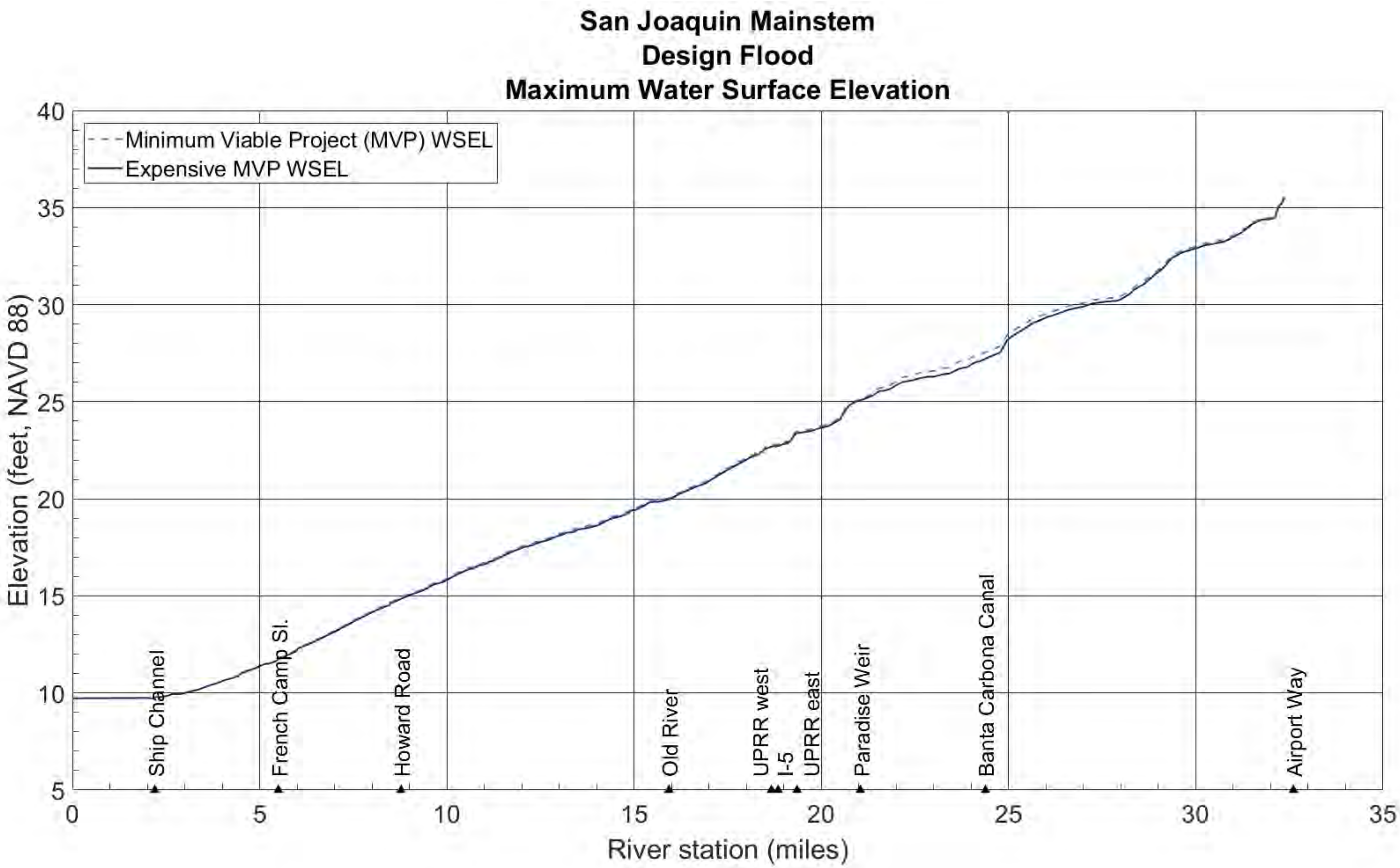
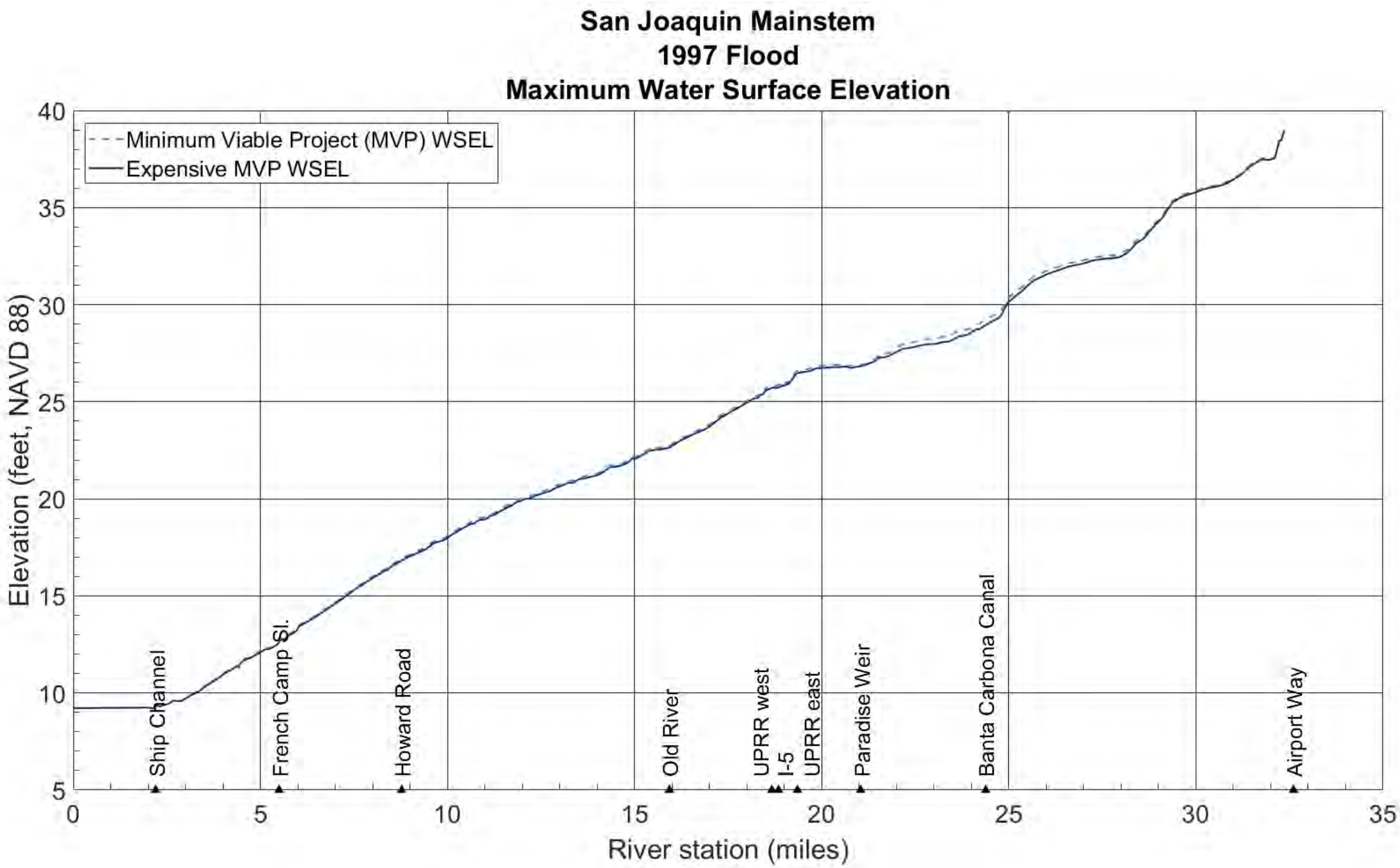

Grant Line Canal
100-Year Flood with Climate Change
Water Surface Impact Relative to Existing Condition Baseline
Modified CVFPP WSEL
Minimum Viable Project WSEL
Change from existing (feet)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
Old River
Tracy Blvd.
0
1
2
3
4
5
6
7
8
River station (miles)

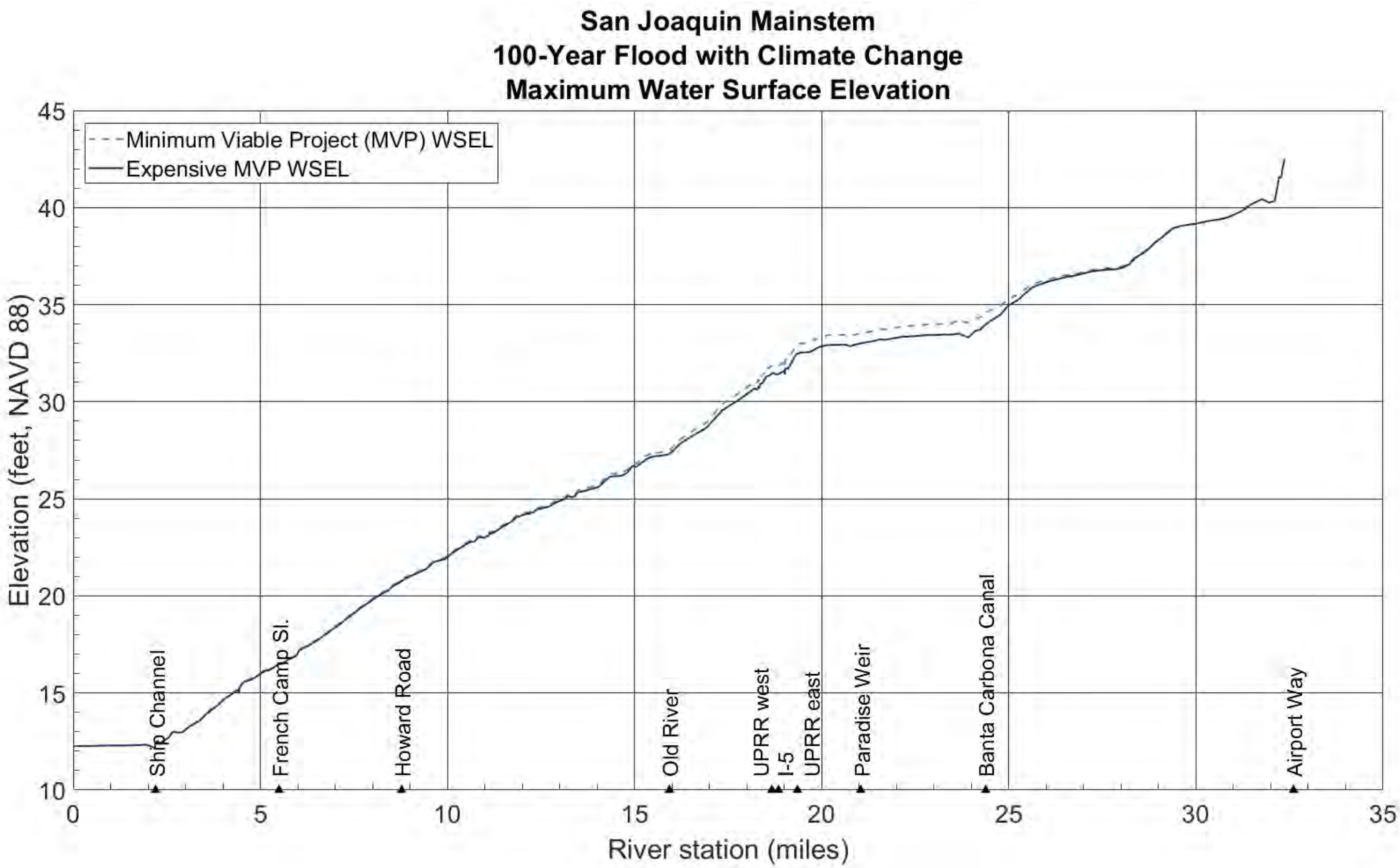
Chart Group 4a
Expensive MVP* vs MVP
water surface elevation

* Not discussed in text – see modeling table run C2 for details.

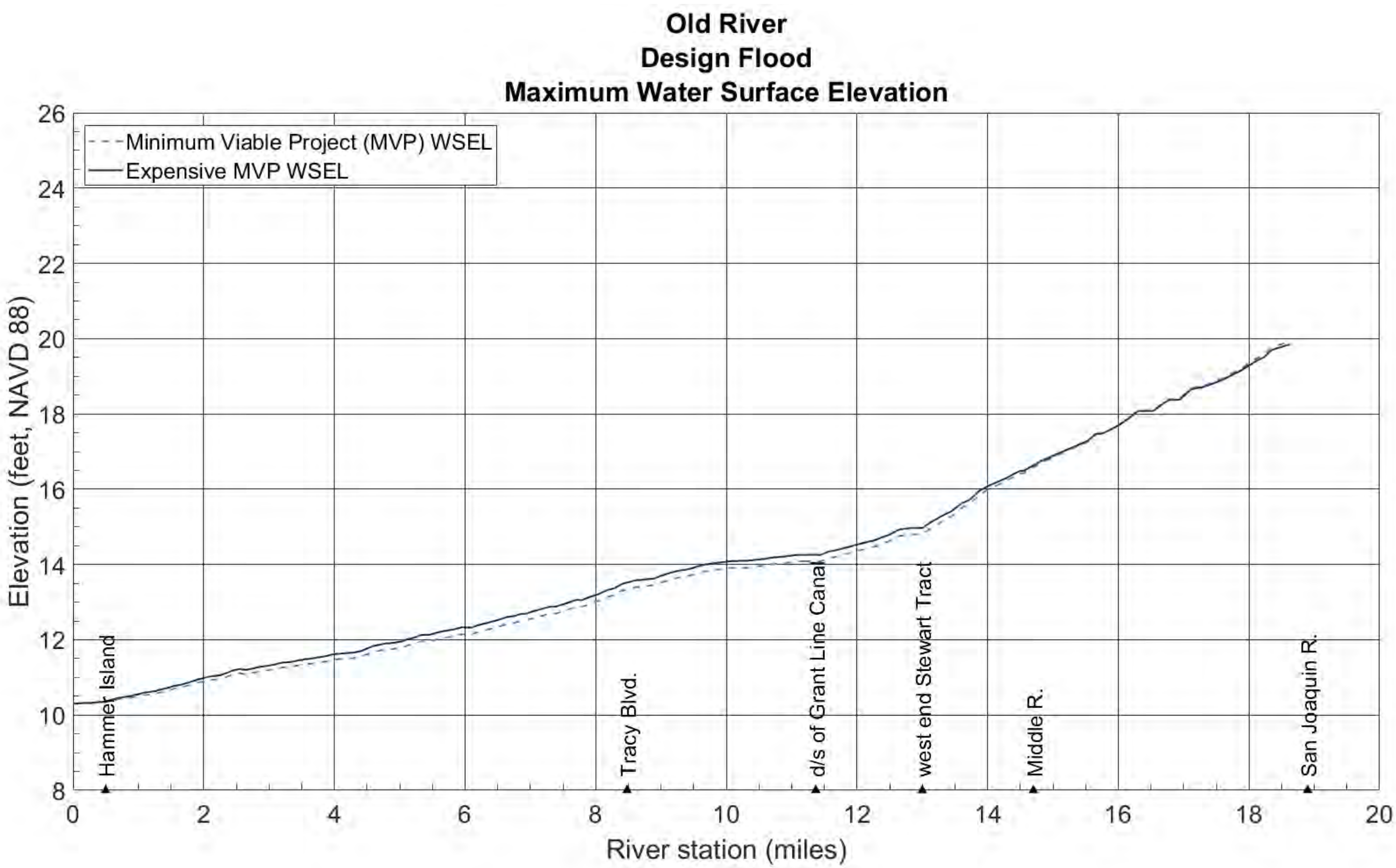


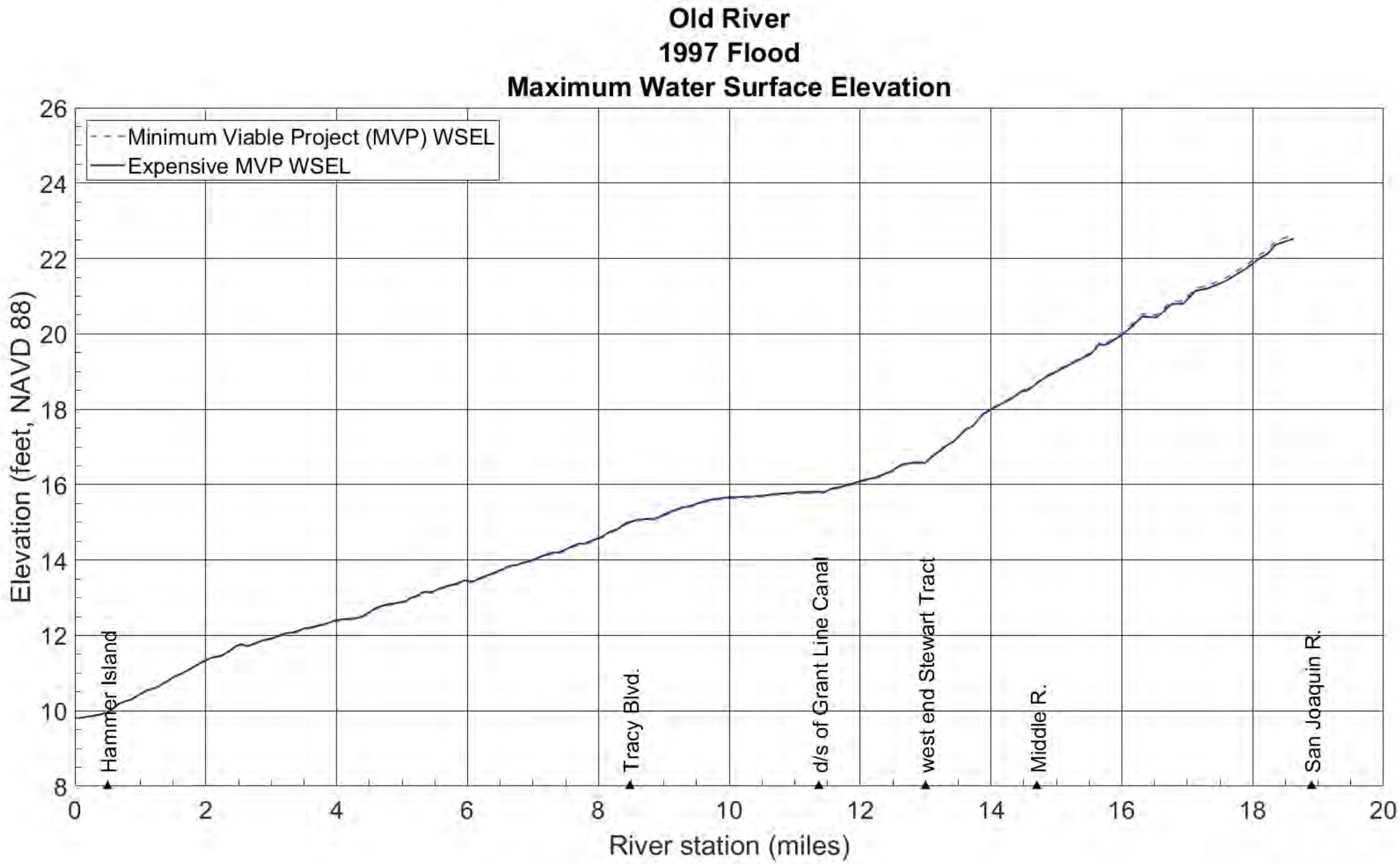
San Joaquin Mainstem
Design Flood
Maximum Water Surface Elevation
Minimum Viable Project (MVP) WSEL
Expensive MVP WSEL
Elevation (feet, NAVD 88)
River station (miles)
Ship Channel
French Camp Sl.
Howard Road
Old River
UPRR west
I-5
UPRR east
Paradise Weir
Banta Carbona Canal
Airport Way
40
35
30
25
20
15
10
5
0
5
10
15
20
25
30
35


San Joaquin Mainstem
1997 Flood
Maximum Water Surface Elevation
Minimum Viable Project (MVP) WSEL
Expensive MVP WSEL
Elevation (feet, NAVD 88)
River station (miles)
Ship Channel
French Camp Sl.
Howard Road
Old River
UPRR west
I-5
UPRR east
Paradise Weir
Banta Carbona Canal
Airport Way
40
35
30
25
20
15
10
5
0
5
10
15
20
25
30
35

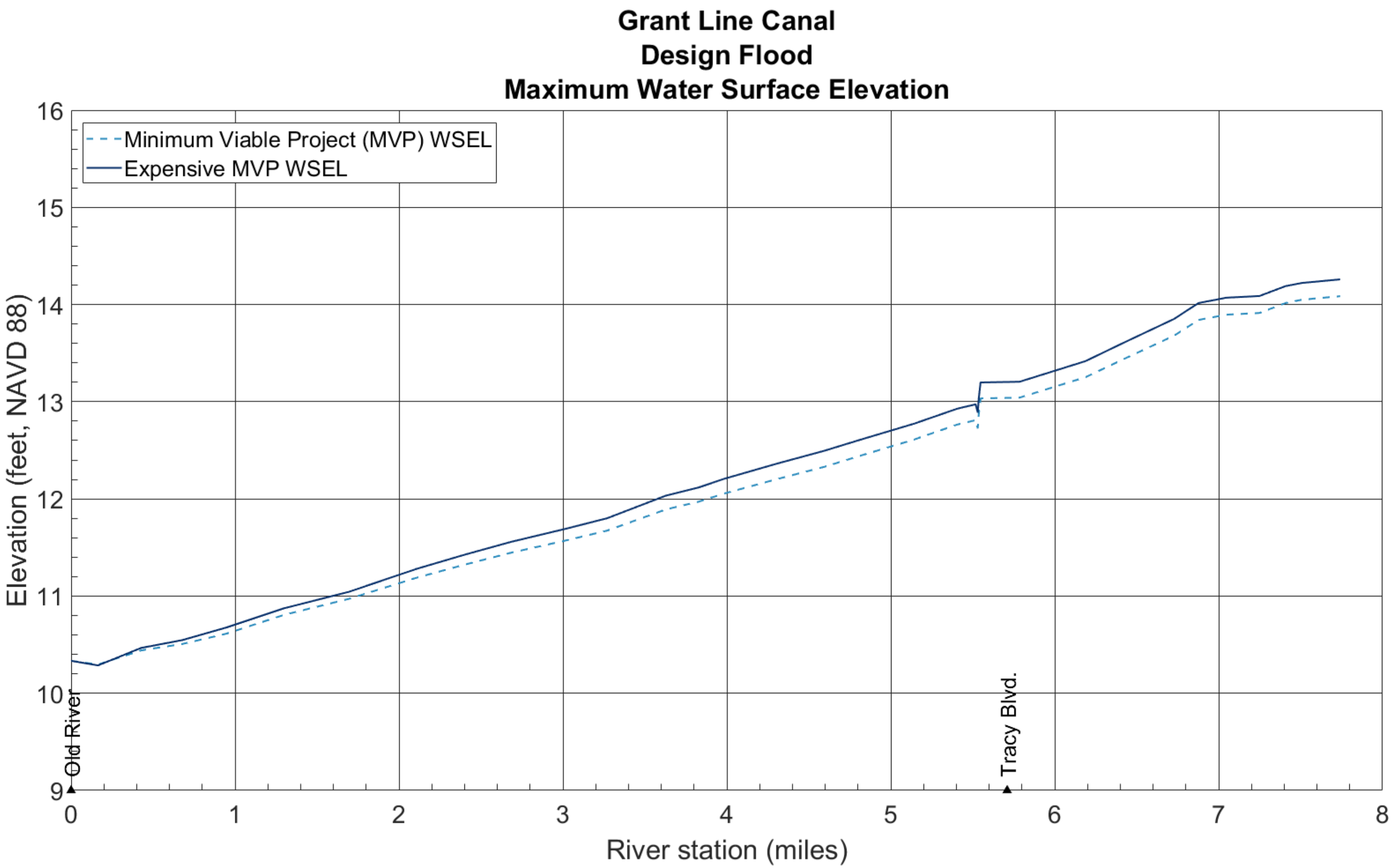


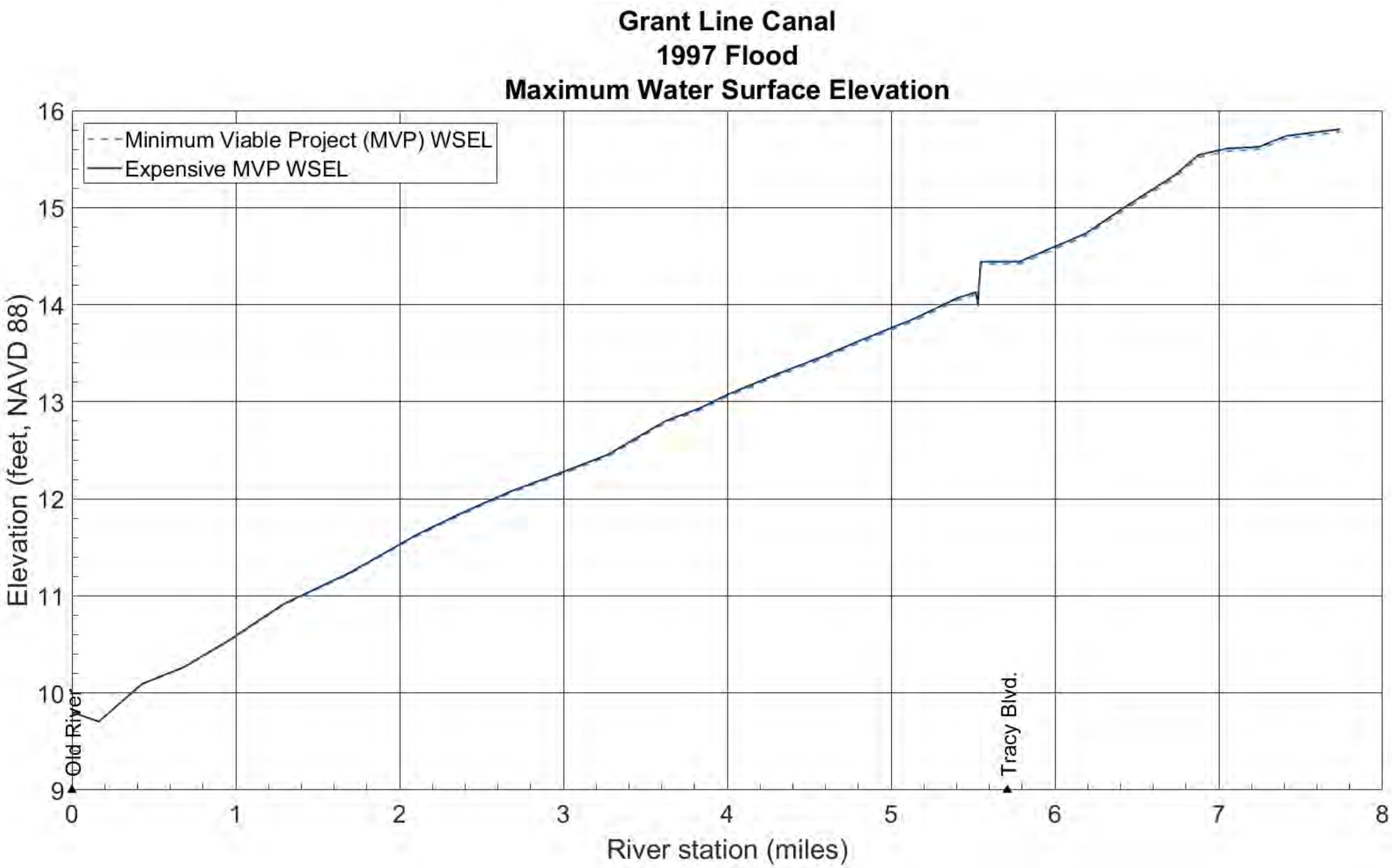
San Joaquin Mainstem
100-Year Flood with Climate Change
Maximum Water Surface Elevation
Minimum Viable Project (MVP) WSEL
Expensive MVP WSEL
Elevation (feet, NAVD 88)
River station (miles)
Ship Channel
French Camp Sl.
Howard Road
Old River
UPRR west
I-5
UPRR east
Paradise Weir
Banta Carbona Canal
Airport Way
10
15
20
25
30
35
40
45
0
5
10
15
20
25
30
35


Old River
Design Flood
Maximum Water Surface Elevation
Minimum Viable Project (MVP) WSEL
Expensive MVP WSEL
Elevation (feet, NAVD 88)
River station (miles)
Hammer Island
Tracy Blvd.
d/s of Grant Line Canal
west end Stewart Tract
Middle R.
San Joaquin R.
26
24
22
20
18
16
14
12
10
8
0
2
4
6
8
10
12
14
16
18
20



Old River
1997 Flood
Maximum Water Surface Elevation
Minimum Viable Project (MVP) WSEL
Expensive MVP WSEL
Elevation (feet, NAVD 88)
26
24
22
20
18
16
14
12
10
8
0
2
4
6
8
10
12
14
16
18
20
River station (miles)
Hammer Island
Tracy Blvd.
d/s of Grant Line Canal
west end Stewart Tract
Middle R.
San Joaquin R.

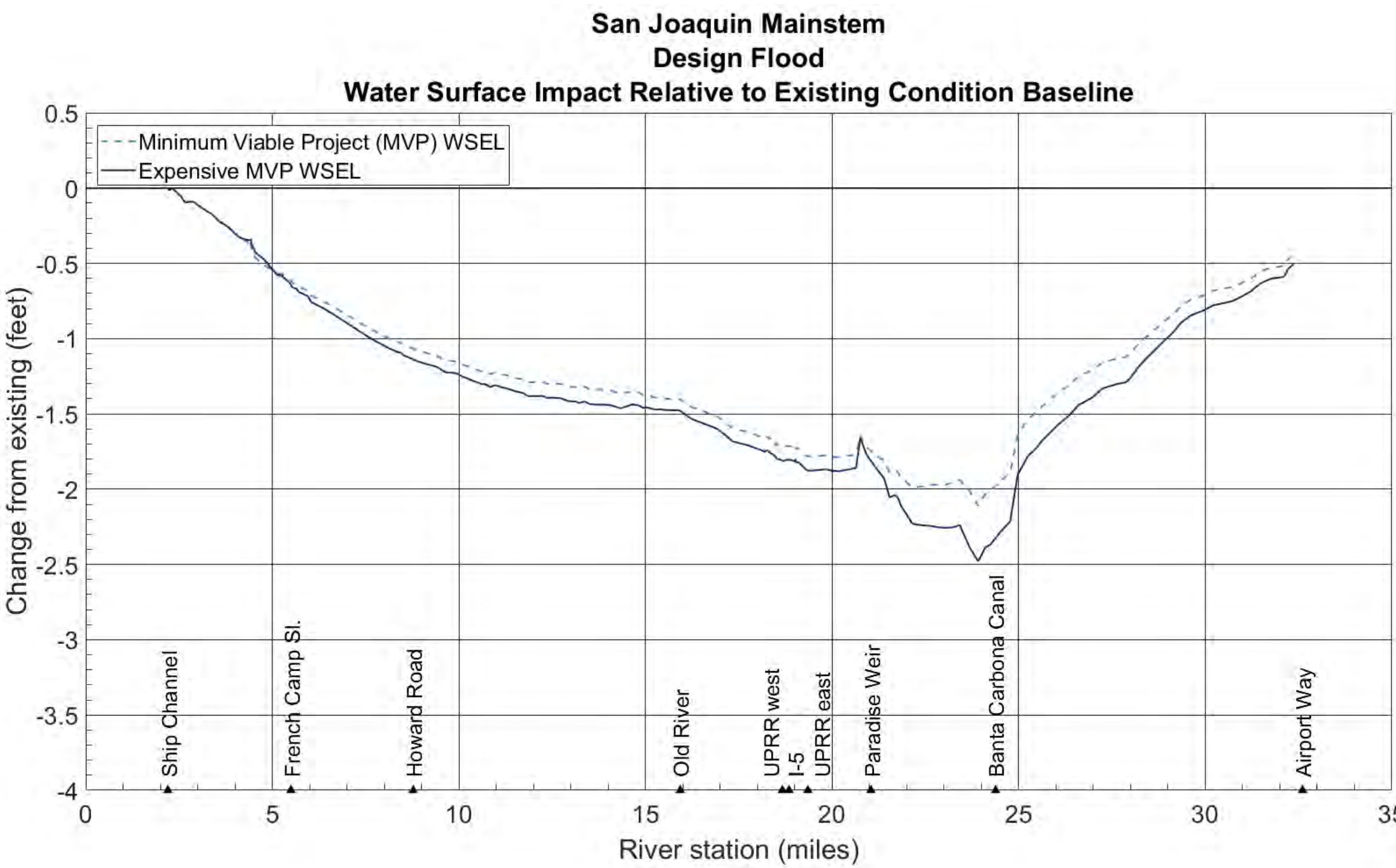

Grant Line Canal
Design Flood
Maximum Water Surface Elevation
Minimum Viable Project (MVP) WSEL
Expensive MVP WSEL
Elevation (feet, NAVD 88)
River station (miles)
Old River
Tracy Blvd.
16
15
14
13
12
11
10
9
0
1
2
3
4
5
6
7
8

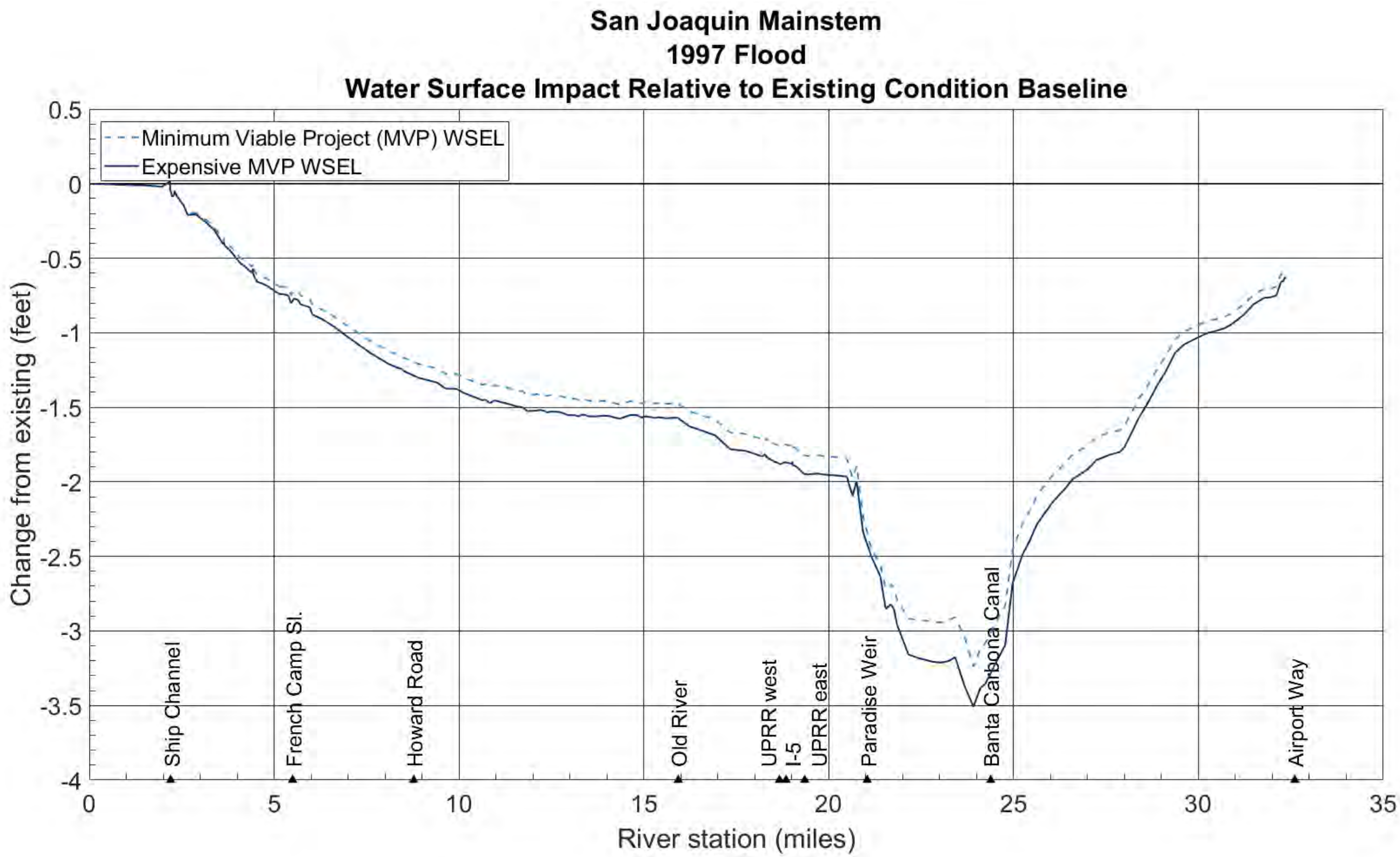


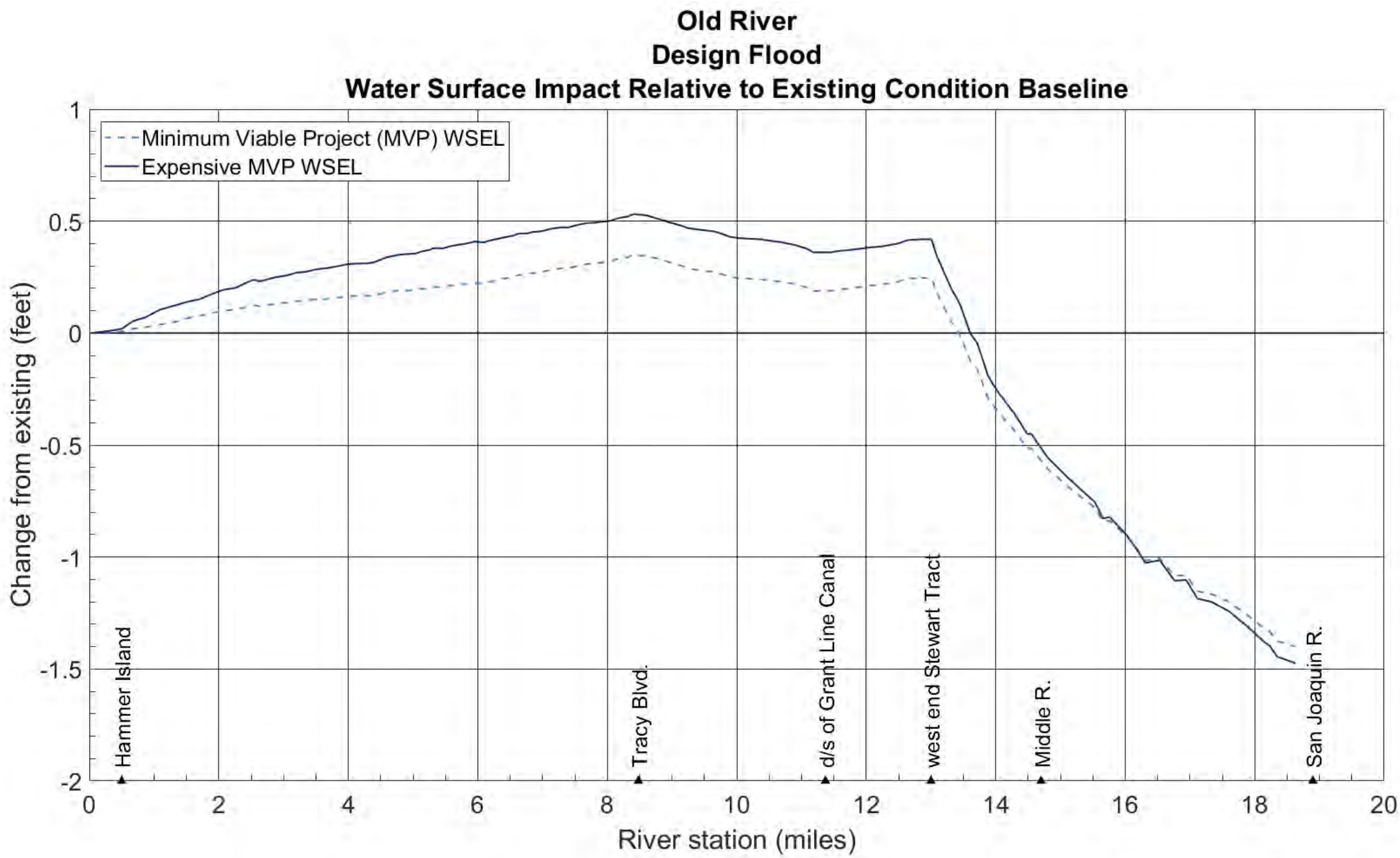
Grant Line Canal
1997 Flood
Maximum Water Surface Elevation
Minimum Viable Project (MVP) WSEL
Expensive MVP WSEL
Elevation (feet, NAVD 88)
River station (miles)
Old River
Tracy Blvd.
16
15
14
13
12
11
10
9
0
1
2
3
4
5
6
7
8

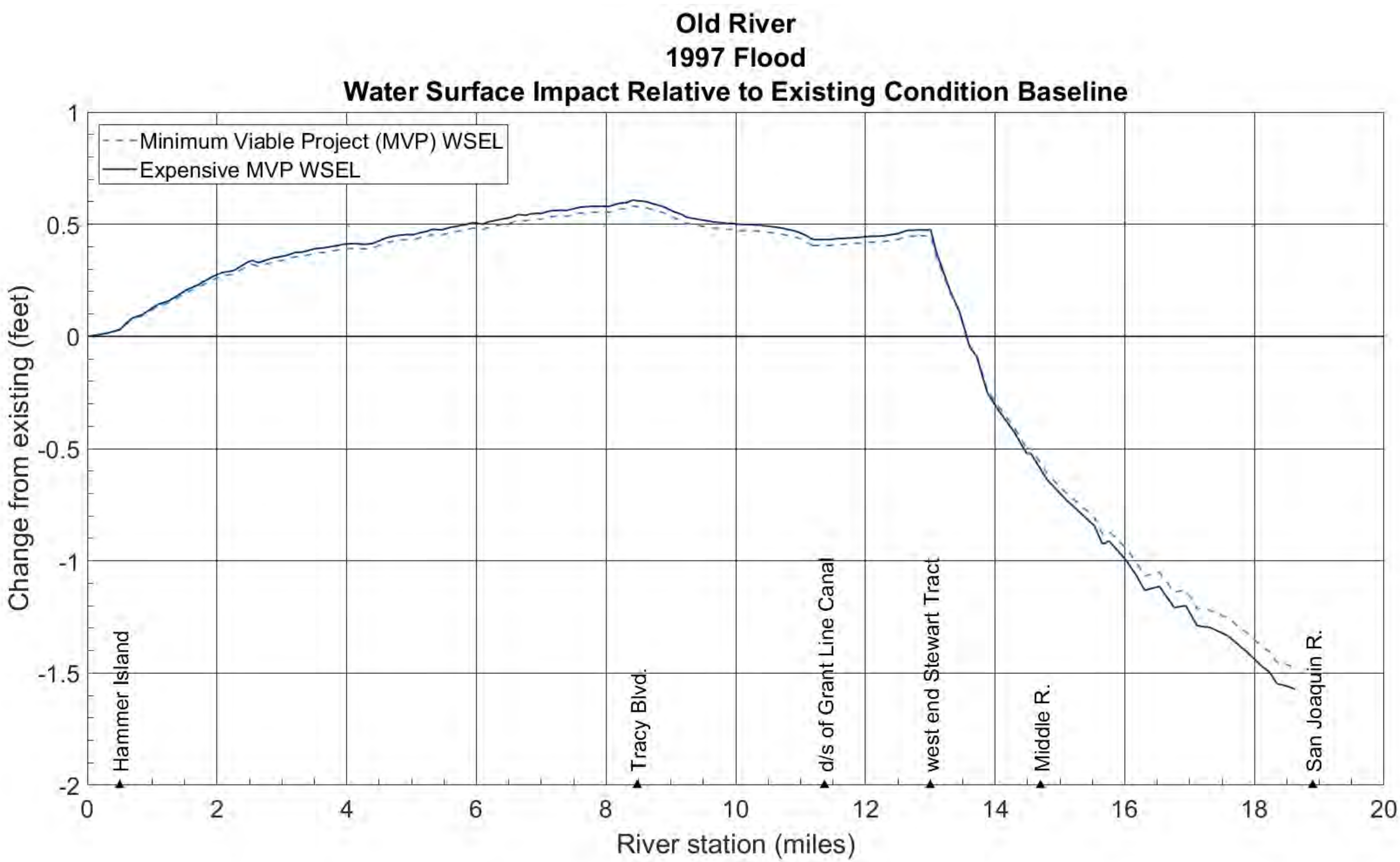
Chart group 4b
Expensive MVP* vs MVP
relative difference

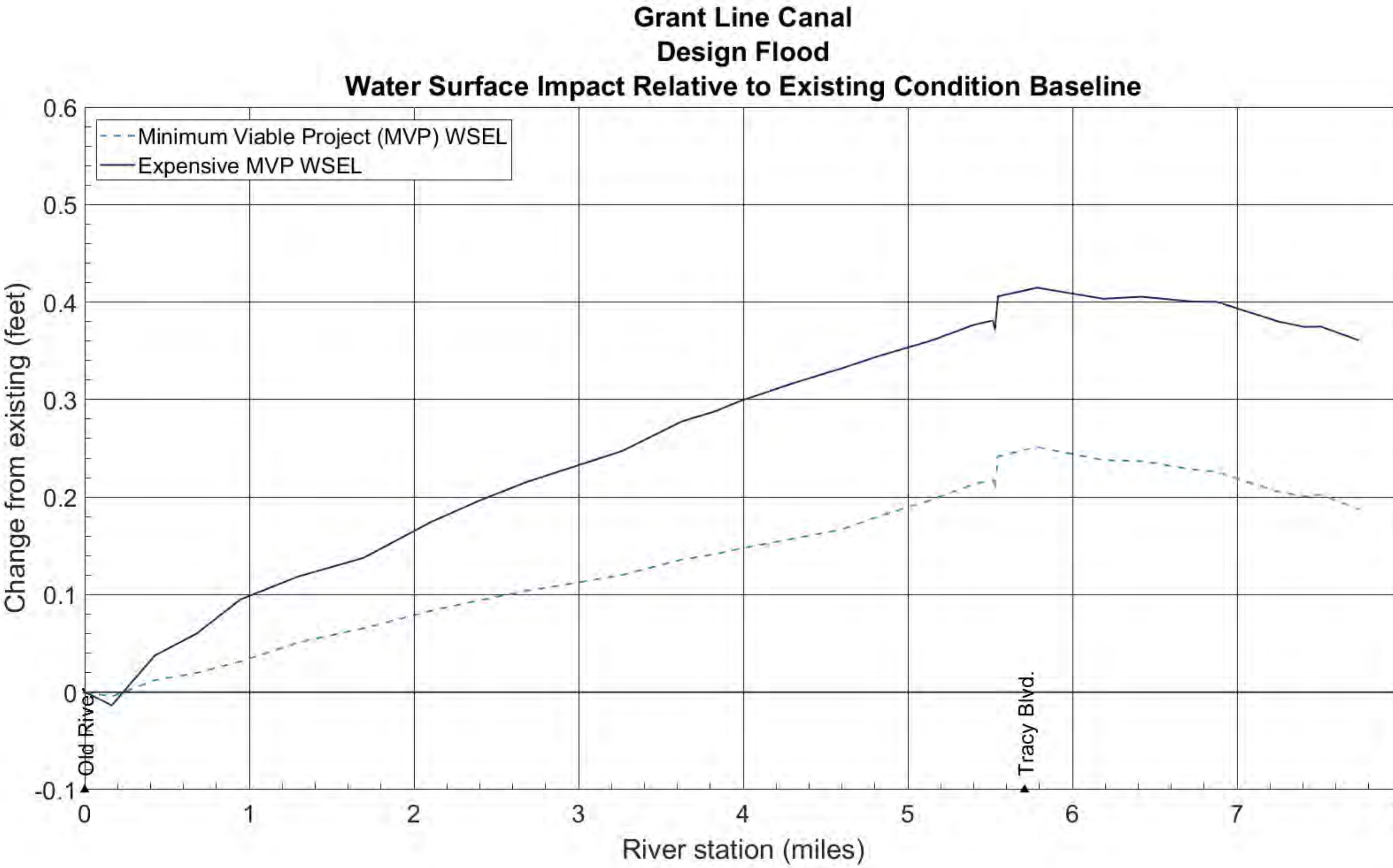
* Not discussed in text – see modeling table run C2 for details.


San Joaquin Mainstem
Design Flood
Water Surface Impact Relative to Existing Condition Baseline
Minimum Viable Project (MVP) WSEL
Expensive MVP WSEL
Change from existing (feet)
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
-4
0
5
10
15
20
25
30
35
River station (miles)
Ship Channel
French Camp Sl.
Howard Road
Old River
UPRR west
I-5
UPRR east
Paradise Weir
Banta Carbona Canal
Airport Way


San Joaquin Mainstem
1997 Flood
Water Surface Impact Relative to Existing Condition Baseline
Minimum Viable Project (MVP) WSEL
Expensive MVP WSEL
Change from existing (feet)
River station (miles)
Ship Channel
French Camp Sl.
Howard Road
Old River
UPRR west
I-5
UPRR east
Paradise Weir
Banta Carbona Canal
Airport Way
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
-4
0
5
10
15
20
25
30
35


Old River
Design Flood
Water Surface Impact Relative to Existing Condition Baseline
Minimum Viable Project (MVP) WSEL
Expensive MVP WSEL
Change from existing (feet)
1
0.5
0
-0.5
-1
-1.5
-2
0
2
4
6
8
10
12
14
16
18
20
River station (miles)
Hammer Island
Tracy Blvd.
d/s of Grant Line Canal
west end Stewart Tract
Middle R.
San Joaquin R.


Old River
1997 Flood
Water Surface Impact Relative to Existing Condition Baseline
Minimum Viable Project (MVP) WSEL
Expensive MVP WSEL
Change from existing (feet)
River station (miles)
Hammer Island
Tracy Blvd.
d/s of Grant Line Canal
west end Stewart Tract
Middle R.
San Joaquin R.


Grant Line Canal
Design Flood
Water Surface Impact Relative to Existing Condition Baseline
Minimum Viable Project (MVP) WSEL
Expensive MVP WSEL
Change from existing (feet)
River station (miles)
Old River
Tracy Blvd.
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
0
1
2
3
4
5
6
7
8

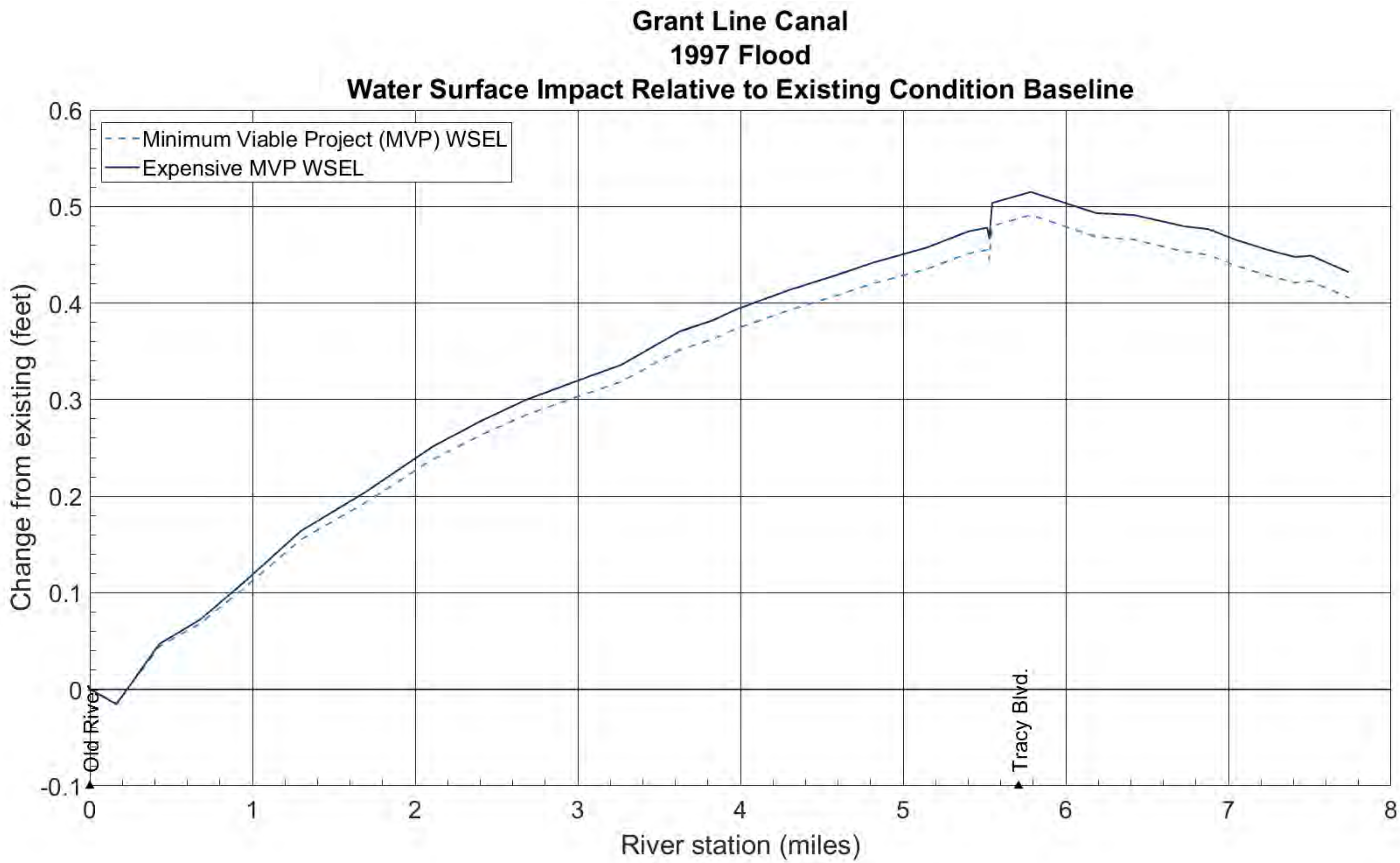
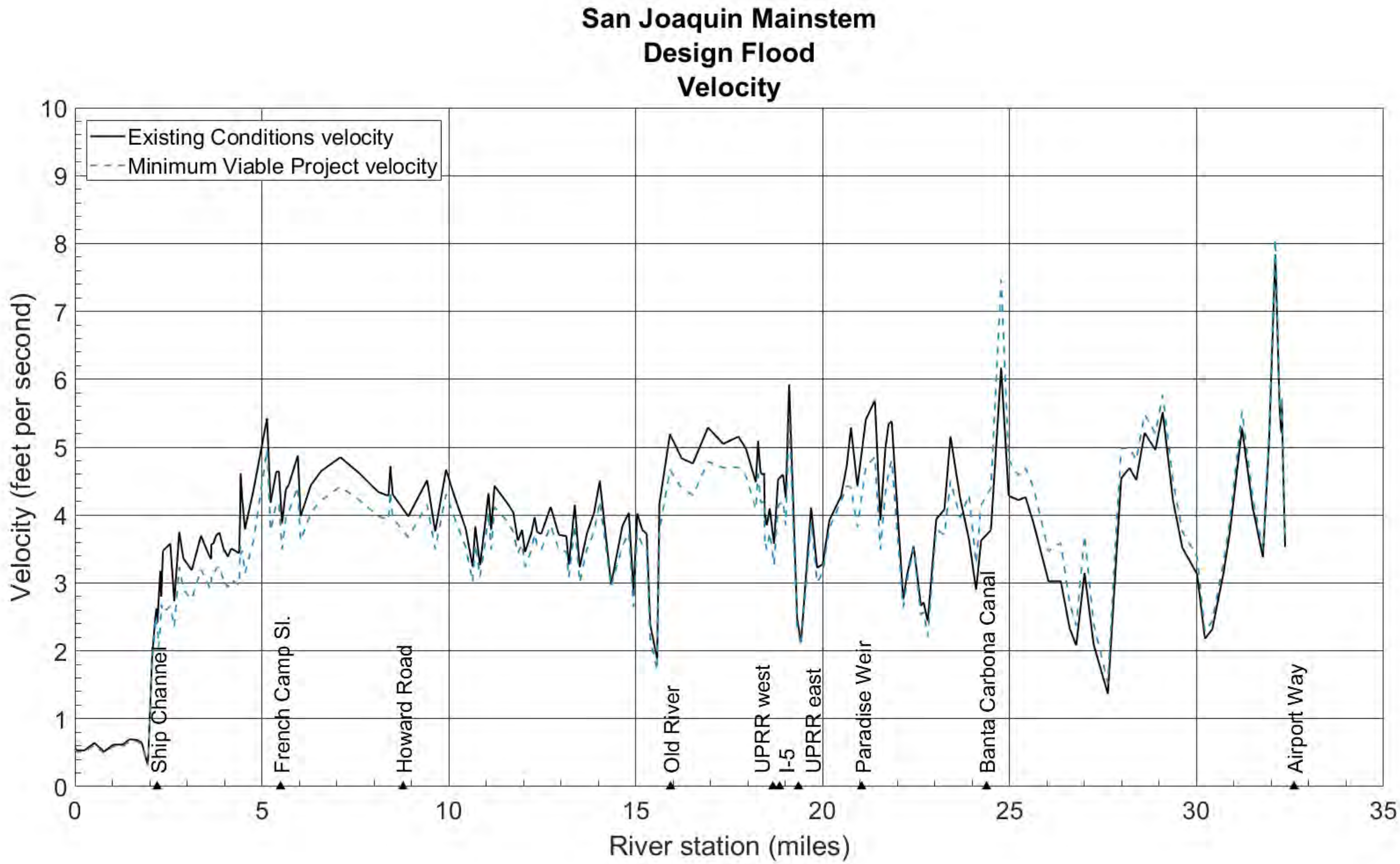
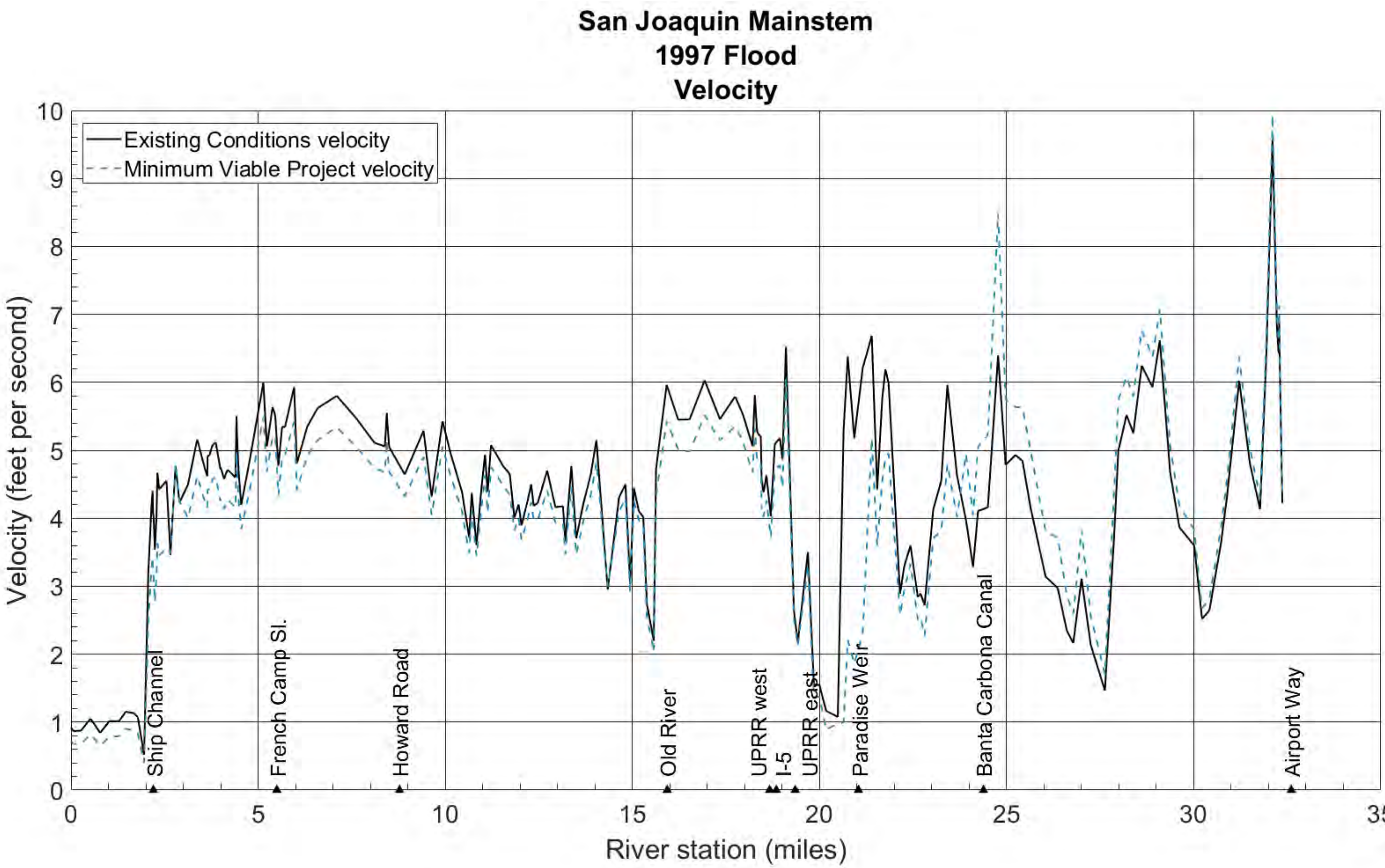
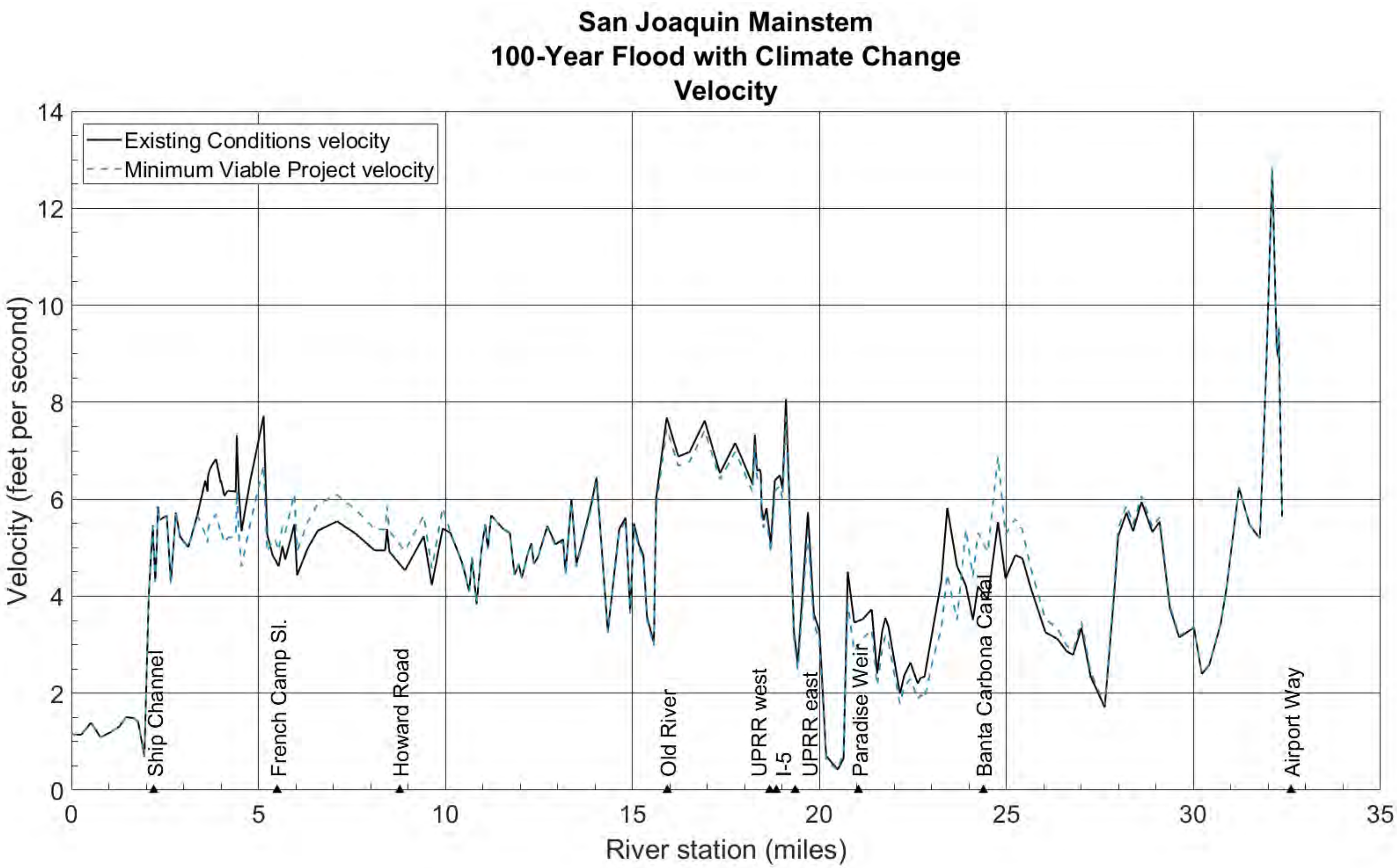
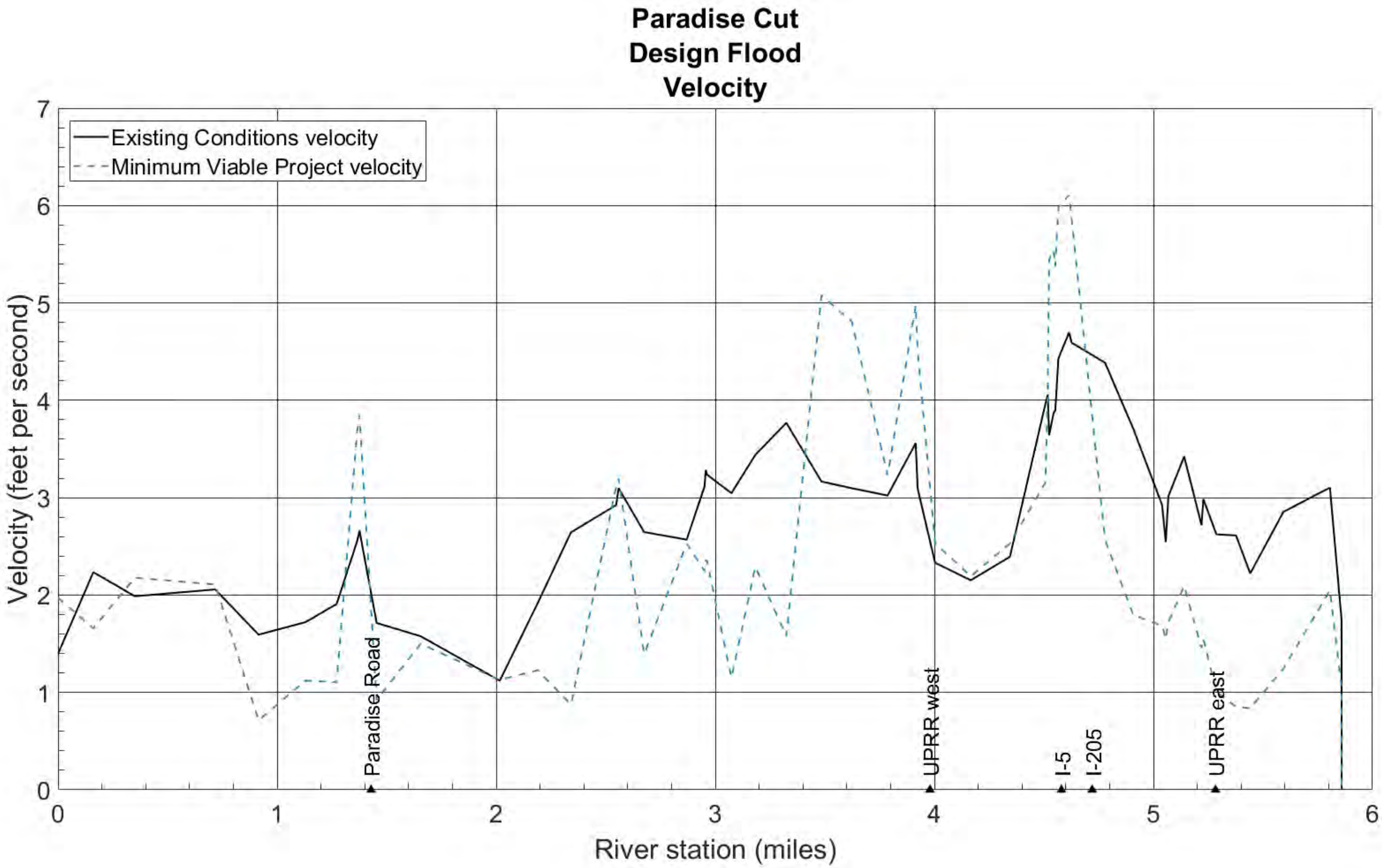

Grant Line Canal
1997 Flood
Water Surface Impact Relative to Existing Condition Baseline
Minimum Viable Project (MVP) WSEL
Expensive MVP WSEL
Change from existing (feet)
River station (miles)
Old River
Tracy Blvd.
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
0
1
2
3
4
5
6
7
8

Chart Group 5
MVP
velocity

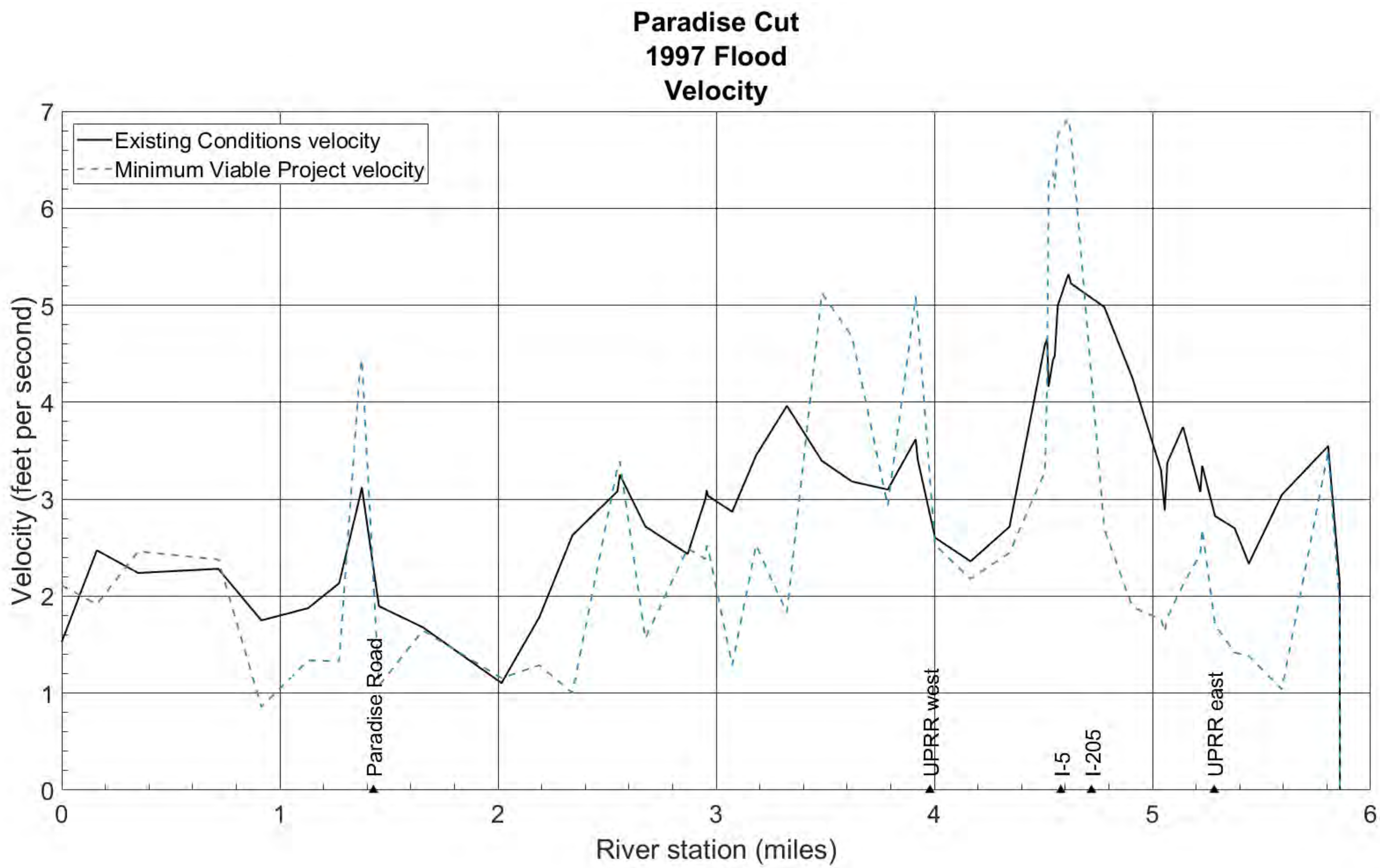

San Joaquin Mainstem
Design Flood
Velocity
Existing Conditions velocity
Minimum Viable Project velocity
Velocity (feet per second)
River station (miles)
Ship Channel
French Camp Sl.
Howard Road
Old River
UPRR west
I-5
UPRR east
Paradise Weir
Banta Carbona Canal
Airport Way
0
1
2
3
4
5
6
7
8
9
10
0
5
10
15
20
25
30
35


San Joaquin Mainstem
1997 Flood
Velocity
Existing Conditions velocity
Minimum Viable Project velocity
Velocity (feet per second)
River station (miles)
Ship Channel
French Camp Sl.
Howard Road
Old River
UPRR west
I-5
UPRR east
Paradise Weir
Banta Carbona Canal
Airport Way
0
1
2
3
4
5
6
7
8
9
10
0
5
10
15
20
25
30
35

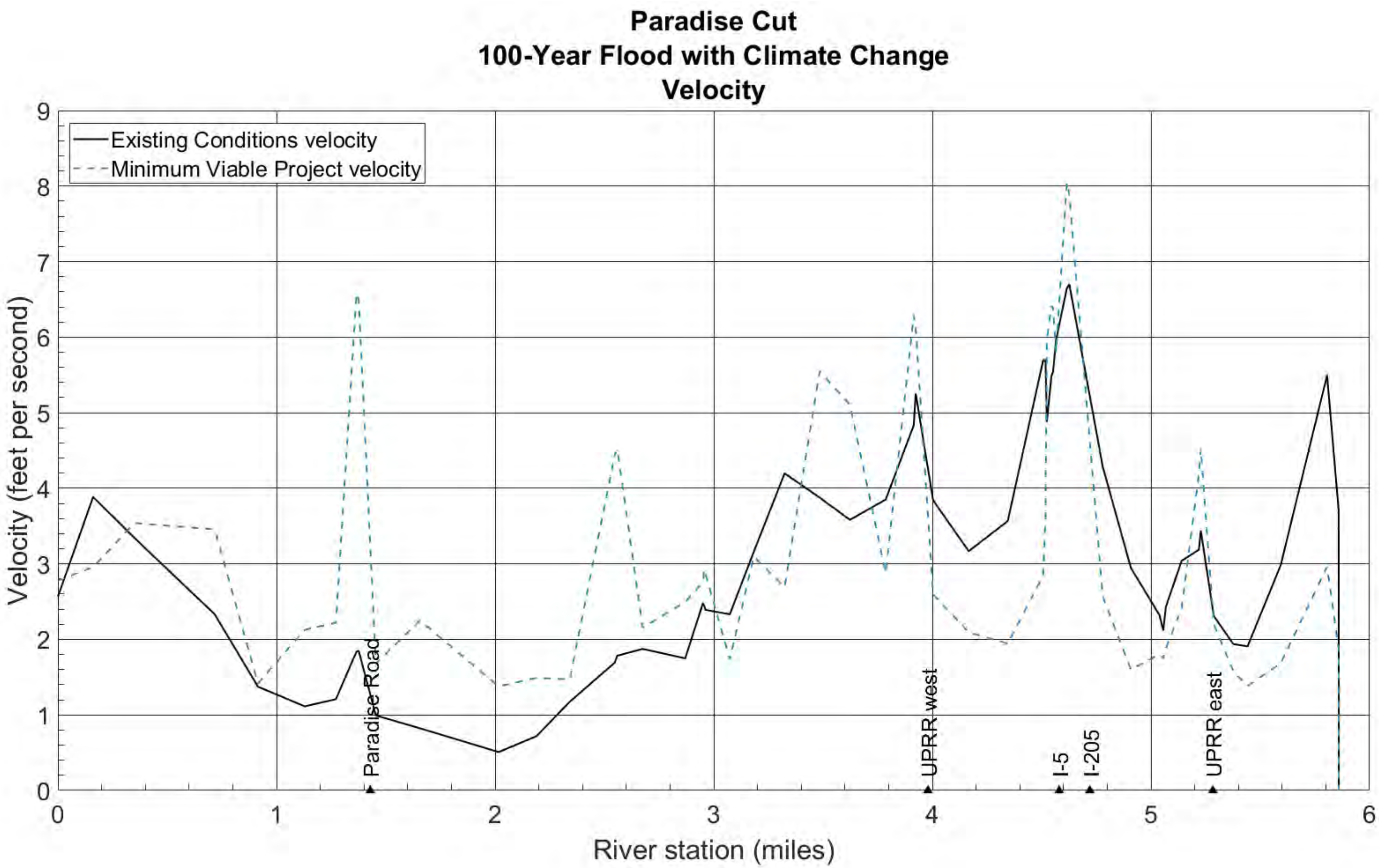

San Joaquin Mainstem
100-Year Flood with Climate Change
Velocity
Existing Conditions velocity
Minimum Viable Project velocity
Velocity (feet per second)
River station (miles)
0
2
4
6
8
10
12
14
0
5
10
15
20
25
30
35
Ship Channel
French Camp Sl.
Howard Road
Old River
UPRR west
I-5
UPRR east
Paradise Weir
Banta Carbona Canal
Airport Way



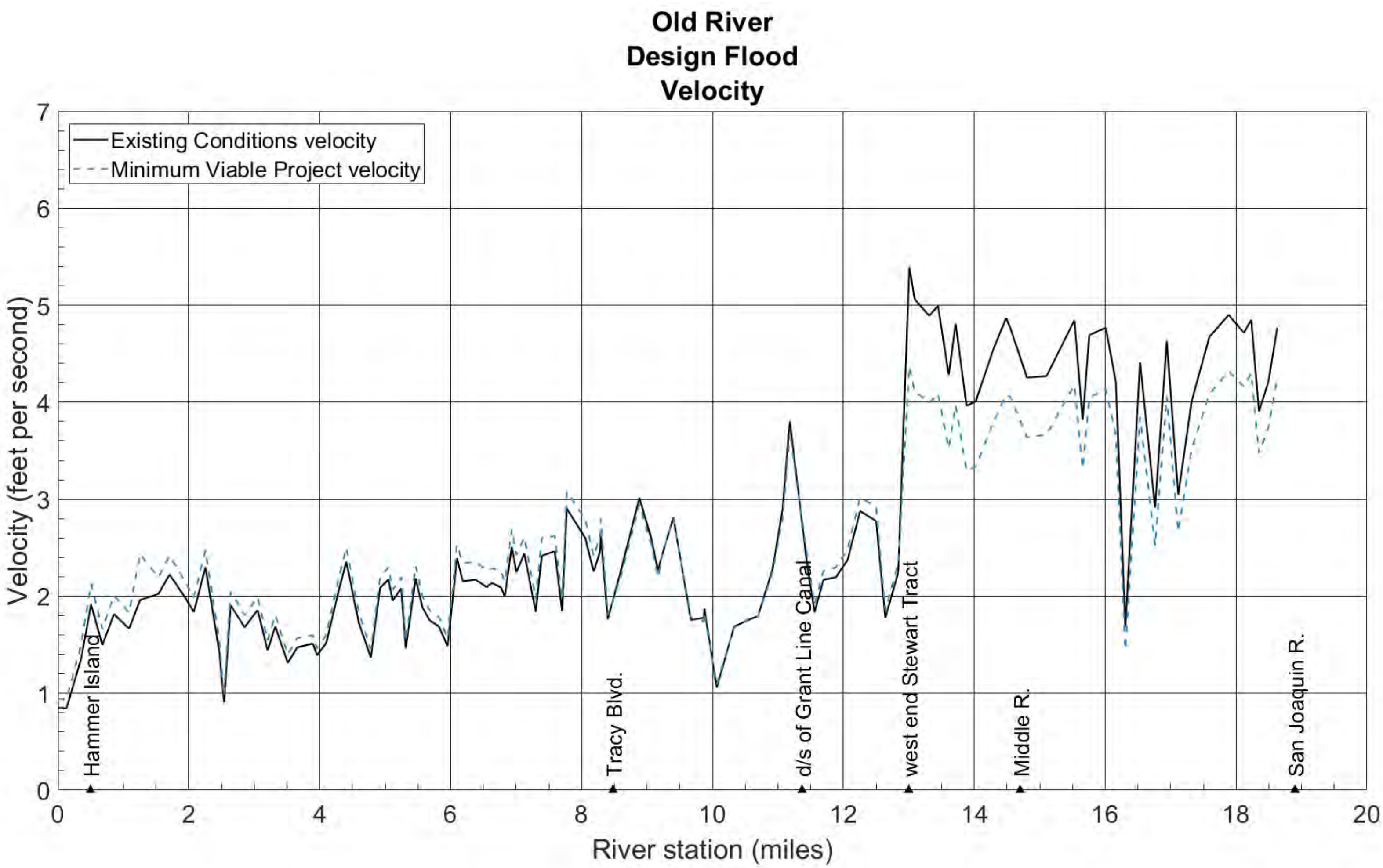
Paradise Cut
Design Flood
Velocity
Existing Conditions velocity
Minimum Viable Project velocity
Velocity (feet per second)
River station (miles)
0
1
2
3
4
5
6
7
Paradise Road
UPRR west
I-5
I-205
UPRR east



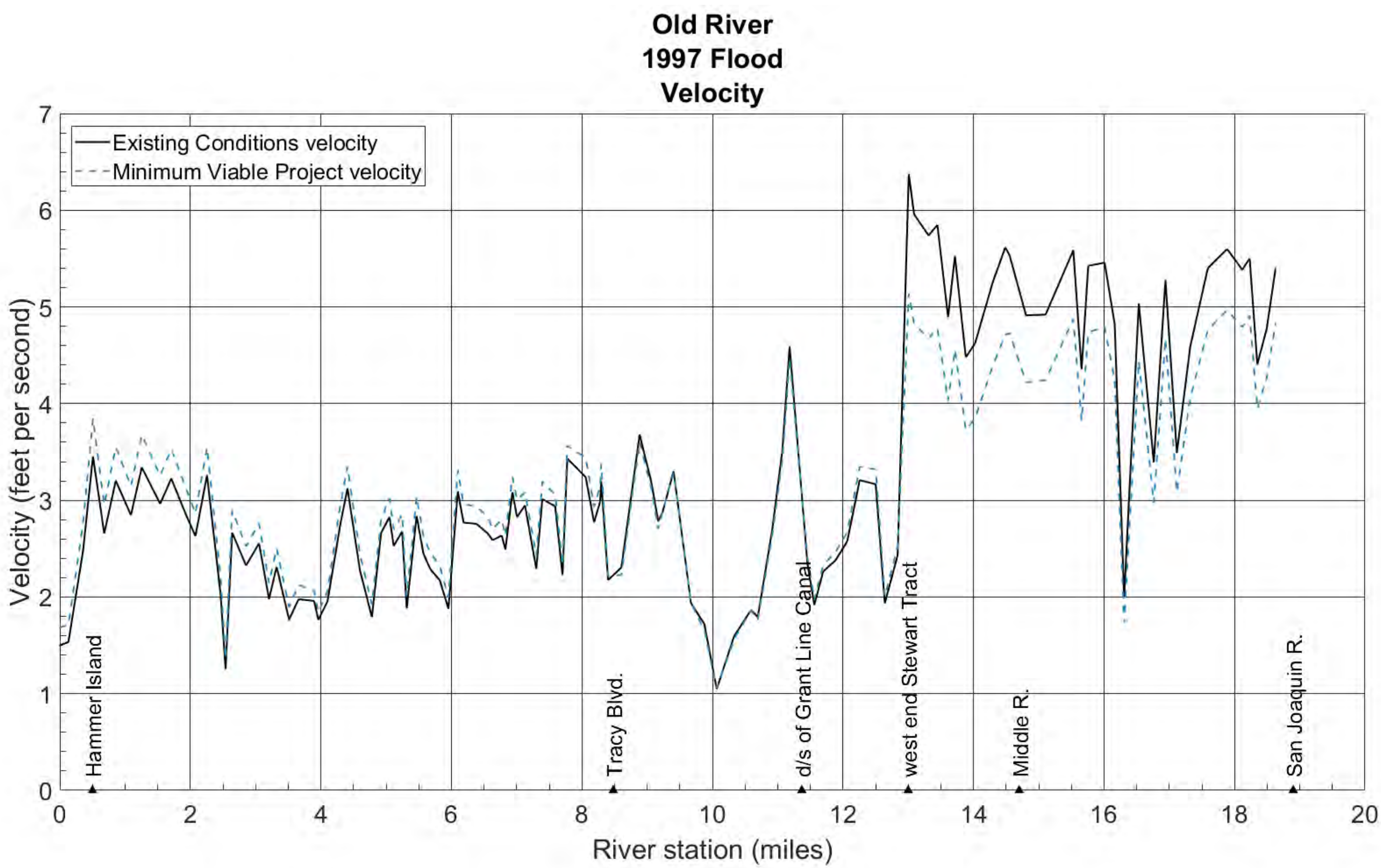
Paradise Cut
1997 Flood
Velocity
Existing Conditions velocity
Minimum Viable Project velocity
Velocity (feet per second)
River station (miles)
Paradise Road
UPRR west
I-5
I-205
UPRR east
0
1
2
3
4
5
6
7



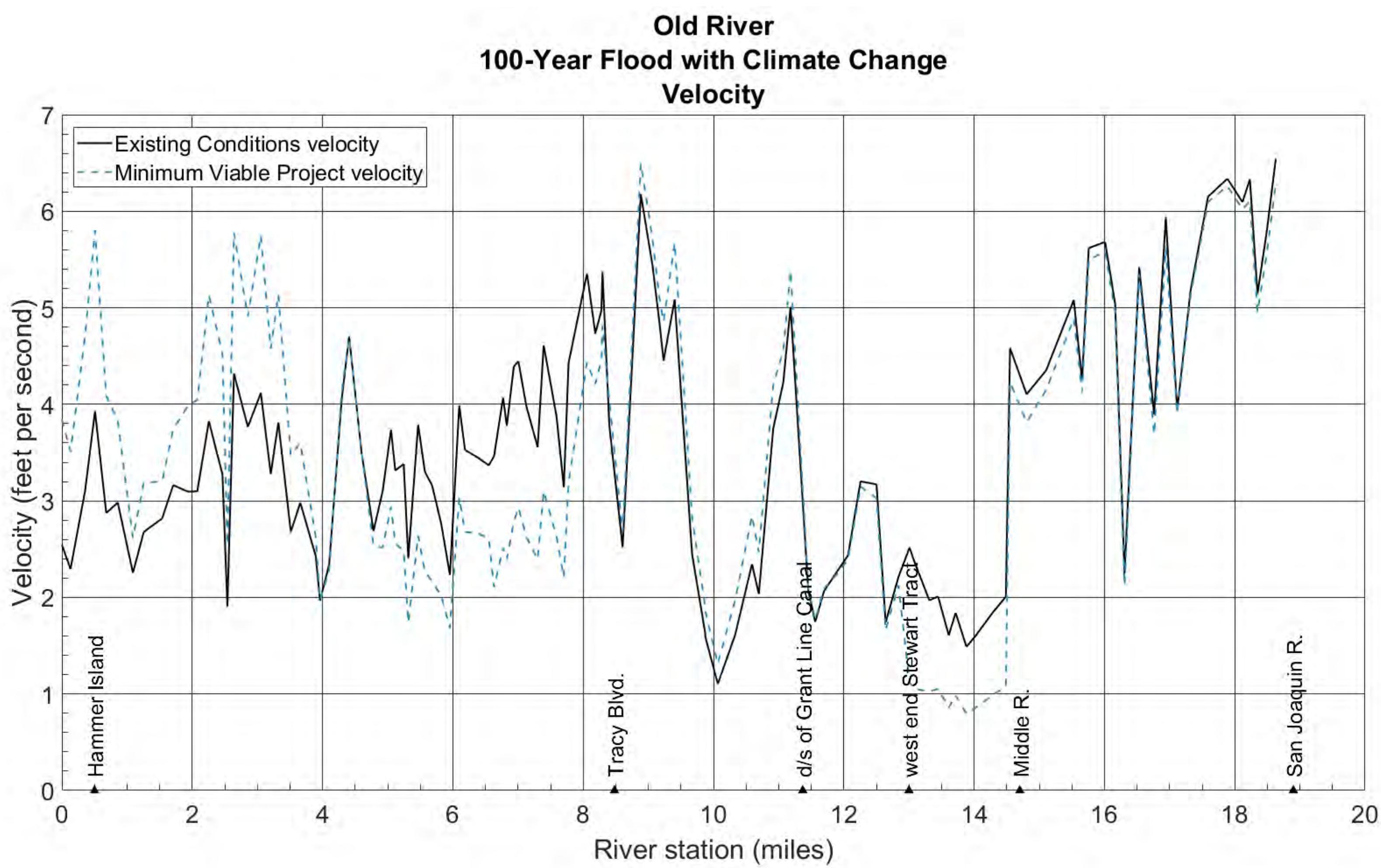
Paradise Cut
100-Year Flood with Climate Change
Velocity
Velocity (feet per second)
River station (miles)
Existing Conditions velocity
Minimum Viable Project velocity
Paradise Road
UPRR west
I-5
I-205
UPRR east
0
1
2
3
4
5
6
7
8
9

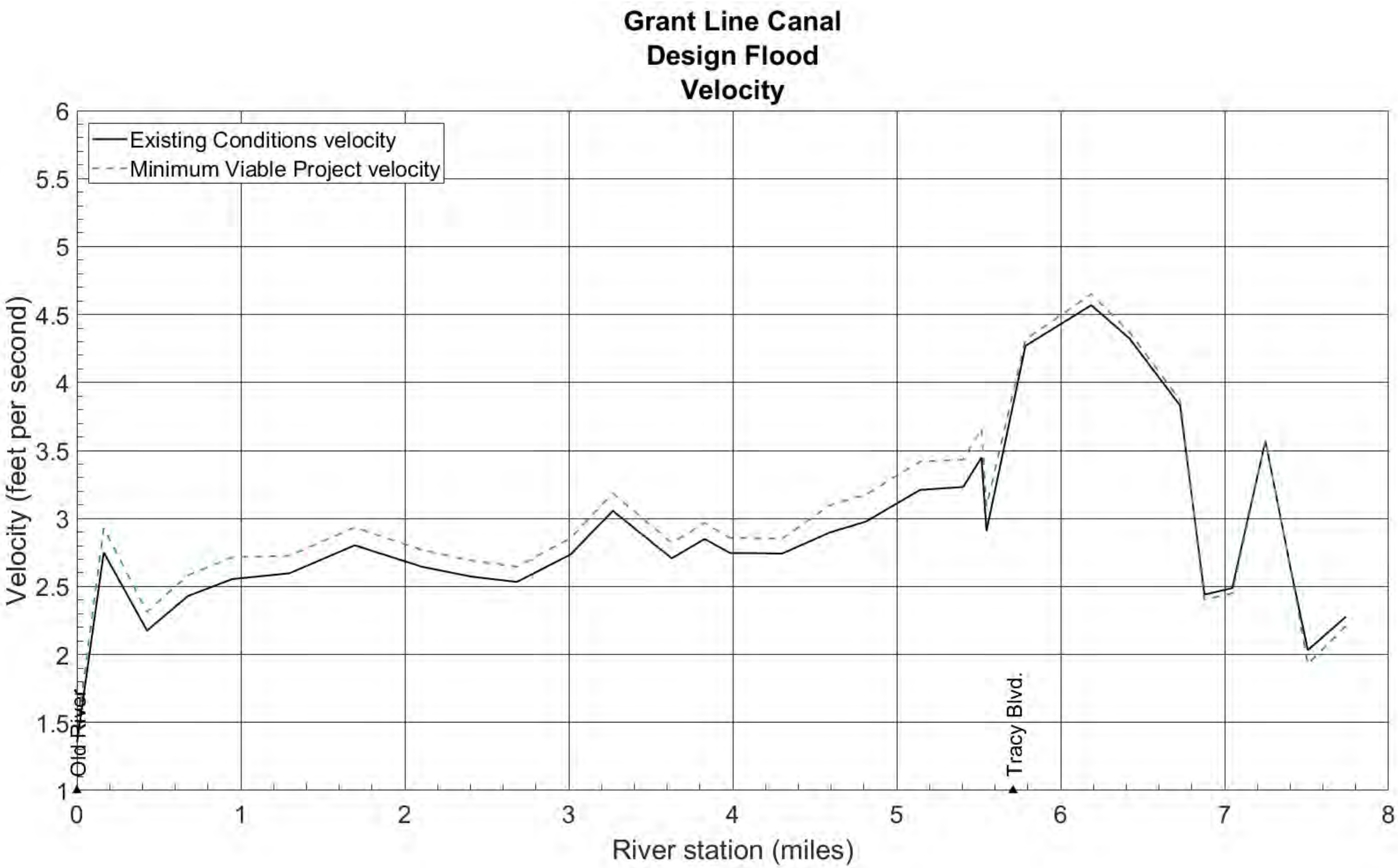


Old River
Design Flood
Velocity
Existing Conditions velocity
Minimum Viable Project velocity
Velocity (feet per second)
River station (miles)
0
1
2
3
4
5
6
7
0
2
4
6
8
10
12
14
16
18
20
Hammer Island
Tracy Blvd.
d/s of Grant Line Canal
west end Stewart Tract
Middle R.
San Joaquin R.

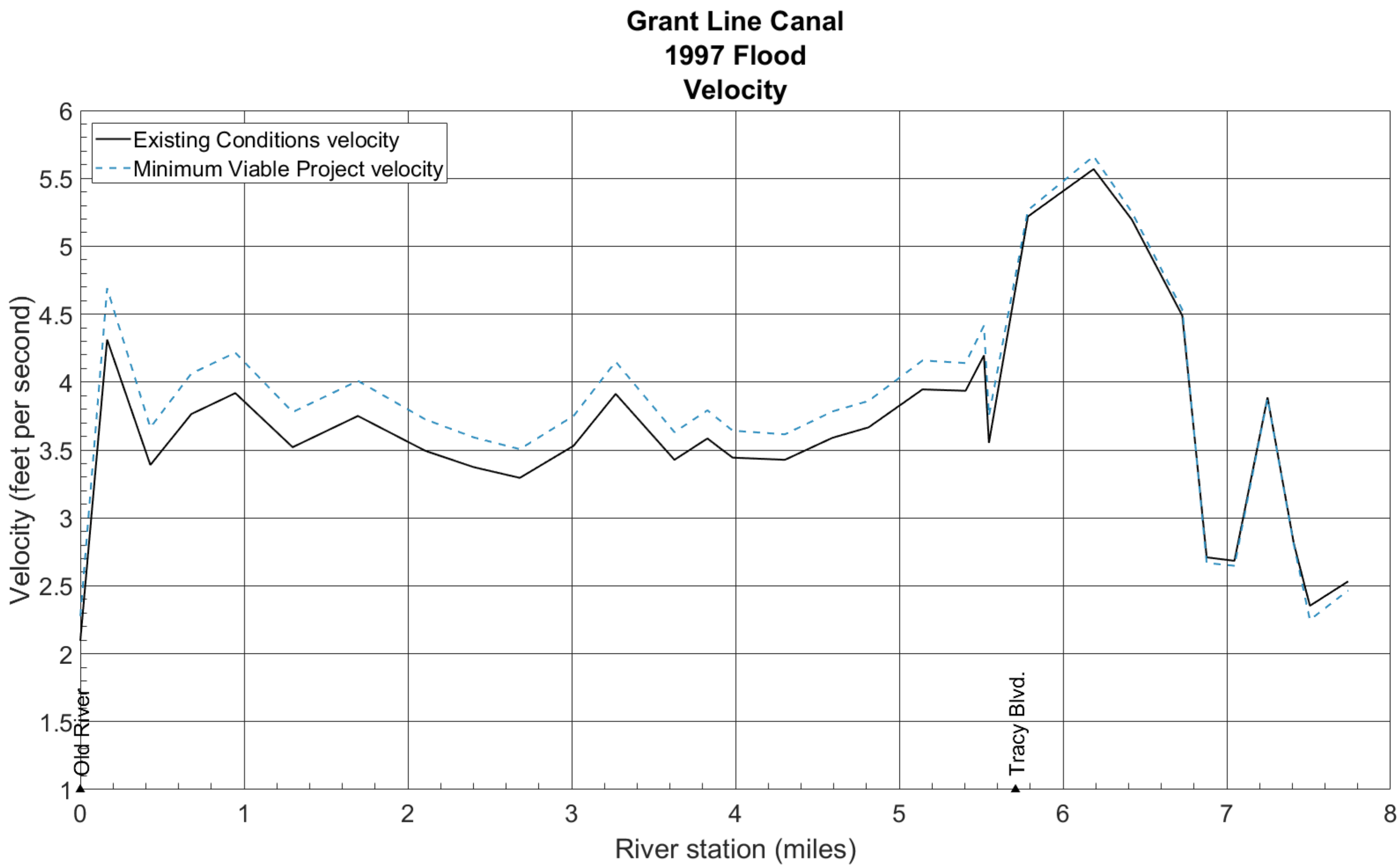


Old River
1997 Flood
Velocity
Existing Conditions velocity
Minimum Viable Project velocity
Velocity (feet per second)
River station (miles)
Hammer Island
Tracy Blvd.
d/s of Grant Line Canal
west end Stewart Tract
Middle R.
San Joaquin R.
0
1
2
3
4
5
6
7
0
2
4
6
8
10
12
14
16
18
20


Old River
100-Year Flood with Climate Change
Velocity
Existing Conditions velocity
Minimum Viable Project velocity
Velocity (feet per second)
River station (miles)
Hammer Island
Tracy Blvd.
d/s of Grant Line Canal
west end Stewart Tract
Middle R.
San Joaquin R.
0
1
2
3
4
5
6
7
0
2
4
6
8
10
12
14
16
18
20



Grant Line Canal
Design Flood
Velocity
Existing Conditions velocity
Minimum Viable Project velocity
Velocity (feet per second)
River station (miles)
Old River
Tracy Blvd.
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0
1
2
3
4
5
6
7
8


Grant Line Canal
1997 Flood
Velocity
Existing Conditions velocity
Minimum Viable Project velocity
Velocity (feet per second)
River station (miles)
Old River
Tracy Blvd.
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0
1
2
3
4
5
6
7
8

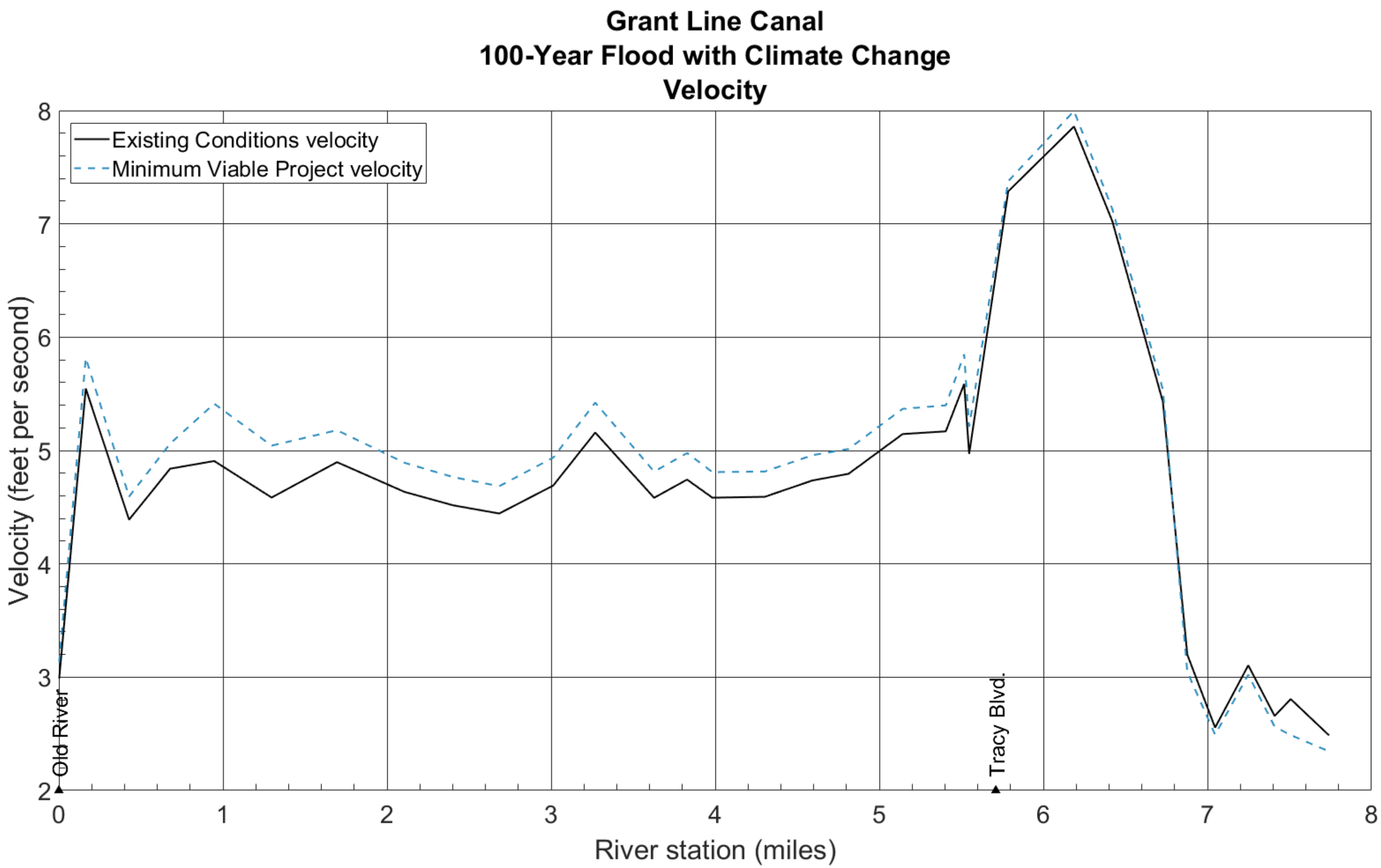
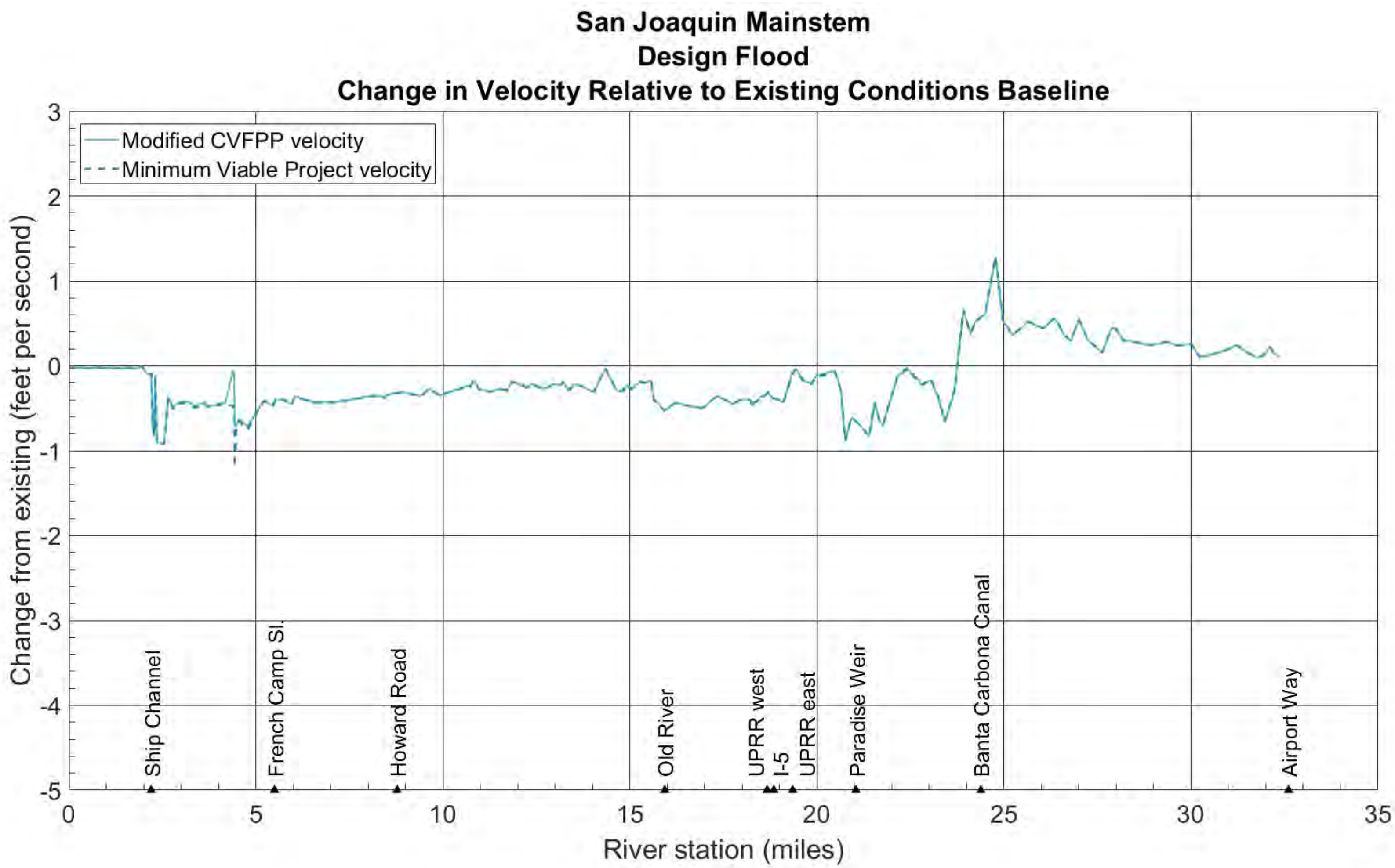
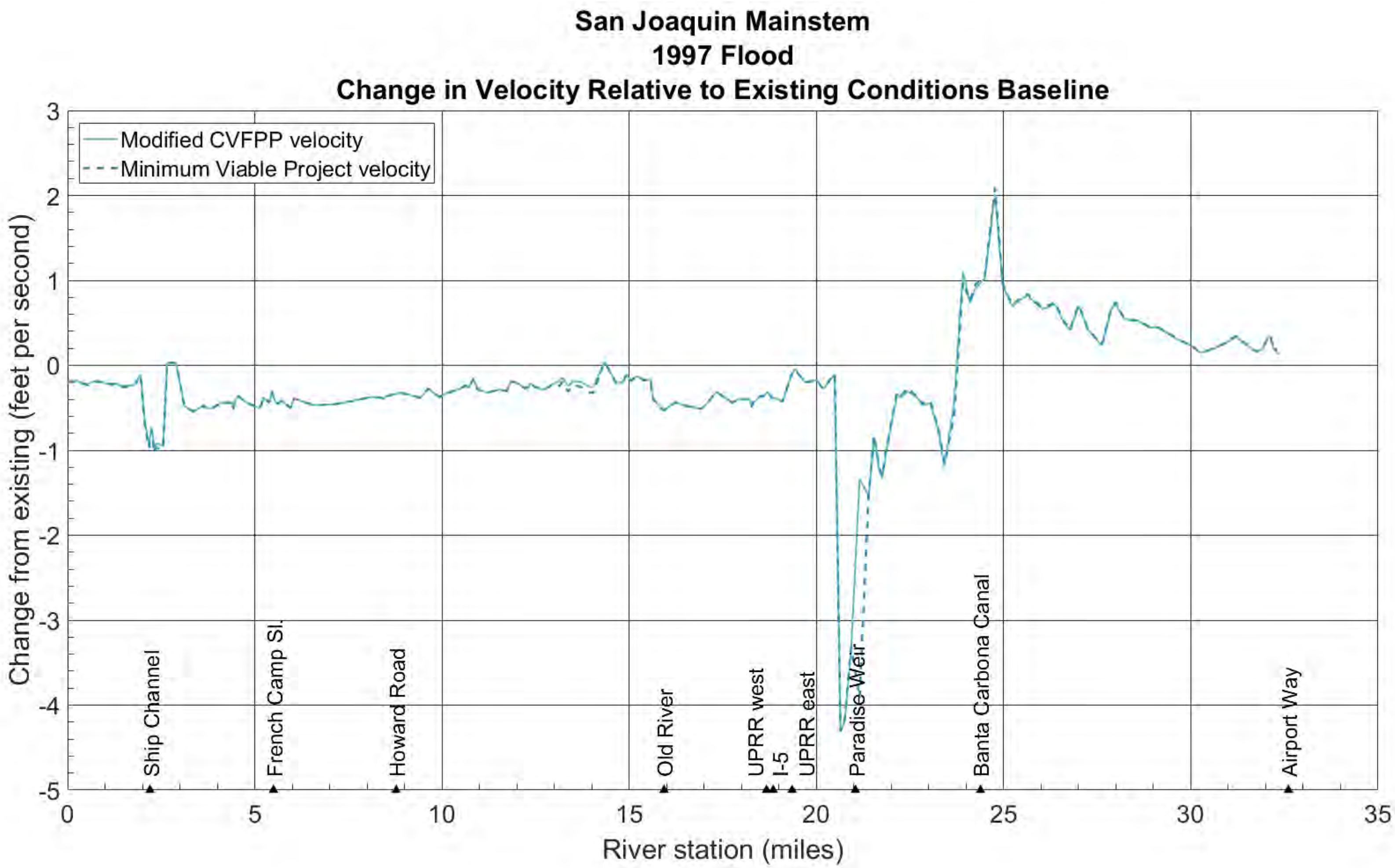

Grant Line Canal
100-Year Flood with Climate Change
Velocity
Existing Conditions velocity
Minimum Viable Project velocity
Velocity (feet per second)
River station (miles)
Old River
Tracy Blvd.
2
3
4
5
6
7
8
0
1
2
3
4
5
6
7
8

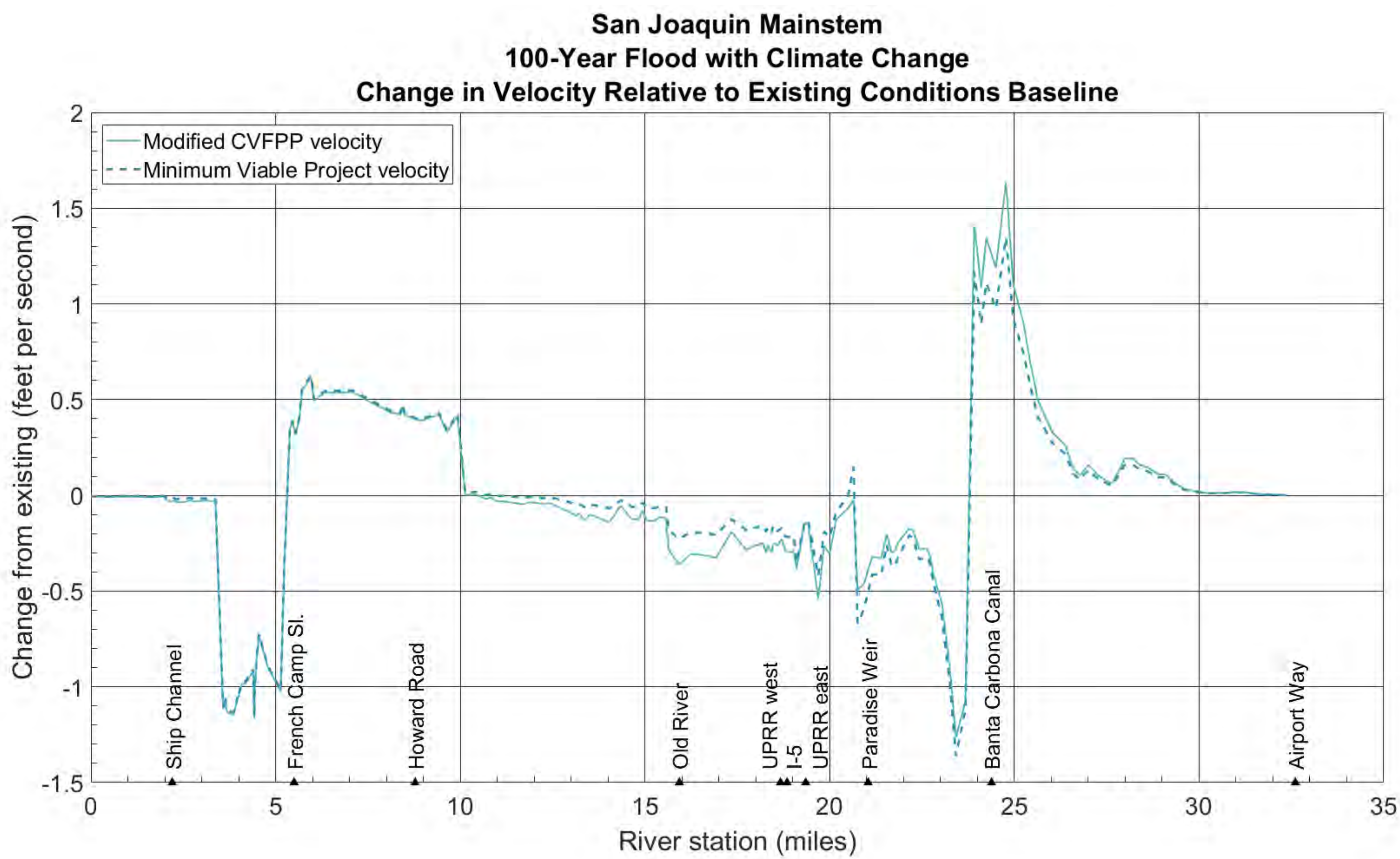
Chart Group 5b
MVP
change in velocity

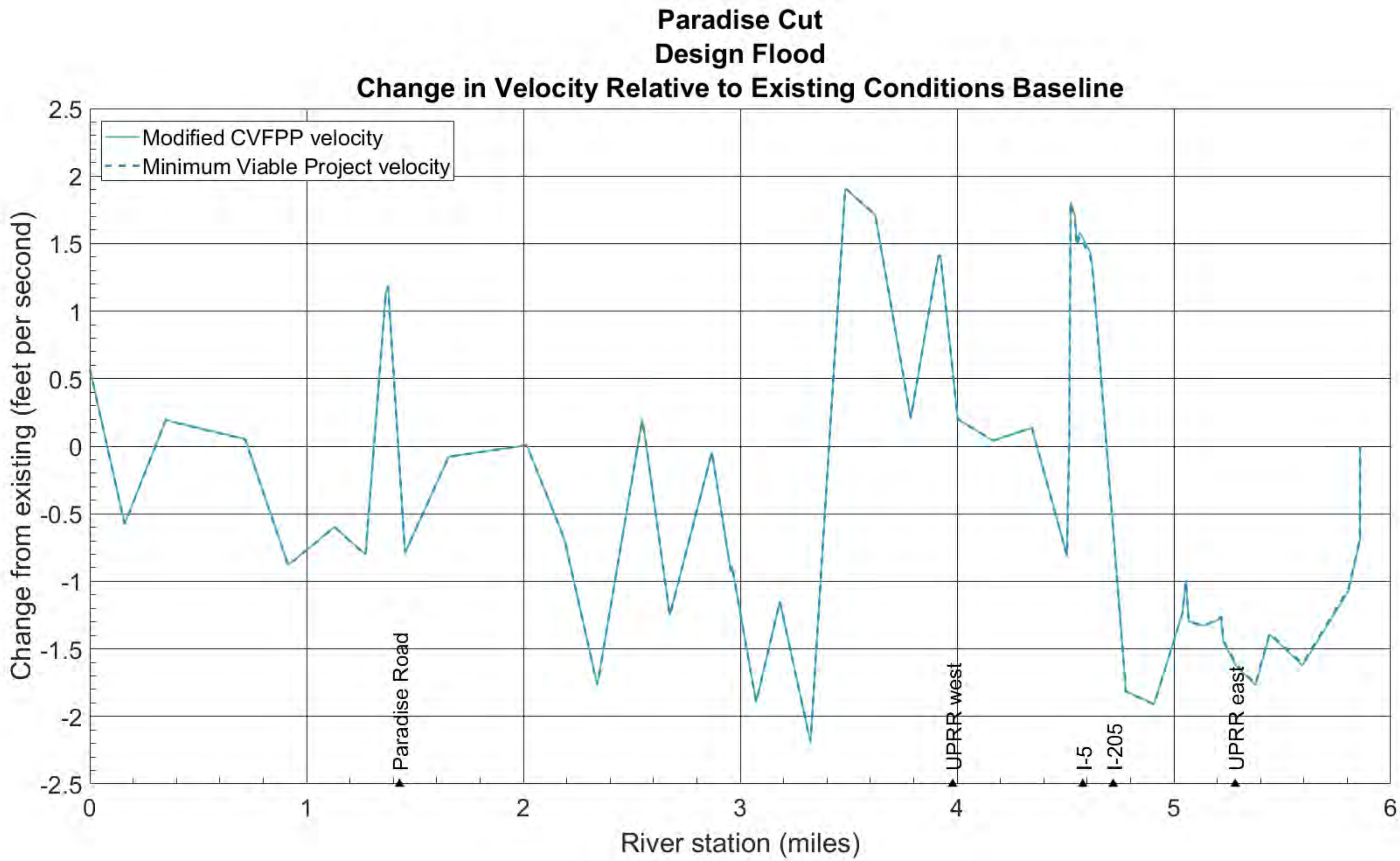


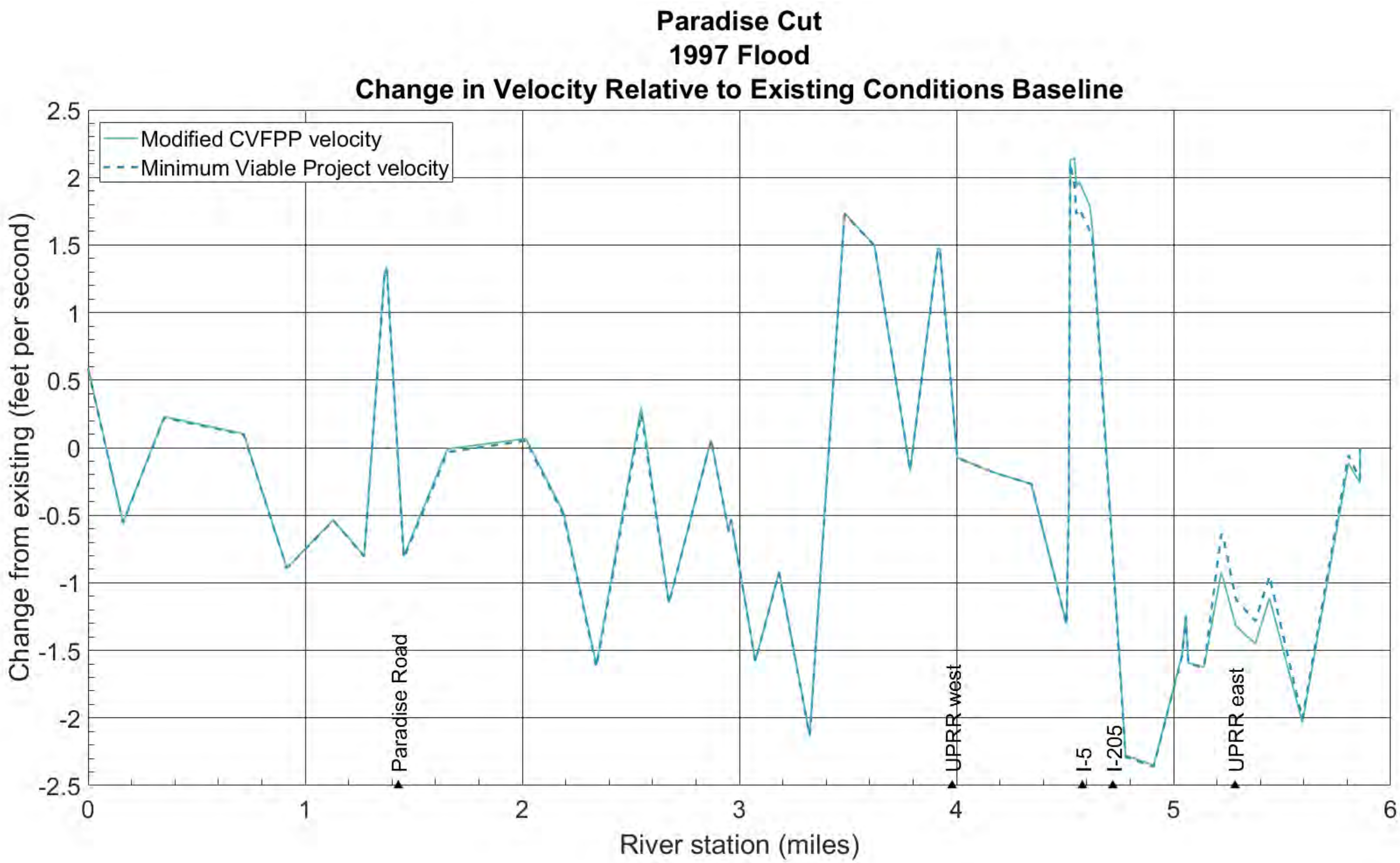
San Joaquin Mainstem
Design Flood
Change in Velocity Relative to Existing Conditions Baseline
Modified CVFPP velocity
Minimum Viable Project velocity
Change from existing (feet per second)
3
2
1
0
-1
-2
-3
-4
-5
Ship Channel
French Camp Sl.
Howard Road
Old River
UPRR west
I-5
UPRR east
Paradise Weir
Banta Carbona Canal
Airport Way
0
5
10
15
20
25
30
35
River station (miles)



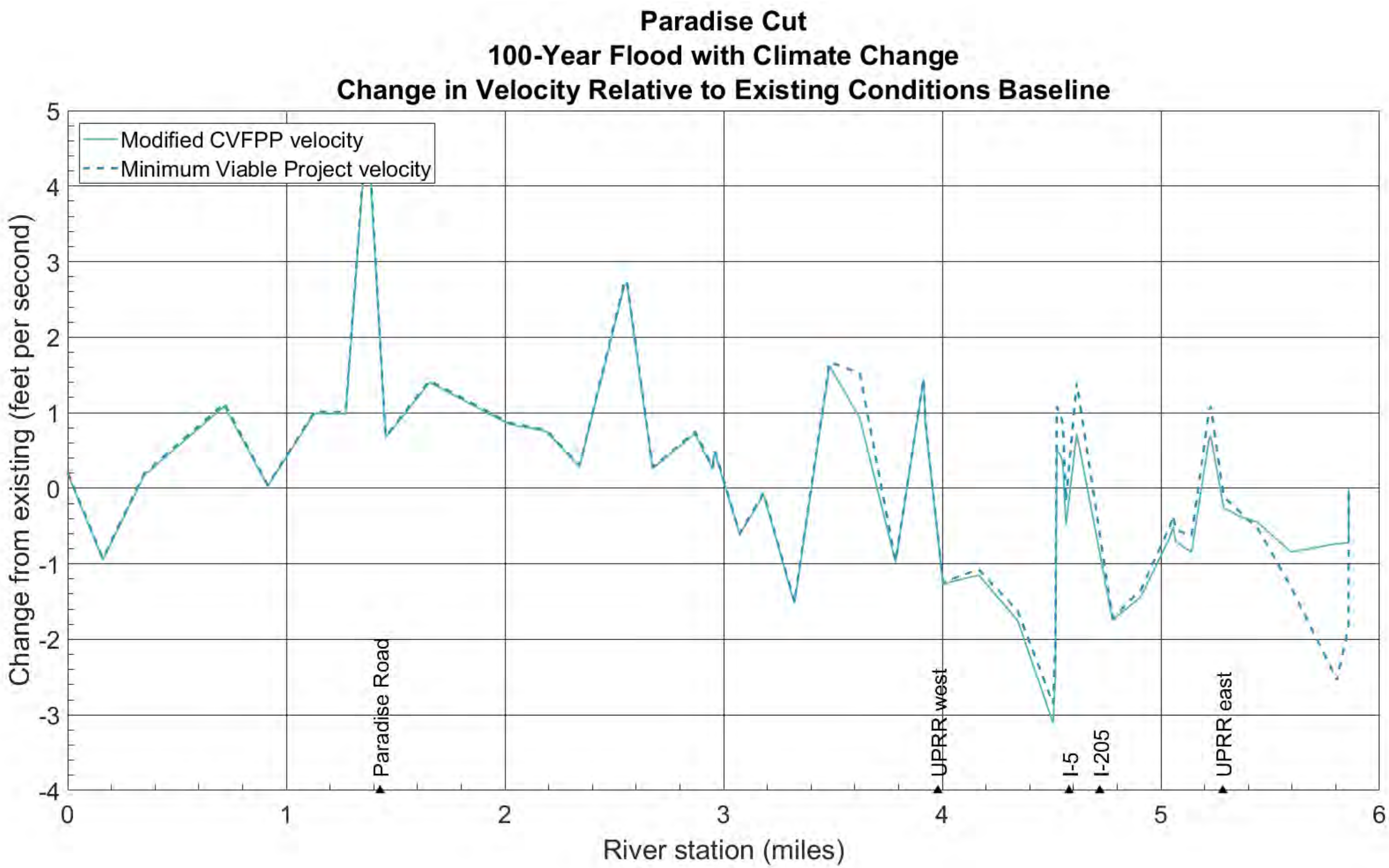
San Joaquin Mainstem
1997 Flood
Change in Velocity Relative to Existing Conditions Baseline
Modified CVFPP velocity
Minimum Viable Project velocity
Change from existing (feet per second)
River station (miles)
3
2
1
0
-1
-2
-3
-4
-5
0
5
10
15
20
25
30
35
Ship Channel
French Camp Sl.
Howard Road
Old River
UPRR west
I-5
UPRR east
Paradise Weir
Banta Carbona Canal
Airport Way


San Joaquin Mainstem
100-Year Flood with Climate Change
Change in Velocity Relative to Existing Conditions Baseline
Modified CVFPP velocity
Minimum Viable Project velocity
Change from existing (feet per second)
River station (miles)
Ship Channel
French Camp Sl.
Howard Road
Old River
UPRR west
I-5
UPRR east
Paradise Weir
Banta Carbona Canal
Airport Way
2
1.5
1
0.5
0
-0.5
-1
-1.5
0
5
10
15
20
25
30
35

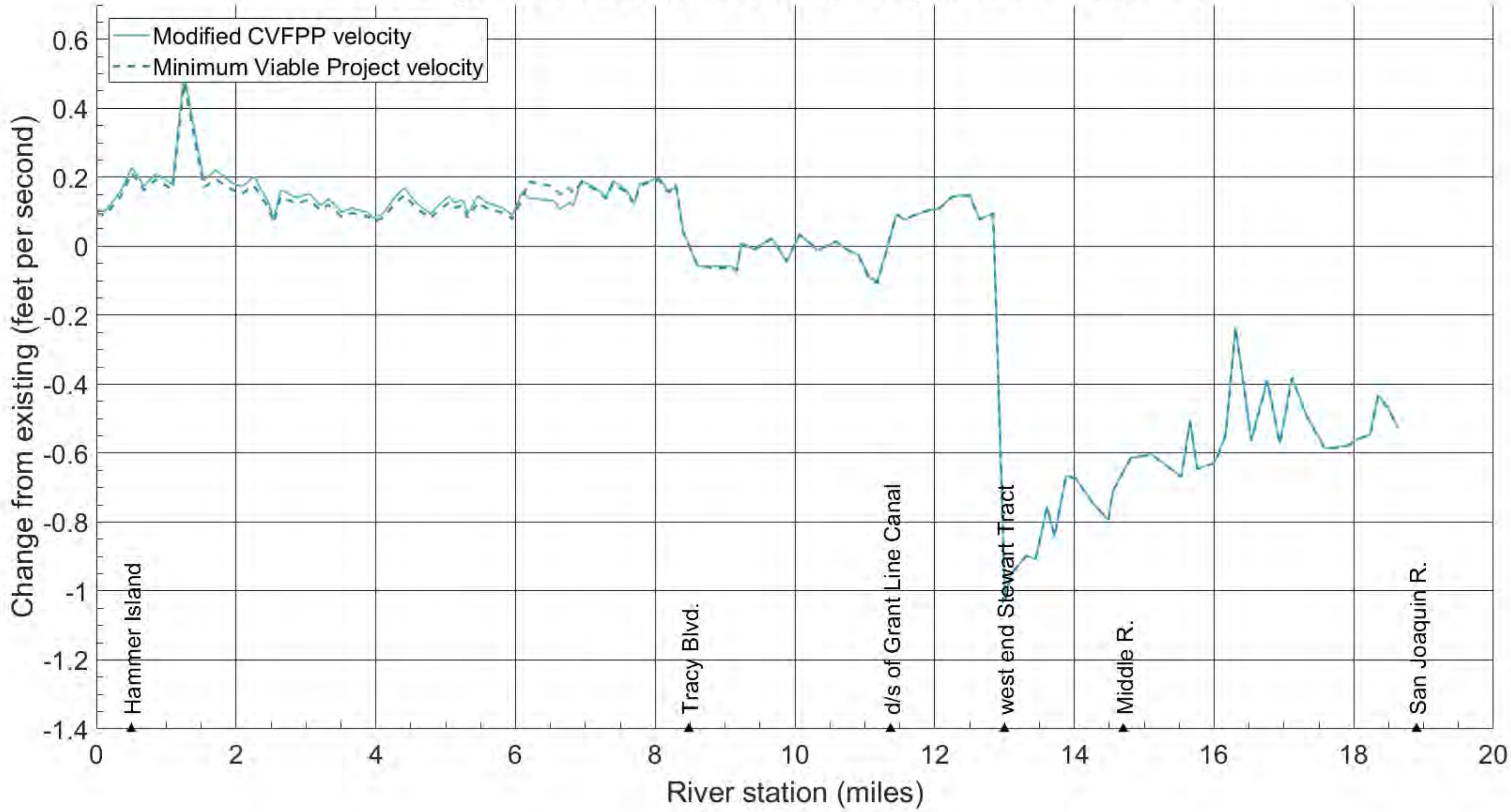

Paradise Cut
Design Flood
Change in Velocity Relative to Existing Conditions Baseline
Modified CVFPP velocity
Minimum Viable Project velocity
Change from existing (feet per second)
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
Paradise Road
UPRR west
I-5
I-205
UPRR east
0
1
2
3
4
5
6
River station (miles)

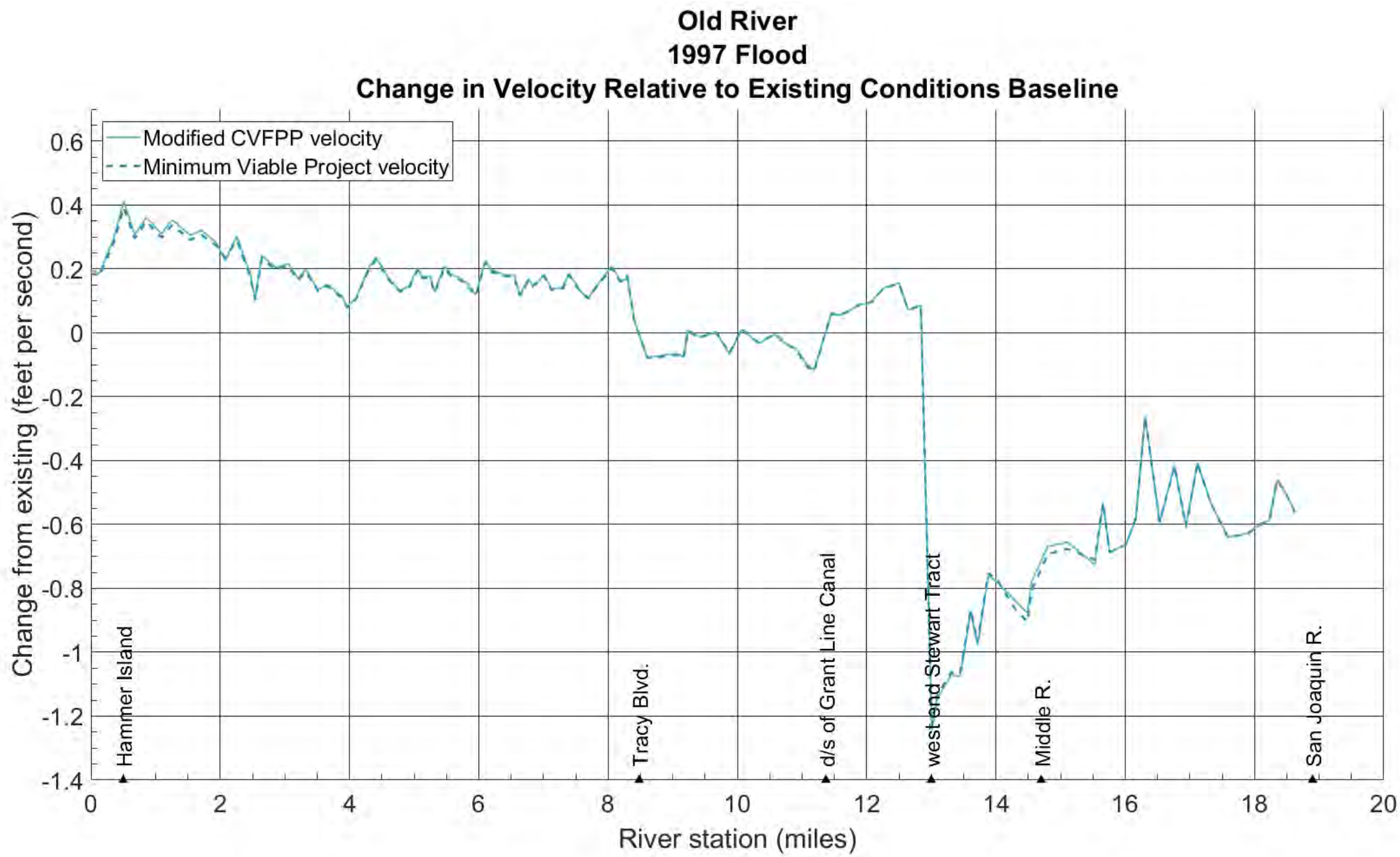


Paradise Cut
1997 Flood
Change in Velocity Relative to Existing Conditions Baseline
Modified CVFPP velocity
Minimum Viable Project velocity
Change from existing (feet per second)
River station (miles)
Paradise Road
UPRR west
I-5
I-205
UPRR east
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
0
1
2
3
4
5
6

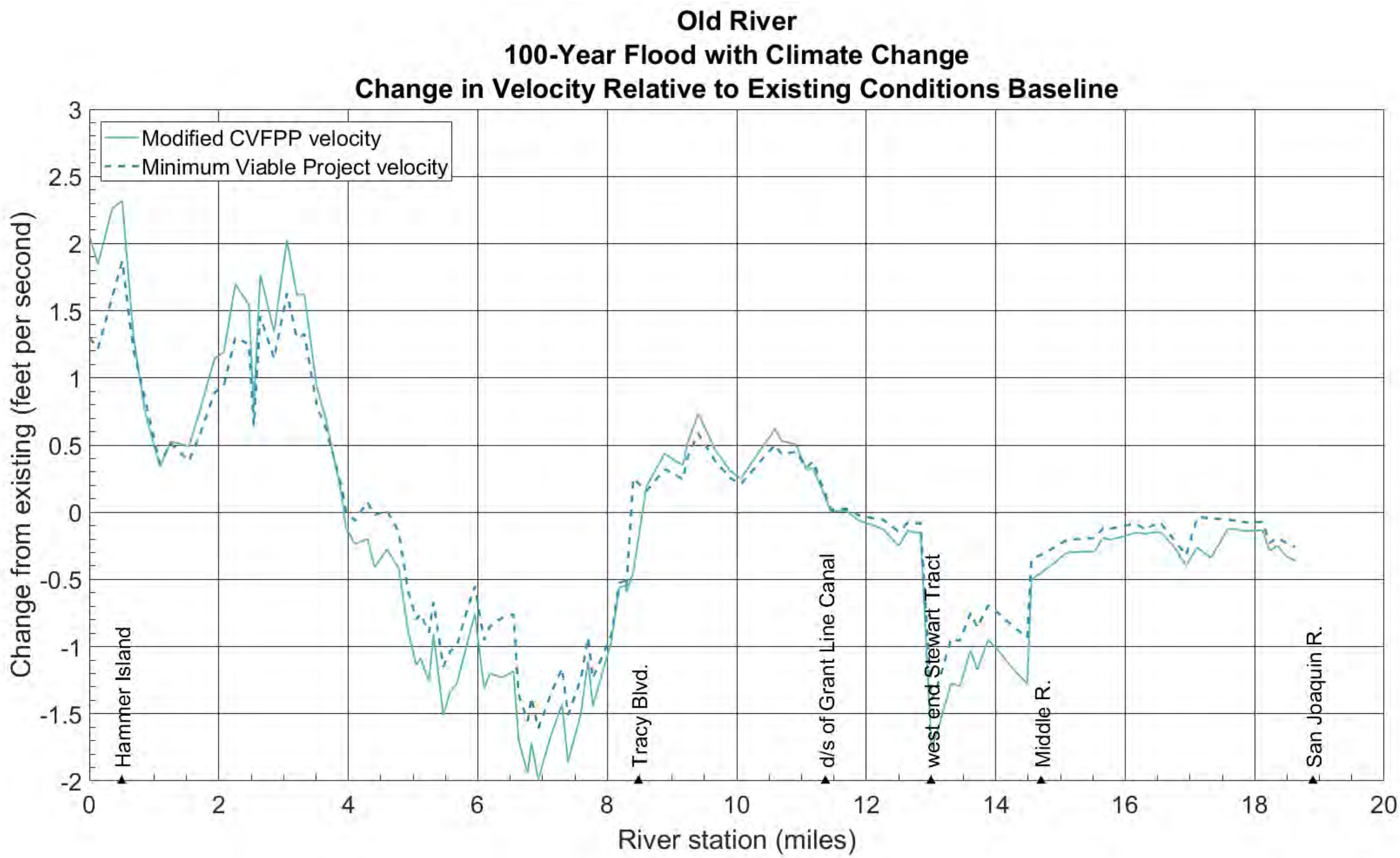

Paradise Cut
100-Year Flood with Climate Change
Change in Velocity Relative to Existing Conditions Baseline
Modified CVFPP velocity
Minimum Viable Project velocity
Change from existing (feet per second)
River station (miles)
Paradise Road
UPRR west
I-5
I-205
UPRR east
5
4
3
2
1
0
-1
-2
-3
-4
0
1
2
3
4
5
6

Old River
Design Flood
Change in Velocity Relative to Existing Conditions Baseline



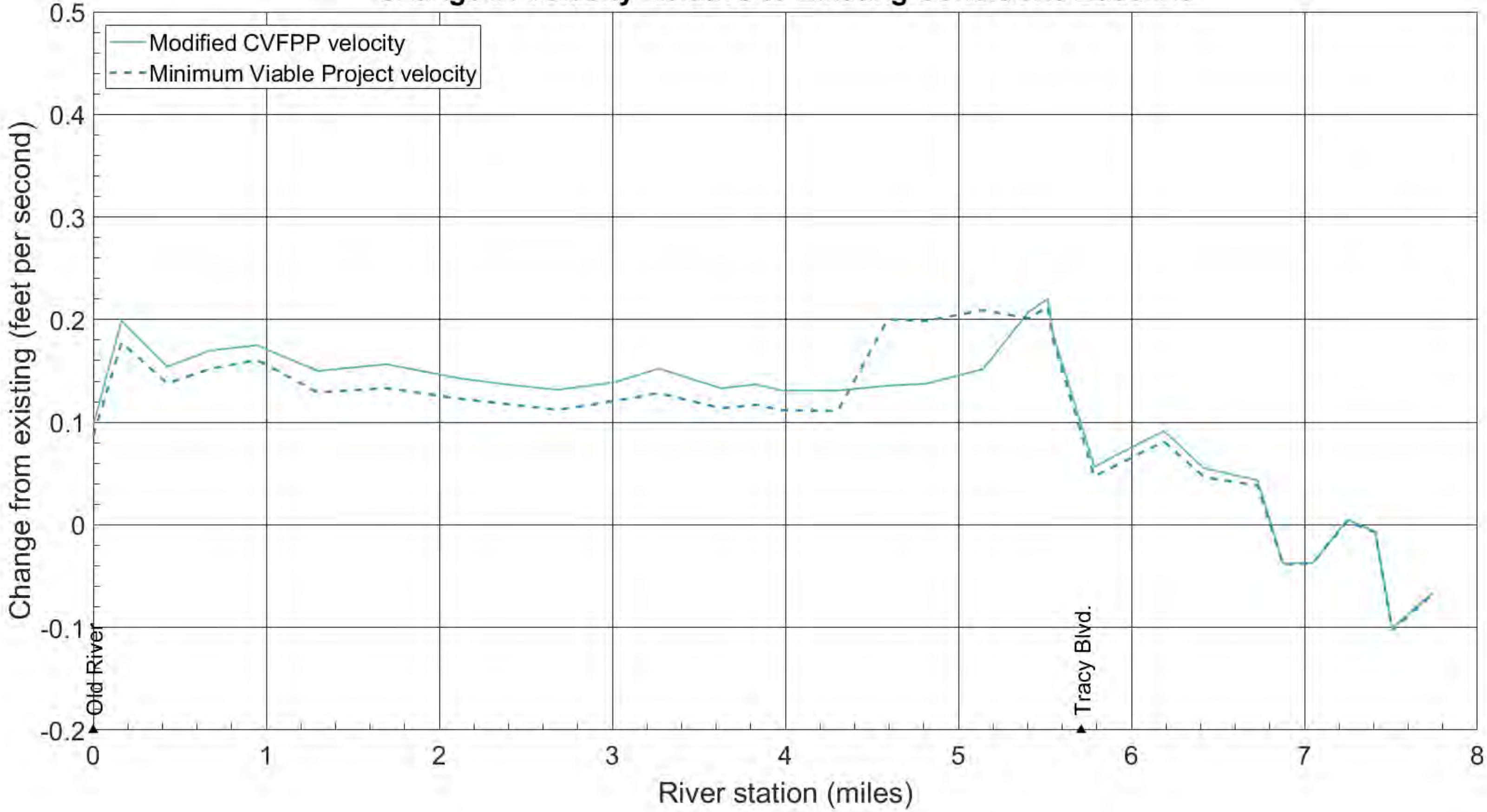


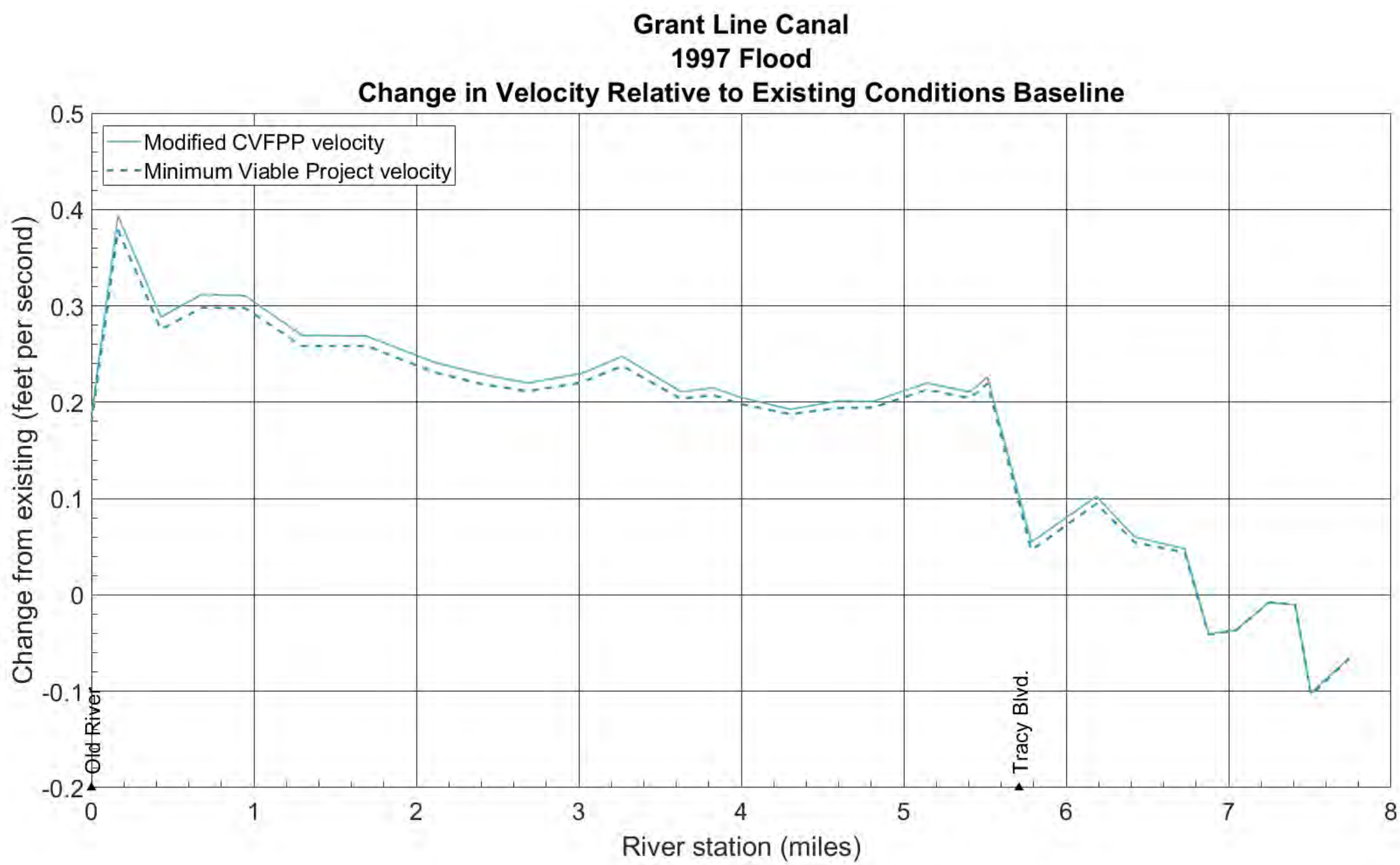
Old River
1997 Flood
Change in Velocity Relative to Existing Conditions Baseline
Modified CVFPP velocity
Minimum Viable Project velocity
Change from existing (feet per second)
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.4
Hammer Island
Tracy Blvd.
d/s of Grant Line Canal
west end Stewart Tract
Middle R.
San Joaquin R.
0
2
4
6
8
10
12
14
16
18
20
River station (miles)



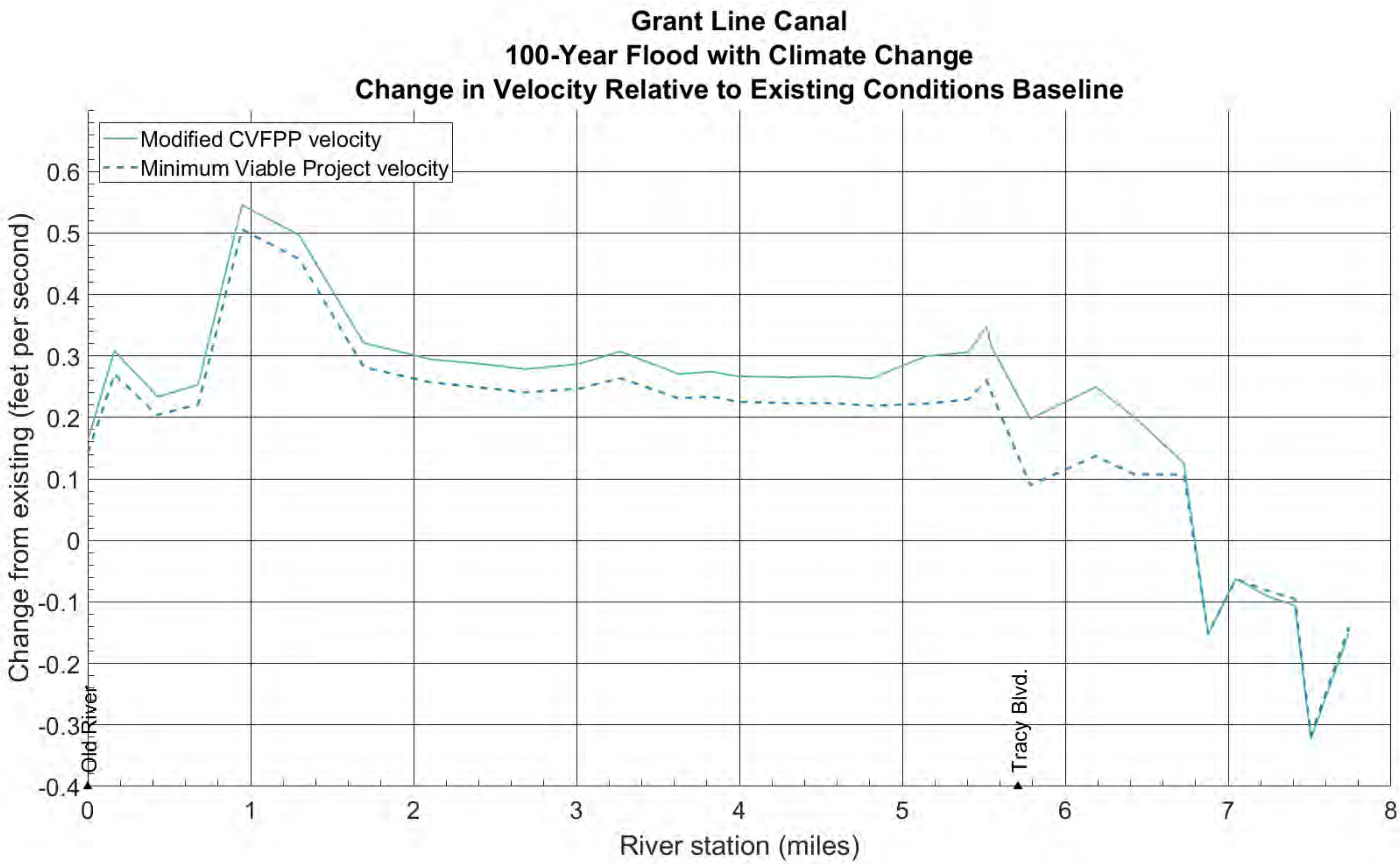
Old River
100-Year Flood with Climate Change
Change in Velocity Relative to Existing Conditions Baseline
Modified CVFPP velocity
Minimum Viable Project velocity
Change from existing (feet per second)
River station (miles)
Hammer Island
Tracy Blvd.
d/s of Grant Line Canal
west end Stewart Tract
Middle R.
San Joaquin R.
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
0
2
4
6
8
10
12
14
16
18
20

Grant Line Canal
Design Flood
Change in Velocity Relative to Existing Conditions Baseline



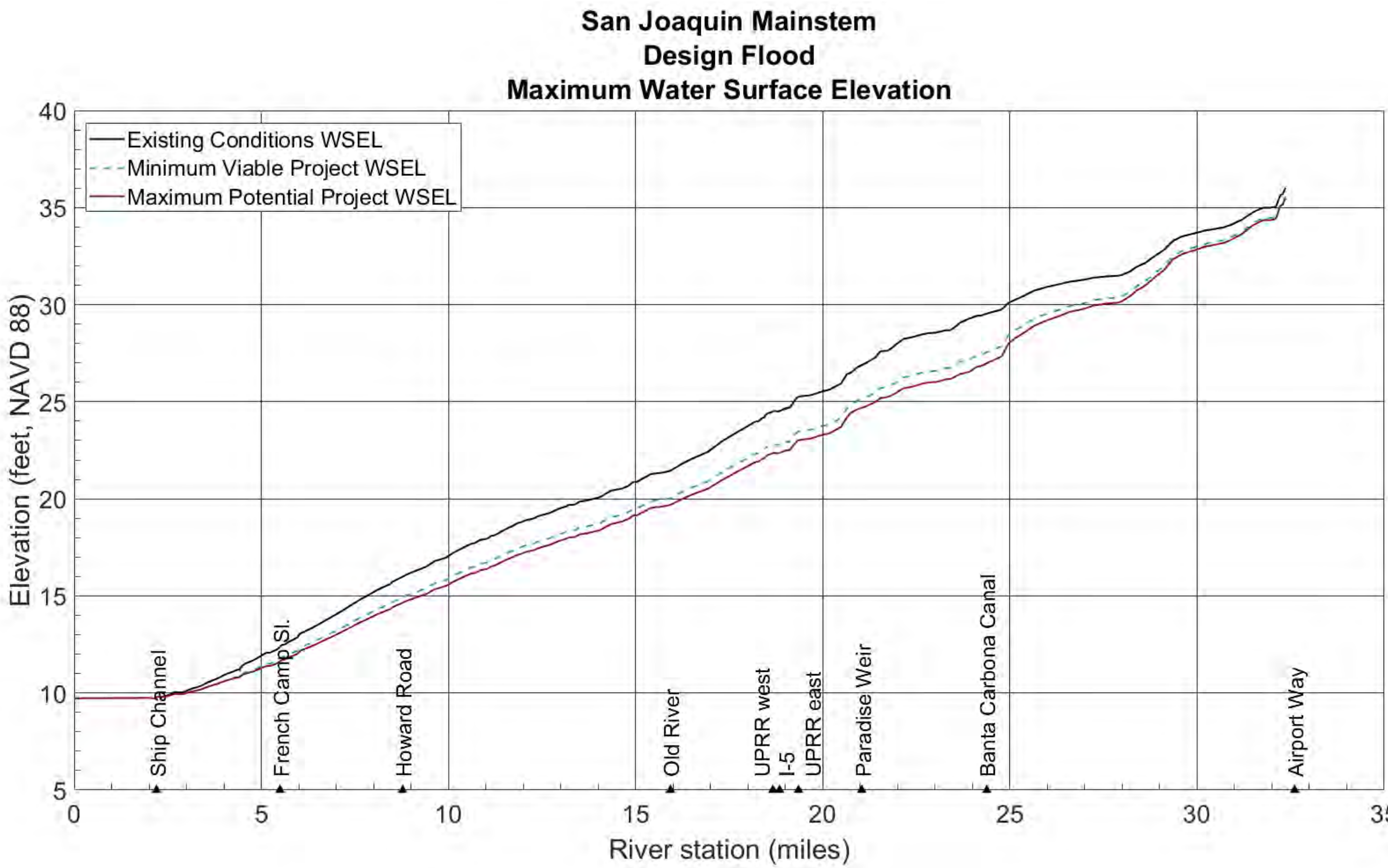


Grant Line Canal
1997 Flood
Change in Velocity Relative to Existing Conditions Baseline
Modified CVFPP velocity
Minimum Viable Project velocity
Change from existing (feet per second)
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
Old River
Tracy Blvd.
0
1
2
3
4
5
6
7
8
River station (miles)

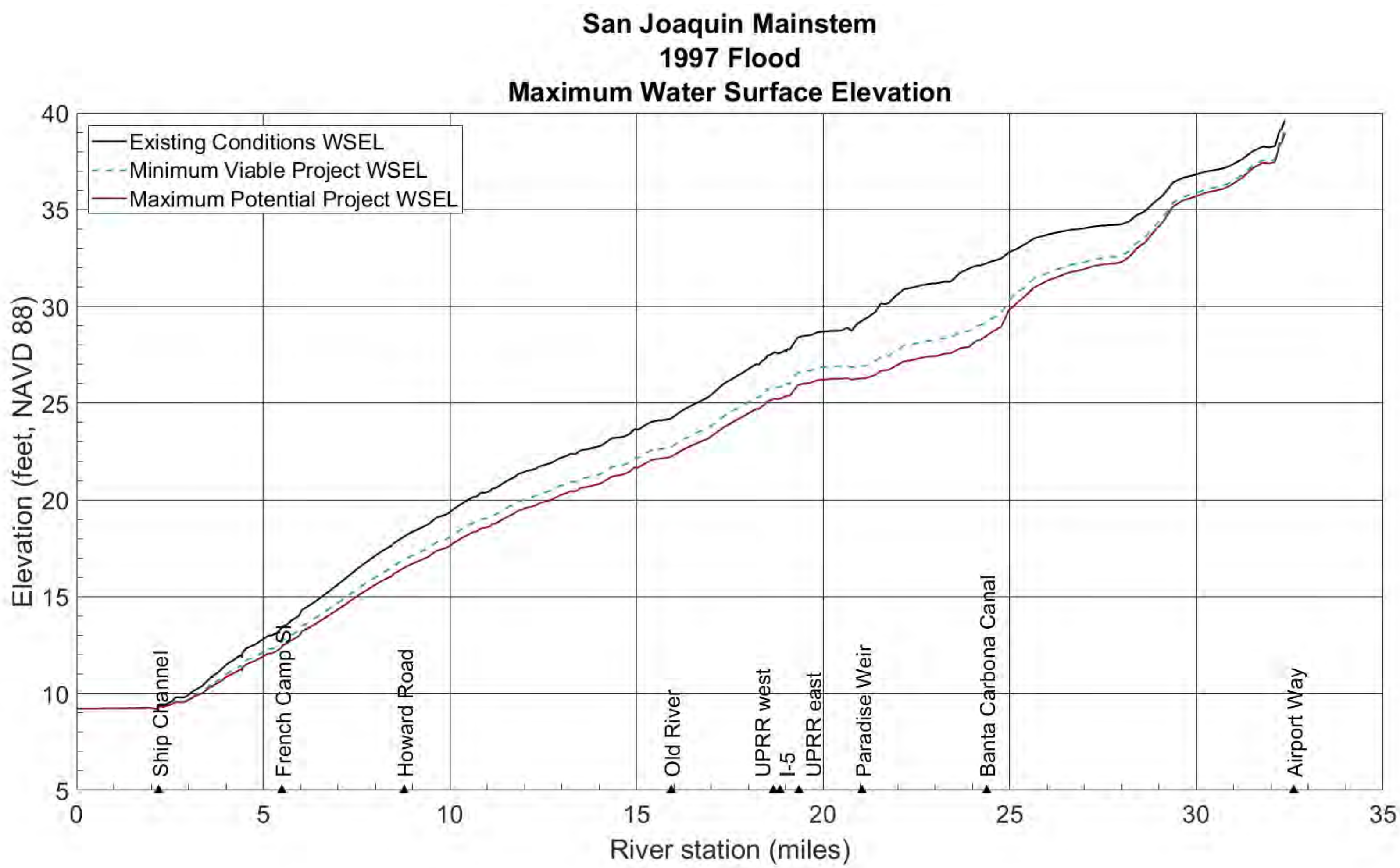


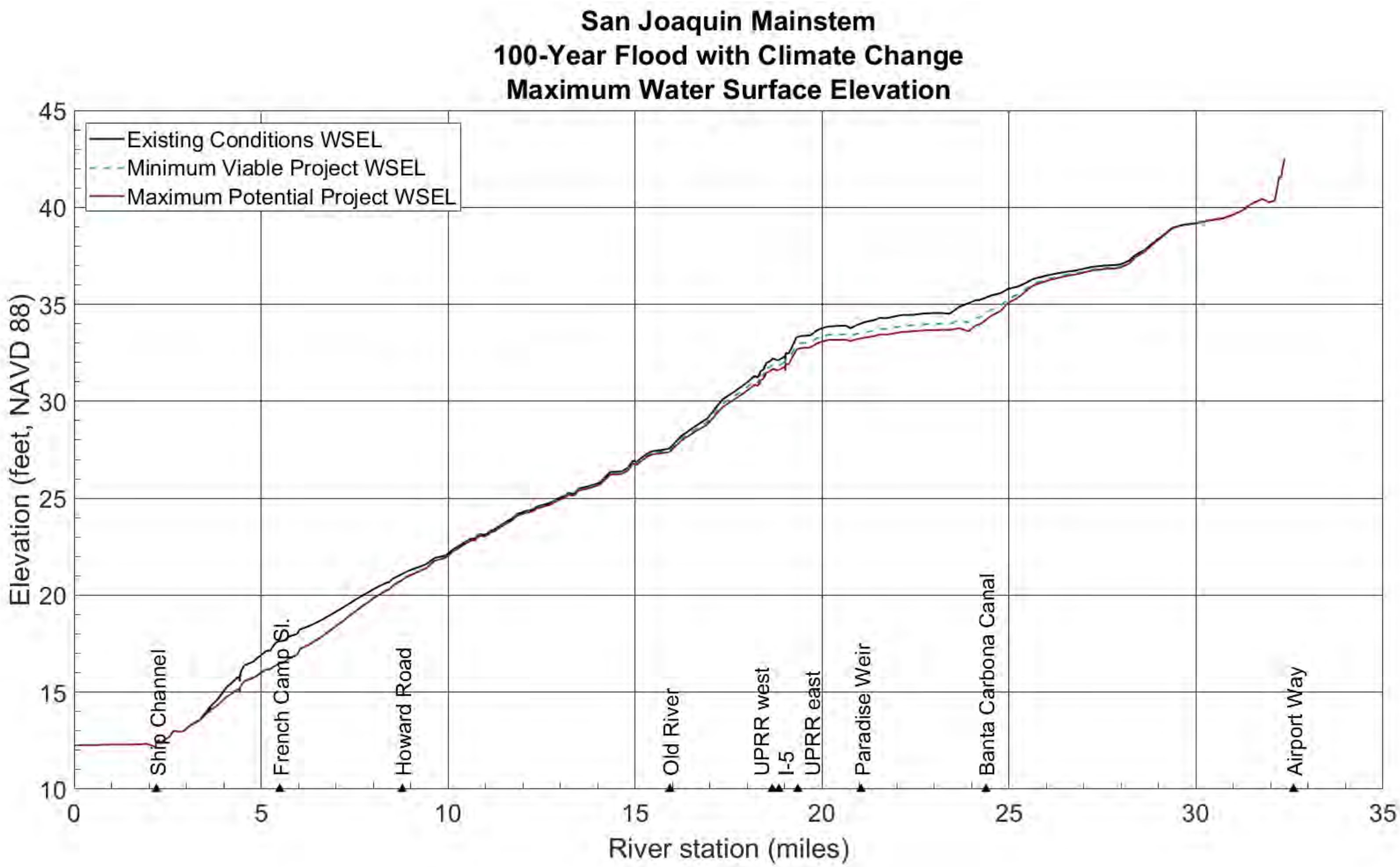
Grant Line Canal
100-Year Flood with Climate Change
Change in Velocity Relative to Existing Conditions Baseline
Modified CVFPP velocity
Minimum Viable Project velocity
Change from existing (feet per second)
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
Old River
Tracy Blvd.
0
1
2
3
4
5
6
7
8
River station (miles)

Chart Group 6a
PMP vs MVP
water surface elevation

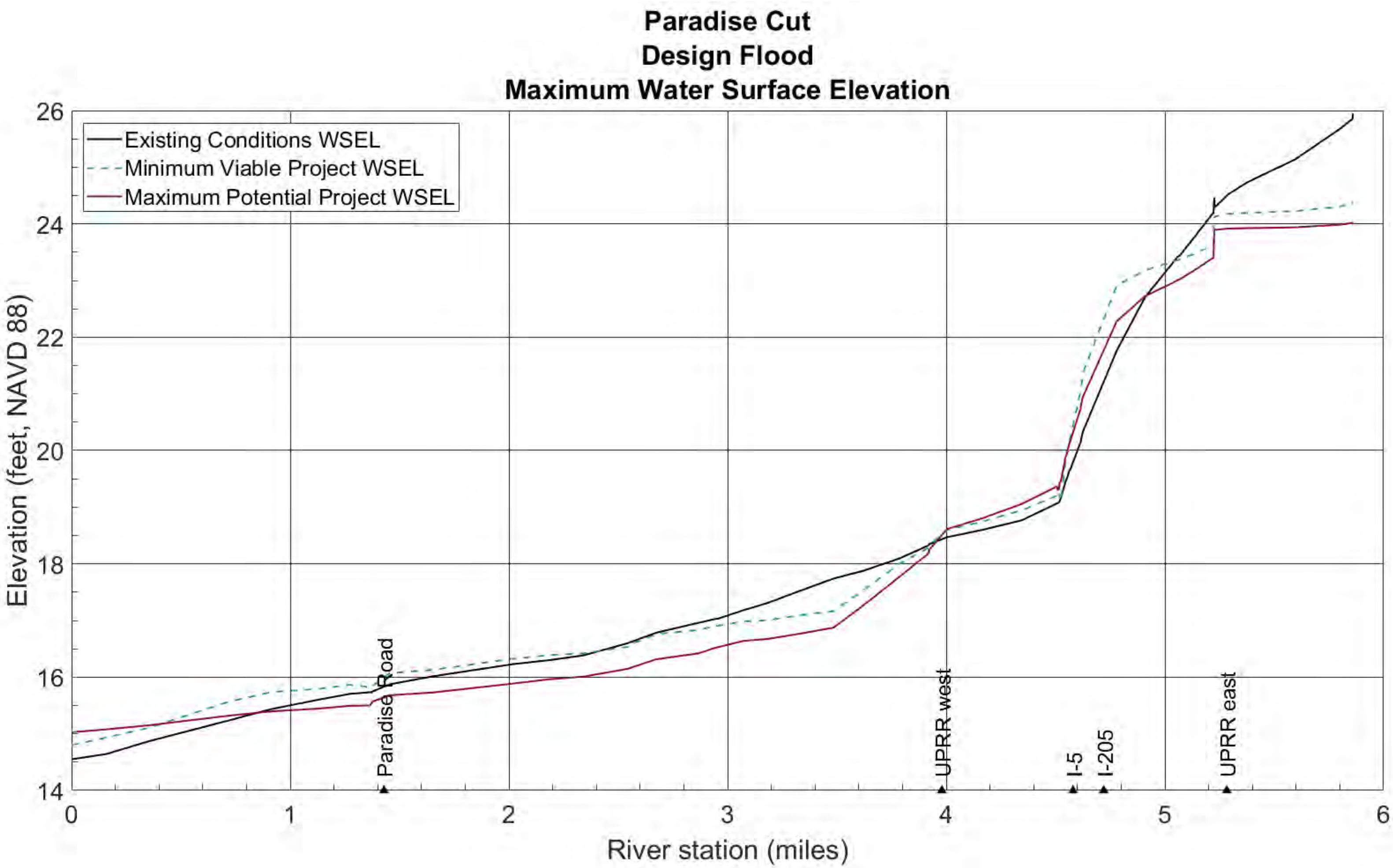


San Joaquin Mainstem
Design Flood
Maximum Water Surface Elevation
Existing Conditions WSEL
Minimum Viable Project WSEL
Maximum Potential Project WSEL
Elevation (feet, NAVD 88)
River station (miles)
40
35
30
25
20
15
10
5
0
5
10
15
20
25
30
35
Ship Channel
French Camp Sl.
Howard Road
Old River
UPRR west
I-5
UPRR east
Paradise Weir
Banta Carbona Canal
Airport Way

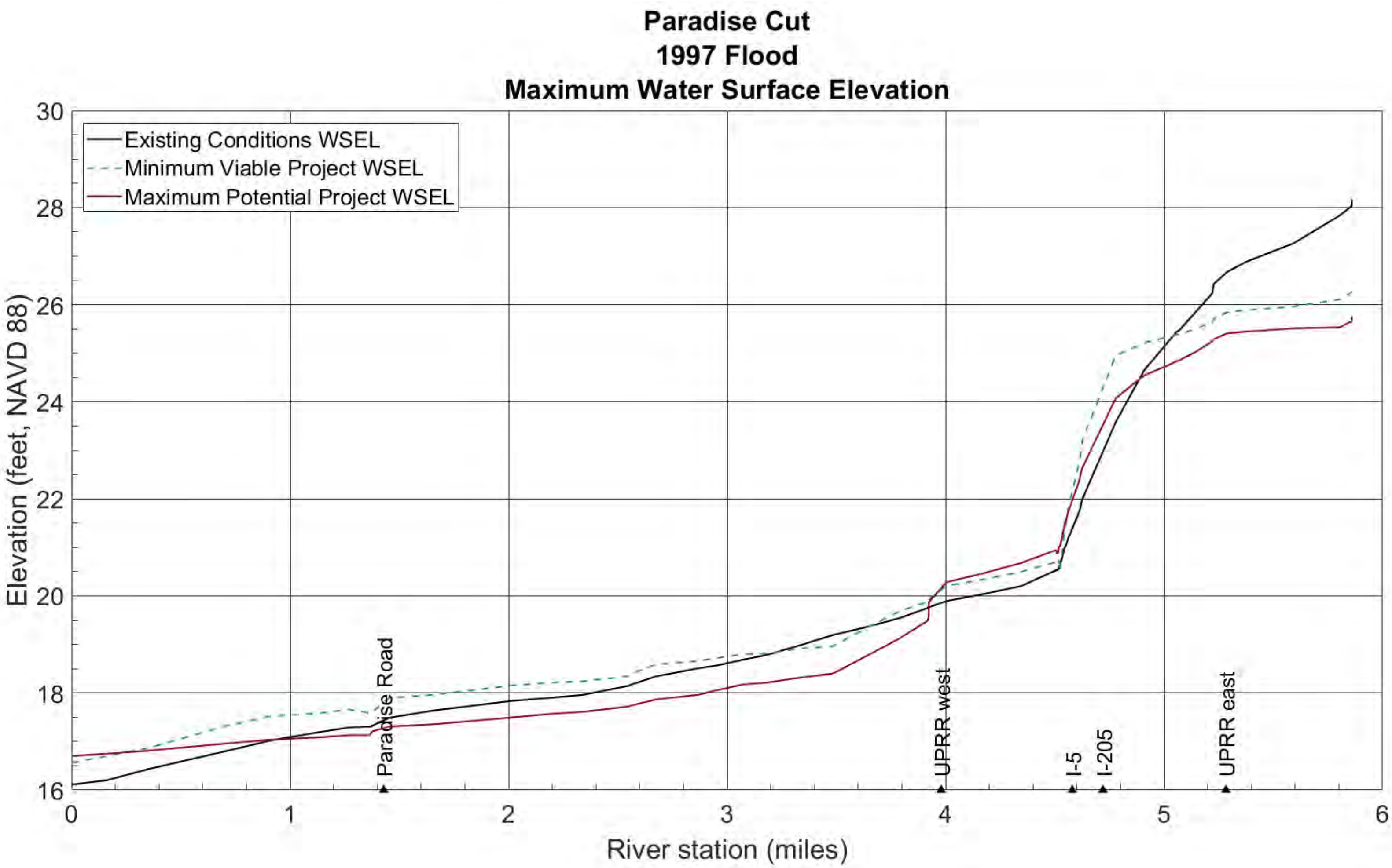

San Joaquin Mainstem
1997 Flood
Maximum Water Surface Elevation
Existing Conditions WSEL
Minimum Viable Project WSEL
Maximum Potential Project WSEL
Elevation (feet, NAVD 88)
River station (miles)
Ship Channel
French Camp Sl
Howard Road
Old River
UPRR west
I-5
UPRR east
Paradise Weir
Banta Carbona Canal
Airport Way
40
35
30
25
20
15
10
5
0
5
10
15
20
25
30
35

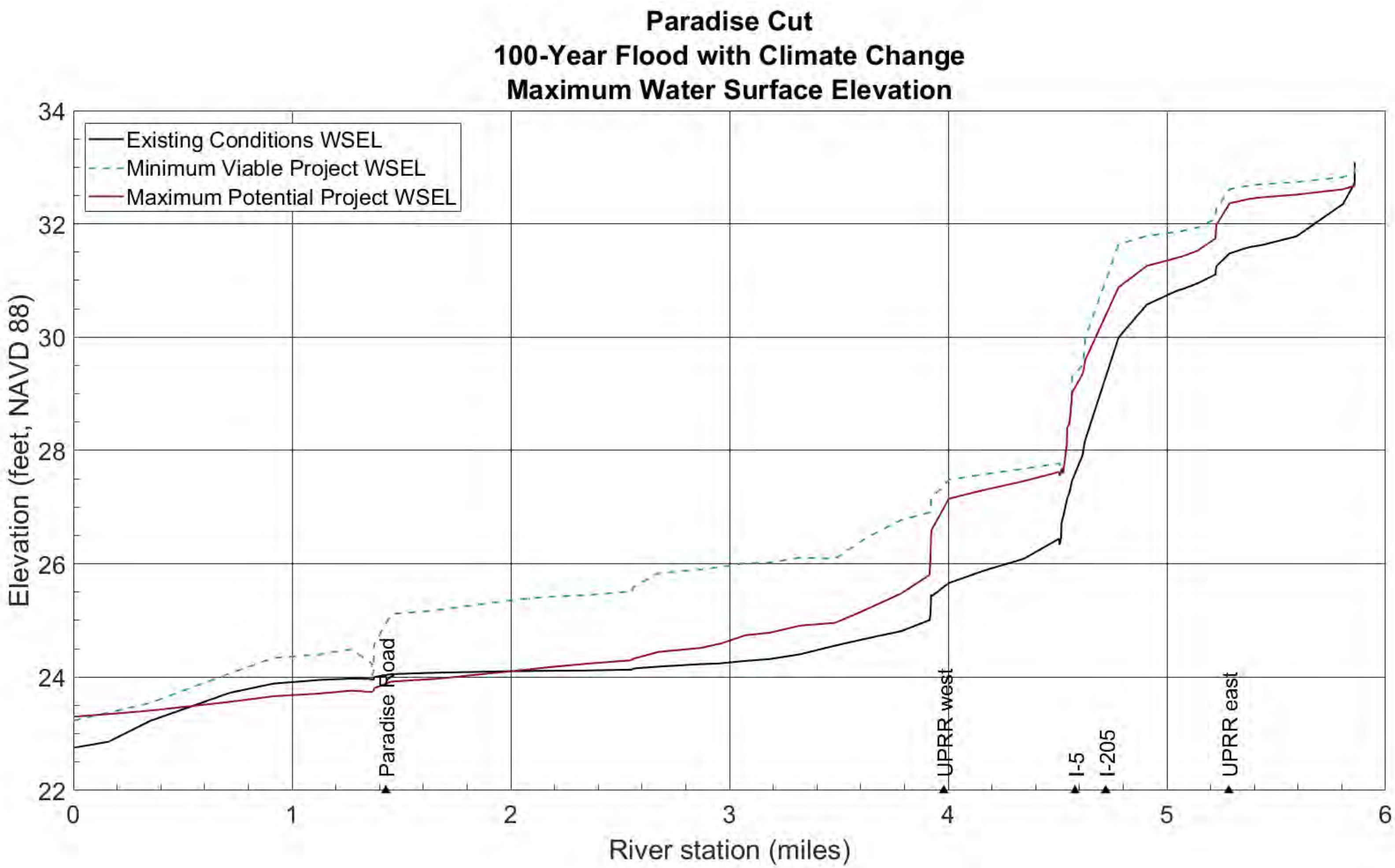


San Joaquin Mainstem
100-Year Flood with Climate Change
Maximum Water Surface Elevation
Existing Conditions WSEL
Minimum Viable Project WSEL
Maximum Potential Project WSEL
Elevation (feet, NAVD 88)
River station (miles)
Ship Channel
French Camp Sl.
Howard Road
Old River
UPRR west
I-5
UPRR east
Paradise Weir
Banta Carbona Canal
Airport Way

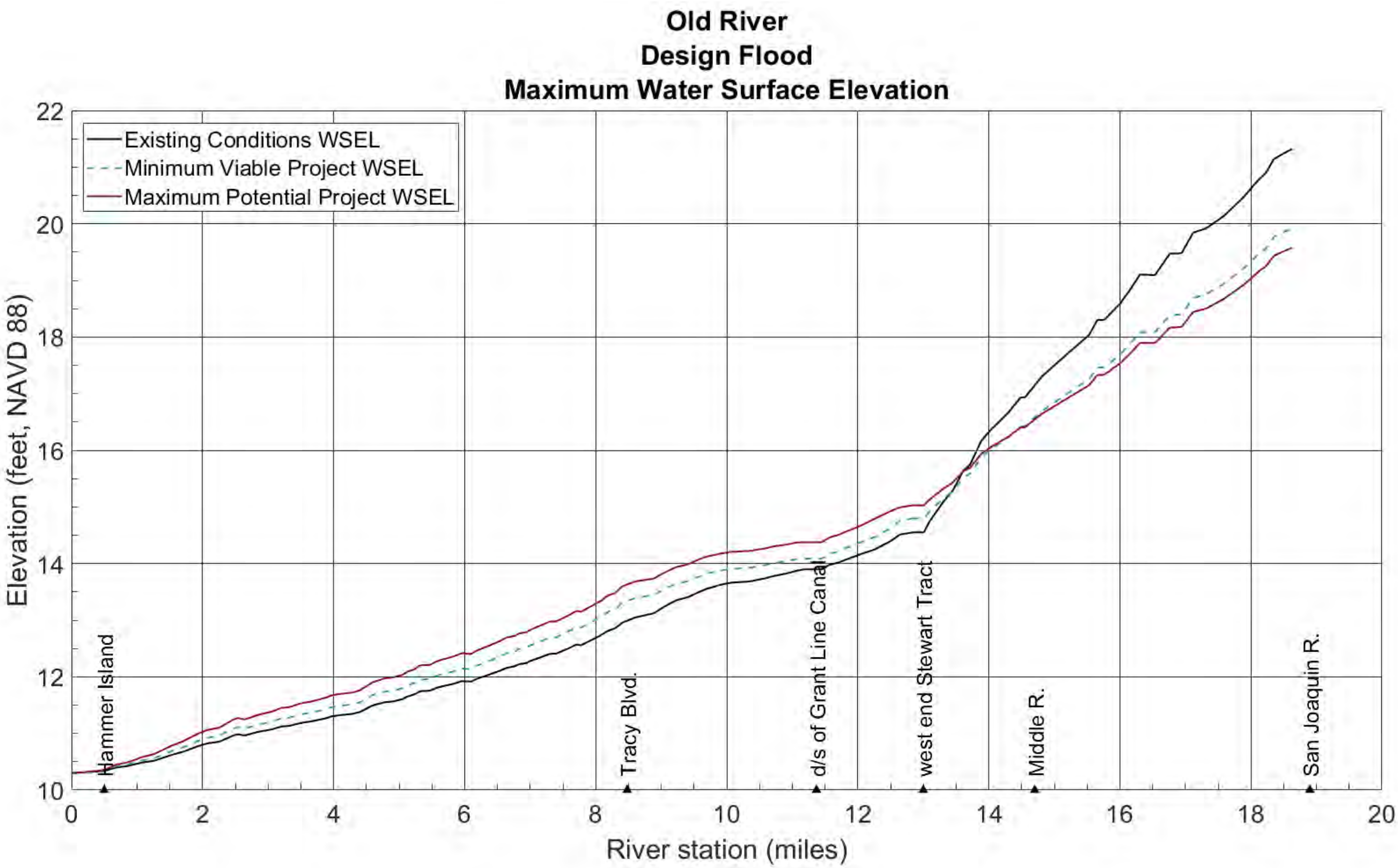


Paradise Cut
Design Flood
Maximum Water Surface Elevation
Existing Conditions WSEL
Minimum Viable Project WSEL
Maximum Potential Project WSEL
Elevation (feet, NAVD 88)
26
24
22
20
18
16
14
0
1
2
3
4
5
6
River station (miles)
Paradise Road
UPRR west
I-5
I-205
UPRR east

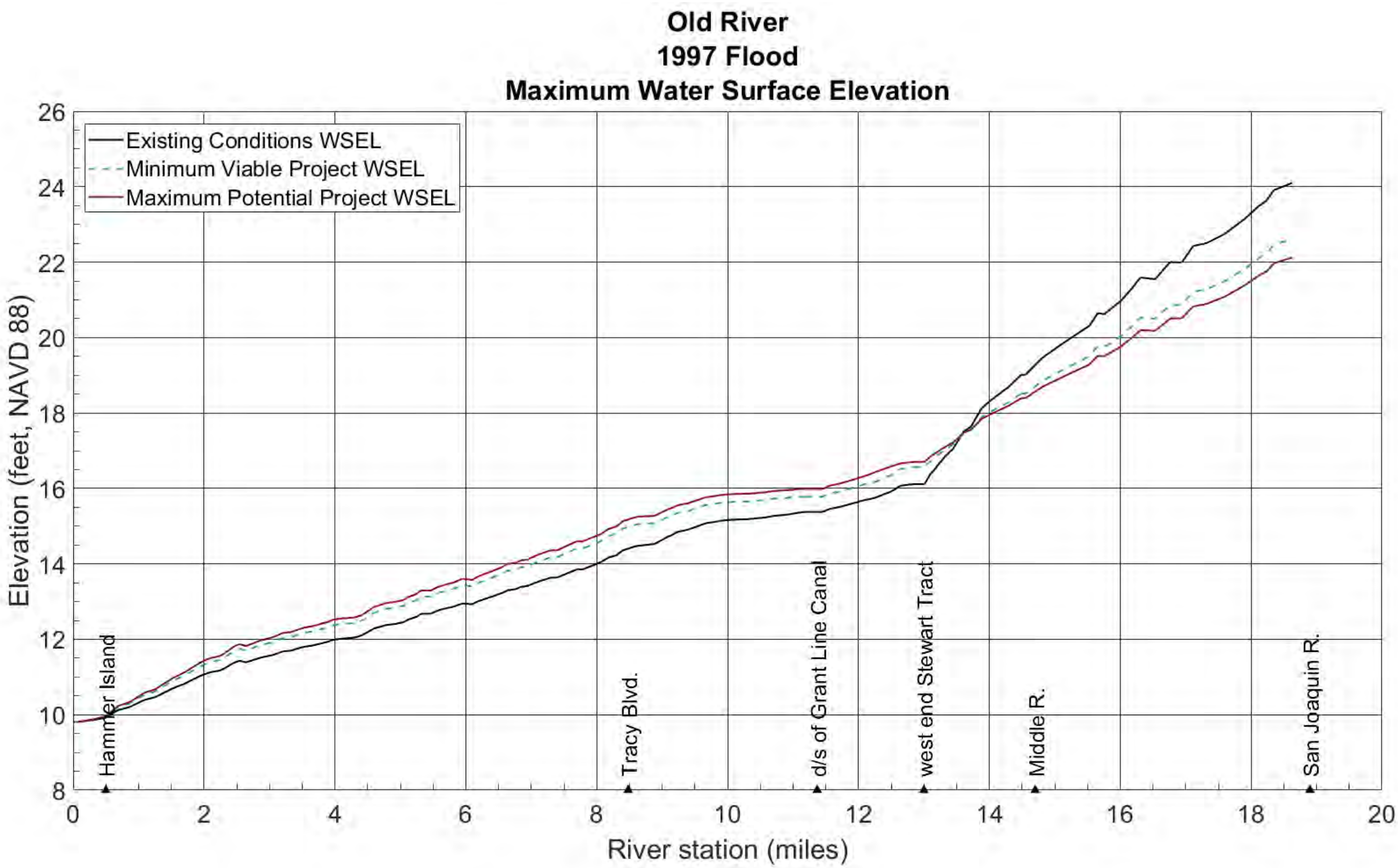

Paradise Cut
1997 Flood
Maximum Water Surface Elevation
Existing Conditions WSEL
Minimum Viable Project WSEL
Maximum Potential Project WSEL
Elevation (feet, NAVD 88)
River station (miles)
Paradise Road
UPRR west
I-5
I-205
UPRR east
30
28
26
24
22
20
18
16
0
1
2
3
4
5
6



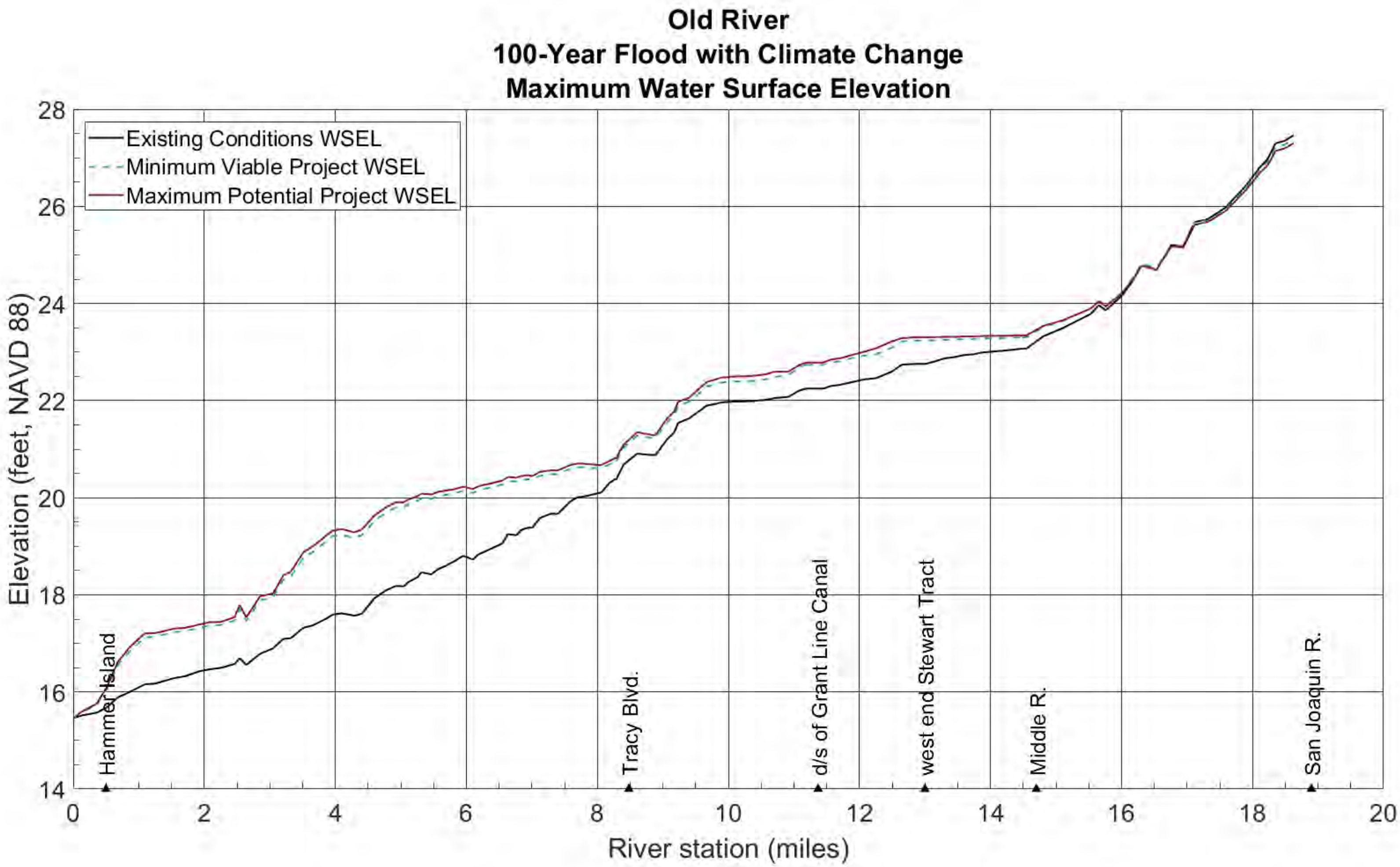
Paradise Cut
100-Year Flood with Climate Change
Maximum Water Surface Elevation
Existing Conditions WSEL
Minimum Viable Project WSEL
Maximum Potential Project WSEL
Elevation (feet, NAVD 88)
River station (miles)
Paradise Road
UPRR west
I-5
I-205
UPRR east
34
32
30
28
26
24
22
0
1
2
3
4
5
6



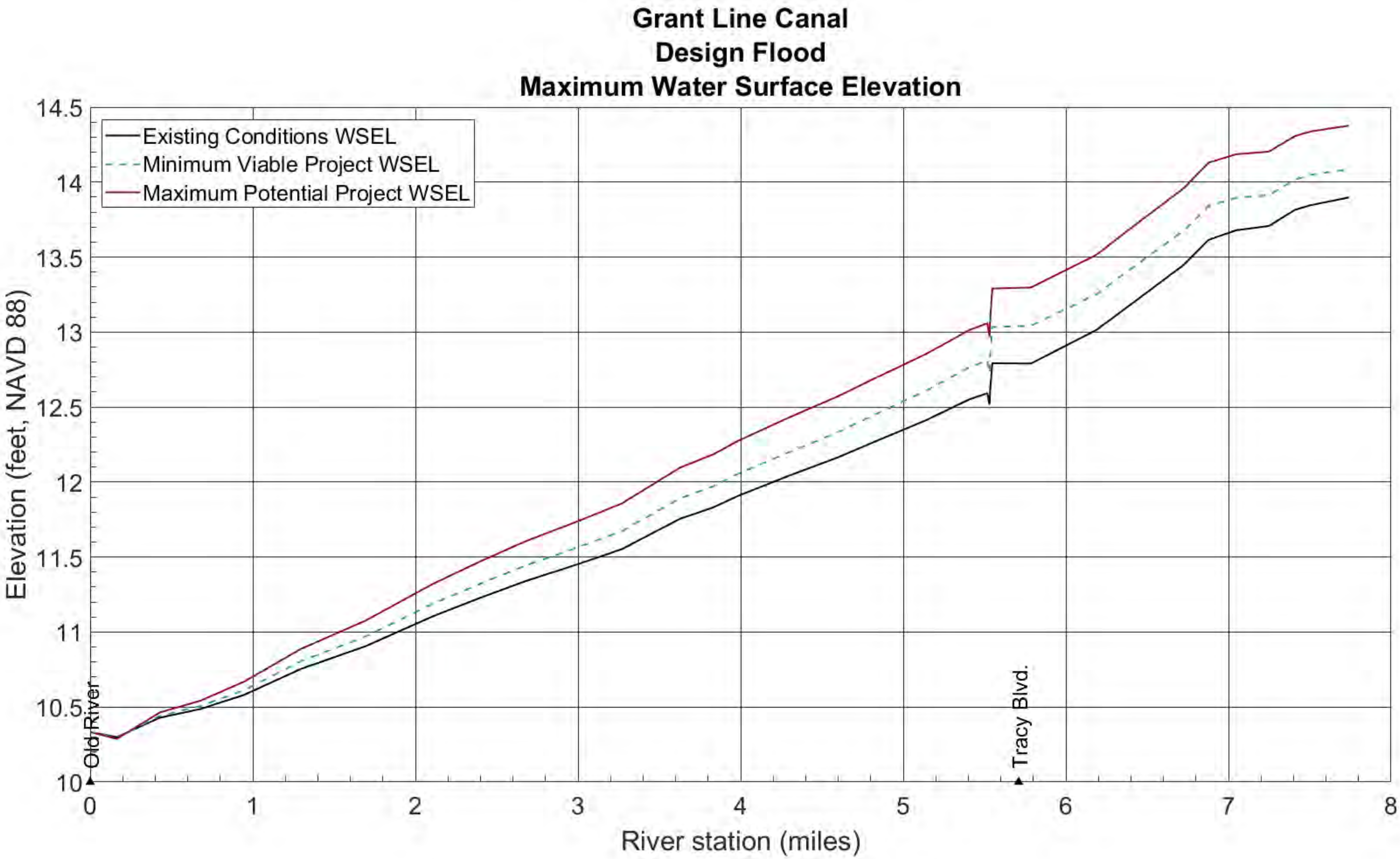
Old River
Design Flood
Maximum Water Surface Elevation
Existing Conditions WSEL
Minimum Viable Project WSEL
Maximum Potential Project WSEL
Elevation (feet, NAVD 88)
River station (miles)
Hammer Island
Tracy Blvd.
d/s of Grant Line Canal
west end Stewart Tract
Middle R.
San Joaquin R.
22
20
18
16
14
12
10
0
2
4
6
8
10
12
14
16
18
20



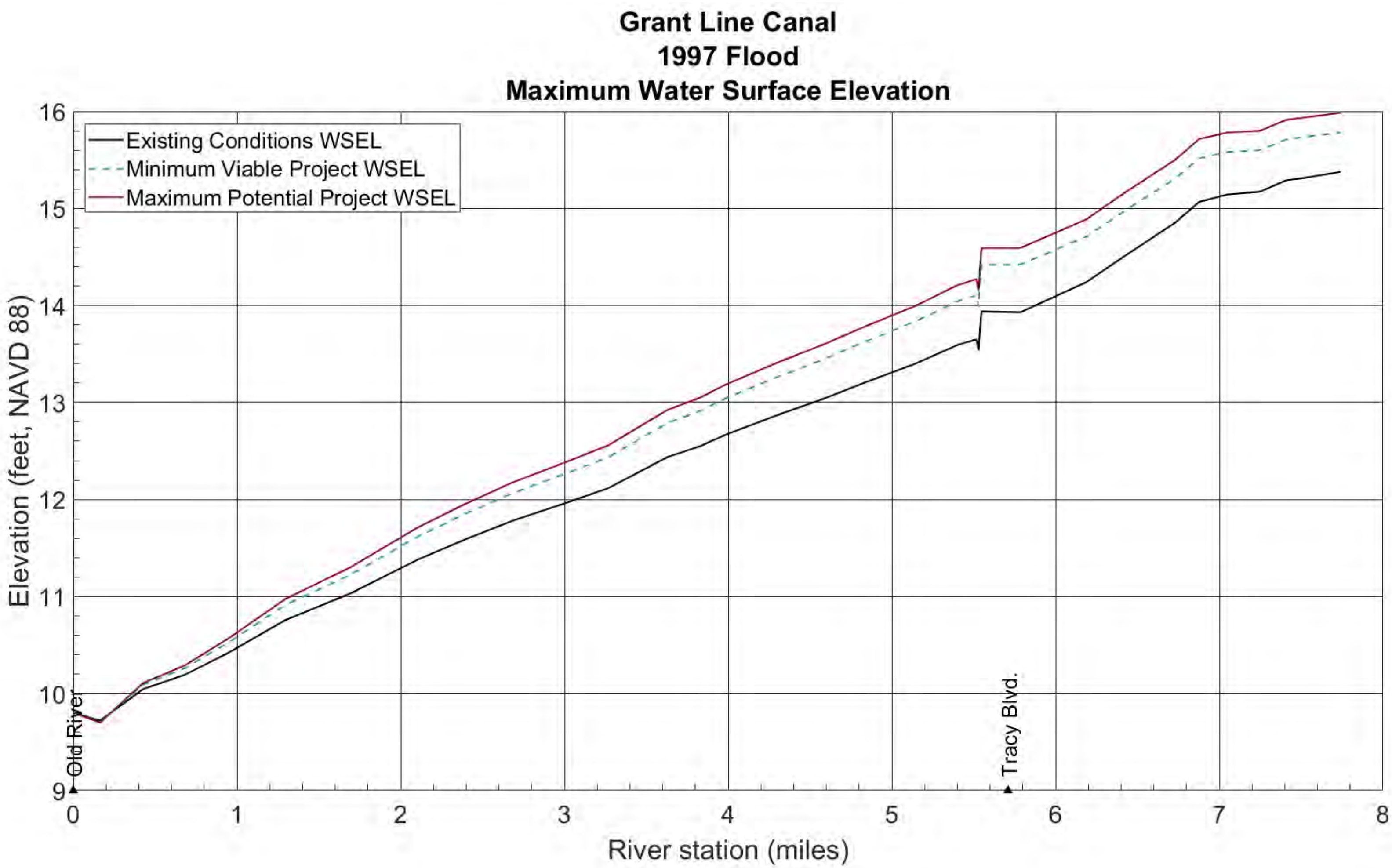
Old River
1997 Flood
Maximum Water Surface Elevation
Existing Conditions WSEL
Minimum Viable Project WSEL
Maximum Potential Project WSEL
Elevation (feet, NAVD 88)
River station (miles)
Hammer Island
Tracy Blvd.
d/s of Grant Line Canal
west end Stewart Tract
Middle R.
San Joaquin R.



Old River
100-Year Flood with Climate Change
Maximum Water Surface Elevation
Existing Conditions WSEL
Minimum Viable Project WSEL
Maximum Potential Project WSEL
Elevation (feet, NAVD 88)
River station (miles)
Hammer Island
Tracy Blvd.
d/s of Grant Line Canal
west end Stewart Tract
Middle R.
San Joaquin R.
28
26
24
22
20
18
16
14
0
2
4
6
8
10
12
14
16
18
20



Grant Line Canal
Design Flood
Maximum Water Surface Elevation
Existing Conditions WSEL
Minimum Viable Project WSEL
Maximum Potential Project WSEL
Elevation (feet, NAVD 88)
River station (miles)
Old River
Tracy Blvd.
14.5
14
13.5
13
12.5
12
11.5
11
10.5
10
0
1
2
3
4
5
6
7
8


Grant Line Canal
1997 Flood
Maximum Water Surface Elevation
Existing Conditions WSEL
Minimum Viable Project WSEL
Maximum Potential Project WSEL
Elevation (feet, NAVD 88)
River station (miles)
Old River
Tracy Blvd.
16
15
14
13
12
11
10
9
0
1
2
3
4
5
6
7
8

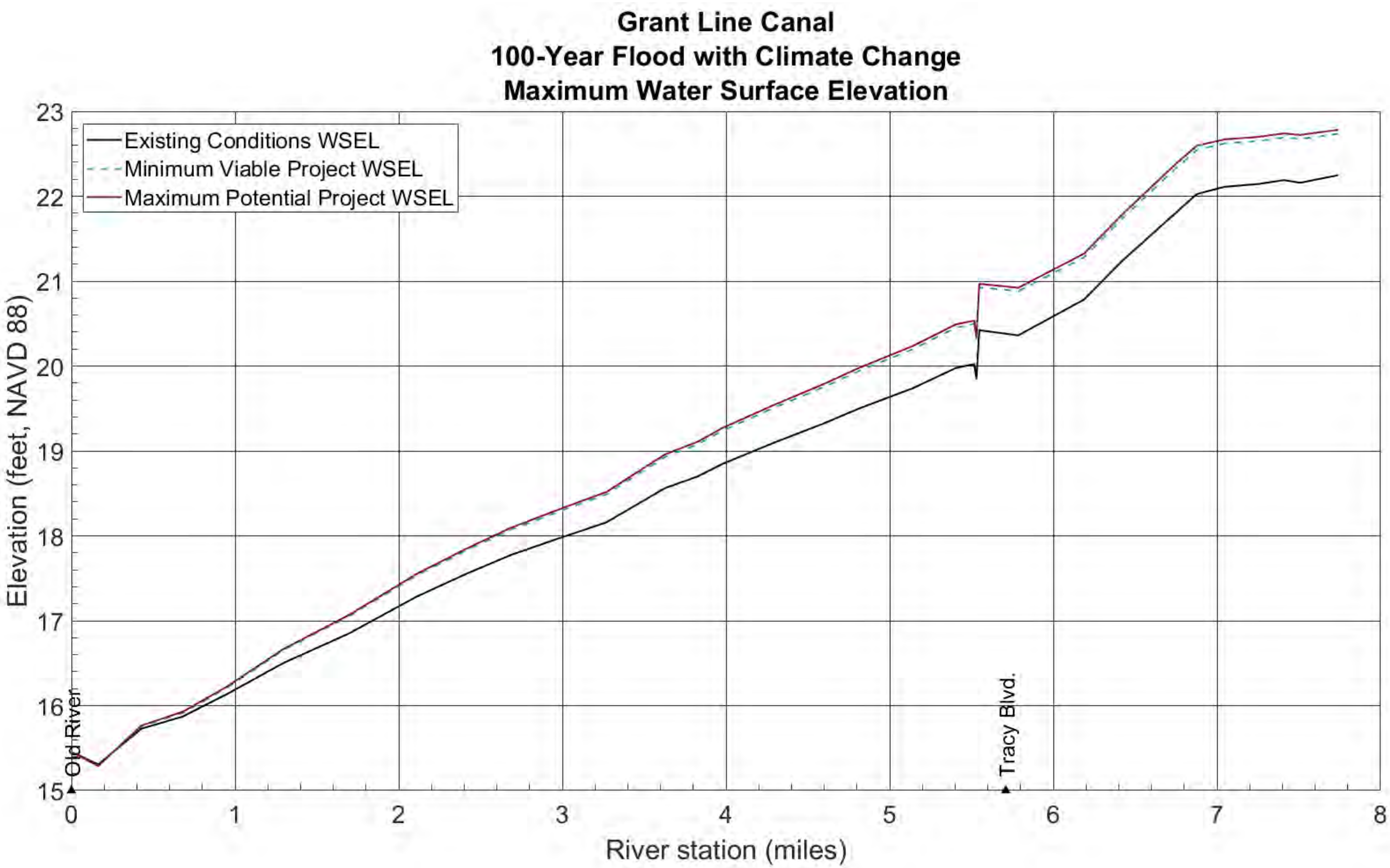
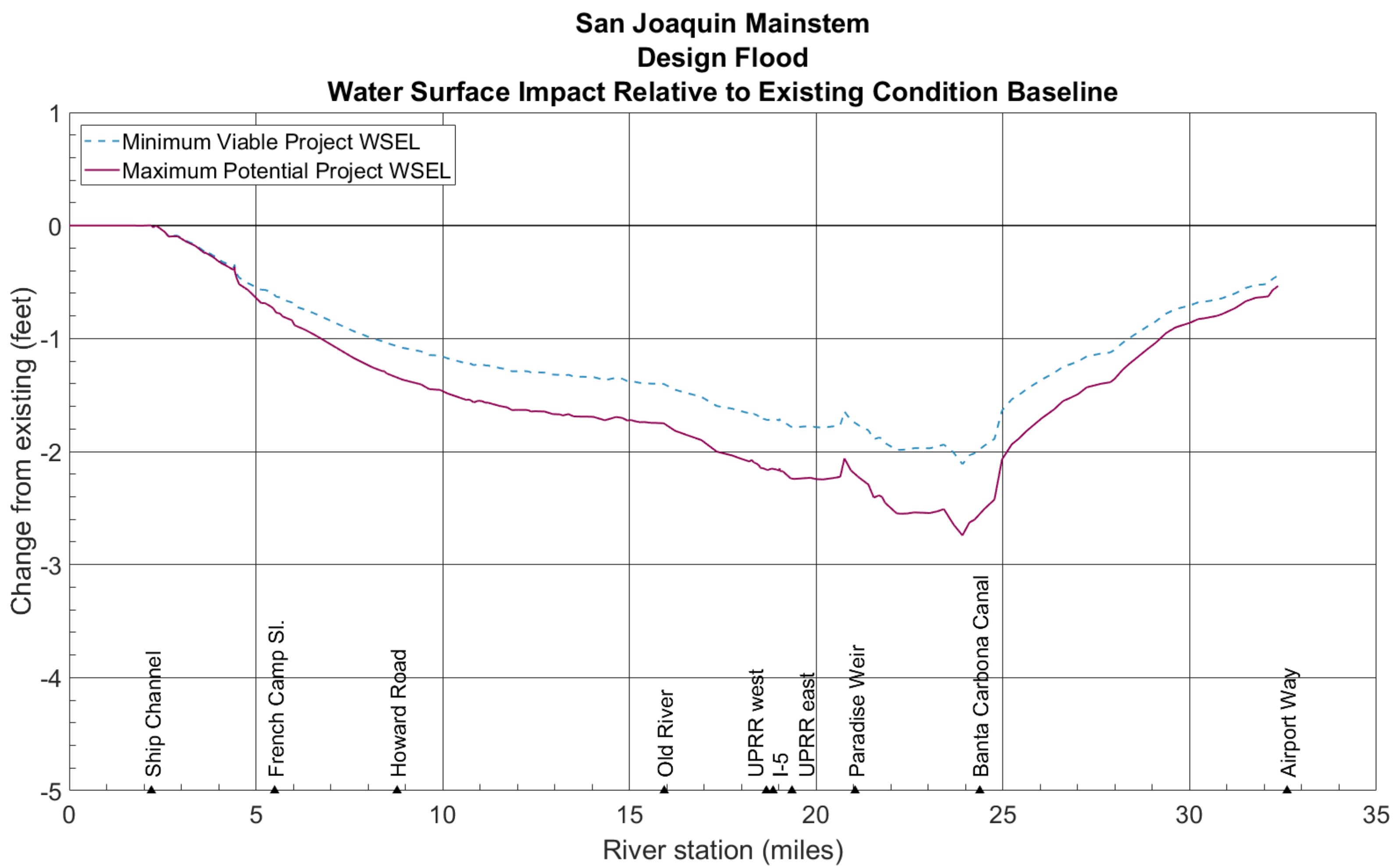
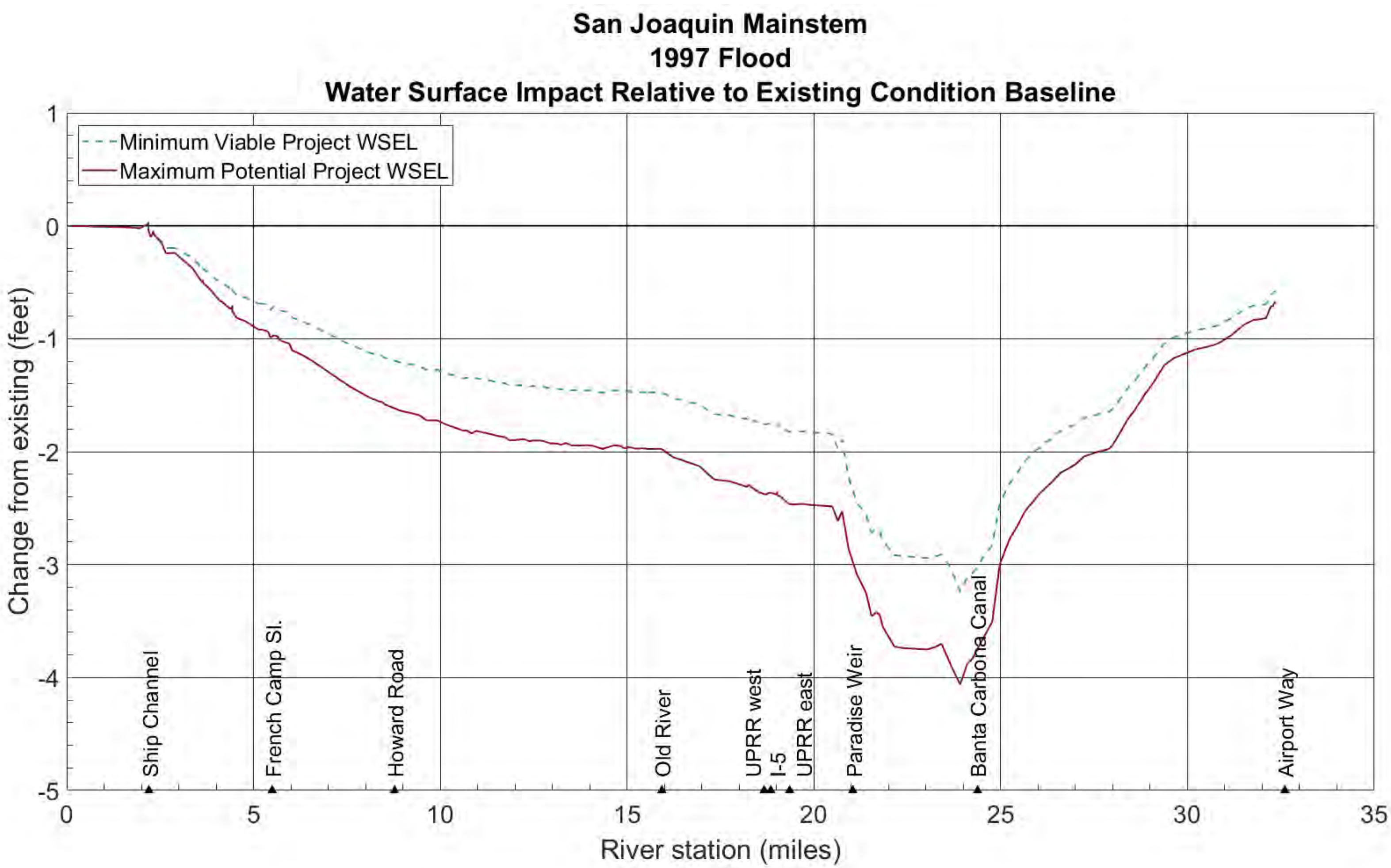
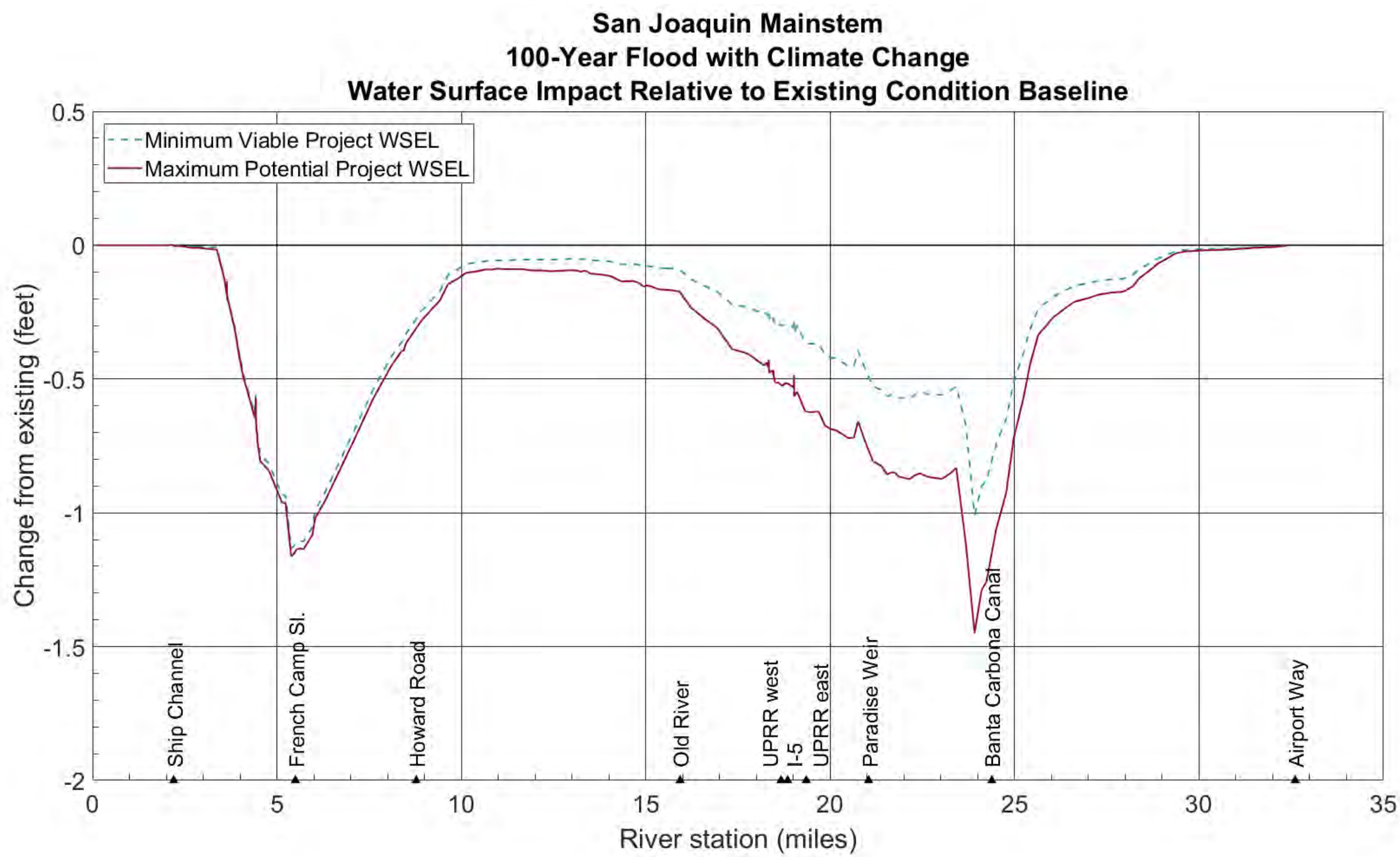

Grant Line Canal
100-Year Flood with Climate Change
Maximum Water Surface Elevation
Existing Conditions WSEL
Minimum Viable Project WSEL
Maximum Potential Project WSEL
Elevation (feet, NAVD 88)
River station (miles)
Old River
Tracy Blvd.
23
22
21
20
19
18
17
16
15
0
1
2
3
4
5
6
7
8

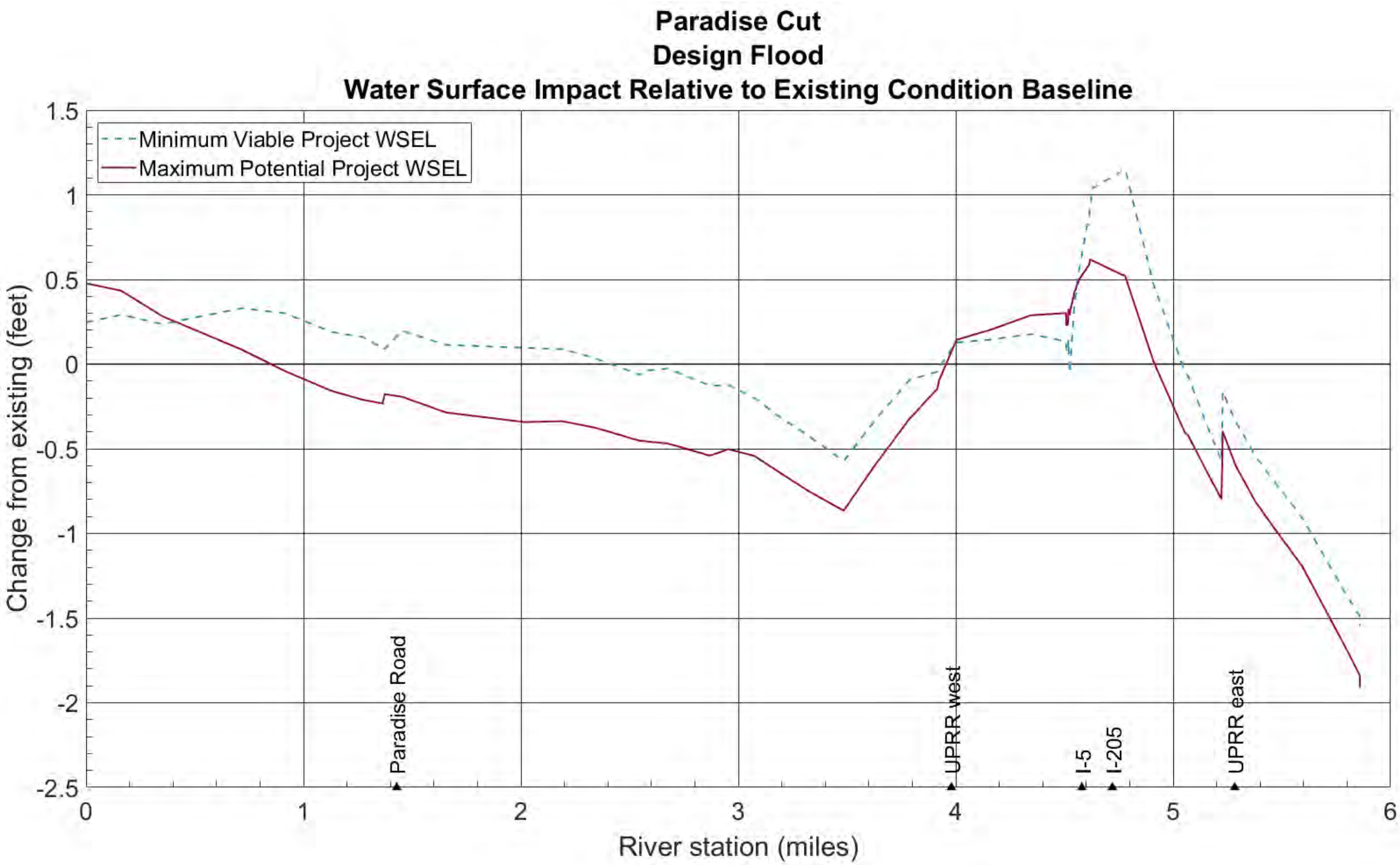
Chart Group 6b
MVP vs PMP
relative difference

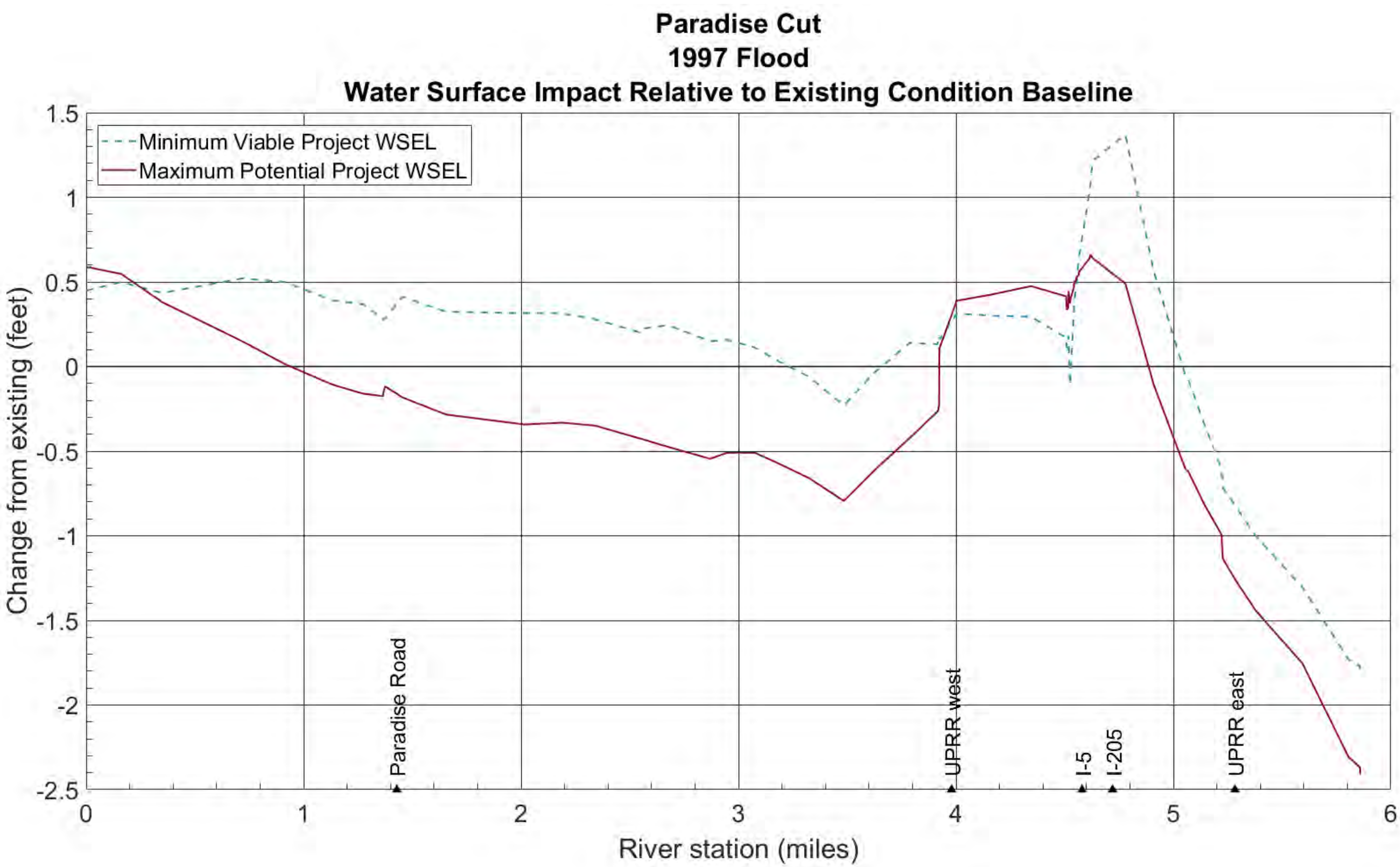

San Joaquin Mainstem
Design Flood
Water Surface Impact Relative to Existing Condition Baseline
Minimum Viable Project WSEL
Maximum Potential Project WSEL
Change from existing (feet)
River station (miles)
1
0
-1
-2
-3
-4
-5
0
5
10
15
20
25
30
35
Ship Channel
French Camp Sl.
Howard Road
Old River
UPRR west
I-5
UPRR east
Paradise Weir
Banta Carbona Canal
Airport Way

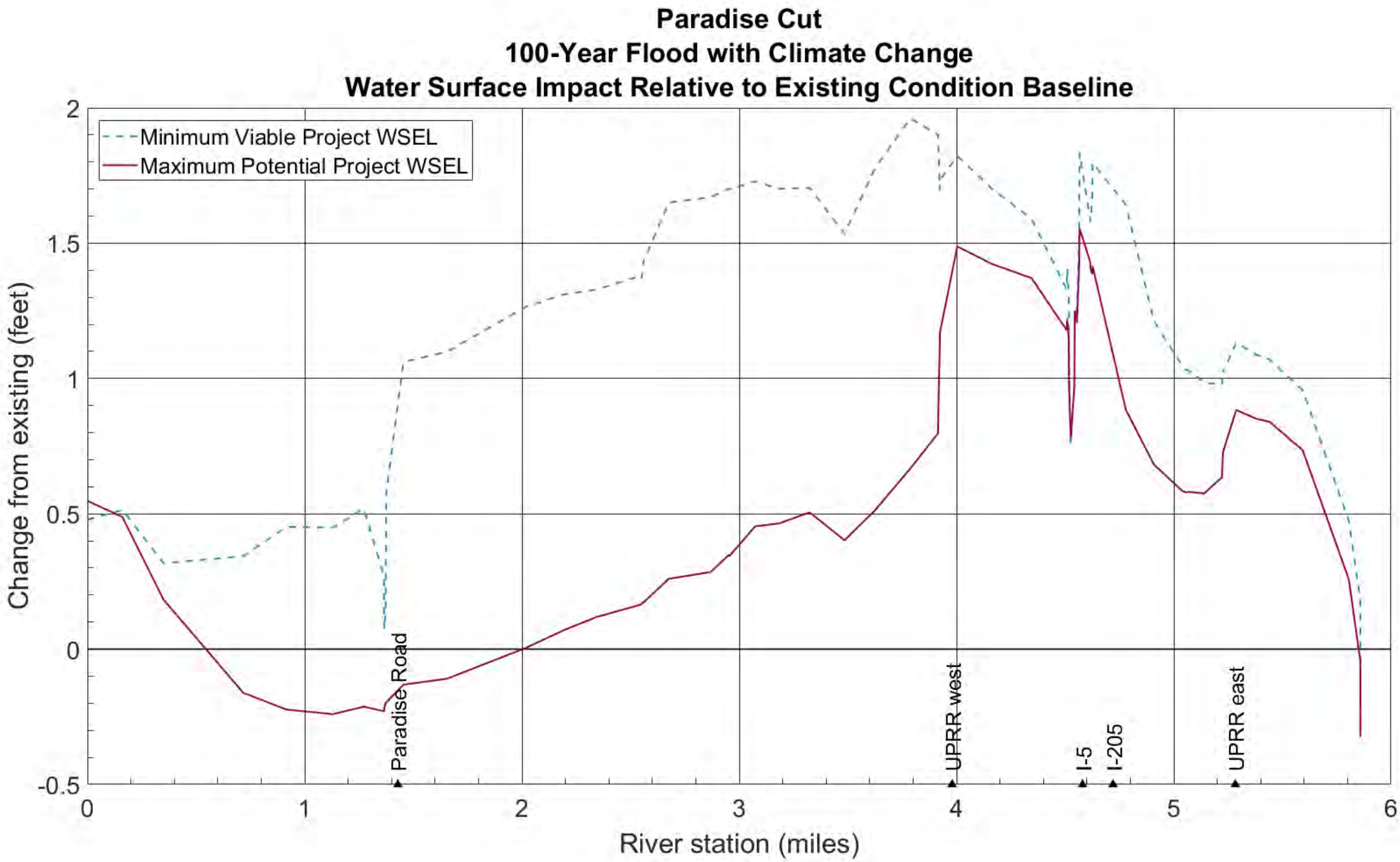


San Joaquin Mainstem
1997 Flood
Water Surface Impact Relative to Existing Condition Baseline
Minimum Viable Project WSEL
Maximum Potential Project WSEL
Change from existing (feet)
River station (miles)
1
0
-1
-2
-3
-4
-5
0
5
10
15
20
25
30
35
Ship Channel
French Camp Sl.
Howard Road
Old River
UPRR west
I-5
UPRR east
Paradise Weir
Banta Carbona Canal
Airport Way


San Joaquin Mainstem
100-Year Flood with Climate Change
Water Surface Impact Relative to Existing Condition Baseline
Minimum Viable Project WSEL
Maximum Potential Project WSEL
Change from existing (feet)
River station (miles)
0.5
0
-0.5
-1
-1.5
-2
0
5
10
15
20
25
30
35
Ship Channel
French Camp Sl.
Howard Road
Old River
UPRR west
I-5
UPRR east
Paradise Weir
Banta Carbona Canal
Airport Way

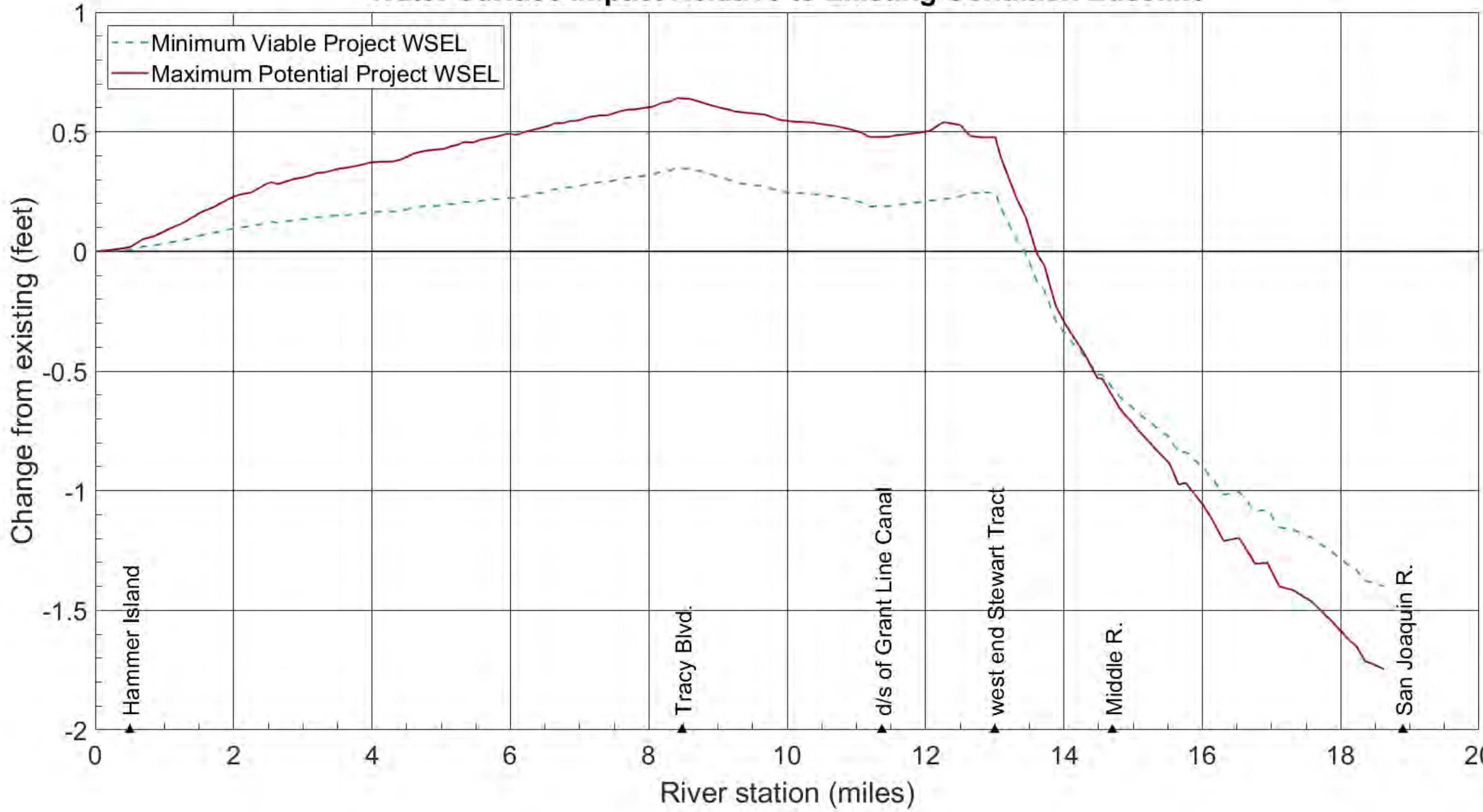

Paradise Cut
Design Flood
Water Surface Impact Relative to Existing Condition Baseline
Minimum Viable Project WSEL
Maximum Potential Project WSEL
Change from existing (feet)
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
River station (miles)
0
1
2
3
4
5
6
Paradise Road
UPRR west
I-5
I-205
UPRR east

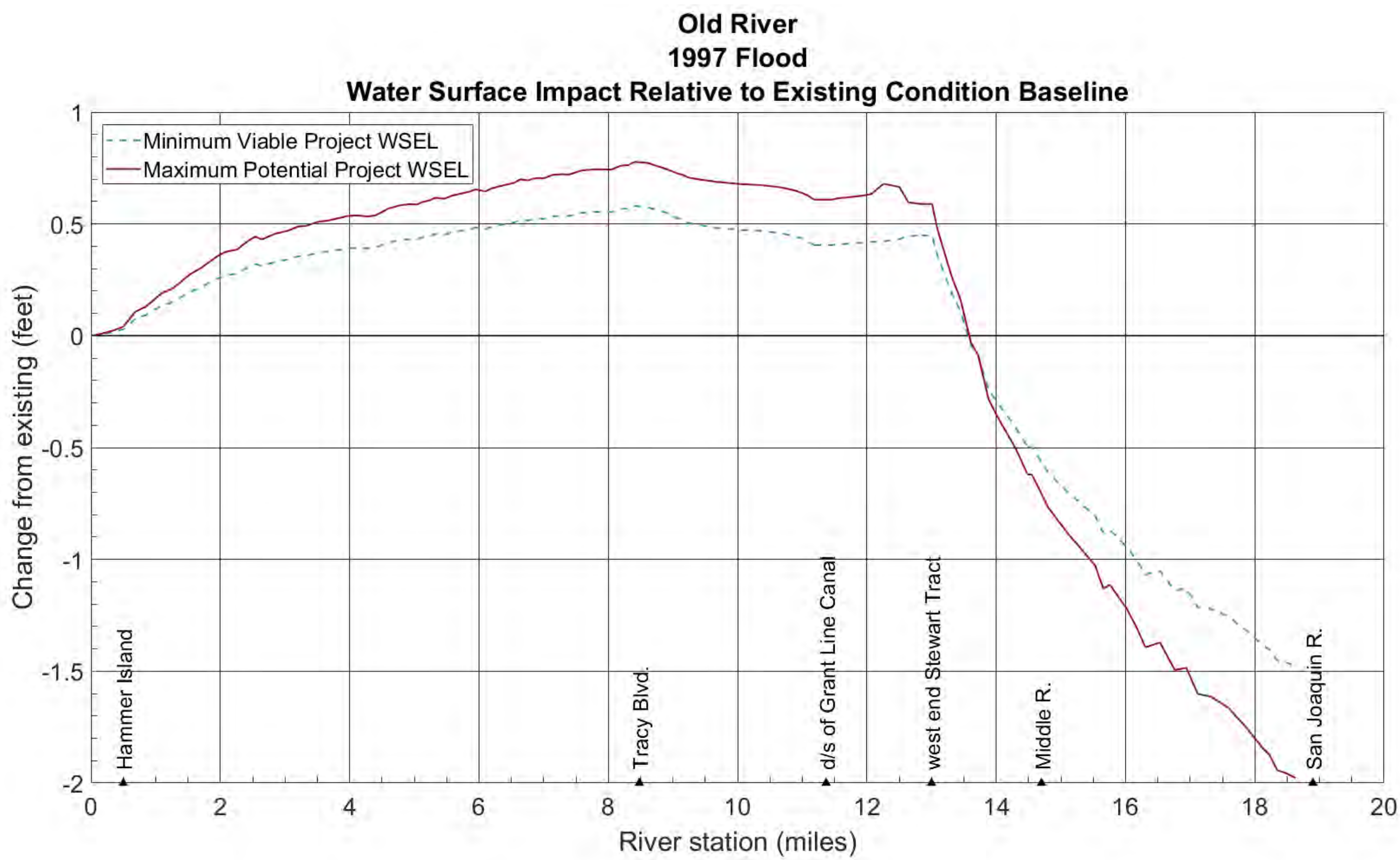

Paradise Cut
1997 Flood
Water Surface Impact Relative to Existing Condition Baseline
Minimum Viable Project WSEL
Maximum Potential Project WSEL
Change from existing (feet)
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
Paradise Road
UPRR west
I-5
I-205
UPRR east
0
1
2
3
4
5
6
River station (miles)



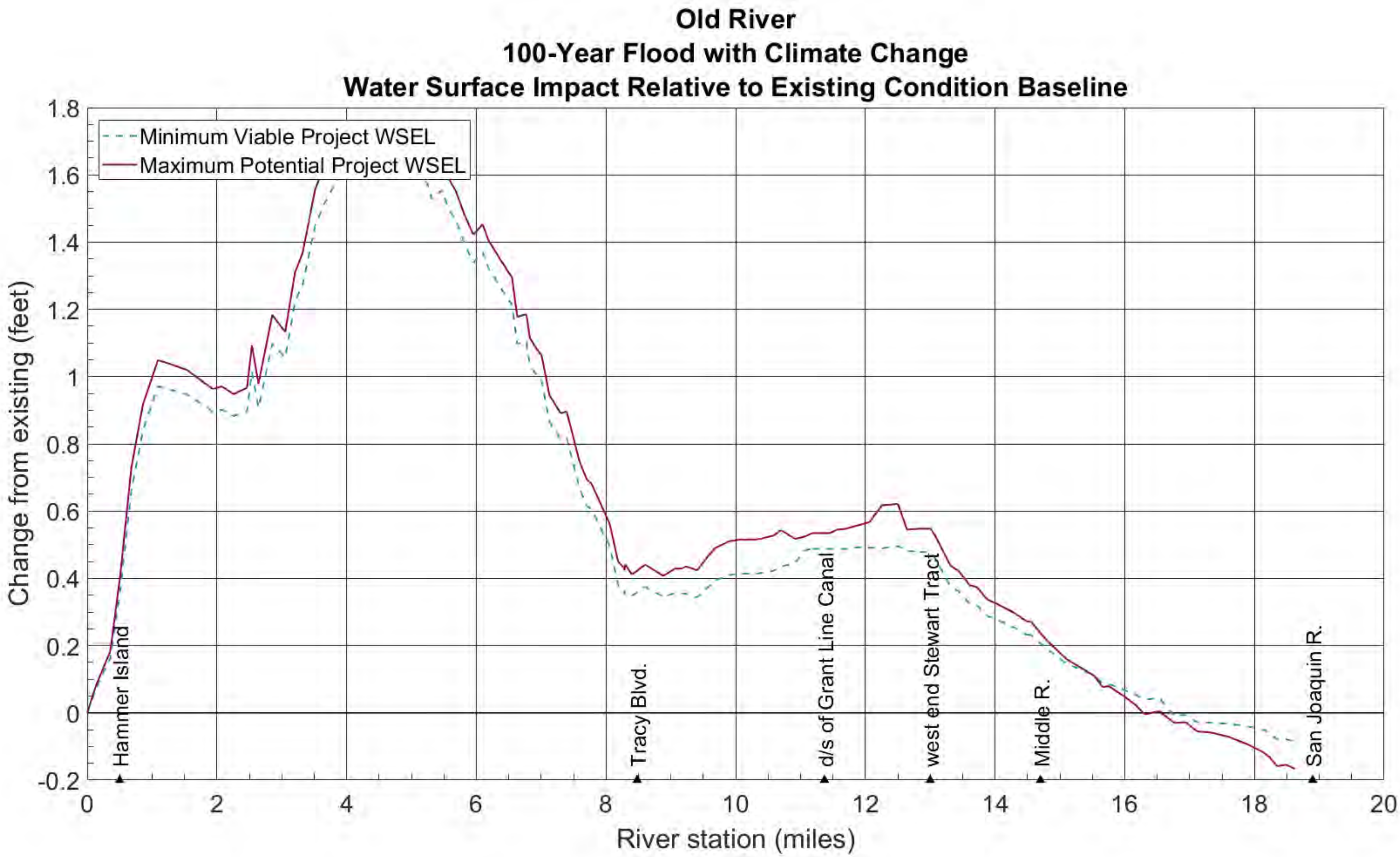
Paradise Cut
100-Year Flood with Climate Change
Water Surface Impact Relative to Existing Condition Baseline
Minimum Viable Project WSEL
Maximum Potential Project WSEL
Change from existing (feet)
River station (miles)
Paradise Road
UPRR west
I-5
I-205
UPRR east
2
1.5
1
0.5
0
-0.5
0
1
2
3
4
5
6

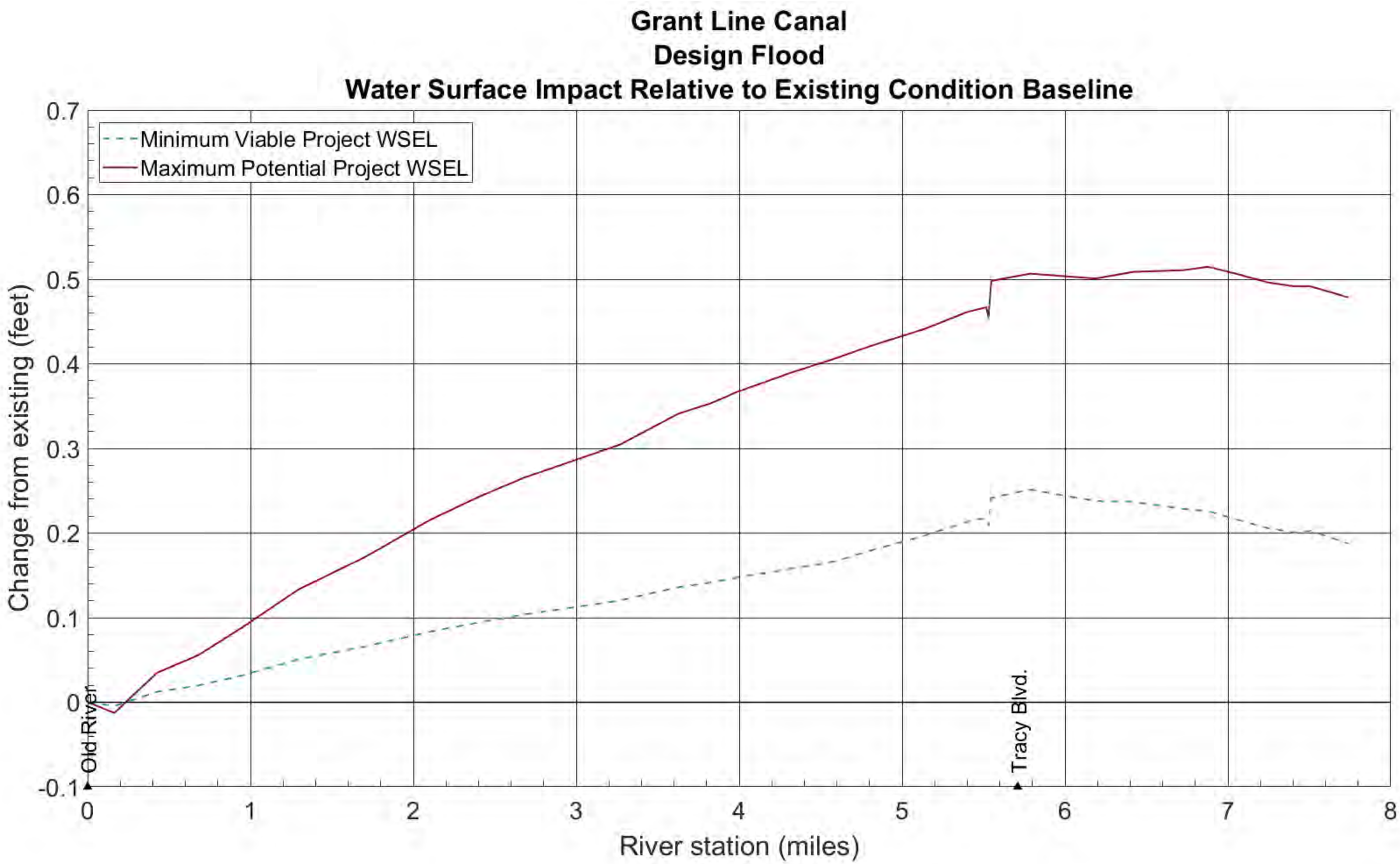
Old River
Design Flood
Water Surface Impact Relative to Existing Condition Baseline

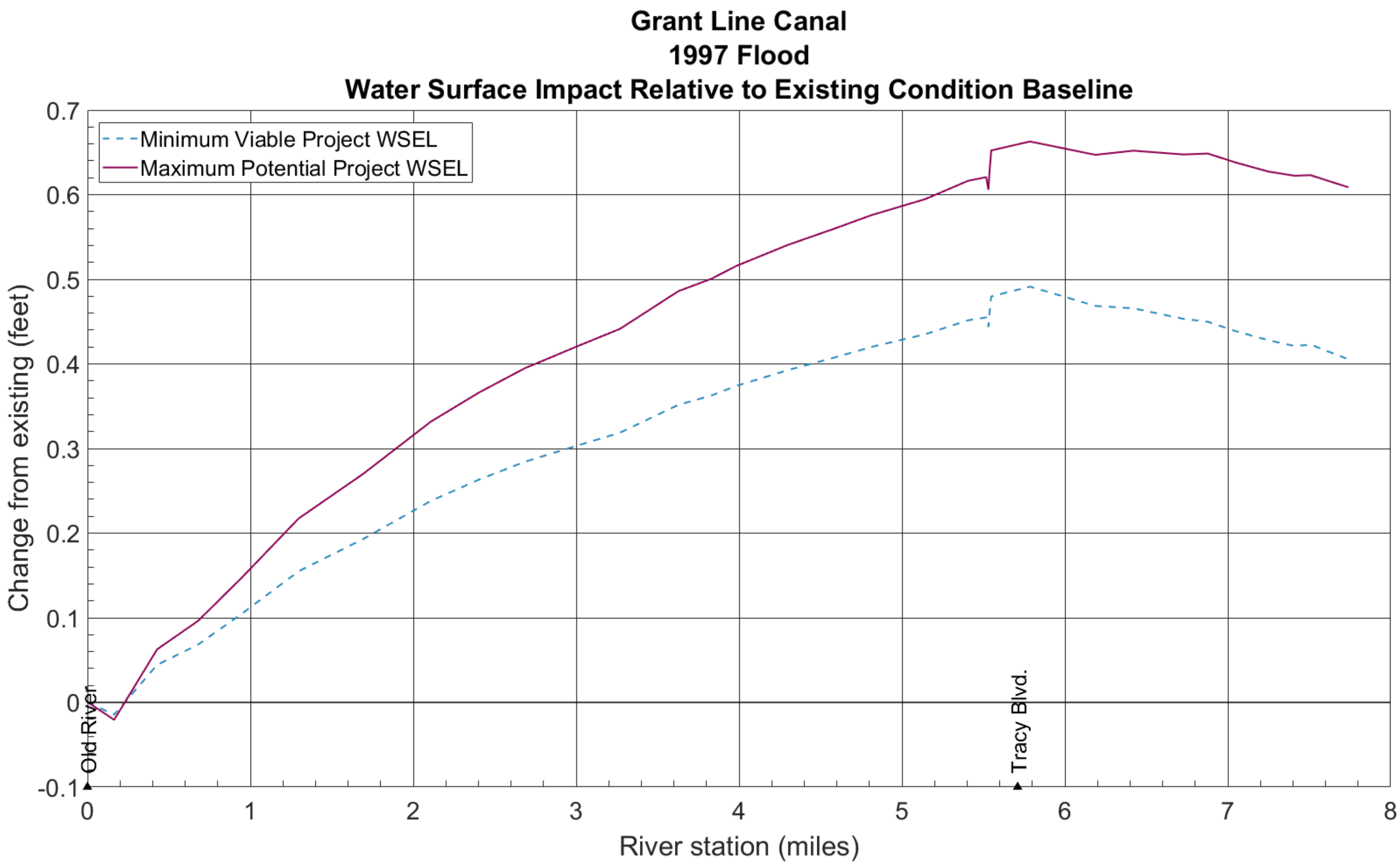




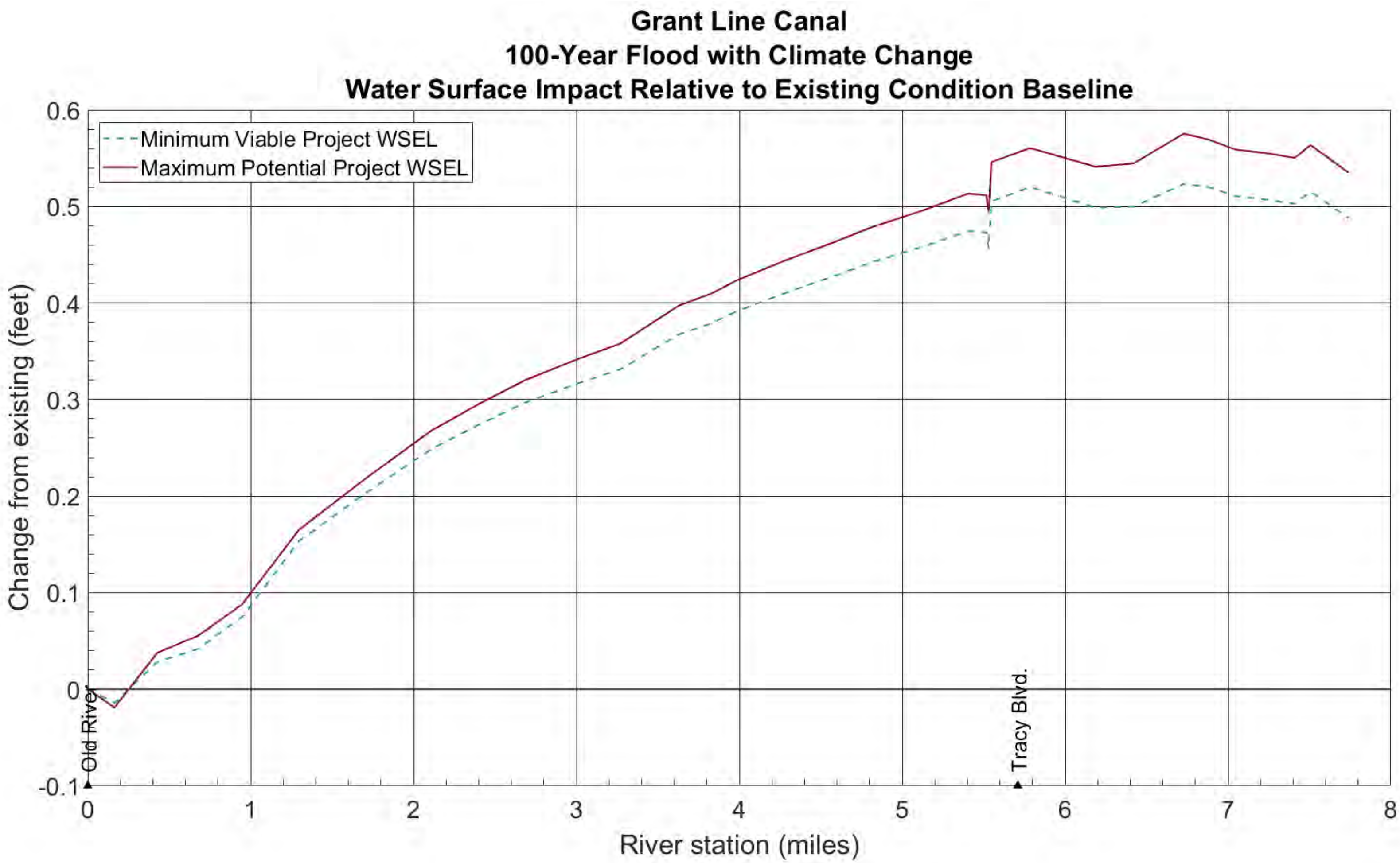
Old River
1997 Flood
Water Surface Impact Relative to Existing Condition Baseline
Minimum Viable Project WSEL
Maximum Potential Project WSEL
Change from existing (feet)
River station (miles)
Hammer Island
Tracy Blvd.
d/s of Grant Line Canal
west end Stewart Tract
Middle R.
San Joaquin R.
1
0.5
0
-0.5
-1
-1.5
-2
0
2
4
6
8
10
12
14
16
18
20


Old River
100-Year Flood with Climate Change
Water Surface Impact Relative to Existing Condition Baseline
Minimum Viable Project WSEL
Maximum Potential Project WSEL
Change from existing (feet)
River station (miles)
Hammer Island
Tracy Blvd.
d/s of Grant Line Canal
west end Stewart Tract
Middle R.
San Joaquin R.
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
0
2
4
6
8
10
12
14
16
18
20


Grant Line Canal
Design Flood
Water Surface Impact Relative to Existing Condition Baseline
Minimum Viable Project WSEL
Maximum Potential Project WSEL
Change from existing (feet)
River station (miles)
Old River
Tracy Blvd.
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
0
1
2
3
4
5
6
7
8

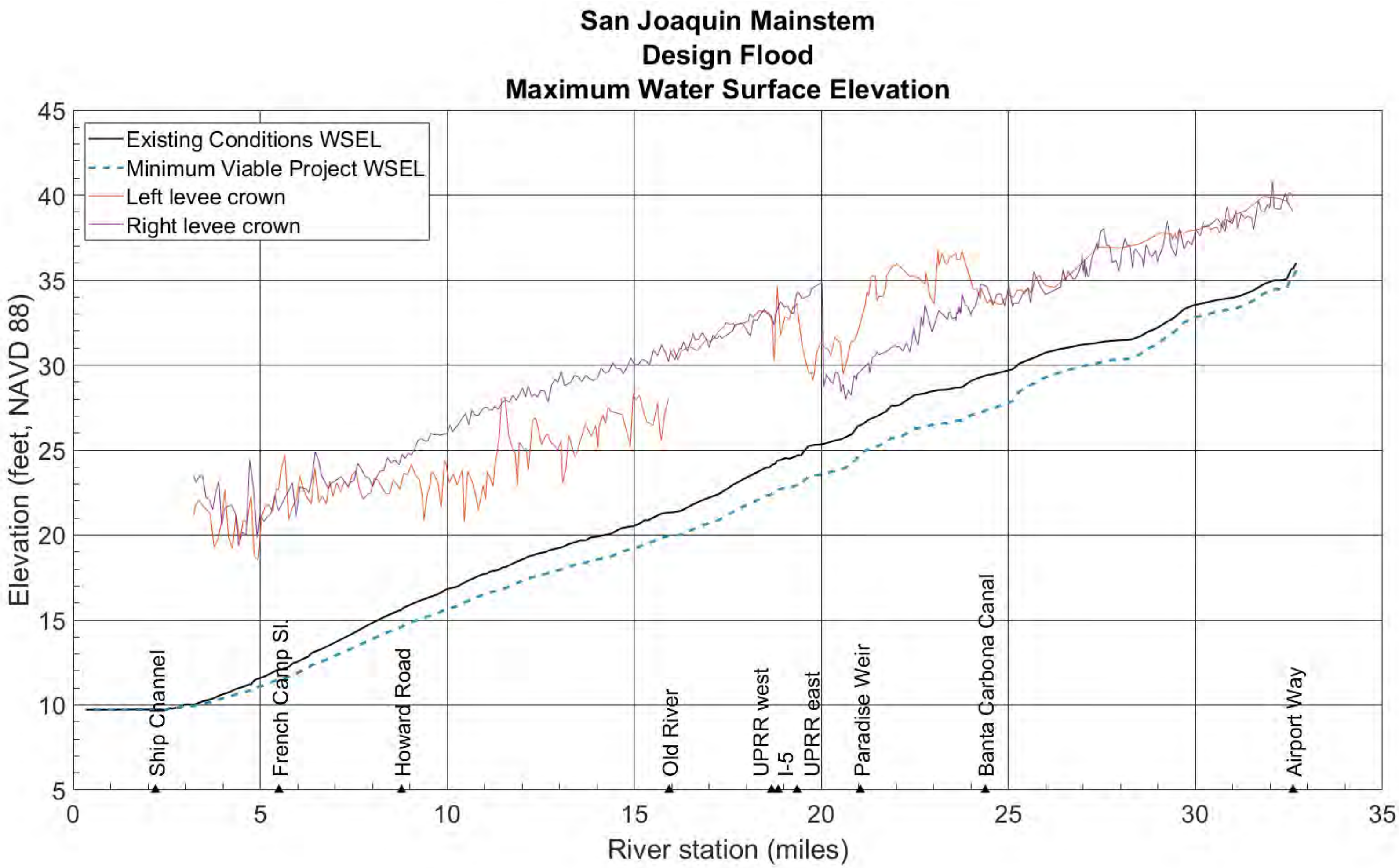


Grant Line Canal
1997 Flood
Water Surface Impact Relative to Existing Condition Baseline
Minimum Viable Project WSEL
Maximum Potential Project WSEL
Change from existing (feet)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
Old River
Tracy Blvd.
0
1
2
3
4
5
6
7
8
River station (miles)

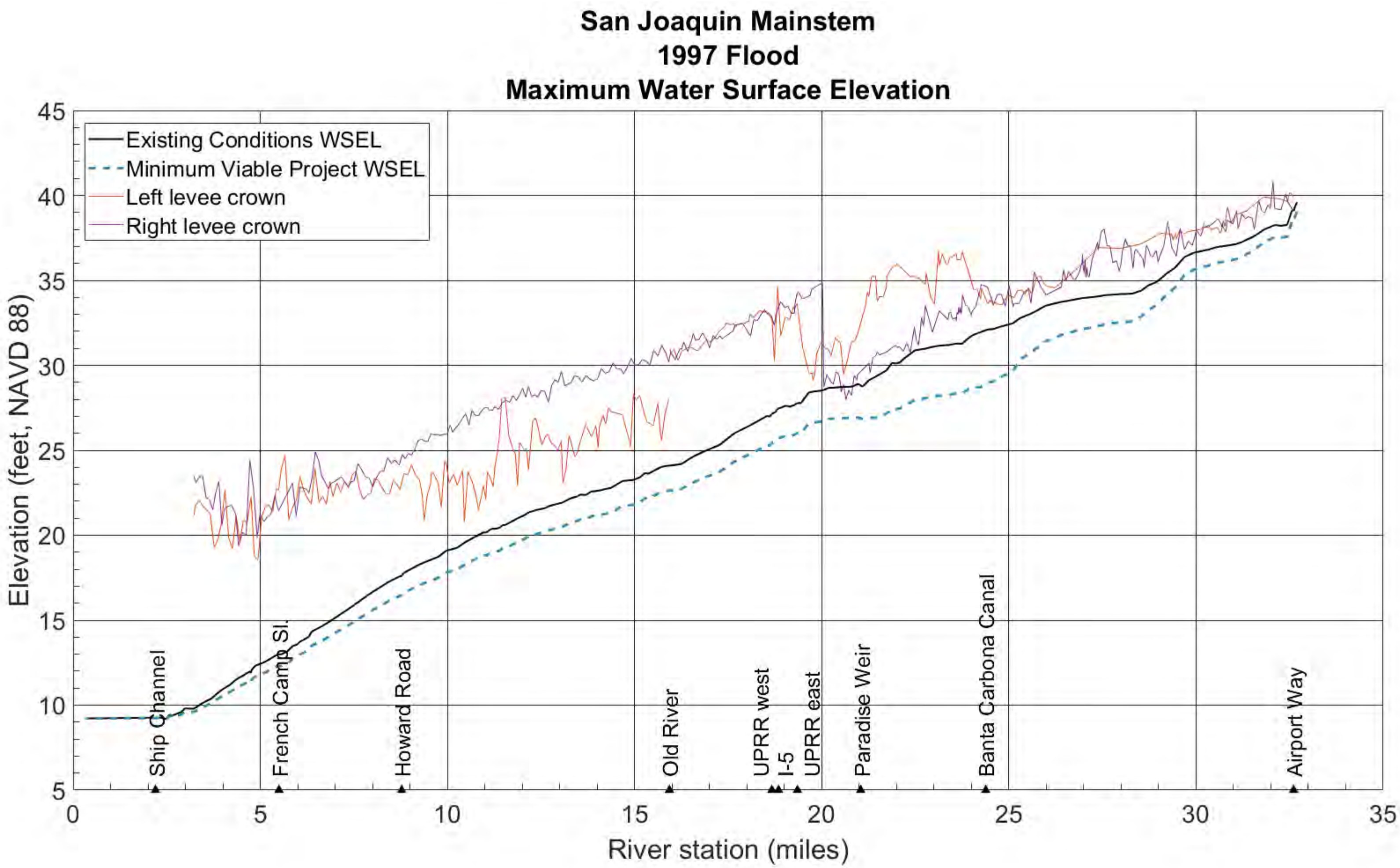


Grant Line Canal
100-Year Flood with Climate Change
Water Surface Impact Relative to Existing Condition Baseline
Minimum Viable Project WSEL
Maximum Potential Project WSEL
Change from existing (feet)
River station (miles)
Old River
Tracy Blvd.
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
0
1
2
3
4
5
6
7
8

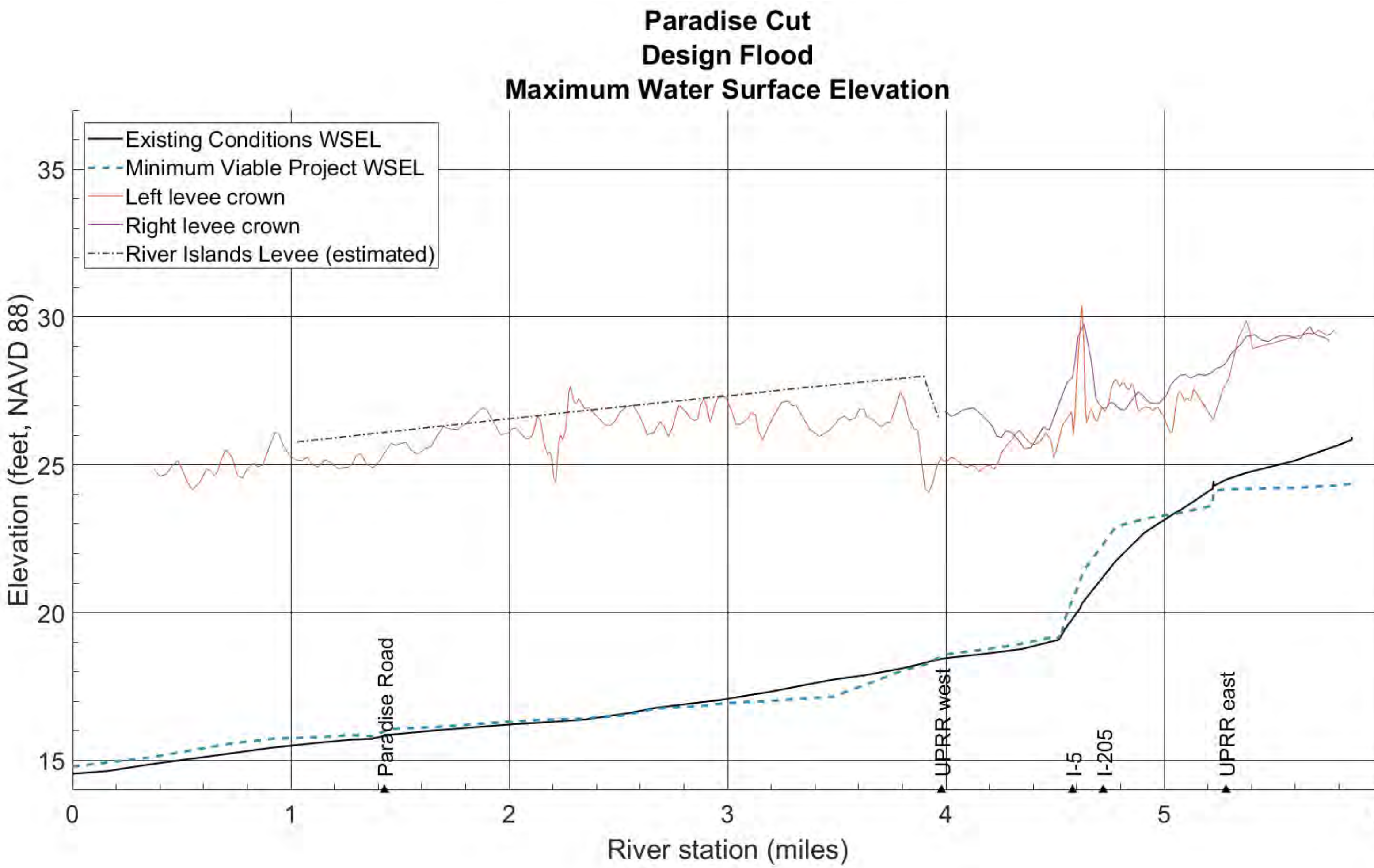
Chart Group 7
MVP vs Crown of Levees
water surface elevation



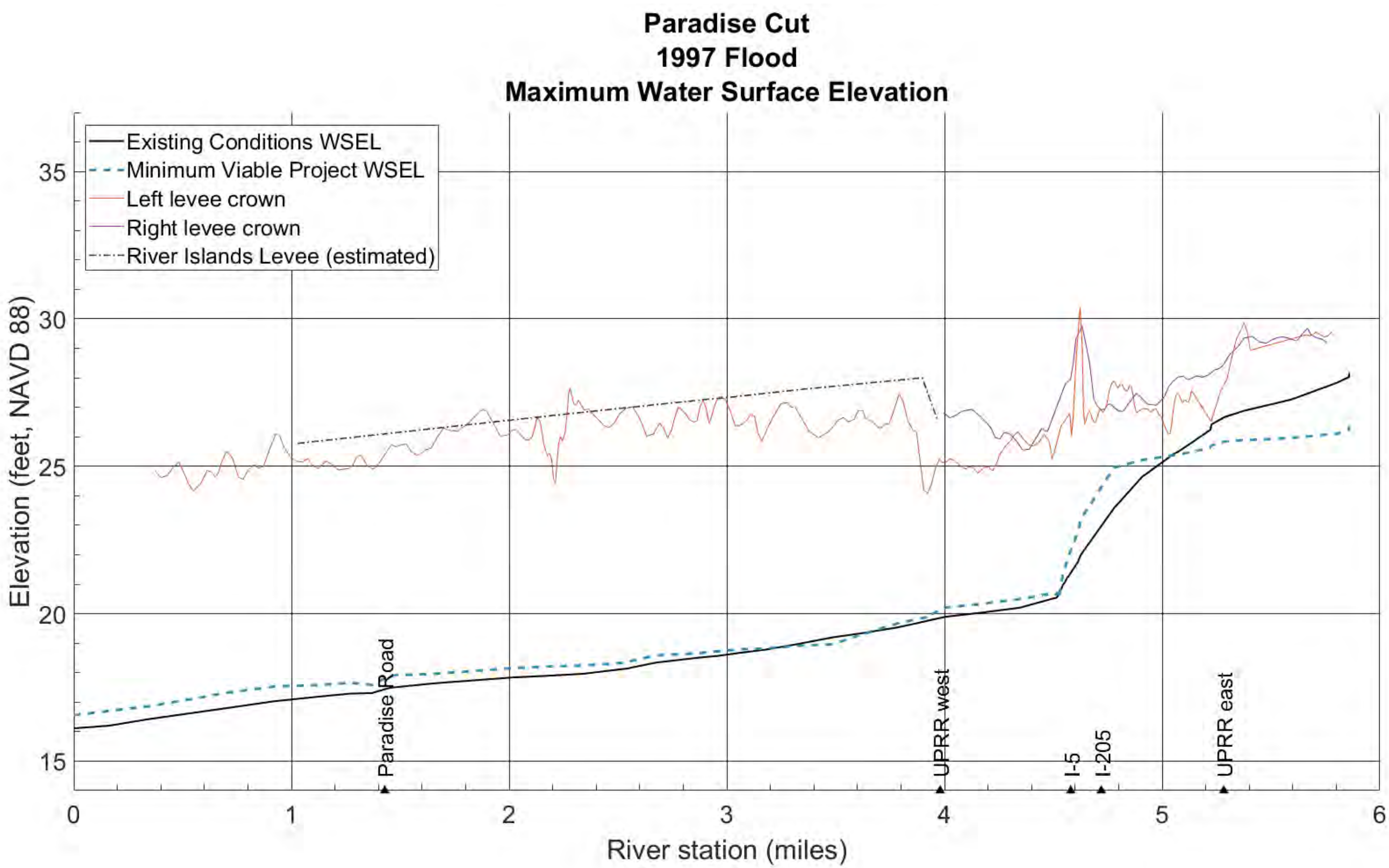
San Joaquin Mainstem
Design Flood
Maximum Water Surface Elevation
Existing Conditions WSEL
Minimum Viable Project WSEL
Left levee crown
Right levee crown
Elevation (feet, NAVD 88)
River station (miles)
Ship Channel
French Camp Sl.
Howard Road
Old River
UPRR west
I-5
UPRR east
Paradise Weir
Banta Carbona Canal
Airport Way
0
5
10
15
20
25
30
35
40
45



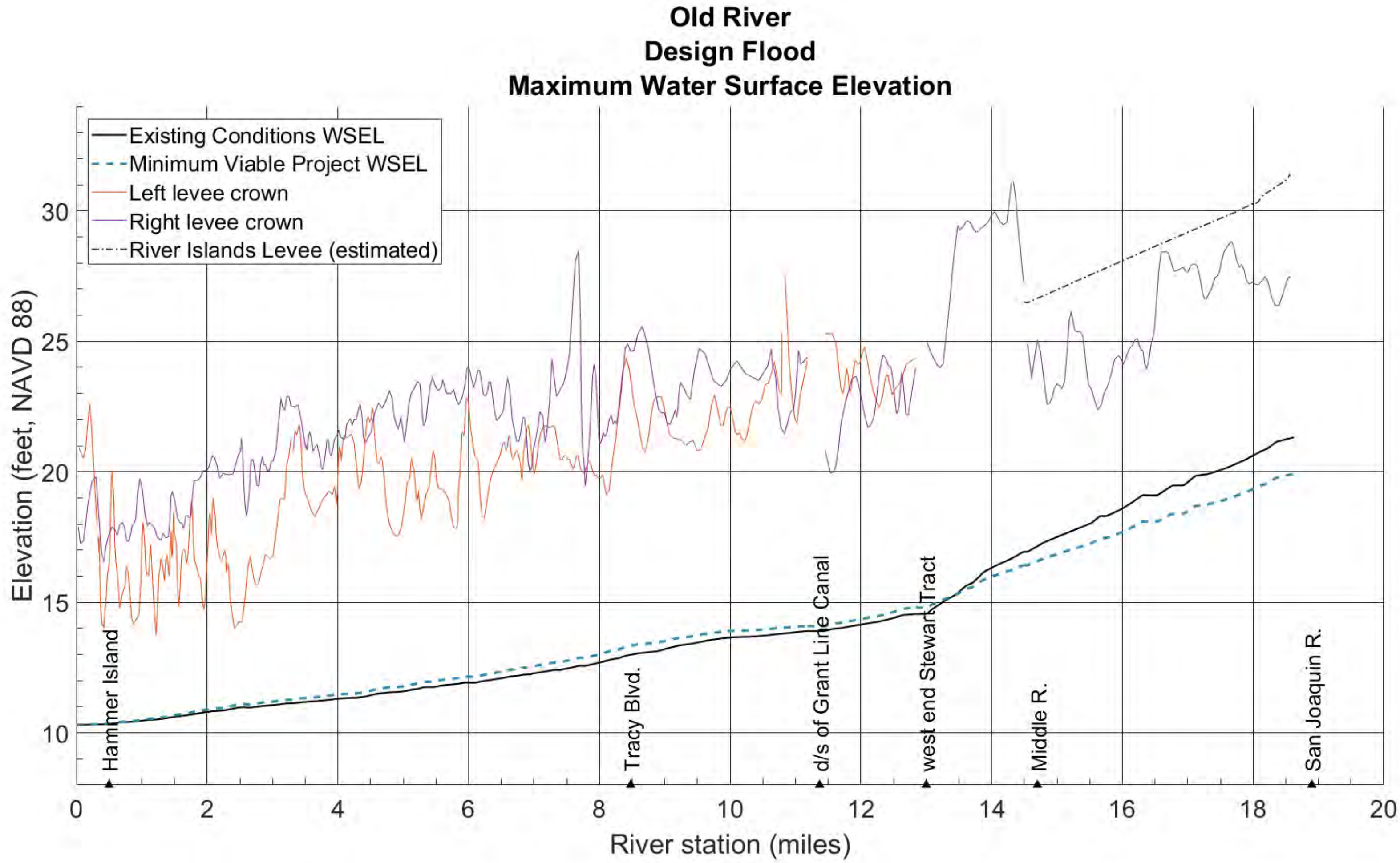
San Joaquin Mainstem
1997 Flood
Maximum Water Surface Elevation
Existing Conditions WSEL
Minimum Viable Project WSEL
Left levee crown
Right levee crown
Elevation (feet, NAVD 88)
River station (miles)
45
40
35
30
25
20
15
10
5
0
5
10
15
20
25
30
35
Ship Channel
French Camp Sl.
Howard Road
Old River
UPRR west
I-5
UPRR east
Paradise Weir
Banta Carbona Canal
Airport Way



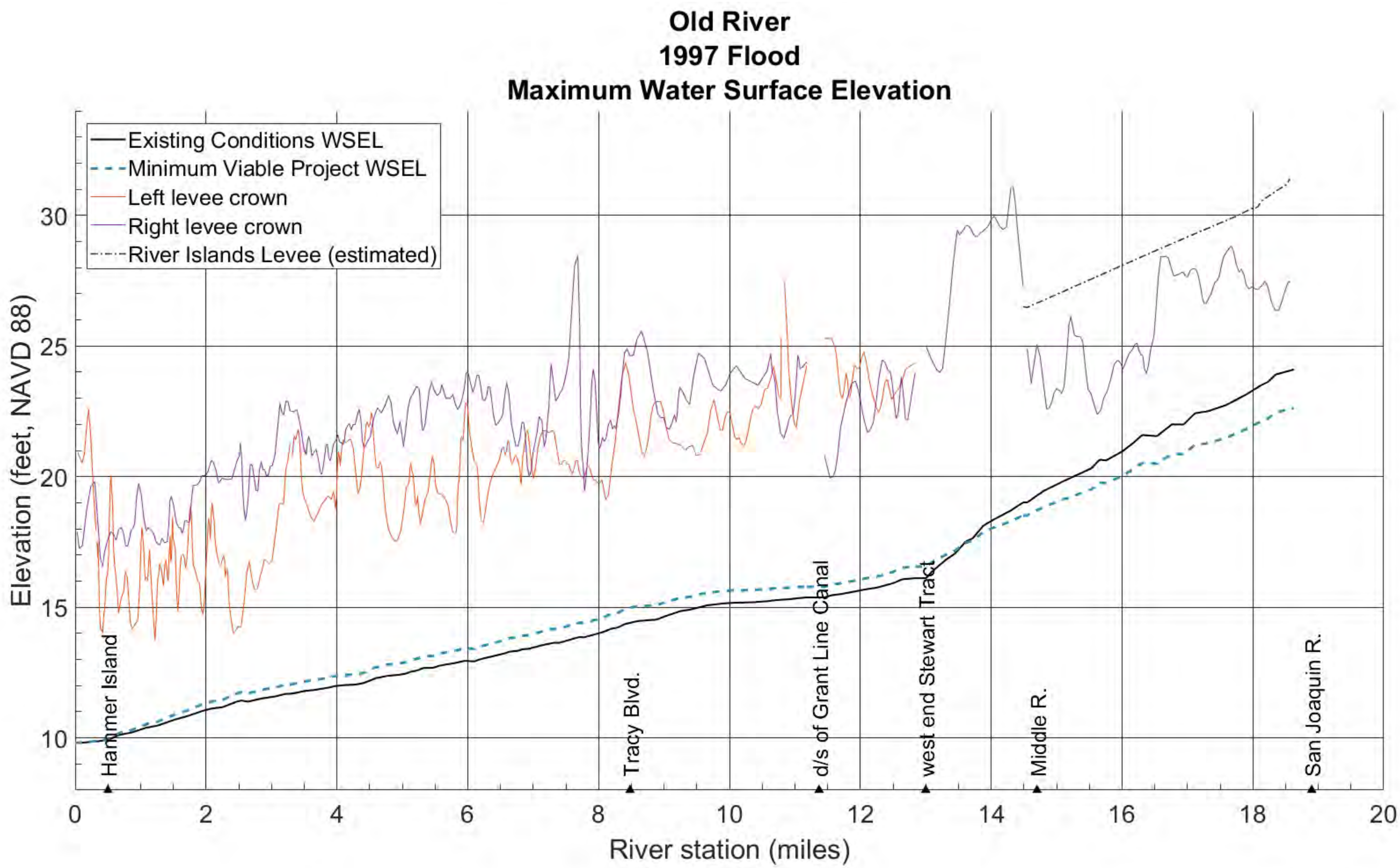
Paradise Cut
Design Flood
Maximum Water Surface Elevation
Existing Conditions WSEL
Minimum Viable Project WSEL
Left levee crown
Right levee crown
River Islands Levee (estimated)
Elevation (feet, NAVD 88)
River station (miles)
35
30
25
20
15
0
1
2
3
4
5
6
Paradise Road
UPRR west
I-5
I-205
UPRR east



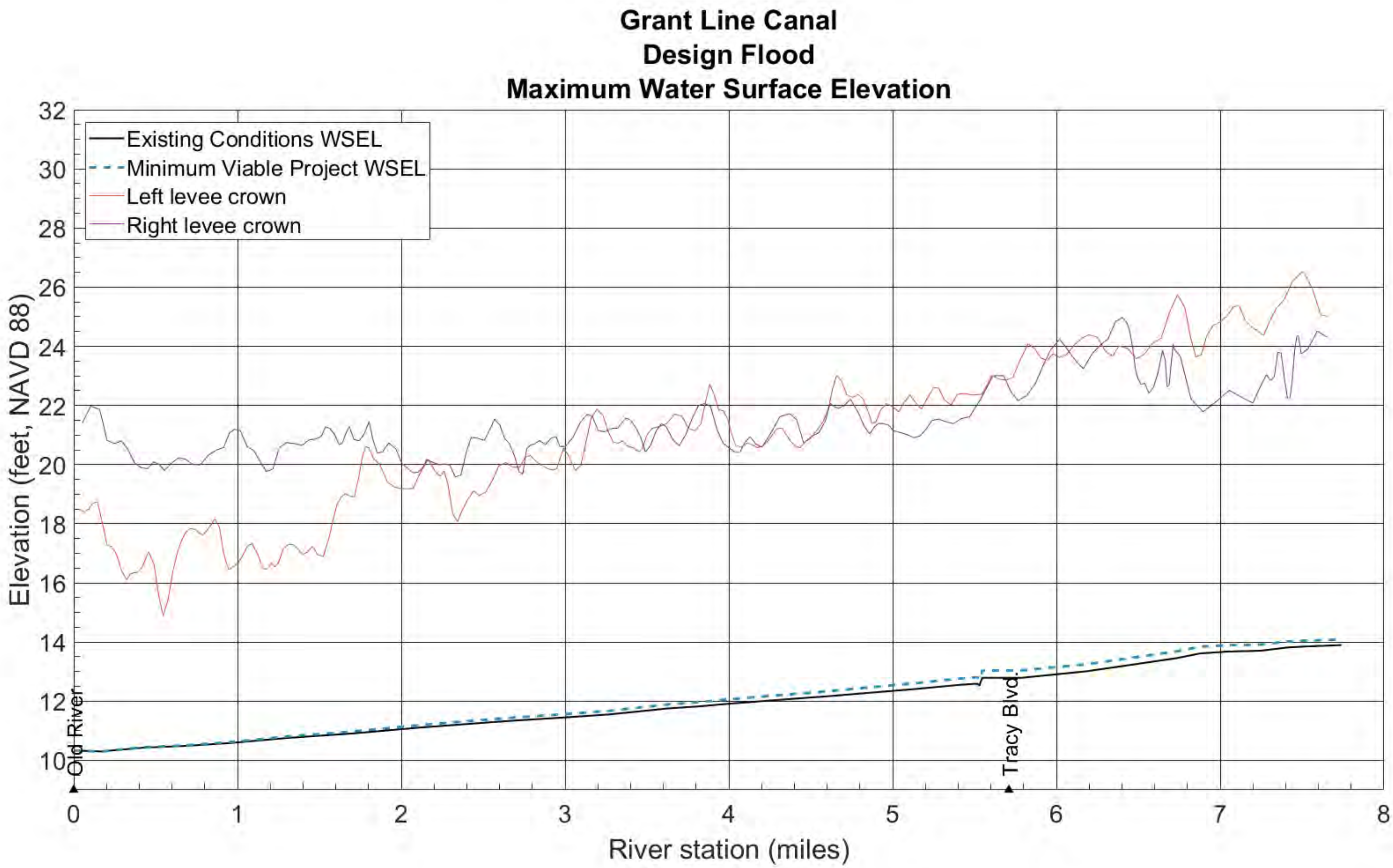
Paradise Cut
1997 Flood
Maximum Water Surface Elevation
Existing Conditions WSEL
Minimum Viable Project WSEL
Left levee crown
Right levee crown
River Islands Levee (estimated)
Elevation (feet, NAVD 88)
35
30
25
20
15
Paradise Road
UPRR west
I-5
I-205
UPRR east
0
1
2
3
4
5
6
River station (miles)



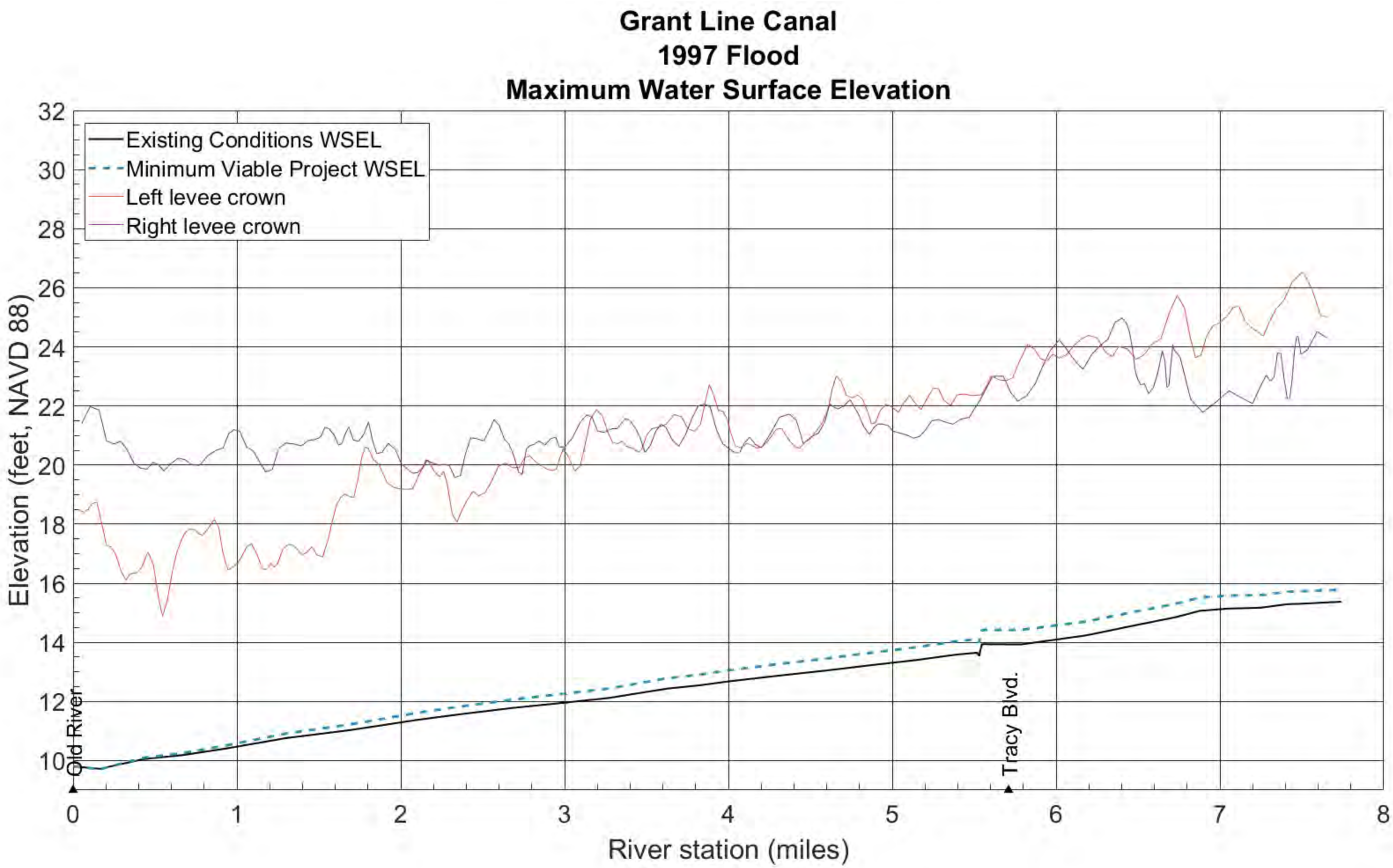
Old River
Design Flood
Maximum Water Surface Elevation
Existing Conditions WSEL
Minimum Viable Project WSEL
Left levee crown
Right levee crown
River Islands Levee (estimated)
Elevation (feet, NAVD 88)
River station (miles)
Hammer Island
Tracy Blvd.
d/s of Grant Line Canal
west end Stewart Tract
Middle R.
San Joaquin R.
10
15
20
25
30
0
2
4
6
8
10
12
14
16
18
20



Old River
1997 Flood
Maximum Water Surface Elevation
Existing Conditions WSEL
Minimum Viable Project WSEL
Left levee crown
Right levee crown
River Islands Levee (estimated)
Elevation (feet, NAVD 88)
30
25
20
15
10
Hammer Island
Tracy Blvd.
d/s of Grant Line Canal
west end Stewart Tract
Middle R.
San Joaquin R.
0
2
4
6
8
10
12
14
16
18
20
River station (miles)



Grant Line Canal
Design Flood
Maximum Water Surface Elevation
Existing Conditions WSEL
Minimum Viable Project WSEL
Left levee crown
Right levee crown
Elevation (feet, NAVD 88)
River station (miles)
Old River
Tracy Blvd.
32
30
28
26
24
22
20
18
16
14
12
10
0
1
2
3
4
5
6
7
8


Grant Line Canal
1997 Flood
Maximum Water Surface Elevation
Existing Conditions WSEL
Minimum Viable Project WSEL
Left levee crown
Right levee crown
Elevation (feet, NAVD 88)
River station (miles)
Old River
Tracy Blvd.
32
30
28
26
24
22
20
18
16
14
12
10
0
1
2
3
4
5
6
7
8