

# Technical Memorandum



**To:** George Booth - Sacramento County  
**From:** Michael Conant, Kris Van Sant, Katie Laird  
**cc:** Jeffrey Twitchell  
**Date:** March 25, 2021  
**Re:** Cost Estimate Development for Flood Risk Reduction Management Actions for the Flood Risk Reduction Feasibility Study for Delta Legacy Community of Locke, CA  
GEI Project 1800778

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GEI Consultants, Inc. (GEI) is assisting the Sacramento County Department of Water Resources in conducting a feasibility study to evaluate structural and non-structural actions to reduce the risk of flooding to the Locke study area. The feasibility study is being funded under the California Department of Water Resources (DWR) Small Communities Flood Risk Reduction Program. As part of this feasibility study, GEI developed cost estimates for the array of flood risk reduction management actions. This Technical Memorandum (TM) summarizes the development, methodology and results of the cost estimates.

## 1. Introduction and Purpose

The purpose of this appendix is to describe the development of cost estimates for the final array of Flood Risk Reduction Management Actions identified in the “Flood Risk Reduction Feasibility Study for the Delta Legacy Community of Locke, CA” (Feasibility Study). As discussed in the Feasibility Study, six Management Actions (MA) were evaluated. The Management Actions proposed in the Feasibility Study are combinations of structural and non-structural elements to provide flood risk mitigation to the small community of Locke. This TM is focused on describing how perimeter levee improvements and a proposed cross levee north of the community of Locke have been developed in order to estimate the costs for the Management Actions.

Figures and descriptions of each of the MAs are provided in the Feasibility Study. These MAs are composed of various elements which are covered in this TM, and additional information is included in the Feasibility Study.

- MA 1: Repair and Strengthen-in-Place Delta Meadows Cross Slough Non-SPFC Levee (portion of Non-Urban Levee Evaluations [NULE] Segment 1054 in Reclamation District [RD] 369)
- MA 2: Repair and Strengthen-in-Place Snodgrass Slough Non-SPFC Levee (portion of NULE Segment 1054 in RD 369)
- MA 3: Repair and Strengthen-in-Place Delta Meadows Slough Non-SPFC Levee (portion of NULE Segment 1040 in RD 551)
- MA 4: Raise, Repair and Strengthen-in-Place Sacramento River Left (east) Bank SPFC Levee (NULE Segment 121 Primarily in RD 369 and a Portion of NULE Segment 127 in RD 554)

- MA 5: Secure 100-Year Federal Emergency Management Agency (FEMA) Certification with Potential Cross Levee North of Locke in RD 369 paired with Perimeter Levee Improvements South of the Proposed Cross Levee
- MA 6: Secure 100-Year FEMA Certification for Entire RD 369 Perimeter Levee System
- MA 7: Raise, Repair, and Strengthen-in-Place Sacramento River Left (east) Bank Levee Improvements (Entirety of NULE Segment 127 in RD 369), Paired with Securing 100-Year FEMA Certification for the Community of Locke with Potential Cross Levee in RD 369 (MA 4 and MA 5 combined)

## **2. Methodology**

The Feasibility Study's final array of management actions includes a mix of improvements for existing levees around the perimeter of the study area and non-structural activities. Elements which have costs developed in this TM include:

- Repair and strengthen-in-place levee improvements for the entire Locke study area levee perimeter, based on levee remediations as outlined in the TM Geotechnical Assessment Report – Delta Small Communities Flood Risk Reduction Program – Community of Locke. Improvements include:
  - Berms
  - Cutoff walls
  - Rock slope protection (RSP)
- Cross levee north of Locke

Cost estimates have been prepared using parametric estimates based on preliminary designs for each of the improvements. Cost estimates are intended to be Class 4 (feasibility-study level) according to the Association for the Advancement of Cost Engineering International (AACEI). A Class 4 estimate is prepared based on limited information where the preliminary engineering is from 1 to 15 percent complete. Strategic planning, project screening, alternative scheme analysis, confirmation of economic and/or technical feasibility, and preliminary budget constraints are also considered to proceed with any preferred alternative.

The Class 4 estimate includes allowances for changes due to the level of detail that typically occurs between the feasibility level and the issuance of final design documents. The expected accuracy ranges for a Class 4 estimate are -15 to -30 percent on the low side and +20 to +50 percent on the high side. The costs presented in this technical memo add a 30 percent contingency cost to the Baseline Cost. The cost estimates in this document are considered a planning-level tool.

### **2.1. Cost Development**

A cost estimate was developed for the elements described above by applying unit costs to quantities based upon conceptual designs. Unit costs were established for construction items included within the conceptual designs.

Capital costs consist of:

- Major Construction Item costs (unit costs)
- Other Construction Costs including:
  - Unallocated items in construction costs as a percentage of the Major Construction Item costs (percentage)
  - Mobilization and demobilization of construction equipment as a percentage of the Major Construction Item costs (percentage)
- Other Owner Costs including:
  - Environmental documentation, permitting, and mitigation as a percentage of all construction costs (percentage)
  - Design and engineering costs as a percentage of all construction costs (percentage)
  - Legal costs to implement project as a percentage of all construction costs (percentage)
  - Construction management as a percentage of all construction costs (percentage)
  - Real estate capital outlay and acquisition costs (unit costs)

The sum of the costs presented above is considered the Baseline Cost. The Baseline Cost does not include a contingency and is considered the expected low range of costs. To accommodate the uncertainty of the estimates, and in line with industry standards, an additional estimating contingency of 30 percent has been included on all the above costs.

The following construction activities are included in the cost estimates for the proposed improvements:

- Clearing and grubbing: Clearing all vegetation and debris (trees, shrubs, stumps, major roots, and rubbish) near the ground surface within the remediated levee embankment footprint.
- Stripping: Stripping the original ground surface a minimum of 12 inches within the remediated levee embankment and berm footprint to remove roots and other organic matter. Further investigation will be needed to determine the existing conditions and depth of stripping actually required. This unit cost does not include off-hauling, as material is assumed to be re-used onsite as appropriate.
- Proof compacting: Proof compacting the surface within the extents of the levee footprint including ripping, moisture conditioning and compaction of the existing ground surface prior to placement of select levee fill.
- Levee fill: Select levee fill used for all levee embankment construction including geometry improvements will conform to requirements (CVFPB, 2014). Local sources of select levee fill have not been identified. Therefore, it is assumed that a source within a 30-mile round trip will be utilized for select levee fill. It is assumed that no levee degrade material will be used for select levee fill.
- Drain fill (Geotextile, Filter Sand, Drain Aggregate): Cost includes placement of geotextile, filter sand, and drain aggregate for internal drainage features.

- **Berm fill:** Berm fill assumed to be locally available due to less stringent material requirements. Compaction of berm fill will be less than that of the select levee fill. Cost includes preparation of the area to receive fill, placement of the fill to the appropriate loose thickness, and compaction of the fill.
- **Cutoff Wall:** Cutoff wall assumed to be 3 feet wide. Soil-bentonite (SB) or cement-soil bentonite (CSB) cutoff walls will be constructed by standard open-trench methods (i.e., excavator and slurry trench, etc.). Where deeper cutoff walls are needed, the deep-mixing method (DMM) will be used (overlapping auger holes). Depths up to 80 feet assumed to be constructed with traditional open trench method, with costs increasing over 40 ft. Depths greater than 80 feet assumed to be constructed using deep mixing method.
- **Inspection trench excavation and backfill:** For new levees. An inspection trench along the centerline of the levee with a minimum depth of 6 feet, width of 12 feet, and side slopes of 0.25H:1V or flatter, and backfilled with select levee fill along the length of the setback levee.
- **Aggregate Base:** A 6-inch-thick, all-weather aggregate base road shall be provided for the levee crown and used as a base layer for asphalt concrete paving. Includes placement and compaction.
- **Asphalt Concrete (AC) Removal:** Required in sections of levee with existing paved road on the levee crest for cutoff walls which require excavation of existing levee crest. Includes excavation and disposal. Assumes that material is not re-used.
- **AC Paving:** Used in sections of levee that currently have paved roads and will be reconstructed to existing conditions. 4" thick AC paving. Includes placement, compaction and any road painting.
- **Hydroseed:** Hydroseeding for erosion protection will occur along both the landside and waterside slopes of the levee as well as the landside and waterside toe access corridors and all disturbed areas impacted by levee construction activities.
- **Rock Slope Protection:** RSP is placed along the waterside levee slope to prevent additional erosion of the levee. Includes purchase, transportation, and placement of the RSP.
- **Right-of-way (ROW) acquisition:** ROW quantities are estimated land required to be purchased for the project including for berms, and any temporary roadways to divert traffic. ROW was estimated based on review of aerial photography of existing land use. ROW acquisition only accounts for the required alignment and doesn't include purchase of full parcels.
- **Structure removal/relocation:** Includes costs for structures which may be required to be removed for the structural levee improvements. Categories split into residential structures and "other" structures which include any non-residential buildings. Structures impacted were estimated based on aerial photography and the proximity to the levee toe.

Additional refinement of impacted structures will need to be considered during the project design phase.

- **Mobilization and Demobilization:** Includes the contractor's mobilization and demobilization of equipment, personnel, field offices, etc. to and from the site in support of the construction.
- **Allowance for unlisted, or unanticipated, items:** This allowance is not a contingency; rather it is an attempt to acknowledge (and quantify) the "known unknowns" in the project as they relate to work items that have yet to be identified in this early development stage for design, regulatory compliance and construction issues and that will likely increase project costs. Construction items not addressed at the current feasibility level of design include but are not limited to items such as utility relocations and pipe relocations unknown at the time these cost estimates were prepared.
- **Environmental documentation and permitting, and environmental compliance monitoring during construction:** Includes all studies and report preparation, documentation necessary to complete an Environmental Impact Report or Environmental Impact Statement and any other environmental permits for the project. Does not include any environmental mitigation costs or environmental construction monitoring. Environmental mitigation costs are not presented within the current scope and is depending upon existing conditions.
- **Design and engineering costs:** Includes investigations, design and engineering of project including surveying, geotechnical investigation, utility investigation and coordination, preparation of plans, specifications and cost estimates along with all other items necessary to complete the design of the project for bidding.
- **Legal costs:** Includes all Owner legal costs to implement the project.
- **Engineering during construction:** Includes engineering during construction activities including review of submittals, Requests for Information, bidder questions, changes, etc.
- **Construction management:** Includes management and oversight of the construction project, including quality assurance inspection and testing.
- **Utility relocations:** The impact of known utilities to be relocated is considered minimal to the larger scope of the project. Unidentified utility relocations are assumed part of the allowance for unlisted items costs. Costs do not include removal and relocation of any existing structure on the landside of the levee, including but not limited to pump stations, residences, etc. The impact of utility crossings on the stability of the levee foundation, embankments and refinements to associated costs for mitigation and / or relocation of these crossings will need to be considered during the project design phase.

## 2.2. Unit Costs Development

Unit costs were developed by evaluating costs presented in previous cost estimating efforts for levee improvements and bid abstracts from local and regional levee improvement projects mostly from within the greater Sacramento River Flood Control Project (SRFCP) within the Central Valley Flood Protection Plan (CVFPP). Prior to comparison, all unit costs were escalated to July 2020 using the 20-city average from the Engineering News-Record (ENR) Construction Cost Index, as. Major construction items, their units of measurement, and unit costs are provided in Table 1. All values include materials, labor, placement, and delivery to site.

Other Construction Costs are applied as a percentage of the Major Construction Item costs. Summing the Major Construction Item and Other Construction Costs together presents the Total Construction Cost representing the physical construction components of the work. Other Owner costs are applied as a percentage to the Total Construction Cost and are meant to represent the additional costs to the Owner expected through the construction of a project.

**Table 1: Unit Costs**

<b>Construction Activity Description</b>	<b>Unit</b>	<b>Unit Cost</b>
Clearing and Grubbing	AC	\$8,342.74
Stripping	AC	\$7,490.00
Stripping	CY	\$7.67
Proof Compacting	AC	\$1,382.62
Select Levee Fill (New Levee Construction)	CY	\$26.70
Berm Fill - Misc.	CY	\$16.68
Aggregate Base	CY	\$54.90
Drain Layers (Geotextile, Filter Sand, Drain Aggregate)	CY	\$77.50
AC Paving	SY	\$40.04
AC Removal	SY	\$5.71
SB Cutoff Wall, Open Trench Method (<40')	SF	\$8.93
SB Cutoff Wall, Open Trench Method (>40' and <80')	SF	\$10.29
CSB Cutoff Wall (DMM, >78' Depth)	SF	\$41.17
CSB Cutoff Wall, Open Trench Method (<80')	SF	\$32.00
Hydroseeding	AC	\$4,693.00
Rock Slope Protection	CY	\$77.50
<b>Other Construction Costs</b>		
Unallocated Items in Construction costs		15.00%
Mobilization and Demobilization		5.00%
<b>Other Owner Costs**</b>		
Environmental Documentation and Permitting		10.00%-20.00% <sup>1</sup>
Design and Engineering Costs		15.00%
Legal Costs		2.00%
Engineering during Construction		2.00%
Construction Management		15.00%

<sup>1</sup> All cost estimates include a 10 percent mark-up for environmental documentation and permitting with the exception of estimates for RSP and the Locke cross levee which include a 20 percent mark-up due to the more probable disturbance of riparian habitat

<b><u>Construction Activity Description</u></b>	<b><u>Unit</u></b>	<b><u>Unit Cost</u></b>
Permanent Right-of Way (fee title) - Seasonal Agricultural Field/ Row Crops	AC	\$25,000
Permanent Right-of Way (fee title) - Orchard/ Vineyard	AC	\$40,000
Permanent Right-of Way (fee title) - Commercial/ Industrial	AC	\$240,000
Permanent Right-of Way (fee title) - Residential	AC	\$180,000
Residential structures	Ea	\$250,000
Other structures	Ea	\$75,000

Cost estimates and bid abstracts from the following alphabetically-listed projects were referenced for unit costs comparisons in addition to engineering judgement:

- Bethel Island Municipal Improvement District, Horseshoe Bend Levee Improvement Project, bid 2017;
- Feather River West Levee Project Phase 1, Projects B, C and D, bid in 2013 and 2014;
- NULE Project Remediation Alternative and Cost Estimates Report (RACER), North NULE Study Area. Prepared by URS for DWR in 2011 (URS, 2011);
- North Area Streams (NAS) Levee Improvement Project, cutoff wall along the waterside toe of the NEMDC East Levee, bid in 2017;
- Sacramento Area Flood Control Agency (SAFCA) Sacramento River East Levee Improvement Project – IFA Construction Cost Estimate; and
- Three Rivers Levee Improvement Authority (TRLIA) levee improvement Segments 1 and 3, bid in 2007, and setback levee Segment 2, bid in 2008.

### **3. Repair and Strengthen-in-Place Levee Improvements**

Repair and strengthen-in-place levee improvements are identified and defined in the Geotechnical Assessment Report – Delta Small Communities Flood Risk Reduction Program – Community of Locke TM (Appendix A). Each reach has deficiencies identified as under seepage or through seepage, with select reaches also deficient for slope stability and erosion. Each deficient reach can be remediated by either a cutoff wall alternative or berm alternative. Erosion concerns are addressed by placement of RSP. No geometric deficiencies were identified in the study area. A description of the repair and strengthen-in-place remediations is included in the following sections and summarized in Table 2.



**Table 2: Levee Remediation Alternatives for Locke Study Area**

NULE Alignment ID	Reach	Reach Length (ft.)	Remediation Alternative 1 Dimensions	Remediation Alternative 2 Dimensions	Vulnerability			
					Underseepage	Through Seepage	Slope Stability	Erosion
SACR-L	SPFC 127-A	900	15-foot deep cutoff wall	15-foot wide, 8-foot tall drained stability berm	-	X	-	-
SACR-L	SPFC 121-A	4,100	75-foot deep cutoff wall	65-foot wide, 9-foot tall combination seepage/stability berm (combo berm)	X	X	-	-
TMSS-L	Non-SPFC 1040-A	3,200	65-foot deep cutoff wall	135-foot wide 15-foot tall combo berm	X	X	-	-
TMXS-R	Non-SPFC 1054-A	1,500	25-foot deep cutoff wall 65-foot wide RSP (1,500 feet)	55-foot wide seepage berm 65-foot wide RSP (1,500 feet)	X	-	-	X
TMXS-R	Non-SPFC 1054-B	1,600	15-foot deep cutoff wall 100-foot wide RSP (1,000 feet)	15-foot wide, 8-foot tall drained stability berm 100-foot wide RSP (1,000 feet)	-	X	-	X*
SDSS-R	Non-SPFC 1054-C	3,100	35-foot deep cutoff wall 110-foot wide RSP (500 feet)	90-foot wide, 9-foot tall combo berm 110-foot wide RSP (500 feet)	X	X	X*	X*
LKSRR	Non-SPFC LKSRR-A	1,400	20-foot deep cutoff wall	80-foot wide, 9-foot tall combo berm	X	X	-	-
Total Perimeter Levee System of Locke Study Area		15,800 (3 miles)						

Notes:

- 1) \* Only affects a portion of the reach
- 2) Wall depths and berm widths rounded up to the nearest 5-foot dimension and stability berm heights rounded to the nearest 1-foot dimension.
- 3) Reach lengths rounded to the nearest 100 ft.

### **3.1. Levee Improvement Berms**

As shown in Table 2, berm remediations for a given reach can include a stability berm, seepage berm, or a combo berm which incorporates elements of a stability and seepage berm. Typical drained stability berm, seepage berm, and combo berm details are shown in Figures 1-3, respectively. A summary of the construction activities for each reach is provided in Table 3. A summary of the total cost estimate for the berm alternatives is provided in Table 4.

**Table 3: Levee Improvement Berm Base Construction Quantities**

Location Description	Berm Type	Clearing and Grubbing	Ground Stripping	Drain Layers	Berm Fill	Hydroseeding	Right of Way		Total Base Construction Estimate	ROW Acquisition
Cost per unit		\$ 8,342.74	\$ 7,489.52	\$ 77.50	\$ 16.68	\$ 4,692.56	AC	\$/ AC		
Units		AC	AC	CY	CY	AC	AC			
SACR-L 127-A	Stability	1.0	0.8	1,677	2,428	1.0	0.3	\$25,000	\$189,000	\$8,000
SACR-L 121-A	Combo	9.3	8.0	19,562	46,808	9.2	12.85	\$81,000	\$2,477,000	\$1,041,000
<b>SPFC Subtotals</b>		<b>10</b>	<b>9</b>	<b>21,239</b>	<b>49,237</b>	<b>10</b>	<b>13</b>	<b>--</b>	<b>\$2,666,000</b>	<b>\$1,049,000</b>
TMSS-L 1040-A	Combo	14.1	12.3	31,871	74,696	12.7	19.47	\$25,000	\$3,985,000	\$487,000
TMXS-R 1054-A	Seepage	2.6	2.6	6,305	15,063	2.6	2.29	\$25,000	\$793,000	\$57,000
TMXS-R 1054-B	Stability	1.8	1.4	3,130	5,903	1.8	0.82	\$25,000	\$375,000	\$20,000
SDSS-R 1054-C	Combo	8.4	7.8	18,154	46,848	8.8	13.51	\$25,000	\$2,357,000	\$338,000
LKSRR LKSRR-A	Combo	3.8	3.3	8,095	19,519	3.7	5.45	\$25,000	\$1,026,000	\$136,000
<b>Non-SPFC Subtotals</b>		<b>31</b>	<b>27</b>	<b>67,554</b>	<b>162,028</b>	<b>30</b>	<b>42</b>	<b>--</b>	<b>\$8,538,000</b>	<b>\$1,038,000</b>
<b>Repair Type Totals</b>		<b>41</b>	<b>36</b>	<b>88,793</b>	<b>211,265</b>	<b>40</b>	<b>55</b>	<b>--</b>	<b>\$11,204,000</b>	<b>\$2,087,000</b>

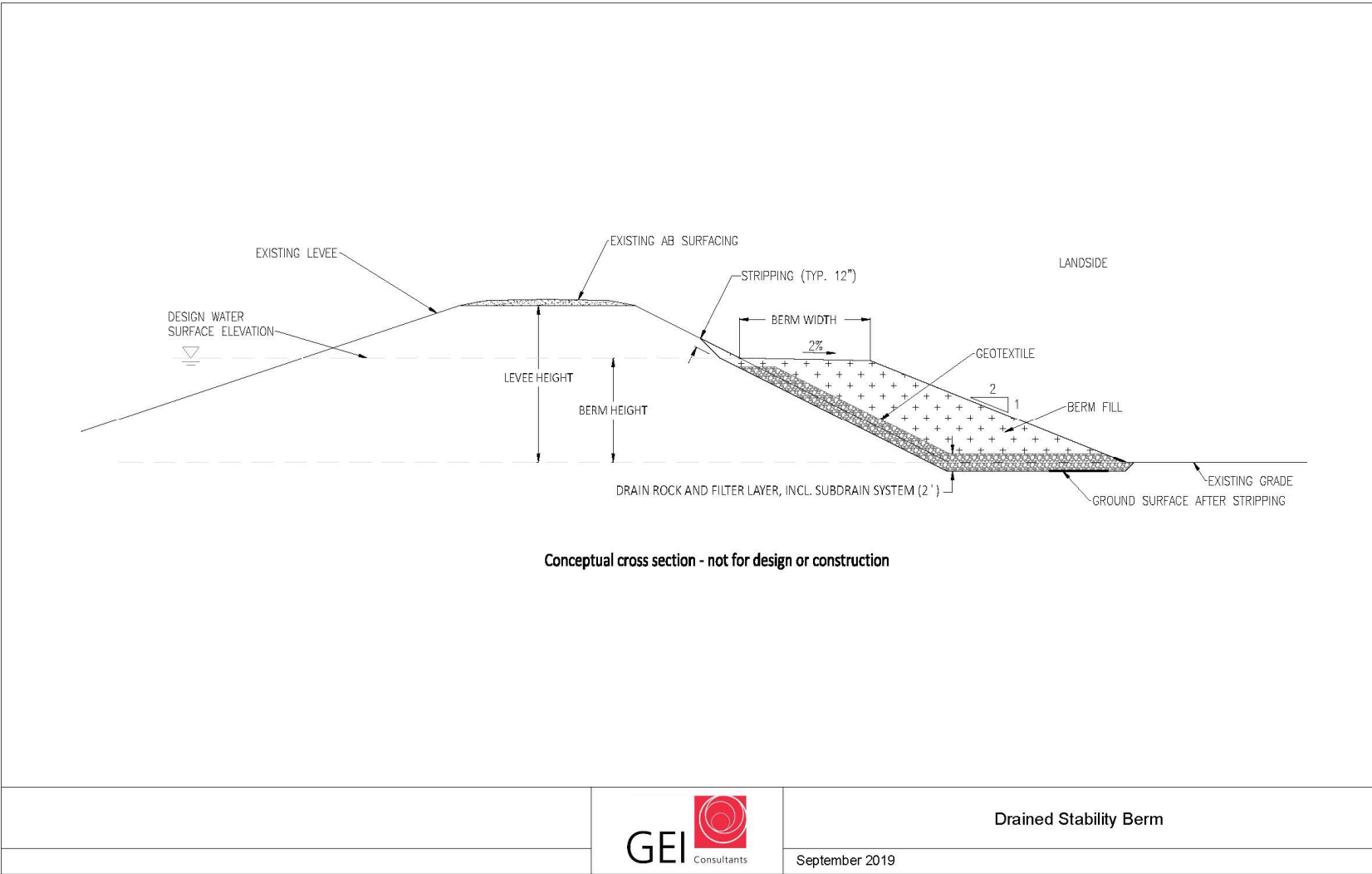
**Table 4: Berm Reach Cost Summary**

Location Description	Stability Berm	Seepage Berm	Combo Berm	Berm Base Cost	Residential Structures		Other Structures		Other Construction Costs*	Other Owner Costs**	Construction Contingency***	Right of Way	Reach Total
					#	Cost (\$250k)	#	Cost (\$75k)			30%		
SACR-L 127-A	\$189,000			\$189,000	1	\$250,000	1	\$75,000	\$76,000	\$343,000	\$239,000	\$8,000	\$1,180,000
SACR-L 121-A			\$2,477,000	\$2,477,000	8	\$2,000,000	6	\$450,000	\$991,000	\$3,694,000	\$2,892,000	\$1,041,000	\$13,544,000
<b>SPFC Subtotals</b>	<b>\$189,000</b>		<b>\$2,477,000</b>	<b>\$2,666,000</b>	<b>9</b>	<b>\$2,250,000</b>	<b>7</b>	<b>\$525,000</b>	<b>\$1,067,000</b>	<b>\$4,037,000</b>	<b>\$3,131,000</b>	<b>\$1,049,000</b>	<b>\$14,724,000</b>
TMSS-L 1040-A			\$3,985,000	\$3,985,000			1	\$75,000	\$1,594,000	\$4,242,000	\$4,142,000	\$487,000	\$14,525,000
TMXS-R 1054-A		\$793,000		\$793,000					\$317,000	\$838,000	\$823,000	\$57,000	\$2,829,000
TMXS-R 1054-B	\$375,000			\$375,000					\$150,000	\$396,000	\$389,000	\$20,000	\$1,331,000
SDSS-R 1054-C			\$2,357,000	\$2,357,000					\$943,000	\$2,489,000	\$2,444,000	\$338,000	\$8,572,000
LKSRR LKSRR-A			\$1,026,000	\$1,026,000					\$410,000	\$1,084,000	\$1,064,000	\$136,000	\$3,721,000
<b>Non-SPFC Subtotals</b>	<b>\$375,000</b>	<b>\$793,000</b>	<b>\$7,368,000</b>	<b>\$8,536,000</b>	<b>0</b>	<b>\$0</b>	<b>1</b>	<b>\$75,000</b>	<b>\$3,414,000</b>	<b>\$9,049,000</b>	<b>\$8,862,000</b>	<b>\$1,038,000</b>	<b>\$30,978,000</b>
<b>Repair Type Totals</b>	<b>\$564,000</b>	<b>\$793,000</b>	<b>\$9,845,000</b>	<b>\$11,202,000</b>	<b>9</b>	<b>\$2,250,000</b>	<b>8</b>	<b>\$600,000</b>	<b>\$4,481,000</b>	<b>\$13,086,000</b>	<b>\$11,993,000</b>	<b>\$2,087,000</b>	<b>\$45,702,000</b>

\* Percentages based on the construction subtotal (see Table 1)

\*\* Percentages based on construction, structure, other construction cost subtotals (see Table 1)

\*\*\* 30% of the construction, structure, other construction cost, other owner cost subtotals



**Figure 1: Drained Stability Berm Conceptual Schematic**

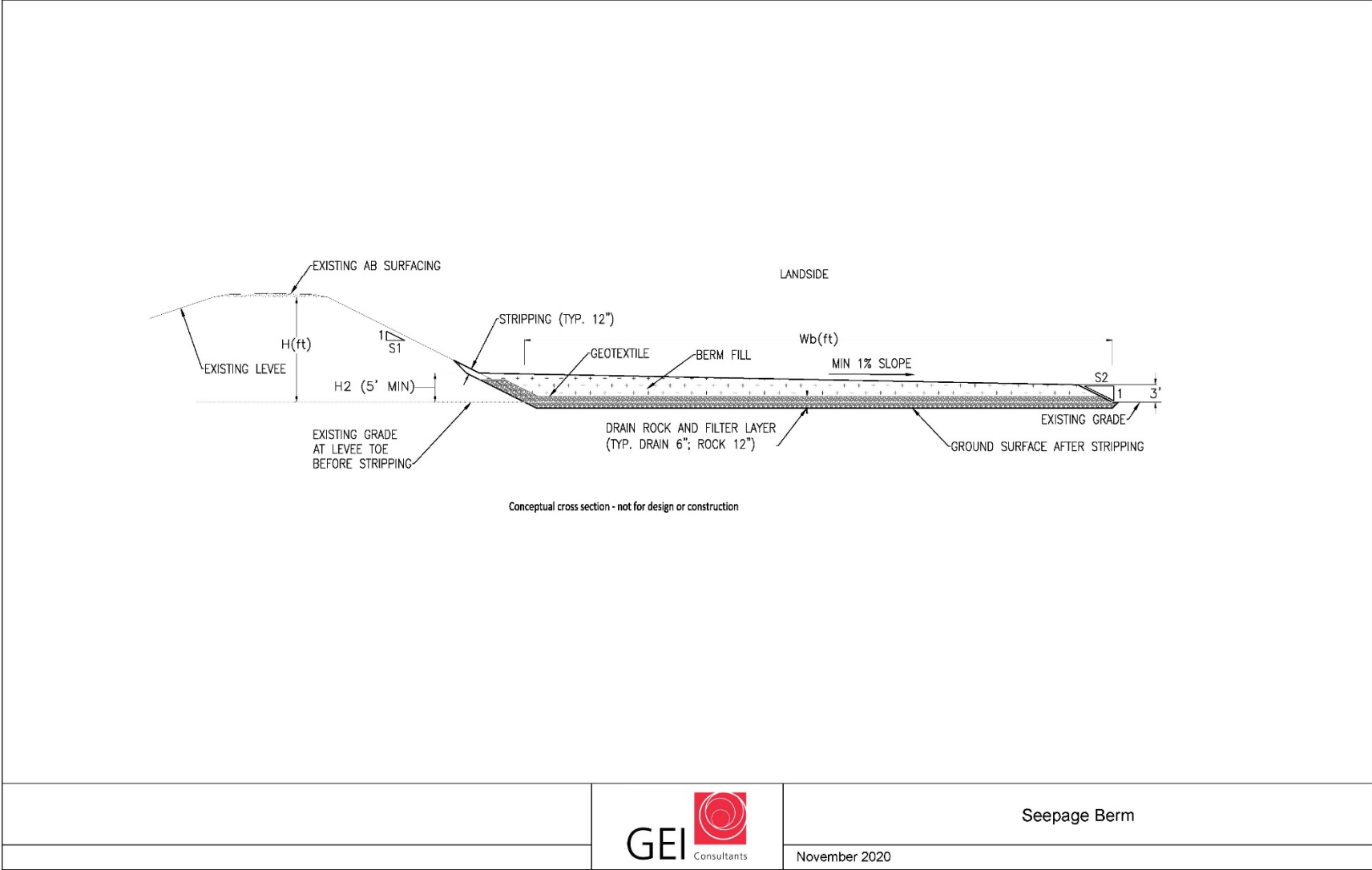
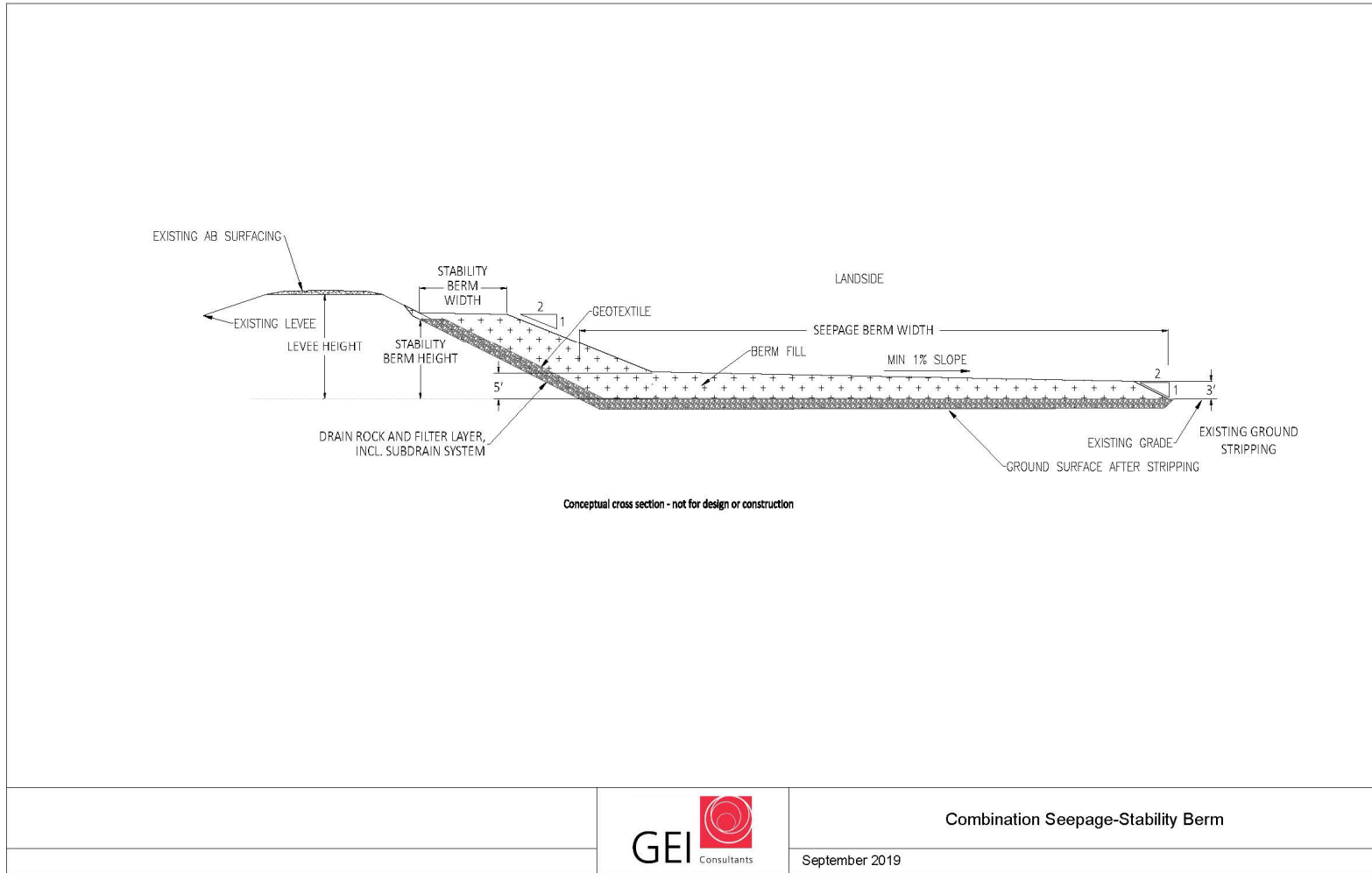


Figure 2: Drained Seepage Berm Conceptual Schematic



**Figure 3: Combination Seepage and Stability Berm Conceptual Schematic**

### **3.2. Levee Improvement Cutoff Walls**

As shown in Table 2, cutoff wall remediations for a given reach vary in depth depending on if through seepage is a concern, and the subsurface conditions. All reaches underlying paved roads assume 1/3 of the levee height is removed to form a suitable working surface for installation of the cutoff walls. Standard practice is to assume 1/2 levee degrade, but due to the wide existing levee prisms it was assumed 1/3 degrade would be permissible. The Geotechnical Assessment Report assumed 1/2 levee degrade in development of the cutoff wall depths, and the difference between these degrade heights were added to the cutoff wall depth. Levee reaches that are not underlying paved roads assume 1/2 levee degrade.

The construction of a cutoff wall along reach 121 and 127 (Sacramento River) would result in disruption of traffic along River Road. Contingencies were included in the estimate for construction of a temporary roadway off the existing levee crown during construction of the cutoff wall. No alignments for this temporary roadway were developed, and additional work is needed during design.

A typical cutoff wall is shown in Figure 4. A summary of the construction activities for each reach is provided in Table 5. A summary of the total cost estimate for the cutoff wall alternatives is provided in Table 6.



**Table 5: Levee Improvement Cutoff Wall Base Construction Quantities**

Location Description	Wall Depth	Degrade Volume	Remove AC	Disposal Volume	Wall Area	Wall Cost/sq. ft	Levee Rebuild	Temporary Roadway				Aggregate Base Levee Crown	New Roadway AC	Hydro-seeding	Right of Way		Total Base Construction Estimate	ROW Acquisition
								Clear & Grub	Proof Compaction	AB	AC				AC	\$/ AC		
Cost per unit		\$6.9	\$5.7	\$10.0	varies	varies	\$26.7	\$8,342.7	\$1,382.6	\$54.9	\$40.0	\$54.9	\$40.0	\$4,692.6				
Units		CY	SY	CY	Sq ft		CY	AC	AC	CY	SY	CY	SY	AC	AC	\$/ AC		
SPFC SACR-L 127-A	15 ft	26,406	0	26,406	14,772	\$32.00	15,577	0.0	0.0	0	0	348	0	0.2	0.0	\$0	\$1,354,000	\$0
SPFC SACR-L 121-A	75 ft	38,662	10,944	38,662	310,622	\$32.00	35,182	22.5	22.5	1,824	10,944	1,520	10,944	0.8	2.7	\$81,000	\$12,977,000	\$221,000
<b>SPFC Subtotals</b>	<b>90 ft</b>	<b>65,068</b>	<b>10,944</b>	<b>65,068</b>	<b>325,394</b>	<b>--</b>	<b>50,759</b>	<b>23</b>	<b>23</b>	<b>1,824</b>	<b>10,944</b>	<b>1,868</b>	<b>10,944</b>	<b>1</b>	<b>3</b>	<b>--</b>	<b>\$14,331,000</b>	<b>\$221,000</b>
Non-SPFC TMSS-L 1040-A	65 ft	83,111	8,533	83,111	208,000	\$10.29	104,400	17.6	17.6	1,422	8,533	1,185	8,533	4.5	2.1	\$25,000	\$7,476,000	\$53,000
Non-SPFC TMXS-R 1054-A	25 ft	9,782	4,000	9,782	37,500	\$8.93	10,219	8.2	8.2	667	4,000	556	4,000	0.5	1.0	\$25,000	\$1,302,000	\$25,000
Non-SPFC TMXS-R 1054-B	17 ft	26,057	4,533	26,057	28,900	\$8.93	29,259	9.3	9.3	756	4,533	630	4,533	1.0	1.1	\$25,000	\$2,081,000	\$28,000
Non-SPFC SDSS-R 1054-C	35 ft	56,070	81,84	56,070	107,415	\$8.93	52,503	16.9	16.9	1,364	8,184	1,137	8,184	1.6	2.0	\$25,000	\$4,392,000	\$51,000
Non-SPFC LKSRR LKSRR-A	20 ft	29,106	3,827	29,106	28,700	\$8.93	22,103	7.9	7.9	638	3,827	531	3,827	0.5	1.0	\$25,000	\$1,844,000	\$24,000
<b>Non-SPFC Subtotals</b>	<b>162 ft</b>	<b>204,125</b>	<b>29,077</b>	<b>204,125</b>	<b>410,515</b>	<b>--</b>	<b>218,486</b>	<b>60</b>	<b>60</b>	<b>4,846</b>	<b>29,077</b>	<b>4,039</b>	<b>29,077</b>	<b>8</b>	<b>7</b>	<b>--</b>	<b>\$17,095,000</b>	<b>\$181,000</b>
<b>Repair Type Totals</b>	<b>252 ft</b>	<b>269,193</b>	<b>40,021</b>	<b>269,193</b>	<b>735,909</b>	<b>--</b>	<b>269,245</b>	<b>82</b>	<b>82</b>	<b>6,670</b>	<b>40,021</b>	<b>5,907</b>	<b>40,021</b>	<b>9</b>	<b>10</b>	<b>--</b>	<b>\$31,426,000</b>	<b>\$402,000</b>

**Table 6: Cutoff Wall Reach Cost Summary**

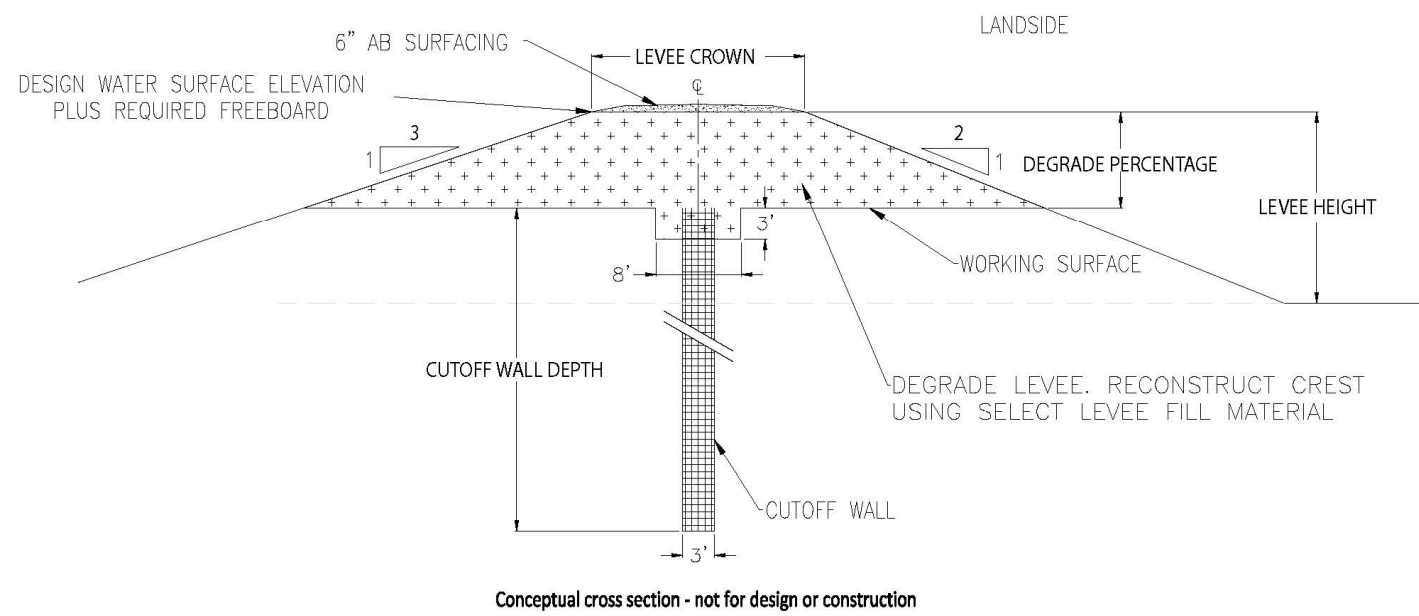
Location Description	Stationing		Length <sup>1</sup> (Feet)	Cutoff Wall	Other Construction Costs*	Other Owner Costs**	Construction Contingency***	Right of Way	Location Total
	From	To					30%		
SPFC SACR-L 127-A	2506+08	2515+48	900	\$1,354,000	\$271,000	\$715,000	\$702,000	\$0	\$3,042,000
SPFC SACR-L 121-A	2515+48	2556+52	4,100	\$12,977,000	\$2,595,000	\$6,852,000	\$6,727,000	\$221,000	\$29,372,000
<b>SPFC Subtotals</b>			<b>5,000</b>	<b>\$14,331,000</b>	<b>\$2,866,000</b>	<b>\$7,567,000</b>	<b>\$7,429,000</b>	<b>\$221,000</b>	<b>\$32,414,000</b>
Non-SPFC TMSS-L 1040-A	1000+00	1032+00	3,200	\$7,476,000	\$1,495,000	\$3,947,000	\$3,875,000	\$53,000	\$16,846,000
Non-SPFC TMXS-R 1054-A	1000+00	1015+00	1,500	\$1,302,000	\$260,000	\$687,000	\$675,000	\$25,000	\$2,949,000
Non-SPFC TMXS-R 1054-B	1015+00	1032+00	1,700	\$2,081,000	\$416,000	\$1,099,000	\$1,079,000	\$28,000	\$4,703,000
Non-SPFC SDSS-R 1054-C	1144+42	1175+11	3,100	\$4,392,000	\$878,000	\$2,319,000	\$2,277,000	\$51,000	\$9,917,000
Non-SPFC LKSRR LKSRR-A		14+35	1,400	\$1,844,000	\$369,000	\$974,000	\$956,000	\$24,000	\$4,167,000
<b>Non-SPFC Subtotals</b>			<b>10,900</b>	<b>\$17,095,000</b>	<b>\$3,418,000</b>	<b>\$9,026,000</b>	<b>\$8,862,000</b>	<b>\$181,000</b>	<b>\$38,582,000</b>
<b>Repair Type Totals</b>			<b>15,900</b>	<b>\$31,426,000</b>	<b>\$6,284,000</b>	<b>\$16,593,000</b>	<b>\$16,291,000</b>	<b>\$402,000</b>	<b>\$70,996,000</b>

<sup>1</sup> Repair lengths rounded to the nearest 100 feet

\* Percentages based on the construction subtotal (see Table 1)

\*\* Percentages based on construction, structure, other construction cost subtotals (see Table 1)

\*\*\* 30% of the construction, structure, other construction cost, other owner cost subtotals



Cutoff Wall

September 2019

Figure 4: Cutoff Wall Conceptual Schematic

### 3.3. Rock Slope Protection (RSP) Improvements

To address existing erosion concerns RSP involves placement of rip-rap along the waterside slope of the levee. Erosion concerns have been identified for repair along reach 1054. These concerns are assumed to require 2-foot thick RSP along the entire waterside slope. The extents along this reach will need to be refined in future designs.

A summary of the construction activities for each reach is provided in Table 7. A summary of the total RSP cost estimate is provided in Table 8.

**Table 7: RSP Base Construction Quantities Cost Summary**

Location Description	Stationing		Length <sup>1</sup> (Feet)	Levee Height	Levee Crest	Ex WS Slope	Repair Length	Repair Width	Rock Slope Protection
	From	To		H	ft	X:1	L	W	CY
SACR-L 127-A	2506+08	2515+48	900	13 ft	165 ft	1.7 :1			-
SACR-L 121-A	2515+48	2556+52	4,100	13 ft	53 ft	1.8 :1			-
TMSS-L 1040-A	1000+00	1032+00	3,200	22 ft	17 ft	5.5 :1			-
TMXS-R 1054-A	1000+00	1015+00	1,500	11 ft	17 ft	2.6 :1	1,500 ft	65 ft	7,222
TMXS-R 1054-B	1015+00	1032+00	1,700	17 ft	25 ft	3.1 :1	1,000 ft	100 ft	7,407
SDSS-R 1054-C	1144+42	1175+11	3,100	18 ft	38 ft	2.4 :1	500 ft	110 ft	4,074
LKSRR LKSRR-A		14+35	1,400	16 ft	54 ft	1.8 :1			-
							Quantity Total		18,704
							Unit Costs		\$77.50
							<b>Total Base Cost</b>		<b>\$1,450,000</b>

<sup>1</sup> Repair lengths rounded to the nearest 100 feet

**Table 8: RSP Reach Cost Summary**

Location Description	Stationing		Length <sup>1</sup> (Feet)	Rock Slope Protection	Other Construction Costs*	Other Owner Costs**	Construction Contingency***	Location Total
	From	To					30%	
SACR-L 127-A	2506+08	2515+48	900					
SACR-L 121-A	2515+48	2556+52	4,100					
TMSS-L 1040-A	1000+00	1032+00	3,200					
TMXS-R 1054-A	1000+00	1015+00	1,500	\$560,000	\$112,000	\$363,000	\$310,000	\$1,345,000
TMXS-R 1054-B	1015+00	1032+00	1,700	\$574,000	\$115,000	\$372,000	\$318,000	\$1,379,000
SDSS-R 1054-C	1144+42	1175+11	3,100	\$316,000	\$63,000	\$204,000	\$175,000	\$759,000
LKSRR LKSRR-A		14+35	1,400					
			<b>Repair Type Totals</b>	<b>\$1,450,000</b>	<b>\$290,000</b>	<b>\$939,000</b>	<b>\$803,000</b>	<b>\$3,483,000</b>

<sup>1</sup> Repair lengths rounded to the nearest 100 feet

\* Percentages based on the construction subtotal

\*\* Percentages based on construction, structure, other construction cost subtotals

\*\*\* Percentages based on construction, structure, other construction cost, other owner cost subtotals

#### 4. Potential Cross Levee North of Locke in RD 369

A 0.30-mile-long potential cross levee north of Locke is proposed in conjunction with levee repairs and improvements to the RD 369 perimeter levee system to secure 100-year FEMA certification for the community of Locke. The dimensions for the potential cross levee are summarized in Table 9. Utilizing these dimensions, construction quantities were calculated based on the existing ground elevations along the proposed cross levee alignment and were summed to calculate the quantities for each activity. The unit costs identified in Table 1 were then applied to the construction quantities to determine the estimated cost for the proposed cross levee. The cost summary for the proposed cross levee is summarized in Table 10.

**Table 9. Cross Levee Dimensions**

Crown Width	Landside Slope	Waterside Slope	Crest Elevation	Average Height
20 ft.	3:1	3:1	20 ft. NAVD 88	11.4 ft.

**Table 10: Cross Levee Cost Summary****Locke Cross Levee Cost Estimate  
Cost Summary (July 2020 Costs)**

Levee length = 1,604 ft, Crest Elevation @ 20.0, Average levee height = 11.4 ft, Crown width = 20 ft

<u>Item</u>	<u>Unit</u>	<u>Quantity</u>	<u>Unit Cost</u>	<u>Cost</u>
<b>New Cross Levee</b>				
<i>Clearing and Grubbing</i>	AC	4.4	\$8,342.74	\$37,000
<i>Stripping</i>	CY	5,367	\$7.67	\$41,000
<i>Inspection Trench - Excavation</i>	CY	6,216	\$6.86	\$43,000
<i>Levee Embankment - Select Levee Fill</i>	CY	52,937	\$26.70	\$1,414,000
<i>Aggregate Base (Crown + LS Maint Rd)</i>	CY	691	\$54.90	\$38,000
<i>Hydroseeding</i>	AC	3.8	\$4,693	\$18,000
<b>Major Construction Items Subtotal =</b>				<b>\$1,590,000</b>
<b>Other Construction Costs*</b>				
Unallocated Items in Construction Costs			15%	\$239,000
Mobilization and Demobilization			5%	\$80,000
<b>Other Construction Costs Subtotal =</b>				<b>\$319,000</b>
<b>Construction Total =</b>				<b>\$1,909,000</b>
<b>Other Owner Costs**</b>				
Environmental Documentation and Permitting			20%	\$382,000
Design and Engineering Costs			15%	\$287,000
Legal Costs			2%	\$38,000
Engineering during Construction			2%	\$38,000
Construction Management			15%	\$287,000
<b>Other Owner Costs Subtotal =</b>				<b>\$1,032,000</b>
<b>Right-of-Way</b>				
<i>Permanent Right-of-Way (fee Title)- Orchard</i>	AC	4.4	\$40,000.00	\$176,000
<b>Total Project Baseline Cost =</b>				<b>\$3,120,000</b>
<b>Contingency 30%</b>				<b>\$940,000</b>
<b>Expected Project Cost =</b>				<b>\$4,060,000</b>

\*Other Construction Costs are a percentage of the Major Construction Items Subtotal

\*\* Other Owner Costs are a percentage of the Construction Total

\*\*\* Contingency is a percentage of Construction Total and Total Other Owners Costs

## **5. Range of Costs to Repair and Strengthen-in-Place Perimeter Levee Reaches in Locke Study Area**

Table 11 provides a range of capital cost estimates by levee reach using the remediation alternatives identified in Table 2. These estimates are used as the basis to develop the range of costs for each of the repair and strengthen-in-place structural elements as summarized in Table 15.

**Table 11: Repair and Strengthen-in-Place Cost Estimates by Levee Reach for Perimeter Levees of Locke Study Area**

Levee Segment Location	Reach	Start Station	End Station	Length (ft) <sup>1</sup>	Remediation Alternative 1	Remediation Alternative 1 Cost Estimate	Remediation Alternative 2	Remediation Alternative 2 Cost Estimate
SPFC Left Bank Sacramento River - RD 369	121-A	2515+48	2556+52	4,100	75 ft. deep cutoff wall	\$29,372,000	65 ft. wide, 9 ft. tall combination seepage and stability berm	\$13,544,000
SPFC Left Bank Sacramento River - RD 554	127-A	2506+08	2515+48	900	15 ft. deep cutoff wall	\$3,042,000	15 ft. wide, 8 ft. tall drained stability berm	\$1,180,000
<b>SPFC Subtotal Locke Study Area</b>				<b>5,000</b>		<b>\$32,414,000</b>		<b>\$14,724,000</b>
Delta Meadows Slough Levee (portion of NULE Segment 1040) – RD 551	1040-A	1000+00	1032+00	3,200	65 ft. deep cutoff wall	\$16,846,000	135 ft. wide, 15 ft. tall combination seepage and stability berm	\$14,525,000
Delta Meadows Cross Slough Right Bank Cross Levee (portion of NULE Segment 1054) – RD 369	1054-A	1000+00	1015+00	1,500	25 ft. deep cutoff wall 65 ft. wide RSP	\$4,294,000	55 ft. wide seepage berm 65 ft. wide RSP	\$4,174,000
	1054-B	1015+00	1032+00	1,700	15-ft. deep cutoff wall 100 ft. wide RSP (1,000 feet)	\$6,082,000	15 ft. wide, 8 ft. tall drained stability berm 100 ft. wide RSP (1,000 feet)	\$2,710,000
Snodgrass Slough Right Bank Levee (portion of NULE Segment 1054) – RD 369 and 554	1054-C	1144+42	1175+11	3,100	35 ft. deep cutoff wall 110 ft. wide RSP (500 ft.)	\$10,676,000	90 ft. wide, 9 ft. tall combination seepage and stability berm 110 ft. wide RSP (500 ft.)	\$9,331,000
Locke South Railroad Embankment – RD 554	LKSR R-A	0+00	14+35	1,400	20 ft. deep cutoff wall	\$4,167,000	80 ft. wide, 9 ft. tall combination seepage and stability berm	\$3,721,000
<b>Non-SPFC Subtotal for Locke Study Area</b>				<b>10,900</b>		<b>\$42,065,000</b>		<b>\$34,461,000</b>
<b>Perimeter Totals for Locke Study Area</b>				<b>15,900</b>		<b>\$74,479,000</b>		<b>\$49,185,000</b>

<sup>1</sup> Reach lengths rounded to the nearest 100 feet



## **6. Range of Costs for 100-Year FEMA Certification for Community of Locke with Potential Cross Levee in RD 369**

The estimated range of costs to secure 100-year FEMA certification for the community of Locke with a potential cross levee are summarized below in Table 12. The cost of securing 100-year FEMA certification for the levee system consisting of a potential cross levee north of Locke as described in Section 4 and perimeter levee improvements south of the cross levee is the summation of all the costs associated with:

- 1) Repairing and strengthening a total of 0.75 miles of SPFC and non-SPFC levees along the left bank of the Sacramento River (NULE Segment 121 in RD 369 and a portion of NULE Segment 127 in RD 554), along the right bank of Snodgrass Slough (portion of NULE Segment 1054 in RD 369), and improving the adjoining railroad embankment to current FEMA standards
- 2) Construction of the cross levee as detailed in Section 4
- 3) Addressing any reaches that contain an immediate freeboard issue (none) or long-term settlement issues (unknown)
- 4) Correcting all encroachments (closures, pipelines, and structures) within and/or adjacent to the entirety of the perimeter levee system that pose a threat to the structural and/or operational integrity of the levee system pursuant to 44 CFR §65.10
- 5) Conducting the applicable interior drainage studies and operational plans
- 6) Updating applicable operation and maintenance plans following all repairs and improvements and modifications to ensure the levees are operated and maintained by RDs 369 and 554 in accordance with FEMA, U.S. Army Corps of Engineers (USACE), and Central Valley Flood Protection Board (CVFPB) standards.

For cost estimating purposes, FEMA certification items (3) through (6) noted herein are estimated at 5 percent of the total combined cost of items (1) and (2) herein associated with repairing and strengthening the levee system and constructing a new cross levee.

**Table 12: Estimated Range of Costs for 100-Year FEMA Certification of Levee System Paired with Potential 0.30-mile-long Cross Levee Just North of Locke - Management Action 5**

<b>Cost Component</b>	<b>Estimated Cost</b>
<b>Remediation Alternative 1 (Cutoff Walls) Implemented for Levee System</b>	
1. Repair and Strengthen-in-Place 0.75 miles of SPFC and Non-SPFC Levee System in RDs 369 and 554 South of Potential Cross Levee: Remediation Alternative 1 (Cutoff Walls)	\$17,359,000
2. Construction of Potential 0.30-mile-long Cross Levee North of Locke in RD 369	\$4,060,000
3. FEMA Certification (5 percent of items 1-2 above)	\$1,071,000
<b>Total</b>	<b>\$22,490,000</b>
<b>Remediation Alternative 2 (Berms) Implemented for Levee System</b>	
1. Repair and Strengthen-in-Place 0.75 miles of SPFC and Non-SPFC Levee System in RDs 369 and 554 South of Potential Cross levee: Remediation Alternative 2 (Berms)	\$10,926,000
2. Construction of Potential 0.30-mile-long Cross Levee North of Locke in RD 369	\$4,060,000
3. FEMA Certification (5 percent of items 1-2 above)	\$749,000
<b>Total</b>	<b>\$15,735,000</b>

**7. Range of Costs for 100-Year FEMA Certification for Entire RD 369 Perimeter Levee System (including Short Non-SPFC Levee Segments of RDs 551 and 554)**

The estimated range of costs to secure 100-year FEMA certification for the community of Locke and the entire RD 369 perimeter levee system are summarized below in Table 13. The cost of securing 100-year FEMA certification for the community of Locke and the entire perimeter levee system of RD 369 is the summation of all the costs associated with:

- 1) Repairing and strengthening the 2.93 miles of SPFC and non-SPFC levees along the left bank of the Sacramento River (the entirety of NULE Segment 121, RD 369, and the northerly 700 ft. portion of NULE Segment 127 in RD 554), along the right bank of Delta Meadows Slough (portion of NULE Segment 1040 in RD 551), along the right bank of Meadows Slough and Snodgrass Slough (portion of NULE Segment 1054 in RD 369), and along the former railroad embankment which extends from the south side of the Snodgrass Slough right bank levee towards the northwest entrance to the Delta Cross Channel to current FEMA standards

- 2) Addressing any reaches that may contain a freeboard issue (Sacramento River left [east] bank levee upstream and adjacent to the community of Locke) or long-term settlement issues (unknown)
- 3) Correcting all encroachments (closures, pipelines, and structures) within and/or adjacent to the entirety of the perimeter levee system that pose a threat to the structural and/or operational integrity of the levee system pursuant to 44 CFR §65.10
- 4) Conducting the applicable interior drainage studies and operational plans, and
- 5) Updating applicable operation and maintenance plans following all repairs and improvements and modifications to ensure the entirety of the perimeter levee system is operated and maintained by RDs 369, 554, and 551 in accordance with FEMA, USACE, and CVFPB standards.

For cost estimating purposes, FEMA certification items (3) through (5) noted herein are estimated at 5 percent of the total cost of item (1) herein associated with repairing and strengthening the levee system.

**Table 13: Estimated Range of Costs for 100-Year FEMA Certification of entire RD 369 Perimeter Levee System (including Small Non-SPFC Levee Segments of RDs 551 and 554) - Management Action 6**

<b>Cost Component</b>	<b>Estimated Cost</b>
<b>Remediation Alternative 1 (Cutoff Walls) Implemented for Entire RD 369 Perimeter Levee System</b>	
1. Repair and Strengthen-in-Place Entire RD 369 Perimeter Levee System: Remediation Alternative 1 (Cutoff Walls)	\$72,557,000
2. FEMA Certification (5 percent of item 1 above)	\$3,628,000
<b>Total</b>	\$76,185,000
<b>Remediation Alternative 2 (Berms) Implemented for Entire RD 369 Perimeter Entire Levee System</b>	
1. Repair and Strengthen-in-Place Repairs to the Entire RD 369 Perimeter Levee System: Remediation Alternative 2 (Berms)	\$47,882,000
2. FEMA Certification (5 percent of item 1 above)	\$2,394,000
<b>Total</b>	\$50,276,000

**8. Range of Costs for Raising, Repairing and Strengthening-in-Place Entirety of Sacramento River Left Bank SPFC Levee in RD 369 to Current Engineering Standards Upstream of Locke (SPFC Levee Segment 121); combined with Securing 100-Year FEMA Certification for Community of Locke with Potential Cross Levee in RD 369**

The cost of Management Action 7 (Table 14) is the summation of costs associated with Management Action 5 described above, plus the cost of repairing and strengthening the northerly 0.60 miles of SPFC levee along the left bank of the Sacramento River associated with Management Action 4.

**Table 14: Estimated Range of Costs for Management Action 7**

<b>Cost Component</b>	<b>Estimated Cost</b>
<b>Remediation Alternative 1 (Cutoff Walls) Implemented for Levee System</b>	
1. Repair and Strengthen-in-Place Levee System: Remediation Alternative 1 (Cutoff Walls)	\$39,173,000
2. Construction of a Cross Levee North of Locke	\$4,060,000
3. FEMA Certification for Community of Locke Only (5 percent of item 1 above for remediations only south of Cross Levee; and 5 percent of item 2 above for Cross Levee)	\$1,071,000
<b>Total</b>	\$44,304,000
<b>Remediation Alternative 2 (Berms) Implemented for Levee System</b>	
1. Repair and Strengthen-in-Place Levee System: Remediation Alternative 2 (Berms)	\$20,985,000
2. Construction of a Cross Levee North of Locke	\$4,060,000
3. FEMA Certification (5 percent of item 1 above for remediations only south of Cross Levee; and 5 percent of item 2 above for Cross Levee)	\$749,000
<b>Total</b>	\$25,794,000

## 9. Cost Summary of Management Actions for Community of Locke Study Area

A summary of capital costs for Management Actions 1-7 is provided in Table 15 below. A range of costs has been provided since levees can be remediated through a cutoff wall or a stability berm.

**Table 15: Estimated Range of Costs for Management Actions 1-7 including FEMA Certification for the Community of Locke**

Management Action	Cutoff Walls	Berms	Cross Levee	RSP	FEMA Certification	Total
1: Repair and Strengthen-in-Place Delta Meadows Cross Slough Non-SPFC Levee (portion of NULE Segment 1054 in RD 369)	\$7,652,000	\$4,160,000	--	\$2,724,000	--	\$6,884,000 - \$10,376,000
2: Repair and Strengthen-in-Place Snodgrass Slough Non-SPFC Levee (portion of NULE Segment 1054 in RD 369) and Portion of RD 554 Former Railroad Embankment	\$12,983,000	\$11,310,000	--	\$759,000	--	\$12,069,000 - \$13,742,000
3: Repair and Strengthen-in-Place Delta Meadows Slough Non-SPFC Levee (portion of NULE Segment 1040 in RD 551)	\$16,846,000	\$14,525,000	--	--	--	\$14,525,000 - \$16,846,000
4: Repair and Strengthen-in-Place, 0.93-miles of Sacramento River SPFC Levee (NULE Segment 121 in RD 369 and a Portion of NULE Segment 127 in RD 554)	\$31,593,000	\$14,406,000	--	--	--	\$14,406,000 - \$31,593,000
5: Secure 100-Year FEMA Certification, South Portion RD 369 Perimeter Levee System Paired with a Potential Cross Levee North of Locke in RD 369	\$16,600,000	\$10,167,000	\$4,060,000	\$759,000	\$749,000 - \$1,071,000	\$15,735,000 - \$22,490,000
6: Secure 100-Year FEMA Certification for Entire RD 369 Perimeter Levee System, including Small Segments of Non-SPFC Levee in RDs 551 and 554 (Summation of Management Actions 1-4) (2.93 miles)	\$69,075,000	\$44,400,000	--	\$3,482,000	\$2,394,000 - \$3,628,000	\$50,276,000 - \$76,185,000
<b>Total Cost per Mile for Management Action 6</b>						<b>\$17M-\$26M</b>
7: Sacramento River SPFC Levee Improvements (0.93 miles) Paired with Securing 100-Year FEMA Certification for the Community of Locke with Potential Cross Levee	\$38,414,000	\$20,226,000	\$4,060,000	\$759,000	\$749,000 - \$1,071,000	\$25,794,000 - \$44,304,000

## 10. References

- California Department of Water Resources: BWFS Sacramento Basin Appendix D, Yolo Bypass Cost Estimates. January 2016.
- Central Valley Flood Protection Board. 2014. Barclays Official California Code of Regulations, Title 23. Waters, Division 1 Central Valley Flood Protection Board. July 2014.
- URS Corporation. 2011a. *Geotechnical Assessment Report, North NULE Project Study Area*. Non-Urban Levee Evaluations Project. Prepared by URS for Department of Water Resources (DWR) Division of Flood Management. April.
- URS Corporation. 2011b. *Remedial Alternatives and Cost Estimating Report (RACER), North NULE Study Area*. Non-Urban Levee Evaluations Project. Prepared by URS for Department of Water Resources (DWR) Division of Flood Management. August.
- URS Corporation. 2012. *Geotechnical Data Report, North NULE Project Study Area*. Non-Urban Levee Evaluations Project. Prepared by URS for DWR Division of Flood Management. November.
- URS Corporation. 2014a. *Geotechnical Overview Report Volume 1, Existing Conditions, Knights Landing Study Area, Segments 162 and 217*. Non-Urban Levee Evaluations Project. Prepared by URS for DWR Division of Flood Management. January.
- URS Corporation. 2014b. *Geotechnical Overview Report Volume 2, Remedial Alternatives, Knights Landing Study Area, Segments 162 and 217*. Non-Urban Levee Evaluations Project. Prepared by URS for DWR Division of Flood Management. September.
- URS Corporation. 2015. *Geotechnical Data Report Addendum, Knights Landing Study Area*. Non-Urban Levee Evaluations Project. Prepared by URS for DWR Division of Flood Management. April.