

# DRAFT Technical Memorandum



**To:** Charles Bergson – City Manager, City of Isleton  
**From:** Michael Conant, Kris Van Sant, Katie Laird  
**cc:** Jeffrey Twitchell  
**Date:** May 25, 2022  
**Re:** Cost Estimate Development for Flood Risk Reduction Management Actions  
for the Flood Risk Reduction Feasibility Study for Delta Legacy Community  
of Isleton, CA  
GEI Project 1800488

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GEI Consultants, Inc. (GEI) is assisting the City of Isleton in conducting a feasibility study to evaluate structural and non-structural actions to reduce the risk of flooding to the Isleton 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 Isleton, CA” (Feasibility Study). As discussed in the Feasibility Study, 12 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 Isleton. This TM is focused on describing how perimeter levee improvements, several potential cross levees, and an all-weather access road/flood fight berm 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 of DWR Flood System Repair Project (FSRP) Critical and Serious Sites within Brannan-Andrus Levee Maintenance District (BALMD)
- MA 2: Raise and Repair/Strengthen-in-Place Reclamation District (RD) 556 Cross Levee Coupled with a Relief Cut along Georgiana Slough within Upper Andrus – RD 556
- MA 3: All-Weather Access Road/Flood Fight Berm for the Community of Isleton, all located within the City limits of Isleton, along 6<sup>th</sup> Street and Jackson Boulevard
- MA 4: Repair and Strengthen-in-Place State Plan of Flood Control (SPFC) Levee along the Left Bank of the Sacramento River (Non-Urban Levee Evaluation [NULE] Segment 378)

- 4A: Repair and Strengthen-in-Place 1.6 Miles of Levee along the Left Bank of the Sacramento River Adjacent to Isleton
- 4B: Repair and Strengthen-in-Place 4.2 Miles of Levee along the Left Bank of the Sacramento River Between the Westerly Boundary of the Community of Isleton and Highway 12
- 4C: Repair and Strengthen-in-Place 2.4 Miles of Levee along the Left Bank of the Sacramento River Between Highway 12 and West Brannan Island Road
- 4D: Repair and Strengthen-in-Place 2.0 Miles of Levee along the Left Bank of the Sacramento River Between the Easterly Boundary of the Community of Isleton and the RD 556 Cross Levee
- MA 5: Repair and Strengthen-in-Place SPFC Levee along the Right Bank of Georgiana Slough (NULE Segment 40)
  - MA 5A: Repair and Strengthen-in-Place 0.90 miles of Levee along the Right Bank of Georgiana Slough Between the North Cross Levee and 450 ft. Downstream of the Isleton Sewer Ponds
  - MA 5B: Repair and Strengthen-in-Place 1.6 Miles of Levee along the Right Bank of Georgiana Slough Between the North and Mid Cross Levees
  - MA 5C: Repair and Strengthen-in-Place 1.9 Miles of Levee along the Right Bank of Georgiana Slough Between the North and South Cross Levees (*includes 5A and 5B above*)
  - MA 5D: Repair and Strengthen-in-Place 2.0 Miles of Levee along the Right Bank of Georgiana Slough Between the South Cross Levee and the Mokelumne River
  - MA 5E: Repair and Strengthen-in-Place 2.2 Miles of Levee along the Right Bank of Georgiana Slough Between the North Cross Levee and the RD 556 Cross Levee
- MA 6: Cross Levee System(s) for the City of Isleton
  - MA 6A: Cross Levee System Adapted from 2012 CVFPP and 2014 RFMP
  - MA 6B: Isleton – Oxbow Marina Cross Levee System with Future Optional Multi-Objective Setback Levee at Oxbow Marina
  - MA 6C: Isleton Sphere of Influence Cross levee System
- MA 7: Repair and Strengthen-in-Place Non-SPFC Levee along the Right Bank of the Mokelumne River (NULE Segment 1050)
- MA 8: Repair and Strengthen-in-Place Non-SPFC Levee along the Right Bank of the San Joaquin River (NULE Segment 1049)
- MA 9: Repair and Strengthen-in-Place 1.35 Miles of Non-SPFC Levee along the Left Bank of Sevenmile Slough (NULE Segment 1048) East of Jackson Slough and Certify Sevenmile Slough Closure Structures
- MA 10: Highway 12 Cross Levee
- MA 11: Secure 100-Year Federal Emergency Management Agency (FEMA) Certification for the Community of Isleton with a Highway 12 Cross Levee Paired with Perimeter Levee Improvements North of Highway 12
- MA 12: Secure 100-Year FEMA Certification for the Entire Study Area inclusive of the Community of Isleton

## **2. Methodology**

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

- Repair and strengthen-in-place levee improvements for the entire levee perimeter of BALMD. Improvements include:
  - Berms
  - Cutoff walls
- All-weather access road/flood fight berm protecting the community of Isleton
- Three cross levees to the east and west of the community of Isleton and a cross levee along Highway 12

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 20 to 30 percent contingency cost to the Baseline Cost. The cost estimates in this document are considered a planning-level tool.

### **2.1. Cost Development**

#### **2.1.1. DWR Previously Identified Repair Needs**

Cost estimates for select levee reaches BALMD were developed based on previously identified assessments, remediations, and associated cost estimates developed by DWR as documented in the 2011 NULE Geotechnical Assessment Report (GAR) and in the 2011 NULE Remedial Alternatives and Cost Estimates Report (RACER) for the North NULE study area. These levee reaches include:

- Portions of NULE Segment 378 along the left bank of the Sacramento River
  - 2.3 Miles of levee along the left bank of the Sacramento River between the easterly boundary of the community of Isleton and the RD 556 cross levee
  - 6.6 Miles of levee along the left bank of the Sacramento River between the westerly boundary of the community of Isleton and West Brannan Island Road

- Portions of NULE Segment 40 along the right bank of Georgiana Slough
  - 2.2 Miles of levee along the right bank of Georgiana Slough between the North Cross Levee and the RD 556 cross levee
  - 1.9 Miles of levee along the right bank of Georgiana Slough between the South Cross Levee and the Mokelumne River
- NULE 1050 along the right bank of the Mokelumne River
- NULE 1049 along the right bank of the San Joaquin River
- 1.35-mile-long portion of NULE 1048 along the left bank of Sevenmile Slough

To develop cost estimates for these reaches, DWR cost estimates as documented in the 2011 NULE RACER were escalated to July 2020 dollars using the 20-city average from the Engineering News-Record (ENR) Construction Cost Index.

#### **2.1.2. Additional Remediations and Improvements**

Cost estimates for the remaining elements were developed by applying unit costs to quantities based upon conceptual designs. These elements include:

- Repairing and strengthening 1.4 Miles of levee along the left bank of the Sacramento River (NULE Segment 378) immediately adjacent to Isleton
- Repairing and strengthening 1.9 Miles of levee along the right bank of Georgiana Slough (NULE Segment 40) between the North and South Cross Levees
- Raising and repairing/strengthening the RD 556 cross levee
- All-weather access road/flood fight berm
- North, Mid, and South Cross Levees (including cross levee system that closely coincides with City's latest proposed Sphere of Influence (SOI) boundaries)
- Highway 12 cross levee

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 or flood fight berms. 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.
- **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. Prior to comparison, all unit costs were escalated to July 2020 using the 20-city average from the ENR

Construction Cost Index. 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**

<u>Construction Activity Description</u>	<u>Unit</u>	<u>Unit Cost</u>
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		10.00%-20.00% <sup>1</sup>
Mobilization and Demobilization		5.00%
<b>Other Owner Costs**</b>		
Environmental Documentation and Permitting		10.00%-20.00% <sup>2</sup>
Design and Engineering Costs		10.00%-15.00% <sup>3</sup>
Legal Costs		2.00%
Engineering during Construction		2.00%
Construction Management		5.00%-15.00% <sup>4</sup>
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

<sup>1</sup> All cost estimates include a 15 percent mark-up for unallocated items in construction costs with the exception of: 1) the proposed RD 563 cross levee which includes a 20 percent mark-up to account for unknown conditions along the proposed cross levee alignment, and 2) the proposed all-weather access road/flood fight berm and dry cross levee improvements which include a 10 percent mark-up.

<sup>2</sup> All cost estimates include a 10 percent mark-up for environmental documentation and permitting with the exception of estimates for RSP which include a 20 percent mark-up due to the more probable disturbance of riparian habitat

<sup>3</sup> All cost estimates include a 15 percent mark-up for design and engineering with the exception of the proposed all-weather access road/flood fight berm and dry cross levee improvements which include a 10 percent mark-up.

<sup>4</sup> All cost estimates include a 15 percent mark-up for construction management with the exception of the proposed all-weather access road/flood fight berm and dry cross levee improvements which include a 5 percent mark-up.

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 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

#### 3.1. DWR Previously Identified Repair Needs

Repair and strengthen-in-place levee improvements for the reaches identified in Section 2.1.1 were developed by DWR and are summarized in the Feasibility Study and detailed in the 2011 NULE RACER. The suite of alternatives developed by DWR for the applicable levee reaches are summarized in Table 2.

**Table 2: DWR Levee Remediation Alternatives**

Levee Segment Location	NULE Segment	Hazard Remediated	Extent (% of Total Segment Length)	Remedial Alternatives
Left Bank Sacramento River (SPFC Levee Segment – 11.6 miles)	378	T	10% @ 1.2 miles	14' High Levee 4' High Drained Stability Berm 20' Deep Slurry Wall
		S	30% @ 3.5 miles	14' High Levee 4' High Drained Stability Berm
		T	20% @ 2.3 miles	14' High Levee 4' High Drained Stability Berm
		E	20% @ 2.3 miles	14' High Levee
Right Bank Georgiana Slough (SPFC Levee Segment – 6.0 miles)	40	T + U	10% @ 0.6 miles	13' High Levee 65' Wide Combination Berm 55' Deep Slurry Wall
		U	5% @ 0.3 miles	13' High Levee 70' Wide Seepage Berm 55' Deep Slurry Wall
		T + U	15% @ 0.9 miles	13' High Levee 75' Wide Combination Berm 55' Deep Slurry Wall
		T + U + S	30% @ 1.8 miles	13' High Levee 11' High Stability Berm 55' Deep Slurry Wall
		T + U + S	30% @ 1.8 miles	13' High Levee 70' Wide Combination Berm 55' Deep Slurry Wall
		FG	90% @ 5.4 miles	13' High Levee
Right Bank Mokelumne River (Non-SPFC Levee Segment – 2.9 miles)	1050	T + U + S	60% @ 1.7 miles	20' High Levee 100' Wide Combination Berm 19' High Drained Stability Berm 45' Deep Slurry Wall
		E	10% @ 0.3 miles	20' High Levee
		FG	10% @ 0.3 miles	20' High Levee Geometry Deficiency Only
Right Bank San Joaquin River (Non-SPFC Levee Segment – 2.6 miles)	1049	U + S	30% @ 0.8 miles	20' High Levee 19' High Drained Stability Berm 70' Deep Slurry Wall
		T + U + S	30% @ 0.8 miles	20' High Levee

Levee Segment Location	NULE Segment	Hazard Remediated	Extent (% of Total Segment Length)	Remedial Alternatives
				19' High Drained Stability Berm 70' Deep Slurry Wall
		U + S	30% @ 0.8 miles	20' High Levee 100' Wide Combination Berm 19' High Drained Stability Berm 70' Deep Slurry Wall
Right Bank San Joaquin River (Non-SPFC Levee Segment – 2.6 miles)	1049	U + S	10% @ 0.3 miles	14' High Levee 13' High Drained Stability Berm 70' Deep Slurry Wall
		E	10% @ 0.3 miles	20' High Levee
		FG	15% @ 0.4 miles	20' High Levee Geometry Deficiency Only
Left Bank Sevenmile Slough (Non-SPFC Levee Segment – 4.6 miles)	1048	T + U + S	40% @ 1.2 miles	27' High Levee 26' High Drained Stability Berm 162' Wide Combination Berm 70' Deep Slurry Wall
		U + S	30% @ 0.9 miles	27' High Levee 26' High Drained Stability Berm 162' Wide Combination Berm 70' Deep Slurry Wall
		T	30% @ 0.9 miles	27' High Levee 26' High Drained Stability Berm 20' Deep Slurry Wall
		FG	55% @ 1.6 miles	27' High Levee Geometry Deficiency Only

T = Through Seepage, U = Underseepage, S = Slope Stability, E = Erosion, FG = Freeboard and/or Geometry

Cost estimates for these remediations were developed by DWR as developed in the RACER. This range of cost estimates were escalated to July 2020 dollars using an ENR cost ratio of 1.26 and a total cost per mile for each levee reach was calculated using the total length of each reach (**Error! Reference source not found.**).

**Table 3: DWR RACER Costs Escalated to 2020 Dollars**

Hazard Remediated	Extent*	Alternative Remediations Considered					Range of Costs	
		Drained Stability Berm	Seepage Berm	Combo Berm	Slurry Wall	Drained Stability Berm and Slurry Wall	Low Cost	High Cost
<b><i>Left Bank of the Sacramento River (NULE Segment 378) Remediation Costs</i></b>								
T	10%	\$7,934,000	-	-	\$10,734,000	-	\$7,934,000	\$10,734,000
S	30%	\$13,745,000	-	-	-	-	\$13,745,000	\$13,745,000
T	20%	\$8,724,000	-	-	-	-	\$8,724,000	\$8,724,000
E	20%	N/A	N/A	N/A	N/A	N/A	\$18,693,000	\$18,693,000
<b>Total Segment 378 Cost (11.6 miles) - 2011 RACER</b>							\$49,096,000	\$51,896,000
<b>Total Segment 378 Cost (11.6 miles) - Escalated to July 2020</b>							<b>\$61,921,000</b>	<b>\$65,453,000</b>
<b>Cost per Mile</b>							<b>\$5,347,000</b>	<b>\$5,652,000</b>
<b><i>Right Bank of Georgiana Slough (NULE Segment 40) Remediation Costs</i></b>								
T+U	10%	-	-	\$5,029,000	\$7,900,000	-	\$5,029,000	\$7,900,000
U	5%	-	\$2,492,000	-	\$3,950,000	-	\$2,492,000	\$3,950,000
T+U	15%	-	-	\$8,393,000	\$11,850,000	-	\$8,393,000	\$11,850,000
T+U+S	30%	\$13,410,000	-	-	\$26,327,000	-	\$13,410,000	\$26,327,000
T+U+S	30%	-	-	\$15,928,000	\$23,701,000	-	\$15,928,000	\$23,701,000
FG	90%	N/A	N/A	N/A	N/A	N/A	\$11,182,000	\$11,182,000
<b>Total Segment 40 Cost (6.0 miles) - 2011 RACER</b>							\$56,434,000	\$84,910,000
<b>Total Segment 40 Cost (6.0 miles) - Escalated to July 2020</b>							<b>\$71,176,000</b>	<b>\$107,091,000</b>
<b>Cost per Mile</b>							<b>\$11,819,000</b>	<b>\$17,782,000</b>
<b><i>Right Bank of the Mokelumne River (NULE Segment 1050) Remediation Costs</i></b>								
T+U+S	60%	-	-	\$24,179,000	-	\$36,469,000	\$24,179,000	\$36,469,000
E	10%	-	-	-	-	-	\$3,428,000	\$3,428,000
FG	10%	-	-	-	-	-	\$444,000	\$444,000
<b>Total Segment 1050 Cost (2.9 miles) - 2011 RACER</b>							\$28,051,000	\$40,341,000
<b>Total Segment 1050 Cost (2.9 miles) - Escalated to July 2020</b>							<b>\$35,379,000</b>	<b>\$50,879,000</b>
<b>Cost per Mile</b>							<b>\$12,200,000</b>	<b>\$17,544,000</b>

Hazard Remediated	Extent*	Alternative Remediations Considered					Range of Costs	
		Drained Stability Berm	Seepage Berm	Combo Berm	Slurry Wall	Drained Stability Berm and Slurry Wall	Low Cost	High Cost
<b><i>Right Bank of the San Joaquin River (NULE Segment 1049) Remediation Costs</i></b>								
U+S	30%	\$7,375,000	-	-	\$15,436,000	-	\$7,375,000	\$15,436,000
T+U+S	30%	\$7,375,000	-	-	\$15,436,000	-	\$7,375,000	\$15,436,000
U+S	30%	-	-	\$9,440,000	-	\$19,096,000	\$9,440,000	\$19,096,000
U+S	10%	\$1,683,000	-	-	\$4,382,000	-	\$1,683,000	\$4,382,000
E	10%	NA	-	NA	NA	NA	\$3,099,000	\$3,099,000
FG	15%	NA	-	NA	NA	NA	\$779,000	\$779,000
<b>Total Segment 1049 Cost (2.6 miles) - 2011 RACER</b>							\$29,751,000	\$58,228,000
<b>Total Segment 1049 Cost (2.6 miles) - Escalated to July 2020</b>							<b>\$37,523,000</b>	<b>\$73,439,000</b>
<b>Cost per Mile</b>							<b>\$14,432,000</b>	<b>\$28,246,000</b>
<b><i>Left Bank of Sevenmile Slough (NULE Segment 1048) Remediation Costs</i></b>								
T+U+S	40%	-	-	\$34,471,000	-	\$53,466,000	\$34,471,000	\$53,466,000
U+S	30%	-	-	\$25,853,000	-	\$40,100,000	\$25,853,000	\$40,100,000
T	30%	\$11,210,000	-	-	\$17,530,000	-	\$11,210,000	\$17,530,000
FG	55%	NA	-	NA	NA	NA	\$4,051,000	\$4,051,000
<b>Total Segment 1048 Cost (4.6 miles) - 2011 RACER</b>							\$75,585,000	\$115,147,000
<b>Total Segment 1048 Cost (4.6 miles) - Escalated to July 2020</b>							<b>\$95,330,000</b>	<b>\$145,226,000</b>
<b>Cost per Mile</b>							<b>\$20,864,000</b>	<b>\$31,784,000</b>

The range of costs for repairing and strengthening the right banks of the Mokelumne River and the San Joaquin River (NULE 1050 and 1049, respectively) and the left bank of Sevenmile Slough (NULE 1048) is provided above in Table 3.

The range of costs associated with repairing and strengthening various portions of the left bank of the Sacramento River - Management Action 4(MA 4) and the right bank of Georgiana Slough (MA 5) was estimated using the length for each reach and the total cost per mile provided in **Error! Reference source not found.** (Table 4).

**Table 4: Cost Summary for MA 4 and MA 5**

MA	NULE Segment	Segment Length (miles)	Cost per Mile (Low)	Cost per Mile (High)	Total Cost (Low)	Total Cost (High)
4B	378 Sac River Left Bank	4.2	\$5,347,000	\$5,652,000	\$22,457,000	\$23,738,000
4C		2.4			\$12,833,000	\$13,565,000
4D		2.3			\$12,298,000	\$13,000,000
5B	40 Georgiana Slough Right Bank	1.6	\$11,819,000	\$17,782,000	\$18,910,000	\$28,451,000
5C		1.9			\$22,456,000	\$33,786,000
5D		1.9			\$22,456,000	\$33,786,000
5E		2.2			\$26,002,000	\$39,120,000

### **3.2. Additional Remediations and Improvements**

Repair and strengthen-in-place levee improvements for the 1.6-mile-long portion of NULE Segment 378 along the left bank of the Sacramento River adjacent to the community of Isleton and the 1.9-mile-long portion of NULE Segment 40 located along the right bank of Georgiana Slough opposite the community of Isleton are identified and defined in the Geotechnical Data and Assessment Report – Delta Small Communities Flood Risk Reduction Program – Community of Isleton TM (Appendix A). Each sub-reach has deficiencies related to through seepage, underseepage, or geometry and can be remediated by either a cutoff wall alternative, a berm alternative, or levee raise to address geometry concerns. A description of the repair and strengthen-in-place remediations is included in the following sections and summarized in Table 5.

**Table 5: Summary of Remedial Alternatives to Address Through Seepage, Underseepage, and Geometry Deficiencies on the SPFC Levee Segments Immediately Adjacent to and Opposite the Community of Isleton**

NULE Alignment ID	NULE Segment	Reach Length (ft.)	Remediation Alternative 1 Dimensions	Remediation Alternative 2 Dimensions	Vulnerability		Freeboard (% Deficient)
					Underseepage	Through Seepage	
SACR-L	378-A	1,250	30 ft. deep cutoff wall	9 ft. tall, 65 ft. wide combination seepage and stability berm (combo berm)	X	X	5%
SACR-L	378-A	500	30 ft. deep cutoff wall 0.5 ft. levee raise*	9 ft. tall, 65 ft. wide combo berm 0.5 ft. levee raise*	X	X	
SACR-L	378-A	6,750	30 ft. deep cutoff wall	9 ft. tall, 65 ft. wide combo berm	X	X	
ILNCL	RD556-A	300	20 ft. deep cutoff wall	15 ft. wide, 23 ft. tall stability berm	-	X	90%
ILNCL	RD556-A	2,200	20 ft. deep cutoff wall 8.0 ft. levee raise*	15 ft. wide, 23 ft. tall stability berm 8.0 ft. levee raise*	-	X	
GGASR-R	40-A	10,000	75 ft. deep cutoff wall 1.5 ft. levee raise*	13 ft. tall, 70 ft. wide combo berm 1.5 ft. levee raise*	X	X	100%

Notes:

- 1) \* To address geometry deficiencies
- 2) Wall depths and berm widths rounded up to the nearest 5 ft. dimension and stability berm heights rounded to the nearest 1 ft. dimension
- 3) Reach lengths rounded to the nearest 100 feet



### 3.2.1. Levee Improvement Berms

As shown in Table 5, berm remediations for a given reach can include a stability berm, or a combo berm which incorporates elements of a stability and seepage berm. Typical details for a drained stability berm and a combo berm are shown in

Figure 1 and

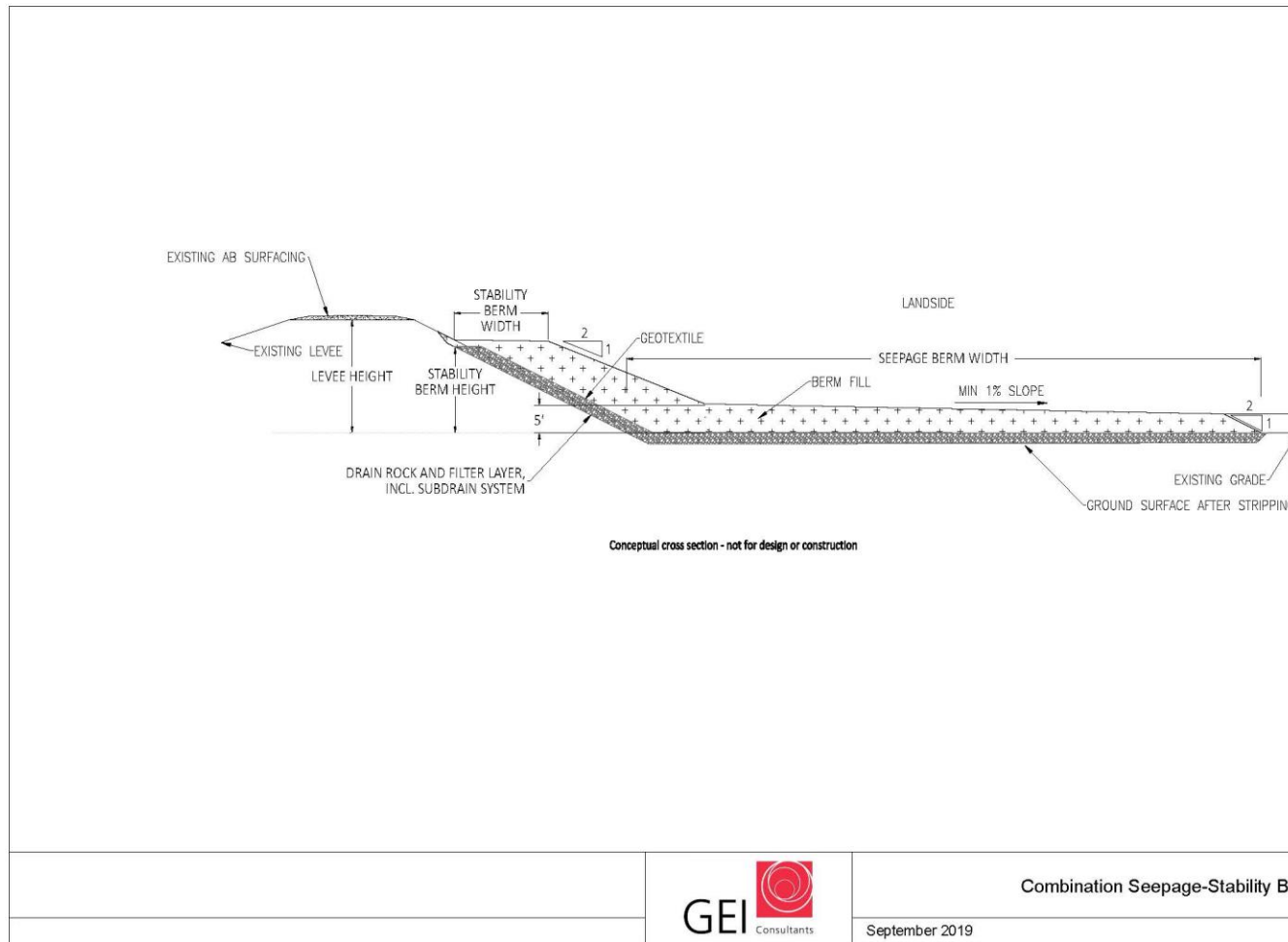
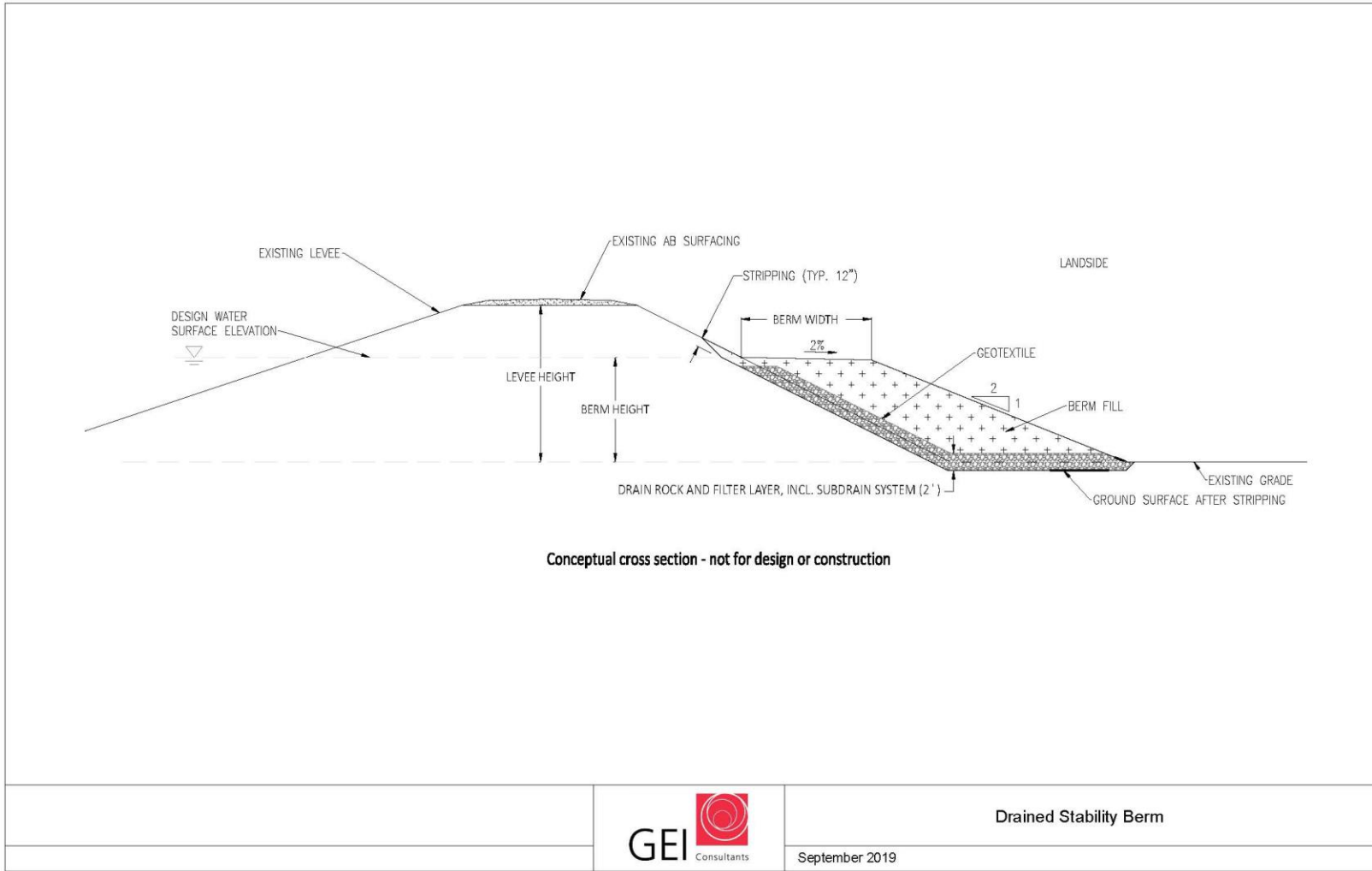
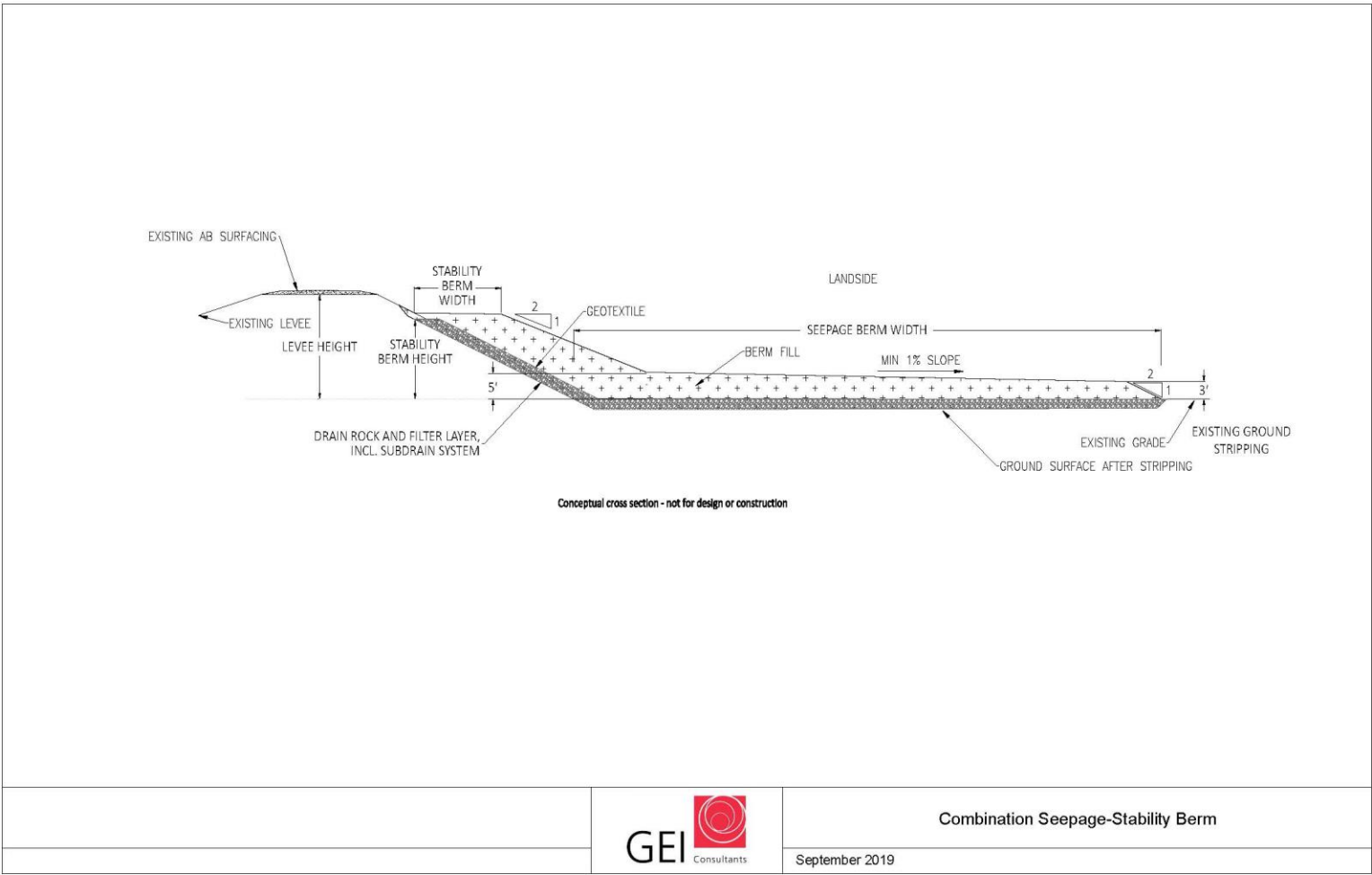


Figure 2, respectively. A summary of the construction activities for each reach is provided in Table 6. A summary of the total cost estimate for the berm alternatives is provided in Table 7.



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



**Figure 2: Combination Seepage and Stability Berm Conceptual Schematic**

**Table 6: 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
							AC	\$/AC		
Cost per unit		\$8,342.74	\$7,489.52	\$77.50	\$16.68	\$4,692.56				
Units		AC	AC	CY	CY	AC	AC	\$/AC		
SACR-L 378-A	Combo	2.9	2.4	6,166	12,623	2.7	3.8	\$180,000	<b>\$744,000</b>	<b>\$686,000</b>
SACR-L 378-A	Combo	1.2	1.0	2,466	5,049	1.1	1.5	\$240,000	<b>\$314,000</b>	<b>\$366,000</b>
SACR-L 378-A	Combo	15.8	13.1	33,295	68,163	14.8	20.6	\$160,700	<b>\$4,017,000</b>	<b>\$3,307,000</b>
ILNCL RD556-A	Stability	0.5	0.4	1,024	2,542	0.5	0.1	\$25,000	<b>\$132,000</b>	<b>\$3,000</b>
ILNCL RD556-A	Stability	4.4	3.9	9,001	22,336	4.4	1.0	\$25,000	<b>\$1,521,000</b>	<b>\$26,000</b>
GGAS-R 40-A	Combo	32.3	27.1	69,701	147,889	29.6	38.8	\$32,750	<b>\$8,881,000</b>	<b>\$1,271,000</b>
<b>Totals</b>		<b>57.1</b>	<b>47.9</b>	<b>121,652</b>	<b>258,601</b>	<b>53.1</b>	<b>65.9</b>	<b>663,450</b>	<b>\$15,609,000</b>	<b>\$5,659,000</b>

**Table 7: 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 378-A			\$744,000	\$744,000					\$521,000	\$723,000	\$596,000	\$686,000	\$3,270,000
SACR-L 378-A			\$314,000	\$314,000			2	\$150,000	\$220,000	\$359,000	\$268,000	\$366,000	\$1,677,000
SACR-L 378-A			\$4,017,000	\$4,017,000	2	\$500,000	1	\$75,000	\$2,812,000	\$4,112,000	\$3,282,000	\$3,307,000	\$18,105,000
ILNCL RD556-A	\$132,000			\$132,000	1	\$250,000			\$92,000	\$218,000	\$133,000	\$3,000	\$828,000
ILNCL RD556-A	\$1,521,000			\$1,521,000					\$1,065,000	\$1,479,000	\$1,220,000	\$26,000	\$6,832,000
GGAS-R 40-A			\$8,881,000	\$8,881,000	4	\$1,000,000	2	\$150,000	\$6,217,000	\$9,046,000	\$7,243,000	\$1,271,000	\$33,808,000
<b>Repair Type Totals</b>	<b>\$1,653,000</b>		<b>\$13,956,000</b>	<b>\$15,609,000</b>	<b>7</b>	<b>\$1,750,000</b>	<b>5</b>	<b>\$375,000</b>	<b>\$10,927,000</b>	<b>\$15,937,000</b>	<b>\$12,742,000</b>	<b>\$5,659,000</b>	<b>\$64,520,000</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

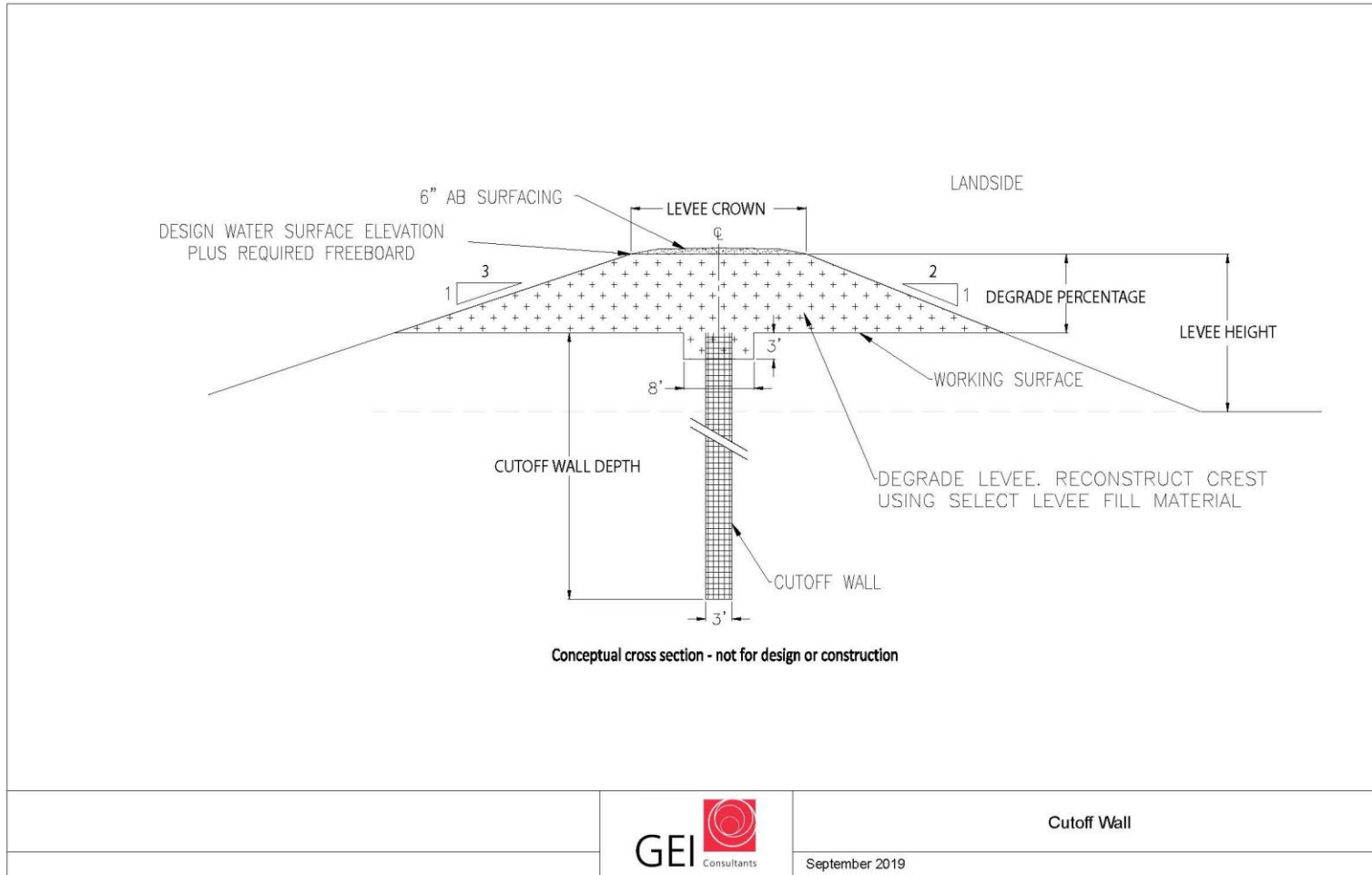
### 3.2.2. Levee Improvement Cutoff Walls

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 wide paved roads assume a maximum 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 Data and 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 the Sacramento River and Georgiana Slough levees would result in disruption of traffic along Highway 160 and Oxbow Marina Drive. 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 3. A summary of the construction activities for each reach is provided in Table 8. A summary of the total cost estimate for the cutoff wall alternatives is provided in

Table 9.



**Figure 3: Cutoff Wall Conceptual Schematic**



**Table 8: Levee Improvement Cutoff Wall Base Construction Quantities**

Location Description	Wall Depth	Degrade Volume	Remove AC	Disposal Volume	Wall Area	Wall Cost/sqft	Levee Rebuild	Temporary Roadway				Aggregate Base Levee Crown	New Roadway AC	Hydroseeding	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		
SACR-L 378-A	30 ft	15,451	2,778	15,451	38,394	\$8.93	11,281	5.9	5.9	463	2,778	556	2,778	0.4	0.7	\$180,000	\$1,258,000	\$129,000
SACR-L 378-A	30 ft	6,181	1,111	6,181	15,358	\$8.93	5,038	2.4	2.4	185	1,111	222	1,111	0.1	0.3	\$240,000	\$517,000	\$69,000
SACR-L 378-A	30 ft	83,438	18,000	83,438	207,326	\$8.93	60,915	37.1	37.1	3,000	18,000	3,000	18,000	1.9	4.5	\$160,700	\$7,127,000	\$722,000
ILNCL RD556-A	20 ft	3,813		3,813	5,000	\$8.93	3,938					111		0.2			\$221,000	
ILNCL RD556-A	20 ft	33,504		33,504	47,236	\$8.93	65,361					976		1.3			\$2,792,000	
GGAS-R 40-A	75 ft	75,134	26,667	75,134	909,240	\$10.29	101,568	56.8	56.8	4,444	26,667	5,333	26,667	4.5	6.9	\$32,750	\$16,736,000	\$226,000
<b>Totals</b>		<b>217,520</b>	<b>48,556</b>	<b>217,520</b>	<b>1,222,553</b>	<b>-</b>	<b>248,100</b>	<b>102</b>	<b>102</b>	<b>8,093</b>	<b>48,556</b>	<b>10,199</b>	<b>48,556</b>	<b>8</b>	<b>12</b>	<b>-</b>	<b>\$28,651,000</b>	<b>\$1,146,000</b>

**Table 9: Cutoff Wall Reach Cost Summary**

Location Description	Stationing		Length <sup>1</sup>	Cutoff Wall	Other Construction Costs*	Other Owner Costs**	Construction Contingency***	Right of Way	Reach Total
	From	To	(Feet)				30%		
SACR-L 378-A	1975+00	1987+50	1,250	\$1,258,000	<b>\$440,000</b>	<b>\$611,000</b>	<b>\$693,000</b>	<b>\$129,000</b>	<b>\$3,131,000</b>
SACR-L 378-A	1987+50	1992+50	500	\$517,000	<b>\$181,000</b>	<b>\$251,000</b>	<b>\$285,000</b>	<b>\$69,000</b>	<b>\$1,303,000</b>
SACR-L 378-A	1992+50	2060+00	6,750	\$7,127,000	<b>\$2,494,000</b>	<b>\$3,464,000</b>	<b>\$3,926,000</b>	<b>\$722,000</b>	<b>\$17,733,000</b>
ILNCL RD556-A		2+50	250	\$221,000	<b>\$77,000</b>	<b>\$107,000</b>	<b>\$122,000</b>		<b>\$527,000</b>
ILNCL RD556-A	2+50	24+47	2,197	\$2,792,000	<b>\$977,000</b>	<b>\$1,357,000</b>	<b>\$1,538,000</b>		<b>\$6,664,000</b>
GGAS-R 40-A	1100+00	1220+00	12,000	\$16,736,000	<b>\$5,858,000</b>	<b>\$8,134,000</b>	<b>\$9,218,000</b>	<b>\$226,000</b>	<b>\$40,172,000</b>
<b>Repair Type Totals</b>			<b>22,947</b>	<b>\$28,651,000</b>	<b>\$10,027,000</b>	<b>\$13,924,000</b>	<b>\$15,782,000</b>	<b>\$1,146,000</b>	<b>\$69,530,000</b>

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

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

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

#### 4. All-Weather Access Road/Flood Fight Berm

Construction of an all-weather access road/flood fight berm would prevent floodwaters originating upstream within BALMD or other upstream RDs or downstream within the greater BALMD basin from entering the community of Isleton, allowing additional time for evacuation.

An all-weather access road and flood fight berm is essentially a slightly elevated all-weather roadway 20 ft. wide to accommodate the temporary placement of interlocking 4 to 8 ft.-high Muscle Wall during flood fight conditions. The height of the flood fight berm varies based on the existing ground elevation and the height of Muscle Wall to be installed. With the installation of the 4ft.-high Muscle Wall, the effective elevation of the berm plus wall is at 10 ft North American Vertical Datum of 1988 (NAVD 88). Additional refinement of the flood fight berm is needed including an assessment of the time needed to deploy the Muscle Wall in inclement weather and development of an Emergency Action Plan.

The dimensions for the flood fight berm are summarized in Table 10 below. The cost estimate for the flood fight berm is included in Table 11.

**Table 10: Flood Fight Berm Dimensions**

Crown Width	20 ft.
Landside Slope	3:1
Waterside Slope	3:1
Maximum Crown Elevation	10 ft.

**Table 11: All-Weather Access Road/Flood Fight Berm Cost Summary**

**Isleton Ring Berm Cost Estimate**

**Cost Summary (July 2020 Costs)**

Berm length = 8,100 ft, Maximum Crest Elevation @ 10.0 NAVD 88,  
Average levee height = 3.7 ft, Crest 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	11	\$8,342.74	\$96,000
<i>Stripping</i>	CY	10,860	\$7.67	\$83,000
<i>Proof Compacting</i>	AC	11	\$1,382.62	\$16,000
<i>Inspection Trench - Excavation</i>	CY	27,600	\$6.86	\$189,000
<i>Levee Embankment - Select Levee Fill</i>	CY	69,787	\$26.70	\$1,864,000
<i>Aggregate Base (Crown + LS Maint Rd)</i>	CY	3,067	\$54.90	\$168,000
<i>Hydroseeding</i>	AC	9	\$4,692.56	\$40,000
<b>Major Construction Items =</b>				<b>\$2,460,000</b>
<b>Other Construction Costs*</b>				
Unallocated Items in Construction Costs			15%	\$369,000
Mobilization and Demobilization			5%	\$123,000
<b>Other Construction Costs =</b>				<b>\$490,000</b>
<b>Construction Total =</b>				<b>\$2,950,000</b>
<b>Other Owner Costs**</b>				
Environmental Documentation and Permitting			10%	\$295,000
Design and Engineering Costs			15%	\$442,500
Legal Costs			2%	\$59,000
Engineering during Construction			2%	\$59,000
Construction Management			15%	\$442,500
<b>Other Owner Costs Subtotal =</b>				<b>\$1,300,000</b>
<b>Right-of-Way</b>				
<i>Permanent Right-of-Way (fee Title)</i>	AC	11.5	\$25,000.00	\$287,000
<b>Total Project Baseline Cost =</b>				<b>\$4,540,000</b>
<b>Contingency*** 30%</b>				<b>\$1,361,000</b>
<b>Expected Project Cost =</b>				<b>\$5,898,000</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 Other Owners Costs

## 5. Cross Levee North of Fertile Acres

A 0.65-mile-long cross levee extending from River Road northeast of the community of Isleton through BALMD to the levee along the right bank of Georgiana Slough could be paired with levee repairs and improvements along the Sacramento River and Georgiana Slough. The dimensions for the cross levee are summarized in Table 12 below. Utilizing these dimensions, construction quantities were calculated based on the existing ground elevations along the proposed cross levee alignment and 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 north of Fertile Acres. The cost summary for a cross levee north of Fertile Acres is summarized in Table 13.

**Table 12: Dimensions for Potential Cross Levee North of Fertile Acres**

Crown Width	20 ft.
Landside Slope	3:1
Waterside Slope	3:1
Crest Elevation	16 ft. NAVD 88

**Table 13: Cross Levee North of Fertile Acres Cost Summary**

**Cross Levee North of Fertile Acres Cost Estimate  
Cost Summary (July 2020 Costs)**

Levee length = 3,400 ft, Crest Elevation @ 19.0, Average levee height = 20.0 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	13.0	\$8,342.74	\$109,000
<i>Stripping</i>	CY	17,323	\$7.67	\$133,000
<i>Proof Compacting</i>	AC	13.0	\$1,382.62	\$18,000
<i>Inspection Trench - Excavation</i>	CY	13,267	\$6.86	\$91,000
<i>Levee Embankment - Select Levee Fill</i>	CY	236,484	\$26.70	\$6,315,000
<i>Aggregate Base (Crown + LS Maint Rd)</i>	CY	1,474	\$54.90	\$81,000
<i>Hydroseeding</i>	AC	12.0	\$4,692.56	\$56,000
<b>Major Construction Items Subtotal =</b>				<b>\$6,803,000</b>
<b>Other Construction Costs*</b>				
Unallocated Items in Construction Costs			15%	\$1,020,000
Mobilization and Demobilization			5%	\$340,000
<b>Other Construction Costs Subtotal =</b>				<b>\$1,360,000</b>
<b>Construction Total =</b>				<b>\$8,163,000</b>
<b>Other Owner Costs**</b>				
Environmental Documentation and Permitting			10%	\$816,300
Design and Engineering Costs			15%	\$1,224,450
Legal Costs			2%	\$163,260
Engineering during Construction			2%	\$163,260
Construction Management			15%	\$1,224,450
<b>Other Owner Costs Subtotal =</b>				<b>\$3,590,000</b>
<b>Right-of-Way</b>				
<i>Permanent Right-of-Way (fee Title)- Agricultural</i>	AC	13.0	\$40,000.00	\$520,860
<b>Total Project Baseline Cost =</b>				<b>\$12,273,000</b>
<b>Contingency*** 30%</b>				<b>\$3,681,900</b>
<b>Expected Project Cost =</b>				<b>\$15,950,000</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 Other Owners Costs

## 6. Isleton/Oxbow Marina Cross Levee

A 2.0-mile-long cross levee extending from River Road northeast of the community of Isleton through BALMD to the levee along the right bank of Georgiana Slough could be paired with levee repairs and improvements along the Sacramento River and Georgiana Slough. The dimensions for the cross levee are summarized in Table 14 below. Utilizing these dimensions, construction quantities were calculated based on the existing ground elevations along the potential cross levee alignment and 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 potential Isleton/Oxbow Marina cross levee. The cost summary for the Isleton/Oxbow Marina cross levee is summarized in Table 15.

**Table 14: Dimensions for the Isleton/Oxbow Marina Cross Levee**

Crown Width	20 ft.
Landside Slope	3:1
Waterside Slope	3:1
Crest Elevation	13 ft. NAVD 88

**Table 15: Isleton/Oxbow Marina Cross Levee Cost Summary**

**Isleton/Oxbow Marina Cross Levee Cost Estimate  
Cost Summary (July 2020 Costs)**

Levee length = 10,800 ft, Crest Elevation @ 13.0, Average levee height = 18.0 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	34.8	\$8,342.74	\$290,000
<i>Stripping</i>	CY	45,422	\$7.67	\$348,000
<i>Proof Compacting</i>	AC	34.8	\$1,382.62	\$48,000
<i>Inspection Trench - Excavation</i>	CY	38,400	\$6.86	\$264,000
<i>Levee Embankment - Select Levee Fill</i>	CY	577,883	\$26.70	\$15,431,000
<i>Aggregate Base (Crown + LS Maint Rd)</i>	CY	4,267	\$54.90	\$234,000
<i>Hydroseeding</i>	AC	31.6	\$4,692.56	\$148,000
<b>Major Construction Items Subtotal =</b>				<b>\$16,763,000</b>
<b>Other Construction Costs*</b>				
Unallocated Items in Construction Costs			15%	\$2,514,000
Mobilization and Demobilization			5%	\$838,000
<b>Other Construction Costs Subtotal =</b>				<b>\$3,350,000</b>
<b>Construction Total =</b>				<b>\$20,113,000</b>
<b>Other Owner Costs**</b>				
Environmental Documentation and Permitting			10%	\$2,011,300
Design and Engineering Costs			15%	\$3,016,950
Legal Costs			2%	\$402,260
Engineering during Construction			2%	\$402,260
Construction Management			15%	\$3,016,950
<b>Other Owner Costs Subtotal =</b>				<b>\$8,850,000</b>
<b>Right-of-Way</b>				
<i>Permanent Right-of-Way (fee Title)- Agricultural</i>	AC	34.8	\$40,000.00	\$1,390,640
<b>Total Project Baseline Cost =</b>				<b>\$30,353,000</b>
<b>Contingency*** 30%</b>				<b>\$9,105,900</b>
<b>Expected Project Cost =</b>				<b>\$39,460,000</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 Other Owners Costs



## 7. Cross Levee at Jackson Slough Road and Terminous Road

A potential 1.8-mile-long cross levee extending from State Hwy Route 160 northwest of the community of Isleton extending easterly through BALMD to the levee along the right bank of Georgiana Slough could be paired with levee repairs and improvements along the Sacramento River and Georgiana Slough. The dimensions for the cross levee are summarized in Table 16 below. Utilizing these dimensions, construction quantities were calculated based on the existing ground elevations along the proposed cross levee alignment and 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 a potential cross levee at Jackson Slough Road and Terminous Road. The cost summary for the cross levee at Jackson Slough Road and Terminous Road is summarized in Table 17.

**Table 16: Dimensions for the Cross Levee at Jackson Slough Road and Terminous Road**

Crown Width	20 ft.(minimum)
Landside Slope	3:1
Waterside Slope	3:1
Crest Elevation	13 ft. NAVD 88

**Table 17: Cross Levee at Jackson Slough Road and Terminous Road Cost Summary**

**Cross Levee at Jackson Slough Road and Terminous Road Cost Estimate  
Cost Summary (July 2020 Costs)**

Levee length = 9,500 ft, Crest Elevation @ 13.0, Average levee height = 19.6 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	36.2	\$8,342.74	\$302,000
<i>Stripping</i>	CY	47,972	\$7.67	\$368,000
<i>Proof Compacting</i>	AC	36.2	\$1,382.62	\$50,000
<i>Inspection Trench - Excavation</i>	CY	37,465	\$6.86	\$257,000
<i>Levee Embankment - Select Levee Fill</i>	CY	645,471	\$26.70	\$17,236,000
<i>Aggregate Base (Crown + LS Maint Rd)</i>	CY	4,163	\$54.90	\$229,000
<i>Hydroseeding</i>	AC	33.3	\$4,692.56	\$156,000
<b>Major Construction Items Subtotal =</b>				<b>\$18,598,000</b>
<b>Other Construction Costs*</b>				
Unallocated Items in Construction Costs			15%	\$2,790,000
Mobilization and Demobilization			5%	\$930,000
<b>Other Construction Costs Subtotal =</b>				<b>\$3,720,000</b>
<b>Construction Total =</b>				<b>\$22,318,000</b>
<b>Other Owner Costs**</b>				
Environmental Documentation and Permitting			10%	\$2,231,800
Design and Engineering Costs			15%	\$3,347,700
Legal Costs			2%	\$446,360
Engineering during Construction			2%	\$446,360
Construction Management			15%	\$3,347,700
<b>Other Owner Costs Subtotal =</b>				<b>\$9,820,000</b>
<b>Right-of-Way</b>				
<i>Permanent Right-of-Way (fee Title)- Agricultural</i>	AC	36.2	\$40,000.00	\$1,447,407
<b>Total Project Baseline Cost =</b>				<b>\$33,588,000</b>
<b>Contingency*** 30%</b>				<b>\$10,076,400</b>
<b>Expected Project Cost =</b>				<b>\$43,660,000</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 Other Owners Costs

## 8. City of Isleton Sphere of Influence Cross Levee System

A cross levee system which closely coincides with the City of Isleton’s proposed sphere of influence could be paired with levee repairs and improvements along the Sacramento River and Georgiana Slough. The cross levee system is comprised of two cross levees: 1) a 0.60-mile-long cross levee approximately 0.40 miles northeast of the cross levee north of Fertile Acres (cross levee north of Isleton Bridge), and 2) a 2.0-mile-long cross levee similar to the cross levee at Jackson Slough Road and Terminous Road which begins at the left bank of the Sacramento River and terminates at the right bank of Georgiana Slough (City’s Southwest Sphere of Influence Line). The dimensions for the two cross levees are summarized in Table 18 below. Utilizing these dimensions, construction quantities were calculated based on the existing ground elevations along the proposed cross levee alignments and 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 levee system. The cost summaries for the cross levee north of Isleton Bridge and the City of Isleton’s Southwest Sphere of Influence Line are summarized in Table 19 and Table 20, respectively.

**Table 18: Dimensions for the Cross Levees North of Isleton Bridge at the City’s Northeast Sphere of Influence Line and the City’s Southwest Sphere of Influence Line**

Crown Width	20 ft. (minimum)
Landside Slope	3:1
Waterside Slope	3:1
Crest Elevation	13-19 ft. NAVD 88

**Table 19: Cost Summary of Cross Levee North of Isleton Bridge at City's Northeast Sphere of Influence Line)**

**Cost Summary of Cross Levee North of Isleton Bridge at City's Northeast Sphere of Influence Line  
Cost Summary (July 2020 Costs)**

Levee length = 3,200 ft, Crest Elevation @ 19.0, Average levee height = 20.0 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	12.1	\$8,342.74	\$101,000
<i>Stripping</i>	CY	16,188	\$7.67	\$124,000
<i>Proof Compacting</i>	AC	12.1	\$1,382.62	\$17,000
<i>Inspection Trench - Excavation</i>	CY	12,244	\$6.86	\$84,000
<i>Levee Embankment - Select Levee Fill</i>	CY	222,604	\$26.70	\$5,944,000
<i>Aggregate Base (Crown + LS Maint Rd)</i>	CY	1,360	\$54.90	\$75,000
<i>Hydroseeding</i>	AC	11.2	\$4,692.56	\$53,000
<b>Major Construction Items Subtotal =</b>				<b>\$6,398,000</b>
<b>Other Construction Costs*</b>				
Unallocated Items in Construction Costs			15%	\$960,000
Mobilization and Demobilization			5%	\$320,000
<b>Other Construction Costs Subtotal =</b>				<b>\$1,280,000</b>
<b>Construction Total =</b>				<b>\$7,678,000</b>
<b>Other Owner Costs**</b>				
Environmental Documentation and Permitting			10%	\$767,800
Design and Engineering Costs			15%	\$1,151,700
Legal Costs			2%	\$153,560
Engineering during Construction			2%	\$153,560
Construction Management			15%	\$1,151,700
<b>Other Owner Costs Subtotal =</b>				<b>\$3,380,000</b>
<b>Right-of-Way</b>				
<i>Permanent Right-of-Way (fee Title)- Agricultural</i>	AC	36.2	\$40,000.00	\$1,447,407
<b>Total Project Baseline Cost =</b>				<b>\$12,508,000</b>
<b>Contingency*** 30%</b>				<b>\$3,752,400</b>
<b>Expected Project Cost =</b>				<b>\$16,260,000</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 Other Owners Costs

**Table 20: Cost Summary of Cross Levee at City's Southwest Sphere of Influence Line**

**Cost Estimate of Cross Levee at City's Southwest Sphere of Influence Line  
Cost Summary (July 2020 Costs)**

Levee length = 10,600 ft, Crest Elevation @ 13.0, Average levee height = 20.7 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	42.1	\$8,342.74	\$351,000
<i>Stripping</i>	CY	56,245	\$7.67	\$431,000
<i>Proof Compacting</i>	AC	42.1	\$1,382.62	\$58,000
<i>Inspection Trench - Excavation</i>	CY	42,105	\$6.86	\$289,000
<i>Levee Embankment - Select Levee Fill</i>	CY	788,402	\$26.70	\$21,053,000
<i>Aggregate Base (Crown + LS Maint Rd)</i>	CY	4,678	\$54.90	\$257,000
<i>Hydroseeding</i>	AC	38.9	\$4,692.56	\$183,000
<b>Major Construction Items Subtotal =</b>				<b>\$22,622,000</b>
<b>Other Construction Costs*</b>				
Unallocated Items in Construction Costs			15%	\$3,393,000
Mobilization and Demobilization			5%	\$1,131,000
<b>Other Construction Costs Subtotal =</b>				<b>\$4,520,000</b>
<b>Construction Total =</b>				<b>\$27,142,000</b>
<b>Other Owner Costs**</b>				
Environmental Documentation and Permitting			10%	\$2,714,200
Design and Engineering Costs			15%	\$4,071,300
Legal Costs			2%	\$542,840
Engineering during Construction			2%	\$542,840
Construction Management			15%	\$4,071,300
<b>Other Owner Costs Subtotal =</b>				<b>\$11,940,000</b>
<b>Right-of-Way</b>				
<i>Permanent Right-of-Way (fee Title)- Agricultural</i>	AC	36.2	\$40,000.00	\$1,447,407
<b>Total Project Baseline Cost =</b>				<b>\$40,532,000</b>
<b>Contingency*** 30%</b>				<b>\$12,159,600</b>
<b>Expected Project Cost =</b>				<b>\$52,690,000</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 Other Owners Costs

## 9. State Highway 12 Cross Levee

A potential 5.7-mile-long cross levee along Highway 12 could be paired in conjunction with levee repairs and improvements along the Sacramento River and Georgiana Slough to protect the City and areas north of Highway 12 from levee breaches occurring within BALMD south of State Highway 12. The dimensions for the cross levee are summarized in Table 21 below. Utilizing these dimensions, construction quantities were calculated based on the existing ground elevations along the proposed cross levee alignment and 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 Potential State Highway 12 cross levee. The cost summary for the State Highway 12 cross levee is summarized in Table 22.

**Table 21. Highway 12 Cross Levee Dimensions**

Crown Width with Hwy 12	36 ft.(minimum)
Landside Slope	3:1
Waterside Slope	3:1
Crest Elevation	13 ft. NAVD 88

**Table 22: State Highway 12 Cross Levee Cost Summary**

**State Highway 12 Cross Levee Cost Estimate  
Cost Summary (July 2020 Costs)**

Levee length = 30,000 ft, Crest Elevation @ 13.0, Average levee height = 22.1 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	132.5	\$8,342.74	\$1,106,000
<i>Stripping</i>	CY	181,598	\$7.67	\$1,392,000
<i>Proof Compacting</i>	AC	132.5	\$1,382.62	\$183,000
<i>Inspection Trench - Excavation</i>	CY	116,000	\$6.86	\$796,000
<i>Levee Embankment - Select Levee Fill</i>	CY	2,792,672	\$26.70	\$74,573,000
<i>Aggregate Base (Crown + LS Maint Rd)</i>	CY	12,889	\$54.90	\$708,000
<i>Hydroseeding</i>	AC	113.4	\$4,692.56	\$532,000
<i>Roadway</i>	SY	77,333.3	\$45.75	\$3,538,000
<b>Major Construction Items Subtotal =</b>				<b>\$82,828,000</b>
<b>Other Construction Costs*</b>				
Unallocated Items in Construction Costs			15%	\$12,424,000
Mobilization and Demobilization			5%	\$4,141,000
<b>Other Construction Costs Subtotal =</b>				<b>\$16,570,000</b>
<b>Construction Total =</b>				<b>\$99,398,000</b>
<b>Other Owner Costs**</b>				
Environmental Documentation and Permitting			10%	\$9,939,800
Design and Engineering Costs			15%	\$14,909,700
Legal Costs			2%	\$1,987,960
Engineering during Construction			2%	\$1,987,960
Construction Management			15%	\$14,909,700
<b>Other Owner Costs Subtotal =</b>				<b>\$43,740,000</b>
<b>Right-of-Way</b>				
<i>Permanent Right-of-Way (fee Title)- Agricultural</i>	AC	132.5	\$40,000.00	\$5,301,330
<b>Total Project Baseline Cost =</b>				<b>\$148,438,000</b>
<b>Contingency*** 30%</b>				<b>\$44,531,400</b>
<b>Expected Project Cost =</b>				<b>\$192,970,000</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 Other Owners Costs

## 10. Cost Summary of all Management Actions for the Isleton Study Area

A summary of capital costs associated with Management Actions 1-12 is summarized below in Table 23.

**Table 23: Estimated Costs for Management Actions 1-12 Including FEMA Certification(s) for the Entire Isleton Study Area**

Management Action	Strengthen-in-Place Levee Repairs	Cross Levees or All-Weather Access Road/Flood Fight Berm	FEMA Certification	Total
1: Repair DWR FSRP Critical and Serious Sites	\$6.0M	--	--	\$6.0M
<i>1A: Repair Two DWR FSRP Critical Stability Sites on the Right Banks of the Mokelumne and San Joaquin Rivers</i>	\$3.7M	--	--	\$3.7M
<i>1B: Repair DWR FSRP Serious Erosion Site on the Left Bank of the Sacramento River</i>	\$1.3M	--	--	\$1.3M
<i>1C: Repair Two DWR FSRP Serious Stability Sites on the Right Bank of Georgiana Slough and One Serious Seepage Site on the Right Bank of the Mokelumne River</i>	\$1.0M	--	--	\$1.0M
2: Raise and Repair/Strengthen-in-Place RD 556 Cross Levee Coupled with a Potential Relief Cut along Georgiana Slough in RD 556	\$7.2M-\$7.7M	--	--	\$7.2M-\$7.7M
3: All-Weather Flood Fight Access Road for the Community of Isleton (excluding \$3.2M to \$4.4M to procure 8,000 ft. of Muscle Wall)	--	\$5.9M	--	\$5.9M
4: Repair and Strengthen-in-Place SPFC Levee along the Left Bank of the Sacramento River (NULE Segment 378) – 10.2 miles	\$68.2M-\$71.7M (\$6.7M-\$7.0M/mile)	--	--	\$68.2M-\$71.7M (\$6.7M-\$7.0M/mile)
<i>4A: Repair and Strengthen-in-Place 1.6 Miles of Levee along the Left Bank of the Sacramento River Adjacent to Isleton</i>	\$22.2M-\$23.1M	--	--	\$22.2M-\$23.1M
<i>4B: Repair and Strengthen-in-Place 4.2 Miles of Levee along the Left Bank of the Sacramento River Between the Westerly Boundary of the Community of Isleton and Highway 12</i>	\$22.5M-\$23.7M	--	--	\$22.5M-\$23.7M
<i>4C: Repair and Strengthen-in-Place 2.4 Miles of Levee along the Left Bank of the Sacramento River Between Highway 12 and West Brannan Island Road</i>	\$12.8M-\$13.6M	--	--	\$12.8M-\$13.6M
<i>4D: Repair and Strengthen-in-Place 2.0 Miles of Levee along the Left Bank of the Sacramento River Between the Easterly Boundary of the Community of Isleton and the RD 556 Cross Levee</i>	\$10.7M-\$11.3M	--	--	\$10.7M-\$11.3M
5: Repair and Strengthen-in-Place SPFC Levee along the Right Bank of Georgiana Slough (NULE Segment 40) – 6.0 miles	\$76.7M-\$106.5M (\$12.8M -17.8M/mile)			\$76.7M-\$106.5M (\$12.8M - 17.8M/mile)
<i>5A: Repair and Strengthen-in-Place 0.90 miles of Levee along the Right Bank of Georgiana Slough Between the potential Cross Levee Alignment North of Fertile Acres and 450 feet Downstream of the Isleton Sewer Ponds</i>	\$13.4M-\$15.9M	--	--	\$13.4M-\$15.9M



Management Action	Strengthen-in-Place Levee Repairs	Cross Levees or All-Weather Access Road/Flood Fight Berm	FEMA Certification	Total
<b>5B:</b> Repair and Strengthen-in-Place 1.6 Miles of Levee along the Right Bank of Georgiana Slough Between the Potential Cross Levee Alignment North of Fertile Acres and the Isleton/Oxbow Marina Cross Levee	\$23.8M-\$28.3M	--	--	\$23.8M-\$28.3M
<b>5C:</b> Repair and Strengthen-in-Place 1.9 Miles of Levee along the Right Bank of Georgiana Slough Between the Potential Cross Levee Alignment North of Fertile Acres and the Potential Cross Levee Alignment at Jackson Slough Road and Terminous Road ( <b>includes 5A and 5B</b> )	\$28.3M-\$33.6M	--	--	\$28.3M-\$33.6M
<b>5D:</b> Repair and Strengthen-in-Place 1.9 Miles of Levee along the Right Bank of Georgiana Slough Between the Potential Cross Levee Alignment at Jackson Slough Road and Terminous Road and the Mokelumne River	\$22.4M-\$33.8M	--	--	\$22.4M-\$33.8M
<b>5E:</b> Repair and Strengthen-in-Place 2.2 Miles of Levee along the Right Bank of Georgiana Slough Between the Potential Cross Levee Alignment North of Fertile Acres and the existing RD 556 Cross Levee	\$26.0M-\$39.1M	--	--	\$26.0M-\$39.1M
<b>6: Potential Cross Levee System(s) for the City of Isleton</b>				
<b>6A:</b> Cross Levee System Adapted from the 2012 CVFPP and 2014 RFMP	\$47.6M-\$53.6M	\$59.6M	\$5.4M - \$5.7M	\$112.6M -\$118.9M
<b>6B:</b> Isleton – Oxbow Marina Cross Levee System with Future Optional Multi-Objective Setback Levee at Oxbow Marina ( <i>excludes cost of potential future multi-objective component of rerouting mainstem of Georgiana Slough northwest of Oxbow Marina</i> )	\$43.2M-\$48.3M	\$55.4M	\$4.9M - \$5.2M	\$103.5M -\$108.9M
<b>6C:</b> Isleton Sphere of Influence Cross Levee System	\$58.4M-\$65.7M	\$59.9M	\$5.9M - \$6.3M	\$124.3M -\$131.9M
7: Repair and Strengthen-in-Place Non-SPFC Levee along the Right Bank of the Mokelumne River (NULE Segment 1050) – 2.9 miles	\$35.4M-\$50.9M (\$12.2M- \$17.5M/mile)	--	--	\$35.4M-\$50.9M (\$12.2M- \$17.5M/mile)
8: Repair and Strengthen-in-Place Non-SPFC Levee along the Right Bank of the San Joaquin River (NULE Segment 1049) – 2.6 miles	\$37.5M-\$73.4M (\$14.4M - \$28.2M/mile)	--	--	\$37.5M-\$73.4M (\$14.4M- \$28.2M/mile)
9: Repair and Strengthen-in-Place 1.35 Miles of Non-SPFC Levee along the Left Bank of Sevenmile Slough (NULE Segment 1048) East of Jackson Slough and Certify Sevenmile Slough Closure Structures (including \$10M for two drainage closure structures @ \$5M each)	\$38.2M-\$52.9M (\$20.9M - \$31.8M/mile)	--	--	\$28.2M-\$42.9M (\$20.9M - \$31.8M/mile)
10: State Highway 12 Cross Levee	--	\$193M	--	\$193M
11: Secure 100-Year FEMA Certification for the Community of Isleton with a Highway 12 Cross Levee Paired with 14.55 miles of Perimeter Levee Improvements North of Highway 12	\$143.4M -\$178.0M	\$193M	\$16.8M - \$18.5M	\$353.2M -\$389.5M

Management Action	Strengthen-in-Place Levee Repairs	Cross Levees or All-Weather Access Road/Flood Fight Berm	FEMA Certification	Total
12: Secure 100-Year FEMA Certification for the Entire BALMD Study Area inclusive of the Community of Isleton – 23.5 miles	\$269.2M - \$369.1M	--	\$13.5M - \$18.4M	\$282.7M - \$387.5M

## 11. References

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