

Technical Memorandum



To: George Booth - Sacramento County
From: Michael Conant, Kris Van Sant, Katie laird
cc: Jeffrey Twitchell
Date: March 15, 2021
Re: Cost Estimate Development for Flood Risk Reduction Management Actions
for the Flood Risk Reduction Feasibility Study for Delta Legacy Community
of East Walnut Grove, CA
GEI Project 1800779

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 East Walnut Grove 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 East Walnut Grove, CA” (Feasibility Study). As discussed in the Feasibility Study, eleven 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 East Walnut Grove. This TM is focused on describing how perimeter levee improvements, a cross levee, 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 and Strengthen-in-Place Sacramento River and Georgiana Slough Left Bank State Plan of Flood Control (SPFC) Levees (Non-Urban Levee Evaluations [NULE] Segment 128) in Reclamation District (RD) 554
- MA 2: Repair and Strengthen-in-Place Snodgrass Slough Right Bank Non-SPFC Levee (NULE Segment 1051) in RD 554
- MA 3: Repair and Strengthen-in-Place Delta Cross Channel Right Bank Non-SPFC Levee in RD 554 (portions of NULE Segment 1052)

- MA 4: Repair and Strengthen-in-Place Non-SPFC RD 554 Dry Cross Levee Adjoining RD 563 along Old Walnut Grove-Thornton Road in RD 554
- MA 5: Secure 100-Year Federal Emergency Management Agency (FEMA) Certification for Portion of East Walnut Grove within RD 554, south of the Delta Cross Channel
- MA 6a: All-Weather Access Road/Flood Fight Berm in RD 563 – Tyler Island
- MA 6b: All-Weather Access Road/Flood Fight Berm and Road Widening along Walnut Grove-Thornton Road in RD 563
- MA 7: Repair and Strengthen-in-Place Snodgrass Slough Right Bank Non-SPFC (NULE Segment 1051) in RD 563
- MA 8: Repair and Strengthen-in-Place North Fork Mokelumne River Right Bank Non-SPFC Levee (950 ft. portion of NULE Segment 1043)
- MA 9: Repair and Strengthen Georgiana Slough Left Bank SPFC Levee (NULE Segment 130) in RD 563
- MA 10: Cross Levee in RD 563 Previously Identified by DWR
- MA 11: Secure 100-Year FEMA Certification for the RD 563 Portion of the Study Area with Cross Levee Previously Identified by DWR in RD 563
- MA 12: Secure 100-Year FEMA Certification for Entire East Walnut Grove Study Area (Management Actions 5 and 11)

2. Methodology

The Feasibility Study’s final array of management actions includes a mix of improvements for existing levees around the perimeter of RD 554 and a portion of RD 563, 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 RD 554, based on: 1) levee remediations developed by Blackburn Consulting as outlined in the TM Preliminary Mitigation Alternatives for Cost Estimate Planning – Community of East Walnut Grove Improvements, 2) levee remediations developed by DWR as documented in the 2011 NULE Geotechnical Assessment Report (GAR) and NULE Remedial Alternatives Cost Estimating Report (RACER) for the North NULE study area, and 3) improvement plans developed by DCC Engineering. Improvements include:
 - Berms
 - Cutoff walls
 - Rock slope protection (RSP) as proposed by DCC Engineering
- All-weather access road/flood fight berm in RD 563 protecting the community of East Walnut Grove as developed by Kjeldsen, Sinnock, and Neudeck (KSN)
- Cross levee in RD 563 south of Walnut Grove-Thornton Road

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 in RDs 554 and 563 were developed based on previously identified assessments, remediations, and associated cost estimates developed by DWR as documented in the 2011 NULE GAR and in the 2011 NULE RACER for the North NULE study area. These levee reaches include:

RD 554:

- NULE 1052 along the right bank of the Delta Cross Channel
- NULE 1051 along the right bank of Snodgrass Slough

RD 563:

- NULE 1051 along the right bank of Snodgrass Slough
- NULE 1043 along the right bank of the Mokelumne River
- NULE 130 along the left bank of Georgiana 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:

RD 554:

- NULE 128 along the left bank of the Sacramento River and Georgiana Slough
- Dry cross levee adjoining RD 554 and RD 563

RD 563:

- All-weather access road/flood fight berm in RD 563
- Cross levee in RD 563 south of Walnut Grove-Thornton Road

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.
- 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. 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

<u>Construction Activity Description</u>	<u>Unit</u>	<u>Unit Cost</u>
Rock Slope Protection	CY	\$77.50
Other Construction Costs		
Unallocated Items in Construction costs		10.00%-20.00% ¹
Mobilization and Demobilization		5.00%
Other Owner Costs**		
Environmental Documentation and Permitting		10.00%-20.00% ²
Design and Engineering Costs		10.00%-15.00% ³
Legal Costs		2.00%
Engineering during Construction		2.00%
Construction Management		5.00%-15.00% ⁴
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 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;

¹ 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.

² 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

³ 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.

⁴ 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.

- 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*	Remedial Alternatives
Right Bank Delta Cross Channel – RD 554	1052 (Non-SPFC Levee Segment)	U + S	30	19' High Levee 95' Wide Combination Berm 18' High Drained Stability Berm 67' Deep Slurry Wall
		U	60	19' High Levee 95' Wide Seepage Berm 67' Deep Slurry Wall
		U	10	16' High Levee 80' Wide Seepage Berm 56' Deep Slurry Wall
		E	10	19' High Levee
		FG	35	19' High Levee Geometry Deficiency Only
Right Bank Snodgrass Slough – RDs 554 & 563	1051 (Non-SPFC Levee Segment)	T + U + S	60	20' High Levee 100' Wide Combination Berm 19' High Drained Stability Berm 70' Deep Slurry Wall
		T + U	40	20' High Levee 100' Wide Combination Berm 70' Deep Slurry Wall
		FG	75	19' High Levee Geometry Deficiency Only
Right Bank Mokelumne River – RD 563	1043 (Non-SPFC Levee Segment)	T + U + S	50	21' High Levee 126' Wide Combination Berm 70' Deep Slurry Wall 20' High Drained Stability Berm
		U	50	21' High Levee 126' Wide Seepage Berm 70' Deep Slurry Wall
		E	50	21' High Levee
		FG	95	21' High Levee Geometry Deficiency Only

Levee Segment Location	NULE Segment	Hazard Remediated	Extent*	Remedial Alternatives
Left Bank Georgiana Slough – RD 563	130 (SPFC Levee Segment)	T + S	40	14' High Levee 12' High Stability Berm
		T + U	30	14' High Levee 75' Wide Combo Berm 49' Deep Slurry Wall
		T + U	20	14' High Levee 70' Wide Combo Berm 49' Deep Slurry Wall
		T	10	14' High Levee 12' High Stability Berm
		E	30	14' High Levee
		FG	41	31% Freeboard Deficiency 14' High Levee – 2.5' Freeboard Deficiency (1%) 14' High Levee – 0.5' Freeboard Deficiency (30%) 14' High Levee – Geometry Deficiency

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

* Extent is percentage of total segment length

Using a least cost approach, a preferred alternative was identified to mitigate the hazards associated with each levee reach. The preferred alternative for each levee reach and the associated cost estimates for the suite of alternatives are further detailed in the 2011 NULE RACER. The cost estimates for the preferred alternatives were escalated to July 2020 dollars using an ENR cost ratio of 1.26 (Table 3).

Table 3: DWR Costs Escalated to 2020 Dollars

NULE Segment	Hazard Remediated	Remediated Length (ft.)	Segment Length (ft.)	Cost Developed by DWR	Escalated Cost	Total Cost Per Mile
1052	U+S	1,260	4,200	\$2,733,000	\$3,447,000	\$15,751,000
	U	2,520		\$4,895,000	\$6,174,000	
	U	420		\$1,046,000	\$1,319,000	
	E	420		\$894,000	\$1,128,000	
	FG	1,470		\$423,000	\$533,000	
				Total	\$12,601,000	
1051	T+U+S	5,330	8,880	\$14,029,000	\$17,694,000	\$19,139,000
	T+U	3,550		\$9,352,000	\$11,795,000	
	FG	6,660		\$2,140,000	\$2,699,000	
				Total	\$32,188,000	
1043	T+U+S	25,780	51,550	\$73,068,000	\$92,155,000	\$27,445,000
	U	25,780		\$66,535,000	\$83,916,000	
	E	25,780		\$57,736,000	\$72,818,000	
	FG	48,970		\$15,112,000	\$19,060,000	
				Total	\$267,949,000	
130	T+S	25,640	64,110	\$23,966,000	\$30,227,000	\$13,161,000
	T+U	19,230		\$36,053,000	\$45,471,000	
	T+U	12,820		\$23,049,000	\$29,070,000	
	T	6,410		\$5,992,000	\$7,557,000	
	E	19,230		\$29,476,000	\$37,176,000	
	FG	26,290		\$8,169,000	\$10,303,000	
				Total	\$159,804,000	

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

The total cost for each levee reach in the respective RDs were estimated using the length for each reach and the total cost per mile provided in Table 3. The costs for NULE 1051 and 1052 in RD 554 were reduced by 50 percent based upon the latest, favorable NULE Hazard ratings of A through B (for underseepage, stability, through-seepage, and erosion criterion) collectively updated by DWR and Sacramento County, and based on input received from RD 554 representatives in 2020 (Table 4).

Table 4: Cost Summary for NULE Reaches 1052, 1051, 1043, and 130 in RDs 554 and 563

NULE Segment	RD	Segment Length (ft.)	Cost per Mile	Total Cost
1052	554	4,200	\$15,751,000	\$12,601,000*
1051	554	6,340	\$19,139,000	\$22,967,000*
	563	2,530		\$9,187,000
1043 (portion)	563	950	\$27,445,000	\$4,938,000
130 (portion)	563	3,700	\$13,161,000	\$9,213,000
			Total	\$58,906,000

* The costs for NULE 1051 and 1052 in RD 554 were reduced by 50 percent based upon the latest, favorable NULE Hazard ratings of A through B (for underseepage, stability, through-seepage, and erosion criterion) collectively updated by DWR and Sacramento County, and based on input received from RD 554 representatives in 2020.

3.2. Additional Remediations and Improvements

Repair and strengthen-in-place levee improvements for NULE Segment 128 along the left bank of the Sacramento River and Georgiana Slough are identified and defined in the Preliminary Mitigation Alternatives for Cost Estimate Planning – Community of East Walnut Grove Improvements TM developed by Blackburn Consulting. Each sub-reach has deficiencies identified as through seepage or stability. NULE Segment 128 can be remediated by either a cutoff wall alternative, a berm alternative, landside levee widening or slope flattening, or some combination of these alternatives (Table 5). Cost estimates for NULE Segment 128 were developed for the preferred cutoff wall alternative for each sub-reach as provided below in Section 3.2.1.

Table 5: Summary of Remedial Alternatives to Address Through Seepage, Stability, and Erosion on the SPFC Levee Segment Immediately Fronting the Community of East Walnut Grove within RD 554

Levee Segment Location	NULE Segment	Reach	Start Station	End Station	Reach Length (ft.) ¹	Remediation Alternative 1	Remediation Alternative 2	Vulnerability		
								Through Seepage	Slope Stability	Erosion
Left Bank Sacramento River and Georgiana Slough – RD 554	128 (SPFC Levee Segment)	A Georgiana Slough	0+00	18+50	1,900	Stability berm and landside slope flattening to 2:1 above the berm	35 ft. deep cutoff wall and landside slope flattening to 2:1	X	X	-
		B* Georgiana Slough & Sac River	18+50	37+50	1,900	35 ft. deep cutoff wall (may or may not be required upon further data and analyses)	-	-	X	-
		C* Sac River	37+50	46+58	900	55 ft. landside levee widening with 2:1 landside slope 750 ft. of RSP (may or may not be required upon further data and analyses)	35' ft. deep cutoff wall Waterside slope flattening to 3:1 Landside slope flattening to 2:1 750 ft. of RSP (may or may not be required upon further data and analyses)	-	X	X

* Pending further geotechnical analysis

¹ Reach lengths rounded to the nearest 100 feet

In addition to the analyses conducted by Blackburn Consulting, DCC engineering on behalf of RD 554 has prepared improvement plans to address erosion concerns that exist along the

left bank of the Sacramento River immediately downstream of the Delta Cross Channel from approximately station 39+50 to 46+50 (portion of NULE Segment 128, reach 128-C). Cost estimates for the proposed RSP to address these erosion concerns are provided below in Section 3.2.2.

Cost estimates were also developed for improvements to the dry cross levee adjoining RD 554 and RD 563 using levee cross sections developed by DCC Engineering as provided in the 2012 RD 554 Five-Year Plan. These cost estimates are provided below in Section 3.2.3.

3.2.1. Levee Improvement Cutoff Wall

A typical cutoff wall is shown in Figure 1. A summary of the construction activities for NULE Segment 128 is provided in Table 6. A summary of the total cost estimate for NULE Segment 128 is provided in Table 7. Note that while cost estimates were developed for each sub-reach of NULE Segment 128, the proposed cutoff wall remediation efforts are currently limited to sub-reach A of NULE segment 128, with no cutoff wall remediations efforts currently identified for sub-reaches B and C. As a result, the cutoff wall cost estimates developed for sub-reach B and C of NULE Segment 128 are not included in the total cost estimate to repair and strengthen NULE Segment 128.

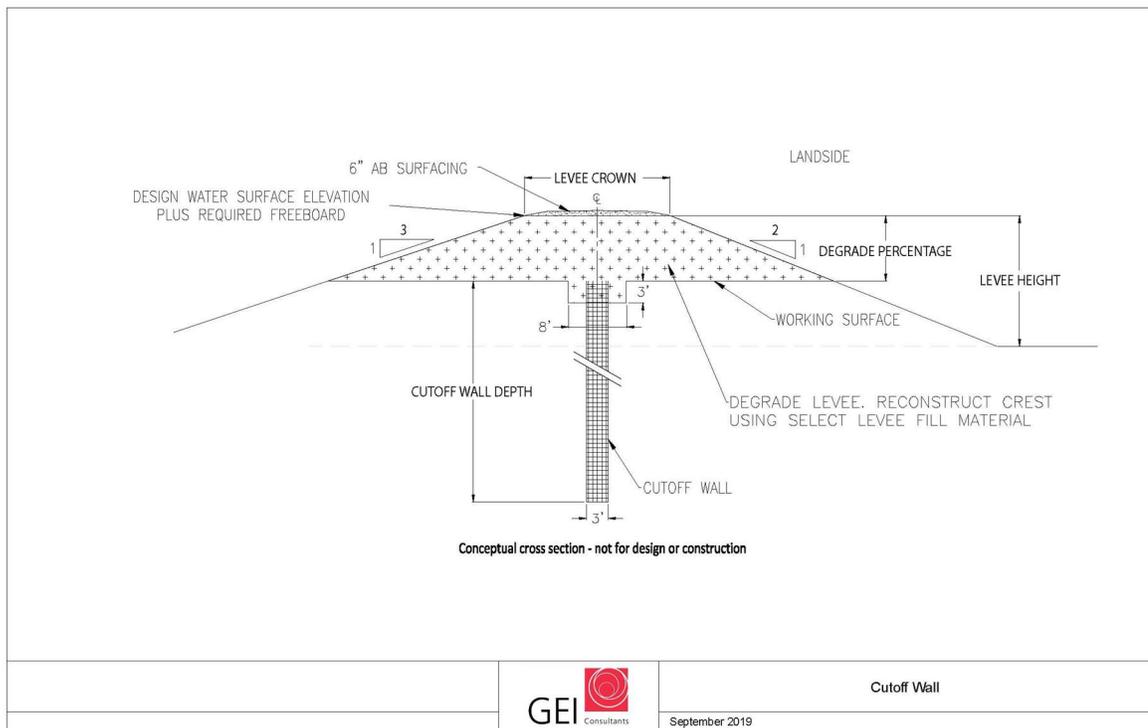


Figure 1: Cutoff Wall Conceptual Schematic

Table 6: Levee Improvement Cutoff Wall Base Construction Quantities

Location Description	Wall Depth	Remove AC	Wall Area	Wall Cost/sq ft	New Roadway AC	Total Base Construction Estimate
Cost per unit		\$5.70	varies	varies	\$40.00	
Units		SY	Sq ft		SY	
SACR-L 128-A	35 ft	4,111	64,750	\$32.00	4,111	\$2,260,000
SACR-L 128-B	35 ft	4,222	66,500	\$32.00	4,222	\$2,321,000
SACR-L 128-C	35 ft	2,018	31,780	\$32.00	2,018	\$1,109,000

Table 7: Cutoff Wall Reach Cost Summary

Location Description	Stationing		Length ¹	Cutoff Wall	Other Construction Costs*	Other Owner Costs**	Construction Contingency***	Reach Total
	From	To	(Feet)				30%	
SACR-L 128-A		18+50	1,850	\$2,260,000	\$452,000	\$1,193,000	\$1,172,000	\$5,077,000
SACR-L 128-B	18+50	37+50	1,900	\$2,321,000	\$464,000	\$1,226,000	\$1,203,000	\$5,214,000
SACR-L 128-C	37+50	46+58	900	\$1,109,000	\$222,000	\$586,000	\$575,000	\$2,492,000
			Repair Type Totals	\$2,260,000	\$452,000	\$1,193,000	\$1,172,000	\$5,077,000

¹ Reach 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

Not reflected in the cost estimate to repair and strengthen NULE Segment 128

3.2.2. Rock Slope Protection Improvements

To address existing erosion concerns RSP involves placement of rip-rap along the waterside slope of the levee. Along NULE Segment 128 (reach 128-C), a specific site has been identified for repair by DCC Engineering, including a quantity estimate for the repairs. These sites are assumed to require 5-foot thick RSP along the entire waterside slope. A base cost estimate to repair the erosion site identified by DCC Engineering in RD 554 was developed using unit costs and construction quantities from Dutra Engineering. Other construction costs, other owner costs, and construction contingency were added to this base cost to develop a total cost estimate to repair the RD 554 erosion site. A summary of the construction activities for reach 128-C is provided in Table 8. A summary of the total RSP cost estimate is provided in Table 9.

Table 8: RSP Base Construction Quantities Cost Summary

Location Description	Stationing		Length (Feet)	Rock Slope Protection	Rock and Soil	Excavation and Disposal	Riparian Bank
	From	To		Tons	Tons	CY	AC
SACR-L 128-C	39+50	46+50	700	8,962	3,594	7,651	0.17
Unit Costs				\$85	\$80	\$75	\$130,222
Total Base Cost				\$762,000	\$288,000	\$574,000	\$22,000

Table 9: Rock Slope Protection (RSP) Cost Summary

Location Description	Stationing		Length (Feet)	Rock Slope Protection	Other Construction Costs*	Other Owner Costs**	Construction Contingency***	Location Total
	From	To					30%	
SACR-L 128-C	39+50	46+50	700	\$1,645,000	\$329,000	\$1,066,000	\$912,000	\$3,953,000

* 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

3.2.3. RD 554 Dry Cross Levee Improvements

RD 554 dry cross levee cost estimates were developed using levee cross sections provided by DCC Engineering. Construction quantities were calculated based on these cross sections 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 improvements to the RD 554 dry cross levee. The cost summary for improvements to the RD 554 dry cross levee is summarized in Table 10.

Table 10: RD 554 Dry Cross Levee Cost Summary

**East Walnut Grove Dry Levee Remediation Cost Estimate
Cost Summary (July 2020 Costs)**

<u>Item</u>	<u>Unit</u>	<u>Quantity</u>	<u>Unit Cost</u>	<u>Cost</u>
New Cross Levee				
<i>Clearing and Grubbing</i>	AC	2.4	\$8,342.74	\$20,070
<i>Stripping</i>	CY	3,881	\$7.67	\$29,759
<i>Existing Ditch Fill</i>	CY	14,345	\$26.70	\$383,060
<i>Hydroseeding</i>	AC	2.4	\$4,692.56	\$11,289
Major Construction Items =				\$440,000
Other Construction Costs*				
Other Construction Costs*				
Unallocated Items in Construction Costs			10%	\$44,000
Mobilization and Demobilization			5%	\$22,000
Other Construction Costs* =				\$70,000
Construction Total =				\$510,000
Other Owner Costs**				
Environmental Documentation, Permitting, and Mitigation			10%	\$51,000
Design and Engineering Costs			10%	\$51,000
Legal Costs			2%	\$10,200
Engineering during Construction			2%	\$10,200
Construction Management			5%	\$25,500
Other Owner Costs =				\$150,000
Right-of-Way				
Permanent Right-of-Way (fee Title)- Agricultural	AC	2.4	\$25,000.00	\$60,000
Total Project Baseline Cost =				\$720,000
Contingency*** 30%				\$144,000
Expected Project Cost =				\$864,000

*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

4. All-Weather Access Road/Flood Fight Berm and Road Widening in RD 563

Construction of an all-weather access road/flood fight berm would prevent floodwaters originating downstream within the RD 563 basin from entering the community of East Walnut Grove, allowing additional time for evacuation. An all-weather access road and flood fight berm is essentially a slightly elevated all-weather roadway to accommodate the temporary placement of interlocking Muscle Wall during flood fight conditions. The noted access road would accommodate the temporary flood fight installation of a 4 to 8 ft.-high

Muscle Wall. The dimensions for the flood fight berm are summarized in Table 11 below. Construction quantities for the proposed flood fight berm were developed in concert with KSN. The unit costs identified in Table 1 were then applied to the construction quantities to determine the estimated cost for the proposed all-weather access road/flood fight berm.

In lieu of just raising the west shoulder of the Walnut Grove – Thornton Road where the flood fight berm alignment is adjacent to and parallel to the subject roadway, it may be advantageous to raise the entire underlying roadway bed and its shoulders. Construction quantities to raise the roadway and its adjoining shoulders were developed in concert with KSN. The unit costs identified in Table 1 were then applied to the construction quantities to determine the estimated cost for the proposed all-weather access road and road widening.

The cost estimates for the all-weather access road and all-weather access road implemented in tandem with road widening along Walnut Grove – Thornton Road are provided in Table 12 and Table 13, respectively.

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.

Table 11: Flood Fight Berm Dimensions

	Flood Fight Berm
Crown Width	8-20 ft.
Landside Slope	3:1
Waterside Slope	3:1
Maximum Crown Elevation	6 ft.

Table 12: All-Weather Access Road/Flood Fight Berm Cost Summary
East Walnut Grove Flood Fight Berm Cost Estimate
Cost Summary (July 2020 Costs)

<u>Item</u>	<u>Unit</u>	<u>Quantity</u>	<u>Unit Cost</u>	<u>Cost</u>
Flood Fight Berm				
<i>Clearing and Grubbing</i>	AC	1.7	\$8,342.74	\$14,000
<i>Stripping</i>	CY	2,782	\$7.67	\$21,000
<i>Proof Compacting</i>	AC	1.7	\$1,382.62	\$2,000
<i>Inspection Trench - Excavation</i>	CY	14,400	\$6.86	\$99,000
<i>Levee Embankment - Select Levee Fill</i>	CY	33,876	\$26.70	\$905,000
<i>Aggregate Base (Crown)</i>	CY	2,319	\$54.90	\$127,000
<i>Asphalt Concrete (AC) Removal</i>	SY	8,347	\$5.71	\$48,000
<i>AC Paving</i>	SY	8,347	\$40.04	\$334,000
<i>Hydroseeding</i>	AC	1.7	\$4,692.56	\$8,000
Major Construction Items =				\$1,560,000
Other Construction Costs*				
Other Construction Costs*				
Unallocated Items in Construction Costs			10%	\$156,000
Mobilization and Demobilization			5%	\$78,000
Other Construction Costs* =				\$230,000
Construction Total =				\$1,790,000
Other Owner Costs**				
Environmental Documentation and Permitting			10%	\$179,000
Design and Engineering Costs			10%	\$179,000
Legal Costs			2%	\$36,000
Engineering during Construction			2%	\$36,000
Construction Management			5%	\$90,000
Other Owner Costs =				\$520,000
Right-of-Way				
Permanent Right-of-Way (fee Title)- Agricultural	AC	4.2	\$25,000.00	\$105,000
Total Project Baseline Cost =				\$2,415,000
Contingency*** 20%				\$483,000
Expected Project Cost =				\$2,898,000

*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 13: All-Weather Access Road/Flood Fight Berm and Road Widening Cost Summary

**East Walnut Grove Flood Fight Berm and Road Widening Cost Estimate
Cost Summary (July 2020 Costs)**

<u>Item</u>	<u>Unit</u>	<u>Quantity</u>	<u>Unit Cost</u>	<u>Cost</u>
Flood Fight Berm				
<i>Clearing and Grubbing</i>	AC	3.0	\$8,342.74	\$25,000
<i>Stripping</i>	CY	4,906	\$7.67	\$38,000
<i>Proof Compacting</i>	AC	3.0	\$1,382.62	\$4,000
<i>Inspection Trench - Excavation</i>	CY	14,400	\$6.86	\$99,000
<i>Levee Embankment - Select Levee Fill</i>	CY	68,362	\$26.70	\$1,825,000
<i>Aggregate Base (Crown)</i>	CY	4,088	\$54.90	\$224,000
<i>Asphalt Concrete (AC) Removal</i>	SY	14,717	\$5.71	\$84,000
<i>AC Paving</i>	SY	14,717	\$40.04	\$589,000
<i>Hydroseeding</i>	AC	3.0	\$4,692.56	\$14,000
Major Construction Items =				\$2,900,000
Other Construction Costs*				
Other Construction Costs*				
Unallocated Items in Construction Costs			10%	\$290,000
Mobilization and Demobilization			5%	\$145,000
Other Construction Costs* =				\$440,000
Construction Total =				\$3,340,000
Other Owner Costs**				
Environmental Documentation and Permitting			10%	\$334,000
Design and Engineering Costs			10%	\$334,000
Legal Costs			2%	\$67,000
Engineering during Construction			2%	\$67,000
Construction Management			5%	\$167,000
Other Owner Costs =				\$970,000
Right-of-Way				
Permanent Right-of-Way (fee Title)- Agricultural	AC	5.5	\$25,000.00	\$138,000
Total Project Baseline Cost =				\$4,448,000
Contingency*** 20%				\$890,000
Expected Project Cost =				\$5,338,000

*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. RD 563 Cross Levee

A 1.0-mile-long cross levee in RD 563 is proposed in conjunction with levee repairs and improvements in RD 563 along Georgiana Slough, Snodgrass Slough, and the Mokelumne River. 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 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 RD 563 cross levee. The cost summary for the RD 563 cross levee is summarized in Table 15.

Table 14. Cross Levee Dimensions

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

Table 15: RD 563 Cross Levee Cost Summary

**East Walnut Grove Cross Levee Cost Estimate
Cost Summary (July 2020 Costs)**

Levee length = 5581 ft, Crest Elevation @ 13.0, Average levee height = 11.8 ft

<u>Item</u>	<u>Unit</u>	<u>Quantity</u>	<u>Unit Cost</u>	<u>Cost</u>
New Cross Levee				
<i>Clearing and Grubbing</i>	AC	15.5	\$8,342.74	\$129,000
<i>Stripping</i>	CY	18,907	\$7.67	\$145,000
<i>Proof Compacting</i>	AC	15.5	\$1,382.62	\$21,000
<i>Inspection Trench - Excavation</i>	CY	21,924	\$6.86	\$150,000
<i>Levee Embankment - Select Levee Fill</i>	CY	188,045	\$26.70	\$5,021,000
<i>Aggregate Base (Crown + LS Maint Rd)</i>	CY	2,436	\$54.90	\$134,000
<i>Hydroseeding</i>	AC	13.5	\$4,692.56	\$63,000
Major Construction Items =				\$5,660,000
Other Construction Costs*				
Unallocated Items in Construction Costs			20%	\$1,132,000
Mobilization and Demobilization			5%	\$283,000
Other Construction Costs* =				\$1,420,000
Construction Total =				
				\$7,080,000
Other Owner Costs**				
Environmental Documentation and Permitting			10%	\$708,000
Design and Engineering Costs			15%	\$1,062,000
Legal Costs			2%	\$142,000
Engineering during Construction			2%	\$142,000
Construction Management			15%	\$1,062,000
Other Owner Costs =				\$3,120,000
Right-of-Way				
Permanent Right-of-Way (fee Title)- Agricultural	AC	15.5	\$25,000.00	\$387,000
Total Project Baseline Cost =				\$10,590,000
Contingency*** 30%				\$3,176,000
Expected Project Cost =				
				\$13,763,000

*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. Cost Summary of all Management Actions for East Walnut Grove Study Area

A summary of capital costs associated with Management Actions 1-12 is summarized below in Table 16.

Table 16: Estimated Costs for Management Actions 1-12 Including FEMA Certification(s) for Entire East Walnut Grove Study Area

Management Action	Project Area/ Reclamation District	Estimated Capital Cost	FEMA Certification	Total
1: Repair and Strengthen-in-Place Sacramento River and Georgiana Slough Left Bank SPFC Levees in RD 554 (NULE Segment 128)	RD 554	\$9,030,000	--	\$9,030,000
2: Repair and Strengthen-in-Place Snodgrass Slough Right Bank Non-SPFC Levee (NULE Segment 1051) in RD 554		\$11,484,000	--	\$11,484,000
3: Repair and Strengthen-in-Place Delta Cross Channel Right Bank Non-SPFC Levee (NULE Segment 1052) in RD 554		\$6,301,000	--	\$6,301,000
4: Repair and Strengthen-in-Place RD 554 Non-SPFC Dry Cross Levee Adjoining RD 563 along Old Walnut Grove-Thornton Road in RD 554		\$864,000	--	\$864,000
5: Secure 100-Year FEMA Certification for Portion of East Walnut Grove within RD 554		\$27,679,000	\$1,384,000	\$29,063,000
6a: All-Weather Access Road/Flood Fight Berm in RD 563	RD 563	\$2,898,000	--	\$2,898,000
6b: All-Weather Access Road/Flood Fight Berm and Road Widening along Walnut-Grove Thornton Road in RD 563		\$5,338,000	--	\$5,338,000
7: Repair and Strengthen-in-Place Snodgrass Slough Right Bank Non-SPFC Levee (portion of NULE Segment 1051 in RD 563) from RD 554 to the North Fork Mokelumne River	RD 563	\$9,187,000	--	\$9,187,000
8: Repair and Strengthen-in-North Fork Mokelumne River Right Bank Non-SPFC Levee (portion of NULE Segment 1043 in RD 563)		\$4,938,000	--	\$4,938,000
9: Repair and Strengthen-in-Place Georgiana Slough Left Bank SPFC Levee (portion of NULE Segment 130 in RD 563)		\$9,213,000	--	\$9,213,000
10: Cross Levee Previously Identified by DWR within RD 563		\$13,763,000	--	\$13,763,000
11: Secure 100-Year FEMA Certification for the RD 563 Portion of the Study Area with Cross Levee System, following Certification of RD 554 South of Delta Cross Channel		\$37,101,000	\$1,855,000	\$38,956,000
12: Secure 100-Year FEMA Certification for the Entire East Walnut Grove Study Area (Management Actions 5 and 11, less the cost of the RD 554 dry cross levee improvements)	Entire Study Area: Portions of RDs 554 and 563	\$63,916,000	\$3,196,000	\$67,112,000

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