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**From:** Sean Minard, PE, PLS

**CC:** Jonathan Kors, PE, PMP

**Date:** April 20, 2016

**Subject:** Sutter Butte Flood Control Agency  
Feather River West Levee Rehabilitation Project  
Assessment of Levee Encroachments, Penetrations, and Closures

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## **1.0 PURPOSE AND SUMMARY**

This memo summarizes MHM's assessment of encroachments, penetrations, and closure structures along the West Feather River from Starr Bend to Thermalito Afterbay. The assessment cover Sutter Butte Flood Control Agency (SBFCA) Project B, C, and D. A determination is made as to whether the identified features pose a hazard to levee integrity under the 200-year design water surface elevation (DWSE). The assessments were performed based on criteria presented in the Department of Water Resources' Urban Levee Design Criteria (ULDC) dated May 2012. The criteria for encroachments are described in ULDC report Section 7.12, criteria for penetrations are described in Section 7.13, and criteria for closure structures are described in Section 7.14. It is our opinion that the existing penetrations, encroachments, and closures present in Project Area A, B, and C pose a low hazard to levee integrity under the 200-year DWSE and comply with the ULDC.

## **2.0 BACKGROUND**

The ULDC provides the following definitions for encroachments and penetrations:  
Encroachment – Any obstruction or physical intrusion by construction of works or device, planting or removal of vegetation, or by whatever means for any purposes, into the following:

- any flood control project works;
- the waterway area of a project;
- the area covered by an adopted plan of flood control; or
- any area outside the above limits, if the encroachment could affect any of the above

For Project Area B, C, and D, it is our opinion that devices and features that were incorporated into the levee as part of levee improvement projects designed, permitted,

and constructed initially by the USACE and subsequently by TRLIA (e.g. access ramps, stability and seepage berms, relief wells, drainage ditch, piezometers, settlement monuments, inclinometers, sign posts) should not be considered encroachments. These items were constructed and incorporated as integral parts of the levee flood control works under permits approved by the USACE and Central Valley Flood Protection Board (CVFPB).

**Penetrations and Closure Structures**– A penetration means a manmade object that crosses through or under a levee or floodwall and has the potential to provide a preferential seepage path or hydraulic connection with the waterside. Typically, a penetration is a pipe or transportation structure, such as a roadway or rail line.

The closure structures associated with transportation penetrations are also assessed under ULDC guidelines. Transportation penetrations are open penetrations that cross the levee below the elevation of the adjacent levee crown, and may require associated closure structures or devices such as gates or flashboards. There is no formal definition of closure structures stated in the ULDC. Closure devices are usually necessary where the levee ties into the structure associated with a transportation penetration (roadway or rail line), and the structure has an opening forming a gap in the levee alignment that must be closed off to the design WSE plus the required freeboard.

### **3.0 BACKGROUND**

MHM reviewed the following documentation to determine whether encroachments, penetrations and closure structures are present along the West Feather River Levee from Starr Bend to Thermalito Afterbay (SBFCA Project Area B, C, and D).

- Drawings of the Feather River West Levee Project – Volume 3 of 6 (Project Area B), Feather River West Levee Improvement Plans – Station 512+00 to 832+40, prepared by Wood Rodgers and MHM, dated February 3, 2014.
- As-built drawings of the Feather River West Levee Project – Volume 3 of 6 (Project Area C), Feather River West Levee Improvement Plans – Station 844+75 to 1433+83, prepared by Nordic Industries, Inc., dated January 11, 2016.
- As-built drawings of the Feather River West Levee Project – Volume 3 of 6 (Project Area C), Feather River West Levee Improvement Plans – Station 1433+83 to 1626+00, prepared by Nordic Industries, Inc., dated January 13, 2016.
- Drawings of the Feather River West Levee Project – Volume 4 of 6 (Project Area D), Feather River West Levee Improvement Plans – Station 1765+00 to 2368+26, prepared by HDR and MHM, dated February 3, 2014.
- Final Periodic Inspection Report No. 1, Feather River – Sutter Basin Protection Area, Periodic Inspection – January 2010, prepared by GHT2 for the USACE.

- Supplement to Standard Operation and Maintenance Manual, Sacramento River Flood Control Project, Unit No. 143, West Levee of Feather River from North Boundary of Reclamation District No. 823 to East Levee of Sutter By-Pass, dated August 1955 (O&M Manual).
- Supplement to Standard Operation and Maintenance Manual, Sacramento River Flood Control Project, Unit No. 144, West Levee of Feather River from North Boundary of Levee District No. 1 to North Boundary of Maintenance Area No. 3 (Previously Reclamation District No. 823), dated June 2013 (O&M Manual).
- Supplement to Standard Operation and Maintenance Manual, Sacramento River Flood Control Project, Unit No. 148, West Levee of Feather River from North Boundary of Levee of Levee District No. 777 to North Boundary of Levee District No. 1, dated August 1955 (O&M Manual).
- Supplement to Standard Operation and Maintenance Manual, Sacramento River Flood Control Project, Unit No. 152, West Levee of Feather River from North Boundary of Reclamation District No. 777 to The Western Canal Intake (Levee of Drainage District No. 1), dated March 1957 (O&M Manual).
- Basis of Design Report for Sutter Butte Flood Control Agency, Feather River West Levee Project – Segments 1 through 7 (Station 10+00 to 2368+00), dated March 2012, prepared by HDR, MHM, Wood Rodger, and URS.
- Pre-Design Formulation Report for Sutter Butte Flood Control Agency, Feather River West Levee Project – Segments 1 through 7 (Station 10+00 to 2368+00), dated August 2011, prepared by HDR, MHM, Wood Rodger, and URS.
- Levee Inspection Logs for Maintenance No. 3, Levee District No. 1 of Sutter County, Levee District No. 9 of Sutter County, Maintenance Area No. 16, Maintenance Area No. 7, and Hamilton Bend Maintenance Area, dated September 2011.
- Memorandum titled, Assessment of Levee Utility Penetrations- Rd 784 Levee Accreditation, Feather River East Segments 1 and 3, prepared for the 100-year FEMA Accreditation Project for RD 784, dated January 29, 2010 (January 2010 Penetration Assessment Memo), prepared by GEI Consultants.
- Levee District No. 1 of Sutter County, Levee Log Summary, prepared by Levee District No. 1.
- Phase 4 Feather River Levee Repair Project, Levee Segments 1&3 Construction Completion Report, prepared by GEI Consultants, dated June 2009.

#### **4.0 TABLES AND ATTACHMENTS**

Table 1	Feather River Levee Encroachment, Penetration, and Closures
Table 2	Urban Levee Design Criteria for Penetrations
Table 3	Urban Levee Design Criteria for Encroachments

TABLE 1 - WEST FEATHER LEVEE ENCROACHMENT, PENETRATION, AND CLOSURES SUMMARY LIST

Levee Mile (Original)	Levee Mile (Adjusted)	Levee Mile (Adjusted) - End LM	SBFCA Project Area	SBFCA Reach	SBFCA BEGIN STA	SBFCA END STA	Encroachment	Proposed Levee Improvement	Description of SBFCA work	CVFPB Status					CVFPB Permit Process					Encroachment Status					CVFPB Permit Information			Owner Information										
										Temp. Application No.	Application Ready	Date Submitted	USACE Approval	Board Hearing	Permit Approved	New Permit	Amend Permit	Remove Permit	No Permit Change	Part of Flood Control	Outside of SBFCA	Permitted	Original O&M	No Records Found	Removed - Permitted	Removed - O&M	Removed - No Record	Outside SBFCA	NoV Notice by CVFPB	Permit No.	Year	APN	Name	Address				
					2371+00		Hamilton Bend Levee Transition																															
			D1	41	2368+00		End Reach 41																															
1	1	1.23			2368+10		USACE PI - Intermittent rutting on crown road	Seepage Berm 100 feet wide, 5 feet thick at levee toe with 1 foot thick filter layer (ASTM C33 fine aggregate) at bottom	USACE PI was addressed by project grading and project improvements																													
2	2	1.23			2368+00		To construct training dike system to surround the borrow area. The borrow area is for the construction of Oroville Dam and consisted of the removal of 78,000,000 cubic yards of material. The removal of which exposed the sandy underlying material. The dike system is designed against crest overtopping by a river discharge of 150,000 cfs. LM 0.00 to 3.38.	Seepage Berm 100 feet wide, 5 feet thick at levee toe with 1 foot thick filter layer (ASTM C33 fine aggregate) at bottom	Protect-in-place																													
3	3	1.23			2368+00		Hamilton Bend LMA - Chainlink fencing and gate USACE PI - Security fence at top of WS	Seepage Berm 100 feet wide, 5 feet thick at levee toe with 1 foot thick filter layer (ASTM C33 fine aggregate) at bottom	Part of Hamilton Bend LMA security system.																													
4	4	1.23			2368+00		To construct the river outlet of the Thermalito Afterbay through the right bank levee of the Feather River. The proposed construction will consist of a channel 1,000 feet long, 15.5 feet deep, and 115 to 160 wide at the base. The side slopes of the channel will be 3:1. Training dikes will be constructed on both banks of the channel.	Seepage Berm 100 feet wide, 5 feet thick at levee toe with 1 foot thick filter layer (ASTM C33 fine aggregate) at bottom	Protect-in-place																													
5	5	1.21	1.24	D1	2367+00	2368+40	Pacific Gas and Electric - 12 KV overhead crossing of levee USACE PI - Power pole center of crown with overhead power lines going to WS.	Seepage Berm 100 feet wide, 5 feet thick at levee toe with 1 foot thick filter layer (ASTM C33 fine aggregate) at bottom	USACE PI was addressed by relocation of poles outside of levee prism area																													
6	6	1.20			2366+25		Hamilton Bend LMA - Waterside Access Ramp	Seepage Berm 100 feet wide, 5 feet thick at levee toe with 1 foot thick filter layer (ASTM C33 fine aggregate) at bottom	Protect-in-place																													
7	7	1.19			2365+66		Furnish and install 106 linear feet of 24-inch 12-gage CM pipe with 2 CM cutoff walls, construct standard reinforced concrete saddle and apron landside. Install 24-inch Calico No. 101 gate with standard riser assembly on waterside.	Seepage Berm 100 feet wide, 5 feet thick at levee toe with 1 foot thick filter layer (ASTM C33 fine aggregate) at bottom	Remove and Dispose																													
8	8	1.11			2361+60		USACE PI - Trees to 1' diameter at WS toe	Seepage Berm 100 feet wide, 5 feet thick at levee toe with 1 foot thick filter layer (ASTM C33 fine aggregate) at bottom	USACE PI was addressed by project clearing and grubbing																													
9	9	1.10			2361+10		Water Well adjacent to Levee about at landward levee toe	Seepage Berm 100 feet wide, 5 feet thick at levee toe with 1 foot thick filter layer (ASTM C33 fine aggregate) at bottom	Protect-in-place																													
10	10	1.09			2360+75		An 8-foot x 8-foot concrete pad with 2-inch conduit located at landside toe.	Seepage Berm 100 feet wide, 5 feet thick at levee toe with 1 foot thick filter layer (ASTM C33 fine aggregate) at bottom	Remove and Dispose																													
11	11	1.09			2360+75		USACE PI - Crown road 10' wide, 2:1 LS slope, 3:1 WS slope, rutting on crown.	Seepage Berm 100 feet wide, 5 feet thick at levee toe with 1 foot thick filter layer (ASTM C33 fine aggregate) at bottom	USACE PI was addressed by project grading and project improvements																													
12	12	1.08			2360+15		Hamilton Bend LMA - Landside Access Ramp	Seepage Berm 100 feet wide, 5 feet thick at levee toe with 1 foot thick filter layer (ASTM C33 fine aggregate) at bottom	Protect-in-place																													
13	13	1.08			2360+15		Hamilton Bend LMA - Waterside Access Ramp	Seepage Berm 100 feet wide, 5 feet thick at levee toe with 1 foot thick filter layer (ASTM C33 fine aggregate) at bottom	Protect-in-place																													
14	14	1.08	1.23	D1	2360+05	2368+00	Pacific Gas and Electric - 12 kv overhead electrical power line located parallel to waterside levee toe. In some locations the power poles are located within the levee toe or within 10 feet.	Seepage Berm 100 feet wide, 5 feet thick at levee toe with 1 foot thick filter layer (ASTM C33 fine aggregate) at bottom	The utility pole was relocated minimum of 30 feet from landward if the landside seepage toe outside of the levee fee area. The overhead electrical crossing of levee has been removed and disposed.																													
15	15	1.07	1.09	D1	2359+65	2360+65	USACE PI - 10 trees to 2' diameter on LS slope and 2 trees to 1' diameter on WS slope in about 100'	Seepage Berm 100 feet wide, 5 feet thick at levee toe with 1 foot thick filter layer (ASTM C33 fine aggregate) at bottom	USACE PI was addressed by project clearing and grubbing																													
16	16	1.07			2359+45		USACE PI - Intermittent trees up to 2' diameter, brush, and blackberries on LS slope and toe	Seepage Berm 100 feet wide, 5 feet thick at levee toe with 1 foot thick filter layer (ASTM C33 fine aggregate) at bottom	USACE PI was addressed by project clearing and grubbing																													
17	17	1.06	1.07	D1	2359+05	2359+58	Sutter Butte Main Canal Headgates	Seepage Berm 100 feet wide, 5 feet thick at levee toe with 1 foot thick filter layer (ASTM C33 fine aggregate) at bottom	Protect-in-place																													
		1.06	1.23	D1	2359+00	2368+00	Reach 40/41 Transition																															





































































































































**Table 2 - Urban Levee Design Criteria for Penetrations (Section 7.13 of the ULDC)**

ULDC Sub-Section	Topic	Key Guidelines	Relevance to West Feather River Levee
7.13.1	Assessment of Existing Penetrations	A hazard assessment and formulation of an engineering opinion needs to be performed for each penetration, whether permitted or not, to determine impacts on reliable performance of the levee for the full range of loading up to the HTOL.	An assessment of the pipe penetrations along West Feather River Levee Project Area B, C, and D was performed. Refer to Table 1 for details about the penetrations.
		Penetrations identified with high hazard will require a full engineering evaluation to determine whether the penetration needs to be removed, abandoned, or properly modified to restore levee integrity.	The penetrations described above are judged to be low hazard. Generally they are recently engineered and constructed pipelines that meet general guidelines in ULDC Chapter 7 and USACE EM 1110-2- 1913.
		Removal, abandonment, or modifications will require an engineering assessment to address seepage, slope stability, and structural integrity of the levee. A removal or modification plan is to be approved by the levee maintaining agency and the Board.	Refer to Table 1 for details about the penetrations.
7.13.2	Pipes and Culverts	Guidance in Chapter 8 of USACE EM 1110-2-1913 (Design and Construction of Levees) should be followed when evaluating pipeline penetrations in levees and embankment soils.	Chapter 8 of EM 1110-2-1913 was reviewed as part of the hazard assessment for the West Feather River Project penetrations. It is our opinion that the pipelines generally meet this guidance and pose a low hazard to the reliability of the West Feather River Project.

ULDCSub-Section	Topic	Key Guidelines	Relevance to West Feather River Levee
7.13.3	Transportation Penetrations (e.g. roadway and railway crossings below the levee crown elevation, including associated closure structures )	Engineering assessment required that includes opinion regarding the effects on seepage, stability, three dimensional effects, closure operations and maintenance and potential for / consequences of overtopping the penetration.	Refer to Table 1 for details about the penetrations.
7.13.4	Investigation for Unknown Penetrations	<p>Engineer needs to identify the presence of existing penetrations based on existing record information.</p> <p>If the presence of penetrations is uncertain, the engineer should perform a geophysical survey with capability of identifying levee penetrations within the levee and upper 20 feet of foundation materials.</p>	Refer to Table 1 for details about the penetrations..
		Identified penetrations need to be permitted or properly abandoned	Refer to Table 1 for details about the penetrations. SBFCA is working with CVFPB to properly permit or amend existing permits to reflect work completed as part of the Feather River West Levee Projects.

ULDC Sub-Section	Topic	Key Guidelines	Relevance to West Feather River Levee
7.13.5	Abandoned Penetrations	Requires an engineering assessment addressing seepage and piping potential and structural integrity of the levee with abandoned structure.	An engineering assessment was performed, and pipe removals were accomplished by excavation and replacement with compacted low permeability backfills. The removals were performed in accordance with approved plan and specification requirements to minimize piping potential and maintain the structural integrity of the levee.
		Abandonment needs to follow USACE and any other regulatory requirements	All abandoned pipelines were removed unless not feasible. Only one pipeline was deemed unfeasible. The entire pipeline was filled with slurry cement.
		Unpermitted abandoned pipes need to be removed or modified.	Refer to Table 1 for details about the penetrations.
7.13.6	Pipe and Culvert Inspections	<p>Interiors of pipes need to be visually inspected and /or pressure tested every five years.</p> <p>A corrosion assessment using non-destructive techniques should be considered for corrosion-susceptible pipe materials.</p>	As stated in the O&M Manual Addendum and the ULDC, the pipes and/or culverts listed in Table 1 need to be video inspected every five years. A more detailed corrosion assessment of concrete box culvert, steel pipeline and reinforced concrete pipelines and appurtenant structures will be performed if there is evidence during routine inspections that steel components are beginning to show signs of corrosion. We understand the private utility lines are subject to regular inspections by the utility companies.
		Exposed portions of pipes need to be visually inspected every year	There are no exposed portions of pipes.

**Table 3 - Urban Levee Design Criteria for Encroachments (Section 7.12 of the ULDC)**

ULDC Sub- Section	Topic	Key Guidelines	Relevance to West Feather River Levee
7.12.1	Assessment of Existing Encroachments	A hazard assessment and formulation of an engineering opinion needs to be performed for each encroachment, whether permitted or not, to determine impacts on reliable performance of the levee for the full range of loading up to the HTOL.	An engineering opinion is formulated in the attached memorandum that the power line encroachments crossing over the West Feather River Levee pose low hazard to the reliable performance of the levee based on the reviewed information cited in this memorandum.
		The following items shall be considered for the hazard assessment/ engineering opinion: type of encroachment, age, condition, performance history, impacts on structural integrity of levee, hydraulic effects on channel, and floodway, and impacts to operations and maintenance.	Refer to Table 1 of this memorandum for a summary description of encroachments.
		Encroachments identified to be a high hazard will require a full engineering evaluation to determine whether the hazard is acceptable and whether the encroachment needs to be removed or properly modified to restore levee integrity.	Not applicable.
		Encroachment removal or modifications will address seepage, slope stability, and structural integrity of the levee. Any removal or modification plan is to be approved by the levee maintaining agency and the Board.	Not applicable.
		An encroachment remediation plan is required for other existing encroachments which are not considered to be high hazard, but either (1) have not been permitted, or (2) interfere with operation maintenance, or flood fight capability.	Not applicable.