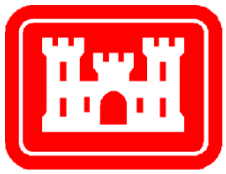
SUPPLEMENT TO STANDARD OPERATION AND MAINTENANCE MANUAL

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 3 (PREVIOUSLY RECLAMATION DISTRICT No. 823)



US Army Corps of Engineers®

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

March 2016 - DRAFT

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 3
(PREVIOUSLY RECLAMATION DISTRICT No. 823)

LOCATION	ADDITION OR REVISION	DATE
Supplemental Manual	This entire supplemental manual was revised to reflect the new format and incorporate the Star Bend setback levee, as well as improvements made to the levee as part of Projects B and C of the Feather River West Levee Project. For historical reference, the previous supplemental manual text and previous revisions can be found in Appendix N.	August 2015

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K. USFWS B.O. # 81420-2009-F-0372-1 (and included for reference, *Habitat Enhancement Plan (HEP) for Feather River Setback Levee and Habitat Enhancement Project at Star Bend*, dated March 6, 2009)

L. Section 408 Permissions

M. USFWS B.O. # 08ESMF00-2013-F-0342-1 (Covers Projects B and C)

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SECTION 1 GENERAL

1-01. This O&M Manual has been prepared in accordance with the guidelines contained in the U.S. Army Corps of Engineers' (USACE) Engineering Regulation ER 1110-2-401, "*Operation, Maintenance, Repair, Replacement, and Rehabilitation Manual for Projects and Separable Elements Managed by Project Sponsors*."

1-02. The levee of Unit No. 144 provides protection to Yuba City and adjacent agricultural land against flood waters of the Feather River and is an essential feature of the Sacramento River Flood Control Project.

1-03. The project works covered by this manual include the west levee and banks of the Feather River from the north boundary of Levee District No. 1 (LD 1) down 16.~~65~~ 15 levee miles to the common boundary between LD 1 and Maintenance Area 3 (MA 3) (formerly Reclamation District No. 823).

1-04. This reach of levee was originally built by local interests and later re-constructed to the adopted grade and section by the USACE. The grade of the adopted floodplain profile in the Feather River varies from elevation 82.38 at the north boundary of LD 1 to elevation 57.0 at the north boundary of MA 3 (Elevations are referred to the United States Engineering Datum (USED)). Freeboard above the project floodplain of 3 feet has been equaled or exceeded within this unit, and the project design capacity is 300,000 cfs upstream of Bear River and 320,000 cfs downstream of Bear River. The low water channel of the Feather River meanders through an overflow area which has a variable width of 1,200 feet to over 6,000 feet with the incorporation of setback levees in the Lower Feather River Corridor (LFRC).

1-05. Environmental compliance and mitigation requirements are briefly described in Section 10-05 of this Supplement and in Appendices J, K and M.

SECTION 2 AUTHORIZATION

2-01. See Standard Manual for the authorization for The Sacramento River Flood Control Project (SRFCP).

2-02. Unit No. 144 of the SRFCP was initially built by local interests and later re-constructed to project grade and section by the USACE. Responsibility for operating and maintaining the completed works of Unit No. 144 was officially accepted by the Reclamation Board of the State of California (now known as the Central Valley Flood Protection Board) on December 18, 1951 and December 2, 1952.

2-03. Flood and Coastal Storm Emergencies Act, Public Law 84-99.

2-04. Fiscal Year 1997 Emergency Supplemental Appropriations Act, Public Law 105-18.

2-05. Bank protection work was authorized by the Flood Control Act of 1960.

2-06. Setback levee work at star bend was administratively authorized by 33 U.S.C. Section 408 permission date June 16, 2009 and CVFPB permit No. 18191BD.

2-07. Work for Project C was administratively authorized by 33 U.S.C. Section 408 permission dated July 19, 2013 and CVFPB Permit No. 18793-1BD.

2-08. Work for Project B was administratively authorized by 33 U.S.C. Section 408 permission dated March 3, 2014 and CVFPB Permit No. 18793-2BD.-

SECTION 3 LOCATION

3-01. The Unit No. 144 levee provides protection to Yuba City and adjacent agricultural lands in Sutter County, California. The project works covered by this manual include the west levee and banks of the Feather River from the north boundary of LD 1 (about 1.9 miles upstream from State Highway 20 bridge crossing at Yuba City), southerly (downstream) to the common boundary between LD 1 and MA 3. Levee Unit No. 144 is approximately 16.15 miles in length and is located along the right bank of the Feather River approximately between RM 13 and RM 30.

3-02. Appendix B contains maps and aerial photos of the LD 1 boundaries and the alignment of the West Levee of the Feather River, Unit No. 144 which depict improvements made to Unit 144 as part of Projects B and C. There are 16.~~65~~ 15 levee miles (LM) within this unit. ~~It is noted that, with the incorporation of the Star Bend Setback Levee, the levee mileage jumps at LM 4.2 to 4.38. This allows for the project to maintain the same levee miles for consistency purposes. The Star Bend Setback Levee is located between LM 3.55 and LM 4.20 (LM 4.38).~~ It should be noted that, with this O&M Supplement, station equations for the Star Bend and Shanghai Bend setback levees have been eliminated; levee mileage reported with this Supplement reflects actual mileage along the existing levee centerline.

SECTION 4 PERTINENT INFORMATION

4-01. Overview of Improvements to Unit 144

As part of the Feather River West Levee Project (FRWLP), soil-bentonite (SB), cement-bentonite (CB), and soil-cement-bentonite (SCB) cutoff walls were constructed at the levee centerline to reduce the hydraulic gradient and seepage flows to acceptable levels in accordance with USACE requirements.

Between LM 4.43 and LM 10.42, the top of the cutoff wall is located at an elevation corresponding to two-thirds of the total levee height. From LM 10.70 to LM 12.19, and LM 15.11 to LM 16.04, the top of the cutoff wall is located at an elevation corresponding to one-half of the total levee height. Between LM 5.04 and LM 5.19, 12 relief wells and a drainage pipe were installed.

Between LM 4.72 and LM 4.98, 25 relief wells were abandoned, and 82 existing relief wells were converted to observation wells between LM 10.73 and LM 12.25. A landside toe berm was constructed at the 10th Street Bridge (LM 14.12). Numerous encroachments and penetrations were also addressed along the levee. Included in Appendix C are the as-built drawings containing specific details of the improvements constructed as part of Project B and Project C.

The relief wells will include a well screen surrounded by a filter material designed to prevent inwash of foundation materials into the well. They are sized to accommodate the maximum design flow without excessive head loss. The anticipated maximum flow from each relief well during a high water event is between 6 and 12 gpm.

The table in Appendix O summarizes the approximate locations of the relief wells, monitoring wells, and observation wells that are part of the federal project in Unit 144.

The relief wells between LM 5.04 and LM 5.19 will drain via an existing pump station that was relocated as part of the 2009 Star Bend setback levee project (see item “t” in Section 5). This pump station will be operated and maintained by LD 1 in the future, and is the only pump station that is part of the federal project in Unit 144.

See Exhibit 2 in Appendix B for an overview of the improvements made as part of Projects B and C. Please see Appendix P for a table correlating Levee Mile, River Mile, and Station for Unit 144.

4-02 Design Water Surface Elevation

As part of the FRWLP, the levee and appurtenant flood control systems were improved. The design water surface elevation was obtained using the USACE Common Features hydraulic model, version 3 (2011). Peterson Brustad, Inc. (PBI) updated this model to include work performed for SBFCA in order to evaluated levee performance. It should also be noted that the FRWLP did not change the authorized design profiles or flows of the federal project.

a. Top of Levee

The design water surface elevation was used as the basis for determining the minimum top-of-levee elevation. During design, it was determined that the existing levee had more than three feet of freeboard above the design water surface elevation at all locations, except at the UPRR Crossing near LM 16.09.

b. Seepage and Slope Stability

Seepage and slope stability were analyzed at four feet above the design water surface elevation in accordance with USACE EM 1110-2-1913. Where this exceeded the actual top of levee, the elevation at the physical top of levee was used. Exit gradients were limited to the following values:

- Landside levee toe: < 0.5
- Toe of seepage berm: < 0.8
- Landside levee toe with seepage berm: < 0.5 (between relief wells)
- Landside levee toe with relief wells: < 0.5
- Bottom of empty ditch at landside toe: < 0.5
- Bottom of empty ditch 150 feet or more from landside toe: < 0.8

4-03 Borrow Material

The levee improvements were constructed using existing levee embankment material and approximately 229,000 cubic yards of imported embankment material which met the requirements of the USACE Engineering Manual EM 1110-2-1913, *"Design and Construction of Levees,"* the Sacramento USACE District Standard Operating Procedure SOP-EDG-03, *"Geotechnical Levee Practice,"* and the *California Code of Regulations, Title 23*. Borrow material was obtained from the North Valley borrow site which is located on the south side of Ella Avenue, approximately one-half mile east of Feather River Road. See Exhibit 1 in Appendix B for the location of the North Valley borrow site.

4-04 Right-of-Way Acquisitions

In general, land was acquired in fee title for the entire levee footprint (landside levee toe to waterside levee toe). In addition to acquiring land for the levee footprint, fee title was also generally obtained 20 feet beyond the landside toe, and 15 feet beyond the waterside toe. Finally, an easement was obtained 10 feet beyond the landside toe fee title acquisition, which resulted in a total of 30 feet of fee and easement acquisitions on the landside. See Exhibit 3 in Appendix B for an overview of the right-of-way that was acquired.

4-05 Datum

Elevations in this manual come from the United States Engineering Datum (USED), the National Geodetic Vertical Datum of 1929 (NGVD 29), and/or the North American Vertical Datum of 1988 (NAVD 88). Conversion factors between these datums is shown below.

Table 4-1 Datum Conversion Factors

To Convert From This Datum	Approximate Adjustment Factor To Convert To This Datum		
	USED	**NGVD 29**	**NAVD 88**
USED	-	- 3.0	- 0.72
NGVD 29	+ 3.0	-	+ 2.28
NAVD 88	+ 0.72	- 2.28	-

SECTION 5 CONSTRUCTION HISTORY

5-01. Unit No. 144 of the Sacramento River Flood Control Project was originally built by local interests and later re-constructed in various stages between 1939 and present to the grades and sections adopted by the USACE. In general, all construction features are based on standard plans and specifications, details being fully covered in the drawings (see Appendix C). The construction work required to bring the local levee unit to project grade and section was accomplished under the following contracts:

a. Levee enlargement of the west levee of the Feather River in the vicinity of Yuba City from station 1380+00 to station 49+40, as shown on Drawing No. 44-172-1, was constructed under Contract No. W-1105-Eng-2350 by Hemstreet and Bell, Contractors, and completed on 26 January 1939.

b. Levee enlargement of west levee of the Feather River from Yuba City to Shanghai Bend and from Star Bend 2 miles southerly as shown on Drawing No. 4-4-188-1; sheets 2, 3, and 4 was constructed under Contract No. W-1105-eng-2405 by Morrison & Knudsen Company, Contractors, and completed 3 September 1939.

c. Levee enlargement of west levee of the Feather River from Shanghai Bend to Star Bend and from 2 miles south of Star Bend to opposite Bear River as shown on Drawing No. 4-4-205-1; sheets 2 to 8, inclusive, was constructed under Contract No. W-1105-eng-2694 by Morrison & Knudsen Company, Contractors, and completed 16 November 1940.

d. A short section of levee crown of the west levee of the Feather River was surfaced for patrol road purposes in the vicinity of Yuba City under Contract No. DA-04-167-eng-828 by Browne and Krull, Contractors, and completed on 2 December 1952. Specification No. 1636, Drawing No. 50-4-2897.

e. Emergency levee repairs along the west levee of the Feather River upstream and downstream from the 10th Street Bridge was accomplished under Contract No. DA-04-167-CIVENG-57-60 by W.H. Darrough and Sons, during the period from 1 October 1956 to 18 October 1956, Specification No. 2238, Drawing No. 4-4-431.

f. Emergency repair and reconstruction of approximately 8,000 feet of destroyed levee on the right bank of the Feather River downstream from Yuba City was accomplished under Contract Nos. DA-04-167-CIVENG-56-41, 56-45, 56-46, 56-102, 56-162, 56-169, and 56-173 by H. Earl Parker, Inc., San Francisco Bridge Company, Associated Dredging Company, and Pacific Gas and Electric Company, during the period from 26 December 1955 to 30 April 1956, Drawing No. 4-13-405.

g. Emergency levee repairs and bank paving, right bank of the Feather River at Star Bend was accomplished under Contract No. DA-04-167-CIVENG-56-154 by Lester L. Rice and Sons during the period from 5 March 1956 to 13 March 1956. No drawings made.

h. Repairing levee of right bank of Feather River from Yuba City from 5th Street Bridge (a.k.a. Twin Cities Memorial Bridge) ½ mile downstream was accomplished under Contract No. DA-04-167-CIVENG-56-161 and 56-75 by Baldwin Contracting Company during the period from 29 December 1955 to 15 January 1956. No drawings made.

i. Emergency relief wells and drains along the Feather River near Yuba City were installed under Contract No. DA-04-167-CIVENG-57-76 by C. S. Phillips Construction Company during the period from 13 November 1956 to 12 April 1957, Specification No. 2256, Drawing No. 4-4-435.

j. Emergency levee repairs, west levee Feather River, relief trench drain at Yuba City was accomplished under Contract no. DA-04-167-CIVENG-57-109 by Baldwin Contracting Company during the period from 17 February 1957 to 14 May 1957, Specification No. 2302, Drawing No. 4-4-437.

k. Emergency levee repairs, right bank Feather River at Shanghai Bend was accomplished under Contract No. DA-04-167-CIVENG-57-65 by H. Earl Parker, Inc. during the period from 8 October 1956 to 12 November 1956, Specification No. 2252, Drawing No. 4-4-433.

l. Drainage pump and sump, right bank Feather River at Shanghai Bend was accomplished under Contract No. DA-04-167-CIVENG-57-112 by Munz Pump, Inc. during the period from 11 March 1957 to 21 June 1957, Specification No. 2295, Drawing No. 4-4-438.

m. Levee stabilization, right bank Feather River, Levee Districts 1 and 9 was accomplished under Contract No. DA-04-167-CIVENG-60-73 by H. Earl Parker, Inc. during the period from 11 May 1960 to 28 July 1960, Specification No. 2655, Drawing No. 4-4-508.

n. Bank protection on the right bank of the Feather River at Mile 24.5 (Unit No. 8) was accomplished under Contract No. DA-04-167-EIVENG-66-50 by H. Earl Parker, Inc. during the period from 18 October 1965 to 14 June 1966. Specification No. 3154. Drawing No. 50-4-4004.

o. Levee repair on the right bank of the Feather River between Levee Mile 2.35 and Levee Mile 3.52 and at Levee Mile 1.5 (LD 1 site) located south of Yuba City along right bank of the Feather river between Levee Mile 1.43 and Levee Mile 1.60. Repair consists of seepage berms and a toe drain. Construction was completed 7 September 2001 under Contract No. DACW05-00-C-0041, Specification No. 1102E, Drawing No. 4-4-627.

p. Emergency levee repairs, at various locations along the right bank of the Feather River in Levee District 1 were completed on 31 October 1997 by Syblon Reed Corp. under Contract No. DACW05-97-C-0122. Specification No. 9885E, Drawing No.

04-04-617.

q. Emergency levee repairs, west levee Feather River, Levee Miles 14.60 to 16.02 in Levee District 1 were completed in July 2001 by BCN Company under Contract No. DACW05-00-C-0032. Specification No. 1101E, Drawing No. 4-25-626.

r. Emergency levee repairs, west levee Feather River Levee Miles 11.00 to 11.50 were completed on December 1999 by Clearwater Group Inc. under Contract No. DACW05-98-D-0035. Specification No. 9998E, Drawing No. 4-4-620.

s. Erosion repair sites, west levee of the Feather River at RM 28.5 (right levee). About 1260 feet of erosion repair work was completed by Newland Entities in December 2009 under Contract No. W91238-09-C-0021, Specification No. 1691, Drawing No. 50-04-6301.

t. At Star Bend, a 3,400 foot setback levee and soil-bentonite (SB) cutoff wall were built from approximately LM 4.20 (LM 4.38) to LM 3.55 with soil-cement-bentonite (SCB) cutoff wall, where the new levee ties into the old levee. The setback levee begins at the intersection of the east end of Star Bend Road and the existing right bank of the Feather River and continues southeasterly to the approximate intersection of the easterly extension of Tudor Road with the right bank of the Feather River. Work was completed by Nordic Industries between 17 July 2009 and 2 November 2009 under LD 1 Contract No. 09-02, USACE Specification No. 1941, and USACE File No. 4-04-0638. As a part of this design and construction, a pump station was reconstructed at least 10 feet beyond the landward toe of the completed setback levee. The original pump station was installed as part of PL 84-99 emergency repairs constructed by the USACE at Star Bend in 1997 (see item p. above).

u. The work completed under Project B (i.e. 408 Permission for the Feather River West Levee Project Areas B and D, dated March 3, 2014) included the following: construction of an SB cutoff wall ranging from 47 to 78 feet in depth along the centerline of the levee from LM 4.43 to LM 10.42; abandonment of 25 existing relief wells between LM 4.72 and 4.98; installation of 12 new relief wells between LM 5.04 and 5.19; conversion of 82 existing relief wells to observation wells between LM 10.73 and 12.25; removal of approximately 3,100 linear feet of an existing concrete relief well drainage ditch; construction of 885 linear feet of new concrete relief well drainage ditch; and correction of various encroachments which did not comply with the California Code of Regulations, Title 23. Construction is anticipated to be completed by the end of 2016 under Contract No. 01-2014B-D

The work completed under Project C (i.e. 408 Permission for the Feather River West Levee Project Area C, dated September 16, 2013) included the following: construction of an SB, CB, and SCB cutoff wall ranging between 91 and 105 feet in depth along the centerline of the levee from LM 10.70 to LM 12.19, and from LM 15.11 to LM 16.04; reconstruction of the levee; and approximately 5,100 feet of depression infill. Construction was completed in June of 2015 under Contract No. 01-2013C.

SECTION 6 PROJECT PERFORMANCE

6-01. As constructed, the levee height provides for a freeboard of at least 3 feet above the adopted floodplain profile.

6-02. The federal project design flow is 300,000 cfs upstream of Bear River and 320,000 cfs downstream of Bear River. The authorized water surface profile of the federal project is the 1957 Profile. These flows and profiles remain unchanged by the improvements made as part of Projects B and C.

6-03. If the levee capacity is exceeded or fails, flooding occurs in the Sutter Basin, which includes portion of Sutter County, Yuba City, and adjacent agricultural areas.

6-04. Flood Flows. For the purposes of this manual, the term "flood" or "high water period" shall refer to flows when the water surface reaches or exceeds:

a. A reading of 65.0 (USED) on the California Data Exchange Center (CDEC) Yuba City (YUB) continuous water stage recorder and staff gage located near the right bank of the Feather River at the 5th Street Bridge (a.k.a. Twin Cities Memorial Bridge) in Yuba City;

b. A reading of 57.0 (USED) on the CDEC continuous water state recorder and staff gage located on the right bank of the Feather River at Boyd's Landing (FBL) near River Mile 21.0, approximately three miles south of Yuba City;

~~c. Staff gages are set on Corps of Engineers datum (USED).~~

SECTION 7 PROJECT COOPERATION AGREEMENT

7-01. Assurance of cooperation by local interests is provided by California State Legislation, as contained in Chapter 3, Part 2, Division 5, of the California State Water Code (see paragraph 2-02a of the Standard Manual).

7-02. Responsibility for operating and maintaining the competed works for Unit No. 144 was officially accepted by the Reclamation Board of the State of California (now known as the Central Valley Flood Protection Board or the CVFPB) on 18 December 1951 and 2 December 1952. See Appendix G.

7-03. Superintendent. The name and address of the Superintendent appointed by local interests to be responsible for the continuous inspection, operation and maintenance of the project works shall be furnished to the District Engineer, and in case of any change of Superintendent, the District Engineer shall be so notified.

7-04. Letters of acceptance and transfers can be found in Appendix G.

7-05. Cooperation Agreements can be found in Appendix I.

SECTION 8 OPERATION

8-01. Operation of the improved levees is to be carried out in the same manner as the existing levee system was operated prior to the improvements.

8-02. The pump station near Star Bend (approximate LM 4.39) shall be operated as necessary to properly drain the relief wells it serves.

8-03. Slide gates and other positive closure devices on irrigation pipelines penetrating the levee should be closed at the conclusion of the irrigation season and confirmed to be closed during each routine patrol during the flood season.

8-04. See Section 10 for maintenance and inspection requirements for Unit 144.

SECTION 9 EMERGENCY OPERATIONS

9-01. Emergency surveillance, communication, and chain of responsibility for the Unit No. 144 levees and associated infrastructure are to be under existing protocols of the Superintendent, under the supervision of the California Department of Water Resources.

9-02. The emergency operations are as recommended in Section 8 of the USACE's "*Standard Operation and Maintenance Manual for the Sacramento River Flood Control Project.*"

9-03. Repair of Damage. In the event of serious damage to the project works, whether due to flood conditions or other causes, and which may be beyond the capability of local interests to repair, the Superintendent will contact a representative of the California Department of Water Resources, who coordinates maintenance of project works of the Sacramento River Flood Control Project. The State representative will give assistance or advice, or will determine appropriate action to be taken.

9-04. Applicable Methods. For applicable methods of combating flood conditions, reference is made to Section VIII of the Revised Standard Manual, where the subject is fully covered.

9-05. Closure Structure Operation. Positive closures on irrigation pipelines should be checked and confirmed to be closed at each routine patrol during the flood season. During emergency high water events, positive closures on other utilities need to be closed. Positive closures on interior drainage pipelines shall be closed on a case-by-basis as determined by the Superintendent.

9-06. UPRR Closure Structure. As part of Project C, a closure structure will be constructed across the UPRR tracks at LM 16.09 to address levee freeboard deficiencies at this location. The closure structure consists of a permanent foundation and temporary aluminum panels that must be installed during a high water event. The temporary components will be stored at the Levee District 1 office located at 250 Second Street, Yuba City, California 95991. The emergency operation activities associated with the operation of the structure are summarized Table 9-1 on the following page. Refer to Appendix Q for more information on the installation of the temporary closure structure components.

Table 9-1 Summary of UPRR Closure Structure Installation Activities

Feather River at Yuba City (YUB) Gauge Elevation (USED)	Action
65.0-feet	• Visually check permanent components for damage. • Verify all temporary components are present and in good condition. • Continue to monitor current and projected river stages.
70.0-feet	• Mobilize temporary components and stage them near the closure structure (outside UPRR right-of-way). • Contact UPRR at 916-789-5152 to discuss the possibility of having to install the temporary components of the closure structure.
76.0-feet (Projected)	• Contact UPRR at 916-789-5152 to discuss the need to install the temporary components of the closure structure. • Install temporary components of the closure structure. • When the river stage subsides and is projected to continue decreasing, LD1 staff will contact UPRR and remove the closure structure.

NOTE: Peak Stage of Record for the YUB gauge was 78.2 feet (USED) on January 2, 1997

9-07. Monitoring of the System. Attention should be given to monitoring the performance of the levees during high water events to ensure that the improvements function as designed. Attention should be given to any cracking or slumping of the slopes or crown.

Groundwater levels should be monitored via the monitoring wells installed between LM 15.44 and LM 16.13 during high water levels. The monitoring wells contain a pressure transducer and are connected to centralized data loggers. The data loggers will transmit information via telemetry to the California Data Exchange Center (CDEC) where this data can be retrieved from http://cdec.water.ca.gov/.

Standard flood-fighting techniques should be employed during high water events and observed problem areas should be addressed promptly. Proper response during high water conditions will include measures to prevent erosion and promptly repair wave wash and scour damage. Typical flood fighting methods will include the following:

- High water patrolling and reporting of trouble spots
- Wave wash protection of eroded slopes
- Caving bank protection
- Scour hole repair
- Topping of low or eroding spots on the levee crown using sandbags, lumber and sack, or mud box bulkhead construction
- Flood barrier construction
- Sandbagging to control boils that are issuing sediment
- Brushing and sacking the landside levee slope

9-08. Other references include:

a. "*Design and Construction of Levees*," U.S. Army Corps of Engineers, EM 1110-2-1913, 30 April 2000.

b. A good summary of flood-fighting methods is contained in the DWR publication entitled, "*Flood Fighting Methods*," dated August 2010. This publication is included as Appendix D for reference.

SECTION 10 MAINTENANCE AND INSPECTION

10-01. Levees

a. Description. The levee described in this manual is located along the westerly side of the Feather River from the north boundary of LD 1 to the north boundary of MA 3. The levee within this unit was originally built by local interests and later re-constructed to project grade and section by the USACE. Surfacing was applied to the crown, turnouts, and road approaches were also provided.

b. For pertinent Requirements of the Code of Federal Regulations and other requirements see the following:
   1) Maintenance – paragraph 4-02 of the Standard Manual.
   2) Check Lists – Appendix E and F of this Supplement to the Standard Manual.
   3) Operation – paragraph 4-04 of the Standard Manual.
   4) Special Instructions – paragraph 4-05 of the Standard Manual.

c. Maintenance of cutoff walls: Modification or repair work in the vicinity of the SB, CB, or SCB cutoff wall should include provisions to avoid damaging the cutoff wall. The cutoff wall acts as an impervious barrier and shall not be penetrated at any point along its length or depth. Proposed future utilities shall be placed over the existing cutoff wall.

10-02. Drainage and Irrigation Structures

a. Description. ~~As part of the original supplemental manual, the drainage and irrigation structures which extend through the right bank of the levee are listed below. Any other encroachments not listed should be documented in the project's levee log.~~ A list of penetrations encountered as part of Projects B and C is included as Appendix R in this Supplement.

~~Location Station~~	~~Size and Kind of Pipe~~	~~Other Structure Description~~
~~1414+10~~	~~3" Steel~~	~~Extra strong galv. Pipe~~
~~1468+79~~	~~36" CMP~~	
~~1469+70~~	~~24" CMP~~	~~Yuba City outfall sewer, No. 781 gate valve No. 781 L.S. 2 Concr.~~
~~1473+60~~	~~18" Steel~~	~~Gas Line~~
~~109+23~~	~~12" Steel~~	
~~333+43~~	~~24" Steel~~	
~~358+00~~	~~8" Steel~~	
~~477+00~~	~~8" Steel~~	
~~486+00~~	~~10" Steel~~	
~~497+00~~	~~6" Steel~~	
~~529+28~~	~~12" Steel~~	

~~537+00~~	~~10" Steel~~	
~~574+20~~	~~8" Steel~~	
~~616+72~~	~~24" Steel~~	
~~638+07~~	~~8" Steel~~	
~~657+00~~	~~8" Steel~~	
~~678+00~~	~~8" Steel~~	
~~735+57~~	~~36" Steel~~	
~~736+00~~	~~54" CMP~~	
~~585+32~~	~~8" Steel~~	

~~CMP = Corrugated Metal Pipe~~
~~LS = Landside~~

b. For pertinent Requirements of the Code of Federal Regulations and other requirements see the following:
   1) Maintenance – paragraph 5-02 of the Standard Manual.
   2) Check Lists – Appendix E and F of this Supplement to the Standard Manual.
   3) Operation – paragraph 5-04 of the Standard Manual.
   4) Additional Requirements – paragraph 5-05 of the Standard Manual.
   5) Safety Requirements – paragraph 5-06 of the Standard Manual.

10-03. Channel

a. Description. The channel of the Feather River within this unit consists of an overflow area that varies in width from 1,200 feet to over 6,000 feet that is confined between levees along both banks. This reach of the Feather River from the north boundary of LD 1 to the north boundary of MA 3, has a project capacity of 300,000 to 320,000 cubic feet per second and the levee provides for a freeboard of at least three feet above the adopted floodplain profile. There is a considerable growth of trees and brush in the overflow portion of the channel. The maintenance and operation of the channel of the Feather River, within this unit, shall be limited to flood control and the requirements which follow shall be observed to that extent and also as indicated in the various Biological Opinions (see Section 10-05 of this Supplement).

b. For pertinent Requirements of the Code of Federal Regulations and other requirements see the following:
   1) Maintenance – paragraph 6-02 of the Standard Manual.
   2) Check Lists – Appendix E and F of this Supplement to the Standard Manual.
   3) Operation – paragraph 6-04 of the Standard Manual.
   4) Safety Requirements – paragraph 5-06 of the Standard Manual.

c. It shall be the duty of the Superintendent to maintain a patrol of the project works during all periods of flood in excess of the reading defined in section 6-04 of this Supplement. The Superintendent shall dispatch a message by the most suitable means to the District Engineer whenever the water surface at Yuba City or below Shanghai bend reaches the gage readings indicated above. The Superintendent shall cause readings to be taken at said gages at intervals of two to four hours during the

period when the water surface is above the flood-flow stage indicated above and record the time of observations. One copy of the readings shall be forwarded to the District Engineer immediately following the flood, and a second copy transmitted as an enclosure to the semi-annual report in compliance with paragraph 3-05 of the Standard Manual.

10-04. Miscellaneous Facilities

a. Description. Miscellaneous structures or facilities which were constructed as part of or existed in conjunction with, the protective works, and which might affect their functioning, include the following:

1) Bridges
   a) Southern Pacific Railroad trestle at station 1384+00
   b) Highway 99E bridge crossing at station 1482+70
   c) Sacramento Northern Railroad Bridge and highway crossing at station 2+77.

2) Utility Relocations.
   a) Portions of the two 15-inch Star Bend Pump Station discharge pipes were re-constructed at LM 4.39.
   b) A portion of the 8-inch Sierra Gold Nursery pipe was reconstructed at LM 4.86.
   c) Portions of the four 26-inch Feather Water District pipes were reconstructed at LM 6.96.
   d) A portion of the 8-inch Sierra Gold Nursery pipe was reconstructed at LM 7.27.
   e) A portion of the 16-inch Oswald Mutual Water Company discharge pipe was reconstructed at LM 7.75.
   f) A portion of the Yuba City Sewer Outfall was reconstructed at LM 10.33.
   g) Portions of the two 26-inch Yuba City drainage discharge pipes were reconstructed at LM 10.91.
   h) A portion of the 18-inch Yuba City Burns Drive discharge pipe was reconstructed at LM 11.62.
   i) A portion of the 12-inch Yuba City drainage discharge pipe was reconstructed at LM 11.63.
   j) A portion of the Levee District 1 Boat Dock and RV Park waterline will be reconstructed at LM 13.11 in the spring and summer of 2016.
   k) Portions of the four Gilsizer County Drainage District storm drain discharge pipes were reconstructed at LM 14.45 and 14.46.
   l) Portions of the three Yuba City raw water pipes and 3-inch air pipe were reconstructed at LM 15.47.
   m) A portion of the 16-inch Yuba City storm drain discharge pipe was reconstructed at LM 15.75.
   n) A portion of the 10-inch Village Green storm drain will be reconstructed at LM 16.05 in the spring and summer of 2016.

3) Hydrographic Facilities (to be maintained by other agencies)
   a) See Section 6 for further information.

4) Relief Wells

a) Maintenance: The relief wells will require maintenance to ensure continuous proper functioning. Relief wells will must be maintained per EM-1110-2-1914.

b) Inspection: The relief wells shall be inspected annually to verify that they are functional and that no conditions exist that would prevent them from operating as intended in the future. Annual inspections shall be planned immediately prior to yearly high flows, and additional inspections may be warranted during unusually high flows. The inspections shall include an examination of the structure, piping, gaskets, and flanges inside each manhole for unauthorized use, vandalism, or other irregularities.

Any items that are malfunctioning or have been damaged shall be replaced. Each relief well shall be sounded to determine whether sediment or other debris have been deposited in the wells. All wells requiring sediment removal shall be pump tested afterward to ensure that the well efficiency has not decreased appreciably due to the presence of foreign material in the well.

Relief well access points shall be maintained so that cover plates can be easily removed for inspection of the tees and surrounding piping. The outfall structures shall be kept clear of debris or other material that may affect the operation of the outlet pipe flap gates.

c) Testing: The relief wells should be pump tested on a regular basis using the procedures outlined in USACE EM 1110-2-1914, Chapter 8. The purpose of these tests is to measure the efficiencies and flow capacities of the wells. Pump tests shall be performed every five years.

During pump tests, runoff shall be directed through the lateral pipes toward the outfall structures in order to ensure that the lines are free of blockages and the flap gates function properly. Sediment amounts in the relief wells shall be measured by sounding the well before and after pump tests. If significant algae or other biological growth is suspected within the well, the well shall be cleaned as described in Section 12-04 of this Supplement. If efficiencies are less than 80% of those recorded at the time of installation, corrective measures per USACE EM 1110-2-1914, Chapters 10 and 11 shall be employed. If corrective measures are implemented but do not improve performance to at least 80% of the original efficiency, replacement of the inefficient well(s) should be considered.

d) Evaluation: The measurements obtained during pump tests shall be evaluated in accordance with EM1110-2-1914 in order to evaluate the performance of the well.

e) Record Keeping: Records shall be kept of all inspection and maintenance of the relief wells. Data shall include pump test information, general maintenance records, and summaries of observed relief wells flows during high water events.

5) Monitoring Wells

The monitoring wells shall be maintained as needed to ensure that they can collect and transmit groundwater levels data during high water events.

6) Observation Wells

Existing relief wells between LM 10.73 and LM 12.25 were converted to observation wells. These wells no longer need to be maintained as relief wells. In the future, these wells will be abandoned, pending confirmation that the cutoff wall in this segment performs satisfactorily during a high water event (defined by the design team as being a flood event equal to or greater than the 2006 event).

7) UPRR Closure Structure

The permanent components for a closure structure across the UPRR tracks will be installed at LM 16.09. During routine inspections of the Feather River West Levee, all permanent components should be inspected to ensure that they are intact. If damage is noted, it should be repaired as soon as practical.

At least once each year, all temporary components need to be visually inspected to ensure that all components are present and in good condition. At least once every five years, the closure structure shall be assembled and installed. Prior to installation of the closure structure, UPRR must be contacted at (916) 789-5152 in order to confirm that activities can be completed within the allowable track windows.

b. For pertinent Requirements of the Code of Federal Regulations and other requirements see the following:
   1) Maintenance – paragraph 7-02 of the Standard Manual.
   2) Check Lists – paragraph 7-03 of the Standard Manual.
   3) Operation – paragraph 7-04 of the Standard Manual.

10-05. Environmental Protection

a. The following and USFWS B.O. #81420-2008-F-0805-1 within Appendix J pertain to the repair site at Feather RM 28.5R;
   1) Trees, either preserved or planted, shall not be removed as long as they remain healthy. As unhealthy trees are removed or fall over, any subsequent cavities in the rock must be filled in a timely manner with rock material equal to the surrounding repair. Leave the fallen trees in place. Dead or fallen trees will be retained except where they are a hazard to existing flood control work.

2) In-stream Woody Material (IWM) has been used in conjunction with levee improvements at these locations. IWM is expected to degrade and wash away over time, therefore, it is not a requirement of normal maintenance to replace this material. IWM should not be removed from the site through maintenance activities. Additionally, any woody debris that arrives at the site and is deposited shall be left in place/not removed by the Superintendant, provided it is not posing a hazard to the existing flood control work.

3) Vegetation within mitigation areas shall be left in a natural state. No additional maintenance such as irrigation or mowing shall be required as a part of normal maintenance.

4) Soil placed on/in rock as a part of the original repair and all associated vegetation (grasses & woody shrubs/trees) within the footprint of the bank protection sites at these locations do not require replacement as a part of normal maintenance. In other words, if the soil is washed out it does not need to be replaced and re-vegetated. However in areas where soil remains or new sediment is deposited and the vegetation is dislodged/ destroyed or leaves areas greater than 3' x 3' of exposed soil for more than 30 days during the months of April through November, those areas shall be hydro-seeded using the seed mix indicated on the As-Built.

5) Vegetation, soil, and IWM placed on the erosion repair site were done so as on-site mitigation for the construction of the site. Vegetation (trees and shrubs) helps protect against soil erosion and provides shade cover for endangered salmonid species migrating up and down the river during various times of the year. Living and dead IWM provides diverse habitat and refuge for several fish species during low flow conditions. These features shall not be removed or damaged in any way.

b. The Superintendant shall preserve and maintain at least 20 acres of Valley Elderberry Longhorn Beetle (VELB) habitat, as long as the VELB is a threatened or endangered species by USFWS, consistent with the USFWS B.O. #81420-2009-F-0372-1, dated February 6, 2009 (Appendix K), and shall use as a reference the Habitat Enhancement Plan (HEP) for the Setback Levee at Star Bend, dated March 6, 2009, (Appendix K) to comply with the B.O.

1) The vegetation maintenance and monitoring plan for the enlarged floodplain at Star Bend should be developed to be responsive to maintaining the flow conveyance and flood safety attributes of the improved flood control system at Star Bend while collectively meeting the USFWS Biological Opinion mitigation, compensatory, and conservation conditions specifically developed for the Setback Levee at Star Bend.

2) In no event shall the vegetation in the floodplain within the Star Bend Project Area be managed to infringe upon the water surface profile defined by the USACE 1957 design profile and associated freeboard.

SECTION 11 SURVEILLANCE

11-01. See Section 10, Maintenance and Inspection for required project surveillance.

11-02. The project design of the Setback Levee (see Section 5-01, item t, of this Supplement to the Standard Manual) anticipated a total post-construction settlement of approximately four inches (0.33 feet). Should the settlement exceed this amount, an engineer should be consulted to evaluate the levee height with respect to the design water surface. The Superintendent shall monitor settlement gages per the design requirements to ensure settlement does not exceed the specified amount.

11-03. Post-construction differential settlement, cracking, and small slips could take place along the ~~setback~~ levee ~~at Star Bend~~. Observations of any cracking, differential settlement, or slips shall be recorded and reported to a qualified engineer, DWR representatives and USACE personnel. Applicable remediation measures shall be developed to correct normal and abnormal distress issues that may be encountered.

11-04 Relief Wells: Flow quantities shall be measured at times during which the wells have been functioning. Flow quantities shall also be checked approximately one week after a peak occurs in the river level.

In addition, the ground area adjacent to the levee shall be checked for wet spots that are indicative of malfunctioning relief wells and for resulting seeps through the underlying clay blanket. The outfall structures shall be inspected for general condition and cleared of debris. Flap gates on outlet pipes shall be inspected to ensure free rotation about their hinges.

11-05 Information will be added to future drafts of this O&M Supplement for levee instrumentation.

SECTION 12 REPAIR, REPLACEMENT, AND REHABILITATION

12-01. Repair is considered to entail those activities of a routine nature that maintain the project in a well-kept condition. Replacement covers those activities taken when a worn-out element or portion thereof is replaced. Rehabilitation refers to a set of activities as necessary to bring a deteriorated project back to its original condition. RR&R actions are to conform to the project as-built plans and specifications unless other arrangements are made with the district commander. These activities are the responsibility of the Superintendent.

12-02. All repairs, replacements, and/or rehabilitations should be made as recommended in the USACE's *"Standard Operation and Maintenance Manual for the Sacramento River Flood Control Project,"* and to the specifications for the original project construction.

12-03. The Superintendent should take into consideration the timing and urgency of the specific repairs. Depending upon the nature and severity of the repair it may be advisable to proceed with the repairs prior the next flood season, or proceed cautiously during a current flood season. Other methods or procedures may need to be deployed by the Superintendent and approved by the USACE if the repairs are required during an immediate flood season.

12-04. Damage to relief wells must be corrected promptly. Any condition that prohibits flow in or from relief wells could result in potentially unstable and hazardous conditions. Malfunctioning and damage to the relief wells can be caused by vandalism, breakage, or excessive deformation of the well screens due to ground movements, corrosion or erosion of the well screen.

a. Repair

The need for relief well repairs is described in EM 1110-2-1914 as follows:
"The analysis of well discharge records and accompanying piezometric data will often indicate whether the relief wells are functioning as intended. A decrease in well discharges with time for similar river stages with rising piezometric levels between wells is usually indicative of decreasing well efficiency. A quantitative measure of the loss in efficiency is only determined by carefully conducted pumping tests. Should the pumping tests indicate a reduction in specific capacity of more than 20 percent compared to that measured at installation, a detailed study should be made of the consequences of the reduction and what remedial measures should be employed. Generally, it may be possible to restore the wells to near their original efficiency by means of rehabilitation techniques."

b. Rehabilitation

The need for relief well rehabilitation is described in EM 1110-2-1914 (Chapter 12) as follows:

i. Mechanical Rehabilitation

Plugging of relief wells by silts, clays, or other particulate media entering the filter pack resulting either from the formation or through the top of the well is usually

difficult to determine except as indicated by periodic pumping tests. If significant reductions in specific yield are noted, rehabilitation of the well is in order. Mechanical redevelopment of the well similar to that used to develop a new well should be the first step. Overpumping or pumping the well at the highest rate attainable is generally advantageous. Surging and the use of horizontal jetting devices also may produce beneficial results.

ii. Chemical Treatment

Mechanical plugging of relief wells is corrected most often by chemical treatment with polyphosphates. These chemicals act as dispersing agents that cause silt and clay particles to repel one another. They also cause and calcium, magnesium, and iron ions adhering to the particles to remain in a soluble state. The most widely used chemicals for this purpose are the glassy sodium phosphates which are inexpensive and readily available. The chemicals are usually applied in concentrations of 15 to 25 pounds per 100 gallons of water in combination with at least 50 ppm of chlorine (about one-half gallon of 3 percent household bleach or chlorox in 100 gallons of water). Phosphate solutions are mixed in a barrel or tank adjacent to the well. The material is best dissolved in small amounts in a wire basket or perforated container in agitated or swirling water. If the material is dropped directly into the tank or well, it will sink to the bottom and form a large gelatinous mass that could remain undissolved for some time. One of the most effective means of introducing the phosphate and chlorine solution into the well is by means of a horizontal jetting device. The well should then be surged vigorously prior to pumping. Three or more repetitions of injecting, surging, and pumping over a 2 to 4-hour cycle will be much more effective than a single treatment with a longer detention time.

As clogging of well screens and filter materials is caused not only by the organic material produced by the bacteria but also by oxides and hydroxides of iron and manganese, better results are usually obtained by treating the well alternately with a chlorine compound to attack the organic material and a strong acid to dissolve the mineral deposits. Between each treatment the well is pumped to waste to ensure that chlorine and acid are not in the well at the same time. A recommended procedure using the two procedures is:

a. Inject a mixture of acid, inhibitor, and wetting agent. The addition of a chelating agent such as hydroxyactic acid may sometimes be beneficial. An inhibitor is needed only if the well screen is metal. The amount of acid should be typically one and a half to two times the volume of the well screen. If a chelating agent is not used, iron will precipitate out if the pH rises above 3. The precipitate can result in clogging; therefore the pH should be monitored throughout the acid treatment and not be allowed to rise above 3 regardless of whether a chelating agent is used.
b. Gently agitate the solution with a jetting tool at b-mm intervals for a period of 1 to 2 hours.
c. Pump out a volume of solution equal to the volume of the well.
d. Determine the pH of solution removed from the well. If the pH is more than 3, repeat steps (a) to (c).

e. Allow the acid to remain in the well for a minimum of 12 hours and then pump to waste.
f. Inject a mixture of chlorine and one or more chloric-stable surfactants (detergents and wetting agents, for example). The concentration of the chlorine should exceed 1,000 ppm.
g. Gently agitate the solution with a jetting tool at b-mm intervals every 2 hours for the first 8 hours and then at 8-hour intervals for at least 24 hours.
h. Pump out a volume of solution equal to the volume of the well.'
i. Determine chlorine concentration. If the concentration is less than 10 percent of the original concentration, repeat steps f to h.
j. Perform a pumping test on the well. If the specific capacity has improved by more than 5 percent, repeat the entire procedure until the specific capacity does not improve by 5 percent.

Table 12-1: Quantities of Various Chlorine Compounds Required to Provide as Much Available Chlorine as 1 lb of Chlorine Gas

Chemical	% Available Chlorine	Number of lb Equivalent to 1 lb Cl_2
Chlorine Gas	100	1.0
Calcium Hypochlorite	65	1-54
Lithium Hypochlorite	36	2.78
Sodium Hypochlorite	12.5	8.0
Trichlorisocyanuric Acid[2]	90	1.11
Sodium dichloroisocyanurate[2]	63	1.59
Potassium dichloroisocyanurate[2]	60	1.67
Chlorine Dioxide	4	25
Chlorine Dioxide	2	50.0

Notes:
1. From Driscoll (1986).
2. Chlorine compounds that incorporate isocyanuric acid stabilize the chlorine against degradation from sunlight. Except for storage, the advantage offered by the addition of isocyanuric acid is less valuable in water wells.

iii. Specialized Treatment

The USACE Waterways Experiment Station personnel, funded under a repair evaluation maintenance and restoration (REMR) work unit, developed a field procedure (Kissane and Leach 1991) for cleaning water wells that provides initial kill of the active bacteria in the well, dissolves the biomass in the screen, in the gravel pack, and some distance into the aquifer, and provides some inhibition of future growth. The procedure was developed using a patented process known as the Aliord Rodgers Cullimore Concept (ARCC). The procedures in general include an initial well diagnosis performed with a prepackaged field microbiological test kit which is designed to give a qualitative indication of the types of bacterial and chemical agents at work in the wells, and a very general indication of the bacterial concentrations. The initial water chemistry is also measured prior to treatment. A treatment is then designed with the information from the tests, targeting the problematic agents with an appropriate set of chemicals. Redevelopment of the wells using the ARCC method is based on the use of blended chemicals and high temperature (BCHT) and is divided into three principle elements of treatment:

a. **Shock.** This phase is achieved by adding high temperature chlorinated water to the well and surrounding aquifer to shock kill or reduce the impact of deleterious algae and bacteria. The water is chlorinated to >700 ppm with gaseous chlorine to avoid binders found in powdered chlorine and is applied to the well as steam until the well temperature is brought above 120 deg F for massive bacteria kill. The chlorine treatment remains in the well for a specified period of time mechanical surging is used and pumping follows for removal of the initial loosened biomass.

b. **Disrupt.** This phase is achieved by the addition of chemical agents, acids and surfactants, and steam to the well and surrounding aquifer while the well is pressurized. Mechanical surging to break up organic and mineral clogging in the system is also used. The mechanical surging and chemical set time are important during this phase to achieve dissolution of the remaining biomass.

c. **Disperse.** This phase of treatment consists of removal of the material that has been clogging the well and aquifer. Acceptance criteria for the well are checked and further cycles are considered or a final cold chlorination treatment is applied for inhibition of any remaining bacterial colonies.

c. Replacement

Relief wells that are no longer acceptable due to collapse, excessive sediment production, or other condition should be replaced according to the plans and specs. New wells should be installed and operational before the old ones are abandoned.

SECTION 13 NOTIFICATION OF DISTRESS

13-01. Notification of distress should be reported in accordance with ER 1110-2-101, "*Reporting of Evidenced of Distress of Civil Works Structures.*"

APPENDICES – DRAFT ONLY INCLUDES B, O, P, Q, and R

APPENDIX B

APPENDIX C

APPENDIX O

RELIEF WELL, MONITORING WELL, AND OBSERVATION WELL LOCATION TABLE				
Aprox. Levee Mile	**Aprox. Station**	**Latitude**	**Longitude**	**Description**
12.25	926+69	39.118254	-121.603925	Observation Well
12.23	925+69	39.118002	-121.604072	Observation Well
12.21	924+69	39.117755	-121.604218	Observation Well
12.19	923+69	39.117507	-121.604373	Observation Well
12.17	922+70	39.117264	-121.604531	Observation Well
12.15	921+69	39.117017	-121.604690	Observation Well
12.13	920+70	39.116773	-121.604847	Observation Well
12.11	919+69	39.116526	-121.605006	Observation Well
12.10	918+70	39.116282	-121.605164	Observation Well
12.08	917+70	39.116036	-121.605320	Observation Well
12.06	916+70	39.115792	-121.605482	Observation Well
12.04	915+69	39.115545	-121.605640	Observation Well
12.02	914+69	39.115301	-121.605799	Observation Well
12.00	913+70	39.115057	-121.605958	Observation Well
11.96	911+72	39.114554	-121.606271	Observation Well
11.94	910+72	39.114284	-121.606394	Observation Well
11.93	909+70	39.114010	-121.606502	Observation Well
11.91	908+67	39.113739	-121.606613	Observation Well
11.89	907+68	39.113476	-121.606710	Observation Well
11.87	906+67	39.113212	-121.606811	Observation Well
11.85	905+65	39.112937	-121.606904	Observation Well
11.83	904+65	39.112659	-121.606997	Observation Well
11.81	903+66	39.112377	-121.607048	Observation Well
11.79	902+63	39.112092	-121.607100	Observation Well
11.77	901+65	39.111820	-121.607140	Observation Well
11.75	900+66	39.111551	-121.607179	Observation Well
11.74	899+66	39.111278	-121.607220	Observation Well
11.72	898+66	39.111005	-121.607261	Observation Well
11.70	897+66	39.110733	-121.607307	Observation Well
11.68	896+66	39.110459	-121.607344	Observation Well
11.66	895+66	39.110189	-121.607398	Observation Well
11.64	894+67	39.109916	-121.607425	Observation Well
11.62	893+57	39.109620	-121.607491	Observation Well
11.60	892+66	39.109365	-121.607445	Observation Well
11.58	891+66	39.109090	-121.607481	Observation Well
11.56	890+66	39.108818	-121.607519	Observation Well
11.55	889+66	39.108544	-121.607555	Observation Well
11.53	888+66	39.108271	-121.607592	Observation Well
11.51	887+71	39.108013	-121.607625	Observation Well
11.49	886+79	39.107763	-121.607662	Observation Well
11.47	885+74	39.107473	-121.607694	Observation Well
11.45	884+67	39.107181	-121.607728	Observation Well
11.43	883+66	39.106905	-121.607760	Observation Well
11.41	882+67	39.106632	-121.607793	Observation Well
11.40	882+12	39.106473	-121.607804	Observation Well
11.37	880+60	39.106040	-121.607813	Observation Well
11.36	879+63	39.105766	-121.607793	Observation Well
11.34	878+69	39.105493	-121.607756	Observation Well

RELIEF WELL, MONITORING WELL, AND OBSERVATION WELL LOCATION TABLE				
Aprox. Levee Mile	**Aprox. Station**	**Latitude**	**Longitude**	**Description**
11.32	877+68	39.105212	-121.607706	Observation Well
11.30	876+67	39.104932	-121.607633	Observation Well
11.28	875+68	39.104653	-121.607545	Observation Well
11.26	874+68	39.104384	-121.607439	Observation Well
11.24	873+69	39.104115	-121.607315	Observation Well
11.22	872+67	39.103849	-121.607174	Observation Well
11.21	871+91	39.103642	-121.607089	Observation Well
11.19	870+97	39.103404	-121.606909	Observation Well
11.18	870+10	39.103165	-121.606806	Observation Well
11.15	868+66	39.102838	-121.606507	Observation Well
11.13	867+65	39.102606	-121.606315	Observation Well
11.11	866+65	39.102378	-121.606115	Observation Well
11.09	865+65	39.102151	-121.605921	Observation Well
11.07	864+66	39.101932	-121.605710	Observation Well
11.05	863+66	39.101699	-121.605522	Observation Well
11.03	862+65	39.101470	-121.605326	Observation Well
11.02	861+65	39.101236	-121.605139	Observation Well
11.00	860+65	39.101009	-121.604942	Observation Well
10.98	859+65	39.100777	-121.604751	Observation Well
10.96	858+66	39.100551	-121.604559	Observation Well
10.94	857+47	39.100273	-121.604340	Observation Well
10.92	856+52	39.100056	-121.604149	Observation Well
10.90	855+60	39.099841	-121.603982	Observation Well
10.88	854+66	39.099624	-121.603801	Observation Well
10.86	853+65	39.099386	-121.603624	Observation Well
10.84	852+66	39.099149	-121.603448	Observation Well
10.83	851+65	39.098910	-121.603273	Observation Well
10.81	850+65	39.098650	-121.603137	Observation Well
10.79	849+65	39.098421	-121.602945	Observation Well
10.77	848+65	39.098191	-121.602752	Observation Well
10.75	847+66	39.097963	-121.602561	Observation Well
10.73	846+64	39.097726	-121.602369	Observation Well
5.19	553+99	39.020512	-121.612445	Relief Well
5.18	553+29	39.020336	-121.612344	Relief Well
5.16	552+59	39.020161	-121.612243	Relief Well
5.15	551+90	39.019805	-121.612035	Relief Well
5.15	551+90	39.019986	-121.612142	Relief Well
5.14	551+20	39.019618	-121.611904	Relief Well
5.12	550+49	39.019451	-121.611765	Relief Well
5.11	549+79	39.019291	-121.611630	Relief Well
5.10	549+09	39.019130	-121.611495	Relief Well
5.08	548+39	39.018969	-121.611360	Relief Well
5.06	547+24	39.018705	-121.611138	Relief Well
5.04	546+09	39.018441	-121.610916	Relief Well
4.98	543+16	39.017778	-121.610430	Abandoned Relief Well
4.97	542+67	39.017653	-121.610360	Abandoned Relief Well
4.96	542+17	39.017528	-121.610294	Abandoned Relief Well

RELIEF WELL, MONITORING WELL, AND OBSERVATION WELL LOCATION TABLE				
Aprox. Levee Mile	**Aprox. Station**	**Latitude**	**Longitude**	**Description**
4.96	541+67	39.017401	-121.610223	Abandoned Relief Well
4.95	541+16	39.017274	-121.610154	Abandoned Relief Well
4.94	540+68	39.017150	-121.610088	Abandoned Relief Well
4.93	540+17	39.017022	-121.610020	Abandoned Relief Well
4.92	539+68	39.016897	-121.609951	Abandoned Relief Well
4.91	539+19	39.016767	-121.609881	Abandoned Relief Well
4.90	538+70	39.016644	-121.609814	Abandoned Relief Well
4.89	538+21	39.016517	-121.609745	Abandoned Relief Well
4.88	537+71	39.016393	-121.609671	Abandoned Relief Well
4.87	537+21	39.016272	-121.609589	Abandoned Relief Well
4.86	536+74	39.016154	-121.609507	Abandoned Relief Well
4.85	536+26	39.016034	-121.609424	Abandoned Relief Well
4.84	535+78	39.015912	-121.609339	Abandoned Relief Well
4.83	535+30	39.015788	-121.609256	Abandoned Relief Well
4.83	534+82	39.015674	-121.609168	Abandoned Relief Well
4.82	534+30	39.015556	-121.609068	Abandoned Relief Well
4.81	533+81	39.015437	-121.608984	Abandoned Relief Well
4.79	532+79	39.015203	-121.608798	Abandoned Relief Well
4.77	531+78	39.014969	-121.608614	Abandoned Relief Well
4.75	530+82	39.014736	-121.608432	Abandoned Relief Well
4.73	529+53	39.014429	-121.608091	Abandoned Relief Well
4.72	529+02	39.014330	-121.607967	Abandoned Relief Well

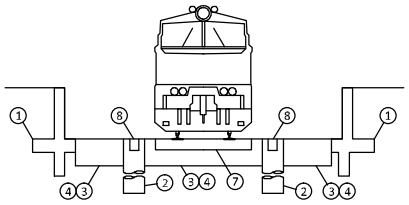
APPENDIX P

Unit 144 Levee Mile, River Mile, and Design Station Conversion Table		
River Mile	Wood Rodgers Design STA	Levee Mile
12.88	280+04	0
13	286+44	0.12
13.25	299+77	0.37
13.5	312+39	0.61
13.75	322+70	0.81
14	335+08	1.04
14.25	349+04	1.31
14.5	363+19	1.57
14.75	378+17	1.86
15	391+03	2.10
15.25	403+05	2.33
15.5	416+13	2.58
15.75	433+56	2.91
16	451+01	3.24
16.25	462+28	3.45
16.5	470+13	3.60
16.75	480+94	3.80
17	485+56	3.89
17.25	487+95	3.94
17.5	491+14	4.00
17.75	494+00	4.05
18	497+04	4.11
18.25	518+90	4.52
18.5	528+98	4.71
18.75	536+23	4.85
19	547+13	5.06
19.25	555+17	5.21
19.5	568+63	5.47
19.75	588+52	5.84
20	604+60	6.15
20.25	619+77	6.43
20.5	633+32	6.69
20.75	646+76	6.95
21	660+47	7.21
21.25	673+30	7.45
21.5	687+12	7.71
21.75	700+18	7.96
22	714+98	8.24
22.25	728+52	8.49
22.5	741+07	8.73
22.75	753+46	8.97
23	768+10	9.24
23.25	780+33	9.48
23.5	794+95	9.75

23.75	808+92	10.02
24	822+69	10.28
24.25	830+76	10.43
24.5	837+44	10.56
24.75	840+85	10.62
25	846+13	10.72
25.25	862+08	11.02
25.5	877+28	11.31
25.75	891+37	11.58
26	906+34	11.86
26.25	920+96	12.14
26.5	934+95	12.40
26.75	947+06	12.63
27	957+88	12.84
27.25	970+11	13.07
27.5	981+74	13.29
27.75	995+12	13.54
28	1007+99	13.79
28.25	1022+81	14.07
28.5	1035+22	14.30
28.75	1044+18	14.47
29	1056+28	14.70
29.25	1069+38	14.95
29.5	1079+65	15.14
29.75	1092+17	15.38
30	1113+57	15.79
30.25	1126+77	16.04
30.36	1132+61	16.15

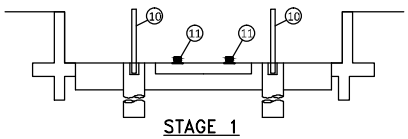
APPENDIX Q

APPENDIX Q - CLOSURE STRUCTURE ASSEMBLY SEQUENCE DETAILS



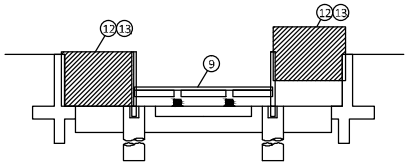
NORMAL OPERATION

NORMAL OPERATION



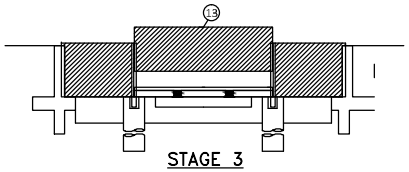
STAGE 1

1. a. INSTALL NEOPRENE GASKET AT RAILS.
   b. REMOVE POST SOCKET COVER PLATE. (31 lbs EACH)
   c. INSTALL POST ASSEMBLIES. (44 lbs EACH)



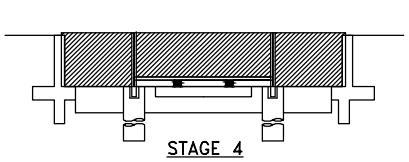
STAGE 2

2. a. INSTALL CHANNEL BASE ASSEMBLY.
   BASE ASSEMBLY – 203 lbs
   b. INSTALL OUTER PANEL ASSEMBLIES.
   OUTER PANEL ASSEMBLIES – 190 lbs
   c. BASE ASSEMBLY IS SECURED BY THE NEOPRENE GASKET WITHIN THE WEB OF THE POST ASSEMBLY (SEE DETAIL 2 THIS SHEET)
   d. OUTER PANEL ASSEMBLY IS SECURED BY THE NEOPRENE GASKET WITHIN THE WEB OF THE POST ASSEMBLY AND INSERTS INTO VERTICAL SLOT AT THE RETAINING WALL. (SEE DETAIL 2 THIS SHEET).



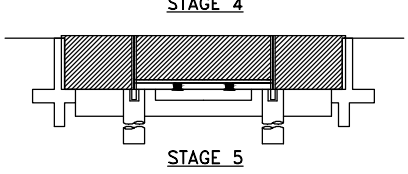
STAGE 3

3. a. INSTALL CENTER PANEL ASSEMBLY. (373 lbs EACH)
   CENTER PANEL ASSEMBLY IS SECURED BY NEOPRENE
   b. GASKETS WITHIN THE WEB OF THE POST ASSEMBLIES.



STAGE 4

4. INSTALL RUBBER STOPS AND SECURE WITH 'C' CLAMPS PER DETAIL 3 ON THIS SHEET



STAGE 5

5. COMPLETED FLOOD GATE

ASSEMBLY SEQUENCE

SCALE: N.T.S.

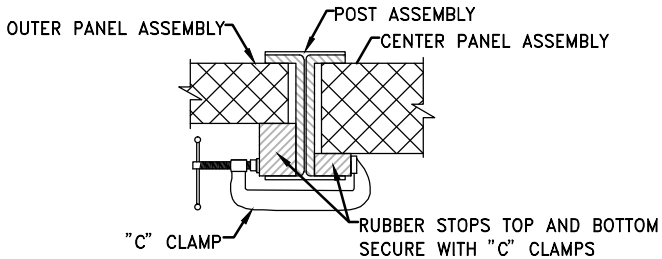
1

PERMANENT COMPONENTS

1. REINFORCED CONCRETE RETAINING WALL (2 TOTAL).
2. CAST IN STEEL SHELL CONCRETE PIER WITH STAINLESS STEEL POCKET ASSEMBLY EMBEDMENT TO RECEIVE REMOVABLE ALUMINUM POST (2 TOTAL).
3. STRUCTURAL STEEL CUTOFF PLATE ASSEMBLY (3 TOTAL).
4. STRUCTURAL STEEL SEAT ASSEBLY BOLTED TO CUTOFF PLATE (3 TOTAL).
5. COMPACTED STRUCTURAL BACKFILL.
6. BALLAST.
7. RAILS AND RR TIES.

REMOVABLE / TEMPORARY COMPONENTS

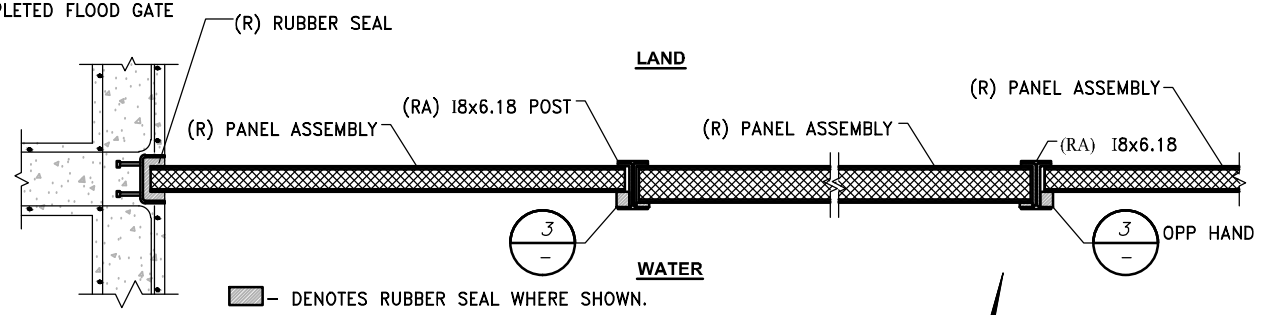
8. POST SOCKET COVER PLATE ASSEMBLY (2 TOTAL).
9. ALUMINUM CHANNEL BASE ASSEMBLY.
10. ALUMINUM POST ASSEMBLY. ASSEMBLY CONSISTS OF ONE I8x6.18 WITH RUBBER GASKETS EACH SIDE OF WEB TO RECEIVE PANEL ASSEMBLIES. (2 TOTAL).
11. NEOPRENE GASKET MOLDED OR CUT TO FIT SNUG AROUND RAIL (2 TOTAL).
12. RUBBER SEAL AT SLOTS IN FACE OF RETAINING WALL (2 TOTAL)
13. ALUMINUM PANEL ASSEMBLY (3 TOTAL).



RUBBER STOPS

SCALE: N.T.S.

3



DETAIL

SCALE: N.T.S.

2

APPENDIX R