IRRIGATION TRAINING & RESEARCH CENTER

Flathead Indian Irrigation Project
Mission Canal Unit Modernization

U.S. Bureau of Indian Affairs
Branch of Irrigation & Power

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Modernization Plan

Figure 1 on the next page shows the general modernization changes in the Mission Canal Unit. The key modernization changes include:

1. Improved flow measurement will be provided at Tabor Reservoir.
2. Control changes will be made in the Mission A Canal in order to keep variable flows in the main canal rather than in the creeks.
3. Flow measurement improvements will be made at Mission A Canal and Ashley Creek.
4. Modifications to the Mission B and C Canal subsystem:
    a. Physical improvements will be made to the Mission B Canal in order to increase the flow rate capacity.
    b. Improved flow measurement will be provided at the head of the Mission B Canal.
    c. The existing water level control down the Mission B Canal will be improved to maintain a constant upstream water level over a wide range of flows.
    d. Multiple limited-demand pipelines will be constructed to divert water from the Mission B Canal to service the majority of the irrigated fields in the Mission Canal Unit.
    e. A new spill channel will convey excess flows near the end of the Mission B Canal to the Post F Canal.
    f. The Mission C Canal will be abandoned.
5. Improved water level control and operations spill measurement will be incorporated into the Mission F Canal to ease management for operators.
6. SCADA will be incorporated to remotely monitor flow rates and water levels at key locations in the Mission Canal Unit in order to effectively manage the movement of water.

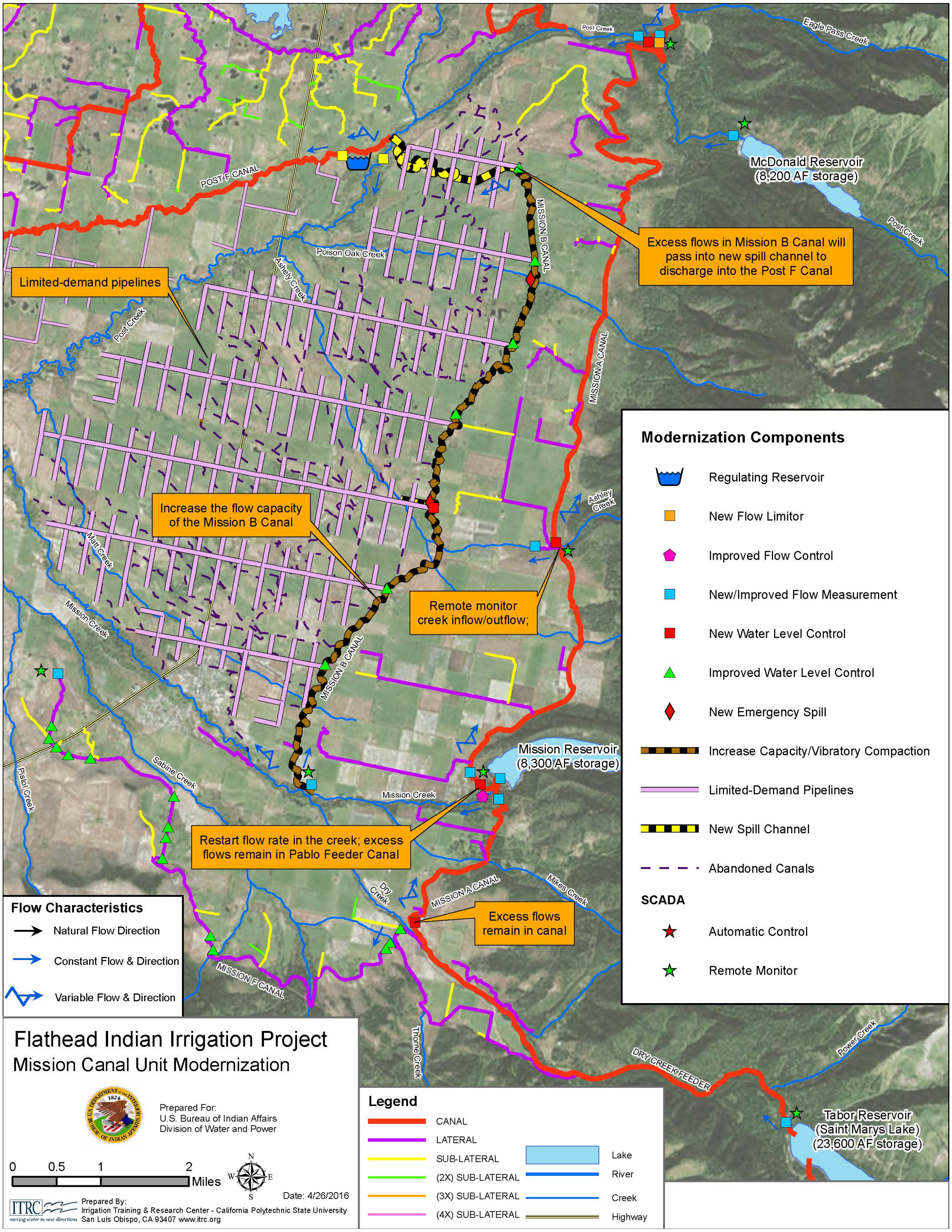

Figure 1. Overall modernization changes made to the Mission Canal Unit

Tabor Reservoir

Tabor Reservoir has a maximum storage capacity of approximate 23,600 AF. The reservoir collects water from the North Fork Jocko River as well as inflows from multiple creeks (Fall Creek being the most significant inflow). A maximum of approximately 250 CFS is released from Tabor Reservoir into the Dry Creek Feeder Canal, which is concrete lined all the way to Dry Creek. A gauging station is used to measure the flow rate released into the canal.

Figure 2 is an aerial image of the Tabor Reservoir discharge into the Dry Creek Feeder Canal.

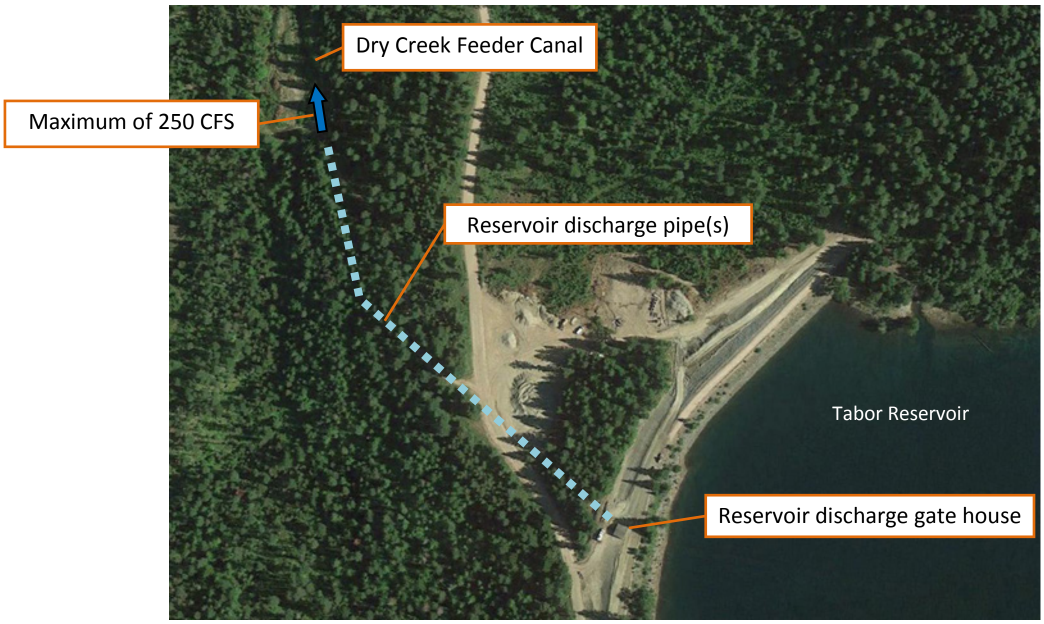

Figure 2. Discharge of Tabor Reservoir into the Dry Creek Feeder Canal

Two cylinder gates (see Figure 3) are used to control the discharge flow released from the reservoir. In 2001, Rodney Hunt-Fontaine Inc. built new gates to be installed at the dam. Sleeving needed to be performed from the inlet pipeline the reservoir to the actual discharge gate location in order to accommodate the new gates. The sleeving was never performed so the new discharge gates have been sitting in a storage yard in Orange, California since 2001. It was estimated that the sleeving would cost approximately $2.5 million (based on year 2000 dollars). BIA continues to pay for the storage of the discharge gates.

Figure 3. Existing Tabor Reservoir discharge cylinder gates

Improvements at Tabor Reservoir

Changes to be made at the Tabor Reservoir will improve control and manage releases from the reservoir. Figure 3 shows the improvements to be made at Tabor Reservoir.

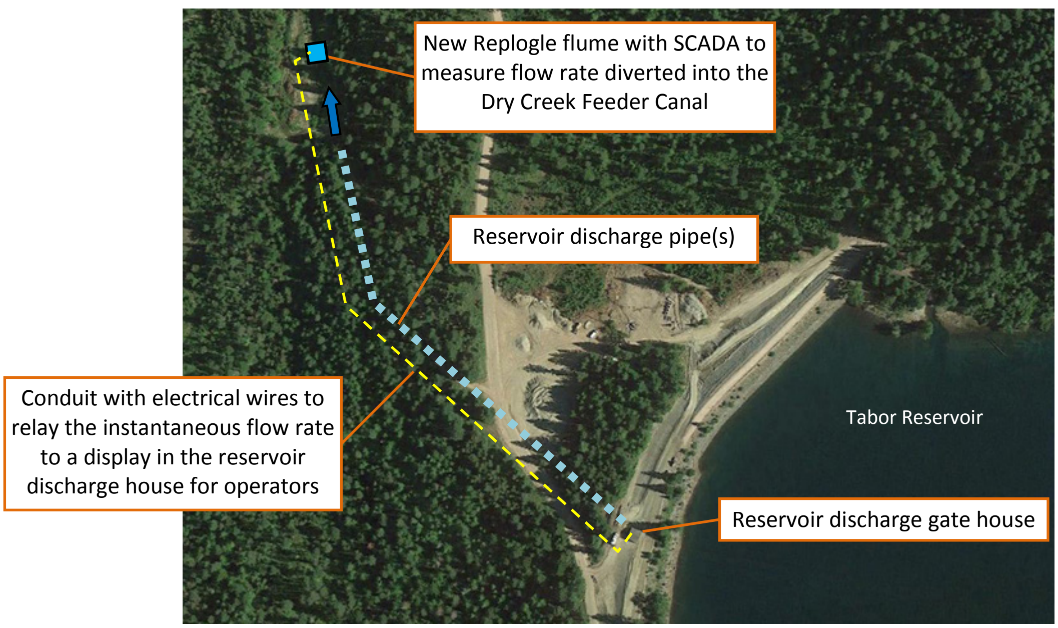

Figure 4. Discharge of Tabor Reservoir into the Dry Creek Feeder Canal

The improvements include:

1. A new Replogle flume will be constructed in the Dry Creek Feeder Canal a few hundred feet downstream of the reservoir discharge to measure the flow released into the canal.
2. A conduit housing electrical wire will be run from the new Replogle flume to the reservoir discharge gate house. This will allow operators to see the instantaneous flow rate readings over the flume and make any necessary adjustments to achieve the target flow rate in the canal.
3. SCADA will be incorporated to remotely monitor the following:
    a. The flow rate released into the Dry Creek Feeder Canal
    b. The water level in Tabor Reservoir

Funding will be required to perform the sleeving to accommodate the new reservoir discharge gates. If the gates were to break, it would not be possible to make any releases from Tabor Reservoir, which would then severely affect the downstream irrigation supply.

Dry Creek Pool

Figure 5 shows the existing control in the Dry Creek Pool at the head of the Mission F Canal.

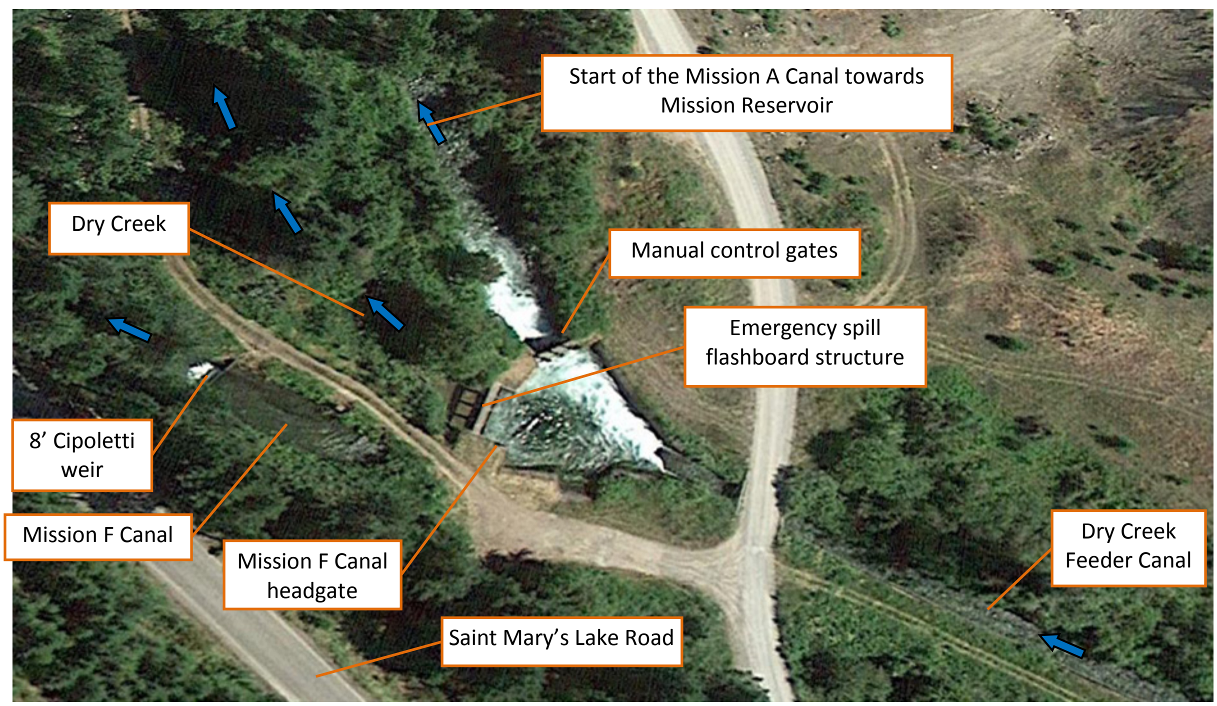

Figure 5. Existing control at the head of the Mission F Canal in the Dry Creek Pool

The existing control is as follows:

- Approximately 200 CFS enters the Dry Creek Pool from the upstream lined portion of the Dry Creek Feeder Canal. The flow is supplied from control releases at the Tabor Reservoir located approximately 5.5 miles upstream.
- There is a drop chute directly upstream of the pool (see Figure 6).

Figure 6. Existing concrete drop chute upstream of the headworks structures. Photo from HKM 2008 report (HW-5).

- A four bay flashboard structure (see Figure 7) is used only to spill extreme excess and emergency flows to Dry Creek. There are no in-stream flow requirements to Dry Creek. There has only been one time in the past seven years when water has spilled over the crest of the flashboards.
- Nearly all of the flow in Dry Creek Pool is diverted into the start of the Mission A Canal through three 4 ft. tall by 5 ft. sluice gates. Figure 8 and Figure 9 show the existing structure dimensions determined from the HKM 2008 report.

Figure 7. Existing control structures at the head of the Mission F Canal

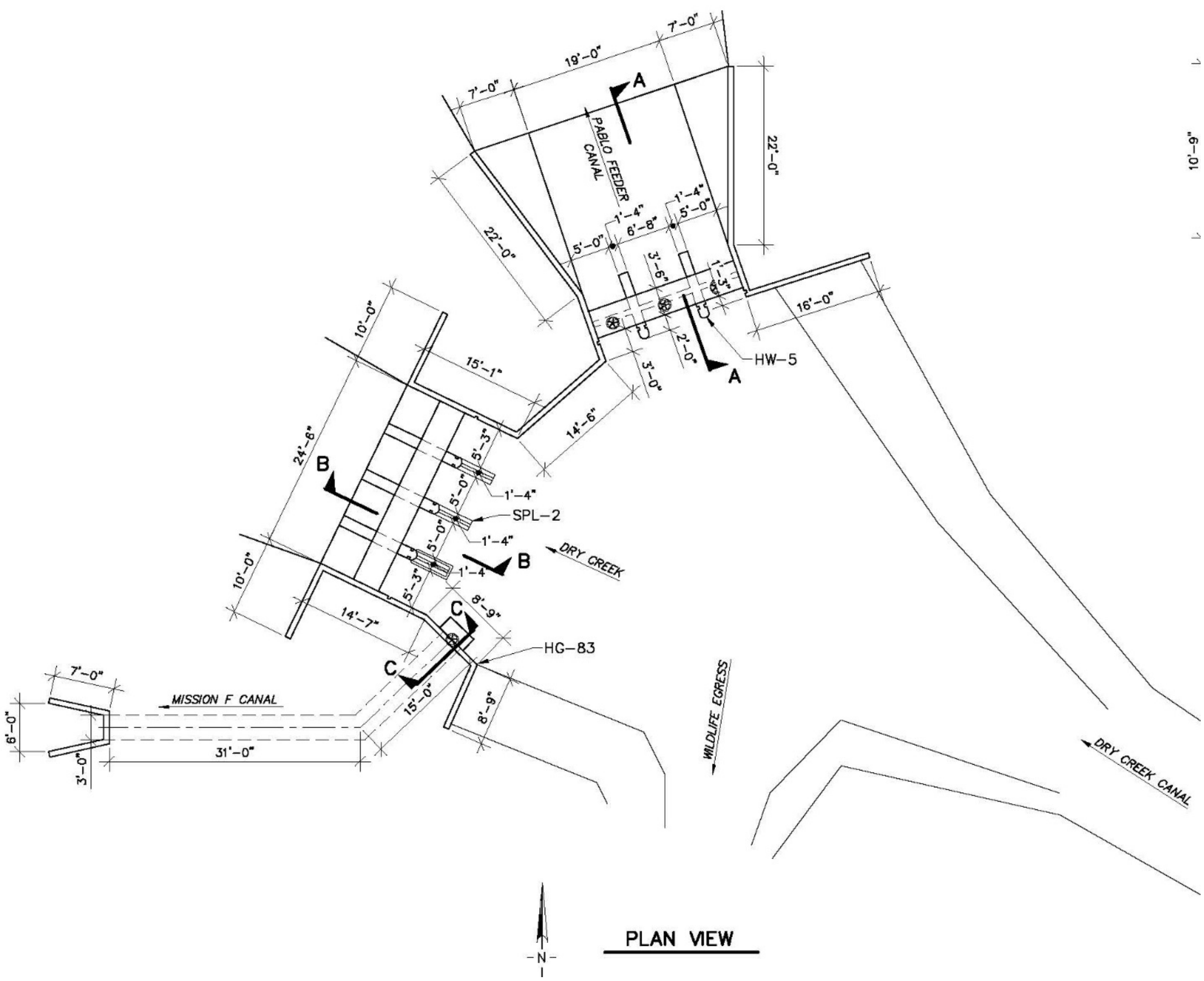

Figure 8. Existing structure dimensions at the head of the Mission F Canal from the HKM 2008 condition assessment report (HW-5)

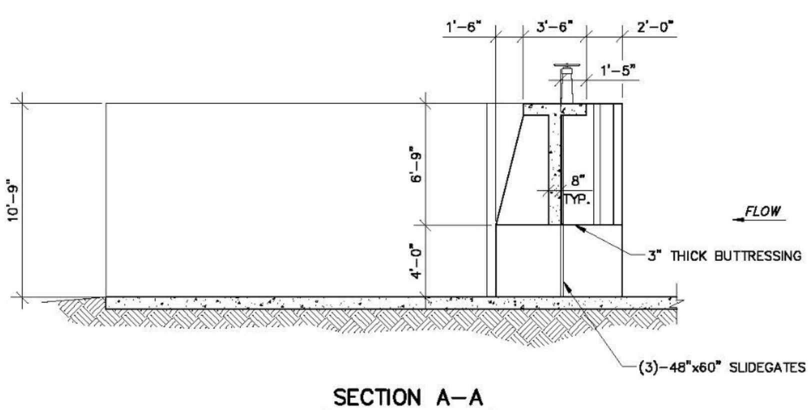

Figure 9. Section view A-A of the existing flow control gates from the HKM 2008 conditions assessment report (HW-5)

- Approximately 20 CFS is diverted into the Mission F Canal. The flow rate is measured by an 8 ft. Cipoletti weir shown in Figure 10. With the backwater effects of the Cipoletti weir, there is very little headloss across the Mission F Canal headgate for controllability.

Figure 10. Existing 8' Cipoletti in the Mission F Canal for flow measurement

New Control Scheme in the Dry Creek Pool

The current control configuration is set up to pass all flow variations into Dry Creek. The downstream portion of the Mission A Canal is capable of handling the base canal flow as well as all typical flow variations to show up at the Dry Creek Pool.

Improvements to the existing control will focus on providing:

- Better control of the flow rate diverted into the Mission F Canal.
- A set target flow to Dry Creek to meet in-stream demands if needed.
- Significantly improved water level control in the Dry Creek Canal Pool while channeling all remaining flow into the downstream portion of the Mission A Canal.

By allowing the canal base flow and any fluctuation to remain in the Mission A Canal, operators will be able to better manage releases from Mission Reservoir located approximately 3 miles downstream. This action would potentially prolong storage in Mission Reservoir.

Figure 11 on the next page shows the new conceptual control components in the Dry Creek Pool.

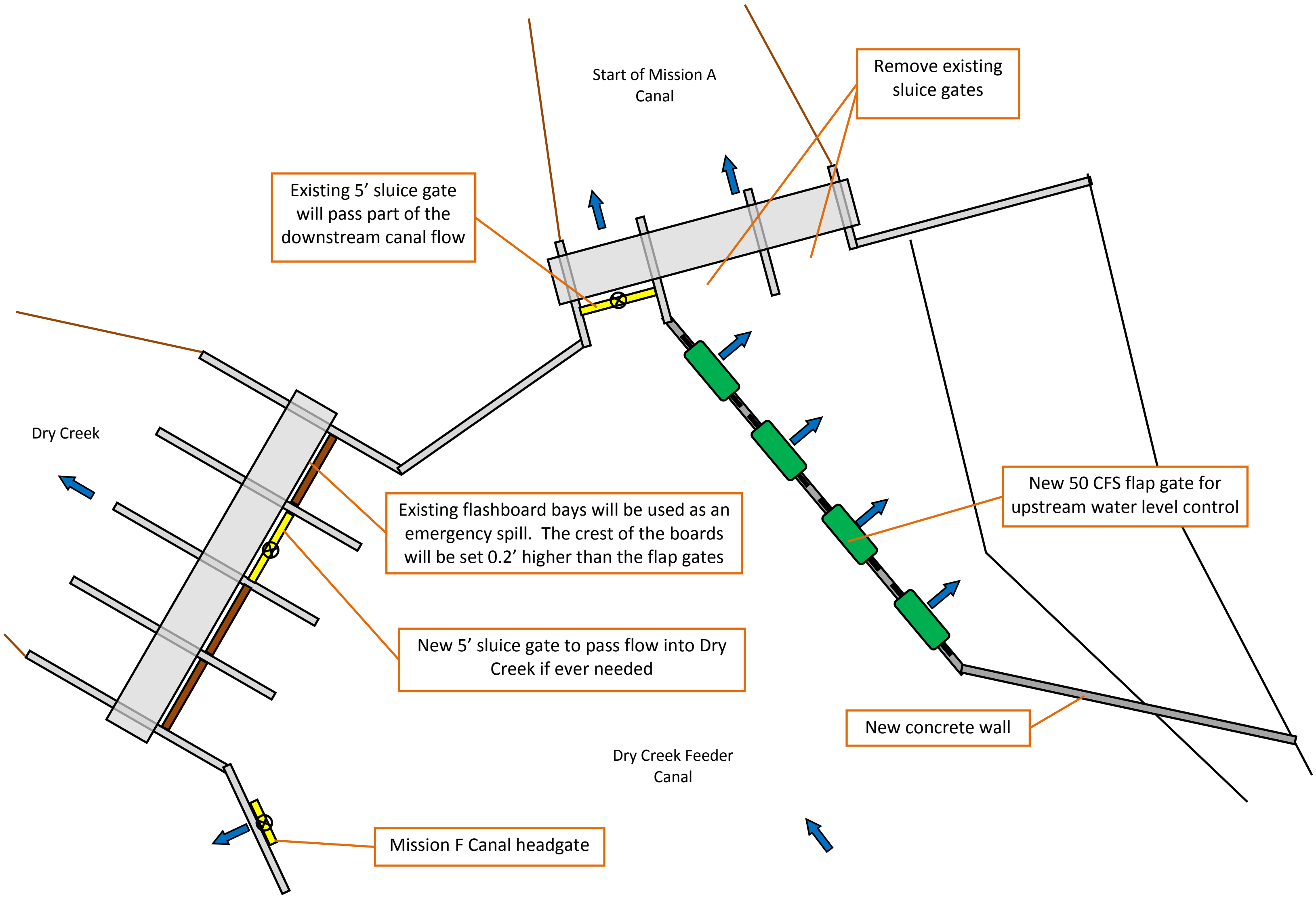

Figure 11. Conceptual plan view of new control components in the Dry Creek Pool at the head of the Mission F Canal

The new control components include:

1. Four identical ITRC Flap Gates (each designed for 50 CFS, 200 CFS total) will be installed in a new concrete wall to maintain a fairly tight upstream water level control while automatically spilling all excess flows into the Mission A Canal.
    a. The new concrete wall that will hold the flap gates will be attached to the existing concrete structure that contains the three sluice gates (refer to Figure 11).
    b. The flap gate frames will sit on flashboards in order to set the flap gate to open at the target water level in the pool.
    c. The existing middle and right sluice gates will be removed to allow the water that spills through the flap gates to freely pass into the downstream portion of the Dry Creek Feeder Canal.
    d. Figure 12 and Figure 13 show a conceptual plan and side view of the flap gates to be installed for improved water level control.
2. The existing left sluice gate will remain as-is to pass a portion of the flow rate into the Mission A Canal.
3. A new 5’ sluice gate will be installed in one of the existing middle flashboard bays to allow operators to release water into Dry Creek if every needed.
4. The remaining three flashboard bays will act as an emergency spill. The crest of the flashboards will be set approximately 0.2 ft. above the target water level in the level pool.

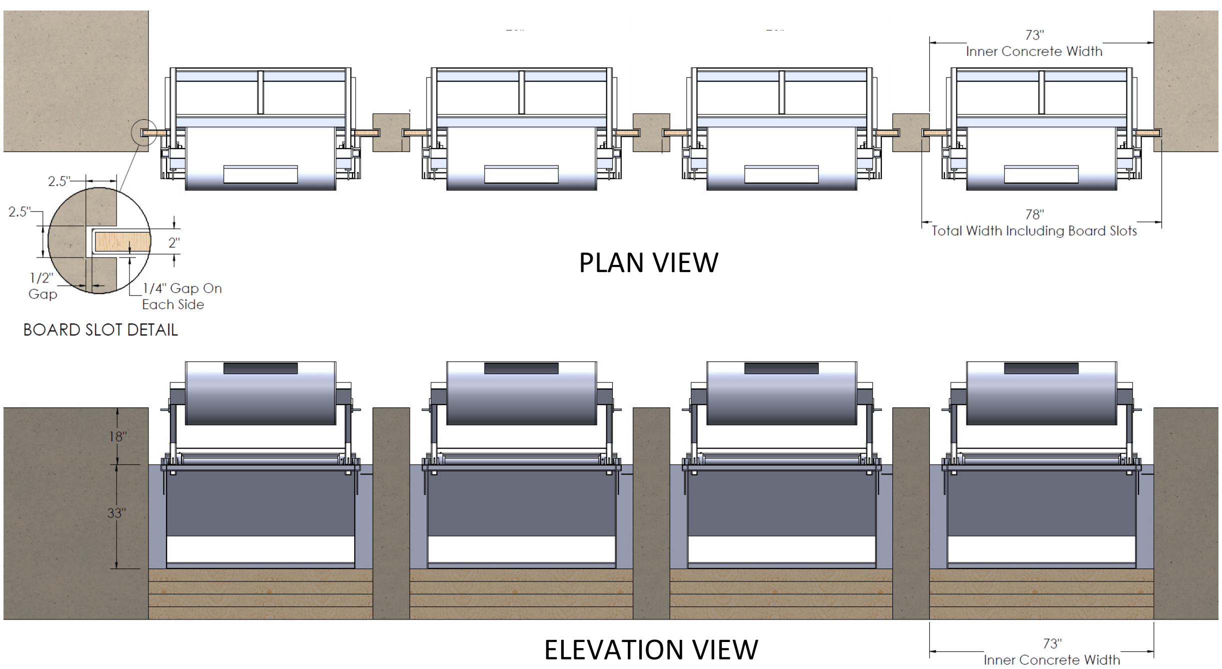

Figure 12. Conceptual plan and side view of new ITRC Flap Gates to be installed in the Dry Creek Pool at the head of the Mission F Canal

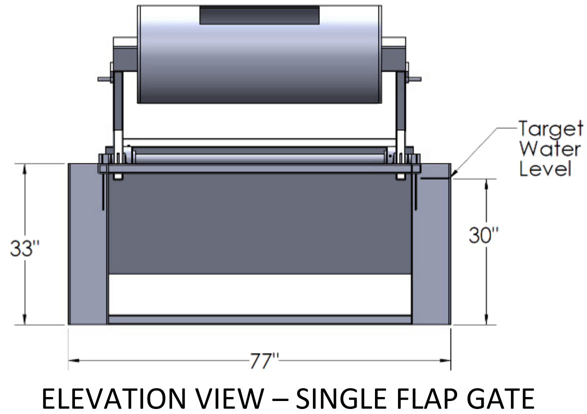

Figure 13. Conceptual elevation view of a single flap gate

Mission Reservoir Discharge

Figure 14 and Figure 15 show the overall view of the existing control components at the discharge of Mission Reservoir.

Figure 14. Overview of existing control at the discharge of Mission Reservoir

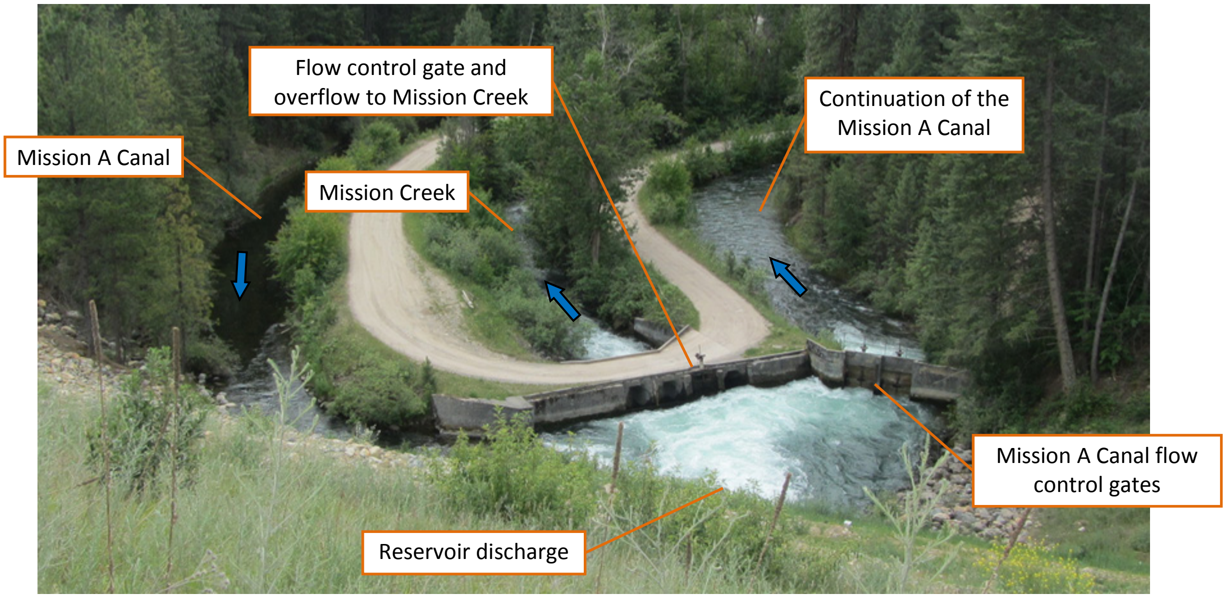

Figure 15. View of the existing control structures in the Mission A Canal from the top of Mission Reservoir Dam

Flow in the upstream portion of the Mission A Canal passes over an existing drop structure (see Figure 16) into the reservoir discharge pool.

Figure 16. Mission A Canal drop in the reservoir discharge pool. Photo from HKM 2008 report (HW-9).

Figure 17 shows the existing control structure to Mission Creek. A single sluice gate sets a target flow rate to Mission Creek but excess flows are allowed to spill to the creek through three bay openings in the structure. A flow rate between 100-150 CFS is diverted into Mission Creek to supply water to the Mission B and C Canals as well as Lateral 6C.

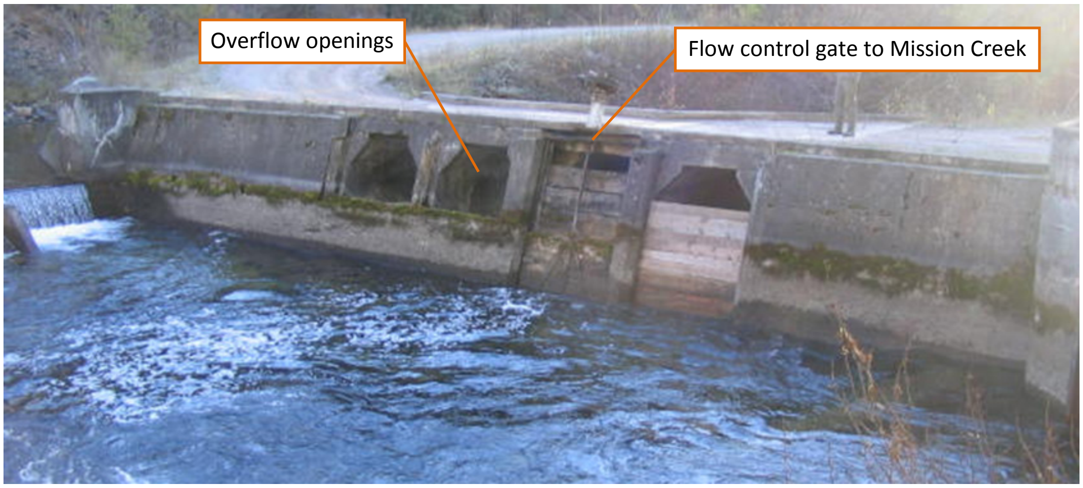

Figure 17. Flow control gate and overflow openings to Mission Creek. Photo from HKM 2008 report (HW-9).

Two identical 6 ft. wide by 5 ft. tall sluice gates installed in the flow control structure at the end of the reservoir discharge pool are used to set a target flow rate into the downstream portion of the Mission A Canal.

Figure 18. Two approximately 6' wide by 5' tall sluice gates to control the flow to the downstream portion of the Mission A Canal. Photo from HKM 2008 report (HW-9).

According to one of the operators of the Mission Canal Unit, the discharge flow rate from Mission Reservoir is adjusted on average every other day. There are three individual existing gauging station that the operator views on his cell phone to determine how to adjust the following flow rates:

- To the downstream portion of the Mission A Canal. The maximum capacity of the downstream canal is approximately 350 CFS.
- To the downstream portion of Mission Creek (also known as the Town Ditch)
- Discharge from Mission Reservoir

A Sutron data logger averages the flow rate for each of the measurement sites every 5-10 minutes but it takes 20 minutes for the system to stabilize once a flow rate change is made.

Control Improvements at the Mission Reservoir Discharge

The existing control at the Mission Reservoir appears to be difficult for operators to manage. The reasons for this are:

- FIIP wants to limit the amount of flow down Mission Creek because any excess flows not primarily used in the Mission B and C Canals are lost to the project. A small amount of flow is needed to service Lateral 6C and Mission H Canal as well as to meet in-stream demands.
- Operators are essentially trying to control the flow at three locations simultaneously while there is really no place to concentrate flow rate fluctuations.
- There is no effective water level control structure. The existing overflow bays to Mission Creek are too small to provide a constant water level. Additionally, the project doesn't want the excess flows in the creek.
- The existing flow measurement site are most likely not accurate.

The modernization changes provided below will allow the movement of water near Mission Reservoir to be easier for operators to manage. Figure 19 shows the modernization changes that will be made at the discharge of Mission Reservoir.

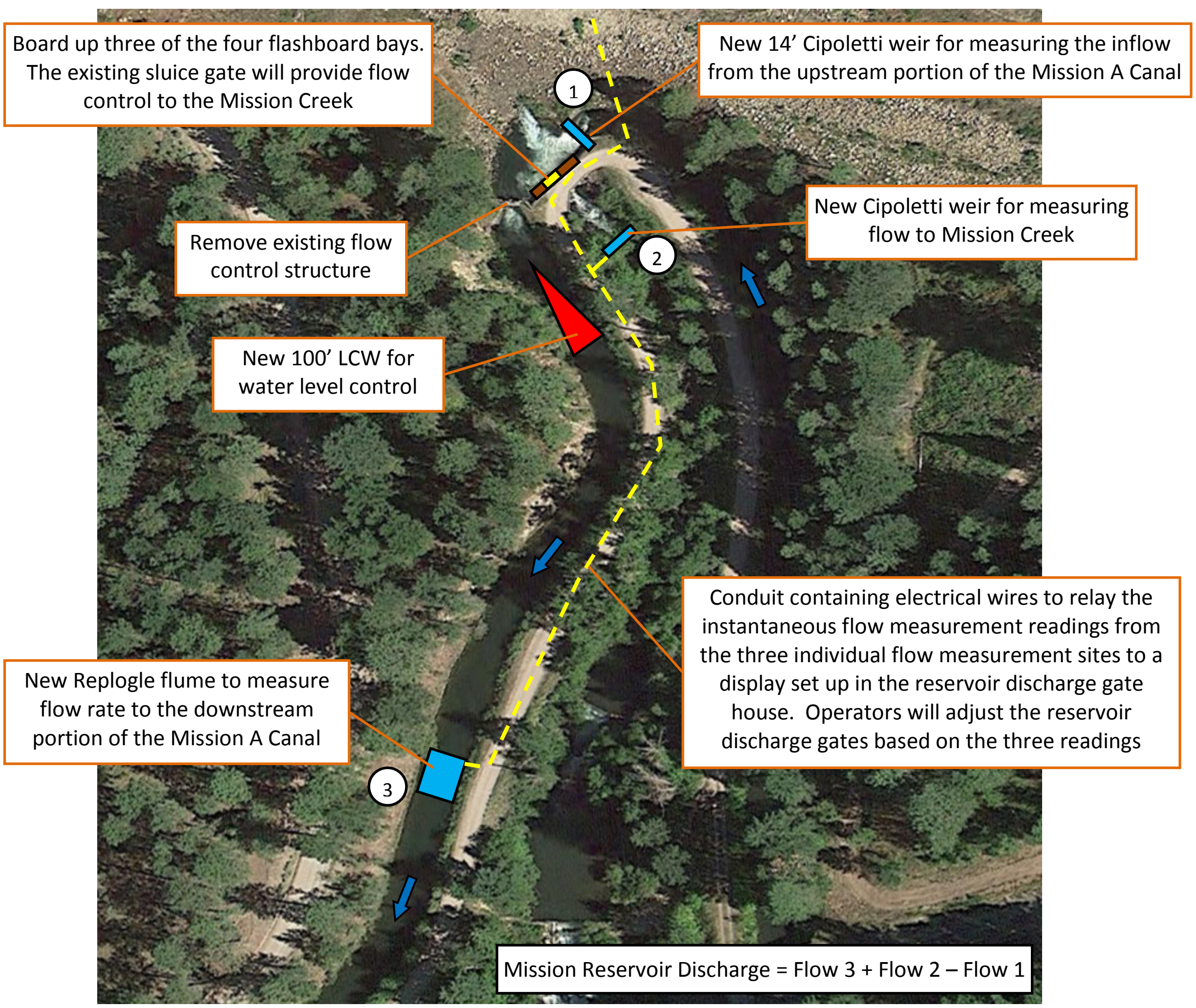

Figure 19. Modernization changes at the discharge of Mission Reservoir

The modernization changes include the following:

1. A new 14 ft. Cipoletti weir will be constructed at the existing drop structure into the reservoir discharge pool to measure the inflow from the upper portion of the Mission A Canal.
    a. The existing ramp in the drop structure will be removed.
    b. A staff gauge installed upstream of the Cipoletti weir will read directly in CFS.
    c. Since the Cipoletti weir will be constructed just downstream of a bend, concrete Bendway Weirs (see Figure 20) will be constructed upstream to:
        i. Divert the higher water particle velocities on the outside of the canal bend toward the center of the canal to flow over the Cipoletti weir.
        ii. Help with erosion control.

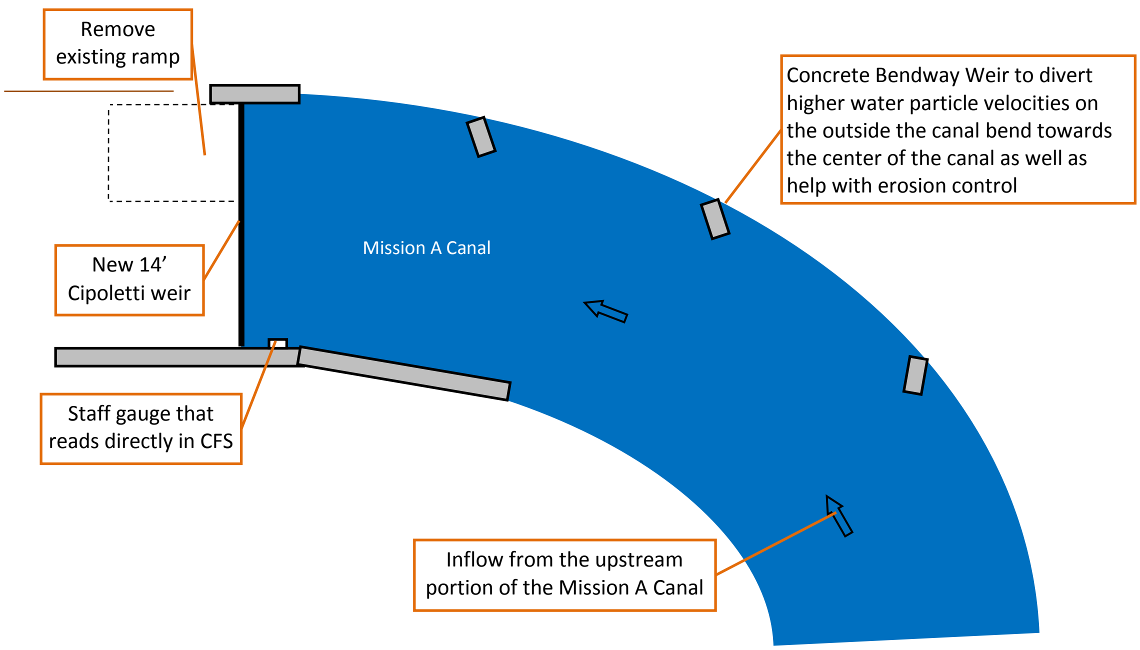

Figure 20. Conceptual drawing of Bendway Weirs upstream of the new 14’ Cipoletti weir (not to scale)

2. The three openings in the Mission Creek structure will be completely boarded up to prevent any flow through the exiting openings. The existing sluice gate in the structure will continue to provide flow control to Mission Creek.
3. A new Cipoletti weir will be constructed in Mission Creek just downstream of the flow control gate to measure the flow rate to the downstream portion of Mission Creek.
4. The existing flow control structure at the continuation of the Mission A Canal will be removed. The existing concrete is in very poor condition and the structure will just be a flow obstruction.
5. A new 100 ft. long-crested weir (LCW) will be constructed in the Mission A Canal to provide upstream water level control for the Mission Creek diversion.
    a. The new LCW structure (see Figure 21) will be constructed in a straight section of the Mission A Canal downstream of the flow control structure to be removed.
    b. Any flow rate variations will be concentrated to the downstream portion of the Mission A Canal to be used in the northern part of the project rather than into Mission Creek as is currently done.

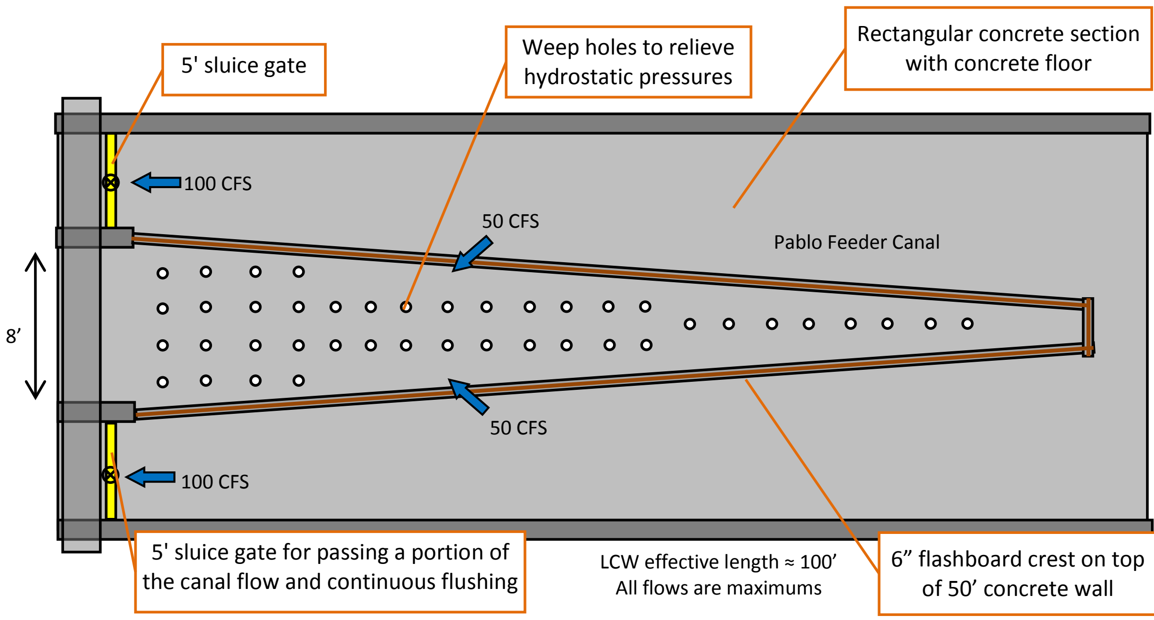

Figure 21. Conceptual plan view of new LCW structure in the Mission A Canal downstream of the discharge from Mission Reservoir (not to scale)

6. A new Replogle flume will be constructed in the Mission A Canal (approximately 400 ft. downstream of the current flow control structure to be removed) in order to measure the flow rate to the downstream portion of the Mission A Canal.
7. SCADA will be incorporated in order to remotely monitor the flow rate:
    a. At the drop to the reservoir discharge pool from the upper portion of the Mission A Canal.
    b. Diverted to Mission Creek to service the Mission B and C Canals.
    c. Continuing downstream in the Mission A Canal towards McDonald Reservoir.
8. Conduit housing electrical wires will be run from each of the three flow measurement sites to the reservoir discharge gate house to relay the instantaneous flow readings to a display for operators.
    a. Operators will adjust the reservoir discharge flow based on the readings from the three flow measurement sites.
    b. The discharge flow rate from the reservoir will be measured based on the following equation:

$$Q_{Res} = Q_3 + Q_2 - Q_1$$

Where:

Q_{Res} = Mission Reservoir discharge flow rate, CFS
Q_3 = Flow rate to the downstream portion of the Mission A Canal, CFS
Q_2 = Flow rate to Mission Creek, CFS
Q_1 = Inflow from the upstream portion of the Mission A Canal, CFS

Mission A Canal at Ashley Creek

Figure 22 shows a conceptual plan view of the existing control at Mission A Canal and Ashley Creek.

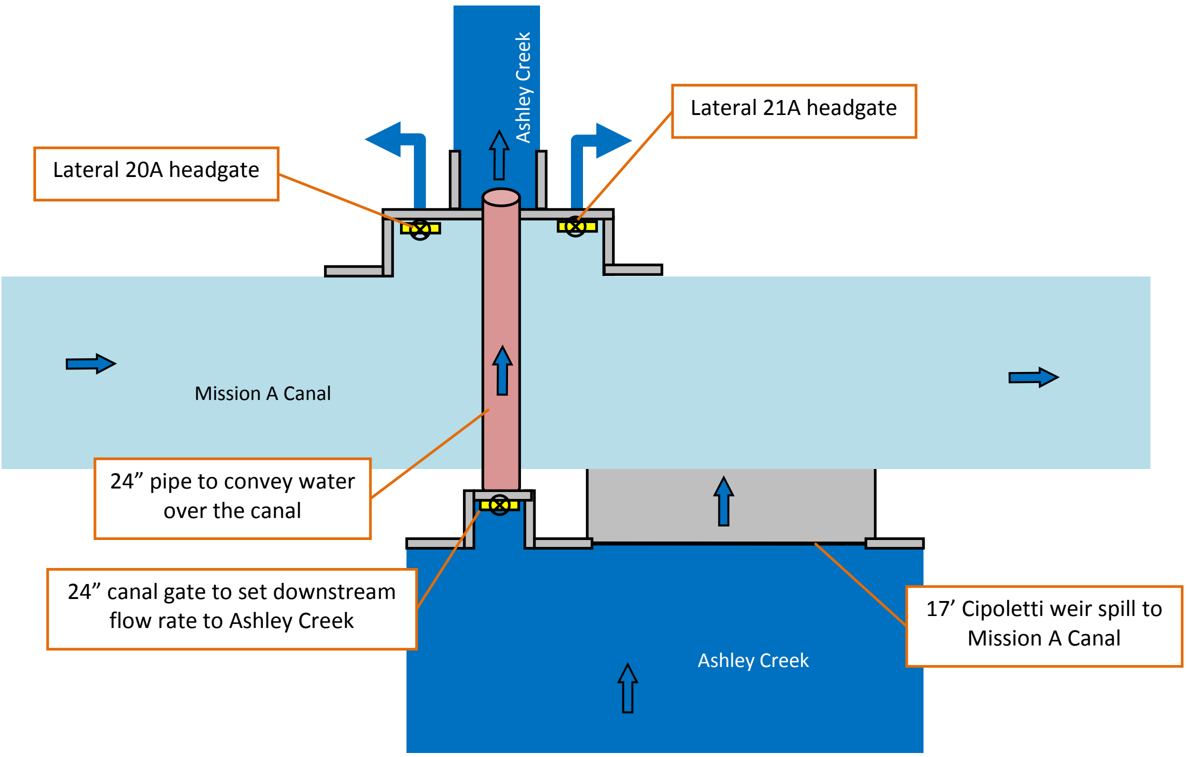

Figure 22. Conceptual plan view of existing control at Mission A Canal and Ashley Creek (not to scale)

The existing control is as follows:

- Water in the upstream portion of Ashley Creek is diverted through a 24" headgate over the Mission A Canal via a 24" pipeline to meet the downstream flow rate demand on the creek. The flow rate requirement to the downstream portion of the creek is based on an annual volume. Figure 23, Figure 24, and Figure 25 show the existing headgate and pipeline.
- The remaining excess flow in the upstream portion of Ashley Creek spills over a 17 ft. Cipoletti weir into the Mission A Canal. The high water mark shown on the concrete in Figure 23 looked to be approximately 1 ft. above the crest of the weir. Therefore, based on the length of the Cipoletti weir, approximately 50-60 CFS can potentially spill into the Mission A Canal from Ashley Creek.
- Water is diverted to both Lateral 20A and 21A from the Mission A Canal.

Figure 23. Upstream of Ashley Creek spill into the Mission A Canal. Photo from HKM 2008 report (CH-240).

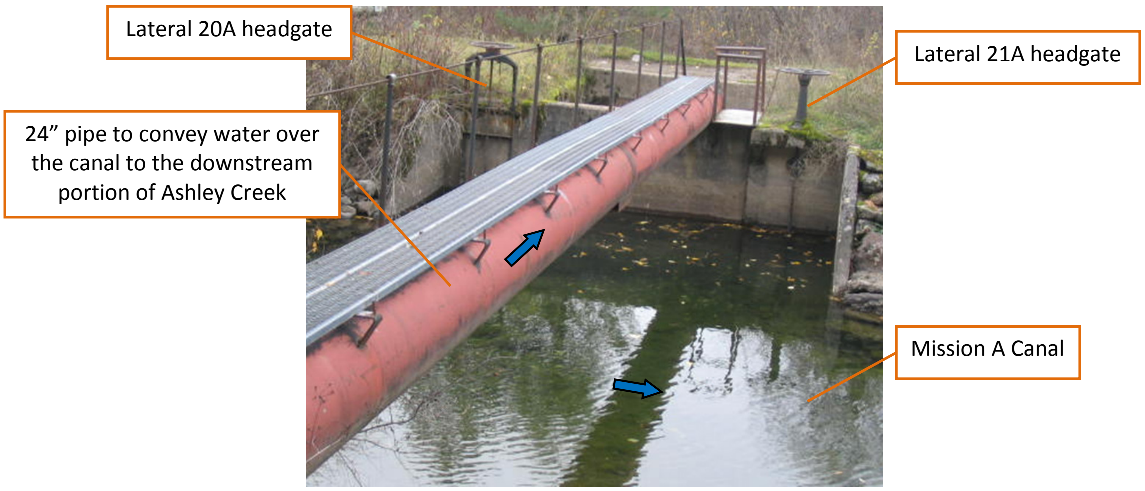

Figure 24. Existing 24” pipe to convey water over the Mission A Canal to supply the downstream portion of Ashley Creek. Photo from HKM 2008 report (CH-240).

Figure 25. Downstream view of 24” pipeline discharge to Ashley Creek. Photo from HKM 2008 report (CH-240).

Improved Flow Measurement at Mission A Canal and Ashley Creek

Modernization changes made at the Mission A Canal and Ashley Creek will focus on:

- Adding a flow meter with a volume totalizer to the Ashley Creek Pipeline
- Making physical changes to the Cipoletti weir structure for passing sediment
- Adding SCADA components to remotely monitor the flow rate spilling from Ashley Creek into the Mission A Canal

Flow Measurement to Ashley Creek

A single point insertion (SPI) flow meter, similar to the one shown in Figure 26, will be installed on the 24" pipeline conveying water to Ashley Creek to provide instantaneous flow measurement as well as a volume totalizer.

Figure 26. Example of a single point insertion (SPI) flow meter for pipelines. Photo from McCrometer Inc.

Figure 27 shows the approximate placement of the SPI on the 24" pipeline.

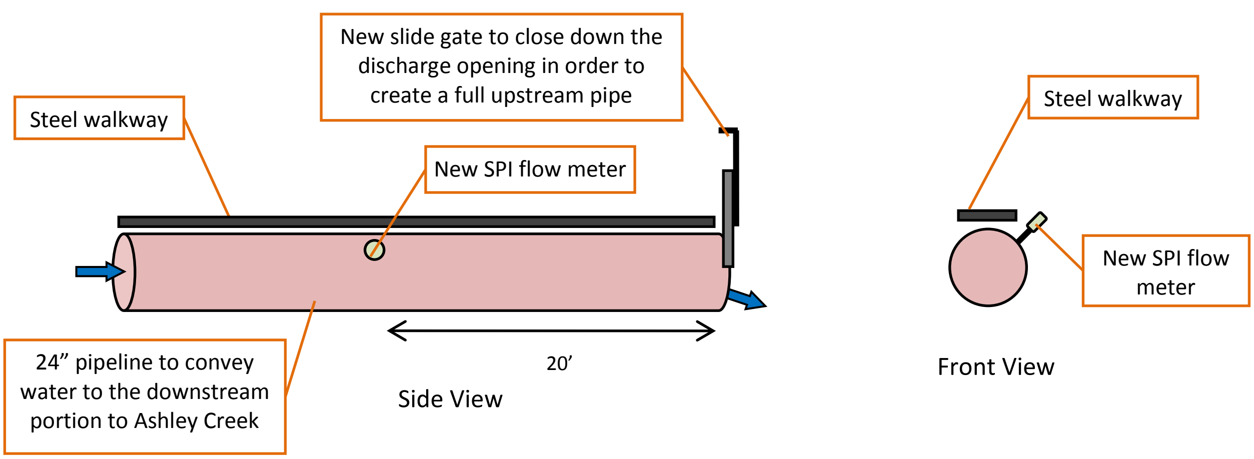

Figure 27. Conceptual modifications to the 24" Ashley Creek pipeline for improved flow measurement

The SPI will be placed approximately 20 ft. (10 pipe diameters) upstream of the pipeline discharge. The SPI requires a full upstream pipe to provide accurate flow measurement readings. Therefore, a slide gate will be installed at the discharge of the pipe to restrict the exit opening and create a full flowing pipe.

Physical Improvements to Ashley Creek Cipoletti Weir

From Figure 23 there is a large amount of sediment buildup directly in front of the right-hand side of the Ashley Creek Cipoletti weir. Currently there is no way to flush the sediment directly in front of the weir, which can lead to inaccurate readings of the flow rate.

One possible inexpensive solution would be to cut multiple holes in the existing concrete along the base of the Cipoletti weir structure as shown in Figure 28. The holes would provide continuous flushing of sediment and prevent buildup directly in front of the weir.

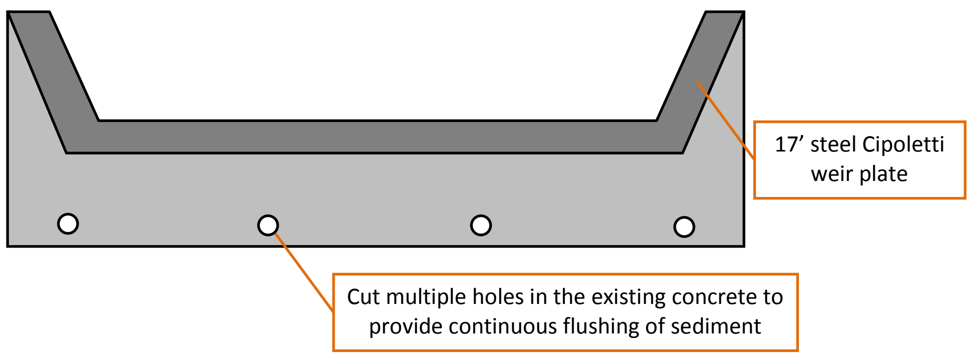

Figure 28. Conceptual front view of new flushing hole in the Ashley Creek Cipoletti weir structure (not to scale)

Ashley Creek Spill SCADA

It may be of some interest to FIIP from a management perspective to remotely monitor the flow rate spilling into the Mission A Canal from Ashley Creek. Inflows from Ashely Creek would influence releases from:

- Mission Reservoir, located approximately 4 miles upstream
- McDonald Reservoir, located approximately 8 miles downstream

Operators would be able to anticipate when to make flow rate changes at the two reservoirs in order to accommodate flow from Ashley Creek. Therefore, the storage levels in the two reservoir could potentially be prolonged.

Modernization Changes to Mission B Canal

The Mission B Canal diverts approximately 30 CFS from Mission Creek and has a total alignment length of approximately 10.5 miles. The canal captures farmer tailwater runoff from irrigated fields that are supplied directly from the Mission A Canal. Variable flows at the end of the Mission B Canal spill into Post Creek approximately 1 mile upstream of the Post F Canal diversion. The modernization goals are listed below, and the following sections explain the modernization changes made at individual sites along the Post F Canal.

The modernization goals for the Mission B Canal will be:

- Increase the flow capacity of the Mission B Canal in order to service irrigated fields supplied by both the Mission B and C Canals.
- Provide flexibility to the new pipelines that will be supplied from the Mission B Canal. Previously, when farmers to the west of the Mission B Canal shut off their flows, the flows continued down through drains to creeks. With the new pipelines, this water will remain in the Mission B Canal, causing significantly more flow fluctuations in the Mission B Canal than are seen now.
- Channel excess flows near the end of the Mission B Canal directly into the Post F Canal to be used for irrigation.
- Ease operational management for FIIP staff.

Figure 29 shows the overall modernization changes to the Mission B Canal. The changes include:

1. Improved flow measurement will be provided at the head of the Mission B Canal.
2. The physical capacity of the entire Mission B Canal alignment will be increased.
3. Multiple limited-demand pipelines will be constructed to service fields located in the Mission B and C Canal service areas. The Mission C Canal will be abandoned.
4. Water level control all along the Mission B Canal will be improved.
5. A new diversion channel will convey excess flows at the end of the Mission B Canal directly into the Post F Canal.
6. SCADA will be incorporated at key locations to help manage the canal system.

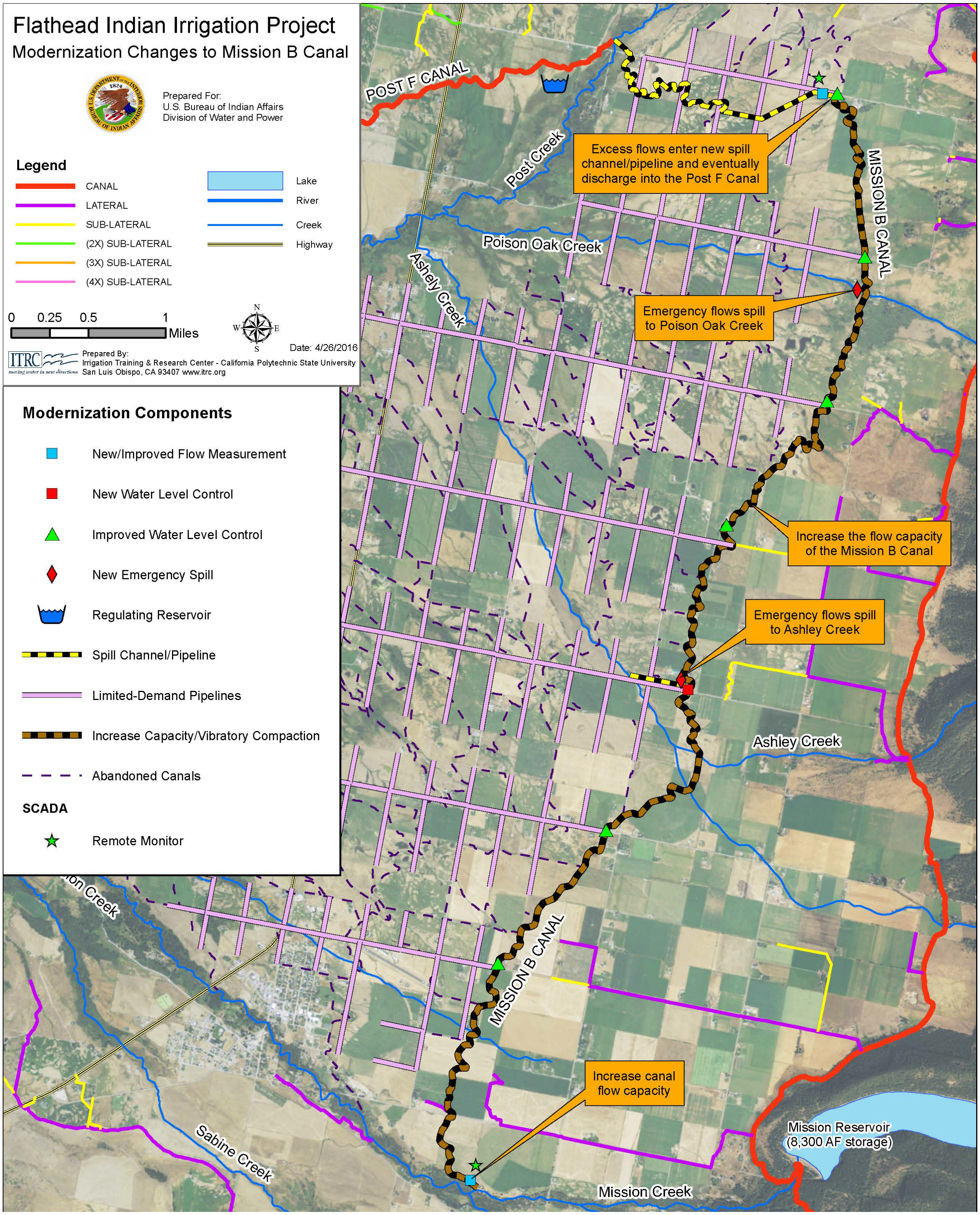

Figure 29. Overall modernization changes to the Mission B Canal

Head of Mission B Canal

Figure 30 provides an overview of the existing control components at the head of the Mission B Canal on Mission Creek.

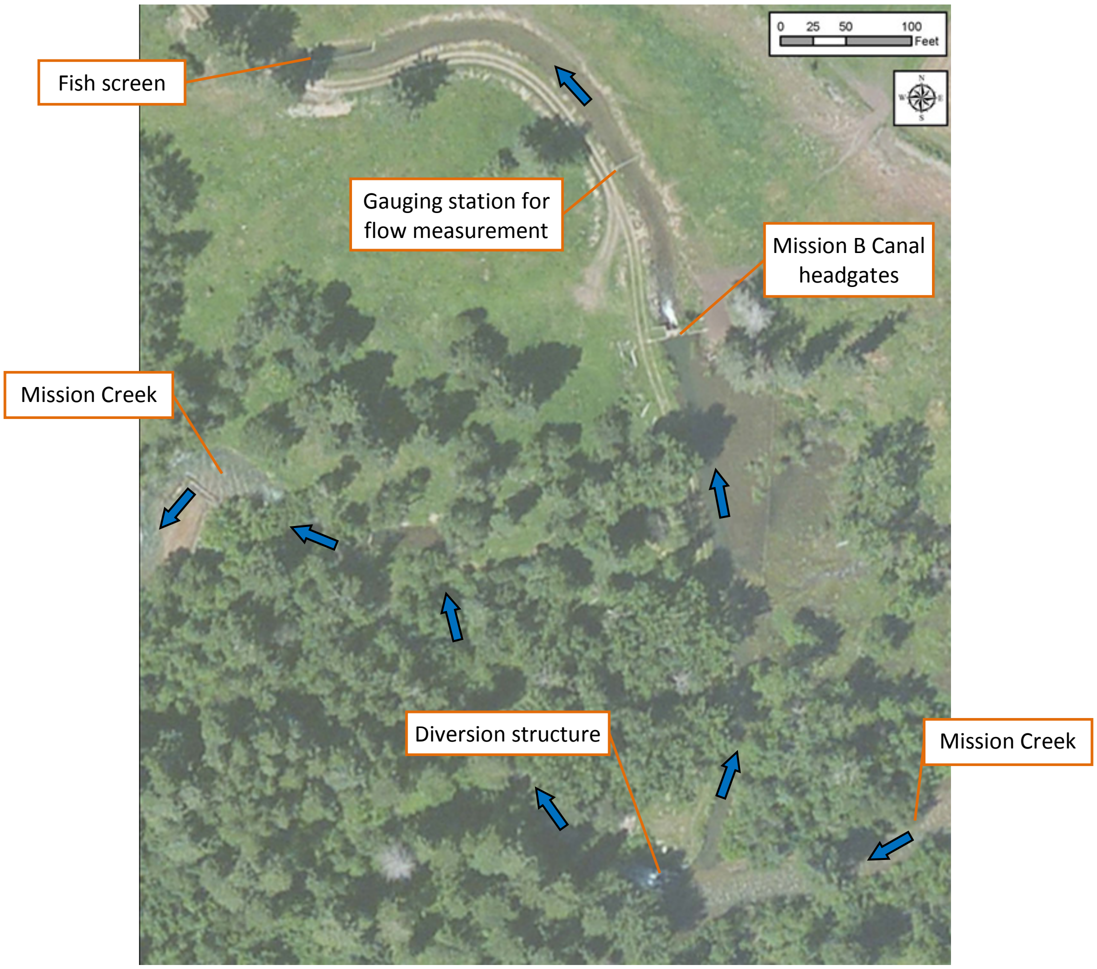

Figure 30. Overview of existing components at the head of the Mission B Canal on Mission Creek

The existing control near the head of the Mission B Canal is as follows:

- Water in Mission Creek is dammed up by a flashboard structure with multiple 4 ft. wide bays that has a total weir crest length of 36 ft. (see Figure 31). A fish ladder is built into the right-hand portion of the structure.
- The creek water flows down a conveyance canal until it reaches the Mission B Canal headgates (see Figure 32). Three identical 3 ft. by 3 ft. sluice gates are used to set a target flow of about 30 CFS into the Mission B Canal. It is unknown if only the center gate is used or if all three gates are used.
- A GOES gauging station (see Figure 33) is located approximately 140 ft. downstream of the canal headgates to measure the flow rate diverted into the Mission B Canal.
- Approximately 250 ft. downstream from the gauging station is a fish screen and bypass back to Mission Creek (see Figure 34).

Figure 31. Existing diversion structure in Mission Creek for the Mission B Canal

Figure 32. Mission B Canal headgates

Figure 33. GOES gauging station for flow measurement downstream of the Mission B Canal headgates

Figure 34. Existing fish screen in the Mission B Canal downstream from the canal head. Photo from HKM 2008 report (MSC-23).

Improved Flow Measurement at Head of Mission B Canal

With the new modernization scheme of the Mission B Canal, the flow diverted into the canal will significantly increase to up to 100-125 CFS. Frequent flow rate changes will also be made at the head of the Mission B Canal depending on the daily turnout flows on the new limited-demand pipelines. It will be critical to have accurate measurement of the flow rate diverted into the canal.

During the site visit, it was determined that there is approximately 3 ft. of headloss across the Mission B Canal headgates, which is ideal for a flow measurement flume. Figure 35 shows the improvements made at the head of the Mission B Canal for improved flow measurement.

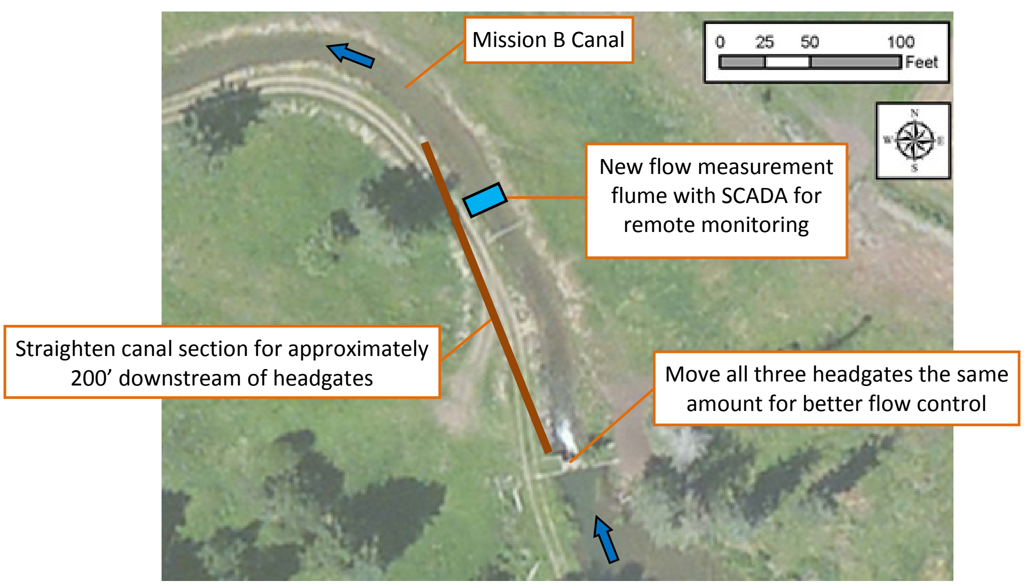

Figure 35. Improvements made at the head of the Mission B Canal

The improvements will include:

1. All three flow control gates should be moved the same amount to control the flow rate diverted into the Mission B Canal.
2. A new flow measurement flume will be constructed approximately 150 ft. downstream of the canal headgates.
    a. A staff gauge will be installed that reads directly in CFS.
    b. SCADA will be utilized to remotely monitor the flow rate through the measurement flume.
3. Approximately 200 ft. of the left canal bank downstream of the canal headgates will be excavated and straightened to provide a better approach path for the water prior to the flow measurement flume.

<u>Increasing the Capacity of the Mission B Canal</u>

Currently, approximately 30 CFS and 75 CFS is diverted into the Mission B and C Canals respectively. The two canals also pick up tailwater runoff from nearby irrigated fields to the east of their alignments.

The Mission B Canal has a total alignment of approximately 10.5 miles. The canal winds and runs through irrigated fields, making access difficult in certain locations. Farmers have constructed fences/gates across the canal operation and maintenance road which the operators must open and close. Figure 36 shows the two examples of the existing Mission B Canal physical characteristics.

Figure 36. Examples of existing Mission B Canal physical characteristics. Photos from HKM 2008 report

Physical Improvement to Mission B Canal

Since the Mission B Canal will now supply water to the Mission C Canal service area via the multiple new limited-demand pipelines, the flow rate capacity of the Mission B Canal will need to be increased to 100-150 CFS. The following physical changes are required to the Mission B Canal:

1. The cross-sectional area of the entire alignment of the Mission B Canal will need to be enlarged to accommodate the increased flow rate.
2. During the excavation, vibratory compaction should be performed to help reduce seepage losses. Vibratory compaction is so inexpensive ($2-$4 per lineal foot of canal) that it should just be performed rather than spending any time or money on a seepage analysis report.
3. The canal alignment should be straightened wherever possible.
4. A wide and durable operation and maintenance road along the entire length of the canal will be constructed. The access road should be free from fences and obstructions.

Improved Water Level Control along the Mission B Canal

The existing flashboard structures will need to be replaced with new LCW structures along the entire length of the Mission B Canal, in order to accomplish the following:

- The flow rate capacity of the Mission B Canal is going to be increased since the turnouts serviced by the Mission C Canal will now be serviced by the Mission B Canal.
- All of the existing laterals along the Mission B and C Canals will be converted to limited-demand pipelines, which will cause frequent flow rate variations in the main canal.
  - Farmers will have the ability to start/stop flows at their turnouts at any time.
  - When a farmer stops taking water, that flow will no longer enter the pipeline; rather, it will remain in the canal.
- The existing canal infrastructure is not capable of maintaining a constant upstream water level over a wide range of flow rate changes.
  - This would cause the direct farmer turnouts on the Mission B Canal (which would not be piped) to have constantly varying turnout flow rates.
  - The LCW will maintain a fairly constant upstream water level while automatically handling all flow rate variations in the Mission B Canal.
- Variable flows will be spilling into the Mission B Canal from runoff from fields east of the canal.

Figure 37 shows the approximate locations of either new or improved water level control structures. The map also shows the approximate locations of new emergency spill structures. Table 1 contains a summary of the improved water level control along the Mission B Canal.

A good elevation survey of the entire Mission B Canal should be performed. The canal must be expanded to handle the increased flow capacity; therefore, it may be possible reduce the number of check structures needed along the canal by raise banks, increasing culvert sizes, etc.

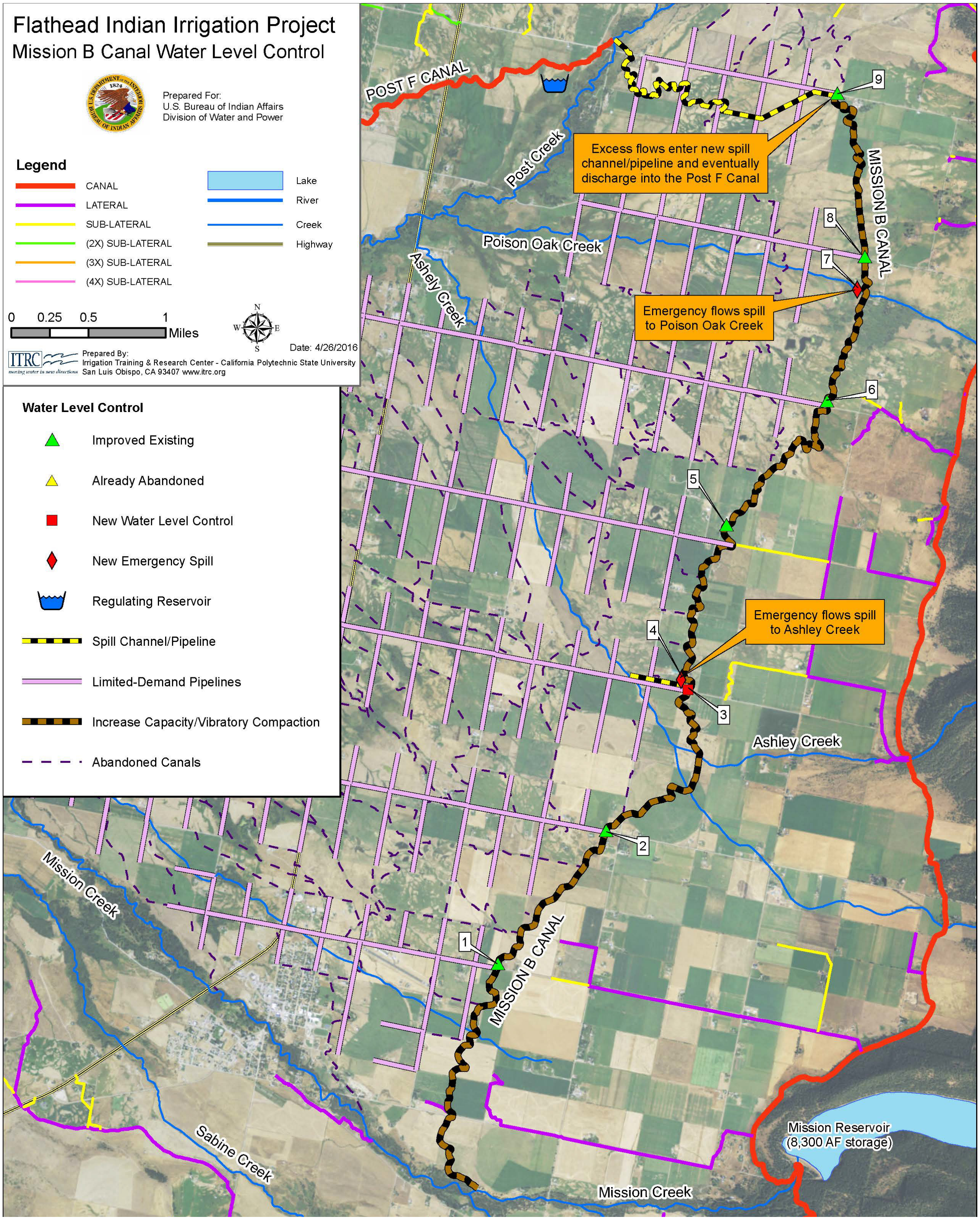

Figure 37. New and improved water level control along the Mission B Canal

Table 1. List of new or improved water level control structures along Mission B Canal

No.	Longitude	Latitude	Status	Structure Type	Design Length (ft.)
1	-114.0672	47.3271	Improved Structure	LCW	50
2	-114.0561	47.3414	Improved Structure	LCW	40
3	-114.0487	47.3559	New Structure	LCW	40
4	-114.0487	47.3559	New Emergency Spill	Flap Gate	--
5	-114.0477	47.3718	Improved Structure	LCW	30
6	-114.0374	47.3851	Improved Structure	LCW	30
7	-114.0349	47.3957	New Emergency Spill	Flap Gate	--
8	-114.0360	47.3991	Improved Structure	LCW	20
9	-114.0440	47.4137	Improved Structure	Flap Gate	--

Figure 38 shows a conceptual example of the new LCW structures to be utilized along the Mission B Canal. The advantages to the presented LCW design are:

- The construction is relatively simple, so the cost of the entire structure is relatively low.
- The structure does not need to be designed by a civil engineer.
- The crest height can easily be adjusted by adding or removing flashboards.

Figure 39 and Figure 40 show similar examples of existing LCW structures installed in two irrigation districts in California.

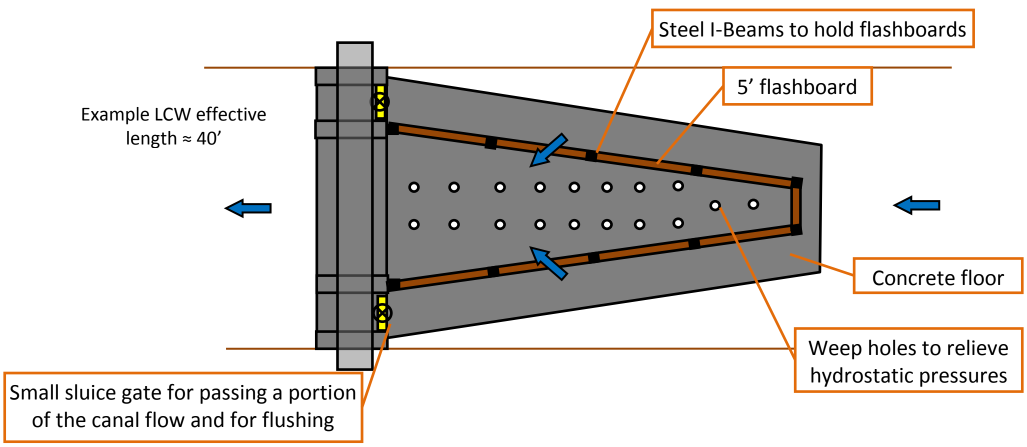

Figure 38. Example of new LCW structures to be constructed along the Mission B Canal (not to scale)

Figure 39. Somewhat similar LCW installed at Turlock ID

Figure 40. Somewhat similar LCW in Fresno ID, but lacking the side sluice gates and the tapered configuration of the LCW itself (although the banks are tapered). This illustrates a construction technique for tying the walls together for strength, and providing access for operators to clean off the weir crest.

Note that there are approximately 15 existing check structures along the Mission B Canal that were not recommended to be improved. These check structures were identified to be of very low priority and it is possible that some may be abandoned with the construction of the new limited-demand pipelines.

New Emergency Spills

New emergency spills are needed in the Mission B Canal to automatically spill all emergency flows in the upstream canal portion if the maximum canal capacity is every exceeded. With the construction of the new limited-demand pipelines, emergency flows will occur in the Mission B Canal when the power goes out in the area due to the turnouts that operate pumps for their wheel lines and center pivots.

Two new emergency spills will be constructed in the Mission B Canal at the following locations (refer to Figure 37):

- At Lemery Road
- Poison Oak Creek

The next two sections discuss components of each emergency spill locations.

Mission B Emergency Spill at Lemery Road

Figure 41 shows the existing conditions in the Mission B Canal at Lemery Road.

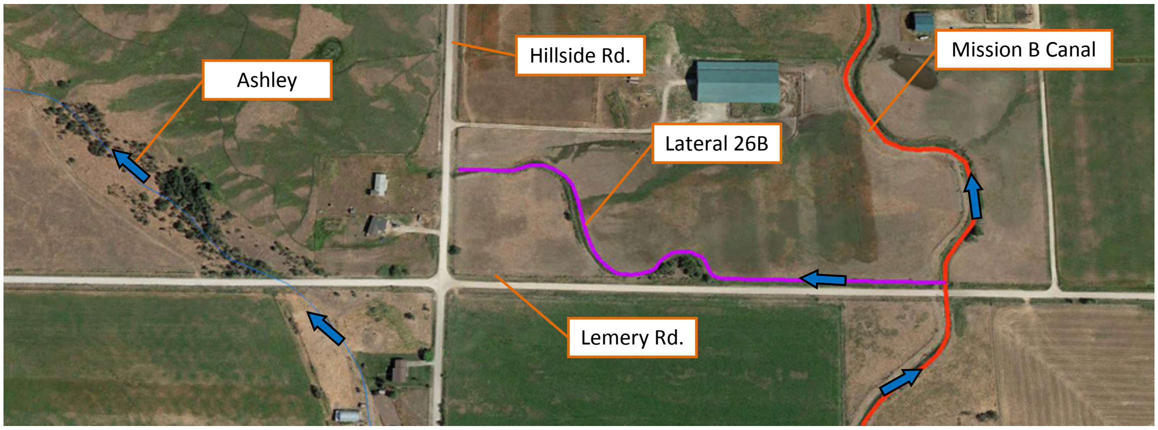

Figure 41. Existing conditions of the Mission B Canal at Lemery Road

Lateral 26B diverts water from the Mission B Canal to service multiple fields. Ashley Creek is located approximately 2,000 ft. due east of the Mission B Canal. An existing check structure is located in the Mission B Canal serval hundred feet downstream from the lateral diversion. To accommodate a new emergency canal spill, the modernization changes shown in Figure 42 will be made.

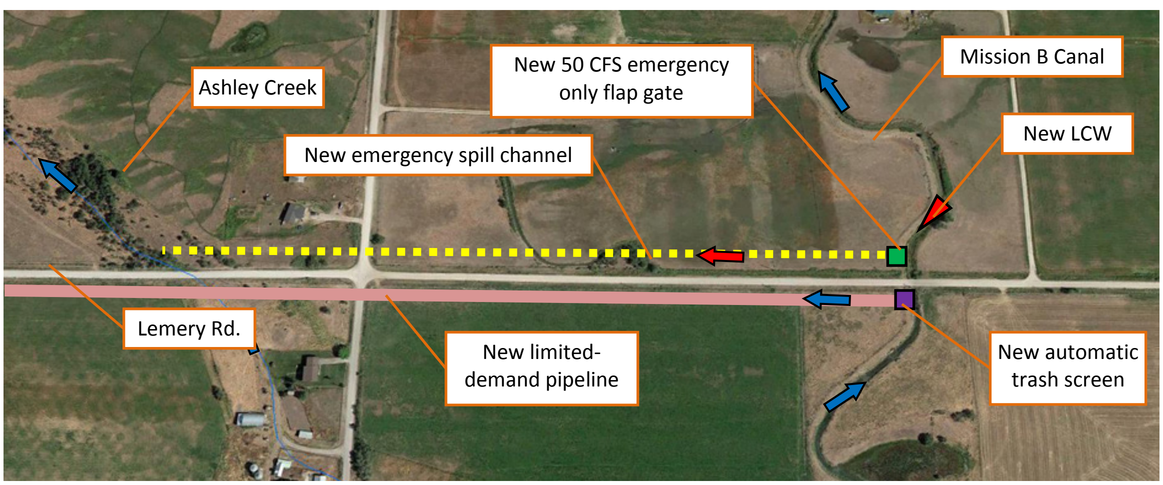

Figure 42. New emergency spill at Mission B Canal and Lemery Road

The modernization changes include:

1. A completely new LCW structure will be constructed in the Mission B Canal downstream of Lemery Road to provide upstream water level control.
2. A new limited-demand pipeline will be constructed upstream of the new LCW. A new automatic trash screen will prevent debris from entering the pipeline.
3. A new ITRC Flap Gate will be installed just downstream of Lemery Road in order to automatically spill all emergency flows from the upstream canal portion. Figure 43 shows a conceptual side view of an ITRC Flap Gate to be used for an emergency spill on the Mission B Canal.

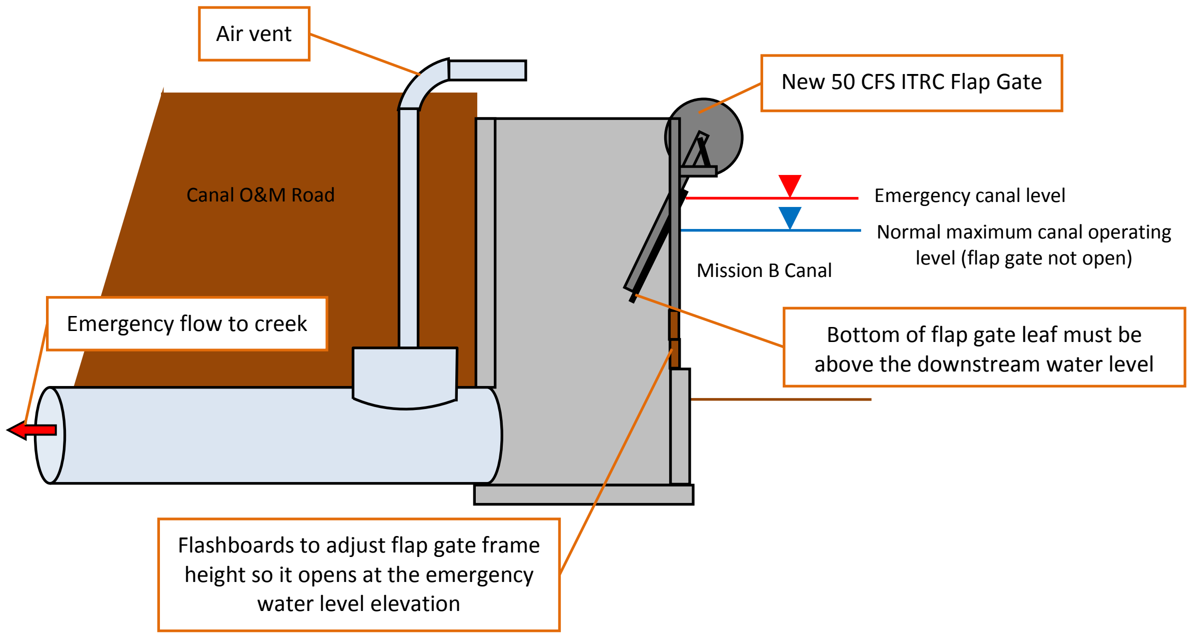

Figure 43. Conceptual side view of improved emergency spill structure for the Mission B Canal (not to scale)

4. A new emergency spill channel will be constructed from the Mission B Canal all the way to Ashley Creek to convey any emergency spill through the flap gate.

Mission B Canal Emergency Spill at Poison Oak Creek

A second emergency spill will be located in the Mission B Canal at Poison Oak Creek (see Figure 44). A 50 CFS emergency-only flap gate similar to the example in Figure 43 will be constructed in the Mission B Canal to automatically pass all emergency flows into the Creek.

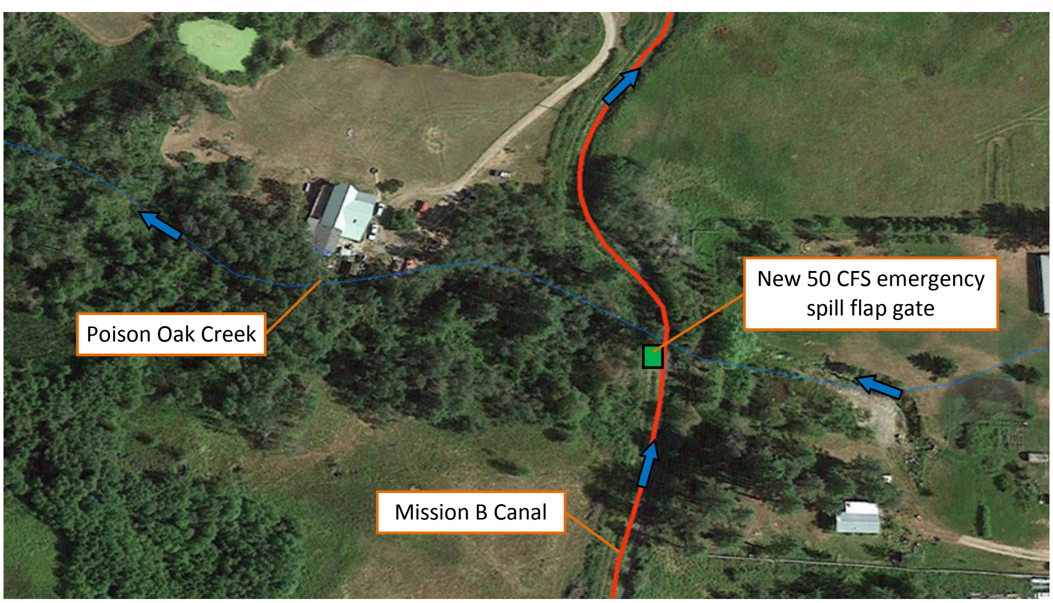

Figure 44. New emergency spill flap gate on the Mission B Canal at Poison Oak Creek

Mission B Canal Spill to Post F Canal

Figure 45 shows the existing Mission B and C Canal alignments near Post Creek.

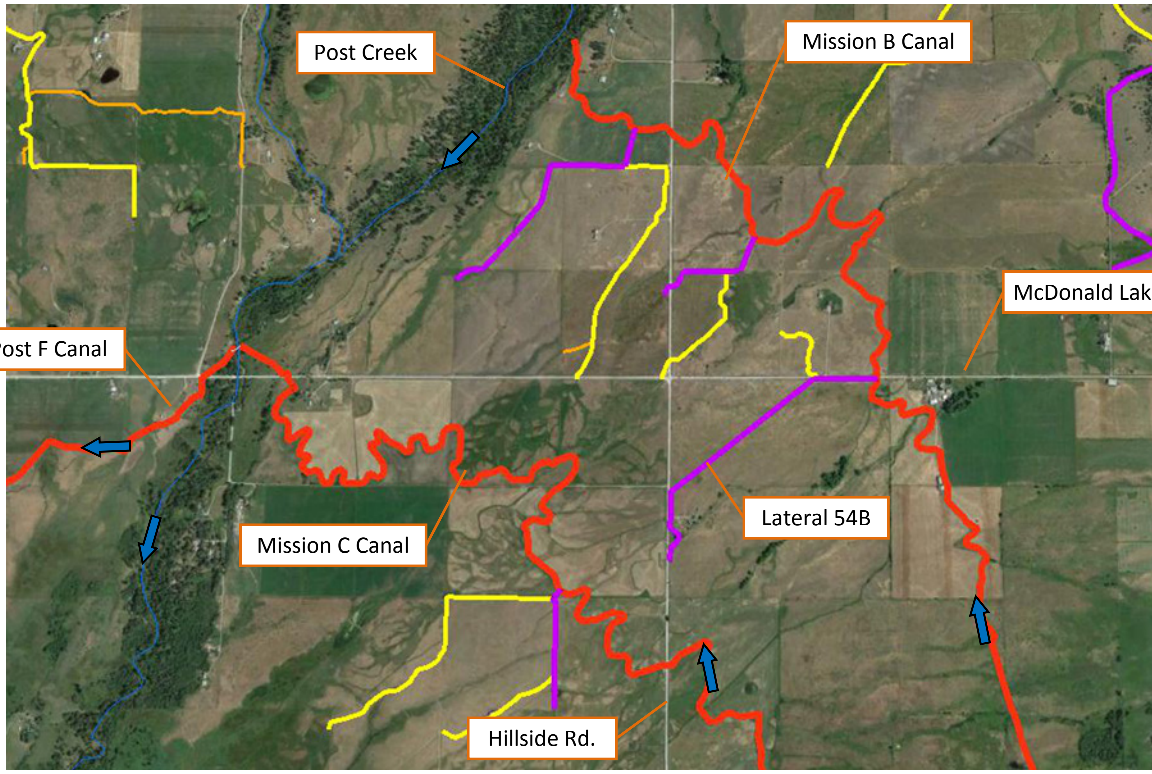

Figure 45. Existing canal layout near the end of Mission B and C Canals near Post Creek

The Mission B Canal services multiple laterals and turnouts north of McDonald Lake Road prior to the excess flows spilling into Post Creek approximately Excess flows in the Mission B Canal spill into Post Creek approximately 1 mile upstream of the Post F Canal.

Any excess flows in the Mission C Canal spill into a siphon that conveys the excess flow under Post Creek to discharge directly into the Post F Canal and prevent the dirty water from the Mission C Canal from mixing with the clean Post Creek water. A GOES gauging station at the very end of the Mission C Canal measures the amount of spill into the Post F Canal. The control improvements at the head of the Post F Canal are discussed in a different report.

Figure 46 shows the existing control components in the Mission B Canal at McDonald Lake Road. A single flashboard check structure shown in Figure 47 provides upstream water level control for the Lateral 54B diversion as well as a single turnout.

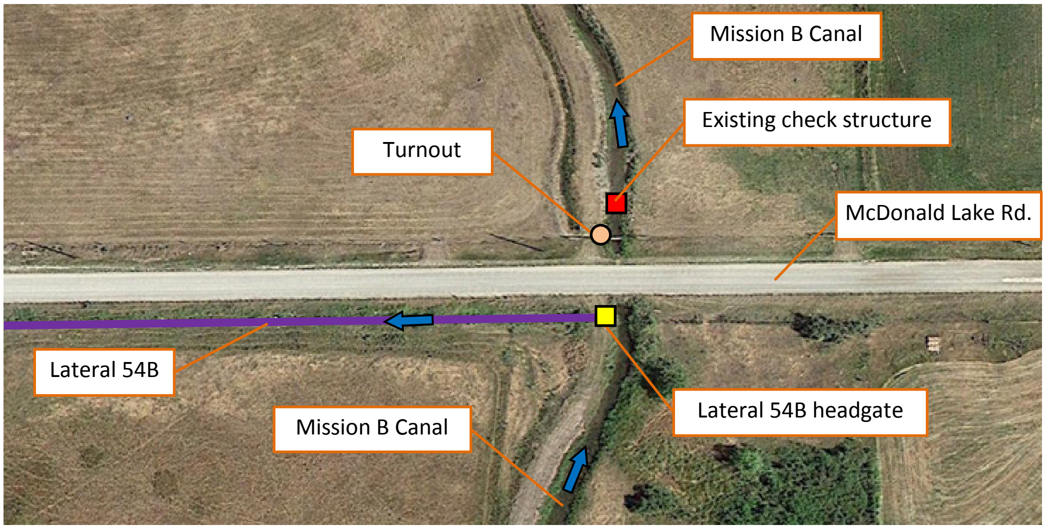

Figure 46. Existing control components in the Mission B Canal at McDonald Lake Road

Figure 47. Existing check structure in the Mission B Canal directly downstream of McDonald Lake Road. Photo from HKM 2008 report (CH-184).

New Spill Channel

With the new operation scheme for the Mission Canal Unit, the Mission C Canal will be eliminated and Mission B Canal will service all water users to the west. If the excess flow in the Mission B Canal were allowed to spill into Post Creek, the dirty canal water would mix with the clean creek water. To avoid contaminating the Post Creek water, excess flows in the Mission B Canal will need to be diverted into the last part of the Mission C Canal. Then the excess flow would discharge directly in the Post F Canal rather than into the creek.

Figure 48 shows the new Mission B Canal spill into the Post F Canal. Figure 49 shows new control components in the Mission B Canal at McDonald Lake Road.

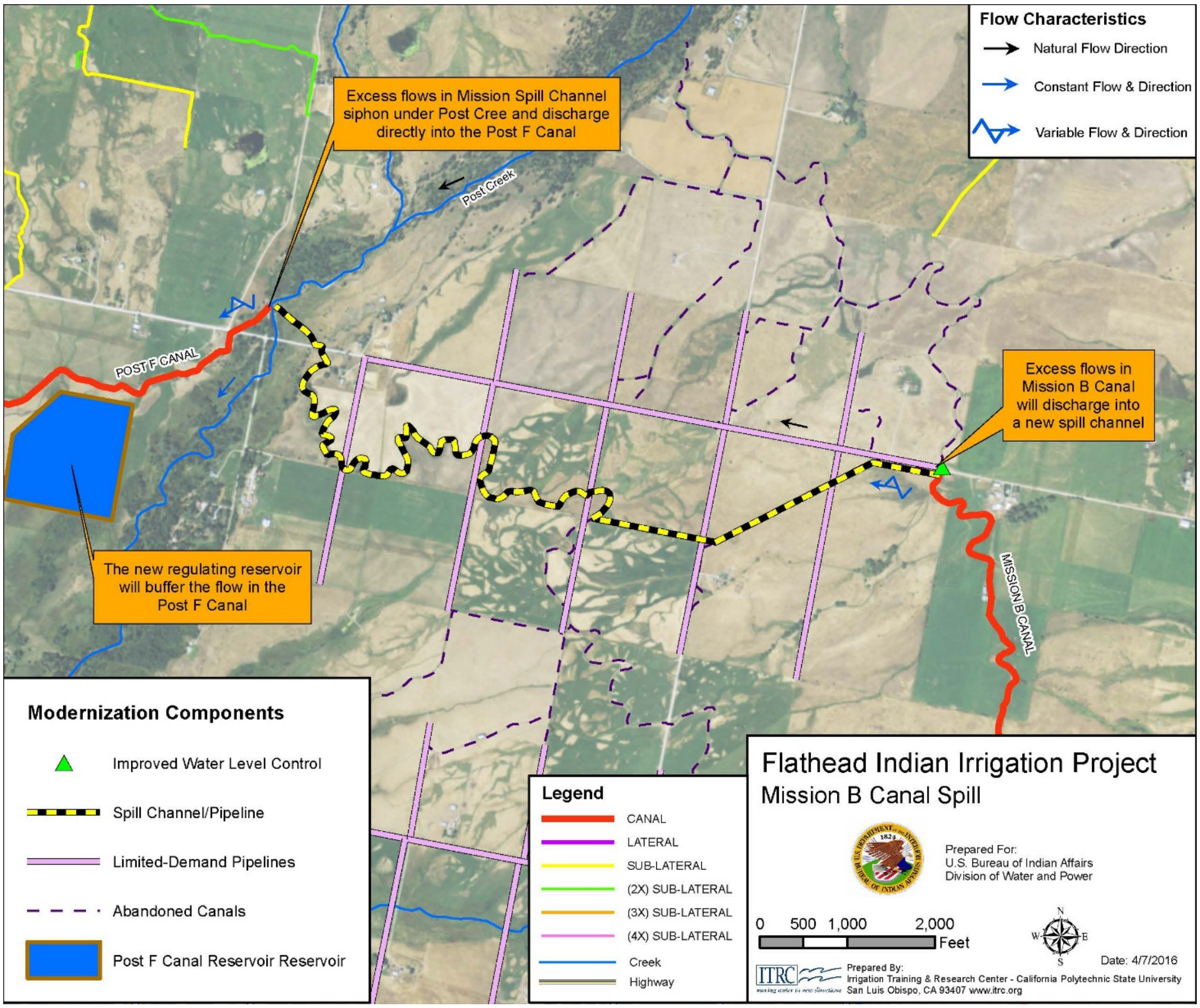

Figure 48. New Mission B Canal Spill Channel to the Post F Canal

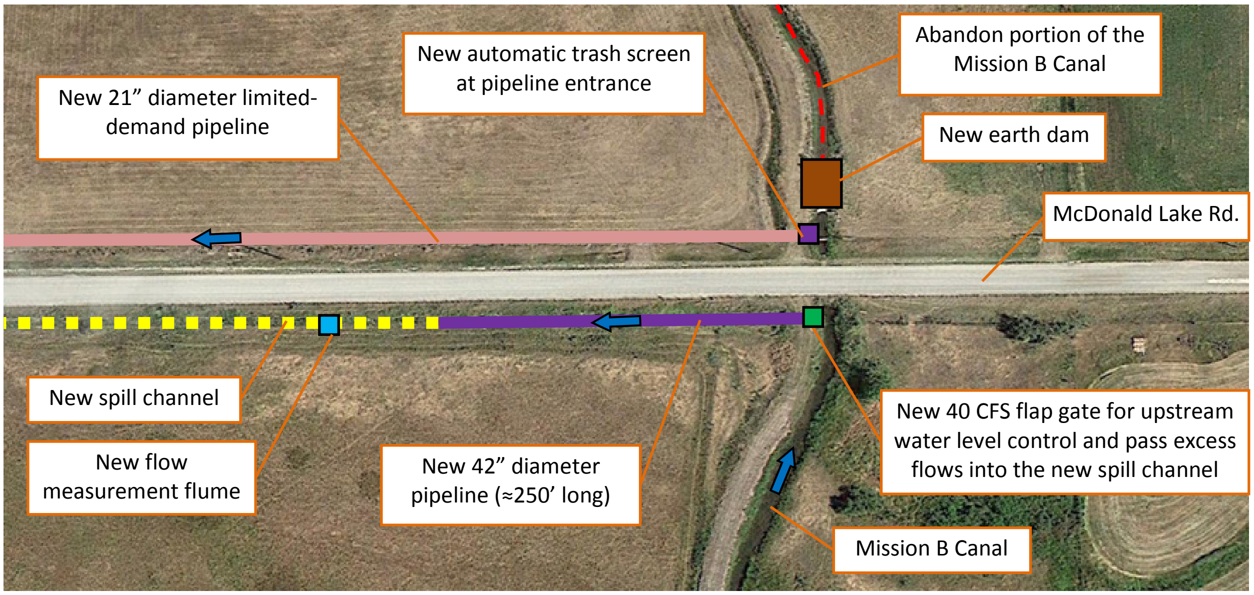

Figure 49. New control components in the Mission B Canal at McDonald Lake Road

The modernization changes include:

1. The existing check in the Mission B Canal just downstream of McDonald Lake Road will be replaced with an earth dam to prevent any flow moving downstream. The last portion of the Mission B Canal will be abandoned.
2. Water in the Mission B Canal will flow directly into a new 21" limited-demand pipeline located just upstream of the new earth dam. A new automatic trash screen will be installed at the inlet of the limited-demand pipeline to remove any debris or trash that may be in the canal.
3. A new 40 CFS flap gate will be installed in the Mission B Canal directly upstream of McDonald Lake Road. The flap gate will:
   a. Maintain a fairly constant upstream water level for the limited-demand pipeline and a single turnout.
   b. Automatically pass all excess flows in the Mission B Canal into a new spill channel.
4. A new spill channel will convey excess flows from the Mission B Canal to the Post F Canal (approximately 2.5 miles long).
   a. The first 250 ft. of the spill will be a 42" diameter pipeline to achieve plenty of elevation drop for the flap gate.
   b. The spill channel will follow a major portion of the existing Lateral 54B alignment and then a new alignment in order to connect to the Mission C Canal.
   c. The Mission C Canal will then be used to convey the excess flows to Post F Canal.
5. A new flow measurement flume will be constructed in the new spill channel approximately 100 ft. downstream of the terminus of the 42" diameter pipeline. SCADA will be utilized to remotely monitor the spill flow. Operators will then divert the necessary flow rate into Post Creek located further upstream in the canal system.

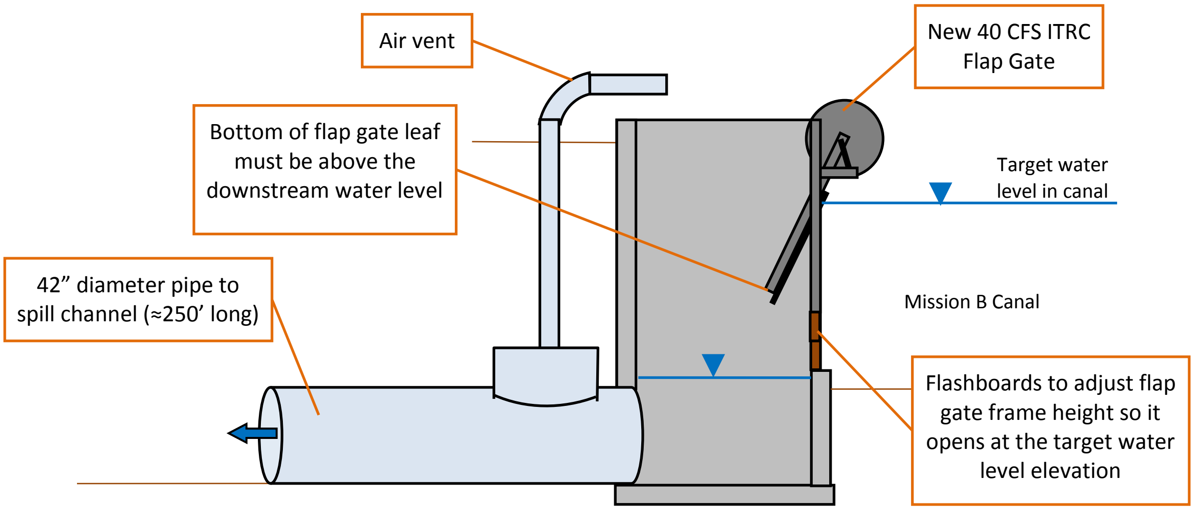

Figure 50. Conceptual side view of ITRC Flap Gate installed in the Mission B Canal (not to scale)

Mission Area Piping

The Mission Area – Existing Conditions

The Mission A, Mission B, and Mission C Canal systems combined service approximately 18,610 irrigated acres. Figure 51 highlights the acreage that is served by these canals. Table 2 summarizes the acreage and service capacity of each of the canals.

Table 2. Irrigated acreage and service area capacity for Mission Canals A, B, and C

Canal	Service Area (Acres)[1]	Service Capacity (CFS)
Mission A	7,280	100 [3]
Mission B	3,500	30 [2]
Mission C	7,830	70 [2]
Mission B+C	11,330	100 [2]
Mission A+B+C	18,610	-

[1] Irrigated Acreage ArcGIS Shapefile HKM 2013
[2] Historical gauging station data provided by Tribe
[3] Estimate

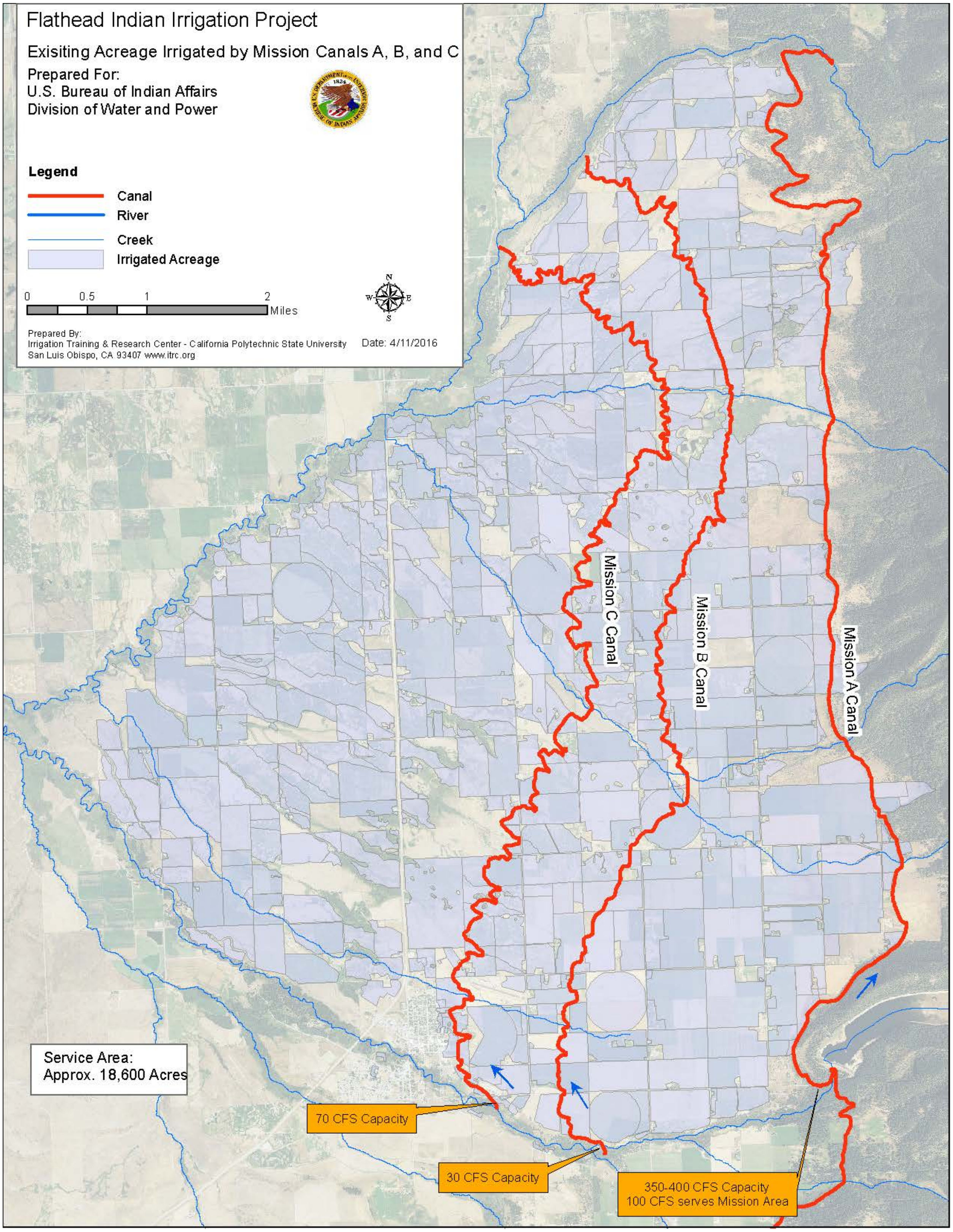

Figure 51. Overview of existing acreage irrigated by Mission Canals A, B, and C

The Mission Area – General Conditions

The Mission area is large and is served by three canals. The most uphill canal is the Mission A Canal. The next downhill is Mission B, and the next is Mission C. Both the Mission B and Mission C Canals intercept surface runoff from upslope fields.

The Mission A canal has good road access. There is a "relatively short" distance between Mission A and Mission B Canals. Some farmers use private PVC pipes to connect between Mission A Canal and fields that are not immediately adjacent to the canal.

The Mission B Canal access road has numerous obstructions that have been installed by farmers – both across the canal and across the road – in violation of USBIA regulations. However, there is a short distance between Mission B and Mission C Canals, so providing reasonable water delivery service to the fields between the two canals is not impossible. Nevertheless, there is no good turnout flow measurement and the access restrictions for USBIA operations make volumetric accounting and billing of water deliveries impractical.

The Mission C Canal has worse canal bank access than the Mission B Canal. Furthermore, the Mission C Canal is much more tortuous than Mission B and Mission A Canals. Mission C Canal services a large area. Lateral canals are positioned along the contour, and are generally impossible to follow and maintain. Turnouts are located within fields, and operators have almost no direct access to individual field turnouts. In some fields, the farmers use the lateral canals as if they were individual field water distribution ditches, and there are no single "turnouts" to a field. Volumetric accounting and billing of water deliveries to individual fields is completely impractical with the existing physical infrastructure.

The Appeal of Pipelines

Various objectives for the tribe and USBIA include reasonably accurate volumetric accounting and billing of water deliveries to individual fields. To achieve this, it will be necessary to provide:

1. A good flow meter for each field, with the ability to also account for volumetric deliveries.
2. Ease of access by the USBIA operators. This means the meters must be next to a road. The road could be a county road or a well maintained and easily accessed canal road – with no private gates or fences blocking the way.
3. A valve that can be shut off or locked at the flow meter location.

With pipelined laterals, these requirements can be met.

Pipelined laterals have the following advantages:

1. They can go up and down hills and swales, which means they can be positioned along roads. This provides the easy turnout access that is needed for good operation and accountability.
2. Pipelines also provide some of the pressure required for sprinkler irrigation. This will reduce power bills for farmers if they modify their pumps properly and use VFD controllers on electric pumps.
3. Pipelines have very little maintenance requirements, compared to open ditches and canals.
4. The irrigation water can be filtered to a reasonable degree at the heads of the piped laterals. This centralized filtration, plus the lack of many miles of un-serviced ditches with weeds, will

provide much cleaner water to individual fields. This will minimize the need for individual field filters for sprinkler systems.

The primary disadvantage of pipelines is the cost of initial installation. In the case of the Mission area, pumping is not needed, so energy costs on the project side are zero.

Assumptions and Pipeline Design

The pipeline design considered a variety of factors:

1. The flow rate requirement is very different from the volumetric allocation. For efficient irrigation with most irrigation systems, the flow rate that is needed is dependent upon the irrigation system design. For example, a wheel line (side roll) sprinkler design will have a design flow rate requirement. The turnout must meet that flow rate requirement.
2. The volumetric limitation can be enforced if USBIA operators have easy access to accurate flow meters with totalizers. In other words, a high flow rate can be allowed, but not 24/7.
3. The design flow rate for individual 40 acre turnouts was 8 GPM/acre, which equals 320 GPM. A check of various sprinkler designs in the area indicated that this was adequate.
4. One can add up the total flow required for a lateral as:

   $$\text{Total lateral flow rate} = 320 \text{ GPM} \times (\text{\# of turnouts supplied by the lateral})$$

   It is quickly apparent that this computation yields an answer that is about twice the actual flow rate into the area at the moment.
5. Because of (4) above, the lateral pipes themselves have been sized using demand theory, which is similar to the logic used to size phone system capacities. The key design criteria for the large lateral pipe sizing is that 95% of the time, the pipes will be able to meet farmer demand. The demand is assumed to be that on the average, the turnouts of 320 GPM will individually be operating only 60% of the time during the middle of the summer.
6. Major pipelines are located adjacent to roads, where possible, for ease of access for flow and volume measurement by FIIP staff.
7. All turnout flow meters and emergency on/off valves are located adjacent to roads. The normal operating valves and final discharge flanges are located at the high point of each 40 acre area.

Other considerations for the conceptual design include:

1. The maximum velocity in the large pipelines is limited to 5.5 feet/second. There should be no water hammer damage at these velocities, because the total flow rate cannot be stopped simultaneously.
2. Maximum pipeline pressures (which occur under static conditions in this case) must be less than 75% of the pressure rating of the pipes.
3. A minimum pressure rating of 80 psi is required for all pipes 12” and above. Smaller pipes (6” – 10”) are rated at a minimum of 100 psi. These minimum pressures are selected based on the properties needed for external soil loading and installation requirements.

Field Turnout Design

Field turnout designs can be found in Appendix A.

Filtration at the Canal

Relatively clean water is important for pipeline applications such as this. For the irrigation water supplier, clean water translates into less need to flush pipes, and no blockage of valves and flow meters. For the farmer with sprinklers, pre-filtration means that only simple screen filters are needed on-farm, and those screen filters will likely need minimal attention. For details on a recommended trash screen model called the AquaSystems 2000, refer to Appendix B.

Canal Modifications

If the Mission C Canal is abandoned, the Mission B Canal will need to be straightened, enlarged, and modified so that it is free from fences and obstructions along the entire length of the access road. Good and simple long-crested weir structures will be needed immediately downstream of each lateral pipeline inlet, so that the screen filters are always sufficiently submerged, and so that there is no vortexing at the inlets to the laterals.

Piping Options Considered

Three piping options were considered for this area of interest in the Mission Canal Unit. Each option varies in cost and benefits. The options described in detail are:
- Option 1: Canal at Mission B only and abandoning Mission C Canal (most expensive, and it also includes canal modification requirements)
- Option 2: Separate pipelines for Mission B and Mission C (less expensive than Option 1)
- Option 3: Piping Mission C service area and maintain gravity service to Mission B Canal area (least expensive).

Option 1: Canal at Mission B only

Option 1 (Figure 52) consists of abandoning Mission C Canal and piping all laterals previously served by both Mission B and Mission C. This totals approximately 11,330 acres. This option requires:
- Improvements to Mission B Canal:
  - Enlargement of canal to increase capacity for increased service acreage
  - Installation of a long-crested weir downstream of each pipe inlet
  - Improvement of canal banks
  - Construction of seven canal-to-pipeline structures
- Boring under U.S. Highway 93:
  - Five of the seven mainlines in this option will require boring under the highway

The benefits associated with this option are:
- Increased flexibility in water delivery to farmers
- Turnout access is greatly improved for FIIP staff for flow and volumetric accounting
- Reduced seepage
- FIIP staff will have only Mission B to focus on for making both water level control and flow rate changes since Mission C will be abandoned in this option.
- Mission C Canal will no longer have to be maintained, which eliminates access issues
- Piping efforts for this area will not have to be considered in the future

The drawbacks of this option are:

- High initial cost – Providing service to this amount of acreage will require larger pipe sizes, which drives up the cost of this option.
- Deliveries will be dependent on the conditions of Mission B. This means that if there are any breaks on Mission B, water deliveries to this service area will be compromised until problems are remedied.

The estimated cost (including engineering, project management, installation, contingencies, etc.) for Option 1 is approximately $31,800,000.

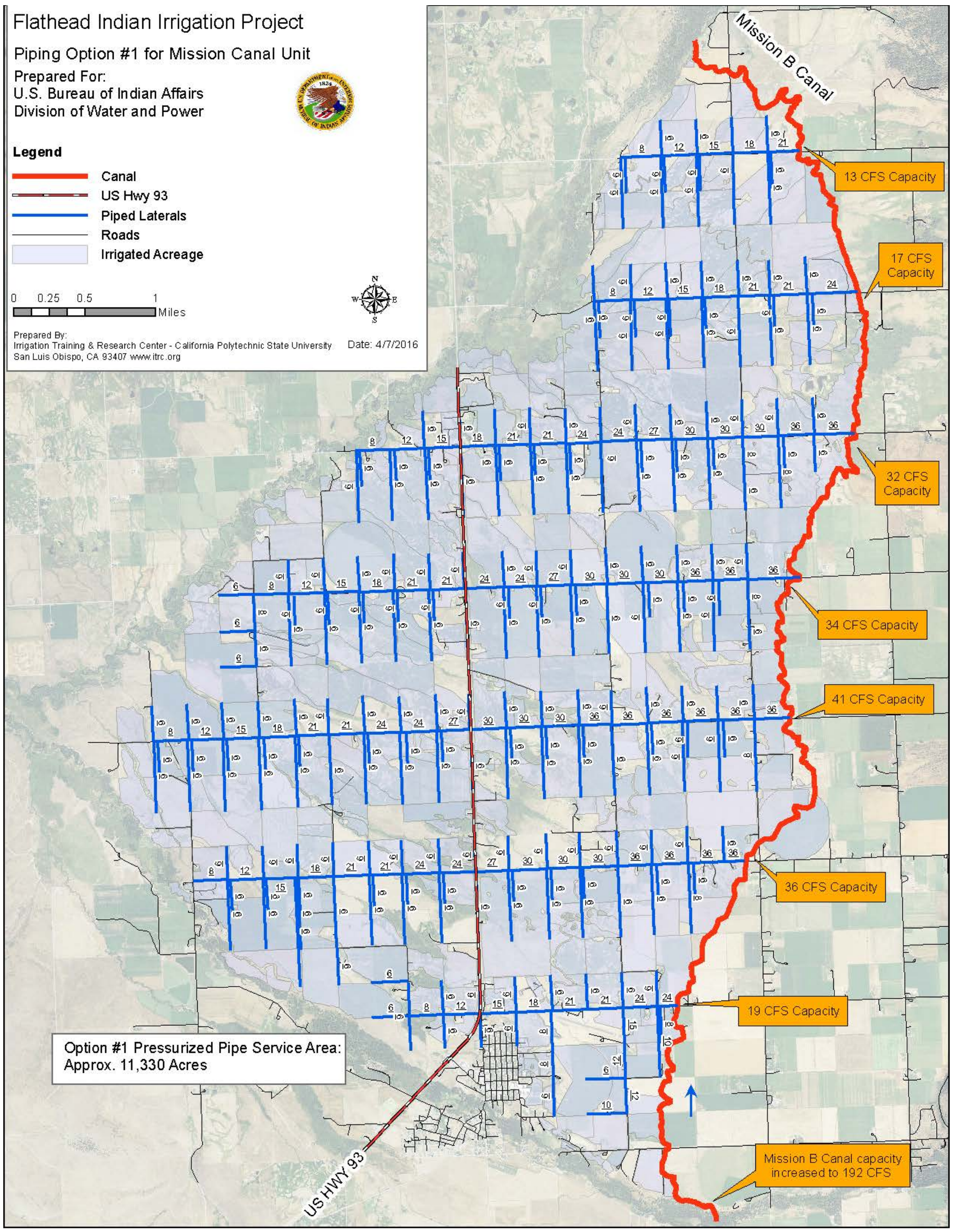

Figure 52. Overview of Option 1 – Abandoning Mission C Canal and piping laterals directly from Mission B Canal

Option 2: Separate Pipelines for Mission B and Mission C

Option 2 (Figure 53) consists of having two separate sets of piped laterals for Mission B and Mission C Canals. The piped laterals for Mission B Canal will service approximately 3,500 acres. The piped laterals for Mission C Canal will service approximately 7,830 acres. This totals approximately 11,330 acres. The capacities of Mission B and Mission C will likely not have to be increased since the service area is not increasing. This option requires:

- Construction of seven canal-to-pipeline structures on Mission B Canal
- Installation of a long-crested weir downstream of each pipe inlet on Mission B Canal
- Construction of six canal-to-pipeline structures on Mission C Canal
- Installation of a long-crested weir downstream of each pipe inlet on Mission C Canal
- Boring under U.S. Highway 93. Five of the 11 mainlines in this option will require boring under the highway

The benefits associated with this option are:

- Increased flexibility in water delivery to farmers
- Greatly improved turnout access for FIIP staff for flow and volumetric accounting
- Reduced seepage
- Modernization efforts for this area will not have to be considered in the future.
- Two canals will be available for water delivery, decreasing dependence on the conditions of one canal.

The drawbacks of this option are:

- Two separate pipe systems will have to be accessed and maintained.
- Twice the amount of canal; to-pipeline structures will be required and will have to be maintained by FIIP staff. This includes:
    - Concrete canal turnout structures
    - Trash screens
    - Propeller meters

The estimated cost (including engineering, project management, installation, contingencies, etc.) for Option 2 is approximately $26,600,000.

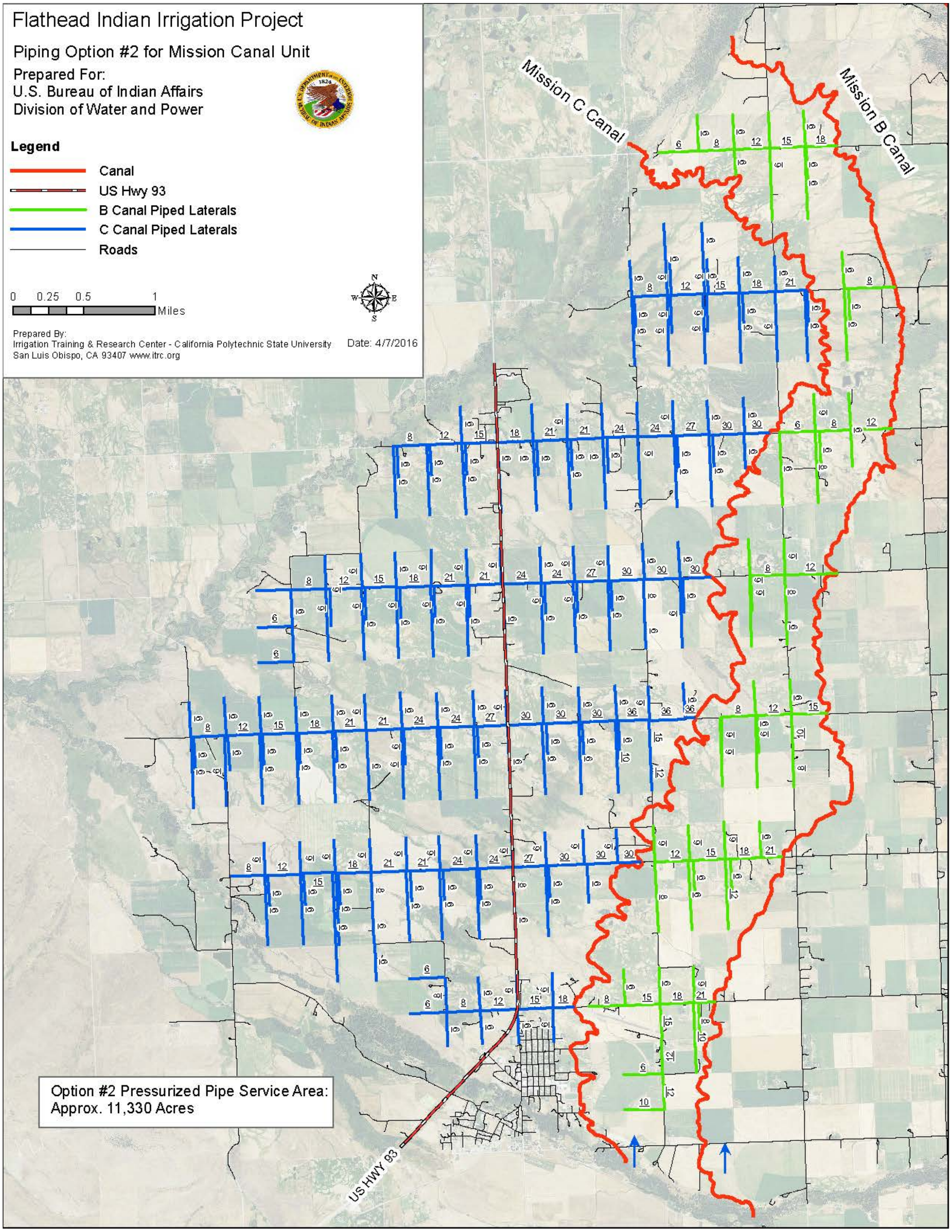

Figure 53. Overview of Option 2 – Piping laterals on the Mission B and Mission C Canals

Option 3: Piping Mission C Service Area Only

This option consists of piping laterals for the Mission C Canal service area while maintaining gravity service to farmers served by Mission B Canal. The piped laterals originating from Mission C Canal will provide pressurized service to approximately 7830 acres.

This option will require the installation of a long-crested weir downstream of each pipe inlet on Mission C Canal.

The benefits associated with this option apply to only the Mission C Canal service area:

- Increased flexibility in water delivery to farmers at about two-thirds of the cost of Option 1
- Turnout access is greatly improved for FIIP staff for flow and volumetric accounting
- Reduced seepage on the laterals

The drawback of this option is that the area serviced by the Mission B Canal will still require traditional gravity water delivery methods that have proven difficult for FIIP staff due to the conditions of canals and laterals in this area.

The estimated cost (including engineering, project management, installation, contingencies, etc.) for Option 3 is approximately $20,200,000.

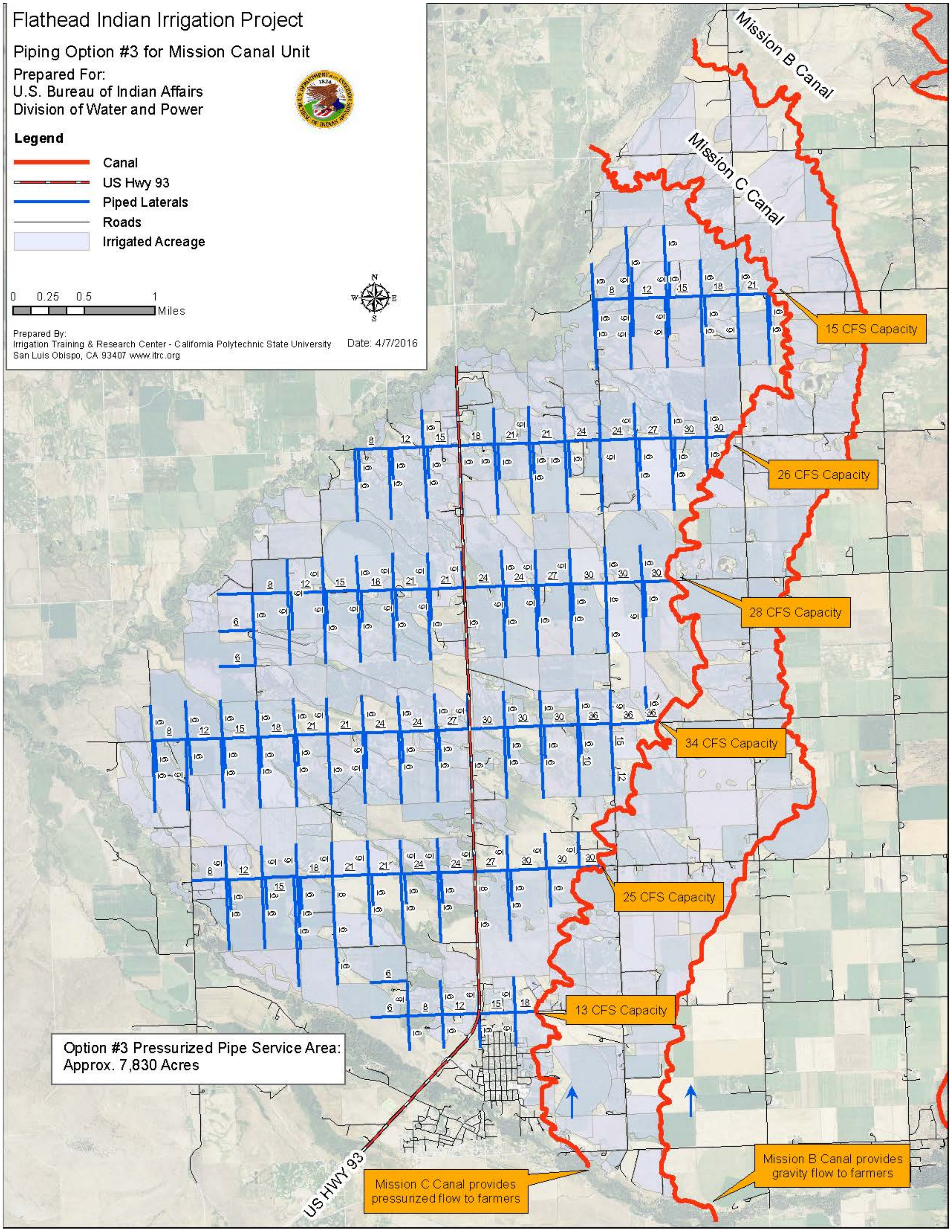

Figure 54. Overview of Option 3 – Piping laterals on the Mission C Canal only

Options Summarized

Table 3 summarizes the service area and construction cost of each option. Option 1 is the most expensive option but offers ease of use for FIIP staff. With the abandonment of C Canal, there is one less canal and simultaneously fewer canal structures for FIIP staff to operate and maintain. Option 2 is less expensive than Option 1 and covers the same acreage of service area that Option 1 does but includes two sets of pipelines that FIIP staff will have to access and maintain. Option 3 is the least expensive and provides service to approximately 70% of the service area of Option 1 at two-thirds of the cost.

Table 3. Cost summary for three piping options in the Mission Canal Unit

Canal	Service Area (Acres)	Construction Cost
Option 1 – Piping to Mission B and abandoning Mission C	11,330	$31,818,300
Option 2 – Piping Mission B and Mission C separately	11,330	$26,547,700
Option 3 – Only piping Mission C service area	7,830	$20,210,800

Improvements to Mission F Canal

Figure 55 shows the existing conditions for the Mission F Canal. The Mission F Canal diverts approximately 20 CFS from the Dry Creek Pool to service numerous turnouts along its 8.5 mile alignment. Though considered a low priority, improvements to the Mission F Canal will focus on:

- Improving the existing water level control along the entire canal to ease management for operators
- Providing flow measurement with remote monitoring of any operational spill at the terminus of the canal

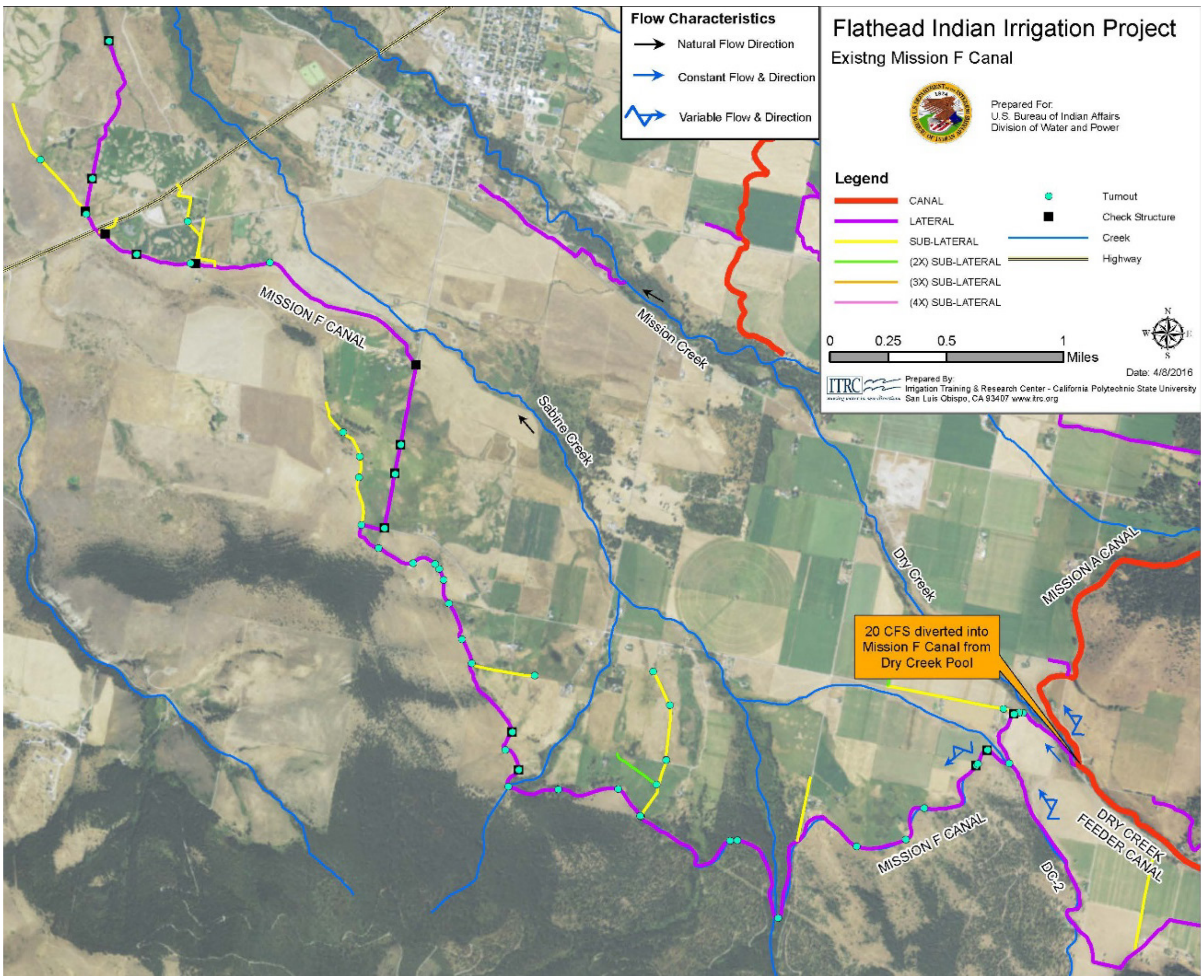

Figure 55. Existing conditions for the Mission F Canal

Improving Water Level Control along Mission F Canal

There are approximately 15 individual check structures for water level control along the Mission F Canal. Figure 56 shows a typical check structure on the Mission F Canal.

Figure 56. Example single bay flashboard check structure on the Mission F Canal. Photo from HKM 2008 report (CH-575).

Improving the existing water level control would achieve the following:

- Better controllability of turnout flow rates, because the upstream levels would remain fairly constant.
- Easier management of the Mission F Canal for operators, because the new water level control structure would not require any manipulation. This would then free up time for operators to manage other areas of the project.

Figure 57 shows the approximate locations for improved water level control along the Mission F Canal. The new water level control structures will be designed similar to the example LCW structure presented in Figure 58. Each structure would have an effective crest length of no more than 20 ft. for managing the upstream water level in the canal.

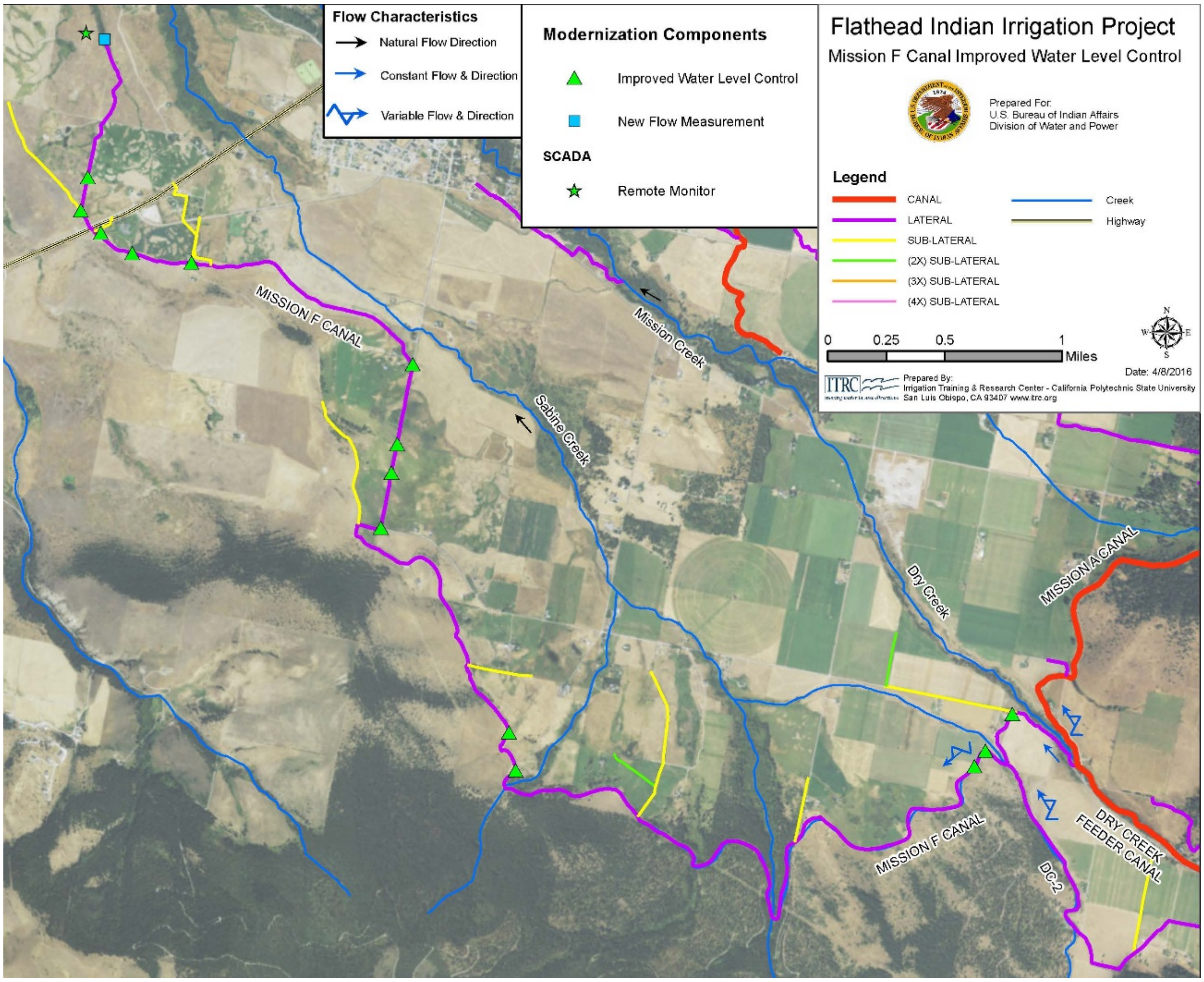

Figure 57. Improved water level locations along the Mission F Canal

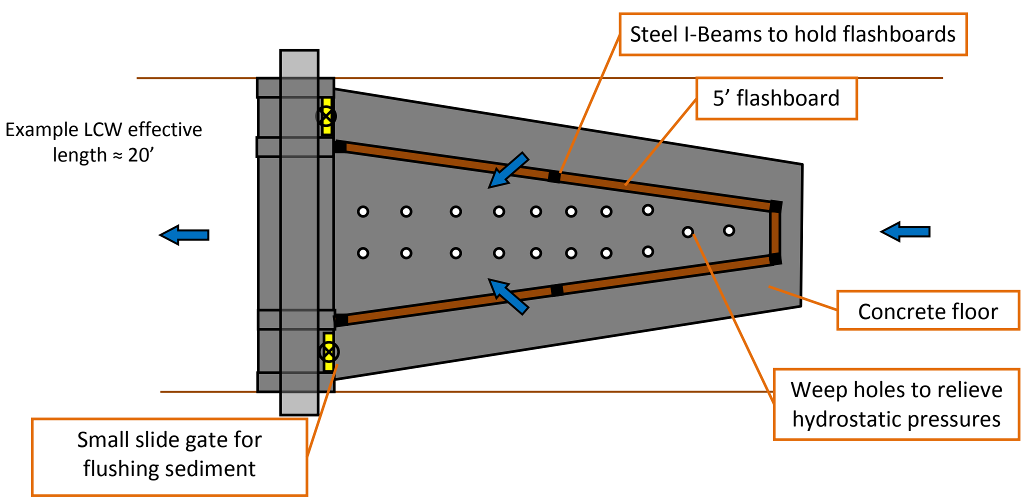

Figure 58. Example of new LCW structures to be constructed along the Mission F Canal (not to scale)

Mission F Canal Spill Measurement

Figure 59 shows the existing 4 ft. wide check/waste structure at the very end of the Mission F Canal. The structure maintains the upstream water level for the last turnout on the canal. Any operational spill eventually ends up in Mission Creek where it is essentially lost to the project.

Figure 59. Existing 4' wide check/waste structure at the end of the Mission F Canal. Photo from HKM 2008 report (CW-74).

Improvements for Measuring Spill

It may be in the interest of FIIP to know the amount of spill at the end of the Mission F Canal at any time so the appropriate flow rate changes can be made back at the head of the canal. The following improvements will be made:

1. A 3.5 ft. wide Cipoletti weir plate will be installed to the existing concrete structure at the end of the Mission F Canal. A staff gauge that reads directly in CFS will also be installed on the concrete headwall.
2. SCADA components would be included to allow operators to remotely monitor the amount of spill over the Cipolleti weir.