RECLAMATION

Managing Water in the West

Lewiston Temperature Management Intermediate Technical Memorandum

Lewiston Reservoir, Trinity County, California

U.S. Department of the Interior
Bureau of Reclamation
Mid-Pacific Region

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1.0 Background

Trinity River Restoration Program

The Trinity River Restoration Program (TRRP) was established by the Trinity River Mainstem Fishery Restoration Record of Decision (2000) as an adaptive management program within the assigned implementation fields of infrastructure, channel rehabilitation, gravel augmentation, and watershed restoration. The TRRP is a multi-agency program with eight Partners that form the Trinity Management Council (TMC), plus numerous other collaborators. The TMC Partners include the California Resources Agency, Hoopa Valley Tribe, Trinity County, U.S. Bureau of Reclamation (Reclamation), U.S. Fish and Wildlife Service, U.S. Forest Service, U.S. National Marine Fisheries Service, and the Yurok Tribe. The TRRP has a number of collaborative work groups for addressing technical issues. The Temperature Work Group (TWG) addresses the challenges of managing water releases for temperature control compliance and coordinates projects focused on temperature monitoring and modeling.

Problem

Reclamation Central Valley Project (CVP) operators face seasonal challenges in meeting downstream temperature targets set by the State Water Resources Control Board. The geometry, hydrodynamics, and incidence of direct solar radiation in Lewiston Reservoir can cause an increase in water temperature during travel of flows from Trinity Dam to Lewiston Dam, and into the Trinity River. This sometimes results in unsuitable mean daily temperatures for anadromous salmonids in the Trinity River below Lewiston Dam.

Purpose

This memorandum provides descriptions and preliminary level cost estimates for alternatives that the TRRP TWG identified to meet the objectives and goals of the Lewiston Temperature Study as described below. The memorandum is not intended to analyze impacts or recommend alternatives to be carried forward for further analysis. The cost estimates were developed to document a very preliminary analysis utilizing readily available data. Cost estimates are summarized in Section 4.0 and cost estimate worksheets are included in Attachment 1.

Goals

The original study objective identified by the TWG was to provide recommendations for improving the transmission of cold water (less than 50 degrees Fahrenheit) through Lewiston Reservoir.

At the April 13 and May 23, 2012, meetings, the TWG members expanded the original objective to include the following generalized study goals. The TWG has yet to finalize, clarify, or rank these goals.

1. Habitat improvement on the Trinity River; increased mileage
2. Improve cold water transmission upstream of Lewiston Dam
3. Increase salmon production
4. Maintain existing level of recreational benefits and minimize impacts to same

Authority

Authorization to implement this project may be provided by Public Law (PL) 392 (Central Valley Project), PL 386 (Trinity River Division), PL 102-575 (Central Valley Project Improvement Act), or other legislation.

Setting

Lewiston Dam and Reservoir are located on the Trinity River within Trinity County, California (see Figure 1). The dam is a zoned earth-fill structure 91 feet high and 754 feet long with a 25-foot crest width. The dam is part of the Trinity River Division (TRD) of the CVP. The TRD provides a cross basin transfer of water from the upper Trinity River watershed to the Sacramento River drainage downstream of Shasta Dam while complying with Trinity River flow objectives below Lewiston Dam. The TRD provides water to the Sacramento River basin by diverting water at the Lewiston Dam into the Clear Creek Tunnel and into Whiskeytown Lake on Clear Creek. A total installed capacity of 154 megawatts (MW) of hydroelectric power generation is produced in the process.

There are four water release points out of Lewiston Reservoir as shown in Figures 1 and 2: the cross basin diversion through Clear Creek Tunnel to Whiskeytown Lake, the spillway gates to Trinity River below the dam, the water supply to the Trinity River Fish Hatchery, and the water supply to Lewiston Powerplant.

Figure 1. Lewiston Dam and Reservoir Facility and Structures.

There are two temperature control curtains within Lewiston Reservoir that are operated to meet water temperature targets in the Trinity River. The 350 kilowatt (kW) Lewiston Powerplant is operated in conjunction with the spillway gates to comply with mandated flows in the Trinity River downstream of the dam. The powerplant has a rated flow discharge capacity of 325 cubic feet per second (cfs), but is currently under restriction to 80 cfs due to structural problems that can lead to stranding of fish in the stilling basin. Also, there is a proposal under consideration by Trinity Public Utility District (TPUD) to replace the existing powerplant with a 2.2-MW powerplant, which would increase the plant capacity to 480 cfs. An Environmental Assessment (EA) was prepared for the powerplant replacement (Reclamation, 2011) and a Finding of No Significant Impact (FONSI) was issued.

Attachment 2 contains additional detail on TRD features including project data and original construction drawings of Lewiston Dam and Powerplant, Clear Creek Power Conduit (tunnel), and Trinity Dam and Powerplant.

Figure 2 shows the water surface elevations and typical flows for Trinity and Lewiston Dam. The water surface elevation difference between the typical Trinity Dam tailwater to Lewiston Reservoir is approximately 2 feet. The Lewiston Reservoir operating range was designed for a relatively narrow 4 feet, between elevation 1898 and 1902. This constraint precludes potential alternatives for conveying water by gravity means between these features, as there is insufficient energy. Figure 3 shows the relative elevations of the features proximate to Lewiston Dam, along with the operating range of the reservoir and the downstream elevation of Trinity River.

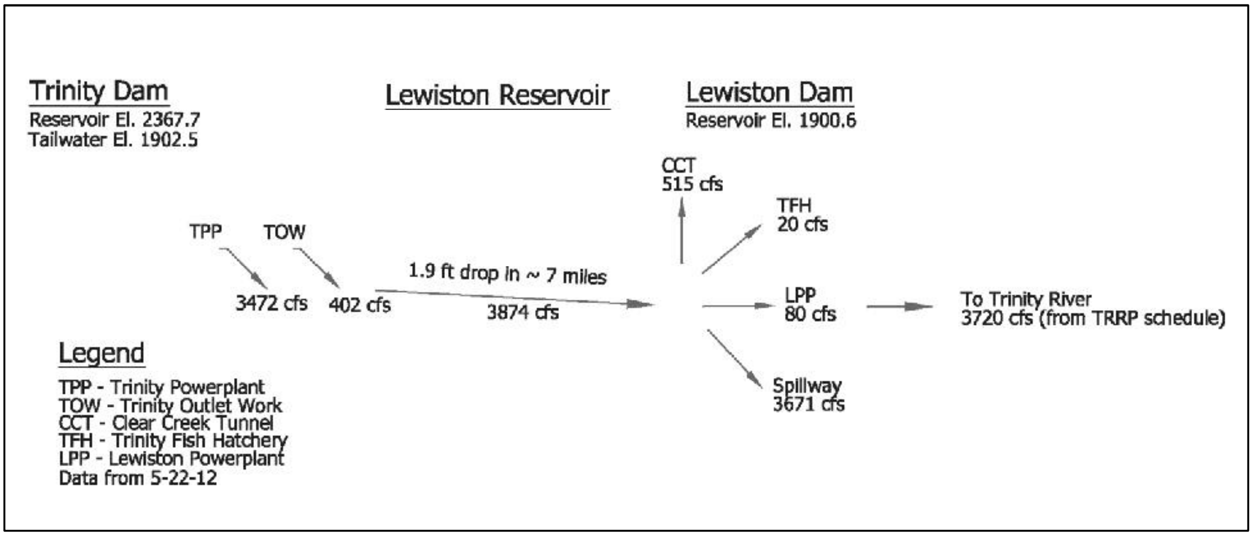

Figure 2. Overview of Existing System.

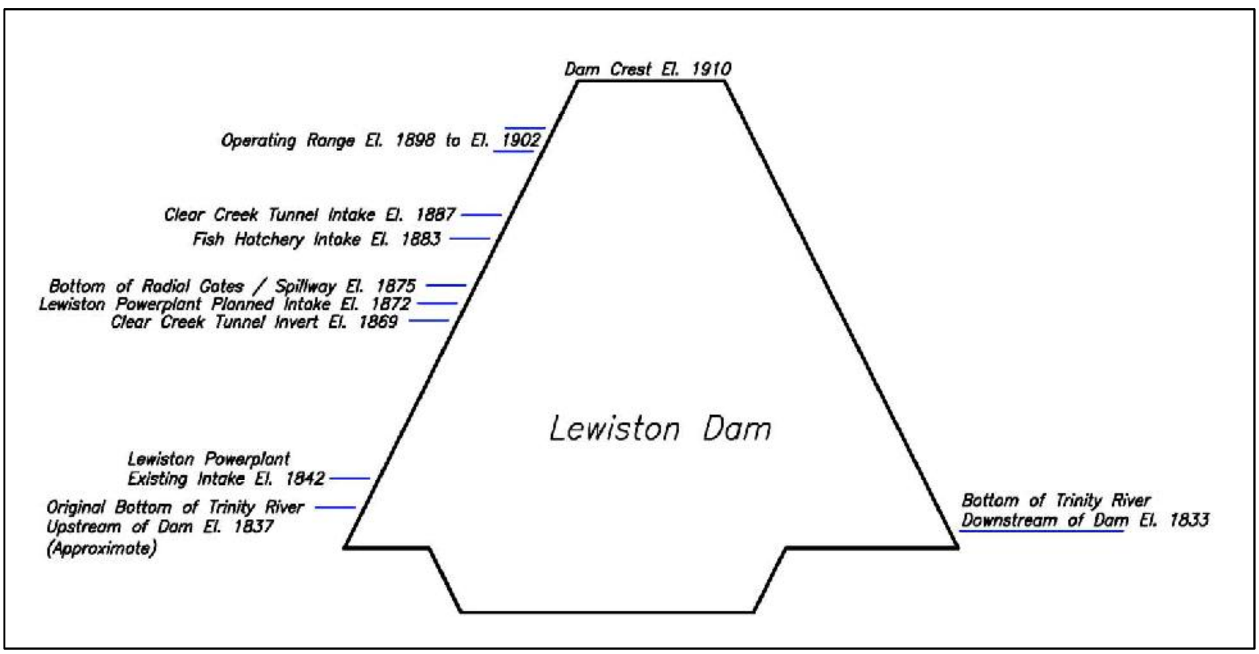

Figure 3. Lewiston Dam Elevation Diagram.

Alternatives and Options

The TWG discussed several alternatives during the April 13, May 23, and June 29, 2012, meetings. It was determined that the following alternatives would be included in this memorandum:

1a. Removal of Lewiston Dam - Canal Water Supply
1b. Removal of Lewiston Dam - Pump Station Water Supply
2. Dredging of Lewiston Reservoir
3a. Tunnel from Trinity Dam to Lewiston Dam
3b. Pipeline from Trinity Dam to Lewiston Dam
4. Raise Lewiston Dam

Detailed descriptions of these alternatives are provided in Section 2.0. In addition to these alternatives, this memorandum describes the following options that could be implemented separately or in combination with the alternatives:

A. Lewiston Powerplant Intake Extension Modification
The TPUD has proposed replacing the existing Lewiston Powerplant with a 2.2-MW powerplant. A potential option to provide additional flexibility for managing downstream temperatures in the Trinity River would be to extend the proposed new intake deeper into the reservoir.

B. Trinity Dam Selective Withdrawal Structure
Reclamation considered the concept of a Trinity Dam selective withdrawal structure in studies conducted in 1978 and 1979. Although the structure was never constructed, this concept remains a potential option for temperature management.

Detailed descriptions of these options are provided in Section 3.0.

2.0 Alternative Descriptions

Alternative #1a - Removal of Lewiston Dam - Canal Water Supply

This alternative focuses on Goal 1, improvement of habitat by increasing the river mileage available for salmonid habitat. This alternative aims to create salmonid habitat following removal of Lewiston Dam by restoration of the former lakebed (see Figure 1). Removal of Lewiston Dam would eliminate the retention time in the reservoir upstream of the dam and associated heating. Consideration would need to be given to the roughly 7 miles of river over which heating would occur. The net change in heating (reservoir versus riverine) is uncertain prior to analysis with advanced riverine temperature prediction models. This alternative does not retain current recreational benefits on Lewiston Reservoir. It adds riverine-based recreational benefits similar to those below Lewiston Dam. See Figure 4 for a plan view of the existing features proximate to Lewiston Dam, and Figure 7 for last year's releases from Lewiston Reservoir.

Figure 4. Demolition Plan.

Major components of Alternative #1a include:

- Constructing a 5.5-mile long, concrete lined canal between Trinity Powerplant and Clear Creek Tunnel intake
- Removing the dam embankment and appurtenant structures (spillway, powerplant, etc.)
- Constructing a new water supply to the hatchery from the new canal

- Removing and managing sediments that have accumulated in the reservoir
- Developing the new riverine habitat between Trinity Dam and the removed Lewiston Dam
- Restoring or establishing recreation facilities in the 7-mile stretch of new riverine area
- Constructing any necessary infrastructure improvements, or stabilization of banks to address impacts from elimination of Lewiston Reservoir.

Following is a detailed description of this alternative.

Clear Creek Tunnel Water Supply

Removal of the dam would eliminate Lewiston Reservoir, which provides water to several features. The Clear Creek Tunnel conveys water from the Trinity River to Whiskeytown Reservoir, and this conveyance would continue after the dam removal activities are complete. One possibility would be to construct an approximately 7-mile long canal along the eastern shoreline of Lewiston Reservoir (see Figure 5). To meet the peak flow requirements of the Clear Creek Tunnel (approximately 3,200 cfs), the canal would need to be adequately sized. Figure 6 depicts typical canal sections. The rough terrain, limited access to the construction area, and the geological conditions (large areas of hard rock), would make canal construction challenging. Due to the minimal elevation change between the base of Trinity Dam and the intake to Clear Creek Tunnel, a bifurcation structure would tap into the high pressure side of the Trinity Dam outlet works above the powerplant.

Figure 5. Canal Alignment.

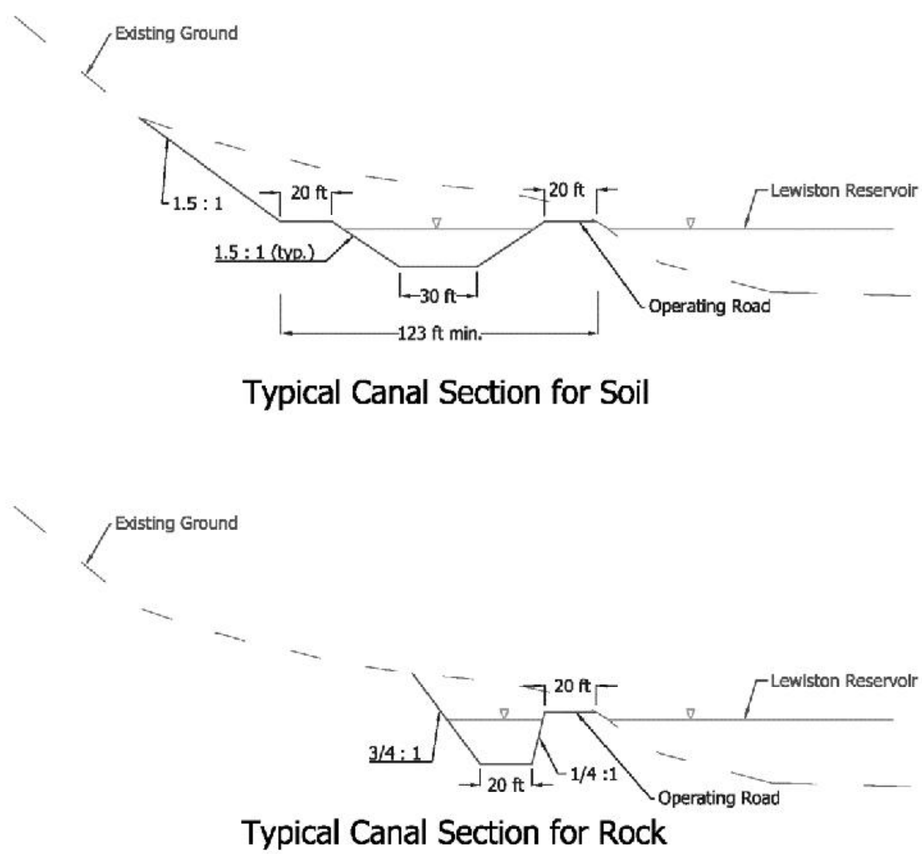

Figure 6. Typical Canal Sections.

The high pressure discharges would be directed to an energy dissipater (stilling basin) before entering the new concrete lined canal. The arrangement would be similar to the Friant Dam outlet to the Friant-Kern Canal (see Attachment 6). The canal alignment would follow the eastern shoreline and would include typical cross drainage and water control structures such as check structures and wasteways (see Attachment 6 for examples). Typical canal cross sections are shown in Figure 6. Canal bottom width would be 20 to 30 feet, with a water depth 18 to 20 feet. Canal discharge into Clear Creek Tunnel would require reconfiguration of the existing intake tower. Under Alternative #1a, a turnout off of the new canal would provide the water supply to the hatchery.

Decommission Powerplant

Water from Lewiston Reservoir currently generates power via a 350 kW powerplant downstream of Lewiston Dam. If the dam is removed, this powerplant would need to be decommissioned.

The primary building, associated structures, turbomachinery, electrical equipment and power lines would be removed. The Lewiston Dam site would no longer generate power, and future revenue associated with that power would be forfeited.

Maintain Fish Hatchery Water Supply and Functions

Trinity River Fish Hatchery located just downstream of Lewiston Dam would remain operational under the dam removal alternative. Removal of the dam would require reconfiguration of the hatchery fish ladder and other features. Elimination of the reservoir would require establishing a new water supply for the hatchery. For Alternative #1a, a turnout off of the new canal supplying Clear Creek tunnel would be established.

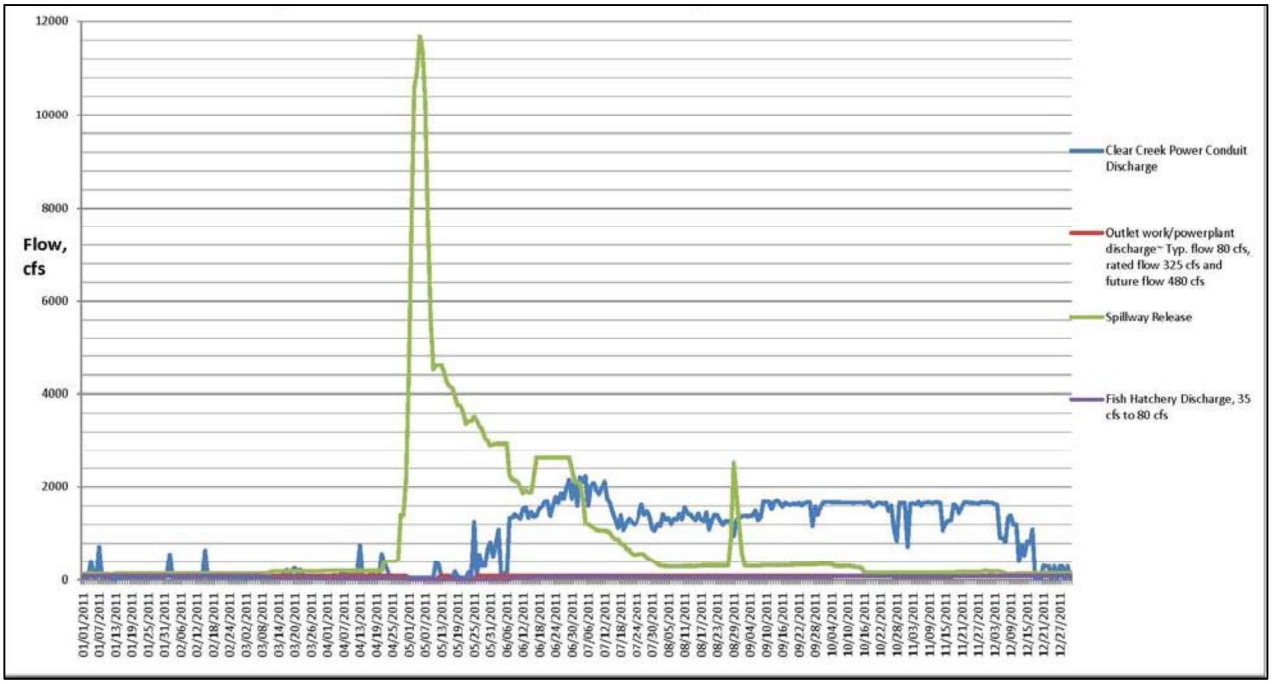

Figure 7. Lewiston Dam Annual Operational Data, 2011.

Remove Temperature Control Curtains

There are currently two temperature control curtains within Lewiston Reservoir. With dam removal, these curtains would need to be removed as well. Tasks related to removing the curtains include demolition, preparation for transport, and disposal at an appropriate location.

Excavate and Remove Dam

Full removal of the embankment, reinforced concrete spillway, and other structures were assumed for this alternative. Removal of the embankment materials would consist of excavating approximately 400,000 cubic yards of material. This material would be transported and disposed of at suitable locations. Approximately 20,000 cubic yards of the material consists of river alluvium. If suitable, it may be possible to reuse this material for portions of the riverine restoration work. Demolished reinforced concrete and metalwork would need to be hauled to an appropriate disposal site.

Sediment Characterization

Throughout the life of Lewiston Dam, sediment has collected in Lewiston Reservoir. Due to the mining history in the area, the sediment in Lewiston Reservoir may contain heavy metals, including mercury. Characterization of the sediment would be required to identify areas of sediment that must be removed. Based on test results, some sediment may be allowed to remain in place, while the remainder would need to be moved to more appropriate locations along the newly exposed riverbanks, or relocated to a repository. This would include excavation, processing of the material, transport, and placement.

Repository for Contaminated Sediment

Based on results of the characterization process, areas of contaminated sediment would be identified. Sediment that is too contaminated to remain in the riverine habitat would be relocated to an appropriately sized repository. Containment methods such as lining material would be utilized to prevent the sediment from leaching contaminants into the surrounding environment. This alternative has the potential for mercury and monomethylmercury release. Refer to Attachment 4, which is an initial assessment of this potential prepared by Dr. James Rytuba of the U.S. Geological Survey.

Trinity Powerplant Tailwater Regulation

Lewiston Dam creates an afterbay (Lewiston Reservoir) which regulates releases from Trinity Dam. The afterbay provides the ability to vary releases from Trinity Powerplant to meet peaking power demands, which is a typical function of hydroelectric facilities. With Lewiston Dam removed, Trinity Powerplant would lose much of its capability to provide variable or peaking power because the powerplant, in combination with the river outlet works, would be dedicated to complying with Trinity River flow objectives below Lewiston Dam.

The cross basin diversion to Whiskeytown Lake would continue to operate in a peaking power/flow mode. Variable flow rates in the new canal could result in changing water depths within the canal. Special design measures would be incorporated to ensure structural integrity of the canal lining for this atypical loading condition.

It should be noted that operating restrictions on the Trinity Powerplant would likely have an adverse impact on power revenue.

Recreation Facilities and River Access Points

Recreation facilities are located along Lewiston Reservoir, including public and private boat docks, fishing areas, picnic areas, parking lots, and campgrounds. With Lewiston Dam removed, these recreation facilities would need to be modified or relocated adjacent to the restored Trinity River. Additional consideration would need to be given to the inclusion of river access points for public access.

General Infrastructure

Removal of Lewiston Dam would require changes to the existing infrastructure, including removing, constructing, and relocating various features as appropriate to accommodate the area's new physical conditions. Sewer lines, roads, power lines, drainage structures, and other infrastructure would be affected by the change. Once completed, these general infrastructure items would function properly with the restored portion of the Trinity River.

Slope Stability

As Lewiston Reservoir is drawn down, areas of instability along the reservoir rim could develop if the reservoir is lowered faster than the bank storage water pressure can dissipate. Large landslide areas exist in the canyon, but these areas would be expected to remain stable if the reservoir is drawn down slowly enough. There is also the potential for localized areas of instability closer to the reservoir. These areas of potential instability would need to be identified, investigated, and possibly stabilized. Possible mitigation measures include buttressing slopes with berms, adding drainage features, removing/reshaping trouble spots, or establishing protective vegetation.

Riverine Restoration and Riparian Revegetation

The bottom of Lewiston Reservoir currently contains significant sediment deposits and is largely void of vegetation. If the dam is removed, the reservoir would be eliminated, and the river would return to a natural state. However, the riverbanks would require some effort to restore. Riverine restoration, including grading, shaping, and planting riparian vegetation, would be necessary to provide cover for fish and wildlife of the Trinity River.

Diversion Tunnel for Dam Removal Work

To excavate the embankment materials and remove the appurtenant structures, the reservoir would need to be drained. The existing outlets at the dam are insufficient to fully drain the reservoir. When Lewiston Dam was built, a pre-existing mining diversion tunnel was upgraded in order to divert the Trinity River around the dam, Clear Creek tunnel, and hatchery worksites (see Attachment 2 drawings). The mining diversion tunnel was approximately 10 feet in diameter and 1,600-foot long and was located west of the dam. Upon completion of construction, an 18-foot long concrete plug was placed at the upstream portal, abandoning the tunnel in place. It should be possible to locate, unplug, and develop the tunnel for diversion purposes. However, the work for developing the tunnel would likely be performed under a partially filled Lewiston Reservoir, increasing the construction challenges. After dam removal work is completed, the tunnel would be plugged again to restore the natural flow of the Trinity River.

Alternative #1b - Removal of Lewiston Dam - Pump Station Water Supply

Like Alternative #1a, this alternative focuses on Goal 1, improvement of habitat by increasing the river mileage available for salmonid habitat. In general, the benefits of Alternative #1a would be retained by Alternative #1b. The primary difference is this alternative would provide water to the Trinity River Fish Hatchery and Clear Creek Tunnel by utilizing a pump station rather than a gravity-based system. See Figure 4 for a plan view of the existing features proximate to Lewiston Dam, and Figure 7 for 2011 releases from Lewiston Reservoir. Several components of Alternative #1b would be substantially the same as Alternative #1a. These components are listed below and are described under Alternative #1a:

- Removing the dam embankment and appurtenant structures (spillway, powerplant, etc.)
- Removing and managing sediments that have accumulated in the reservoir
- Developing the new riverine habitat between Trinity Dam and the removed Lewiston Dam
- Restoring or establishing recreation facilities in the 7-mile stretch of new riverine area
- Constructing any necessary infrastructure improvements, or stabilization of banks to address impacts from elimination of Lewiston Reservoir

The following components would differ from Alternative #1a. These components are described below.

- Constructing a 3,200 cfs pump station to lift water approximately 70 feet from the Trinity River into the Clear Creek tunnel intake
- Establishing a new 125 cfs water supply to the hatchery from the new pump station
- This hatchery water supply may require disinfection

Clear Creek Tunnel Water Supply

Removal of the dam would eliminate Lewiston Reservoir, which provides water to several features. The Clear Creek Tunnel conveys water from the Trinity River to Whiskeytown Reservoir, and this conveyance would continue after dam removal activities are complete. Alternative #1b would convey water to the Clear Creek Tunnel by utilizing a new pump station on Trinity River. The new indoor pump station would be sized for a pumping capacity of 3,300 cfs to maintain the current tunnel operating conditions, and to supply the hatchery. The preliminary design layout estimates that 22 vertical pumping units, each pumping 150 cfs, would be required. The units would discharge into 4-foot diameter steel pipe discharge lines fitted with butterfly and check valves. These pipes would manifold into larger pipes installed above grade that would discharge into Clear Creek tunnel. This pump station would require an approximately 2,000-foot long, 5-foot high fish screen (see Figure 8) to prevent fish entrainment to comply with National Marine Fisheries Service fish screening criteria. An example of a similar pumping plant and fish screen facility is the recently completed Red Bluff Diversion Dam/Tehama Colusa Canal Fish Passage Improvement Project (2,200 cfs diversion, 1,100-foot fish screen).

Power Supply

The pump station would require a significant amount of power to operate. Power infrastructure would need to be constructed to provide the necessary power, including transmission lines and substations.

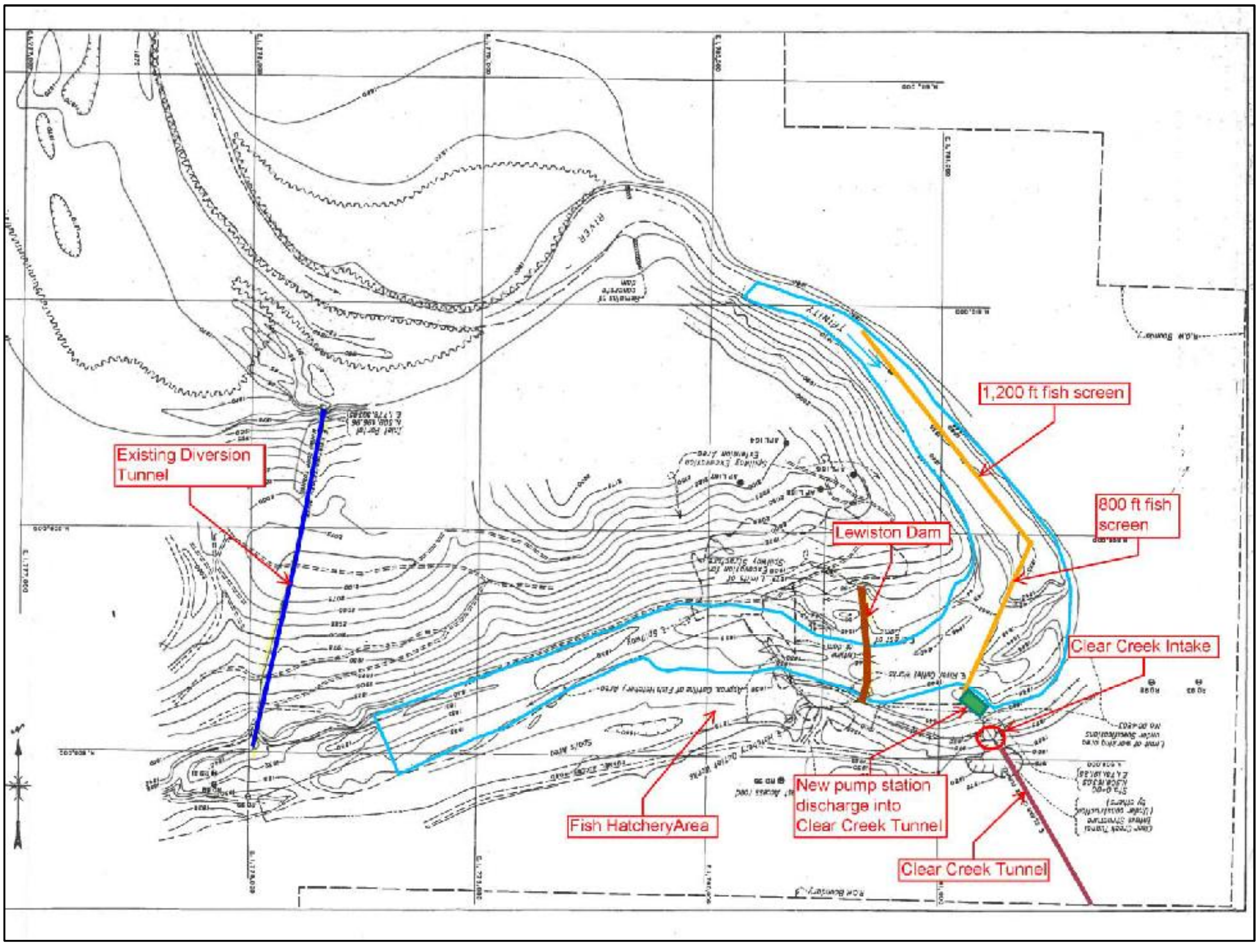

Figure 8. Removal of Lewiston Dam- Pump Station Water Supply.

Alternative #2 - Dredging of Lewiston Reservoir

This alternative focuses on Goal 2, increasing efficiency of cold water transmission from Trinity Dam to the Trinity River below Lewiston Dam. It aims to leverage the stratification in Lewiston Reservoir forced by the Lewiston temperature control curtain. Improving the cold-water density current between Pine Cove Marina and roughly 2.5 miles downstream may result in more cold water transiting the reservoir quicker and with less mixing. The construction of submerged berms in selected areas would reduce lateral mixing while maintaining recreation for surface watercraft.

This alternative would not result in a significant change in the area. Most of the work required for this approach involves the dredging operations and management of the associated construction activities. Existing operations at the Clear Creek Tunnel, both dams, and both powerplants would not be changed as a result of this alternative. Current recreational benefits on Lewiston Reservoir would not be adversely affected. Major components of this alternative include:

- Excavating/dredging approximately 2.5 miles of existing stream channel sediments to create an underwater cold water corridor

- Constructing submerged berms at key locations along the river bank using the excavated sediments

Following is a detailed description of this alternative.

Sediment Characterization

This alternative would involve dredging material and constructing berms. As with Alternatives #1a and #1b, some of the sedimentary material may be contaminated with mercury in concentrations that would require removal of the sediment. Characterization of the sediment would be needed to identify areas of sediment for removal. This alternative has the potential for mercury and monomethylmercury release. Refer to Attachment 4, which is an initial assessment of this potential prepared by Dr. James Rytuba of the U.S. Geological Survey.

Excavate Sediment

In order to create the underwater channel that is the centerpiece of this alternative, dredging would be required within Lewiston Reservoir. The dredging would be planned to carve an optimum path along a determined route based on existing bathymetry. A temperature analysis would be used to identify locations that would be widened or closed off as required to achieve the desired objective. Hard rock would be avoided wherever possible, focusing the dredging operations on sedimentary material within the reservoir.

Construct Berm

To increase the effectiveness of the channel and further decrease the propensity of lateral mixing, berms would be constructed adjacent to the channel (see Figure 9). Material from the dredging operations would be used to construct the berms. No imported material would be required.

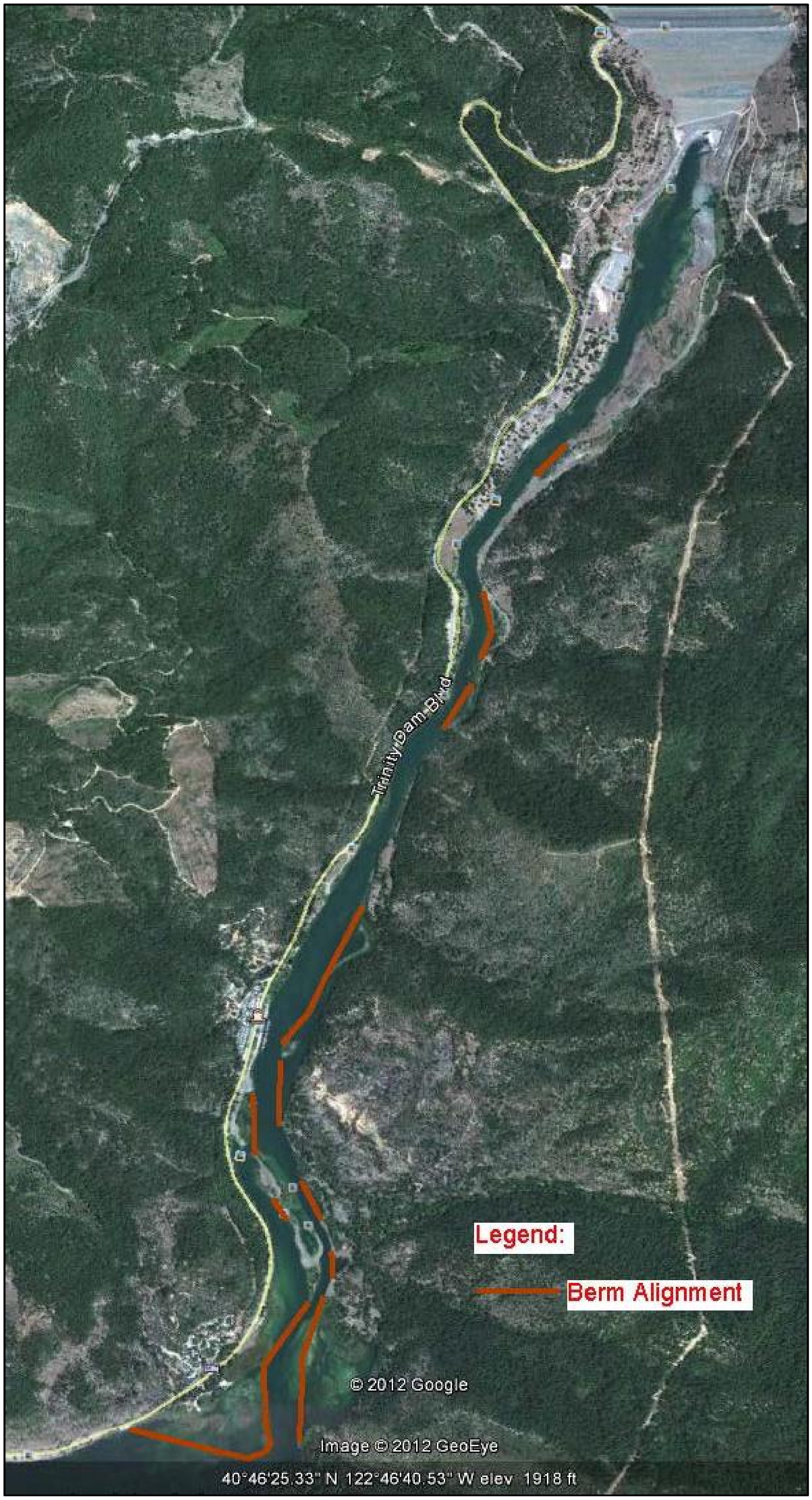

Figure 9. Dredging & Berm Alignment.

The top of the berms would be under the water surface at a sufficient depth to avoid any issues with boats and other watercraft using Lewiston Reservoir. See Figure 10, which shows a typical berm cross section, and Attachment 5, which includes recent bathymetry of Lewiston Reservoir.

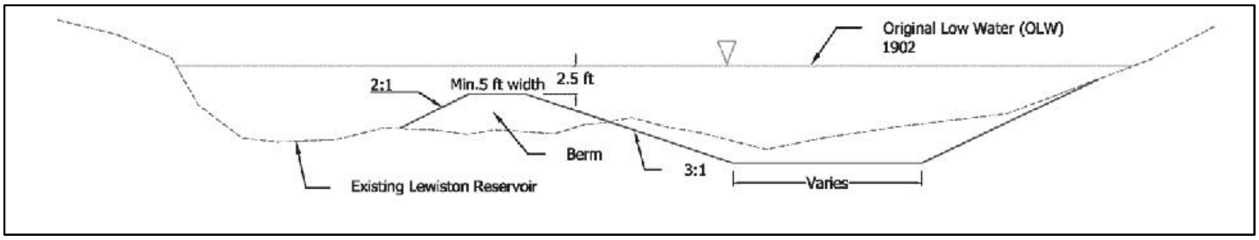

Figure 10. Typical Berm Cross Section.

Repository for Contaminated Sediment

Contaminated sediment with high concentrations of pollutants would need to be removed. This sediment would require an appropriately sized repository for disposal.

Turbidity Management

It is expected that dredging operations would result in significant turbidity issues. Material currently settled at the bottom of the reservoir could become suspended in the water after being disturbed. Measures would need to be in place to contain the turbidity and prevent an excessive amount of suspended solids from entering the Trinity River downstream of Lewiston Dam.

Site Restoration

Although disturbance of the areas around the reservoir would be minimized, it is expected that some locations may be affected. Areas changed through the elimination of side channels, disturbance of the shoreline, or accumulation of material would need to be restored after construction is complete. Revegetation is expected to be the primary means of restoring the site, although additional work may be required.

Recreation & Navigation

Any areas significantly disturbed in a manner that could adversely affect boating operations or existing recreational activities would need to be addressed. This could include installation of buoys and replacement of recreational facilities such as docks, picnic tables, and other measures.

Alternative #3a - Tunnel from Trinity Dam to Lewiston Dam

This alternative focuses on Goal 2, improving cold water transmission between Trinity Dam and Lewiston Dam by using a tunnel to transmit 650 cfs of cold water from Trinity Dam to Lewiston Reservoir. This would decrease retention time, eliminate lateral mixing, and prevent the water from being heated by the sun during the conveyance between the dams. This alternative would result in minimal impact to the general area and to recreational benefits, as most of the construction related to the tunnel would be underground. Operations at the Clear Creek Tunnel, both dams, and both powerplants would continue without major changes. Major components of this alternative include:

- Constructing a 5-mile long, 10-foot diameter, 650-cfs capacity, concrete-lined pressure tunnel on the east side of the Trinity River between Trinity Dam outlet works and Lewiston Reservoir
- Constructing a new bifurcation structure to tap into the high pressure side of the Trinity Dam river outlet works above the powerplant to supply the tunnel
- Constructing a tunnel outlet structure that discharges the 650 cfs into the deeper level of Lewiston Reservoir
- Constructing associated tunnel ventilation and access shafts
- Constructing access roads needed for tunnel construction and operation and maintenance

Following is a detailed description of this alternative.

Tunnel Boring

Tunnel boring is the primary effort required for this alternative. The tunnel would take an approximately direct path from Trinity Dam to Lewiston Dam, which would shortcut major curves in Lewiston Reservoir (see Figure 11). It is expected that most of the bored material would be hard rock. Tunnel boring machines would be mobilized to the site, and the construction process to complete the tunnel would be time intensive.

Access Roads

The tunnel alignment would be on the east side of Lewiston Reservoir, where access is very limited. Although much of the tunnel may be constructed underground with boring machines, access would still be needed at various locations along the route, such as near access shafts. Access roads would be constructed to provide a path to these areas. Due to the topography and vegetation, construction of access roads would require removal of numerous trees, significant excavation and embankment, and careful planning of the routes. Steep slopes would increase the difficulty of constructing access roads.

Trinity Outlet Works Tap

At the Trinity Dam side of the tunnel, water would enter via a direct tap of the dam's outlet works. A bifurcation structure would tap into the high pressure side of the Trinity Dam outlet works above the powerplant. The high pressure discharges would be regulated by appropriate valving before being discharged into the tunnel. By connecting to the outlet works directly, water in the tunnel would have enough pressure to achieve the required flow to overcome friction losses through the tunnel.

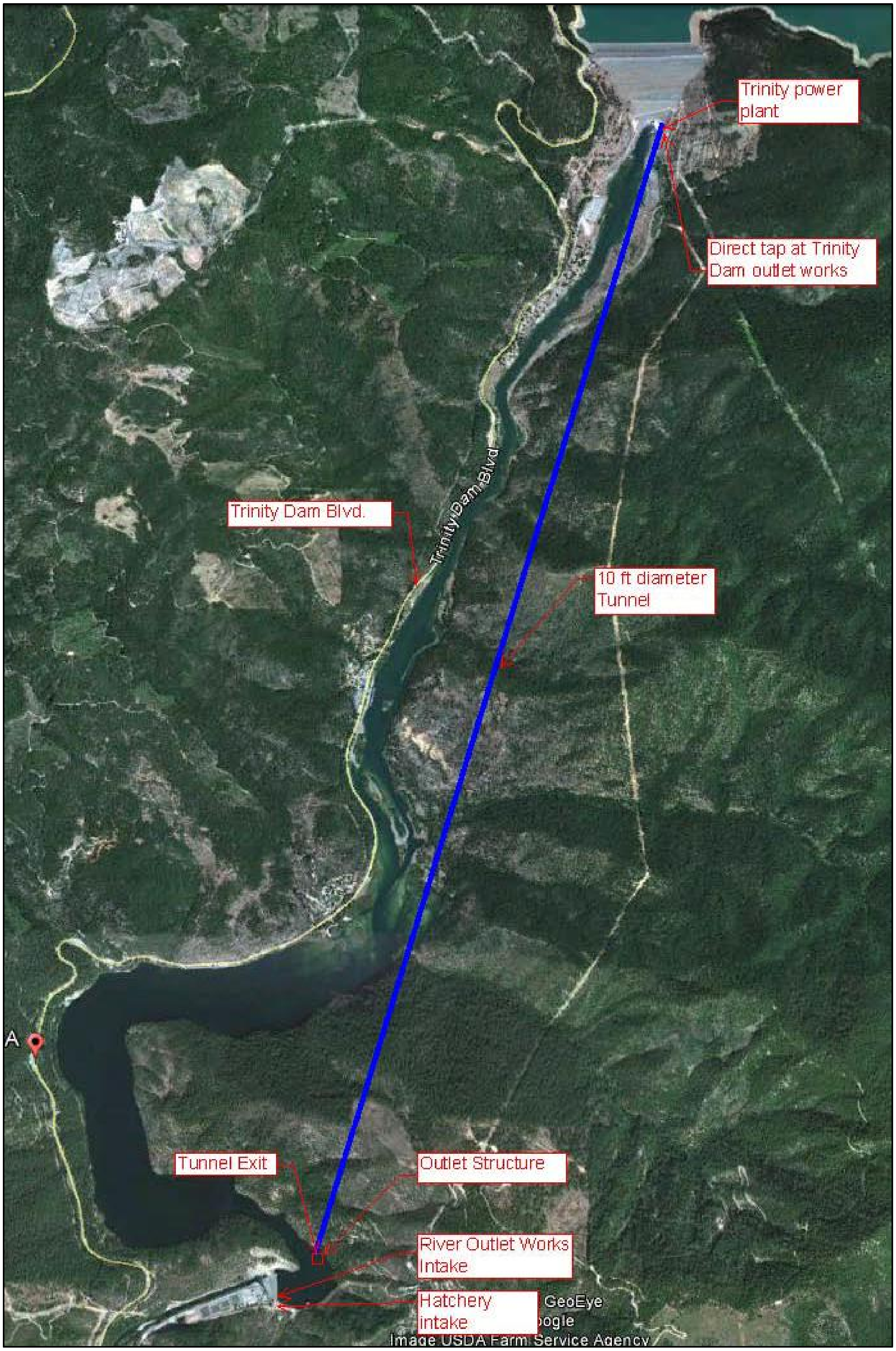

Figure 11. Tunnel Alignment.

Outlet Structure

The tunnel exit would require a streamlined outlet structure to prevent mixing of the cold water exiting the tunnel and to direct cooler water to a discharge point in the deeper level of Lewiston Reservoir. The outlet structure would include a smooth transition between the tunnel and reservoir to minimize turbulence and to reduce mixing of the colder discharge water with warmer reservoir water.

Tunnel Ventilation and Access Shafts

Ventilation and access shafts may be required to allow entrance for construction equipment and for long term inspection, operation, and maintenance purposes. In this case, with a tunnel conveying water under pressure, the ventilation shafts could act as surge tanks to provide pressure relief, mitigating sudden pressure increases. Without such features in place, pressure increases could result in the formation of cracks, seepage, and further damage to the tunnel and its components. Alternately, transient pressure control could be accommodated using appropriate valving at the bifurcation. This would require further investigation. Access shafts, which could be designed to provide the required ventilation, would be located where access is available above ground so maintenance personnel could reach the entrances. They would be sized to accommodate any equipment needed to construct and maintain the tunnel.

Other Considerations

Construction of the tunnel bore, shafts, and outlet structure would require some degree of dewatering in order to complete the work in the dry.

The outlet structure would be submerged approximately 50 feet below the normal reservoir level. It would be constructed using a combination of underwater methods and “lake tap” techniques.

Removal and disposal of tunnel muck (from the rock excavation for the bore and shafts) would result in approximately 150,000 cubic yards of angular rock that would be disposed at suitable locations, potentially including the reservoir.

Alternative #3b - Pipeline from Trinity Dam to Lewiston Dam

This alternative focuses on Goal 2, improving cold-water transmission between Trinity Dam and Lewiston Dam by using a pipeline to transmit 650 cfs of cold water from Trinity Dam to Lewiston Reservoir. This would decrease retention time, eliminate lateral mixing, and prevent the sun from heating the water during conveyance between the dams. This alternative would result in minimal permanent impact to the general area and to recreational benefits. Operations at the Clear Creek Tunnel, both dams, and both powerplants would continue without major changes. Major components of this alternative include:

- Constructing a 7.5-mile long, 10-foot diameter, 650-cfs capacity, reinforced concrete pressure pipeline on the west bank of the Trinity River between Trinity Dam outlet works and Lewiston Reservoir

- Constructing a new bifurcation structure to tap into the high pressure side of the Trinity Dam river outlet works above the powerplant to supply the pipeline
- Constructing a pipeline outfall structure that discharges the 650 cfs into the deeper level of Lewiston Reservoir
- Constructing access maintenance holes, air valve, and blowoff structures
- Constructing access roads

Following is a detailed description of this alternative.

Trench Excavation

A trench (see Figure 12) would need to be excavated along the pipe's alignment. This work would require some dredging in Lewiston Reservoir, excavation along the shoreline, and temporary removal of other infrastructure to accommodate the pipe. The pipeline would be significantly longer than a tunnel, as it would conform to the existing topography (see Figure 13). Lewiston Reservoir has multiple curves which would affect the pipe's alignment. The material to be excavated would include sediment within the reservoir, sedimentary material outside of the reservoir, and hard rock. The complexity of this alternative would largely depend on the volumes of the different material types to be excavated. The proportions of the different materials are unknown at this time.

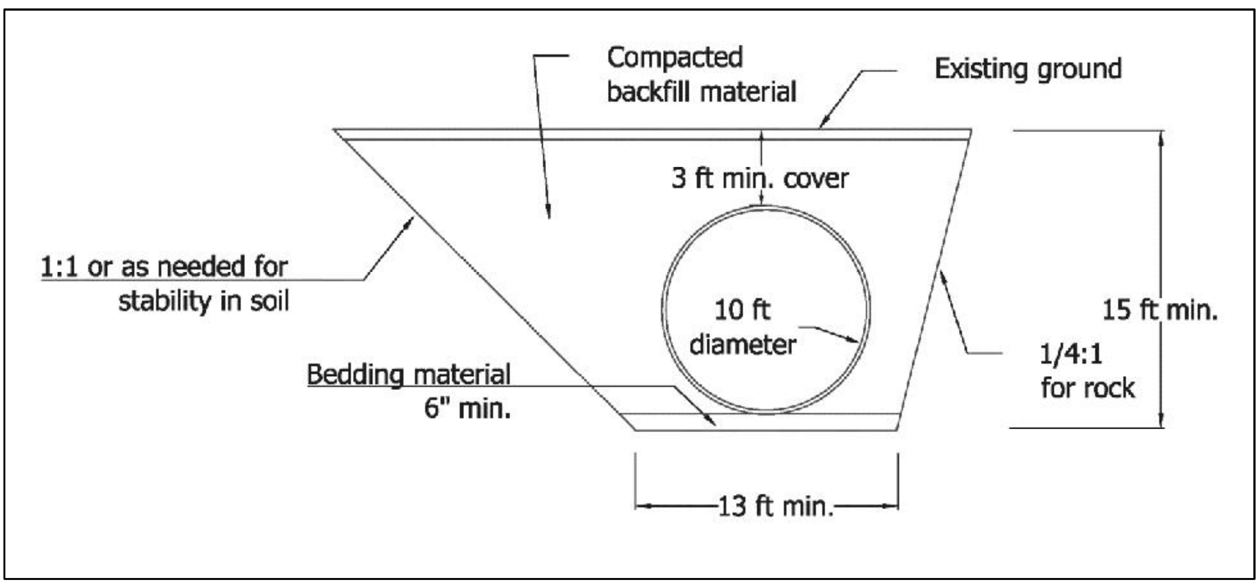

Figure 12. Typical Trench Section.

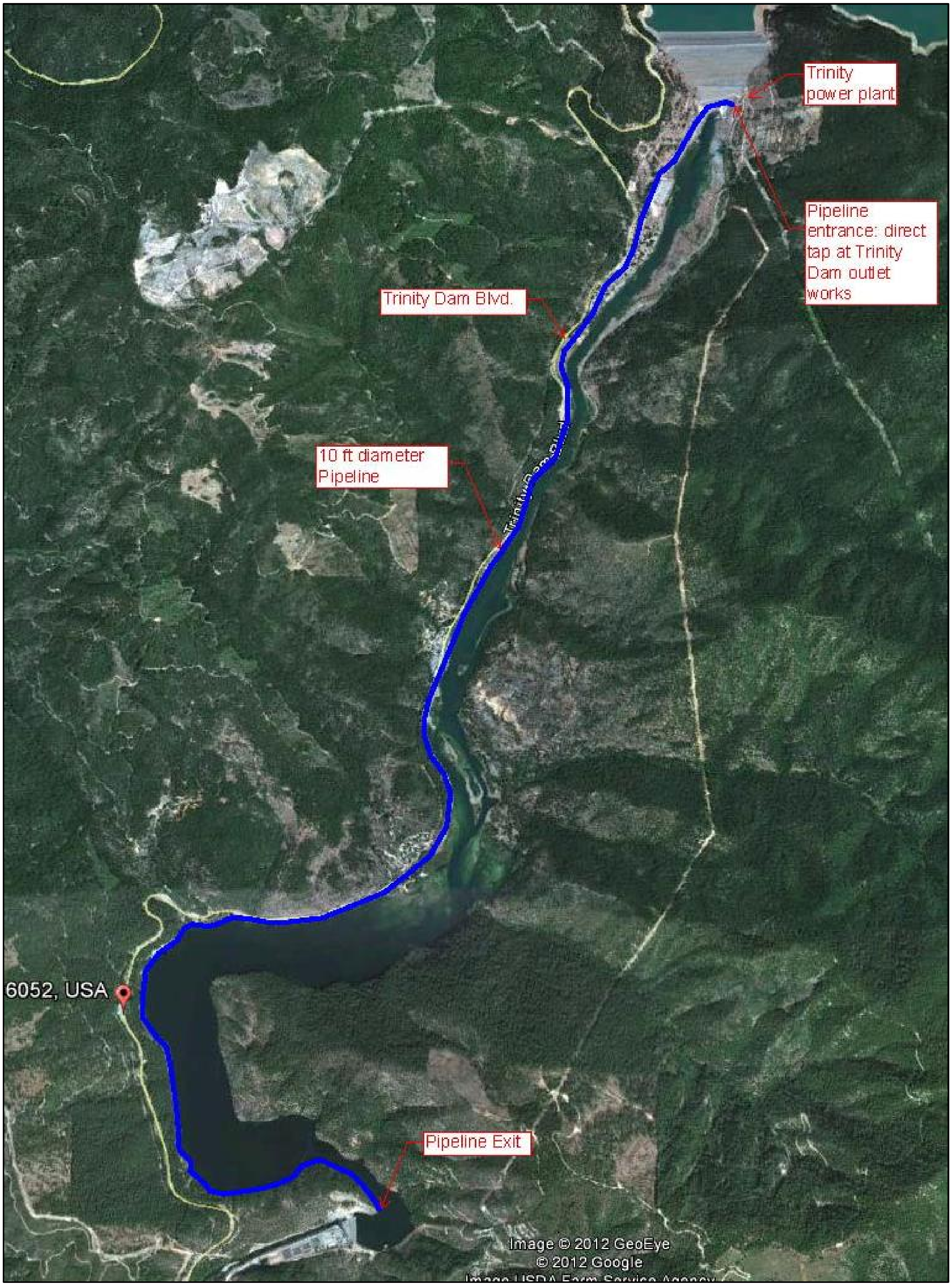

Figure 13. Pipeline Alignment.

Material Disposal

Excavating the trench would result in removing a significant volume of material. A portion of the material could be disposed near Lewiston Reservoir, while the remainder that is unsuitable for reuse as backfill would be hauled offsite. Disposal sites have not yet been identified, and the percentage of material that may be disposed near the reservoir is unknown.

Dewatering

Although some portions of the pipeline would be installed within Lewiston Reservoir, other sections would be placed along the shoreline or further from the water. Trench excavation near the reservoir would require dewatering operations, as the pipe bedding and backfill cannot be placed underwater, and saturated soil cannot be compacted. Dewatering may include the use of portable pumps and the construction of temporary cofferdams.

Pipe Installation

Furnishing and laying large diameter reinforced concrete pipe would require large lifting equipment. Adequate working room would need to be provided. More than 4,000 pipe segments would be transported to the site, which would be a significant effort.

Pipe Bedding

Portions of the pipeline installed in dry locations would be placed on sand bedding that would be imported from offsite.

Backfill

After placement, the pipe would be covered with compacted backfill to protect it from damage by vehicle loads and vandalism, and to provide restraint from movement such as thrust loads from changes in direction. It is expected that the material from the trench excavation could be used as backfill in most locations. Areas with hard rock may need backfill material supplied from other areas. Tasks associated with backfill include placement, compaction, and transportation.

Trinity Outlet Works Tap

At Trinity Dam, water would enter the pipe via a direct tap of the dam's outlet works. A bifurcation structure would tap into the high pressure side of the Trinity Dam outlet works above the powerplant. The high pressure discharges would be regulated by appropriate valving before being discharged into the pipeline. By connecting to the outlet works directly, water in the pipe would have sufficient pressure to overcome friction and other losses for the required flow between Trinity Dam and Lewiston Reservoir. High pressure would also allow the pipe to be placed at higher elevations where needed.

Outlet Structure

Most of the pipeline installation would involve typical trenching, laying pipe, and backfilling. Where the pipeline would be routed to the deeper levels of Lewiston Reservoir, the pipe would be installed as an above ground pipeline anchored to the existing ground. It would follow the terrain until it reaches its discharge point deep in the reservoir. At the pipe terminus, a streamlined outlet structure would be installed to prevent mixing of cold water exiting the pipe and to direct cooler water to a discharge point in the deeper level of Lewiston Reservoir. The outlet structure would be designed to provide a smooth flow transition between the pipe discharge and the reservoir. It would minimize turbulence to reduce mixing of the colder discharge water with warmer reservoir water. Construction of the outlet structure and submerged portions of the pipeline would involve underwater techniques employing divers, and may include controlled sinking of precast structures.

Infrastructure Improvements

Installing the pipeline would require changes to the existing infrastructure, including removing, constructing, and relocating various features as appropriate to accommodate the pipeline. A portion of the pipe alignment would be under existing roads. The roads would need to be restored and repaved after the pipeline is installed. Other affected infrastructure such as parking lots and recreational areas would also require restoration.

Turbidity Management

Pipeline placed within Lewiston Reservoir may cause turbidity issues. Material settled within the reservoir could become suspended in the water after being disturbed. Measures would need to be in place to contain the turbidity and prevent an excessive quantity of suspended solids from entering the Trinity River downstream of Lewiston Dam.

Alternative #4 - Raise Lewiston Dam

This alternative focuses on Goal 2, increasing efficiency of cold water transmission from Trinity Dam to the Trinity River below Lewiston Dam. This alternative aims to leverage the stratification in Lewiston Reservoir forced by the Lewiston temperature control curtain by raising Lewiston Dam 5 feet. Increased depth in Lewiston Reservoir may result in stronger stratification, less lateral mixing, and thus greater efficiency of cold-water transmission. A 5-foot raise would have a minimal effect on Trinity Dam and Powerplant, and recreation for surface watercraft would be maintained. Major components of this alternative include:

- Raising the existing dam embankment 5 feet with imported materials, including modifying hatchery and powerplant facilities on the downstream side of the dam due to the increased embankment footprint
- Modifying the existing Clear Creek tunnel and fish hatchery intake structures
- Raising the existing spillway structures and enlarging the radial gates
- Modifying various components of the Trinity Powerplant

Following is a detailed description of this alternative.

Dam Embankment

This alternative would raise the existing Lewiston Dam five feet, which would require increasing the dimensions of the dam structure. Since Lewiston Dam is an earthfill dam, additional embankment material would be required to increase the dam crest elevation. Borrow material would be identified and processed to be incorporated into the dam. The material would then be properly placed and compacted. See Figures 14 and 15.

A 22.5-foot extension of the downstream toe of the embankment was assumed. This increase in the downstream embankment footprint would impact the existing powerplant and fish hatchery facilities. Oversteepening of the downstream embankment may be considered to offset this impact. However, installing retaining walls or relocating certain hatchery facilities would be considered.

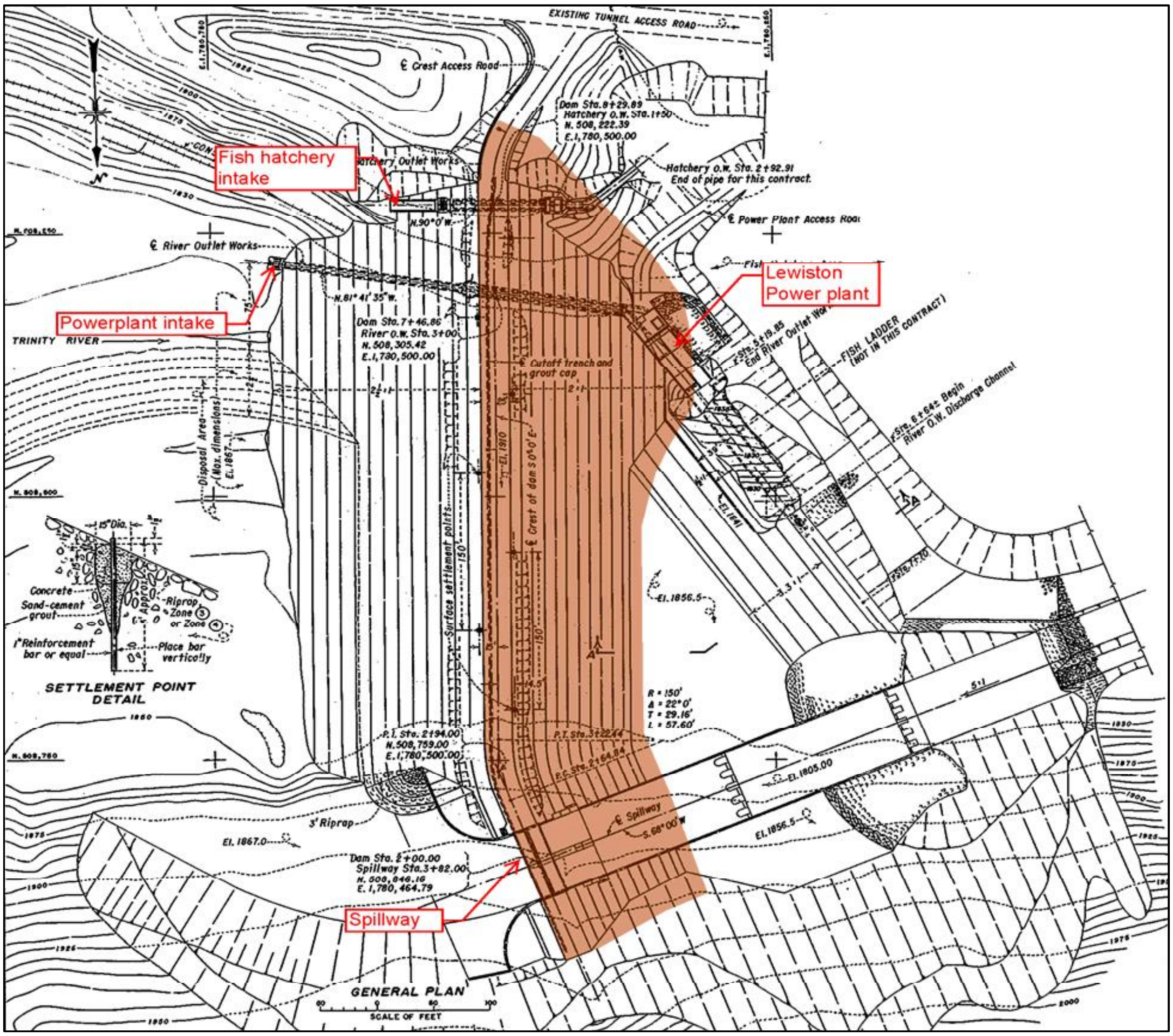

Figure 14. Lewiston Dam Embankment Fill Area.

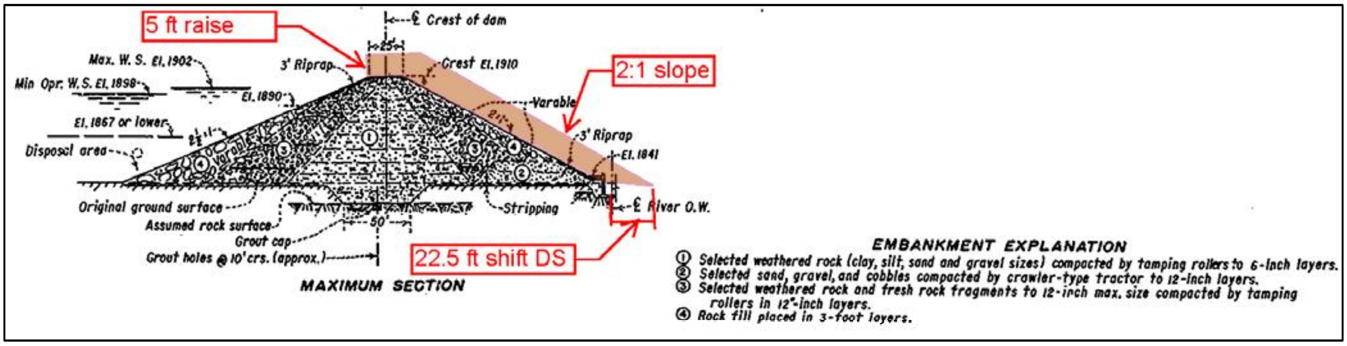

Figure 15. Lewiston Dam Embankment Fill Section Details.

Overhaul

Supplying Lewiston Dam with the additional material for the raise would include overhaul, consisting of the volume of borrow material and the haul distance of the material. More distant borrow sites would increase the overhaul component of the work.

Clear Creek Tunnel Intake Modifications

Since the Clear Creek Tunnel elevation cannot be changed, the tunnel intake would need to be raised along with Lewiston Dam. Raising the Clear Creek Tunnel intake would involve increasing the height of the reinforced concrete structure. Support structures would need to be evaluated and strengthened to accommodate the additional mass of the new concrete.

Trinity Fish Hatchery and Lewiston Powerplant Intake Modifications

Both the Trinity Fish Hatchery and the Lewiston Powerplant have existing intakes within Lewiston Reservoir. Like the other structures, these intakes would need to be modified as necessary to maintain their current operational capabilities.

Raise Spillway Structure

Raising Lewiston Dam would result in a higher water level behind the spillway gates. The gates would be subjected to additional forces that were not considered in the original design. The gates and spillway structure would need to be altered or completely rebuilt to accommodate the increased loads resulting from the dam raise.

Recreation Facilities

Recreation facilities are located along Lewiston Reservoir, including boat docks, fishing areas, picnic areas, and parking lots. If Lewiston Dam is raised, many of these facilities would be inundated. New facilities would need to be constructed at a higher elevation along the new shoreline of Lewiston Reservoir. New access points for fishing and other recreation would also need to be constructed.

Trinity Powerplant Modifications

If Lewiston Dam is raised and the water level of the reservoir is increased, water would encroach on the Trinity Powerplant and outlet works. Various components of these features would need to be modified to accommodate the raise and to ensure continued functionality.

A maximum Trinity Dam tailwater surface raise of 5 feet was selected based on input from Reclamation mechanical designers and system operators. This is the maximum amount of raise that would require a limited amount of modifications to these features. Higher raises would result in significant reconfiguration of the powerplant hydromachinery and structures (powerplant building, transformer and parking lot), the outlet works hollow jet valves, and control house. Additional impacts of a 5-foot raise would include reducing the discharge capacity of these outlets, which could impact performance during flood releases and performance of the stilling basin. Equipment corrosion could also occur.

It should be noted that raising the tailwater surface elevation on the Trinity Powerplant would have an adverse impact on power revenue.

General Infrastructure

Raising the dam would require changes to the existing infrastructure between Lewiston and Trinity Dams. General infrastructure considerations include removing utilities, roads, and structures. This infrastructure would then need to be relocated or rebuilt at higher elevations. Residences near the reservoir would also need to be relocated because of the higher water level.

Slope Stability

If the elevation of Lewiston Reservoir increases, the soil conditions in the area would change as higher areas around the reservoir become saturated. Changing soil conditions may cause slope stability issues. Raising the dam would require the inclusion of slope stability measures and management of potential landslide areas.

Site Restoration

Although disturbance of the areas around the reservoir would be minimized, it is expected that some locations may be impacted. Areas affected by the elimination of side channels, disturbed shoreline, or accumulation of material would need to be restored after construction is complete. Revegetation is expected to be the primary means of restoring the site, although additional work may be required.

Potential for Release of Mercury

This alternative would involve inundation of some of the dredge tailings and dredge ponds on the east side of the reservoir. This alternative has the potential for mercury and monomethylmercury release, but it is unlikely to be significant. If wetlands are developed in the vicinity, the potential for release increases. Refer to Attachment 4, which is an initial assessment of this potential prepared by Dr. James Rytuba of the U.S. Geological Survey.

3.0 Option Descriptions

Option A - Lewiston Powerplant Intake Extension Modification

The TPUD has proposed replacing the existing 350 kW Lewiston Powerplant with a 2.2-MW powerplant. An EA was prepared for the powerplant replacement (Reclamation, 2011) and a FONSI was issued. Although it was not addressed in the EA, a potential option to provide additional flexibility for managing downstream temperatures in the Trinity River would be to extend the proposed new intake to a lower reservoir level. If the extension could be incorporated into the existing plans and built with the new powerplant, the cost would be lower than modifying the intake later. If the new intake is extended further than currently planned, cooler water at the bottom of the reservoir could be used to generate power. This cooler water could then be tapped when necessary to assist with temperature control. This option would not affect the current operations of Clear Creek Tunnel, Trinity Fish Hatchery, or Trinity Powerplant. The Lewiston Powerplant intake extension option could be implemented independently or combined with any of the alternatives except #1a or #1b (removal of Lewiston Dam). Components of this option include:

- Relocating the TPUD planned intake structure location from the existing bench at elevation 1872 to an elevation 30 feet lower at the same flat terrain of the existing outlet works/powerplant intake structure (elevation 1842)
- Extending the planned 96-inch steel siphon penstock to the new intake location

Siphon Intake Structure Supports

New supports would be constructed for the siphon intake structure. A new concrete pad with rock anchors would support the structure, and additional anchors would be located along the length of the siphon penstock to provide anchorage and handle thrust forces where needed. This would require underwater work with specialized equipment and construction methods.

Siphon Intake Penstock Extension

As currently planned, the new siphon intake would be located on an existing bench at elevation 1872 (previous railroad grade) on the upstream left abutment of Lewiston Dam. Moving the new intake downslope would require constructing an additional bend in the intake penstock to cross over the elevation 1872 bench. The approximate length of additional 96-inch steel siphon penstock is 70 feet. Extending the siphon would not result in direct contact with the dam. Most of the work to install the siphon extension and relocated intake structure would be conducted below the water surface, increasing the difficulty of the work. See Figures 16 and 17.

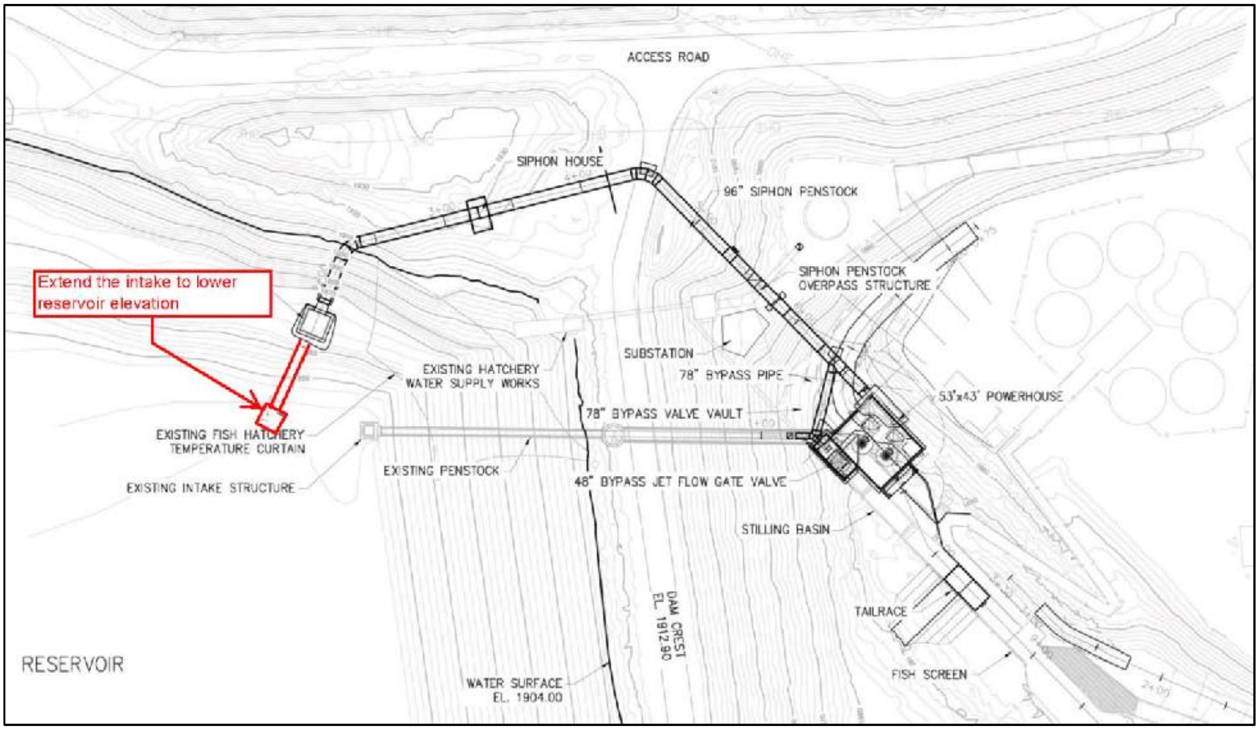

Figure 16. Modification of Lewiston Powerplant Intake - Plan.

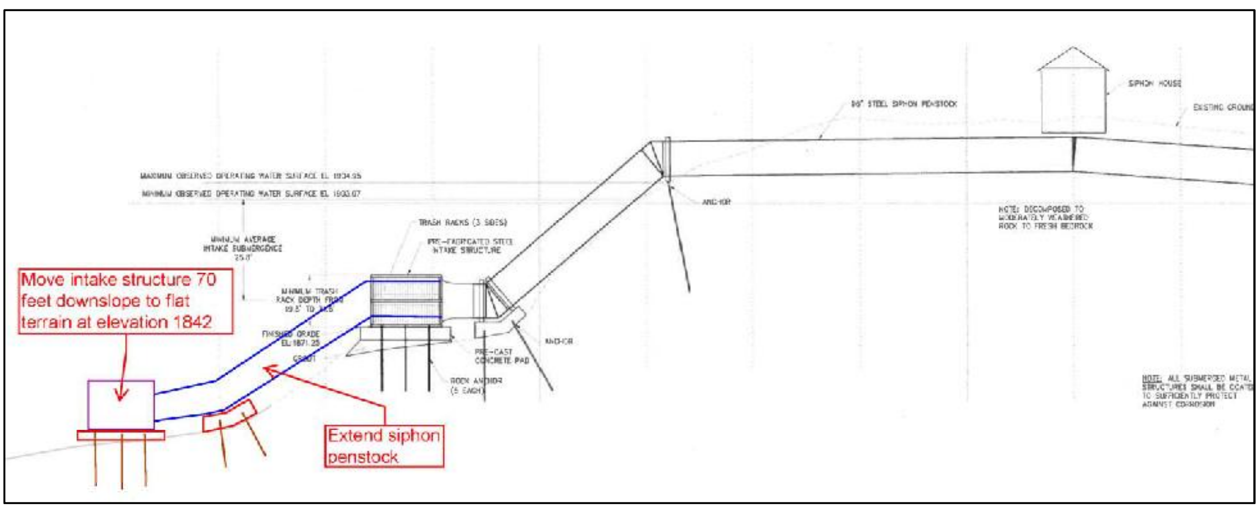

Figure 17. Modification of Lewiston Powerplant Intake - Profile.

Turbidity Management

It is anticipated that work related to extending the Lewiston Powerplant siphon intake would disturb sediment within the reservoir. These disturbances may cause turbidity issues. Sediment near the intake extension could become suspended in the water after being disturbed. Measures would need to be implemented to contain the turbidity and prevent an excessive amount of suspended solids from entering the Trinity River downstream of Lewiston Dam.

Option B - Trinity Dam Selective Withdrawal Structure

Another potential option for managing downstream temperatures in the Trinity River involves increasing the operational flexibility of Trinity Dam. A selective withdrawal structure at Trinity Dam would enable water to be released from a wide range of depths to influence the temperature of Lewiston Reservoir. This option could be implemented independently or combined with any of the alternatives, and would not affect the operation of Trinity Powerplant. Functionality of the Clear Creek Tunnel, Lewiston Dam, Trinity Fish Hatchery, and Lewiston Powerplant would not be impacted. Reclamation considered this concept in a 1978 study that included preliminary designs and cost estimates for installation of a multi-level intake device on the outlet works intake of Trinity Dam. In a 1979 study, Reclamation evaluated the potential impact of a multi-level intake device on water temperatures by mathematical modeling. Although the multi-level intake device was never constructed, both of these studies were reviewed for preparing the cost estimate for Option B included in this memorandum. See Attachment 3, which contains a photo of the as-constructed outlet works intake structure where a multi-level device would be installed, and the 1978 plan and profile of the sloping level intake structure.

Selective Withdrawal Intake Structure

The selective withdrawal intake structure would require underwater work. The structural section of Trinity Dam would not be impacted. The selective withdrawal intake structure, as described in the 1978 study, would consist of a 920-foot long, 46-foot wide sloping intake structure anchored to the rock slope of the upstream left abutment of the dam. The sloping intake structure would extend and attach to the base of the existing intake structure. This sloping intake structure would provide access to water at a wide range of depths and temperatures. A sufficient foundation with appropriate supports and structural connections would be required to handle the loads of the new structure. Construction of the foundation may require underwater work with hard rock, including drilling and removal.

Modify Existing Intake

To function properly with the new selective withdrawal intake structure, Trinity Dam's existing intake would need to be modified to attach to the new sloping intake structure. The existing intake is a reinforced concrete structure that is approximately 300 feet high. Strengthening the structure's foundation may be required if additional loading results from the alterations. Work associated with these alterations would also require underwater work.

Turbidity Control

Installing a selective withdrawal structure in Trinity Reservoir would disturb sediment within the reservoir, potentially causing turbidity issues. Material currently settled proximate to the construction area could become suspended in the water after being disturbed. Measures would need to be implemented to contain the turbidity and prevent an excessive amount of suspended solids from entering Lewiston Reservoir.

4.0 Summary of Cost Estimates

Table 1 provides preliminary cost estimates for each alternative and option. Preliminary cost estimates are prepared by Reclamation for studies conducted at the very early stages of the planning process. They are developed to document a very preliminary analysis utilizing readily available data. Major pay items were determined based on the scope of the alternatives and options. Depending on the item, the cost was estimated using lump sums or quantities and unit prices. An allowance for mobilization and preparatory work of approximately 10% was added to each alternative and option. Design contingencies (20%) were then added to calculate the Contract Cost. Construction contingencies (25%) were added to the Contract Cost to determine the Field Cost.

Table 1 - Summary of Cost Estimates*

Alternative/Option	**Contract Cost**	**Field Cost**	**Construction Cost**
1a - Removal of Lewiston Dam - Canal Water Supply	$145,000,000	$180,000,000	$250,000,000
1b - Removal of Lewiston Dam - Pump Station Water Supply	$140,000,000	$175,000,000	$250,000,000
2 - Dredging of Lewiston Reservoir	$12,500,000	$15,500,000	$22,000,000
3a - Tunnel from Trinity Dam to Lewiston Dam	$280,000,000	$350,000,000	$490,000,000
3b - Pipeline from Trinity Dam to Lewiston Dam	$165,000,000	$210,000,000	$290,000,000
4 - Raise Lewiston Dam	$18,500,000	$23,000,000	$32,000,000
Option A - Lewiston Powerplant Intake Extension Modification	$1,050,000	$1,300,000	$1,800,000
Option B - Trinity Dam Selective Withdrawal Structure**	$96,000,000	$120,000,000	$170,000,000

* Reclamation has provided these cost estimates as a resource for use in discussions among interested parties. Presentation of these estimates does not in and of itself imply Reclamation's support for moving forward with the effort. When appropriate, Reclamation specifically will articulate support for further action through other means, such as a report containing recommendations.

**The cost estimate for Option B was derived from a 1978 study involving modifications to the Trinity Dam's outlet works intake. Costs were indexed from 1978 to 2012 using a factor of 3.2.

Construction activities require mobilization, site preparation, and demobilization. Mobilization is the cost of moving equipment and materials to the jobsite. This could include a mobile trailer for use as an office for construction personnel. Site preparation could include fencing, grading, establishing parking and staging areas, and possibly construction of some access roads. Demobilization involves removing equipment, unused materials, and debris from the jobsite. The jobsite and surrounding areas must be left clean after the work is completed. Temporary facilities must be removed and disturbed areas must be restored to their previous state. All cost estimates include an allowance for mobilization, site preparation, and demobilization.

Non-contract costs (40%) were added to the Field Cost to calculate the Construction Cost. Non-contract costs typically include items such as design, design data collection, surveying, geological exploration, land acquisition, permitting and compliance, procurement, construction management, and post-construction activities. These estimates do not account for operation and maintenance costs or opportunity costs such as diminished power revenue.

Attachment 1 includes the cost estimate worksheets for each of the alternatives and options. The cost estimate for Option B was derived from a 1978 Reclamation study involving modifications to Trinity Dam's outlet works intake to achieve multilevel withdrawal.

5.0 Next Steps

TRRP is currently working on a temperature model for the Lewiston Reservoir. The next steps include planned future modeling to determine the performance of applicable alternatives and options described in this document in terms of projected summer and early fall temperatures of water delivered to the Trinity River downstream of Lewiston Dam. The next steps would also include confirmation of the study authority, goals, and alternatives to be carried forward for more detailed evaluation.

6.0 References

California Department of Water Resources. 2009. Bathymetry Data.

Rytuba, James J. 2012. Potential for Mercury and Monomethylmercury Release Resulting from Implementing Possible Alternatives to Control Water Temperature. U.S. Geological Survey memorandum. August.

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United States Department of the Interior, Water and Power Resources Service. 1981. Project data, pages 219 to 223.

7.0 List of Attachments

1. Cost Estimate Worksheets
2. Reference Drawings and Project Data
3. Trinity Multilevel Intake Structure Photo and Figures
4. Summary of Mercury Issues
5. Lewiston Reservoir Bathymetry
6. Friant-Kern Canal Examples

Attachment 1

Cost Estimate Worksheets

- Alternative #1a: Removal of Lewiston Dam – Canal Water Supply
- Alternative #1b: Removal of Lewiston Dam – Pump Station Water Supply
- Alternative #2: Dredging of Lewiston Reservoir
- Alternative #3a: Tunnel from Trinity Dam to Lewiston Dam
- Alternative #3b: Pipeline from Trinity Dam to Lewiston Dam
- Alternative #4: Raise Lewiston Dam
- Option A: Lewiston Powerplant Intake Extension Modification
- Option B: Trinity Dam Selective Withdrawal Structure

Bureau of Reclamation

ESTIMATE WORKSHEET

SHEET 1 OF 1

FEATURE	PROJECT
Lewiston Temperature Control Alt #1a: Removal of Lewiston Dam - Canal Water Supply	Lewiston Temperature Control
	DIVISION MP-210
	FILE I:\Lewiston Temperature Control\Cost Estimates\Final\[LewistonTempAlt1A.xls]1A

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	1	Clear Creek Tunnel Water Supply (Canal)		7	Miles	$11,000,000	$77,000,000
	2	Decommission Lewiston Powerplant		1	LS	$2,500,000	$2,500,000
	3	Maintain Fish Hatchery Water Supply and Functions		1	LS	$1,000,000	$1,000,000
	4	Remove Temperature Control Curtains		1	LS	$280,000	$280,000
	5	Excavate and Remove Lewiston Dam		410,000	CY	$30	$12,300,000
	6	Sediment Characterization (Mercury)		1	LS	$100,000	$100,000
	7	Repository for Contaminated Sediment		5	Acres	$50,000	$250,000
	8	Trinity Powerplant Tailwater Regulation		1	LS	$1,000,000	$1,000,000
	9	Recreation Facilities and River Access Points		1	LS	$380,000	$380,000
	10	General Infrastructure		1	LS	$250,000	$250,000
	11	Slope Stability		1	LS	$1,000,000	$1,000,000
	12	Riverine Restoration and Riparian Revegetation		7	Miles	$2,000,000	$14,000,000
	13	Diversion Tunnel for Dam Removal Work		1	LS	$1,400,000	$1,400,000
		Mobilization and Preparatory Work		1	LS	$11,146,000	$11,000,000
		(10% of other items due to remote site)					
		Design Contingencies (20%, adjusted for rounding)		1	LS	$24,492,000	$22,540,000
		CONTRACT COST					$145,000,000
		Construction Contingencies (25%, rounded)		1	LS	$36,250,000	$35,000,000
		FIELD COST					$180,000,000
		Non-contract Costs (40%, rounded)		1	LS	$72,000,000	$70,000,000
		CONSTRUCTION COST					$250,000,000

QUANTITIES		PRICES	
BY Jason Quiñones, P.E.	CHECKED/REVISED Carisa Mai, P.E.	BY Jason Quiñones, P.E.	CHECKED/REVISED Carisa Mai, P.E.
DATE PREPARED 26-Sep-12	APPROVED Jim Goodwin, P.E.	DATE 26-Sep-12	PRICE LEVEL September 2012

Bureau of Reclamation

ESTIMATE WORKSHEET

SHEET 1 OF 1

FEATURE	PROJECT
Lewiston Temperature Control Alt #1b: Removal of Lewiston Dam - Pump Station Water Supply	Lewiston Temperature Control
	DIVISION MP-210
	FILE I:\Lewiston Temperature Control\Cost Estimates\Final\[LewistonTempAlt1B.xls]1B

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	1	Pump Station for Clear Creek Tunnel		1	LS	$59,000,000	$59,000,000
	2	Pump Station Power Supply		1	LS	$12,000,000	$12,000,000
	3	Decommission Lewiston Powerplant		1	LS	$2,500,000	$2,500,000
	4	Maintain Fish Hatchery Water Supply and Functions		1	LS	$1,000,000	$1,000,000
	5	Remove Temperature Control Curtains		1	LS	$280,000	$280,000
	6	Excavate and Remove Lewiston Dam		410,000	CY	$30	$12,300,000
	7	Sediment Characterization (Mercury)		1	LS	$100,000	$100,000
	8	Repository for Contaminated Sediment		5	Acres	$50,000	$250,000
	9	Trinity Powerplant Tailwater Regulation		1	LS	$1,000,000	$1,000,000
	10	Recreation Facilities and River Access Points		1	LS	$380,000	$380,000
	11	General Infrastructure		1	LS	$250,000	$250,000
	12	Slope Stability		1	LS	$1,000,000	$1,000,000
	13	Riverine Restoration and Riparian Revegetation		7	Miles	$2,000,000	$14,000,000
	14	Diversion Tunnel for Dam Removal Work		1	LS	$1,400,000	$1,400,000
		Mobilization and Preparatory Work		1	LS	$10,546,000	$10,500,000
		(10% of other items due to remote site)					
		Design Contingencies (20%, adjusted for rounding)		1	LS	$23,192,000	$24,040,000
		CONTRACT COST					$140,000,000
		Construction Contingencies (25%, rounded)		1	LS	$35,000,000	$35,000,000
		FIELD COST					$175,000,000
		Non-contract Costs (40%, rounded)		1	LS	$70,000,000	$75,000,000
		CONSTRUCTION COST					$250,000,000

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DATE PREPARED 26-Sep-12	APPROVED Jim Goodwin, P.E.	DATE 26-Sep-12	PRICE LEVEL September 2012

ESTIMATE WORKSHEET

SHEET 1 OF 1

FEATURE	PROJECT
Lewiston Temperature Control Alt #2: Dredging of Lewiston Reservoir	PROJECT: Lewiston Temperature Control DIVISION: MP-210 FILE: I:\Lewiston Temperature Control\Cost Estimates\Final\[LewistonTempAlt2.xls]A1

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	1	Sediment Characterization (Mercury)		1	LS	$50,000	$50,000
	2	Excavate Sediment		50,000	CY	$62	$3,100,000
	3	Construct Berm		40,000	CY	$80	$3,200,000
	4	Repository for Contaminated Sediment		2	Acres	$50,000	$100,000
	5	Turbidity Management		1	LS	$500,000	$500,000
	6	Site Restoration		1	LS	$1,500,000	$1,500,000
	7	Recreation & Navigation		1	LS	$1,000,000	$1,000,000
		Mobilization and Preparatory Work		1	LS	$945,000	$950,000
		(10% of other items due to remote site)					
		Design Contingencies (20%, adjusted for rounding)		1	LS	$2,080,000	$2,100,000
		CONTRACT COST					$12,500,000
		Construction Contingencies (25%, rounded)		1	LS	$3,125,000	$3,000,000
		FIELD COST					$15,500,000
		Non-contract Costs (40%, rounded)		1	LS	$6,200,000	$6,500,000
		CONSTRUCTION COST					$22,000,000

QUANTITIES		PRICES	
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DATE PREPARED 26-Sep-12	APPROVED Jim Goodwin, P.E.	DATE 26-Sep-12	PRICE LEVEL September 2012

ESTIMATE WORKSHEET

FEATURE	PROJECT
Lewiston Temperature Control Alt #3a: Tunnel from Trinity Dam to Lewiston Dam	Lewiston Temperature Control
	DIVISION MP-210
	FILE I:\Lewiston Temperature Control\Cost Estimates\Final\[LewistonTempAlt3A.xls]A1

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	1	Tunnel Boring		5	Miles	$40,800,000	$204,000,000
	2	Access Roads		1	LS	$530,000	$530,000
	3	Outlet Works Tap		1	LS	$1,000,000	$1,000,000
	4	Outlet Structure - Within Reservoir		1	LS	$2,500,000	$2,500,000
	5	Ventilations / Access Shafts		200	FT	$15,500	$3,100,000
		Mobilization and Preparatory Work		1	LS	$21,113,000	$21,000,000
		(10% of other items due to remote site)					
		Design Contingencies (20%, adjusted for rounding)		1	LS	$46,426,000	$47,870,000
		CONTRACT COST					$280,000,000
		Construction Contingencies (25%, rounded)		1	LS	$70,000,000	$70,000,000
		FIELD COST					$350,000,000
		Non-contract Costs (40%, rounded)		1	LS	$140,000,000	$140,000,000
		CONSTRUCTION COST					$490,000,000

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BY Jason Quiñones, P.E.	CHECKED/REVISED Carisa Mai, P.E.	BY Jason Quiñones, P.E.	CHECKED/REVISED Carisa Mai, P.E.
DATE PREPARED 26-Sep-12	APPROVED Jim Goodwin, P.E.	DATE 26-Sep-12	PRICE LEVEL September 2012

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ESTIMATE WORKSHEET

SHEET 1 OF 1

FEATURE	PROJECT
Lewiston Temperature Control Alt #3b: Pipeline from Trinity Dam to Lewiston Dam	Lewiston Temperature Control
	DIVISION MP-210
	FILE I:\Lewiston Temperature Control\Cost Estimates\Final\[LewistonTempAlt3B.xls]A1

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	1	Excavate Pipeline Trench		330,000	CY	$50	$16,500,000
	2	Material Disposal		2,760,000	MiCY	$2	$5,520,000
	3	Dewatering		1	LS	$2,500,000	$2,500,000
	4	Furnish and Install Pipe (120" Diameter)		39,600	LF	$1,600	$63,360,000
	5	Bedding Material		96,800	CY	$200	$19,360,000
	6	Backfill Material (Placement and Compaction)		232,000	CY	$35	$8,120,000
	7	Outlet Works Tap		1	LS	$1,000,000	$1,000,000
	8	Outlet Structure - Within Reservoir		1	LS	$2,500,000	$2,500,000
	9	Infrastructure Improvements		1	LS	$3,800,000	$3,800,000
	10	Turbidity Management		1	LS	$1,500,000	$1,500,000
		Mobilization and Preparatory Work		1	LS	$12,416,000	$12,500,000
		(10% of other items due to remote site)					
		Design Contingencies (20%, adjusted for rounding)		1	LS	$27,332,000	$28,340,000
		CONTRACT COST					$165,000,000
		Construction Contingencies (25%, rounded)		1	LS	$41,250,000	$45,000,000
		FIELD COST					$210,000,000
		Non-contract Costs (40%, rounded)		1	LS	$84,000,000	$80,000,000
		CONSTRUCTION COST					$290,000,000

QUANTITIES		PRICES	
BY Jason Quiñones, P.E.	CHECKED/REVISED Carisa Mai, P.E.	BY Jason Quiñones, P.E.	CHECKED/REVISED Carisa Mai, P.E.
DATE PREPARED 26-Sep-12	APPROVED Jim Goodwin, P.E.	DATE 26-Sep-12	PRICE LEVEL September 2012

Bureau of Reclamation

ESTIMATE WORKSHEET

SHEET 1 OF 1

FEATURE	PROJECT
Lewiston Temperature Control Alt #4: Raise Lewiston Dam	Lewiston Temperature Control
	DIVISION MP-210
	FILE I:\Lewiston Temperature Control\Cost Estimates\Final\[LewistonTempAlt4.xls]A1

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	1	Dam Embankment Fill (Excavate Elsewhere)		55,000	CY	$25	$1,375,000
	2	Overhaul		550,000	MiCY	$2	$1,100,000
	3	Intake Mods, Clear Creek Tunnel		1	LS	$400,000	$400,000
	4	Intake Mods, Trinity Fish Hatchery		1	LS	$50,000	$50,000
	5	Intake Mods, Lewiston Powerplant		1	LS	$50,000	$50,000
	6	Raise Spillway Structure		1	LS	$2,500,000	$2,500,000
	7	Recreation Facilities		1	LS	$1,800,000	$1,800,000
	8	Trinity PP Modifications		1	LS	$2,500,000	$2,500,000
	9	General Infrastructure		1	LS	$500,000	$500,000
	10	Slope Stability		1	LS	$1,000,000	$1,000,000
	11	Site Restoration		1	LS	$2,500,000	$2,500,000
		Mobilization and Preparatory Work		1	LS	$1,377,500	$1,400,000
		(10% of other items due to remote site)					
		Design Contingencies (20%, adjusted for rounding)		1	LS	$3,035,000	$3,325,000
		CONTRACT COST					$18,500,000
		Construction Contingencies (25%, rounded)		1	LS	$4,625,000	$4,500,000
		FIELD COST					$23,000,000
		Non-contract Costs (40%, rounded)		1	LS	$9,200,000	$9,000,000
		CONSTRUCTION COST					$32,000,000

QUANTITIES		PRICES	
BY Jason Quiñones, P.E.	CHECKED/REVISED Carisa Mai, P.E.	BY Jason Quiñones, P.E.	CHECKED/REVISED Carisa Mai, P.E.
DATE PREPARED 26-Sep-12	APPROVED Jim Goodwin, P.E.	DATE 26-Sep-12	PRICE LEVEL September 2012

Bureau of Reclamation

ESTIMATE WORKSHEET

SHEET 1 OF 1

FEATURE	PROJECT
Lewiston Temperature Control Opt A: Lewiston Powerplant Intake Extension Modification	Lewiston Temperature Control
	DIVISION MP-210
	FILE I:\Lewiston Temperature Control\Cost Estimates\Final\[LewistonTempOptA.xls]A1

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	1	Construct Siphon Extension Supports		1	LS	$350,000	$350,000
	2	Furnish and Install Siphon Extension		1	LS	$400,000	$400,000
	3	Turbidity Management		1	LS	$30,000	$30,000
		Mobilization and Preparatory Work		1	LS	$78,000	$80,000
		(10% of other items due to remote site)					
		Design Contingencies (20%, adjusted for rounding)		1	LS	$172,000	$190,000
		CONTRACT COST					$1,050,000
		Construction Contingencies (25%, rounded)		1	LS	$262,500	$250,000
		FIELD COST					$1,300,000
		Non-contract Costs (40%, rounded)		1	LS	$520,000	$500,000
		CONSTRUCTION COST					$1,800,000

QUANTITIES		PRICES	
BY Jason Quiñones, P.E.	CHECKED/REVISED Carisa Mai, P.E.	BY Jason Quiñones, P.E.	CHECKED/REVISED Carisa Mai, P.E.
DATE PREPARED 26-Sep-12	APPROVED Jim Goodwin, P.E.	DATE 26-Sep-12	PRICE LEVEL September 2012

7-1654 (7-73)
Bureau of Reclamation

COMPUTATION SHEET

BY	DATE	PROJECT	SHEET 3 OF
QC		Triniti	
CHKD BY DOB.	DATE 9-15-78	FEATURE Multi-Level O.W. Modif	
DETAILS Rev. 11-9-78	SUMMARY		

Total Costs - January 1978 Level

	10/20/76 Reconn. ELEV. 2375 to 2100	1/26/78 Speed Team ELEV 2375 to 1950
Normal W.S		
Proposal 1	$ 23,000,000 ~~15,000,000~~ ~~14,035,000~~	$ 26,000,000 ~~16,500,000~~ ~~15,438,000~~
Proposal 2	1,847,000	~~2,000,000~~ ~~1,939,000~~
Proposal 3	~~2,724,000~~	~~3,000,000~~ ~~2,860,000~~
	8,310,000	9,000,000
Low Resv. W. S.		
Proposal 1	27,000,000 ~~17,333,000~~	30,000,000 ~~19,066,000~~

Option B - Trinity Dam Selective Withdrawal Structure

Cost Estimate from Trinity River Basin Action Program, Intake Structure Modifications, 1978

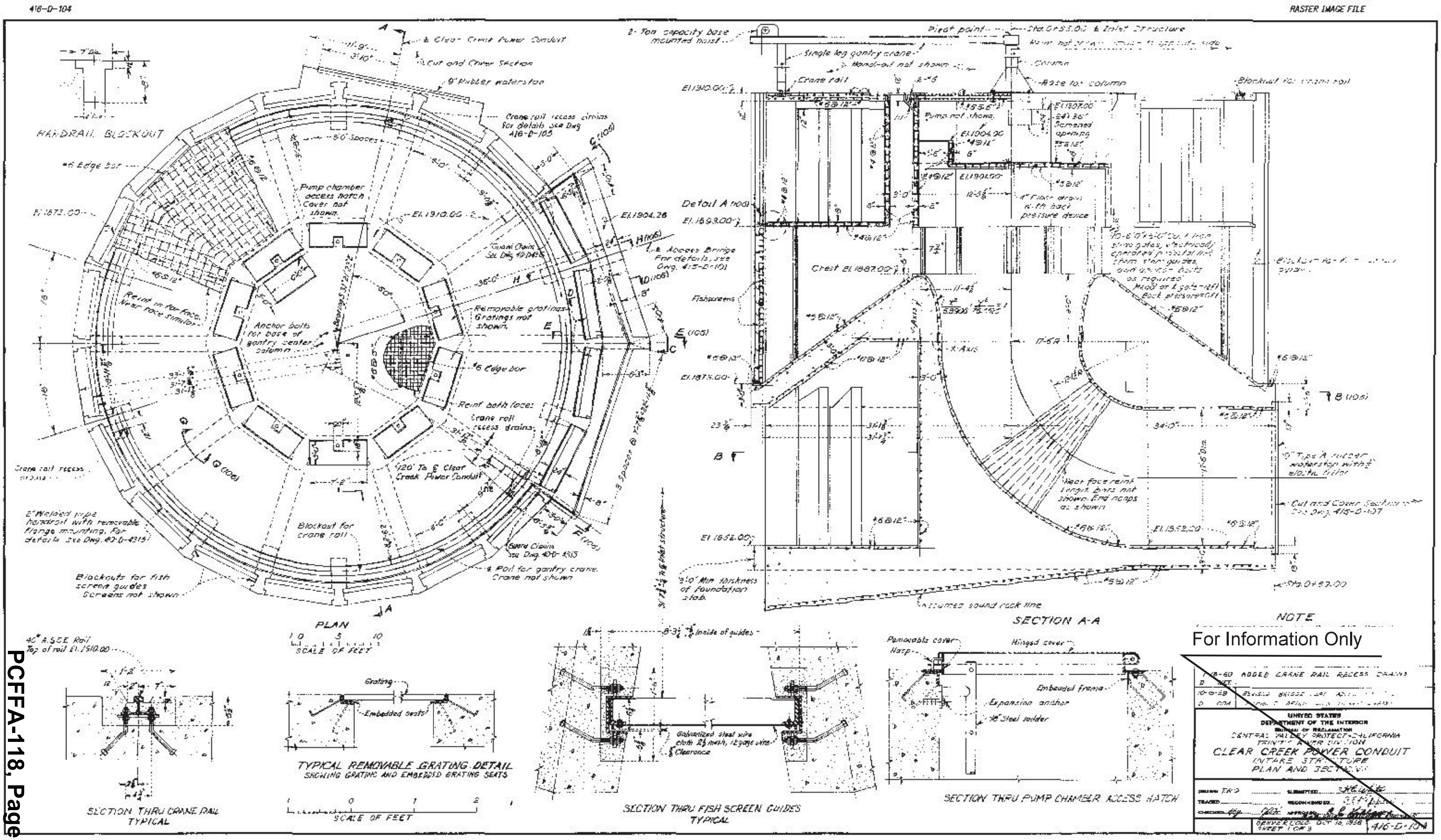
Costs Indexed from 1978 to 2012 using a factor of 3.2

$30,000,000 x 3.2 Index Factor = $96,000,000

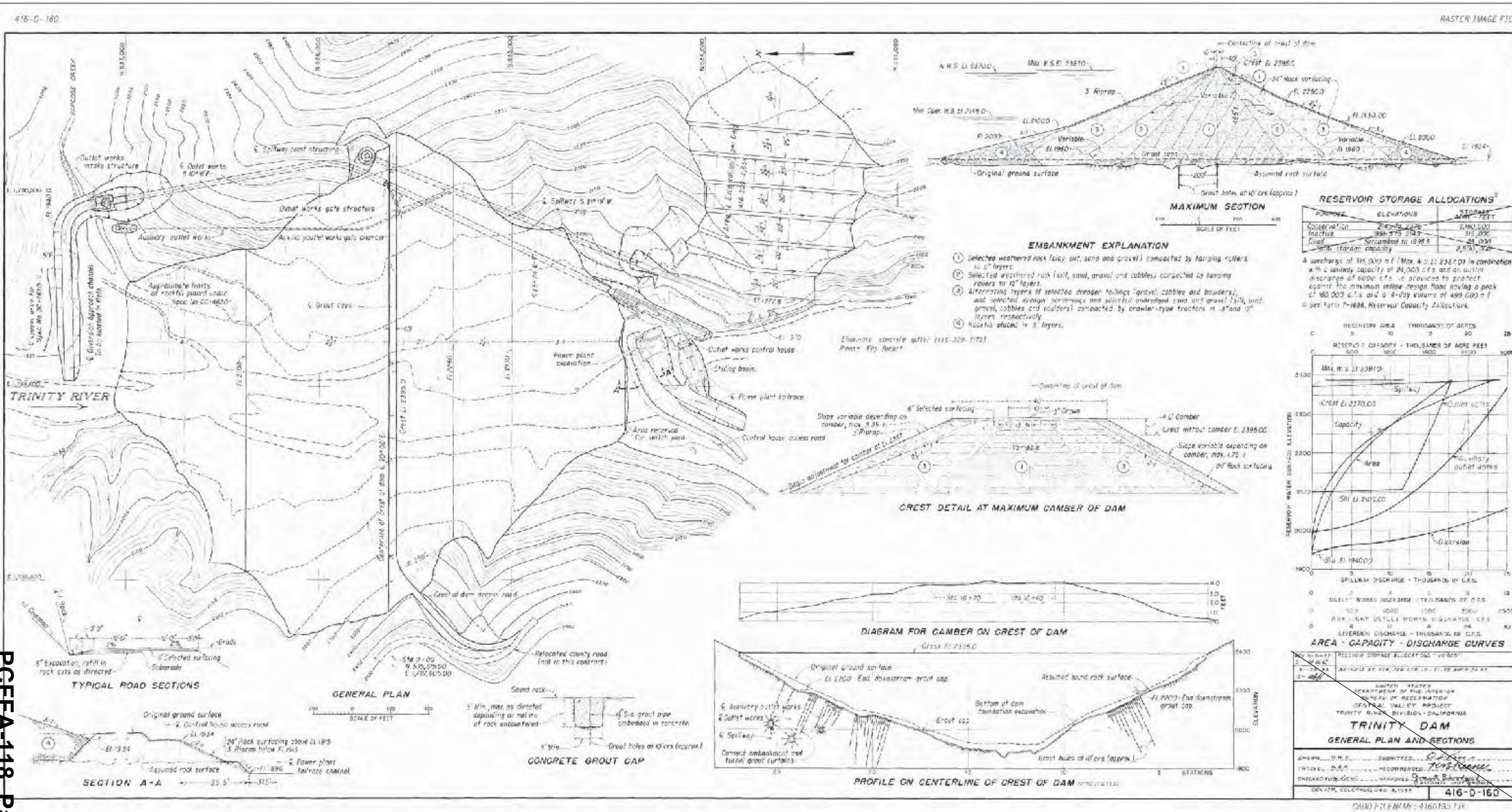
Attachment 2

Reference Drawings and Project Data

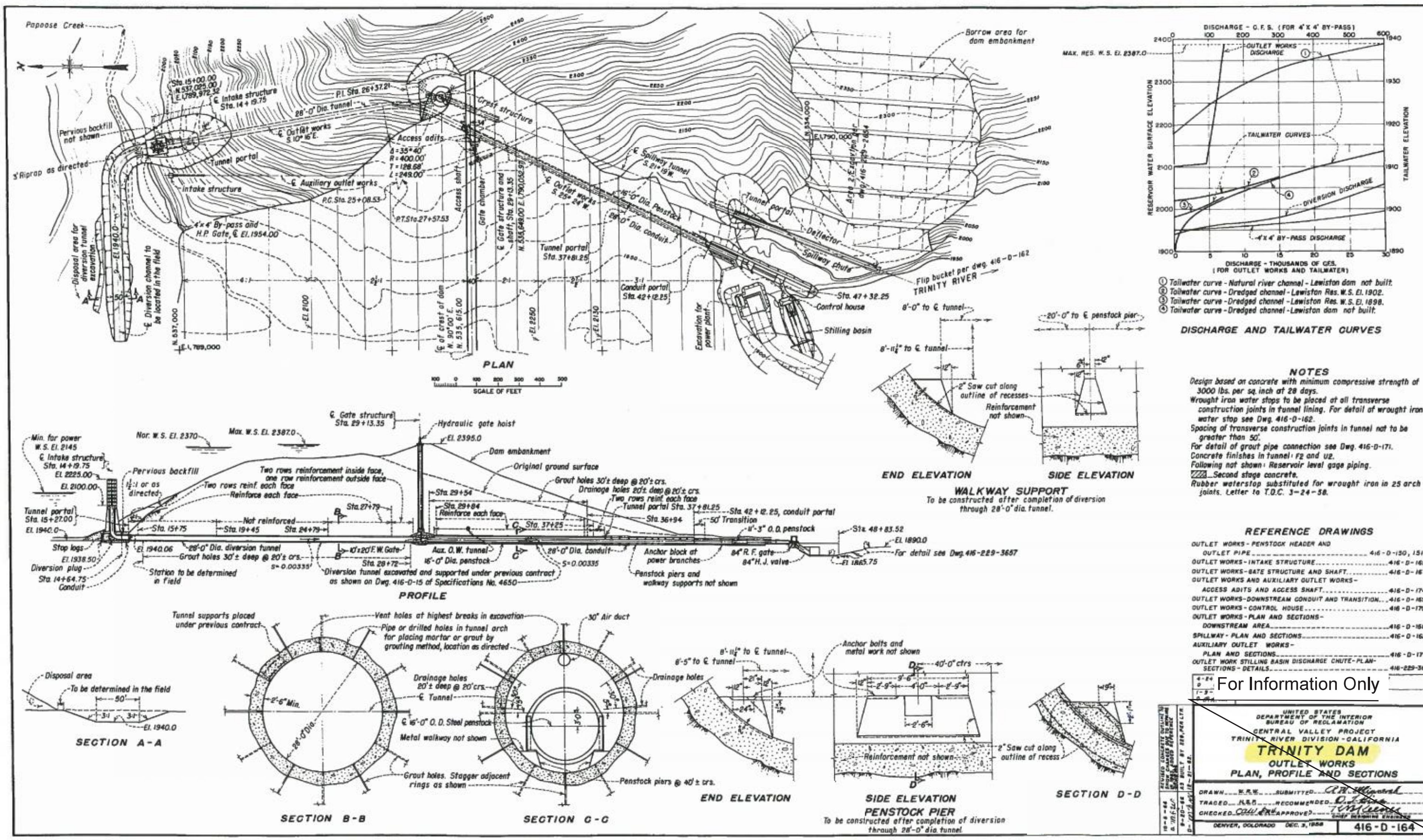
- Drawing 416-D-104: Clear Creek Power Conduit Intake Structure
- Drawing 416-D-160: Trinity Dam General Plan and Sections
- Drawing 416-D-164: Trinity Dam Outlet Works
- Drawing 416-D-168: Trinity Dam Outlet Works Downstream Area
- Drawing 416-D-530: Trinity Power Plant General Plan and Section
- Drawing 416-D-1058: Lewiston Dam General Plan and Sections
- Drawing 416-D-1061: Lewiston Dam Spillway Gate Structure
- Drawing 416-D-1104: Lewiston Dam Existing Tunnel Plug
- Drawing 416-D-1238: Lewiston Dam Site Vicinity Plan
- Reclamation Project Data Book pages 218 and 219
- Reclamation Project Data Book pages 220 and 221
- Reclamation Project Data Book pages 222 and 223

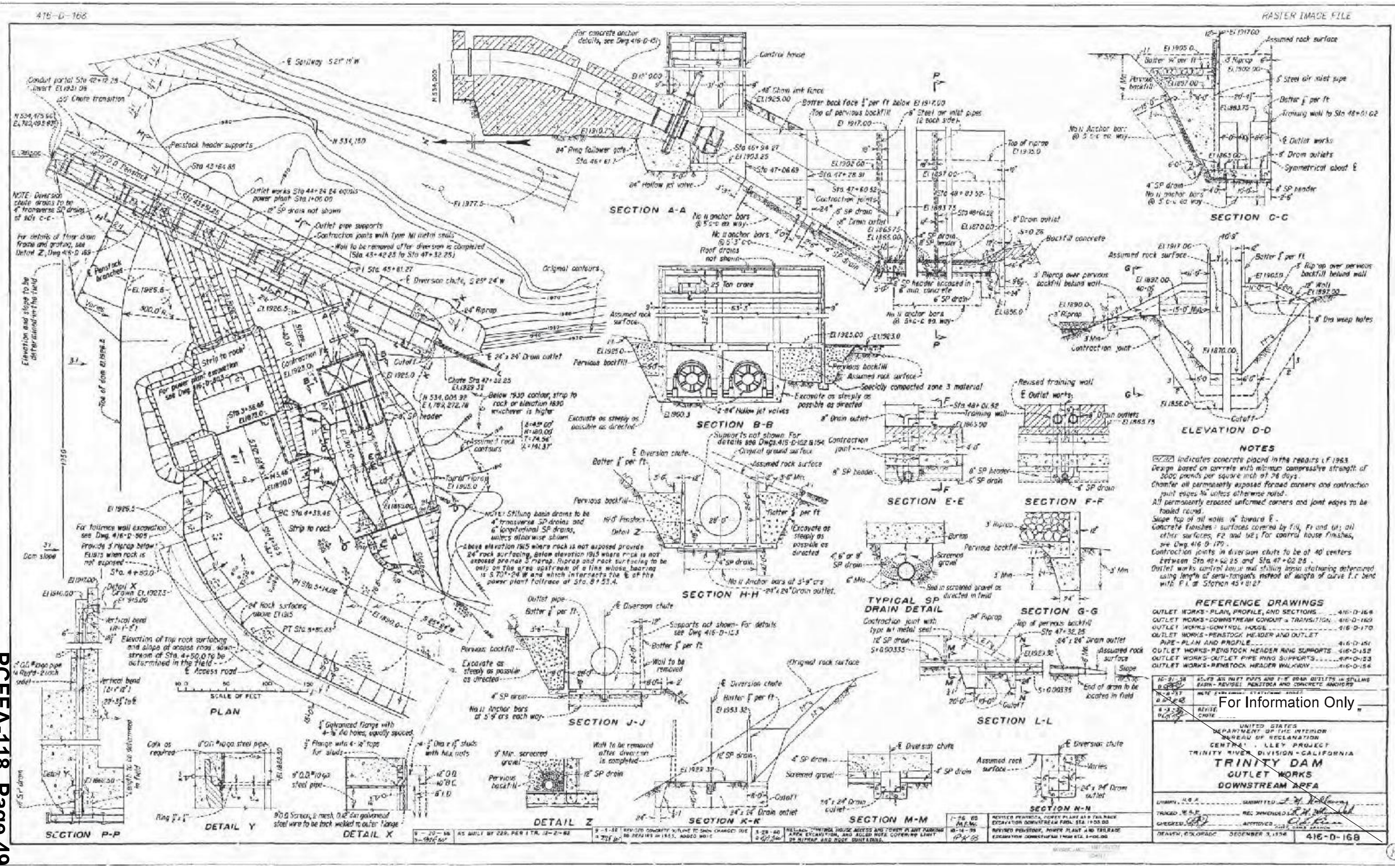


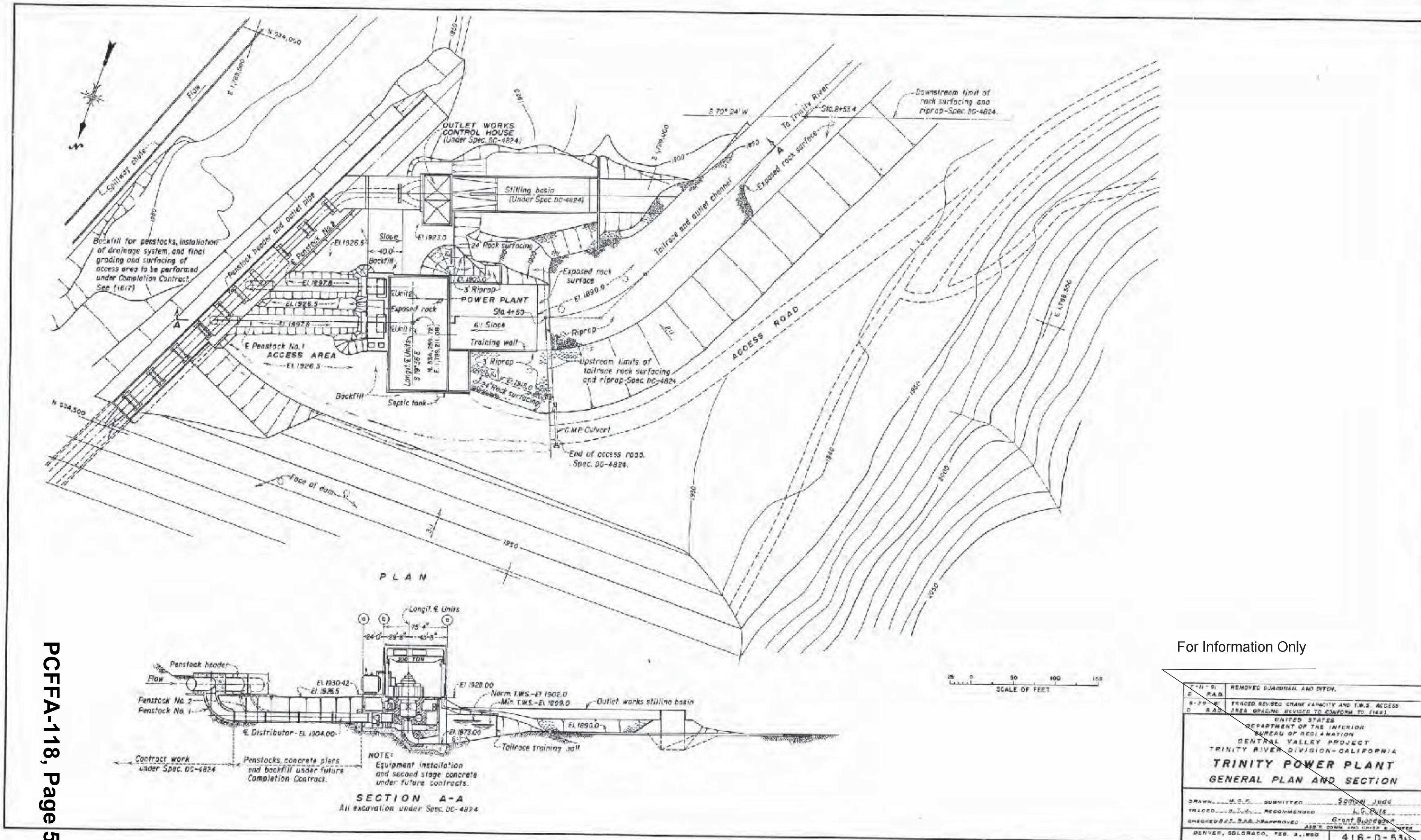
For Information Only


416-D-160
RASTER IMAGE FILE
TRINITY RIVER
Outlet works intake structure
Outlet works gate structure
Auxiliary outlet works
Spillway crest structure
Grout caps
Power plant excavation
Outlet works control house
Stilling basin
Power plant surface
Control house access road
Crest El. 2395.0
GENERAL PLAN
SCALE OF FEET
MAXIMUM SECTION
Original ground surface
Assumed rock surface
Grout holes at 10' crs (approx.)
3' Riprap
EMBANKMENT EXPLANATION
(1) Selected weathered rock (clay, silt, sand and gravel) compacted by tamping rollers to 6" layers.
(2) Selected weathered rock (silt, sand, gravel and cobbles) compacted by tamping rollers to 12" layers.
(3) Alternating layers of selected dredger tailings (gravel, cobbles and boulders), and selected dredger screenings and selected undredged sand and gravel (silt, sand, gravel, cobbles and boulders) compacted by crawler-type tractors in 18" and 12" layers respectively.
(4) Rockfill placed in 3' layers.
RESERVOIR STORAGE ALLOCATIONS
PURPOSE
ELEVATIONS
STORAGE ACRE-FEET
Conservation
2145 to 2370
2,160,000
Inactive
1995.5 to 2145
315,000
Dead
Streambed to 1995.5
25,000
Total storage capacity
2,500,000
A surcharge of 315,000 a.f. (Max. W.S. El. 2387.0) in combination with a spillway capacity of 24,000 c.f.s. and an outlet discharge of 6000 c.f.s. is provided to protect against the maximum inflow design flood having a peak of 180,000 c.f.s. and a 4-day volume of 489,000 a.f.
See Form 7-1686, Reservoir Capacity Allocations.
CREST DETAIL AT MAXIMUM CAMBER OF DAM
DIAGRAM FOR CAMBER ON CREST OF DAM
PROFILE ON CENTERLINE OF CREST OF DAM
AREA - CAPACITY - DISCHARGE CURVES
RESERVOIR AREA - THOUSANDS OF ACRES
RESERVOIR CAPACITY - THOUSANDS OF ACRE FEET
SPILLWAY DISCHARGE - THOUSANDS OF C.F.S.
DIVERSION DISCHARGE - THOUSANDS OF C.F.S.
TYPICAL ROAD SECTIONS
SECTION A-A
CONCRETE GROUT CAP
UNITED STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION
CENTRAL VALLEY PROJECT
TRINITY RIVER DIVISION - CALIFORNIA
TRINITY DAM
GENERAL PLAN AND SECTIONS
DENVER, COLORADO
416-D-160

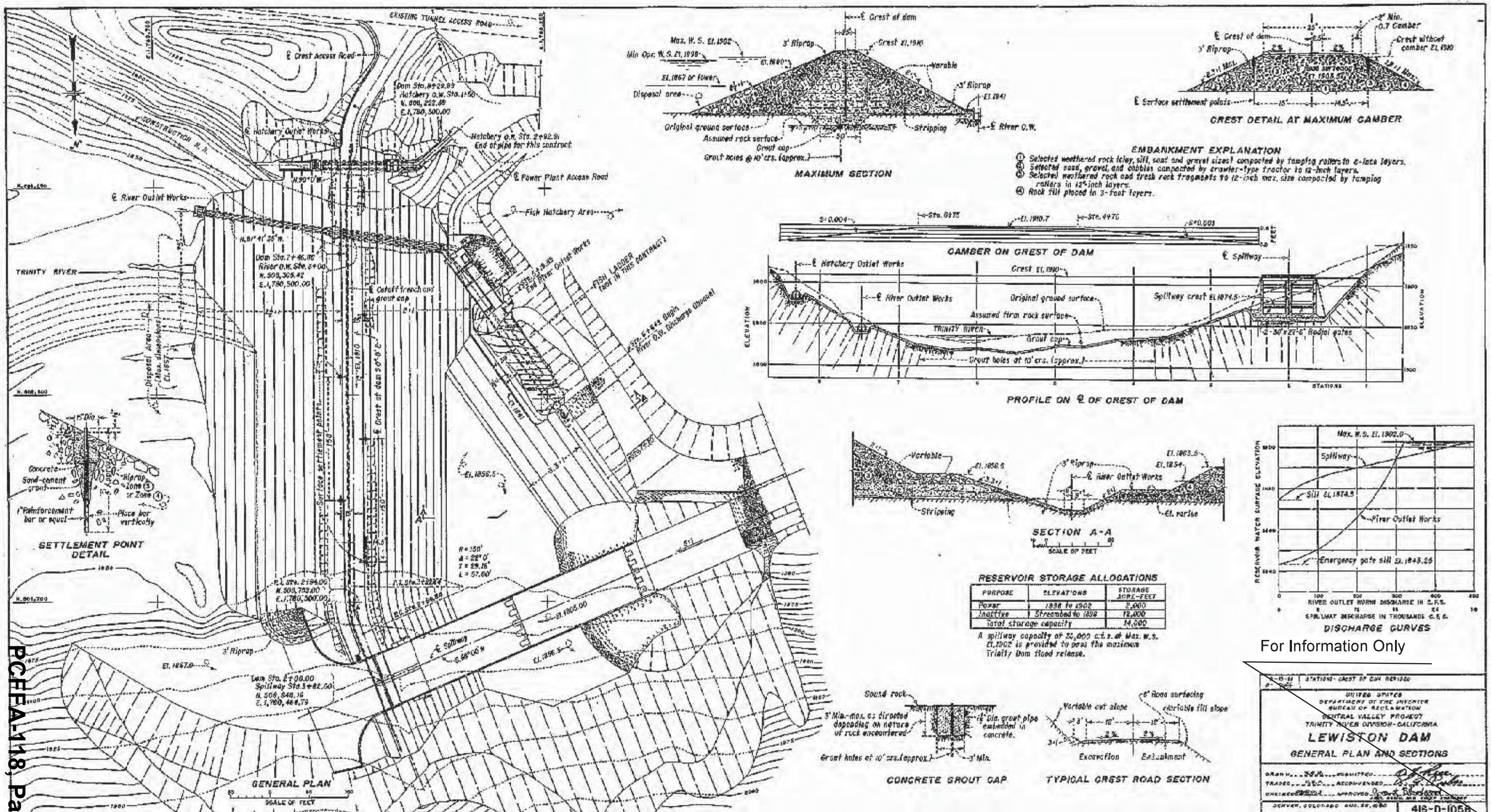
RASTER IMAGE FILE



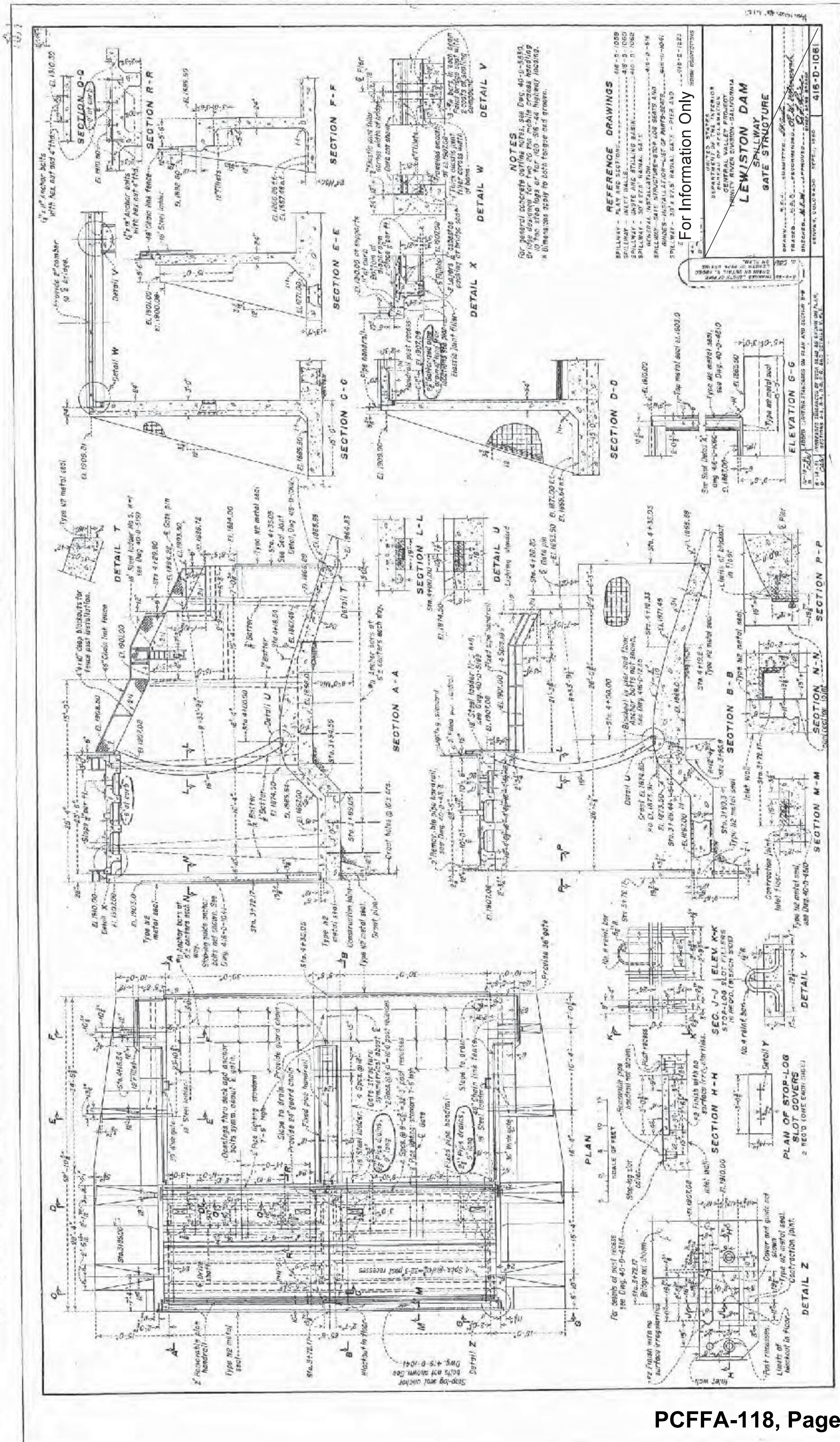

416-D-168
RASTER IMAGE FILE
SECTION A-A
SECTION B-B
SECTION C-C
ELEVATION D-D
SECTION E-E
SECTION F-F
TYPICAL SP DRAIN DETAIL
SECTION G-G
SECTION H-H
SECTION J-J
SECTION K-K
SECTION L-L
SECTION M-M
SECTION N-N
SECTION P-P
PLAN
DETAIL X
DETAIL Y
DETAIL Z
NOTES
REFERENCE DRAWINGS
OUTLET WORKS-PLAN, PROFILE, AND SECTIONS 416-D-166
OUTLET WORKS-DOWNSTREAM CONDUIT & TRANSITION 416-D-169
OUTLET WORKS-CONTROL HOUSE 416-D-170
OUTLET WORKS-PENSTOCK HEADER AND OUTLET PIPE-PLAN AND PROFILE 416-D-151
OUTLET WORKS-PENSTOCK HEADER RING SUPPORTS 416-D-152
OUTLET WORKS-OUTLET PIPE RING SUPPORTS 416-D-153
OUTLET WORKS-PENSTOCK HEADER WALKWAY 416-D-154
For Information Only
UNITED STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION
CENTRAL VALLEY PROJECT
TRINITY RIVER DIVISION-CALIFORNIA
TRINITY DAM
OUTLET WORKS
DOWNSTREAM AREA
DENVER, COLORADO DECEMBER 3, 1958
416-D-168

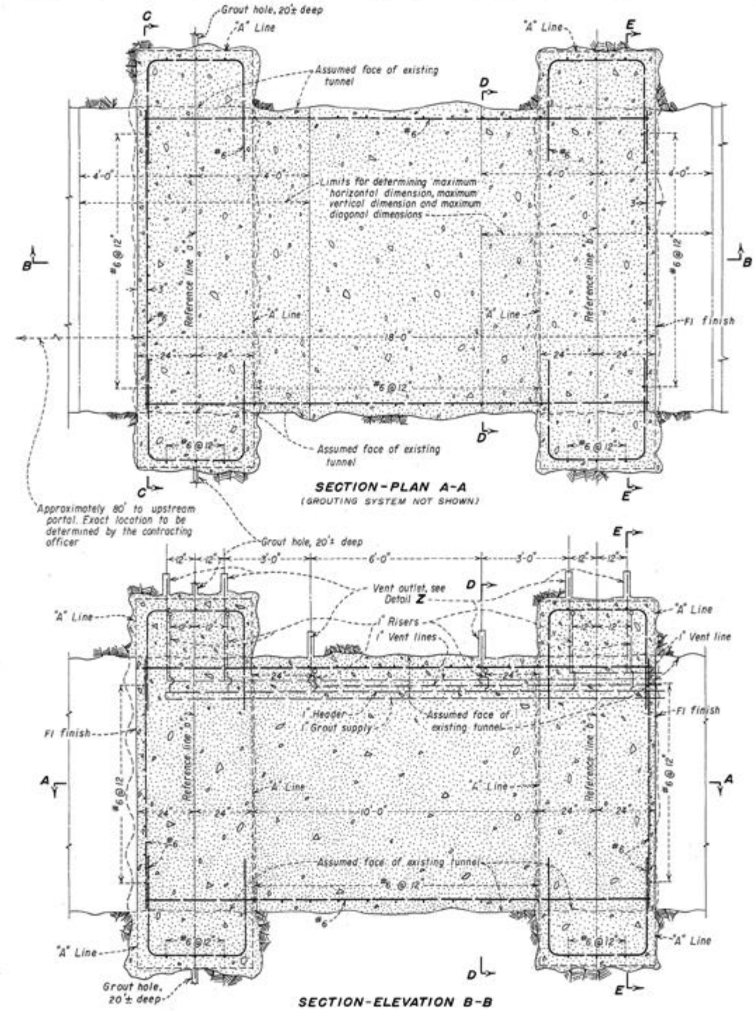


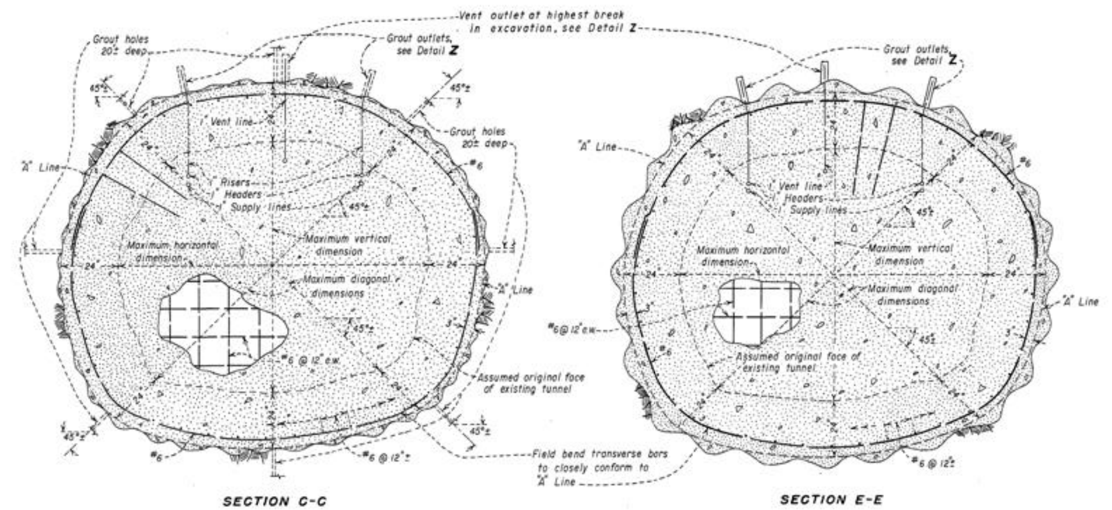
For Information Only

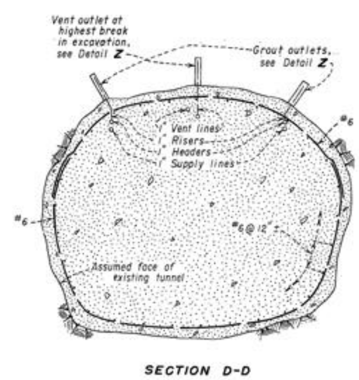


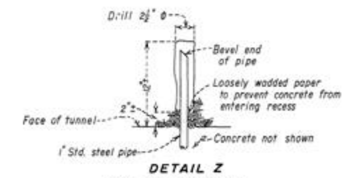
LEWISTON DAM
GENERAL PLAN AND SECTIONS
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL VALLEY PROJECT
TRINITY RIVER DIVISION-CALIFORNIA
416-D-1056
For Information Only
GENERAL PLAN
MAXIMUM SECTION
CREST DETAIL AT MAXIMUM CAMBER
EMBANKMENT EXPLANATION
CAMBER ON CREST OF DAM
PROFILE ON ℄ OF CREST OF DAM
SECTION A-A
RESERVOIR STORAGE ALLOCATIONS
PURPOSE | ELEVATIONS | STORAGE ACRE-FEET
Power | 1898 to 1902 | 2,000
Inactive | Streambed to 1898 | 12,000
Total storage capacity | | 14,000
A spillway capacity of 20,000 c.f.s. at Max. W.S. El.1902 is provided to pass the maximum Trinity Dam flood release.
DISCHARGE CURVES
SETTLEMENT POINT DETAIL
CONCRETE GROUT CAP
TYPICAL CREST ROAD SECTION
TRINITY RIVER


For Information Only
LEWISTON DAM
SPILLWAY
GATE STRUCTURE
416-D-1061
SECTION A-A
SECTION B-B
PLAN
REFERENCE DRAWINGS
NOTES







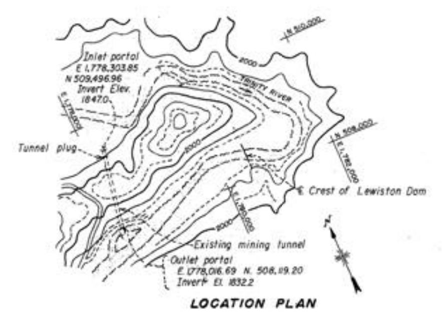


NOTES

For general notes, see drawings 40-D-5530 and 40-D-5586.
Exact location of grout and vent outlets to be determined by the contracting officer.
Additional grout outlets for grouting that are needed to fill the void spaces at the roof of the tunnel to be installed as directed by the contracting officer.
Points on the "A" line for tunnel plug excavation are located by adding 24" on each end of the maximum vertical, horizontal and diagonal dimensions of the existing tunnel cross sections. The "A" line is determined by joining these points with smooth undefined curves as directed.

REFERENCE DRAWING

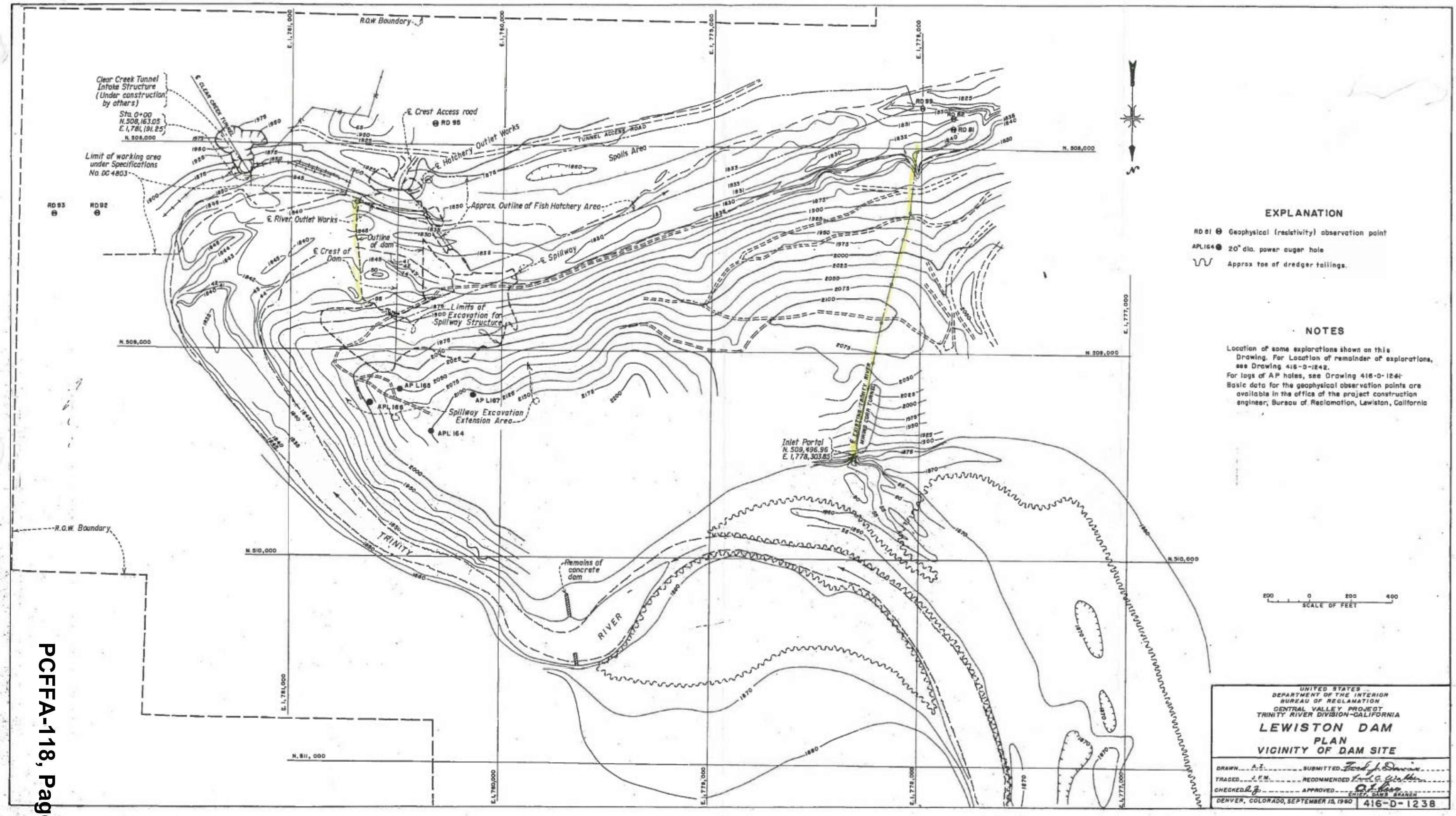
LEWISTON DAM - GENERAL PLAN AND SECTIONS........416-D-1058

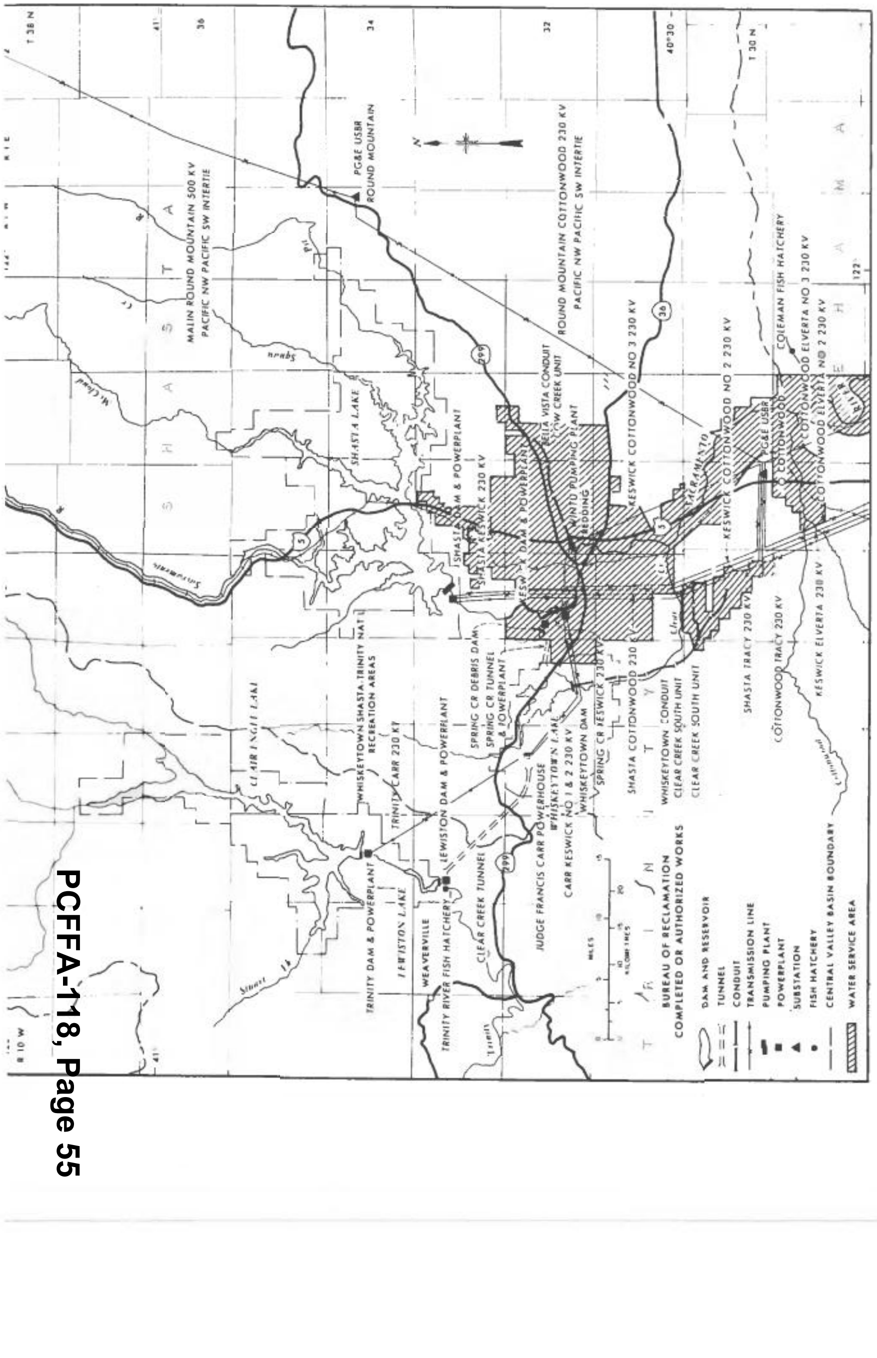


UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL VALLEY PROJECT
TRINITY RIVER DIVISION-CALIFORNIA

LEWISTON DAM
EXISTING MINING TUNNEL
TUNNEL PLUG

DRAWN R.R.J. SUBMITTED M. A. Jabara
TRACED F.D. RECOMMENDED R. W. Whinnerah
CHECKED CAW APPROVED C. L. Rice, CHIEF, DAMS BRANCH
DENVER, COLORADO SEPT. 1, 1960 416-D-1104


EXPLANATION
RD 81 Geophysical (resistivity) observation point
APL164 20" dia. power auger hole
Approx toe of dredger tailings.
NOTES
Location of some explorations shown on this Drawing. For Location of remainder of explorations, see Drawing 416-D-1242.
For logs of AP holes, see Drawing 416-D-1241.
Basic data for the geophysical observation points are available in the office of the project construction engineer, Bureau of Reclamation, Lewiston, California
SCALE OF FEET
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL VALLEY PROJECT
TRINITY RIVER DIVISION-CALIFORNIA
LEWISTON DAM
PLAN
VICINITY OF DAM SITE
DENVER, COLORADO, SEPTEMBER 13, 1960
416-D-1238
Clear Creek Tunnel Intake Structure (Under construction by others)
Sta. 0+00 N. 508,163.05 E. 1,781,191.25
Limit of working area under Specifications No. DC 4803
R.O.W. Boundary
℄ Crest Access road
℄ Hatchery Outlet Works
Tunnel Access Road
Spoils Area
Approx. Outline of Fish Hatchery Area
℄ River Outlet Works
Outline of dam
℄ Crest of Dam
℄ Spillway
Limits of Excavation for Spillway Structure
Spillway Excavation Extension Area
Inlet Portal N. 509,496.96 E. 1,778,303.85
Remains of concrete dam
TRINITY
RIVER



Central Valley Project, Shasta/Trinity River Divisions

Trinity Dam and Lake Clair Engle

4,552,000 acre-feet, provides abundant recreation, including boating, fishing, swimming, water skiing, camping, hunting, and houseboating. Many summer homesites have been developed along the shore, some accessible only by boat. Many resorts cater to the needs of the visitors to the Shasta Lake Recreation Area.

Shasta Powerplant

Shasta Powerplant is located just below Shasta Dam. Water from the dam is released through five 15-foot penstocks leading to the five main generating units and two station service units. Total capacity of these units is 539,000 kilowatts.

Keswick Dam and Reservoir

Keswick Dam is located on the Sacramento River 9 miles downstream from Shasta Dam. It is a concrete gravity structure 157 feet high with a crest length of 1,046 feet. The dam creates a 23,800 acre-foot afterbay for Shasta Lake and the Trinity River Division, and stabilizes the uneven water releases from the powerplants. The dam also has migratory fish trapping facilities that operate in conjunction with the Coleman Fish Hatchery 25 miles downstream on Battle Creek. Salmon and other migratory fish are trapped as they reach the dam, and are then taken to the hatchery operated by the Fish and Wildlife Service.

Keswick Powerplant

Keswick Powerplant, located at Keswick Dam, has three generating units with a total capacity of 75,000 kilowatts.

Trinity Dam and Clair Engle Lake

On the Trinity River, Trinity Dam regulates flows and stores surplus water for irrigation. Completed in 1962, it is an earthfill structure 538 feet high with a crest length of 2,450 feet. The dam forms Clair Engle Lake with a storage capacity of 2,448,000 acre-feet. The lake offers recreation facilities for camping, boating, water skiing, swimming, fishing, and hunting.

Trinity Powerplant

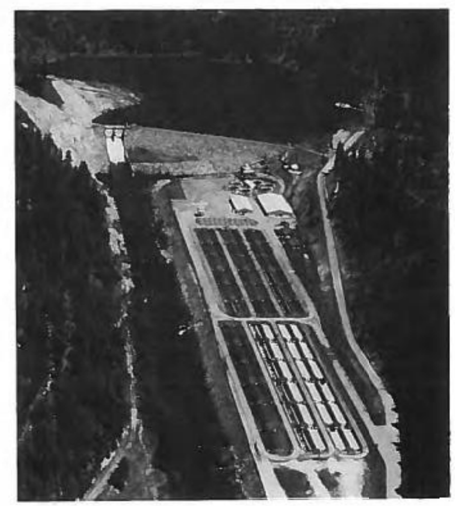
Trinity Powerplant at Trinity Dam has two generators with a total capacity of 105,556 kilowatts.

Lewiston Dam and Lake

Lewiston Dam, about 7 miles downstream from Trinity Dam, creates an afterbay to Trinity Powerplant and diverts water by means of Clear Creek Tunnel to Whiskeytown Lake. Lewiston Dam is an earthfill structure 91 feet high and 745 feet long, forming a reservoir with a capacity of 14,660 acre-feet.

Lewiston Powerplant

Lewiston Powerplant, using releases for the support of fish life and other downstream purposes in the Trinity River, has one station service unit with a capacity of 350 kilowatts.



Lewiston Dam and Reservoir

Trinity River Fish Hatchery

The Trinity River Fish Hatchery, operated by the California Department of Fish and Game, has a capacity of about 40 million eggs. It is immediately downstream from Lewiston Dam and compensates for the upstream spawning area that has been rendered inaccessible and unusable by the dams.

Clear Creek Tunnel

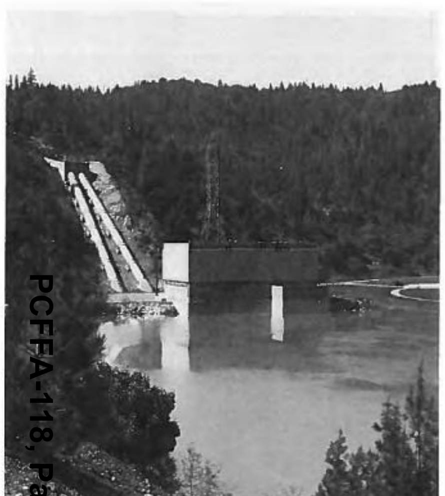
Clear Creek Tunnel, 17.4 feet in diameter and 10.7 miles long, conveys water from Lewiston Lake to Judge Francis Carr Powerhouse and Whiskeytown Lake. A bypass is provided into Crystal Creek.

Judge Francis Carr Powerhouse

The Judge Francis Carr Powerhouse on Clear Creek has two generators with a total capacity of 141,444 kilowatts.

Whiskeytown Dam and Lake

Located on Clear Creek, Whiskeytown Dam provides regulation for Trinity River flows discharged from Judge Francis Carr Powerhouse and regulates the runoff from the Clear Creek drainage area. The dam is an earthfill structure 282 feet high with a crest length of 4,000 feet. The reservoir, Whiskeytown Lake, has a capacity of 241,100 acre-feet and provides recreation facilities for picnicking, camping, swimming, boating, water skiing, fishing, and hunting.



Judge Francis Carr Powerhouse

Whiskeytown Dam and Lake

Spring Creek Tunnel

The Spring Creek Tunnel diverts water from Whiskeytown Lake on Clear Creek, a tributary of the Sacramento River, to the Spring Creek Powerplant. The tunnel is 18.4 feet in diameter and about 2.4 miles in length, including the 0.6-mile-long, 17-foot-diameter Rock Creek Siphon.

Spring Creek Powerplant

Spring Creek Powerplant is located on an arm of Spring Creek at Keswick Reservoir. It has two generators with a total capacity of 150,000 kilowatts.

Spring Creek Debris Dam and Reservoir

Spring Creek Debris Dam, located on Spring Creek above the Spring Creek Powerplant tailrace, is an earthfill structure 196 feet high with a crest length of 1,110 feet. Spring Creek Reservoir, with a capacity of 5,870 acre-feet, controls debris which would otherwise enter the powerplant tailrace, and provides important fishery benefits by controlling contaminated runoff resulting from old mine tailings on Spring Creek.

Distribution System

The Cow Creek Unit and the Clear Creek South Unit were authorized as a part of the Trinity River Division. They consist of pumping plants and conveyance systems to transport irrigation water to some 6,800 acres of irrigable land east of Redding, and 4,600 acres of irrigable land west of Anderson, respectively.

Keswick Dam and Powerplant

PROJECT DATA

Land Areas (1977)

Irrigable area:		
Supplemental irrigation service	475,828	acres
Number of irrigated farms	3,532	

Facilities in Operation

Storage dams	6	
Conduits and aqueducts	16.3	mi
Tunnels	13.3	mi
Pumping plants	1	
Powerplants	5	
Transmission lines	11.99	mi
Substations	6	

Climatic Conditions

Annual precipitation:		
Trinity River Hatchery	35.7	in
Shasta Dam	60.1	in
Temperature:		
Maximum	116	°F
Minimum	−7	°F
Mean	53	°F
Growing season	150	days
Elevation of irrigable area	550.0	ft

Settlement

Number of persons served with project water (1977):	
Farm irrigation service	13,954
Urban/suburban irrigation service	16,927
Municipal and other water service	36,725
Total	67,606

ENGINEERING DATA

Water Supply

SACRAMENTO RIVER

Drainage area at Shasta Dam	6,665	mi²
Annual discharge:		
Maximum (1958)	9,121,000	acre-ft
Minimum (1924)	2,654,000	acre-ft
Average	5,575,000	acre-ft

TRINITY RIVER

Drainage at Lewiston	719	mi²
Annual discharge:		
Maximum (1941)	2,672,000	acre-ft
Minimum (1968)	126,300	acre-ft
Average	1,245,000	acre-ft

CLEAR CREEK

Drainage area at Igo	228	mi²
Annual discharge:		
Maximum (1941)	747,800	acre-ft
Minimum (1972)	58,620	acre-ft
Average	333,300	acre-ft

Storage Facilities

SHASTA DAM

Type: Concrete curved gravity, embankment wing
Location: On the Sacramento River 9 mi northwest of Redding, Calif.
Construction period: 1938-45

Reservoir, Shasta Lake:	
Average annual inflow, 1922-70	5,439,600 acre-ft
Total capacity to El. 1067	4,552,000 acre-ft
Active capacity, El. 840 to 1067	3,965,000 acre-ft
Surface area at El. 1067	29,740 acres
Length	35 mi
Shoreline	365 mi
Dimensions:	
Structural height	602 ft
Hydraulic height	525 ft
Top width	30 ft
Maximum base width	883 ft
Crest length	3,460 ft
Crest elevation	1077.5 ft
Total volume	8,430,000 yd³
Spillway: Overflow section near center of dam controlled by three 110- by 28-ft drum gates.	
Elevation top of gates	1069.5 ft
Crest elevation	1037.0 ft
Capacity, El. 1065[1]	186,000 ft³/s
Outlet works: Eighteen 102-in-diameter conduits through dam in three tiers (6-in upper, 8-in middle, 4-in lower) controlled by fourteen 96-in wheel-type gates (upper and middle) and four 102-in tube valves. Five 183-in-diameter steel pipes through dam, controlled by five 15- by 19-ft coaster gates, deliver water to the powerplant.	
Capacity	81,800 ft³/s
Foundation: Hard, tough, durable greenstone; usually hard and sound beneath streambed. In abutments, decay of the geologically ancient formation penetrates deeply along many joints and occasional small crush zones.	
Special treatment: Cement grout curtain with adjacent drainage holes placed beneath foundation drainage gallery; crush zones cleaned out to sound rock and backfilled with concrete; mud seams, joints, and crevices pressure-grouted.	
Mass concrete: Natural aggregate from pits near Redding, Calif. Oversize crushed; low heat cement; temperature control with river water and refrigerated water in extreme heat; aggregate and mixing water cooled in summer, heated in winter.	
Volume:	
Earth	2,160,000 yd³
Concrete	6,270,000 yd³

Keswick Dam

Type: Concrete gravity, embankment wings	
Location: On the Sacramento River about 4 mi northwest of Redding, Calif.	
Construction period: 1941-50	
Reservoir, Keswick:	
Average annual inflow 1943-70	6,091,300 acre-ft
Total capacity to El. 587	23,800 acre-ft
Active capacity, El. 574 to 587	7,470 acre-ft
Surface area at El. 587	640 acres
Length	9 mi
Shoreline	25.5 mi
Dimensions:	
Structural height	157 ft
Hydraulic height	118 ft
Top width	20 ft
Maximum base width	110.6 ft
Crest length	1,046 ft
Crest elevation	595.5 ft

[1]Capacity does not include 2-ft flashboards.

Total volume	197,000 yd³
Spillway: Overflow section at left side of dam controlled by four 50-ft-square slide gates.	
Elevation top of gates	587 ft
Crest elevation	537.0 ft
Capacity, El. 589.8	271,000 ft³/s
Outlet works: Power — nine penstock openings in powerhouse section controlled by nine 23- by 17-ft fixed-wheel gates. Fish trap — concrete conduit through dam controlled by one 5-ft-square slide gate.	
Capacity of power outlet works	248,000 ft³/s
Foundation: Badly weathered quartz-biotite schist cut by calcite veins, quartz veins, clay seams, and mud seams. Large fault marked by a crush zone 10 to 12 ft wide strikes up and downstream and crosses the damsite under the old stream channel.	
Special treatment: Grout blanket over entire foundation area; grout curtain along upstream toe.	
Volume	197,000 yd³

Trinity Dam

Type: Zoned earthfill	
Location: On the Trinity River about 9 mi upstream from Lewiston, Calif.	
Construction period: 1957-62	
Reservoir, Clair Engle Lake:	
Average annual inflow 1912-70	1,168,500 acre-ft
Total capacity to El. 2370	2,448,000 acre-ft
Active capacity, El. 2145-2370	2,135,000 acre-ft
Surface area at El. 2370	16,535 acres
Shoreline	145 mi
Dimensions:	
Structural height	538 ft
Hydraulic height	440 ft
Top width	40 ft
Maximum base width	2,680 ft
Crest length	2,450 ft
Crest elevation	2395.0 ft
Total volume	29,410,000 yd³
Spillway: Tunnel on left abutment; uncontrolled morning-glory concrete crest structure 54 ft in diameter.	
Crest elevation	2370.0 ft
Capacity, El. 2387	24,000 ft³/s
Outlet works: Tunnel 28 ft in diameter through left abutment with one penstock bifurcating into two just upstream from powerhouse, with bypass outlet facilities adjacent to the powerplant.	

Lewiston Dam (Storage and Diversion)

Type: Zoned earthfill	
Location: On the Trinity River about 7 mi downstream from Trinity Dam.	
Construction period: 1960-63	
Reservoir, Lewiston Lake:	
Total capacity to El. 1902	14,660 acre-ft
Active capacity, El. 1898-1902	2,890 acre-ft
Surface area at El. 1902	750 acres
Shoreline	15 mi
Dimensions:	
Structural height	91 ft
Hydraulic height	73 ft
Top width	25 ft
Maximum base width	380 ft
Crest length	745 ft
Crest elevation	1910.0 ft
Total volume	265,000 yd³

Spillway: Gated chute with two 30- by 27.5-ft radial gates.	
Elevation, top of gates	1902.0 ft
Crest elevation	1874.5 ft
Capacity, El. 1902	30,000 ft³/s

Whiskeytown Dam

Type: Zoned earthfill	
Location: On Clear Creek about 5 mi west of Redding, Calif.	
Construction period: 1960-63	
Reservoir, Whiskeytown Lake:	
Total capacity to El. 1210	241,100 acre-ft
Active capacity, El. 1100-1210	213,550 acre-ft
Surface area at El. 1210	3,220 acres
Shoreline	36 mi
Dimensions:	
Structural height	282 ft
Hydraulic height	252 ft
Top width	30 ft
Maximum base width	1,450 ft
Crest length	4,000 ft
Crest elevation	1228.0 ft
Total volume	4,535,000 yd³
Spillway: Morning-glory type, 24.5 ft in diameter, leading to a 21-ft-diameter concrete lined tunnel with a flip bucket and outlet channel.	
Crest elevation	1210.0 ft
Capacity, El. 1220.5	28,650 ft³/s
Outlet works: Consists of a 19-ft-diameter conduit and concrete lined tunnel, and an upper level system consisting of a concrete intake structure and shaft with a 6-ft-diameter concrete lined tunnel. Flow into the control house controlled by 2.75- by 3.75-ft gates.	
Capacity at El. 1220.5	12,500 ft³/s
Foundation special treatment: A double cap and grout curtain was placed at the bottom of the cutoff trench along with an upstream grout curtain. Grouting also performed in rock surrounding the spillway and outlet works shafts and tunnels.	

Spring Creek Debris Dam

Type: Earthfill	
Location: On Spring Creek upstream from the Spring Creek Powerplant tailrace channel.	
Construction period: 1961-63	
Reservoir, Spring Creek:	
Total capacity to El. 795	5,870 acre-ft
Active capacity, El. 679-795	5,650 acre-ft
Surface area at El. 795	87 acres
Shoreline	2.5 mi
Dimensions:	
Structural height	196 ft
Hydraulic height	169 ft
Top width	30 ft
Maximum base width	1,040 ft
Crest length	1,110 ft
Crest elevation	816.0 ft
Total volume	1,891,000 yd³
Spillway: Ungated chute	
Crest elevation	795.0 ft
Capacity, El. 809.5	5,260 ft³/s
Outlet works: A 6-ft-diameter concrete lined tunnel with two 2.25-ft-square gates to a 6.5-ft flat bottom concrete conduit.	
Capacity at El. 809.5	660 ft³/s

Carriage Facilities

Clear Creek South Main Aqueduct

Construction period: 1965-67	
Length	8.5 mi
Capacity	73 ft³/s
Cross section:	
Diameter	2.8-2.6 ft
Lining type: Steel and concrete	

Cow Creek Main Aqueduct

Construction period: 1965-66	
Length	7.8 mi
Capacity	92 ft³/s
Cross section:	
Diameter	3.4 ft
Lining type: Pretensioned reinforced concrete	

Spring Creek Tunnel

Location: From the east side of Whiskeytown Lake easterly through the Rock Creek Siphon, then to the Spring Creek Powerplant.	
Construction period: 1960-63	
Length	12,707 ft
Capacity	3,800 ft³/s
Cross section:	
Diameter	18.4 ft
Lining type: Circular	
Lining thickness	9-37 in

Clear Creek Tunnel

Location: From Lewiston Reservoir near Lewiston Dam southeasterly to the Judge Francis Carr Powerhouse and Whiskeytown Lake.	
Construction period: 1957-62	
Length	56,668 ft
Capacity	3,200 ft³/s
Cross section:	
Diameter	17.4 ft
Lining type: Circular	
Lining thickness	9-37 in

Spring Creek Powerplant Tailrace Tunnel

Construction period: 1960-62	
Length	567 ft
Capacity	3,600 ft³/s
Cross section:	
Diameter	21 ft
Lining type: Horseshoe	

Judge Francis Carr Powerhouse Bypass

Construction period: 1969-70	
Length	270 ft
Capacity	1,600 ft³/s
Cross section:	
Diameter	6 ft
Lining type: Circular	
Lining thickness	9 in

Wintu Pumping Plant

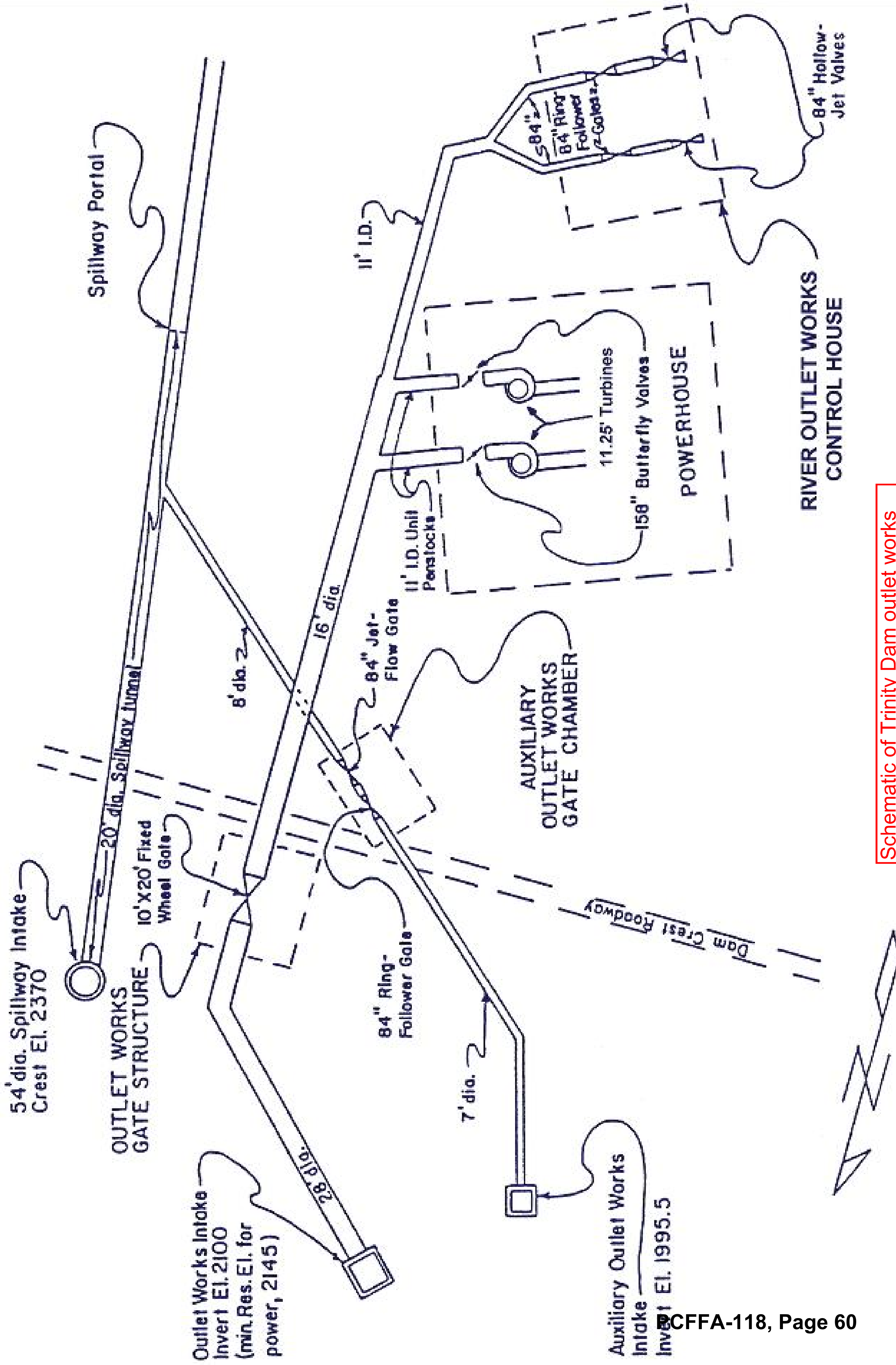
Number of units	4
Total capacity	100 ft³/s
Total dynamic head	295 ft
Total horsepower	4,000

Attachment 3

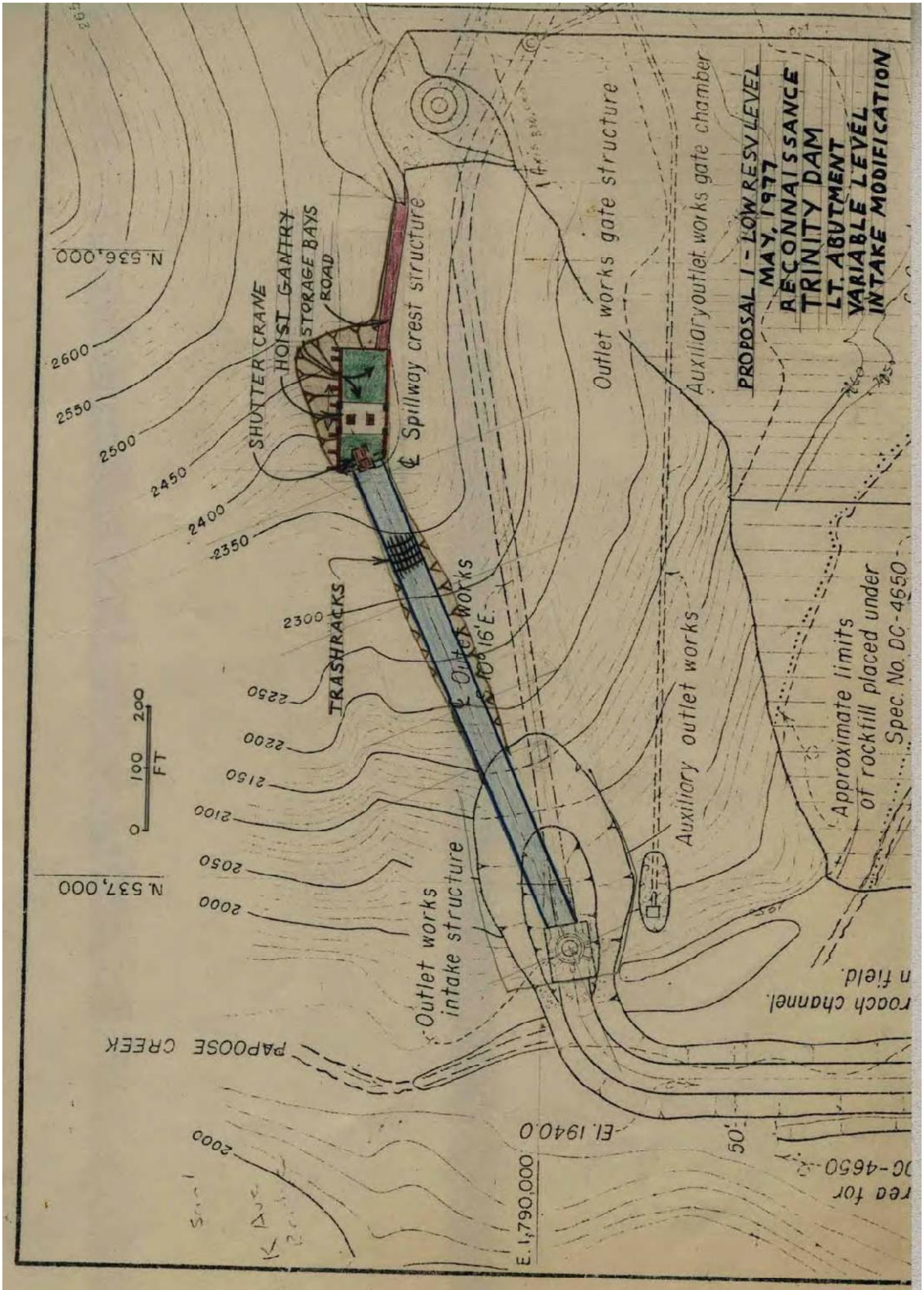
Trinity Multilevel Intake Structure
Photo and Figures

- Construction Photo of Existing (September 1960) Trinity Dam Outlet Works Intake Structure from Reclamation 1978 Intake Structure Modifications Report
- Trinity Dam Outlet Works Schematic
- Proposed Variable Level Intake Modification, Plan View, from Reclamation 1978 Intake Structure Modifications Report
- Proposed Variable Level Intake Modification, Profile View, from Reclamation 1978 Intake Structure Modifications Report

Upstream face of Trinity Dam, September 1960. Note outlet works intake tower where variable level intake would be attached.



Schematic of Trinity Dam outlet works


PROPOSAL I - LOW RESV LEVEL
MAY, 1977
RECONNAISSANCE
TRINITY DAM
LT. ABUTMENT
VARIABLE LEVEL
INTAKE MODIFICATION
SHUTTER CRANE
HOIST GANTRY
STORAGE BAYS
ROAD
℄ Spillway crest structure
Outlet works gate structure
Auxiliary outlet works gate chamber
TRASHRACKS
℄ Outlet works
N. 10° 16' E.
Auxiliary outlet works
Approximate limits
of rockfill placed under
Spec. No. DC-4650
Outlet works
intake structure
PAPOOSE CREEK
N. 536,000
N. 537,000
E. 1,790,000
EL. 1940.0
0
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200
FT
2600
2550
2500
2450
2400
2350
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2250
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roach channel.
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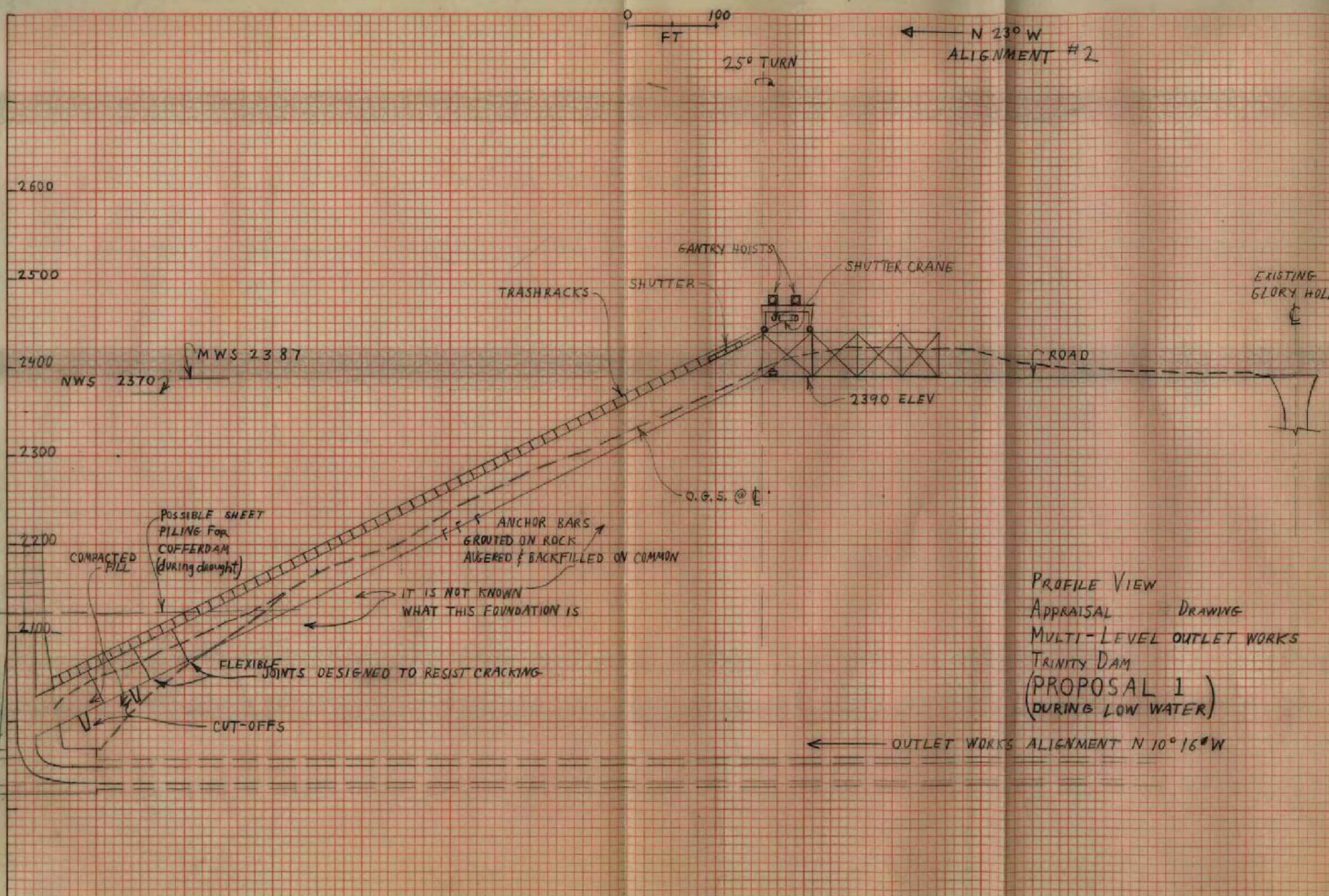
DC-4650



0
100
FT
25° TURN
N 23° W
ALIGNMENT #2
2600
2500
2400
2300
2200
2100
EXISTING GLORY HOLE
GANTRY HOISTS
SHUTTER CRANE
SHUTTER
TRASHRACKS
MWS 2387
NWS 2370
ROAD
2390 ELEV
O.G.S. @ ℄
POSSIBLE SHEET PILING FOR COFFERDAM (during drought)
COMPACTED FILL
ANCHOR BARS GROUTED ON ROCK AUGERED & BACKFILLED ON COMMON
IT IS NOT KNOWN WHAT THIS FOUNDATION IS
FLEXIBLE JOINTS DESIGNED TO RESIST CRACKING
CUT-OFFS
PROFILE VIEW
APPRAISAL DRAWING
MULTI-LEVEL OUTLET WORKS
TRINITY DAM
(PROPOSAL 1 DURING LOW WATER)
OUTLET WORKS ALIGNMENT N 10° 16' W

Attachment 4

Summary of Mercury Issues

Dr. James Rytuba, U.S. Geological Survey
Per Email dated 8-29-12

Potential for mercury and monomethylmercury release resulting from implementing possible alternatives to control water temperature

James J. Rytuba, US Geological Survey, 345 Middlefield Road, Menlo Park, CA

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Introduction

Since its construction the Lewiston Dam has caused the deposition of sediment in Lewiston Lake and this limits the amount of mercury (Hg) released to the Trinity River below the dam. Mercury is commonly associated with particulates in the water column and removal of sediment decreases the transport of Hg. As a result both suspended sediment and concentrations of Hg in water are very low in the segment of the Trinity River downstream from the dam. Even under controlled high releases from the dam both Hg and monomethylmercury (MMeHg) concentrations in Trinity River water are very low downstream from the dam (Ashley and others, 2004). Sediment deposited in Lewiston Lake is potentially enriched in Hg and MMeHg as a result of mercury used in placer and dredge mining of gold in the upper part of the Trinity watershed. MMeHg is the form of Hg that is of concern since it is a potent neurotoxin. MMeHg is bioaccumulated up the food web such that even relatively low levels of MMeHg in the water column can result in high concentrations of MMeHg in fish that are of concern to both humans and wildlife. MMeHg most commonly forms as a result of sulfate-reducing bacteria methylating Hg in a sedimentary environment where there is a boundary between oxygenated and reduced environments. Wetlands are particularly favorable for the formation of MMeHg as are anoxic lakes.

Potential relative effects of each alternative

Several of the proposed alternatives to control temperature in Lewiston Lake have the potential to increase the release of Hg and MMeHg from sediments that have accumulated behind the Lewiston Dam. Modification or removal of Lewiston Dam, alternative #1, has the highest potential to release Hg and MMeHg enriched sediment into the Trinity River downstream from the dam. The proposal to dredge the middle reach of the reservoir, alternative #2, has the potential to release both Hg and MMeHg enriched sediment during the process of dredging. Elevated concentrations of Hg and MMeHg may remain in the water column of Lewiston Lake after the dredging is completed but will return to baseline levels when suspended sediment settles out of the water column. Both alternatives 1 and 2 would require characterization of the concentration of Hg and MMeHg in the sediment that has accumulated in Lewiston Lake. Alternative 1 would require coring and characterization of sediments throughout the lake and the riverbed between Lewiston Lake and Trinity Dam. Alternative 2 would require coring and characterization of sediment only in the middle reach of the reservoir where dredging would be carried out.

Alternative #4 proposes to increase the height of the Lewiston Dam resulting in a 3-5 feet increase the water level of Lewiston Lake. This alternative does not have the potential to significantly increase the release of Hg and MMeHg from Lewiston Lake. However, there is a possibility of inundation of some of the dredge tailings and dredge ponds on the east side of Lewiston Lake. This has the potential to locally release Hg from the tailings. If wetlands are created in and adjacent to the dredge tailings, there is a potential to locally increase methylation of Hg and increase the concentration of MMeHg in biota in the wetlands. It is unlikely that this will increase the MMeHg in the eastern part of Lewiston Lake.

Alternative #3 proposes to transfer water from Trinity Lake to Lewiston Lake in a pipe of tunnel. This alternative has no effect on the transport or release of Hg and MMeHg from Lewiston Lake. Of all the alternatives this has the least potential effect on Hg and MMeHg release from Lewiston Lake.

Analysis of each alternative

Alternative #1, Modification of Lewiston Dam

Removal or notching of the Lewiston Dam has the potential to release a large volume of Hg enriched sediment that has accumulated behind the dam. Release of Hg enriched sediment will increase the Hg concentration in both sediment and water in the Trinity River downstream from the dam. The increase in Hg and MMeHg concentration in the Trinity River would be a function of flow with high flows leading to higher releases of Hg and MMeHg. This has the potential to significantly increase MMeHg in the water and sediment downstream from the dam and possible uptake of MMeHg by biota. Under the present configuration the Trinity River downstream from the Lewiston Dam has very low Hg and MMeHg concentration because sediment is deposited in Lewiston Lake. At present, the controlled releases from the Lewiston Dam to establish high flows in the Trinity River do not significantly increase Hg and MMeHg in the segment of the Trinity River downstream from the Lewiston Dam.

This proposal also includes restoration of the approximately 7 miles of the former riverbed between Trinity Lake and Lewiston Lake. Restoration of the riverbed will lead to erosion and transport of Hg and MMeHg enriched sediment that presently occupies the riverbed and bank deposits. During high flows and flood events significantly more Hg and MMeHg will be released and transported downstream by the reestablished Trinity River. At present there is likely minimal transport of Hg and MMeHg in this segment of the river between Lewiston Lake and Trinity Lake.

Further work prior to implementing this alternative would require characterization of the Hg and MMeHg concentrations in sediments accumulated in Lewiston Lake and in the riverbed extending to the Trinity Dam. Procedures for characterizing Hg contaminated sediment would be similar to that carried out for the Daguerre Point Dam which is under consideration for removal (Hunerlach and others, 2004). It is likely that Hg and MMeHg concentrations will vary with depth and that some sedimentary layers will have concentrations of Hg that are high and require isolation in a repository.

Erosion control of the sediments will be necessary to minimize release of sediment into the Trinity River under all flow regimes.

Alternative # 2 Dredging of the middle reach of the reservoir

Dredging of the middle reach of the reservoir will involve removing Hg and MMeHg enriched sediment that has accumulated in Lewiston Lake. The process of dredging will cause the concentration of Hg and MMeHg to increase in the water column of Lewiston Lake. Since Hg and MMeHg are primarily bound to particles, the elevated concentration of Hg and MMeHg will persist until the suspended sediment settles and is deposited on the lake floor. If this extends over a protracted period of time, it has the potential to increase MMeHg in biota within the lake.

Further work prior to implementing this alternative would require characterization of the Hg and MMeHg concentrations in sediments accumulated in the middle reach of the reservoir. It is likely that Hg and MMeHg concentration will vary with depth and that some sedimentary layers will have concentrations of Hg that potentially require isolation in a repository.

Alternative #3 Tunnel or Pipe Trinity Flows

The alternative to transport water from the Trinity Dam to Lewiston Dam either in a pipe or tunnel will have no or minimal impact on Hg and MMeHg transport into Lewiston Lake. During transit water within a pipe or tunnel will not be in an environment in which methylation of Hg will occur. The expected low concentrations of Hg and MMeHg in the water released from Trinity Lake will not increase during transport to Lewiston Lake. However it is not known whether the cold water in the lower part of Trinity Lake has seasonally elevated levels of MMeHg. Characterization of the seasonal changes in MMeHg concentration in the lower level of Trinity Lake would be needed to assess whether the water transported to Lewiston Lake would potentially increase MMeHg in the lower water layer of Lewiston Lake. Since the volume of water from Trinity Lake would be low, mixing with the Lewiston Lake water would result in significant dilution of MMeHg concentration.

Alternative #4 Raise Lewiston Dam

Raising the level of Lewiston Dam by 3-5 feet has the potential to inundate some of the dredge tailings and dredge ponds that are closest to the east side of the Lewiston Lake. This may cause Hg in sluice sands located beneath stacker cobble tailings to be mobilized (Rytuba and Goldstein, 2012). The Hg that is released may be locally methylated especially if wetlands are developed in and adjacent to the stacker cobble tailings and underlying sluice sands (Rytuba and others, 2010).

Further work prior to implementing this alternative would require assessing the area of dredge tailings that would be inundated and estimating the area of new wetlands that would be created. It is expected that only a limited area of dredge tailings would be inundated. The dredge tailings that have the potential to be inundated would need to be analyzed for Hg and existing wetlands would need to be evaluated for methyl mercury formation and uptake by biota. These studies would provide a basis for estimating the additional MMeHg that would form. It is unlikely that a significant release of MMeHg into Lewiston Lake will occur if this alternative is implemented.

References

Ashley, R.P.,, Hothem, R.L., May, J.T., and Rytuba, J.J., 2004, Preliminary report on mercury and methylmercury in water, sediment, biota, and placer tailings, Hocker Flat Restoration Project Area, Trinity County, California: U.S. Geological Survey Administrative Report, 18 p.

Hunerlach, M.P., Alpers, C.N., Marvin-DiPasquale, M., Taylor, H.E., and De Wild, J.F., 2004, Geochemistry of mercury and other trace elements in fluvial tailings upstream of Daguerre Point Dam, Yuba River, California, August 2001: U.S. Geological Survey Scientific Investigations Report 2004-5165, 66 p.

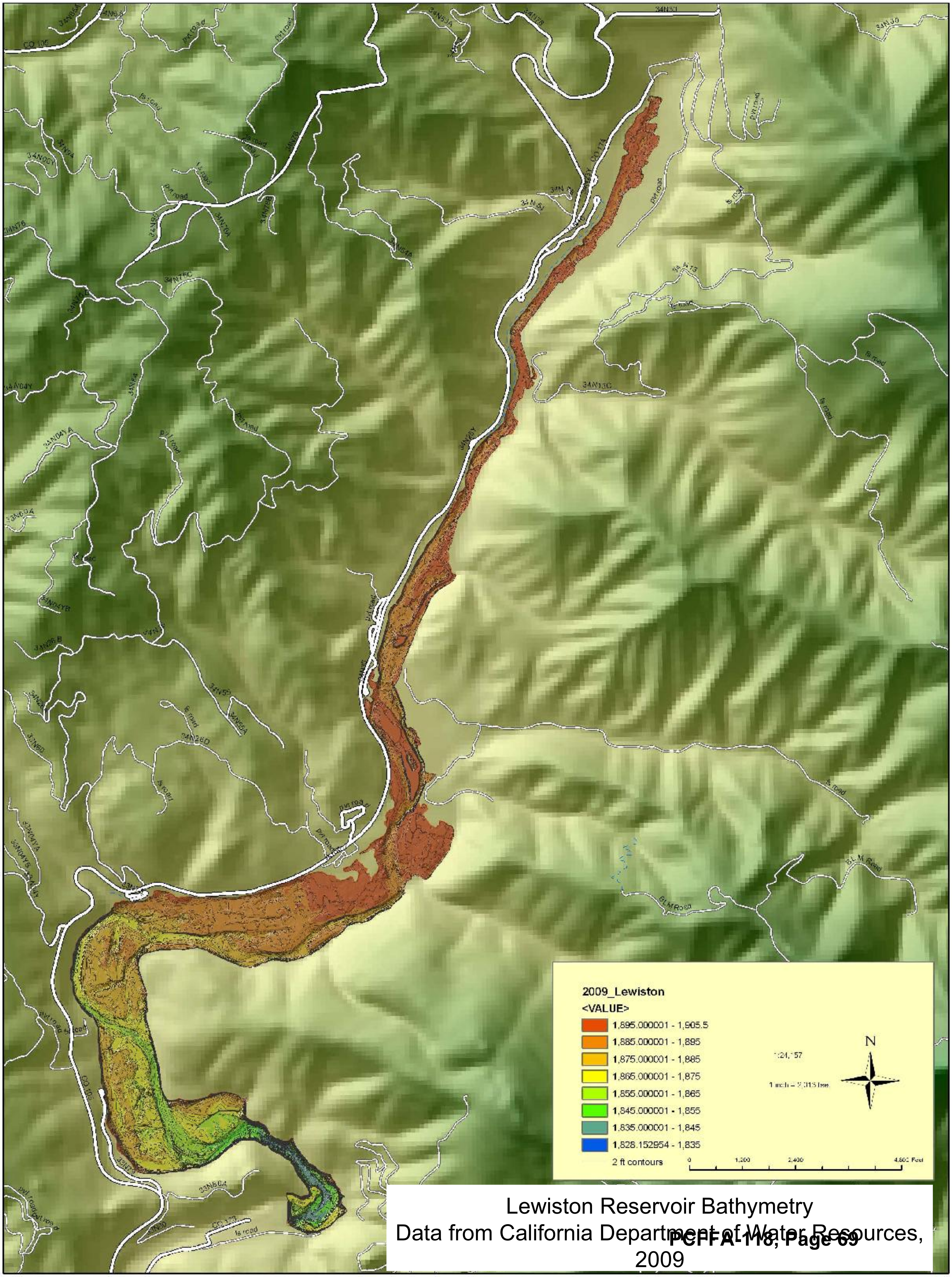
Rytuba, J.J., Ashley, R.P., and Goldstein, D., 2010, Report on mercury and methylmercury in water and sediments from wetlands, ponds, and Trinity River, Trinity River Restoration Project Areas, Trinity County, California: U.S. Geological Survey Administrative Report, 26 p.

Rytuba, J.J., and Goldstein, D., 2012, Potential for mercury methylation and release from sluice sands in dredge ponds as a result of planned side-channel construction in the Trinity River floodplain, Trinity County, California: U.S. Geological Survey Administrative Report, 35 p.

Attachment 5

Lewiston Reservoir Bathymetry

Data from California Department of Water Resources, 2009

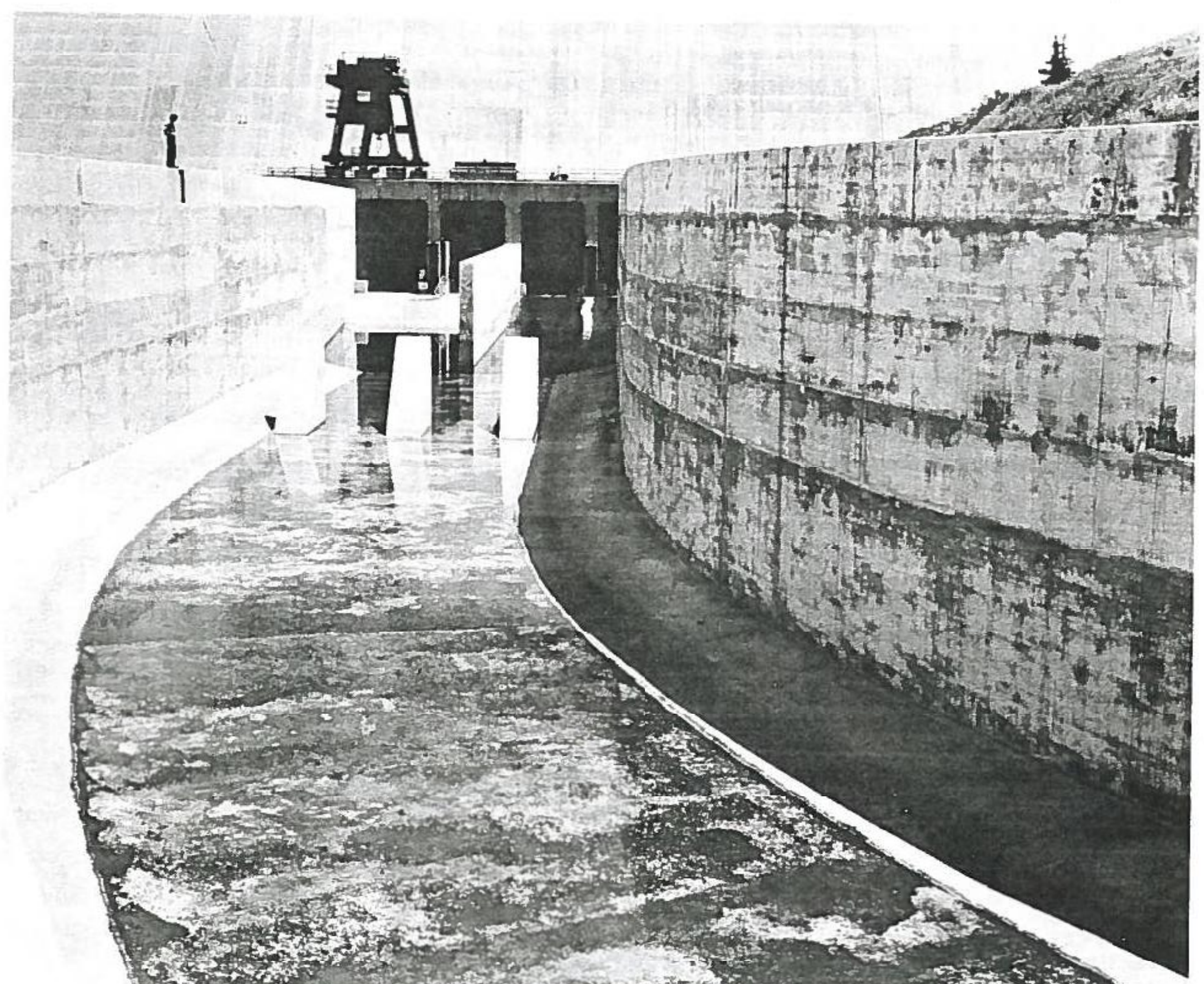


Lewiston Reservoir Bathymetry
Data from California Department of Water Resources, 2009

Attachment 6

Friant-Kern Canal Examples

- Friant Dam Outlet Works to Friant-Kern Canal, Energy Dissipator
- Canal to Tunnel Transition, Friant-Kern Canal to Siphon Intake
- Kaweah River Siphon, General Plan and Sections



Friant Dam Outlet Works to Friant-Kern Canal,
Energy Dissipator. Approx 5,000 cfs capacity.

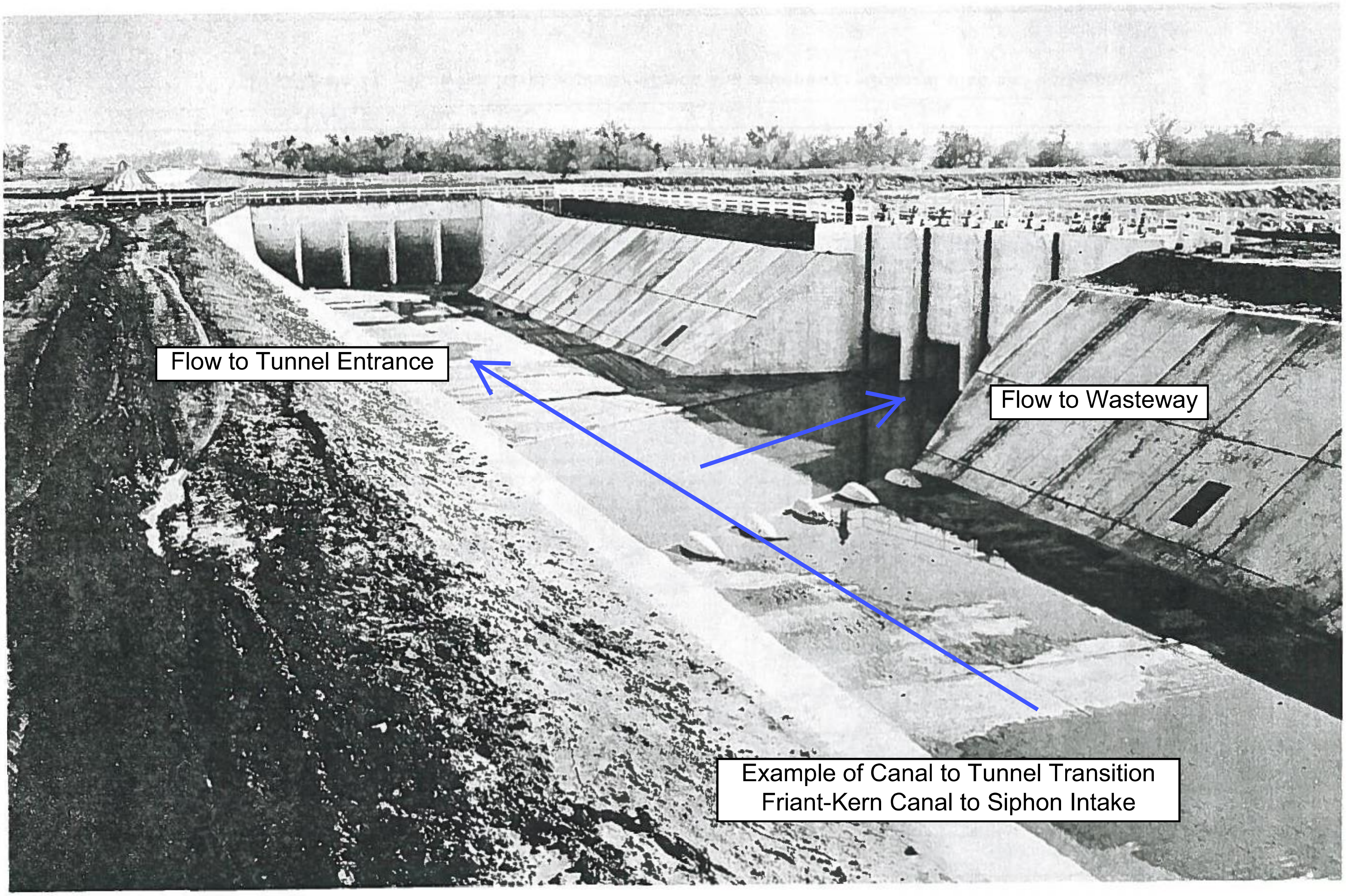


Figure 16. --Looking downstream at inlets of completed wasteway and canal siphon structure, St. Johns River, station 3765. FK-2286-CV, February 2, 1950.

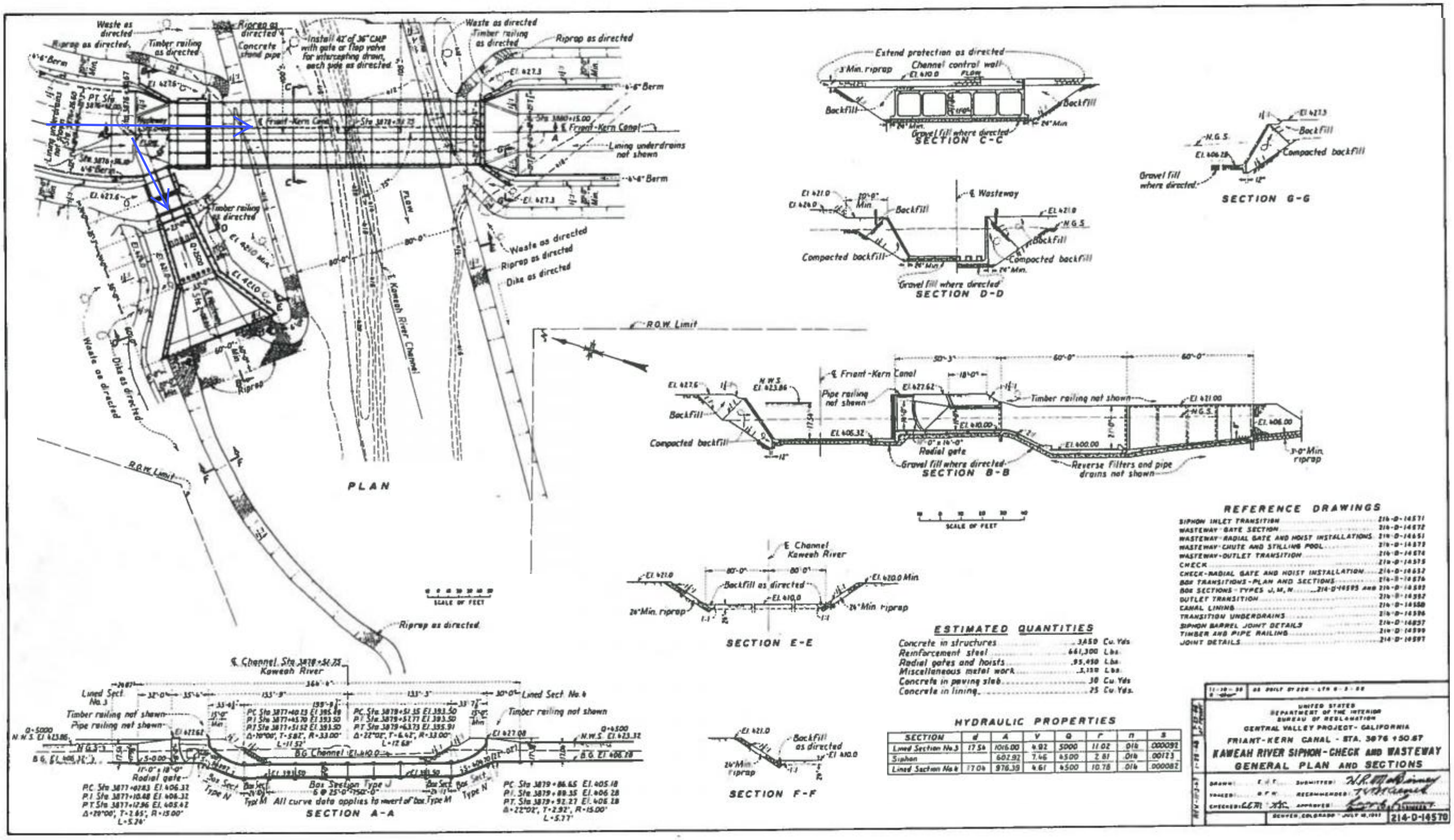


Figure 17. --Kaweah River siphon--Check and wasteway--General plan and sections.