Summary

This technical memorandum examines the feasibility of eliminating the diversion of irrigation water from Big Chico Creek by constructing a new pump station on the Sacramento River. Also examined are various options for intake, pumping, and conveyance systems to deliver water from the Sacramento River to the north end of the Phelan Canal.

Three alternatives have been developed that consider intake structure location, pump station location, and conveyance systems. The proposed alternative consists of a river intake and pump station on the east bank of the river approximately 800 feet downstream of the mouth of Big Chico Creek.

Both flat-plate and cylindrical intake screens were considered. The proposed river inlet would have submerged cylindrical intake screens with an automatic cleaning system. The screens would be constructed to meet applicable standards for streams inhabited by anadromous fish species.

The pump station would have a capacity of 120 cubic feet per second (cfs). Three vertical turbine pumps would be used. The pumps would be driven by natural gas engines to reduce operating costs and to allow variable speed operation.

The station would pump into a 66-inch pipeline which would be connected to a new discharge structure at the head of the Phelan Canal.

Numerous regulatory agencies will be involved in permitting and/or reviewing the proposed project. The permitting issues involved are biological impact on threatened or endangered species; modification of flood control structures; dredging or fill operations in a navigable waterway; water quality impacts from construction activities; and conformance to applicable building codes.
The new pump station and intake is estimated to have a construction cost of approximately $3.3 million. The estimate was developed on the basis of preliminary estimated quantities of major system components, telephone contact with component vendors, and cost curves. It is provided for guidance, but should not be considered a definitive estimate.

Contents

This technical memorandum is organized into the following sections:

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- Cost Opinion
- Environmental Compliance And Regulatory Permits

Design Criteria

The general criteria are:

- **Water source**—The water source should be dependable year-round. The system must have the capability to draw water at all river levels, from typical flood stages down to minimum summer flows.

- **Delivery point**—The pump station and conveyance system should deliver the water to the north end of the Phelan Canal, which is the current distribution facility for the water.

- **Hydraulic Capacity**—The pump station should have a normal pumping capacity of 120 cubic feet per second.

- **Fish Screening Capability**—The fish screen facility should satisfy all applicable state and federal guidelines and performance criteria for the appropriate fish species.

- **Flood Control Impact**—The flow conduit through the existing flood control levee should have redundant positive closure capability to prevent compromising the integrity of the levee during flood flows.
• **Construction**—The overall project design should be one that can be readily constructed with standard construction techniques and materials, in a minimum amount of time.

• **Cost**—Both capital and operation and maintenance (O&M) costs should be as low as possible and satisfy the other general criteria.

### Site Considerations

The location for the new intake structure, pump station, and conveyance system must satisfy several considerations that will affect the capital and O&M cost, operational reliability, construction, and overall efficiency of the system.

### Land Ownership

The pump station and conveyance system should be located on M&T property to minimize the need for right-of-way acquisition and permitting. The conveyance system will be located entirely within M&T property, with the exception of the River Road crossing.

### Proximity to Both the Water Source and Delivery Point

The pump station should be located close to the Phelan Canal to reduce the length of the conveyance system and the size of the pumps. The location should enable the design flow rate to the pumps to be provided under gravity flow at the lowest expected river levels. Two methods of conveyance are available from the intake structure: (1) gravity pipeline or (2) open channel canal.

### River Hydraulics

The intake structure and pump station should be located to operate at design capacity under the wide range of riverflow conditions, from minimum drought flows to maximum flood flows. In addition, the pump station should be located at an elevation that will ensure major equipment is protected during a 100-year flood.

Available hydrologic data for the portion of the Sacramento River near the confluence with Big Chico Creek show that the 100-year return flood event has a flow rate of 285,000 cfs. This flow rate is projected to produce a floodplain elevation of approximately 136 feet. The existing flood control levee (left bank, rivermile [RM] 192.6) has a top elevation of approximately 140 feet.

The projected low-flow water surface elevation, 112 feet, corresponds to an average minimum flow of approximately 3,200 cfs at the proposed intake location. California
Department of Water Resources (DWR) gage data for Hamilton City (RM 199.2) and Ord Bend (RM 184.0) indicate that the flow in the Sacramento River was approximately 3,200 cfs in November 1994, when Charles Harris surveyed the water surface elevation at 112.6 feet.

Geomorphology

The site of the intake structure must be in an area of long-term stability in terms of riverbank erosion and channel migration. Discussions with California Department of Water geomorphologists Stacey Cepello and Koll Buer indicate that the best site for a river intake is the east bank of the Sacramento River immediately south of the mouth of Big Chico Creek. The riverbank in this section is formed by a flood control levee with a riprap surface. Channel migration to the west is possible but is considered unlikely because the site is at the downstream end of a long, straight section of river that has been stable throughout the period of recorded data. The influence of Big Chico Creek and the riprap levee will both tend to maintain the deepest part of the channel along the east bank.

Recent aerial photos, as well as one taken in the 1940s, show a large sand bar above the mouth of Big Chico Creek. This sand bar appears to be increasing in size and extending downstream. However, it is the opinion of the geomorphologists that the main channel flow and the flow from Big Chico Creek will prevent the sandbar from encroaching on the proposed intake site.

Geotechnical Review

Subsurface Conditions At Pump Station

As determined by site reconnaissance, discussions with Les Heringer of M&T Chico Ranch, and review of a boring log from a well located approximately 1,000 feet south of the pump station site, the soil profile consists of approximately 24 feet of silty topsoil underlain by 60 feet of gravel. The gravel is underlain by hardpan, cemented gravel, and alternating layers of gravel and hardpan with some sand to a depth of 665 feet. The subsurface conditions at the new pump station are probably similar to the profile described above, but the depth to the gravel layer may vary. No existing information is available on the permeability of the topsoil or shallow gravel layers.

Subsurface Conditions Along Discharge Pipeline

The soils along the pipeline consist of deep silt and sandy silt. The route is farmed annually, except for several drainage ditches which are typically 5 feet deep or less. On the basis of exposures of the soil in the Phelan Canal and nearby riverbanks, the soil is consistent with depth. It is possible that some braided subsurface drainage channels are present, but no evidence of these was observed. The pipeline will have to extend under the existing drainage channels to allow drainage from the fields to occur as it does now. Where the pipeline ends at the Phelan Canal, the soil is sandy silt.
Design and Construction Considerations

For a pump station located adjacent to the existing levee, the levee could be removed and the soil excavated down to near the groundwater level. The dewatering requirements will depend on the permeability of the soil surrounding the excavation. It is likely that significant quantities of water will enter excavations below the water table. This water can probably be controlled with either wells, sheet-piling, or bentonite clay slurry walls. These techniques have been used successfully at other pump stations along the river. After the excavation is completed, the pump station floor and walls will be constructed up to the water table. The excavation can then be backfilled and the top of the pump station completed.

An alternative construction method would be to excavate the levee and soil down to the river level and construct the pump station as a concrete caisson. This method involves placing a steel cutting ring on the ground and forming a concrete cylinder above the ground surface. The soil within the cylinder is excavated with a clamshell, and as the soil is removed the cylinder sinks. Some internal and external dewatering is required. When the cylinder has reached its desired elevation, the excavation is stopped and a floor slab is constructed, either underwater or by dewatering and placing the concrete in the dry. This method does not require any excavation below the water table.

From our experience in the Sacramento River, both sheet piles and H-piles can be driven to depths sufficient for vertical and horizontal support of pipes, debris deflectors, or other structures in the water. With appropriate permits it may be possible to construct a cofferdam a short distance out into the water to drive the piles and construct the intake. Work from a barge is also possible but expensive. It may be possible to install falsework from the shoreline to enable personnel to work over the water.

Power Source for Pump Station

The pump station should be located near existing power sources to minimize service charges and the cost for new utility lines. Discussions with PG&E indicate that both gas and electrical service are available near the proposed pump station location.

Pump Station Location and Conveyance System Alternatives

The following section presents three alternatives that take into consideration the major components of the system: the intake structure, pump station, and conveyance system.

Hydraulic analysis for the conveyance alternatives was performed by using a flow rate of 120 cfs. Each alternative was developed by assuming a minimum intake water surface elevation of 112 feet (low level in the Sacramento River) and a delivery point water
surface of 134 feet (Phelan Canal elevation). The alternatives all assume a straight-line route for the conveyance system, across open land from the Sacramento River to the head of the Phelan Canal, approximately 4,200 feet long. The conveyance system would include one road crossing at River Road.

**Alternative I**

Under Alternative I, the pump station would be located adjacent to the intake structure, immediately east of the existing flood control levee, as shown in Figure 1. Water would be conveyed from the pump station to the head of the Phelan Canal through a gravity pipeline from the pump discharge chamber. The pipeline would be approximately 4,200 feet long and installed with a minimum depth of cover of 3 to 5 feet. With a 66-inch-diameter pipeline, flow velocity would be 5.1 feet per second (fps) and pipe friction head loss would be 3.8 feet. The pump station’s required total dynamic head would be 27 feet.

This alternative meets all of the design criteria and site considerations discussed earlier, and is the recommended alternative. The long-term impact on the surrounding land would be minimal, and the land within the pipeline route would be returned to its original condition following construction. Because the pipeline would be installed at minimum depth and would follow the existing land contour, excavation costs and construction time would be kept to a minimum.

**Alternative II**

Under Alternative II, the pump station would be located away from the riverbank to improve access and reduce the risk of flood damage. Two sites were considered; one at River Road, approximately midway along the conveyance route; and a second at the head of the Phelan Canal. Water would be conveyed to the pump station from the intake structure via a gravity pipeline, and then pumped the remaining distance to the canal. With a 6-foot-diameter pipeline, a slope of 0.001 foot per foot (ft/ft) would be required. Depth below existing grade for the intake pipeline would average approximately 18 feet.

This alternative would have the same minimal long-term impact as Alternative I. However, the pipeline invert elevation and slope required to provide gravity flow from the river to the pump station site would result in excessive excavation depths along the entire length of the pipeline. Trench depth for installation would average approximately 23 feet.

**Alternative III**

Alternative III is similar to Alternative II, but an open channel canal would be used to convey water to the pump station from the river intake. With a 10-foot canal base width, 1.75 to 1 (horizontal to vertical) sideslope, and a bottom slope of 0.0001 ft/ft, the flow depth would be 5.3 feet. The depth of the canal invert below existing grade would average 20 feet. If the canal structure were designed to match the existing flood control levee height, the canal depth would increase to approximately 34 feet. The minimum top
width for the canal would exceed 80 feet. The canal would need to be siphoned beneath two existing sloughs along its route, or the sloughs would have to be siphoned beneath the canal.

This alternative is the least favorable. The canal would result in permanent loss of land for other uses along its route. It would bisect fields and interfere with existing drainage patterns. Assuming an unlined canal, the required cleaning and maintenance would add to the O&M costs. A canal would not be practical from a cost, constructability, or operations standpoint.

**Intake Structure and Fish Screens**

**Background**

The proposed location of the intake structure and fish screen facility is on the east bank of the flood control levee, approximately 800 feet downstream from the mouth of Big Chico Creek. A 66-inch-diameter pipe would be used to convey water from the fish screen, through the flood control levee, to the pump station.

Currently, two basic types of screen systems are suitable for this application: flat-plate screens and cylindrical screens. Both types satisfy existing regulations.

**Regulatory Issues**

Both state and federal regulations for screen performance will be applicable to the proposed screen system. Because there are multiple sets of criteria and standards, the most restrictive were used in evaluating proposed systems. The status (threatened or endangered) of potentially affected fish species, which affects the design of this system, is currently subject to change. Discussion with state and federal fisheries personnel indicate that existing State of California Department of Fish and Game (CDFG) screen requirements provide a good basis for the design of the screen system. Following is a summary of the CDFG guidelines:

- **Approach Velocity**—The allowable approach velocity is determined by the species of concern. Current standards are set at 0.33 fps for the spring-run Chinook salmon. Discussion with federal and state fishery personnel indicate that this value may change in the future, depending on the listing status of other fish species.

For screens that do not have an automatic cleaning system, the maximum design approach velocity is reduced to only 0.0825 fps, and the screens are required to be manually cleaned before the actual approach velocity reaches 0.33 fps.
• **Sweeping Velocity**—The velocity of flow past the screen, the sweeping velocity, shall be at least two times the allowable approach velocity. It is expected that any screen surface located directly in the flowstream of the Sacramento River will easily satisfy this criterion.

• **Structure Placement**—The screen face should be parallel to the riverflows and the bankline, at or below the annual low-flow water edge. The screen structure should be placed to prevent eddies in front, upstream, and downstream of the structure.

• **Screen Opening**—The screen surface must have 50 percent or greater effective open area. Slotted openings may not exceed 3/32 inch. Round or square (measured horizontally) openings shall not exceed 5/32 inch.

**Design Factors**

Most screen systems are a combination of "off-the-shelf" materials (screen, framing, and pipe manifolds) and custom fabrication, to allow each system to meet site-specific needs. The screens should have an automatic cleaning mechanism (air burst, water jets, and/or brushing) to remove debris, algae, and other blockages. The screens should be removable, with reasonable effort, for maintenance and/or inspection. The framing structure and screen material should be able to withstand anticipated impact by flood debris with little or no damage. The screens should be located to prevent or minimize silt accumulation within the intake piping, and should allow the maximum design flow rate with the minimum projected water surface elevation. The screen system’s framing and intake structure should be designed to minimize modifications to the existing levee structure and flow obstruction in the river channel.

**Screen Configuration Alternatives**

**Flat-Plate Screen Structure**

The support structure for a flat-plate screen system would have a rectangular box shape, forming an inlet chamber. One side of the box would consist of square panel screen sections mounted in a vertical support wall parallel to the levee and the riverflow, with the top mounting sill below the lowest expected water level of 112 feet. The screen panels would slide into channel-type supports, such as vertical H-beams. The structure would consist of a combination of sheet piling, H-beams, and/or reinforced concrete.

The structure would be approximately 14 feet high and 50 feet long. The upstream and downstream sidewalls would protrude approximately 30 feet out into the river at the low water level.

An automated cleaning system would remove debris from the screen panels. This system would use either water jets on a rotating wand or high-pressure air bursts to clean the screens. Both types of systems are available from screen manufacturers. Conventional
trash raking systems can also be modified to clean flat-plate fish screens. However, the large fluctuation in river levels would make it impractical to mount the necessary tracks, motors, and related equipment high enough to avoid submergence under high river levels.

A flat-plate screen system has several disadvantages given the site conditions and criteria for the proposed system. First, the large profile that the structure would present perpendicular to the riverflow would be expected to create significant eddies along the levee. This may be a concern from a flood control perspective because of the increased potential for erosion and scouring of the levee. When compared to other alternatives, construction for this structure would involve sheet-piling, dewatering, and excavation along a much larger area of the levee, as well as in the river. This would increase construction costs and time spent working in the river. Because the National Marine Fisheries Service (NMFS) will only permit work in the river from mid-May to mid-June, minimizing construction in the river is essential.

**Cylindrical Screen Structure**

This type of screen system would consist of cylindrical screen sections mounted to a single header. An illustration of this system is provided in Figure 2. A single 66-inch-diameter intake pipe would protrude into the river. The pipe would have mounting flanges for four cylindrical screens. Each screen section would be approximately 5 feet in diameter and 7 feet long.

The crowns of the screens would be located approximately 5 feet beneath the lowest expected water surface. Two pilings would bracket the manifold on the upstream and downstream sides, with a horizontal collar supporting the underside of the manifold. The manifold would protrude approximately 35 feet out from the levee surface. Three deflection pilings would be driven upstream of the screen structure to deflect flood debris.

An automated cleaning system would remove debris from the screen panels. The system would use either water jets on a rotating wand or high-pressure air bursts to clean the screens.

This arrangement would present a minimum profile to reduce eddies and dead-flow areas along the levee. Construction activity for the cylindrical intake system would involve significantly less excavation along the levee, minimizing required sheet-piling, dewatering, and overall time spent working in the river.

**Recommended Intake and Screen System**

Both the flat-plate and cylindrical-type screens could be designed to meet the applicable regulatory performance criteria. However, the cylindrical screen intake appears to be more adaptable to the particular site conditions. Overall construction cost, construction time in the river, and disruption of the existing levee structure all would be kept to a minimum with the cylindrical screen intake structure.
Pump Selection

Two alternative pumping systems were considered. Each system uses vertical turbine pumps, but they differ in that one uses electric-motor drives and the other uses gas-engine drives. Vertical turbine pumps appear to be the logical choice for this pumping system. An alternative would be the horizontal, split-case pumps similar to the existing units. Horizontal pumps would require individual suction pipes to the river intake, a vacuum priming system, piping above floor level, and considerably more floor area in the pump station. Vertical turbine pumps will take suction from a common sump, with water flowing to the sump through a single pipe from the river intake. Piping could be located below the ground floor level. The proposed pump station structure is shown in Figures 3 and 4.

Energy Source for the Pumps

PG&E was contacted to verify availability of electricity or natural gas service at the pump station site. It was determined that either energy source could be extended to the site at no cost to the owner. The applicable rate schedule for each energy source was furnished for a comparative cost analysis.

The estimated yearly energy requirements for pumping reflect the following pumping schedule:

<table>
<thead>
<tr>
<th>Month</th>
<th>Pumping Rate (cfs)</th>
<th>Acre-Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>30</td>
<td>1,810</td>
</tr>
<tr>
<td>February</td>
<td>30</td>
<td>1,810</td>
</tr>
<tr>
<td>March</td>
<td>55</td>
<td>3,318</td>
</tr>
<tr>
<td>April</td>
<td>137</td>
<td>8,265</td>
</tr>
<tr>
<td>May</td>
<td>150</td>
<td>9,050</td>
</tr>
<tr>
<td>June</td>
<td>150</td>
<td>9,050</td>
</tr>
<tr>
<td>July</td>
<td>150</td>
<td>9,050</td>
</tr>
<tr>
<td>August</td>
<td>150</td>
<td>9,050</td>
</tr>
<tr>
<td>September</td>
<td>150</td>
<td>9,050</td>
</tr>
<tr>
<td>October</td>
<td>131</td>
<td>7,903</td>
</tr>
<tr>
<td>November</td>
<td>69</td>
<td>4,163</td>
</tr>
<tr>
<td>December</td>
<td>61</td>
<td>3,680</td>
</tr>
<tr>
<td><strong>Total Acre-Feet</strong></td>
<td></td>
<td><strong>76,199</strong></td>
</tr>
</tbody>
</table>

The total annual energy requirements and associated costs were calculated as follows:

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>Energy</th>
<th>Cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas</td>
<td>300,000 therms</td>
<td>66,000</td>
</tr>
<tr>
<td>Electricity</td>
<td>2,600,000 kWh</td>
<td>170,000</td>
</tr>
</tbody>
</table>

The use of natural gas-engine drives will add to maintenance costs of the pump station when compared to the use of electric-motor drives. This cost was estimated at a rate of $0.015 cfs per horsepower-hour, to cover oil changes, routine service, and overhauls. The total estimated maintenance cost is $50,000 per year.
Electric-Drive Pumps

The number and size of fixed-speed electric-drive pumps would be selected to provide a total of 120 cfs in 15-cfs increments. A 15-cfs pump would be cycled to meet system demand. A storage pond in the system would equalize the system demand with the pumping operation. Adjustable-speed electric drives are not considered appropriate for the application.

The pumps would be selected as follows:

- Two 15-cfs units, 75 horsepower (hp), 900 rpm = 30 cfs
- Three 30-cfs units, 150 hp, 720 rpm = 90 cfs
  Total = 120 cfs
- Total connected horsepower = 600

Engine-Drive Pumps

Engine-drive pumps have an advantage in that speed adjustment is possible, allowing regulation of pumping rate without pump cycling. The number and size of pumps would be selected to provide a total of 120 cfs with equally sized units capable of being regulated down to 15 cfs. The storage pond in the system would still be used, but instead of regularly starting and stopping a pump, the running speed would occasionally be changed.

The pumps would be selected as follows:

- Three 40-cfs units, 200 hp, 720 rpm = 120 cfs.
- Pumps with natural gas-driven motors at 900 to 1400 rpm through right-angle, speed-reducing gear heads.
- Each unit would have an adjustable pumping rate of 15 to 40 cfs.

Cost Comparison

The estimated cost of the pump station with engine-drive pumps is approximately $50,000 greater than that with electric-drive pumps. The engine drives are more expensive than electric drives, but fewer engine-driven pumps are required. The building must be slightly larger to provide the space necessary for the engine drives and their servicing requirements. This difference in capital cost would be offset by the lower yearly costs of using natural gas as the energy source. Referring to the figures developed previously for the cost of energy, the difference between gas and electricity is as follows:

\[ \$170,000 - (\$66,000 + \$50,000) = \$54,000 \] per year more for electricity

The difference in capital cost would be paid for by the annual cost savings within 1 year.
Summary Description of Recommended System

The following section summarizes the type and location of the recommended system and is based on the previously discussed evaluations of the system's major components. The intake structure and fish screens will be located on the Sacramento River's east bank flood control levee, approximately 800 feet south of Big Chico Creek's outlet.

Water from the river will be drawn in through a cylindrical-type screen manifold with four 60-inch, 7-foot-long screen sections. The screens will have an integrated, automatic cleaning system using either water jets or high-pressure air. A single 66-inch-diameter pipe will convey water by gravity flow into the pump station sump area.

The pump station will be located on the land side of the flood control levee, at or near the top of the levee. The pump station housing will contain the pumps, electrical controls, and any auxiliary equipment for the screen cleaning system. The pumps will be selected as follows:

- Three 40-cfs units (total 120 cfs capacity), 200 hp, 720 rpm.
- Pumps with natural gas-driven engines at 900 to 1400 rpm through right-angle, speed-reducing gear heads.
- Each pump would have an adjustable pumping rate of 15 to 40 cfs.

From the pump discharge chamber, the water will be conveyed through a single 66-inch gravity pipeline to the north end of the Phelan Canal. The pipeline will be routed directly to the Phelan Canal across open land owned by M&T Ranch, with one road crossing at River Road. The pipeline will be installed at a minimum depth of cover of 3 feet. A concrete outlet structure will be built where the pipeline enters the Phelan Canal to dissipate energy from the incoming water and prevent erosion of the canal banks.

Cost Opinion

The cost opinion for the previously described system was prepared without detailed engineering data. It was based on cost curves, phone contact with component vendors, and preliminary estimated quantities of major system components. This type of estimate is referred to by the American Association of Cost Engineers as an order-of-magnitude estimate. It is normally expected that an estimate of this type would be accurate to within +50 percent to -30 percent.

The cost estimates shown here have been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project and resulting feasibility will depend on the actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, and other variable factors. As a result, the final project costs will vary from the estimates presented here. The project feasibility, benefit cost ratios, risks, and funding
needs must be carefully reviewed prior to making specific financial decisions or establishing project budgets to help ensure proper evaluation and adequate funding.

O&M costs (excluding power costs) were developed on the basis of a percentage of the facility capital costs as follows:

1. Fish screen and cleaning system—1 percent of capital cost
2. Pump station and intake pipe—1 percent of capital cost plus annual power cost
3. Sixty-six-inch pipeline—0.5 percent of capital cost
4. Outlet Structure—1 percent of capital cost

Table 1 contains a cost summary for the proposed facility.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Unit</th>
<th>Unit Cost ($)</th>
<th>Quantity</th>
<th>Construction Cost ($)</th>
<th>Annual O&amp;M Cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fish Screen and Cleaning System</td>
<td>LS</td>
<td>460,000</td>
<td>1</td>
<td>460,000</td>
<td>5,000</td>
</tr>
<tr>
<td>2</td>
<td>Pump Station and Intake Pipe</td>
<td>LS</td>
<td>1,410,000</td>
<td>1</td>
<td>1,410,000</td>
<td>100,000</td>
</tr>
<tr>
<td>3</td>
<td>66-inch Pipeline</td>
<td>LF</td>
<td>225</td>
<td>4,200</td>
<td>950,000</td>
<td>5,000</td>
</tr>
<tr>
<td>4</td>
<td>Outlet Structure</td>
<td>LS</td>
<td>40,000</td>
<td>1</td>
<td>40,000</td>
<td></td>
</tr>
<tr>
<td>Subtotal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2,860,000</td>
<td>110,000</td>
</tr>
<tr>
<td>Allowance for undefined items</td>
<td></td>
<td></td>
<td></td>
<td>400,000</td>
<td></td>
<td></td>
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<tr>
<td>Construction Cost</td>
<td></td>
<td></td>
<td></td>
<td>3,260,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engineering, Administration, and Legal Fees (15 percent)</td>
<td></td>
<td></td>
<td></td>
<td>490,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Capital Cost</td>
<td></td>
<td></td>
<td></td>
<td>3,750,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Annual O&amp;M</td>
<td></td>
<td></td>
<td></td>
<td>110,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The cost estimate for the 120-cfs system was also used as a basis for cost estimates for 90-cfs and 200-cfs installations. Pipe diameters, number of pumps, building areas, etc., were modified as necessary for each of the two additional sizes. Estimates were prepared by using ratios between the 120-cfs system and the other systems. The three costs were plotted on a graph to compare capital cost with the flow rate. The results are shown in Figure 5. This figure allows simple approximation of capital costs for pumping systems of any size between 90 cf/s and 200 cf/s.
FIGURE 5
M & T CHICO RANCH
SACRAMENTO RIVER PUMP STATION
Environmental Compliance and Regulatory Permits

Numerous local, state, and federal agencies have regulatory jurisdiction over the proposed pump station and intake structure. Initial contact was made with most of these agencies to discuss their regulatory responsibilities and typical concerns. The following section lists the agency names and their permitting and/or review procedures.

In general, the permitting issues involved are biological impact on threatened or endangered species; modification of flood control structures; dredging or fill operations in a navigable waterway; water quality impacts from construction activities; right-of-way for building on state lands; and conformance to applicable building codes.

Each of the state and federal agencies contacted stressed the importance of regular contact with key personnel at the agencies and coordinated review of plans as early as possible. For example, three different agencies will need to review and approve the fish screening facility for the new intake structure. Having the appropriate representatives from each of the agencies together for a single review meeting may reduce the chance of delay and redundant review.

Because the project will require a discretionary permit and may generate significant impacts within the State of California, the proposed action must comply with the California Environmental Quality Act (CEQA). Proposed funding of the project by the U.S. Bureau of Reclamation (Reclamation) will also require compliance with the National Environmental Policy Act (NEPA). On the basis of preliminary information available on the project, the proposed action might be processed as a categorical exclusion (NEPA)/exemption (CEQA), or an environmental assessment (NEPA)/initial study (CEQA) may be required. A determination that potentially significant impacts could not be mitigated to a less than significant level would necessitate the preparation of an Environmental Impact Statement (EIS) and Report (EIR). Potential lead agencies for this effort would be Reclamation or the Corps of Engineers (NEPA) and the California State Reclamation Board (CEQA).

U.S. Army Corps of Engineers—The U.S. Army Corps of Engineers (Corps) has responsibility under the River and Harbors Act (Section 10) and the Clean Water Act (Section 404) for approving any project that is within a navigable waterway and/or involves dredging or fill operations in same. The permit issued by the Corps is commonly referred to as a "404" permit, in reference to its regulatory section. The Corps will typically issue one permit to cover both the Section 404 and the Section 10 issues of the project.

The Corps' approval is granted under a nationwide, regional, or individual permit, depending on the nature of the project. Nationwide and regional permits approve common projects of a nature and extent which the Corps has already reviewed and approved. They are generally preferable to an individual permit, as they involve a faster and less extensive review process. Projects similar to the proposed pump station relocation have been approved under existing regional permits. However, further consultation with the Corps
regarding the specifics of this project needs to occur to determine if this project can proceed under a regional permit, or if an individual permit will be required.

**U.S. Fish and Wildlife Service**—The U.S. Fish and Wildlife Service (USFWS) does not directly issue a separate permit. Instead, the lead federal agency on the project (potentially Reclamation or the Corps) would submit the project plans to USFWS for review if the likelihood exist that an endangered or threatened species under the jurisdiction of the USFWS may be affected. If such a species is determined to be potentially affected, the USFWS will review the project for compliance with Section 7 of the Endangered Species Act. Recommendations could include design modifications, construction scheduling, mitigation measures, or other changes necessary to address the biological impact of the project. The USFWS will also comment on impacts to species under their jurisdiction through the Corps’ interagency Section 404 consultation process, in addition to the NEPA process.

**National Marine Fisheries Service**—NMFS’s role is similar to that of USFWS, with NMFS’s primary concern being the biological impact on endangered or threatened anadromous fish species. The NMFS will be consulted by the lead federal agency, and will amend the permit conditions to include recommendations for design modifications, construction scheduling, mitigation measures, or other changes necessary to address the biological impacts of the project.

The NMFS also recommends time periods within which construction activity should take place to minimize impacts on anadromous fish species. This "construction window" varies for different river areas, depending on the fish species present there. The **construction window for rivermile 193 (RM 193) is mid-May to mid-June.** NMFS personnel strongly recommend adherence to this construction window as much as possible. Construction activity in this time frame will generally require much stricter controls and mitigation measures.

**California Department of Fish and Game**—CDFG will have primary responsibility at the state level for reviewing possible biological impacts of the project. CDFG will list its requirements through a Proposed Stream or Lake Alteration agreement. CDFG will list any monitoring, mitigation, or other conditions that the project must comply with.

Similar to USFWS, CDFG maintains the State responsibility under CEQA and through the Corps’ 404 process to comment on potential impacts to special-status species. The CDFG is also responsible for project compliance with the California Endangered Species Act, and must be consulted if impacts to state-listed endangered species are determined to be likely to occur.

**California State Reclamation Board**—The State Reclamation Board must approve any work that takes place in waterways within or adjacent to federal or state flood control structures. The Board will review the project for its possible impact on flood control. Requirements for construction scheduling, design modifications, and any other conditions will be detailed in the encroachment permit issued by the Reclamation Board. The
Reclamation Board does not allow any construction activity in the Sacramento River during the flood season from November 1 to April 15.

California State Lands Commission—The California State Lands Commission has state jurisdiction over the beds of navigable waterways such as the Sacramento River. A land use lease must be obtained from the Commission for any project that encroaches on such land. It is likely that the final design of this project will involve some encroachment on the bed of the Sacramento River.

Review of a recent similar project on the Sacramento River for Pelger Mutual Water Company (RM 111.72) indicates that no permit or lease from the State Lands Commission was required because the project was approved under permit from the Reclamation Board and the Corps of Engineers.

Regional Water Quality Control Board—The Regional Water Quality Control Board (the Board) will review the project for any water quality impacts that may occur during construction. The Board will issue a water quality certification following its review through the Corps’ 404 process, or it will waive this certification provided the project owner complies with the Board’s conditions for construction and/or water quality monitoring.

Board approval, typically through a waiver, will be required even if the Corps determines the activity qualifies for a nationwide permit. If it is determined that more than 5 acres of surface area will be disturbed (e.g., through installation of the pipeline), a General Construction Activity Storm Water Permit would be required.

Butte County Building Department—The Butte County Building Department may need to approve portions of the project, such as a pump housing structure. The need for County review will depend on the final design and further discussion with the County Building Department regarding application of County code to a project of this type.