

# RECLAMATION

*Managing Water in the West*

## **Appraisal Assessment of the Black Rock Alternative Delivery System for Roza, Terrace Heights, Selah-Moxee, and Union Gap Irrigation Districts**

A component of  
Yakima River Basin Water Storage Feasibility Study, Washington

Technical Series No. TS-YSS-3

Black Rock Valley



U.S. Department of the Interior  
Bureau of Reclamation  
Pacific Northwest Region

December 2004

*The mission of the Department of the Interior* is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to island communities.

*The mission of the Bureau of Reclamation* is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

**Yakima River Basin Water Storage Feasibility Study,  
Washington**

**APPRAISAL ASSESSMENT OF  
BLACK ROCK ALTERNATIVE DELIVERY SYSTEM FOR  
ROZA, TERRACE HEIGHTS, SELAH-MOXEE, AND  
UNION GAP IRRIGATION DISTRICTS**

**December 2004**

**Prepared by  
U.S. Department of the Interior  
Bureau of Reclamation  
Pacific Northwest Region**

## Glossary and Acronyms

Black Rock outlet facility	a potential facility to divert water at the downstream end of the outflow conveyance system into potential or existing Roza and Sunnyside Divisions' delivery systems; this facility would include a bifurcation works and a Black Rock powerplant
Black Rock powerplant	a potential powerplant near Roza Canal MP 22.6 at the potential Black Rock outlet facility
cfs	flow rate in cubic feet per second
delivery systems	the potential canal, pipeline, or tunnel systems that would deliver water from the potential Black Rock outlet facility to the existing or modified Roza and Sunnyside Divisions' canal systems for delivery to Yakima Project lands
Facilities Report	the <i>Appraisal Assessment of the Black Rock Alternative Facilities and Field Cost Estimates Technical Services No. TS-YSS-4 December 2004</i> ; prepared by Reclamation's Denver Technical Service Center
hydraulic grade line	the surface or profile of water flowing out of hydraulic gradient; the slope of the hydraulic grade line is under pressure; the hydraulic grade line is the actual level to which water would rise in a small vertical tube connected to the pipe
hydraulic gradient	the slope of the surface of open or underground water
kW, kWh	kilowatt, kilowatt-hour
MP	mile post – refers to locations on the Roza Canal with MP 0.0 being at Roza Diversion Dam
MW, MWh	megawatt, megawatt-hour
outflow conveyance	the potential system and facilities that would release water stored in a Black Rock reservoir and convey it to a downstream Black Rock outlet facility
PRV	pressure relief valve
Reclamation	Bureau of Reclamation of the U.S. Department of the Interior,
RM	river mile – refers to locations on either the Yakima River or the Columbia River
Roza Division	a division of the Yakima Project comprised of Roza Irrigation District
Roza Powerplant	the existing powerplant located at Roza Canal MP 11
Roza-Selah lands	those irrigated lands upstream from the inlet of Roza Canal Tunnel No. 3
SH	State Highway
storage facilities	a potential Black Rock dam and related facilities that would impound in a Black Rock reservoir the Columbia River water received via an inflow conveyance system
Storage Study	<i>Yakima River Basin Water Storage Feasibility Study</i> ; a multi-year evaluation of the viability and acceptability of several storage augmentation alternatives, including potential water exchange and storage augmentation for the benefit of fish, irrigation, and municipal water supply within the Yakima River basin
Sunnyside Division	a division of the Yakima Project, comprised of Sunnyside Valley Irrigation District and eight other irrigation districts, companies, and cities
Sunnyside Canal powerplant	a potential new powerplant at Sunnyside Canal MP 3.83

## PREFACE

The Congress directed the Secretary of the Interior, acting through the Bureau of Reclamation (Reclamation), to conduct a feasibility study of options for additional water storage for the Yakima River basin, Washington. Section 214 of the Act of February 20, 2003 (Public Law 108-7) contains this authorization and includes the provision "... with emphasis on the feasibility of storage of Columbia River water in the potential Black Rock Reservoir and the benefit of additional storage to endangered and threatened fish, irrigated agriculture, and municipal water supply."

Reclamation initiated the *Yakima River Basin Water Storage Feasibility Study* (Storage Study) in May 2003. As guided by the authorization, the purposes of the Storage Study are to identify and examine the viability and acceptability of alternate projects by: (1) diversion of Columbia River water to the potential Black Rock reservoir for further water transfer to irrigation entities in the lower Yakima River basin as an exchange supply, thereby reducing irrigation demand on Yakima River water and improving Yakima Project stored water supplies, and (2) creation of additional storage within the Yakima River basin. In considering the benefits to be achieved, study objectives will be to modify Yakima Project flow management operations to most closely mimic the historic flow regime of a Yakima River system for fisheries, provide a more reliable supply for existing proratable water users, and provide additional supplies for future municipal demands.

State support for the Storage Study was provided in the 2003 Legislative session. The capital budget included a \$4 million appropriation for the Department of Ecology (Ecology) with the provision the funds "... are provided solely for expenditure under a contract between the Department of Ecology and the United States Bureau of Reclamation for the development of plans, engineering, and financing reports and other preconstruction activities associated with the development of water storage projects in the Yakima river basin, consistent with the Yakima river basin water enhancement project, P.L. 103-434. The initial water storage feasibility study shall be for the Black Rock reservoir project."

Reclamation's Upper Columbia Area Office in Yakima, Washington, is managing and directing the Storage Study. Pursuant to the legislative directives, Reclamation has placed initial emphasis on Black Rock alternative study activities. These study activities are collectively referred to as the Black Rock Alternative Assessment (Assessment).

The Assessment has three primary objectives. First, it provides the emphasis directed by Federal and State legislation. Second, it builds upon prior work and studies to provide more information on the configuration and field construction cost of the primary components of a Black Rock alternative; it examines legal and institutional considerations of water supply and use, and identifies areas where further study is needed. Third, it is a step forward in identifying the viability of a Black Rock alternative.

This technical document, prepared by Reclamation's Pacific Northwest Construction Office in Yakima, is one of a series of documents prepared under the Storage Study. This particular document is a component of the Assessment reporting on preliminary appraisal-level engineering evaluation of designs and cost estimates of a potential Black Rock delivery system for the Roza Division of the

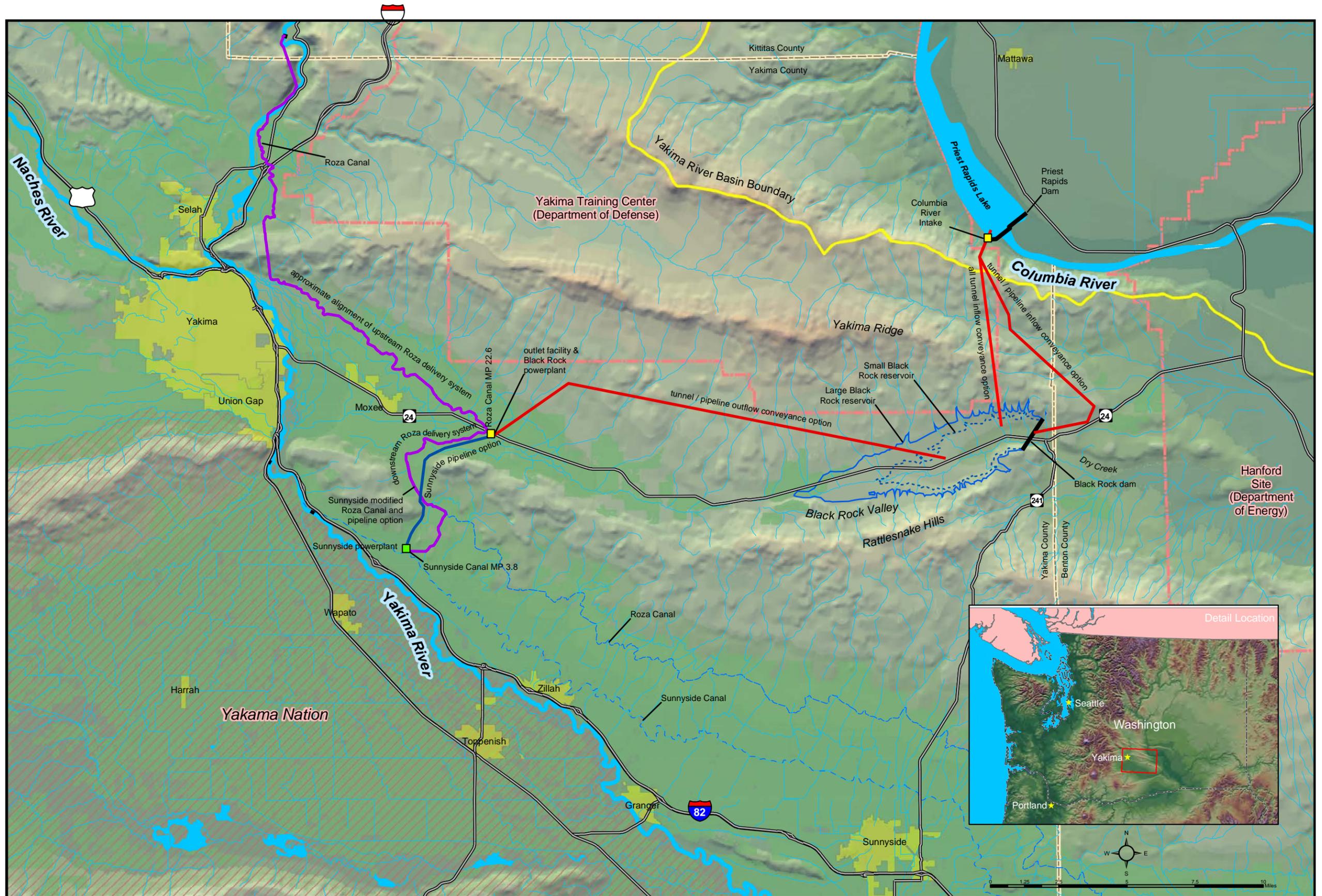
Yakima Project. Information and findings of this technical document are included in the Assessment Summary Report.

## **FURTHER CONSULTATIONS**

The information available at this time is necessarily preliminary, has been developed only to an appraisal level of detail, and is therefore subject to change if this alternative is investigated further in the course of the Yakima River Basin Storage Feasibility Study (Storage Study). Finally, economic, financial, environmental, cultural, and social evaluations of the Black Rock alternative have not yet been conducted.

The policy of Reclamation requires non-Federal parties to share the costs of financing feasibility studies and the eventual construction of Federal reclamation projects. In light of this policy, the preliminary cost estimates presented in the Assessment Summary Report, and current Federal budgetary constraints, Reclamation is not reaching a decision at this time as to whether the Black Rock alternative will be carried forward into the next phase of the Storage Study or dropped from further consideration. Rather, Reclamation will consult with the State of Washington (which is cost sharing in the Storage Study), the Yakama Nation, the potential water exchange participants, project proponents, and other interested parties before making a decision in this regard. It is anticipated that a decision will be reached by the fall of 2005.

If the Congress provides further funding for the Storage Study, all technically viable alternatives would be compared and an alternative(s) selected for further analyses in the feasibility phase. (Whether the Columbia River-Yakima River water exchange concept in the form of the Black Rock alternative is included will depend upon whether Reclamation, after these additional consultations, decides to carry that alternative forward into the plan formulation phase of the Storage Study.) The selected alternative(s) would then be subject to detailed evaluation in the feasibility phase in terms of engineering, economic, and environmental considerations, and cultural and social acceptability. This feasibility phase would be the last phase of the Storage Study. Preparation of the Feasibility Report/Environmental Impact Statement would be a part of this final phase.



Preface Figure 1. Location Map and Black Rock Alternative Facilities Options

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# 1. INTRODUCTION

A primary consideration as to the viability of a Columbia River water importation alternative is whether existing irrigation water users are so situated and willing to receive Columbia River water in lieu of diverting from the Yakima River. The amount or extent of exchange water that could be secured from willing participants in the lower Yakima Valley is critical in addressing the viability of the Black Rock alternative. Consequently, initial study activities involve:

- Identifying irrigation entities that may be willing to exchange water.
- Determining the amount of a water exchange.

These points are necessary to determine the quantity of imported water that could be exchanged and the configuration of the Black Rock alternative facilities necessary to transport such water from the Columbia River to potential exchange participants. This process requires the development of preliminary appraisal-level plans of how to deliver exchange water to their existing systems and the estimated costs of such systems.

The following irrigation entities have been identified as potential water exchange participants: Roza Division (Roza Irrigation District) and Terrace Heights, Selah Moxee, and Union Gap Irrigation Districts; and the Sunnyside Division (Sunnyside Valley Irrigation District and eight other irrigation districts, companies, and cities that comprise this divisions). These entities have expressed their willingness to explore water exchange possibilities. No agreements have been made or negotiated for these entities to make the water exchange.

Potential delivery system alternatives for Roza, Terrace Heights, Selah-Moxee I.D. and Union Gap Irrigation Districts are discussed in this report. In order to understand how the systems may be altered to deliver Columbia River exchanged water, this report will address their existing systems and then discuss possible water delivery plans. The delivery system for the Sunnyside Division is discussed in the report *Appraisal Assessment of the Black Rock Alternative Delivery System for Sunnyside Division, Technical Series No. TS-YSS-4, December 2004*.

## 1.1 EXISTING SYSTEMS OF POTENTIAL WATER EXCHANGE PARTICIPANTS

Figure 1-1 shows the location of the main canals of the potential water exchange participants and the relationship to the Black Rock alternative water supply. A description of the existing main delivery systems of these potential water exchange participants follows.

### 1.1.1 Roza Irrigation District and Terrace Heights Irrigation District

The Roza Irrigation District (Roza I.D.) service area is comparable with the Roza Division of the Yakima Project. The division was authorized in 1935 by the President for construction by the Bureau of Reclamation (Reclamation); the first lands were served in 1941.

Roza I.D. provides irrigation water service to about 72,000 acres of land. These lands lie along the northeast (left) side of the Yakima River. The service area is about 65 miles long and up to 3 miles in width. The Roza Canal is the main conveyance facility. Its headworks is located at Yakima River

mile (RM) 127.9, about 11 miles upstream from the confluence of the Naches River. The canal is about 95 miles long and the terminus is in the vicinity of Benton City in the Lower Yakima Valley.

Up to 2,200 cfs can be diverted at the canal's headworks for irrigation and hydroelectric generation. The first 11 miles of the Roza Canal includes a concrete siphon under the Yakima River and a concrete tunnel through the Yakima Ridge. At Roza Canal mile post (MP) 11.0, just below the outlet of Yakima Ridge Tunnel No. 3, about 1,020 cfs can be diverted (bifurcated) to the Roza Power Plant for hydroelectric generation. This power flow passes through the Roza Power Plant and re-enters the Yakima River through Wasteway No. 2 at RM 113.3.

Power generated at Roza Power Plant is credited to Roza I.D. to offset power used by its pumping plants. Excess energy is marketed by the Bonneville Power Administration (BPA). Irrigation water is diverted only during the irrigation season. Power water can be diverted year round except during periods of icing and when the operation of the power plant is subordinated for fish by leaving water instream in the Yakima River bypass reach (RM 127.9 to RM 113.3).

Upstream from Tunnel No. 3 inlet (MP 8.8), Roza I.D. delivers about 40 cfs for irrigation service to the area identified as "Roza-Selah Lands." Lands above the canal are served by Pumping Plant No. 1 (MP 7.2). Gravity service is provided to lands below the canal.

Below the bifurcation works, the canal's carrying capacity is reduced to about 1,100 cfs. Lands between this point and the Roza Canal's intersection with State Highway 24 (MP 22.6) require about 175 cfs for irrigation service. In this 11-mile section there are three pumping stations: Terrace Heights Pumping Plant (MP 13.0) which serves the Terrace Heights Irrigation District (Terrace Heights I.D.) pursuant to an agreement with Roza I.D.; and Roza I.D. Pumping Plants No. 2 (MP 16.8) and No. 3 (MP 22.5). Gravity service is provided to down slope Roza I.D. lands.

Below Highway 24 (MP 22.6), Roza I.D. requires approximately 885 cfs for irrigation service. Lands above the Roza Canal are served by an additional 15 pumping plants; lands below the canal receive gravity service. In total, Roza pump lands comprise about 27,000 of the 72,000 acres.

Reclamation and Roza I.D. jointly maintain the first 11 miles of the canal and the diversion dam; operation is Reclamation's responsibility. Roza I.D. is responsible for all operation and maintenance (O&M) of the pumping plants and laterals upstream from Roza Canal MP 11.0, and all facilities downstream.

### **1.1.2 Selah-Moxee Irrigation District**

The Selah-Moxee Irrigation District (Selah-Moxee I.D.) diverts water from the Yakima River into the Selah-Moxee Canal at RM 23.6, near Pomona. The canal runs parallel to and downhill from the Roza Canal, tunnels through the Yakima Ridge, and ends in the southeast side of the Moxee Valley. Selah-Moxee I.D. serves irrigation water to about 5,800 acres. In 1997, the Moxee Ditch Company and the Moxee-Hubbard Irrigation Company, with a total service area of about 2,000 acres, merged into the Selah-Moxee I.D. Those two entities receive water via a pipe drop structure downstream of Selah-Moxee Yakima Ridge Tunnel or from pumps located in the Roza Power Plant Wasteway; these facilities are operated by Selah-Moxee. I.D. Moxee Ditch and the Moxee-Hubbard Canal run parallel and down slope of the Roza and Selah-Moxee Canals, ending in the Moxee Valley.

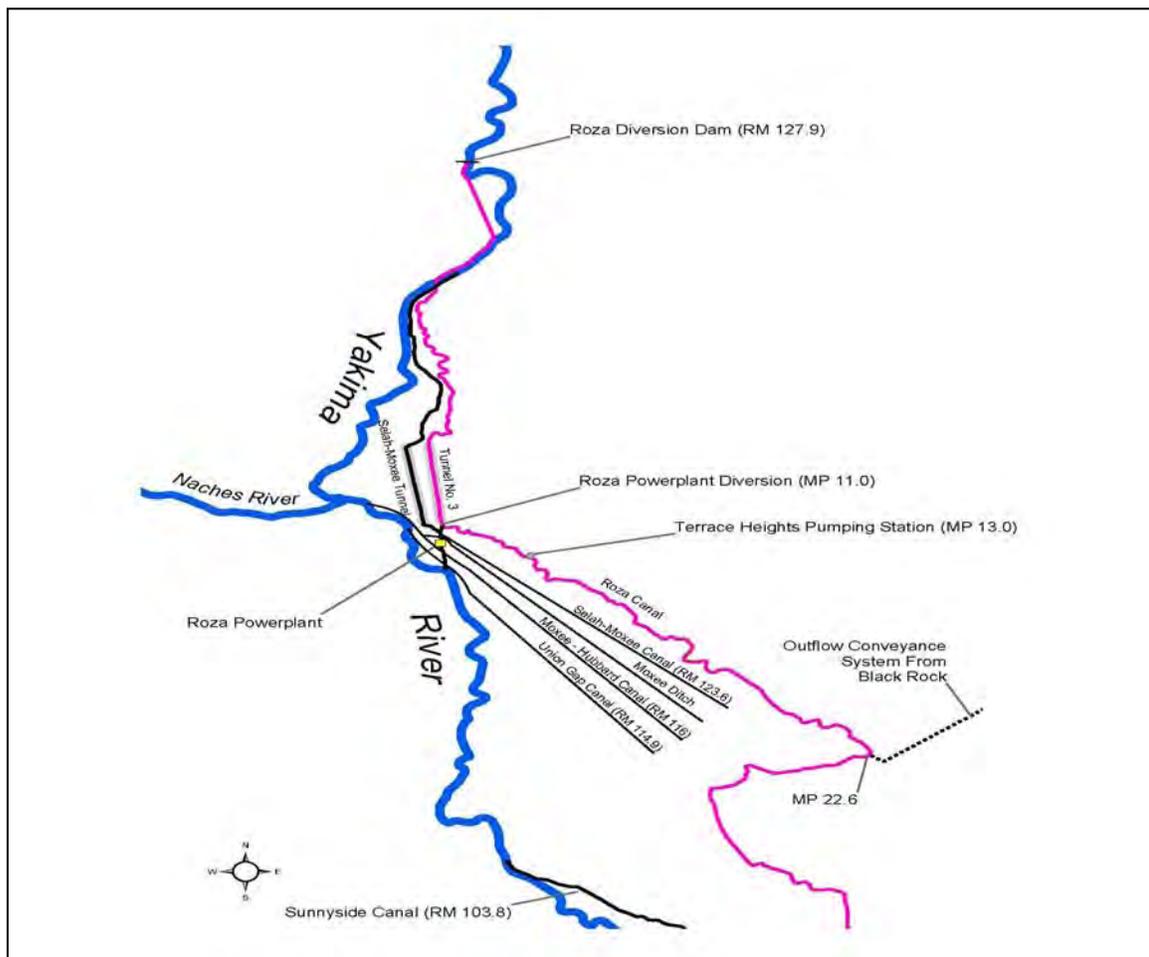
Water delivery requirements of Selah-Moxee I.D. above their Yakima Ridge tunnel is 20 cfs; delivery required below the tunnel, including the merged areas, is 80 cfs.

### 1.1.3 Union Gap Irrigation District

Union Gap Irrigation District (I.D.) diverts from the Yakima River into the Union Gap Canal at RM 114.9. The canal runs through the Moxee Valley parallel to and downslope from the canals described above. It continues in pipeline and flume through the Union Gap. At a point above the Sunnyside Diversion Dam, it continues in a canal parallel and upslope of the Sunnyside Canal. Approximately 1,700 acres are served in the Moxee Valley, mostly between the canal and the Yakima River. Another 2,950 acres are served in the lower Yakima Valley, mostly between the Union Gap Canal and the Sunnyside Canal, before ending north of Zillah. Irrigation facilities are operated by Union Gap I.D.

The irrigation water delivery requirement is 70 cfs.

**Figure 1–1. Schematic drawing of potential water exchange participant’s existing irrigation systems, diversion points (in parenthesis), and connection to the Black Rock alternative.**



## 2. WATER DELIVERY SYSTEM PLANS

Columbia River water pumped to a potential Black Rock reservoir would be released into an outflow conveyance system transporting the water west to the Roza Canal (at MP 22.6) and State Highway 24 intersection. The potential Black Rock outlet facility would be on the southeast corner of Roza Canal. The facility would include a Black Rock powerplant, a bypass structure to permit water deliveries when the unit was off-line or to pass flows in excess of powerplant design flows, a flowmeter, and manifold piping and valving for pressure pipe diversions to Roza and Sunnyside Divisions.

The potential Black Rock outlet facility is described in the report, *Appraisal Assessment of the Black Rock Alternative Facilities and Field Cost Estimates, Technical Series No. TS-TSS-2* (December 2004). This document noted that the configuration of the Black Rock powerplant would depend on the type of system selected to deliver water to the potential exchange participants (including Sunnyside Division). At this time, two powerplant configurations were developed: one with a turbine design flow of 1,500 cfs and output of 38 MW and the other with a turbine design of 900 cfs and an output of 23 MW.

The service areas of the four potential water exchange participants addressed in this report are shown on Figure 2-1. These service areas in relation to Roza Canal MP 22.6 are:

- Roza I.D. – both upstream and downstream with the majority of its service being downstream
- Terrace Heights I.D. – upstream from the Roza Canal at MP 13.0
- Selah-Moxee I.D. – upstream
- Union Gap I.D. – downstream

The proposed point-of-delivery of Columbia River exchange water to Selah-Moxee I.D. and Union Gap I.D. is near Roza Canal MP 11.7. This is where the exiting delivery canals of these two irrigation districts are in close proximity to the Roza Canal.

With a Black Rock alternative, Columbia River water available at Roza Canal MP 22.6 could replace a major portion of Roza I.D.'s current Yakima River irrigation diversions to meet downstream demands. This exchange water could continue to be delivered to downstream Roza I.D. lands by the Roza Canal with no need for new delivery facilities. However, delivery of exchange water to upstream Roza I.D. lands and to the Terrace Heights, Selah-Moxee, and Union Gap Irrigation Districts would require new delivery facilities and modifications to existing facilities.

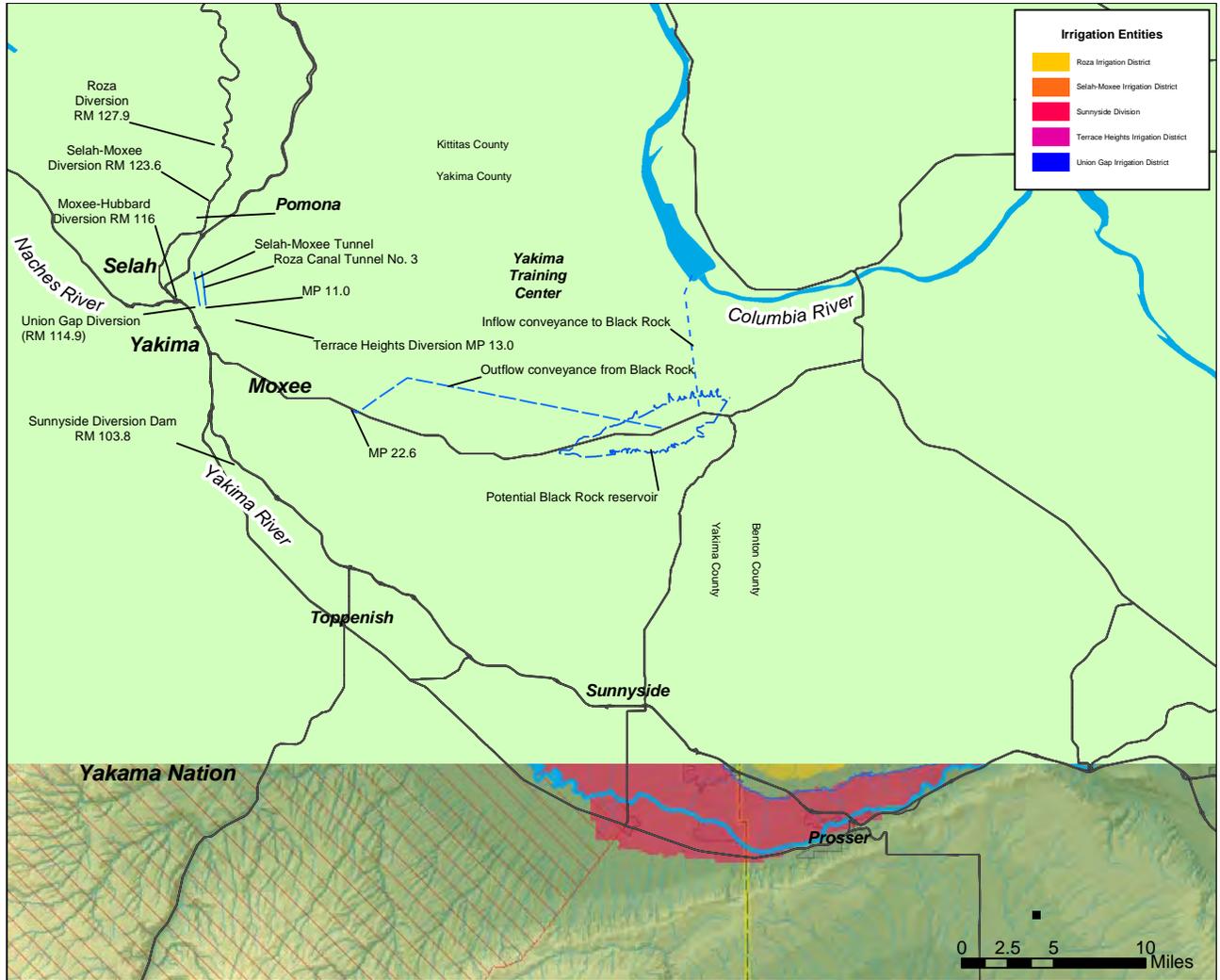
### 2.1 APPRAISAL-LEVEL PLANS

Six appraisal-level plans have been developed for the potential delivery of Columbia River exchange water from Roza Canal MP 22.6 upstream to Roza, Terrace Heights, Selah-Moxee, and Union Gap Irrigation Districts. Plans 1, 2, 3, and 4 would involve construction of a mainline delivery system extending from the Black Rock outlet facility. Plan 5 would involve installation of checks and pumps in Roza Canal to reverse the flow. Plan 6 would require no new construction.

The water delivery plans developed to date could result in a Columbia River irrigation water exchange of up to 1,210 cfs; the current Yakima River supply is 1,270 cfs. Table 2-1 summarizes the irrigation requirements of these four potential exchange participants upstream and downstream from Roza Canal MP 22.6 and identifies possible water supply sources for each plan.

<b>Table 2-1. Preliminary irrigation requirements in CFS based on six appraisal-level water delivery plans</b>						
<b>UPSTREAM FROM ROZA CANAL MP 22.6</b>						
	<b>Plan 1</b>	<b>Plan 2</b>	<b>Plan 3</b>	<b>Plan 4</b>	<b>Plan 5</b>	<b>Plan 6</b>
<b>Irrigation Requirements</b>	385	385	385	385	385	385
<b>Potential Columbia River Supply</b>						
Roza I.D. and Terrace Heights I.D.	215	175	175	175	175	35
Selah-Moxee I.D.	—	—	—	80	80	—
Union Gap I.D.	—	—	—	70	70	—
<i>Total Columbia River Supply</i>	<i>215</i>	<i>175</i>	<i>175</i>	<i>325</i>	<i>325</i>	<i>35</i>
<b>Continued Yakima River Supply</b>						
Roza I.D. and Terrace Heights I.D.	—	40	40	40	40	180
Selah-Moxee I.D.	100	100	100	20	20	100
Union Gap I.D.	70	70	70	—	—	70
<i>Total Continued Yakima River Supply</i>	<i>170</i>	<i>210</i>	<i>210</i>	<i>60</i>	<i>60</i>	<i>350</i>
<b>Total Upstream from MP 22.6</b>	<b>385</b>	<b>385</b>	<b>385</b>	<b>385</b>	<b>385</b>	<b>385</b>
<b>DOWNSTREAM FROM ROZA CANAL MP 22.6</b>						
	<b>Plan 1</b>	<b>Plan 2</b>	<b>Plan 3</b>	<b>Plan 4</b>	<b>Plan 5</b>	<b>Plan 6</b>
<b>Irrigation Requirements</b>	885	885	885	885	885	855
<b>Potential Columbia River Supply</b>						
Roza I.D.	885	885	885	885	885	855
<i>Total Potential Columbia River Supply</i>	<i>885</i>	<i>885</i>	<i>885</i>	<i>885</i>	<i>885</i>	<i>855</i>
<b>Continued Yakima River Supply</b>						
Roza I.D.	—	—	—	—	—	30
<i>Total Continued Yakima River Supply</i>	<i>—</i>	<i>—</i>	<i>—</i>	<i>—</i>	<i>—</i>	<i>30</i>
<b>Total Downstream from MP 22.6</b>	<b>885</b>	<b>885</b>	<b>885</b>	<b>885</b>	<b>885</b>	<b>855</b>
<b>POTENTIAL WATER SUPPLY SOURCES</b>						
Columbia River	1,110	1,060	1,060	1,210	1,210	890
Yakima River	170	210	210	60	60	380
<b>Total Potential Water Supply Sources</b>	<b>1,270</b>	<b>1,270</b>	<b>1,270</b>	<b>1,270</b>	<b>1,270</b>	<b>1,270</b>

Figure 2–1. Irrigated lands of potential water exchange participants.



### 3. SUMMARY OF PLAN CONSIDERATIONS

#### 3.1 PEAK IRRIGATION FLOWS

For the purpose of sizing facilities for delivery of Columbia River water to the potential water exchange participants, the peak irrigation flows shown in Table 3-1 were used.

<b>Table 3-1. Peak irrigation requirements in CFS used to develop conceptual water delivery plans</b>	
	<b>cfs</b>
<b>Upstream from Roza Canal MP 22.6</b>	
Roza I.D. — Upstream of Tunnel No. 3 Inlet (MP 8.8)	40
Roza I.D. and Terrace Heights I.D. — Downstream of Tunnel No. 3 Outlet (MP 11.0) to MP 22.6	175
<i>Subtotal —Upstream of MP 22.6</i>	<i>215</i>
<b>Downstream from Roza Canal MP 22.6</b>	
Roza I.D.	885
<i>Subtotal Roza I.D. and Terrace Heights I.D.</i>	<i>1,100</i>
<b>Selah-Moxee I.D.</b>	80
<b>Union Gap I.D.</b>	70
<b>Total for all four irrigation districts</b>	<b>1,250</b>

The combined requirement for Roza I.D. and Terrace Heights I.D. is 1,100 cfs. Of this, 215 cfs is for Roza I.D. and Terrace Heights I.D. users upstream from Roza Canal MP 22.6 and 885 cfs downstream from MP 22.6. In addition, flows of up to 1,020 cfs are diverted from the Roza Canal at MP 11.0 for hydropower generation at Roza Powerplant. Selah-Moxee I.D. requires 100 cfs; of this 20 cfs is for lands above their Yakima Ridge Tunnel, and would continue to be supplied from the Yakima River. Union Gap I.D. requires 70 cfs.

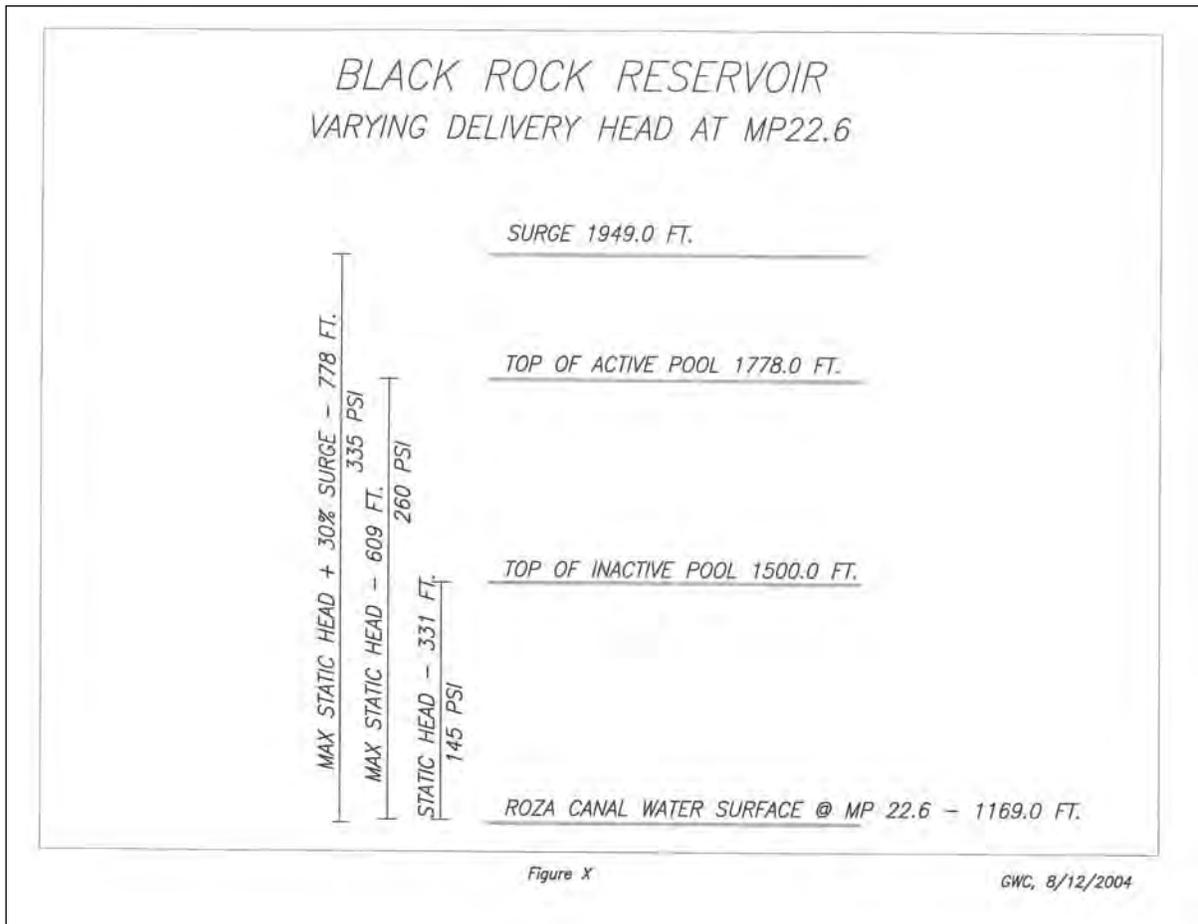
#### 3.2 RESERVOIR ELEVATION – PIPELINE RELATIONSHIPS

For the Black Rock alternative Assessment, the potential Black Rock reservoir total capacity would be 1,457,600 acre-feet; of this, 1,300,000 acre-feet would be active capacity and 157,600 acre-feet would be inactive capacity. The top of the active pool would be elevation 1778 feet (maximum water surface), and the top of the inactive pool would be elevation 1500 feet. The water surface elevation of the Roza Canal at MP 22.6 is 1170 feet. These differences in elevations would result in a static pressure at the Black Rock reservoir outflow conduit bifurcation works ranging from 260 pounds per square inch (psi) to 150 psi depending on the contents of the active pool throughout the irrigation season. (This does not take into account system friction losses.)

The design pressure at the bifurcation works could be as much as 335 psi for a maximum reservoir static pressure plus a 30 percent surge which could occur if water releases from the bifurcation works were abruptly curtailed.

Figure 3-1 illustrates the difference in elevation static pressures.

Figure 3–1. Varying delivery head at Roza Canal MP 22.6 from Black Rock reservoir



### 3.3 MAINLINE WATER DELIVERY SYSTEM

#### 3.3.1 Pressure Reducing Valve (PRV) System

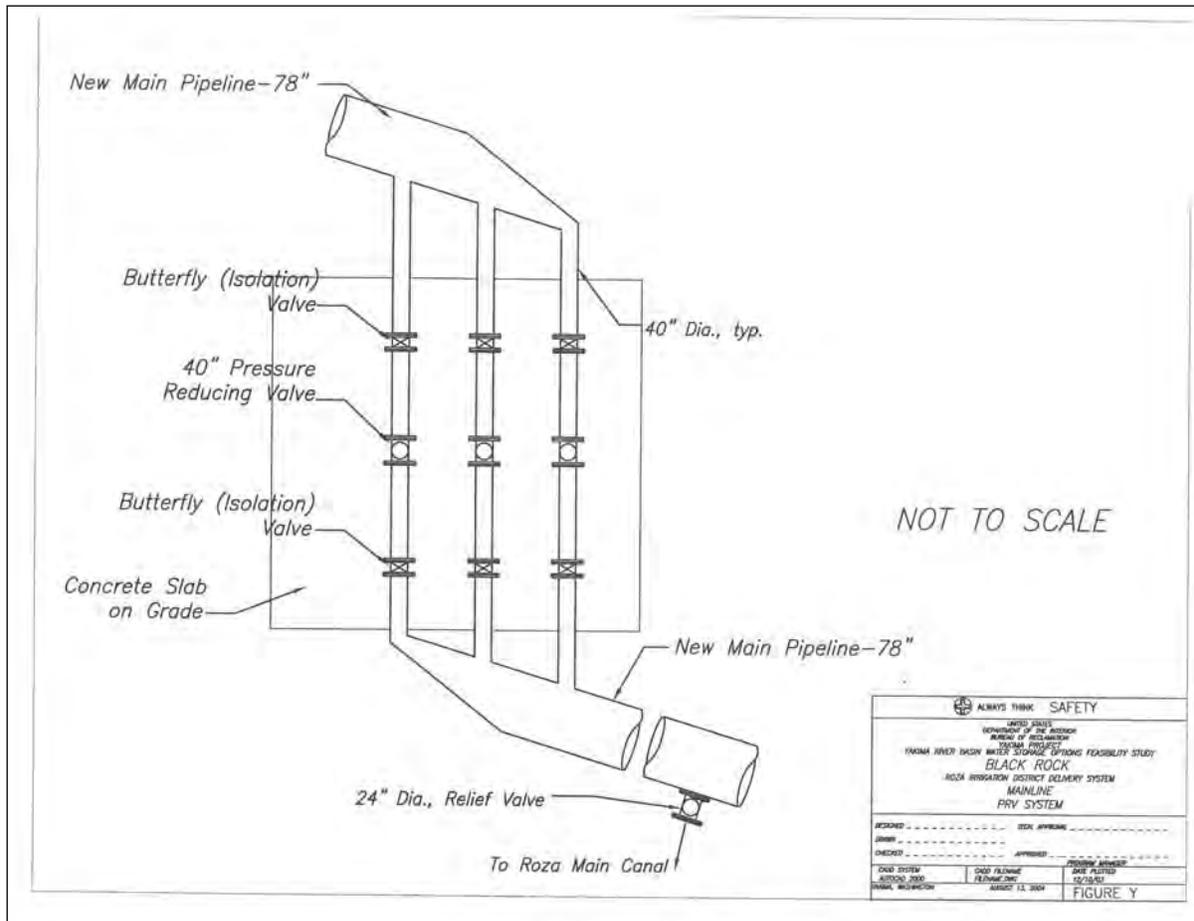
With the potential for significant differences in static pressure, there is the need to ensure the operational integrity and safety of the mainline delivery system which would convey water for irrigation service upstream from Roza Canal MP 22.6. There are several ways to do this:

- by increasing the head class (wall thickness) of the pipe,
- by installing a pressure reducing valve (PRV) system between the bifurcation works and the mainline delivery system,
- by discharging water from the bifurcation works through a generator directly into the Roza Canal and then pumping into the mainline delivery system.

PRV systems were discussed with the Cla-Valve Company of Newport Beach, California. To operate over the range of heads and flows of a Black Rock project, Cla-Valve proposed a system of three Tytan 40-inch valves in parallel, and a 24-inch pressure-relief safety valve downstream of the

pressure reducing valves. This system would use standard manufactured Cla-Valves in its design application. A schematic of the mainline PRV system proposed by Cla-Valve at the bifurcation works is shown in Figure 3-2.

**Figure 3-2. Typical mainline PRV (pressure relief valve) system**



### 3.3.2 Pipeline Characteristics

Plans 1 through 4 for mainline delivery systems would contain the following common features.

- A buried steel pipeline would originate at the potential Black Rock outlet facility bifurcation works. The static pressure resulting from the difference in head between stored water elevations (in a Black Rock reservoir) and mainline delivery system elevations would provide for upstream conveyance. A PRV system installed between the bifurcation works and the pipeline would dissipate any excess pressure to ensure the reliability and safety of the mainline delivery system.
- A buried steel pipeline would originate at a new pumping plant in Roza Canal at MP 22.6. Water discharged from the outlet facility through a new Black Rock powerplant would be pumped into the steel pipeline for upstream conveyance. Pressure would dissipate by discharging water through the generator.

### 3.3.3 Hydraulic Gradelines

The hydraulic gradelines of the mainline delivery systems for Plans 1 through 4 are shown in Attachment B. For example, here is an explanation of these figures using the figure for Plan 1.

- The hydraulic gradeline for the pipeline is shown in blue. This represents the static head in the pipeline.
- The Roza Canal water surface or the delivery elevation is shown in magenta at various stations along the canal, most notably at the existing pumping plants and at points halfway in between the pumping plants.
- Design flows for the system are shown in rectangles at the pumping plant stations to indicate deliveries at each pumping plant and canal turnouts per canal reach (150 cfs, 61 cfs, and so on). Below the design flows are the pipe diameters to show the downsizing of the pipe due to the drop in flow at the pumping plants and turnouts (60-inch diameter to 57-inch diameter, and so on).
- The delivery elevations of the existing pumping plants are shown by green triangles.

The full length of the mainline delivery system is designed for beginning static heads at the upstream end plus 30 percent for transients. For instance in Attachment B, the figure “Options 1 and 1A, Full Exchange, High Pressure Pipe,” the static head is 1,494.52 feet; some type of pressure reducing system would be required to prevent overpressure of the Pumping Plant No. 3 discharge line. As long as the hydraulic grade line at the points of delivery are greater than the delivery elevations of the existing pumping plants, and the reservoir elevation is 1650 feet and greater, water delivery to the high elevation lateral can be provided by gravity pressure. However, when the hydraulic grade line at the point of delivery is less than the delivery elevations of the existing pumping plants, such as Pumping Plant No.1, water must be delivered into the pump sump for subsequent pumping to the high elevation lateral.

For Options 1-A through 4-A of Plans 1 through 4, new pumping plants would pump water from the Roza Canal into the mainline delivery system at the required flows and beginning heads. Table 3-2 provides information for these new pumping plants.

**Table 3-2. Options 1-A, 2-A, 3-A, and 4-A — Pumping Plant Stations off Roza Canal**

<b>Plant Number</b>	<b>Peak demand flow (in cfs)</b>	<b>Plant operating horsepower (hp)</b>	<b>Operating units (each)</b>	<b>TDH at peak flows (in feet)</b>
1-A	215	12,000	6	350
2-A	175	10,000	5	345
3-A	175	2,750	5	100
4-A	325	9,000	6	160

Plant horsepower is based on demand flow plus 5 percent for wear, without spare.

Pump/motor combined efficiency is 75 percent

<b>Plant No. 1-A — 215 CFS</b>				<b>Plant No. 3-A — 175 CFS</b>		
<b>Unit</b>	<b>Horsepower</b>	<b>Type</b>		<b>Unit</b>	<b>Horsepower</b>	<b>Type</b>
1	2,000	Fixed		1	550	Fixed
2	2,000	Fixed		2	550	Fixed
3	2,000	Fixed		3	550	Fixed
4	2,000	Fixed		4	550	VFD
5	2,000	VFD		5	550	VFD
6	2,000	VFD		6 (spare)	550	Fixed
7 (spare)	2,000	Fixed		<b>TOTAL</b>	<b>3,300</b>	
<b>TOTAL</b>	<b>14,000</b>					
<b>Plant No 2-A — 175 CFS</b>				<b>Plant No. 4-A — 325 CFS</b>		
<b>Unit</b>	<b>Horsepower</b>	<b>Type</b>		<b>Unit</b>	<b>Horsepower</b>	<b>Type</b>
1	2,000	Fixed		1	1,500	Fixed
2	2,000	Fixed		2	1,500	Fixed
3	2,000	Fixed		3	1,500	Fixed
4	2,000	VFD		4	1,500	Fixed
5	2,000	VFD		5	1,500	VFD
6 (spare)	2,000	Fixed		6	1,500	VFD
<b>TOTAL</b>	<b>12,000</b>			7 (spare)	1,500	Fixed
				<b>TOTAL</b>	<b>10,500</b>	

### **3.3.4 Farm Service Deliveries to Roza I.D. and Terrace Heights I.D.**

Farm service deliveries for Roza I.D. and Terrace Heights I.D. upstream of Roza Canal MP 22.6 would be by means of turnouts from the mainline delivery system to both up-slope and down-slope lands. Up-slope and down-slope irrigation deliveries are discussed below.

#### **3.3.4.1. Up-slope of Mainline Delivery System**

Up-slope lands are presently served by pumping stations at Roza Canal mile posts 7.2, 13.0 (Terrace Heights I.D.), 16.8, and 22.5; these lift water from the canal to higher-elevation laterals. These pumping stations consist of a concrete channel (or pump sump) perpendicular to the Roza Canal. Flow from the Roza Canal into the pump sump can be controlled by stop logs. (See Attachment F-5, drawing 33-D-3063, “Mile 7.2 Pumping Plant.”)

When delivery of exchange water to the Roza-Selah lands is involved, the water is released to the pump sump of the pumping plant at Roza Canal MP 7.2. Existing pumping plants of Roza I.D. (MP 16.8 and MP 22.5) and Terrace Heights I.D. (MP 13.0) would continue to be used in conjunction with the new mainline delivery systems in the following manner.

With a high-pressure pipeline system originating at the bifurcation works, a dual operation would be required contingent on the Black Rock reservoir water surface elevation. When the reservoir was at elevation 1650 feet and higher, water released from the mainline delivery system would be routed through a new PRV system to the existing pumping plant discharge manifold extending to the high-elevation lateral.

When the reservoir water surface was lower than elevation 1650 feet, water would be routed through the new PRV system to the existing pump sump for subsequent pumping to the high-elevation lateral. With a low-pressure pipeline, released would go into the existing pump sump and then would be pumped to the high-elevation lateral.

For a high-pressure system beginning at a new Roza Canal pumping plant, water released from the mainline delivery system for service to upslope lands always would be routed through the existing pumping plant discharge manifold to the high-elevation lateral. A low-pressure system starting at the same point would make releases to the existing pump sump for pumping at the existing plant to the high-elevation lateral.

Table 3-3 summarizes the above with respect to mainline water deliveries to existing Roza Canal pumping plants (mile posts 13.0, 16.8, and 22.5) servicing lands upslope of the canal. For purposes of discussing the individual plans, the two locations of the mainline inlet (at the bifurcation and at a new pumping plant) are identified in each plan, i.e. for Plan 1, a mainline pipeline inlet at the bifurcation is Option 1 and a mainline pipeline inlet at a new pumping plant is Option 1-A.

Water would be delivered to the high-elevation laterals at the same pressure as currently provided. (See Attachment E, drawing 133-155T-376, “Manifold to Supply Existing Pumping Plants ...”)

<b>Pipeline Inlet</b>	<b>Type of system</b>	<b>Releases routed to:</b>	<b>Is pumping required at existing plants?</b>
<b>New Bifurcation</b>	High pressure	Existing pump manifold discharge to high-elevation lateral	No – if reservoir water surface were at elevation 1650.0 feet or higher
		Existing pump sump to high-elevation lateral	Yes – if reservoir water surface level were lower than elevation 1650 feet
	Low pressure	Existing pump sump to high elevation lateral	Yes – regardless of reservoir water surface elevation
<b>New Pumping Plant</b>	High pressure	Existing pump manifold discharge to high-elevation lateral	No
	Low Pressure	Existing pump sump to high-elevation lateral	Yes – regardless of reservoir water surface elevation

### **3.3.4.2 Downslope of Mainline Delivery System**

Down-slope lands of the Roza I.D. and Terrace Heights I.D. are presently served by individual gravity turnouts from the Roza Canal. The down-slope mainline delivery system would be fed by valved and metered individual turnouts from the mainline and new pipelines (6 inches to 10 inches in diameter) that would cross over or under the existing Roza Canal. The turnouts would have a meter and pressure reducing valve(s) to ensure a downstream pressure of 40-60 psi. (See Attachment E, drawing 33-155T-377 “Typical Downslope Farm Turnout.”)

### **3.3.5 Farm Service Deliveries to Selah-Moxee I.D. and Union Gap I.D.**

The water delivery facilities to Selah-Moxee I.D. and Union Gap I.D. would include a pipe/drop turnout structure from the mainline delivery system at about Roza Canal MP 11.7. Exchange water would be diverted to the irrigation canals of these two irrigation districts via 36-inch and 33-inch diameter pipes, respectively.

## 4. UPSTREAM PLANS 1–6

Six upstream plans provide various combinations of delivery of Columbia River water to Roza Terrace Heights, Selah-Moxee, and Union Gap Irrigation Districts. Plans 1, 2, 3, and 4 would involve construction of a mainline delivery system extending from the Black Rock outlet facility. Plan 5 would involve installation of checks and pumps in Roza Canal to reverse the flow. Plan 6 would require no new construction.

During the development of delivery system plans, the matter of ensuring that the mainline system would never be subjected to full reservoir head became a concern. As noted, this was discussed with Cla-Valve and information was obtained on the configuration and cost of a PRV system at the bifurcation works.

Options 1, 2, 3 and 4 of Plans 1 through 4 include a PRV system at the connection of the mainline delivery system to the bifurcation works of the potential Black Rock outlet facility. Delivery systems addressing the reservoir head concern by other means were also developed. This was done by discharging through the outlet facility into the Roza Canal and then pumping into a mainline delivery system. These are identified as Options 1-A, 2-A, 3-A, and 4-A (of Plans 1 through 4). Another option (Option 4-B of Plan 4) was prepared using full-head-class pipe beginning at the bifurcation works. This option relies on the wall thickness of the pipe instead of a PRV system to handle the system pressure.

A description of the potential Black Rock reservoir outflow conduit, bifurcation works, and Black Rock powerplant is provided in the report *Appraisal Assessment of the Black Rock Alternative Facilities and Field Cost Estimates, Technical Series No. TS-YSS-2; December 2004*.

The “construction cost” estimates shown for each plan summary are appraisal-level field construction cost estimates. These were developed solely for comparing the plans and options and do not represent the total delivery systems cost if a Black Rock alternative were to be authorized for construction. Chapter 6 describes how these appraisal-level field construction cost estimates were prepared.

### 4.1 UPSTREAM PLAN 1 – 215 CFS EXCHANGE USING HIGH-PRESSURE PIPELINE

Plan 1 is a total exchange for Roza I.D. and Terrace Heights I.D., whose combined April-October irrigation requirements (215 cfs) between Roza Diversion Dam and Roza Canal MP 22.6 would be met with Columbia River water. This plan assumes that hydroelectric generation at Roza Powerplant would terminate, and up to 1,020 cfs currently diverted from the Yakima River at Roza Diversion Dam for hydroelectric generation would not be diverted.<sup>1</sup> Roza Canal would be dewatered from Roza Diversion Dam to MP 22.6. Plan 1 would not deliver Columbia River water to Selah-Moxee I.D. and Union Gap I.D.

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<sup>1</sup> The existing Roza Canal bifurcation works to the Roza Powerplant is at MP 11.0.

Options 1 and 1-A of Plan 1 involves construction of a high-pressure mainline delivery system. The mainline pipeline would run along the northeasterly side of Roza Canal, through Roza Canal Tunnel No. 3, and end at approximate MP 5.5. This provides up to 40 cfs to the Roza-Selah lands (those lands upstream from the inlet of Roza Canal Tunnel No. 3). Up to 175 cfs would be provided to Roza I.D. and Terrace Heights I.D. lands downstream from the tunnel outlet (MP 11.0 to 22.6).

The appraisal-level field construction cost for Plan 1, Option 1 is estimated at \$66 million. The cost of Option 1-A of Plan 1 is \$74 million.

The appraisal-level field construction cost of a high-pressure pipe system originating at a new Roza Canal pumping plant (Option 1-A of Plan 1) is \$8 million more than a high-pressure system extending from the Black Rock outlet facility (Option 1 of Plan 1). However, Option 1-A eliminates the need for the dual operation associated with providing water to lands upslope of Roza Canal described in Section 3.3.4.1.

<b>Table 4-1. Features of Plan 1, 215 cfs Exchange Using High-Pressure Pipeline</b>	
<b>Type of Service</b>	
Option 1	High pressure mainline delivery system with PRV system at bifurcation
Option 1-A	High pressure mainline delivery system with new pumping plant in Roza Canal
Participants	Roza I.D. and Terrace Heights I.D.
Extent of exchange	100 percent (215 cfs)
<b>Construction Cost (Field)</b>	
Option 1	\$66.0 million
Option 1A	\$74.0 million

## **4.2 UPSTREAM PLAN 2 – 175 CFS EXCHANGE USING HIGH-PRESSURE PIPELINE**

Plan 2 would meet all of the Roza I.D. irrigation requirements from the Columbia River, except for 40 cfs (Roza-Selah lands) and all of the Terrace Heights I.D. requirements.

This plan also would involve only Roza I.D. and Terrace Heights I.D.; however, the extent of the water exchange would decrease to 175 cfs by eliminating delivery of Columbia River water to the Roza-Selah lands. These lands would be served by continuing to divert 40 cfs from the Yakima River. This plan assumes Roza Powerplant would continue to operate, requiring the diversion of up to 1,020 cfs from the Yakima River but that Roza Canal be dewatered from MP 11.0 to MP 22.6.

The new mainline high-pressure pipe system would run along the northeasterly side of Roza Canal, ending at about MP 11.7. The appraisal-level field construction cost of Plan 2, Option 2 is \$30.1 million. The cost of Plan 2, Option 2-A is \$36 million.

The additional field construction cost for inclusion of the 40 cfs irrigation requirement of the Roza-Selah lands as a part of the water exchange program (in Plan 1, Options 1 and 1-A) is \$36 to \$38 million.

<b>Table 4-2. Features of Plan 2, 175 cfs Exchange Using High-Pressure Pipeline</b>	
<b>Type of Service</b>	
Option 2	High pressure mainline delivery system with PRV system at bifurcation
Option 2A	High pressure mainline delivery system with new pumping plant in Roza Canal
Participants	Roza I.D. and Terrace Heights I.D.
Extent of exchange	96 percent (175 cfs)
<b>Field Construction Costs</b>	
Option 2	\$30.1 million
Option 2-A	\$36.0 million

### 4.3 UPSTREAM PLAN 3 – 175 CFS EXCHANGE USING LOW-PRESSURE PIPELINE

Plan 3 delivers 175 cfs of Columbia River water in the same manner as Plan 2 – 175 cfs for Roza I.D. and Terrace Heights I.D. but not to the Roza-Selah lands. The new mainline delivery system would be low pressure; this would result in a decrease of the wall thickness of the steel pipe. It would require continued use of the existing pumping plants to lift water to the high-elevation laterals up-slope of Roza Canal. This plan assumes Roza Powerplant would continue to operate, but that Roza Canal would be dewatered from MP 11.0 to MP 22.6.

Option 3 (of Plan 3) is similar to Option 2 (of Plan 2), but the delivery system would be operated at lower head (beginning head is elevation 1270 feet instead of 1500 feet). This would deliver water into the existing Roza I.D. pumping plant sumps, without pressure. Pressure heads to other farm turnouts would vary from 97 feet to 4 feet. Excess head from the potential Black Rock reservoir would be reduced with a pressure reducing system.

The construction cost of Option 3 of Plan 3 is \$30.1 million; the cost of Option 3-A is \$33 million.

The appraisal-level field construction cost of a high-pressure pipeline and a low-pressure pipeline originating at the outlet facility and conveying the same flows to the same delivery points is identical.

<b>Table 4-3. Features of Plan 3, 175 cfs Exchange Using Low-Pressure Pipeline</b>	
<b>Type of Service</b>	
Option 3	Low pressure mainline delivery system with PRV system at bifurcation
Option 3-A	Low pressure mainline delivery system with new pumping plant in Roza Canal
Participants	Roza I.D. and Terrace Heights I.D.
Extent of exchange	96 percent (175 cfs)
<b>Field Construction Costs</b>	
Option 3	\$30.1 million
Option 3-A	\$33.0 million

#### 4.4 UPSTREAM PLAN 4 – 325-CFS EXCHANGE CONSIDERING THREE PIPELINE OPTIONS

Upstream Plan 4 would provide a total of 325 cfs of exchange water and includes all potential water exchange participants upstream from Roza Canal MP 22.6 (Roza, Terrace Heights, Selah-Moxee, and Union Gap Irrigation Districts). This plan would meet all of the Roza I.D. and Terrace Heights I.D. irrigation requirements of 175 cfs (except for the Roza-Selah lands), and the 70 cfs Union Gap I.D. irrigation requirement. Selah-Moxee I.D. would get 80 cfs of its 100 cfs requirement. Yakima River diversions of 60 cfs (40 cfs for the Roza-Selah lands and 20 cfs for Selah-Moxee lands) would continue. Exchange water for Selah-Moxee I.D. and Union Gap I.D. would be delivered into their existing canals from the mainline pipeline by turnout/drop structures near MP 11.7. Plan 4 assumes Roza Powerplant would continue to operate (requiring the diversion of up to 1,020 cfs from the Yakima River) and that Roza Canal would be dewatered from MP 11.0 to MP 22.6.

Plan 4 considers three mainline delivery systems.

- Option 4 is a low-pressure pipeline extending from the outlet facility bifurcation works.
- Option 4-A is a low-pressure pipeline extending from a new Roza Canal pumping plant.
- Option 4-B is a high-pressure, full-head-class pipe system beginning at the outlet facility bifurcation works. This option would rely on the wall thickness of the pipe instead of a PRV system to handle the system pressure, thereby removing concerns that a PRV system may not consistently operate to ensure system pressure attributed to the head differential would not bypass the PRV system

An additional 150 cfs (for Selah-Moxee I.D. and Union Gap I.D.) could be obtained for a water exchange at a field construction cost of \$29.0 to \$31.0 million (Plan 4 compared to Plan 3). The bifurcation works would have significant pressure variations. If there are concerns about the reliability of a PRV system and a full-head-class pipe is required, the field construction cost increases by about \$54.0 million (Option 4-B compared to Option 4).

<b>Type of Service</b>	
Option 4	Low pressure mainline delivery system with PRV system at bifurcation
Option 4A	Low pressure mainline delivery system with new pumping plant in Roza Canal
Option 4B	High pressure mainline delivery system with full head class pipe
Participants	Roza I.D., Terrace Heights I.D., Selah-Moxee I.D., and Union Gap I.D.
Extent of exchange	Roza I.D. and Terrace Heights I.D. – 96 percent (175 cfs) Selah-Moxee I.D. – 80 percent (80 cfs) Union Gap I.D. – 100 percent (70 cfs)
<b>Field Construction Costs</b>	
Option 4	\$59.0 million
Option 4-A	\$64.0 million
Option 4-B	\$113.0 million

## 4.5 UPSTREAM PLAN 5 – 325 CFS EXCHANGE WITH ROZA CANAL CHECKS AND RELIFT PUMPS

Plan 5 is similar to Plan 4 and it also would deliver 325 cfs to the four upstream irrigation districts. However, this would be accomplished by installing checks and relift pumps to reverse the flow in Roza Canal. This plan would supply 1,210 cfs of Columbia River water from the potential Black Rock outlet facility into Roza Canal at MP 22.6. The flow direction in Roza Canal would be reversed from MP 22.6 to MP 11.0. This would deliver 175 cfs to existing Roza pumping plants and turnouts and an additional flow of 150 cfs to serve Selah-Moxee I.D. and Union Gap I.D.

At Roza Canal MP 11.7, a new turnout/drop structures would deliver 80 cfs into Selah-Moxee Canal south of the Yakima Ridge Tunnel, and 70 cfs into Union Gap Canal. In Roza Canal, the reverse-flow water would be re-lifted in increments of about 5 feet by each of four new relift pumping plants and checks, see Table 4.5.

New pumping plants and checks would be located at Roza Canal MP 20.6 and 18.7. A new pumping plant would be located at the existing check downstream of Pumping Plant No. 2 (MP 16.8), and a new pumping plant and check would be located near Terrace Heights Pumping Plant (MP 13). A terminal check would also be added at Roza Canal MP 11.7.

Delivering Selah-Moxee I.D. and Union Gap I.D. water via Roza Canal would provide adequate flow velocities to keep the reverse-flow water from becoming stagnant. Roza I.D. and Selah-Moxee I.D. lands upstream from the tunnels and Roza Power Plant hydropower generation flows would continue to be provided by diversions from the Yakima River.

Drawing 33-155T-378 in Attachment E shows a typical check-relift structure. The number of relift pump units would vary according to flow requirements for each existing pumping station. These are shown in Table 4-5. Relift pumps would be controlled by sensors in each “checked reach.”

This plan assumes Roza Powerplant would continue to operate. Roza Canal from MP 11.7 to MP 22. would be watered-up by the delivery of Columbia River water as the result of the reverse-flow operation. The field construction cost of estimate of Plan 5 is \$6.3 million.

Plan 5 results in a 325 cfs water exchange, the same as Plan 4. The field construction cost of Plan 5 is \$50 million less than Option 4 of Plan 4.

<b>Table 4-5. Features of Plan 5, 325 cfs Exchange With Roza Canal Checks And Relift Pumps</b>	
<b>Type of Service</b>	
Option 5	Checks and relift pumps in Roza Canal to reverse the flow.
Participants	Roza I.D. and Terrace Heights I.D., Selah-Moxee Irrigation District, and Union Gap Irrigation District
Extent of exchange	Roza I.D. and Terrace Heights I.D.: 96 percent (175 cfs)
	Selah-Moxee Irrigation District: 80 % (80 cfs)
	Union Gap Irrigation District: 100% (70 cfs)
<b>Field Construction Cost</b>	
Option 5	\$6.3 million

**Table 4-6. Plan 5 – Relift Pumping Plant Stations**

<b>Plant No.</b>	<b>Peak demand flow (cfs)</b>	<b>Flow plus 10% recovery, plus 5% wear (cfs)</b>	<b>Plant operating horsepower (in hp)</b>	<b>Operating units (each)</b>	<b>TDH at peak flows (in feet)</b>
1	256	296	550	5	12
2	240	277	510	5	12
3	236	273	500	5	12
4	156	180	330	4	12

Plant horsepower is based on demand flow plus 10% recovery plus 5% for wear, without spare.

Pump/motor combined efficiency is 75 percent.

<b>Plant No. 1 — 256 cfs</b>			<b>Plant No. 3 — 236 cfs</b>		
<b>Unit No.</b>	<b>Horsepower (hp)</b>	<b>Type</b>	<b>Unit No.</b>	<b>Horsepower (hp)</b>	<b>Type</b>
1	110	VFD	1	100	VFD
2	110	VFD	2	100	VFD
3	110	VFD	3	100	VFD
4	110	VFD	4	100	VFD
5	110	VFD	5	100	VFD
6 (spare)	110	VFD	6 (spare)	100	VFD
<b>Total</b>	<b>600</b>		<b>Total</b>	600	
<b>Plant No. 2 — 240 cfs</b>			<b>Plant No. 4 — 156 cfs</b>		
<b>Unit No.</b>	<b>Horsepower (hp)</b>	<b>Type</b>	<b>Unit No.</b>	<b>Horsepower (hp)</b>	<b>Type</b>
1	100	VFD	1	85	VFD
2	100	VFD	2	85	VFD
3	100	VFD	3	85	VFD
4	100	VFD	4	85	VFD
5	100	VFD	5 (spare)	85	
6 (spare)	100	VFD	<b>Total</b>	425	
<b>Total</b>	<b>600</b>				

## 4.6 UPSTREAM PLAN 6 – 35 CFS EXCHANGE

Under Plan 6, the only upstream water exchange would be with Roza I.D. It would involve the delivery of 35 cfs of Columbia River water to meet a portion of the irrigation requirement at Pumping Plant No. 3 (65 cfs) at Roza Canal MP 22.5. Table 4-7 shows that Yakima River diversions would continue at 180 cfs.

Upstream from MP 11.0 (Roza-Selah lands)	—	40 cfs
MP 11-0 to MP 22.6 (total requirement)	175 cfs	—
<less> Pumping Plant No. 3 exchange	<35 cfs>	—
Residual	—	140 cfs
Yakima River irrigation diversions		180 cfs

The 35 cfs would be provided at Pumping Plant No. 3 from the backflow of Columbia River water discharged from the Black Rock outlet facility through a Black Rock powerplant into Roza Canal at MP 22.6. The Yakima River would provide the remaining 30 cfs required at Pumping Plant No. 3. In addition to the 180 cfs Yakima River Diversion to meet other upstream irrigation requirements, 30 cfs would also be diverted as flow-through water to keep the canal from getting stagnant. This flow-through water would then be used for irrigation downstream from Roza Canal MP 22.6. Table 4-8 summarizes the features of Plan 6.

<b>Type of Service</b>	
Option 6	Pumping Plant No.3 by backflow from Roza Canal
Participants	Roza I.D.
Extent of exchange	Roza I.D. and Terrace Heights I.D. – 16 percent (35 cfs)
<b>Field Construction Cost</b>	
Option 6	None

Table 4-9 provides a summary of all upstream potential water delivery plans.

**Table 4-9. Summary of Upstream Potential Water Delivery System Plans**

Item	Option					
	1 and 1-A	2 and 2-A	3 and 3-A	4, 4-A, 4-B	5	6
<b>Water Source</b>						
Roza I.D.	CR	CR d/s MP 11 YR u/s MP 11	CR d/s MP 11 YR u/s MP 11	CR d/s MP 11 YR u/s MP 11	CR d/s MP 11 YR u/s MP 11	CR d/s MP 11 YR u/s MP 11
Selah-Moxee I.D.	YR	YR	YR	CR d/s tunnel YR u/s tunnel		YR
Union Gap I.D.	YR	YR	YR	CR	CR	YR
<b>Columbia River Water Delivery upstream of MP 22.7 (cfs)</b>						
Roza I.D.	215	CR 175 YR 40	CR 175 YR 40	CR 175 YR 40	CR 175 YR 40	CR 35 YR 180
Selah-Moxee I.D.	n/a	n/a	n/a	CR 80 YR 20	CR 80 YR 20	n/a
Union Gap I.D.	n/a	n/a	n/a	70	70	n/a
<b>Type of Service</b>						
Roza I.D. – u/s of MP 11	HPP	gravity canal	gravity canal	gravity canal	gravity canal	gravity canal
Roza I.D. – MP 11 to 22.7	HPP	HPP	LPP	4, 4-A = LPP 4-B = HPP	reverse canal	gravity canal
Selah-Moxee I.D.	n/a	n/a	n/a	pipe turnout; drop	Reverse canal; pipe turnout; drop	n/a
Union Gap I.D.	n/a	n/a	n/a	pipe turnout; drop	Reverse canal; pipe turnout; drop	n/a
Roza Powerplant operation	No	Yes	Yes	Yes	Yes	Yes
Roza Canal dewatered	YR to MP 22.6	YR to MP 22.6	YR to MP 22.6	YR to MP 22.6	None	None
<b>Field Construction Cost Estimates (in millions)</b>						
Option with PRV system	\$66.0	\$30.1	\$30.1	\$59.0		
Option with pumping plant	\$74.0	\$36.0	\$33.0	\$64.0		
Full-head-class pipe				\$113.0		
Reverse flow					\$6.3	
CR = Columbia River; YR = Yakima River; u/s = upstream; d/s = downstream; HPP = high-pressure pipe; LPP = low-pressure pipe; Roza Powerplant is at MP 11						

## 5. DOWNSTREAM PLANS

Roza I.D. irrigation requirements downstream from Roza Canal MP 22.6 are 885 cfs. This could be met entirely by Columbia River water provided from the potential Black Rock outlet facility into Roza Canal without incurring additional costs for construction of water delivery facilities. This exchange water could then be conveyed to existing pumping plants and turnouts for the irrigation of upslope and downslope lands.

Two plans were developed for a potential water exchange with Sunnyside Division. Delivery of exchange water to Sunnyside Canal at this time could involve either a new pressure-pipe delivery system extending from the potential outlet facility bifurcation through Konnowock Pass to Sunnyside Canal at MP 3.83 or by modifications to Roza Canal combined with a shorter pipeline to Sunnyside Canal at the same discharge point.

For the potential Sunnyside Division water delivery system plan involving modifications to Roza Canal, these would begin at Roza Canal MP 22.6 and consist of a new siphon, enlargement of Roza Canal, and construction of a new Tunnel No. 5 to carry an additional 1,262 cfs flow to about Roza Canal MP 29.2. At this point, the exchange water would be routed into Roza Canal Wasteway No. 3, which would be enlarged from 1,252 cfs to 2,514 cfs to carry the additional flow. Five new check/drop structures would also be installed.

At about 1.75 miles from the wasteway headworks, a new turnout would divert Sunnyside Division exchange water into a new 12-foot-diameter pipeline extending a little over 0.75 miles to Sunnyside Canal MP 3.83.

Further information on these two Sunnyside Division water exchange plans can be found in the report *Appraisal Assessment of the Black Rock Alternative Delivery System for Sunnyside Division, Technical Series No. TS-YSS-4, December 2004.*

## 6. PRIMARY DELIVERY SYSTEM FEATURES

For Plans 1 through 4, the mainline delivery system features include a steel main pipeline and turnouts from the main pipeline. The pipeline would be located along the uphill side of the Roza Canal and buried with about five feet of cover. Additional right-of-way along agricultural lands would be acquired to provide room for construction. There are several logical alternate pipeline routes shown on Attachment C (“Aerial Photographs”) which could shorten and simplify the pipeline construction, but would also require new right-of-way.

The pipeline would be mortar-lined, polytape-wrapped, and welded steel with a cathodic monitoring/protection system. As described in Section 3.3.3, the full-length of the pipeline would be designed for beginning static heads (shown on Attachment B), at the upstream end of the pipeline plus 30 percent for transients. The gradelines shown in Attachment B are for maximum flow using “Hazen Williams  $C=120$ ” which should provide slightly oversized pipe.

In-line air chambers along the pipeline are not included at this stage of the work and a transient analysis would need to be completed as decisions are made regarding which potential water exchange entities would actually participate in an exchange and the extent of their participation. For Plan 1, involving a Columbia River water exchange with the Roza-Selah lands upstream from the inlet of Roza Canal Tunnel No. 3, the pipeline would be installed in the tunnel arch, supported by steel cross members. The pipeline through the tunnel would have access manholes and air vents at approximate spacing of 2,000 feet.

For Plan 4, Selah-Moxee I.D. and Union Gap I.D. would be served from the main pipeline by larger turnout/ pipeline drop/outlet structures from the main pipeline.

The existing pumping plant sumps would be bulkheaded at canal intakes to hold water at those times when exchange water must be delivered into the pumping plant sumps.

For Plan 5, flow in each of the five canal reaches would be substantially less than the Roza Canal original design flow; therefore, the chemical treatment program for aquatic weed growth would be increased.

## 7. FIELD CONSTRUCTION COST ESTIMATES

Reclamation's Pacific Northwest Construction Office (PNCO) prepared the appraisal-level field construction cost estimates for Plans 1 through 5. Concepts and assumptions used in this study have not been subject to detailed design and value engineering. Therefore, the reader should not infer the presented concept designs, capacities, assemblies, and quantities imply the best design. Feasibility studies would validate or improve concepts and estimates. Field construction cost estimates would change accordingly as the project develops.

Field construction costs include the itemized pay items of construction contracts, plus costs for contractor mobilization, plus and allowance for "unlisted items" (collectively referred to as "construction contract costs") and contingencies.

Estimated contract pay items are based on competitive prices taken from bid abstracts for similar construction, RS Means and industry cost rate publications, and supplier pricing for commercially available equipment and materials. There were two primary sources of cost data. The first was taken from various bid abstracts for comparable pipeline and pumping plant projects constructed from 1992 to 1998 as part of the Umatilla Basin Project (Oregon). The second was from information in a series of engineering reports in 2002 and 2003 relating to the proposed Kennewick and Columbia Irrigation Districts pump exchange program. Consideration is given for degree of risk and difficulty, worksite conditions, and seasonal construction periods.

The pay item estimates assume work and materials would be obtained by fixed-price, competitive, sealed-bid contracts. Excavation, bedding, and compact backfill are based on excavated quantities being reused. There would be room to stockpile and waste along existing right-of-way, so no excessive haul distance or stockpiling effort would be required.

Pumping plant contract cost estimates for Options 1-A through 4-A of Plans 1 through 4 were taken from a cost curve for finished plants without air chambers or variable frequency drives (VFD). The cost curve was developed by PNCO based on completed construction costs for 70 previous Reclamation pumping plants of various horsepower; it is not included here. Costs were indexed to February 2004 price levels using *Engineering News Record's* "Construction Cost Index." Pumping-plant line-item costs were based on curve values which were adjusted to mark-ups for removal, unlisted, contingencies, mobilization and tax, and to add air chambers and VFD's.

Mobilization costs include mobilizing contractor personnel and equipment to the work site during initial construction start-up. The pay items subtotal cost is assessed 5% based on past experience with similar projects.

Unlisted items includes numerous small items which do not have enough individual impact to warrant individual pricing, but which in total are significant. Unlisted items are added as a percentage (15%) of the sum of the pay item cost plus the mobilization cost.

Contingencies are then added as a percentage (25%) of the construction contract cost (the sum of the pay items, mobilization costs, and unlisted items) to determine the "field construction cost." Contingencies cover risks and uncertainties during construction to account for construction contract changes and claims to ensure an adequate funding for the construction contract.

It should be noted that additional non-contract costs would need to be incurred once a proposed Federal water resource project was authorized and the Congress provided construction appropriations. These additional costs would include such items a preparation of final engineering designs and specification, regulatory compliance and permitting activities, environmental mitigation and monitoring, and construction contract administration and management. Right-of-way acquisition costs for project construction and subsequent project operation must also be included.

## **8. PRELIMINARY REACTION TO WATER DELIVERY SYSTEM PLANS**

Reclamation submitted a draft water delivery system report to the Roza, Terrace Heights, Selah-Moxee, and Union Gap Irrigation Districts. The preliminary reaction provided is summarized below.

### **8.1 ROZA IRRIGATION DISTRICT**

Roza Irrigation District manager and staff offered the following ideas, concerns, and preferences in meetings to discuss the exchange options.

- Roza I.D. would prefer to run its power plant at MP 11; the district would not support a plan that eliminated its project power.
- Roza I.D. prefers that its canal be watered-up throughout the season because the reinforced lining was not designed with expansion joints. If dewatered, warm temperatures/sunlight on the concrete lining would cause thermal expansion and buckling. Expansion joints have already been added to some sections of concrete lining damaged by thermal expansion and buckling during hot-weather shut downs. Options that dewater reaches of Roza Canal may need to include installation of expansion joints into existing lining at appropriate intervals.
- Roza would be willing to carry Selah-Moxee water above Tunnel No. 3. Roza is reluctant to receive water upstream of Tunnel No. 3 from Selah-Moxee Canal in lieu of Plan 1 piping Black Rock water through Tunnel No. 3. The Selah-Moxee I.D. Diversion has some operational challenges, deliveries would have to be pumped, and the Roza I.D. canal needs to be watered up to prevent thermal buckling.
- Roza is receptive to options that would carry water to Selah-Moxee below Yakima Ridge and Union Gap via Roza Canal or common distribution pipeline.
- Using Columbia River water means no waste allowed, operational waste is a reality, and is difficult to avoid in the event of power failure, unless extensive re-regulation reservoirs are used to capture waste water.
- Canal water-up at beginning of irrigation season requires large flows of water to flush the canal system, and flushing flows are wasted into the Yakima River.
- Roza I.D. wishes to keep existing systems in-place and operational as back-up to Black Rock.
- Roza I.D. prefers gravity supply from Black Rock for reliability.
- Clear water from Black Rock will increase the need for aquatic weed treatment.

### **8.2 SELAH-MOXEE IRRIGATION DISTRICT**

The appraisal-level design for Upstream Plans 4 and 5 would include the delivery of Columbia River water to Selah-Moxee I.D. The district's main canal diverts from the Yakima River near Pomona,

runs parallel to and downslope of Roza Canal, tunnels through the Yakima Ridge, and ends in the southeast side of Moxee Valley.

For design purposes, it was assumed the district's water demand was about 100 cfs with 80 cfs required downstream from the Yakima Ridge tunnel. The Yakima River would deliver the remaining 20 cfs. The appraisal-level design would limit service with use of Columbia River exchange water to the area downstream from the tunnel.

### **8.3 UNION GAP IRRIGATION DISTRICT**

Appraisal-level design for Upstream Plans 4 and 5 also would include the delivery of Columbia River water to Union Gap I.D. Currently, the district diverts from the Yakima River downstream from Pomona; its main canal is parallel to and downslope of Roza and Selah-Moxee Canals. After passing through Union Gap and to its end point north of Zillah, the canal is upslope of Sunnyside Canal.

All of the Union Gap service area lies downstream from Roza Canal MP 11.0. The district has indicated an interest in receiving Columbia River water as a full in-lieu supply as long as there would be no additional cost to the district.

# ATTACHMENTS

The following section of attachments contains figures, photographs, worksheets, and drawings. There are six “upstream” plans involving the delivery of various amounts of Columbia River water to some or all of the potential exchange participants. Plans 1 through 4 include options of the potential mainline delivery systems extending from the Roza Canal at MP 226. Plans 5 and 6 do not have options.

In the caption boxes of Attachment C, “Aerial Photographs,” the term “option” was used rather than “plan.”

## CONTENTS

**ATTACHMENT A. FLOW DIAGRAMS, PLANS 1-6**

**ATTACHMENT B. HYDRAULIC GRADELINES, PLANS 1-5**

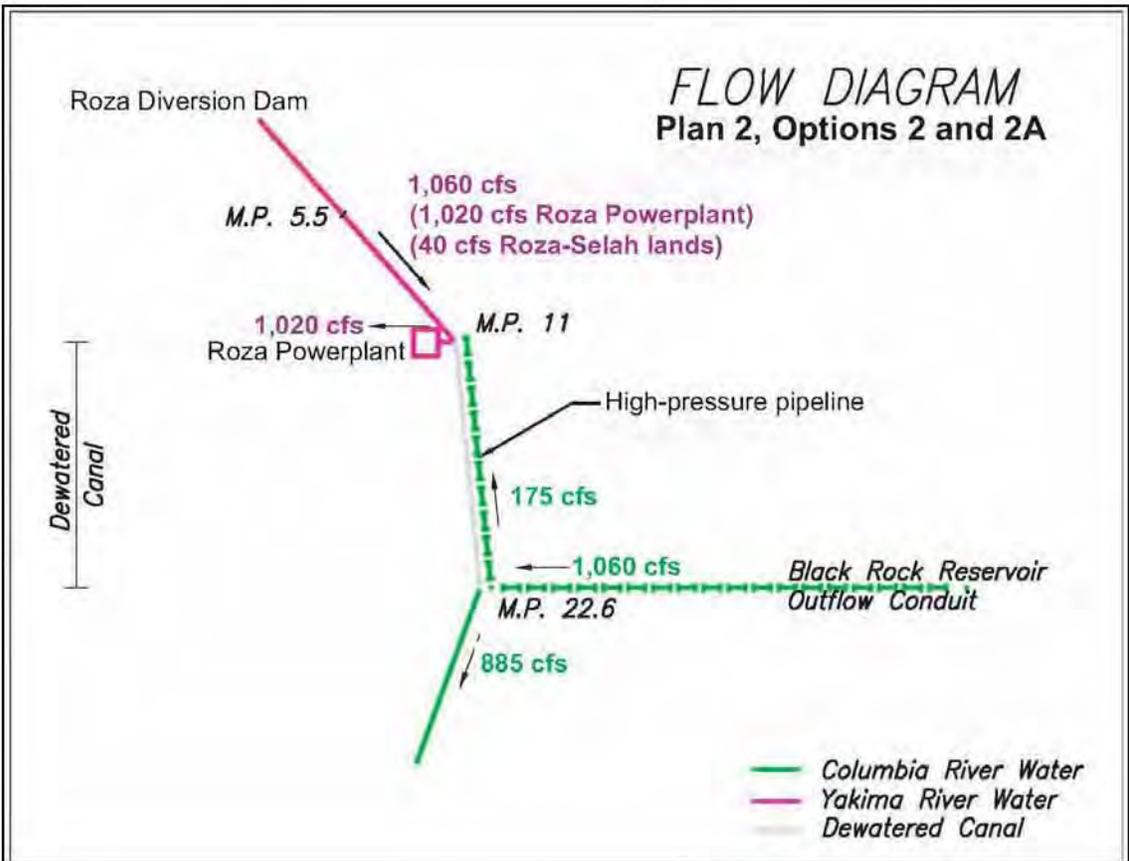
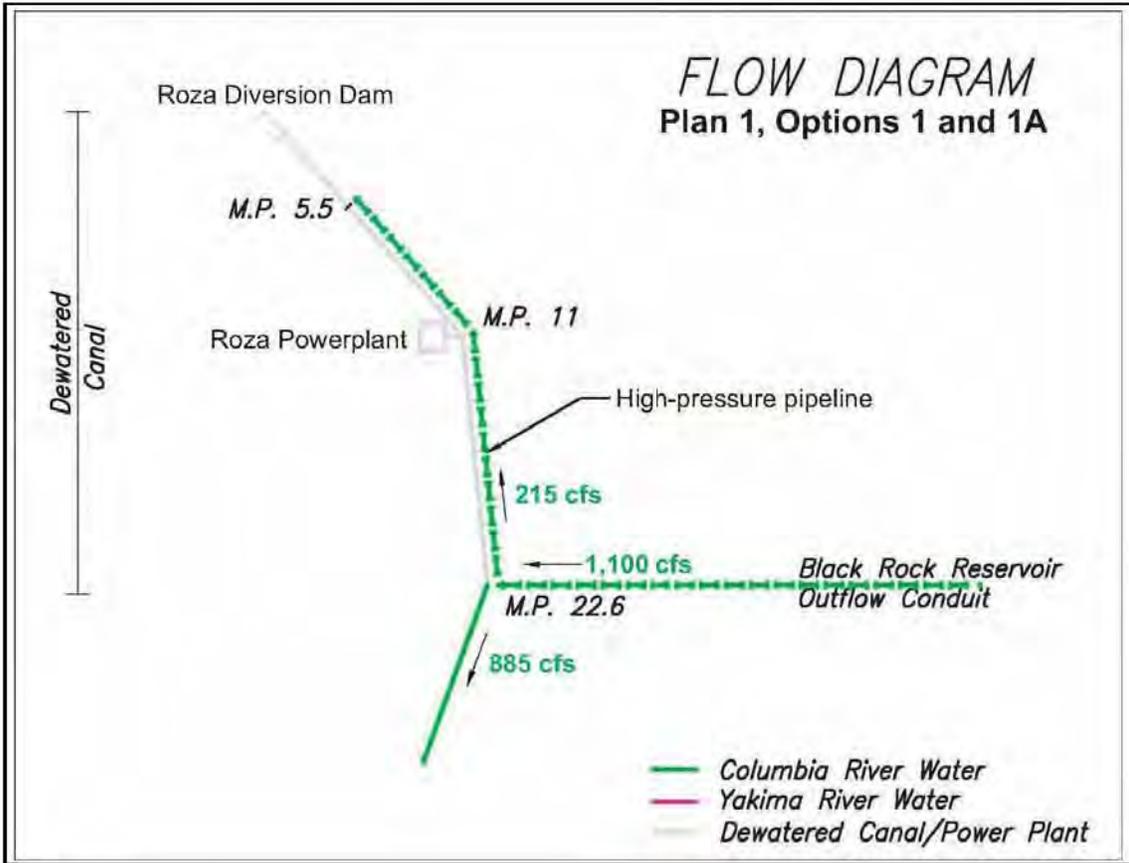
**ATTACHMENT C. AERIAL PHOTOGRAPHS PROPOSED DELIVERY PLANS 1-6**

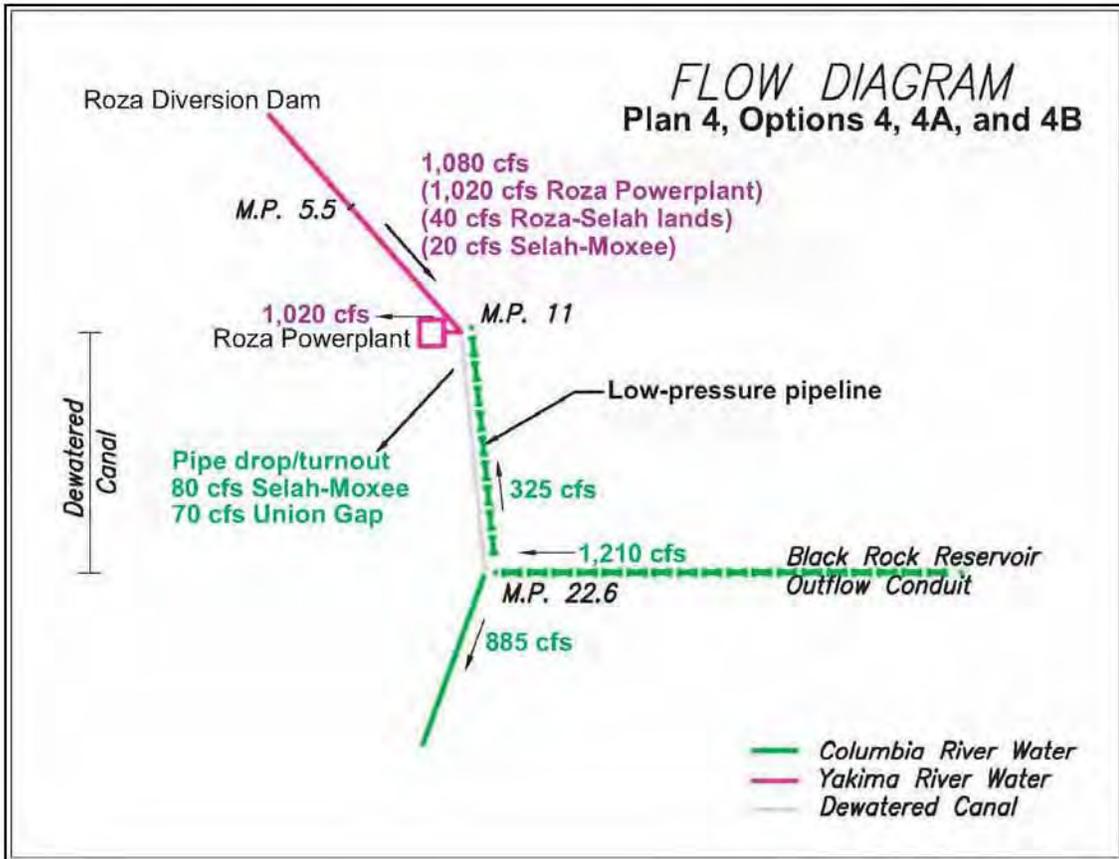
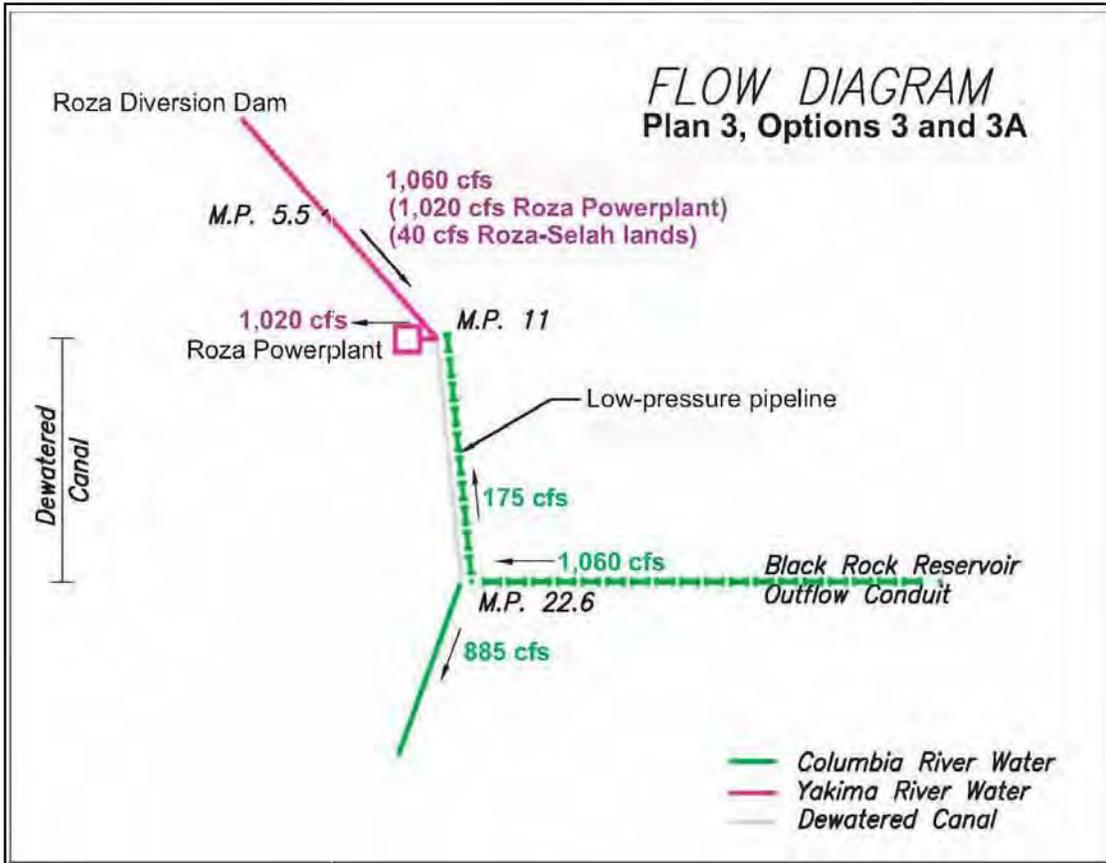
**ATTACHMENT D. COST ESTIMATES, PLANS 1-5**

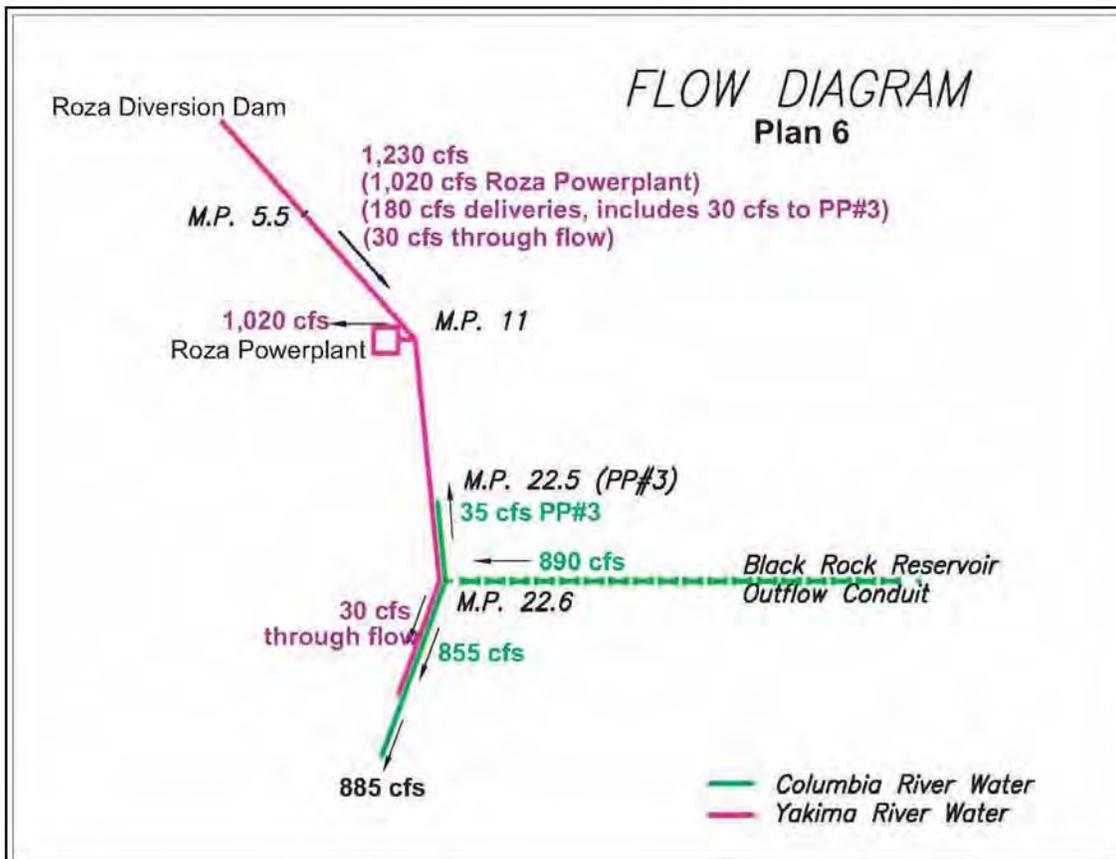
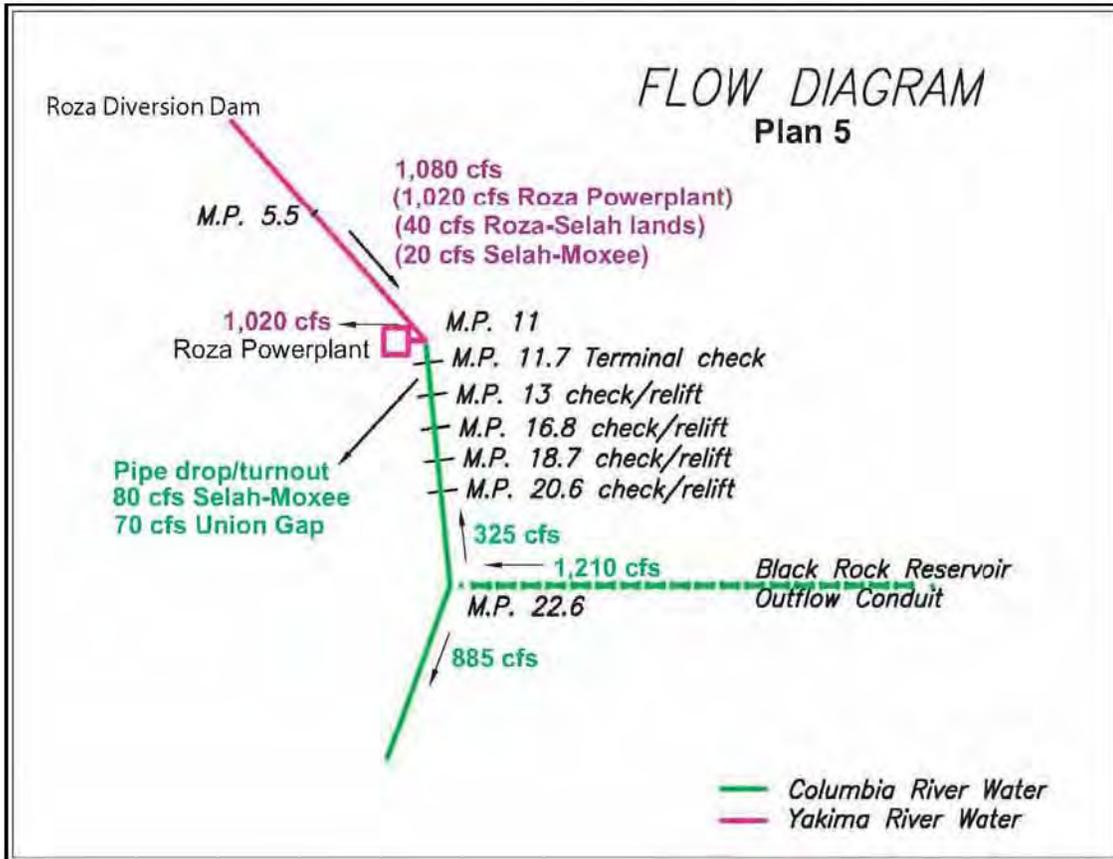
**ATTACHMENT E. DRAWINGS**

**ATTACHMENT F. REFERENCE DRAWINGS**

**ATTACHMENT A.**  
**FLOW DIAGRAMS, PLANS 1-6**



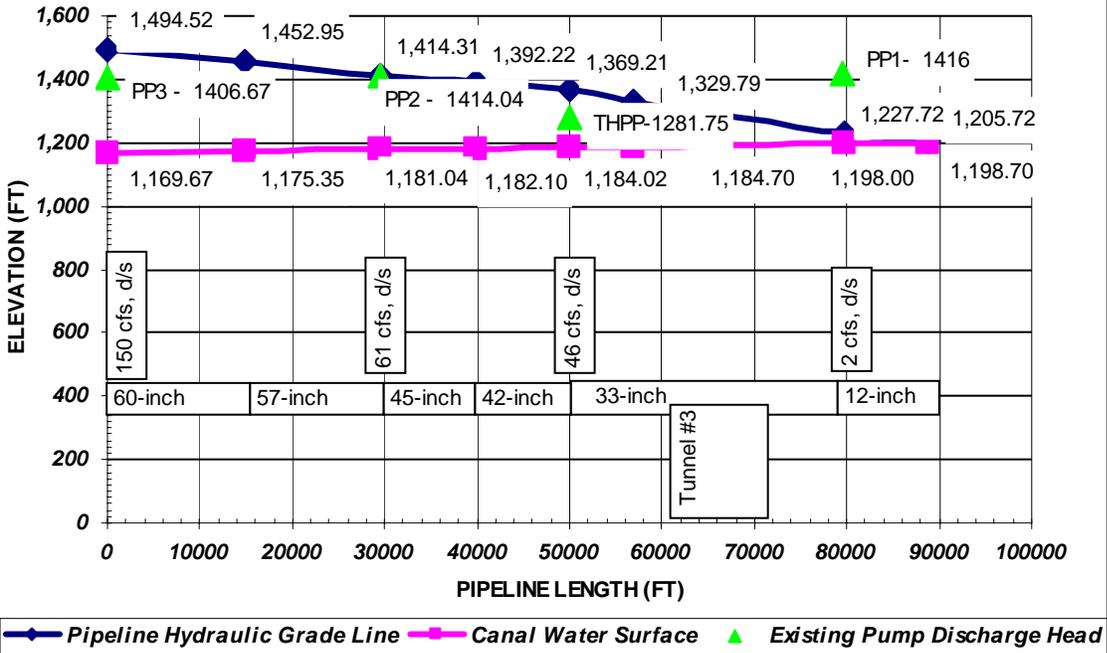




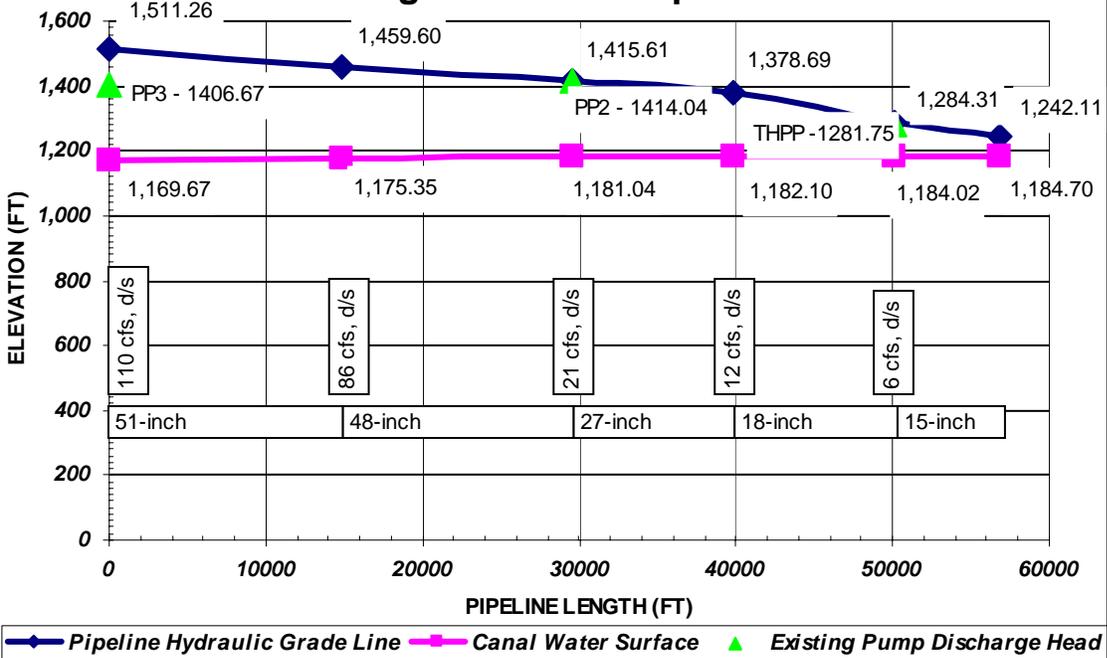
# **ATTACHMENT B.**

## **HYDRAULIC GRADELINES, PLANS 1-5**

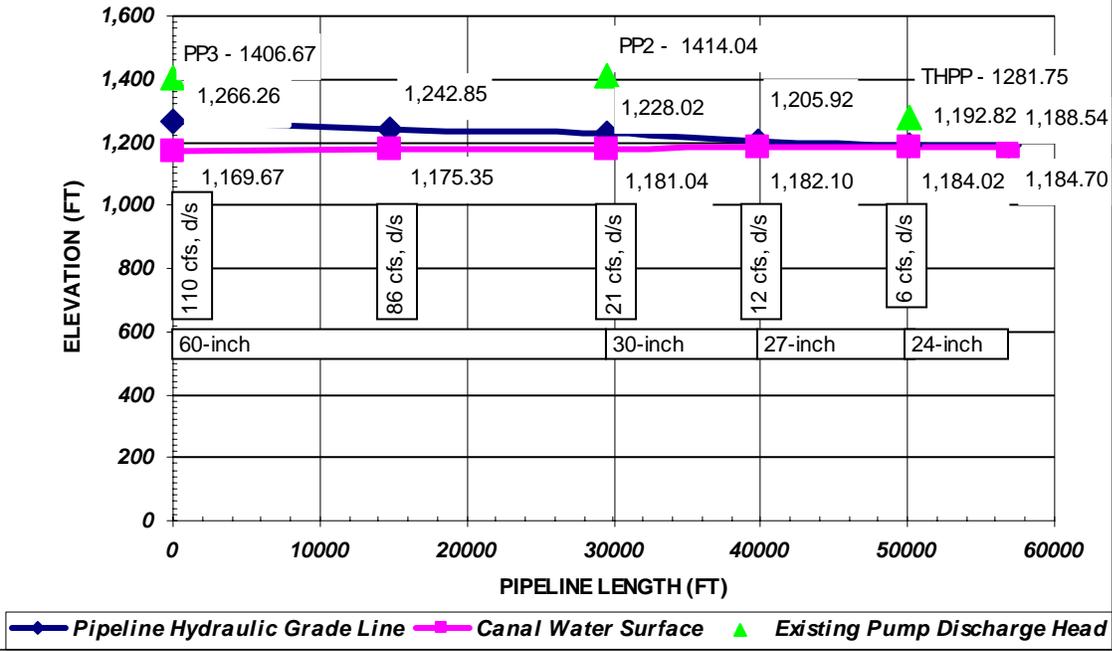
## Roza Irrigation District, Options 1 and 1-A. Full Exchange, High-Pressure Pipe



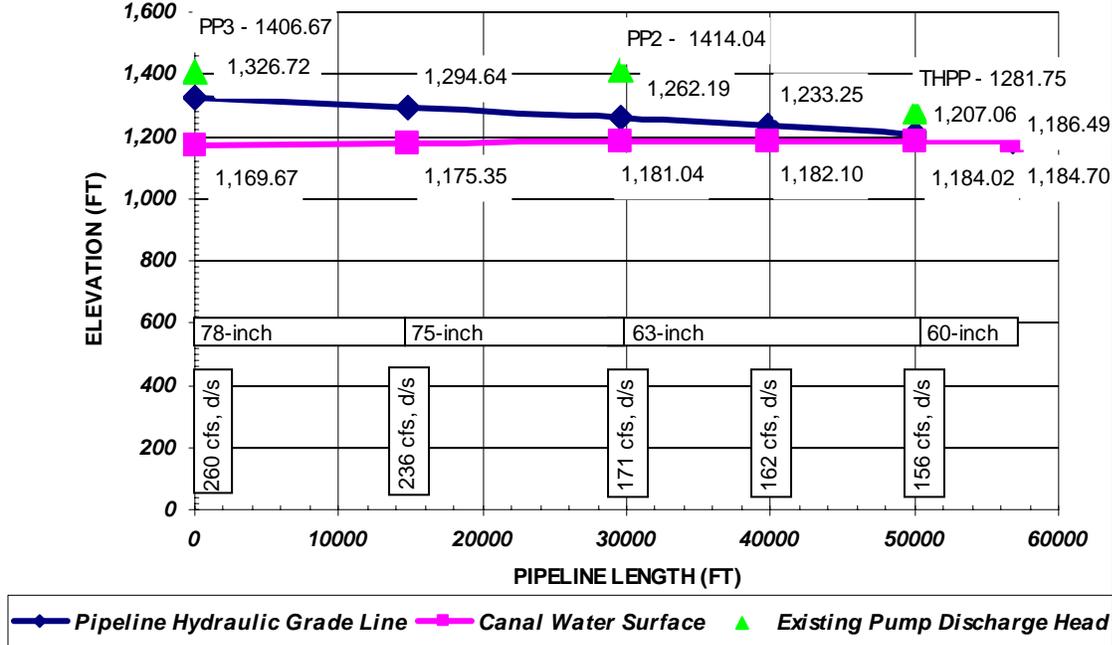
## Roza Irrigation District, Options 2 and 2-A. High-Pressure Pipe

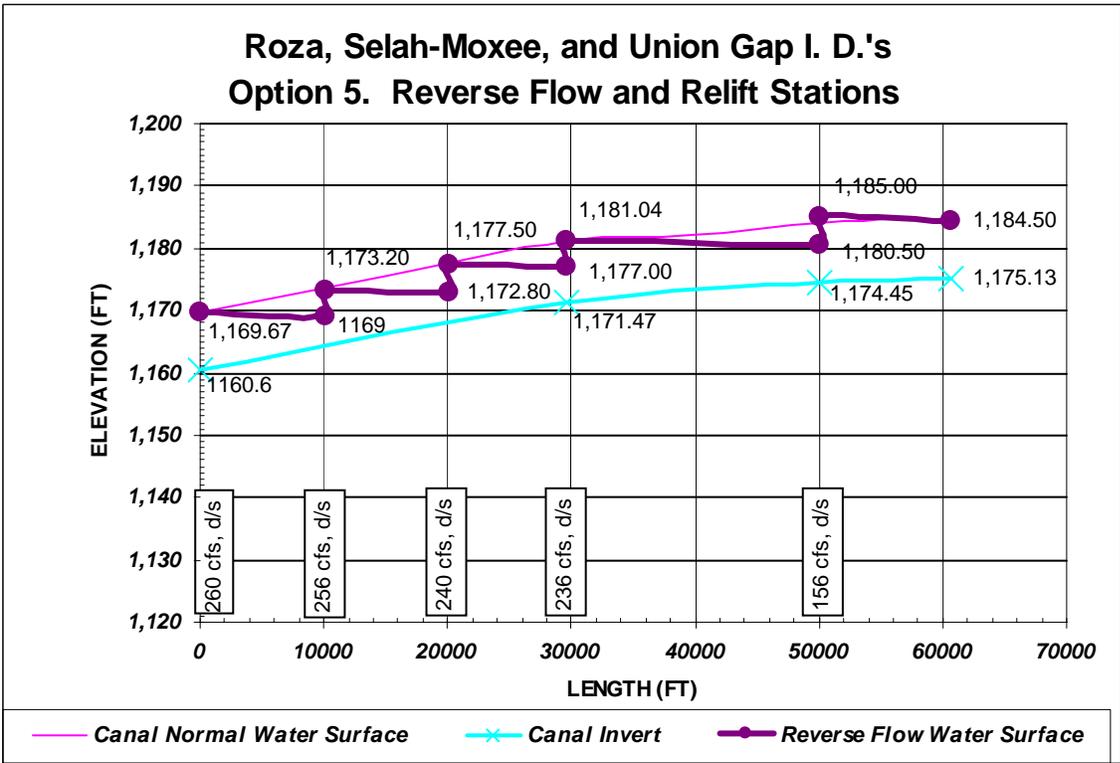
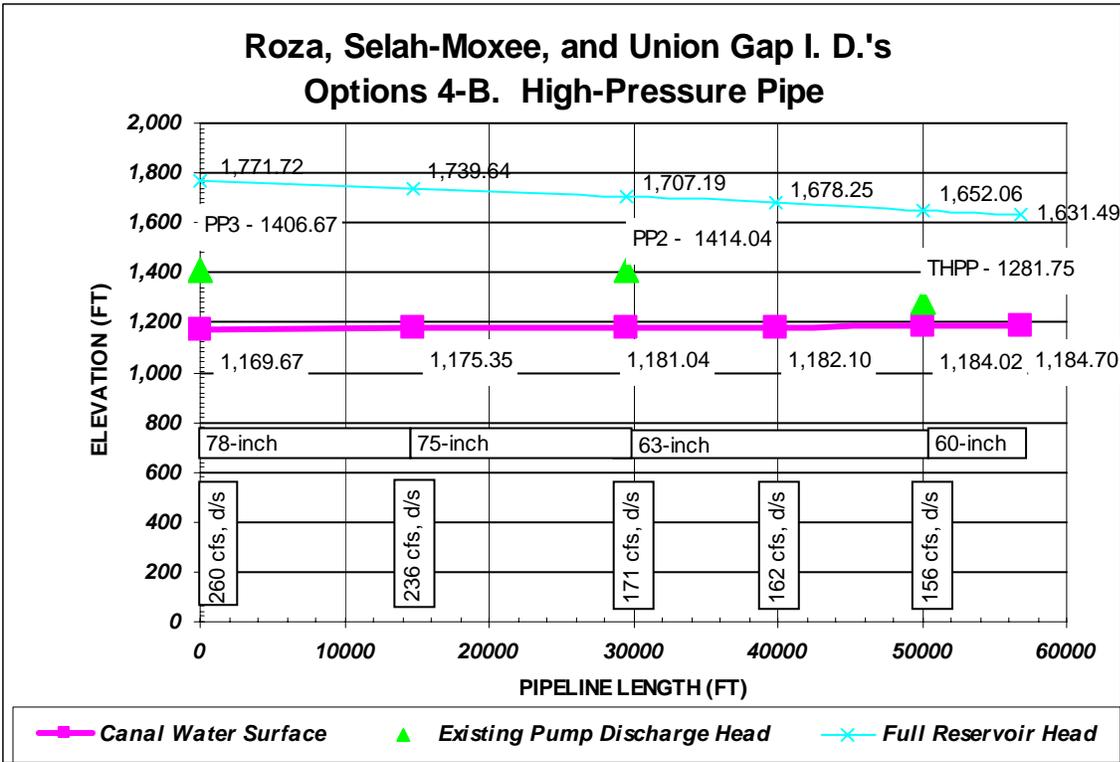


### Roza Irrigation District, Options 3 and 3-A. Low-Pressure Pipe

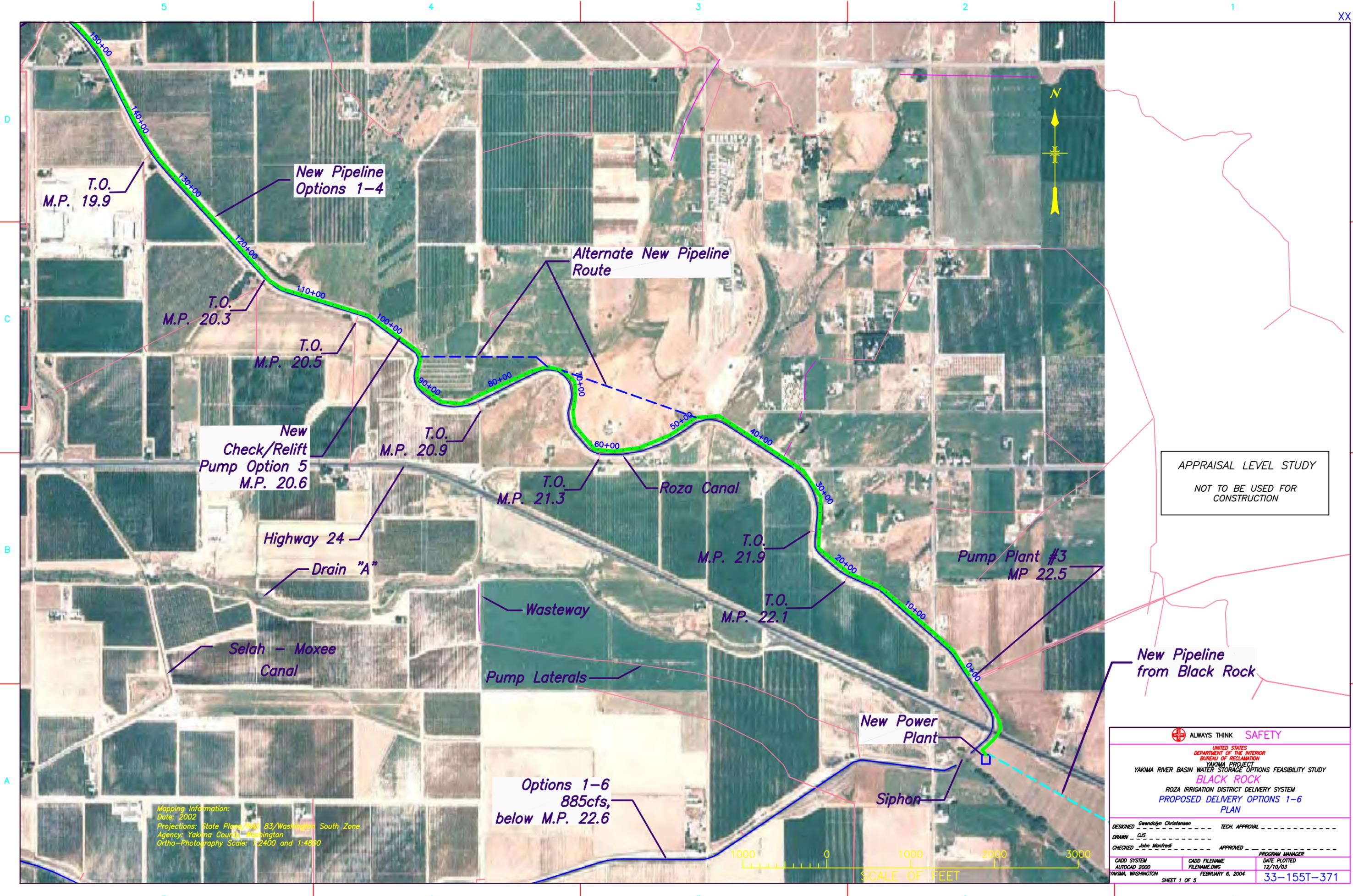


### Roza, Selah-Moxee, Union Gap I. D.'s Options 4 and 4-A. Low-Pressure Pipe





**ATTACHMENT C.**  
**AERIAL PHOTOGRAPHS**



T.O.  
M.P. 19.9

New Pipeline  
Options 1-4

Alternate New Pipeline  
Route

T.O.  
M.P. 20.3

T.O.  
M.P. 20.5

New  
Check/Relift  
Pump Option 5  
M.P. 20.6

T.O.  
M.P. 20.9

T.O.  
M.P. 21.3

Roza Canal

Highway 24

Drain "A"

T.O.  
M.P. 21.9

T.O.  
M.P. 22.1

Pump Plant #3  
MP 22.5

Selah - Moxee  
Canal

Wasteway

Pump Laterals

New Power  
Plant

New Pipeline  
from Black Rock

Options 1-6  
885cfs,  
below M.P. 22.6

Siphon

APPRAISAL LEVEL STUDY  
NOT TO BE USED FOR  
CONSTRUCTION

Mapping Information:  
Date: 2002  
Projections: State Plane/NAD 83/Washington South Zone  
Agency: Yakima County, Washington  
Ortho-Photography Scale: 1:2400 and 1:4800



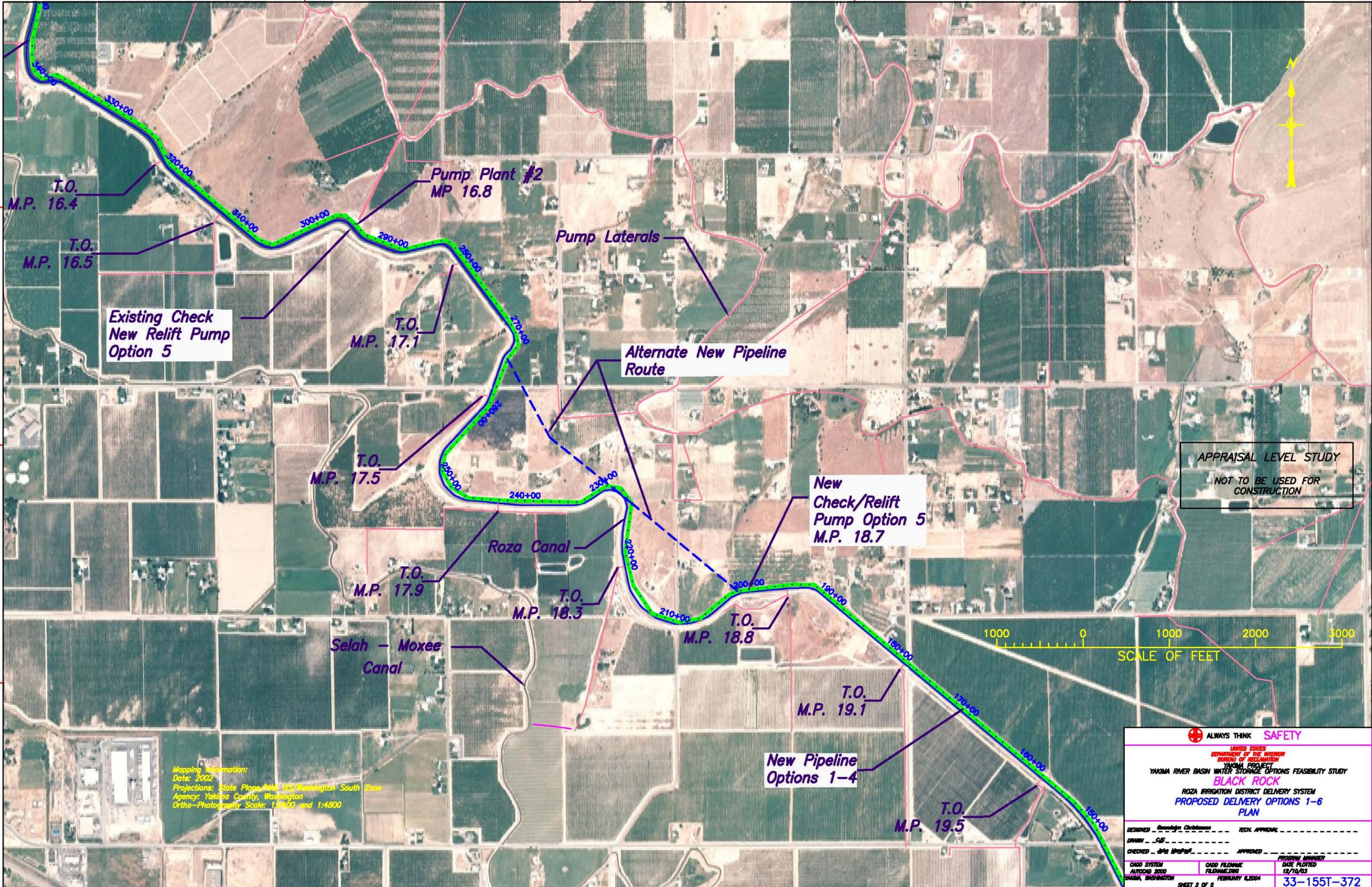
ALWAYS THINK SAFETY

UNITED STATES  
DEPARTMENT OF THE INTERIOR  
BUREAU OF RECLAMATION  
YAKIMA PROJECT  
YAKIMA RIVER BASIN WATER STORAGE OPTIONS FEASIBILITY STUDY  
BLACK ROCK  
ROZA IRRIGATION DISTRICT DELIVERY SYSTEM  
PROPOSED DELIVERY OPTIONS 1-6  
PLAN

DESIGNED: *Gwendolyn Christensen*      TECH. APPROVAL: \_\_\_\_\_  
DRAWN: *CJS*      \_\_\_\_\_  
CHECKED: *John Manfredi*      APPROVED: \_\_\_\_\_  
PROGRAM MANAGER: \_\_\_\_\_

CADD SYSTEM AUTOCAD 2000	CADD FILENAME FILENAME.DWG	DATE PLOTTED 12/10/03
YAKIMA, WASHINGTON	FEBRUARY 6, 2004	33-155T-371

SHEET 1 OF 5



Existing Check  
New Relift Pump  
Option 5

Alternate New Pipeline  
Route

New  
Check/Relift  
Pump Option 5  
M.P. 18.7

APPRAISAL LEVEL STUDY  
NOT TO BE USED FOR  
CONSTRUCTION

1000 0 1000 2000 3000  
SCALE OF FEET

Mapping Information:  
Date: 2002  
Projections: State Plane 4803 Washington South Zone  
Agency: Yakima County, Washington  
Ortho-Photography Scale: 1:2400 and 1:4800

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BUREAU OF RECLAMATION  
YAKIMA PROJECT  
YAKIMA RIVER BASIN WATER STORAGE OPTIONS FEASIBILITY STUDY  
BLACK ROCK  
ROZA IRRIGATION DISTRICT DELIVERY SYSTEM  
PROPOSED DELIVERY OPTIONS 1-6  
PLAN

DESIGNED: *Gwendolyn Christensen* TECH. APPROVAL: \_\_\_\_\_  
DRAWN: *JCS* \_\_\_\_\_  
CHECKED: *John Wright* APPROVED: \_\_\_\_\_

GRID SYSTEM AUTOCAD 2000	GRID FILENAME FILENAME.DWG	DATE PLOTTED 12/10/03
SHEET 2 OF 5		PROGRAM NUMBER 33-155T-372



New Check  
Relift  
Pump  
Option 5  
M.P. 13.0

Alternate New  
Pipeline Route  
Options 1-4

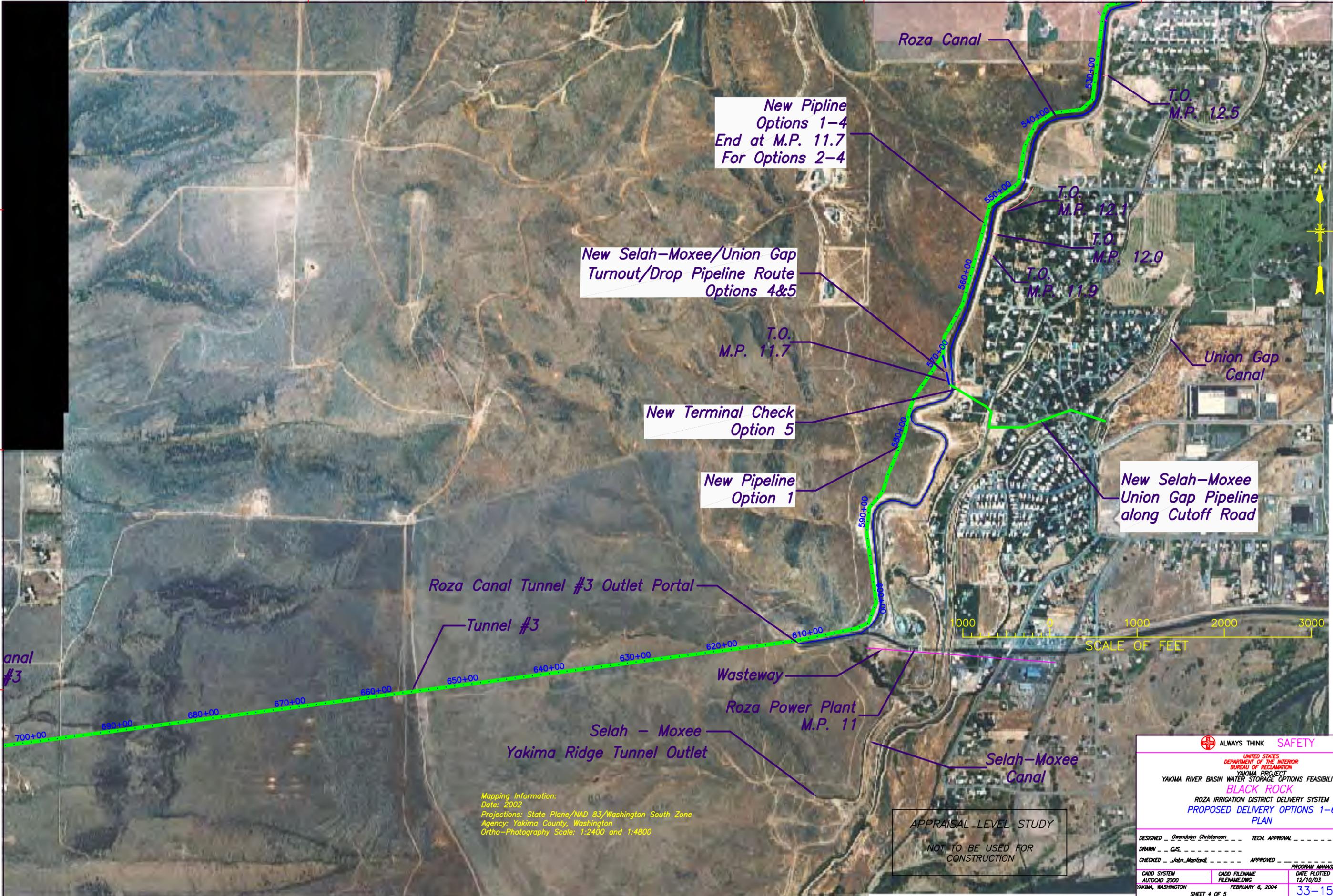
Proposed New Pipeline  
Options 1-4

APPRAISAL LEVEL STUDY  
NOT TO BE USED FOR  
CONSTRUCTION

SCALE OF FEET  
0 1000 2000 3000

Mapping Information  
Date: 2012  
Projection: State Plane/MID 83/Washington State Zone  
Agency: Yakima County, Washington  
Title: Photography Scale: 1:2500 @ 1:4800

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2012'S RIGHT APPROPRIATE TO THE IRRIGATOR STATE OF WASHINGTON SPECIAL DISTRICT YAKIMA RIVER BASIN WATER STORAGE OPTIONS FEASIBILITY STUDY BLACK ROCK ROCA IRRIGATION DISTRICT DELIVERY SYSTEM PROPOSED DELIVERY OPTIONS 1-6 PLAN			
DESIGNED: Christopher Christensen	DATE PLOTTED:	DATE APPROVED:	PROJECT NUMBER:
CHECKED: Jeff Brinker	DATE PLOTTED:	DATE APPROVED:	12/10/12
DATE PRINTED:	DATE PLOTTED:	DATE APPROVED:	33-155T-373
YAKIMA COUNTY	PLANNING	PLANNING	
YAKIMA, WASHINGTON	FEBRUARY 8, 2013		
SHEET 2 OF 2			



New Pipeline  
Options 1-4  
End at M.P. 11.7  
For Options 2-4

New Selah-Moxee/Union Gap  
Turnout/Drop Pipeline Route  
Options 4&5

T.O.  
M.P. 11.7

New Terminal Check  
Option 5

New Pipeline  
Option 1

New Selah-Moxee  
Union Gap Pipeline  
along Cutoff Road

Roza Canal Tunnel #3 Outlet Portal

Tunnel #3

Wasteway

Roza Power Plant  
M.P. 11

Selah - Moxee  
Yakima Ridge Tunnel Outlet

Selah-Moxee  
Canal

APPRAISAL LEVEL STUDY  
NOT TO BE USED FOR  
CONSTRUCTION

Mapping Information:  
Date: 2002  
Projections: State Plane/NAD 83/Washington South Zone  
Agency: Yakima County, Washington  
Ortho-Photography Scale: 1:2400 and 1:4800

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DEPARTMENT OF THE INTERIOR  
BUREAU OF RECLAMATION  
YAKIMA PROJECT  
YAKIMA RIVER BASIN WATER STORAGE OPTIONS FEASIBILITY STUDY  
BLACK ROCK  
ROZA IRRIGATION DISTRICT DELIVERY SYSTEM  
PROPOSED DELIVERY OPTIONS 1-6  
PLAN

DESIGNED *Gwendolyn Christensen* TECH. APPROVAL \_\_\_\_\_  
DRAWN *G.J.S.* \_\_\_\_\_  
CHECKED *John Manfredi* APPROVED \_\_\_\_\_  
PROGRAM MANAGER \_\_\_\_\_

CADD SYSTEM AUTOCAD 2000	CADD FILENAME FILENAME.DWG	DATE PLOTTED 12/10/03
YAKIMA, WASHINGTON	FEBRUARY 6, 2004	33-155T-374

SHEET 4 OF 5



Mapping Information:  
 Date: 2002  
 Projection: State Plane/NAD 83/Washington South Zone  
 Agency: Yakima County, Washington  
 Ortho-Photography Scale: 1:2400 and 1:4800

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UNITED STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION YAKIMA PROJECT <b>BLACK ROCK</b> ROZA IRRIGATION DISTRICT DELIVERY SYSTEM PROPOSED DELIVERY OPTIONS 1-6 PLAN		
DESIGNED <i>Gregory Christman</i>	TECH. APPROVAL _____	
DRAWN <i>CS</i>	_____	
CHECKED <i>John Marshall</i>	APPROVED _____	
CADD SYSTEM AUTOCAD 2000	CADD FILENAME FILENAME.DWG	PROGRAM NUMBER DATE PLOTTED 12/10/03
YAKIMA, WASHINGTON		FEBRUARY 6, 2004
SHEET 5 OF 5		33-155T-375

The five aerial photographs in Attachment C are excluded from this file because of their large sizes. Each individual aerial photograph can be viewed from the Roza delivery system website:

[http://137.77.133.1/pn/programs/storage\\_study/roza.html](http://137.77.133.1/pn/programs/storage_study/roza.html)

**ATTACHMENT D.**

**FIELD CONSTRUCTION COST ESTIMATE  
WORKSHEETS, PLANS 1-5**

Item	Schedule						Total	
1	Main Pipeline							\$32,490,400
			Steel Pipe Wall Thickness (in) from Table 4-2*					
		Hydraulic (ID) Diameter (in)	AWWA M11	Pounds	Unit Cost of Steel Pipe	Cost		
2	Length (ft)							
3	1,000.00	60	0.375	323110.00	\$2.00	\$646,220		
4	14,769.50	60	0.375	4772173.15	\$2.00	\$9,544,346		
5	14,769.50	57	0.3125	3964281.50	\$2.00	\$7,928,563		
6	10,234.11	45	0.25	1860049.49	\$2.00	\$3,720,099		
7	10,234.12	42	0.25	1457952.74	\$2.00	\$2,915,905		
8	6,796.77	33	0.1793	764296.79	\$2.00	\$1,528,594		
9	13,300.00	33	0.1793	861441.00	\$2.00	\$1,722,882		
10	9500	33	0.25	856140.00	\$5.00	\$4,280,700		
11	9,140.00	12	0.075	101545.40	\$2.00	\$203,091		
12								
13	Turnout and Crossing Pumping Plant 1 (MP7.2)	Quantity	Unit Quantity	Unit Cost	Cost		Total	\$155,000
14	Valves and Manifold	1	L.S.	\$100,000	\$100,000			
15	Main Pipe 12" dia crossing under plant	80	I.f.	\$250	\$20,000			
16	Civil, Electrical	1	L.S.	\$35,000	\$35,000			
17								
18	Turnout and Crossing Terrace Heights Pumping Plant	Quantity	Unit Quantity	Unit Cost	Cost		Total	\$116,000
19	Valves and Manifold	1	L.S.	\$60,000	\$60,000			
20	Main Pipe 33" dia crossing under plant	80	I.f.	\$450	\$36,000			
21	Civil, Electrical	1	L.S.	\$20,000	\$20,000			
22								
23	Turnout and Crossing Pumping Plant 2 (MP16.8)	Quantity	Unit Quantity	Unit Cost	Cost		Total	\$308,500
24								
25	Flow rate and PRV Valve w/ CheckValve feature - 16"	5	ea	\$15,000.00	\$75,000			
26	Butterfly Valve - 16"	10	ea	\$3,000.00	\$30,000			
27	Manifold Piping - 16" to 36" dia. Steel pipe	25000	lb.	\$1.50	\$37,500			
28	Manifold Fabrication	25000	lb.	\$2.00	\$50,000			
29	Concrete slab and encasement	30	cy	\$600.00	\$18,000			
30	Earthwork/site work	1	L.S.	\$5,000.00	\$5,000			
31	Electrical/Control system	1	L.S.	\$20,000.00	\$20,000			
32	Fence	1	L.S.	\$3,000.00	\$3,000			
33	Main Pipe 45" dia crossing under plant	100	I.f.	\$700.00	\$70,000			
34								
35	Turnout and Crossing Pumping Plant 3 (MP 22.5)	Quantity	Unit Quantity	Unit Cost	Cost		Total	\$348,500
36								
37	Flow rate and PRV Valve w/ CheckValve feature - 16"	5	ea	\$15,000.00	\$75,000			
38	Butterfly Valve - 16"	10	ea	\$3,000.00	\$30,000			
39	Manifold Piping - 16" to 36" dia. Steel pipe	25000	lb.	\$1.50	\$37,500			
40	Manifold Fabrication	25000	lb.	\$2.00	\$50,000			
41	Concrete slab and encasement	30	cy	\$600.00	\$18,000			
42	Earthwork/site work	1	L.S.	\$5,000.00	\$5,000			
43	Electrical/Control system	1	L.S.	\$20,000.00	\$20,000			
44	Fence	1	L.S.	\$3,000.00	\$3,000			
45	Main Pipe 60" dia crossing under plant	100	I.f.	\$1,100.00	\$110,000			
46								
47	Earthwork (CY)							
48	Excavation						Total	\$2,543,292
49	Diameter	Length	Unit Quantity	Quantity	Unit Cost	Cost		
50	60	1,000.00	8.47	8,470	\$5.00	\$42,350		
51	60	14,769.50	8.47	125,098	\$5.00	\$625,488		
52	57	14,769.50	8.01	118,318	\$5.00	\$591,592		
53	45	10,234.11	6.31	64,587	\$5.00	\$322,937		
54	42	10,234.12	5.92	60,555	\$5.00	\$302,776		
55	33	6,796.77	4.81	32,706	\$5.00	\$163,530		
56	33	13,300.00	4.81	64,000	\$5.00	\$319,998		
57	12	9,140.00	3.82	34,924	\$5.00	\$174,620		
58	Total							
59								
60	Bedding						Total	\$214,919

61	Diameter	Length	Unit Quantity	Quantity	Unit Cost	Cost		
62	60	1,000.00	0.16	164	\$25.00	\$4,100		
63	60	14,769.50	0.16	2,422	\$25.00	\$60,555		
64	57	14,769.50	0.16	2,334	\$25.00	\$58,340		
65	45	10,234.11	0.09	921	\$25.00	\$23,027		
66	42	10,234.12	0.09	890	\$25.00	\$22,259		
67	33	6,796.77	0.08	517	\$25.00	\$12,914		
68	33	13,300.00	0.08	1,011	\$25.00	\$25,270		
69	12	9,140.00	0.04	338	\$25.00	\$8,455		
70								
71	Embedment (.7)						Total	\$1,987,141
72	Diameter	Length	Unit Quantity	Quantity	Unit Cost	Cost		
73	60	1,000.00	1.52	1,524	\$25.00	\$38,100		
74	60	14,769.50	1.52	22,509	\$25.00	\$562,718		
75	57	14,769.50	1.40	20,736	\$25.00	\$518,409		
76	45	10,234.11	0.97	9,937	\$25.00	\$248,433		
77	42	10,234.12	0.87	8,945	\$25.00	\$223,616		
78	33	6,796.77	0.61	4,153	\$25.00	\$103,821		
79	33	13,300.00	0.61	8,126	\$25.00	\$203,158		
80	12	9,140.00	0.39	3,555	\$25.00	\$88,887		
81								
82								
83	Compacted Backfill						Total	\$2,227,926
84	Diameter	Length	Unit Quantity	Quantity	Unit Cost	Cost		
85	60	1,000.00	5.79	5,790	\$6.00	\$34,740		
86	60	14,769.50	5.79	85,515	\$6.00	\$513,092		
87	57	14,769.50	5.56	82,045	\$6.00	\$492,267		
88	45	10,234.11	4.65	47,548	\$6.00	\$285,286		
89	42	10,234.12	4.43	45,306	\$6.00	\$271,839		
90	33	6,796.77	3.79	25,739	\$6.00	\$154,436		
91	33	13,300.00	3.79	50,367	\$6.00	\$302,203		
92	12	9,140.00	3.17	29,010	\$6.00	\$174,062		
93								
94								
95	Farm Turnout Tees and Valves						Total	\$59,250
96	Size	Quantity	Unit Cost	Cost				
97	in	ea	\$/ea	\$				
98	14 (PP#1, MP 7.2)	1	\$3,000.00	\$3,000.00				
99	8	3	\$1,385.00	\$4,155.00				
100	6	12	\$1,150.00	\$13,800.00				
101	4	19	\$905.00	\$17,195.00				
102	2	3	\$700.00	\$2,100.00				
103	Installation	38	\$500.00	\$19,000.00				
104								
105	PRV and Valve Vaults						Total	\$589,000
106	Size	Quantity	Unit Cost	Cost				
107	in	ea	\$/ea	\$				
108	14 (PP#1, MP 7.2)	1	\$30,000.00	\$30,000.00				
109	8	3	\$17,000.00	\$51,000.00				
110	6	12	\$14,000.00	\$168,000.00				
111	4	19	\$12,000.00	\$228,000.00				
112	2	3	\$12,000.00	\$36,000.00				
113	Installation	38	\$2,000.00	\$76,000.00				
114								
115								
116	Flow Meters and Precast Vaults						Total	\$200,500
117	Size	Quantity	Unit Cost	Cost				
118	in	ea	\$/ea	\$				
119	10 (PP #1, MP 7.2)	1	\$7,000.00	\$7,000.00				
120	8	3	\$5,500.00	\$16,500.00				
121	6	12	\$4,500.00	\$54,000.00				
122	4	19	\$4,000.00	\$76,000.00				
123	2	3	\$3,000.00	\$9,000.00				
124	Installation	38	\$1,000.00	\$38,000.00				
125								
126	Steel Pipe Xings for Turnouts						Total	\$564,000
127	Size	Quantity	Unit Cost	Cost				
128	Steel Pipe Xings - 10"	3	\$18,000.00	\$54,000.00				
129	Steel Pipe Xings - 6"	34	\$15,000.00	\$510,000.00				
130								
131	Road crossings	Quantity	Unit Cost	Cost			Total	\$190,000
132	Hwy 24	1	L.S.	\$30,000.00				
133	34+00	1	L.S.	\$10,000.00				
134	147+00	1	L.S.	\$10,000.00				
135	178+00	1	L.S.	\$10,000.00				
136	210+00	1	L.S.	\$10,000.00				
137	263+00	1	L.S.	\$10,000.00				
138	404+00	1	L.S.	\$10,000.00				
139	422+50	1	L.S.	\$10,000.00				
140	441+00	1	L.S.	\$10,000.00				
141	450+00	1	L.S.	\$10,000.00				
142	467+00	1	L.S.	\$10,000.00				
143	484+00 - Terrace Height Blvd.	1	L.S.	\$30,000.00				

144	495+00	1	L.S.	\$10,000.00				
145	508+00	1	L.S.	\$10,000.00				
146	837+00	1	L.S.	\$10,000.00				
147								
148								
149								
150	Special Structures							
151	Access Manholes, Airvalves (every 2000')	40	ea	\$7,000.00			Total	\$280,000
152								
153	Fence Replacement	70000	l.f.	\$3.00			Total	\$210,000
154								
155								
156								
157								
158								
159								
160	SCADA	L.S.		\$250,000.00			Total	\$250,000
161								
162	Subtotal w/o Mobilization							\$42,734,428
163	Mobilization 5%							\$2,100,000
164	Subtotal w/ Mobilization							\$44,834,428
165	Unlisted 15%							\$6,725,164
166	CONTRACT COST							\$52,000,000
167	Construction Contingences 25%							\$13,000,000
168	FIELD COST							\$65,000,000
169								
170								
171	Right-of-Way	100	acres	\$2,500.00			Total	\$250,000
172								
173								
174								

MAINLINE PRESSURE REDUCING STATION

		Quantity	Unit Cost	Cost			Total	\$764,000
190	40" Tytan valve	2	\$150,000.00	\$300,000.00				
191	24" Tytan valve	1	\$25,000.00	\$25,000.00				
192	24" Pressure Relief Valve	1	\$25,000.00	\$25,000.00				
193	Control System		Lump Sum	\$75,000.00				
194	42" Isolation Vavles	4	\$24,000.00	\$96,000.00				
195	24" Isolation Vavles	2	\$9,000.00	\$18,000.00				
196	Manifold		Lump Sum	\$150,000.00				
197	Structure		Lump Sum	\$75,000.00				
198	Subtotal w/o Mobilization							\$764,000
199	Mobilization 5%							\$38,000
200	Subtotal w/ Mobilization							\$800,000
201	Unlisted 15%							\$120,000
202	CONTRACT COST							\$900,000
203	Construction Contingences 25%							\$225,000
204	FIELD COST							\$1,100,000
205								
206								
207								
208								
209								
210								
211								

Project: Black Rock Project Assessment  
Feature: Delivery System to Roza Irrigation District  
- Full Exchange High Pressure Pipe with Pumping Plant at Roza Canal

1	Pumping Plant - 14,000 hp							\$6,000,000
2	Subtotal from Plan 1 (line 161, above)							\$42,734,428
3								
4	Revised Subtotal w/o Mobilization							\$48,734,428
5	Mobilization 5%							\$2,400,000
6	Revised Subtotal w/ Mobilization							\$51,134,428
7	Unlisted 15%							\$7,670,164
8	CONTRACT COST							\$59,000,000
9	Construction Contingences 25%							\$14,750,000
10	FIELD COST							\$74,000,000
11								
12								
13	Right-of-Way	100	acres	\$2,500.00			Total	\$250,000
14								
15								

**Project: Black Rock Project Assessment**  
**Feature: Delivery System to Roza Irrigation District**  
**Details: Plan 2 - High Pressure Pipe**  
**Beginning Hydraulic Gradeline: 1515 ft.**

By: Wendy Christensen

Checked by: John Manfredi

Item	Schedule						Total	
1	Main Pipeline							\$11,954,557
2	Length (ft)	Hydraulic (ID) Diameter (in)	Steel Pipe Wall Thickness (in) from Table 4-2* AWWA M11	Pounds	Unit Cost of Steel Pipe	Cost		
3	1,000.00	60	0.3750	241830	\$2.00	\$483,660		
4	14,769.50	51	0.3125	2529719.96	\$2.00	\$5,059,440		
5	14,769.50	48	0.3125	2381729.57	\$2.00	\$4,763,459		
6	10,234.11	27	0.1563	475783.7739	\$2.00	\$951,568		
7	10,234.12	18	0.1046	227504.49	\$2.00	\$455,009		
8	6,796.77	15	0.1046	120710.64	\$2.00	\$241,421		
9								
10								
11								
12								
13								
14								
15	Turnout and Crossing Pumping Plant Terrace Heights	Quantity	Unit Quantity	Unit Cost	Cost		Total	\$104,000
16	Valves and Manifold	1	L.S.	\$60,000.00	\$60,000.00			
17	Main Pipe 18" dia crossing under plant	80	l.f.	\$300.00	\$24,000.00			
18	Civil, Electrical	1	L.S.	\$20,000.00	\$20,000.00			
19								
20	Turnout and Crossing Pumping Plant 2 (MP16.8)	Quantity	Unit Quantity	Unit Cost	Cost		Total	\$278,500
21								
22	Flow rate and PRV Valve w/ CheckValve feature - 16"	5	ea	\$15,000.00	\$75,000.00			
23	Butterfly Valve - 16"	10	ea	\$3,000.00	\$30,000.00			
24	Manifold Piping - 16" to 36" dia. Steel pipe	25000	lb.	\$1.50	\$37,500.00			
25	Manifold Fabrication	25000	lb.	\$2.00	\$50,000.00			
26	Concrete slab and encasement	30	cy	\$600.00	\$18,000.00			
27	Earthwork/site work	1	L.S.	\$5,000.00	\$5,000.00			
28	Electrical/Control system	1	L.S.	\$20,000.00	\$20,000.00			
29	Fence	1	L.S.	\$3,000.00	\$3,000.00			
30	Main Pipe 27" dia crossing under plant	100	l.f.	\$400.00	\$40,000.00			
31								
32	Turnout and Crossing Pumping Plant 3 (MP 22.5)	Quantity	Unit Quantity	Unit Cost	Cost		Total	\$333,500
33								
34	Flow rate and PRV Valve w/ CheckValve feature - 16"	5	ea	\$15,000.00	\$75,000.00			
35	Butterfly Valve - 16"	10	ea	\$3,000.00	\$30,000.00			
36	Manifold Piping - 16" to 36" dia. Steel pipe	25000	lb.	\$1.50	\$37,500.00			
37	Manifold Fabrication	25000	lb.	\$2.00	\$50,000.00			
38	Concrete slab and encasement	30	cy	\$600.00	\$18,000.00			
39	Earthwork/site work	1	L.S.	\$5,000.00	\$5,000.00			
40	Electrical/Control system	1	L.S.	\$20,000.00	\$20,000.00			
41	Fence	1	L.S.	\$3,000.00	\$3,000.00			
42	Main Pipe 51" dia crossing under plant	100	l.f.	\$950.00	\$95,000.00			
43								
44	Earthwork (CY)							
45	Excavation						Total	\$1,602,519
46	Diameter	Length	Unit Quantity	Quantity	Unit Cost	Cost		
47	60	1,000.00	8.47	8,468	\$5.00	\$42,340		
48	51	14,769.50	7.14	105,395	\$5.00	\$526,976		
49	48	14,769.50	6.72	99,207	\$5.00	\$496,034		
50	27	10,234.11	4.14	42,359	\$5.00	\$211,795		
51	18	10,234.12	3.82	39,105	\$5.00	\$195,523		
52	15	6,796.77	3.82	25,970	\$5.00	\$129,852		
53								
54								
55	Total							
56								
57	Bedding						Total	\$114,170
58	Diameter	Length	Unit Quantity	Quantity	Unit Cost	Cost		
59	60	1,000.00	0.16	164	\$25.00	\$4,100		

60	51	14,769.50	0.10	1,433	\$25.00	\$35,816		
61	48	14,769.50	0.09	1,388	\$25.00	\$34,708		
62	27	10,234.11	0.07	706	\$25.00	\$17,654		
63	18	10,234.12	0.06	604	\$25.00	\$15,095		
64	15	6,796.77	0.04	272	\$25.00	\$6,797		
65								
66								
67								
68	Embedment (.7)						Total	\$1,151,690
69	Diameter	Length	Unit Quantity	Quantity	Unit Cost	Cost		
70	60	1,000.00	1.52	1,524	\$25.00	\$38,100		
71	51	14,769.50	1.18	17,398	\$25.00	\$434,962		
72	48	14,769.50	1.07	15,833	\$25.00	\$395,823		
73	27	10,234.11	0.46	4,687	\$25.00	\$117,181		
74	18	10,234.12	0.39	3,981	\$25.00	\$99,527		
75	15	6,796.77	0.39	2,644	\$25.00	\$66,099		
76								
77								
78								
79								
80	Compacted Backfill						Total	\$1,449,208
81	Diameter	Length	Unit Quantity	Quantity	Unit Cost	Cost		
82	60	1,000.00	5.79	5,790	\$6.00	\$34,740		
83	51	14,769.50	5.09	75,236	\$6.00	\$451,415		
84	48	14,769.50	4.87	71,913	\$6.00	\$431,476		
85	27	10,234.11	3.38	34,540	\$6.00	\$207,241		
86	18	10,234.12	3.17	32,483	\$6.00	\$194,899		
87	15	6,796.77	3.17	21,573	\$6.00	\$129,438		
88								
89								
90								
91								
92	Farm Turnout Tees and Valves						Total	\$43,515
93	Size	Quantity	Unit Cost	Cost				
94	in	ea	\$/ea	\$				
95								
96	8	3	\$1,385.00	\$4,155.00				
97	6	12	\$1,150.00	\$13,800.00				
98	4	12	\$905.00	\$10,860.00				
99	2	1	\$700.00	\$700.00				
100	Installation	28	\$500.00	\$14,000.00				
101								
102	PRV and Valve Vaults						Total	\$431,000
103	Size	Quantity	Unit Cost	Cost				
104	in	ea	\$/ea	\$				
105								
106	8	3	\$17,000.00	\$51,000.00				
107	6	12	\$14,000.00	\$168,000.00				
108	4	12	\$12,000.00	\$144,000.00				
109	2	1	\$12,000.00	\$12,000.00				
110	Installation	28	\$2,000.00	\$56,000.00				
111								
112								
113	Flow Meters and Precast Vaults						Total	\$149,500
114	Size	Quantity	Unit Cost	Cost				
115	in	ea	\$/ea	\$				
116								
117	8	3	\$5,500.00	\$16,500.00				
118	6	12	\$4,500.00	\$54,000.00				
119	4	12	\$4,000.00	\$48,000.00				
120	2	1	\$3,000.00	\$3,000.00				
121	Installation	28	\$1,000.00	\$28,000.00				
122								
123	Steel Pipe Xings for Turnouts						Total	\$429,000
124	Size	Quantity	Unit Cost	Cost				
125	Steel Pipe Xings - 10"	3	\$18,000.00	\$54,000.00				
126	Steel Pipe Xings - 6"	25	\$15,000.00	\$375,000.00				
127								
128	Road crossings	Quantity	Unit Cost	Cost			Total	\$180,000
129	Hwy 24	1	L.S.	\$30,000.00				
130	34+00	1	L.S.	\$10,000.00				
131	147+00	1	L.S.	\$10,000.00				
132	178+00	1	L.S.	\$10,000.00				
133	210+00	1	L.S.	\$10,000.00				
134	263+00	1	L.S.	\$10,000.00				
135	404+00	1	L.S.	\$10,000.00				
136	422+50	1	L.S.	\$10,000.00				
137	441+00	1	L.S.	\$10,000.00				
138	450+00	1	L.S.	\$10,000.00				
139	467+00	1	L.S.	\$10,000.00				

140	484+00 - Terrace Height Blvd.	1	L.S.	\$30,000.00			
141	495+00	1	L.S.	\$10,000.00			
142	508+00	1	L.S.	\$10,000.00			
143							
144							
145							
146							
147	Special Structures						
148	Access Manholes, Airvalves (every 2000')	30	ea	\$7,000.00		Total	\$210,000
149							
150	Fence Replacement	50000	l.f.	\$3.00		Total	\$150,000
151							
152							
153							
154							
155							
156							
157	SCADA	L.S.		\$200,000.00		Total	\$200,000
158							
159	Subtotal w/o Mobilization						\$18,781,160
160	Mobilization 5%						\$940,000
161	Subtotal w/ Mobilization						\$19,721,160
162	Unlisted 15%						\$2,958,174
163	CONTRACT COST						\$23,000,000
164	Construction Contingences 25%						\$5,750,000
165	FIELD COST						\$29,000,000
166							
167							
168	Right-of-Way	90	acres	\$2,500.00		Total	\$225,000
169							
170							
171							

MAINLINE PRESSURE REDUCING STATION

		Quantity	Unit Cost	Cost		Total	\$764,000
190	40" Tytan valve	2	\$150,000.00	\$300,000.00			
191	24" Tytan valve	1	\$25,000.00	\$25,000.00			
192	24" Pressure Relief Valve	1	\$25,000.00	\$25,000.00			
193	Control System		Lump Sum	\$75,000.00			
194	42" Isolation Vavles	4	\$24,000.00	\$96,000.00			
195	24" Isolation Vavles	2	\$9,000.00	\$18,000.00			
196	Manifold		Lump Sum	\$150,000.00			
197	Structure		Lump Sum	\$75,000.00			
198	Subtotal w/o Mobilization						\$764,000
199	Mobilization 5%						\$38,000
200	Subtotal w/ Mobilization						\$800,000
201	Unlisted 15%						\$120,000
202	CONTRACT COST						\$900,000
203	Construction Contingences 25%						\$225,000
204	FIELD COST						\$1,100,000
205							
206							
207							
208							
209							
210							
211							

Project: Black Rock Project Assessment  
Feature: Delivery System to Roza Irrigation District  
Plan 2-A - High Pressure Pipe with Pumping Plant at Roza Canal

1	Pumping Plant - 12,000 hp						\$5,250,000.00
2	ubtotal from Plan 2 (line 158, above)						\$18,781,160.15
3							
4	Revised Subtotal w/o Mobilization						\$24,031,160.15
5	Mobilization 5%						\$1,200,000.00
6	Revised Subtotal w/ Mobilization						\$25,231,160.15
7	Unlisted 15%						\$3,784,674.02
8	CONTRACT COST						\$29,000,000.00
9	Construction Contingences 25%						\$7,250,000.00
10	FIELD COST						\$36,000,000.00
11							
12							
13	Right-of-Way	90	acres	\$2,500.00		Total	\$225,000.00
14							

**Project: Black Rock Project Assessment**  
**Feature: Delivery System to Roza Irrigation District**  
**Details: Plan 3 - Low Pressure Pipe**  
**Beginning Hydraulic Gradeline: 1270 ft.**

By: Wendy Christensen

Checked by: John Manfredi

Item	Schedule						Total	
1	Main Pipeline							\$11,545,821
		<b>Hydraulic (ID) Diameter (in)</b>	<b>Steel Pipe Wall Thickness (in) from Table 4-2* AWWA M11</b>	<b>Pounds</b>	<b>Unit Cost of Steel Pipe</b>	<b>Cost</b>		
2	Length (ft)							
3	1,000.00	60	0.25	160,890.00	\$2.00	321,780		
4	14,769.50	60	0.25	2,376,264.86	\$2.00	4,752,530		
5	14,769.50	60	0.25	2,376,264.86	\$2.00	4,752,530		
6	10,234.11	30	0.1046	364,743.68	\$2.00	729,487		
7	10,234.12	27	0.1046	341,819.61	\$2.00	683,639		
8	6,796.77	24	PVC		\$45.00	305,855		
9								
10								
11								
12								
13								
14								
15	Turnout and Crossing Pumping Plant Terrace Heights	Quantity	Unit Quantity	Unit Cost	Cost		Total	\$113,800
16	Valves and Manifold	1	L.S.	\$60,000.00	\$60,000.00			
17	Main Pipe 24" dia crossing under plant	80	l.f.	\$360.00	\$28,800.00			
18	Civil, Electrical	1	L.S.	\$25,000.00	\$25,000.00			
19								
20	Turnout and Crossing Pumping Plant 2 (MP16.8)	Quantity	Unit Quantity	Unit Cost	Cost		Total	\$256,000
21								
22	Flow rate and PRV Valve w/ Check Valve feature - 16"	5	ea	\$15,000.00	\$75,000.00			
23	Butterfly Valve - 16"	10	ea	\$3,000.00	\$30,000.00			
24	Manifold Piping - 16" to 36" dia. Steel pipe	18,000	lb.	\$1.50	\$27,000.00			
25	Manifold Fabrication	18,000	lb.	\$2.00	\$36,000.00			
26	Concrete slab and encasement	30	cy	\$600.00	\$18,000.00			
27	Earthwork/site work	1	L.S.	\$5,000.00	\$5,000.00			
28	Electrical/Control system	1	L.S.	\$20,000.00	\$20,000.00			
29	Fence	1	L.S.	\$3,000.00	\$3,000.00			
30	Main Pipe 30" dia crossing under plant	100	l.f.	\$420.00	\$42,000.00			
31								
32	Turnout and Crossing Pumping Plant 3 (MP 22.5)	Quantity	Unit Quantity	Unit Cost	Cost		Total	\$318,000
33								
34	Flow rate and PRV Valve w/ Check Valve feature - 16"	5	ea	\$15,000.00	\$75,000.00			
35	Butterfly Valve - 16"	10	ea	\$3,000.00	\$30,000.00			
36	Manifold Piping - 16" to 36" dia. Steel pipe	18,000	lb.	\$1.50	\$27,000.00			
37	Manifold Fabrication	18,000	lb.	\$2.00	\$36,000.00			
38	Concrete slab and encasement	20	cy	\$600.00	\$12,000.00			
39	Earthwork/site work	1	L.S.	\$5,000.00	\$5,000.00			
40	Electrical/Control system	1	L.S.	\$20,000.00	\$20,000.00			
41	Fence	1	L.S.	\$3,000.00	\$3,000.00			
42	Main Pipe 60" dia crossing under plant	100	l.f.	\$1,100.00	\$110,000.00			
43								
44	Earthwork (CY)							
45	Excavation						Total	\$1,863,350
46	Diameter	Length	Unit Quantity	Quantity	Unit Cost	Cost		
47	60	1,000.00	8.47	8,468	\$5.00	42,340		
48	60	14,769.50	8.47	125,068	\$5.00	625,341		
49	60	14,769.50	8.47	125,068	\$5.00	625,341		
50	30	10,234.11	4.47	45,736	\$5.00	228,681		
51	27	10,234.12	4.14	42,359	\$5.00	211,795		
52	24	6,796.77	3.82	25,970	\$5.00	129,852		
53								
54								
55	Total							
56								
57	Bedding						Total	\$172,330
58	Diameter	Length	Unit Quantity	Quantity	Unit Cost	Cost		
59	60	1,000.00	0.16	164	\$25.00	4,100		
60	60	14,769.50	0.16	2,422	\$25.00	60,555		

61	60	14,769.50	0.16	2,422	\$25.00	60,555	
62	30	10,234.11	0.07	737	\$25.00	18,421	
63	27	10,234.12	0.07	706	\$25.00	17,654	
64	24	6,796.77	0.07	442	\$25.00	11,045	
65							
66							
67							
68	Embedment (.7)						Total \$1,482,929
69	Diameter	Length	Unit Quantity	Quantity	Unit Cost	Cost	
70	60	1,000.00	1.52	1,524	\$25.00	38,100	
71	60	14,769.50	1.52	22,509	\$25.00	562,718	
72	60	14,769.50	1.52	22,509	\$25.00	562,718	
73	30	10,234.11	0.53	5,445	\$25.00	136,114	
74	27	10,234.12	0.46	4,687	\$25.00	117,181	
75	24	6,796.77	0.39	2,644	\$25.00	66,099	
76							
77							
78							
79							
80	Compacted Backfill						Total \$1,617,432
81	Diameter	Length	Unit Quantity	Quantity	Unit Cost	Cost	
82	60	1,000.00	5.79	5,790	\$6.00	34,740	
83	60	14,769.50	5.79	85,515	\$6.00	513,092	
84	60	14,769.50	5.79	85,515	\$6.00	513,092	
85	30	10,234.11	3.58	36,638	\$6.00	219,829	
86	27	10,234.12	3.38	34,540	\$6.00	207,241	
87	24	6,796.77	3.17	21,573	\$6.00	129,438	
88							
89							
90							
91							
92	Farm Turnout Tees and Valves						Total \$43,515
93	Size	Quantity	Unit Cost	Cost			
94	in	ea	\$/ea	\$			
95							
96	8	3	\$1,385.00	\$4,155.00			
97	6	12	\$1,150.00	\$13,800.00			
98	4	12	\$905.00	\$10,860.00			
99	2	1	\$700.00	\$700.00			
100	Installation	28	\$500.00	\$14,000.00			
101							
102	PRV and Valve Vaults						Total \$431,000
103	Size	Quantity	Unit Cost	Cost			
104	in	ea	\$/ea	\$			
105							
106	8	3	\$17,000.00	\$51,000.00			
107	6	12	\$14,000.00	\$168,000.00			
108	4	12	\$12,000.00	\$144,000.00			
109	2	1	\$12,000.00	\$12,000.00			
110	Installation	28	\$2,000.00	\$56,000.00			
111							
112							
113	Flow Meters and Precast Vaults						Total \$149,500
114	Size	Quantity	Unit Cost	Cost			
115	in	ea	\$/ea	\$			
116							
117	8	3	\$5,500.00	\$16,500.00			
118	6	12	\$4,500.00	\$54,000.00			
119	4	12	\$4,000.00	\$48,000.00			
120	2	1	\$3,000.00	\$3,000.00			
121	Installation	28	\$1,000.00	\$28,000.00			
122							
123	Steel Pipe Xings for Turnouts						Total \$429,000
124	Size	Quantity	Unit Cost	Cost			
125	Steel Pipe Xings - 10"	3	\$18,000.00	\$54,000.00			
126	Steel Pipe Xings - 6"	25	\$15,000.00	\$375,000.00			
127							
128	Road crossings	Quantity	Unit Cost	Cost			Total \$180,000
129	Hwy 24	1	L.S.	\$30,000.00			
130	34+00	1	L.S.	\$10,000.00			
131	147+00	1	L.S.	\$10,000.00			
132	178+00	1	L.S.	\$10,000.00			
133	210+00	1	L.S.	\$10,000.00			
134	263+00	1	L.S.	\$10,000.00			
135	404+00	1	L.S.	\$10,000.00			
136	422+50	1	L.S.	\$10,000.00			
137	441+00	1	L.S.	\$10,000.00			
138	450+00	1	L.S.	\$10,000.00			
139	467+00	1	L.S.	\$10,000.00			
140	484+00 - Terrace Height Blvd.	1	L.S.	\$30,000.00			
141	495+00	1	L.S.	\$10,000.00			

142	508+00	1	L.S.	\$10,000.00				
143								
144								
145								
146								
147	Special Structures							
148	Access Manholes, Airvalves (every 2000')	30	ea	\$7,000.00			Total	\$210,000
149								
150	Fence Replacement	50000	l.f.	\$3.00			Total	\$150,000
151								
152								
153								
154								
155								
156								
157	SCADA	L.S.		\$200,000.00			Total	\$200,000
158								
159	Subtotal w/o Mobilization							\$19,162,676
160	Mobilization 5%							\$960,000
161	Subtotal w/ Mobilization							\$20,122,676
162	Unlisted 15%							\$3,018,401
163	CONTRACT COST							\$23,000,000
164	Construction Contingences 25%							\$5,750,000
165	FIELD COST							\$29,000,000
166								
167								
168	Right-of-Way	90	acres	\$2,500.00			Total	\$225,000
169								
170								
171								

MAINLINE PRESSURE REDUCING STATION

		Quantity	Unit Cost	Cost			Total	\$764,000
190	40" Tytan valve	2	\$150,000.00	\$300,000.00				
191	24" Tytan valve	1	\$25,000.00	\$25,000.00				
192	24" Pressure Relief Valve	1	\$25,000.00	\$25,000.00				
193	Control System		Lump Sum	\$75,000.00				
194	42" Isolation Vavles	4	\$24,000.00	\$96,000.00				
195	24" Isolation Vavles	2	\$9,000.00	\$18,000.00				
196	Manifold		Lump Sum	\$150,000.00				
197	Structure		Lump Sum	\$75,000.00				
198	Subtotal w/o Mobilization							\$764,000
199	Mobilization 5%							\$38,000
200	Subtotal w/ Mobilization							\$800,000
201	Unlisted 15%							\$120,000
202	CONTRACT COST							\$900,000
203	Construction Contingences 25%							\$225,000
204	FIELD COST							\$1,100,000
205								
206								
207								
208								
209								
210								
211								

Project: Black Rock Project Assessment  
Feature: Delivery System to Roza Irrigation District  
Plan 3-A - Low Pressure Pipe with Pumping Plant at Roza Canal

1	Pumping Plant - 3,300 hp							\$2,000,000
2	ubtotal from Plan 3 (line 158, above)							\$19,162,676
3								
4	Revised Subtotal w/o Mobilization							\$21,162,676
5	Mobilization 5%							\$1,100,000
6	Revised Subtotal w/ Mobilization							\$22,262,676
7	Unlisted 15%							\$3,339,401
8	CONTRACT COST							\$26,000,000
9	Construction Contingences 25%							\$6,500,000
10	FIELD COST							\$33,000,000
11								
12								
13	Right-of-Way	90	acres	\$2,500.00			Total	\$225,000
14								
15								
16								

Item	Schedule						Total	\$26,508,271
1	Main Pipeline							
		Hydraulic (ID) Diameter (in)	Steel Pipe Wall Thickness (in) from Table 4-2' AWWA M11	Pounds	Pounds	Cost		
2	Length (ft)							
3	1,000.00	78	0.31	261,400.00	\$2.00	\$522,800		
4	14,769.50	78	0.31	3,860,747.30	\$2.00	\$7,721,495		
5	14,769.50	75	0.31	3,712,904.61	\$2.00	\$7,425,809		
6	10,234.11	63	0.31	2,162,774.47	\$2.00	\$4,325,549		
7	10,234.12	63	0.31	2,162,776.58	\$2.00	\$4,325,553		
8	6,796.77	60	0.25	1,093,532.33	\$2.00	\$2,187,065		
9								
10								
11								
12								
13								
14								
15	Turnout and Crossing Pumping Plant Terrace Heights						Total	\$168,000
16	Valves and Manifold	Quantity	Unit Quantity	Unit Cost	Cost			
		1	L.S.	\$60,000.00	\$60,000.00			
17	Main Pipe 60" dia crossing under plant	80	l.f.	\$1,100.00	\$88,000.00			
18	Civil, Electrical	1	L.S.	\$20,000.00	\$20,000.00			
19								
20	Turnout and Crossing Pumping Plant 2 (MP16.8)						Total	\$334,000
21		Quantity	Unit Quantity	Unit Cost	Cost			
22	Flow rate and PRV Valve w/ Check Valve feature - 16"	5	ea	\$15,000.00	\$75,000.00			
23	Butterfly Valve - 16"	10	ea	\$3,000.00	\$30,000.00			
24	Manifold Piping - 16" to 36" dia. Steel pipe	18,000	lb.	\$1.50	\$27,000.00			
25	Manifold Fabrication	18,000	lb.	\$2.00	\$36,000.00			
26	Concrete slab and encasement	30	cy	\$600.00	\$18,000.00			
27	Earthwork/site work	1	L.S.	\$5,000.00	\$5,000.00			
28	Electrical/Control system	1	L.S.	\$20,000.00	\$20,000.00			
29	Fence	1	L.S.	\$3,000.00	\$3,000.00			
30	Main Pipe 63" dia crossing under plant	100	l.f.	\$1,200.00	\$120,000.00			
31								
32	Turnout and Crossing Pumping Plant 3 (MP 22.5)						Total	\$349,000
33		Quantity	Unit Quantity	Unit Cost	Cost			
34	Flow rate and PRV Valve w/ Check Valve feature - 16"	5	ea	\$15,000.00	\$75,000.00			
35	Butterfly Valve - 16"	10	ea	\$3,000.00	\$30,000.00			
36	Manifold Piping - 16" to 36" dia. Steel pipe	18,000	lb.	\$1.50	\$27,000.00			
37	Manifold Fabrication	18,000	lb.	\$2.00	\$36,000.00			
38	Concrete slab and encasement	30	cy	\$600.00	\$18,000.00			
39	Earthwork/site work	1	L.S.	\$5,000.00	\$5,000.00			
40	Electrical/Control system	1	L.S.	\$20,000.00	\$20,000.00			
41	Fence	1	L.S.	\$3,000.00	\$3,000.00			
42	Main Pipe 78" dia crossing under plant	100	l.f.	\$1,350.00	\$135,000.00			
43								
44	Earthwork (CY)							
45	Excavation						Total	\$2,915,046
46	Diameter	Length	Unit Quantity	Quantity	Unit Cost	Cost		
47	78	1,000.00	11.47	11,470	\$5.00	\$57,350.00		
48	78	14,769.50	11.47	169,406	\$5.00	\$847,030.83		
49	75	14,769.50	10.94	161,578	\$5.00	\$807,891.65		
50	63	10,234.11	8.94	91,493	\$5.00	\$457,464.72		
51	63	10,234.12	8.94	91,493	\$5.00	\$457,465.16		
52	60	6,796.77	8.47	57,569	\$5.00	\$287,843.21		
53								
54								
55	Total							
56								
57	Bedding						Total	\$262,140
58	Diameter	Length	Unit Quantity	Quantity	Unit Cost	Cost		
59	78	1,000.00	0.20	196	\$25.00	\$4,900		
60	78	14,769.50	0.20	2,895	\$25.00	\$72,371		
61	75	14,769.50	0.19	2,821	\$25.00	\$70,524		
62	63	10,234.11	0.17	1,730	\$25.00	\$43,239		
63	63	10,234.12	0.17	1,730	\$25.00	\$43,239		
64	60	6,796.77	0.16	1,115	\$25.00	\$27,867		
65								
66								

67									
68	Embedment (.7)						Total	\$2,834,644	
69	Diameter	Length	Unit Quantity	Quantity	Unit Cost	Cost			
70	78	1,000.00	2.34	2,340	\$25.00	\$58,500			
71	78	14,769.50	2.34	34,561	\$25.00	\$864,016			
72	75	14,769.50	2.19	32,375	\$25.00	\$809,369			
73	63	10,234.11	1.65	16,876	\$25.00	\$421,901			
74	63	10,234.12	1.65	16,876	\$25.00	\$421,902			
75	60	6,796.77	1.52	10,358	\$25.00	\$258,957			
76									
77									
78									
79									
80	Compacted Backfill						Total	\$2,283,720	
81	Diameter	Length	Unit Quantity	Quantity	Unit Cost	Cost			
82	78	1,000.00	7.26	7,262	\$6.00	\$43,572			
83	78	14,769.50	7.26	107,256	\$6.00	\$643,537			
84	75	14,769.50	7.00	103,387	\$6.00	\$620,319			
85	63	10,234.11	6.03	61,681	\$6.00	\$370,086			
86	63	10,234.12	6.03	61,681	\$6.00	\$370,086			
87	60	6,796.77	5.79	39,353	\$6.00	\$236,120			
88									
89									
90									
91									
92	Farm Turnout Tees and Valves						Total	\$43,515	
93	Size	Quantity	Unit Cost	Cost					
94	in	ea	\$/ea	\$					
95									
96	8	3	\$1,385.00	\$4,155.00					
97	6	12	\$1,150.00	\$13,800.00					
98	4	12	\$905.00	\$10,860.00					
99	2	1	\$700.00	\$700.00					
100	Installation	28	\$500.00	\$14,000.00					
101									
102	PRV and Valve Vaults						Total	\$431,000	
103	Size	Quantity	Unit Cost	Cost					
104	in	ea	\$/ea	\$					
105									
106	8	3	\$17,000.00	\$51,000.00					
107	6	12	\$14,000.00	\$168,000.00					
108	4	12	\$12,000.00	\$144,000.00					
109	2	1	\$12,000.00	\$12,000.00					
110	Installation	28	\$2,000.00	\$56,000.00					
111									
112									
113	Flow Meters and Precast Vaults						Total	\$149,500	
114	Size	Quantity	Unit Cost	Cost					
115	in	ea	\$/ea	\$					
116									
117	8	3	\$5,500.00	\$16,500.00					
118	6	12	\$4,500.00	\$54,000.00					
119	4	12	\$4,000.00	\$48,000.00					
120	2	1	\$3,000.00	\$3,000.00					
121	Installation	28	\$1,000.00	\$28,000.00					
122									
123	Steel Pipe Xings for Turnouts						Total	\$429,000	
124	Size	Quantity	Unit Cost	Cost					
125	Steel Pipe Xings - 10"	3	\$18,000.00	\$54,000.00					
126	Steel Pipe Xings - 6"	25	\$15,000.00	\$375,000.00					
127									
128	Road crossings	Quantity	Unit Cost	Cost			Total	\$180,000	
129	Hwy 24	1	L.S.	\$30,000.00					
130	34+00	1	L.S.	\$10,000.00					
131	147+00	1	L.S.	\$10,000.00					
132	178+00	1	L.S.	\$10,000.00					
133	210+00	1	L.S.	\$10,000.00					
134	263+00	1	L.S.	\$10,000.00					
135	404+00	1	L.S.	\$10,000.00					
136	422+50	1	L.S.	\$10,000.00					
137	441+00	1	L.S.	\$10,000.00					
138	450+00	1	L.S.	\$10,000.00					
139	467+00	1	L.S.	\$10,000.00					
140	484+00 - Terrace Height Blvd.	1	L.S.	\$30,000.00					
141	495+00	1	L.S.	\$10,000.00					
142	508+00	1	L.S.	\$10,000.00					
143									
144	ah-Moxee/Union Gap Drop Structure						Total	\$420,360	
145	Upstream Shutoff Valve, 36" BFV	2	ea	\$10,000.00	\$20,000.00				
146	Road crossings	3	ea	\$10,000.00	\$30,000.00				
147	Pipe 33" - Union Gap	550	l.f.	\$180.00	\$99,000.00				
148	Pipe 36" - Selah-Moxee	100	l.f.	\$200.00	\$20,000.00				
149	Flow rate and PRV Valve w/ Check Valve feature - 16"	8	ea	\$15,000.00	\$120,000.00				
150	Butterfly Valve - 16"	16	ea	\$2,000.00	\$32,000.00				
151	Manifold Piping - 16" to 36" dia. Steel pipes	15000	lb.	\$3.00	\$45,000.00				

152	Concrete Outlet Boxes	60	cy	\$700.00	\$42,000.00		
153	Safety Racks (6x10)	2800	lb	\$4.00	\$11,200.00		
154	Excavation	100	cy	\$8.00	\$800.00		
155	Compacted Backfill	30	cy	\$12.00	\$360.00		
156							
157							
158							
159							
160							
161	Special Structures						
162	Access Manholes, Airvalves (every 2000')	30	ea	\$7,000.00		Total	\$210,000
163							
164	Fence Replacement	50000	l.f.	\$3.00		Total	\$150,000
165							
166							
167							
168							
169	SCADA	L.S.		\$230,000.00		Total	\$230,000
170							
171	Subtotal w/o Mobilization						\$37,898,195
172	Mobilization 5%						\$1,900,000
173	Subtotal w/ Mobilization						\$39,798,195
174	Unlisted 15%						\$5,969,729
175	CONTRACT COST						\$46,000,000
176	Construction Contingences 25%						\$11,500,000
177	FIELD COST						\$58,000,000
178							
179							
180	Right-of-Way	90	acres	\$2,500.00		Total	\$225,000
181							
182							
183							

MAINLINE PRESSURE REDUCING STATION

		Quantity	Unit Cost	Cost		Total	\$1,062,000
190	40" Tytan valve	3	\$150,000.00	\$450,000.00			
191	24" Tytan valve	1	\$25,000.00	\$25,000.00			
192	24" Pressure Relief Valve	1	\$25,000.00	\$25,000.00			
193	Control System		Lump Sum	\$100,000.00			
194	42" Isolation Vavles	6	\$24,000.00	\$144,000.00			
195	24" Isolation Vavles	2	\$9,000.00	\$18,000.00			
196	Manifold		Lump Sum	\$200,000.00			
197	Structure		Lump Sum	\$100,000.00			
198	Subtotal w/o Mobilization						\$1,062,000
199	Mobilization 5%						\$53,000
200	Subtotal w/ Mobilization						\$1,100,000
201	Unlisted 15%						\$165,000
202	CONTRACT COST						\$1,250,000
203	Construction Contingences 25%						\$312,500
204	FIELD COST						\$1,600,000
205							
206							
207							
208							
209							
210							
211							

Project: Black Rock Project Assessment  
Feature: Delivery System to Roza Irrigation District  
Pipe with Selah-Moxee and Union Gap Drop Structure and Pumping Plant at Roza Canal

1	Pumping Plant - 10,500 hp						\$4,750,000
2	Subtotal from Plan 4 (line 170, above)						\$37,898,195
3							
4	Revised Subtotal w/o Mobilization						\$42,648,195
5	Mobilization 5%						\$2,100,000
6	Revised Subtotal w/ Mobilization						\$44,748,195
7	Unlisted 15%						\$6,712,229
8	CONTRACT COST						\$51,000,000
9	Construction Contingences 25%						\$12,750,000
10	FIELD COST						\$64,000,000
11							
12							
13	Right-of-Way	90	acres	\$2,500.00		Total	\$225,000
14							
15							
16							

Project: Black Rock Project Assessment  
 Feature: Delivery System to Roza Irrigation District  
 an 4-B - High Pressure Pipe Roza, Selah-Moxee and Union Gap  
 Beginning Hydraulic Gradeline Elevation: 1778 ft.

By: Wendy Christensen

Checked by: John Manfredi

Item	Schedule						Total	
1	Main Pipeline							\$60,156,634
2	Length (ft)	Hydraulic (ID) Diameter (in)	Steel Pipe Wall Thickness (in) from Table 4-2' AWWA M11	Pounds	Unit Cost of Steel Pipe	Cost		
3	1,000.00	78	0.75	630,870.00	\$2.00	\$1,261,740		
4	14,769.50	78	0.75	9,317,634.47	\$2.00	\$18,635,269		
5	14,769.50	75	0.75	8,962,723.38	\$2.00	\$17,925,447		
6	10,234.11	63	0.625	4,346,938.22	\$2.00	\$8,693,876		
7	10,234.12	63	0.625	4,346,942.47	\$2.00	\$8,693,885		
8	6,796.77	60	0.5625	2,473,208.67	\$2.00	\$4,946,417		
9								
10								
11								
12								
13								
14								
15	Turnout and Crossing Pumping Plant Terrace Heights	Quantity	Unit Quantity	Unit Cost	Cost		Total	\$238,000
16	Valves and Manifold	1	L.S.	\$120,000.00	\$120,000.00			
17	Main Pipe 60" dia crossing under plant	80	l.f.	\$1,100.00	\$88,000.00			
18	Civil, Electrical	1	L.S.	\$30,000.00	\$30,000.00			
19								
20								
21	Bifurcation Structure at TH Plant	1	L.S.	\$10,000.00	\$10,000.00		Total	\$10,000
22								
23								
24								
25	Turnout and Crossing Pumping Plant 2 (MP16.8)	Quantity	Unit Quantity	Unit Cost	Cost		Total	\$678,000
26								
27	Flow rate and PRV Valve w/ Check Valve feature - 16"	10	ea	\$30,000.00	\$300,000.00			
28	Butterfly Valve - 16"	10	ea	\$6,000.00	\$60,000.00			
29	Manifold Piping - 16" to 36" dia. Steel pipe	36,000	lb.	\$1.50	\$54,000.00			
30	Manifold Fabrication	36,000	lb.	\$2.00	\$72,000.00			
31	Concrete slab and encasement	40	cy	\$600.00	\$24,000.00			
32	Earthwork/site work	1	L.S.	\$5,000.00	\$5,000.00			
33	Electrical/Control system	1	L.S.	\$40,000.00	\$40,000.00			
34	Fence	1	L.S.	\$3,000.00	\$3,000.00			
35	Main Pipe 63" dia crossing under plant	100	l.f.	\$1,200.00	\$120,000.00			
36								
37	Bifurcation Structure at Plant #2						Total	\$60,000
38								
39	Isolation Valves - 24"	2	ea	\$10,000.00	\$20,000.00			
40	Isolation Valves - 36"	2	ea	\$20,000.00	\$40,000.00			
41								
42								
43								
44	Turnout and Crossing Pumping Plant 3 (MP 22.5)	Quantity	Unit Quantity	Unit Cost	Cost		Total	\$693,000
45								
46	Flow rate and PRV Valve w/ Check Valve feature - 16"	10	ea	\$30,000.00	\$300,000.00			
47	Butterfly Valve - 16"	10	ea	\$6,000.00	\$60,000.00			
48	Manifold Piping - 16" to 36" dia. Steel pipe	36,000	lb.	\$1.50	\$54,000.00			
49	Manifold Fabrication	36,000	lb.	\$2.00	\$72,000.00			
50	Concrete slab and encasement	40	cy	\$600.00	\$24,000.00			
51	Earthwork/site work	1	L.S.	\$5,000.00	\$5,000.00			
52	Electrical/Control system	1	L.S.	\$40,000.00	\$40,000.00			
53	Fence	1	L.S.	\$3,000.00	\$3,000.00			
54	Main Pipe 78" dia crossing under plant	100	l.f.	\$1,350.00	\$135,000.00			

55									
56	Bifurcation Structure at Plant #3							Total	\$60,000
57	Valves								
58	Isolation Valves - 24"	2	ea	\$10,000.00	\$20,000.00				
59	Isolation Valves - 36"	2	ea	\$20,000.00	\$40,000.00				
60									
61	Earthwork (CY)								
62	Excavation							Total	\$2,915,046
63	Diameter	Length	Unit Quantity	Quantity	Unit Cost	Cost			
64	78	1,000.00	11.47	11,470	\$5.00	\$57,350			
65	78	14,769.50	11.47	169,406	\$5.00	\$847,031			
66	75	14,769.50	10.94	161,578	\$5.00	\$807,892			
67	63	10,234.11	8.94	91,493	\$5.00	\$457,465			
68	63	10,234.12	8.94	91,493	\$5.00	\$457,465			
69	60	6,796.77	8.47	57,569	\$5.00	\$287,843			
70									
71									
72	Total								
73									
74	Bedding							Total	\$262,140
75	Diameter	Length	Unit Quantity	Quantity	Unit Cost	Cost			
76	78	1,000.00	0.20	196	\$25.00	\$4,900			
77	78	14,769.50	0.20	2,895	\$25.00	\$72,371			
78	75	14,769.50	0.19	2,821	\$25.00	\$70,524			
79	63	10,234.11	0.17	1,730	\$25.00	\$43,239			
80	63	10,234.12	0.17	1,730	\$25.00	\$43,239			
81	60	6,796.77	0.16	1,115	\$25.00	\$27,867			
82									
83									
84									
85	Embedment (.7)							Total	\$2,834,644
86	Diameter	Length	Unit Quantity	Quantity	Unit Cost	Cost			
87	78	1,000.00	2.34	2,340	\$25.00	\$58,500			
88	78	14,769.50	2.34	34,561	\$25.00	\$864,016			
89	75	14,769.50	2.19	32,375	\$25.00	\$809,369			
90	63	10,234.11	1.65	16,876	\$25.00	\$421,901			
91	63	10,234.12	1.65	16,876	\$25.00	\$421,902			
92	60	6,796.77	1.52	10,358	\$25.00	\$258,957			
93									
94									
95									
96									
97	Compacted Backfill							Total	\$2,283,720
98	Diameter	Length	Unit Quantity	Quantity	Unit Cost	Cost			
99	78	1,000.00	7.26	7,262	\$6.00	\$43,572			
100	78	14,769.50	7.26	107,256	\$6.00	\$643,537			
101	75	14,769.50	7.00	103,387	\$6.00	\$620,319			
102	63	10,234.11	6.03	61,681	\$6.00	\$370,086			
103	63	10,234.12	6.03	61,681	\$6.00	\$370,086			
104	60	6,796.77	5.79	39,353	\$6.00	\$236,120			
105									
106									
107									
108									
109	Farm Turnout Tees and Valves							Total	\$174,060
110	Size	Quantity	Unit Cost	Cost					
111	in	ea	\$/ea	\$					
112									
113	8	6	\$2,770.00	\$16,620.00					
114	6	24	\$2,300.00	\$55,200.00					
115	4	24	\$1,810.00	\$43,440.00					
116	2	2	\$1,400.00	\$2,800.00					
117	Installation	56	\$1,000.00	\$56,000.00					
118									
119	PRV and Valve Vaults							Total	\$862,000
120	Size	Quantity	Unit Cost	Cost					
121	in	ea	\$/ea	\$					
122									
123	8	6	\$17,000.00	\$102,000.00					
124	6	24	\$14,000.00	\$336,000.00					
125	4	24	\$12,000.00	\$288,000.00					
126	2	2	\$12,000.00	\$24,000.00					
127	Installation	56	\$2,000.00	\$112,000.00					
128									
129									
130	Flow Meters and Precast Vaults							Total	\$149,500
131	Size	Quantity	Unit Cost	Cost					

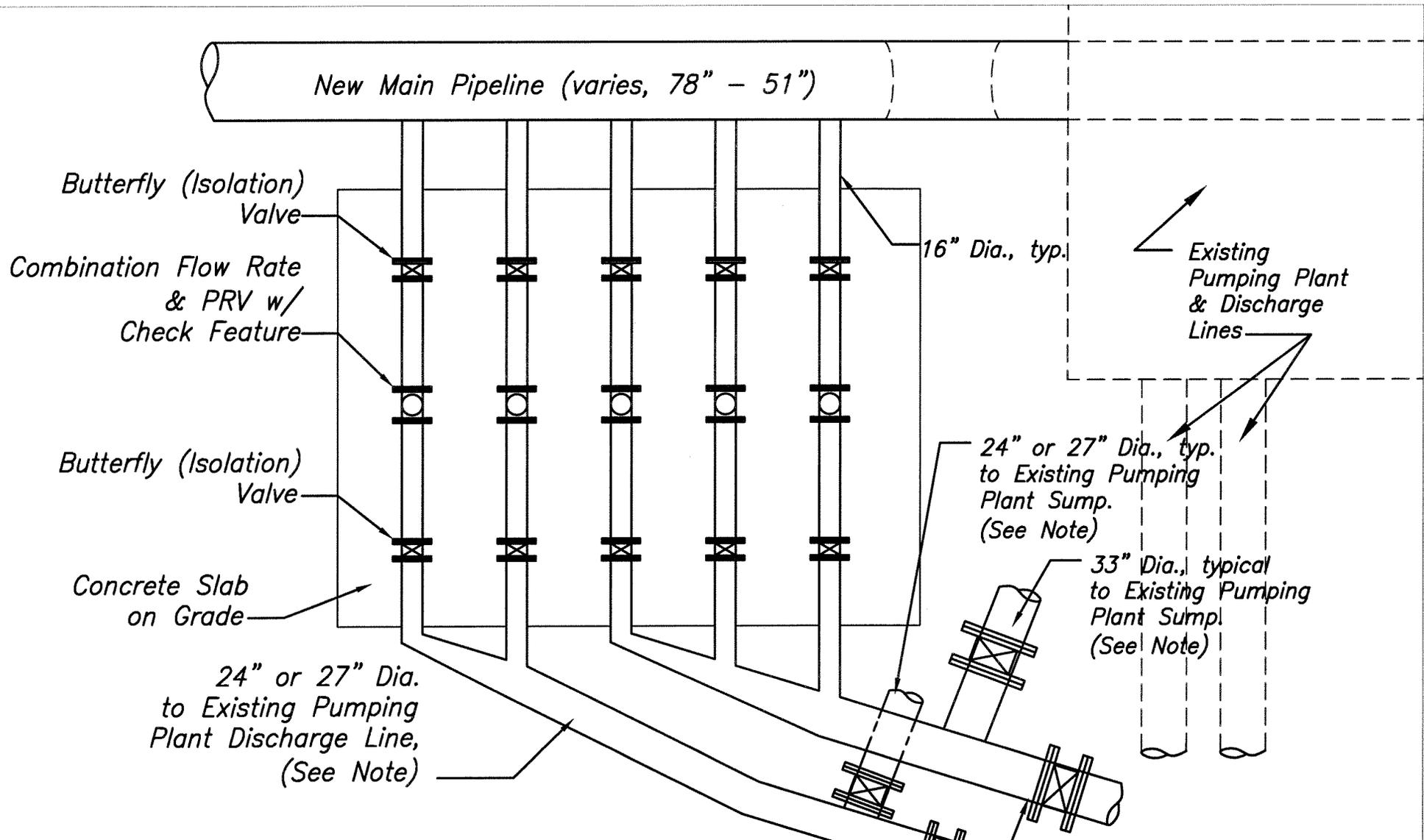
132	in	ea	\$/ea	\$			
133							
134	8	3	\$5,500.00	\$16,500.00			
135	6	12	\$4,500.00	\$54,000.00			
136	4	12	\$4,000.00	\$48,000.00			
137	2	1	\$3,000.00	\$3,000.00			
138	Installation	28	\$1,000.00	\$28,000.00			
139							
140	Steel Pipe Xings for Turnouts					Total	\$643,500
141	Size	Quantity	Unit Cost	Cost			
142	Steel Pipe Xings - 10"	3	\$27,000.00	\$81,000.00			
143	Steel Pipe Xings - 6"	25	\$22,500.00	\$562,500.00			
144							
145	Road crossings	Quantity	Unit Cost	Cost		Total	\$180,000
146	Hwy 24	1	L.S.	\$30,000.00			
147	34+00	1	L.S.	\$10,000.00			
148	147+00	1	L.S.	\$10,000.00			
149	178+00	1	L.S.	\$10,000.00			
150	210+00	1	L.S.	\$10,000.00			
151	263+00	1	L.S.	\$10,000.00			
152	404+00	1	L.S.	\$10,000.00			
153	422+50	1	L.S.	\$10,000.00			
154	441+00	1	L.S.	\$10,000.00			
155	450+00	1	L.S.	\$10,000.00			
156	467+00	1	L.S.	\$10,000.00			
157	484+00 - Terrace Height Blvd.	1	L.S.	\$30,000.00			
158	495+00	1	L.S.	\$10,000.00			
159	508+00	1	L.S.	\$10,000.00			
160							
161	ah-Moxee/Union Gap Drop Structure					Total	\$937,879
162	Upstream Shutoff Valve, 36" BFV	2	ea	\$20,000.00	\$40,000.00		
163	Road crossings	3	ea	\$10,000.00	\$30,000.00		
164	Pipe 33" - Union Gap, 550'	61847.5	l.f.	\$2.00	\$123,695.00		
165	Pipe 36" - Selah-Moxee, 100' Flow rate and PRV Valve w/ Check Valve feature - 16"	11912	l.f.	\$2.00	\$23,824.00		
166	Butterfly Valve - 16"	16	ea	\$30,000.00	\$480,000.00		
167	Manifold Piping - 16" to 36" dia. Steel pipes	30000	lb.	\$3.00	\$90,000.00		
168	Concrete Outlet Boxes	60	cy	\$700.00	\$42,000.00		
169	Safety Racks (6x10)	2800	lb	\$4.00	\$11,200.00		
170	Excavation	100	cy	\$8.00	\$800.00		
171	Compacted Backfill	30	cy	\$12.00	\$360.00		
172							
173							
174							
175							
176							
177							
178	Special Structures						
179	Access Manholes, Airvalves (every 2000')	30	ea	\$14,000.00		Total	\$420,000
180							
181	Fence Replacement	50000	l.f.	\$3.00		Total	\$150,000
182							
183							
184							
185							
186	SCADA	L.S.	\$460,000.00			Total	\$460,000
187							
188	Subtotal w/o Mobilization						\$74,168,123
189	Mobilization 5%						\$3,800,000
190	Subtotal w/ Mobilization						\$77,968,123
191	Unlisted 15%						\$11,695,218
192	CONTRACT COST						\$90,000,000
193	Construction Contingences 25%						\$23,000,000
194	FIELD COST						\$113,000,000
195							
196							
197	Right-of-Way	90	acres	\$2,500.00		Total	\$225,000
198							
199							
200							

Item	Schedule						Total	
1	Pump Station #1 (MP 20.6) - 256 cfs							\$948,200
2	Item	Quantity	Unit	Unit Cost	Cost			
3								
4	Concrete - plant and check structure	180	cy	\$700.00	\$126,000			
5	Trashrack (12 x 60)	15000	lb	\$4.00	\$60,000			
6	Excavation	1000	cy	\$8.00	\$8,000			
7	Compacted Backfill	300	cy	\$12.00	\$3,600			
8	110 hp vertical propeller pumps - fixed	4	ea	\$82,500.00	\$330,000			
9	110 hp vertical propeller pumps -vfd	2	ea	\$91,300.00	\$182,600			
10	Manifold	20000	lb	\$3.00	\$60,000			
11	24" Check Valves	6	ea	\$20,000.00	\$120,000			
12	24" Butterfly Valves	6	ea	\$5,000.00	\$30,000			
13	Power supply	1	L.S.	\$25,000.00	\$25,000			
14	Walkway	150	ft <sup>2</sup>	\$20.00	\$3,000			
15								
16								
17	Pump Station #2 (MP 18.7) - 240 cfs						Total	\$901,600
18								
19								
20	Concrete - plant and check structure	180	cy	\$700.00	\$126,000			
21	Trashrack (12 x 60)	15000	lb	\$4.00	\$60,000			
22	Excavation	1000	cy	\$8.00	\$8,000			
23	Compacted Backfill	300	cy	\$12.00	\$3,600			
24	100 hp vertical propeller pumps - fixed	4	ea	\$75,000.00	\$300,000			
25	100 hp vertical propeller pumps -vfd	2	ea	\$83,000.00	\$166,000			
26	Manifold	20000	lb	\$3.00	\$60,000			
27	24" Check Valves	6	ea	\$20,000.00	\$120,000			
28	24" Butterfly Valves	6	ea	\$5,000.00	\$30,000			
29	Power supply	1	L.S.	\$25,000.00	\$25,000			
30	Walkway	150	ft <sup>2</sup>	\$20.00	\$3,000			
31								
32								
33								
34								
35	Pump Station #3 (MP 16.8) - 236 cfs						Total	\$862,400
36								
37								
38	Concrete - plant and check structure	180	cy	\$700.00	\$126,000			
39	Trashrack (12 x 50)	12000	lb	\$4.00	\$48,000			
40	Excavation	800	cy	\$8.00	\$6,400			
41	Compacted Backfill	250	cy	\$12.00	\$3,000			
42	100 hp vertical propeller pumps - fixed	4	ea	\$75,000.00	\$300,000			
43	100 hp vertical propeller pumps -vfd	2	ea	\$83,000.00	\$166,000			
44	Manifold	20000	lb	\$3.00	\$60,000			
45	24" Check Valves	6	ea	\$20,000.00	\$120,000			
46	24" Butterfly Valves	6	ea	\$5,000.00	\$30,000			
47	Walkway	150	ft <sup>2</sup>	\$20.00	\$3,000			
48								
49								
50								
51								
52	Pump Station #4 (MP 13) - 156 cfs						Total	\$631,750
53								
54								
55	Concrete - plant and check structure	120	cy	\$700.00	\$84,000			
56	Trashrack (12 x 50)	12000	lb	\$4.00	\$48,000			
57	Excavation	800	cy	\$8.00	\$6,400			
58	Compacted Backfill	250	cy	\$12.00	\$3,000			
59	85 hp vertical propeller pumps - fixed	3	ea	\$63,750.00	\$191,250			
60	85 hp vertical propeller pumps -vfd	2	ea	\$70,550.00	\$141,100			
61	Manifold	15000	lb	\$3.00	\$45,000			
62	18" Check Valves	5	ea	\$18,000.00	\$90,000			
63	18" Butterfly Valves	5	ea	\$4,000.00	\$20,000			
64	Walkway	150	ft <sup>2</sup>	\$20.00	\$3,000			
65								
66								
67	Selah-Moxee/Union Gap Drop Structure						Total	\$459,640
68								
69	Road crossings	3	ea	\$10,000.00	\$30,000			
70	Pipe 33" - Union Gap	550	l.f.	\$180.00	\$99,000			
71	Pipe 36" - Selah-Moxee	100	l.f.	\$200.00	\$20,000			
72	Upstream Gate Structure Concrete	120	cy	\$700.00	\$84,000			

73	Trash racks (12x24)	16000	lb.	\$4.00	\$64,000		
74	Slide gates/operators	4	ea	\$20,000.00	\$80,000		
75	Concrete Baffled Outlets	100	cy	\$700.00	\$70,000		
76	Safety Racks (6 x 10)	2800	lb	\$4.00	\$11,200		
77	Excavation	120	cy	\$8.00	\$960		
78	Compacted Backfill	40	cy	\$12.00	\$480		
79							
80	Terminal check	30.00	cy	700		Total	\$21,000
81							
82							
83	SCADA	L.S.	\$300,000.00			Total	\$300,000
84							
85	-- Subtotal w/o Mobilization						\$4,124,590
86	Mobilization 5%						\$210,000
87	Subtotal w/ Mobilization						\$4,334,590
88	Unlisted 15%						\$650,189
89	CONTRACT COST						\$5,000,000
90	Construction Contingences 25%						\$1,250,000
91	FIELD COST						\$6,300,000
92							
93							
94	Right-of-Way	10	acres	\$2,500.00		Total	\$25,000
95							

## **ATTACHMENT E. DRAWINGS**

- 33-155T-376 — Manifold to Supply Existing Pumping Plants 2 & 3 for Plans 1 through 4-A
- 33-155T-377 — Typical Farm Turnout for Plans 1 through 4-A
- 33-155T-378 — Typical Relift Pump, Plan 5



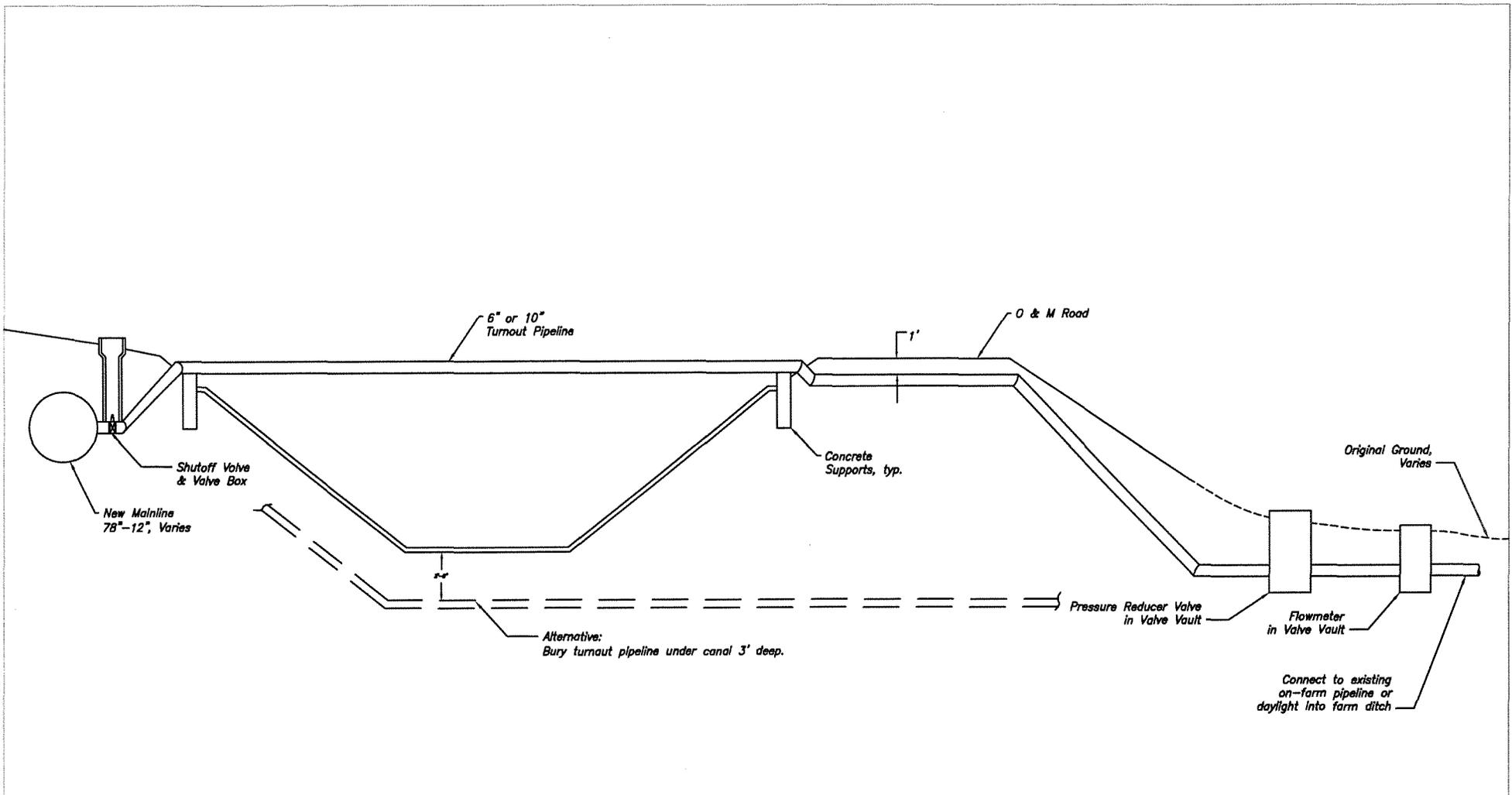
- Notes:**
1. For low pressure, manifold pipelines would discharge into existing pump sumps.
  2. Terrace Heights pumping plant manifold, similar.

APPRAISAL LEVEL STUDY  
 NOT TO BE USED FOR  
 CONSTRUCTION

NOT TO SCALE

33" Dia., typical  
 to Existing Pumping  
 Plant Discharge Line,  
 (See Note)

ALWAYS THINK SAFETY		
UNITED STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION YAKIMA PROJECT YAKIMA RIVER BASIN WATER STORAGE OPTIONS FEASIBILITY STUDY BLACK ROCK ROZA IRRIGATION DISTRICT DELIVERY SYSTEM MANIFOLD TO SUPPLY EXISTING PUMPING PLANTS 2 & 3 OPTIONS 1, 1A, 2, 2A, 3, 3A, 4, 4A, 4B		
DESIGNED - Grandolyn Christensen	TECH. APPROVAL - _____	
DRAWN - CJS	_____	
CHECKED - John Manfredi	APPROVED - _____	
CADD SYSTEM AUTOCAD 2000 YAKIMA, WASHINGTON	CADD FILENAME FILENAME.DWG FEBRUARY 4, 2004	DATE PLOTTED 12/10/03 PROGRAM MANAGER 33-155T-376

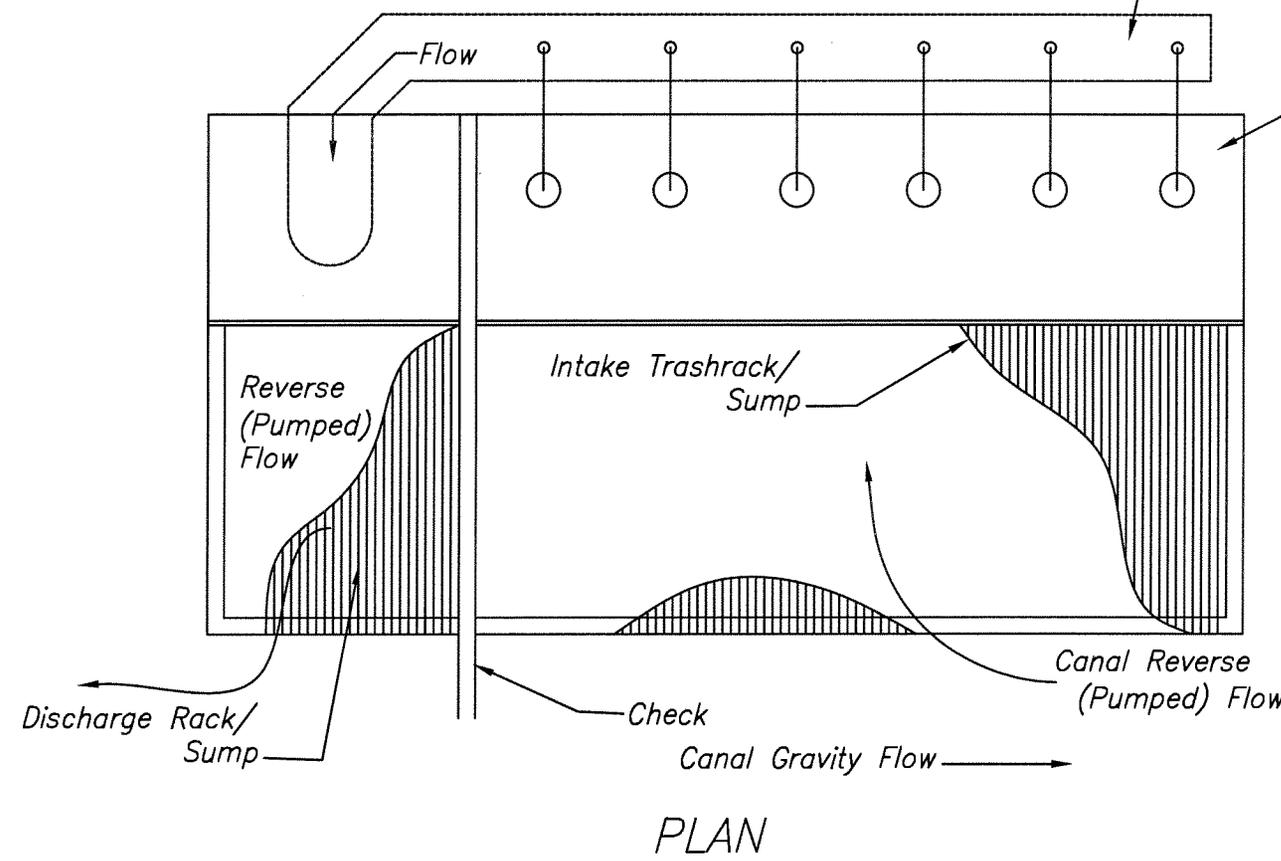
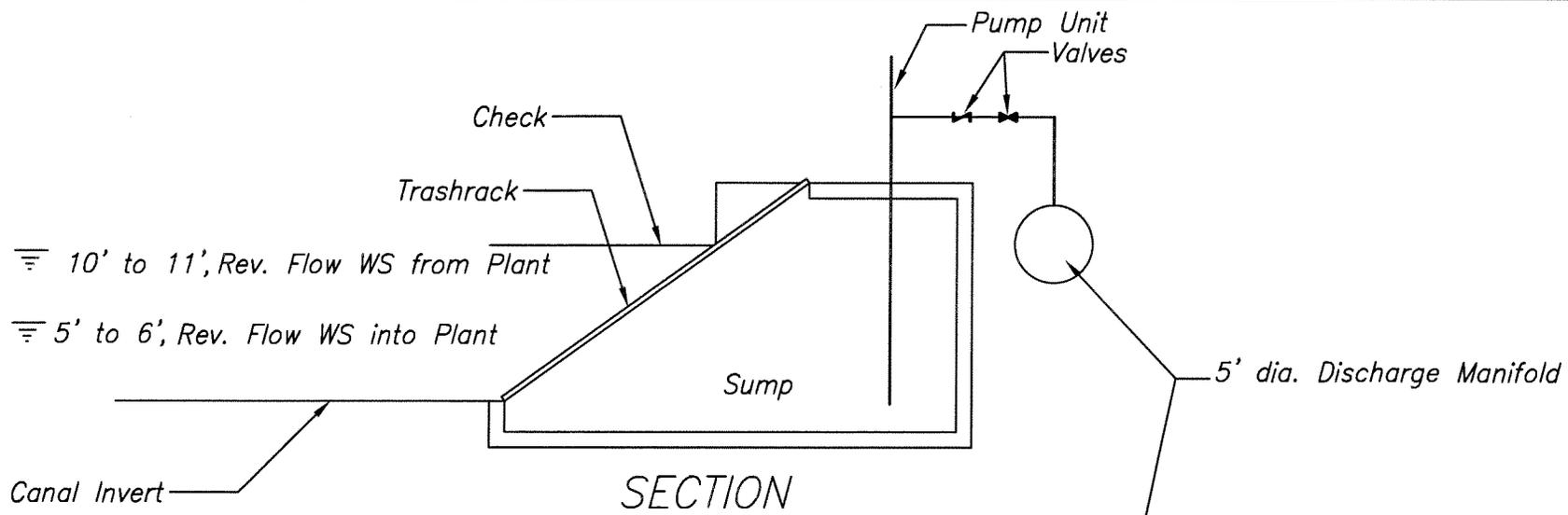


**NOTES:**

- 1. Air valves not shown.

APPRAISAL LEVEL STUDY  
NOT TO BE USED FOR  
CONSTRUCTION

<b>ALWAYS THINK SAFETY</b>		
<small>UNITED STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION YAKIMA PROJECT YAKIMA RIVER BASIN WATER STORAGE OPTIONS FEASIBILITY STUDY <b>BLACK ROCK</b> ROZA IRRIGATION DISTRICT DELIVERY SYSTEM TYPICAL DOWNSLOPE FARM TURNOUT OPTIONS 1, 1A, 2, 2A, 3, 3A, 4, and 4A</small>		
DESIGNED <i>Grandolph Christensen</i>	TECH. APPROVAL _____	
DRAWN _____	C.S.L. _____	
CHECKED <i>John M. ...</i>	APPROVED _____	PROGRAM MANAGER _____
<small>CADD SYSTEM AUTOCAD 2000</small>	<small>CADD FILENAME FILENAME.DWG</small>	<small>DATE PLOTTED 12/10/03</small>
<small>YAKIMA, WASHINGTON</small>	<small>FEBRUARY 7, 2004</small>	<b>33-155T-377</b>



40-50 cfs pumps;  
number to match design  
flow, plus one spare.

APPRAISAL LEVEL STUDY  
NOT TO BE USED FOR  
CONSTRUCTION

NOT TO SCALE

ALWAYS THINK SAFETY		
UNITED STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION YAKIMA PROJECT YAKIMA RIVER BASIN WATER STORAGE OPTIONS FEASIBILITY STUDY BLACK ROCK ROZA IRRIGATION DISTRICT DELIVERY SYSTEM TYPICAL RELIFT PUMP OPTION 5		
DESIGNED <i>Geordyn Christensen</i>	TECH. APPROVAL -----	
DRAWN <i>C.S.</i>	DATE PLOTTED <i>12/10/03</i>	
CHECKED <i>John Manfred</i>	APPROVED ----- PROGRAM MANAGER	
CADD SYSTEM AUTOCAD 2000 YAKIMA, WASHINGTON	CADD FILENAME FILENAME.DWG FEBRUARY 9, 2004	33-155T-378

# **ATTACHMENT F. REFERENCE DRAWINGS**

**F-1. Canal Station 313+00 to Station 576+81.5; Specification No. 678** (four drawings)

**F-2. Canal Station 721+35 to Station 804+74.35 and Station 942+00 to Station 1120+00; Specification No.729** (five drawings)

**F-3. Canal Station 1120+00 to Station 1595+00; Specification No.748** (three drawings)

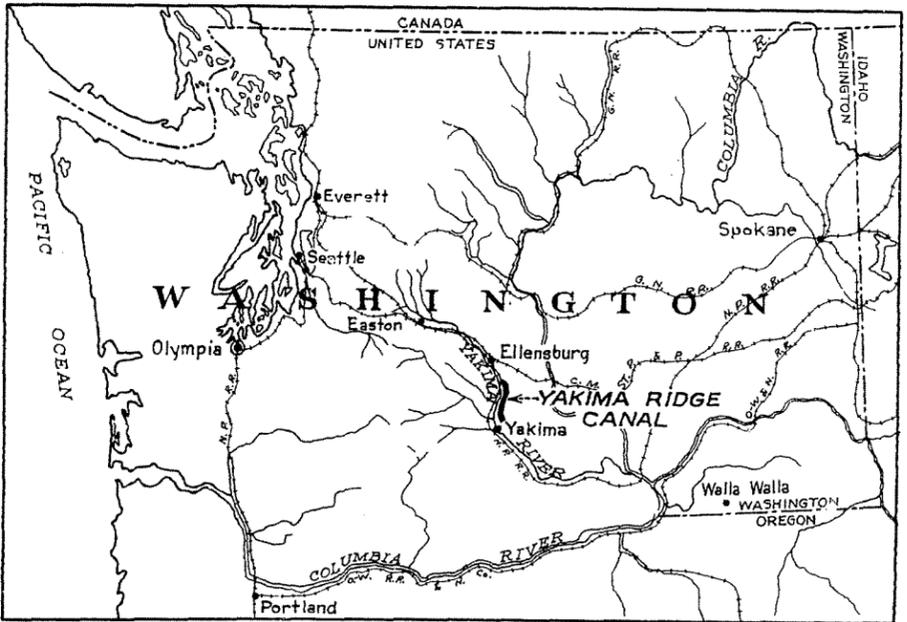
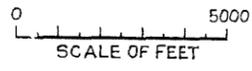
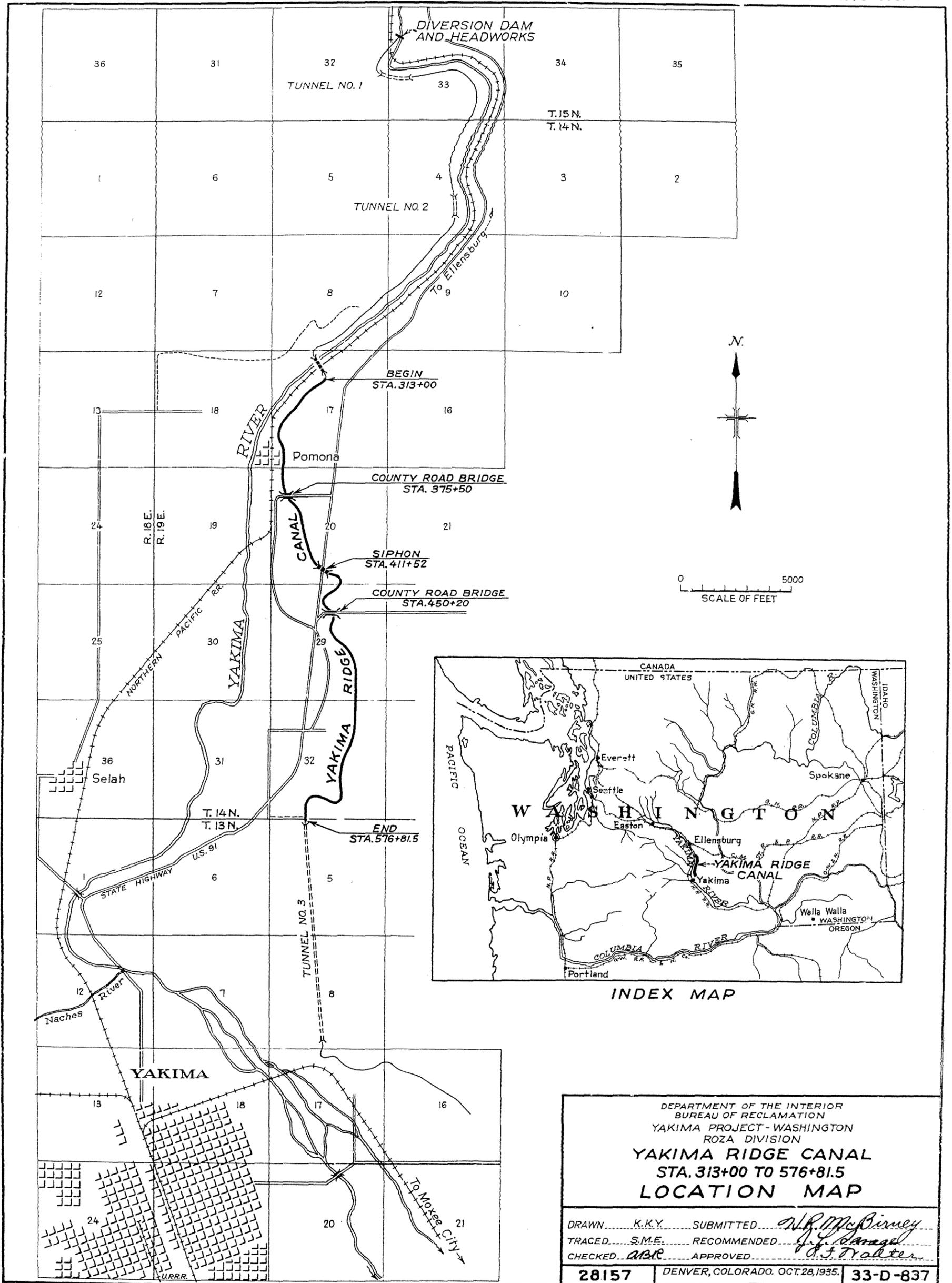
**F-4. Tunnels No. 1 and No. 3** (four drawings)

**F-5. Pumping Plants** (four drawings)

**F-6. Miscellaneous Structures and Bridges** (four drawings)

## **F-1. Canal Station 313+00 to Station 576+81.5; Specification No. 678**

- 33-D-837 — Yakima Ridge Canal, Sta. 313+00 to 576+81.5, Location Map
- 33-D-838 — Yakima Ridge Canal, Sta. 313+00 to 576+81.5, Profile and Sections
- 33-D-850 — Yakima Ridge Canal, 12" Concrete Pipe Turnout –Lined Section
- 33-D-851 — Yakima Ridge Canal, 12" Concrete Pipe Turnout – Unlined Section

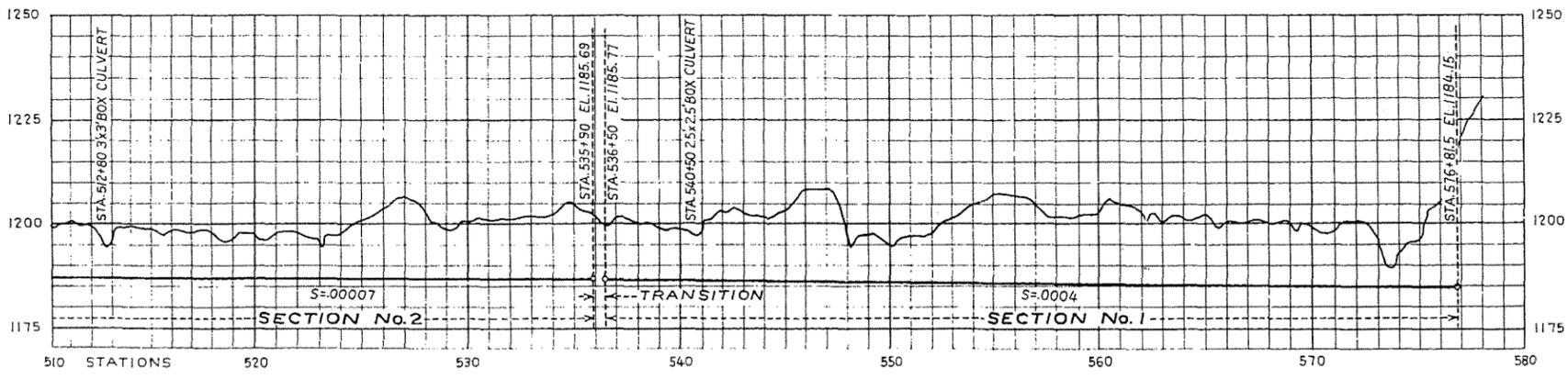
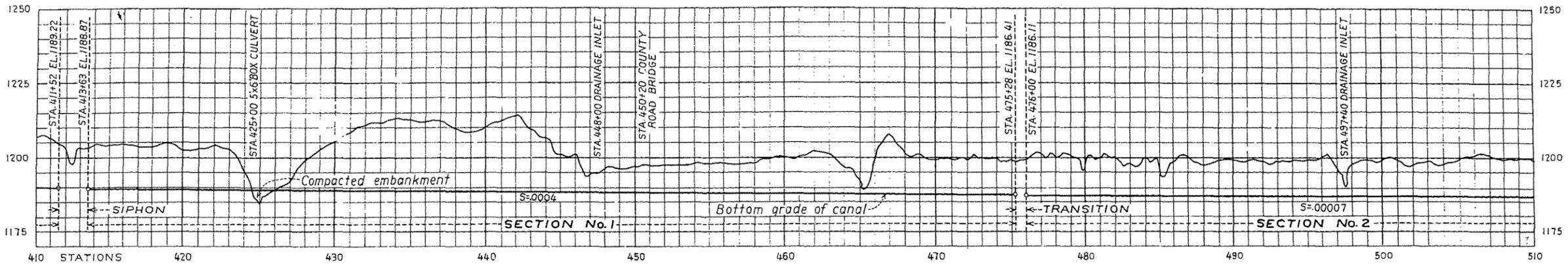
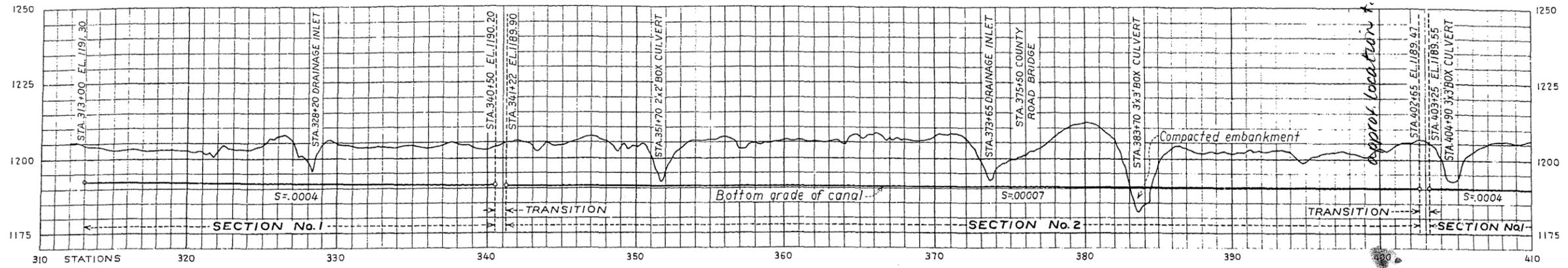


INDEX MAP

DEPARTMENT OF THE INTERIOR  
BUREAU OF RECLAMATION  
YAKIMA PROJECT - WASHINGTON  
ROZA DIVISION

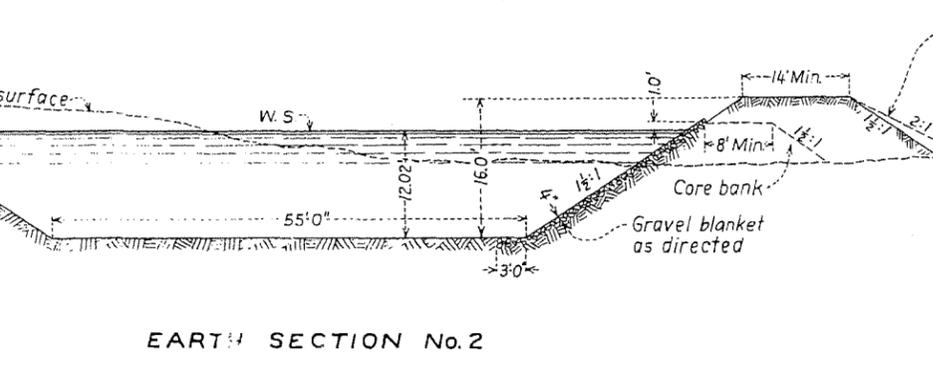
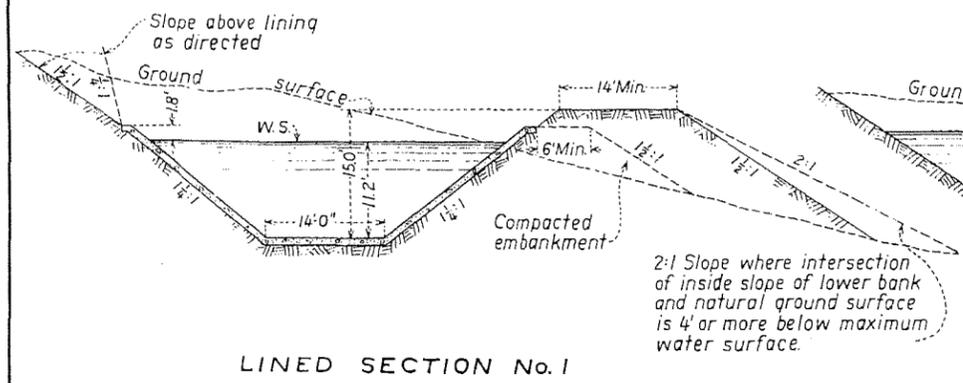
**YAKIMA RIDGE CANAL**  
STA. 313+00 TO 576+81.5  
**LOCATION MAP**

DRAWN.....	K.K.Y.	SUBMITTED.....	<i>W.R. McBirney</i>
TRACED.....	S.M.E.	RECOMMENDED.....	<i>J. J. Daniel</i>
CHECKED.....	<i>ABR</i>	APPROVED.....	<i>A. J. Drake</i>
<b>28157</b>	DENVER, COLORADO, OCT. 28, 1935.		<b>33-D-837</b>



HYDRAULIC PROPERTIES

SECTION	A	V	Q	$\Gamma$	$\eta$	S
Lined section No.1	313.60	7.02	2201	6.29	.014	.0004
Earth section No.2	877.82	2.51	2203	8.93	.0225	.00007

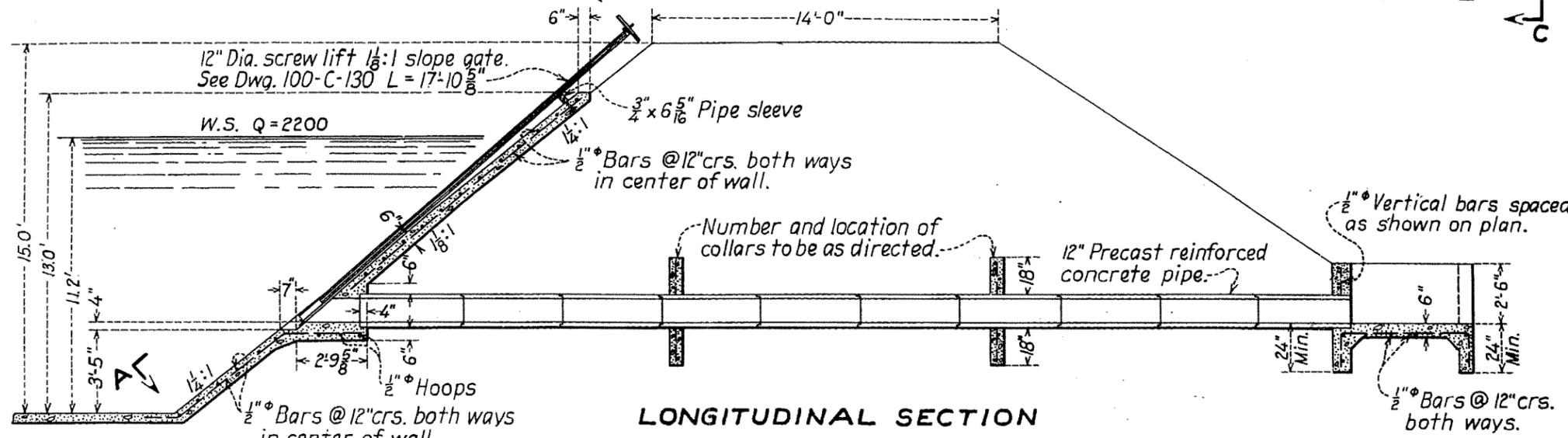
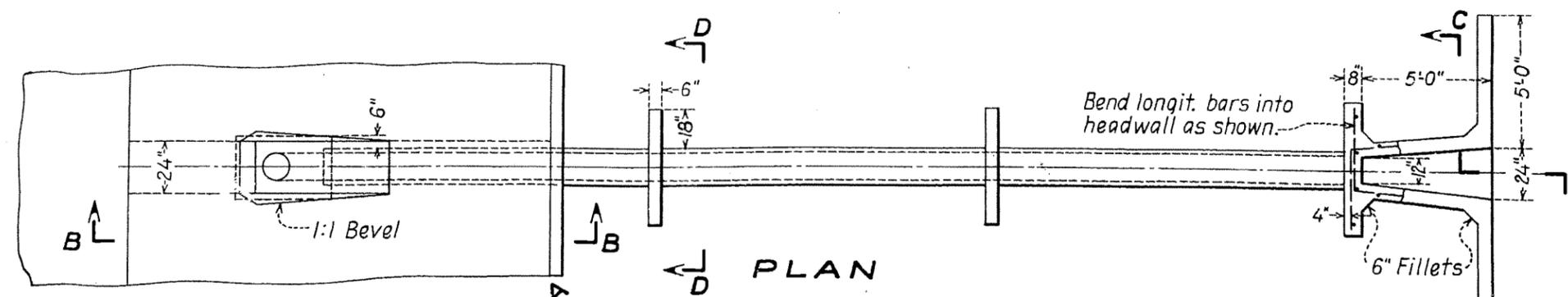


DEPARTMENT OF THE INTERIOR  
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YAKIMA PROJECT-WASHINGTON  
ROZA DIVISION

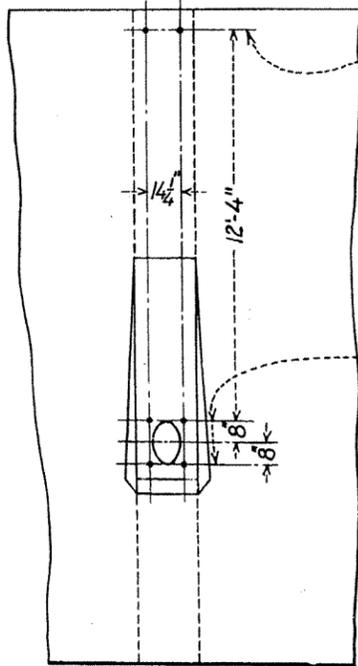
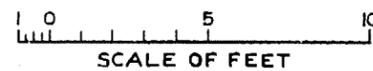
**YAKIMA RIDGE CANAL- STA. 313+00 TO STA. 576+81.5**  
**PROFILE AND SECTIONS**

DRAWN *K.K.Y.* SUBMITTED *W.F. McBurney*  
TRACED *C.V.R.* RECOMMENDED *J.R. George*  
CHECKED *SAR* APPROVED *A.F. Tratter*

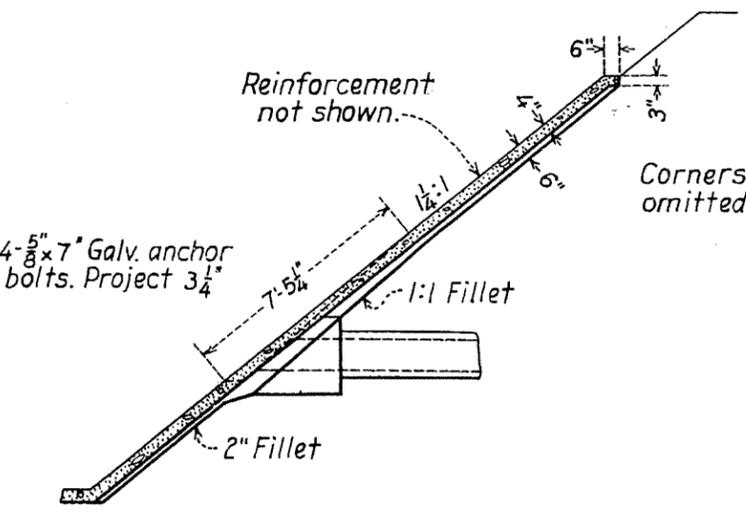
28158 DENVER, COLORADO FEB. 28, 1936 33-D-838



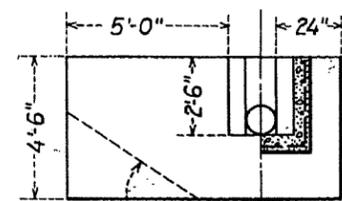
LONGITUDINAL SECTION



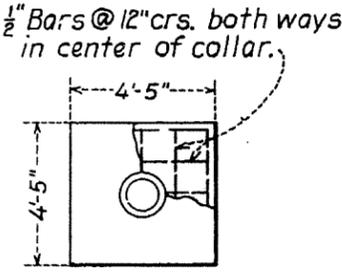
SECTION A-A



SECTION B-B



SECTION C-C



SECTION D-D

**ESTIMATED QUANTITIES**

Concrete	4 Cu. Yds.
Reinforcement steel	250 Lbs.
Gate and gate hoist	360 Lbs.
12" Precast concrete pipe	40 Lin. Ft.

**NOTES**

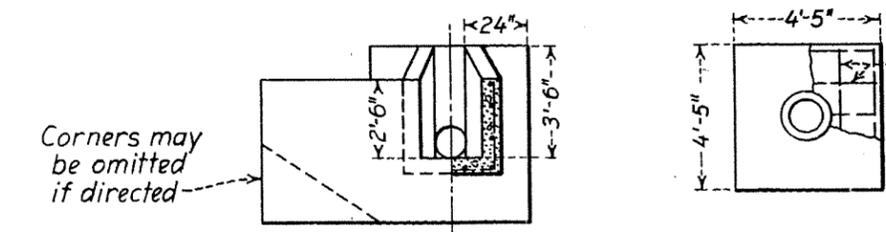
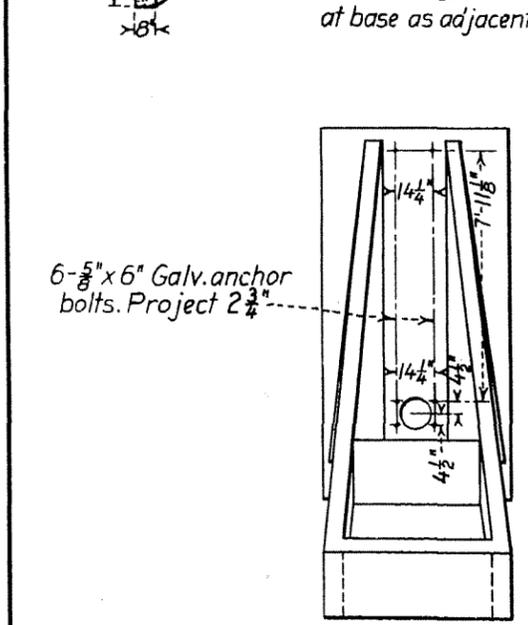
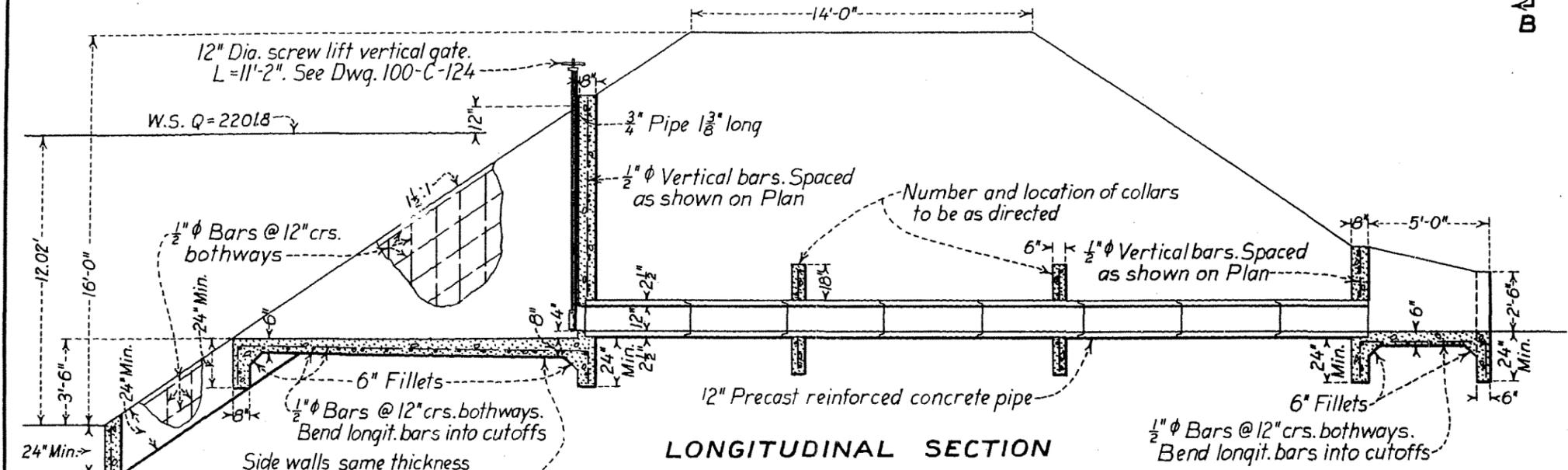
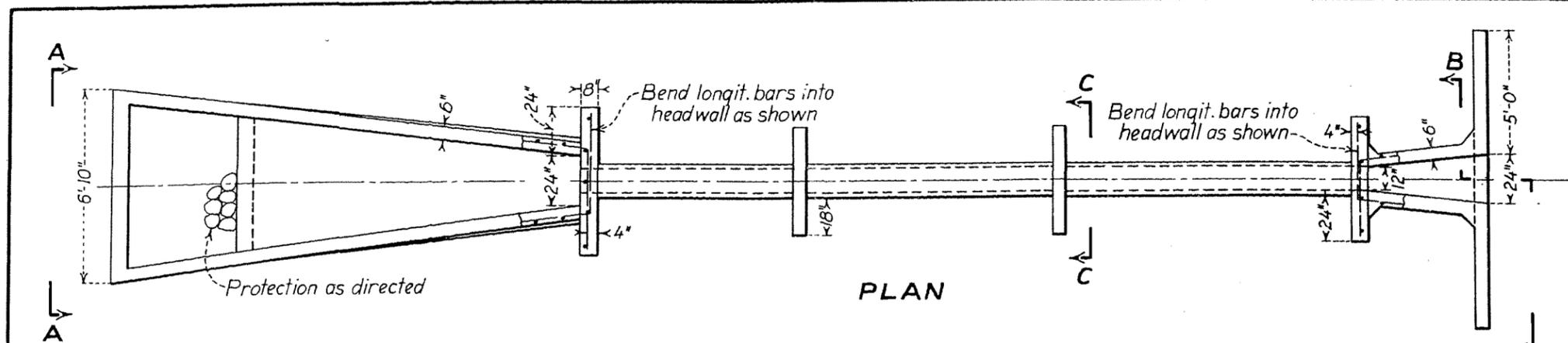
All reinforcement shall be placed so that the centers of bars in the outer layer will be 2" from face of concrete unless otherwise shown. Lap all bars 40 diameters at splices. All anchor bolts to be galvanized.

DEPARTMENT OF THE INTERIOR  
BUREAU OF RECLAMATION  
YAKIMA PROJECT-WASHINGTON  
ROZA DIVISION  
**YAKIMA RIDGE CANAL**  
**12" CONCRETE PIPE TURNOUT-LINED SECTION**

Rev 4-17-36

DRAWN: L.H.E. SUBMITTED: *W. McBurney*  
TRACED: C.E.S. RECOMMENDED: *J. ...*  
CHECKED: *H.W.* APPROVED: *A.S. ...*

28170 DENVER, COLORADO, JAN. 25, 1936 33-D-850



**LONGITUDINAL SECTION**

**SECTION B-B SECTION C-C**

**ESTIMATED QUANTITIES**

Concrete.....	10 Cu. Yds.
Reinforcement steel.....	900 Lbs.
Gate and gate hoist.....	200 Lbs.
12" Precast concrete pipe.....	32 Lin. Ft.

**NOTES**  
 All reinforcement shall be placed so that the centers of bars in the outer layer will be 2" from face of concrete unless otherwise shown.  
 Lap all bars 40 diameters at splices.  
 All anchor bolts to be galvanized.

DEPARTMENT OF THE INTERIOR  
 BUREAU OF RECLAMATION  
 YAKIMA PROJECT - WASH.  
 ROZA DIVISION

**YAKIMA RIDGE CANAL**  
**12" CONCRETE PIPE TURNOUT-UNLINED SECTION**

DRAWN: L.H.E. SUBMITTED: *W.R. McBurney*  
 TRACED: G.E.W. RECOMMENDED: *J.S. Savage*  
 CHECKED: *H.P.* APPROVED: *A.J. Walker*

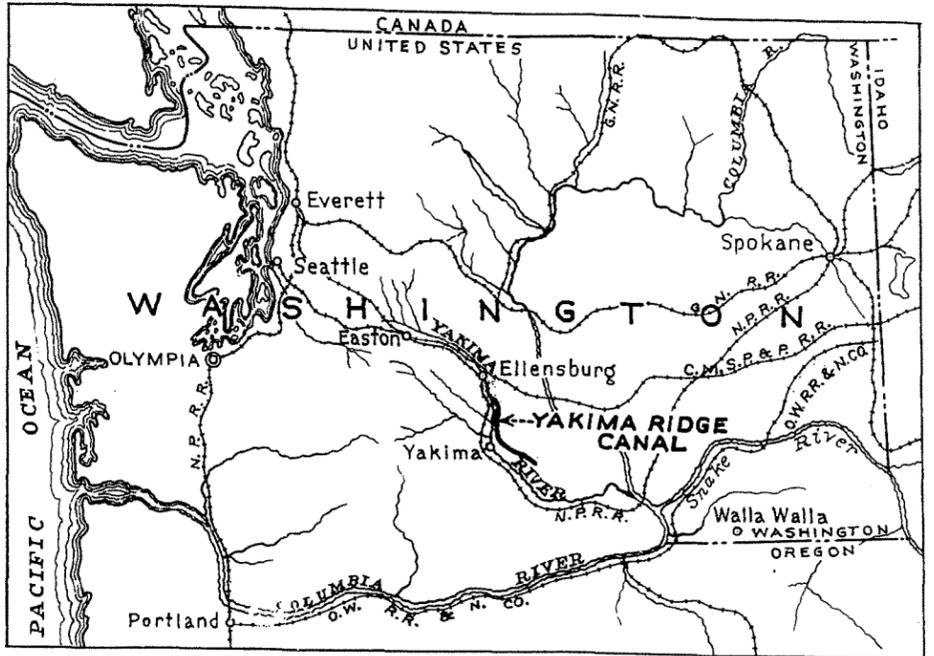
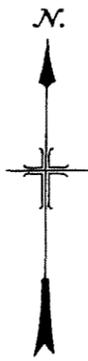
28171 DENVER, COLO., JAN. 23 1936. 33-D-851

**F-2. Canal Station 721+35 to Station 804+74.35 and Station 942+00 to Station 1120+00; Specification No.729**

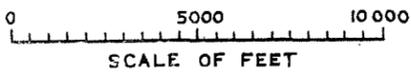
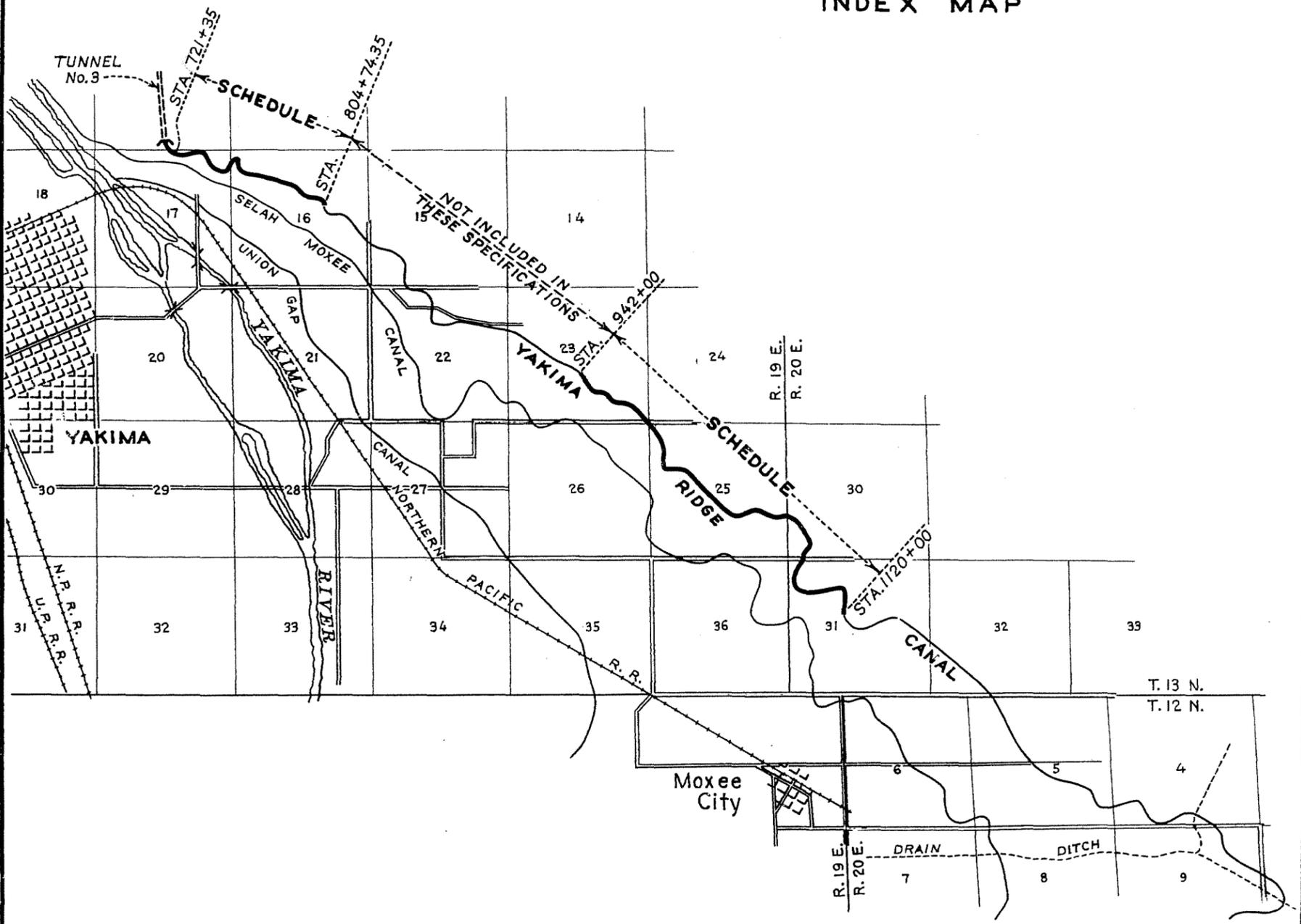
- 33-D-1027 — Yakima Ridge Canal, Sta. 721+35 to 804+74.35 and Sta. 942+00 to 1120+00, Location Map
- 33-D-1028 — Yakima Ridge Canal, Sta. 721+35 to 804+74.35 and Sta. 942+00 to 1120+00, Profile and Sections
- 33-D-1234 — Yakima Ridge Canal, Sta. 804+74.35 to Sta. 942+00 and County Road Revision, Profile and Section
- 33-D-1029 — Yakima Ridge Canal, Sta. 721+35 to 1120+00, Canal Lining – Transitions
- 33-D-1030 — Yakima Ridge Canal, Sta. 742+68 to 750+15, Bench Flume – Transitions

SPECIFICATIONS No.729

DRAWING No. 1

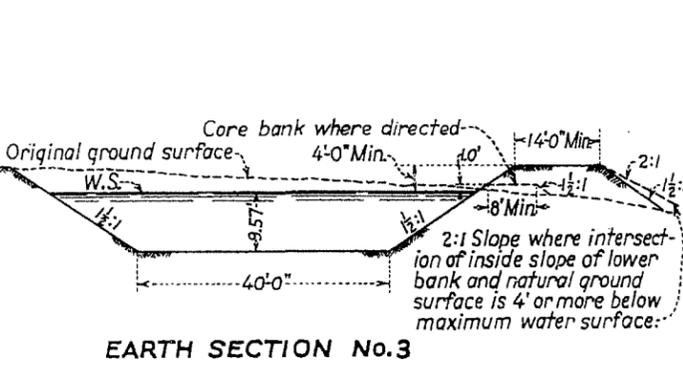
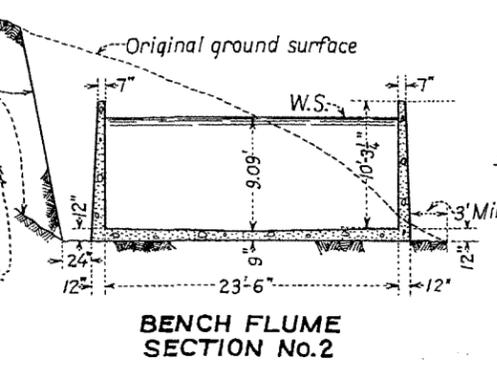
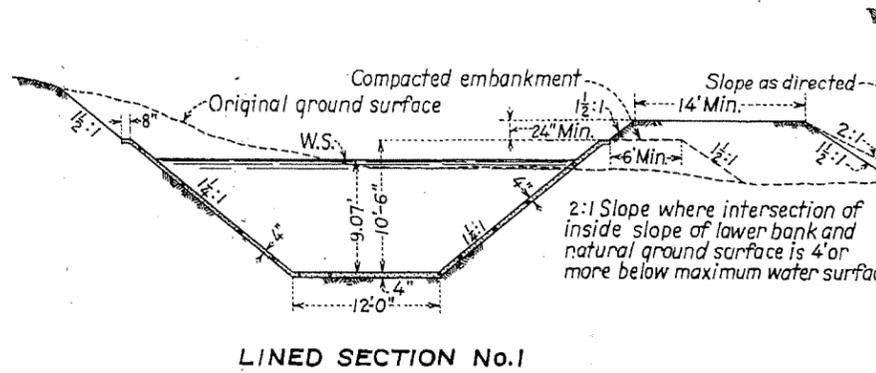
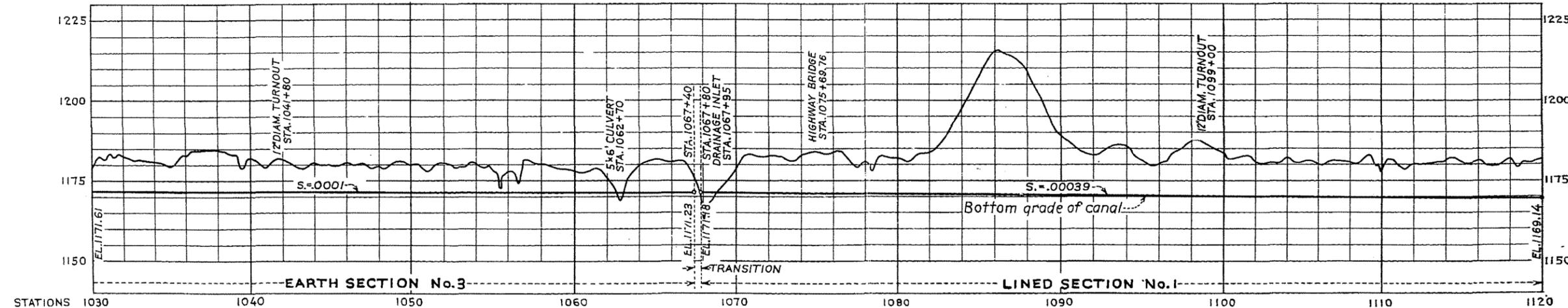
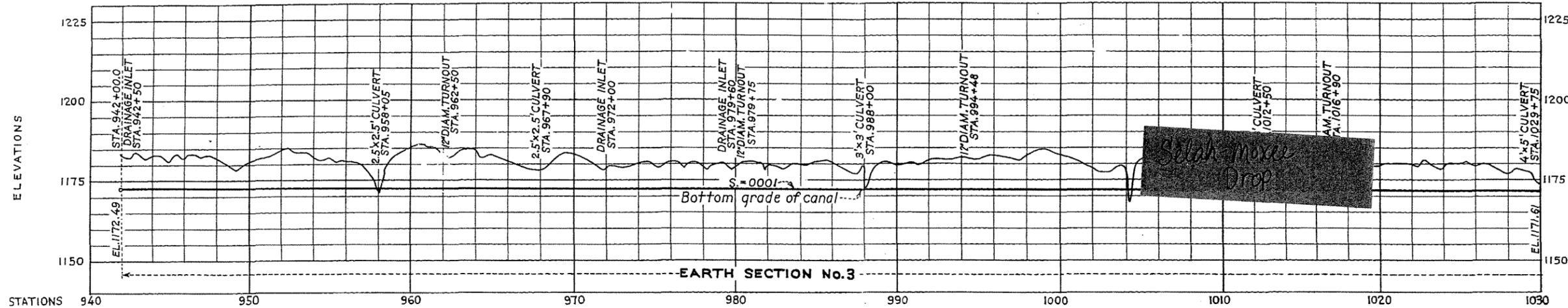
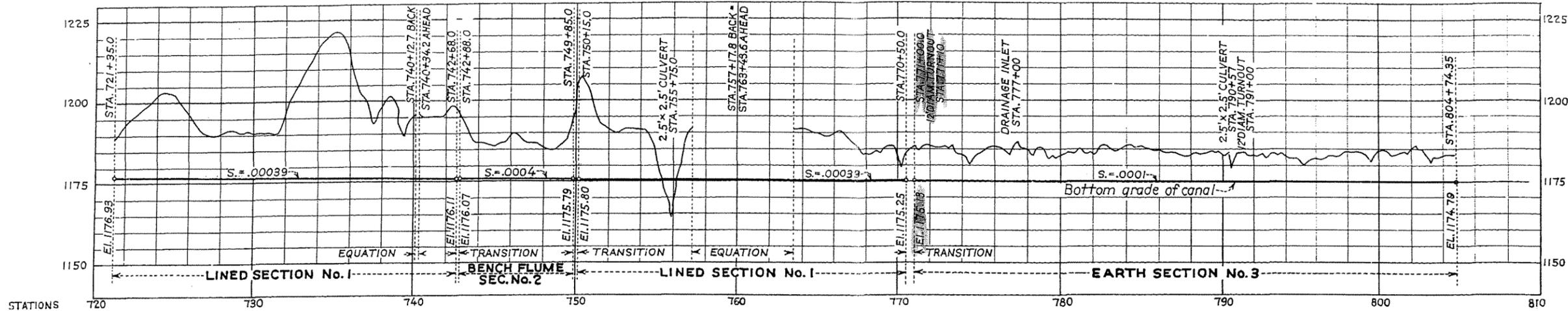


INDEX MAP



DEPARTMENT OF THE INTERIOR  
 BUREAU OF RECLAMATION  
 YAKIMA PROJECT - WASHINGTON  
 ROZA DIVISION  
**YAKIMA RIDGE CANAL**  
**STA. 721+35 TO 804+74.35 AND STA. 942+00 TO 1120+00**  
**LOCATION MAP**

DRAWN: K.S.E. SUBMITTED: *W.M. McKinney*  
 TRACED: J.J.B. RECOMMENDED: *W.A. Nelder*  
 CHECKED: *A.A. Z...* APPROVED: *A.J. Walter*  
**29052** DENVER, COLORADO - FEB. 11, 1937 **33-D-1027**



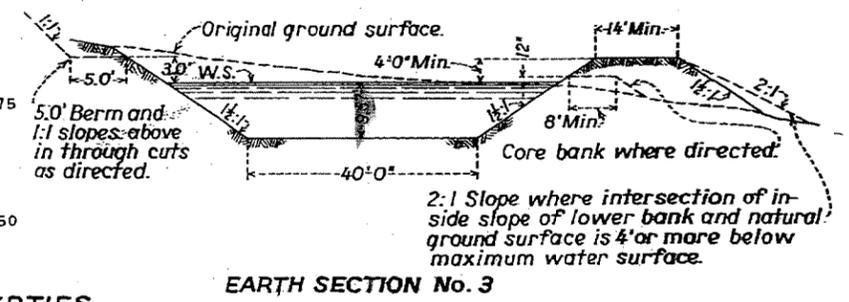
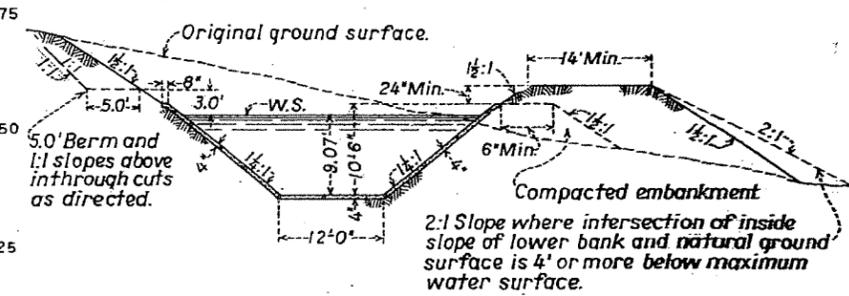
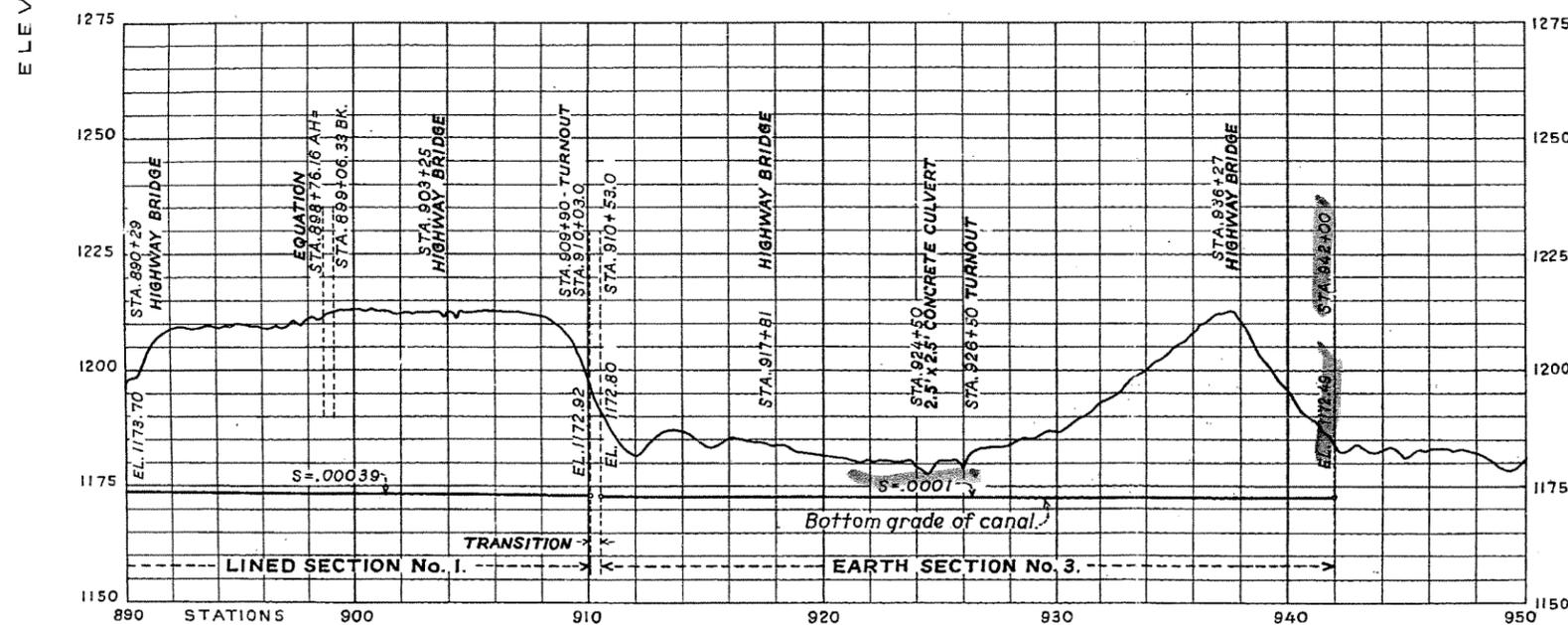
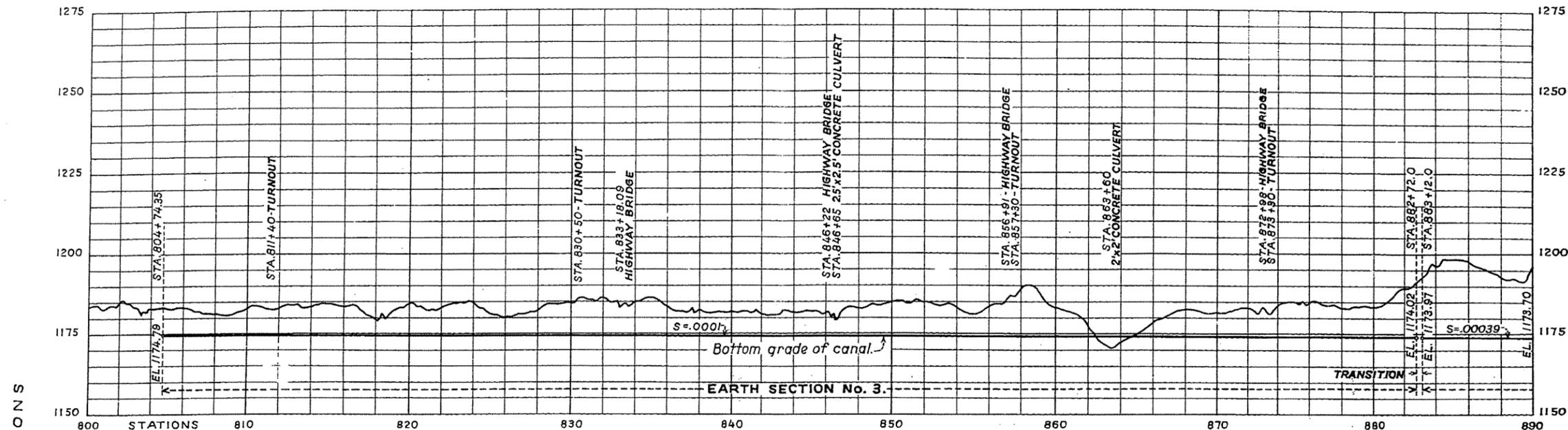
**HYDRAULIC PROPERTIES**

SECTION	A	V	Q	r	n	S
Lined Section No. 1	211.67	6.14	1300	5.16	.014	.00039
Bench Flume Sec. No. 2	209.56	6.21	1300	5.14	.014	.0004
Earth Section No. 3	520.17	2.50	1300	6.98	.0225	.0001

DEPARTMENT OF THE INTERIOR  
BUREAU OF RECLAMATION  
YAKIMA PROJECT - WASHINGTON  
ROZA DIVISION  
YAKIMA RIDGE CANAL  
STA. 721+35 TO 804+74.35 AND STA. 942 TO 1120  
**PROFILE AND SECTIONS**

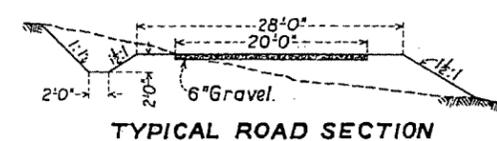
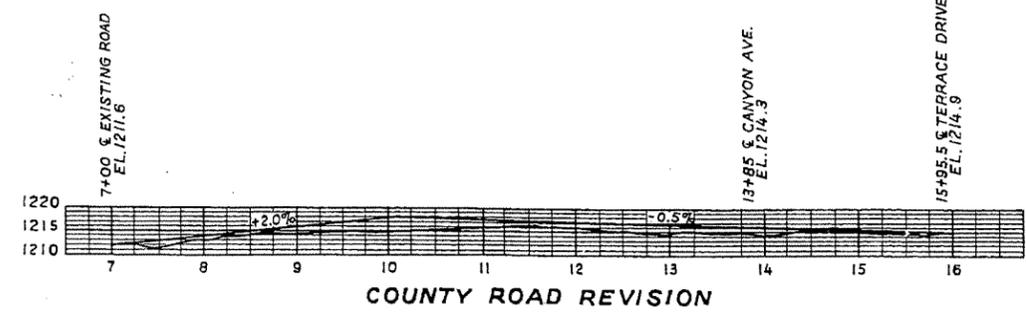
DRAWN: K.S.E. SUBMITTED: *[Signature]*  
TRACED: J.S.B. RECOMMENDED: *[Signature]*  
CHECKED: U.S.I. APPROVED: *[Signature]*

**29053** DENVER, COLORADO - MAR. 2, 1937 **33-D-1028**



HYDRAULIC PROPERTIES

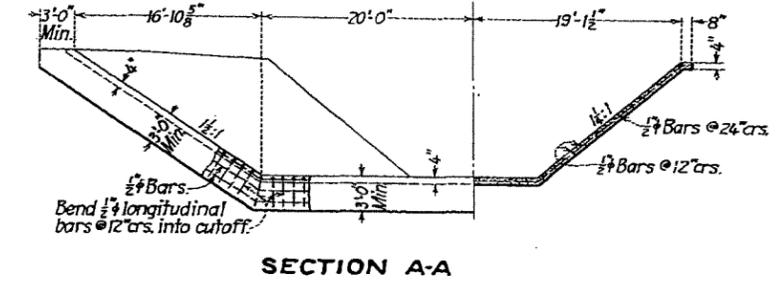
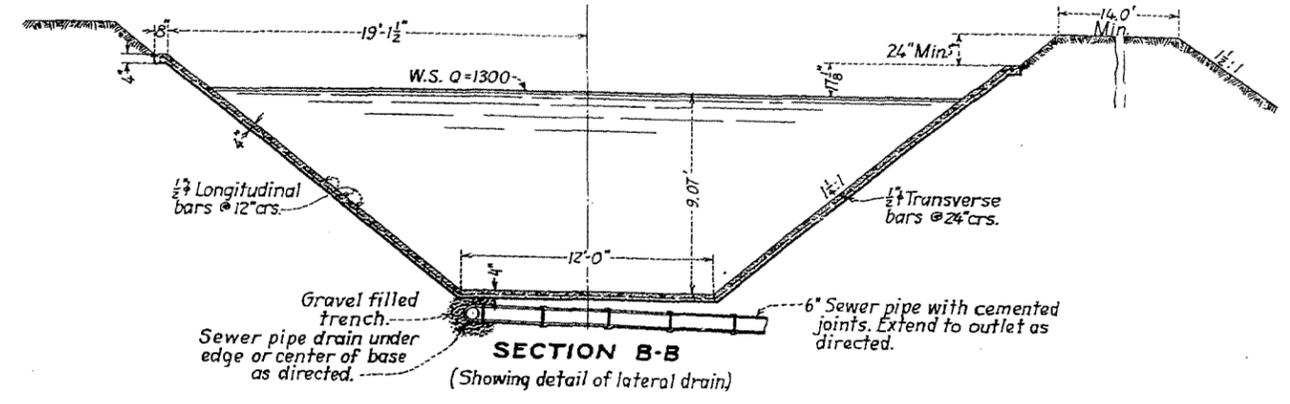
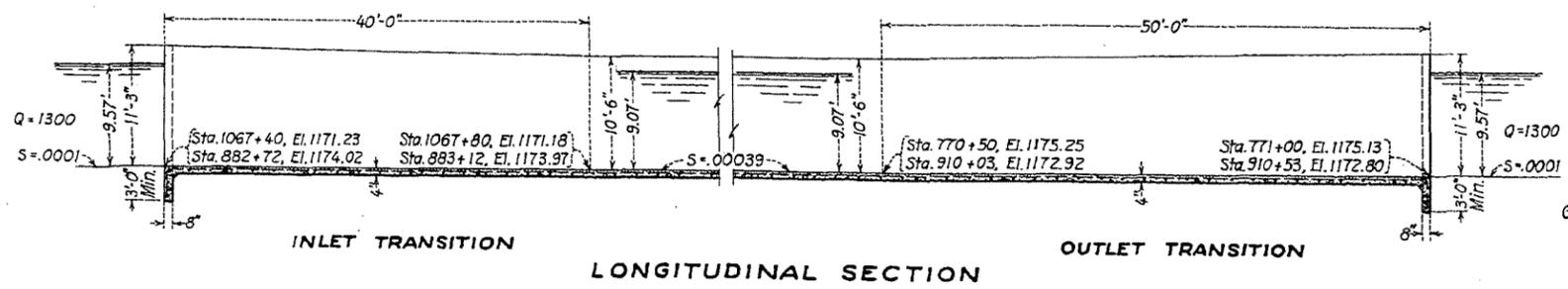
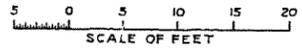
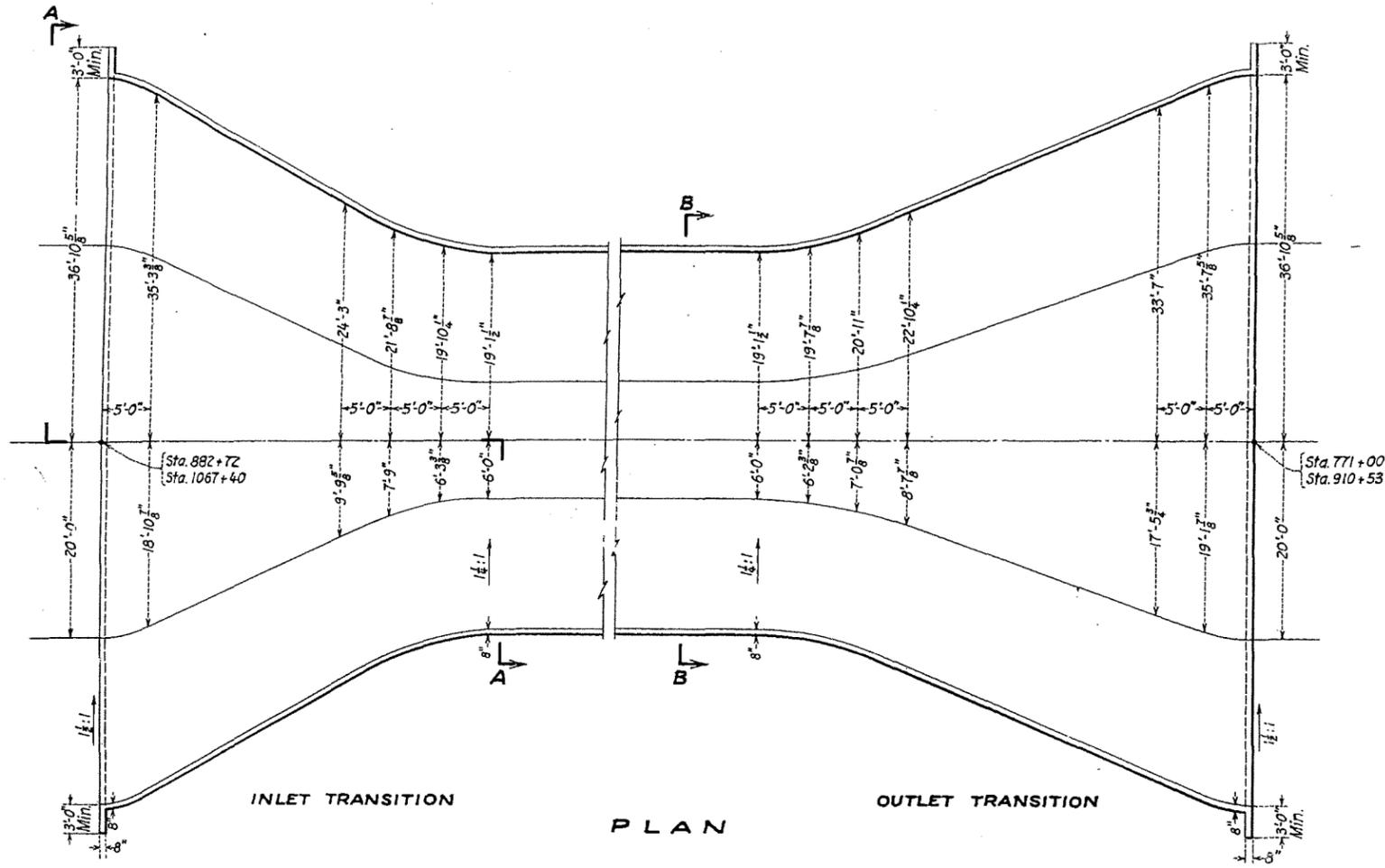
SECTION	A	V	Q	r	n	s
Lined Section No. 1	211.67	6.14	1300	5.16	.014	.00039
Earth Section No. 3	520.17	2.50	1300	6.98	.0225	.0001



DEPARTMENT OF THE INTERIOR  
BUREAU OF RECLAMATION  
YAKIMA PROJECT-WASHINGTON  
ROZA DIVISION  
YAKIMA RIDGE CANAL-STA. 804+74.35 TO 942+00  
AND COUNTY ROAD REVISION  
PROFILE AND SECTIONS

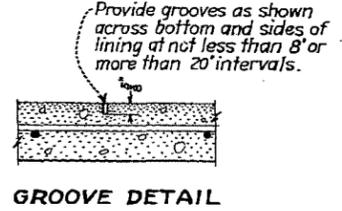
DRAWN: K.S.E. SUBMITTED: *[Signature]*  
TRACED: J.A.R. RECOMMENDED: *[Signature]*  
CHECKED: *[Signature]* APPROVED: *[Signature]*

38-278 DENVER, COLORADO, FEB. 2, 1938 33-D-1234



**HYDRAULIC PROPERTIES**

SECTION	A	V	Q	r	n	s
Earth Canal	520.17	2.50	1300	6.98	.0225	.0001
Lined Canal	211.67	6.14	1300	5.16	.014	.00039



**ESTIMATED QUANTITIES**

**INLET TRANSITION**

Concrete 37 Cu. Yds.  
Reinforcement Steel 3040 Lbs.

**OUTLET TRANSITION**

Concrete 45 Cu. Yds.  
Reinforcement Steel 3690 Lbs.

**CANAL LINING**

Concrete 0.58 Cu. Yds. per ft.  
Reinforcement Steel 47.5 Lbs. per ft.

**NOTES**

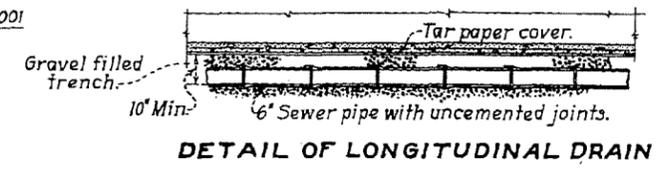
All reinforcement shall be placed so that the centers of bars in the outer layers will be 1/4" from face of concrete unless otherwise noted.

Lap all bars 40 diameters at splices.

Transitions and canal lining to be placed on undisturbed natural foundation or thoroughly compacted fill.

Vertical construction joint across bottom and sides at not less than 8 ft., or more than 20 ft. intervals and finished with suitable edging tool, making grooves 3/8" deep.

Longitudinal reinforcement to be continuous thru joints.

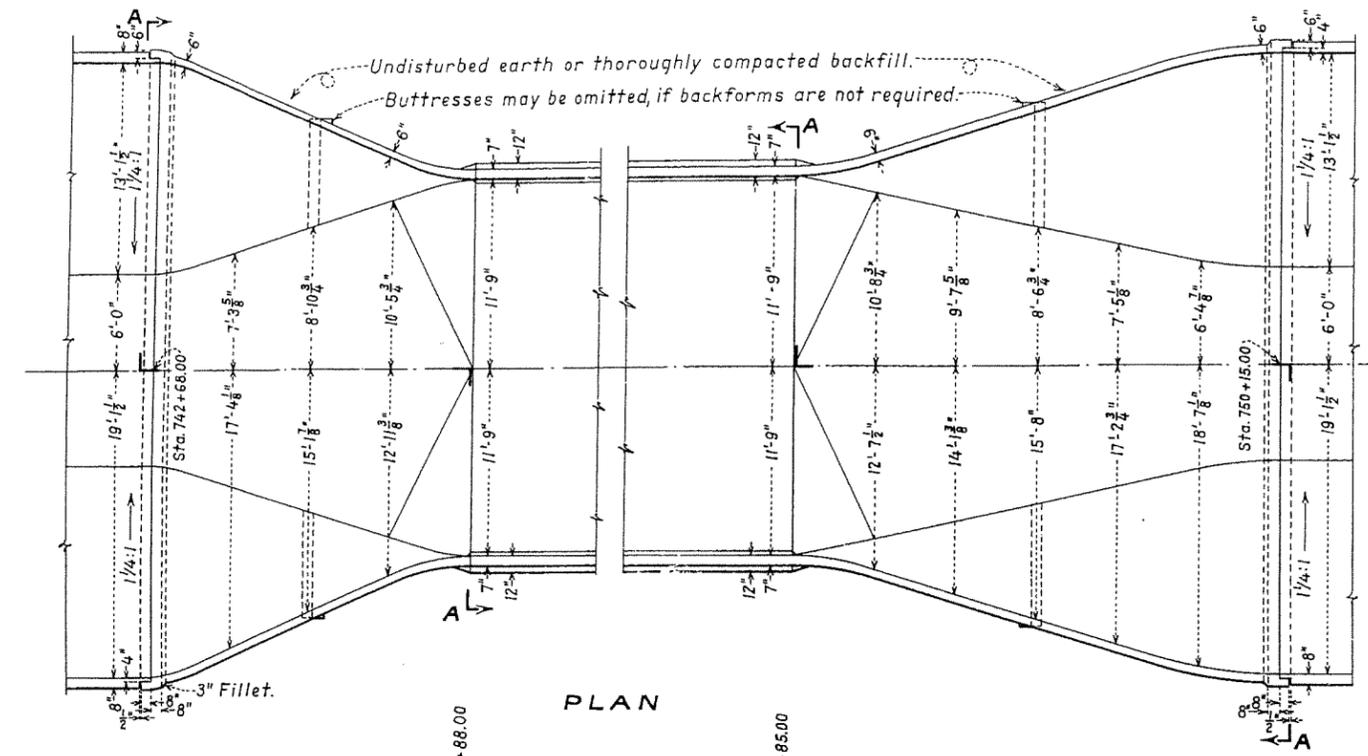


DEPARTMENT OF THE INTERIOR  
BUREAU OF RECLAMATION  
YAKIMA PROJECT - WASHINGTON  
ROZA DIVISION  
YAKIMA RIDGE CANAL - STA. 721+35 TO 1120+00  
CANAL LINING - TRANSITIONS

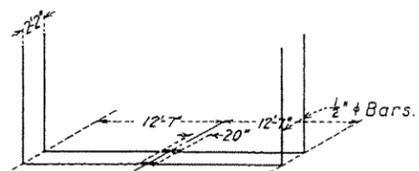
REV. 2-5-38

DRAWN: K.K.Y. SUBMITTED: *W.M. Gifford*  
TRACED: W.H.B. RECOMMENDED: *W.D. Walker*  
CHECKED: *K.F.P.* APPROVED: *R.S. Walter*

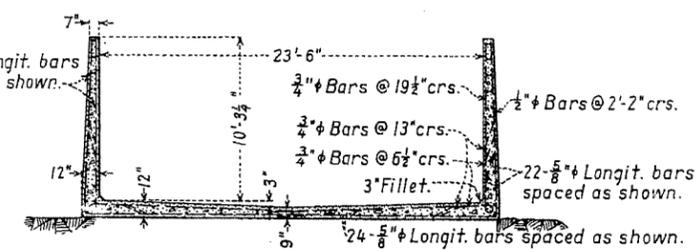
29054 DENVER, COLORADO, FEB. 12, 1937 33-D-1029



PLAN



TIE BARS - OUTSIDE



TYPICAL SECTION OF FLUME  
(REINFORCED FOR WATER - NO BACKFILL)

HYDRAULIC PROPERTIES

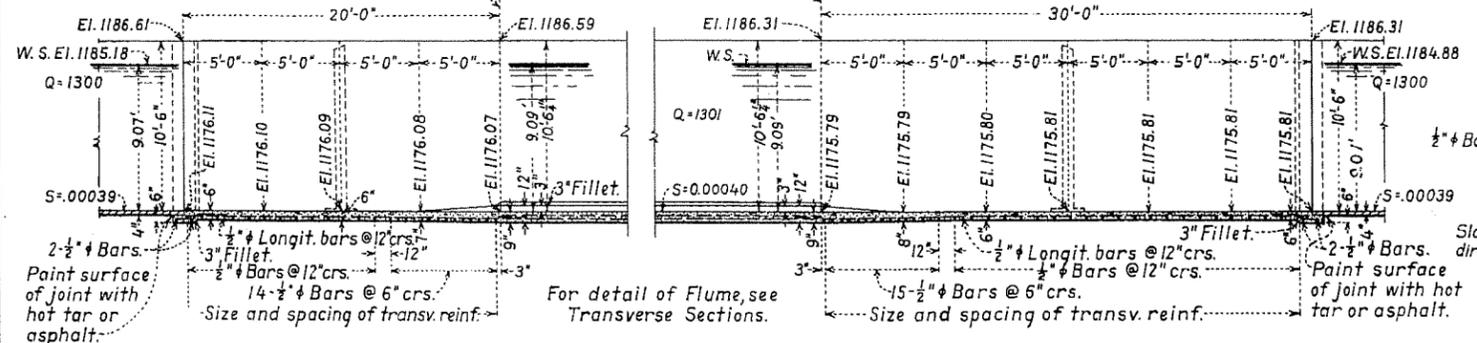
SECTION	A	V	Q	r	n	s
Bench flume	209.56	6.21	1301	5.14	0.014	0.00040
Lined canal	211.67	6.14	1300	5.16	0.014	0.00039

ESTIMATED QUANTITIES

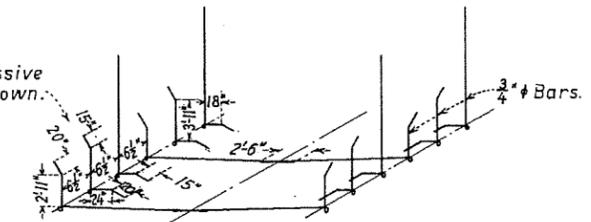
Concrete.....1065 Cu. Yds.  
Reinforcement steel.....127,000 Lbs.

NOTES

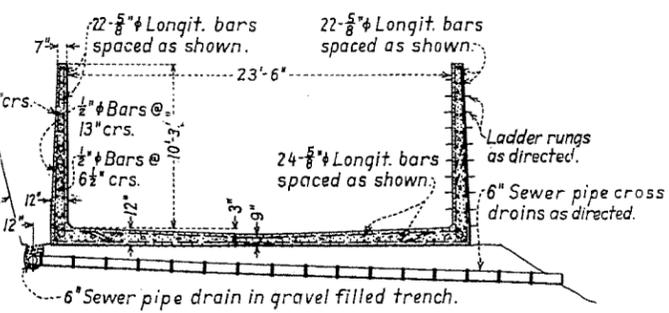
All reinforcement shall be placed so that the centers of bars in the outer layers are 2" from the face of concrete, unless otherwise shown.  
Lap all bars 40 diameters at splices.  
Thickness of concrete to vary uniformly between dimensions shown.  
Stations and elevations, shown on plan and sections, refer to bottom grade, unless otherwise noted.



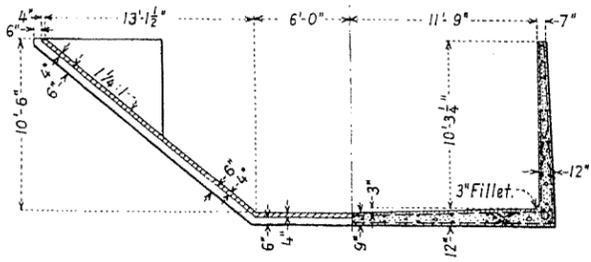
LONGITUDINAL SECTION



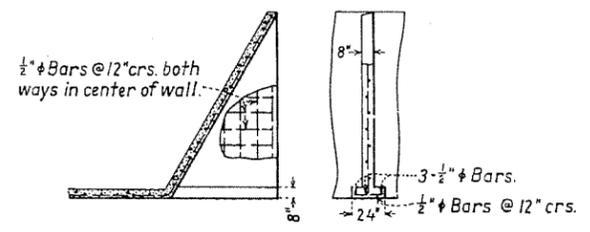
INSIDE REINFORCEMENT FOR WATER



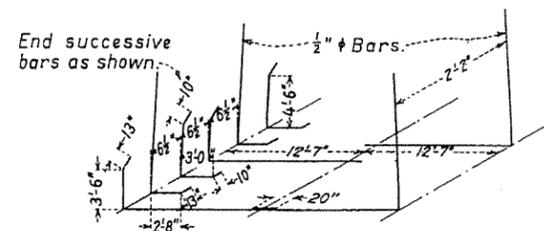
TYPICAL SECTION OF FLUME  
(REINFORCED FOR WATER AND BACKFILL)



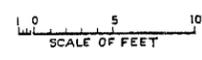
SECTION A-A



DETAIL OF BUTTRESS



OUTSIDE REINFORCEMENT  
(BACKFILL ON ONE SIDE)



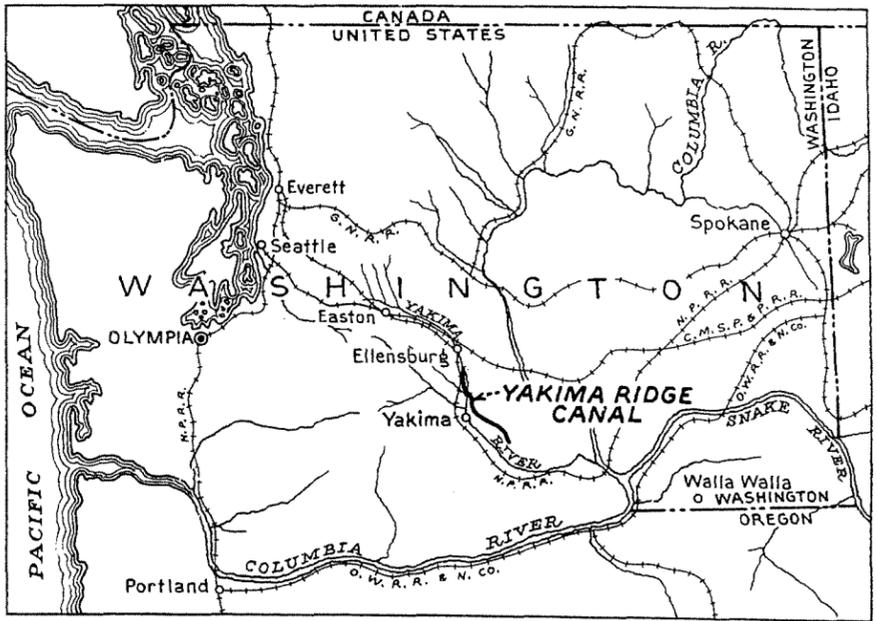
DEPARTMENT OF THE INTERIOR  
BUREAU OF RECLAMATION  
YAKIMA PROJECT - WASHINGTON  
ROZA DIVISION  
**YAKIMA RIDGE CANAL - STA. 742+68 TO 750+15  
BENCH FLUME-TRANSITIONS**

DRAWN: K.E.B. SUBMITTED: *W.M. Bimney*  
TRACED: S.E.W. RECOMMENDED: *W.M. Bimney*  
CHECKED: *W.M. Bimney* APPROVED: *R.S. Walter*

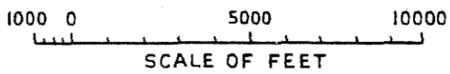
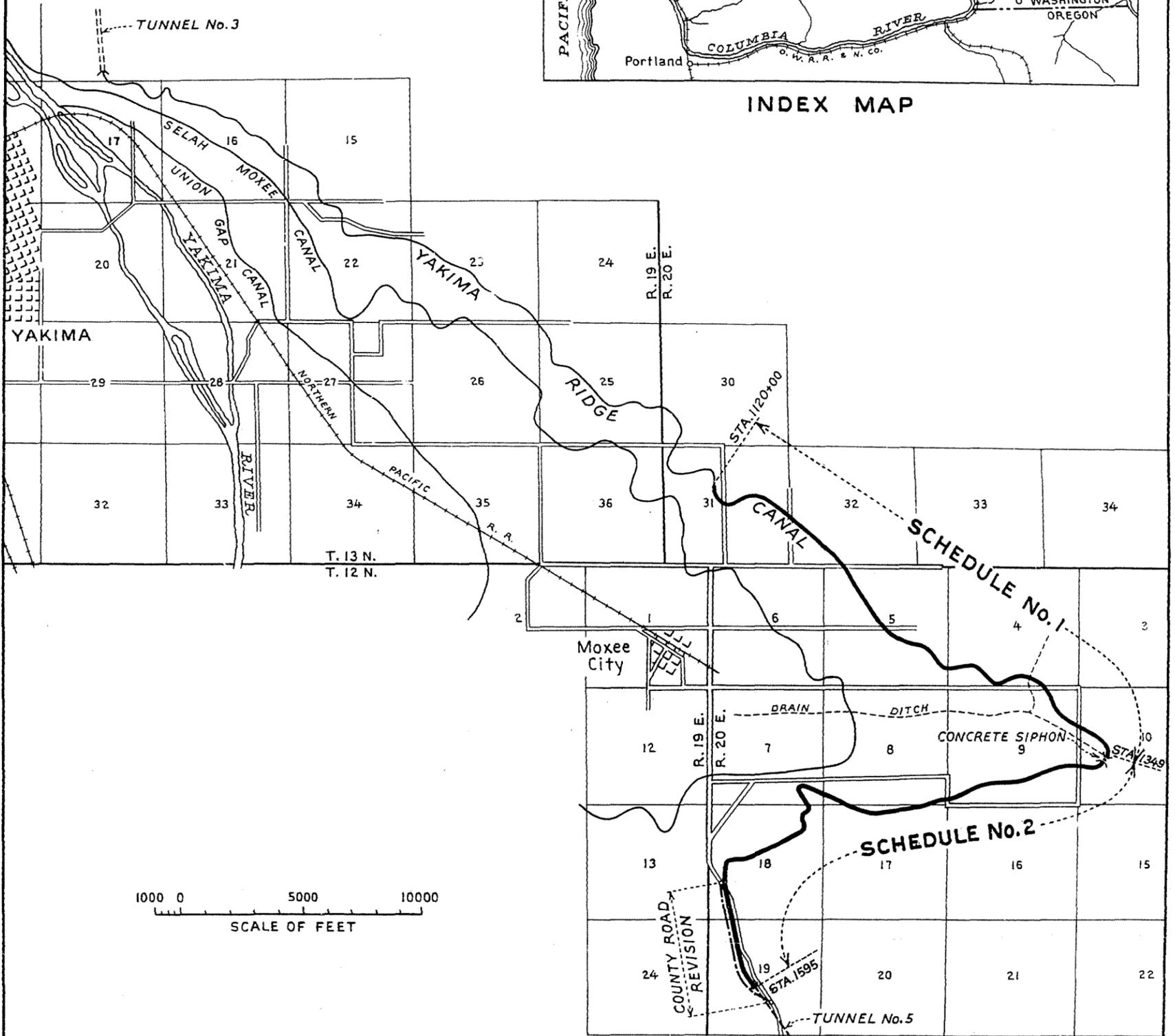
29055 DENVER, COLORADO, FEB. 19, 1937. 33-D-1030

### **F-3. Canal Station 1120+00 to Station 1595+00; Specification No.748**

- 33-D-1132 — Yakima Ridge Canal, Sta. 1120+00 to 1595+00, Location Map
- 33-D-1133 — Yakima Ridge Canal, Sta. 1120+00 to 1349+00, Profile and Section
- 33-D-1134 — Yakima Ridge Canal, Sta. 1349+00 to 1595+00, Profile and Section



INDEX MAP



DEPARTMENT OF THE INTERIOR  
BUREAU OF RECLAMATION  
YAKIMA PROJECT-WASHINGTON  
ROZA DIVISION  
**YAKIMA RIDGE CANAL-STA. 1120+00 TO 1595+00**  
**LOCATION MAP**

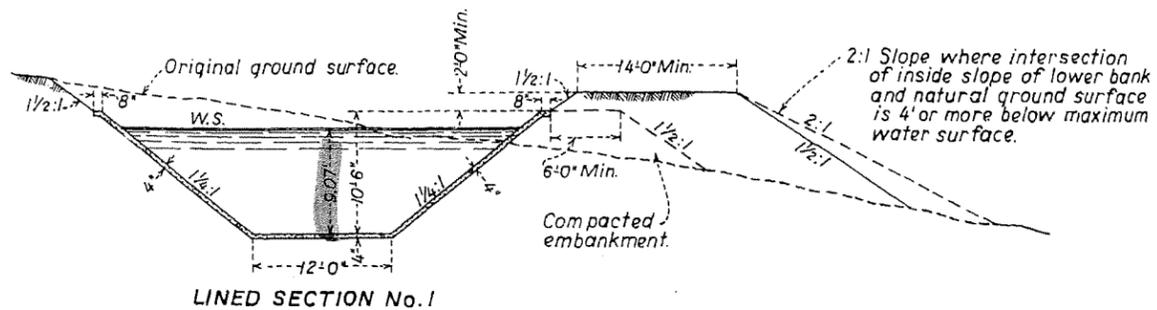
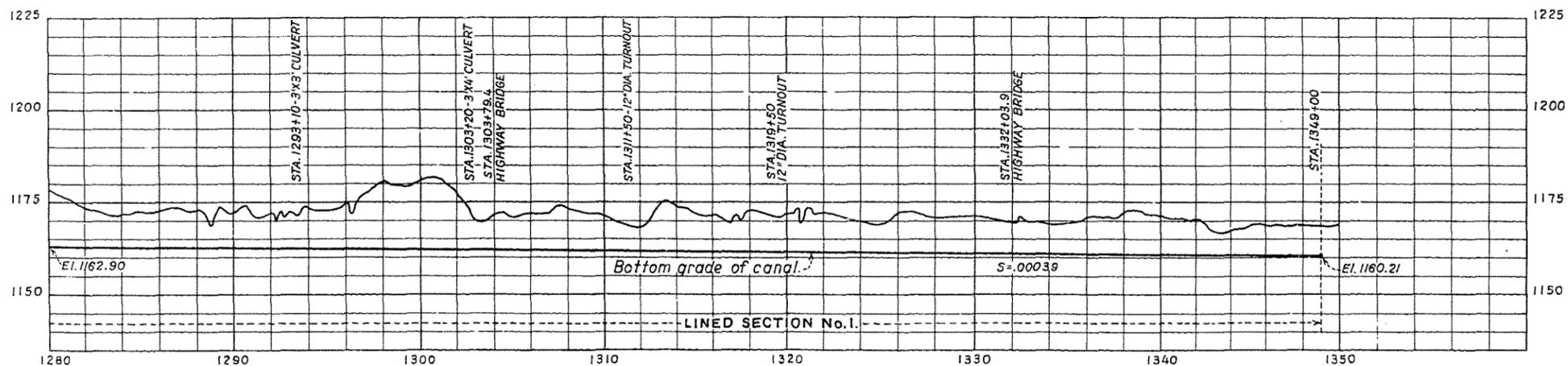
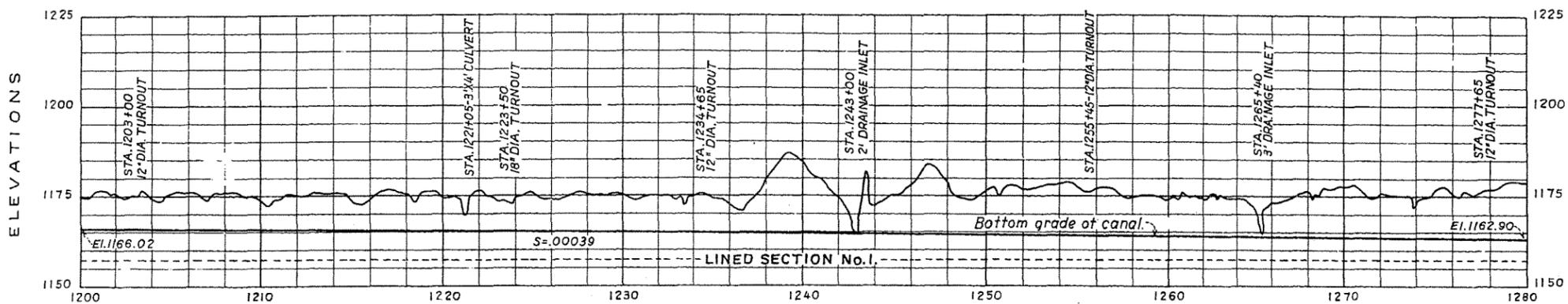
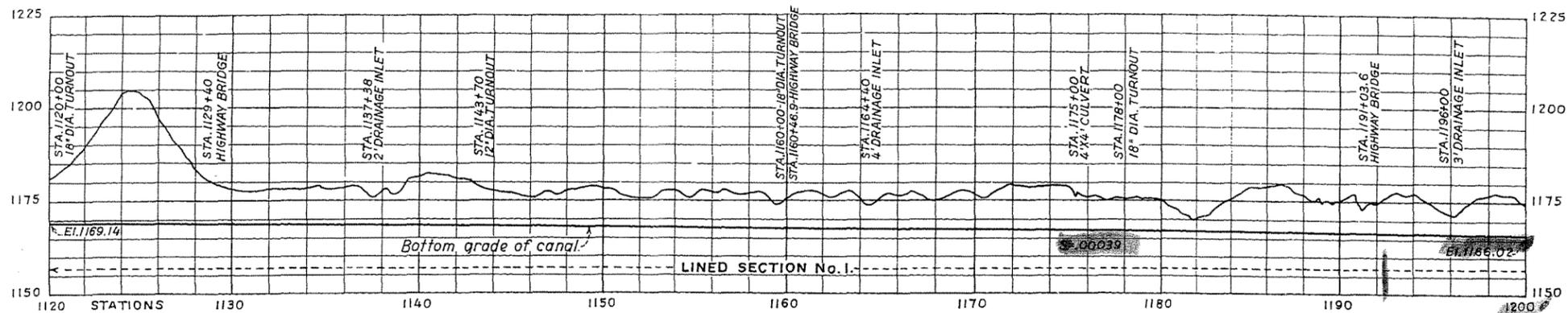
DRAWN: K.S.E. SUBMITTED: *W.R. McKinney*  
TRACED: C.E.M. RECOMMENDED: *J.W. Nallen*  
CHECKED: *ABR* APPROVED: *Dotson*

29284

DENVER, COLORADO, JUNE 8, 1937.

33-D-1132

16"x21"



LINED SECTION No. 1

HYDRAULIC PROPERTIES

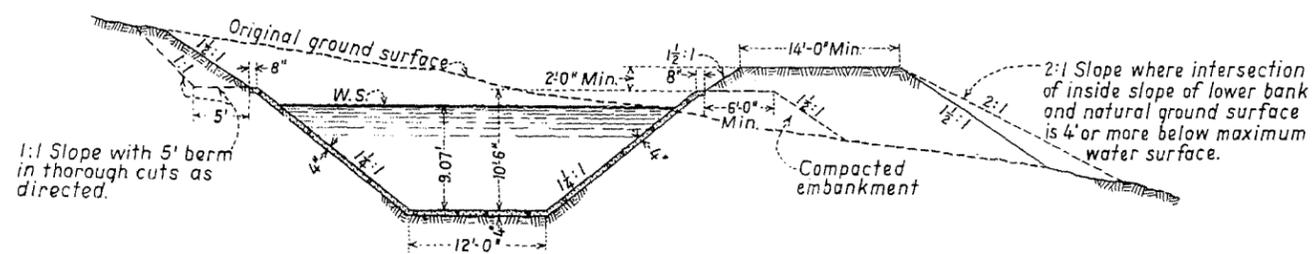
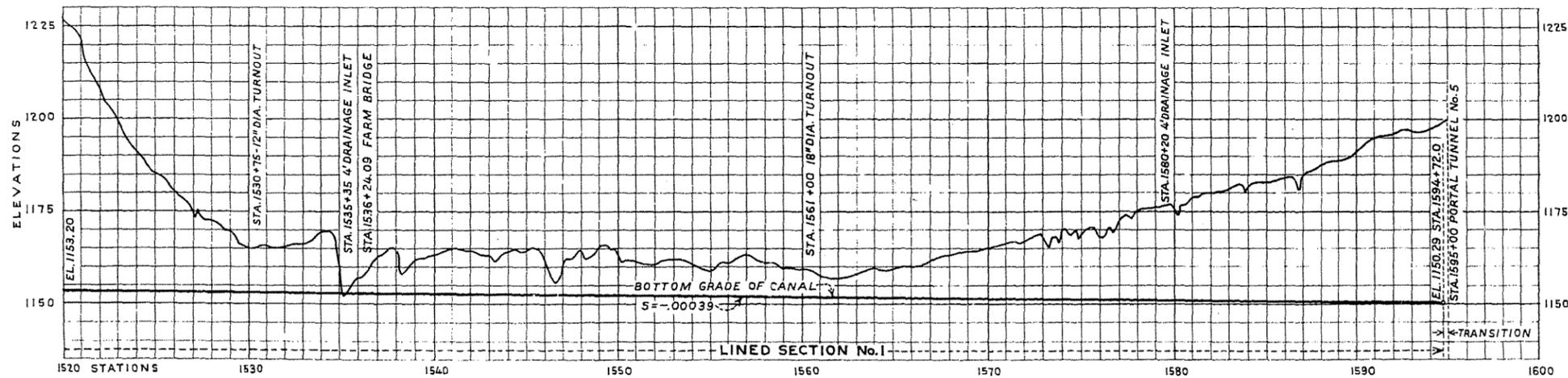
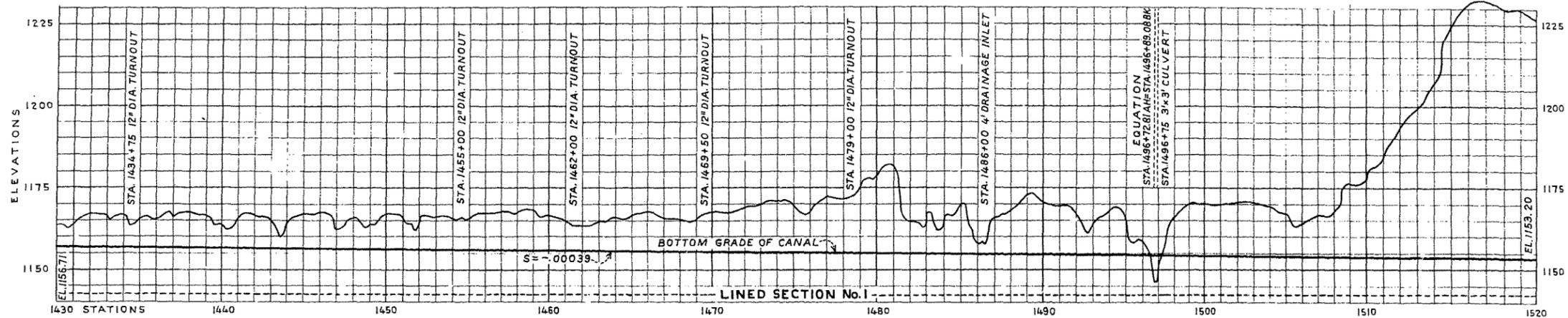
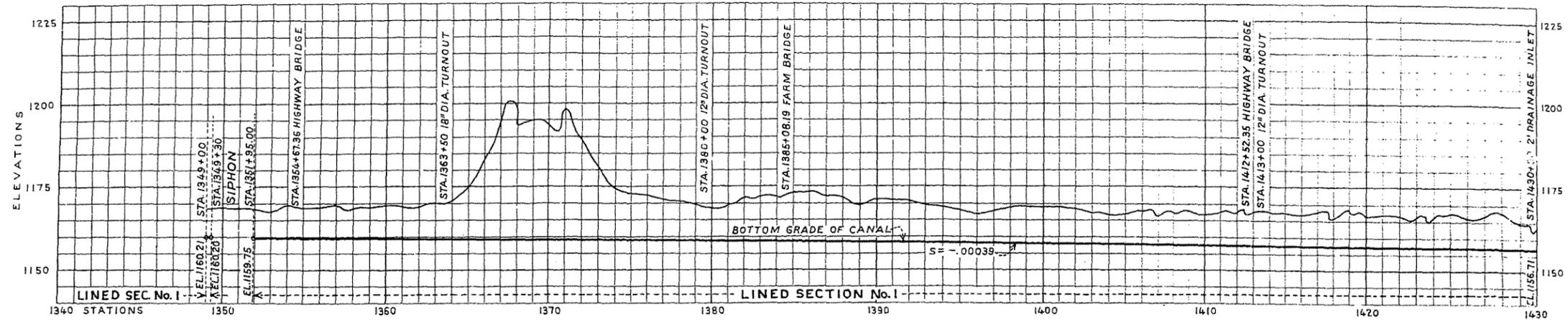
A	V	Q	r	n	s
211.67	6.14	1300	5.16	.014	.00039

SCHEDULE NO. 1

DEPARTMENT OF THE INTERIOR  
 BUREAU OF RECLAMATION  
 YAKIMA PROJECT - WASHINGTON  
 ROZA DIVISION  
**YAKIMA RIDGE CANAL - STA. 1120+00 TO 1349+00**  
**PROFILE AND SECTION**

DRAWN: K.S.E. SUBMITTED: *[Signature]*  
 TRACED: W.A.R. RECOMMENDED: *[Signature]*  
 CHECKED: U.S.J. APPROVED: *[Signature]*

29285 DENVER, COLORADO, APR. 6, 1937. 33-D-1133



LINED SECTION No. 1

HYDRAULIC PROPERTIES

A	V	Q	r	n	s
211.67	5.14	1300	5.16	.014	.00039

SCHEDULE NO. 2

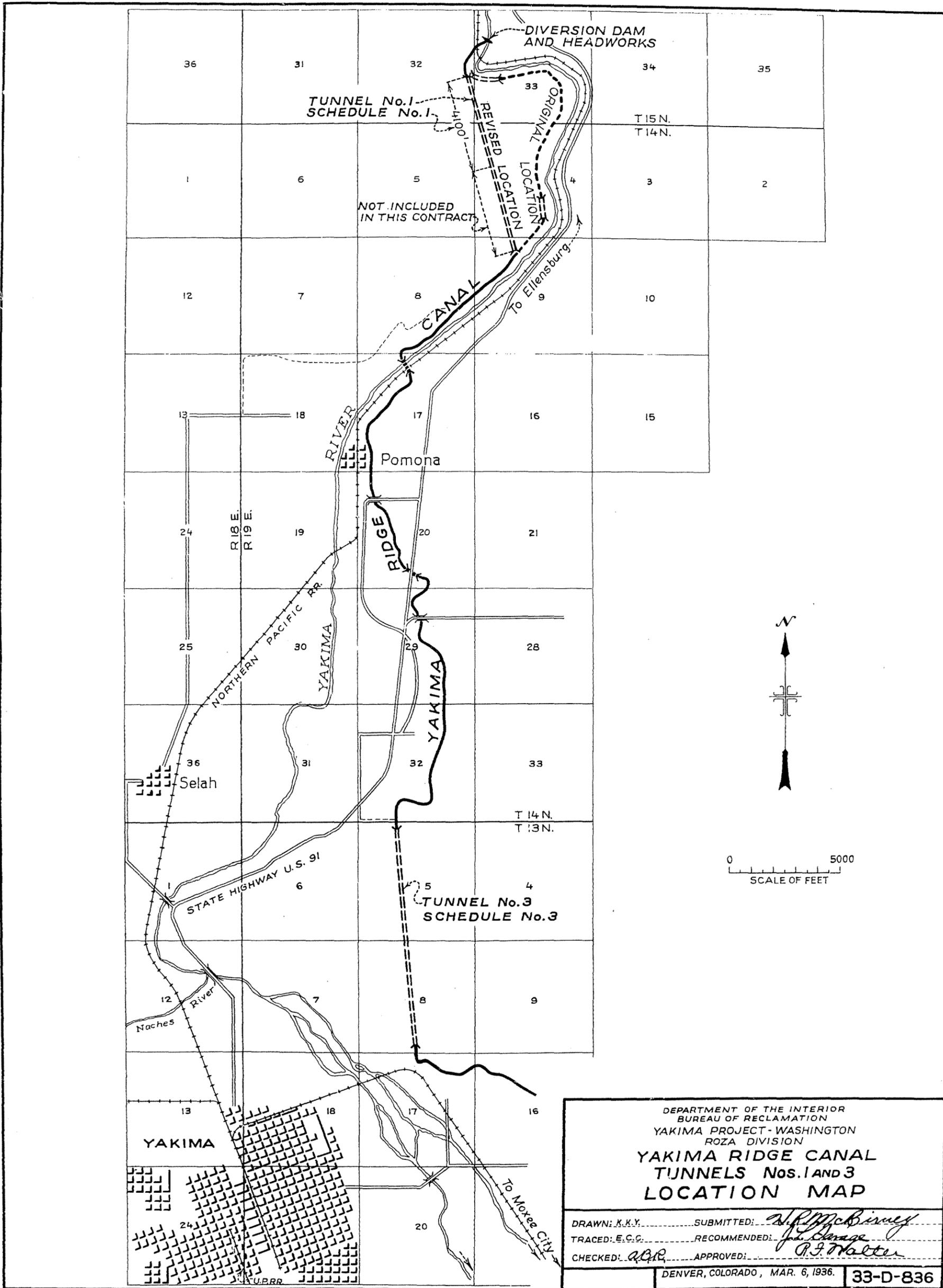
DEPARTMENT OF THE INTERIOR  
BUREAU OF RECLAMATION  
YAKIMA PROJECT-WASHINGTON  
ROZA DIVISION  
**YAKIMA RIDGE CANAL - STA. 1349 TO 1595  
PROFILE - SECTION**

DRAWN... K.S.E. SUBMITTED... *[Signature]*  
 TRACED... C.A.R. RECOMMENDED... *[Signature]*  
 CHECKED... V.P. APPROVED... *[Signature]*

29286 DENVER, COLORADO JUNE 26, 1937 33-D-1134

#### **F-4. Tunnels No. 1 and No. 3**

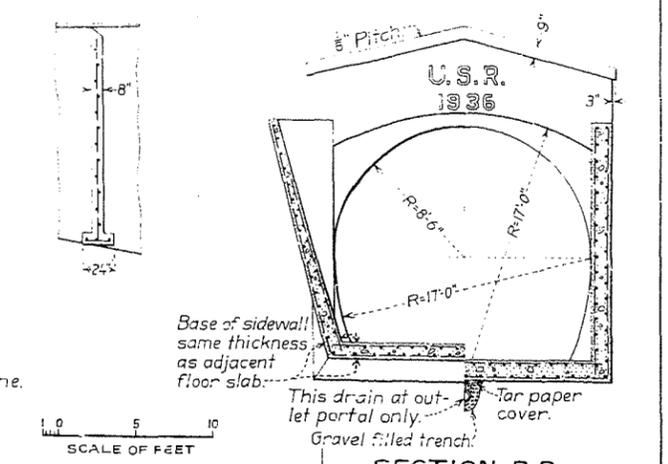
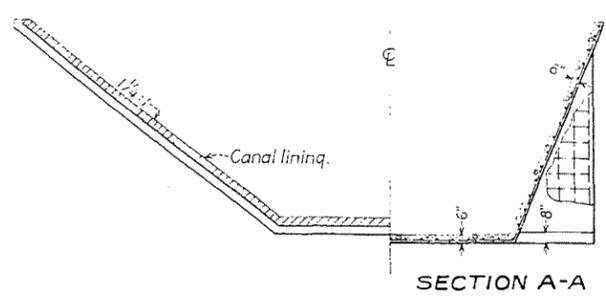
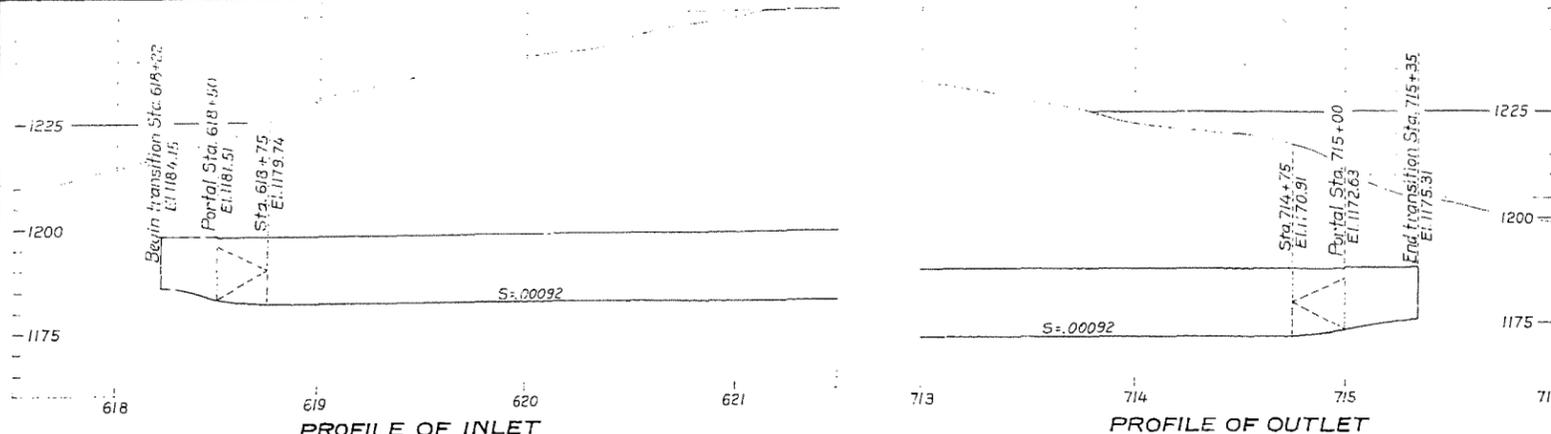
- 33-D-836 — Yakima Ridge Canal, Tunnels Nos. 1 and 3, Location Map
- 33-D-1127 — Yakima Ridge Canal, Tunnels Nos. 1 and 3, Section
- 33-D-1057 — Yakima Ridge Canal, Tunnel No. 3 - Sta. 618+50, Portal Structure — Transitions Bar Placing Diagram
- 33-D-1058 — Yakima Ridge Canal, Tunnel No. 3 - Sta. 618+50, Portal Structure – Transitions Bar Placing Diagram



DEPARTMENT OF THE INTERIOR  
 BUREAU OF RECLAMATION  
 YAKIMA PROJECT - WASHINGTON  
 ROZA DIVISION  
**YAKIMA RIDGE CANAL  
 TUNNELS Nos. 1 AND 3  
 LOCATION MAP**

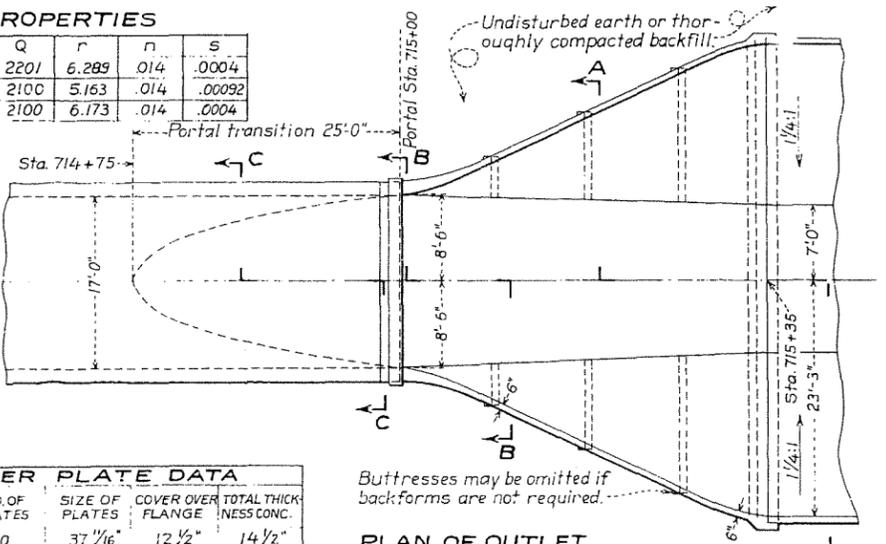
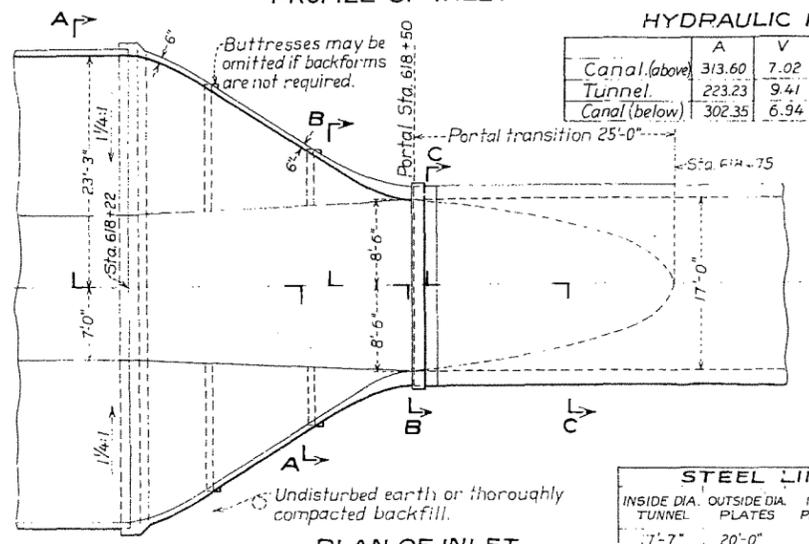
DRAWN: K.K.Y. SUBMITTED: *H. J. McBriney*  
 TRACED: E.C.C. RECOMMENDED: *J. C. Cange*  
 CHECKED: *ALR* APPROVED: *P. J. Walter*

DENVER, COLORADO, MAR. 6, 1936. **33-D-836**



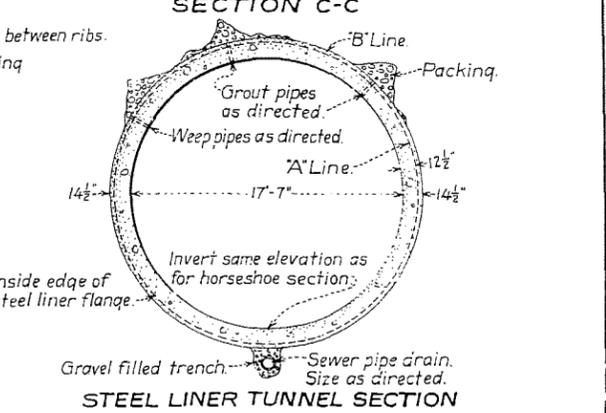
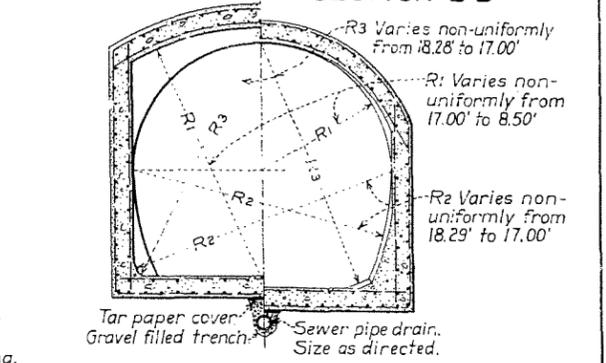
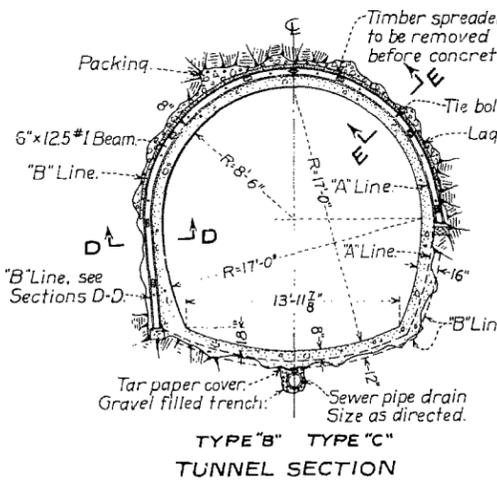
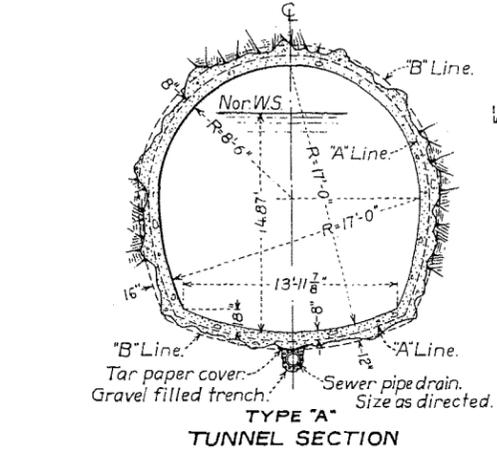
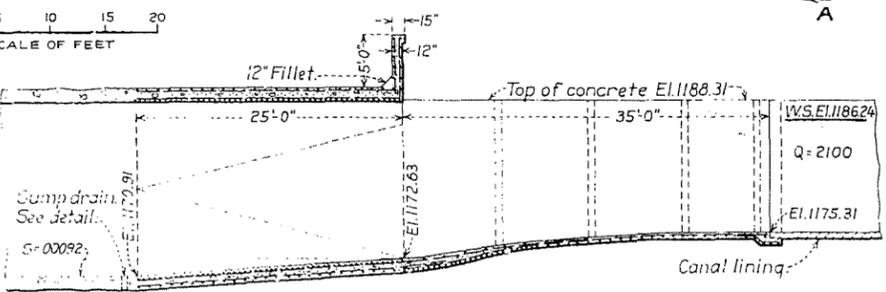
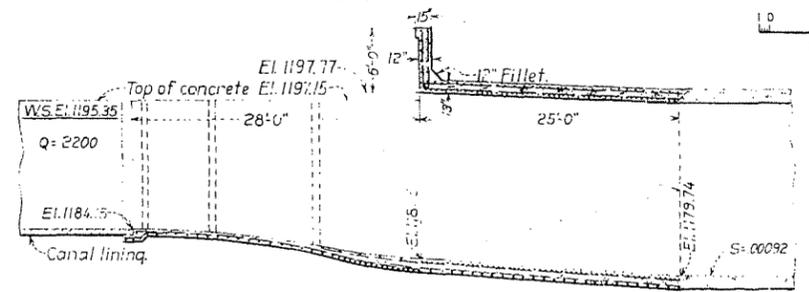
**HYDRAULIC PROPERTIES**

	A	V	Q	r	n	S
Canal (above)	313.60	7.02	2201	6.289	.014	.0004
Tunnel	223.23	9.41	2100	5.163	.014	.00092
Canal (below)	302.35	6.94	2100	6.173	.014	.0004



**STEEL LINER PLATE DATA**

INSIDE DIA. TUNNEL	OUTSIDE DIA. PLATES	NO. OF PLATES	SIZE OF PLATES	COVER OVER FLANGE	TOTAL THICKNESS CONC.
17'-7"	20'-0"	20	37 1/16"	12 1/2"	14 1/2"

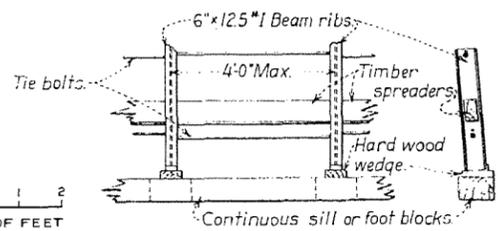
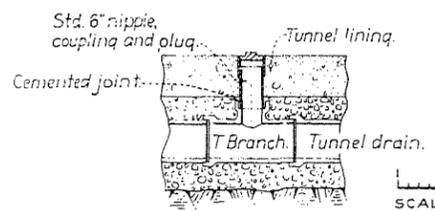
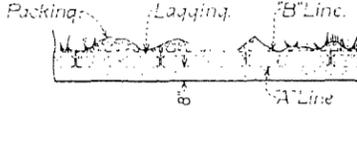
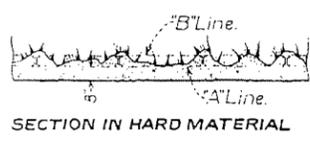
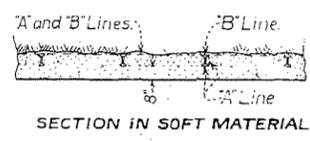


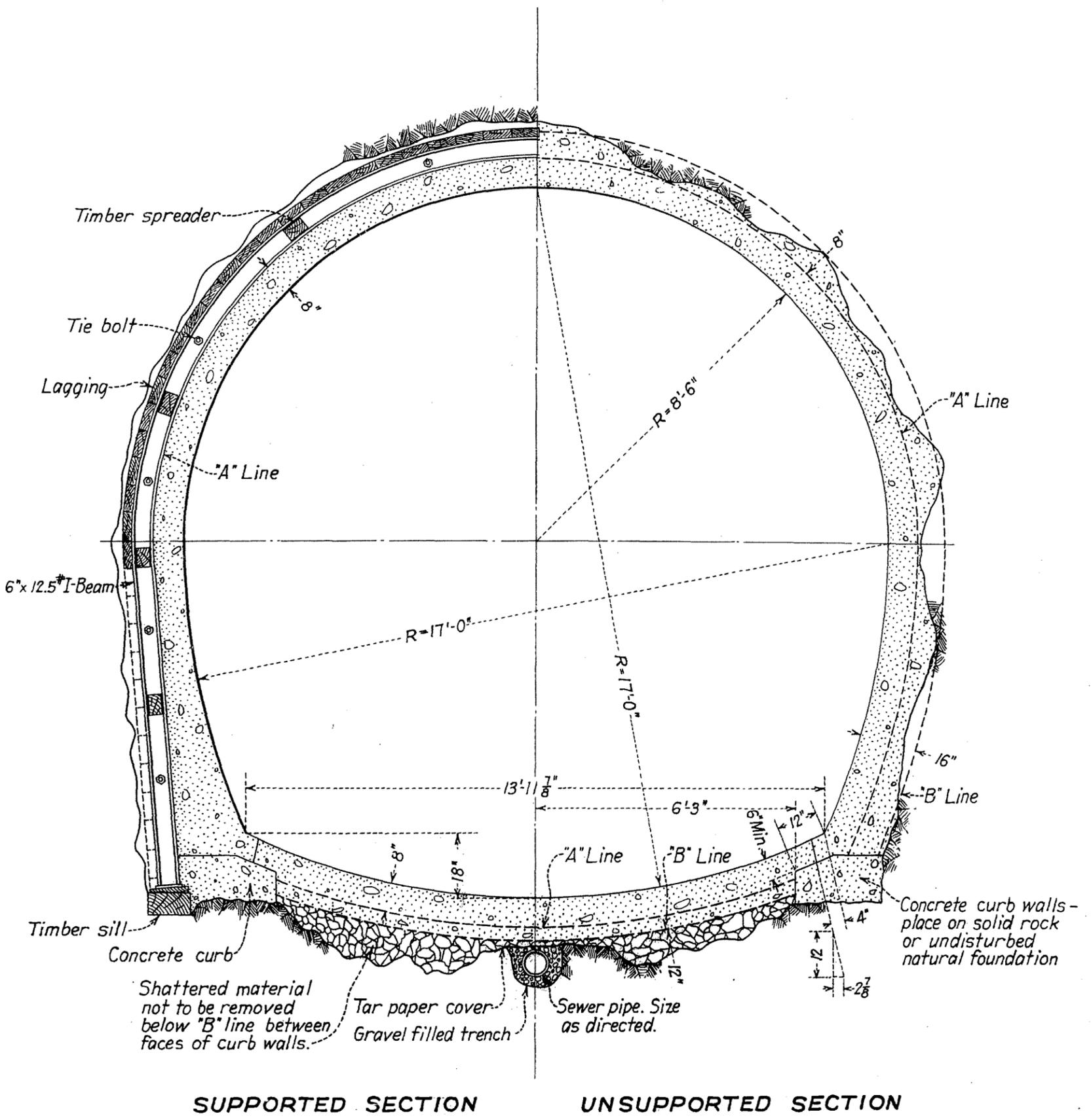
**ESTIMATED QUANTITIES**

Concrete, reinforced	250 Cu.Yds.
Concrete tunnel lining	28,000 Cu.Yds.
Reinforcement steel	21,900 Lbs.

DEPARTMENT OF THE INTERIOR  
BUREAU OF RECLAMATION  
YAKIMA PROJECT-WASH.  
ROZA DIVISION  
**YAKIMA RIDGE CANAL-STA. 618+22  
TUNNEL NO. 3**

Rev. 3-9-36  
DRAWN: J.H.K. SUBMITTED: J.L. Mobley  
TRACED: C.E.W. RECOMMENDED: J.S. Dwyer  
CHECKED: L.P. APPROVED: R.S. Matus  
27773 DENVER, COLO. NOV. 5, 1935. 33-D-833



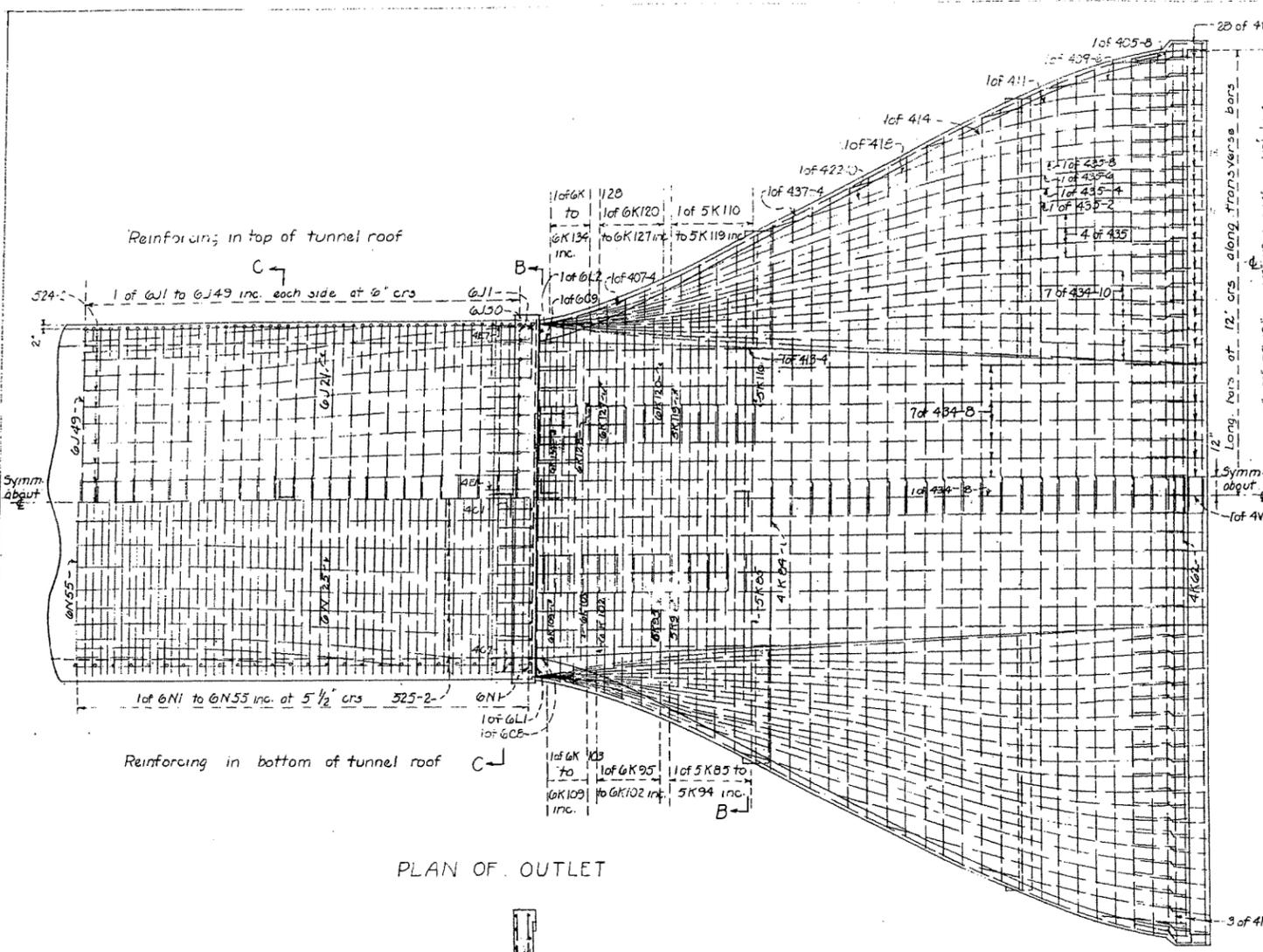


DEPARTMENT OF THE INTERIOR  
 BUREAU OF RECLAMATION  
 YAKIMA PROJECT-WASHINGTON  
 ROZA DIVISION  
 YAKIMA RIDGE CANAL  
 TUNNELS NO. 1 AND NO. 3  
 SECTION

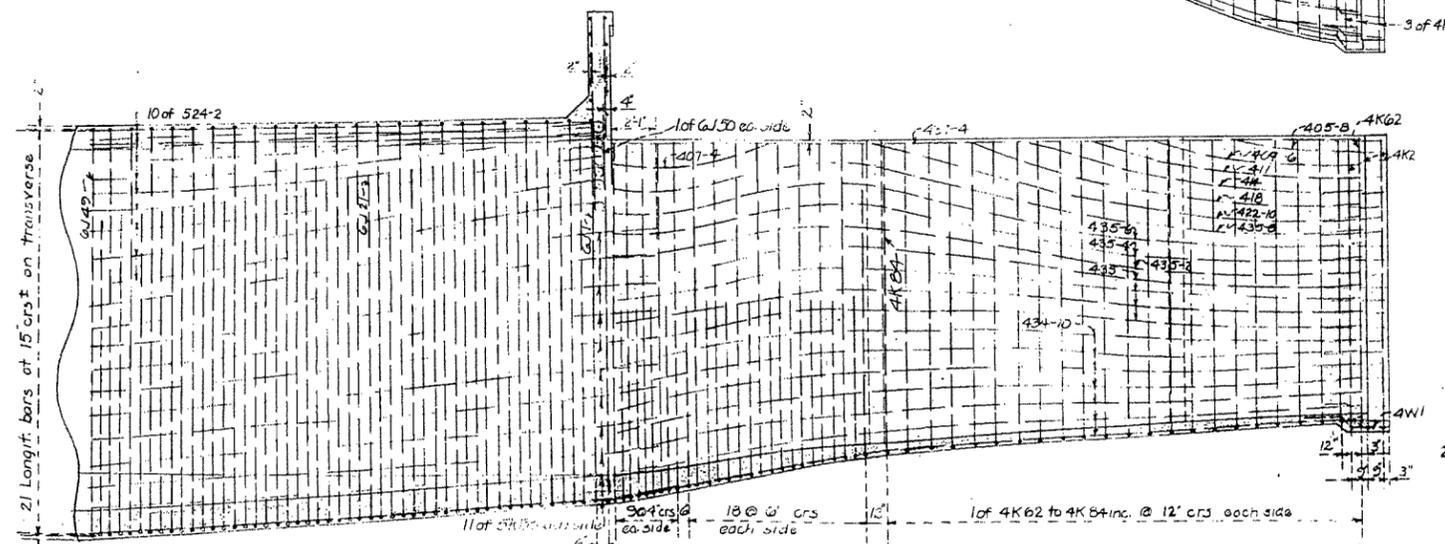
DRAWN: W.C.O. SUBMITTED: *W.C.O.*  
 TRACED: S.M.E. RECOMMENDED: *S.M.E.*  
 CHECKED: *abb* APPROVED: *W.C.O.*

DENVER, COLORADO. JULY 6, 1937. 33-D-1127

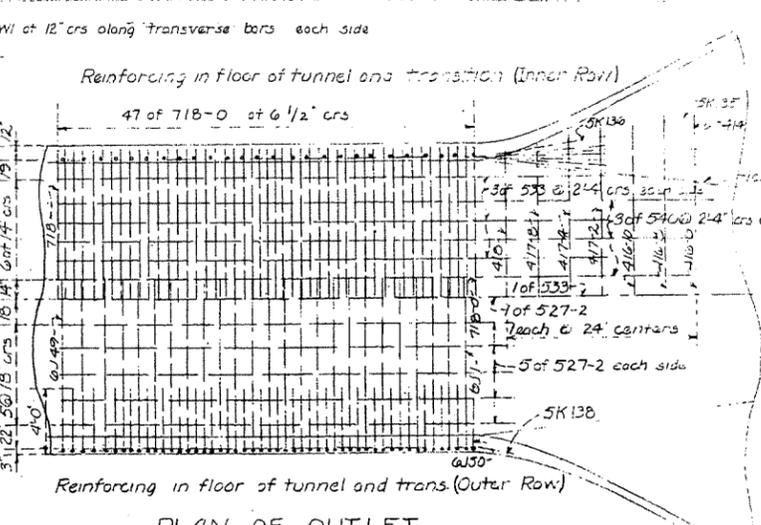
16"x 21"



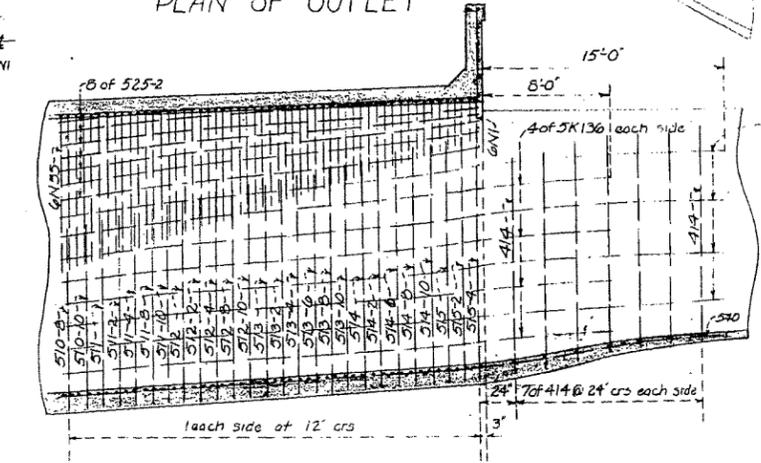
PLAN OF OUTLET



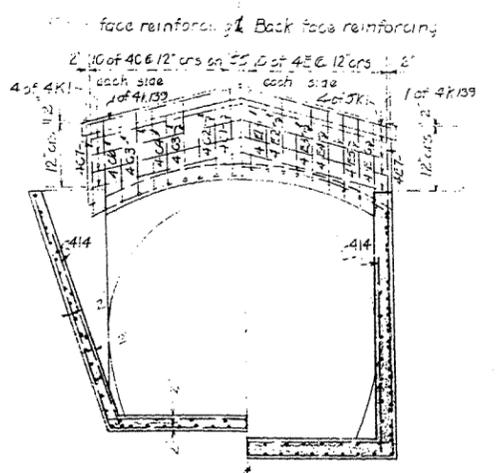
LONGITUDINAL SECTION OF OUTLET



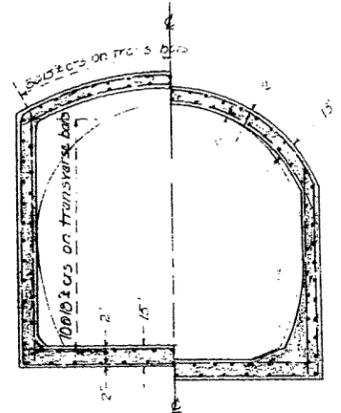
PLAN OF OUTLET



LONGITUDINAL SECTION OF OUTLET



SECTION B-B



SECTION C-C

NOTES

All reinforcement shall be placed so the centers of bars in the outer layers will be 2 from face of concrete unless shown otherwise.  
Lap all bars 40 diameters at all times.  
For details of structure see drawing 33-D-855

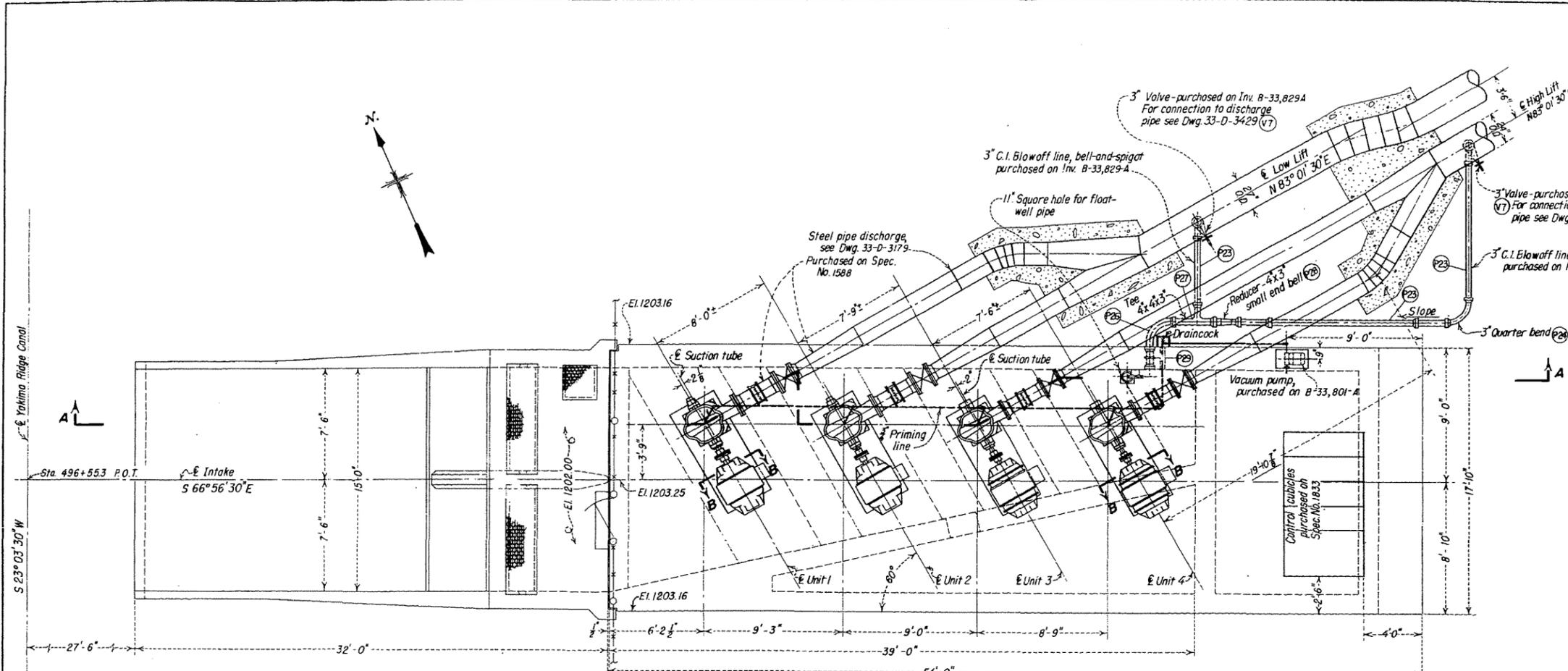
DEPARTMENT OF THE INTERIOR  
BUREAU OF RECLAMATION  
YAKIMA PROJECT - WASH  
ROZA DIVISION  
YAKIMA RIDGE CANAL-TUNNEL NO.3-5 to 61B+50  
PORTAL STRUCTURE-TRANSITIONS  
BAR PLACING DIAGRAM  
DRAWN: C.J.M. SUBMITTED: *[Signature]*  
RECOMMENDED: *[Signature]*  
CHECKED: C.S. APPROVED: *[Signature]*  
DENVER, COLO. JUNE 4, 1936 33-D-1058  
Sheet 2 of 4

Buttress No. 4  
2 Required

Buttress No. 3  
2 Required

## **F-5. Pumping Plants**

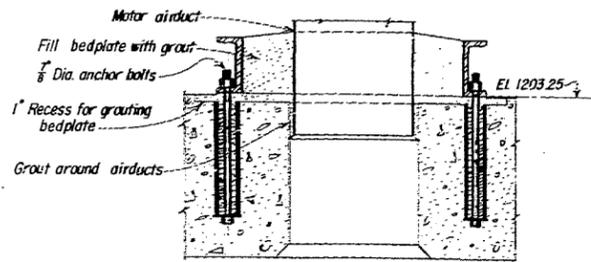
- 33-D-3063 — Roza Division, Mile 7.2 Pumping Plant, Plan and Sections
- 33-D-3064 — Roza Division, Mile 16.8 Pumping Plant, Plan and Sections
- 33-D-3065 — Roza Division, Mile 22.5 Pumping Plant, Plan and Sections
- 33-D-3072 — Roza Division, Outdoor Pumping Plants, Area Numbers 1, 2, 3, 4, 8, 15, 16, Concrete Outline and Reinforcement



PLAN

**PUMPING UNIT DATA**

	UNITS 1&2	UNITS 3&4
Specification No.	1257	1257
Spec. Item No.	1	8
Pump Capacity - c.f.s.	106	9.1
Total dynamic head - ft.	106	219
Rated H.P.	200	300
R.P.M. full load	1170	1760



SECTION B-B

SCALE OF FEET

**REFERENCE DRAWINGS**

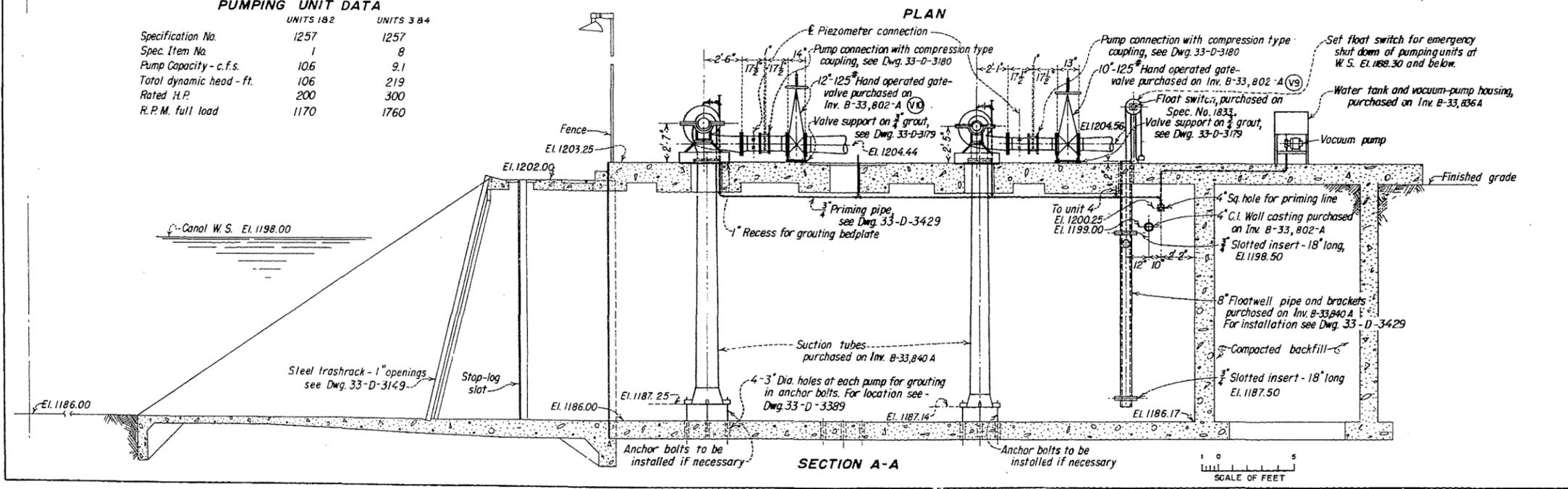
LOCATION PLAN AND SECTIONS	33-D-3388
ELECTRICAL INSTALLATION	33-D-3287
FENCE	33-D-3504
CONCRETE OUTLINE AND DETAILS	33-D-3389
INTAKE STRUCTURE	33-D-3050
DISCHARGE PIPE MANIFOLDS	33-D-3178
WORTHINGTON PUMP & MOTOR CORR-12-LC-3 PUMP	RY-84195
WORTHINGTON PUMP & MOTOR CORR-10-LC-4 PUMP	RY-84203
MISCELLANEOUS STRUCTURAL STEEL	33-D-3430
FLOATWELLS AND SUCTION TUBES	33-D-3507
VACUUM PUMP TANK AND CABINET	33-D-3525
INTAKE STRUCTURE TRASHRACKS	33-D-3149
MISCELLANEOUS INSTALLATION DETAILS	33-D-3429

BILL OF MATERIAL 33-DM-3063

AREA 1

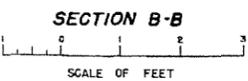
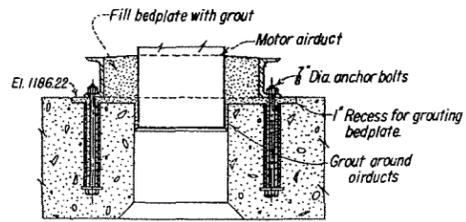
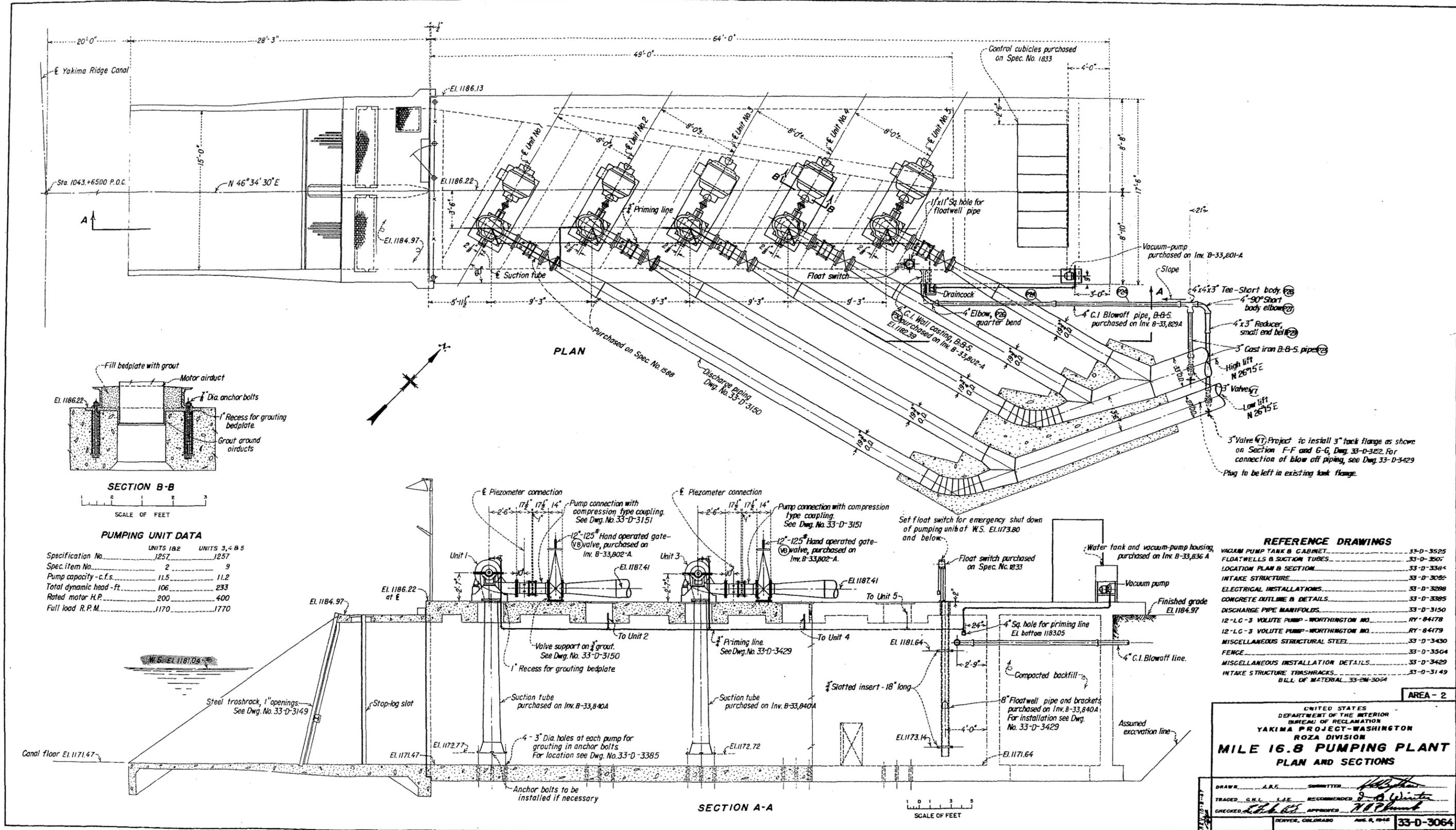
UNITED STATES  
DEPARTMENT OF THE INTERIOR  
BUREAU OF RECLAMATION  
YAKIMA PROJECT - WASHINGTON  
ROZA DIVISION  
**MILE 7.2 PUMPING PLANT  
PLAN AND SECTIONS**

DRAWN: *[Signature]*  
CHECKED: *[Signature]*  
TRACED: *[Signature]*  
APPROVED: *[Signature]*  
DENVER, COLORADO  
AUG. 12, 1944  
33-D-3063



SECTION A-A

SCALE OF FEET



**PUMPING UNIT DATA**

	UNITS 1&2	UNITS 3,4&5
Specification No.	1257	1257
Spec. Item No.	2	9
Pump capacity - c.f.s.	11.5	11.2
Total dynamic head - ft.	106	233
Rated motor H.P.	200	400
Full load R.P.M.	1170	1770

**REFERENCE DRAWINGS**

VACUUM PUMP TANK & CABINET	33-D-3525
FLOATWELLS & SUCTION TUBES	33-D-3507
LOCATION PLAN & SECTION	33-D-3384
INTAKE STRUCTURE	33-D-3026
ELECTRICAL INSTALLATIONS	33-D-3288
CONCRETE OUTLINE & DETAILS	33-D-3385
DISCHARGE PIPE MANIFOLDS	33-D-3150
12"-LC-3 VOLUTE PUMP - WORTHINGTON MO.	RY-84178
12"-LC-3 VOLUTE PUMP - WORTHINGTON MO.	RY-84179
MISCELLANEOUS STRUCTURAL STEEL	33-D-3430
FENCE	33-D-3564
MISCELLANEOUS INSTALLATION DETAILS	33-D-3429
INTAKE STRUCTURE TRACKS	33-D-3149
BILL OF MATERIAL 33-2M-3064	

**AREA - 2**

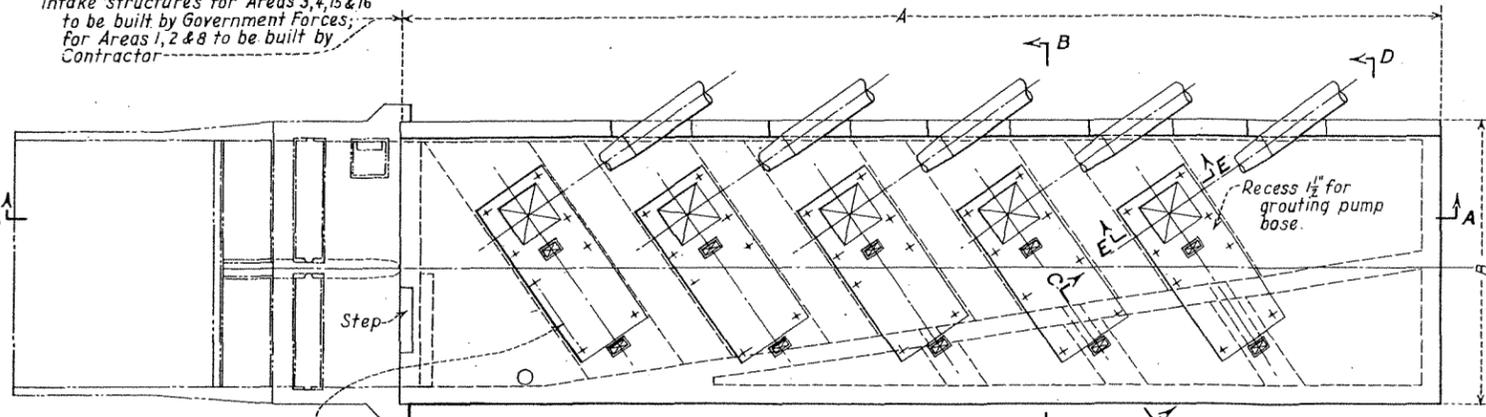
UNITED STATES  
DEPARTMENT OF THE INTERIOR  
BUREAU OF RECLAMATION  
YAKIMA PROJECT - WASHINGTON  
ROZA DIVISION

**MILE 16.8 PUMPING PLANT  
PLAN AND SECTIONS**

DRAWN	J.A.F.	REVISIONS	
TRACED	G.H.L.	RECOMMENDED	J.A. Winter
CHECKED	E.H. Hill	APPROVED	J.H. Plummer
DENVER, COLORADO		DATE	APR 8, 1946
		PROJECT NO.	33-D-3064



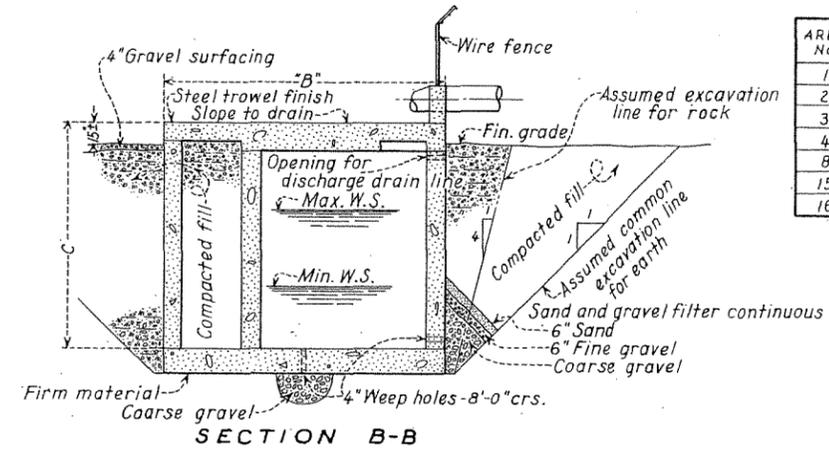
Intake structures for Areas 3, 4, 15 & 16 to be built by Government Forces; for Areas 1, 2 & 8 to be built by Contractor



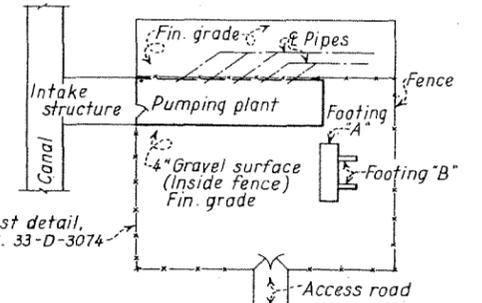
Size and arrangement of anchor bolts to be determined after pumps are purchased

**TYPICAL PLAN AREA NO'S 1, 2, 3, 8, 15 & 16**  
For number of units and approximate dimensions see table.  
Plants to be as shown or opposite hand as determined later.

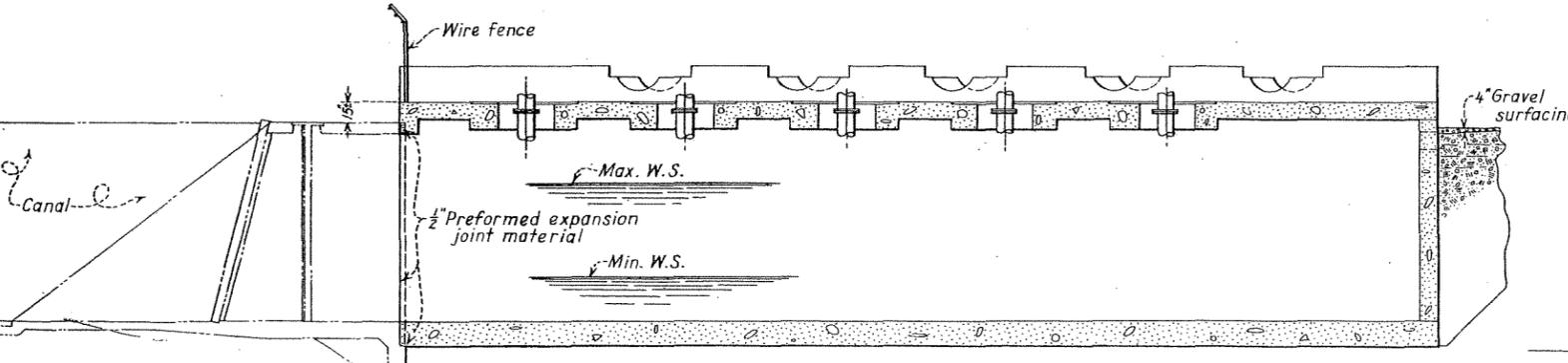
AREA NO	PLANT LOCATION MILE NO.	NUMBER OF UNITS	APPROXIMATE DIMENSIONS			DWG. NO. INTAKE STRUCTURE
			A	B	C	
1	7.2	4	55'-0"	17'-4"	17'-3"	33-D-3050
2	16.8	5	64'-0"	17'-4"	14'-9"	33-D-3059
3	22.5	5	64'-0"	17'-4"	13'-9"	33-D-3051
4	24.0	2	13'-0"	26'-0"	13'-9"	33-D-3051
8	42.8	3	45'-0"	17'-4"	13'-7"	33-D-3060
15	78.8	6	75'-0"	20'-4"	10'-9"	33-D-3061
16	88.4	5	64'-0"	20'-4"	8'-3"	33-D-3062



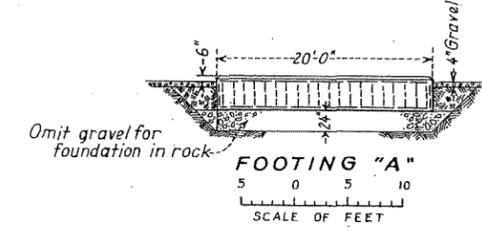
**SECTION B-B**



**TYPICAL PLOT PLAN**

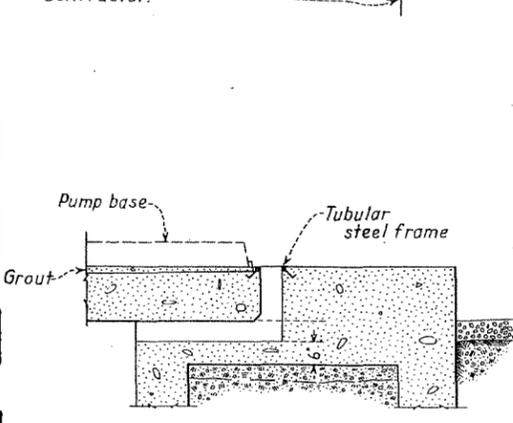


**SECTION A-A**

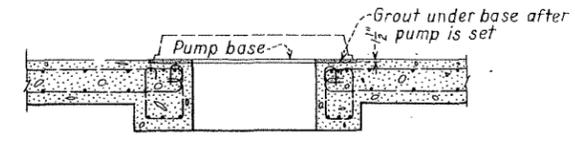


**FOOTING "A"**

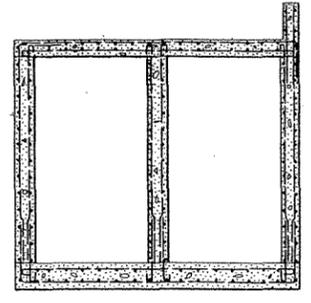
Intake structures for Areas 3, 4, 15 & 16 to be built by Government Forces; for Areas 1, 2, & 8, to be built by Contractor



**SECTION C-C**



**SECTION E-E**

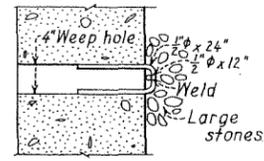


**SECTION D-D**

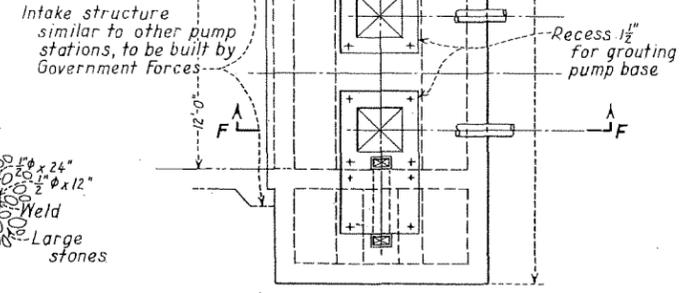


**PLAN OF CORNER WALLS**

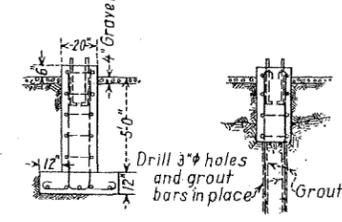
**TYPICAL REINFORCEMENT**



**DETAIL OF WALL WEEP HOLE**

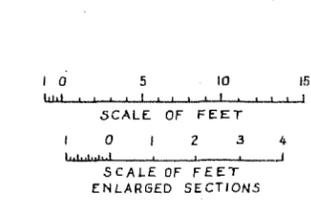


**PLAN - AREA NO 4**

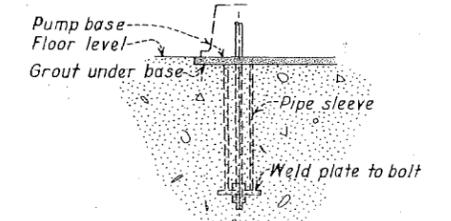


**EARTH FOOTING "B"**

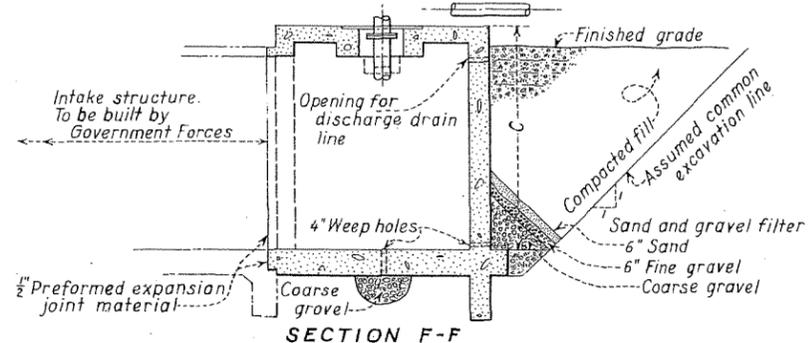
**ROCK FOOTING "B"**



**SCALE OF FEET ENLARGED SECTIONS**



**PUMP ANCHOR BOLT DETAIL**



**SECTION F-F**

**REFERENCE DRAWINGS**  
GENERAL ARRANGEMENT, MILE 22.5.....33-D-3054  
TYPICAL ELECTRICAL INSTALLATION.....33-D-3074

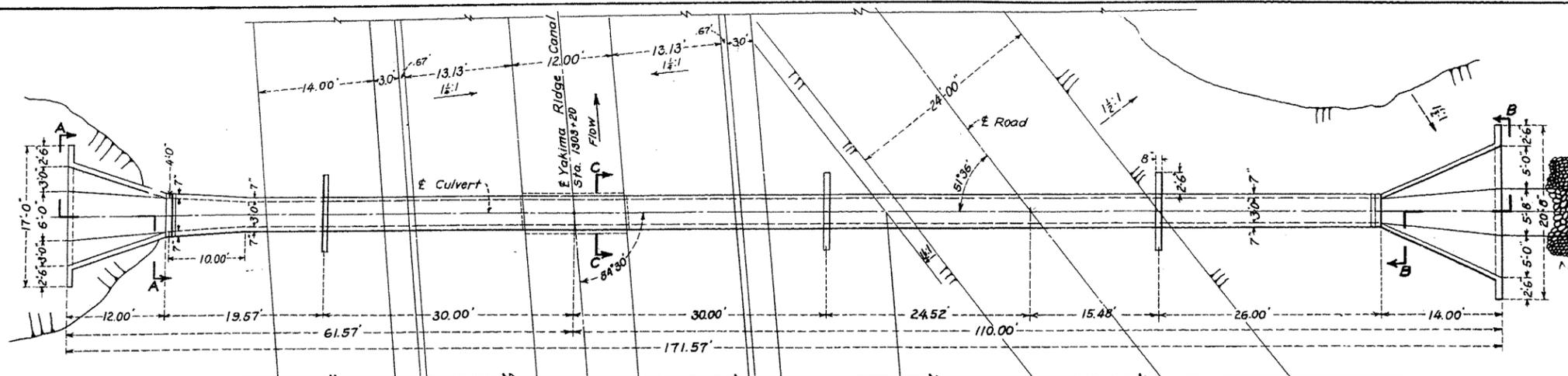
UNITED STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION  
YAKIMA PROJECT-WASHINGTON ROZA DIVISION

**OUTDOOR PUMPING PLANTS**  
AREA NUMBERS 1, 2, 3, 4, 8, 15, 16  
CONCRETE OUTLINE AND REINFORCEMENT

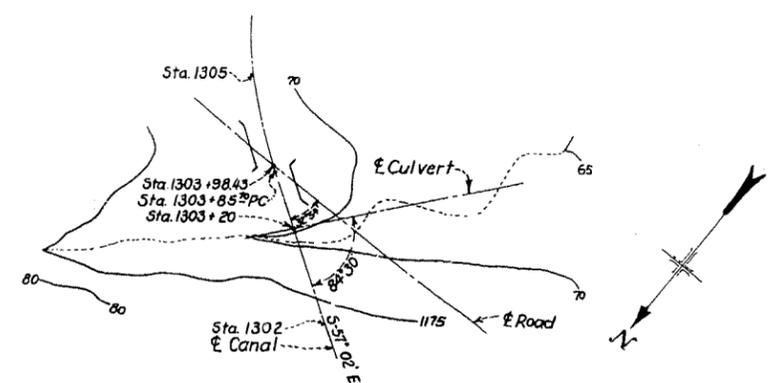
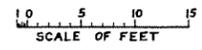
DRAWN... N.R.-W.E.V. SUBMITTED...  
TRACED... H.D.B. RECOMMENDED...  
CHECKED W.H.R. C.E. ST. APPROVED...  
DENVER, COLORADO FEB. 19, 1946 **33-D-3072**

## **F-6. Miscellaneous Structures and Bridges**

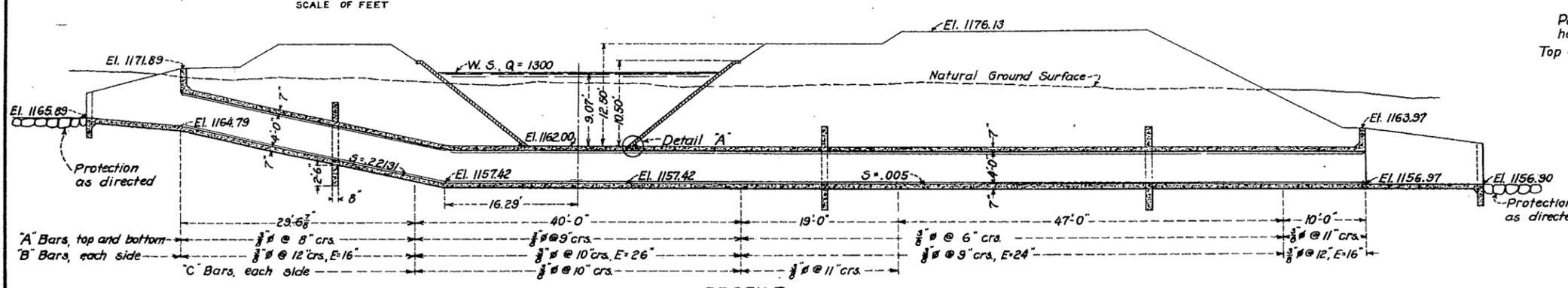
- 33-D-1143 — Roza Division, Yakima Ridge Canal – Sta. 1303+20, 3.0'x4.0' Concrete Culvert
- 33-D-1144 — Roza Division, Yakima Ridge Canal – Sta. 1303+79.4, Highway Bridge, Plan — Section – Abutments
- 33-D-1145 — Roza Division, Yakima Ridge Canal – Sta. 1303+79.4, Highway Bridge, Structural Steel — Slab – Railing
- 33-D-1146 — Roza Division, Yakima Ridge Canal – Sta. 1349+30, Concrete Siphon



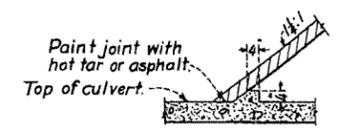
PLAN



LOCATION PLAN

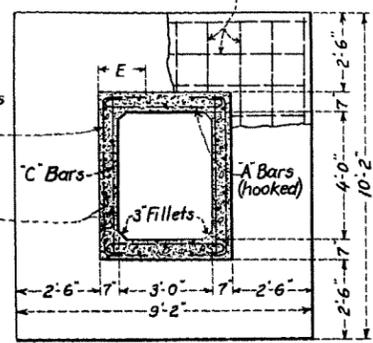


PROFILE



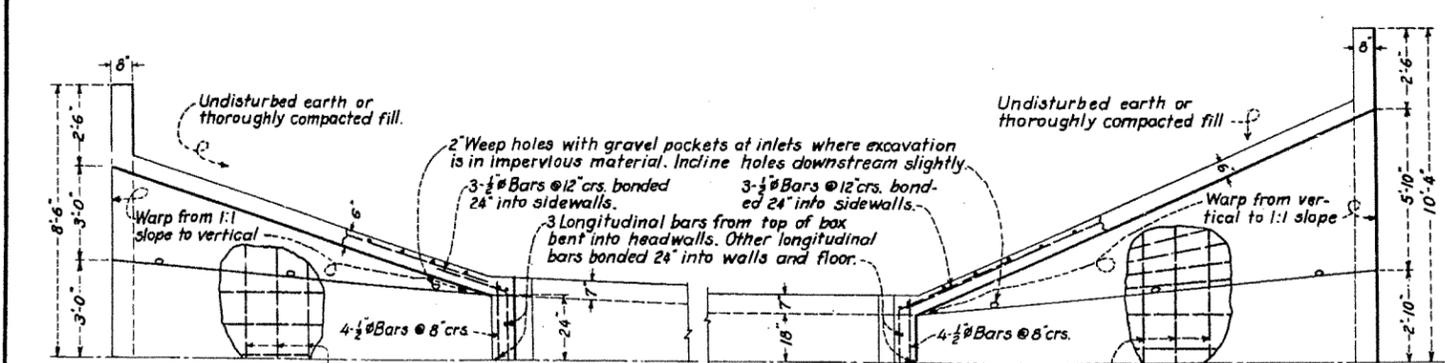
DETAIL "A"

1/2" Bars @ approx. 12" crs. both ways in center of collar. Bond short bars into box 20".

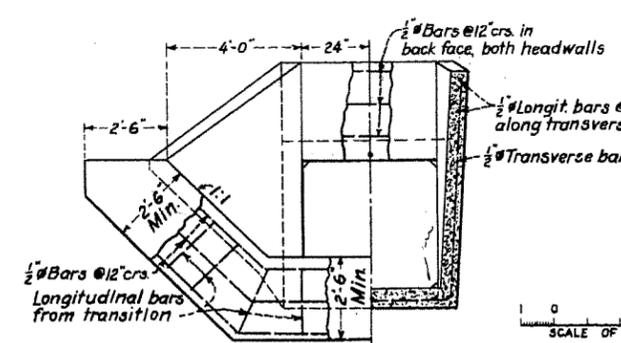


SECTION OF BARREL SHOWING COLLAR

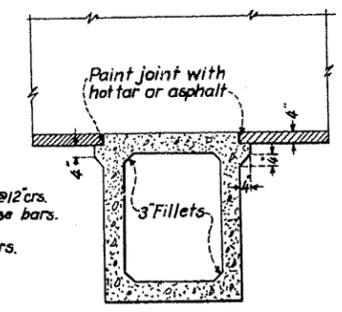
See Profile for size and spacing of transverse bars



HALF PLAN



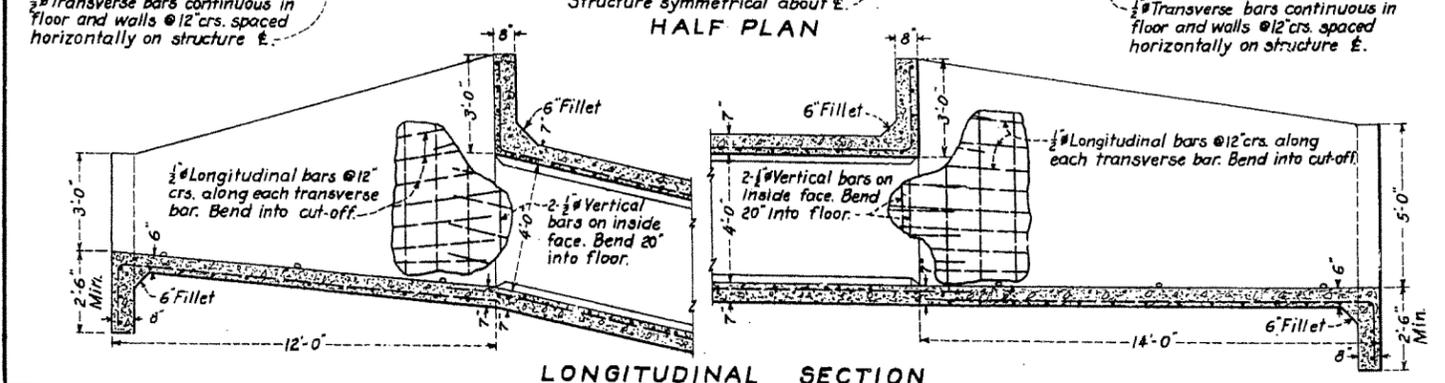
SECTION A-A



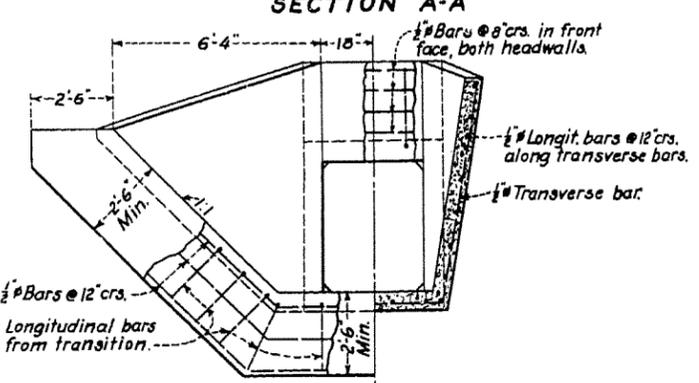
SECTION C-C

NOTES

All reinforcement shall be placed so that the centers of bars in the outer layer will be 2" from face of concrete, unless otherwise shown.  
Lap all bars 40 diameters at splices. Stagger splices. Thickness of concrete to vary uniformly between dimensions shown.  
Hooks with bends of 180° radii of 4 bar diameters and lengths of 16 bar diameters to be provided where shown.



LONGITUDINAL SECTION



SECTION B-B

ESTIMATED QUANTITIES

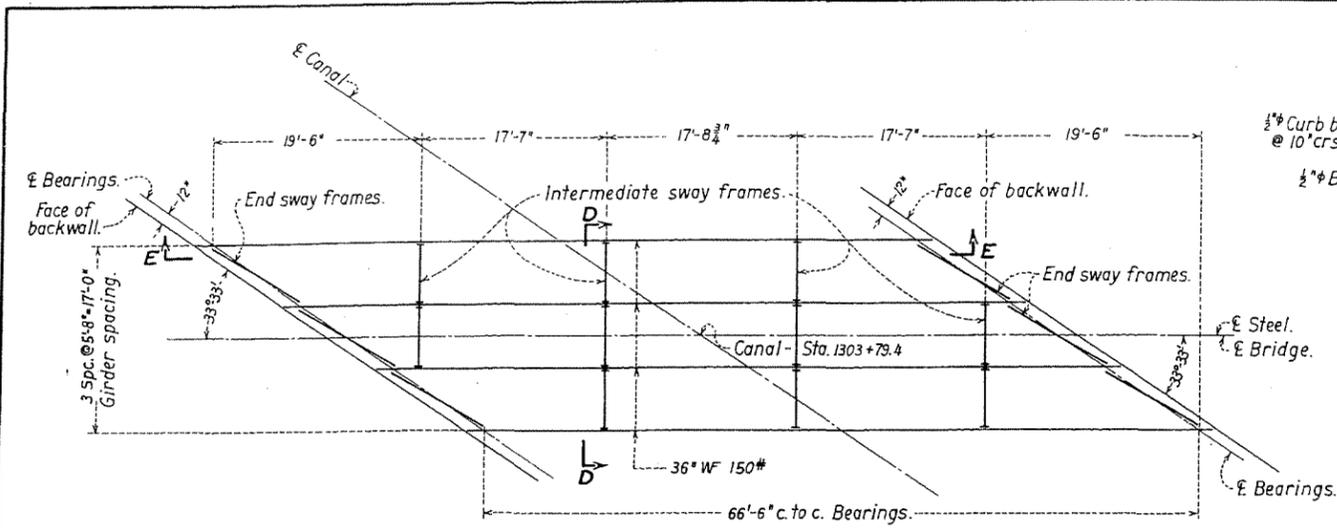
Concrete ..... 59 Cu. Yds.  
Reinforcement Steel ..... 5000 Lbs.

THIS DWG. SUPERSEDES DWG. OF JUNE 7, 1937 SAME NUMBER

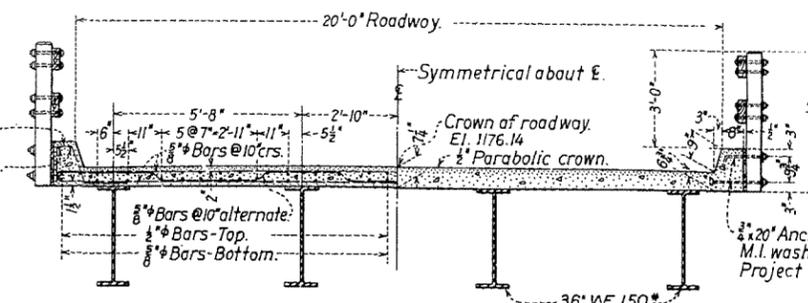
DEPARTMENT OF THE INTERIOR  
BUREAU OF RECLAMATION  
YAKIMA PROJECT-WASHINGTON  
ROZA DIVISION  
**YAKIMA RIDGE CANAL - STA. 1303+20**  
**3.0'x4.0' CONCRETE CULVERT**

DRAWN: W.G.M.-C.E.L. SUBMITTED: *H. H. Pearson*  
TRACED: G.B.L. RECOMMENDED: *H. H. Pearson*  
CHECKED: H.H.R. APPROVED: \_\_\_\_\_

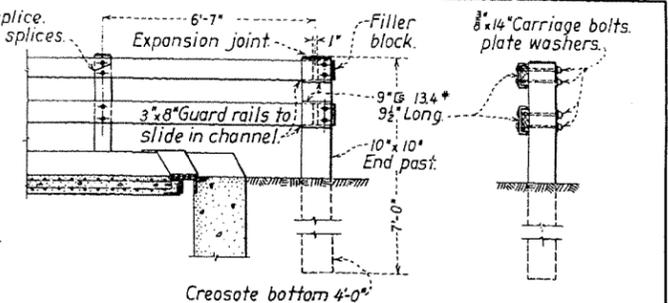
29295 YAKIMA, WASH. FEB. 2, 1938 33-D-1143



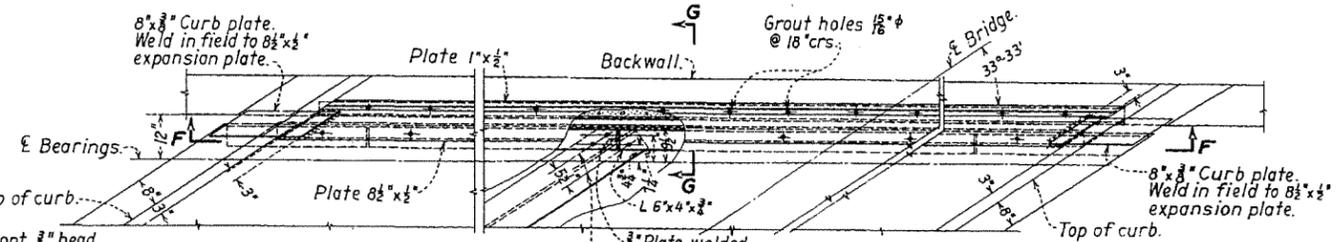
**STEEL PLAN**  
SCALE OF FEET



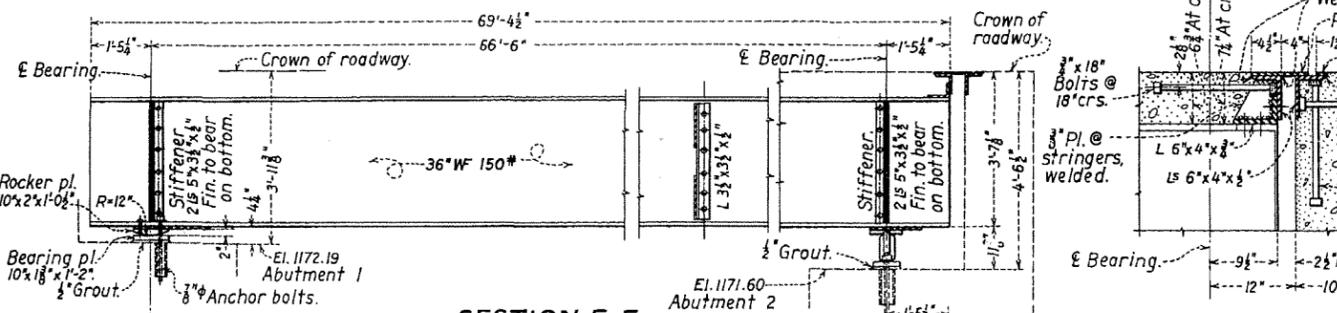
**SECTION D-D**  
SCALE OF FEET



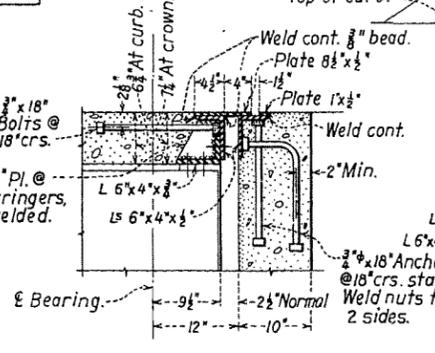
**END HANDRAIL DETAIL**



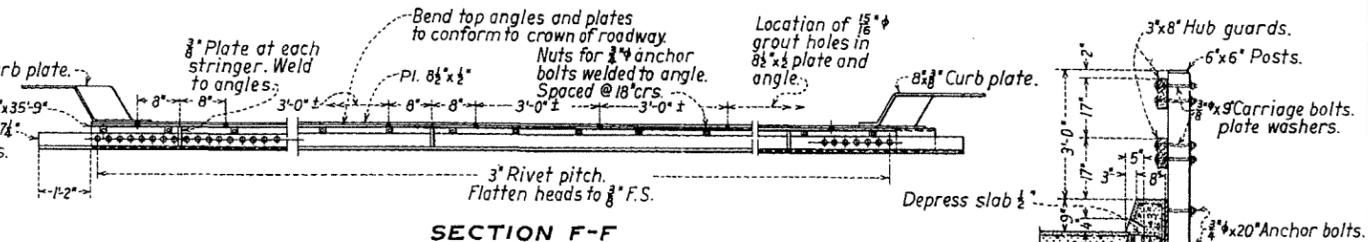
**PLAN OF EXPANSION JOINT**



**SECTION E-E**

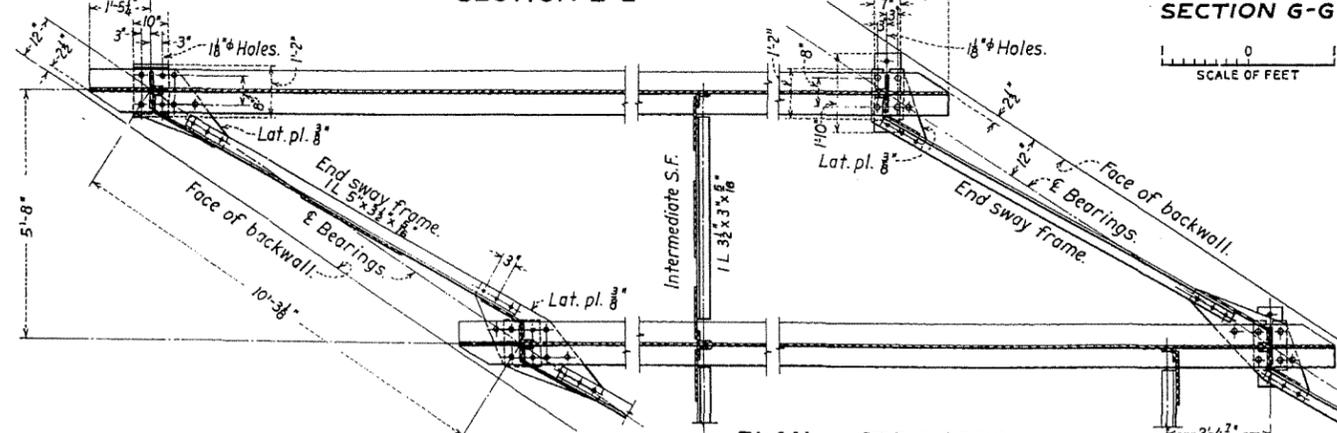


**SECTION G-G**  
SCALE OF FEET

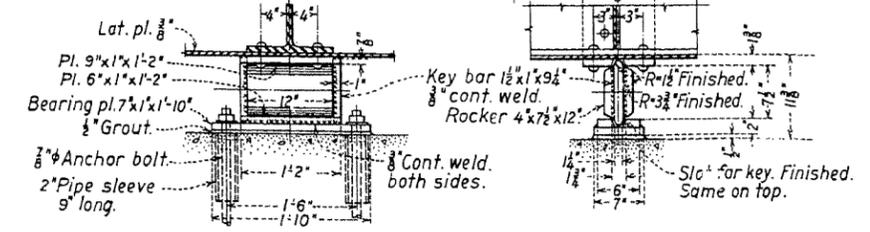


**SECTION F-F**

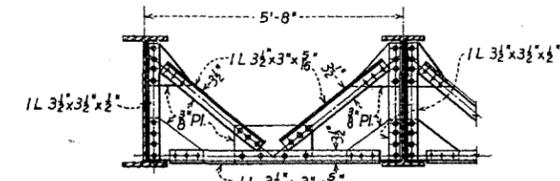
**DETAIL OF HANDRAIL AND PIPE DRAINS**



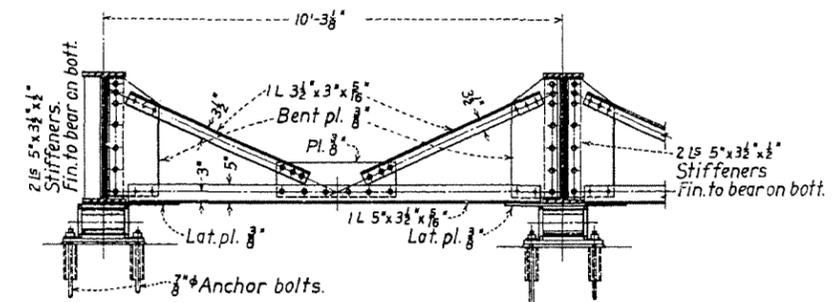
**PLAN OF STRINGERS**



**EXPANSION BEARING DETAILS**



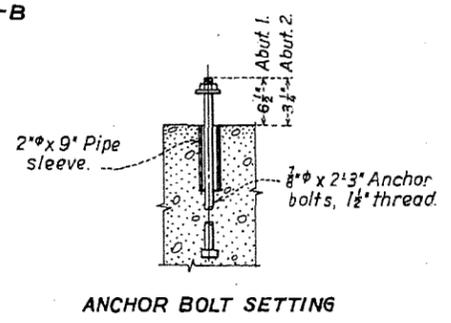
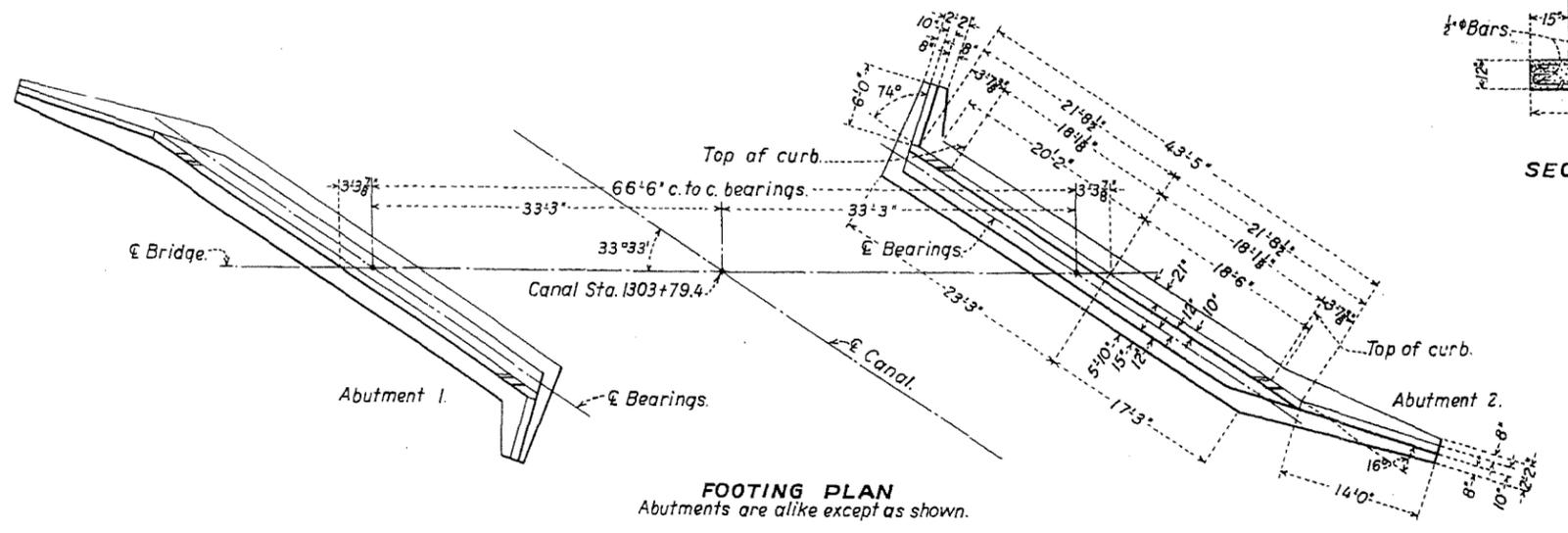
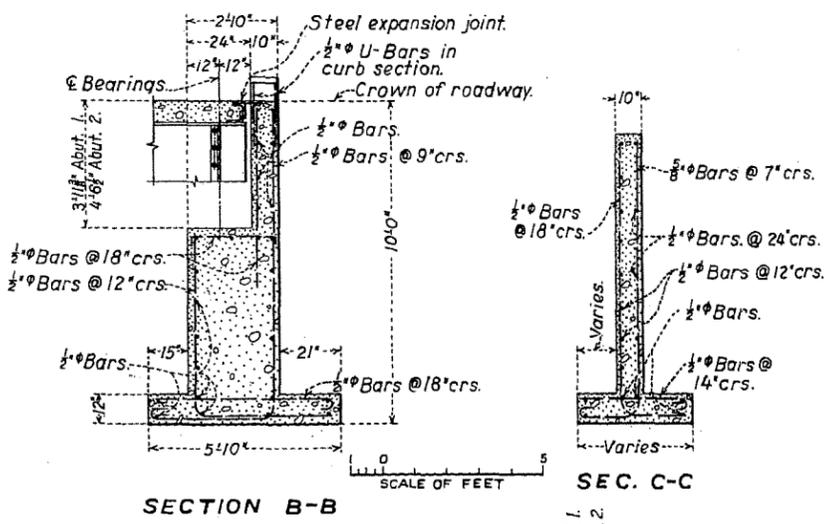
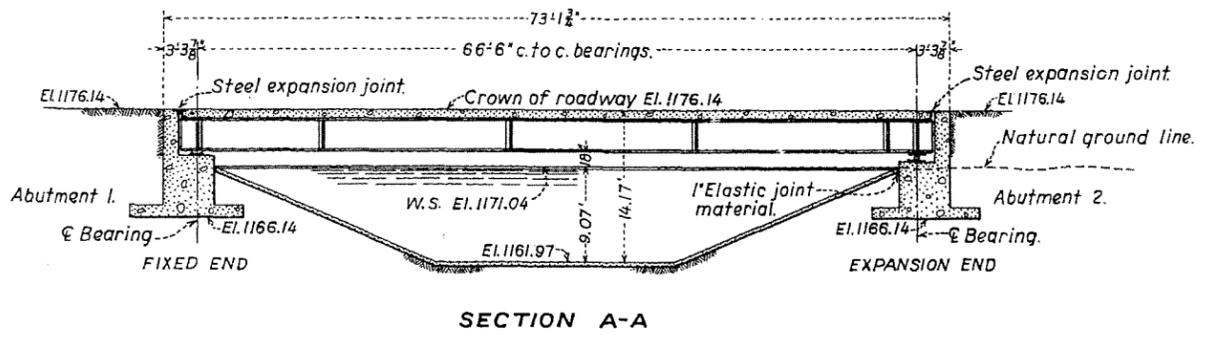
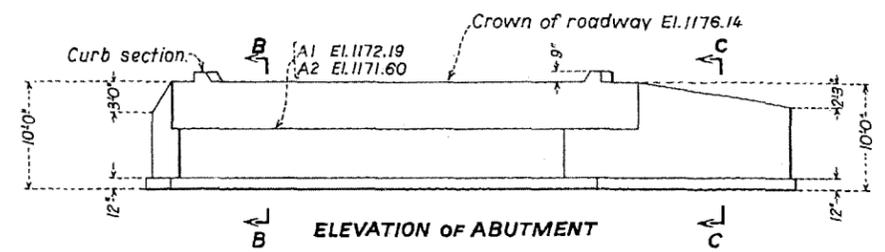
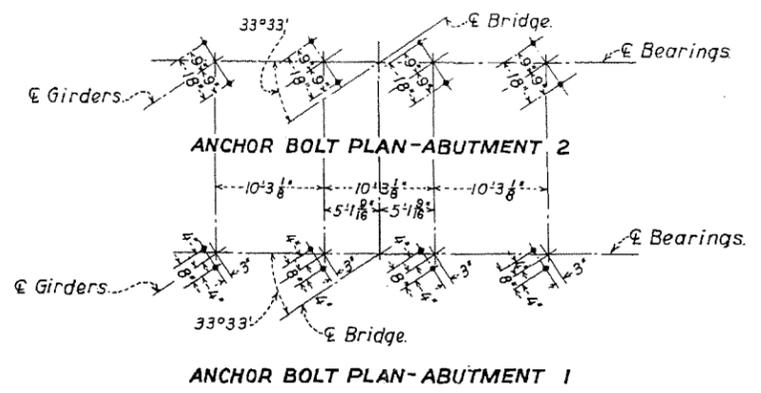
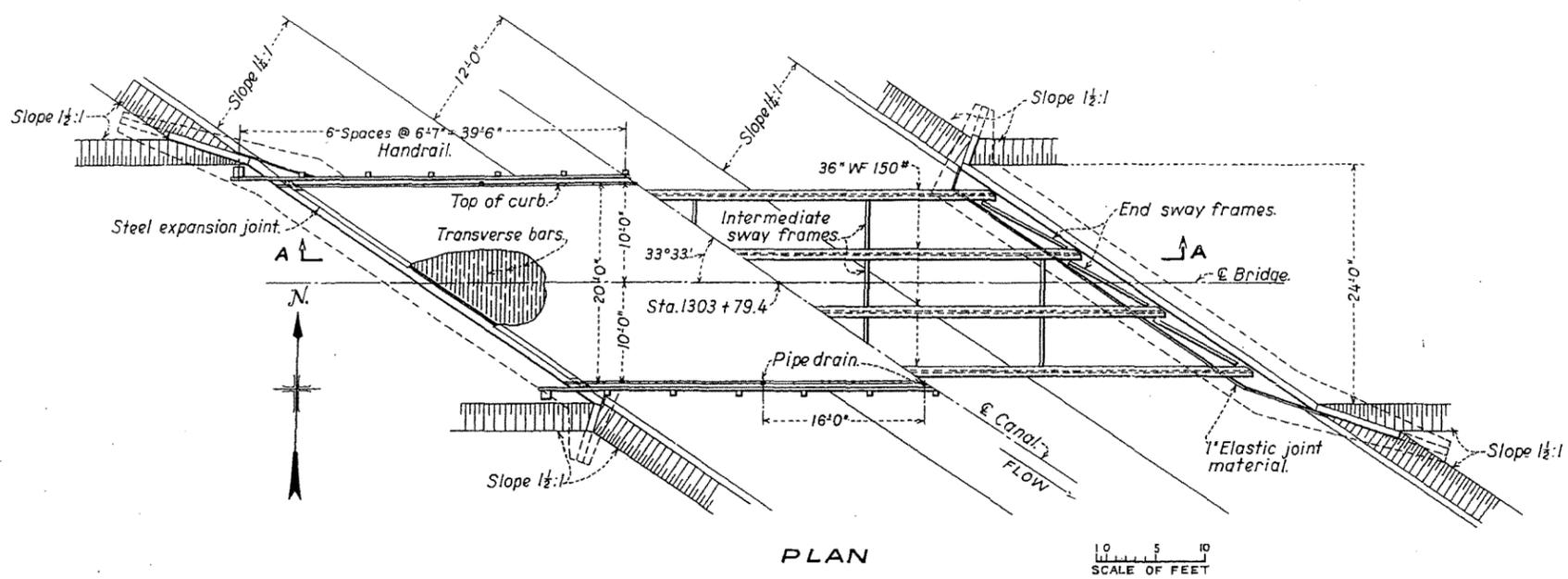
**INTERMEDIATE SWAY FRAME**



**END SWAY FRAME**  
SCALE OF FEET

**NOTES**  
For general notes, see Dwg. 33-D-1144  
Open holes 1/8" dia. unless otherwise shown.  
Use 3/4" dia. rivets for shop connections, use 3/8" dia. rivet bolts for field connections unless otherwise shown.  
All steel beams to be cambered 1/4" in shop.

DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION YAKIMA PROJECT-WASHINGTON ROZA DIVISION YAKIMA RIDGE CANAL - STA. 1303 + 79.4 <b>HIGHWAY BRIDGE</b> STRUCTURAL STEEL-SLAB-RAILING			
DRAWN. W.E.K.	SUBMITTED. <i>[Signature]</i>		
TRACED. M.Z.	RECOMMENDED. <i>[Signature]</i>		
CHECKED. <i>[Signature]</i>	APPROVED. <i>[Signature]</i>		
29297	DENVER, COLO. JUNE 11, 1937.	33-D-1145	



**ESTIMATED QUANTITIES**

Concrete	122 Cu. Yds.
Reinforcement steel	15 900 Lbs.
Structural steel	53 800 Lbs.
Lumber	1 200 F.B.M.

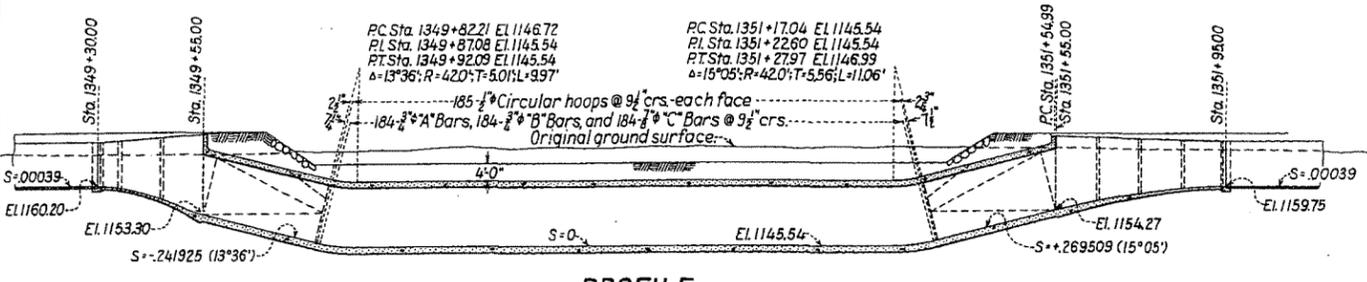
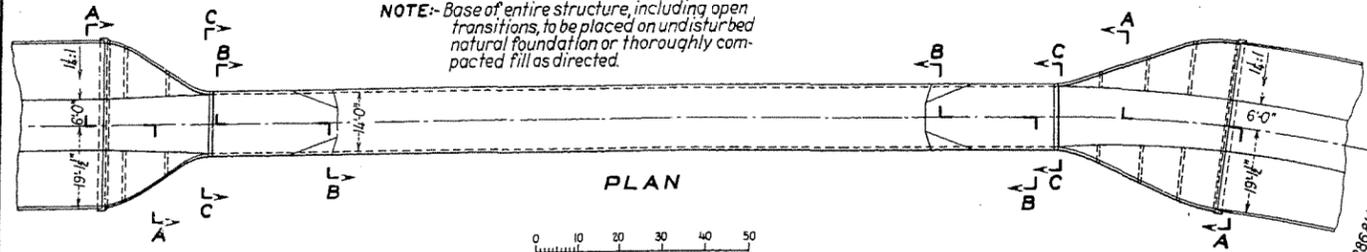
**NOTES**  
 Concrete to have a minimum compressive strength of 3000 lbs. per sq. inch. at 28 days.  
 Design based on two lanes of H-15 ton trucks in accordance with Standard Specifications for Highway Bridges - The American Association of State Highway Officials 1935 Edition.  
 All reinforcement to be placed so that the centers of bars in the outer layer will be 2" from face of concrete unless otherwise shown.  
 All dimensions to reinforcement bars are to center line of bars.  
 Railing timbers to be Douglas Fir, surfaced four sides and painted white.

DEPARTMENT OF THE INTERIOR  
 BUREAU OF RECLAMATION  
 YAKIMA PROJECT-WASHINGTON  
 ROZA DIVISION  
 YAKIMA RIDGE CANAL - STA. 1303+79.4  
**HIGHWAY BRIDGE**  
**PLAN - SECTION - ABUTMENTS**

DRAWN: W.E.K. SUBMITTED: *[Signature]*  
 TRACED: J.A.B. RECOMMENDED: *[Signature]*  
 CHECKED: *[Signature]* APPROVED: *[Signature]*

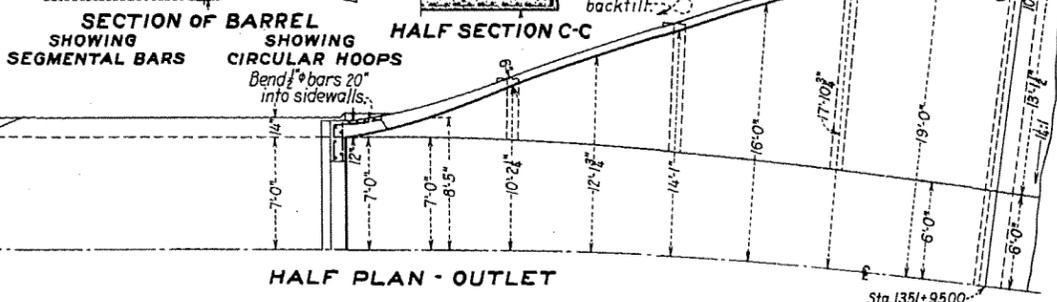
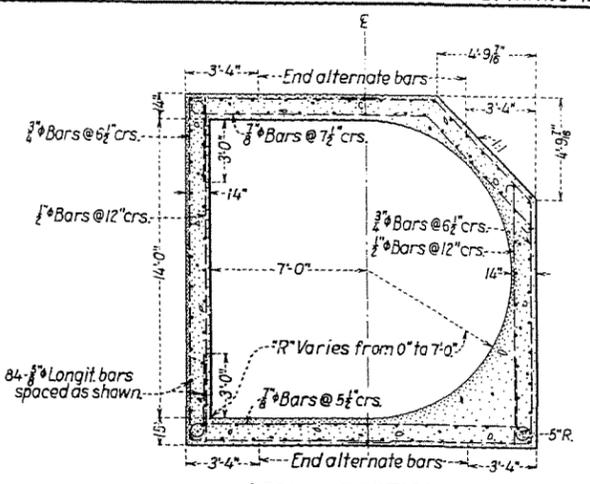
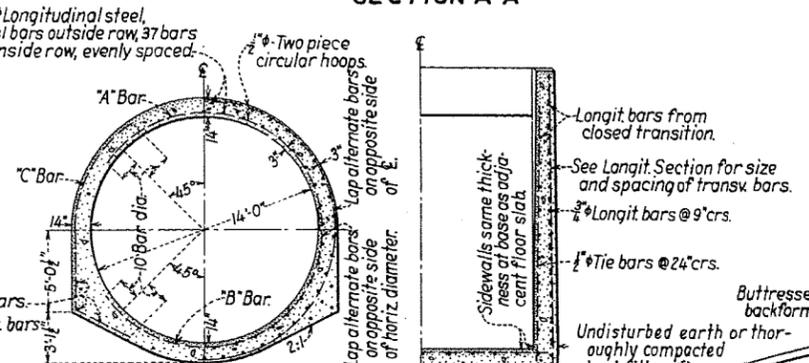
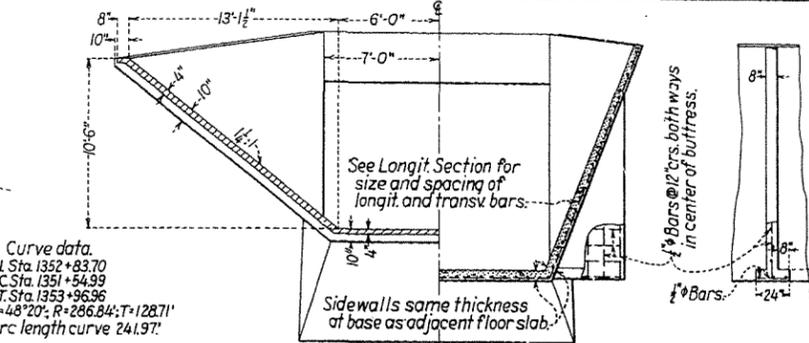
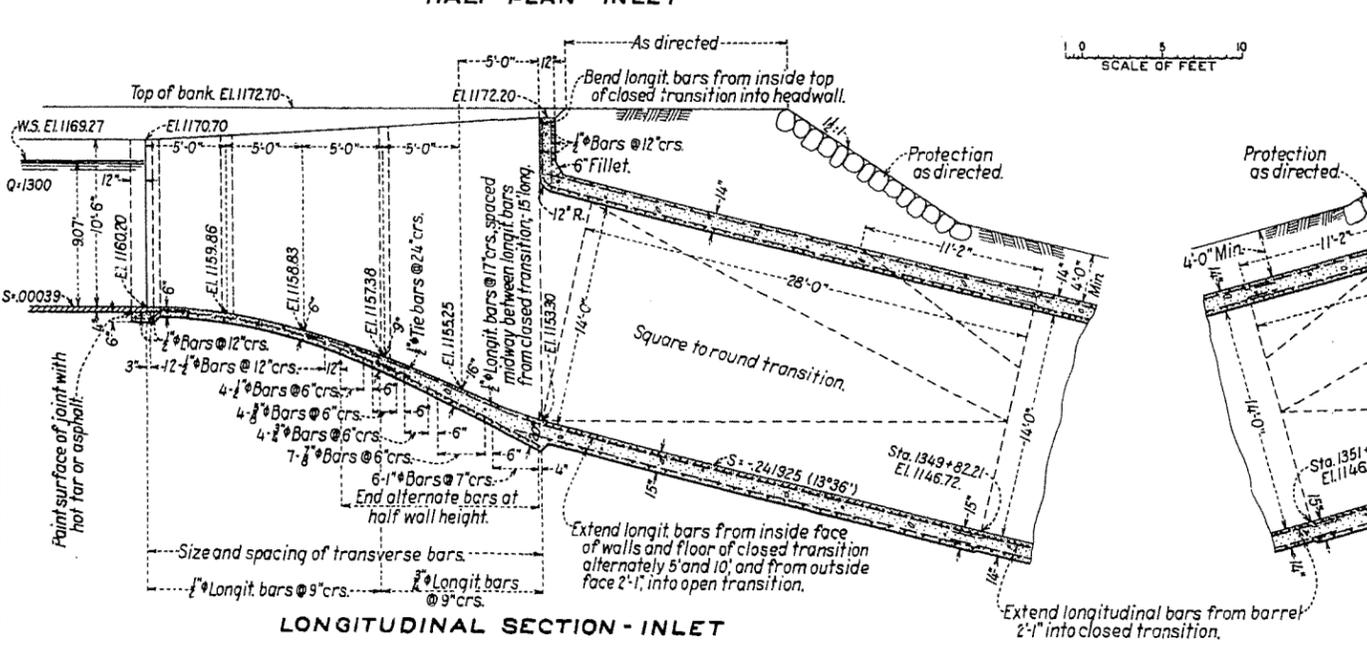
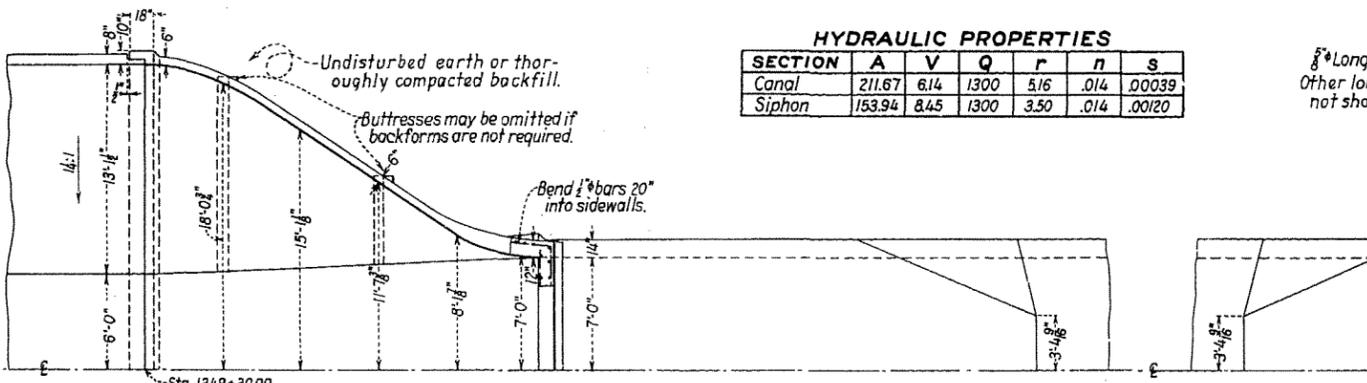
29296 DENVER, COLO. JUNE 8 1937 33-D-1144

NOTE: Base of entire structure, including open transitions, to be placed on undisturbed natural foundation or thoroughly compacted fill as directed.



**HYDRAULIC PROPERTIES**

SECTION	A	V	Q	r	n	S
Canal	211.67	6.14	1300	5.16	.014	.00039
Siphon	153.94	8.45	1300	3.50	.014	.00120



**ESTIMATED QUANTITIES**

Concrete	622 Cu. Yds
Reinforcement steel	114,000 Lbs.

**NOTES**  
 All reinforcement shall be placed so that the centers of bars in the outer layer will be 2" from face of concrete unless otherwise shown.  
 Lap all bars 40 diameters of splices.  
 Hooks with 180° bends, radii of 4 bar diameters, and lengths of 16 bar diameters to be provided where shown.  
 Space transverse reinforcement in barrel along longitudinal bars and on longer arc of curves. Thickness of concrete to vary uniformly between dimension shown.  
 Stations, elevations, and radii, shown on profile refer to invert of barrel unless otherwise noted.  
 Segmental bars to be placed midway between circular hoops.  
 Backfill along siphon barrel as directed.

DEPARTMENT OF THE INTERIOR  
 BUREAU OF RECLAMATION  
 YAKIMA PROJECT - WASHINGTON  
 ROZA DIVISION  
**YAKIMA RIDGE CANAL - STA. 1349+30**  
**CONCRETE SIPHON**

DRAWN: L.H.E. SUBMITTED: *[Signature]*  
 TRACED: P.M.H. RECOMMENDED: *[Signature]*  
 CHECKED: *[Signature]* APPROVED: *[Signature]*

29298 DENVER, COLORADO, JUNE 24, 1981 33-D-1148