

RECLAMATION

Managing Water in the West

Appraisal Assessment of the Yakima River Pump Exchange Alternative Delivery System for Roza and Sunnyside Valley Irrigation Districts

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

Technical Series No. TS-YSS-11

Roza Canal, Yakima River Valley



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

October 2006

Appraisal Assessment of the Yakima River Pump Exchange Alternative Delivery System for Roza and Sunnyside Valley Irrigation Districts

A component of the Yakima River Basin
Water Storage Feasibility Study,
Washington
Technical Series No. TS-YSS-11

Prepared by
Golder Associates Inc.
Redmond Washington
In conjunction with MWH Americas, Inc. and
Anchor Environmental, LLC

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

Washington State
Department of Ecology
Central Region
Yakima, Washington



October 2006

013-1500-007A.005

TABLE OF CONTENTS

1.0	INTRODUCTION.....	1
2.0	EXISTING WATER DELIVERY SYSTEMS	2
2.1	Sunnyside Division and Sunnyside Valley Irrigation District.....	2
2.2	Roza Division and Roza Irrigation District	3
3.0	PROPOSED WATER DELIVERY SYSTEMS	5
3.1	Plan 1.....	5
3.2	Plan 2.....	6
4.0	PIPELINE ROUTE SELECTION.....	8
4.1	Pipeline Section #1.....	8
4.2	Pipeline Sections #2 and #2a.....	8
4.3	Pipeline Sections #3, #3a and #3b.....	9
5.0	PIPELINE FACILITIES	10
5.1	Hydraulic Analysis - Overview	10
5.1.1	Plan 1 – Hydraulics Characteristics.....	11
5.1.2	Plan 2 – Hydraulic Characteristics	13
5.2	Pipe Selection.....	15
6.0	PUMP STATION FACILITIES	18
6.1	Intake (Plans 1 & 2)	18
6.1.1	Location and Property	18
6.1.2	Description	18
6.1.3	Construction	19
6.1.4	Conduits to Pump Station.....	20
6.2	Pump Station #1 (Plans 1 & 2).....	20
6.2.1	Pump Station General Description	20
6.2.2	Pumping Equipment.....	20
6.2.3	Valves and Piping System.....	21
6.2.4	Hydraulic Transient.....	22
6.2.5	Pump Station # 1 Electrical Supply.....	22
6.2.6	Pump Station Electrical Equipment	22
6.3	Pump Station #2 (Plans 1 & 2).....	22
6.3.1	Pump Station General Description	22
6.3.2	Pumping Equipment.....	23
6.3.3	Valves and Piping System.....	23
6.3.4	Hydraulic Transient.....	24
6.3.5	Pump Station # 2 Electrical Supply.....	25
6.3.6	Overflow Provisions.....	25
6.4	Pump Station #3 (Plan 1).....	26
6.4.1	Pump Station General Description	26
6.4.2	Pumping Equipment.....	26

6.4.3	Valves and Piping System.....	27
6.4.4	Hydraulic Transient.....	28
6.4.5	Pump Station # 3 Electrical Supply.....	28
6.4.6	Overflow Provisions.....	28
6.5	Pump Station #3 (Plan 2).....	29
6.5.1	Pumping Equipment.....	29
6.5.2	Valves and Piping System.....	30
6.5.3	Hydraulic Transient.....	31
6.5.4	Pump Station # 3 Electrical Supply.....	31
6.5.5	Overflow Provisions.....	31
7.0	PUMP SYSTEM OPERATION	32
7.1	Normal Operation.....	32
7.2	Emergency Operation.....	33
7.3	Transients	33
8.0	DELIVERY FACILITIES	34
9.0	FIELD CONSTRUCTION COST ESTIMATES	37
9.1	Pipeline Costs.....	37
9.2	Typical Excavation Cross-Section	38
9.3	Pipeline Crossings.....	38
9.4	Unit Costs and Cost Trend Index	39
9.5	Additional Project Costs and Contingency.....	39
9.6	Pump Station Costs	39
9.7	Delivery Facility Costs.....	40
10.0	OPERATION, MAINTENANCE AND REPLACEMENT COSTS.....	42
10.1	Electricity Costs	42
10.2	Staff Costs	44
10.3	Maintenance and Replacement Costs.....	44
11.0	RECOMMENDED FURTHER STUDY	45
11.1	Sunnyside Canal Improvements.....	45
11.2	Energy Recovery	45
11.3	Eliminate Overflow Reservoirs	45
11.4	Locate Pipeline alignment from Pump Station #2 to lower elevation.....	45
11.5	Investigate Gravity Delivery of Pumped Flows from Pump Station #3 in Plan 1.....	46
11.6	Optimize Pipeline Routing	46
12.0	REFERENCES	47

LIST OF TABLES

Table 1	Plan 1 and Plan 2 – Delivery Scenarios
Table 2	Plan 1 – Pumping Facilities
Table 3	Plan 1 – Pipelines
Table 4	Plan 2 – Pumping Facilities
Table 5	Plan 2 – Pipelines
Table 6	Plan 1 – Proposed Minimum Steel Pipe Wall Thickness
Table 7	Plan 2 – Proposed Minimum Steel Pipe Wall Thickness
Table 8	Pump Schedule – Pump Station #1
Table 9	Valve Schedule – Pump Station #1
Table 10	Pump Schedule – Pump Station #2
Table 11	Valve Schedule – Pump Station #2
Table 12	Pump Schedule – Pump Station #3 (Plan 1)
Table 13	Valve and Gate Schedule – Pump Station #3 (Plan 1)
Table 14	Pump Schedule – Pump Station #3 (Plan 2)
Table 15	Valve and Gate Schedule – Pump Station #3 (Plan 2)
Table 16	Delivery Facilities
Table 17	Appraisal Level Project Costs – (July 2004)
Table 18	Average Energy Use and Costs by Month
Table 19	Annual Energy Requirements and Costs
Table 20	Annual Operation, Maintenance and Replacement Costs

LIST OF FIGURES

Figure 1	Project Location Map
Figure 2	Pipeline Overview Map
Figure 3	Plans 1 & 2 – Segment 1
Figure 4	Plans 1 & 2 – Segment 2
Figure 5	Plans 1 & 2 – Segment 3
Figure 6	Plans 1 & 2 – Segment 4
Figure 7	Plans 1 & 2 – Segment 5
Figure 8	Plans 1 & 2 – Segment 6
Figure 9	Plans 1 & 2 – Segment 7
Figure 10	Plans 1 & 2 – Segment 8
Figure 11	Plans 1 & 2 – Segment 9
Figure 12	Plans 1 & 2 – Segment 10
Figure 13	Plans 1 & 2 – Segment 11
Figure 14	Plans 1 & 2 – Segment 12
Figure 15	Plans 1 & 2 – Segment 13
Figure 16	Plan 1 – Pump Station 3
Figure 17	Plans 1 & 2 – Segment 14
Figure 18	Plans 1 & 2 – Segment 15
Figure 19	Plans 1 & 2 – Segment 16
Figure 20	Plans 1 & 2 – Segment 17
Figure 21	Plans 1 & 2 – Segment 18
Figure 22	Plans 1 & 2 – Segment 19
Figure 23	Plans 1 & 2 – Segment 20

Figure 24	Plan 2 – Pump Station 3
Figure 25	Plan 2 – Delivery Profiles
Figure 26	Plans 1 & 2 – Segment 14
Figure 27	Pump Station No. 1 Site Plan
Figure 28	Pump Station No. 1 Plan and Section
Figure 29	Pump Station No. 1 Sections
Figure 30	Pump Station No. 2 Site Plan
Figure 31	Pump Station No. 3 Site Plan 1
Figure 32	Pump Station No. 3 Enlarged Site Plan 1
Figure 33	Pump Station No. 3 Plan 1
Figure 34	Pump Station No. 3 Site Plan 2
Figure 35	Pump Station No. 3 Enlarged Site Plan 2
Figure 36	Pump Station No. 3 Plan 2
Figure 37	Reclamation Type VI Stilling Basin (Impact-Type Stilling Basin)
Figure 38	Typical Pipeline Excavation Cross Section

LIST OF APPENDICES

Appendix A	Hydraulic Profiles
	Figure A-1 – Plan 1 – Columbia River to Sunnyside Canal
	Figure A-2 – Plan 2 – PS #3 to Roza Canal
	Figure A-3 – Plan 2 – PS #3 to Sunnyside Canal
Appendix B	Field Construction Cost Estimate Worksheets

GLOSSARY AND ACRONYMS

Throughout this document and unless otherwise noted:

ASTM	American Society for Testing Materials
AWWA	American Water Works Association
Black Rock reservoir	A proposed reservoir to be located north of the study area that will store water pumped from the Columbia River
cfs	Volume of water flow in cubic feet per second
Delivery system	The proposed pump station and pipeline system that will deliver water from an intake on the Columbia River in Kennewick, Washington to delivery facilities at several proposed locations on the Sunnyside and Roza Canals
Ecology	State of Washington Department of Ecology
fps	Velocity of water flow in feet per second
hp	Horsepower rating of pump capacity
HPU	Hydraulic power unit
Hydraulic grade line	The surface or profile of water flowing out of hydraulic gradient. The slope of the hydraulic grade line is water under
kV	Kilovolt

MP	Mile post – refers to locations on the Sunnyside and Roza Canals with MP 0.0 on each canal being the intakes diversions on the Yakima River
MW-HRS	Megawatt hours
NOAA	National Oceanic & Atmospheric Administration
Pipeline alignment	The proposed plan location of the pipeline or pipelines
Pipeline profile	The elevation line that coincides with ground surface along the alignment of the pipeline or pipelines
PLC	Programmable logic controller
Pump Exchange	The delivery of water from the Columbia River to the Sunnyside and Roza Irrigation Districts via a pump and pipeline system in exchange for water that would normally be diverted from the Yakima River
Pump Station (PS)	A plant facilities containing multiple electric driven pumps to lift water from the Columbia River in one of three stages for delivery via pipeline to several proposed locations on the Sunnyside and Roza Canals
Reclamation	United States Department of Interior Bureau of Reclamation
Roza Division	An irrigation entity that includes the Roza Irrigation District that delivers water from the Yakima River
RID	Roza Irrigation District
SCADA	Supervisory control and data acquisition

Sunnyside Division	An irrigation entity comprised of the Sunnyside Valley Irrigation District and eight other irrigation districts, companies and cities that deliver water from the Yakima River
SVID	Sunnyside Valley Irrigation District
TDH	Total developed head
USGS Quad	Topographic mapping sheets at 1:24,000 scale prepared by the United States Geological Survey that were used to identify the pipeline alignment and pipeline profile

1.0 INTRODUCTION

The United States Bureau of Reclamation (Reclamation) and the Washington Department of Ecology (Ecology) are developing alternatives for augmenting storage in the Yakima River Basin. Two identified delivery system plans involving the Sunnyside Division and the Roza Division of the Yakima Project have been developed at an appraisal-level. These involve a pump and pipeline system to deliver up to 1,200-cfs of water from near the mouth of the Yakima River in Kennewick Washington to various points in the Sunnyside Valley and Roza Irrigation Districts (SVID and RID) southeast of Yakima, Washington. Water delivered to the SVID and RID by this system would be exchanged for the water that would normally divert from the Yakima River. The Yakima River water left in the river in exchange for pumped water would be used to improve fishery habitat and provide irrigation water to downstream proratable irrigators during dry years. Water delivery from the pump and pipeline system would take place during the irrigation season from April through October, mainly from mid May through mid September (4-months). The two delivery system plans are described below. The SVD and RID expressed their willingness to explore water exchange possibilities. No agreements have been made or negotiated for these entities to make the water exchange.

This appraisal-level study is part of the Yakima River Basin Water Storage Feasibility Study (Storage Study). Congress authorized the Storage Study in 2003 through Public Law 108-7 to conduct a feasibility study of options for additional water storage in the Yakima River basin 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. The State of Washington also passed legislation authorizing Ecology to cost share in the Storage Study with Reclamation to develop plans, engineering, and financing reports associated with the development of water storage projects in the Yakima Basin.

This document presents facility descriptions, explanations of analyses, designs and cost estimates for this alternative. At the time this work was carried out, this alternative was at the concept stage, so there was no previous work available for guidance. All facility sizing and locations have been developed on the basis of previous experience, rules of thumb and basic analyses. The design has not been optimized and more cost effective configurations could exist. Narrative descriptions, drawings, tables, maps, and graphs are provided to explain the facilities and issues associated with this alternative concept. This study was completed on behalf of Reclamation and Ecology as a collaborative effort between Golder Associates Inc., MWH Americas, Inc. and Anchor Environmental, LLC.

2.0 EXISTING WATER DELIVERY SYSTEMS

The location of the Sunnyside and Roza Canals operated by the potential water exchange participants (SVID and RID) and the relationship to the Yakima River Pump Exchange Alternative facilities are shown in Figure 1. A description of the existing main delivery systems of these potential water exchange participants follows.

2.1 Sunnyside Division and Sunnyside Valley Irrigation District

The Sunnyside Diversion Dam (RM 103.8) diverts Yakima River flows into the 1,320-cfs capacity Sunnyside Canal, the main conveyance facility which transports water to four irrigation districts, two ditch companies, and three cities servicing a total of about 100,000 acres. These entities collectively are referred to as the Sunnyside Division of the Yakima Project. The Sunnyside Division, extends about 60 miles and serves lands generally north and east of the Yakima River, as well as south of the river in the vicinity of the communities of Mabton, Grandview, and Prosser.

The origin of Sunnyside Canal dates back to about 1878 when Konewock Ditch was constructed. Approximately 3,500 acres serviced by the Konewock Ditch Company received their first Yakima River water in 1880. In 1890, the Northern Pacific, Yakima and Kittitas Irrigation Company made plans to enlarge and extend the ditch. The company entered into a contract with Konewock Ditch Company to supply water to its lands in exchange for purchase of the ditch and right-of-way. Purchase took place in 1893, canal enlargement followed, and the name of the ditch changed to Sunnyside Canal.

In 1900, the Washington Irrigation Company acquired the Sunnyside Canal and began selling lands for irrigated agriculture. The Reclamation Service (now Reclamation) purchased the Sunnyside Canal in 1905 with the Washington Irrigation Company retaining 9,000 acres. The terms of the purchase required the Reclamation Service to provide water to the 9,000 acres and to honor previously executed water right contracts. The canal capacity at that time was 650-cfs serving about 40,000 acres.

The existing Sunnyside Division is the result of work performed by the Reclamation Service, and subsequently Reclamation between 1906 and 1923. Reclamation initially operated and maintained the Sunnyside Division's diversion and conveyance facilities. Reclamation entered into contracts in 1945 with each entity establishing a Board of Control with responsibility for operation and maintenance of Sunnyside Canal and some ancillary facilities. The Board of Control is comprised of

12 directors representing entities of the Sunnyside Division. The Board of Control took over operation and maintenance of Sunnyside Diversion Dam in 1959. The Sunnyside Valley Irrigation District is the largest of the entities and operates and maintains the Division's joint-use facilities on behalf of the Board of Control. The Board of Control includes the Sunnyside Valley Irrigation District (SVID), Grandview Irrigation District, Benton Irrigation District, Zillah Irrigation District, Konewock Ditch Company, Piety Flat Ditch Company, City of Grandview, City of Sunnyside, and the City of Prosser.

Yakima River water rights for the Sunnyside Division during the April - October period originally totaled 458,520 acre-feet. However, a 2003 mediated settlement agreement and Conditional Final Order of the Adjudication Court reduced these summer water rights to 435,422 acre-feet. The Sunnyside Division can divert up to 12,000 acre-feet of "flood flows" in March when available. The 2003 mediated settlement agreement also requires a reduction of water rights down to 415,972 acre-feet, and an instantaneous flow (the flow at a particular instant in time) of 1,262-cfs, by the year 2017. A further reduction down to 399,472 acre-feet, and an instantaneous flow of 1,216-cfs, is to occur at some future date. For purposes of preparing conceptual delivery plans for a potential Columbia River water exchange with the Sunnyside Division, the peak delivery requirement is 1,262-cfs.

2.2 Roza Division and Roza Irrigation District

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

RID 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 are 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 include 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 RID 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), RID 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 plants: Terrace Heights Pumping Plant (MP 13.0) which serves the Terrace Heights Irrigation District (THID) pursuant to an agreement with RID; and RID Pumping Plants No. 2 (MP 16.8) and No. 3 (MP 22.5). Gravity service is provided to down slope RID lands.

Below Highway 24 (MP 22.6), RID 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 lands serviced by pumping comprise about 27,000 of the 72,000 acres.

Reclamation and RID jointly maintain the first 11 miles of the canal and the diversion dam; operation is Reclamation's responsibility. RID 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.

3.0 PROPOSED WATER DELIVERY SYSTEMS

Two water delivery systems or plans to deliver water pumped from the mouth of the Yakima River are examined in this report. Both plans involve three pump stations and buried steel pipelines. The first plan would deliver 1200-cfs to the Sunnyside Canal to totally replace the diversion from the Yakima River at Sunnyside Dam. A 750-cfs delivery would be made near the headworks at Mile Post (MP) 2.35 and two other deliveries would be made prior to that point; 400-cfs at MP 37.0 and 50-cfs at MP 59.29 (at the re-regulating reservoir at end of Sunnyside Canal prior to Benton I.D.). The intermediate deliveries are intended to save piping and pumping costs while still achieving minimum operating flow requirements in the Sunnyside Canal. The second plan would split the deliveries between SVID and RID with 650-cfs delivered to Sunnyside Canal and 550-cfs to Roza Canal.

The difference between Plan 1 and Plan 2 is that deliveries would not be made to the head of the Sunnyside Canal in Plan 2. This would save a substantial length of pipe and cost. Deliveries would be made to the Sunnyside Canal at three locations: 400-cfs at MP 37.0, 200-cfs at MP 30.0 and 50-cfs at MP 59.29. A single delivery of 550-cfs would be made to the Roza Canal at MP 59.0. The split of flow between SVID and RID could be adjusted. More detailed descriptions of each plan follows.

3.1 Plan 1

Plan 1 has the following components (see Figure 2, Pipeline Overview Map, for project features):

- Pump Station #1 located in Kennewick at an elevation of approximately 350-feet, with a capacity of 1200-cfs, pumping from the Columbia River with a water surface elevation of approximately 341-feet (see Figure 3).
- Pipeline Section #1 consisting of two 132-inch diameter steel pressure pipes, that could be reduced in size in some areas to fit within right-of-way restrictions, with a length of approximately 17 miles, delivering from Pump Station #1 to Pump Station #2 (see Figures 3, 4, 5, 6, 7 and 8).
- Pump Station #2 located near Benton City at an elevation of approximately 800-feet with a capacity of 1200-cfs (see Figure 8).

- Pipeline Section #2 consisting of two 132-inch diameter steel pressure pipes, with a length of approximately 31 miles, delivering 1150-cfs from Pump Station #2 to Pump Station #3 (see Figures 8, 9, 10, 11, 12, 13, 14 and 15).
- Pipeline Section #2a consisting of a single 36-inch diameter steel gravity pipe, with a length of approximately 1 mile, delivering 50-cfs from Pipeline Section #2 to MP 59.29 on the Sunnyside Canal (at the re-regulating reservoir near end of SVID system – see Figure 10).
- Pump Station #3 located near MP 37.0 on the Sunnyside Canal at an elevation of approximately 960-feet, with a capacity of 750-cfs (see Figure 14).
- Pipeline Section #3 consisting of a single 132-inch diameter steel pressure pipe, with a length of approximately 26 miles, delivering 750-cfs from Pump Station #3 to MP 2.35 on the Sunnyside Canal (see Figures 16, 17, 18, 19, 20, 21, 22 and 23).
- Pipeline Section #3a consisting of a single 84-inch diameter steel gravity pipe, with a length of approximately 2 miles, delivering 400-cfs from the forebay of Pump Station #3 to MP 37.0 on the Sunnyside Canal (see Figure 18).

3.2 Plan 2

Plan 2 has the following components (see Figure 2, Pipeline Overview Map, for project features):

- Pump Station #1 located in Kennewick at an elevation of approximately 350-feet, with a capacity of 1200-cfs, pumping from the Columbia River with a water surface elevation of approximately 341-feet (see Figure 3).
- Pipeline Section #1 consisting of two 132-inch diameter steel pressure pipes, that could be reduced in size in some areas to fit within right-of-way restrictions, with a length of approximately 17 miles, delivering from Pump Station #1 to Pump Station #2 (see Figures 3, 4, 5, 6, 7 and 8).
- Pump Station #2 located near Benton City at an elevation of approximately 800-feet, with a capacity of 1200-cfs (see Figure 8).
- Pipeline Section #2 consisting of two 132-inch diameter steel pressure pipes, with a length of approximately 31 miles, delivering 1150-cfs from Pump Station #2 to Pump Station #3 (see Figures 8, 9, 10, 11, 12, 13, 14 and 15).
- Pipeline Section #2a consisting of a single 36-inch diameter steel gravity pipe, with a length

of approximately 1 mile, delivering 50-cfs from Pipeline Section #2 to MP 59.29 on the Sunnyside Canal (at the re-regulating reservoir near end of SVID system – see Figure 10).

- Pump Station #3 located near MP 37.0 on the Sunnyside Canal at an elevation of approximately 960-feet, with a capacity of 750-cfs (see Figure 14).
- Pipeline Section #3 consisting of a single 72-inch diameter steel gravity pipe, with a length of approximately 5 miles delivering 200-cfs from Pump Station #3 to MP 30.0 on the Sunnyside Canal (see Figures 23, 24 and 25).
- Pipeline Section #3a consisting of a single 84-inch diameter steel gravity pipe, with a length of approximately 2 miles, delivering 400-cfs from the forebay of Pump Station #3 to MP 37.0 on the Sunnyside Canal (see Figures 23 and 24).
- Pipeline Section #3b consisting of a single 120-inch diameter steel pipe, with a length of approximately 1 mile, delivering 550-cfs from Pump Station #3 to MP 59.0 on Roza Canal (see Figures 23 and 24).

It was assumed that all running steel pipe would be mortar lined and epoxy coated and that sections would be welded in the trench. Table 1 below presents a summary of the delivery scenarios for both Plan 1 and Plan 2. Condensed ground and hydraulic profiles are presented in Appendix A.

TABLE 1

Plan 1 and Plan 2 – Delivery Scenarios

Plan 1 Delivery		Plan 2 Delivery	
Sunnyside Canal MP 59.29	50-cfs	Sunnyside Canal MP 59.29	50-cfs
Sunnyside Canal MP 2.35	750-cfs	Sunnyside Canal MP 30.0	200-cfs
Sunnyside Canal MP 37.0	400-cfs	Sunnyside Canal MP 37.0	400-cfs
		Roza Canal MP 59.0	550-cfs

4.0 PIPELINE ROUTE SELECTION

Possible pipeline alignments were identified generally utilizing existing powerline and pipeline easements, road alignments, and railway corridors along a route that would provide a reasonable hydraulic grade line, that would accommodate three pump stations and that would allow delivery of water in accordance with Plan 1 and Plan 2 discussed above. However, locally, departure from this criteria was required to reduce high points on the hydraulic grade line. Through several iterations the proposed pipeline alignments were developed using USGS Quad topography, local knowledge and field reconnaissance. For discussion purposes the pipeline alignments are referenced in terms of Pipeline Sections in the paragraphs below. It has been assumed that a permanent right-of-way could be acquired and temporary working easements could be negotiated to meet the project requirements but no discussions were completed with any of the agencies or landowners that currently control these alignments.

4.1 Pipeline Section #1

The first pipeline section would be the same for both Plan 1 and Plan 2 and would extend approximately 17 miles from a new pump station (Pump Station #1) at the Columbia River near Kennewick at an elevation of approximately 350-feet to the second pump station (Pump Station #2) located on Acord Road north of Benton City at an elevation of approximately 800-feet. The pipeline route would require major crossings of SR 240, I 182 and the Yakima River, Minor crossings of SR 224 and SR 225 as well as a minor crossing of the existing Sunnyside Canal. The pipeline system would consist of two 132-inch diameter steel pressure pipes. Rapid urban development is occurring in the Kennewick area. Future encroachment onto lands identified for the pipeline alignment in this study, could require that alternate routing or local reductions in pipeline diameter be considered as work on this project proceeds.

4.2 Pipeline Sections #2 and #2a

The second pipeline section would be the same for both Plan 1 and Plan 2 and would extend approximately 31 miles from Pump Station #2 to a third pump station (Pump Station #3) located northwest of Sunnyside at an elevation of approximately 960-feet. The pipeline route would require several minor creek crossings including Corral Creek, Snipes Creek and Spring Creek and two crossings of the Sunnyside Canal. The pipeline system would generally consist of two 132-inch diameter steel pressure pipes; however a single 36-inch diameter steel pressure pipe approximately

1 mile long (Section #2a) would be required to deliver 50-cfs to the Benton irrigation system at MP 59.29 (at the existing re-regulating reservoir near end of SVID system).

4.3 Pipeline Sections #3, #3a and #3b

Under both Plan 1 and Plan 2, Pipeline Section #3a consisting of a single 84-inch diameter steel gravity pipe would discharge 400-cfs directly into the Sunnyside Canal at MP 37.0 directly downslope of Pump Station #3.

Under Plan 1 the remaining 750-cfs would be pumped approximately 26 miles via Pipeline Section #3 consisting of a single 132-inch diameter steel pressure pipe to MP 2.35 on the Sunnyside Canal, just downstream of the Sunnyside Diversion near Yakima, Washington. This pipeline would cross SR 241 and the Sunnyside Canal once near Zillah, Washington. The end elevation at MP 2.35 on the Sunnyside Canal would be approximately 900-feet.

Under Plan 2, 200-cfs would be pumped through Pipeline Section #3a consisting of a single 72-inch diameter steel gravity pipe to MP 30.0 on the Sunnyside Canal. The remaining 550-cfs would be pumped through Pipeline Section #3b consisting of a single 120-inch diameter steel pressure pipeline up to MP 59.0 on the Roza Canal.

5.0 PIPELINE FACILITIES

5.1 Hydraulic Analysis - Overview

A hydraulic analysis of the Yakima Pump Exchange project was completed to determine preliminary sizes of pumping and transmission facilities needed to deliver water to the SVID and RID systems.

The hydraulic analysis was performed using WaterCAD hydraulic modeling software. WaterCAD is commonly used to perform hydraulic calculations on water distribution and transmission piping networks. A hydraulic model of the facilities needed to deliver water under both Plans 1 and 2 was created based on the pipeline alignment and profile shown in Figures 3 through 26 of the report. The hydraulic model was then used to simulate flow and pressure conditions through delivery pipelines based on a series of inputs related to the physical and operational characteristics of the piping network. The inputs include pipe diameter, pipe material, pipe roughness, pipe length, elevation, pump characteristics, and water demands. The model calculated a variety of hydraulic parameters, including velocities, friction head losses, minor losses, hydraulic gradients and pressures. The Hazen-Williams Formula was applied to the model to calculate friction head losses and estimate pressures in the delivery pipelines as follows:

$$H_L = \frac{4.72Q^{1.85} L}{C^{1.85} D^{4.87}}$$

Where:

H_L	=	Friction Head Loss (feet)
Q	=	Discharge (cfs)
L	=	Length of Pipe (feet)
C	=	Hazen Williams Roughness Coefficient
D	=	Pipe Diameter (feet)

Minor losses were also estimated by applying minor loss coefficients to each pipe in the model based on conservative assumptions regarding the number and location of valves and fittings. Relatively large minor loss coefficients were also applied to pipes in the model that represent pump station piping to ensure that pump station losses were conservatively estimated.

The pipe diameters, pumping characteristics and other model inputs were adjusted through several iterations of analysis in an effort to optimize the size of the facilities and to ensure that the deliveries specified could be made while maintaining positive pressures throughout the delivery system.

The resulting hydraulic characteristics are illustrated in Appendix A. The hydraulic characteristics of each plan are described in detail below.

5.1.1 Plan 1 – Hydraulics Characteristics

The facilities included as part of Plan 1 consist of a series of pump stations and transmission pipelines that would be needed to deliver water from the Columbia River to the Sunnyside Canal.

The following deliveries were assumed:

- A 50-cfs delivery to the Sunnyside Canal at MP 59.29;
- A 400-cfs delivery to the Sunnyside Canal at MP 37.0; and
- A 750-cfs delivery to the Sunnyside Canal at MP 2.35.

Table 2 summarizes the hydraulic characteristics of the pumping facilities that were included as part of Plan 1. The analysis assumed that Pump Station #1 would draw water from the Columbia River at a pool elevation of 341-feet. The analysis assumed that Pump Stations #2 and #3 would each have wet wells and overflow forebay pond facilities open to the atmosphere that would maintain a relatively constant water level on the suction side of each pump station roughly equal to the elevation of the pump station. Pump Station #3 was sized to deliver 750-cfs to MP 2.35 on the Sunnyside Canal near its headworks. Pumping facilities were sized to deliver the specified flows at a hydraulic gradient that would be sufficient to maintain positive pressures throughout the delivery system.

TABLE 2

Plan 1 – Pumping Facilities

Pumping Facility	Elevation (feet)	Design Capacity (cfs)	Discharge HGL at Design Capacity (feet)	Total Dynamic Head (feet)
PS #1	341-feet	1200-cfs	871-feet	530-feet
PS #2	800-feet	1200-cfs	1070-feet	270-feet
PS #3	960-feet	750-cfs	1060-feet	100-feet

Table 3 summarizes the hydraulic characteristics of the transmission pipelines needed to make the deliveries associated with Plan 1. Two parallel 132-inch diameter pipelines are proposed to deliver 1200-cfs from PS #1 to PS #2. Two parallel 132-inch pipelines are also proposed to deliver 1200-cfs from PS #2 to PS #3, with 50-cfs being diverted to MP 59.0 on the Sunnyside Canal. A single 84-inch diameter pipeline is proposed to deliver 400-cfs by gravity from the forebay on the suction side of Pump Station #3 to MP 37 on the Sunnyside Canal. A single 132-inch diameter pipeline is proposed to deliver the remaining 750-cfs to MP 2.35 on the Sunnyside Canal. The hydraulic grade line for the Plan 1 pumped system from the Columbia River to MP 2.35 on the Sunnyside Canal is shown on Figure A-1.

TABLE 3

Plan 1 – Pipelines

Upstream Facility	Downstream Facility	Pipeline Section #	Pipes (# -diam.)	Length (miles)	Design Capacity	Velocity
PS #1	PS #2	1	2 – 132"	16.95	1200-cfs	6.3 fps
PS #2	PS #3	2	2 – 132"	30.97	1200-cfs	6.3 fps
Sta. 1410+00	Sunnyside Canal MP 59.29	2a	1 – 36"	0.88	50-cfs	7.1 fps
PS #3	Sunnyside Canal MP 2.35	3	1 – 132"	24.76	750-cfs	8.0 fps
PS#3 Forebay	Sunnyside Canal MP 37.0	3a	1 – 84"	1.79	400-cfs	10.4 fps

The analysis and sizing of transmission piping assumed that transmission lines would be ASTM A572, Grade 60 Steel pipe with a Hazen-Williams roughness coefficient of 140. The pipelines were sized to limit velocities to less than 8 fps for pipelines flowing under pressure created by pumping. Higher velocities were allowed in pipelines flowing by gravity. Pipe sizes and pump characteristics were adjusted through several iterations in a preliminary effort to balance the capital costs associated with the size of transmission facilities with the operational costs associated with the pumping energy required for the project. Facility costs and operating costs are outlined in Sections 9 and 10.

The hydraulic profile generated by the analysis of Plan 1 is presented as Figure A-1 in Appendix A. The results indicate that the pumping and transmission facilities outlined above would have the capacity to make the deliveries listed above while maintaining positive pressure in the delivery system.

5.1.2 Plan 2 – Hydraulic Characteristics

The facilities included as part of Plan 2 would consist of a series of pump stations and transmission pipelines that would be needed to deliver water from the Columbia River to both the Sunnyside Valley Irrigation District Canal and the Roza Irrigation District Canal. The following deliveries were assumed:

- A 50-cfs delivery to the Sunnyside Canal at MP 59.29;
- A 200-cfs delivery to the Sunnyside Canal at MP 30.0;
- A 400-cfs delivery to the Sunnyside Canal at MP 37.0; and,
- A 550-cfs delivery to the Roza Canal at MP 59.0.

Table 4 summarizes the hydraulic characteristics of the pumping facilities that were included as part of Plan 2. Pump Stations #1 and #2 would be identical to those proposed as part of Plan 1. Pump Station #3 was sized to deliver 550-cfs to MP 59.0 on the Roza Canal. Pumping facilities were sized to deliver the specified flows at a hydraulic gradient that would be sufficient to maintain positive pressures throughout the delivery system.

TABLE 4

Plan 2 – Pumping Facilities

Pumping Facility	Elevation (feet)	Design Capacity (cfs)	Discharge HGL at Design Capacity (feet)	Total Dynamic Head (feet)
PS #1	341-feet	1200-cfs	871-feet	530-feet
PS #2	800-feet	1200-cfs	1070-feet	270-feet
PS #3	960-feet	550-cfs	1125-feet	165-feet

Table 5 summarizes the hydraulic characteristics of the transmission pipelines needed to make the deliveries associated with Plan 2. The pipelines from Pump Station #1 to Pump Station #3 would be identical to those proposed as part of Plan 1. A single 120-inch diameter pipeline is proposed to deliver 550-cfs from Pump Station #3 to MP 59.0 on the Roza Canal. The hydraulic grade line for the Plan 2 pumped system from Pump Station #3 to MP 59.0 on the Roza Canal is shown on Figure A-2. A single 84-inch diameter pipeline is proposed as part of Plan 2 to deliver 400-cfs by gravity from the forebay on the suction side of Pump Station #3 to MP 37.0 on the Sunnyside Canal. A single 72-inch diameter pipeline is proposed to deliver the remaining 200-cfs by gravity from the forebay on the suction side of Pump Station #3 to MP 30.0 on the Sunnyside Canal. The hydraulic grade line for the Plan 2 gravity system from Pump Station #3 to MP 30.0 on the Sunnyside Canal is shown on Figure A-3.

TABLE 5

Plan 2 – Pipelines

Upstream Facility	Downstream Facility	Pipeline Section #	Pipes (# - diam.)	Length (miles)	Design Capacity	Velocity
PS #1	PS #2	1	2 – 132"	16.95	1200-cfs	6.3 fps
PS #2	PS #3	2	2 – 132"	30.97	1200-cfs	6.3 fps
Sta. 1410+00	Sunnyside Canal MP 59.29	2a	1 – 36"	0.88	50-cfs	7.1 fps
PS #3 Forebay	Sunnyside Canal MP 30.0	3	1 – 72"	5.35	200-cfs	7.1-fps
PS #3 Forebay	Sunnyside Canal MP 37.0	3a	1 – 84"	1.79	400-cfs	10.4 fps
PS #3	Roza Canal MP 59.0	3b	1 – 120"	1.14	550-cfs	7.0 fps

The assumptions that were previously noted regarding pipe material, roughness, and velocities for Plan 1 were also applied to the analysis of Plan 2. Pipe sizes and pump characteristics were adjusted through several iterations in a preliminary effort to balance the capital costs associated with the size of transmission facilities with the operational costs associated with the pumping energy required for the project.

The hydraulic characteristics of the facilities upstream of Pump Station #3 for Plan 2 would be identical to those shown on the hydraulic profile of Plan 1 (see Figure A-1 in Appendix A). The hydraulic profile of the 120-inch pipeline proposed to deliver 550-cfs to MP 59.0 on the Roza Canal from Pump Station #3 is also illustrated in Appendix A as Figure A-2. The profile shows that a pumping head of 165-feet would be needed to lift the water from the pond on the suction side of PS #3 to the Roza Canal. The hydraulic profile for the 72-inch line that is proposed to deliver 200-cfs from the pond on the suction side of Pump Station #3 to MP 30.0 on the Sunnyside Canal is shown in Figure A-3. The figure shows that, because Pump Station #3 was located at a high point along the pipeline, no additional pumping would be required to deliver 200-cfs at the Sunnyside Canal. A residual pressure of approximately 35 psi would be available at the delivery location.

5.2 Pipe Selection

The design of steel pipelines requires a calculation of the required wall thickness for each pipeline section. The required wall thickness of steel pipes is a function of steel strength and the internal pressure. The guidelines presented in the American Water Works Association (AWWA) Manual M11 were used to determine proposed pipeline wall thickness. These guidelines include the following equation that was used to determine the required wall thickness of steel pipe:

$$t = \frac{pd}{2s}$$

Where:

- t = pipe wall thickness (in.)
- p = pressure (psi)
- d = outside diameter (in.)
- s = allowable stress (psi)

The allowable stress, s, is equal to 50% of the minimum specified yield strength of the steel. The pipelines proposed as part of both Plans 1 and 2 were assumed to consist of ASTM A572, Grade 60 steel pipe, which has a yield strength of 60 ksi. The operating pressures determined by the hydraulic analysis were used to determine the required thickness of each of the proposed pipelines. In addition, the required thickness was also calculated for comparison using a maximum transient pressure, that was assumed to be 1.3 times the operating pressure at the pump station discharge, with the hydraulic gradient decreasing linearly to equal the water surface elevation at the end of each pipeline section. An allowable stress of 50% of the minimum specified yield strength was also used to calculate the required pipe wall thickness for the maximum transient pressure condition.

The greater of the required pipe thicknesses calculated was compared with the minimum wall thickness recommended in AWWA M11 for handling steel pipe. The following equation was used for estimating the minimum wall thickness for handling:

$$t = \frac{D + 20}{400} \quad \text{Where:} \quad \begin{array}{l} t = \text{pipe wall thickness (in.)} \\ D = \text{pipe diameter (in.)} \end{array}$$

The pipeline diameters and upstream and downstream pressures included in the hydraulic model for each section of pipeline were used to estimate the required minimum wall thickness, the minimum wall thickness required for handling, and the proposed design wall thickness. The proposed wall thicknesses are summarized below in Tables 6 and 7.

TABLE 6

Plan 1 – Proposed Minimum Steel Pipe Wall Thickness

Upstream Location	Downstream Location	Pipes # - diam.	Pipe Length (ft)	Proposed Pipe Wall Thickness
PS #1	Sta. 114+00	2 – 132"	10,400	0.625"
Sta. 114+00	Sta. 310+00	2 – 132"	19,600	0.500"
Sta. 310+00	PS #2	2 – 132"	59,500	0.375"
PS #2	Sta. 939+00	2 – 132"	3,400	0.500"
Sta. 939+00	PS #3	2 – 132"	160,100	0.375"
Sta. 1410+00	Sunnyside Canal MP 59.29	1- 36"	4,646	0.1875"
PS #3	Sunnyside Canal MP 2.35	1 – 132"	130,736	0.375"
PS#3 Forebay	Sunnyside Canal MP 37.0	1- 84"	9,457	0.3125"

TABLE 7

Plan 2 – Proposed Minimum Steel Pipe Wall Thickness

Upstream Location	Downstream Location	Pipes # - diam.	Pipe Length (ft)	Proposed Pipe Wall Thickness
PS #1	Sta. 114+00	2 – 132”	10,400	0.625”
Sta. 114+00 ¹	Sta. 310+00	2 – 132”	19,600	0.500”
Sta. 310+00	PS #2	2 – 132”	59,500	0.375”
PS #2	Sta. 939+00	2 – 132”	3,400	0.500”
Sta. 939+00	PS #3	2 – 132”	160,100	0.375”
Sta. 1410+00	Sunnyside Canal MP 59.29	1- 36”	4,646	0.1875”
PS#3 Forebay	Sunnyside Canal MP 30.0	1 – 72”	28,260	0.3125”
PS#3 Forebay	Sunnyside Canal MP 37.0	1 – 84”	9,457	0.3125”
PS #3	Roza Canal MP 59.0	1 – 120”	6,039	0.375”

6.0 PUMP STATION FACILITIES

Both Plan 1 and Plan 2 require an intake on the Columbia River immediately downstream from the confluence of the Yakima River and three pump stations.

6.1 Intake (Plans 1 & 2)

The design of the intake will be common to both Plan 1 and Plan 2 and will have a capacity of 1,200-cfs. Details are discussed below.

6.1.1 Location and Property

The intake would be located in the Columbia River about 250-feet out from shore in a water depth of about 20-feet. The property straddles the boundary between the Cities of Kennewick and Richland. The intake structure would be located on land below ordinary high water, which is owned by the State of Washington, under the jurisdiction of the Department of Natural Resources. The conduits from the intake to the pump station would be located on City of Kennewick land in Columbia Park (see Figure 27).

The intake would be the pool created by McNary Dam. Therefore, the river water surface elevation would be controlled by the operation of the dam. The river elevations for design and operations are provided below (Reclamation, October 19, 2004).

River Water Surface Elevations

Minimum water surface elevation	335.0-feet
Minimum operating water surface elevation	337.0-feet
Maximum operating water surface elevation	342.0-feet
Project flood water surface elevation	352.0-feet

6.1.2 Description

The intake structure would have an overall length of 305.5-feet and a width of 25.0-feet (see Figures 28 and 29). The top of the structure would be at elevation 355.0-feet. Water would flow on both sides of the structure; however the fish screens would be located only on the north side, or river side, of the structure. There would be 22 stainless steel wedge wire fish screen panels, each measuring 11-feet wide and 14-feet high. The screens would have 1.75 mm openings and meet all NOAA Fisheries criteria. Field observations indicate that there would be sufficient sweeping velocity in this

area to meet NOAA criteria. The screens would be supported by 2-feet wide by 4-feet deep piers. A wall would extend from 14-feet above the floor up to elevation 355.0-feet. The effective screen area would be 10-feet wide by 14-feet high. Blank stainless steel plates would be located above the screens to an elevation of 352.0-feet to form a smooth face for fish passage. The screens would be cleaned by two brush screen cleaners, which would be raised out of the flow when not in use. Each screen panel would have an adjustable baffle panel behind them. During startup the baffle panels would be adjusted to achieve an equal flow through each screen bay. Both upstream and downstream ends of the structure would have fairings to provide better hydraulic conditions along the fish screens.

A sediment re-suspension system, consisting of a submersible pump inside the structure pressurizing a manifold and piping system, would be installed. The water jets issuing from the nozzles at appropriate locations in the pipes would be directed along the floor inside the structure. These jets would re-suspend sediment, which would be carried into the intake.

Existing borehole information indicates that the structure would need to be supported on piles. No analysis was performed to ascertain the size, depth, or type of piles required. Pilings on six-foot centers were assumed. The structure would be built of steel reinforced concrete with a concrete deck. Slots in the deck covered by grating would allow access to the inside of the structure for removal and replacement of the baffles and fish screen panels.

6.1.3 Construction

The assumed approach for constructing the intake would be to drive sheet piling around the structure with a corridor back to the riverbank for access. Cross bracing would be required inside the structure. The sheet piles would be driven from a barge. Permanent support piles would be driven inside the structure. Concrete would then be tremie poured inside the sheet piling enclosure to resist water pressure from piping through the floor into the structure. The water would then be pumped out and the rest of the structure would be built.

Due to of the length of time required for construction, and the short instream work window, a cofferdam would be required. It has been estimated that the work in the river would require about 2-months for sheet pile installation and about 2-months for sheet pile removal. The structure in the dewatered area could be built in 1 or 2-years.

6.1.4 Conduits to Pump Station

Two 12-feet by 12-feet square concrete conduits would carry water to the pump station. Bulkhead slots would be provided at both the upstream and downstream end of the conduits. The bulkheads would be used for dewatering the conduits for inspection and maintenance.

The flow in the conduits would be 600-cfs each with a maximum velocity of 4.2-fps. The total head loss through the fish screens, intake structure, and conduit has been estimated to be about 1-foot.

6.2 **Pump Station #1 (Plans 1 & 2)**

6.2.1 Pump Station General Description

Pump Station # 1 would take water from the Columbia River through the fish screen and intake, and would deliver flow to Pump Station #2. Pump Station #1 would consist of a wet well, pump room, valve vault, and electrical rooms. The wet well would serve as a forebay and provide adequate volume to control the pumps. Flow straightening devices would be provided to insure proper hydraulic operation of the pumps. See Figures 28 and 29.

6.2.2 Pumping Equipment

The pump station would be equipped with 7 (6+1 standby) vertical turbine pump units as indicated in Table 8. Each pump would be rated for 200-cfs, and would have 15,000-hp open-drip-proof motors and 13.8-kV, 3-phase, 60-hz. power supply. The station would have a total capacity of 1,200-cfs. Pump Station #1 would deliver flow to Pump Station #2 through dual 132-inch diameter conveyance pipelines. A flow metering structure with isolation valves would be provided outside of the pump station to provide flexibility of using one or the other pipes in the event that one was being repaired. Two (2) pumps would have induction-type motors, driven by variable frequency drives. Five (5) pumps would be driven by synchronous, constant speed drives with soft starters for better efficiency. Pumping equipment materials for construction are assumed to be standard bronze fittings, ductile iron bowls, stainless steel shafts, and epoxy lined and coated steel discharge column and head.

TABLE 8

Pump Schedule - Pump Station # 1

Pump Station	Service	Type	Total PS Flow	No. of Units	Flow per pump	TDH	Motor Size
PS #1	Raw Water	Vertical Turbine	1200-cfs	6+1	200-cfs	530-feet	15,000-hp

6.2.3 Valves and Piping System

Each pump train would consist of a pump control valve and an isolation valve as indicated in Table 9. The pump control valve would be a butterfly-type valve with a dedicated hydraulic power unit (HPU). The HPU would operate the pump control valve to provide controlled opening and closing during normal starting and stopping of the pumps and controlled closure during a power failure condition in order to alleviate hydraulic transients in the pipeline. Motor operated isolation butterfly valves would be utilized during maintenance of the pumps. All butterfly valves would be triple offset metal seated valves, ductile iron or fabricated steel body, epoxy lined and coated. All piping materials would be to AWWA C200, cement mortar lined and epoxy coated steel pipes.

TABLE 9

Valve Schedule - Pump Station # 1

Pump Station	Service	Type	Function	Size (inches)	No of Units	Flow (cfs)	Max Working Press (psi)	Actuator
PS #1	Raw Water	Triple offset Valve	Pump Control	72	7	2000	350	HPU
PS #1	Raw Water	Triple offset Valve	Isolation	72	7	2000	350	Electric
PS #1	Raw Water	Triple offset Valve	Isolation	132	3	TBD	350	Electric
PS #1	Raw Water	Triple offset Valve	Surge Tank Isolation	54	6	600	350	Manual

6.2.4 Hydraulic Transient

Preliminary transient analysis indicates a total of six 40-foot diameter spherical surge tanks are required. Three surge tanks would be required for each of the 132-inch transmission pipelines located inside the pump station facility as indicated in Figures 27, 28, and 29. Each surge tank would have an isolation valve and would be installed inside a vault with floor elevation of 15-feet below finished grade. The surge tanks would be pressurized by compressed air to provide an air cushion to absorb surge. A duplex-type air compressor would be provided.

6.2.5 Pump Station # 1 Electrical Supply

A new 500-kV powerline with metal towers would be constructed from Pump Station # 1 to the closest substation assuming BPA extends their 500-kV line into Richland/Kennewick as BPA has proposed. Alternatively, 115-kV or 230-kV lines with wood poles could be run to the existing utility lines of the same voltage nearby. The cost estimate assumes that a half mile long 500-kV line and switchyard would be used.

6.2.6 Pump Station Electrical Equipment

All three pump stations would be equipped with overhead cranes and space for unit disassembly and auxiliary mechanical and electrical equipment, although specific equipment has not been identified. Each pump station would require a switchyard that would include transformers, SF6 circuit breakers, disconnect switches, and the end of line structure. A 7-foot chain-link fence would be provided around the switchyards for security. The power would be transformed to 13.8-kilovolt (kV) for power input into the main pumps reduced-voltage and variable speed motor starter. The motor starters and motors could operate on lower voltage if it were advantageous in terms of reduced cost and space. The 13.8-kV would be transformed to 480/277 volts to feed the double-ended station service switchgear and motor control centers, and distribution panel boards.

6.3 Pump Station #2 (Plans 1 &2)

6.3.1 Pump Station General Description

Pump Station #2 would receive a maximum flow of 1,200-cfs from Pump Station #1. Pump Station #2 would deliver flow to Pump Station #3 through a dual 132-inch diameter conveyance pipeline. At approximately one-third of the length of the pipeline, 50-cfs would be delivered to the Sunnyside

Canal, and the remainder of the flows would be conveyed to Pump Station #3. A flow metering structure with isolation valves would be provided outside of the pump station to provide the flexibility of using one or the other conveyance pipelines in the event that one lateral was being repaired (See Figure 30). The pump station would consist of a wet well, pump/motor, valve and electrical rooms. The wet well would serve as a forebay to provide adequate volume to control the pumps. Flow straightening devices would be provided to insure proper operation of the pumps. The wet well would also include an overflow weir to automatically divert excess flows to an overflow reservoir in the event of power outages at Pump Station 2 while Pump Station #1 was operating. Excavation for this pump station would mostly be in rock.

6.3.2 Pumping Equipment

The pump station would be equipped with 7 (6+1 standby) vertical turbine pump units as indicated in Table 10. Each pump would be rated for 200-cfs, 7,750-hp open-drip-proof motors and 13.8-kV, 3-phase, 60-hz. power supply. The pump station would have a total capacity of 1,200-cfs. Two (2) pumps would have induction-type motors, driven by a variable frequency drives. Five (5) pumps would be driven by synchronous, constant speed drives with soft starters for better efficiency. Pumping equipment materials of construction are assumed to be standard bronze fitted, ductile iron bowls, stainless steel shafts, epoxy lined and coated steel discharge column and head.

TABLE 10

Pump Schedule - Pump Station # 2

Pump Station	Service	Type	Total PS Flow	No. of Units	Flow per pump	TDH	Motor Size
PS #2	Raw Water	Vertical Turbine	1200-cfs	6+1	200-cfs	270-feet	7,750-hp

6.3.3 Valves and Piping System

Each pump train would consist of a pump control valve and an isolation valve as indicated in Table 11. The pump control valve would be a butterfly-type valve with a dedicated hydraulic power unit (HPU). The HPU would operate the pump control valve to provide controlled opening and closing during normal starting and stopping of the pumps and controlled closure during a power failure

condition in order to alleviate hydraulic transients in the pipeline. Motor operated isolation butterfly valves would be utilized during maintenance of the pumps. All butterfly valves would be triple offset metal-seated valves, ductile iron or fabricated steel body, epoxy lined and coated. All piping materials would be to AWWA C200, cement mortar lined and coated steel pipes.

TABLE 11

Valve Schedule - Pump Station # 2

Pump Station	Service	Type	Function	Size (inches)	No of Units	Flow (cfs)	Max Working Press (psi)	Actuator
PS #2	Raw Water	Triple offset Valve	Pump Control	72	7	2000	200	HPU
PS #2	Raw Water	Triple offset Valve	Isolation	72	7	2000	200	Electric
PS #2	Raw Water	Triple offset Valve	Isolation	132	3	TBD	200	Electric
PS #2	Raw Water	Triple offset Valve	Surge Tank Isolation	54	6	600	200	Manual
PS #2	Raw Water	Flap Valve	Flow Control	72	1	200	50	-

6.3.4 Hydraulic Transient

Preliminary transient analysis indicates that a total of six 40-feet diameter spherical surge tanks are required. Three 40-feet spherical surge tanks would be required for each of the 132-inch transmission pipelines located inside the pump station facility as indicated in Figure 30. Each surge tank would have an isolation valve and would be installed inside a vault with floor elevation of 15-feet below finished grade. The surge tanks would be pressurized by compressed air to provide an air cushion to absorb surge. A duplex-type air compressor would be provided. Additionally, air vacuum inlet structures would be constructed at two locations at high points downstream of Pump Station #2 (see Figure 8).

6.3.5 Pump Station # 2 Electrical Supply

A new 115-kV or 230-kV powerline with wood poles would be constructed from an existing nearby the substation to Pump Station # 2 over a distance of approximately 1.5- miles.

6.3.6 Overflow Provisions

In event of a loss of power or a multi-pump failure at Pump Station # 2, pumped flow leaving the station would cease or be reduced. An automatic signal would be sent to Pump Station # 1 to shut down all or some of the pumps depending on the nature of the event. However, shutting down pumps takes time, therefore an overflow would be designed into the wet well of Pump Station # 2 to carry away incoming flow until Pump Station # 1 ceases or reduces operation. The overflow would be a fixed weir with a 70-foot crest length, and a 70-foot channel that would carry the flow to an overflow reservoir. An overflow reservoir has been included to reduce the number of times flow would be sent down a wasteway channel to the Yakima River. The overflow reservoir would be designed to retain one hour of the full pumping flow, or about 99 acre-feet. It would be 800-feet wide by 1,400-feet long. The wasteway would carry away water to the east in a 12-foot wide open channel and through a stilling basin to the Yakima River. The total length would be about 11,500-feet. The head difference between the overflow reservoir and the river would be about 320-feet. An energy dissipation structure would be located near the river. A 24-inch diameter drain pipe would be used to drain the overflow reservoir into the wasteway. A 72-inch overflow return pipe extends from the wet-well to the overflow reservoir. It would be fitted with a one-way check valve, which allows flow from the reservoir to the wet well. This allows water from the overflow reservoir to be pumped upon re-start of the pumps and limits the amount of water admitted to the raceways from the overflow reservoir. An alternate wasteway route would be down Corral Creek to the river. This route would be about 2,500-feet shorter and would require significant alteration of Corral Creek and a crossing of a road and the Kiona Canal.

If Pump Station # 2 ceases operation, Pump Station # 3 would automatically shut down based on low water levels in the wet well.

6.4 Pump Station #3 (Plan 1)

6.4.1 Pump Station General Description

Pump Station #3 would receive 1,150-cfs from Pump Station #2. Under Plan 1 the flows would be distributed two ways: 750-cfs to Sunnyside Canal at about MP 2.35 by pumping, and 400-cfs to Sunnyside Canal at about MP 37.0 by gravity. This split would be designed to occur at the wet well or forebay of Pump Station #3. Pump Station #3 would be rated for a maximum capacity of 750-cfs, and deliver flows to Sunnyside through a single 132-inch diameter conveyance pipeline. A flow metering structure with isolation valve would be provided outside of the pump station. The pump station would consist of a wet well, pump/motor, valve and electrical rooms. The wet well would serve as a forebay to provide adequate volume to control the pumps. Flow straightening devices would be provided to insure proper operation of the pumps. The wet well would also include an overflow weir to automatically divert excess flows to the overflow reservoir in the event of a power outage at Pump Station #3 while Pump Station #2 was operating. Diversion gates to control flow to Sunnyside Canal would be installed inside the wet well (see Figures 31 through 33).

6.4.2 Pumping Equipment

The pump station would be equipped with 5 (4+1 standby) vertical turbine pump units as indicated in Table 12. Each pump would be rated for 187.5-cfs, 2,700-hp open-drip-proof motors and 13.8-kV, 3-phase, 60-hz. power supply. The pump station would have a total capacity of 750-cfs. Two (2) pumps would be induction-type motors, driven by a variable frequency drive. Three (3) pumps would be driven by synchronous, constant speed drives with soft starters for better efficiency. Pumping equipment materials of construction are assumed to be standard bronze fitted, ductile iron bowls, stainless steel shafts, epoxy lined and coated steel discharge column and head.

TABLE 12

Pump Schedule - Pump Station # 3 (Plan 1)

Pump Station	Service	Type	Total PS Flow	No. of Units	Flow per pump	TDH	Motor Size
PS #3	Raw Water	Vertical Turbine	750-cfs	4+1	187.5-cfs	100-feet	2,700-hp

6.4.3 Valves and Piping System

Each pump train would consist of a pump control valve and an isolation valve as indicated in Table 13. The pump control valve would be a butterfly-type valve with a dedicated hydraulic power unit (HPU). The HPU would operate the pump control valve to provide controlled opening and closing during normal starting and stopping of the pumps and controlled closure during power failure condition in order to alleviate hydraulic transients in the pipeline. The motor operated isolation butterfly valve would be utilized during maintenance of the pumps. Because the maximum pressure would be below the Class 150 psi rating, all butterfly valves would be AWWA C504, resilient seated valves, ductile iron or fabricated steel body, epoxy lined and coated. All piping materials would be to AWWA C200, cement mortar lined and epoxy coated steel pipes.

TABLE 13

Valve and Gate Schedule - Pump Station # 3 (Plan 1)

Pump Station	Service	Type	Function	Size (inches)	No of Units	Flow/ valve (cfs)	Max Working Press (psi)	Actuator
PS #3	Raw Water	Resil. Seated BV	Pump Control	72	5	200	150	HPU
PS # 3	Raw Water	Resil. Seated BV	Isolation	72	5	200	150	Electric
PS #3	Raw Water	Resil. Seated BV	Isolation	132	1	750	150	Electric
PS #3	Raw Water	Resil. Seated BV	Surge Tank Isolation	54	4	TBD	150	Manual
PS #3	Raw Water	Cast Iron Sluice Gates	Flow Control	72x72	2	200	50-feet seating/ 0-feet unseating head	Electric
PS #3	Raw Water	Flap Valve	Flow Control	72	1	200	50	-

6.4.4 Hydraulic Transient

Preliminary transient analysis indicates that no surge tanks would be required for the 132-inch discharge pipeline. Instead, air vacuum inlet structures would be constructed at two high points along the pipeline downstream of Pump Station 3 as shown on Figures 18 and 20.

6.4.5 Pump Station # 3 Electrical Supply

A new 115-kV powerline with wood poles would be constructed from the closest tap onto an existing power line to Pump Station # 3. The distance to the nearest power line was assumed to be 3-miles. The power line tap would include circuit breakers and disconnect switches.

6.4.6 Overflow Provisions

In the event of a loss of power or a multi-pump failure at Pump Stations # 3, pumped flow leaving the station would cease or be reduced. An automatic signal would be sent to Pump Station #1 and Pump Station #2 to shut down some or all of the pumps depending on the nature of the event. However, shutting down pumps would take time. Therefore an overflow would be designed into the wet well of Pump Station # 3 to carry away incoming flow until Pump Station # 2 ceases or reduces operation sufficiently. The overflow would be a fixed weir with a 50-foot crest length, and a 50-foot wide channel, which would carry the flow to an overflow reservoir. An overflow reservoir would be included to reduce the number of times flow would be sent down the Sulphur Creek wasteway to the Yakima River. The overflow reservoir would be designed to retain one hour of the full pumping flow of 750-cfs at Pump Station #3, or about 62 acre-feet. It would be 340-feet wide by 2,000-feet long (see Figure 31). An overflow to the Roza Wasteway #5 would carry water south to the Yakima River. The Sulphur Creek wasteway below the Sunnyside Canal is designed for 1,350-cfs and would not have to be improved to carry the 750-cfs overflow. It has been assumed that the 400-cfs gravity delivery to the Sunnyside Canal out of the wet well would continue. Pump Station #1 and Pump Station #2 would continue to pump the 400-cfs. A 24-inch diameter drain pipe would be used to drain the overflow reservoir into the wasteway. A 72-inch overflow return pipe extends from the wet-well to the overflow reservoir. It would be fitted with one-way check valve, which allows flow from the reservoir to the wet well. This would allow water from the overflow reservoir to be pumped upon re-start of the pumps and would limit the amount of water admitted to the wasteways from the overflow reservoir.

6.5 Pump Station #3 (Plan 2)

Under Plan 2 the intake and Pump Stations #1 and #2 are the same as in Plan 1 as discussed in previous sections. The modification for Plan 2 occurs at Pump Station #3. Pump Station #3 would receive 1,150-cfs from Pump Station #2. Under Plan 2 the flows would be distributed three ways: 200-cfs to the Sunnyside Canal at MP 30.0 by gravity, 550-cfs to the Roza Canal by pumping, and 400-cfs to Sunnyside Canal at MP 37.0 by gravity. This split would be designed to occur at the wet well or forebay of Pump Station 3 (see Figures 34 through 36). Pump Station #3 would be rated for a maximum capacity of 550-cfs. Pump Station #3 would deliver flows to Roza Canal through a single 120-inch diameter pipeline. A flow metering structure with an isolation valve would be provided outside of the pump station. The pump station would consist of a wet well, pump/motor, valve and electrical rooms. The wet well would serve as a forebay to provide adequate volume to control the pumps. Flow straightening devices would be provided to insure proper operation of the pumps. The wet well would also include an overflow weir to automatically divert excess flows to an overflow reservoir in the event of a power outage or pump failure at Pump Station #3. Diversion gates to provide 400-cfs to the Sunnyside Canal and 200-cfs the Sunnyside Canal at about MP 30.0 would also be installed inside the wet well.

6.5.1 Pumping Equipment

The pump station would be equipped with 4 (3+1 standby) vertical turbine pump units as indicated in Table 14. Each pump would be rated for 183-cfs, 4,350-hp open-drip-proof motors and 13.8-kV, 3-phase, 60-hz. power supply. The station would have a total capacity of 550-cfs. Two (2) pumps would have induction-type motors, driven by a variable frequency drive. Two (2) pumps would be driven by synchronous, constant speed drives with soft starters for better efficiency. Pumping equipment materials of construction are assumed to be the same as for Pump Stations #1 and #2.

TABLE 14

Pump Schedule - Pump Station # 3 (Plan 2)

Pump Station	Service	Type	Total PS Flow	No. of Units	Flow per pump	TDH	Motor Size
PS #3	Raw Water	Vertical Turbine	550-cfs	3+1	183-cfs	165-feet	4,350-hp

6.5.2 Valves and Piping System

Each pump train would consist of a pump control valve and an isolation valve as indicated in Table 15. The pump control valve would be a butterfly-type valve with a dedicated hydraulic power unit (HPU). The HPU would operate the pump control valve to provide controlled opening and closing during normal starting and stopping of the pumps and controlled closure during a power failure condition in order to alleviate hydraulic transients in the pipeline. Motor operated isolation butterfly valves would be utilized during maintenance of the pumps. Because the maximum pressure would be below the Class 150 psi rating, all butterfly valves would be AWWA C504, resilient seated valves, ductile iron or fabricated steel body, epoxy lined and coated. All piping materials would be to AWWA C200, cement mortar lined and epoxy coated steel pipes.

TABLE 15

Valve and Gate Schedule - Pump Station 3 (Plan 2)

Pump Station	Service	Type	Function	Size (inches)	No of Units	Flow/unit (cfs)	Max Working Press (psi)	Actuator
PS #3	Raw Water	Resil. Seated BV	Pump Control	72	4	200	150	HPU
PS #3	Raw Water	Resil. Seated BV	Isolation	72	4	200	150	Electric
PS #3	Raw Water	Resil. Seated BV	Isolation	120	1	550	150	Electric
PS #3	Raw Water	Resil. Seated BV	Surge Tank Isolation	54	3	TBD	150	Manual
PS #3	Raw Water	Cast Iron Sluice Gates	Flow Control	72x72	2	200	50-feet seating/ 0-feet unseating head	Electric
PS #3	Raw Water	Cast Iron Sluice Gates	Flow Control	60x60	2	100	50-feet seating/ 0-feet unseating head	Electric
PS #3	Raw Water	Flap Valve	Flow Control	72	1	200	50	-

6.5.3 Hydraulic Transient

Preliminary transient analysis indicates three 25-foot spherical surge tanks would be required for the 120-inch discharge main as indicated in Figures 34 and 35. Each surge tank would have an isolation valve, and would be installed inside a vault with floor elevation of 15-feet below finish grade. The surge tanks would be pressurized by compressed air to provide an air cushion to absorb surge. A duplex-type air compressor would be provided.

6.5.4 Pump Station # 3 Electrical Supply

A new 115-kV powerline with wood poles would be constructed from the closest tap onto an existing power line to Pump Station # 3. The distance to the nearest power line was assumed to be 3 miles. The power line tap would include circuit breakers and disconnect switches.

6.5.5 Overflow Provisions

In the event of a loss of power or a multi-pump failure at Pump Stations # 3, pumped flow leaving the station would cease or be reduced. An automatic signal would be sent to Pump Station #1 and Pump Station #2 to shut down some or all the pumps depending on the nature of the event. However, shutting down pumps would take time, therefore an overflow would be designed into the wet well of Pump Station #3 to carry away incoming flow until Pump Station #2 ceases or reduces operation. The overflow would have a fixed weir with a 40-foot crest length. A 40-foot channel would carry the flow to an overflow reservoir. The overflow reservoir has been included to reduce the number of times flow would be sent down the wasteway to the Yakima River. The overflow reservoir would be designed to retain one hour of the 550-cfs pumping flow, or about 45 acre-feet. It would be 250-feet wide by 2,000-feet long. An overflow from the reservoir to the Sulphur Creek wasteway would carry water south to the Yakima River. The wasteway is be designed for 1,350-cfs and would not have to be improved to carry the overflow. It has been assumed that the 400-cfs and 200-cfs gravity deliveries to the Sunnyside Canal out of the wet well would continue. Pump Stations #1 and #2 would continue to pump the 600-cfs. A 24-inch diameter drain pipe would be used to drain the overflow reservoir into the wasteway. A 72-inch overflow return pipe extends from the wet-well to the overflow reservoir. It would be fitted with a one-way check valve, which allows flow from the reservoir to the wet well. This would allow water from the overflow reservoir to be pumped upon re-start of the pumps and would limit the amount of water admitted to the wasteways from the overflow reservoir.

7.0 PUMP SYSTEM OPERATION

It has been assumed that the entire pumping station and pipeline system would be operated in three modes/ locations. The first would be at the remote location designated by Reclamation. The second would be at Pump Station #1 (Central Control Station). The third would be at each pump station. A Supervisory Control and Data Acquisition (SCADA) system would be the preferred normal operating mode from the Central Control Station at Pump Station #1. It has also been assumed that the system flow would vary between 200-cfs to a maximum of 1,200-cfs. The system capacity would be pre-determined based on the water demand scheduled by Reclamation and districts.

All three pump stations would have a telemetry link between them and for remote control. Each station would have a stand-alone PLC (Programmable Logic Controller) to start and stop pumps to deliver the requested flow rate. It has been assumed that two direct buried fiber-optic cables would be installed in the pipeline trench, one on each side, to connect the pump station PLC's together. This would allow Pump Stations # 2 and #1 to be automatically shut down if Pump Station # 3 were to go off line, and for Pump Station # 1 to be automatically shut down if Pump Station # 2 were to go off line. Remote access could be via a secure dial-up telephone connection to allow operators to remotely operate the pump stations. Pump safety features would be hard-wired into the individual motor starters to allow safe manual pump operation with the PLC off-line. The PLC's and telemetry equipment would have backup power to allow communications to occur for a limited time after a loss of utility power.

Each pump station would be equipped with a modular size pump between 183 to 200-cfs, with at least two (1+1standby) variable speed driven pumps. The remainder of the pump units would be constant speed pumps. The variable speed pumps would be used as lead pumps, and the constant speed pumps would be used as lag pumps. The variable speed pumps would be used to trim flows so that the hydraulic capacities among the pump stations would match, especially when flows to turn outs are adjusted.

7.1 Normal Operation

It has been assumed that the pumps at Pump Stations #2 and #3 would be controlled by water level in the wet well. Pumps at Pump Station #1 would be started one at a time. As the wet well water level rises at Pump Stations #2 and #3, the level control would start the pumps one at a time starting with the variable speed pump as lead pump. When the number of pumps operating at Pump Station #1

decreases, the pumps at Pump Stations #2 and #3 would stop one at a time in the reverse order of the starting sequence.

For example, if the 50-cfs turnout downstream of Pump Station #2 were activated, the flow to Pump Station #3 would decrease. This decrease in flow would cause the wet well level to drop, and consequently, reduce the speed of the variable speed pump to maintain the level in the wet well.

Each pump station could also be operated manually by placing plant operators at each pump station with radio communication to the central control room. This would not be the preferred way to operate the system, however, it could be required during periodic maintenance.

Each pump station and each turnout would be equipped with flow meters so that flows could be recorded and used for monitoring and control. Historical trending could also be monitored to check the efficiency of the system.

7.2 Emergency Operation

In the event of emergency power outages while the pumps are in operation, it would be possible that Pump Station #2 could have a power failure while Pump Station #1 could continue to operate. The high water level alarm at Pump Station #2 would signal Pump Station #1 to stop, one pump at a time. This controlled stopping sequence would normally take at least 10 minutes for each pump to come to a complete stop. The controls would be designed for starting and stopping each pump, in order to minimize water hammer and surging in the system.

After emergency shutdown, the reason for the shutdown would be investigated and corrected. After clearing the cause of the shutdown, the pump system would be restarted as described above. Water would remain in the overflow reservoir to act as an additional wet well volume during startup. A 72-inch overflow return pipe would carry flow sufficient for one pump (200-cfs) from the overflow reservoir to the wet well. A one-way check valve in the pipe would prevent flow from traveling out of the wet well to the overflow reservoir.

7.3 Transients

Results of a preliminary surge analysis indicates the need for surge chambers near the discharge manifold of each pump station, and air release and vacuum fittings at high points along the pipeline alignment.

8.0 DELIVERY FACILITIES

As outlined previously, Plan 1 includes delivery at three locations along the Sunnyside Canal: MP 2.35 near the headworks, MP 37.0, and MP 59.29. Plan 2 includes delivery at four locations: MP 30.0, MP 37.0, and MP 59.29 on the Sunnyside Canal and MP 59.0 on the Roza Canal. The deliveries proposed as part of each plan would be made by discharging from the piped delivery system into the existing Sunnyside and Roza Canals. A structure would be provided at each point of delivery to the canals to dissipate the hydraulic energy of the water as it exits the pipe and discharges into the canal. It is proposed that the structures be designed to discharge water to the canal at a 30° angle from the centerline of the canal to minimize flow disturbances in the canal. It is also proposed that the canals be lined approximately 50-feet upstream and 100-feet downstream of each point of delivery to provide additional protection.

A Reclamation Type VI (impact-type) stilling basin is proposed at each delivery to dissipate energy. The stilling basing includes a reinforced concrete box, with a headwall at the pipe exit and sidewalls that taper down toward the canal. Energy would be dissipated in the basin as the water jet impacts a reinforced concrete baffle near the end of the pipe. A copy of the standard detail for an impact-type stilling basin has been included as Figure 37.

The facilities required for delivery of water under Plans 1 and 2 are as follows:

- Delivery of 50-cfs to the Sunnyside Canal at MP 59.29 is proposed as part of both Plans 1 and 2 and would require a 36-inch diameter steel pipe to carry water to the point of delivery approximately 1 mile south of the parallel 132-inch pipes that are proposed to deliver water from Pump Station #2 to Pump Station #3. The pipe would discharge to a single Reclamation Type VI stilling basin for delivery to the Sunnyside Canal.
- An 84-inch diameter pipe is proposed as part of both Plans 1 and 2 to deliver 400-cfs from the pond at the suction side of Pump Station #3 by gravity to the Sunnyside Canal at MP 37.0. The pipe would discharge to a single Reclamation Type VI stilling basin for delivery to the Sunnyside Canal.
- A 132-inch pipe is proposed to deliver 750-cfs from Pump Station #3 to MP 2.35 on the Sunnyside Canal under Plan 1. Because the delivery exceeds the 400-cfs maximum flow proposed for an impact-style stilling basin, it is proposed that the flow be split just

- upstream of the stilling basin into two 96-inch pipes. The pipes would discharge into identical Reclamation Type VI stilling basins, located adjacent to one another.
- A 120-inch pipe is proposed to deliver 550-cfs from Pump Station #3 to MP 59.0 on the Roza Canal under Plan 2. Because the delivery exceeds the 400-cfs maximum flow proposed for an impact-style stilling basin, it is proposed that the flow be split just upstream of the stilling basin into two 84-inch pipes. The pipes would discharge into identical Reclamation Type VI stilling basins, located adjacent to one another.
 - A 72-inch pipe is proposed as part of Plan 2 to deliver 200-cfs from the pond at the suction side of Pump Station #3 by gravity to MP 37.0 on the Sunnyside Canal. The pipe would discharge to a single Reclamation Type VI stilling basin for delivery to the Sunnyside Canal.

Table 16 includes a list of the proposed deliveries under each plan and a description of the structure that would be required at each point of delivery.

TABLE 16

Delivery Facilities

Delivery Location	Flow	Pipe at Delivery (# -diam.)	Velocity in Pipe	Stilling Basin Dimensions		
				Inside Width W	Inside Length L	Headwall Height H
PLAN 1						
Sunnyside Canal MP 59.29	50-cfs	1 – 36”	7.1 fps	9’-0”	12’-0”	6’-9”
Sunnyside Canal MP 37.0	400-cfs	1 – 84”	10.4 fps	21’-0”	28’-0”	15’-9”
Sunnyside Canal MP 2.35 ¹	750-cfs	2 – 96”	7.5 fps	24’-0”	32’-0”	18’-0”
PLAN 2						
Sunnyside Canal MP 59.29	50-cfs	1 – 36”	7.1 fps	9’-0”	12’-0”	6’-9”
Sunnyside Canal MP 37.0	400-cfs	1 – 84”	10.4 fps	21’-0”	28’-0”	15’-9”
Roza Canal MP 59.0 ¹	550-cfs	2 – 84”	7.2 fps	21’-0”	28’-0”	15’-9”
Sunnyside Canal MP 30.0	200-cfs	1 – 72”	7.1 fps	18’-0”	24’-0”	13’-6”

Notes:

- 1) Reclamation recommends that impact-style stilling basin be used for flows up to 400-cfs. For flows in excess of 400-cfs, Reclamation recommends multiple basins side by side. Delivery under Plan 1 at Sunnyside Canal MP 2.35 exceeds 400-cfs. Delivery under Plan 2 to Roza Canal MP 59.0 also exceeds 400-cfs. Stilling basin sizing assumes flow in 120-inch pipe would be split upstream of delivery and discharged into identical stilling basins located side by side.

9.0 FIELD CONSTRUCTION COST ESTIMATES

This section presents the appraisal-level field costs for the intake and pump stations, pipelines and delivery structures for the Yakima River Pump Exchange alternative. Field costs are limited to the costs of construction contracts and do not include non-contract costs such as land and easement acquisition, engineering designs, permitting, regulatory compliance, environmental mitigation and monitoring, and construction management and administration.

These field construction costs were developed for the purposes of comparing Plan 1 and Plan 2 and for comparing the Yakima Pump Exchange alternative with other water delivery alternatives that are being considered within the Yakima River Basin for agricultural, municipal, and environmental purposes. These costs could change as more data are collected and designs are refined. These field cost estimates were based on limited analysis and data. They rely on unit costs derived from the Black Rock Summary Report (U.S. Department of Interior, December 2004), unit costs from recent bid experience, cost estimate information from similar projects, and some vendor quotes for major equipment.

9.1 Pipeline Costs

An appraisal-level Field Construction Cost Estimate was developed for the Yakima Pump Exchange pipeline system. These costs include only the installation of the pipelines and associated civil construction. Costs for pump station and other infrastructure were not included. These costs are assumed to be of a preliminary-level. Final engineering designs, permitting and regulatory compliance, right-of-way acquisition, etc. will be additional cost items incurred at a later stage in the project development.

Excavation quantities and materials were developed for the installation of several configurations and combinations of pipeline including two parallel 132-inch diameter steel pipelines, one 132-inch diameter pipeline, one 120-inch diameter pipeline, one 84-inch diameter pipeline one 72-inch diameter pipeline. The alignments for Plan 1 and Plan 2 were mapped and geologic conditions were determined using water well log information along the alignment. The geology was broken down into three sections for costing purposes:

1. Depth to Bedrock greater than 15-feet;
2. Depth to Bedrock between 5-15 feet; and;
3. Depth to Bedrock between 0-5 feet.

The total length of alignment for each of these geologic conditions was determined, and excavation and installation quantities determined for each condition for both plans. Appendix B includes detailed information on cost development and provides total cost estimates for both plans.

9.2 Typical Excavation Cross-Section

A typical excavation cross-section was developed for the pipeline installation as shown in Figure 38 for typical cross-sections. The following criteria were used for the cross-section development:

- Two 132-inch steel pipelines installed within the same trench;
- Minimum cover of 5-feet over the top of pipe;
- 1:1 H:V side slopes for excavation;
- Pipe bedding of 1-foot plus a 1-foot deep concrete saddle for each pipe (continuous along length); and
- Minimum separation of one pipe diameter between the two pipes, and a minimum separation of 5-feet between the pipes and edge of excavation.

Similar cross-sections were developed for single pipe installations to develop appropriate estimates of excavation volume.

For the case where depth to bedrock was greater than 15-feet, the excavation was assumed to be in all soil, since the depth of trench would be approximately 18-feet. Where the depth to bedrock was determined to be between 5 and 15-feet, an average depth of 10-feet to bedrock was used. For the case where depth to bedrock ranged from 0 to 5-feet, it was assumed that the entire excavation was bedrock. The portions of the alignment in bedrock are assumed to require drilling and blasting of rock before excavation, resulting in additional cost.

Excavated soil was assumed to be appropriate for backfill. Disposal of excess soil and rock was not included in the cost because it was assumed that it could be disposed on site. However, import for additional backfill required was included.

9.3 Pipeline Crossings

Several crossings of waterways and roadways were addressed specifically in this preliminary cost analysis, since these crossings could be potentially large cost items. The crossings considered include:

- Crossing of SR 240;
- Crossing of I-182;
- Yakima River Crossing at Songbird Island; and,
- 4 Crossings of the Sunnyside Canal.

Costs for each of these crossings were considered individually, based on site conditions and method of crossing. The costs for crossing roadways and the canals were assumed to be bored tunnel crossings. Individual crossing lengths were considered, as well as percentage of soil and rock for each crossing (based on geology data). The Yakima River Crossing cost was calculated based on an assumed crossing at Songbird Island. Dewatering and excavation costs were calculated for a total crossing cost. Costs for crossing other roads, secondary highways and small streams were assumed to be part of the costs for the running pipelines.

9.4 Unit Costs and Cost Trend Index

Unit costs were developed using both data from Reclamation's Black Rock Study reports and the RS Means Guide for Heavy Construction Cost Data, 2005. These unit costs include material, labor and equipment. After the total cost for each line item of construction was developed, Reclamation's Construction Cost Trends indexes were applied to estimate 2004 construction costs. Generally, the index ranged between 89%-94% to develop 2004 costs from 2005 costs.

9.5 Additional Project Costs and Contingency

Additional project cost elements such as mobilization, and other unlisted items were applied to the total capital cost. Additionally, a standard preliminary level contingency of 25% was included on the total cost. Contingencies reflect additional costs incurred during construction resulting from changed site conditions, changed work orders, and other unseen items. Generally, the higher the level of design, the lower the contingency applied.

9.6 Pump Station Costs

Preliminary pump equipment costs were obtained from quotes provided by Hitachi, Johnston, and Ebara. All costs were adjusted to April 2004 using cost adjustment factors from the Construction Cost Trends. This was done to compare these costs to those of the Black Rock and Wymer

alternatives evaluated in the Yakima River Basin Storage Alternatives Appraisal Assessment (U.S. Department of Interior, May 2006).

9.7 Delivery Facility Costs

Estimates for mobilization, site work, steel pipe quantities, reinforced concrete for stilling basin, concrete for canal lining and related costs including mobilization and other unlisted costs were prepared for the delivery facilities under each delivery plan.

Table 17 below, provides a cost summary for each of the primary cost components. The subtotal capital cost includes the material and labor costs to complete the project. The subtotal project cost includes the additional costs such as mobilization, contractor overhead and taxes. The total project cost reflects the estimated project cost after the contingency was applied.

TABLE 17

Appraisal-Level Project Costs -(July 2004)

Feature	Plan 1 Delivery 50-cfs – Sunnyside MP 59.29 750-cfs – Sunnyside MP 2.35 400-cfs – Sunnyside MP 37.0	Plan 2 Delivery 50-cfs – Sunnyside MP 59.29 200-cfs – Sunnyside MP 30.0 400-cfs – Sunnyside MP 37.0 550-cfs – Roza Canal MP 59.0
Intake Structure	\$15,200,000	\$15,200,000
Pump Station #1	\$86,800,000	\$86,800,000
Pump Station #2	\$98,300,000	\$98,300,000
Pump Station #3	\$41,700,000	\$43,900,000
Delivery Facilities	\$360,000	\$350,000
Pipelines	\$1,156,500,000	\$1,022,800,000
Subtotal of Pay Items	\$1,398,860,000	\$1,267,350,000
Total Mobilization Cost (5%)	\$69,943,000	\$63,367,500
Subtotal with Mobilization	\$1,468,803,000	\$1,330,717,500
Total Unlisted Items (15%)	\$220,320,450	\$199,607,625
Construction Contract Cost	\$1,689,123,450	\$1,530,325,125
Total Contingencies (25%)	\$422,281,000	\$382,581,000
Total Field Cost	\$2,111,404,000	\$1,912,906,000
Non-Contract Costs (35%)	\$738,991,400	\$669,517,100
Total Project Cost	\$2,850,395,400	\$2,582,423,100
Note: Costs exclude land acquisition, relocation, and rights-of-ways. Operation, maintenance and replacement costs are presented separately.		

10.0 OPERATION, MAINTENANCE AND REPLACEMENT COSTS

The operation, maintenance and replacement costs consist of electricity costs for running the pumps, staffing costs for operating the facilities, costs for major maintenance and routine replacement of facility components.

10.1 Electricity Costs

Electricity costs are based on the energy required to pump the water at all three pump stations, plus the energy needed for station service needs. The pumped flow was determined from a schedule of deliveries derived for the proposed project to the Sunnyside and Roza Canals (Reclamation, Sonnichsen, pers. communication). The needs were calculated from historic daily data of canal diversions from 1980 through 2003. These values were averaged for each month. The head loss and pumping head were calculated using these average flows. The pumps were assumed to have a water-to-wire efficiency of 80%. The deliveries from Pump Station #3 would be by gravity and pump. It was assumed that the deliveries by pump would be up to the pump capacity. The flows above this were assumed to be delivered by gravity. This provides a conservative estimate of the power requirements. Table 18 shows the electricity cost, energy requirements, and total electric cost by month. Table 19 shows the average MW-HRS of energy required and the cost of power at each pump station on an annual basis.

TABLE 18

Average Energy Use and Costs by Month

		Plan 1		Plan 2	
Month	Energy Cost (\$)	Energy Use (MW-HRS)	Energy Cost (\$)	Energy Use (MW-HRS)	Energy Cost (\$)
March	\$ 42.14	14,800	\$624,000	14,800	\$624,000
April	\$ 37.60	59,700	\$2,245,000	57,900	\$2,177,000
May	\$ 31.92	80,900	\$2,582,000	81,300	\$2,595,000
June	\$ 22.68	78,600	\$1,783,000	79,700	\$1,808,000
July	\$ 32.24	81,100	\$2,615,000	82,200	\$2,650,000
August	\$ 40.69	81,100	\$3,300,000	82,100	\$3,341,000
September	\$ 43.64	72,600	\$3,168,000	71,600	\$3,125,000
October	\$ 55.56	30,700	\$1,706,000	28,700	\$1,595,000
Total		499,500	\$18,023,000	498,300	\$17,915,000

TABLE 19

Annual Energy Requirements and Costs

	Plan 1		Plan 2	
	Energy Requirement (MW-HRS)	Cost	Energy Requirement (MW-HRS)	Cost
Pump Station # 1	307,900	\$ 11,118,000	307,900	\$ 11,118,000
Pump Station # 2	151,900	\$ 5,444,000	151,900	\$ 5,444,000
Pump Station # 3	39,700	\$ 1,461,000	38,500	\$ 1,353,000
Totals	499,500	\$ 18,023,000	498,300	\$ 17,915,000

10.2 Staff Costs

It has been assumed that operations staff could perform basic maintenance, such as minor painting, facility cleaning, lubrication, etc. The operations costs are calculated in terms of full-time-equivalent (FTE) units of labor and incidental purchases such as lubricating oil, filters, cleaning supplies, etc. It has been assumed that 15 FTE's are required for the project, a project superintendent, administrator, five operators at the main control room, and eight additional personnel for the pipeline, intake, and other pump stations. The average annual cost of each employee was assumed to be \$100,000. This includes salary, vacation, holidays, and benefits. Minor purchases for such things as small tools, lubricants, and small parts, are set at \$50,000 per year.

10.3 Maintenance and Replacement Costs

A maintenance and replacement sinking fund has been assumed for the major maintenance and routine replacement items. It has been assumed to be 2.5% of the construction cost per year for the pump station and intakes and 0.25% of construction cost for the pipeline.

The total operation, maintenance and replacement costs are shown in Table 20 below.

TABLE 20

Annual Operation, Maintenance and Replacement Costs

	Plan 1	Plan 2
Energy Costs	\$ 18,023,000	\$ 17,915,000
Operation Costs	\$ 1,550,000	\$ 1,550,000
Maintenance and Replacement	\$ 13,456,000	\$ 13,032,000
Totals	\$ 33,029,000	\$ 32,497,000

11.0 RECOMMENDED FURTHER STUDY

In the short time allotted for this study many assumptions were made to expedite the work. Several ideas were generated but could not be pursued. If the pump exchange alternative is to be studied further, we recommend that the following ideas be considered.

11.1 Sunnyside Canal Improvements

Water could possibly be diverted from the supply pipes to the Sunnyside Canal further upstream (to the east). This would reduce the size of the pipes, reducing the project cost. However, improvements would have to be made to the Sunnyside Canal system to accomplish this.

11.2 Energy Recovery

An energy recovery station could be built south of Pump Station # 3 near the Sunnyside Canal. Energy recovery could be about 2.2 MW, with an available head of about 90-feet and a flow of 400-cfs.

11.3 Eliminate Overflow Reservoirs

The overflow reservoirs were included in the present design to reduce the number of overflows out of the pump station to the river. If it could be determined that the number of unscheduled outages at Pump Stations #2 and #3 would be low, the overflow reservoirs could be reduced or eliminated. In addition, the wet well could be expanded so that the volume above the normal operating water surface and below the overflow could be increased so that the number of overflow events could be reduced. This would make this alternative more attractive.

11.4 Locate Pipeline alignment from Pump Station #2 to lower elevation

The present assumption for the pipeline alignment from Pump Station #2 to Pump Station #3 would pass through elevation 940-feet. If the alignment could be relocated to a lower elevation of for example 900-feet and follow the route of Sunnyside Canal south of the pump station, the pump total design head could be lower and energy could also be lower.

11.5 Investigate Gravity Delivery of Pumped Flows from Pump Station #3 in Plan 1

In Plan 1, the pumped flow of 750-cfs from Pump Station #3 would be delivered to the Sunnyside Canal at MP 2.35. This point is at an elevation that is approximately 55 feet lower than proposed Pump Station #3. It might be possible to deliver the 750-cfs from Pump Station #3 without pumping if a larger pipe were used. This would eliminate Pump Station #3 for a considerable cost savings.

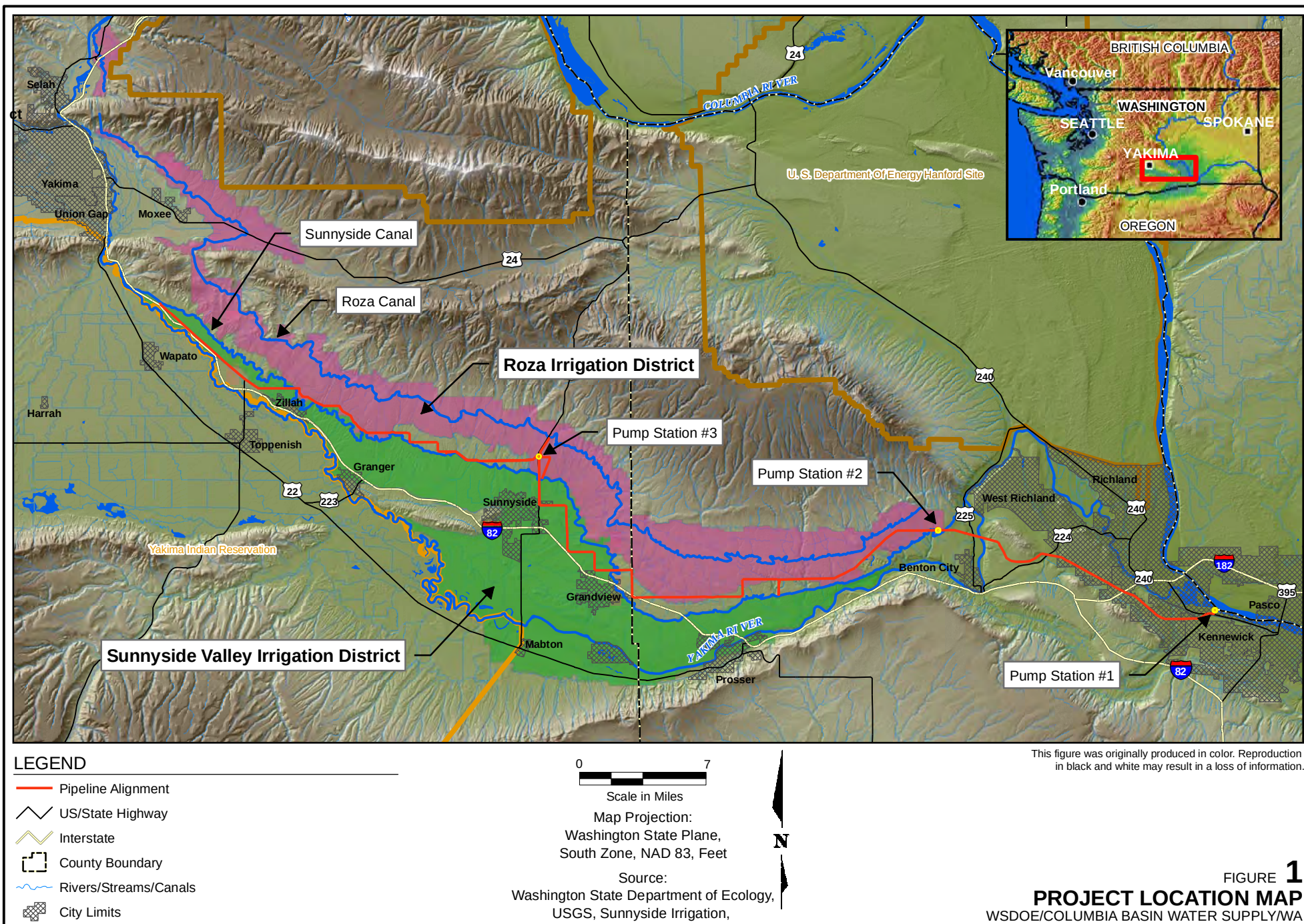
11.6 Optimize Pipeline Routing

Opportunities could exist to optimize the pipeline routing through urban areas by having twin pipes follow separate routes to decrease the total required working width where easements are restricted. Opportunities could also exist to straighten and shorten the pipe by traversing diagonally across cultivated land instead of following existing road alignments.

12.0 REFERENCES

- U.S. Department of Interior, Bureau of Reclamation, *Hydraulic Design of Stilling Basins and Energy Dissipators*, Engineering Monograph No. 25, A.J. Peterka, Denver, Colorado, 1974
- U.S. Department of Interior, Bureau of Reclamation, *Kennewick Irrigation District and Columbia Irrigation District Pump Exchange Feasibility Study, Intake Screens and Manifolds, Partial Exchange concept Design Report, Yakima River Basin Water Enhancement Project*, Upper Columbia Area Office, Yakima Project – Washington, October 19, 2004
- U.S. Department of Interior, Bureau of Reclamation, *Appraisal Assessment of the Black Rock Alternative Delivery System for Sunnyside Division, A Component of Yakima River Basin Water Storage Feasibility Study*, Washington, Pacific Northwest Region Office, December, 2004, Technical Series TSS-YSS-4
- U.S. Department of Interior, Bureau of Reclamation, *Yakima River Basin Storage Alternatives Appraisal Assessment, A Component of Yakima River Basin Water Storage Feasibility Study*, Washington, Technical Series No. TS-YSS-8, Pacific Northwest Region, May, 2006
- U.S. Department of Interior, Bureau of Reclamation, *Personal Communication with Roger Sonnichsen*, August, 2006.

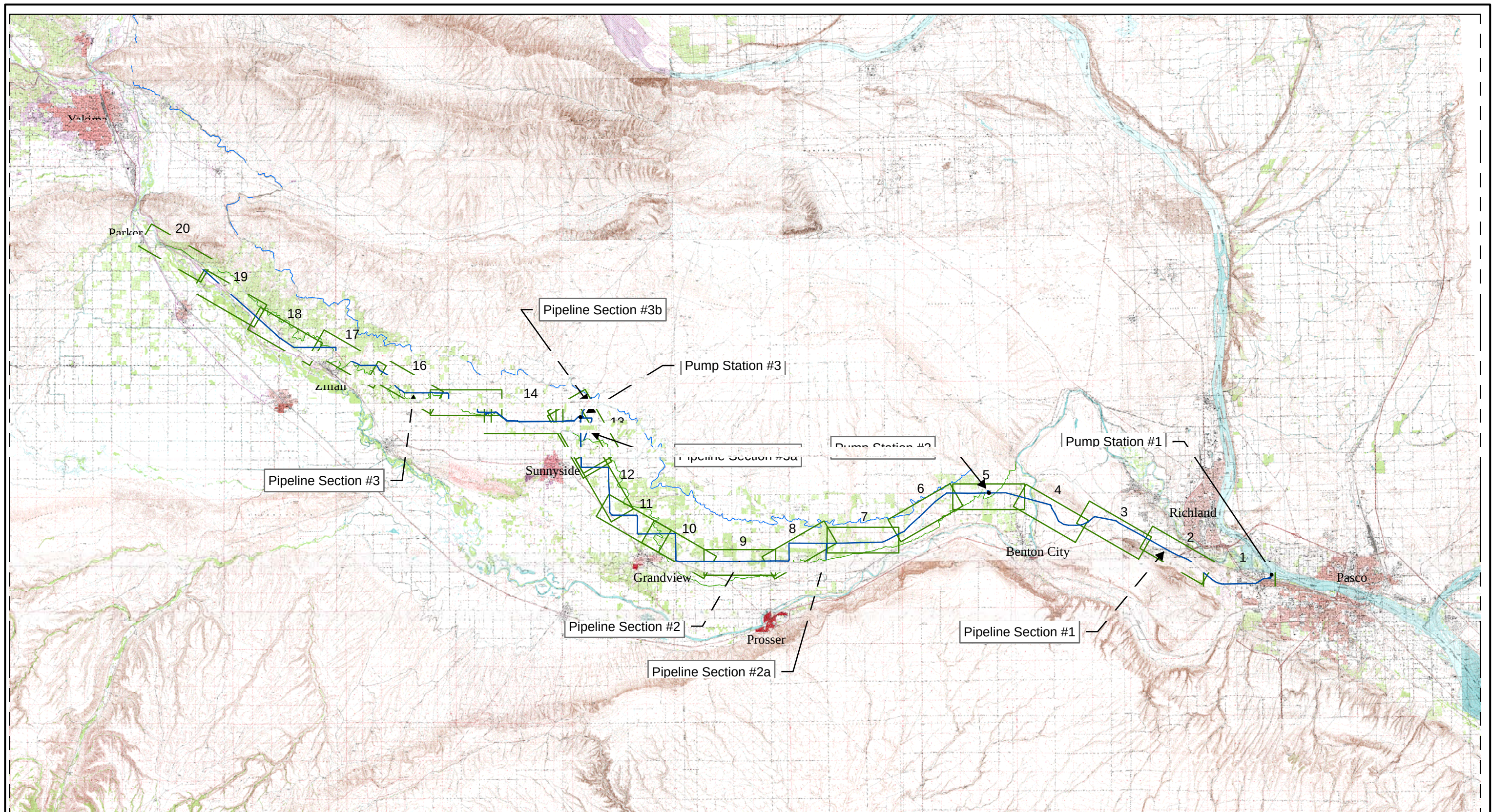
FIGURES



0131500007006F07R01.mxd | MOD: 10/11/2006 | KBD

FIGURE 1
PROJECT LOCATION MAP
 WSDOE/COLUMBIA BASIN WATER SUPPLY/WA

Golder Associates



LEGEND

- Proposed Pipeline
- Pipeline Segment
- Sunnyside Canal
- Roza Canal



Map Projection:
Washington State Plane,
South Zone, NAD 83, Feet

Source: WSDOT, WSDNR, ESRI, USGS



This figure was originally produced in color. Reproduction in black and white may result in a loss of information.

FIGURE 2

PIPELINE OVERVIEW MAP
WSDOE/COLUMBIA BASIN WATER SUPPLY/WA

Golder Associates

NOTE: VERTICAL EXAGGERATION = 15

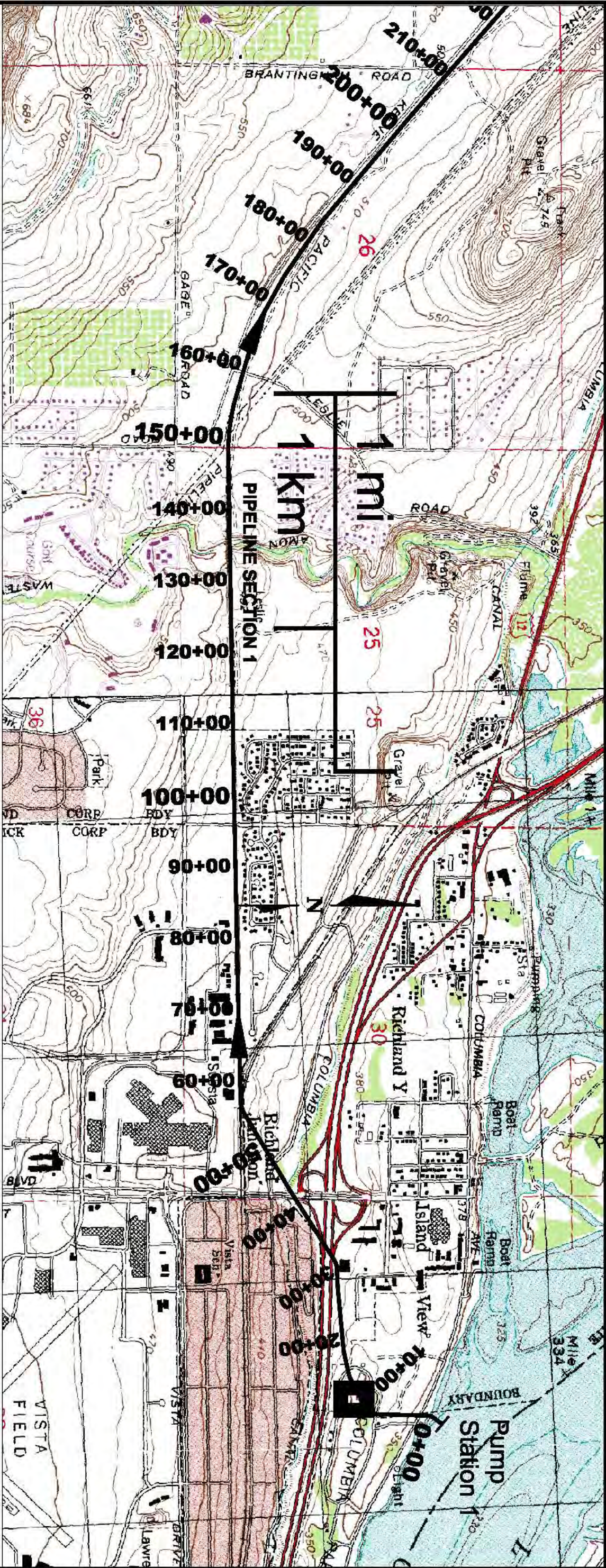
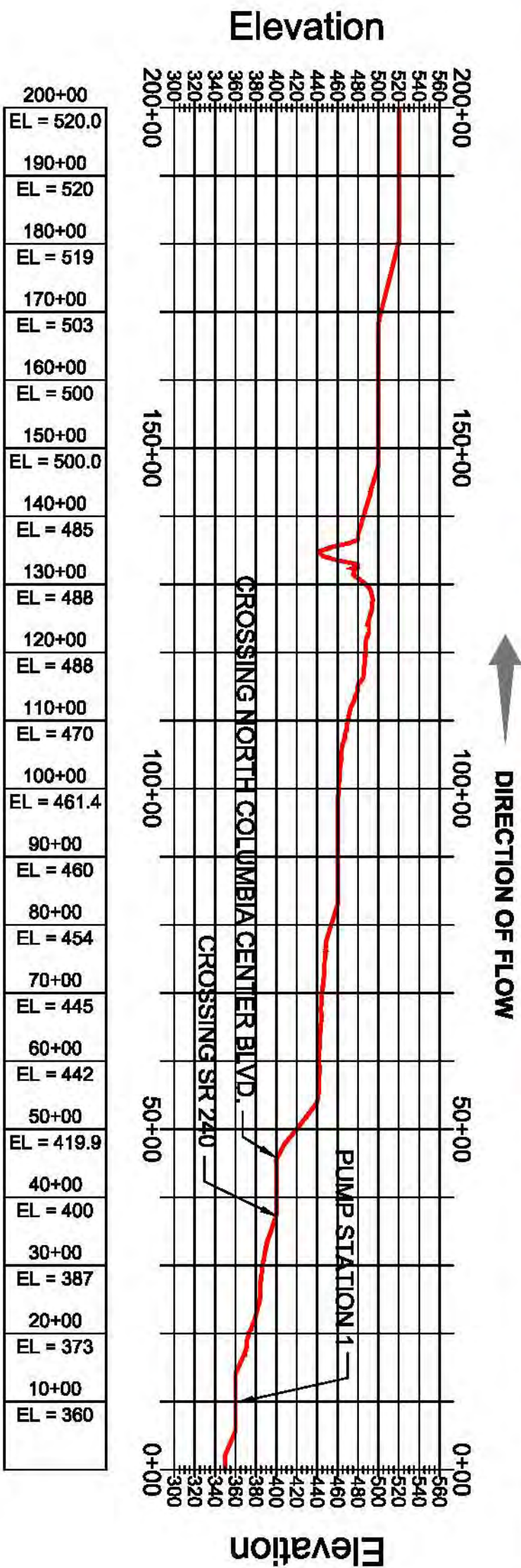


FIG 3

FILE NO.	PLAN 1
REV. 2	SCALE 1"=1500'
DESIGN	08/05/06
CADD	08/05/06
CHECK	10/05/06
REVIEW	10/05/06

TITLE

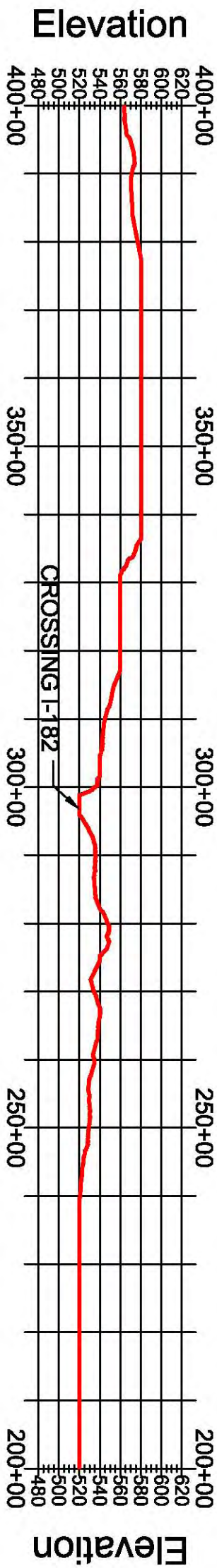
PRELIMINARY PIPE ALIGNMENT
PLANS 1 & 2 - SEGMENT 2

PROJECT

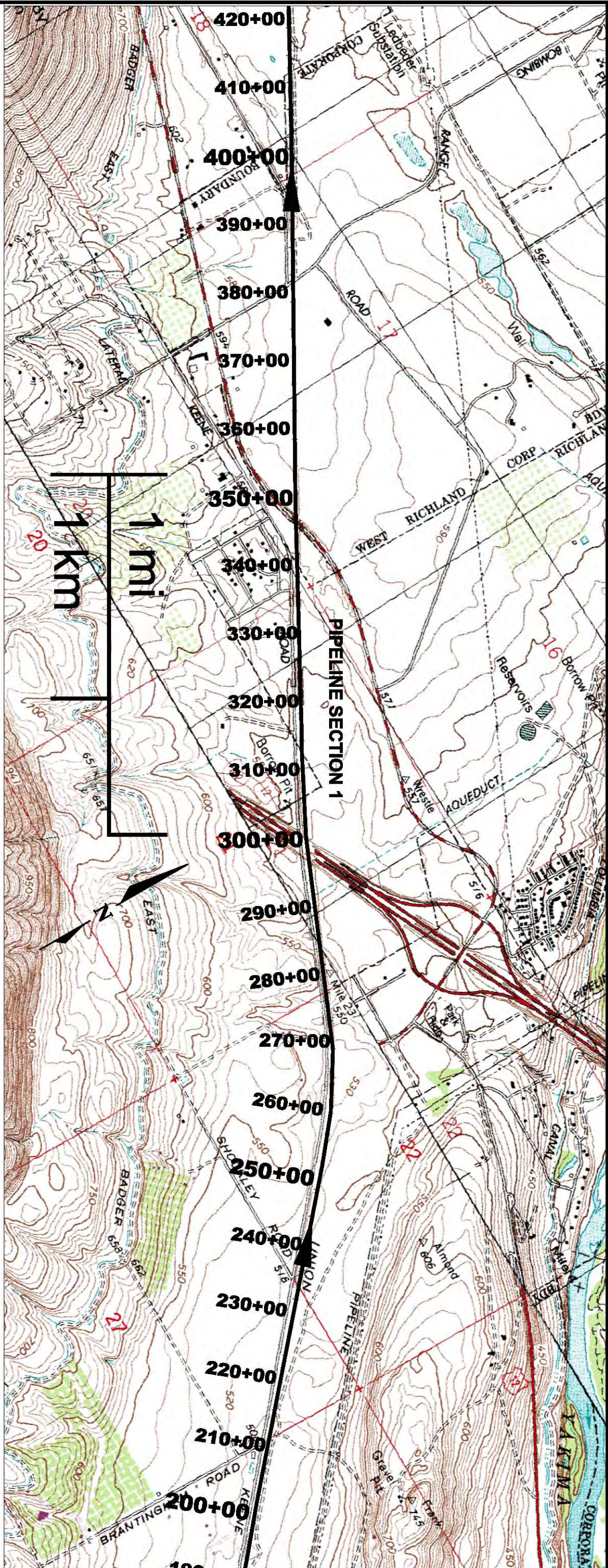
WSDOE/YAKIMA PUMP EXCHANGE/WA
PROJECT# 013-1500007
WASHINGTON DEPT OF ECOLOGY
US BUREAU OF RECLAMATION



GOLDER ASSOCIATES INC.
18300 NE UNION HILL ROAD, SUITE 200
REDMOND, WA USA 98052-3333
TEL: (425) 883-0777
FAX: (425) 882-6498

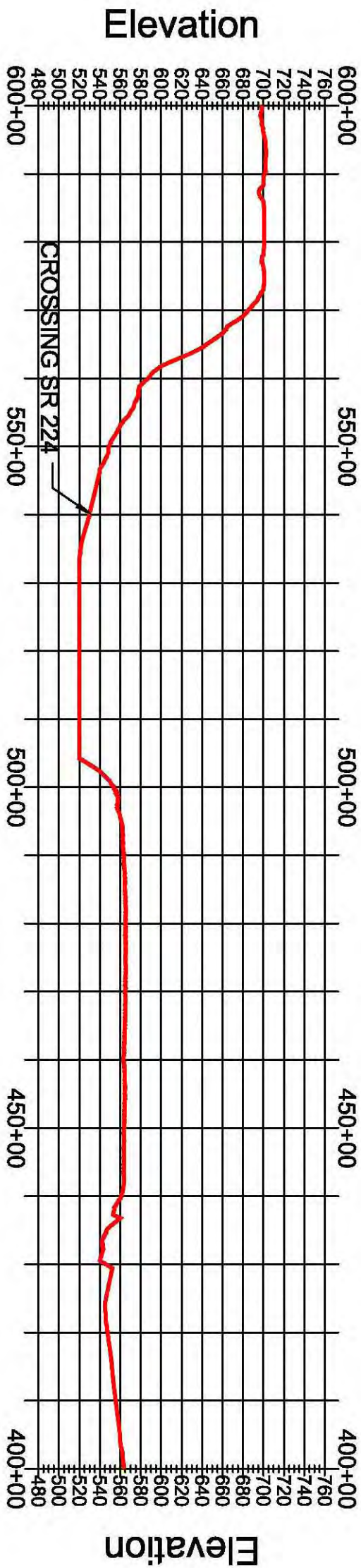


NOTE: VERTICAL EXAGGERATION = 15



NOTE: VERTICAL EXAGGERATION = 15

590+00
EL = 701
580+00
EL = 701
570+00
EL = 685
560+00
EL = 587
550+00
EL = 549.0
540+00
EL = 530
530+00
EL = 520
520+00
EL = 520
510+00
EL = 520
500+00
EL = 553.3
490+00
EL = 563
480+00
EL = 565
470+00
EL = 565
460+00
EL = 563
450+00
EL = 563.6
440+00
EL = 561
430+00
EL = 546
420+00
EL = 548
410+00
EL = 555



DIRECTION OF FLOW

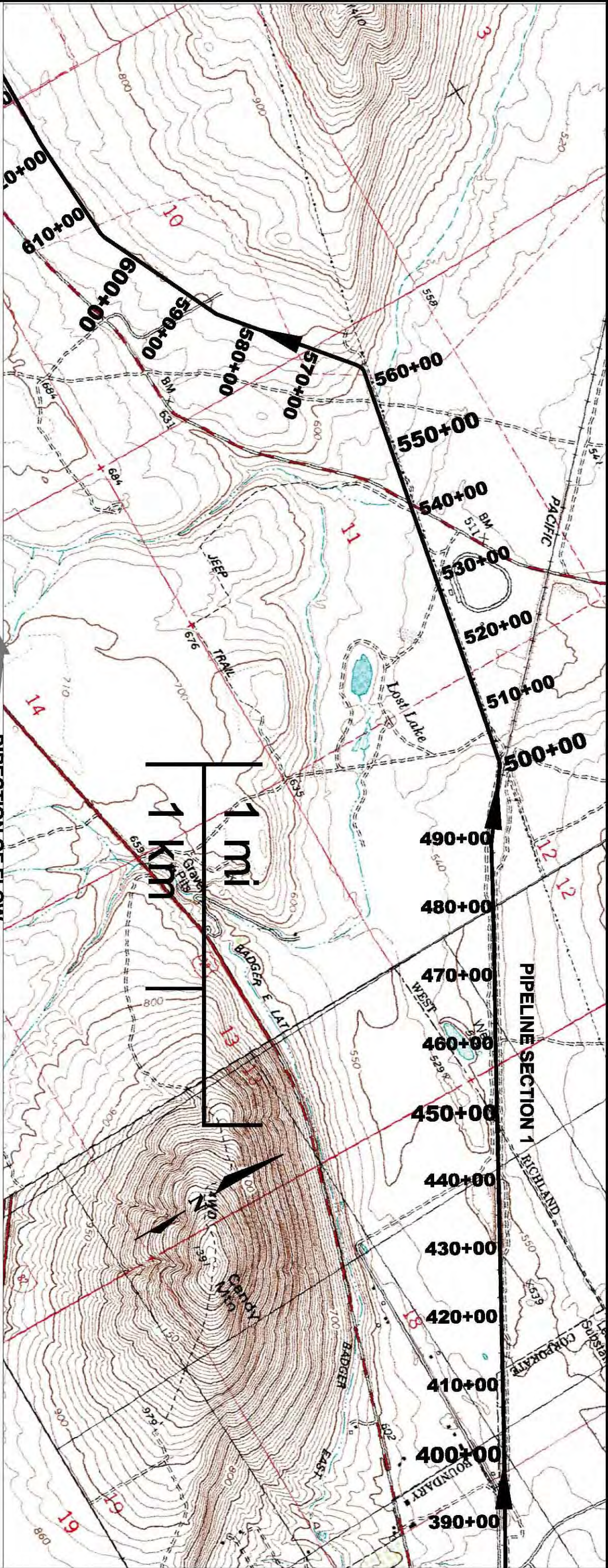


FIG 5

FILE No.	PLAN 1
REV. 2	SCALE 1"=1500'
DESIGN	OTH 09/05/06
CADD	OTH 08/05/06
CHECK	AHR 10/05/06
REVIEW	AHR 10/05/06

TITLE

PRELIMINARY PIPE ALIGNMENT
PLANS 1 & 2 - SEGMENT 3

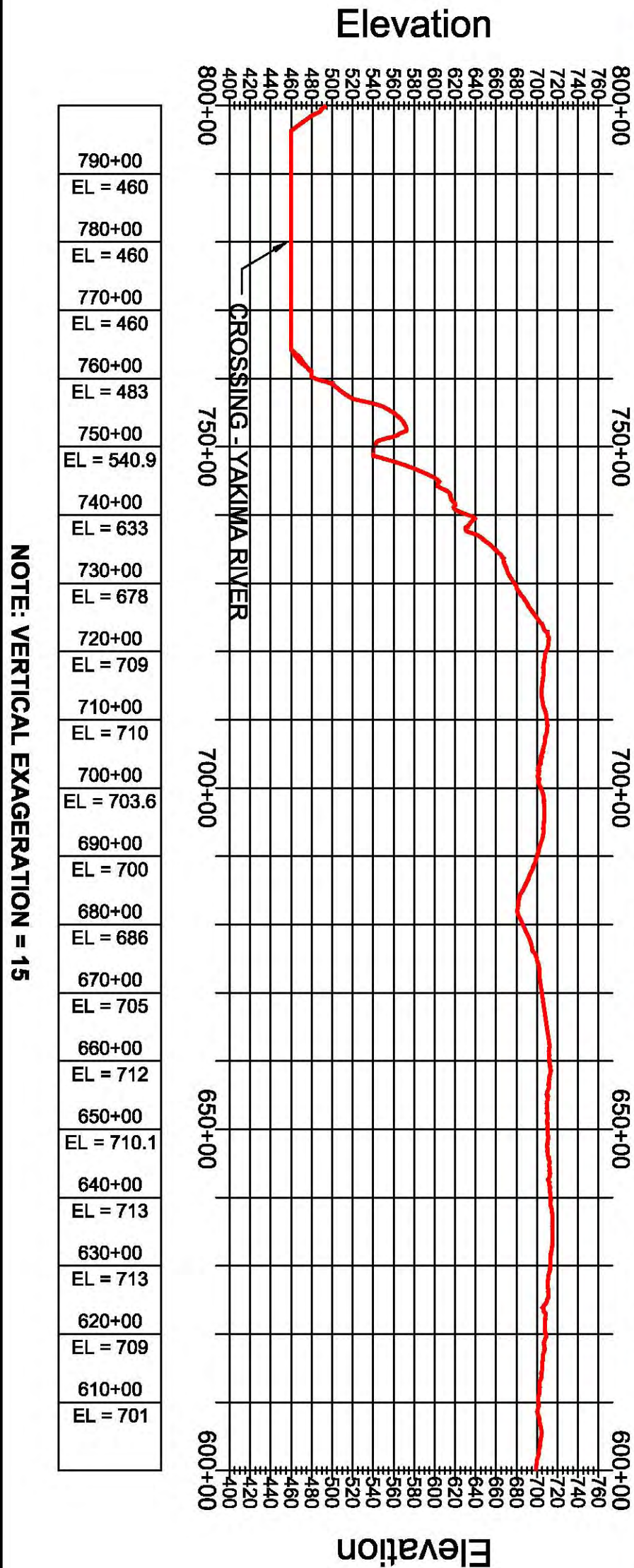
PROJECT

WSDOE/YAKIMA PUMP EXCHANGE//WA
PROJECT# 013-1500007
WASHINGTON DEPT OF ECOLOGY
US BUREAU OF RECLAMATION



Golder Associates

GOLDER ASSOCIATES INC.
18300 NE UNION HILL ROAD, SUITE 200
REDMOND, WA USA 98052-3333
TEL: (425) 883-0777
FAX: (425) 882-5498



NOTE: VERTICAL EXAGGERATION = 15

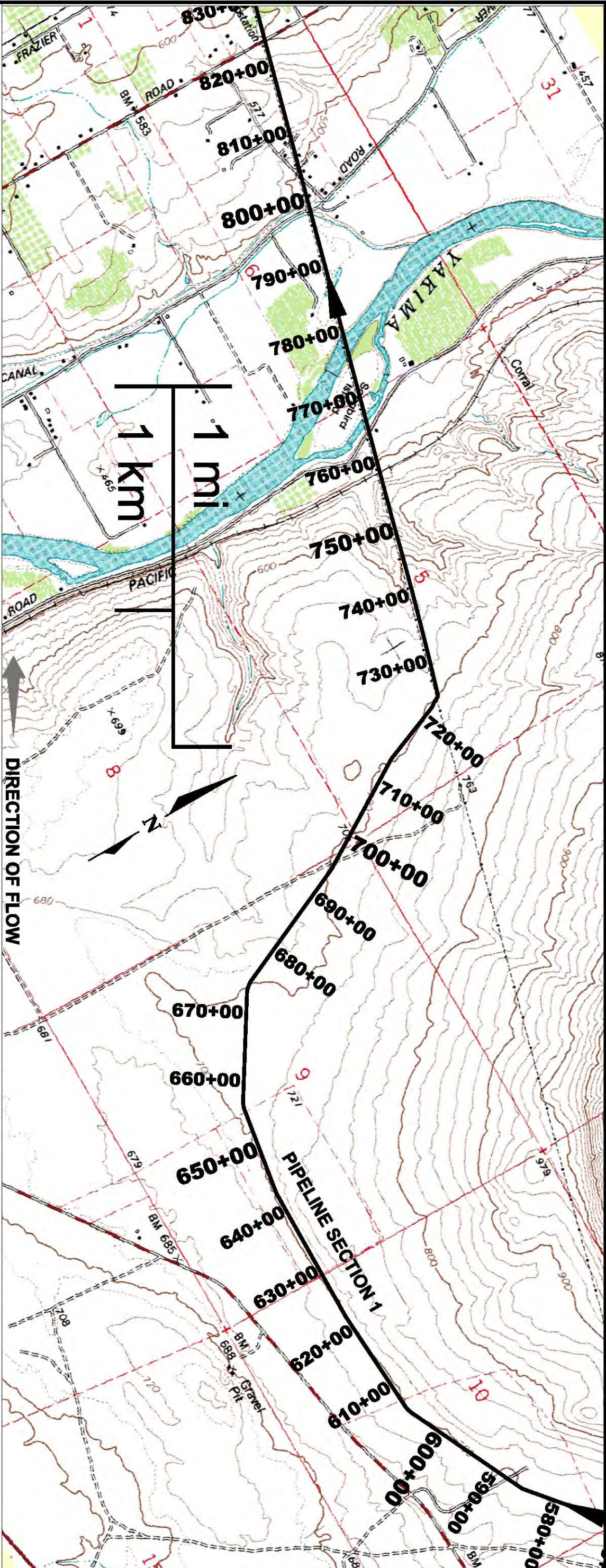


FIG 6

TITLE			
PRELIMINARY PIPE ALIGNMENT PLANS 1 & 2 - SEGMENT 4			
PROJECT: 013-1500007A			
FILE No. PLAN 1			
REV. 2 SCALE 1"=1500'			
DESIGN	OTH	08/05/06	08/05/06
CADD	OTH	08/05/06	08/05/06
CHECK	AHR	10/05/06	10/05/06
REVIEW	AHR	10/05/06	10/05/06

PROJECT
WSDOE/YAKIMA PUMP EXCHANGE/WA
PROJECT# 013-1500007
WASHINGTON DEPT OF ECOLOGY
US BUREAU OF RECLAMATION

 **Golder Associates**
GOLDER ASSOCIATES INC.
18300 NE UNION HILL ROAD, SUITE 200
REDMOND, WA USA 98062-3333
TEL: (425) 883-0777
FAX: (425) 882-5498

NOTE: VERTICAL EXAGGERATION = 15

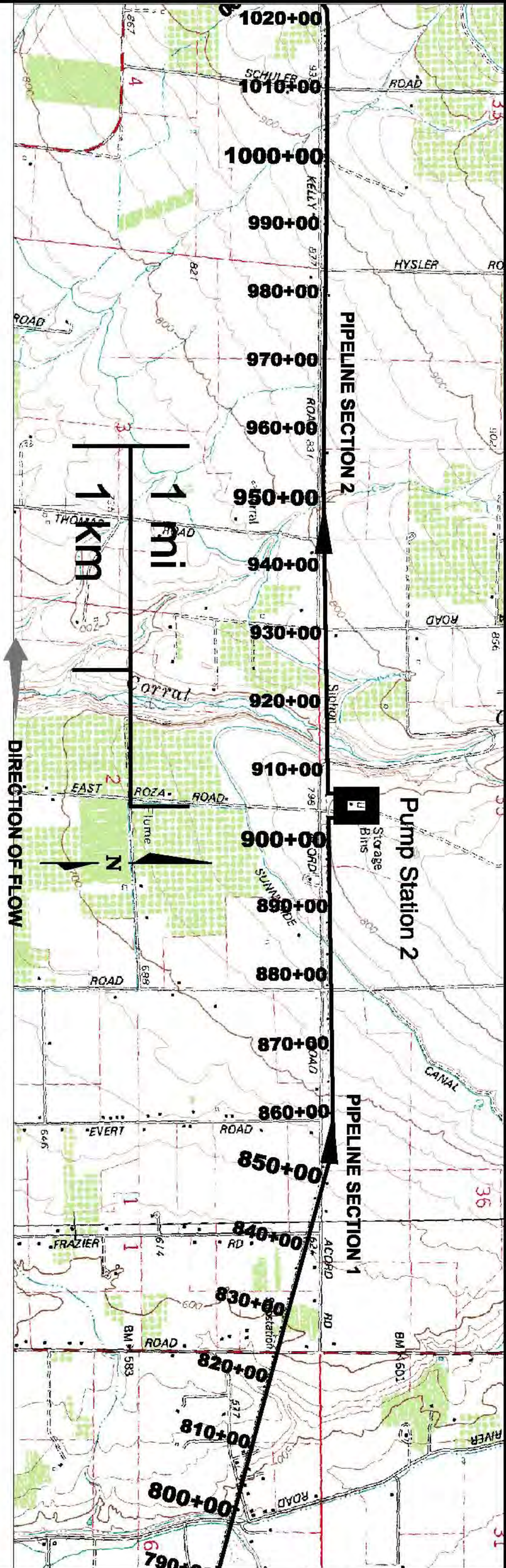
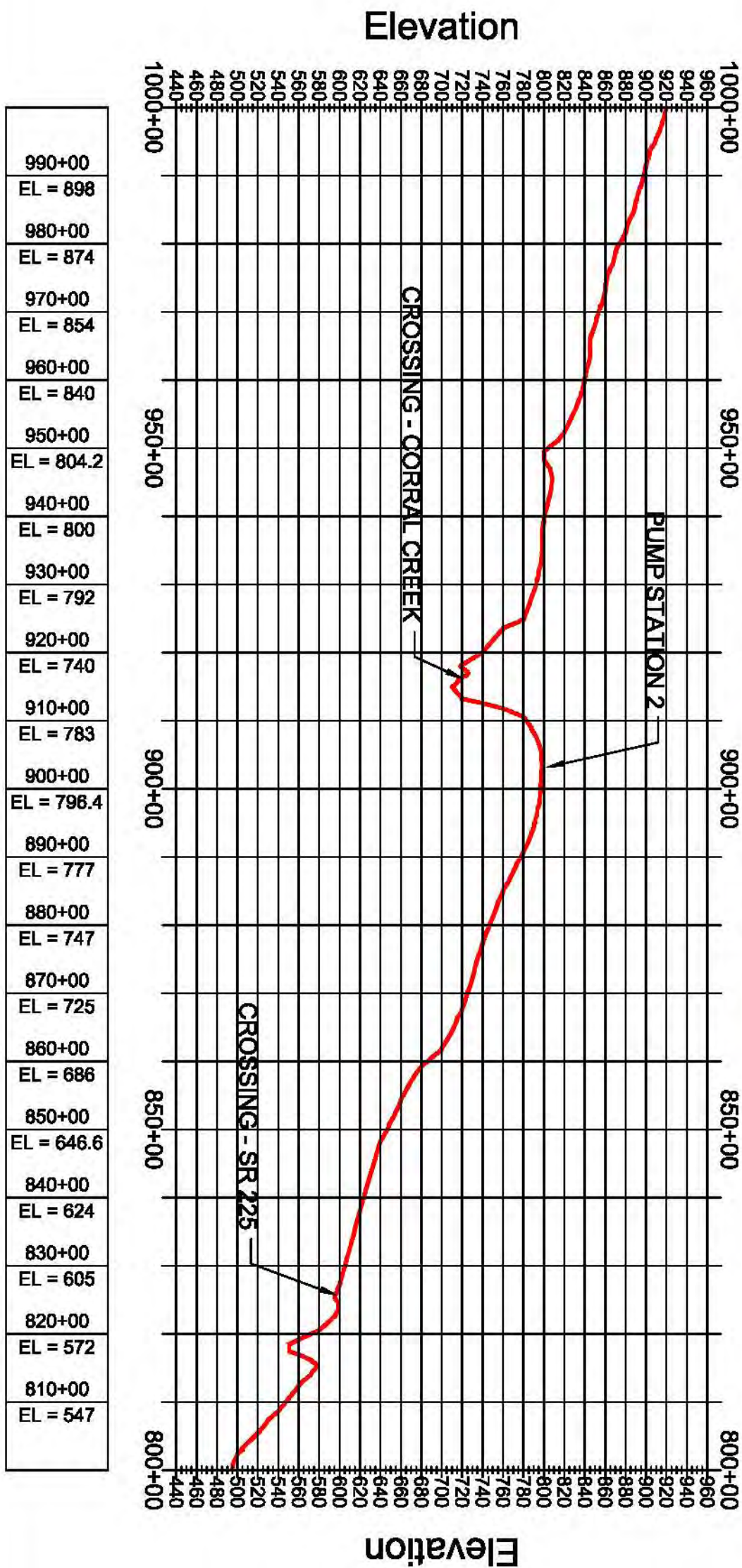


FIG 7

PROJECT: 013-1500007A	FILE NO.	PLAN 1
REV. 2	SCALE 1"=1500'	
DESIGN	OTH	09/05/06
CADD	OTH	09/05/06
CHECK	AHR	10/05/06
REVIEW	AHR	10/05/06

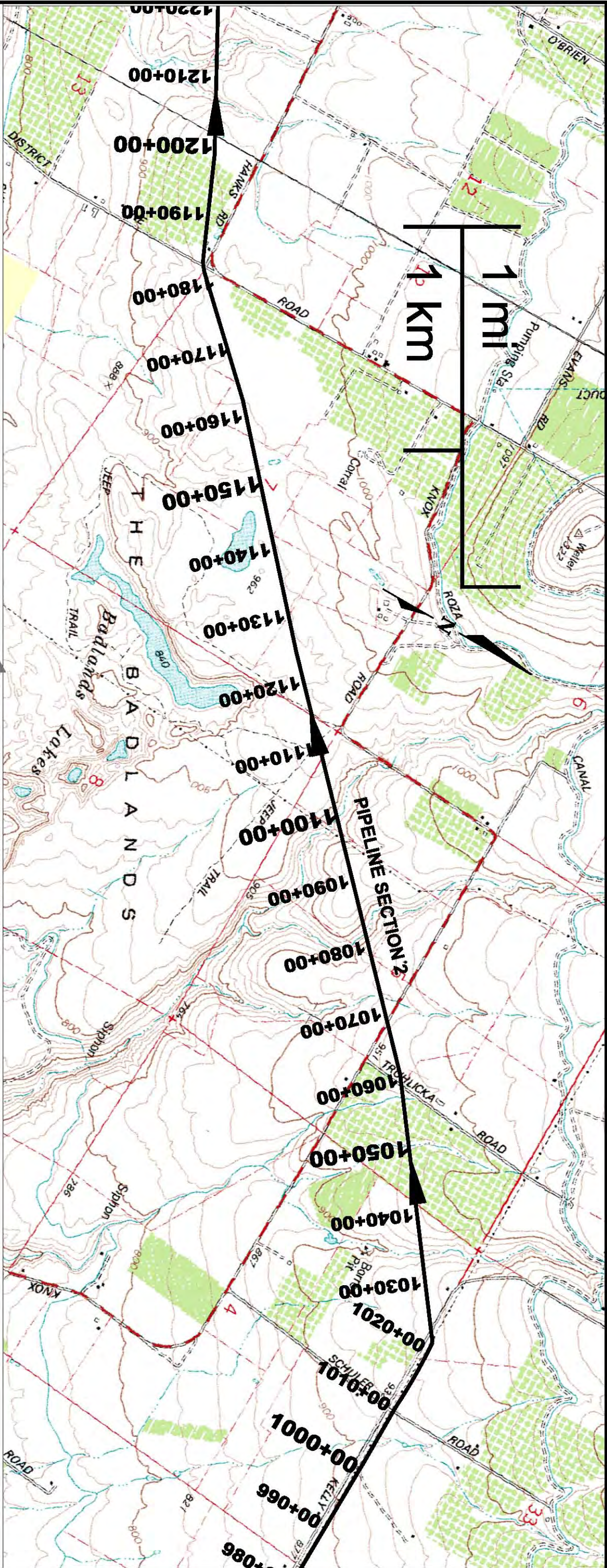
PRELIMINARY PIPE ALIGNMENT
PLANS 1 & 2 - SEGMENT 5

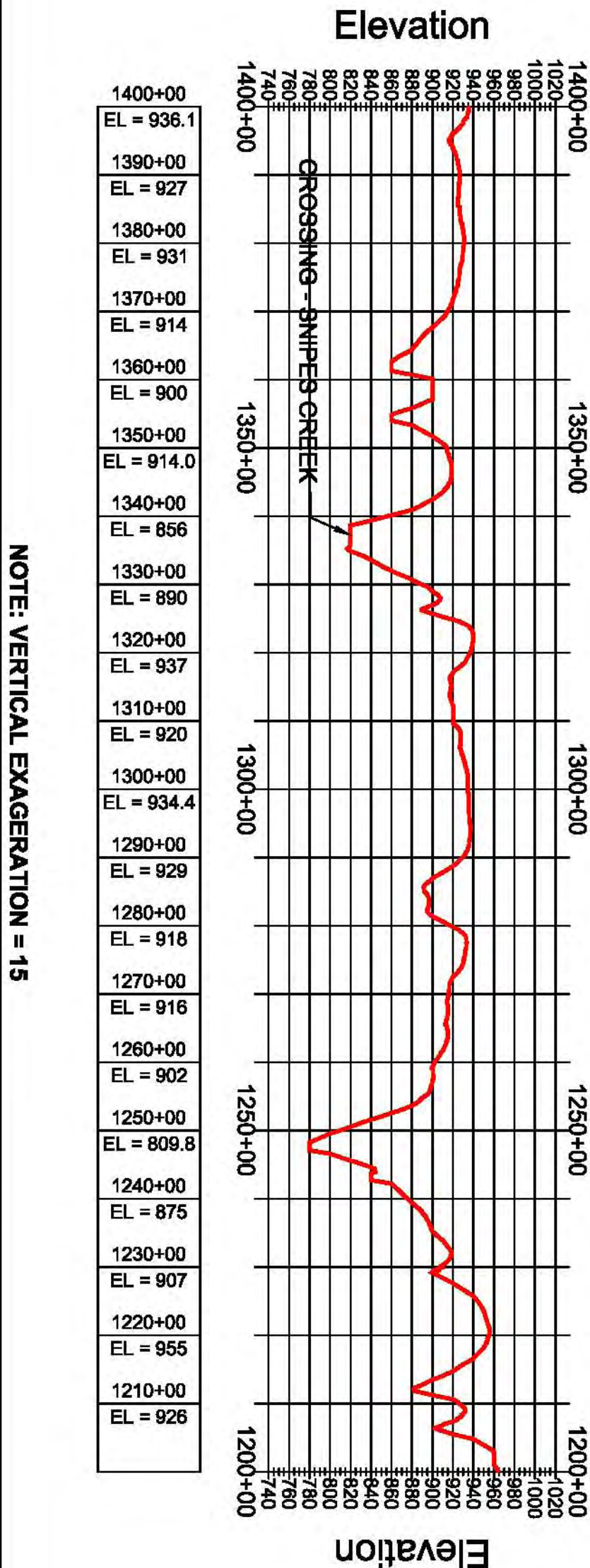
PROJECT

WSDOE/YAKIMA PUMP EXCHANGE/WA
PROJECT# 013-1500007
WASHINGTON DEPT OF ECOLOGY
US BUREAU OF RECLAMATION

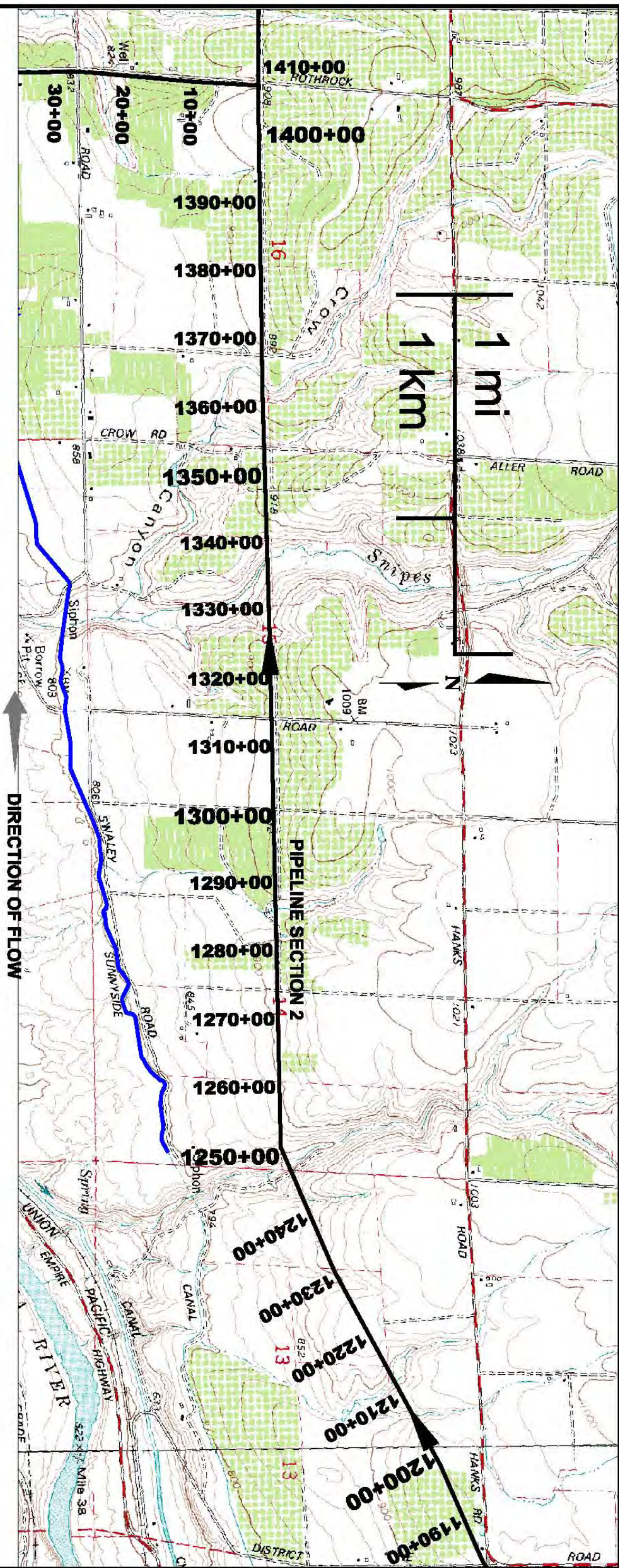
Golder Associates

GOLDER ASSOCIATES INC.
18300 NE UNION HILL ROAD, SUITE 200
REDMOND, WA USA 98052-3333
TEL: (425) 883-0777
FAX: (425) 882-6496





NOTE: VERTICAL EXAGGERATION = 15



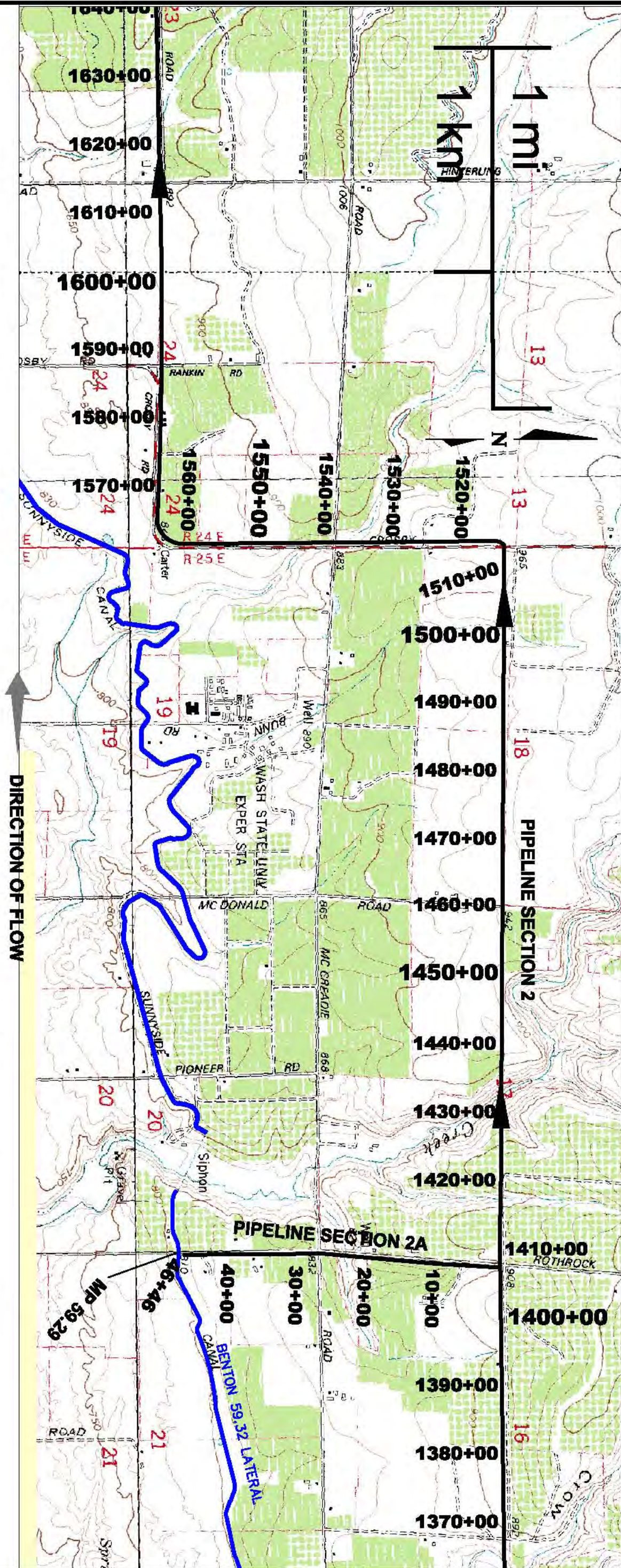


FIG 10

PROJECT: 013-1500007A	
FILE NO.	PLAN 1
REV. 2	SCALE 1"=1500'
DESIGN	OTH 09/05/06
CADD	OTH 09/05/06
CHECK	AHR 10/05/06
REVIEW	AHR 10/05/06

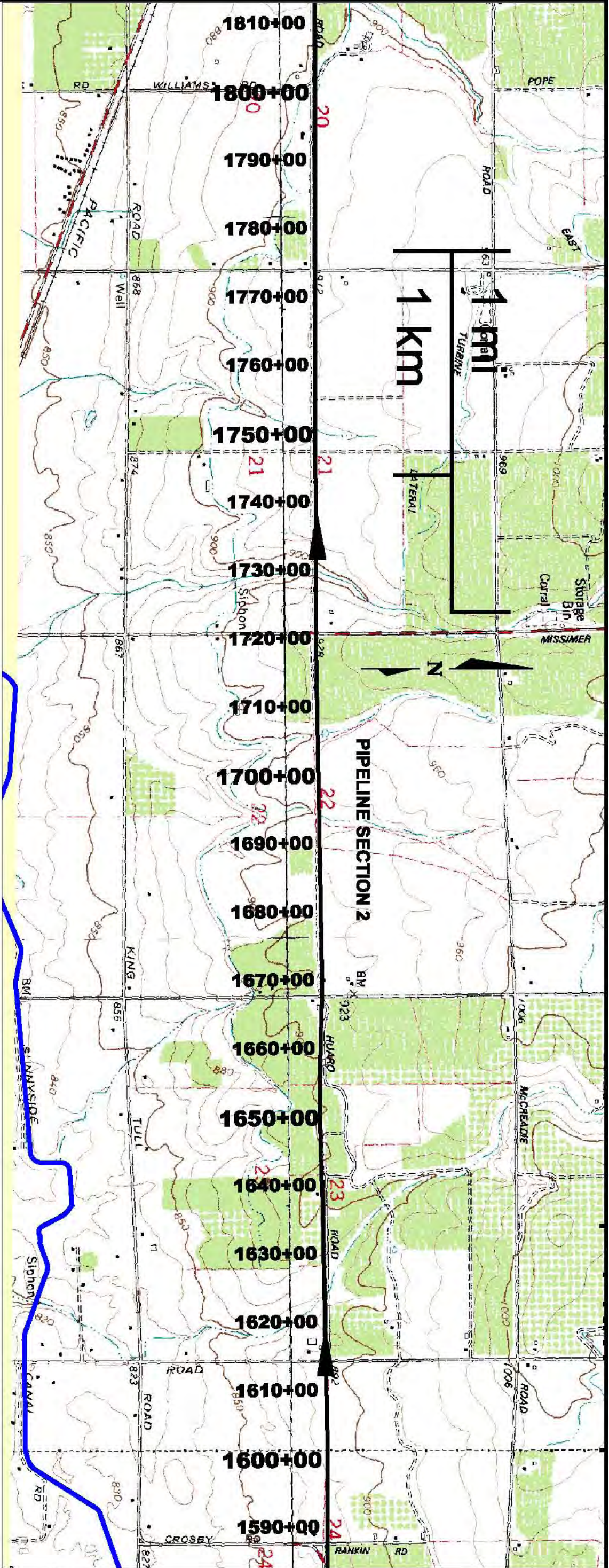
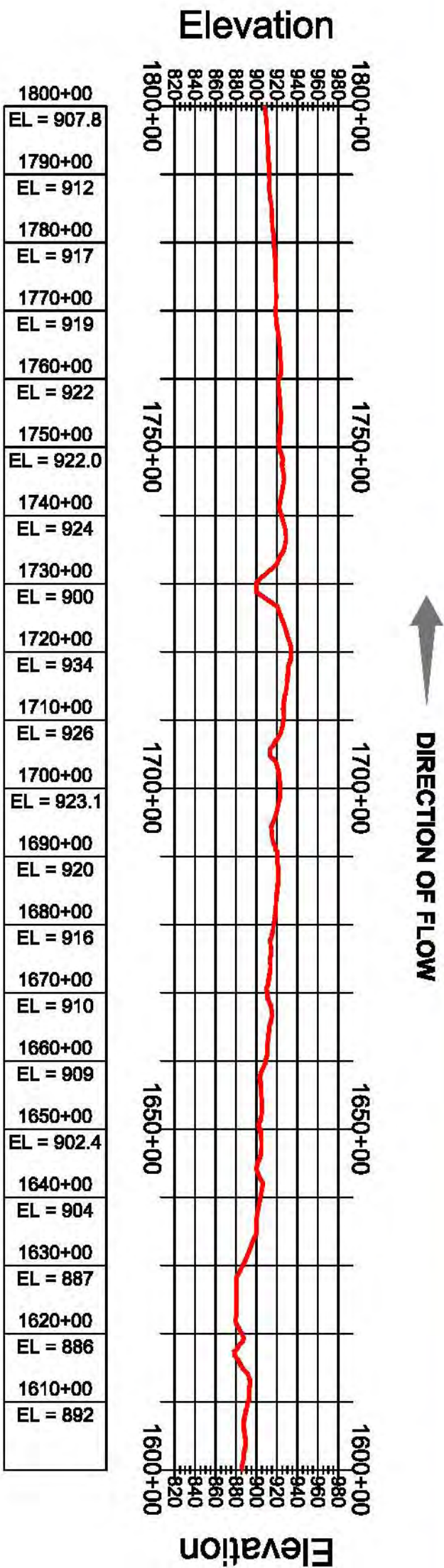
PRELIMINARY PIPE ALIGNMENT PLANS 1 & 2 - SEGMENT 8

PROJECT

WSDOE/YAKIMA PUMP EXCHANGE//WA
PROJECT# 013-1500007
WASHINGTON DEPT OF ECOLOGY
US BUREAU OF RECLAMATION



NOTE: VERTICAL EXAGGERATION = 15



NOTE: VERTICAL EXAGGERATION = 15

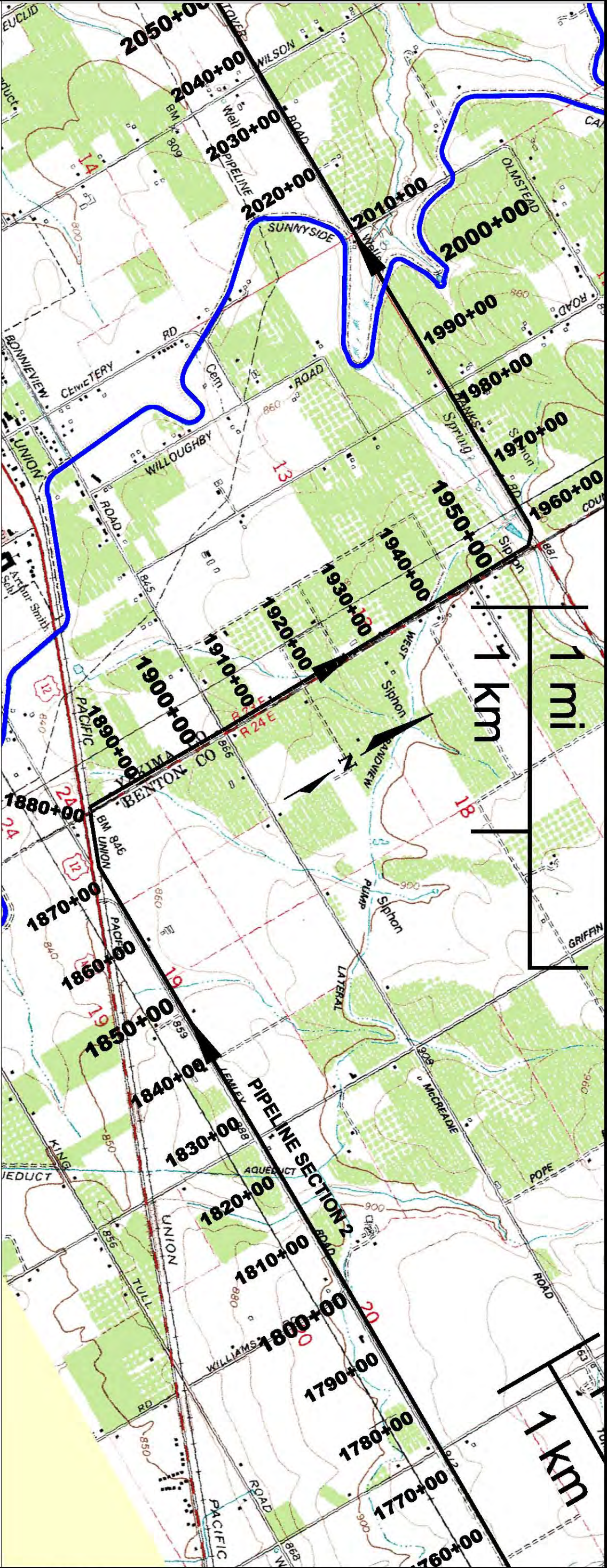
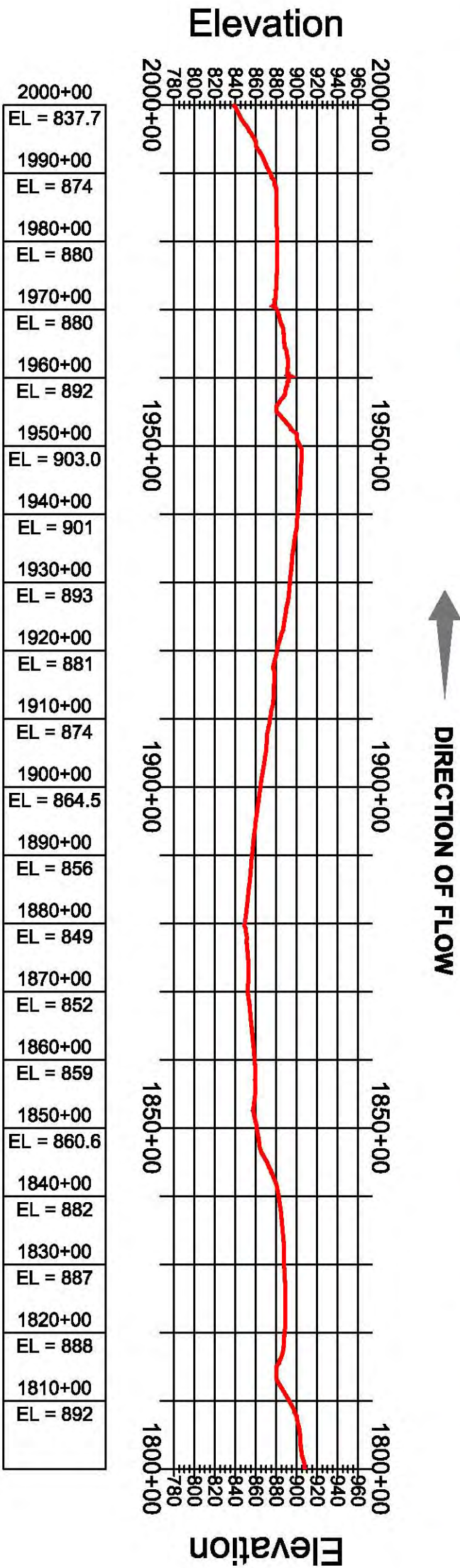


FIG 12

REVIEW	CHECK	DESIGN	FILE NO.	PROJECT
10/05/06	10/05/06	09/05/06	013-1500007A	PRELIMINARY PIPE ALIGNMENT
10/05/06	10/05/06	09/05/06	PLAN 1	PLANS 1 & 2 - SEGMENT 10
10/05/06	10/05/06	09/05/06	SCALE 1"=1500'	

PRELIMINARY PIPE ALIGNMENT
PLANS 1 & 2 - SEGMENT 10

PROJECT

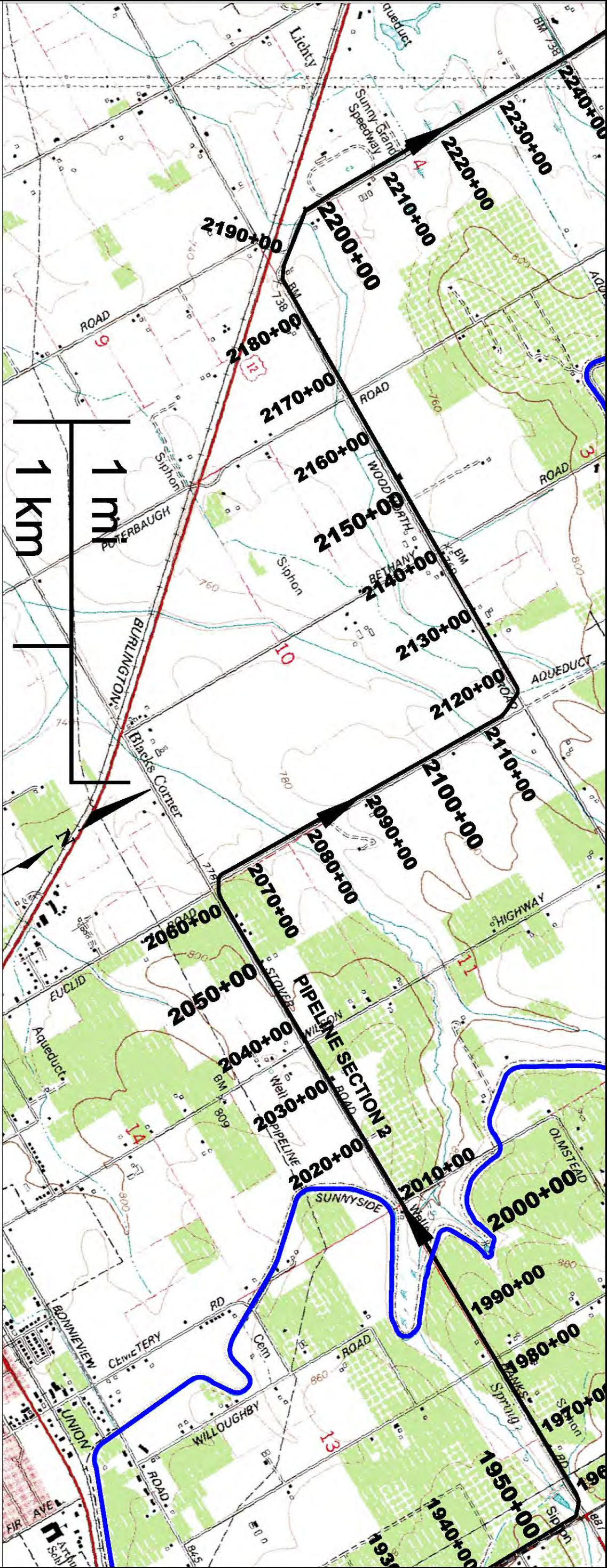
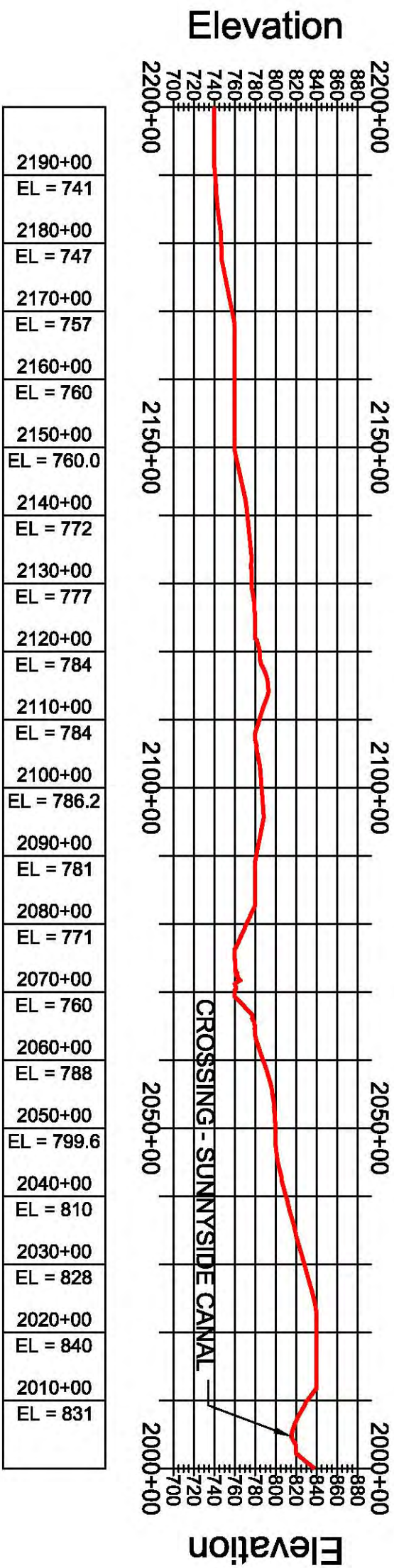
WSDOE/YAKIMA PUMP EXCHANGE//WA
PROJECT# 013-1500007
WASHINGTON DEPT OF ECOLOGY
US BUREAU OF RECLAMATION

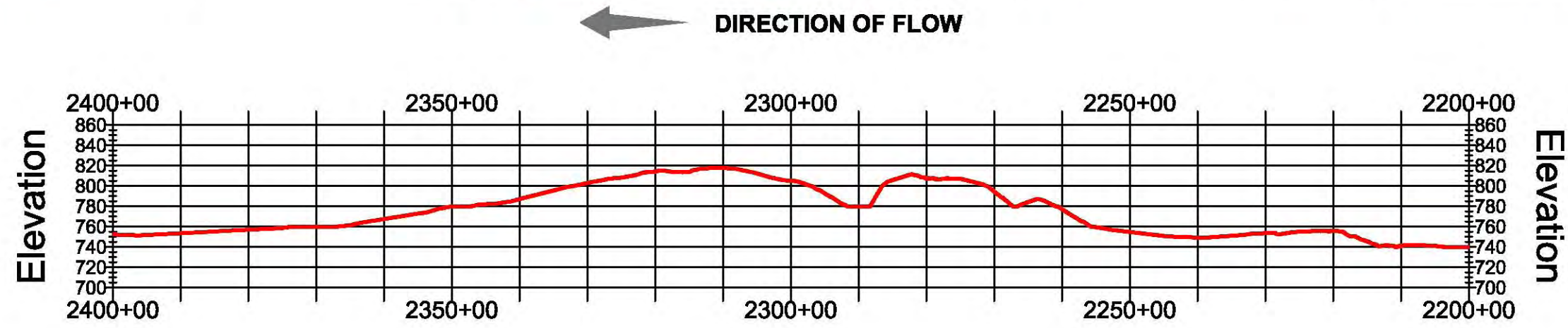
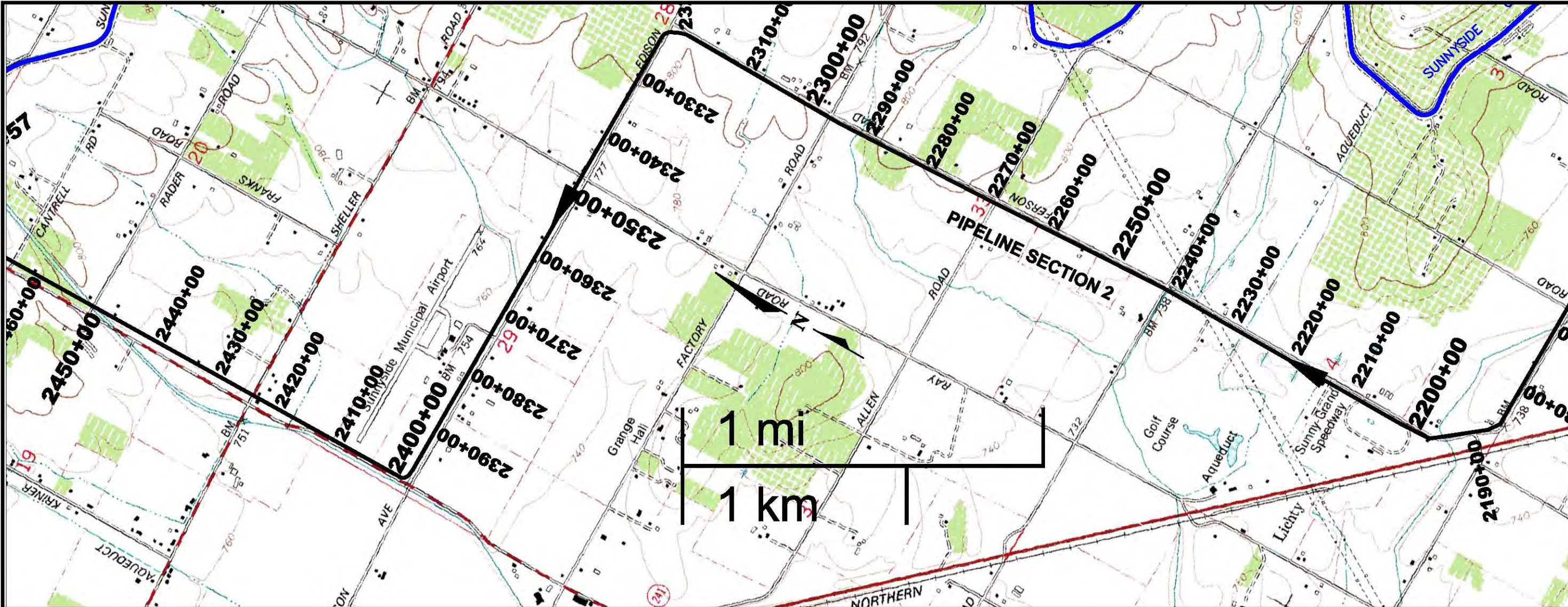


Golder Associates

GOLDER ASSOCIATES INC.
18300 NE UNION HILL ROAD, SUITE 200
REDMOND, WA USA 98052-3333
TEL: (425) 883-0777
FAX: (425) 882-5498

NOTE: VERTICAL EXAGGERATION = 15





2400+00	EL = 752.4
2390+00	EL = 753
2380+00	EL = 757
2370+00	EL = 760
2360+00	EL = 767
2350+00	EL = 779.7
2340+00	EL = 787
2330+00	EL = 803
2320+00	EL = 814
2310+00	EL = 818
2300+00	EL = 805.1
2290+00	EL = 780
2280+00	EL = 807
2270+00	EL = 795
2260+00	EL = 777
2250+00	EL = 754.7
2240+00	EL = 749
2230+00	EL = 754
2220+00	EL = 756
2210+00	EL = 741

NOTE: VERTICAL EXAGGERATION = 15

Golder Associates
GOLDER ASSOCIATES INC.
18500 NE UNION HILL ROAD, SUITE 200
REDMOND, WA USA 98052-3333
TEL: (425) 883-0777
FAX: (425) 882-5498

PROJECT

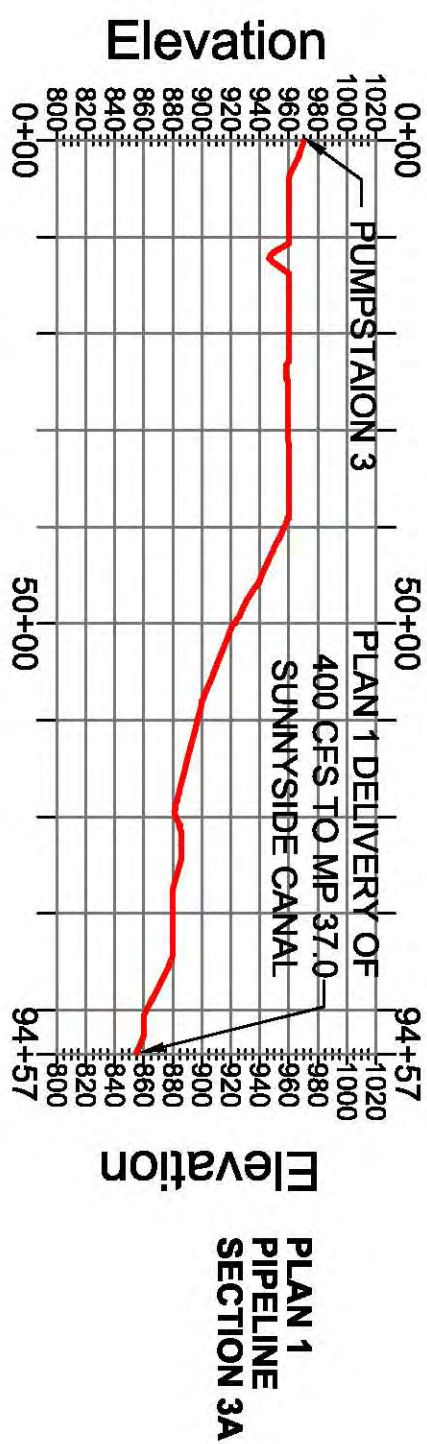
WSDOE/YAKIMA PUMP EXCHANGE/WA
PROJECT# 013-1500007
WASHINGTON DEPT OF ECOLOGY
US BUREAU OF RECLAMATION

TITLE

PRELIMINARY PIPE ALIGNMENT
PLANS 1 & 2 - SEGMENT 12

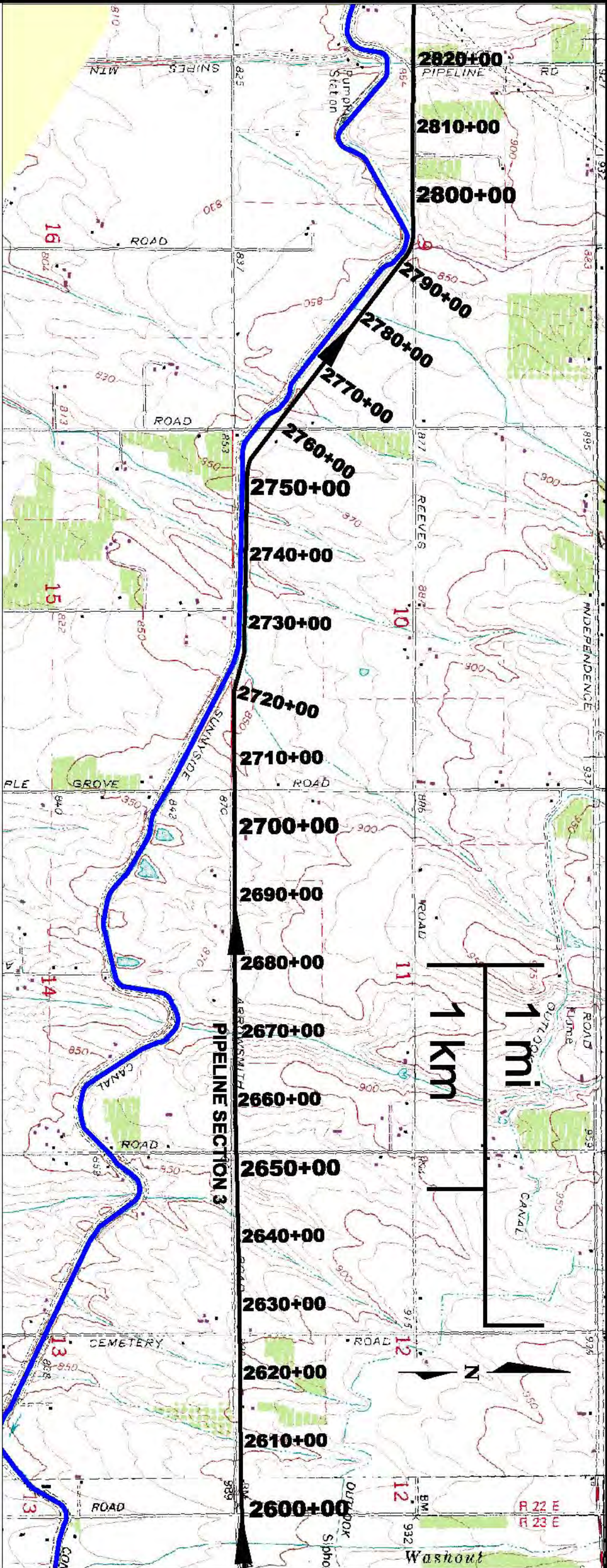
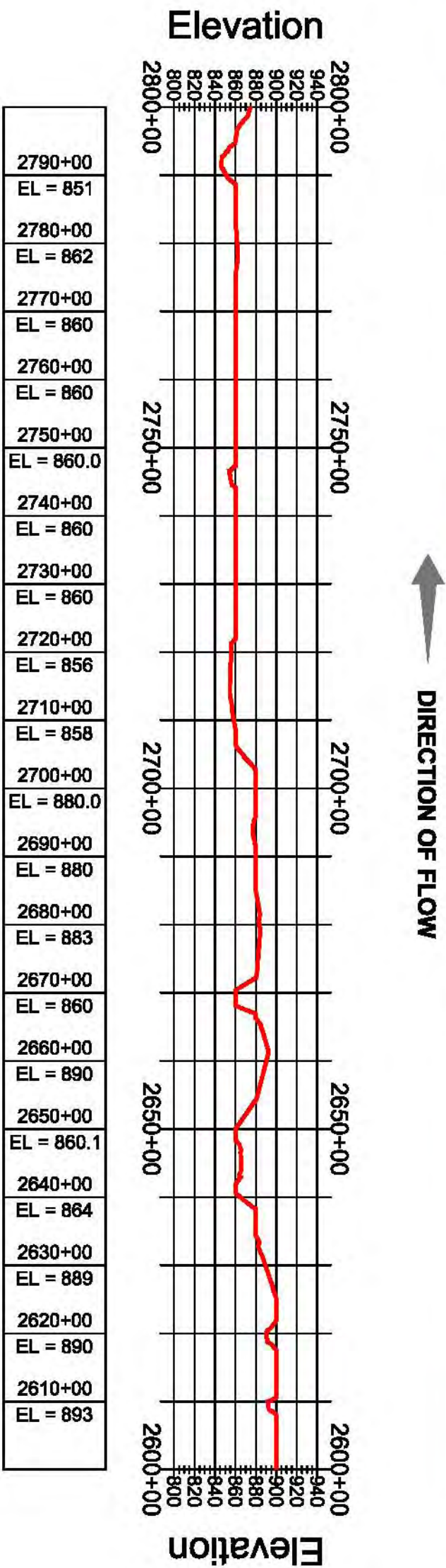
PROJECT:	013-1500007A
FILE No.	PLAN 1
REV. 2	SCALE 1"=1500'
DESIGN	OTH 09/05/06
CADD	OTH 09/05/06
CHECK	AHR 10/05/06
REVIEW	AHR 10/05/06

FIG 14



NOTE: VERTICAL EXAGGERATION = 15

EL = 960
10+00
EL = 960
20+00
EL = 971
30+00
EL = 957
40+00
EL = 922.0
50+00
EL = 897
60+00
EL = 882
70+00
EL = 880
80+00
EL = 862
90+00



NOTE: VERTICAL EXAGGERATION = 15

TITLE

PRELIMINARY PIPE ALIGNMENT
PLAN 1 - SEGMENT 14

PROJECT

WSDOE/YAKIMA PUMP EXCHANGE/WA
PROJECT# 013-1500007
WASHINGTON DEPT OF ECOLOGY
US BUREAU OF RECLAMATION



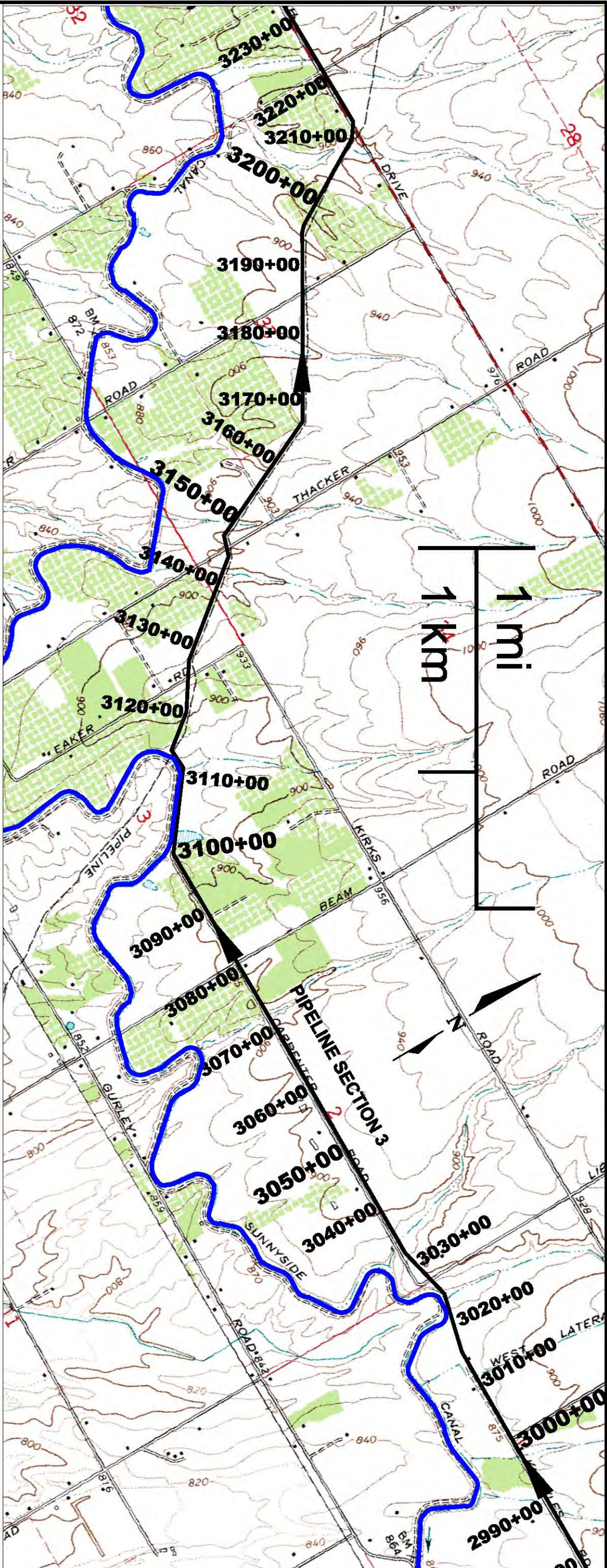
GOLDER ASSOCIATES INC.
18300 NE UNION HILL ROAD, SUITE 200
REDMOND, WA USA 98062-3333
TEL: (425) 883-0777
FAX: (425) 882-6498

FIG 17

The profile view shows the vertical alignment of the proposed road. The vertical axis represents elevation in feet, ranging from 800 to 980. The horizontal axis represents stationing, ranging from 3000+00 to 3200+00. The profile line is red, showing the road grade. A vertical curve is visible between stations 3100+00 and 3150+00, where the elevation rises from approximately 880 feet to 920 feet. The profile shows a slight dip at station 3100+00 and a slight rise at station 3150+00.



DIRECTION OF FLOW



1 km

三

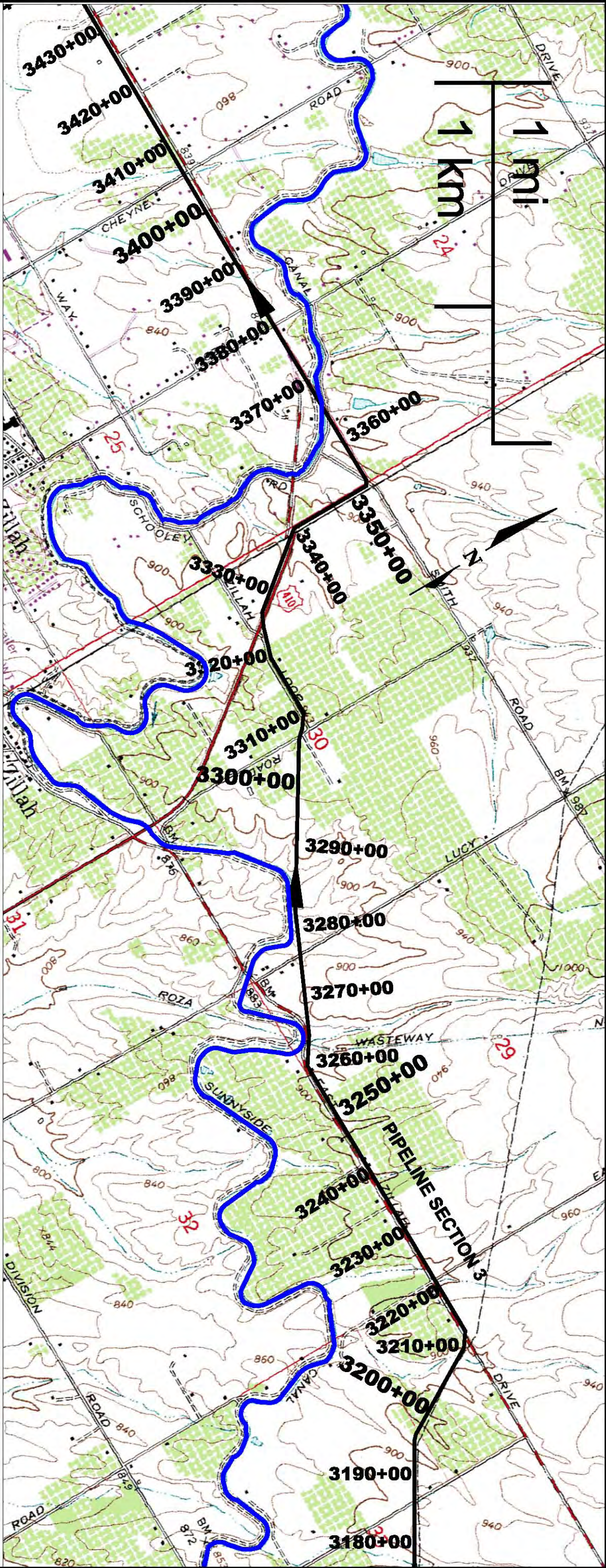
PROJECT: 013-1500007A	
FILE No.	PLAN 1
REV. 2	SCALE 1"=1500'
DESIGN	OTH 08/17/06
CADD	OTH 08/17/06
CHECK	AHR 10/05/06
REVIEW	AHR 10/05/06

PROJECT

WSDOE/YAKIMA PUMP EXCHANGE/WA
PROJECT# 013-1500007
WASHINGTON DEPT OF ECOLOGY
US BUREAU OF RECLAMATION



FIG 19

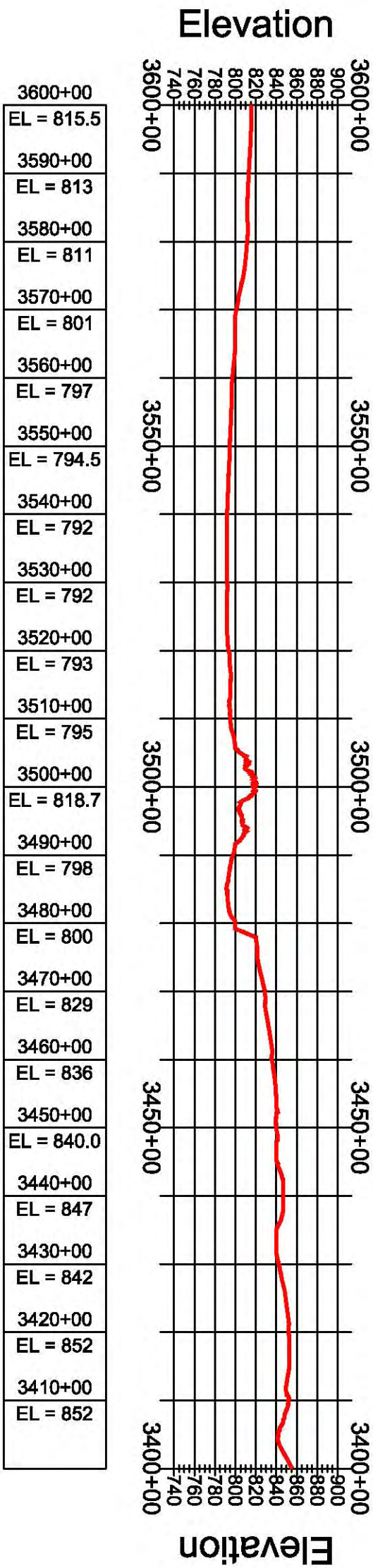
**FIG 20**

**PRELIMINARY PIPE ALIGNMENT
PLAN 1 - SEGMENT 17**



Golder Associates

GOLDER ASSOCIATES INC.
 18300 NE UNION HILL ROAD, SUITE 200
 REDMOND, WA USA 98052-3333
 TEL: (425) 883-0777
 FAX: (425) 882-5498



NOTE: VERTICAL EXAGGERATION = 15

DIRECTION OF FLOW

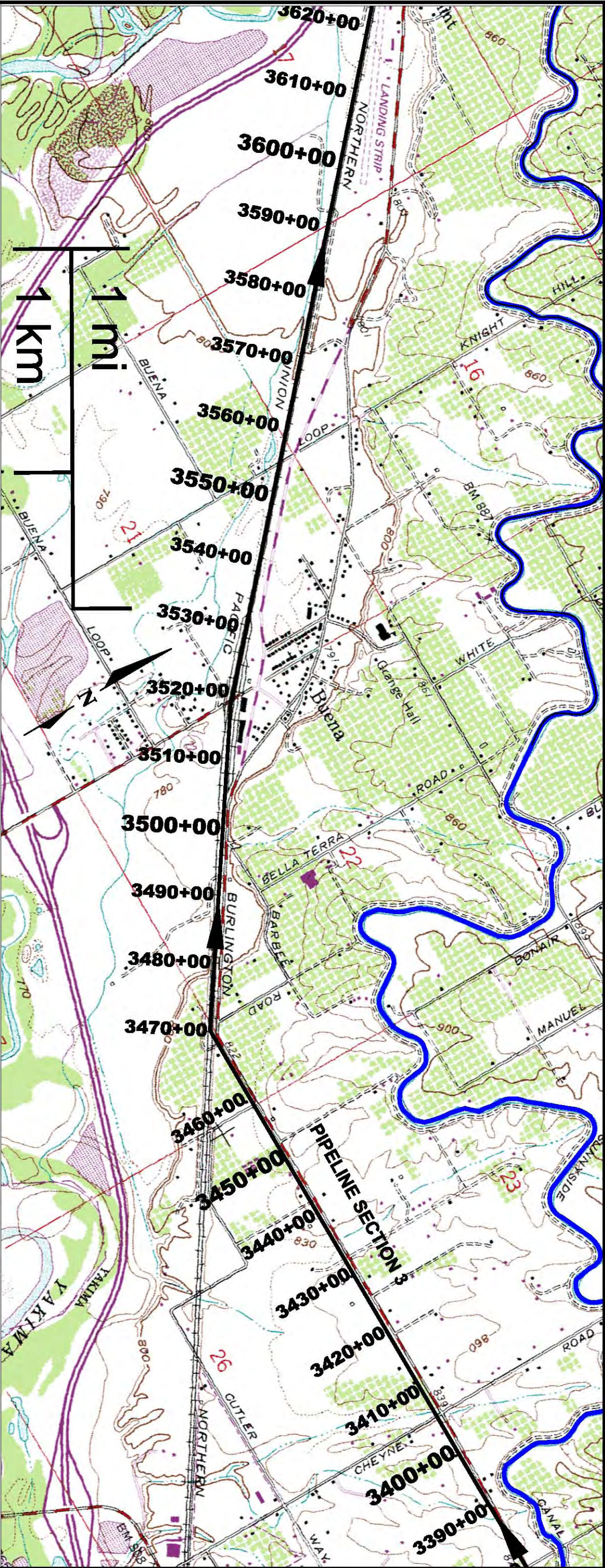


FIG 21

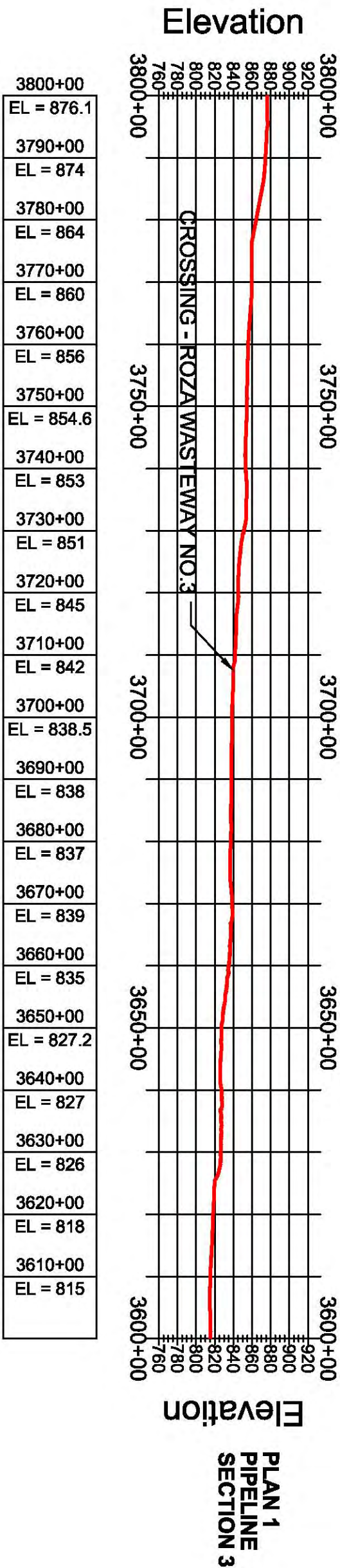
PROJECT: 013-1500007A	FILE No.	PLAN 1
REV. 2	SCALE 1"=1500'	
DESIGN	OTH 08/17/06	
CADD	OTH 08/17/06	
CHECK	AHR 10/05/06	
REVIEW	AHR 10/05/06	

PRELIMINARY PIPE ALIGNMENT
PLAN 1 - SEGMENT 18

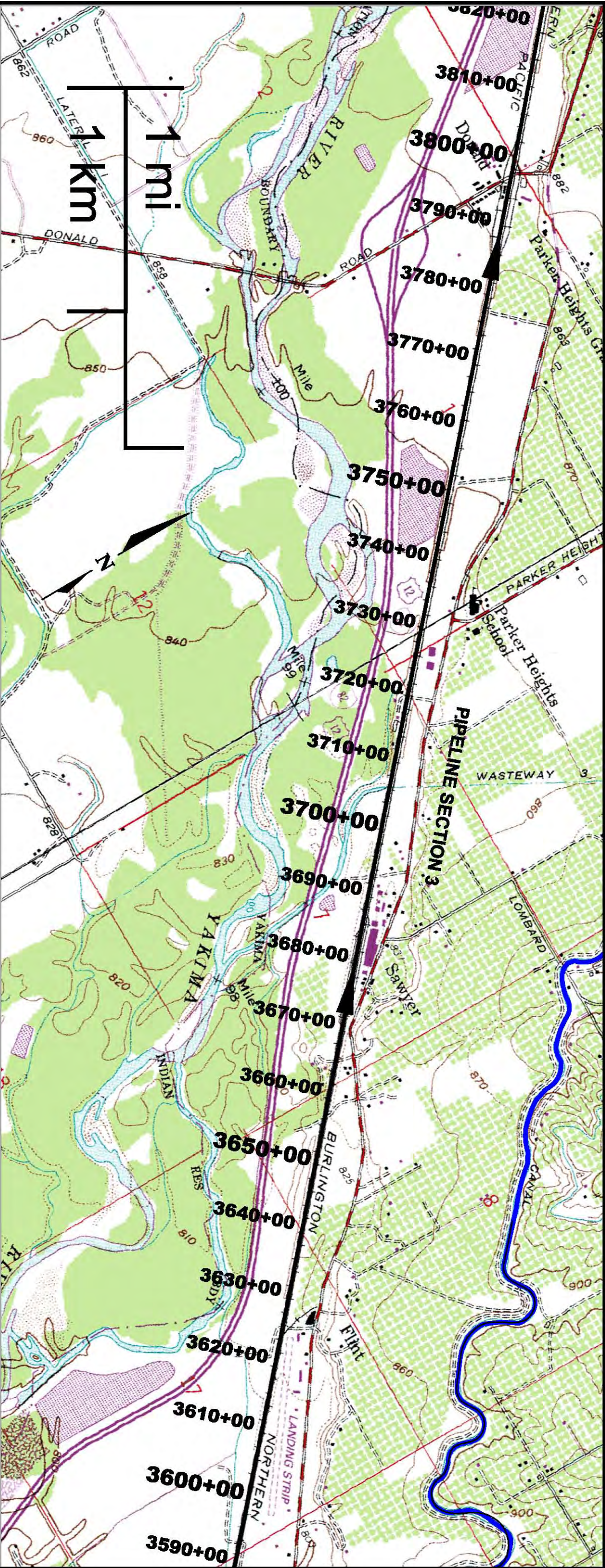
PROJECT

WSDOE/YAKIMA PUMP EXCHANGE/WA
PROJECT# 013-1500007
WASHINGTON DEPT OF ECOLOGY
US BUREAU OF RECLAMATION

 **Golder Associates**
GOLDER ASSOCIATES INC.
18300 NE UNION HILL ROAD, SUITE 200
REDMOND, WA USA 98052-3333
TEL: (425) 883-0777
FAX: (425) 882-5498



DIRECTION OF FLOW



NOTE: VERTICAL EXAGGERATION = 15

TITLE

PRELIMINARY PIPE ALIGNMENT
PLAN 1 - SEGMENT 19

PROJECT

WSDOE/YAKIMA PUMP EXCHANGE/WA
PROJECT# 013-1500007
WASHINGTON DEPT OF ECOLOGY
US BUREAU OF RECLAMATION



GOLDER ASSOCIATES INC.
18300 NE UNION HILL ROAD, SUITE 200
REDMOND, WA USA 98052-3333
TEL: (425) 883-0777
FAX: (425) 882-5498

FIG 22

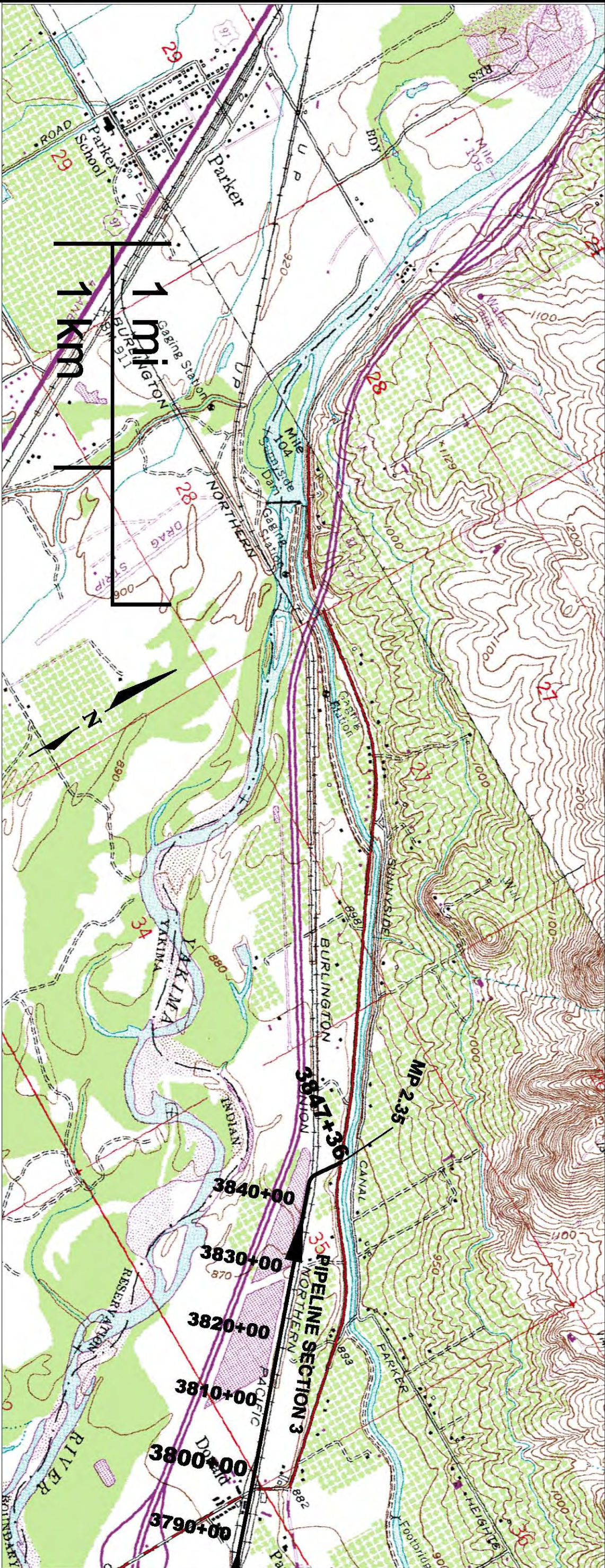
PROJECT: 013-1500007A	PLAN 1
FILE No.	PLAN 1
REV. 2 SCALE 1"=1500'	08/17/06
DESIGN OTH	08/17/06
CADD OTH	08/17/06
CHECK AHR	10/05/06
REVIEW AHR	10/05/06

2990+00	EL = 880
2980+00	EL = 900
2970+00	EL = 898
2960+00	EL = 880
2950+00	EL = 865.4
2940+00	EL = 864
2930+00	EL = 880
2920+00	EL = 885
2910+00	EL = 896
2900+00	EL = 900.0
2890+00	EL = 905
2880+00	EL = 912
2870+00	EL = 919
2860+00	EL = 904
2850+00	EL = 883.6
2840+00	EL = 867
2830+00	EL = 868
2820+00	EL = 865
2810+00	EL = 875

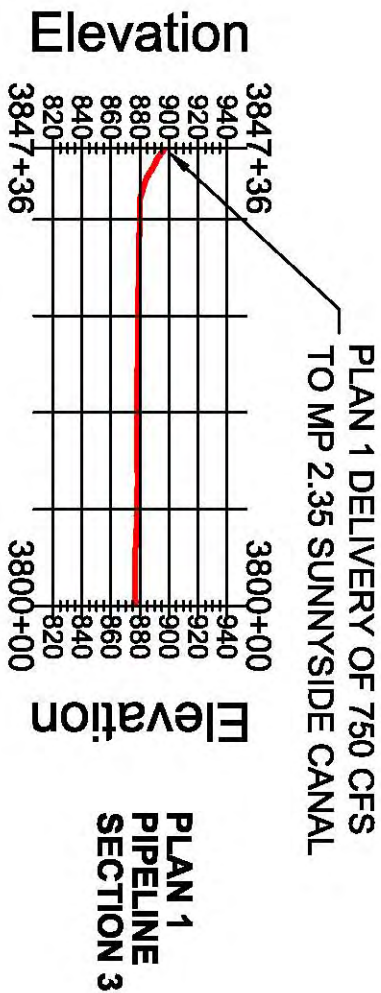
DIRECTION OF FLOW 
AIR VACUUM INLET STRUCTURE 

 **Golder Associates**
GOLDER ASSOCIATES INC.
18300 NE UNION HILL ROAD, SUITE 200
REDMOND, WA USA 98052-3333
TEL: (425) 883-0777
FAX: (425) 882-6496

FIG 18



↑
DIRECTION OF FLOW



3840+00
EL = 880
3830+00
EL = 878
3820+00
EL = 878
3810+00
EL = 878
3800+00

NOTE: VERTICAL EXAGGERATION = 15

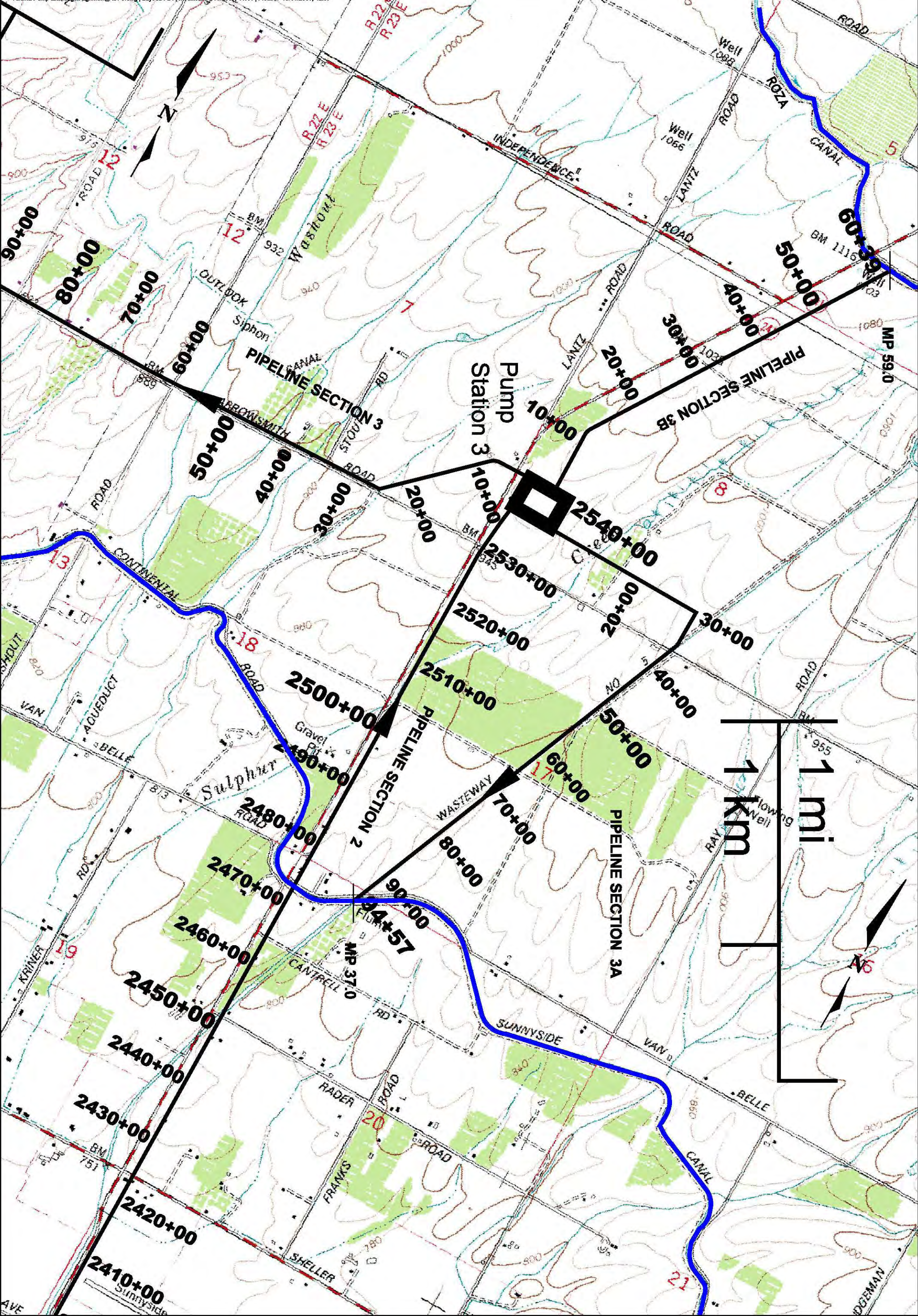
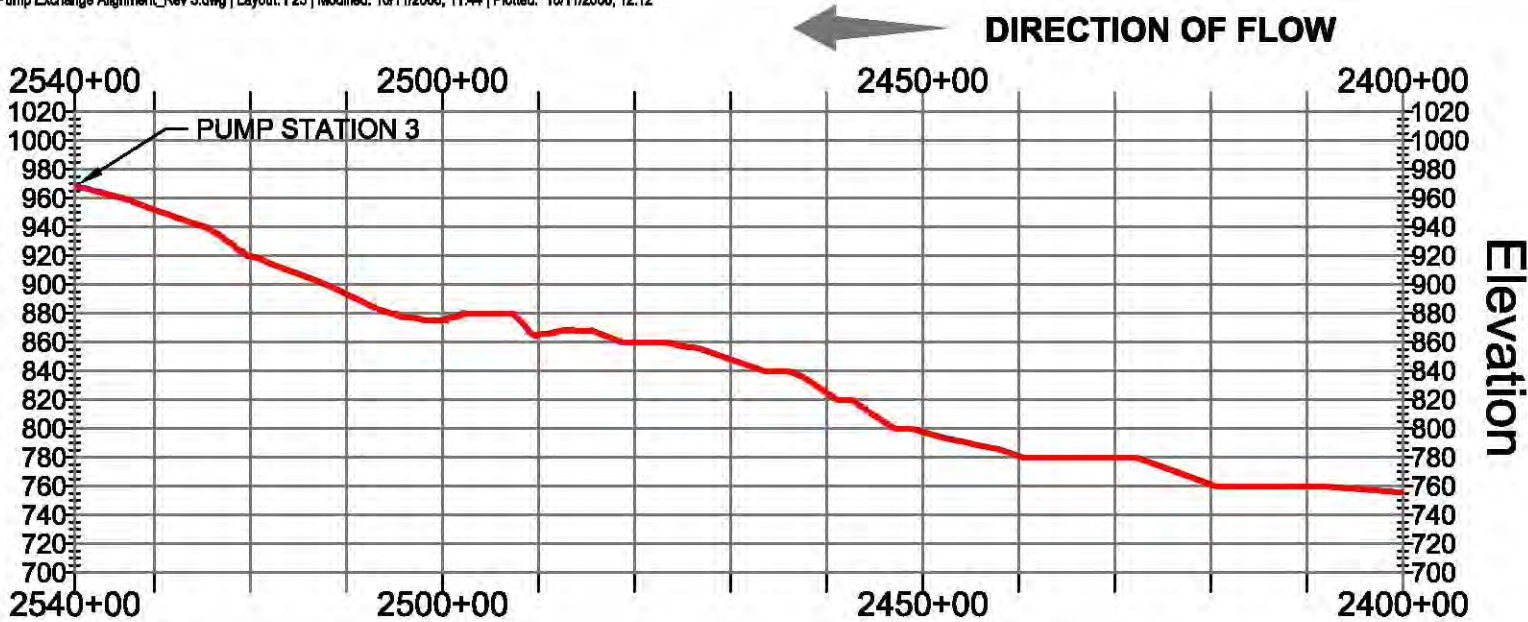


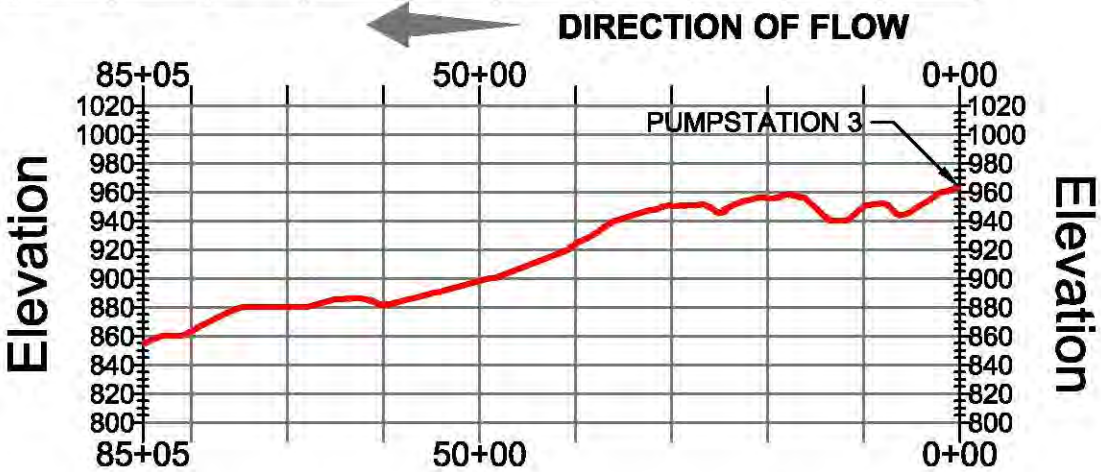
FIG 24	PROJECT: 013-1500007A	TITLE	PROJECT	 GOLDER ASSOCIATES INC. 18300 NE UNION HILL ROAD, SUITE 200 REDMOND, WA USA 98052-3333 TEL: (425) 883-0777 FAX: (425) 882-5498
	FILE No. PLAN 2	PRELIMINARY PIPE ALIGNMENT PLAN 2 - PUMP STATION 3	WSDOE/YAKIMA PUMP EXCHANGE//WA _PROJECT# 013-1500007 WASHINGTON DEPT OF ECOLOGY US BUREAU OF RECLAMATION	
	REV. 2 SCALE 1"=1500'			
	DESIGN OTH 08/17/06			
	CADD OTH 08/17/06			
	CHECK AHR 10/05/06			
	REVIEW AHR 10/05/06			

Elevation



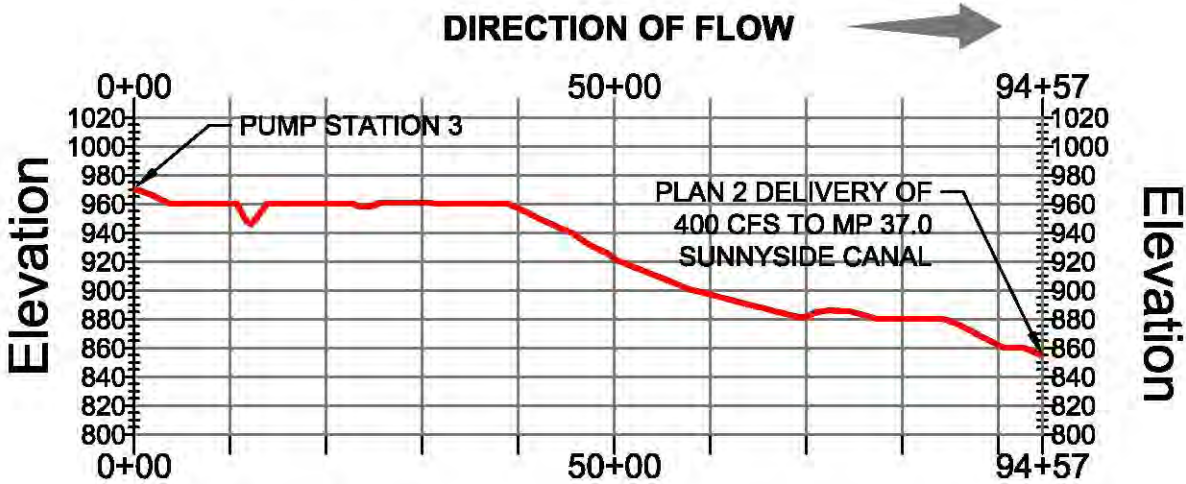
PLAN 2
PIPELINE
SECTION 2

2530+00	EL = 952	2520+00	EL = 920	2510+00	EL = 893	2500+00	EL = 875.0	2490+00	EL = 865	2480+00	EL = 860	2470+00	EL = 848	2460+00	EL = 825	2450+00	EL = 797.6	2440+00	EL = 781	2430+00	EL = 780	2420+00	EL = 761	2410+00	EL = 760
---------	----------	---------	----------	---------	----------	---------	------------	---------	----------	---------	----------	---------	----------	---------	----------	---------	------------	---------	----------	---------	----------	---------	----------	---------	----------



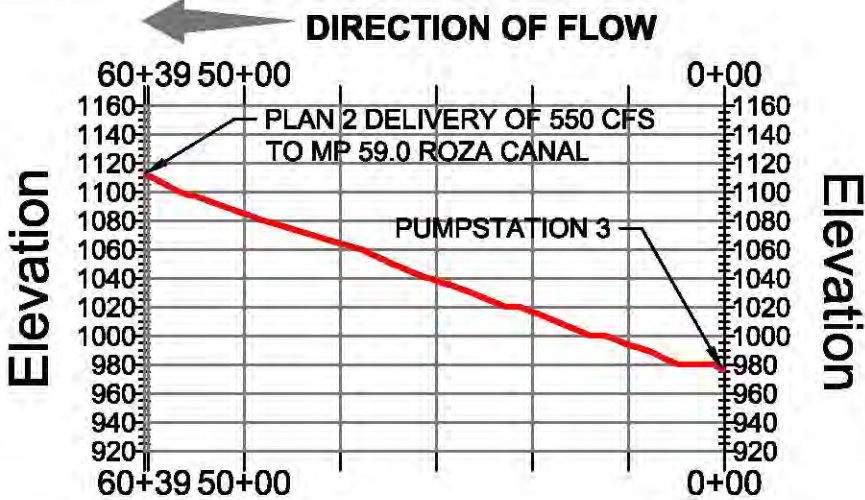
PLAN 2
PIPELINE
SECTION 3

80+00	EL = 864	70+00	EL = 880	60+00	EL = 881	50+00	EL = 898.2	40+00	EL = 924	30+00	EL = 951	20+00	EL = 955	10+00	EL = 950
-------	----------	-------	----------	-------	----------	-------	------------	-------	----------	-------	----------	-------	----------	-------	----------



PLAN 2
PIPELINE
SECTION 3A

EL = 960	10+00	EL = 960	20+00	EL = 971	30+00	EL = 957	40+00	EL = 922.0	50+00	EL = 897	60+00	EL = 882	70+00	EL = 880	80+00	EL = 862	90+00
----------	-------	----------	-------	----------	-------	----------	-------	------------	-------	----------	-------	----------	-------	----------	-------	----------	-------



PLAN 2
PIPELINE
SECTION 3B

60+00	EL = 1112	50+00	EL = 1084.9	40+00	EL = 1064	30+00	EL = 1038	20+00	EL = 1016	10+00	EL = 994
-------	-----------	-------	-------------	-------	-----------	-------	-----------	-------	-----------	-------	----------

NOTE: VERTICAL EXAGGERATION = 15

FIG 25

TITLE

PRELIMINARY PIPE ALIGNMENT
PLAN 2 - DELIVERY PROFILES

PROJECT

WSDOE/YAKIMA PUMP EXCHANGE//WA
PROJECT# 013-1500007
WASHINGTON DEPT OF ECOLOGY
US BUREAU OF RECLAMATION

WSDOE/YAKIMA PUMP EXCHANGE/WA
PROJECT# 013-1500007
WASHINGTON DEPT OF ECOLOGY
US BUREAU OF RECLAMATION

PROJECT

PRELIMINARY PIPE ALIGNMENT
PLAN 2 - SEGMENT 14

TITLE

PROJECT: 013-1500007A

FILE No. PLAN 2

REV. 2 SCALE 1"=1500'

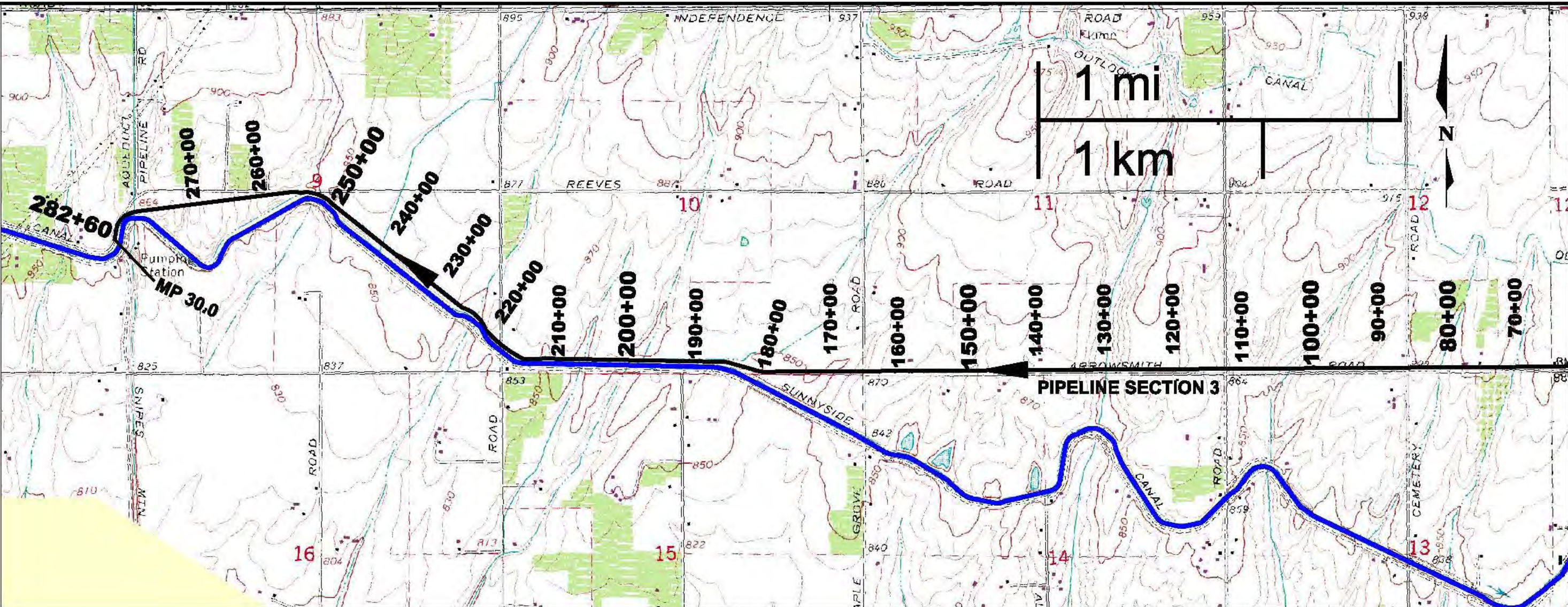
DESIGN OTH 08/17/06

CADD OTH 08/17/06

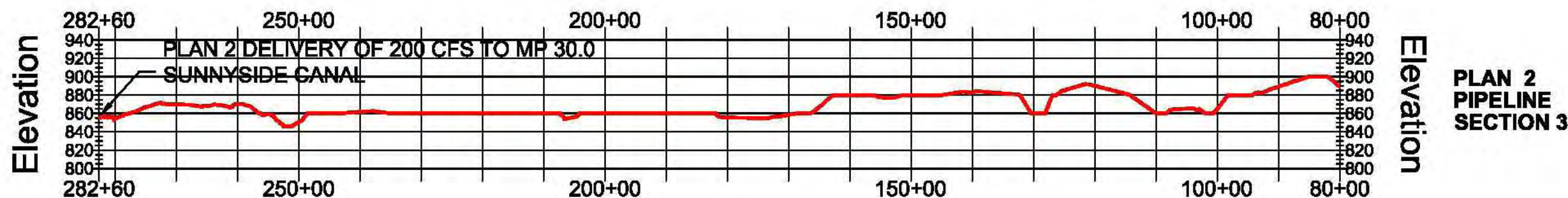
CHECK AHR 10/05/06

REVIEW AHR 10/05/06

FIG 26



← DIRECTION OF FLOW



280+00	EL = 854	270+00	EL = 870	260+00	EL = 870	250+00	EL = 850.5	240+00	EL = 862	230+00	EL = 860	220+00	EL = 860	210+00	EL = 860	200+00	EL = 860.0	190+00	EL = 860	180+00	EL = 856	170+00	EL = 858	160+00	EL = 880	150+00	EL = 880.0	140+00	EL = 883	130+00	EL = 860	120+00	EL = 890	110+00	EL = 860	100+00	EL = 865.1	90+00	EL = 889
--------	----------	--------	----------	--------	----------	--------	------------	--------	----------	--------	----------	--------	----------	--------	----------	--------	------------	--------	----------	--------	----------	--------	----------	--------	----------	--------	------------	--------	----------	--------	----------	--------	----------	--------	----------	--------	------------	-------	----------

NOTE: VERTICAL EXAGGERATION = 15

\\usps4design\Design\Projects\Yakima_PSY\PreDesign\Mec\Rev-1\YBP-FIGURE-27.dgn



SCALE
1"=200'

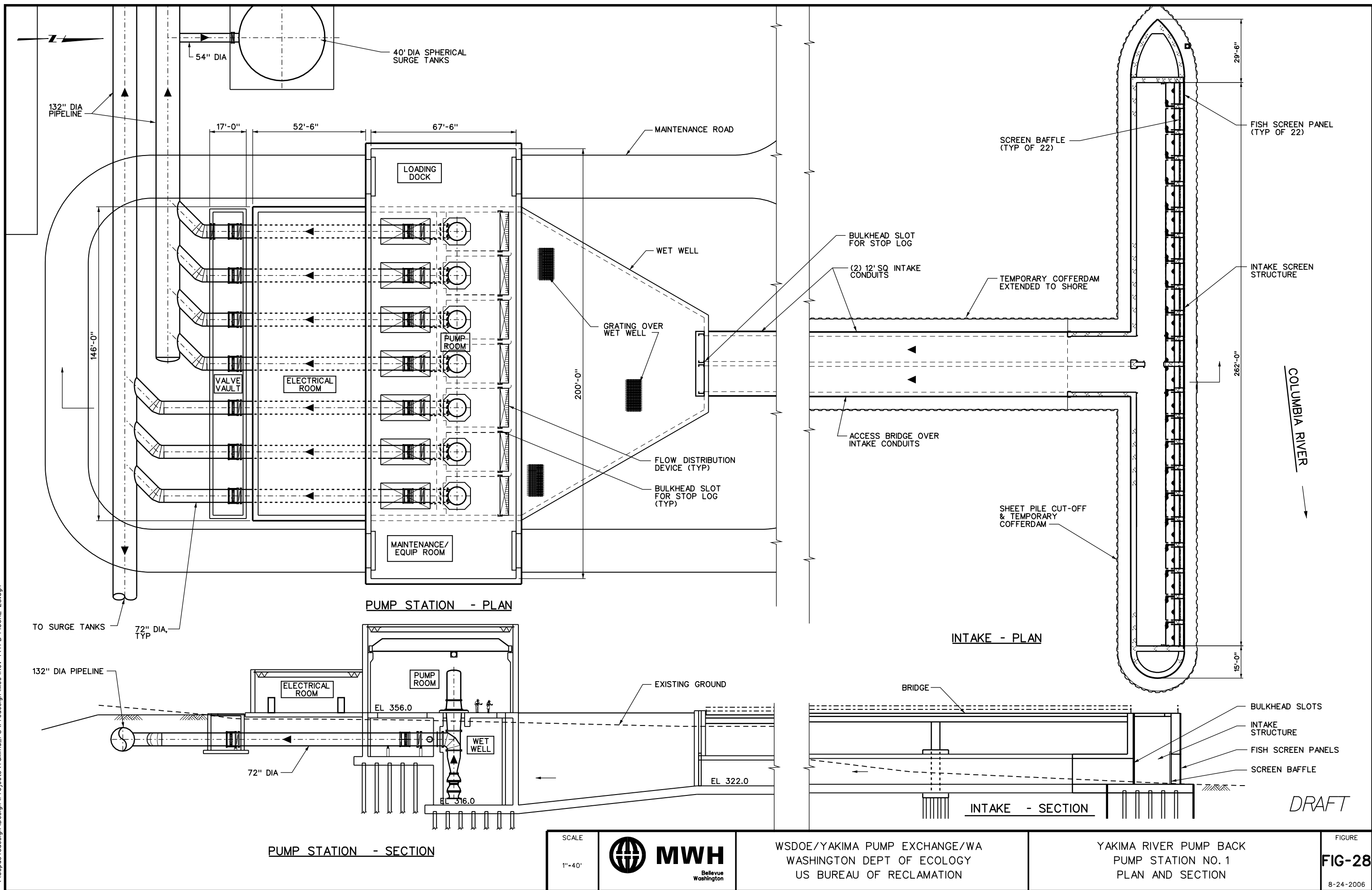


WSDOE/YAKIMA PUMP EXCHANGE/WA
WASHINGTON DEPT OF ECOLOGY
US BUREAU OF RECLAMATION

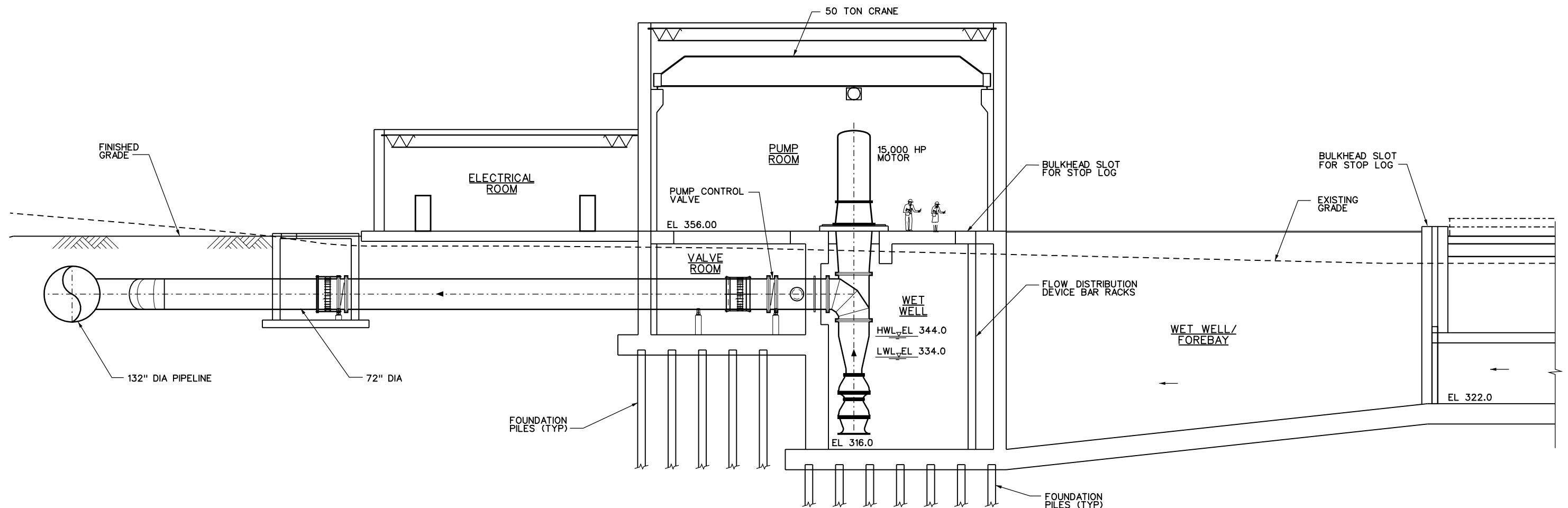
YAKIMA RIVER PUMP BACK
PUMP STATION NO. 1
SITE PLAN

FIGURE
FIG-27
8-24-2006

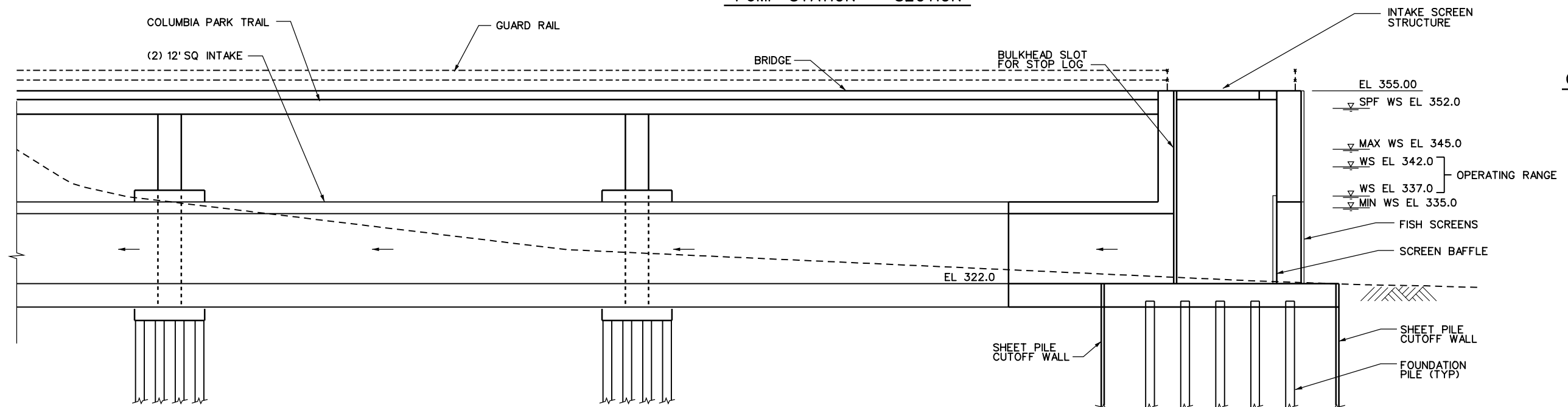
\\uspos4design\Design\Projects\Yakima_PSY\PreDesign\Mec\Rev-1\YPB-FIGURE-28.dgn



\\usps4design\Design\Projects\Yakima_PS\PreDesign\Mec\Rev-1\YBPB-FIGURE-29.dgn



PUMP STATION - SECTION



INTAKE - SECTION

DRAFT

SCALE
1"=20'

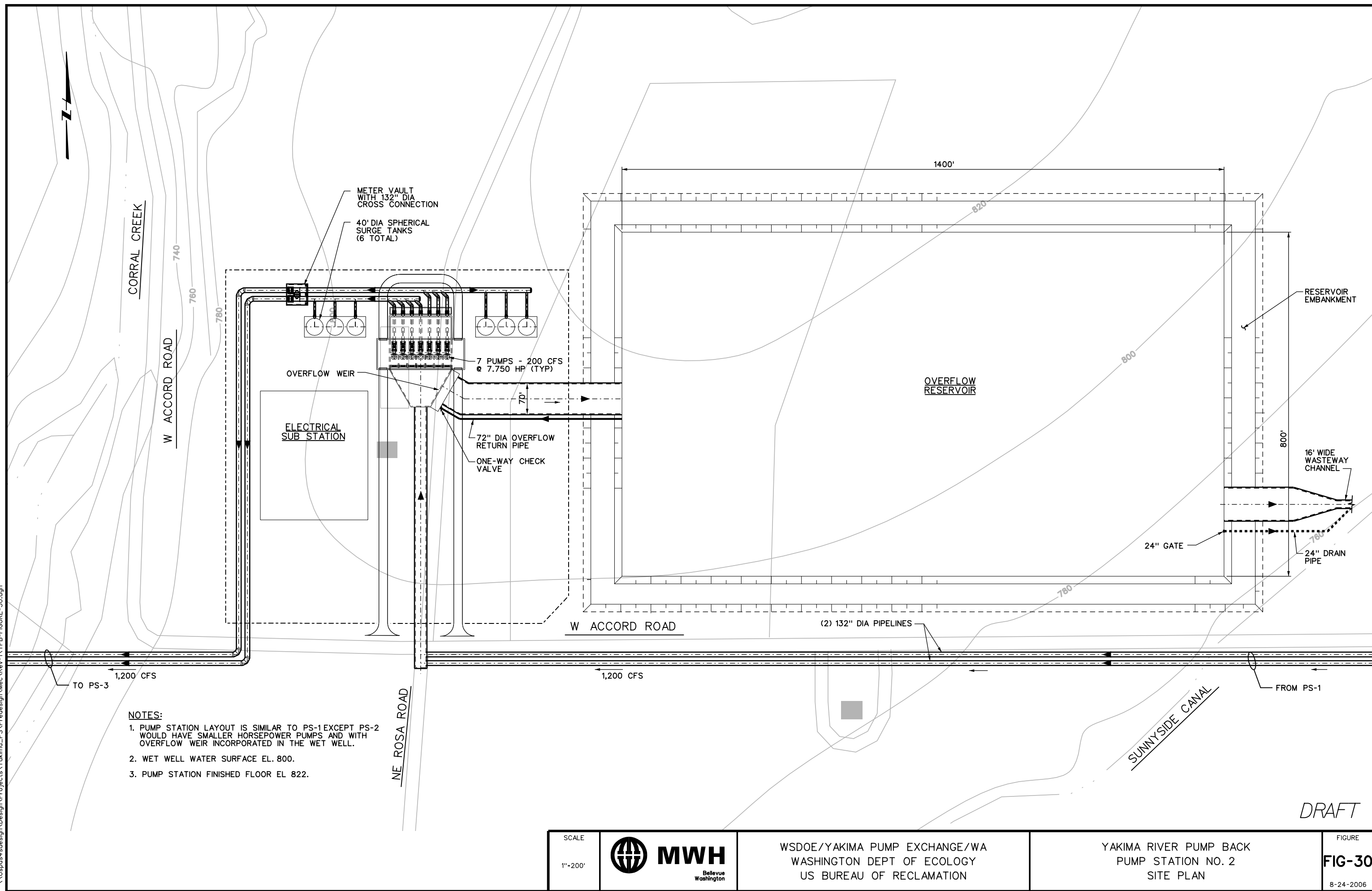


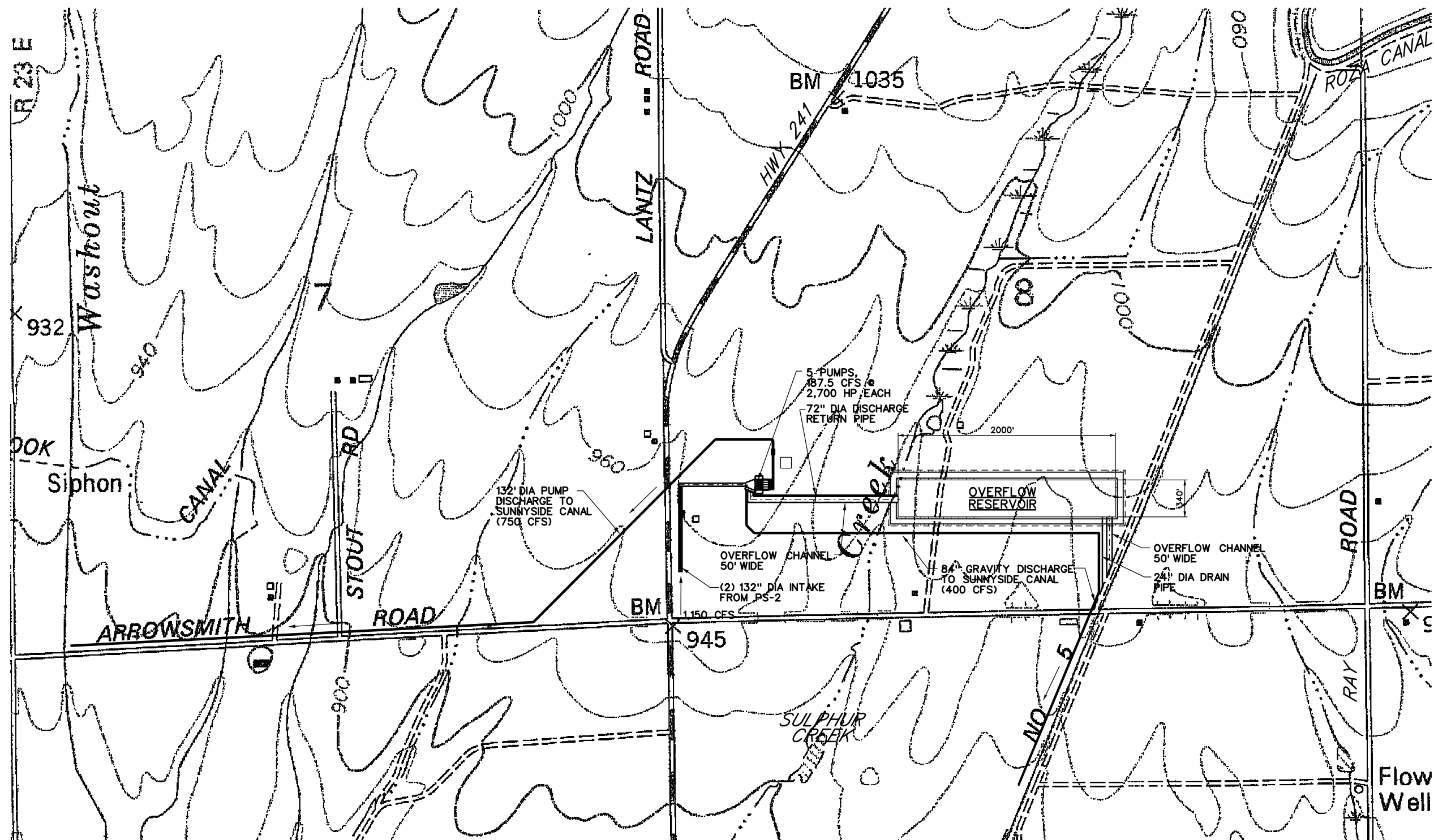
WSDOE/YAKIMA PUMP EXCHANGE/WA
WASHINGTON DEPT OF ECOLOGY
US BUREAU OF RECLAMATION

YAKIMA RIVER PUMP BACK
PUMP STATION NO. 1
SECTIONS

FIGURE
FIG-29
8-24-2006

\\uspos4design\Design\Projects\Yakima_PS\PreDesign\Mec\Rev-1\YPB-FIGURE-30.dgn





SITE PLAN- PLAN 1

SCALE
1"=1000'



WSDOE/YAKIMA PUMP EXCHANGE/WA
WASHINGTON DEPT OF ECOLOGY
US BUREAU OF RECLAMATION

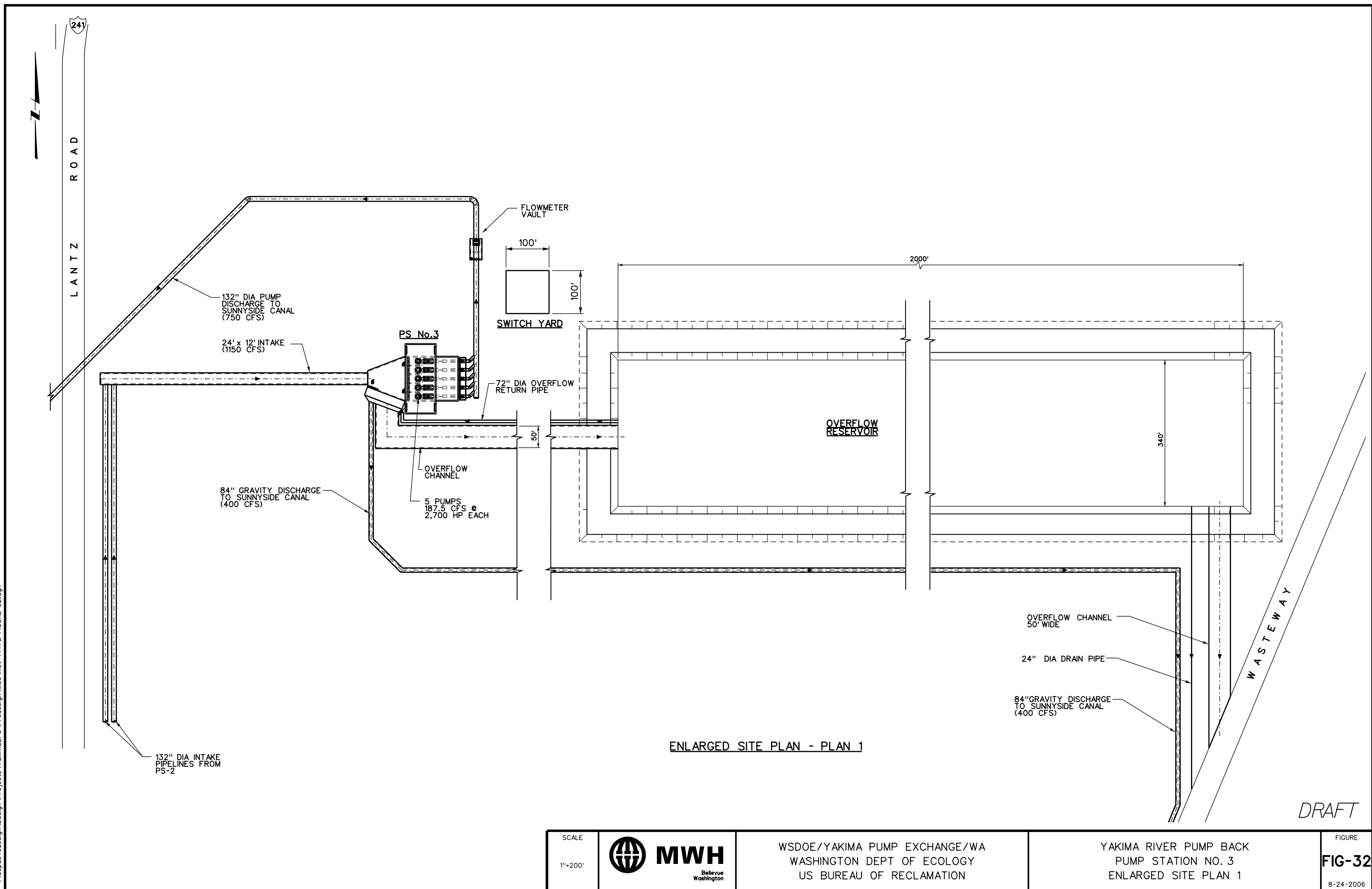
YAKIMA RIVER PUMP BACK
PUMP STATION NO. 3
SITE PLAN 1

FIGURE

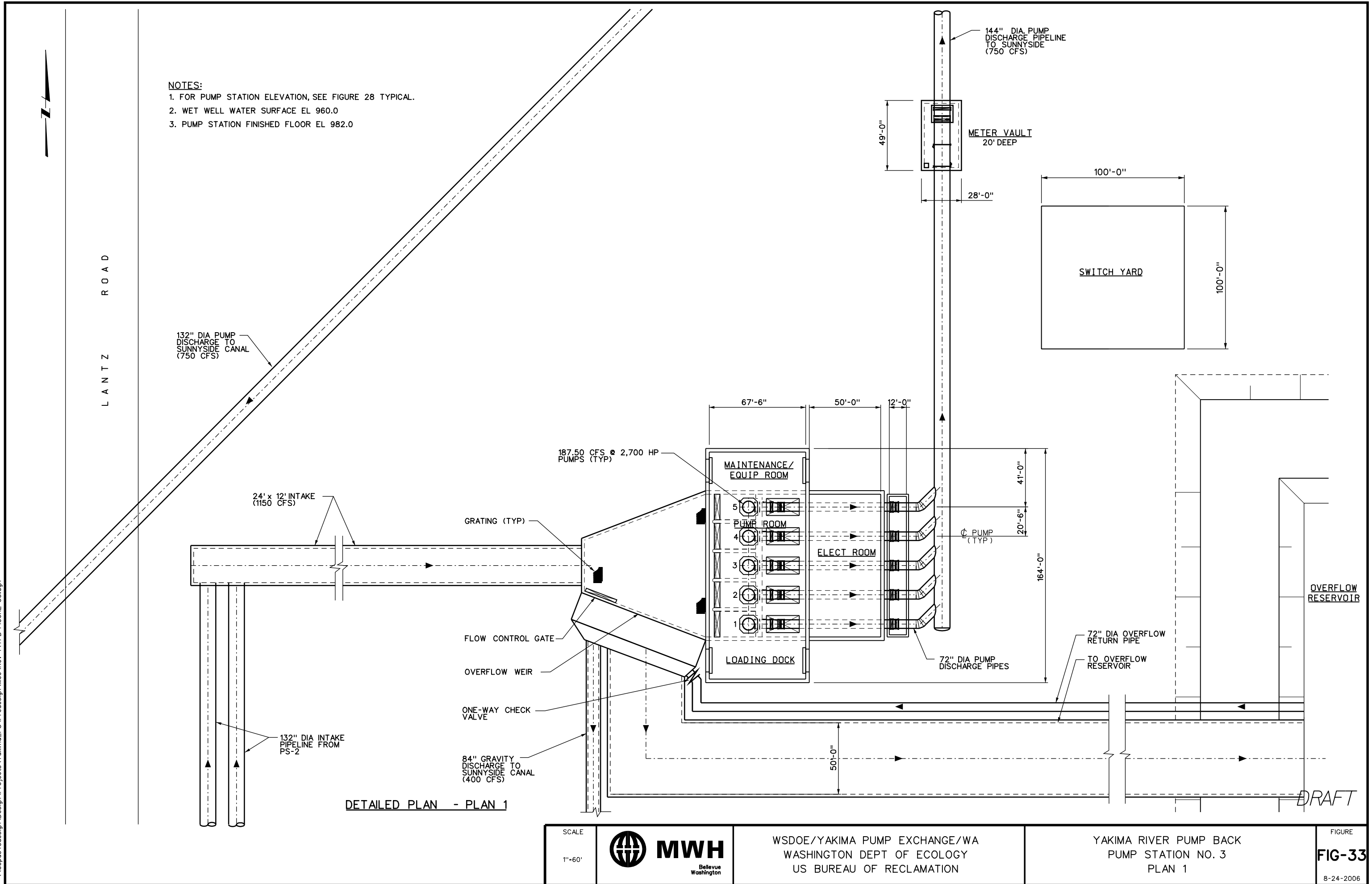
FIG-31

8-24-2006

\\usps4design\Design\Projects\Yakima_PS\PreDesign\Mec\Rev-1\YPB-FIGURE-32.dgn



\\usps4design\Design\Projects\Yakima_PS\PreDesign\Mec\Rev-1\YPB-FIGURE-33.dgn



SCALE
1"=60'

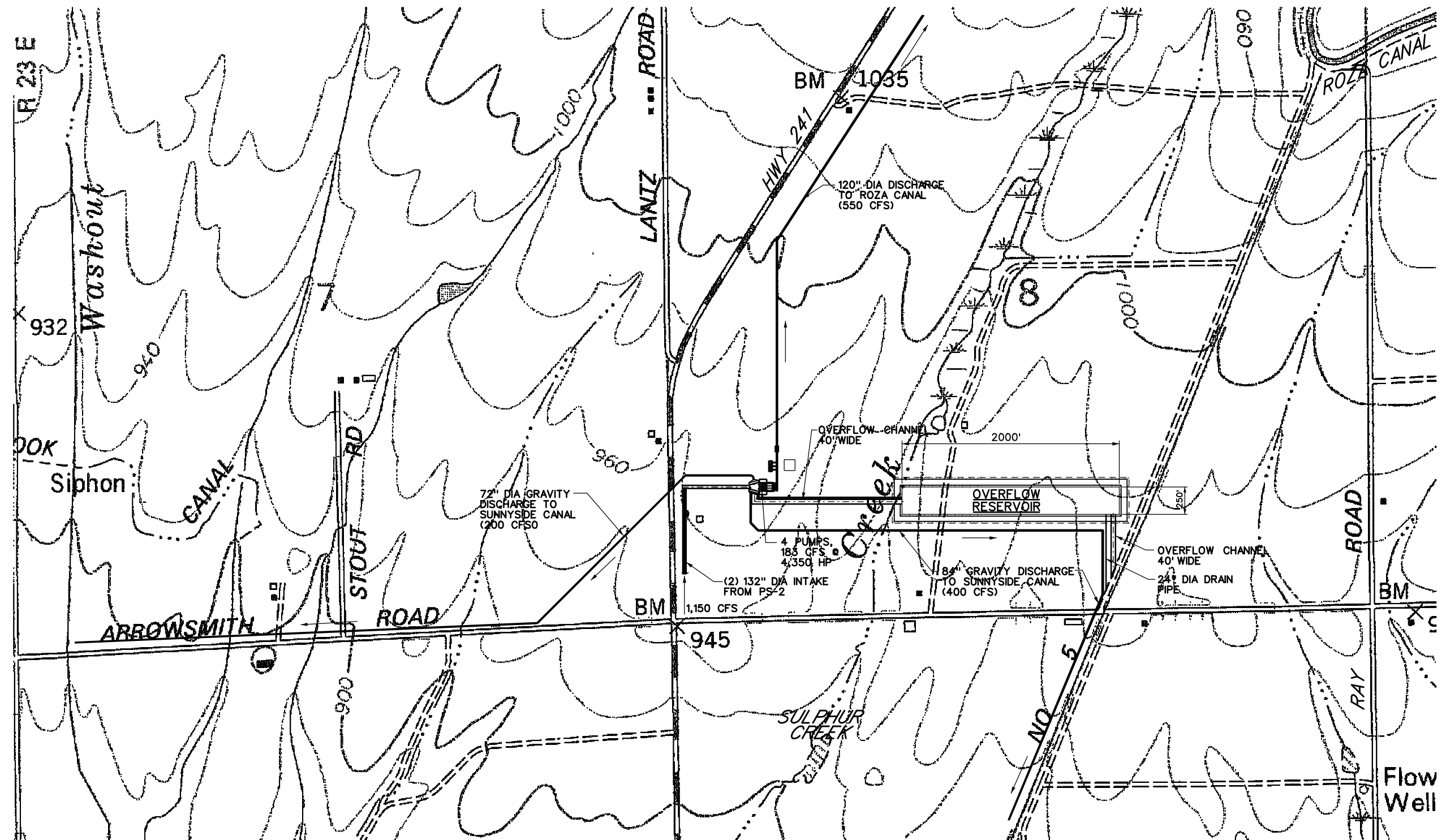


WSDOE/YAKIMA PUMP EXCHANGE/WA
WASHINGTON DEPT OF ECOLOGY
US BUREAU OF RECLAMATION

YAKIMA RIVER PUMP BACK
PUMP STATION NO. 3
PLAN 1

FIGURE
FIG-33
8-24-2006

\\usps4sdesign\Design\Projects\Yakima_PS\PreDesign\Mec\Rev-1\YPB-FIGURE-34.dgn



SITE PLAN - PLAN 2

SCALE

1"=1000'



MWH
Bellevue
Washington

WSDOE/YAKIMA PUMP EXCHANGE/WA
WASHINGTON DEPT OF ECOLOGY
US BUREAU OF RECLAMATION

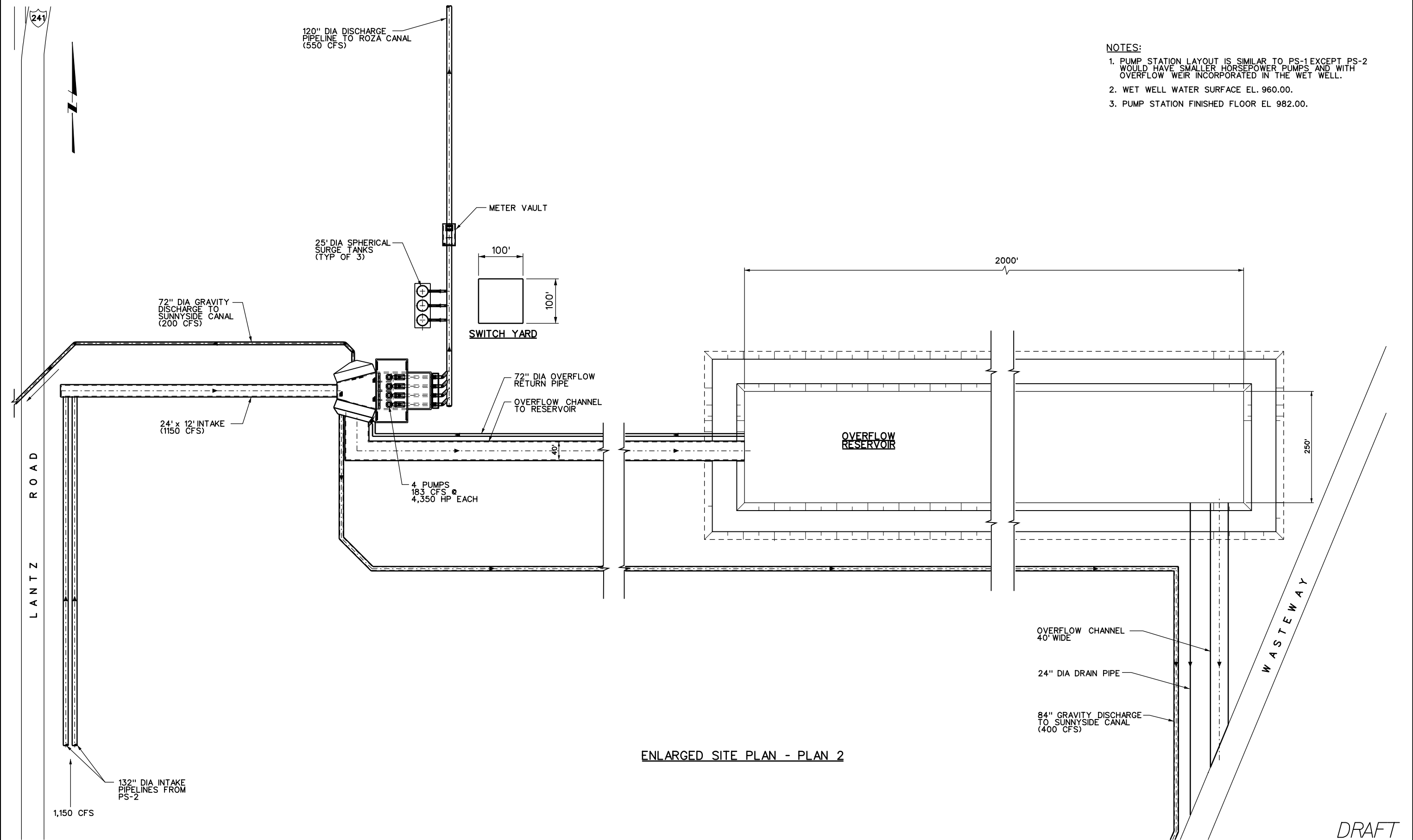
YAKIMA RIVER PUMP BACK
PUMP STATION NO. 3
SITE PLAN 2

FIGURE

FIG-34

8-24-2006

\\uspos4design\Design\Projects\Yakima_PS\PreDesign\Mec\Rev-1\YPB-FIGURE-35.dgn



ENLARGED SITE PLAN - PLAN 2

DRAFT

SCALE
1"=200'

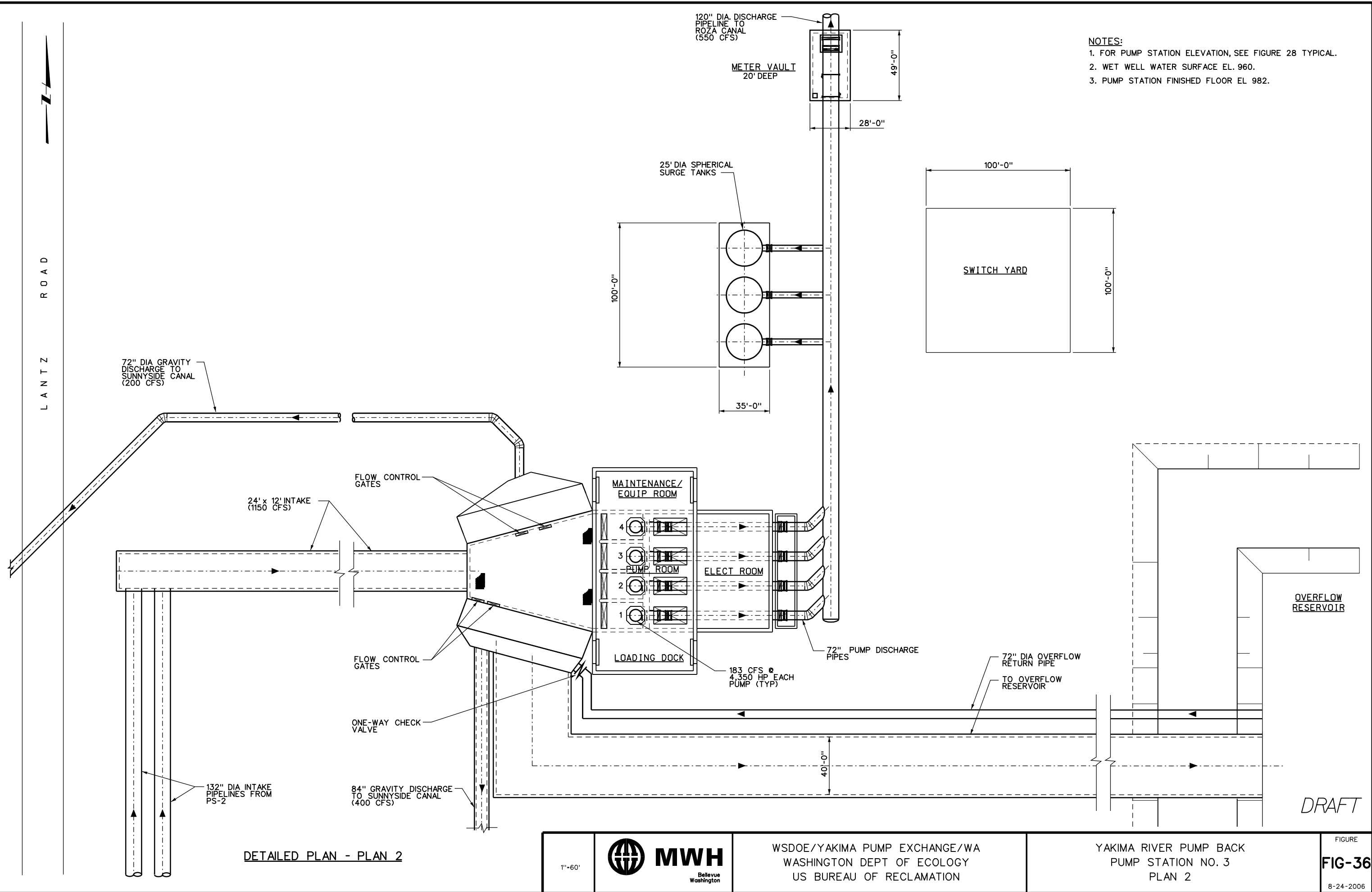


WSDOE/YAKIMA PUMP EXCHANGE/WA
WASHINGTON DEPT OF ECOLOGY
US BUREAU OF RECLAMATION

YAKIMA RIVER PUMP BACK
PUMP STATION NO. 3
ENLARGED SITE PLAN 2

FIGURE
FIG-35
8-24-2006

\\usps4design\Design\Projects\Yakima_PSY\PreDesign\Mec\Rev-1\YPB-FIGURE-36.dgn



USBR Type VI Stilling Basin (Impact-Type Stilling Basin)

The image contains three technical drawings of a riprap apron and wing wall structure:

- PLAN:** A top-down view of the structure. It shows a rectangular apron of width a and length L . The wing wall has a width W . The structure is shown with a $1:1$ slope on the left and a $1.5:1$ slope on the right. A section line A-A is indicated.
- SECTION:** A cross-sectional view showing the profile of the apron. The height is H . The apron width is a . The base width is b . The height to the riprap is c . The riprap thickness is d . The base width is e . The structure is shown with a $1:1$ slope on the left and a $1.5:1$ slope on the right. A fillet is shown at the base of the wing wall.
- Wing Wall Detail:** A detail view of the wing wall showing a 45° angle and a flat fillet.

Riprap stone size diameter = $W/20$

ALTERNATE
END SILL AND
WING WALL

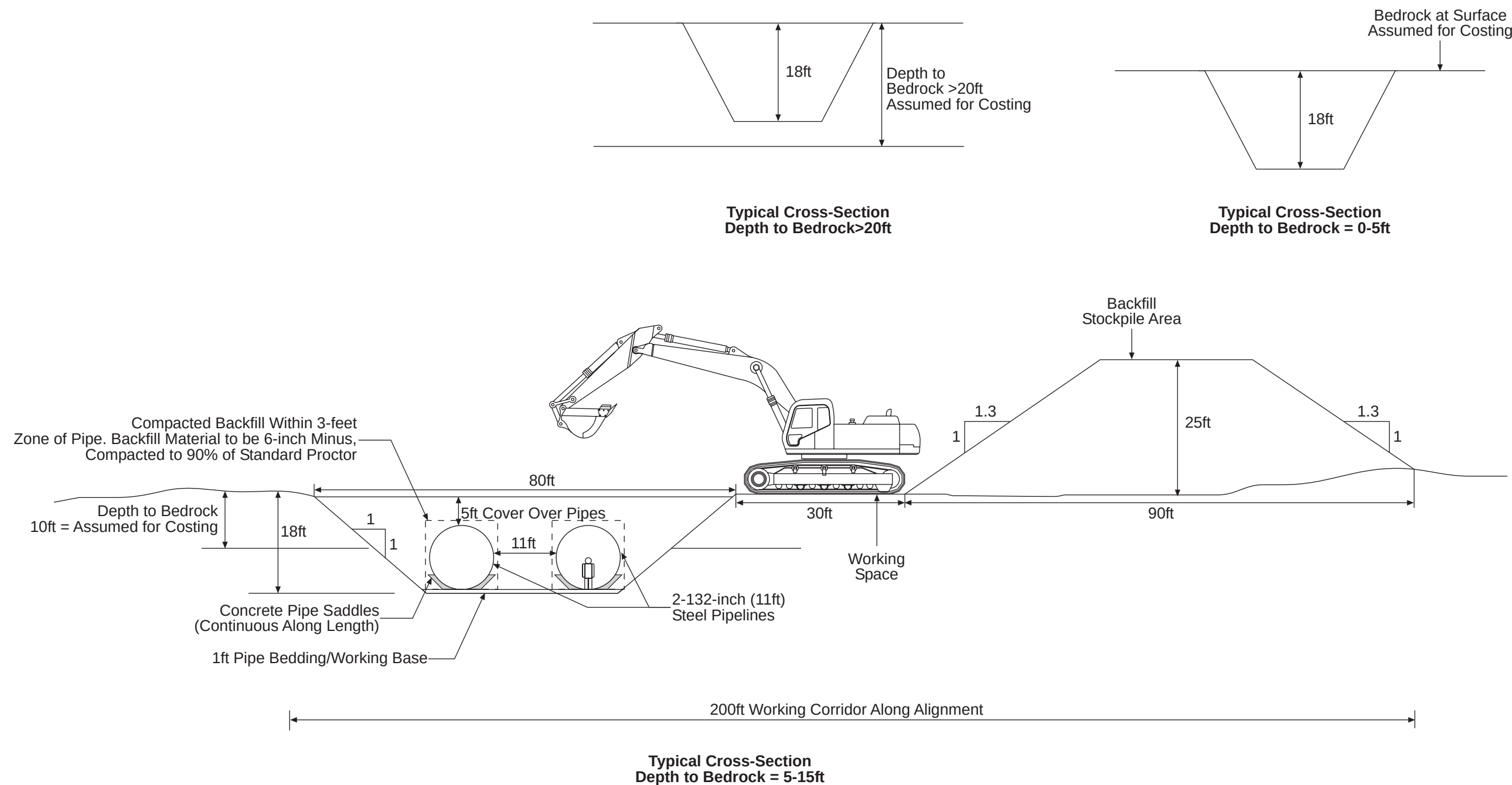
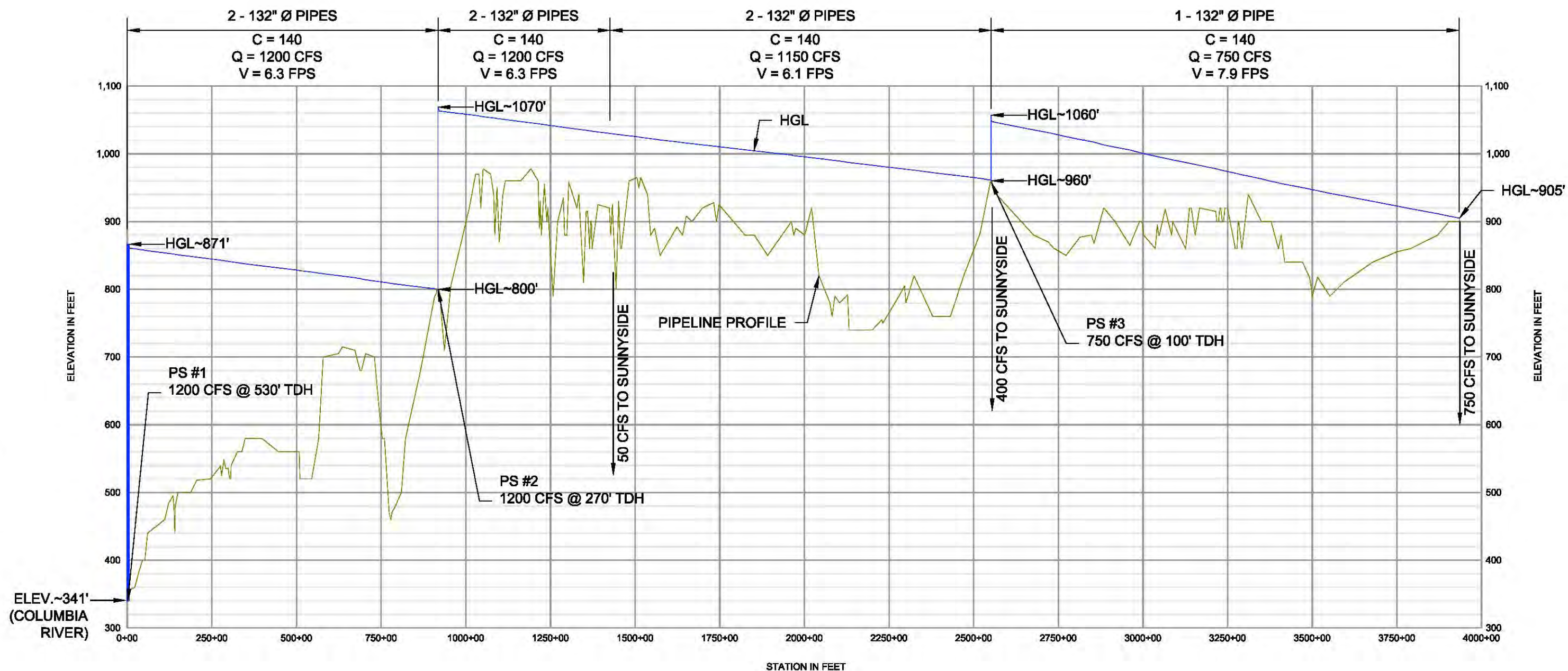


FIGURE 38
TYPICAL PIPELINE EXCAVATION CROSS-SECTION
FOR APPRAISAL LEVEL COST ESTIMATE
WSDOE/COLUMBIA BASIN WATER v.1/WA

APPENDIX A

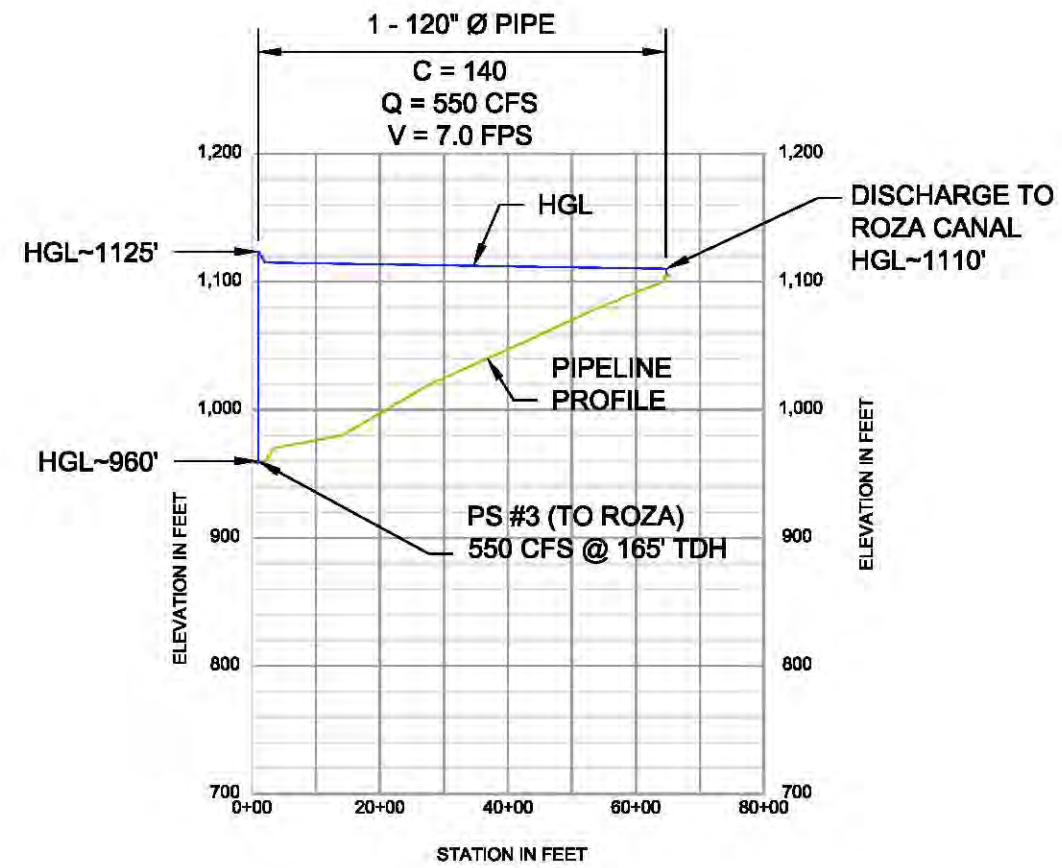
HYDRAULIC PROFILES

Oct 04, 2006 3:39pm hlevasseur K:\Jobs\060083 Yakima River\060083-01\06008301-001.dwg Plan 1



0 30,000
Scale in Feet

Oct 04, 2006 3:39pm hlevasseur K:\Jobs\060083 Yakima River\060083-01\060083-001.dwg Plan 2 - Roza

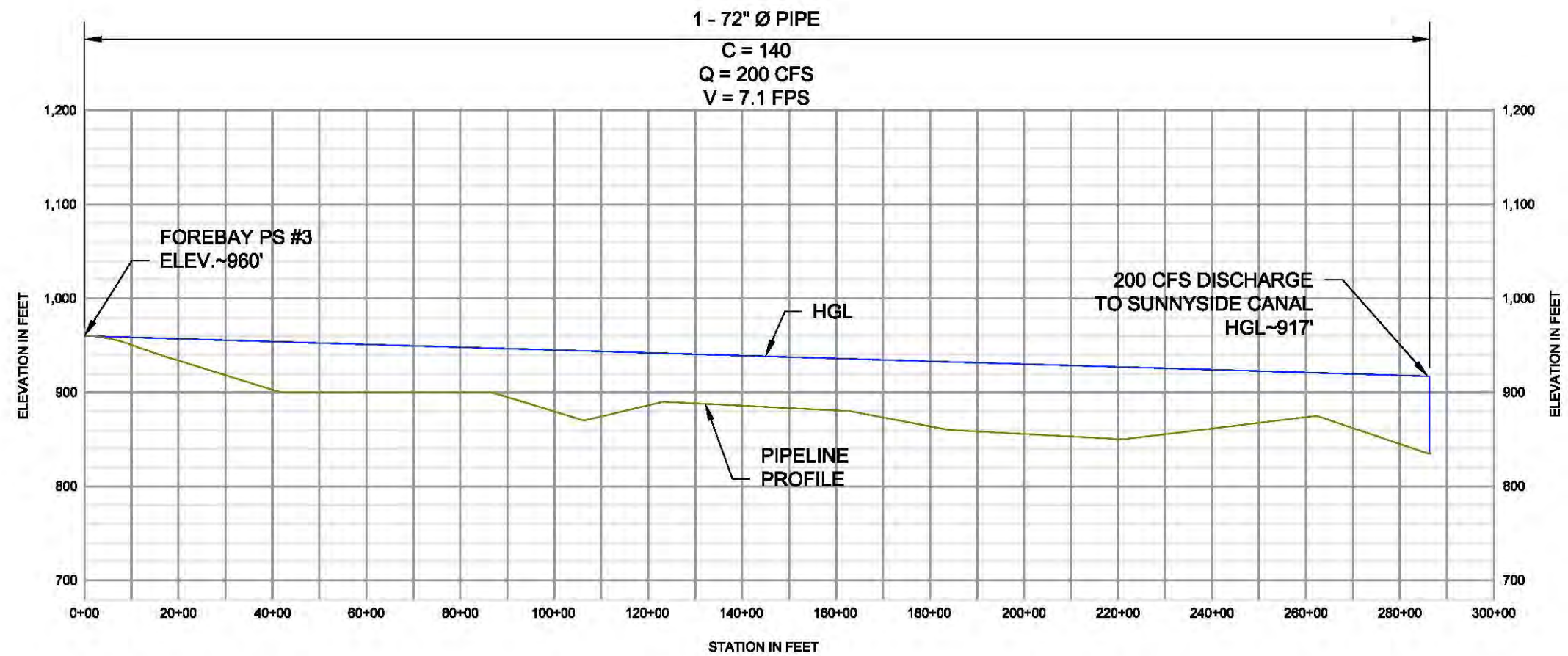


NOTE:
1) HYDRAULIC PROFILE FROM COLUMBIA RIVER TO PS #3 WOULD BE THE SAME UNDER PLANS 1 AND 2. SEE FIGURE A-1 FOR PLAN 1 PROFILE.

0 3,000
Scale in Feet



Figure A-2
Hydraulic Analysis Results - Hydraulic Profile
Yakima Pump Exchange
Plan 2 - PS #3 to Roza Canal



NOTES:

- 1) HYDRAULIC PROFILE FROM COLUMBIA RIVER TO PS #3 WOULD BE THE SAME UNDER PLANS 1 AND 2. SEE FIGURE A-1 FOR PLAN 1 PROFILE.
- 2) PROFILE SHOWN IS FOR 200 CFS DELIVERED BY GRAVITY. NO PUMPING IS REQUIRED AT PS #3 TO MAKE DELIVERY.

0 3,000
Scale in Feet

APPENDIX B

FIELD CONSTRUCTION COST ESTIMATE WORKSHEETS

Intake	2 sheets
Pump Station #1	3 sheets
Pump Station #2	4 sheets
Pump Station #3 - Plan 1	4 sheets
Pump Station #3 - Plan 2	3 sheets
Pump Stations Plan 1 Summary	2 sheets
Pump Stations Plan 2 Summary	2 sheets
Pipeline Construction – Plan 1	1 sheet
Pipeline Construction – Plan 2	1 sheet
Special Crossings Plans 1 & 2	1 sheet
Delivery Facilities Plan 1	1 sheet
Delivery Facilities Plan 2	1 sheet

ESTIMATE WORKSHEET

FEATURE: INTAKE		PROJECT:			
		Yakima Pump Exchange			
		COMPANY: MWH	PRICE LEVEL: Pre-Appraisal		
		FILE: G:\Golder Yakima Pump Back\06 Studies, Reports, Data\6.4 Report Cost Estimate \Cost Estimate 2006-09-05.xls\Intake			
DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	AMOUNT	
Structural					
<u>Intake</u>					
Concrete	3,600	CY	\$ 501.03	\$ 1,803,698.63	
Foundation Piles	10,400	LF	\$ 20.00	\$ 208,000.00	
Miscellaneous Metals	1	LS	\$ 200,000.00	\$ 200,000.00	
<u>Bridge</u>					
Deck & Supports	1	LS	\$ 400,000.00	\$ 400,000.00	
<u>Box Culvert Conduits (2 12' X 12')</u>					
Concrete	10,400	CY	\$ 501.03	\$ 5,210,684.93	
Mechanical					
<u>Fish Screens</u>					
All panels installed	3,080	SF	\$ 142.34	\$ 438,407.20	
<u>Other</u>					
Screen cleaners (brush)	1	LS	\$ 250,000.00	\$ 250,000.00	
Baffles	115,500	LB	\$ 4.00	\$ 462,000.00	
Sediment suspension system	1	LS	\$ 190,000.00	\$ 190,000.00	
Bulkheads	15,000	LB	\$ 6.00	\$ 90,000.00	
Electrical					
Plant Grounding (F&I)	1	LS	\$ 5,000.00	\$ 5,000.00	
Insulated Conductor (F&I)	1	LS	\$ 1,000.00	\$ 22,000.00	
Conduit Systems (F&I)	1	LS	\$ 33.00	\$ 33,000.00	
Distribution Panelboards (F&I)	1	EA	\$ 24,000.00	\$ 24,000.00	
Lighting Systems (F&I)	4	EA	\$ 400.00	\$ 1,600.00	
Sheet Subtotal				\$ 9,338,390.76	
Intake Subtotal				\$ 15,133,414.22	
BY Tom Finnegan		DATE 10/03/06	CHECKED <i>CME</i>	DATE 10/04/06	

ESTIMATE WORKSHEET

FEATURE: Pump Station 1		PROJECT: Yakima Pump Exchange			
		COMPANY: MWH	PRICE LEVEL: Pre-Appraisal		
		FILE: G:\Golder Yakima Pump Back\06 Studies, Reports, Data\6.4 Report Cost Estimates\Cost Estimate 2006-08-29.xls\Pump Station 1			
DESCRIPTION		QUANTITY	UNIT	UNIT PRICE	AMOUNT
Civil					
<u>Access Road</u>					
Clearing	3	AC	\$ 3,500.00	\$ 10,500.00	
Base	702	CY	\$ 26.00	\$ 18,252.00	
Paving	702	CY	\$ 135.00	\$ 94,770.00	
Drainage	1,895	LF	\$ 200.00	\$ 379,000.00	
<u>Switch Yard</u>					
Clearing	2	AC	\$ 3,500.00	\$ 7,000.00	
Base	1,393	CY	\$ 26.00	\$ 36,218.00	
Gravel	1,393	CY	\$ 26.00	\$ 36,218.00	
<u>Service Yard</u>					
Clear	15	AC	\$ 3,500.00	\$ 52,500.00	
Excavation	53,035	CY	\$ 5.00	\$ 265,175.00	
Backfill, Local Borrow	30,257	CY	\$ 9.00	\$ 272,313.00	
Base	175	CY	\$ 26.00	\$ 4,550.00	
Paving	175	CY	\$ 135.00	\$ 23,625.00	
Fence, Entire Site	3,255	LF	\$ 20.00	\$ 65,100.00	
<u>Dewatering</u>					
Wellpoints	1	LS	\$ 260,000.00	\$ 260,000.00	
<u>Surface Drainage</u>					
Site Drainage	1,000	LF	\$ 200.00	\$ 200,000.00	
Structural					
<u>Pump Station</u>					
Concrete	8,345	CY	\$ 463.52	\$ 3,868,108.58	
Steel Roof	1	LS	\$ 125,000.00	\$ 125,000.00	
Miscellaneous Metals	388,000	LB	\$ 7.00	\$ 2,716,000.00	
Sheet Subtotal					\$ 8,434,329.58
BY Tom Finnegan		DATE 10/03/06	CHECKED JLL	DATE 10/04/06	

ESTIMATE WORKSHEET

FEATURE: Pump Station 1		PROJECT: Yakima Pump Exchange		
		COMPANY: MWH	PRICE LEVEL: Pre-Appraisal	
		FILE: File Location, File Name, and Worksheet Tab		
DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	AMOUNT
<u>Flow Meter Vault</u>				
Concrete	200	CY	\$ 463.52	\$ 92,704.82
Miscellaneous Metals	70,000	LB	\$7.00	\$ 490,000.00
<u>Surge Tank Vaults</u>				
Concrete	3,100	CY	\$ 463.52	\$ 1,436,924.70
Miscellaneous Metals	60,000	LB	\$7.00	\$ 420,000.00
Mechanical				
<u>Pumps</u>				
Pumps	7	EA	\$2,900,000.00	\$ 20,300,000.00
Motors	7	EA	\$1,085,000.00	\$ 7,595,000.00
Valves, shutoff (ANSI)	7	EA	\$390,800.00	\$ 2,735,600.00
Valves, Pump Control (ANSI)	7	EA	\$511,000.00	\$ 3,577,000.00
Pump and Motor Installation	7	EA	\$1,200,000.00	\$ 8,400,000.00
<u>Other</u>				
Lubrication	1	LS	\$50,000.00	\$ 50,000.00
Fire System	1	LS	\$200,000.00	\$ 200,000.00
Cooling Water	1	LS	\$250,000.00	\$ 250,000.00
Compressed Air System	1	LS	\$100,000.00	\$ 100,000.00
Service Water	1	LS	\$100,000.00	\$ 100,000.00
Bridge Crane	1	LS	\$250,000.00	\$ 250,000.00
Flow Distribution Device	188,650	LB	\$4.00	\$ 754,600.00
Bulkhead	56,000	LB	\$4.00	\$ 224,000.00
HVAC	1	LS	\$565,000.00	\$ 565,000.00
54" Diameter Steel Pipe	1	LS	\$280,000.00	\$ 280,000.00
72" Diameter Steel Pipe	1	LS	\$1,740,000.00	\$ 1,740,000.00
132 " Diameter Steel Pipe	1	LS	\$3,310,000.00	\$ 3,310,000.00
Sheet Subtotal				\$ 52,870,829.52
BY Tom Finnegan		DATE 10/03/06	CHECKED 	DATE 

ESTIMATE WORKSHEET

FEATURE: Pump Station 1	PROJECT: Yakima Pump Exchange			
	COMPANY: MWH	PRICE LEVEL: Pre-Appraisal		
	FILE: File Location, File Name, and Worksheet Tab			
DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	AMOUNT
<u>Other</u>				
54" Flexible Coupling	6	EA	\$100,000.00	\$ 600,000.00
72" Flexible Coupling	14	EA	\$125,000.00	\$ 1,750,000.00
132" Flexible Coupling	3	EA	\$200,000.00	\$ 600,000.00
54" Butterfly Valve (ANSI)	6	EA	\$141,900.00	\$ 851,400.00
132" Butterfly Valve (ANSI)	3	EA	\$1,480,300.00	\$ 4,440,900.00
Ultrasonic Flowmeter	2	EA	\$50,000.00	\$ 100,000.00
40' Spherical Steel Surge Tank	6	EA	\$1,130,000.00	\$ 6,780,000.00
<u>Electrical</u>				
Plant Grounding (F&I)	1	LS	\$26,500.00	\$ 26,500.00
Motor Bus & Switchgear (F&I)	1	LS	\$4,275,000.00	\$ 4,275,000.00
Motor Control Equipment (F&I)	1	LS	\$200,000.00	\$ 200,000.00
Motors (listed under Plant Mechanical)				
15kV Metal-Clad Switchgear (F&I)	1	LS	\$90,000.00	\$ 90,000.00
15kV Non-Segregated-Phase Bus (F&I)	1	LS	\$80,000.00	\$ 80,000.00
Plant Station-Service Equipment (F&I)	1	LS	\$81,000.00	\$ 81,000.00
Building Lighting Systems (F&I)	1	LS	\$26,000.00	\$ 26,000.00
Building Fire Detection and Alarm System (F&I)	1	LS	\$150,000.00	\$ 150,000.00
Distribution Panelboards (F&I)	3	EA	\$80,000.00	\$ 240,000.00
Motor Control Centers (F&I)	2	EA	\$120,000.00	\$ 240,000.00
Insulated Conductor (F&I)	1	LS	\$52,000.00	\$ 52,000.00
Conduit Systems (F&I)	1	LS	\$49,000.00	\$ 49,000.00
Switchyard (F&I)	1	LS	\$3,255,000.00	\$ 3,255,000.00
Construct Transmission Line, 115kV	0.5	MILES	\$350,000.00	\$ 175,000.00
SCADA (F&I)	1	LS	\$1,356,000.00	\$ 1,356,000.00
Sheet Subtotal				\$ 25,417,800.00
Pump Station 1 Subtotal				\$ 86,722,959.10
BY Chris Deerkop	DATE 10/03/06	CHECKED <i>CMS</i>		DATE <i>10/24/06</i>

ESTIMATE WORKSHEET

FEATURE: Pump Station 2		PROJECT: Yakima Pump Exchange			
		COMPANY: MWH		PRICE LEVEL: Pre-Appraisal	
		FILE: G:\Golder Yakima Pump Back\06 Studies, Reports, Data\6.4 Report Cost Estimates\Cost Estimate 2006-08-29.xls\Pump Station 2			
DESCRIPTION		QUANTITY	UNIT	UNIT PRICE	AMOUNT
Civil					
<u>Access Road</u>					
Paving, Gravel	2,028	CY	\$ 26.00	\$ 52,728.00	
<u>Service Yard</u>					
Clear	16	AC	\$ 3,500.00	\$ 56,000.00	
Excavation, Common	7,031	CY	\$5.00	\$ 35,155.00	
Excavation, Rock	48,625	CY	\$32.00	\$ 1,556,000.00	
Base	667	CY	\$26.00	\$ 17,342.00	
Paving	667	CY	\$135.00	\$ 90,045.00	
Fence	3,340	LF	\$20.00	\$ 66,800.00	
<u>Surface Drainage</u>					
Site Drainage	1,000	LF	\$200.00	\$ 200,000.00	
<u>Reservoir</u>					
Clear	37	AC	\$ 3,500.00	\$ 129,500.00	
Excavation, Common	124,445	CY	\$5.00	\$ 622,225.00	
Excavation, Rock	41,182	CY	\$32.00	\$ 1,317,824.00	
Embankment, Exc. Material	73,516	CY	\$8.00	\$ 588,128.00	
Lining, Concrete	28,162	CY	\$350.00	\$ 9,856,700.00	
Fencing	5,052	LF	\$20.00	\$ 101,040.00	
Spillway In	1	LS	\$500,000.00	\$ 500,000.00	
Spillway Out	1	LS	\$150,000.00	\$ 150,000.00	
<u>Wasteway to River</u>					
Excavation	103,000	CY	\$5.00	\$ 515,000.00	
Backfill, Local Borrow	40,900	CY	\$9.00	\$ 368,100.00	
Concrete	13,628	CY	\$ 463.52	\$ 6,316,906.39	
Access	1	LS	\$400,000.00	\$ 400,000.00	
Stilling Basin	1	LS	\$3,000,000.00	\$ 3,000,000.00	
Sheet Subtotal				\$ 25,939,493.39	
BY Tom Finnegan		DATE 10/03/06	CHECKED JLL	DATE 10/04/06	

ESTIMATE WORKSHEET

FEATURE: Pump Station 2		PROJECT: Yakima Pump Exchange			
		COMPANY: MWH		PRICE LEVEL: Pre-Appraisal	
		FILE: File Location, File Name, and Worksheet Tab			
DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	AMOUNT	
Structural					
<u>Pump Station</u>					
Concrete	8,345	CY	\$ 463.52	\$ 3,868,108.58	
Steel Roof	1	LS	\$350,000.00	\$ 350,000.00	
Miscellaneous Metals	388,000	LB	\$7.00	\$ 2,716,000.00	
<u>Flow Meter Vault</u>					
Concrete	200	CY	\$ 463.52	\$ 92,704.82	
Miscellaneous Metals	70,000	LB	\$7.00	\$ 490,000.00	
<u>Surge Tank Vaults</u>					
Concrete	3,100	CY	\$ 463.52	\$ 1,436,924.70	
Miscellaneous Metals	60,000	LB	\$7.00	\$ 420,000.00	
Mechanical					
<u>Pumps</u>					
Pumps	7	EA	\$1,950,000.00	\$ 13,650,000.00	
Motors	7	EA	\$860,000.00	\$ 6,020,000.00	
Valves, shutoff (ANSI)	7	EA	\$390,800.00	\$ 2,735,600.00	
Valves, check (ANSI)	7	EA	\$511,000.00	\$ 3,577,000.00	
Pump and Motor Installation	7	EA	\$840,000.00	\$ 5,880,000.00	
<u>Other</u>					
Lubrication	1	LS	\$50,000.00	\$ 50,000.00	
Fire System	1	LS	\$200,000.00	\$ 200,000.00	
Cooling Water	1	LS	\$250,000.00	\$ 250,000.00	
Compressed Air System	1	LS	\$100,000.00	\$ 100,000.00	
Service Water	1	LS	\$100,000.00	\$ 100,000.00	
Bridge Crane	1	LS	\$250,000.00	\$ 250,000.00	
Flow Distribution Device	188,650	LB	\$4.00	\$ 754,600.00	
Bulkhead	56,000	LB	\$4.00	\$ 224,000.00	
Sheet Subtotal				\$ 43,164,938.10	
BY Tom Finnegan		DATE 10/03/06	CHECKED CMS		DATE 10/04/06

ESTIMATE WORKSHEET

FEATURE: Pump Station 2	PROJECT: Yakima Pump Exchange				
	COMPANY: MWH		PRICE LEVEL: Pre-Appraisal		
	FILE: File Location, File Name, and Worksheet Tab				
DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	AMOUNT	
HVAC	1	LS	\$565,000.00	\$ 565,000.00	
54" Diameter Steel Pipe	1	LS	\$280,000.00	\$ 280,000.00	
72" Diameter Steel Pipe	1	LS	\$1,740,000.00	\$ 1,740,000.00	
132 " Diameter Steel Pipe	1	LS	\$3,310,000.00	\$ 3,310,000.00	
54" Flexible Coupling	6	EA	\$100,000.00	\$ 600,000.00	
72" Flexible Coupling	14	EA	\$125,000.00	\$ 1,750,000.00	
132" Flexible Coupling	3	EA	\$200,000.00	\$ 600,000.00	
54" Butterfly Valve (ANSI)	6	EA	\$141,900.00	\$ 851,400.00	
132" Butterfly Valve (ANSI)	3	EA	\$1,480,300.00	\$ 4,440,900.00	
Ultrasonic Flowmeter	2	EA	\$50,000.00	\$ 100,000.00	
40' Spherical Steel Surge Tank	6	EA	\$1,130,000.00	\$ 6,780,000.00	
Electrical					
Plant Grounding (F&I)	1	LS	\$26,500.00	\$ 26,500.00	
Motor Bus & Switchgear (F&I)	1	LS	\$3,500,000.00	\$ 3,500,000.00	
Motor Control Equipment (F&I)	1	LS	\$200,000.00	\$ 200,000.00	
Motors (listed under Plant Mechanical)					
15kV Metal-Clad Switchgear (F&I)	1	LS	\$90,000.00	\$ 90,000.00	
15kV Non-Segregated-Phase Bus (F&I)	1	LS	\$80,000.00	\$ 80,000.00	
Plant Station-Service Equipment (F&I)	1	LS	\$81,000.00	\$ 81,000.00	
Building Lighting Systems (F&I)	1	LS	\$26,000.00	\$ 26,000.00	
Building Fire Detection and Alarm System (F&I)	1	LS	\$150,000.00	\$ 150,000.00	
Distribution Panelboards (F&I)	3	EA	\$80,000.00	\$ 240,000.00	
Motor Control Centers (F&I)	2	EA	\$120,000.00	\$ 240,000.00	
Insulated Conductor (F&I)	1	LS	\$52,000.00	\$ 52,000.00	
Conduit Systems (F&I)	1	LS	\$49,000.00	\$ 49,000.00	
Sheet Subtotal					
				\$ 25,751,800.00	
BY Chris Deerkop	DATE 10/03/06	CHECKED <i>CMS</i>		DATE 10/04/06	

ESTIMATE WORKSHEET

[illegible]

ESTIMATE WORKSHEET

FEATURE: Pump Station 3 - Plan 1	PROJECT: Yakima Pump Exchange			
	COMPANY: MWH	PRICE LEVEL: Pre-Appraisal		
	FILE: G:\Golder Yakima Pump Back\06 Studies, Reports, Data\6.4 Report Cost Estimates\Cost Estimate 2006-08-29.xls\Pump Station 3			
DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	AMOUNT
Civil				
<u>Access Road</u>				
Clearing	1	AC	\$ 3,500.00	\$ 3,500.00
Base	240	CY	\$ 26.00	\$ 6,240.00
Paving	240	CY	\$ 135.00	\$ 32,400.00
Drainage	650	LF	\$ 200.00	\$ 130,000.00
<u>Service Yard</u>				
Clear	3	AC	\$ 3,500.00	\$ 10,500.00
Excavation, Common	6,192	CY	\$ 5.00	\$ 30,960.00
Excavation, Rock	42,826	CY	\$ 32.00	\$ 1,370,432.00
Base	296	CY	\$ 26.00	\$ 7,696.00
Paving	296	CY	\$ 135.00	\$ 39,960.00
Fence, Entire Site	9,000	LF	\$ 20.00	\$ 180,000.00
<u>Switch Yard</u>				
Clear	1	AC	\$ 3,500.00	\$ 3,500.00
Base	185	CY	\$ 26.00	\$ 4,810.00
Paving	185	CY	\$ 135.00	\$ 24,975.00
<u>Surface Drainage</u>				
Site Drainage	750	LF	\$ 200.00	\$ 150,000.00
<u>Reservoir</u>				
Clear	33	AC	\$ 3,500.00	\$ 115,500.00
Excavation, Common	75,540	CY	\$ 5.00	\$ 377,700.00
Excavation, Rock	25,000	CY	\$ 32.00	\$ 800,000.00
Embankment, Exc. Material	44,625	CY	\$ 8.00	\$ 357,000.00
Lining, Concrete	17,095	CY	\$ 400.00	\$ 6,838,000.00
Spillway In	1	LS	\$ 950,000.00	\$ 950,000.00
Spillway Out	1	LS	\$ 500,000.00	\$ 500,000.00
Sheet Subtotal				\$ 11,933,173.00
BY Tom Finnegan	DATE 10/03/06	CHECKED JLL	DATE 10/04/06	

ESTIMATE WORKSHEET

FEATURE: Pump Station 3 - Plan 1		PROJECT: Yakima Pump Exchange			
		COMPANY: MWH		PRICE LEVEL: Pre-Appraisal	
		FILE: File Location, File Name, and Worksheet Tab			
DESCRIPTION		QUANTITY	UNIT	UNIT PRICE	AMOUNT
<u>Intake</u>					
Clear	1	AC	\$ 3,500.00	\$ 3,500.00	
Excavation, Common	2,889	CY	\$5.00	\$ 14,445.00	
Excavation, Rock	7,367	CY	\$32.00	\$ 235,744.00	
Concrete	2,200	CY	\$ 463.52	\$ 1,019,753.01	
Structural					
<u>Pump Station</u>					
Concrete	2,900	CY	\$ 463.52	\$ 1,344,219.88	
Steel Roof	1	LS	\$125,000.00	\$ 125,000.00	
Miscellaneous Metals	135,000	LB	\$7.00	\$ 945,000.00	
<u>Flow Meter Vault</u>					
Concrete	310	CY	\$ 463.52	\$ 143,692.47	
Miscellaneous Metals	25,000	LB	\$7.00	\$ 175,000.00	
Mechanical					
<u>Pumps</u>					
Pumps	5	EA	\$1,400,000.00	\$ 7,000,000.00	
Motors	5	EA	\$407,000.00	\$ 2,035,000.00	
Valves, shutoff (AWWA)	5	EA	\$145,000.00	\$ 725,000.00	
Valves, Pump Control (AWWA)	5	EA	\$265,000.00	\$ 1,325,000.00	
Pump and Motor Installation	5	EA	\$540,000.00	\$ 2,700,000.00	
Sheet Subtotal				\$ 17,791,354.36	
BY Tom Finnegan		DATE 10/03/06	CHECKED 		DATE 

ESTIMATE WORKSHEET

[illegible]

ESTIMATE WORKSHEET

FEATURE: Pump Station 3 - Plan 1		PROJECT: Yakima Pump Exchange		
		COMPANY: MWH	PRICE LEVEL: Pre-Appraisal	
		FILE: File Location, File Name, and Worksheet Tab		
DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	AMOUNT
Electrical				
Plant Grounding (F&I)	1	LS	\$19,000.00	\$ 19,000.00
Motor Bus & Switchgear (F&I)	1	LS	\$1,500,000.00	\$ 1,500,000.00
Motor Control Equipment (F&I)	1	LS	\$200,000.00	\$ 200,000.00
Motors (listed under Plant Mechanical)				
15kV Metal-Clad Switchgear (F&I)	1	LS	\$90,000.00	\$ 90,000.00
15kV Non-Segregated-Phase Bus (F&I)	1	LS	\$80,000.00	\$ 80,000.00
Plant Station-Service Equipment (F&I)	1	LS	\$81,000.00	\$ 81,000.00
Building Lighting Systems (F&I)	1	LS	\$26,000.00	\$ 26,000.00
Building Fire Detection and Alarm System (F&I)	1	LS	\$150,000.00	\$ 150,000.00
Distribution Panelboards (F&I)	3	EA	\$80,000.00	\$ 240,000.00
Motor Control Centers (F&I)	2	EA	\$120,000.00	\$ 240,000.00
Insulated Conductor (F&I)	1	LS	\$52,000.00	\$ 52,000.00
Conduit Systems (F&I)	1	LS	\$49,000.00	\$ 49,000.00
Switchyard (F&I)	1	LS	\$500,000.00	\$ 500,000.00
Tap at existing 115kV line	1.0	LS	\$272,000.00	\$ 272,000.00
Construct Transmission Line, 115kV	3	MILES	\$350,000.00	\$ 1,050,000.00
Sheet Subtotal				\$ 4,549,000.00
Pump Station 3 - Plan 1 Subtotal				\$ 41,640,527.36
BY Chris Deerkop		DATE 10/03/06	CHECKED 	DATE 10/04/06

ESTIMATE WORKSHEET

FEATURE: Pump Station 3 - Plan 2		PROJECT: Yakima Pump Exchange			
		COMPANY: MWH	PRICE LEVEL: Pre-Appraisal		
		FILE: G:\Golder Yakima Pump Back\06 Studies, Reports, Data\6.4 Report Cost Estimates\Cost Estimate 2006-08-29.xls\Pump Station 3			
DESCRIPTION		QUANTITY	UNIT	UNIT PRICE	AMOUNT
Civil					
<u>Access Road</u>					
Clearing	1	AC	\$ 3,500.00	\$ 3,500.00	
Base	240	CY	\$ 26.00	\$ 6,240.00	
Paving	240	CY	\$ 135.00	\$ 32,400.00	
Drainage	650	LF	\$ 200.00	\$ 130,000.00	
<u>Service Yard</u>					
Clear	3	AC	\$ 3,500.00	\$ 10,500.00	
Excavation, Common	6,192	CY	\$ 5.00	\$ 30,960.00	
Excavation, Rock	42,826	CY	\$ 32.00	\$ 1,370,432.00	
Base	296	CY	\$ 26.00	\$ 7,696.00	
Paving	296	CY	\$ 135.00	\$ 39,960.00	
Fence, Entire Site	9,100	LF	\$ 20.00	\$ 182,000.00	
<u>Switch Yard</u>					
Clear	1	AC	\$ 3,500.00	\$ 3,500.00	
Base	185	CY	\$ 26.00	\$ 4,810.00	
Paving	185	CY	\$ 135.00	\$ 24,975.00	
<u>Surface Drainage</u>					
Site Drainage	1	LS	\$ 200,000.00	\$ 200,000.00	
<u>Reservoir</u>					
Clear	28	AC	\$ 3,500.00	\$ 98,000.00	
Excavation, Common	55,685	CY	\$ 5.00	\$ 278,425.00	
Excavation, Rock	18,430	CY	\$ 32.00	\$ 589,760.00	
Embankment, Exc. Material	32,900	CY	\$ 8.00	\$ 263,200.00	
Lining, Concrete	12,600	CY	\$ 400.00	\$ 5,040,000.00	
Spillway In	1	LS	\$ 900,000.00	\$ 900,000.00	
Spillway Out	1	LS	\$ 430,000.00	\$ 430,000.00	
Sheet Subtotal				\$ 9,646,358.00	
BY Tom Finnegan		DATE 10/03/06	CHECKED JLL		DATE 10/04/06

ESTIMATE WORKSHEET

FEATURE: Pump Station 3 - Plan 2		PROJECT: Yakima Pump Exchange			
		COMPANY: MWH		PRICE LEVEL: Pre-Appraisal	
		FILE: File Location, File Name, and Worksheet Tab			
DESCRIPTION		QUANTITY	UNIT	UNIT PRICE	AMOUNT
Civil Continued					
<u>Intake</u>					
Clear	1	AC	\$ 3,500.00	\$ 3,500.00	
Excavation, Common	2,889	CY	\$5.00	\$ 14,445.00	
Excavation, Rock	7,367	CY	\$32.00	\$ 235,744.00	
Concrete	2,200	CY	\$ 463.52	\$ 1,019,753.01	
Structural					
<u>Pump Station</u>					
Concrete	2,500	CY	\$ 463.52	\$ 1,158,810.24	
Steel Roof	1	LS	\$100,000.00	\$ 100,000.00	
Miscellaneous Metals		LB	\$7.00		
<u>Flow Meter Vault</u>					
Concrete	310	CY	\$ 463.52	\$ 143,692.47	
Miscellaneous Metals	25,000	LB	\$7.00	\$ 175,000.00	
<u>Flow Meter Vault</u>					
Concrete	1,000	CY	\$ 463.52	\$ 463,524.10	
Miscellaneous Metals	60,350	LB	\$7.00	\$ 422,450.00	
Mechanical					
<u>Pumps</u>					
Pumps	4	EA	\$1,800,000.00	\$ 7,200,000.00	
Motors	4	EA	\$791,000.00	\$ 3,164,000.00	
Valves, shutoff (AWWA)	4	EA	\$145,000.00	\$ 580,000.00	
Valves, Pump Control (AWWA)	4	EA	\$265,000.00	\$ 1,060,000.00	
Pump Installation	4	EA	\$780,000.00	\$ 3,120,000.00	
Sheet Subtotal					\$ 18,860,918.82
BY Tom Finnegan		DATE 10/03/06	CHECKED <i>cmg</i>		DATE 10/04/06

ESTIMATE WORKSHEET

[illegible]

ESTIMATE WORKSHEET

[illegible]

ESTIMATE WORKSHEET

FEATURE: PLAN 1 SUMMARY		PROJECT:		
		Yakima Pump Exchange		
		COMPANY: MWH	PRICE LEVEL: Pre-Appraisal	
		FILE: G:\Golder Yakima Pump Back\06 Studies, Reports, Data\6.4 Report Cost Estimate \Cost Estimate 2006-09-05.xls\Summary		
DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	AMOUNT
PUMP STATION 2				
Subtotal				\$ 98,300,000
Mobilization	+/-	5%		\$ 5,000,000
Subtotal with mobilization				\$ 103,300,000
Unlisted items	+/-	15%		\$ 14,800,000
PUMP STATION 2 CONTRACT COST				\$ 118,100,000
Contingencies	+/-	25%		\$ 29,600,000
PUMP STATION 2 FIELD COST				\$ 147,700,000
PUMP STATION 3				
Subtotal				\$ 41,700,000
Mobilization	+/-	5%		\$ 2,100,000
Subtotal with mobilization				\$ 43,800,000
Unlisted items	+/-	15%		\$ 6,300,000
PUMP STATION 3 CONTRACT COST				\$ 50,100,000
Contingencies	+/-	25%		\$ 12,600,000
PUMP STATION 3 FIELD COST				\$ 62,700,000
TOTAL FIELD COST				\$ 363,700,000
BY Tom Finnegan		DATE 10/3/2006	CHECKED DED	DATE 10-4-06

ESTIMATE WORKSHEET

FEATURE: PLAN 2 SUMMARY		PROJECT:		
		Yakima Pump Exchange		
		COMPANY: MWH	PRICE LEVEL:	Pre-Appraisal
		FILE:		
G:\Golder Yakima Pump Back\06 Studies, Reports, Data\6.4 Report Cost Estimate Cost Estimate 2006-09-05.xls\Summary				
DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	AMOUNT
Estimate worksheet identify one type of intake, Pump Station 1, and Pump Station 2, and two types of Pump Station 3:				
Plan 1: Pumped				
Plan 2: Pumped and gravity				
INTAKE				
Subtotal				\$ 15,200,000
Mobilization		+/- 5%		\$ 800,000
Subtotal with mobilization				\$ 16,000,000
Unlisted items		+/- 15%		\$ 2,300,000
INTAKE CONTRACT COST				\$ 18,300,000
Contingencies		+/- 25%		\$ 4,600,000
INTAKE FIELD COST				\$ 22,900,000
PUMP STATION 1				
Subtotal				\$ 86,800,000
Mobilization		+/- 5%		\$ 4,400,000
Subtotal with mobilization				\$ 91,200,000
Unlisted items		+/- 15%		\$ 13,100,000
PUMP STATION 1 CONTRACT COST				\$ 104,300,000
Contingencies		+/- 25%		\$ 26,100,000
PUMP STATION 1 FIELD COST				\$ 130,400,000
BY		DATE	CHECKED	DATE
Tom Finnegan		10/3/2006	DED	10-4-06

ESTIMATE WORKSHEET

FEATURE: PLAN 2 SUMMARY	PROJECT:			
	Yakima Pump Exchange			
	COMPANY:	MWH	PRICE LEVEL:	Pre-Appraisal
	FILE: G:\Golder Yakima Pump Back\06 Studies, Reports, Data\6.4 Report Cost Estimate \Cost Estimate 2006-09-05.xls\Summary			
DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	AMOUNT
PUMP STATION 2				
Subtotal				\$ 98,300,000
Mobilization		+/- 5%		\$ 5,000,000
Subtotal with mobilization				\$ 103,300,000
Unlisted items		+/- 15%		\$ 14,800,000
PUMP STATION 2 CONTRACT COST				\$ 118,100,000
Contingencies		+/- 25%		\$ 29,600,000
PUMP STATION 2 FIELD COST				\$ 147,700,000
PUMP STATION 3				
Subtotal				\$ 43,900,000
Mobilization		+/- 5%		\$ 2,200,000
Subtotal with mobilization				\$ 46,100,000
Unlisted items		+/- 15%		\$ 6,600,000
PUMP STATION 3 CONTRACT COST				\$ 52,700,000
Contingencies		+/- 25%		\$ 13,200,000
PUMP STATION 3 FIELD COST				\$ 65,900,000
TOTAL FIELD COST				\$ 366,900,000
BY	Tom Finnegan		DATE	10/3/2006
CHECKED	DED		DATE	10-4-'06

ESTIMATE WORKSHEET

FEATURE: PIPELINE CONSTRUCTION - PLAN 1	PROJECT: Yakima Pump Exchange			
	COMPANY: GOLDER	PRICE LEVEL: Pre-Appraisal		
	FILE: Environmental\PROJECTS\2001 PROJECTS\013-1500 - Ecology Water Rights\Ext 007A Yakima Pump Exchange\preliminary costs- ver5USBR			
DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	AMOUNT
<u>Site Preparation</u>				
Clear and Grade	1831	AC	\$ 3,203.18	\$ 5,865,757.73
<u>Excavation of Pipe Trench</u>				
Soil Excavation	10672926	CY	\$ 4.47	\$ 47,714,258.69
Rock Excavation (drilling and blasting)	3246440	CY	\$ 44.71	\$ 145,134,955.64
Shallow Groundwater Dewatering	1	LS	\$ 369,005.63	\$ 369,005.63
<u>Stockpiling and Backfill</u>				
Backfill Pipe Trench	10461733	CY	\$ 6.00	\$ 62,770,395.31
Borrow Backfill (and hauling)	0	CY	\$ 22.25	\$ -
Pipe Bedding (includes hauling)	529127	CY	\$ 41.28	\$ 21,839,857.74
Pipe Saddle Supports (concrete)	157154	CY	\$ 463.00	\$ 72,762,137.15
<u>Special Crossings</u>				
I-182 Crossing	1	LS	\$ 217,800.00	\$ 217,800.00
SR 240 Crossing	1	LS	\$ 689,700.00	\$ 689,700.00
Canal 1 Crossing	1	LS	\$ 21,000.00	\$ 21,000.00
Canal 2 Crossing	1	LS	\$ 83,600.00	\$ 83,600.00
Canal 3 Crossing	1	LS	\$ 26,400.00	\$ 26,400.00
Canal 4 Crossing	1	LS	\$ 36,000.00	\$ 36,000.00
Yakima River Crossing	1	LS	\$ 1,790,452.32	\$ 1,790,452.32
<u>Pipe</u>				
Steel Pipe, 132-inches	638,736	LF	\$ 1,237.80	\$ 790,627,064.68
Steel Pipe, 84-inches	9,457	LF	\$ 562.86	\$ 5,322,967.02
Steel Pipe, 36-inches	4,646	LF	\$ 144.32	\$ 670,496.38
Air/Vacuum Standpipe Structure	5	EA	\$ 106,146	\$ 530,730.00
<u>Subtotal</u>				\$ 1,156,472,578.30
<u>Subtotal Pay Items</u>				\$ 1,156,500,000.00
<u>Mobilization Cost</u>	5%			\$ 57,800,000.00
<u>Unlisted Items</u>	15%			\$ 182,100,000.00
<u>Subtotal Construction Contract Cost</u>				\$ 1,396,400,000.00
<u>Preliminary Contingency</u>	25%			\$ 349,100,000.00
<u>TOTAL FIELD COST</u>				\$ 1,745,500,000.00
BY Colby Caywood	DATE 10/2/2006		CHECKED AR	DATE 10/3/2006

ESTIMATE WORKSHEET

FEATURE: PIPELINE CONSTRUCTION - PLAN 2	PROJECT:			
	Yakima Pump Exchange			
	COMPANY: GOLDER	PRICE LEVEL: Pre-Appraisal		
	FILE:			
\\Environmental\PROJECTS\ 2001 PROJECTS\ 013-1500 - Ecology Water Rights\Ext 007A Yakima Pump Exchange\preliminary costs ver4				
ITEM	QUANTITY	UNIT	UNIT COST	AMOUNT
<u>Site Preparation</u>				
Clear and Grade	1388	AC	\$ 3,203.18	\$ 4,446,858.38
<u>Excavation of Pipe Trench</u>				
Soil Excavation	7807953	CY	\$ 4.47	\$ 34,906,143.34
Rock Excavation (drilling and blasting)	3246440	CY	\$ 44.71	\$ 145,134,955.64
Shallow Groundwater Dewatering	1	LS	\$ 369,005.63	\$ 369,005.63
<u>Stockpiling and Backfill</u>				
Backfill Pipe Trench	8530361	CY	\$ 6.00	\$ 51,182,167.57
Borrow Backfill (and hauling)	2208939	CY	\$ 22.25	\$ 49,146,518.41
Pipe Bedding (includes hauling)	438753	CY	\$ 41.28	\$ 18,109,654.75
Pipe Saddle Supports (concrete)	133928	CY	\$ 463.00	\$ 62,008,503.56
<u>Special Crossings</u>				
I-182 Crossing	1	LS	\$ 217,800.00	\$ 217,800.00
SR 240 Crossing	1	LS	\$ 689,700.00	\$ 689,700.00
Canal 1 Crossing	1	LS	\$ 21,000.00	\$ 21,000.00
Canal 2 Crossing	1	LS	\$ 83,600.00	\$ 83,600.00
Canal 3 Crossing	1	LS	\$ 26,400.00	\$ 26,400.00
Yakima River Crossing	1	LS	\$ 1,790,452.32	\$ 1,790,452.32
<u>Pipe</u>				
Steel Pipe, 132-inches	507,907	LF	\$ 1,237.80	\$ 628,687,810.17
Steel Pipe, 120-inches	6,039	LF	\$ 964.34	\$ 5,823,649.26
Steel Pipe, 84-inches	9,457	LF	\$ 562.86	\$ 5,322,967.02
Steel Pipe, 72-inches	28,266	LF	\$ 482.74	\$ 13,645,128.84
Steel Pipe, 36-inches	4,646	LF	\$ 144.32	\$ 670,496.38
Air/Vacuum Standpipe Structure	5	EA	\$ 106,146	\$ 530,730.00
<u>Subtotal</u>				\$1,022,813,541.26
<u>Subtotal Pay Items</u>				\$1,022,800,000.00
<u>Mobilization Cost</u>	5%			\$ 51,100,000.00
<u>Unlisted Items</u>	15%			\$ 161,100,000.00
<u>Subtotal Construction Contract Cost</u>				\$1,235,000,000.00
<u>Preliminary Contingency</u>	25%			\$ 308,800,000.00
<u>TOTAL FIELD COST</u>				\$1,543,800,000.00
BY Colby Caywood	DATE 10/2/2006		CHECKED AR	DATE 10/3/2006

ESTIMATE WORKSHEET

FEATURE: SPECIAL CROSSINGS PLAN 1 AND PLAN 2	PROJECT:			
	Yakima Pump Exchange			
	COMPANY: GOLDER	PRICE LEVEL: Pre-Appraisal		
	FILE:			
Environmental\PROJECTS\2001 PROJECTS\013-1500 - Ecology Water Rights\Ext 007A Yakima Pump Exchange/preliminary costs. ver5USBR				
DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	AMOUNT
<u>Highway I-182 Crossing</u>				
Soil Excavation	1	LS	\$ 217,800.00	\$ 217,800.00
Rock Excavation (drilling and blasting)	0	LS	\$ -	\$ -
<u>SR 240 Crossing</u>				
Mixed Rock and Soil Excavation	1	LS	\$ 689,700.00	\$ 689,700.00
<u>Canal Crossings</u>				
Canal 1 Crossing	1	LS	\$ 21,000.00	\$ 21,000.00
Canal 2 Crossing	1	LS	\$ 83,600.00	\$ 83,600.00
Canal 3 Crossing	1	LS	\$ 26,400.00	\$ 26,400.00
Canal 4 Crossing	1	LS	\$ 36,000.00	\$ 36,000.00
<u>Yakima River Crossing</u>				
Excavation	132,719	CY	\$ 10.52	\$ 1,396,530.61
River Diversion/Dewatering	49	DAY	\$ 1,052.25	\$ 51,560.25
Special Installation	650	LF	\$ 526.13	\$ 341,981.25
Subtotal				\$ 1,790,452.32
<u>Subtotal</u>				\$ 2,864,952.32
<u>Subtotal Pay Items</u>				\$ 2,900,000.00
<u>Mobilization Cost</u>	5%			\$ 100,000.00
<u>Unlisted Items</u>	15%			\$ 500,000.00
<u>Subtotal Construction Contract Cost</u>				\$ 3,500,000.00
<u>Preliminary Contingency</u>	25%			\$ 900,000.00
<u>TOTAL FIELD COST</u>				\$ 4,400,000.00
BY	DATE		CHECKED	DATE
Colby Caywood	10/2/2006		AR	10/3/2006

FEATURE: DELIVERY FACILITIES PLAN 1	PROJECT: Yakima Pump Exchange			
	COMPANY: Anchor	PRICE LEVEL: Pre-Appraisal		
	FILE:			
DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	AMOUNT
<u>Site Preparation</u>				
Clear and Grade	0.3	AC	\$ 3,500.00	\$ 1,050.00
<u>Excavation</u>				
Soil Excavation	1600	CY	\$ 5.00	\$ 8,000.00
Rock Excavation (drilling and blasting)	1600	CY	\$ 50.00	\$ 80,000.00
Shallow Groundwater Dewatering	1	LS	\$ 40,000.00	\$ 40,000.00
<u>Stockpiling and Backfill</u>				
Backfill	625	CY	\$ 6.00	\$ 3,750.00
Borrow Backfill (and hauling)	100	CY	\$ 26.10	\$ 2,610.00
<u>Structures</u>				
Concrete	350	CY	\$ 400.00	\$ 140,000.00
Misc Metals (grates, railings)	1000	LB	\$ 7.00	\$ 7,000.00
<u>Canal Lining Erosion Protection</u>				
Shotcrete Lining	21000	SF	\$ 2.60	\$ 54,600.00
<u>Pipe</u>				
Steel Pipe, 96-inches	20	LF	\$ 643.50	\$ 12,870.00
Steel Pipe, 84-inches	20	LF	\$ 562.86	\$ 11,257.20
Steel Pipe, 36-inches	20	LF	\$ 144.32	\$ 2,886.34
<u>Subtotal</u>				\$ 364,023.54
<u>Subtotal Pay Items</u>				\$ 360,000.00
<u>Mobilization Cost</u>	5%			\$ 20,000.00
<u>Unlisted Items</u>	15%			\$ 60,000.00
<u>Subtotal Construction Contract Cost</u>				\$ 440,000.00
<u>Preliminary Contingency</u>	25%			\$ 110,000.00
<u>TOTAL FIELD COST</u>				\$ 550,000.00
BY Robert Montgomery	DATE 10/2/2006		CHECKED CC	DATE 10/3/2006

FEATURE: DELIVERY FACILITIES PLAN 2	PROJECT: Yakima Pump Exchange			
	COMPANY: Anchor		PRICE LEVEL: Pre-Appraisal	
	FILE:			
DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	AMOUNT
<u>Site Preparation</u>				
Clear and Grade	0.4	AC	\$ 3,500.00	\$ 1,400.00
<u>Excavation</u>				
Soil Excavation	750	CY	\$ 5.00	\$ 3,750.00
Rock Excavation (drilling and blasting)	750	CY	\$ 50.00	\$ 37,500.00
Shallow Groundwater Dewatering	1	LS	\$ 35,000.00	\$ 35,000.00
<u>Stockpiling and Backfill</u>				
Backfill	375	CY	\$ 6.00	\$ 2,250.00
Borrow Backfill (and hauling)	75	CY	\$ 26.10	\$ 1,957.50
<u>Structures</u>				
Concrete	350	CY	\$ 400.00	\$ 140,000.00
Misc Metals (grates, railings)	1000	LB	\$ 7.00	\$ 7,000.00
<u>Canal Lining Erosion Protection</u>				
Shotcrete Lining	28000	SF	\$ 2.60	\$ 72,800.00
<u>Pipe</u>				
Steel Pipe, 84-inches	40	LF	\$ 562.86	\$ 22,514.40
Steel Pipe, 72-inches	40	LF	\$ 482.74	\$ 19,309.60
Steel Pipe, 36-inches	20	LF	\$ 144.32	\$ 2,886.34
<u>Subtotal</u>				\$ 346,367.84
<u>Subtotal Pay Items</u>				\$ 350,000.00
<u>Mobilization Cost</u>	5%			\$ 20,000.00
<u>Unlisted Items</u>	15%			\$ 60,000.00
<u>Subtotal Construction Contract Cost</u>				\$ 430,000.00
<u>Preliminary Contingency</u>	25%			\$ 110,000.00
<u>TOTAL FIELD COST</u>				\$ 540,000.00
BY Robert Montgomery	DATE 10/2/2006		CHECKED CC	DATE 10/3/2006