WaterSMART

Water and Energy Efficiency Grants for Fiscal Year 2018

Funding Opportunity Announcement

No. BOR-DO-18-F006

Prepared by

KITTITAS RECLAMATION DISTRICT

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EXECUTIVE SUMMARY

Date:	May 9, 2018
Applicant:	Kittitas Reclamation District
City/County/State:	Ellensburg, Kittitas, Washington
Reclamation Area:	Yakima Project

The Kittitas Reclamation District ("KRD") presents this application for funding by the U.S. Bureau of Reclamation's ("Reclamation") WaterSMART: Water and Energy Efficiency Grants for Fiscal Year 2018 Funding Opportunity Announcement No. BOR-DO-18-F006. KRD seeks $300,000 in federal funding assistance for Federal Funding Group I. KRD will use the funds (matched with $300,000 non-Federal) to provide benefits for fish and wildlife and the environment through a water conservation program designed to restore instream flows in over-appropriated or flow-impaired tributaries to the upper Yakima River. The program provides the instream flow through measures designed to reduce canal seepage and designate 100% of the otherwise lost water through an allocation, management, and protection agreement for instream flows. This application will eliminate water loss in a section of KRD's South Branch Canal. The water will then be delivered for instream flow to the streams in Figure 1. The project provides significant benefits for irrigators and for fish and wildlife and the environment. Water delivered to the streams for instream flow will benefit designated Critical Habitat for ESA-listed steelhead and Bull trout. KRD will begin implementation after the 2018 irrigation season and complete by spring 2019. Water designated for instream flow is estimated at 183 acre-feet/year (0.51 cfs).

BACKGROUND DATA

SERVICE AREA AND PROJECT LOCATION

KRD lies in Kittitas County in central Washington State and is part of Reclamation's 'Yakima Basin Project' (Fig. 1). Headquartered in the city of Ellensburg, KRD diverts water from the Yakima River near Lake Easton and serves lands along both sides of the Yakima River through the Kittitas Valley. The total service area encompasses about 104,588 acres and is approximately 40 miles long by 10 miles wide.

KRD was organized under Revised Code of Washington Title 87, Irrigation Laws of the State of Washington, on September 25, 1911, and in accordance with KRD's Federal Repayment Contract. KRD assesses and delivers water to customers that irrigate 59,478 acres. Primary crops within KRD's service area include fruit orchards (apple, pear, cherry) and hay (timothy, alfalfa), all under combinations of pivots, sprinklers, and flood irrigation systems.

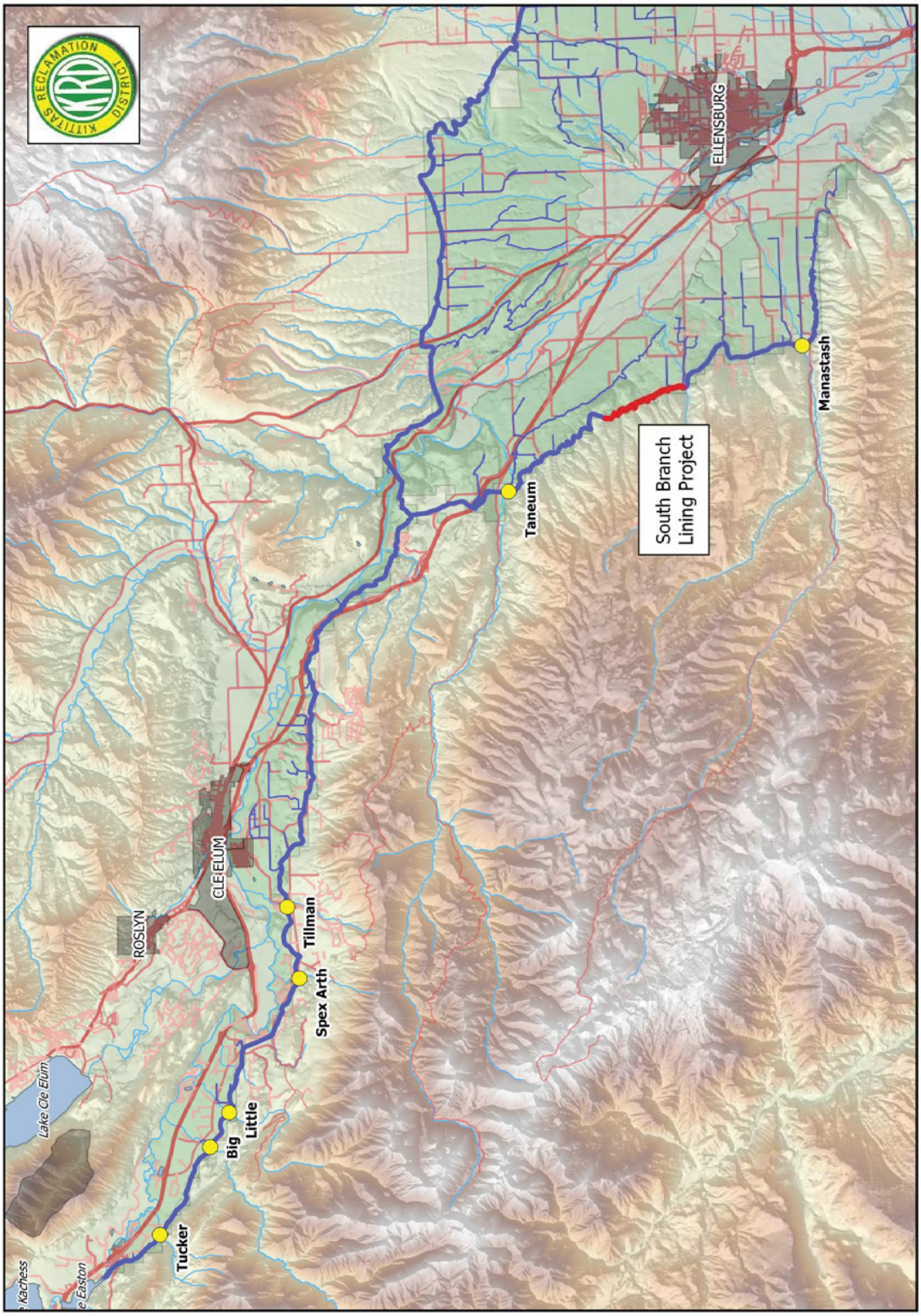

Figure 1. KRD sits in Kittitas County of Central Washington, east of the Cascade Mountains in the upper Yakima River Basin and provides water through over 330 miles of canals and laterals.

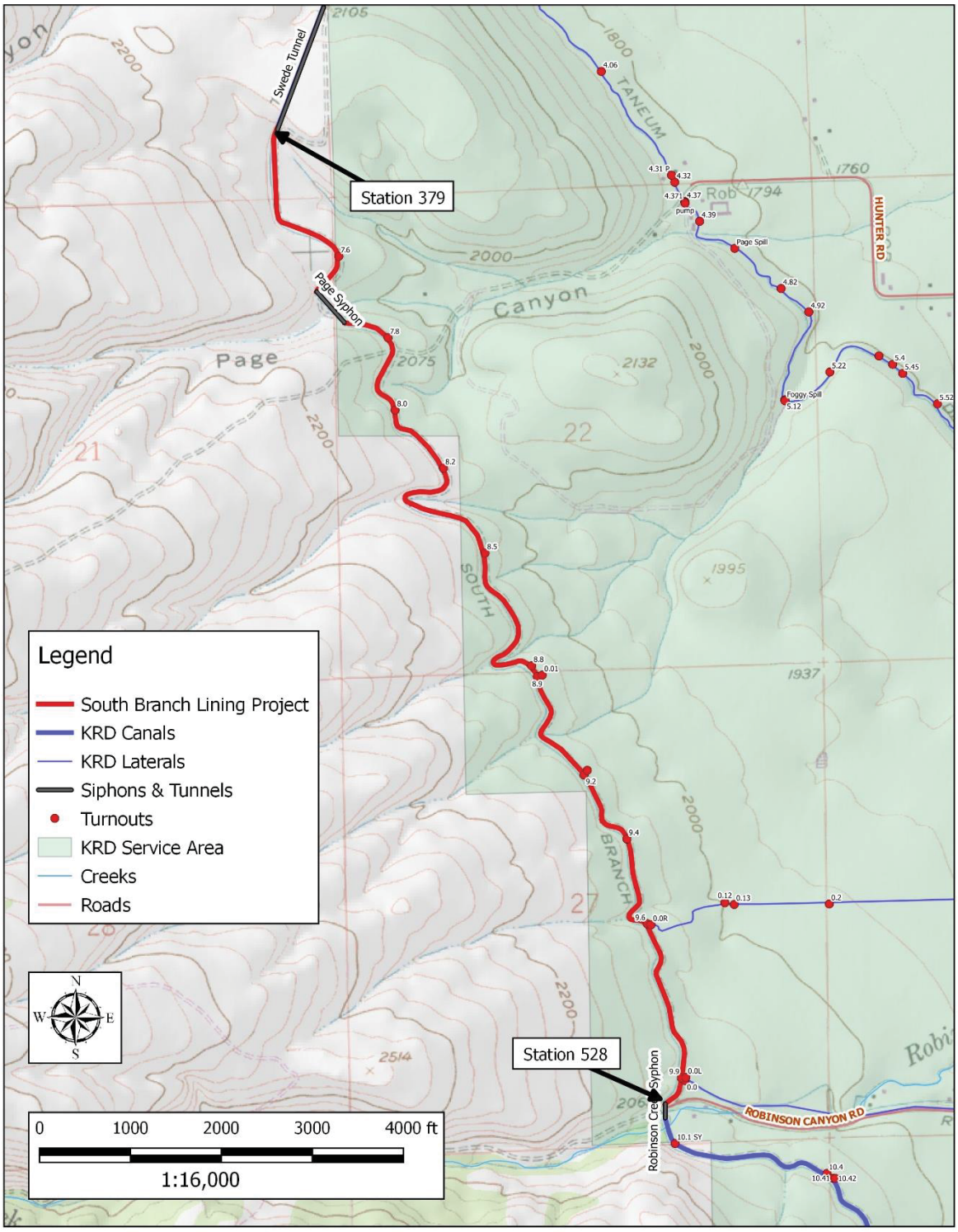

Figure 2. KRD plans 13,862 LF of total SBC lining.

The present proposal will provide funding for Phase I of KRD's South Branch Canal project ("SBC"). Phase I is designed and will proceed once funding is attained, projected for fall 2018. The total SBC efforts will line 13,862' of canal and conserve 1585 acre-feet/year (at 4.4 cfs constant delivery) for instream flow supplementation.

WATER SUPPLY AND WATER RIGHTS

KRD's water source is surface water from the Yakima River headwaters. The source typically provides water from mid-April thru mid-October for the 178 day growing season (avg). KRD's water right authorizes diversion from April 1 through October 15. However, KRD's water right is 'proratable' due to its priority date of 1905. In the Yakima Basin project operations this means KRD's annual water supply depends on total water supply available. In a full supply year, KRD receives 336,000 Acre feet (AF) and may deliver up to 5.0 AF/assessed acre.

In drought years, Yakima Basin water supply is greatly reduced and is insufficient to fulfill prorated water rights and, as such, KRD receives a prorated amount of its entitlement. Significant shortfalls occurred in 2001, 2005, and 2015, when KRD got less than 50% of its entitlement (Table 1). However, a formal drought declaration is not necessarily a trigger for KRD to receive less than 100% of its water. Rather, the water supply in any given year when paired with weather conditions may result in less than 100% of water supply.

Table 1. KRD Annual Water Supply and Prorationing Level from 2000 through 2016. (Bolded years indicate formal drought declarations.)

	Annual Water Supply	
Year	**Acre-feet**	**Percentage**
2000	305,873	91%
2001	**139,168**	**41%**
2002	294,366	88%
2003	278,995	83%
2004	287,313	86%
2005	**155,056**	**46%**
2006	286,832	85%
2007	303,050	90%
2008	288,499	86%
2009	312,334	93%
2010	280,446	83%
2011	292,537	87%
2012	314,896	94%
2013	309,433	92%
2014	316,908	94%
2015	**154,146**	**46%**
2016	297,167	88%
Avg.	**271,589**	**81%**

Between 2000 and 2017, the Yakima Basin experienced a formal drought declaration three (3) times—one in every six years. Additionally, KRD's water supply is frequently below 100% which highlights that the water supply is not guaranteed, even for an irrigation district relying on large reservoirs.

WATER DELIVERY SYSTEM AND CURRENT USES

KRD receives water from two storage reservoirs, Keechelus and Kachess—both owned and operated by Reclamation. Water from the reservoirs enters the Yakima River and KRD diverts its irrigation water at the Easton Diversion Dam (Fig. 1). The diversion structure is a drum gate, two radial gates, fish ladder, and fish screening facilities and is designed to divert the KRD's maximum authorized instantaneous flow of 1,320 cubic feet per second (cfs).

From the Easton Diversion Dam, diverted water enters an open-channel canal system, with over 330 miles of canals and laterals. Water is conveyed from the point of diversion through the 26-mile long, and mostly concrete lined, Main Canal. The Main Canal's initial capacity is 1,320 cfs and includes two tunnels, eight siphons, and three wasteways. The Main Canal splits into two smaller canals: the North and South Branches. The South Branch Canal is 14.2 miles long starting at the Main Canal bifurcation. There are 2 tunnels, 6 siphons, and 2 wasteways in this section. The initial capacity of the South Branch Canal is 250 cfs with a final capacity of 55 cfs.

EXISTING AND PREVIOUS RECLAMATION PARTNERSHIPS

Since 1999, KRD, the Washington Department of Ecology ("Ecology"), and Reclamation have collaborated and partnered to plan, design, and construct the Manastash Creek Project through the Yakima River Basin Water Enhancement Project (YRBWEP). The Manastash project, an award-winning water conservation pilot project near Ellensburg, Washington, replaced 20,000 LF of unlined lateral with a buried gravity pressure pipeline. The project, completed in spring 2014, annually conserves about 1,215 AF of water by eliminating seepage, operational spills, and evaporation. Conserved water is used to increase flow and restore habitat in Manastash Creek through a water allocation and management agreement between KRD, Ecology, and Reclamation. The pressurized system also reduces irrigator costs for pumping and maintenance.

Additionally, in 2016 KRD received a WaterSMART award ($147,104) to implement Phase I of the NBC lining project. As part of Phase I, KRD received technical assistance from partners to complete all permitting and compliance requirements. Moreover, both projects demonstrate KRD's ongoing partnership with Reclamation to allocate, manage, and protect conserved water (from these types of project) for the benefit of environmental restoration goals.

In 2017, KRD was awarded a WaterSMART Water Marketing grant award ($198,989) to develop a water market strategy for the Yakima Basin. Also in 2017, KRD was awarded $3 million from the Yakima River Basin Water Enhancement Program to line sections of the North Branch Canal and use 100% of conserved water for instream flow.

TECHNICAL PROJECT DESCRIPTION

KRD thinks this unique project may serve as a model for other western U.S. irrigation districts. The total SBC project aims to eliminate seepage losses and conserve water over at least 2.5 miles of leaking canal. The present proposal, for Phase I, will line about 1600 LF of the SBC between

Swede Tunnel and Robinson Siphon (Fig. 2). The existing SBC canal bottom is an earthen mix of cobbles, fine silts and sands, and basalt bedrock. KRD identified seepage losses from water measurements, visual observations canal bank seepage, and vegetation growth downslope of canal banks.

Phase I will eliminate seepage losses through the project area and immediately accrue significant water for fish, wildlife, and environmental benefits. KRD identified the project benefits as enhanced improved instream flows for ESA-listed species and habitat with an additional benefit of water management efficiency for irrigation delivery. Combined these benefits demonstrate the true multi-purpose value of the project, which helps avoid taking emergency steps to deliver water during drought years.

The technical aspects of the lining portion of this project are relatively straightforward. KRD proposes to install about 1600 LF of an impermeable geotextile membrane overlain with concrete in the SBC. Prior to installation of the membrane and concrete, KRD's contractor will excavate the SBC bed to properly prepare the surface to maximize the membrane's life expectancy and product warranties. The contractor will then use onsite fill or bring in clean fill to build the lining foundation, which includes a drain under the canal. Once the bed is prepared, the contractor will install the membrane, a crushed rock overlay, and then pour concrete (or shotcrete) on top. Included in the process are environmental BMPs. KRD is successfully using this method to line and conserve water in the North Branch Canal.

The concrete used in the lining system will be an easily flowable concrete mix design with a minimum strength of 4,500 pounds per square inch. Additional reinforcing, such as polyester fiber and reinforcing steel will be used as necessary to increase long-term durability.

The technical aspects of the water allocation, management, and protection are designed to provide benefits for fish, wildlife, and the environment during years of impaired stream flows in upper Yakima River tributaries—especially during drought periods. KRD accomplishes this through a three-party agreement between KRD, Reclamation, and the Washington Department of Ecology that specifies KRD will use the conserved water to supplement instream flows in upper Yakima River tributaries that are provide habitat for ESA-listed and unlisted species. The water from Phase I will go to improve stream flows in Manastash Creek, where KRD will utilize existing infrastructure at the creek-canal intersection to deliver a controlled amount of conserved water to help restore flows and keep the creek flowing.

If water is not biologically necessary in Manastash Creek, then this project allows KRD to use its conveyance system to deliver the water to other streams in need of flow. The priority stream for this water is Manastash Creek, but KRD will use a committee made of local Yakima Basin fisheries and water professionals to identify additional stream(s) most needing instream flow help on an annual basis. The committee will recommend the stream for supplementation to mimic natural flows. KRD will then spill the water into the stream for ecosystem benefits. The Washington Department of Ecology administers protection of this water.

This project provides the flexibility to shape the water delivery as needed to mimic natural flows. Moreover, by lining the canal, KRD creates additional system capacity so that the canal system can also "wheel" downstream irrigation district water during drought conditions through the canal system and supplement stream flows without risk of delaying downstream water user water delivery due to canal seepage loss. This is possible because the water is Reclamation Yakima Project water and is protected by Ecology.

This project is modeled on an ongoing effort by KRD, Ecology, and basin partners to find innovative ways to conserve water for instream flows. Traditional methods of acquiring water rights to restore flows is less predictable and, even when the most senior water is acquired, can leave a stream dry during drought conditions. In addition to providing guaranteed water during drought years, this project also provides water during non-drought years so the environment is resilient to drought conditions. Given that "drought is a period of abnormally dry weather that persists long enough to produce a serious hydrologic imbalance," the over-appropriated streams in the upper Yakima River Basin may be viewed as having an annual drought due to unnaturally dry conditions due to surface water diversions.

PRIOR PHASE COMPLETION

Between 2001 and 2015, KRD identified water conservation opportunities and ranked them in order of priority based on estimated water loss. Seepage losses in the NBC were apparent for years based on annual water measurements, observed seepage, and vegetation growth downslope of the canal banks.

In 2016, Reclamation awarded a WaterSMART grant of $147,104 to KRD to begin Phase I of the larger, NBC lining project. The 2016 award, paired with an initial $147,104 of state and applicant funding, allowed KRD to complete design work and initial project implementation. KRD hired TetraTech to complete necessary engineering designs for fall 2016 construction. TetraTech based its work on the KRD's Feasibility Investigation completed that was completed March of 2015. The Feasibility Investigation provided the basis for the proposed implementation of KRD's water conservation projects identified in KRD's Comprehensive Water Conservation Plan.

Phase II of the NBC lining completed in Spring 2018, with $3.5 million in total funding with 100% of saved water going to tributary enhancement.

No prior phases of South Branch Lining have been completed as of the writing of this proposal.

PERFORMANCE MEASURES

KRD measures the delivery of saved water to impaired streams through flow meters and loggers. An annual summary of deliveries, including daily stream supplementation and total acre-feet, is made available to Reclamation and the Washington State Dept. of Ecology. Additionally, the Washington Department of Fish and Wildlife are monitoring the ecological responses to continually wet streams during summer months to identify and track any changes in ecosystem health.

EVALUATION CRITERIA

CRITERION A: QUANTIFIABLE WATER SAVINGS (30 POINTS)

*Up to **30 points** may be awarded for this criterion. This criterion prioritizes projects that will conserve water and improve water use efficiency by modernizing existing infrastructure. Points will be allocated based on the quantifiable water savings expected as a result of the project. Points will be allocated to give greater consideration to projects that are expected to result in more significant water savings.*

Q. *Describe the amount of estimated water savings.* *For projects that conserve water, please state the estimated amount of water expected to be conserved (in acre-feet per year) as a direct result of this project. Please include a specific quantifiable water savings estimate; do not include a range of potential water savings.*

A. KRD estimates conserved water to total approximately 183 acre-feet/year.

Q. *Describe current losses:* *Please explain where the water that will be conserved is currently going (e.g., back to the stream, spilled at the end of the ditch, seeping into the ground)?*

A. Currently, water lost to seepage from the South Branch Canal goes into the ground or is consumptively used by vegetation growing along canal banks. The water does not, to KRD's knowledge, influence any stream flows.

Q. *Describe the support/documentation of estimated water savings:* *Please provide sufficient detail supporting how the estimate was determined, including all supporting calculations. Note: projects that do not provide sufficient supporting detail/calculations may not receive credit under this section. Please be sure to consider the questions associated with your project type (listed below) when determining the estimated water savings, along with the necessary support needed for a full review of your proposal. In addition, please note that the use of visual observations alone to calculate water savings, without additional documentation/data, are not sufficient to receive credit under this section. Further, the water savings must be the result of reducing or eliminating a current, ongoing loss, not the result of an expected future loss.* ***Please address the following questions according to the type of infrastructure improvement you are proposing for funding.***

A. This is a water savings project achieved through canal lining. The following answers address canal lining, water savings, and irrigation flow measurements.

1. *Canal lining/piping projects can provide water savings when irrigation delivery systems experience significant losses due to canal seepage. Applicants proposing lining/piping projects should address the following:*

Q. *How has the estimated average annual water savings that will result from the project been determined? Please provide all relevant calculations, assumptions, and supporting data.*

A. The District estimated canal losses using current metering, water balances, and accepted engineering. Table 2 shows the total supply, deliveries to landowners for the South Branch Lining project area, and the flow at the end of the project reach. The difference between the supply, the total deliveries, and the remaining water at Robinson siphon (project reach end) represents the total conveyance losses in this canal reach as shown in Table 2. KRD assumed a 10% loss attributable evaporation; therefore, 90% of the losses are estimated as the water savings associated with lining this reach of the South Branch Canal. WaterSmart funding will line about 12% of the total project, and will therefore save 12% of the total seepage losses in this area.

TABLE 2 - CONVEYANCE LOSSES OF SOUTH BRANCH LINING PROJECT

Site	Turnout	4/26/2016 Discharge (cfs)	5/18/2016 Discharge (cfs)	7/25/2016 Discharge (cfs)	8/26/2016 Discharge (cfs)
Outlet Swede Tunnel (Beginning of Project)		58.43	50.16	117.20	121.41
Deliveries	7.6	0.00	0.00	0.00	0.00
	7.8	0.10	0.00	0.03	0.35
	8.2	0.00	0.00	0.00	0.00
	8.5	0.00	0.00	0.00	0.00
	8.8	0.00	0.00	2.23	2.23
	8.9	0.00	0.00	0.00	0.00
	9.2-0.01L	0.00	0.00	0.00	0.00
	9.2-0.01	0.42	0.00	0.00	0.97
	9.4	0.00	1.66	1.50	3.15
	9.6	0.00	1.00	2.00	1.25
Total Deliveries		0.52	2.66	5.76	7.95
Above Robinson Siphon (End of Project Area)		54.16	44.99	104.58	106.84
Conveyance Loss		**3.75**	**2.51**	**6.86**	**6.62**
Average Conveyance Loss			**4.93**		
Estimated Average Evaporation Loss			0.49		
Estimated Average Seepage Loss for SBC from Swede Tunnel to Robinson Canyon			**4.44**		
Phase 1 – 1,600 lineal feet out of a 13,862 project – 12%			**0.51**		

Q. *How have average annual canal seepage losses been determined? Have ponding and/or inflow/outflow tests been conducted to determine seepage rates under varying conditions? If so, please provide detailed descriptions of testing methods and all results. If not, please provide an explanation of the method(s) used to calculate seepage losses. All estimates should be supported with multiple sets of data/measurements from representative sections of canals.*

A. The District estimated canal losses using current metering, water balances, and accepted engineering. Table 2 shows the total supply, deliveries to landowners for the South Branch Lining project area, and the flow at the end of the project reach. The difference between the supply, the total deliveries, and the remaining water at Robinson siphon (project reach end) represents the total conveyance losses in this canal reach as shown in Table 2. KRD assumed a 10% loss attributable evaporation; therefore, 90% of the water is assumed lost to seepage, which

totals approximately 0.512 cfs over the project reach. The KRD runs approximately 180 days each season, so water savings would be 0.512 cfs * 1.9835 * 180 days = 183 acre-feet.

Q. *What are the expected post-project seepage/leakage losses and how were these estimates determined (e.g., can data specific to the type of material being used in the project be provided)?*

A. This project is expected to eliminate (through canal lining) any seepage or leakage in the lining area. A max 10% amount of evaporation loss is expected, though this percentage will likely vary according to the amount of water in the canal and local weather conditions.

Q. *What are the anticipated annual transit loss reductions in terms of acre-feet per mile for the overall project and for each section of canal included in the project?*

A. The overall project will save 4.44 cfs, or 1,585 acre-feet of water. The total project length is 13,862 feet, or 2.62 miles. The savings per mile is:

1,585 acre-feet / 2.62 miles = 603.8 acre-feet per mile.

Water savings for the 0.30 mile section covered by this funding would be:

603.8 acre-feet per mile * 0.30 miles = 183 acre-feet.

Q. *How will actual canal loss seepage reductions be verified?*

A. Actual canal loss seepage reductions will be verified according to the pre/post project inflow/outflow measurements for the area of canal lined. KRD will conduct the measurements.

Q. *Include a detailed description of the materials being used.*

A. Geocomposite liner shall be a top 12 oz/yd$_2$ polypropylene non-woven bonded to a 30 mil polyethylene geomembrane middle layer which is bonded to a bottom 12 oz/yd$_2$ polyester non-woven. The Contractor shall furnish and install HUESKER Canal 3® 123012-C Geocomposite, Coletanche ES 3 bituminous geomembrane or an approved equal as specified in the contract.

The concrete for canal bottom and side slopes shall be constructed by the placement of cement concrete surfacing being either poured or pneumatically placed upon the finished grade with joints placed as defined in these specials or in the contract plans. Specifications:

Concrete – Class 4000 with Air Entrainment (meeting the requirements of Section 6-02.3)
Shotcrete – 4000 psi compressive strength (meeting the requirements of Section 6-18.3)

2. ***Irrigation Flow Measurement:*** *Irrigation flow measurement improvements can provide water savings when improved measurement accuracy results in reduced spills and over-deliveries to irrigators. Applicants proposing [irrigation flow measurement] projects should address the following:*

Q. *How have average annual water savings estimates been determined? Please provide all relevant calculations, assumptions, and supporting data.*

A. The District has estimated the losses using current metering, water balances, and accepted engineering. Table 2 shows the total supply and deliveries to landowners, and the flow at the end of the project. The difference between the supply, the total deliveries, and the remaining water at Robinson siphon (the end of the project) represents the total conveyance losses in this canal reach as shown in Table 2. It was assumed that 10% of the losses identified was due to evaporation; therefore, 90% of the losses are attributable to seepage and make up the estimated water savings associated with lining this reach of the South Branch Canal.

Q. *Have current operational losses been determined? If water savings are based on a reduction of spills, please provide support for the amount of water currently being lost to spills.*

A. Cross sectional flows were measured above and below the proposed project with a current meter. Factoring in the deliveries to landowners, which are measured over cipoletti weirs, resulted in total water loss for the reach.

Q. *Are flows currently measured at proposed sites and if so what is the accuracy of existing devices? How has the existing measurement accuracy been established?*

A. Cross section current metering is estimated to be 2% accurate. W Carter, Rolland. (1973). Accuracy of Current Meter Measurements. Hydrometry: Proceedings of the Koblenz Symposium, UNESCO. 1.

Q. *Provide detailed descriptions of all proposed flow measurement devices, including accuracy and the basis for the accuracy.*

A. The project will install ramp flumes with associated stilling wells at the outlet of Swede Tunnel and above Robinson Canyon Siphon. Ramp flumes have a reliable, stable, and known relationship between stage and flows. Eventually a gauge station will be added at least one of these ramp flumes that will be connected to the District's telemetry system. Long-throated flumes can be computer calibrated to within +2 percent error: USBR Water Measurement Manual.

Q. *Will annual farm delivery volumes be reduced by more efficient and timely deliveries? If so, how has this reduction been estimated?*

A. Farm deliveries should remain unchanged.

Q. *How will actual water savings be verified upon completion of the project?*

A. Actual water savings will be verified by KRD staff by measuring canal flows and irrigation deliveries post project.

CRITERION B: WATER SUPPLY RELIABILITY (18 POINTS)

*Up to **18 points** may be awarded under this criterion. This criterion prioritizes projects that address water reliability concerns, including making water available for multiple beneficial uses and resolving water related conflicts in the region.*

Please address how the project will increase water supply reliability. Proposals that will address more significant water supply shortfalls benefitting multiple sectors and multiple water users, will be prioritized. General water supply reliability benefits (e.g., proposals that will increase resiliency to drought) will also be considered. Please provide sufficient explanation of the project benefits and their significance. These benefits may include, but are not limited to, the following:

Q. *Does the project promote and encourage collaboration among parties in a way that helps increase the reliability of the water supply?*

A. Yes, this project requires collaboration among fish and water resource managers.

Q. *Is there widespread support for the project?*

A. Yes, this project receives widespread support from stakeholders in the Yakima Basin.

Q. *What is the significance of the collaboration/support?*

A. The support and collaboration is significant in that it shows how this project is bridging divides for water resources. The support brings diverse stakeholders together to find an alternative solution to instream flow for the ecosystem while maintaining the water needed to maintain the agricultural nature of area.

Q. *Is the possibility of future water conservation improvements by other water users enhanced by completion of this project?*

A. Yes, this project provides greater water delivery certainty (increases reliability) which should enable water users to have a more known quantity of water available annually.

Q. *Will the project make water available to address a specific water reliability concern? Please address:*

a) *Explain and provide detail of the specific issue(s) in the area that is impacting water reliability, such as shortages due to drought, increased demand, or reduced deliveries.*

Water availability and reliability in the area served by the South Branch are the primary issues. KRD has a junior water right that is proratable depending on the amount of water available in the Yakima Basin (termed 'Total Water Supply Available'). The annual amount can vary (see Table 1) which results in a variable supply for irrigators. Moreover, Manastash Creek, which is crossed by the South Branch Canal experiences annual drought conditions in a key reach due to irrigation withdraws of surface water rights. The resulting dewatered reach historically provided no habitat

and impeded passage for fish (ESA-listed and unlisted species). However, through canal and lateral lining/piping, KRD is able to eliminate sources of seepage and provide a more reliable delivery to customers. KRD is also able to deliver the formerly lost, non-consumptive water (that would go to ground water and then ultimately to downstream water users) to supplement flows in Manastash Creek and restore fish passage to headwater habitat.

b) *Describe where the conserved water will go/how it will be used. Will the project directly address a heightened competition for finite water supplies and over-allocation (e.g., population growth)? Will it be left in the river system*?

The technical aspects of the water allocation, management, and protection are designed to provide benefits for fish, wildlife, and the environment during years of impaired stream flows in upper Yakima River tributaries—especially during drought periods. KRD accomplishes this through a three-party agreement between KRD, Reclamation, and the Washington Department of Ecology that specifies KRD will use the conserved water to supplement instream flows in upper Yakima River tributaries that are provide habitat for ESA-listed and unlisted species. The water from Phase I will go to improve stream flows in Manastash Creek, where KRD will utilize existing infrastructure at the creek-canal intersection to deliver a controlled amount of conserved water to help restore flows and keep the creek flowing.

c) *Describe how the project will address the water reliability concern?*

The project improves the management of existing water supplies by both increasing conveyance efficiency and improving operational flexibility. The increased conveyance efficiency allows water managers to reduce the amount of water needed to deliver the desired amount down-canal of the leaking section. This provides managers greater certainty in their ability to deliver the irrigator's water because they no longer must account for "lost water". The improved reliability also provides mangers the flexibility to use the conserved water for instream flow (100% goes to instream flow) and to use the additional capacity during drought periods to wheel downstream irrigation district water through the formerly leaking section to increase the amount for instream flow without the risk of delaying the water for downstream irrigation use.

d) *Will the project help to prevent a water-related crisis or conflict? Is there frequently tension or litigation over water in the basin?*

Yes, this project will help prevent crisis and conflicts for water in the Yakima Basin. The Yakima Basin is undergoing a surface water adjudication that is over 40 years old. The adjudication has made water rights more certain for surface water right owners from tributaries. However, there is also a clear water need for instream flows to restore stream ecosystems. These competing needs are a constant source of tension among resource users and managers. This project presents a pathway to provide instream flows without requiring landowners to dry-up productive agricultural lands. By using for instream flows the water currently lost to canal seepage, KRD is able to help supplement flows that are well below natural levels due to surface water diversions without increasing costs to irrigation water customers.

e) *Provide a description of the mechanism that will be used, if necessary, to put the conserved water to the intended use.*

KRD has a water "allocation, management, and protection" memorandum of agreement with the U.S. Bureau of Reclamation and Washington Department of Ecology. This agreement provides the pathway to allocate the water for instream flow on an annual basis (and adjust it during the irrigation season as conditions require). This 3-party MOA is the key to this project.

f) *Describe the roles of any partners in the process. Please attach any relevant supporting documents.*

Project partners are numerous and vital to project success. KRD leads the process for lining the canal and moving water for irrigators and instream flow. Partners and their roles are:

- WA Dept of Ecology is responsible for water protection and enforcement;
- WA Dept of Fish and Wildlife is responsible for monitoring the environmental benefits and making recommendations for water delivery for instream flow;
- U.S. Bureau of Reclamation operates the Yakima Project and is supportive of the KRD's water conservation plans and how the KRD system can be used to meet the goals of the Yakima Basin Integrated Plan.
- Kittitas County Conservation District is responsible for working with landowners to implement irrigation efficiency (on-farm) projects that enhance canal lining benefits;
- Trout Unlimited assists with instream flow projects that reduce the need for instream flow and enhance instream flow benefits

g) *Indicate the quantity of conserved water that will be used for the intended purpose.*

KRD anticipates 0.51 cfs and about 183 acre-feet/year will be conserved for stream flow.

Q. *Will the project benefit Indian tribes?*

A. Yes, this project will help restore fish populations to which the Yakama Nation has a Treaty Right to harvest.

Q. *Will the project benefit rural or economically disadvantaged communities?*

A. Yes, this project will benefit rural KRD customers being served by the South Branch Canal.

Q. *Will the project benefit species (e.g., federally threatened or endangered, a federally recognized candidate species, a state listed species, or a species of particular recreational, or economic importance). Please describe the relationship of the species to the water supply, and whether the species is adversely affected by a Reclamation project*.

Yes, this project will provide significant benefits for fish and wildlife. The species of interest are Coho and Chinook salmon, Mid-Columbia steelhead (ESA-threatened), and Bull trout (ESA-threatened). Coho and Chinook salmon historically had access to and likely migrated and reared in the lower reaches of upper Yakima River tributaries. These fish are all reliant on adequate

water supply and quality to provide passage and habitat. KRD expects benefits to include: improved instream flows that increase available fish habitat and improve fish passage through flow-impaired stream reaches; improved conditions for aquatic insects (prey base for fish and wildlife); improved natural stream processes such as sediment transport and channel formation; and improved riparian forest health. Moreover, KRD (through its work with the Washington Department of Fish and Wildlife, expects these benefits to interact and provide greater ecosystem benefits that are difficult to measure. For example, improved stream flows will likely promote riparian vegetation growth that shade the stream and reduce the stream's solar exposure which, in turn, may limit the stream's high temperatures during summer months, which in turn may provide more habitat than originally anticipated and increase aquatic invertebrates' diversity and density—the prey base for fish.

This project will benefit two ESA-listed species (both threatened): Mid-Columbia steelhead and Bull trout. Both fish species are subject to plans for recovery and conservation within the Yakima Basin. The 2009 Yakima Steelhead Recovery Plan states that "drought worsens the effects of other threats on adult spawning success and juvenile survival" (p. 73, 2009 Yakima Steelhead Recovery Plan). Specifically, the flow, temperature, and key habitat quantity may be impaired. The proposed project would help reduce the impacts of drought on Steelhead by providing continuous flow in tributaries that provide habitat for adult and juvenile fish.

Bull trout distribution in the Yakima Basin have an Action Plan (2012) that provides guidance on species recovery. The Yakima Bull trout are, like all fish, reliant on water for survival. However, they are less likely to be present in the immediate flow supplementation areas due to the timing and general habitat conditions in the streams. Rather, the Bull trout in tributaries may inhabit headwaters where conditions are more suitable when the instream flow restoration is taking place in the flow impaired (lower) reaches. Regardless, the project will help improve stream conditions during summer and fall months that leave the stream in better health for winter months when the Bull trout may utilize lower reaches for feeding, migration, or overwintering.

Q. *Will the project address water supply reliability in other ways not described above?*

A. This project also helps build long-term resilience to drought by eliminating a source of water loss and then designating the previously lost water as water for instream flow. The instream flows help restore stream ecosystems and natural processes to benefit fish and wildlife habitat and the riparian communities (people and nature). The project will also free up system capacity to deliver conserved water to Manastash Creek.

CRITERION C: IMPLEMENTING HYDROPOWER (18 POINTS)

*Up to **18 points** may be awarded for this criterion. This criterion prioritizes projects that will install new hydropower capacity in order to utilize our natural resources to ensure energy is available to meet our security and economic needs.*

Not applicable.

CRITERION D: COMPLEMENTING ON-FARM IRRIGATION IMPROVEMENTS (10 PTS)

*Up to **10 points** may be awarded for projects that describe in detail how they will **complement on-farm irrigation improvements** eligible for NRCS financial or technical assistance.* Note: *Scoring under this criterion is based on an overall assessment of the extent to which the WaterSMART Grant project will complement ongoing or future on-farm improvements. Applicants should describe any proposal made to NRCS, or any plans to seek assistance from NRCS in the future, and how an NRCS-assisted activity would complement the WaterSMART Grant project. Financial assistance through the Environmental Quality Incentives Program (EQIP) is the most commonly used program by which NRCS helps producers implement improvements to irrigation systems, but NRCS does have additional technical or financial assistance programs that may be available. Applicants may receive maximum points under this criterion by providing the information described in the bullet points below. **Applicants are not required to have assurances of NRCS assistance by the application deadline to be awarded the maximum number of points under this sub-criterion.** Reclamation may contact applicants during the review process to gather additional information about pending applications for NRCS assistance if necessary.*

The Kittitas County Conservation District (KCCD) has received $6.2 million from the USDA's Regional Conservation Partnership Program (RCPP), which will triple the amount of local EQIP funding available for the next four years. The KCCD estimates that 2300 acres of irrigated land under the South Branch Canal are eligible for this funding. This project would help provide cleaner water for sprinklers (less canal bank erosion), and more reliable water by increasing the canal capacity.

CRITERION E: DEPARTMENT OF THE INTERIOR PRIORITIES (10 POINTS)

*Up to **10 points** may be awarded based on the extent that the proposal demonstrates that the project supports the Department of the Interior priorities. Please address those priorities that are applicable to your project. It is not necessary to address priorities that are not applicable to your project. A project will not necessarily receive more points simply because multiple priorities are addressed. Points will be allocated based on the degree to which the project supports one or more of the priorities listed, and whether the connection to the priority(ies) is well supported in the proposal.*

1. *Creating a conservation stewardship legacy second only to Teddy Roosevelt*
   a. Utilize science to identify best practices to manage land and water resources and adapt to changes in the environment;

      This project makes use of projected changes in regional precipitation patterns in future years. The projection is for a shift in precipitation type and timing, from snow to rain and more falling during winter months. The projected change in water availability shifts to drier conditions in late summer. This project helps with water conservation that can

extend the season of availability for limited water supplies by eliminating sources of canal seepage.

b. Examine land use planning processes and land use designations that govern public use and access;

N/A

c. Revise and streamline the environmental and regulatory review process while maintaining environmental standards.

N/A

d. Review DOI water storage, transportation, and distribution systems to identify opportunities to resolve conflicts and expand capacity;

This project aligns with the goals of the Yakima Basin Integrated Water Resource Management Plan that examines water storage and distribution to decrease conflicts surrounding the resource.

e. Foster relationships with conservation organizations advocating for balanced stewardship and use of public lands;

This project helps the Kittitas Reclamation District and Trout Unlimited, among other conservation organizations, have a productive working relationship.

f. Identify and implement initiatives to expand access to DOI lands for hunting and fishing;

N/A

g. Shift the balance towards providing greater public access to public lands over restrictions to access.

N/A

2. *Utilizing our natural resources*

a. Ensure American Energy is available to meet our security and economic needs;

The present is located in the Columbia Basin, which is home to the Federal Columbia River Power System—a vital source of energy for the western United States. This project helps maintain the water supply necessary to fill the hydropower lakes and increase water security by increasing the efficiency of delivering the water. This helps to maintain the agricultural economics of the Kittitas Valley in central Washington State.

b. Ensure access to mineral resources, especially the critical and rare earth minerals needed for scientific, technological, or military applications;

N/A

c. Refocus timber programs to embrace the entire 'healthy forests' lifecycle;

N/A

d. Manage competition for grazing resources.
N/A

3. *Restoring trust with local communities*

a. Be a better neighbor with those closest to our resources by improving dialogue and relationships with persons and entities bordering our lands;

This project builds upon the ongoing dialogue with neighbors made possible through the Yakima Basin Integrated Water Resource Management Plan. Through the "Plan" stakeholders have a place to discuss ideas surrounding water resources and improved water security for fish, farms, and communities in the Yakima Basin.

b. Expand the lines of communication with Governors, state natural resource offices, Fish and Wildlife offices, water authorities, county commissioners, Tribes, and local communities.

Again, the Plan (mentioned above) is a key part of improving the communication between all levels of statekholders—from water users to Reclamation Commissioners.

4. *Striking a regulatory balance*

a. Reduce the administrative and regulatory burden imposed on U.S. industry and the public;

N/A

b. Ensure that Endangered Species Act decisions are based on strong science and thorough analysis.

N/A

5. *Modernizing our infrastructure*

a. Support the White House Public/Private Partnership Initiative to modernize U.S. infrastructure;

This project advances the Public/Private Partnership Initiative from the White House to modernize infrastructure by taking an earthen ditch built in the early 20th century to a modern, impermeable canal built in the 21st century. The public will provide the initial investment and KRD's customers (private) will assume the long-term maintenance costs of the canal section through their annual assessment fees.

b. Remove impediments to infrastructure development and facilitate private sector efforts to construct infrastructure projects serving American needs;

N/A

c. Prioritize DOI infrastructure needs to highlight: (i) construction of infrastructure; (ii) cyclical maintenance; and (iii) deferred maintenance.

This project addresses vitally needed infrastructure upgrades that could be classified as quasi-new construction. The canal already exists but it is earthen presently. The construction activities will create a concrete canal that should provide years of minimal maintenance operation.

CRITERION F: IMPLEMENTATION AND RESULTS (6 PTS)

*Up to **6 points** may be awarded for these subcriteria.*

Subcriterion 1. Project Planning: *Points may be awarded for proposals with planning efforts that provide support for the proposed project. Does the applicant have a Water Conservation Plan and/or System Optimization Review (SOR) in place? Please self-certify, or provide copies of these plans where appropriate to verify that such a plan is in place.*

Yes, KRD described its facilities and evaluated its operations in a 1999 Comprehensive Water Conservation Plan (CWCP). In 2001, Addendum No. 1 to the CWCP was prepared to address items suggested by the Feasibility Investigation Team. At the time the CWCP and Addendum was finalized, it was determined that a Feasibility Investigation was needed to provide a basis for the proposed implementation of the water conservation measures identified in the CWCP and Addendum. The CWCP is in Appendix #.

Provide the following information regarding project planning:

1. *Identify any district-wide, or system-wide, planning that provides support for the proposed project. This could include a Water Conservation Plan, SOR, Drought Contingency Plan or other planning efforts done to determine the priority of this project in relation to other potential projects.*

The water conservation plan and addendum, in conjunction with the Feasibility Investigation provides support for the present project. The documents apply to the entire KRD service area. KRD is constantly seeking additional opportunities to implement water conservation projects.

2 *Describe how the project conforms to and meets the goals of any applicable planning efforts, and identify any aspect of the project that implements a feature of an existing water plan(s).*

In the CWCP, KRD identifies 26 projects that will conserve water to improve delivery for customers. This project specifically addresses the need to eliminate key sources of canal leakage to increase conveyance efficiency. The impermeable liner and concrete overlay implement water

conservation measures that improve conveyance, reduce maintanence, and improve on-farm reliability.

Subcriterion 2. Performance Measures: *Points may be awarded based on the description and development of performance measures to quantify actual project benefits upon completion of the project.*

Provide a brief summary describing the performance measure that will be used to quantify actual benefits upon completion of the project (e.g., water saved or better managed). For more information calculating performance measure, see Appendix A: Benefit Quantification and Performance Measure Guidance.

KRD proposes the present project to line a section of leaking South Branch Canal to eliminate water seepage and reduce evapotranspiration on ditch banks. Prior to implementing the project, KRD staff will conduct inflow/outflow testing to measure the flow rate of water flowing in and out of the canal reach. KRD will conduct at least two tests, one early and one late in the irrigation season, and will provide the results as acre-feet/year and CFS/SF/mile (cubic feet per second of seepage per cubic feet per second of canal flow per mile of canal).

Post-project, KRD will use the same inflow/outflow testing for the lined sections of canal to identify the amounts of water conserved. KRD will keep records on the increased conveyance efficiency through lined portions of the canal.

Note*: All Water and Energy Efficiency Grant applicants are required to propose a "performance measure". A provision will be included in all assistance agreements with Water and Energy Efficiency Grant recipients describing the performance measure, and requiring the recipient to quantify the actual project benefits in their final report to Reclamation upon completion of the project. If information regarding project benefits is not available immediately upon completion of the project, the financial assistance agreement may be modified to remain open until such information is available and until a Final Report is submitted. Quantifying project benefits is an important means to determine the relative effectiveness of various water management efforts, as well as the overall effectiveness of Water and Energy Efficiency Grants.*

CRITERION G: NEXUS TO RECLAMATION PROJECT ACTIVITIES (4 PTS)

*Up to **4 points** may be awarded if the proposed project is in a basin with connections to Reclamation project activities. No points will be awarded for proposals without connection to a Reclamation project or Reclamation activity.*

Q. Is the proposed project connected to Reclamation project activities?

A. Yes, KRD is part of Reclamation's Yakima Basin Project.

Q. Does the application receive Reclamation project water?

A. Yes, KRD receives water from Reclamation owned/operated reservoirs in the Yakima River headwaters.

Q. Is the project on Reclamation project lands or involving Reclamation facilities?

A. Yes, the proposed lining would be within lands owned by Reclamation and conserved water would be delivered to tributaries within the Yakima Basin Project.

Q. Will the proposed work contribute water to a basin where a Reclamation project is located?

A. On July 9, 2013, Lorri J. Lee, Reclamation Regional Director Pacific Northwest Region U.S., signed and approved the Record of Decision for the Yakima River Basin Integrated Water Resource Management Plan (Integrated Plan) Final Programmatic Environmental Impact Statement Yakima Project, Washington. *District canal modifications to reduce seepage and enhance tributary flows are specifically listed as a priority in the Record of Decision* under Structural and Operational Changes goals. KRD is uniquely situated to provide multiple benefits to improve water supply for agriculture and fish and improve the ability of water and fisheries managers to adapt to climate change because of KRD's location relative to many important tributaries in the upper Yakima River Basin. KRD will also have a three-party agreement that includes Reclamation as a signatory for the allocation, management, and protection of water for instream flow.

Q. Is the project in the same basin as a Reclamation project or activity?

A. Yes, the presently proposed project will occur in the Upper Yakima River Basin where Reclamation operates the Yakima Project.

Q. Will the project benefit any tribe(s)?

A. Yes, the water delivered to tributaries with no or low summer flows will help recover salmon stocks and contribute to Yakama Nation Treaty Rights.

CRITERION H: ADDITIONAL NON-FEDERAL FUNDING (4 PTS)

*Up to **4 points** may be awarded to proposals that provide non-Federal funding in excess of 50 percent of the project costs. State the percentage of non-Federal funding as the following:*

Federal Funding / Total Project Cost

KRD has received commitments for funding for this project from the Washington State Dept. of Ecology of $2,107,000.

$300,000 / $2,107,000 = 14% Federal funds.

PROJECT BUDGET

FUNDING PLAN AND LETTERS OF COMMITMENT

The project cost is $600,000. The project estimate is based on reasonable and allowable costs, price sheets from a geomembrane liner vendor, input from engineering professionals, and historical costs and production rates. These costs were assembled with the intent for construction to begin following the 2018 irrigation season and be completed before the 2019 irrigation season.

Table 2. Summary of non-federal and federal funding sources. KRD's non-federal amount will come from the Washington Department of Ecology's Office of Columbia River.

Funding Sources	**Amount**
Non-Federal Entities	
Washington Department of Ecology	$ 300,000.00
Non-Federal Subtotal	$ 300,000.00
Other Federal Entities	
none	
Other Federal Subtotal	$ 0.00
Requested Reclamation Funding	**$ 300,000.00**

The Washington Department of Ecology's Office of Columbia River's letter of commitment is attached. These funds are committed to KRD and expected to be available before fall 2018.

KRD will not incur any costs that will be included as project costs before the anticipated start date**.** KRD will receive committed funding from the Washington Department of Ecology's Office of Columbia River in the amount of $300,000 to match this request.

At the present time, KRD has not requested nor received any additional federal funds to contribute to this project. If this changes, KRD will notify reclamation to comply with the cost-share requirements for this project.

BUDGET PROPOSAL

BUDGET ITEM DESCRIPTION	COMPUTATION		Quantity Type	TOTAL COST
	$/Unit	Quantity		
Salaries and Wages				
Employee 1				$ -
Employee 2				$ -
Employee 3				$ -
Fringe Benefits				
Full-Time Employees				$ -
Part-Time Employees				$ -
Travel				
Trip 1				$ -

Trip 2				$ -
Trip 3				$ -
Equipment				
Item A				$ -
Item B				$ -
Supplies and Materials				
Item A				$ -
Item B				$ -
Contractual/Construction				
Construction Contractor				$ 565,500.00
Engineering Services				$ 34,500.00
TOTAL DIRECT COSTS				$ 600,000.00
Indirect Costs				
Schedule & Market Condition				$ -
TOTAL ESTIMATED PROJECT COSTS				$ 600,000.00

SALARIES AND WAGES

KRD is not requesting or claiming any salary or wage related expenses from this project.

FRINGE BENEFITS

KRD is not requesting or claiming fringe benefits related expenses from this project.

TRAVEL

KRD is not requesting or claiming travel-related expenses from this project.

EQUIPMENT

KRD is not requesting or claiming equipment-related expenses from this project.

MATERIALS AND SUPPLIES

KRD will furnish materials and supplies and expects minimal costs from this action and excludes it from the project budget.

CONTRACTUAL (CONSTRUCTION)

The total contractual budget is for construction costs and engineering service during construction. The District will hire a contractor to complete construction of the project. The contractor chosen for construction of the proposed project will be selected based on the results of an advertised competitive bidding process. The contractor will enter into a unit price contract for furnishing and installing all equipment and materials necessary for construction of the complete and functional proposed upgrades.

Anticipated tasks include the following:

A. Installation of the geomembrane liner and concrete
    a. Excavation and fill for reshaping of 1600 LF of existing canal
    b. Furnish and installation of a 30-mil PVC or HDPE geomembrane liner
    c. A 4-inch-thick shotcrete or concrete lining of 1600 LF of existing canal including a fiber mesh or steel bar reinforcement
    d. Underdrain for the entire distance of construction activities; assume 18-inch-deep by 12-inch-wide trench, 4-inch-diameter ADS slotted pipe, trench backfilled with concrete aggregate sand (graded coarse material); trench spoils go same place as new access road material.
B. Construction of a new access road:
    a. Excavation and haul of bulk bank soils
    b. Construction of a dirt access road
C. Regrade access road to repair possible minor damage during construction

Construction scheduling and, to some extent, costs, may be affected by the need to do the entire canal lining work during the non-irrigation season. The limited available construction season occurs during the fall and winter months.

Actual markup percentages may vary from those shown here and are the responsibility of the bidding contractor. Cost breakdowns are supplied in Attachment E.

ENVIRONMENTAL AND REGULATORY COMPLIANCE

Environmental and regulatory compliance are in process. KRD anticipates completion of all necessary regulatory steps by DATE? KRD does not anticipate any further environmental or regulatory compliance costs except for a possible construction stormwater permit. Those costs will be within the contractor's bid price, however.

OTHER—REPORTING

This line item includes costs to be incurred while reporting to federal funders. In accordance with the FOA requirements, KRD will prepare and submit to Reclamation an SF-425 Federal Financial Report, two quarterly reports, and a final report. KRD will assume this cost as part of regular operations.

INDIRECT COSTS

For this project, the recipient will not have any indirect costs. All costs associated with the project are direct and can be documented as such.

TOTAL COSTS

The estimated total project cost is $600,000. The requested federal share through the WaterSMART program is $300,000; the total non-federal share is $300,000. A copy of the completed SF 424C, Budget Information – Construction Programs, is provided.

ENVIRONMENTAL & CULTURAL RESOURCES COMPLIANCE

To allow Reclamation to assess the probable environmental and cultural resources impacts and costs associated with each application, all applicants must respond to the following list of questions focusing on the NEPA, ESA, and NHPA requirements. Please answer the following questions to the best of your knowledge. If any question is not applicable to the project, please explain why. The application should include the answers to:

Q. *Will the project impact the surrounding environment (i.e., soil [dust], air, water [quality and quantity], animal habitat, etc.)? Please briefly describe all earth-disturbing work and any work that will affect the air, water, or animal habitat in the project area. Please also explain the impacts of such work on the surrounding environment and any steps that could be taken to minimize the impacts.*

A. The canal lining improvements will take place within the existing canal right-of-way. Existing KRD maintenance roads provide adequate site access, and all work will occur within KRD's right-of-way. An environmental review shows that there will be minor or no negative environmental impacts to earth (soils), air, plants, animals, energy and natural resources, environmental health (health hazards and noise), land and shoreline use, housing, aesthetics, light and glare, recreation, historic and cultural preservation, transportation, public services, and utilities. During construction, best management practices (BMPs), such as sediment control fencing and sprinkling the ground surface for dust control, will be maintained in ground-disturbance areas. There is no earth disturbing work anticipated from the stream supplementation component.

Q. *Are you aware of any species listed or proposed to be listed as a Federal threatened or endangered species, or designated critical habitat in the project area? If so, would they be affected by any activities associated with the proposed project?*

A. Yes, KRD is aware of listed species and designated critical habitat in the project area (including Manastash Creek for instream flow). Stream supplementation will occur in streams with ESA-listed fish species and designated Critical Habitat. Both the habitat and fish species will be affected by the stream supplementation, though the effects are expected to be positive and help with species' recovery.

Q. *Are there wetlands or other surface waters inside the project boundaries that potentially fall under CWA jurisdiction as "Waters of the United States?" If so, please describe and estimate any impacts the proposed project may have.*

A. Construction activities will occur along the existing KRD right-of-way, which does not possess wetlands or "waters of the United States"; therefore, impacts to wetlands and/or waters under Federal jurisdiction are not anticipated. Regardless, construction activities will implement BMP measures to control erosion, turbidity from de-watering water, dust, and noise. Required mitigation of impacts to the environment is not anticipated. Streams receiving supplementation water do fall within the "waters of the United States" under Federal Clean Water Act jurisdiction. KRD expects positive impacts to these streams will be restored flows. Moreover, KRD has non-sediment producing, designated turnout structures for each stream. The flows entering the stream will enter via designated and established input locations. As such, KRD does not anticipate any negative impacts from the stream supplementation portion.

Q. *When was the water delivery system constructed?*

A. The South Branch Canal was constructed in 1928.

Q. *Will the proposed project result in any modification of or effects to, individual features of an irrigation system (e.g., headgates, canals, or flumes)? If so, state when those features were constructed and describe the nature and timing of any extensive alterations or modifications to those features completed previously.*

A. Yes, this project will affect one canal originally constructed in 1928. Routine maintenance may have altered the canal since its original construction. A cultural review was conducted in 2016 to determine if any turnouts are of historical significance. A finding of adverse effect was recommended. A mitigation plan has been agreed upon, and an MOA has been signed between Washington State Historic Preservation Officer, Reclamation, and the KRD.

Q. *Are any buildings, structures, or features in the irrigation district listed or eligible for listing on the National Register of Historic Places? A cultural resources specialist at your local Reclamation office or the State Historic Preservation Office can assist in answering this question.*

A. The cultural review identified two historic properties within the Area of Potential Effects (APEs). The 14.2-mile-long South Branch Canal was previously inventoried and evaluated by Reclamation and determined eligible for listing on the NRHP. A 2.8-mile segment of the South Branch Canal lining is located within the APE. The portion of the South Branch Canal within the APE is recommended as a contributing element to the NRHP-eligible South Branch Canal (Property ID 708748).

Q. *Are there any known archeological sites in the proposed project area?*

A. No archaeological deposits or Traditional Cultural Places (TCPs) were identified within the APEs.

Q. *Will the proposed project have a disproportionately high and adverse effect on low income or minority populations?*

A. No, the total project will not have a disproportionally high and adverse effect on low income or minority populations. KRD is not aware of any low-income or minority population communities adjacent to, and subject to disproportionately high and adverse effects, the project area.

Q. *Will the proposed project limit access to and ceremonial use of Indian sacred sites or result in other impacts on tribal lands?*

A. No, this project will not limit access to and ceremonial use of Indian sacred sites.

Q. *Will the proposed project contribute to the introduction, continued existence, or spread of noxious weeds or non-native invasive species known to occur in the area?* **A.** No, the project will not contribute to the spread of noxious weeds or non-native invasive species. BMP measures will take place during construction to limit introduction of noxious weeds and/or non-native invasive species. Post-construction, a native seed mix will be planted in all disturbed areas. Non-native Brook or Brown trout *may* be present in supplemental flow streams. Both species are present in other areas in the upper Yakima Basin but are typically confined to headwater reaches. As such, providing more natural stream flows will not likely contribute to the continued existence of these fish as they already exist and this project is designed to help recover native fish in the lower, dewatered reaches of perennial streams.

REQUIRED PERMITS AND/OR APPROVALS

FEDERAL PERMITTING

Cultural reviews and mitigation plans have been completed. The Columbia-Cascades Area Office is currently completing a NEPA review. Moreover, KRD anticipates that the project does not have significant impacts on the environment and will fit within a recognized Categorical Exclusion to NEPA. Environmental impacts will be minimized during construction using BMPs.

STATE PERMITTING

Permits for canal lining within KRD's right-of-way are not required. If necessary, a Construction General Permit for the protection of water quality during construction will be acquired by the contractor.

LOCAL PERMITTING

Permits for the canal lining and flow supplementation are not required at a local level.

LETTERS OF PROJECT SUPPORT

KRD attained and attached (Attachment A) letters of commitment or support from:

Washington Department of Ecology - Office of the Columbia River, Washington Department of Ecology - Water Resources, Kittitas County Public Works, Trout Unlimited, American Rivers, Kittitas County Conservation District, and the Yakama Nation.

OFFICIAL RESOLUTION

Kittitas Reclamation District
P.O. Box 276
Ellensburg, WA 98926
Phone: (509) 925-6158 Fax: (509) 925-7425

RESOLUTION 2018-04

WHEREAS, the Kittitas Reclamation District is in receipt of the U.S. Bureau of Reclamation Funding Opportunity Announcement No. BOR-DO-18-F006, WaterSMART – Water and Energy Efficiency Grants for Fiscal Year 2018; and;

WHEREAS, the Kittitas Reclamation District has legal authority to enter into a grant with the Bureau of Reclamation; and;

WHEREAS, the Board of Directors of the Kittitas Reclamation District supports the application submitted; and;

WHEREAS, the Kittitas Reclamation District will work with the U.S. Bureau of Reclamation to meet established deadlines for entering into a cooperative agreement.

NOW, THEREFORE, IT IS HEREBY RESOLVED by the Board of Directors that the Secretary-Manager, Urban Eberhart, has legal authority to enter into agreement with the U.S. Bureau of Reclamation WaterSMART Grant financial assistance program and to sign any and all documents necessary to enter into the WaterSMART program.

DATED, this 1st day of May, 2018.

Larry Bland
CHAIRMAN

Ed Wetzel
VICE CHAIRMAN

Paul Weaver did not sign, voted in favor.
BOARD MEMBER

Mark Hanson
BOARD MEMBER

Fred Schnebly
BOARD MEMBER

Urban Eberhart
SECRETARY-MANAGER

ATTACHMENTS

A: Letters of Commitment and Project Support

B: Cost determinations

C: KRD-Ecology-Reclamation Allocation, Management, and Protection Agreement

D: KRD Water Conservation Plan Feasibility Investigation

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
1250 W Alder St • Union Gap, WA 98903-0009 • (509) 575-2490

May 3, 2018

Mr. Kevin Connolly
Bureau of Reclamation
Financial Assistance Operations
PO Box 25007, MS 84-27814
Denver, CO 80225

RE: Kittitas Reclamation District WaterSMART Water and Energy Efficiency Grants for Fiscal Year 2018

Dear Kevin:

The Washington State Department of Ecology's Office of Columbia River (OCR) pledges a cash match of $300,000 for the Kittitas Reclamation District's WaterSMART proposal: *Water and Energy Efficiency Grants for Fiscal Year 2018*. The project is designed to supplement instream flows in upper Yakima River tributaries for fish, wildlife, and environmental benefits. The flow is created through a canal lining project that eliminates a leaking section of the Kittitas Reclamation District's South Branch Canal and 100% of the saved water is allocated, managed, and protected for instream flows in various streams, including Manastash Creek.

The project will help restore fish passage and habitat, and improve riparian ecosystem health along the streams. A secondary benefit is that this project improves the water management through the leaking portion of the canal, thus making delivery to irrigators more efficient and reliable during times of drought. The match will be available on June 1, 2018, and will remain committed for this purpose. There are no constraints or contingencies on this match as it is related to Ecology's OCR work on developing water supplies and implementing the Yakima Basin Integrated Plan. We encourage Kittitas Reclamation District's support and approval of this project.

Ecology's OCR is extremely interested in making this project a success. We look forward to working with the Kittitas Reclamation District on this project. If you have any questions, please contact Ecology staff, Danielle Squeochs, at (509) 454-4242 or by email at Danielle.Squeochs@ecy.wa.gov.

Sincerely,

G. Thomas Tebb, L.Hg., L.E.G.
Director
Office of Columbia River

GT:DS:cmr (180503)

cc: Justin Bezold, Trout Unlimited
Danielle Squeochs, Ecology- Office of Columbia River

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
1250 W Alder St • Union Gap, WA 98903-0009 • (509) 575-2490

May 4, 2018

Bureau of Reclamation Financial
Assistance Support Section
Attn: Mr. Darren Olson
P.O. Box 25007, Mail code: 84-27814
Denver, CO 80225

RE: Kittitas Reclamation District 2018 WaterSMART Proposal – Water Efficiency Grant

Dear Mr. Olson:

The Department of Ecology's Water Resources Program is pleased to support the WaterSMART proposal, "Improving South Branch Canal Conveyance Efficiency", being submitted by Kittitas Reclamation District under the 2018 WaterSMART Water and Energy Efficiency Grants for FY2018.

This proposal focuses on the upper Yakima River Basin in Washington State and is designed to address water shortages in Yakima River tributaries. As Climate change is expected to significantly impact the Yakima Basin, the Department of Ecology's Water Resources Program is especially interested in finding alternative and innovative ways to keep streams flowing while providing water to maintain the agricultural heritage of the basin, both in normal water supply years and during periods of drought - which is exactly what KRD does with this project.

This proposal builds on years of success and work accomplished under the Yakima Basin Integrated Water Resource Management Plan (YBIP). YBIP goals include addressing reduced Cascade Mountain snowpack and climate change by employing seven different elements. As a key part of restoring fish and wildlife habitat under the YBIP, this proposal helps advance the goals and improve the Basin's water supply security.

We encourage Reclamation's support and approval of this proposal. If you have any questions regarding our support for the project, please contact me by phone at (509)454-4240, or via email at trevor.hutton@ecy.wa.gov.

Sincerely,

Trevor Hutton

Trevor Hutton, Section Manager
Water Resources Program
Central Regional Office
Department of Ecology

TH:VD:SS/180510

KITTITAS COUNTY
DEPARTMENT OF PUBLIC WORKS
Mark Cook, Director

May 4, 2018

Bureau of Reclamation Financial
Assistance Support Section
Attn: Mr. Darren Olson
P.O. Box 25007, Mail code: 84-27814
Denver, CO 80225

RE: Kittitas Reclamation District 2018 WaterSMART Proposal – Water Efficiency Grant

Dear Mr. Olson.

Kittitas County Flood Control District is pleased to support the WaterSMART proposal: Water Efficiency Grant being submitted by Kittitas Reclamation District under the 2018 WaterSMART Water and Energy Efficiency Grants for FY2018.

This proposal focuses on the Upper Yakima River Basin in Washington State and is designed to address water shortages in Yakima River tributaries. As Climate change is expected to significantly impact the Yakima Basin, Kittitas County Flood Control District is especially interested in finding alternative and innovative ways to keep streams flowing while providing water that benefits fish, wildlife and the environment through a water conservation program designed to restore instream flows in over-appropriated or flow-impaired tributaries to the Upper Yakima River. Reducing canal seepage provides otherwise lost water towards regional conservation goals.

This proposal builds on years of success and work accomplished under the Yakima Basin Integrated Water Resource Management Plan (YBIP). As a key part of restoring fish and wildlife habitat under the YBIP, this conservation proposal helps advance YBIP goals and improves the Basin's water supply security. We encourage Reclamation's support and approval of this proposal.

If you have any questions regarding this letter, please contact me at (509) 962-7523.

Sincerely,

Mark R. Cook
Flood Control Zone District Administrator

411 N. Ruby, Suite #1
Ellensburg, WA 98926
TEL (509) 962-7523
FAX (509) 962-7663

May 9, 2018

U.S. Bureau of Reclamation
Financial Assistance Support Section
Attn: Mr. Darren Olson
P.O. Box 25007, Mail code: 84-27814
Denver, CO 80225

RE: Kittitas Reclamation District 2018 WaterSMART Proposal – Water Efficiency Grant

Dear Mr. Connolly:

Trout Unlimited is pleased to support the Kittitas Reclamation District's 2018 application for project funding to support "Improving South Branch Canal Conveyance Efficiency," being submitted under the 2018 WaterSMART Water and Energy Efficiency Grants for FY2018.

Trout Unlimited is a national coldwater fisheries conservation non-profit working in Washington's Yakima Basin to find solutions that create positive outcomes to water management issues for all stakeholders involved in water use. The present project focuses on the water delivery through the upper Yakima River Basin in Washington State and is designed to address water conveyance efficiency and help with water shortages in Yakima River tributaries. This project finds alternative and innovative ways to keep streams flowing while providing water to maintain the agricultural heritage of the Yakima Basin—both of vital importance to the Basin.

This proposal also builds on years of success and work accomplished under the Yakima Basin Integrated Water Resource Management Plan (YBIP). YBIP goals include addressing reduced Cascade Mountain snowpack and climate change by employing seven different elements. As a key part of restoring fish and wildlife habitat under the YBIP, this proposal helps advance the goals and improve the Basin's water supply security.

We fully support this proposal and encourage Reclamation to fund it fully.

If you have any questions regarding this letter, please contact Lisa Pelly at LPelly@tu.org or 509-630-0467.

Sincerely,

Lisa Pelly

Lisa Pelly, director
Trout Unlimited

Washington Water Project
103 Palouse, Suite 14, Wenatchee, WA 98801; 115 S. Glover Street, Twisp, WA 98856;
P.O. Box 1987, Yakima, WA 98907
(509) 888-0970 • Fax: (509) 888-4352 • www.tu.org

American Rivers
Rivers Connect Us

May 7, 2018

Bureau of Reclamation Financial Assistance Support Section
Attn: Mr. Darren Olson
P.O. Box 25007, Mail code: 84-27814
Denver, CO 80225

RE: Kittitas Reclamation District 2018 WaterSMART Proposal – Water Efficiency Grant

Dear Mr. Connolly:

American Rivers is pleased to **support the WaterSMART proposal: "Improving South Branch Canal Conveyance Efficiency"**, being submitted by Kittitas Reclamation District (KRD) under the 2018 WaterSMART Water and Energy Efficiency Grants for FY2018.

This proposal focuses on the upper Yakima River Basin in Washington state and is designed to address water shortages in Yakima River tributaries. As climate change is expected to significantly impact the Yakima Basin, American Rivers is especially interested in finding alternative and innovative ways to keep water in streams while providing water to maintain the agricultural heritage of the basin, both in normal water supply years and during periods of drought. This is precisely what Kittitas Reclamation District does this project.

KRD's proposal builds on years of success and work accomplished under the Yakima Basin Integrated Water Resource Management Plan (YBIP). YBIP goals include implementing drought resiliency projects given reduced snowpack in the Cascade Mountains. As a key part of restoring fish and wildlife habitat under the YBIP, KRD's proposal helps advance the goals and improve the Basin's water supply security.

We encourage Reclamation's support and approval of this proposal. If you have any questions regarding this letter, please contact me at wmcdermott@americanrivers.org or at 206-213-0330 ext 1.

Sincerely,

Wendy McDermott
Director, Puget Sound and Columbia Basin Programs

Puget Sound-Columbia Basin Office • P.O. Box 1234 • Bellingham, WA 98227 • 206-213-0330

Kittitas County Conservation District
2211 W. Dolarway Rd, Suite 1 - Ellensburg, WA 98926 - Phone (509) 925-3352 · Fax (888) 546-0825

May 1, 2018

Bureau of Reclamation Financial Assistance
Support Section
Attn: Mr. Darren Olson
P O Box 25007, Mail code. 84-27814
Denver, CO 80225

RE: Kittitas Reclamation District 2018 WaterSMART Proposal – Water Efficiency Grant

Dear Mr. Olson:

The Kittitas County Conservation District is pleased to support the Wate SMART proposal IMPROVING SOUTH BRANCH CANAL CONVEYANCE EFFICIENCY, being submitted by Kittitas Reclamation District under the 2018 WaterSMART Water and Energy Efficiency Grants for FY2018

This proposal focuses on the upper Yakima River Basin in Washington State and is designed to address water shortages in Yakima River tributaries. As Climate change is expected to significantly impact the Yakima Basin, the Kittitas County Conservation District is especially interested in finding alternative and innovative ways to keep streams flowing while providing water to maintain the agricultural heritage of the basin, both in normal water supply years and during periods of drought—which is exactly what KRD does with this project

This proposal builds on years of success and work accomplished under the Yakima Basin Integrated Water Resource Management Plan (YBIP). YBIP goals include addressing reduced Cascade Mountain snowpack and climate change by employing seven different elements. As a key part of restoring fish and wildlife habitat under the YBIP, this proposal helps advance the goals and improve the Basin's water supply security

For the KCCD in particular, this proposal also builds on a phenomenal effort and partnership for the Manastash Creek Restoration Project. The KCCD facilitated a Steering Committee (including irrigators, local, state, federal, tribal and environmental stakeholders) and coordinated the Manastash Creek Restoration Project beginning in 2003 to address fish screens, passage and instream flow while keeping agriculture in watershed whole. YBIP came into and supported the Manastash Project at a critical juncture to ensure that the goals of opening up 25 miles of stream habitat in the upper watershed and consistent instream flow in a traditionally dewatered reach of the creek in the lower watershed were possible. KRD staff have worked very closely with KCCD staff to continue to develop strategies and take advantage of opportunities to ensure instream flow while supporting irrigated agriculture in the watershed. This proposal helps to move that effort forward and we very strongly encourage Reclamation's support and approval of this proposal.

If you have any questions regarding this letter, please contact me at (509) 925-3352 ext. 207.

Sincerely,

Anna Lael, District Manager

Confederated Tribes and Bands
of the Yakama Nation

Established by the
Treaty of June 9, 1855

May 7, 2018

Bureau of Reclamation
Financial Assistance Support Section
Attn: Mr. Darren Olson
P.O. Box 25007, Mail code: 84-27814
Denver, CO 80225

RE: Kittitas Reclamation District 2018 WaterSMART Proposal – Water Efficiency Grant

Dear Mr. Olson:

The Yakama Nation Department of Natural Resources is pleased to support the WaterSMART proposal: IMPROVING SOUTH BRANCH CANAL CONVEYANCE EFFICIENCY being submitted by Kittitas Reclamation District under the 2018 WaterSMART Water and Energy Efficiency Grants for FY2018.

This proposal focuses on the upper Yakima River Basin in Washington State and is designed to address water shortages in Yakima River tributaries. As reduced snowmelt runoff is expected to significantly impact both salmon runs and agricultural water supply in the Yakima Basin, Yakama Nation Department of Natural Resources is especially interested in finding alternative and innovative ways to keep streams flowing while providing water to maintain the agricultural heritage of the basin, both in normal water supply years and during periods of drought. This project addresses long standing flow issues in the tributaries caused by dwindling snowpack, diversions, and land use changes by using the basin's robust irrigation conveyance system to augment streamflow in a way that is water-budget neutral to irrigators. This is entirely consistent with the 1994 YRBWEP legislation that made fish and wildlife a Yakima Project purpose and furthers the consensus goals of fisheries restoration and irrigation efficiency embodied in the Yakima Basin Integrated Plan (YBIP).

This proposal builds on years of success and work accomplished under YBIP. YBIP goals include addressing reduced Cascade Mountain snowpack and earlier runoff by employing seven different elements. As a key part of restoring fish and wildlife habitat under the YBIP, this proposal helps advance the goals and improve the Basin's water supply security.

We encourage Reclamation's support and approval of this proposal.

If you have any questions regarding this letter, please contact Phil Rigdon at 509-865-5121, extension 4655.

Sincerely,

Philip Rigdon, Superintendent
Yakama Nation Department of Natural Resources

Post Office Box 151, Fort Road, Toppenish, WA 98948 (509) 865-5121

						Construction Contractor Total:		$ 565,435.99
CONTRACTOR ADMINISTRATION								$ 150,106.82
	Mobilization						$ 21,491.85	
	Permitting						$ 11,082.50	
	General Contractor Overhead & Profit						$ 103,196.88	
	Record Documents						$ 1,442.79	
	Demobilization						$ 12,892.80	
SITE PREPARATION								$ 13,001.53
	Access Improvement						$ 10,028.68	
	Staging Site Improvements						$ 2,972.85	
				QUANTITY	UNIT	UNIT	SUBTOTALS	
PROJECT REACH 1 (Sta. 379+40 to 396+68)				1600	LF	$ 251.45		$ 402,327.63
210	Concrete Lining & Adjoining Access Road Improvements			1600	LF	$ 245.84	$ 393,343	
		Excavation and regrade of canal (125% swell)		3478	CY	$ 12.45	$ 43,309	
		Soft soil stabilizing fabric/geotextile		4174	SY	$ 4.14	$ 17,272	
		Soft soil ballast material		348	CY	$ 37.97	$ 13,208	
		Filter fabric/geotextile		5565	SY	$ 1.01	$ 5,629	
		Drain rock		278	CY	$ 36.34	$ 10,113	
		Drainage board		1461	SY	$ 4.87	$ 7,120	
		Underdrain pipe, 10" dia. corrugated HDPE		1600	LF	$ 9.13	$ 14,615	
		Impermeable membrane/geotextile		5635	SY	$ 7.82	$ 44,044	
		Macrofiber reinforcing (3 lbs/cy) - sub. O&P		835	CY	$ 17.73	$ 14,797	
		Concrete, 4,000 psi ready mix - sub. O&P		835	CY	$ 123.97	$ 103,488	
		Winter concrete hot water added cost - sub. O&P		835	CY	$ 5.38	$ 4,494	
		Egress ladder rungs, approx. "8 rungs every 500-ft		28	EA	$ 36.54	$ 1,017	
		Gravel Base Course		1600	CY	$ 40.04	$ 64,064	
		Maintenance access road crushed surfacing top coarse		209	CY	$ 45.73	$ 9,543	
		Slope stabilization seeding		2435	SY	$ 2.12	$ 5,163	
		Associated labor for for installation of vendor quoted material		27	Day	$ 1,330.00	$ 35,467	
220	Overshot & Undershot Drains						$ 4,685	
		Added overshot drians		1.00	LS	$ 750.00	$ 750	
		Wye to connection to undershot drians		2.00	EA	$ 268.60	$ 538	
		Elbows for connection to undershot drians - 3 per each		2.00	EA	$ 495.88	$ 992	
		Underdrain pipe, 10" dia. corrugated HDPE - "45' per each		2.00	EA	$ 411.06	$ 823	
		Flared end drain outfall		2.00	EA	$ 290.92	$ 582	
		Misc. regrading and outlet erosion control		2.00	LS	$ 500.00	$ 1,000	
240	Flume (additive to lineal foot of canal cost)						$ 4,300	
		Added flume grading and concrete		1.00	EA	$ 1,000.00	$ 1,000	
		Stillingwell (48" Manhole)		1.00	EA	$ 2,800.00	$ 2,800	
		Stillingwell piping connection		1.00	EA	$ 500.00	$ 500	
			Engineering services during construction					
			Construction Management	$ 75.00/HR	135	$ 10,125.00		
			Construction Inspection	$ 53.50/HR	400	$ 21,400.00		
			Submittal Review	$ 150.00/HR	20	$ 3,000.00		
				Total Engineering Services:		$ 34,525		

ATTACHMENT C: KRD-ECOLOGY-RECLAMATION ALLOCATION, MANAGEMENT, AND PROTECTION AGREEMENT

MEMORANDUM OF AGREEMENT
Between
Bureau of Reclamation
Pacific Northwest Region, Columbia-Cascades Are Office
and
Kittitas Reclamation District
and
Washington State Department of Ecology

PROVIDING FOR THE ALLOCATION, MANAGEMENT, AND PROTECTION OF CONSERVED WATER

THIS AGREEMENT, is entered into pursuant to the Act of June 17, 1902 (32 Stat. 388), and acts amendatory thereof and supplementary thereto, and particularly section 1207 of Title XII of Public Law 103-434, October 31, 1994 (108 Stat. 4550) (commonly known as the Yakima River Basin Water Enhancement Project (YRBWEP) Act), as amended, by and between **THE UNITED STATES OF AMERICA,** acting through the Bureau of Reclamation, hereinafter referred to as Reclamation, the **KITTITAS RECLAMATION DISTRICT,** hereinafter referred to as the District, and the **WASHINGTON STATE DEPARTMENT OF ECOLOGY,** hereinafter referred to as Ecology; jointly referred to as the "Parties".

WITNESSETH, THAT;

EXPLANATORY RECITALS

1. WHEREAS, the United States, acting through the Bureau of Reclamation, constructed and is operating the Yakima Project (Project), Washington, for the storage and delivery of water for irrigation and other beneficial uses; and

2. WHEREAS, the District is a special purpose district of the State of Washington, created pursuant to the Revised Code of the State of Washington (RCW)

87.03, that delivers irrigation water pursuant to a water right confirmed in *State of Washington, Department of Ecology v. James J. Acquavella, et al.*, Yakima County Superior Court Cause No. 77-2-01484-5 *(Acquavella)*, which is subject to a Conditional Final Order entered June 1, 1994, as modified by the Kittitas Reclamation District Water Rights Settlement Agreement. The water right authorizes the District to deliver Project irrigation water pursuant to an amendatory contract between the United States of America and the District dated January 20, 1949 to those irrigable lands within the boundaries of the District that are designated as irrigable by Reclamation; and

3. WHEREAS, Reclamation implements YRBWEP for multiple purposes, including to: (a) protect, mitigate, and enhance fish and wildlife through improved water management, improved instream flows, and by other appropriate means of habitat improvement; (b) improve the reliability of the water supply for irrigation; and (c) implement a Yakima River basin water conservation program that will improve the efficiency of water delivery and use; and

4. WHEREAS, the District intends to enter into the Wipple Canal Lining and Conservation Project (Wipple Conservation Project), which involves construction of an impervious lined canal in place of an existing unlined dirt canal. The distance between the beginning of the lining project and the end of the lining project is approximately 17,109 linear feet, to be done in phases with approximately 1,983 linear feet in this Phase 1; and

5. WHEREAS, Trout Unlimited (TU), which is working to obtain funding to support the implementation of the Wipple Conservation Project but is not a party to this Agreement, has applied for funding from both the Columbia Basin Water Transactions Program (CBWTP), which is administered by the National Fish and Wildlife Foundation,

through Transaction No. 440-15, and Ecology for a total of $600,000.00 for the use of conserved water associated with Phase I of the Wipple Conservation Project, which is to line approximately 1,983linear feet of canal and will conserve at least 1.01 cfs, and at least 312.94 acre-feet and up to 431.244 acre-feet of water, to augment instream flows in tributaries of the Yakima River; and

6. WHEREAS, the District, as part of the Wipple Conservation Project, intends to enter into this Agreement Providing for the Allocation, Management, and Protection of Conserved Water for the Wipple Conservation Project with Ecology and Reclamation; and

7. WHEREAS, the Project's water right for the Kittitas Division has a priority date of 1905 and the District is a proratable irrigation district, meaning that within the Project, in years when there is less than a full water supply, the quantity of water available to the District for delivery to lands entitled to water within the District boundaries is subject to reduction and curtailment.

8. WHEREAS, the parties recognize that the conserved water realized by the Wipple Conservation Project will benefit the public interest, the interests of Reclamation to protect and restore habitat for fish and other species in various tributaries of the Yakima River, and the interests of Ecology to protect instream flow water for fish and other species in various tributaries of the Yakima River; and

NOW, THEREFORE, in consideration of the mutual and dependent provisions herein contained, the parties hereto agree as follows:

9. **Definitions.** The following terms, wherever used in this Agreement, shall have the following respective meanings:

9.1 "Conserved Water" shall mean for purposes of this Agreement and the Wipple Conservation Project only, the water saved from conveyance losses as a result of the conversion of the open canal lateral delivery system into an impervious lined canal.

9.2 "Contracting Officer" shall mean the Secretary of the Interior's duly authorized representative acting pursuant to this Agreement or applicable Federal reclamation law, regulation or policy.

9.3 "Project" shall mean the entire Yakima Project constructed by the United States under the Federal Reclamation laws.

9.4 "Secretary" shall mean the Secretary of the Interior, a duly appointed successor, or an authorized representative acting pursuant to the authority of the Secretary.

9.5 "Amendatory Contract" shall mean the amendatory contract between the United States of America and the District dated January 20, 1949, as amended and supplemented.

10. **Scope of Agreement.**

10.1 This Agreement pertains only to the realization of conserved water and its discharge into tributaries of the Yakima River as stated in Article 12.1.2 herein, and is not intended to and does not create a legally binding contract or any right or benefit, substantive or procedural, enforceable at law or in equity by any party against another party, its directors, officers, employees or other persons. This Agreement does not constitute an explicit or implicit agreement to subject any of the parties to the jurisdiction of any federal or state court over and above any rights or procedures presently available to

the parties. This Agreement does not create any right or benefit, substantive or procedural, enforceable at law or in equity, by any person or entity against the parties. This Agreement shall not be construed to create any right to judicial review involving the compliance or noncompliance of the parties with this Agreement.

10.2 Nothing in this Agreement shall result in an amendment or modification of the rights and obligations of the District and the United States under the Amendatory Contract, or affect the priority dates of any existing water rights.

11. **Term of Agreement.**

11.1 This Agreement shall become effective on the date upon which it is executed by all the parties.

11.2 This Agreement has no expiration date.

11.3 Any of the parties may formally request the review, amendment or modification of this Agreement. Amendments or modifications to this Agreement shall be made by mutual consent of the parties, with the issuance of a written amendment, signed and dated by all parties, prior to any changes being made.

12. **Treatment of Conserved Water Discharged into Tributaries of the Yakima River.**

12.1 **District Responsibilities:**

12.1.1 **Discharge of Conserved Water.** The District will discharge Project water conserved by the Wipple Conservation Project from District facilities directly to the tributaries of the Yakima River at the locations identified on Exhibit A.

12.1.2 **Determination of Which of the Tributaries of the Yakima River to Discharge Water to.** Each year a determination shall be made, pursuant to paragraph 12.1.7 as to which of the tributaries of the Yakima River identified on Exhibit A conserved water will be discharged into. The District will determine which of the tributaries recommended for supplementation following the process set forth in paragraph 12.1.7 it is operationally able to discharge conserved water into from the list of locations identified on Exhibit A hereto.

12.1.3 **Quantity of Conserved Water.** Reclamation, the District, and Ecology recognize, agree, and anticipate that at least 312.94 acre-feet and up to 431.244 acre-feet per year is the quantity of conserved water the District will discharge to tributaries of the Yakima River. The target flow rate to discharge to the tributaries of the Yakima River is a constant 1.01 cfs. Depending on variances in deliveries and other factors that may not be in the District's control, the target rate may not be achieved at all times and the actual delivery may be higher or lower. The quantity of conserved water the District will discharge to the creeks will be reduced in years when the District does not receive a full water supply because the District's water allocation from Reclamation has been prorated. In years when the District's water allocation is prorated, the amount of the reduction in the target quantity of conserved water shall be determined by multiplying the annual target quantity of at least 312.94 acre-feet and up to 431.244 acre-feet per year by the percentage of the water supply the District receives as a result of proration.

12.1.4 **No Increase in Diversion Quantities.** The District re-affirms its agreement to limit its diversions of water from the Yakima River and its tributaries

to the quantity it is authorized to divert under the *Acquavella* Conditional Final Order and the Kittitas Reclamation District Water Rights Settlement Agreement (effective June 24, 2006).

12.1.5 **Conserved Water Realized, Segregated, and Conveyed from the Yakima River.** The District recognizes that although there will be no reduction in the quantity of water annually diverted from the Yakima River at least 312.94 acre-feet and up to 431.244 will be segregated and excluded from irrigation use, at the diversion works on the Yakima River, and recognized as the conserved water realized from the Wipple Conservation Project. Reclamation and the District will then convey that conserved water through the District's delivery system to the tributaries identified on Exhibit A using the process specified in Paragraph 12.1.2.

12.1.6 **No Right of Recapture.** The District agrees that once it discharges conserved water to tributaries of the Yakima River the District or its members will not seek to recapture or deliver the conserved water at another location.

12.1.7 **Process to Determine Which Tributaries to Supplement.**

12.1.7.1 **Purpose and Goal of the Committee.** Each year the District shall be responsible for convening and facilitating the District's Tributary Supplementation Program Committee (hereinafter referred to as the "Committee"). The purpose of the committee shall be to make recommendations to Reclamation on the quantities of conserved water to be discharged to tributaries in Kittitas County. The goal of determining how conserved water is going to be discharged to tributaries to supplement flow is to balance the instream flow need in the tributaries with the District's operational ability to deliver

conserved water to a given tributary. Each year Reclamation shall make its recommended determination of which tributaries receive what quantities of conserved water only after consulting with the Committee. Reclamation shall, after said consultation and based on its water supply forecast, determine how much conserved water shall be discharged into each tributary identified on Exhibit A. The District shall inform Reclamation which tributaries recommended for supplementation that the District is operationally able to discharge conserved water into.

12.1.7.2 **Composition of the Committee**. The committee shall be comprised of one representative from the following entities: Yakama Nation, Ecology, Washington State Department of Fish and Wildlife, National Marine Fisheries Service, U.S. Fish and Wildlife Service, the District and TU. Each of the above referenced agencies shall designate one individual to participate in the committee and its work, as described herein, each year.

12.1.7.3 **Timing of Committee Actions**. The District shall, on or before April 1 of each year convene a meeting of the Committee. The committee shall meet and/or confer thereafter during the irrigation season on an "as-needed to" basis to monitor and adjust and regulate how much conserved water is discharged to which tributaries.

12.2 **Reclamation Responsibilities.** Reclamation will treat the conserved water discharged by the District to the creeks as instream flow for the benefit of species listed under the Endangered Species Act (ESA), will recognize the Wipple Conservation Project, and will not use the discharged conserved water for other project purposes while in the creeks. Reclamation will apply to Ecology to change the purpose of use to instream flow for

conserved water. The parties acknowledge and agree that the change in purpose of use to instream flow, (with a correlating change to the place of use), is limited to the 356.796 acre feet of conserved water and no other or additional part of the water right confirmed in the name of the United States for the benefit of the District in *Ecology v. Acquavella*, Yakima County Superior Court Cause No. 77-2-01484-5, Court claim Nos. 00465, (A)03033, (A)05444, as modified by written agreement dated January 3, 2006, shall be included in the proposed change in purpose of use. Where authorized, Reclamation will assist Ecology to protect the conserved water while in tributaries of the Yakima River against appropriation or other uses. Reclamation will protect the conserved water consistent with the other provisions of this Agreement and consistent with all other agreements and contracts between the District and Reclamation, except where explicitly superseded by this Agreement. Reclamation will include recognition of this project as part of its ESA efforts in the Yakima Basin.

12.3 **Ecology Responsibilities:**

Ecology will manage and protect the conserved water from the point of discharge into tributaries of the Yakima River, as shown in Exhibit A, downstream to the confluence of the Yakima River.

13. **Notices.** Any notice, demand, or request authorized or required by this Agreement shall be deemed to have been given, on behalf of the United States, when mailed, postage prepaid, or delivered either to the Regional Director, Pacific Northwest Region, Bureau of Reclamation, 1150 N. Curtis Road, Suite 100, Boise, ID 83706-1234, or to the Columbia-Cascades Area Office Manager, Yakima Project, 1917 Marsh Road, Yakima. WA 98901-2058; and on behalf of the District, when mailed, postage prepaid, or delivered to

the Manager, Kittitas Reclamation District. P.O. Box 276, Ellensburg, WA 98926; and on behalf of Ecology, when mailed, postage prepaid, or delivered to: Water Resources Program Section Manager, Central Regional Office, 1250 W. Alder St., Union Gap, WA 98903. The designation of the addressee or the address may be changed by notice given in the same manner as provided in this article for other notices.

14. **Principal Contacts.** The principal contacts for this Agreement are:

Reclamation:
Dawn Wiedmeier
Area Manager
U.S. Bureau of Reclamation
Columbia-Cascades Area Office
1917 Marsh Road
Yakima, WA 98901-2058
Phone: 509-575-5848
Email: dwiedmeier@usbr.gov

The District:
Urban Eberhart
Secretary/Manager
Kittitas Reclamation District
P.O. Box 276
Ellensburg, WA 98926
Phone: 509-925-6158
Email: urban@krdistrict.org

Ecology:
Trevor Hutton
Water Resources Program Section Manager
Central Regional Office
1250 W. Alder St.
Union Gap, WA 98903
thut461@ecy.wa.gov

15. **General Provisions.**

15.1 Non-Fund Obligating Document. This Agreement is neither a fiscal nor a funds obligating document. Any endeavor or transfer of anything of value involving reimbursement or contribution of funds between the Parties will be handled in accordance

with applicable laws, regulations, and procedures including those for Government procurement and printing. Such endeavors will be outlined in separate agreements that shall be made in writing by representatives of the Parties and shall be independently authorized by appropriate statutory authority. This Agreement does not provide such authority. Specifically, this MOU does not establish authority for noncompetitive award to the parties of any contract or other agreement.

15.2 No Binding Rights or Obligations. Nothing in the Agreement is intended to create any right or benefit, substantive or procedural, enforceable at law by a party against the United States, its agencies its officers, or any other person. Nothing in this MOU shall be deemed to increase the liability of the United States beyond that currently provided in the Federal Tort Claims Act (28 U.S.C. 2671 et seq.).

15.3 **No Sharing of Benefits.** No member of or delegate to Congress, or resident Commissioner, shall be admitted to any share or part of this Agreement or to any benefit that may arise out of it.

15.4 Freedom of Information Act. Any information furnished to Reclamation under this Agreement is subject to the Freedom of Information Act (5 U.S.C. 552).

15.5 **Compliance with Federal Laws.** All Parties to this Agreement agree to comply with all Federal statutes relating to nondiscrimination, including but not limited to: Title VII of the Civil Rights Act of 1964, as amended, which prohibits discrimination on the basis of race, color, religion, sex, or national origin; Title IX of the Education amendments of 1972, as amended, which prohibits discrimination of the basis of sex; the Rehabilitation Act of 1973, as amended, and the Americans with Disabilities Act of

1990, as amended, which prohibit discrimination on the basis of disability; the Age Discrimination in Employment Act of 1967, as amended, which prohibits discrimination based on age against those who are at least 40 years of age; and the Equal Pay Act of 1963. All Parties to this Agreement agree to comply with all Federal statutes relating to nondiscrimination, including but not limited to: Title VII of the Civil Rights Act of 1964, as amended, which prohibits discrimination on the basis of race, color, religion, sex, or national origin; Title IX of the Education amendments of 1972, as amended, which prohibits discrimination of the basis of sex; the Rehabilitation Act of 1973, as amended, and the Americans with Disabilities Act of 1990, as amended, which prohibit discrimination on the basis of disability; the Age Discrimination in Employment Act of 1967, as amended, which prohibits discrimination based on age against those who are at least 40 years of age; and the Equal Pay Act of 1963.

16. **Agreement Drafting Considerations.** This Agreement has been negotiated and reviewed by the parties hereto, each of whom is sophisticated in the matters to which this Agreement pertains. Articles 1 through 13 of this Agreement have been drafted, negotiated, and reviewed by the parties, and no one party shall be considered to have drafted the stated articles.

IN WITNESS WHEREOF, the parties hereto have executed this Agreement as of the last date written below.

KITTITAS RECLAMATION DISTRICT

Urban Eberhart

Urban Eberhart
Secretary/Manager
Kittitas Reclamation District

9/30/2016
Date

UNITED STATES OF AMERICA

Dawn Wiedmeier, Area Manager
Columbia-Cascades Area Office
United States Department of the Interior
Bureau of Reclamation

9/30/16
Date

STATE OF WASHINGTON DEPARTMENT OF ECOLOGY

Trevor Hutton, Manager
Water Resources Program Section
Central Regional Office

9/30/16
Date

ATTACHMENT D: KRD WATER CONSERVATION PLAN FEASIBILITY INVESTIGATION

Submitted as attachment at Grants.gov.

Final Report

Kittitas Reclamation District Feasibility Investigation

Prepared for

Kittitas Reclamation District

March 2015

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Submitted to

Kittitas Reclamation District

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This document has been prepared under the direction of a Registered Professional Engineer

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Executive Summary

History

The Kittitas Reclamation District (KRD), located in central Washington, was organized under RCW Title 87, Irrigation Laws of the State of Washington, on September 25, 1911, and in accordance with KRD's Federal Repayment Contract. The KRD encompasses approximately 104,588 acres and currently assesses 59,478 acres. Irrigation water is currently applied to about 60,000 acres within the District.

Water is supplied to the KRD from two Bureau of Reclamation (BOR) storage reservoirs, Keechelus and Kachess. Irrigation water is diverted from the Yakima River at the Easton Diversion Dam.

On July 9, 2013 Lorri J. Lee, BOR Regional Director Pacific Northwest Region U.S., signed and approved the Record of Decision (ROD) for the Yakima River Basin Integrated Water Resource Management Plan (Integrated Plan) Final Programmatic Environmental Impact Statement (EIS) Yakima Project, Washington. KRD Canal Modifications to reduce seepage and enhance tributary flows are specifically listed as a priority in the ROD under Structural and Operational Changes goals. KRD is uniquely situated to provide multiple benefits to improve water supply for agriculture and fish, and improve the ability of water and fisheries managers to adapt to climate change because of KRD's location relative to many important tributaries in the upper Yakima River Basin. A recent successful example of this benefit is the KRD South Branch Lateral 13.8 – Manastash Creek Conservation and Tributary Enhancement piping project that was constructed by the BOR as the first on the ground construction project of the Integrated Plan.

In 1999, KRD described its facilities and evaluated its operations in a Comprehensive Water Conservation Plan (CWCP). In 2001, Addendum No. 1 to the CWCP was prepared to address items suggested by the Feasibility Investigation Team. At the time the CWCP and Addendum was finalized, it was determined that a Feasibility Investigation was needed to provide a basis for the proposed implementation of the water conservation measures identified in the CWCP and Addendum. This Feasibility Investigation provides the basis for implementing final design of the proposed water conservation measures. The Feasibility Investigation is funded by the Washington State Department of Ecology (Ecology), the United States Bureau of Reclamation (BOR), and KRD.

KRD has been an active participant along with Ecology, BOR and others in the creation of the Integrated Plan. The conservation measures in this Feasibility Investigation are consistent with the components in the Initial Development Phase of the Integrated Plan. The Initial Development phase will span the time frame from passage of Washington State's Integrated Plan authorizing legislation in 2013 through the year 2023. The Initial Development Phase represents a set of projects and activities that will quickly achieve tangible improvements in stream flow, habitat, and fish passage as well as to provide increased security of existing out-of-stream water supplies. The KRD improvements in this Feasibility Investigation will play a crucial role in meeting some of the Integrated Plan Initial Development phase objectives. Some of the key components of the Initial Development Phase that will be sources of funding for these improvements include the

Integrated Plan agricultural conservation projects component, the Integrated Plan flood plain and tributary habitat restoration project and acquisitions component, the Integrated Plan additional fish passage projects component, the Integrated Plan aquifer storage and recovery project component as well as the Integrated Plan water banking and exchange programs component. There also may be other funding sources available for these improvements in the initial development phase through other federal and state agencies in addition to Ecology and BOR funding sources.

Water Conservation Measures - Conceptual Design

Some of the water saved by the system improvements discussed in this feasibility investigation may be needed to satisfy irrigation demand. The remaining saved water may be used to increase upper Yakima River tributaries in stream flows or other purposes. A portion of the conserved water may become available to supplement creek water or for users currently diverting from Yakima River tributaries. In addition, some conserved water and canal capacity made available from water conservation projects could be used for groundwater storage projects.

Conceptual design of the facilities investigated in this feasibility investigation includes the following:

- Line the high water loss portion of the North Branch canal between the Johnson Siphon and the Wippel Pumping Plant.
- Line the high water loss portion of the South Branch canal between the Swede Tunnel and the Robinson Canyon Siphon.
- Pipe specific high water loss open canal laterals and sub-laterals on the North and South Branch canals.
- Construct automated flow control facilities with instrumentation and radio telemetry to regulate flow in the North and South Branch canals and at the Wippel Pumping Plant.
- Construct reregulation reservoirs for the North and South Branch canals (two reservoirs total).

Site Suitability

KRD's system of open irrigation canals and flumes has existed since the original construction and operation of the facilities began in the 1920's. The proposed addition of piping and lining existing laterals and sub laterals and installation of automated facilities within existing easements eliminates the need for an extensive site suitability survey for these facilities. The existing rights-of-way provide locations for new pipelines and lining to connect to the existing irrigation turnouts. These points of connection have been and will continue to define the limits of KRD operation and maintenance responsibility.

General siting of the proposed reregulation reservoirs has been performed as part of this Feasibility Investigation to confirm whether suitable land is available for the proposed reservoir volume and configuration. Geotechnical exploration is still needed at the reservoir sites as well as negotiations with landowners to purchase reservoir site land.

Site suitability is not considered a problem for the proposed addition of piping and turnouts to serve KRD water to creek water diversion points or to supplement creek water flow upstream of the diversion points. A few new pipeline easements outside of the existing KRD right-of-way may be needed to be obtained from landowners along the proposed pipeline alignments for economy of construction.

Design Criteria

Standards and criteria for the conceptual design of the proposed facilities adhere to engineering principles and state of the art design as practiced by the irrigation industry and Ecology – Dam Safety Division criteria and guidelines.

The hydraulic sizing criteria for new pipelines identified in this Feasibility Investigation that are being converted from an existing open ditch lateral, sub lateral, or sub sub lateral to a pipeline are derived from an on-farm application peak flow rate of 7 gpm per acre. The application flow rate is slightly lower than historical usage of 9.17 gpm per acre (North Branch) and 7.90 gpm per acre (South Branch) which accommodate significant conveyance losses. KRD agreed to set the future application flow rate at 7 gpm per acre for the water conservation pipeline projects identified in this Feasibility Investigation with the understanding that the conservation improvements will substantially reduce system losses and permit adequate flows to be delivered to the farmland.

It was determined that standard AWWA C900/C905 or ASTM D2241PVC or other plastic pipe materials offer a cost effective approach to piping laterals with appropriate safety factor for hydraulic surges.

The system operating pressure for the piped irrigation systems was evaluated. The proposed gravity system piping takes advantage of the elevation differential between lateral piping head works and turnout locations along laterals or sub laterals. Pressures will vary from approximately 10 psi to a maximum of 85 psi. In areas where the gravity pressure would exceed 85 psi, some pressure reducing valves may be needed. The piped gravity system minimizes maintenance and operational issues and provides a substantial benefit to the water users.

American Water Works Association (AWWA) rated butterfly valves, resilient wedge gate valves, bronze curb stop valves, and slide gates will be used. Other appurtenances will be standard mechanical propeller type flow meters or battery operated magnetic flowmeters, and continuously acting air vent/vacuum relief valves.

Native materials, free of organic material, trash, and other deleterious material, will be used where suitable for pipe bedding and pipe zone material. 92 percent relative compaction will be obtained in the pipe zone and where the pipeline passes under roadways, with all other areas to have an 85 percent relative compaction.

Review of water hammer control in pipelines shows that adequate protection can be achieved by maintaining low velocities and adequate air/vacuum relief in the enclosed piped system. Solids will be screened and removed at the lateral head gate. Although bed loads are not expected to be excessive, the lateral head gate design will allow the majority of the bed load to flow past the head gate, and any remaining bed load can be carried through the system and discharged at turnouts and periodic blowoff valves. In most cases, drainage

flows that currently enter the open canals will not be connected to the pipeline systems. Arrangements will be made for these flows during detailed design.

An existing franchise agreement is in place between Kittitas County and KRD for installation of facilities and operations within county rights-of-way.

Canal lining hydraulic criteria established by the BOR during the original design will be used to adjust and correct the existing canal cross section. Canal side slopes, and bottom slopes will not change. The only change will be the friction coefficient of the lined portion which will provide smoother flow characteristics when compared to the existing earthen lining.

Reregulating reservoirs will be designed in accordance and in consultation with Ecology – Dam Safety Division. The earth fill reservoirs will be constructed with materials meeting strict gradation and drainage requirements, as well as geotextiles cushions, geomembrane lining, and rock slope protection. The associated reservoir pump stations will be designed in accordance with Hydraulic Institute Standards for vertical turbines installed in pump cans.

Construction Cost Estimates

Direct construction costs including contingency are estimated at $94,900,000. Contingency is estimated at $13,700,000. Indirect costs such as tax, engineering, services during construction, legal, and administration are estimated at $24,600,000. The total cost for upgrades for both direct and indirect costs is approximately $119,500,000 in 2014 dollars.

Factors, such as a limited construction season, oil costs (affecting PVC pipe costs), labor, contractor bidding process, materials, permitting, and environmental impacts may affect both construction scheduling and costs.

Operation, Maintenance, and Replacement Cost Estimates

This project will significantly reduce the operation and maintenance costs associated with KRD's existing open ditch laterals and sub laterals to be piped or lined as well as operation of the Wippel Pump Plant. Some additional operational costs will be associated with the new pipelines and turnouts associated with creek water supplementation as well as operation of the reregulation reservoirs. Maintenance costs for the new system will be insignificant for the first 10 years of operation, and will increase as new facilities require repair and replacement.

Operational Capability

Estimated losses of the current system are 30 percent of the total diversion for both the conveyance and operational spills. An estimated water savings of 39,300 acre-feet annually can be produced by these improvements. In order to assess the actual water savings that result from the system improvements, both Pre and Post Monitoring programs will be implemented.

KRD's currently adjudicated irrigation water rights amount to more than 336,000 acre-feet annually. A portion of this water could be saved. Some of the saved water could be used to supplement creek water flows in Yakima River tributaries that intersect the KRD delivery system as well as for groundwater storage projects in the vicinity of the KRD delivery system.

Measuring, Monitoring, and Reporting

Pre-implementation water measuring data is currently being collected at select locations within the KRD system. The KRD anticipates using Section 1207 - Enhancement of Water Supplies for Yakima Basin Tributaries in Public Law 103-434 October 31, 1994 (SEC. 1207) or as the section is amended consistent with the Integrated Plan as well as other funding sources to accomplish much of the savings in this Feasibility Investigation.

Measuring, monitoring and reporting will be consistent with SEC. 1207 requirements and subsequent agreements.

Financial

KRD has options to obtain funding for its canal improvements. Sources include the Yakima River Basin Water Enhancement Project or other sources made possible because of the Integrated Plan process.

KRD is in sound financial condition. However, costly near-term capital projects for major KRD facilities are in the planning stages at this time. Therefore, it is KRDs expectation that it will use SEC. 1207 or as the section is amended consistent with the Integrated Plan or other funding sources to accomplish much of the savings in this Feasibility Investigation.

KRD will need to indicate its willingness to meet the commitments of this project through actions of its Board of Directors. It is anticipated that funding agreements for the water conservation and/or groundwater storage projects will be developed for review by the KRD.

Environmental

An environmental review shows that there will be minor or no negative environmental impacts to earth (soils), air, plants, animals, energy and natural resources, environmental health (health hazards and noise), land and shoreline use, housing, aesthetics, light and glare, recreation, historic and cultural preservation, transportation, public services, and utilities. The only potential significant impact foreseen is related to locations where leaky open ditch canals are replaced with pipelines or lining. At these locations, existing vegetation growing adjacent to open ditch canals will be impacted when seepage is reduced or eliminated. When the upgraded system is operational, there will be an overall positive effect to the environment, particularly to increasing water quality, increasing tributary stream flows, and/or providing water and capacity for groundwater storage projects.

Conclusions

The proposed system improvements may allow KRD to conserve approximately 39,300 acre-feet in a full water supply year (see Table E1), and at the same time improve water quantity and quality for Yakima Basin tributaries through SEC. 1207 or as the section is amended consistent with the Integrated Plan. River diversions would remain similar to existing diversions with the resulting system capacity used to supplement tributary stream flows and/or provide for increased groundwater storage.

An estimated cost of the conservation measures shown in this Feasibility Investigation is approximately $119,500,000. Table E-1 summarizes the individual water conservation projects benefits and estimated costs. By utilizing the information provided in Table E-1, a

staged approach could be used to implement the conservation measures over time. High priority or high water conservation projects could be initiated in the near future pending funding. At a minimum, construction contract documents as well as reservoir geotechnical investigations could be prepared for priority projects at much smaller overall costs relative to construction. Having construction contract documents on the shelf ready for bidding by contractors the moment funding becomes available will facilitate efficient authorization and appropriation of project construction funding.

Table E-1
Water Conservation Projects Benefits and Costs

Project Identification	New Pipe (LF)	Acres Served (acre)	Estimated Annual Water Savings (AF)	2014 Estimated Cost
New North Branch Reregulating Reservoir	340	N/A	4100	$10,600,000
North Branch Canal Lining between Johnson Siphon and Wippel Pumping Plant	0	N/A	2700	$5,200,000
New South Branch Reregulating Reservoir	340	N/A	2000	$8,100,000
South Branch Canal Lining from Swede Tunnel to Robinson Canyon	0	N/A	2000	$3,200,000
Pipe Lateral NB 4.1	33,230	659	900	$6,300,000
Pipe Lateral NB 5.8	4,860	344	400	$800,000
Pipe Lateral NB 6.4	6,890	680	900	$1,300,000
Pipe Lateral NB 7.7	26,640	940	1300	$5,100,000
Pipe Lateral NB 8.3	22,110	1486	2100	$5,300,000
Pipe Lateral NB 20.2	8,590	996	1400	$2,200,000
Pipe Sub Lateral NB 20.8-0.8	8,060	1036	1400	$2,200,000
Pipe Lateral NB 22.0	9,230	2779	3800	$4,300,000
Pipe Lateral NB 22.8	650	287	300	$300,000
Pipe Lateral NB 26.7	40,790	2160	3200	$10,300,000
Pipe Lateral NB 27.5	5,330	502	700	$1,000,000
Pipe Lateral NB 28.6	2,100	213	200	$500,000
Pipe Lateral NB 33.5	35,050	1566	2200	$7,400,000
Pipe Lateral NB 35.1	4,420	411	500	$900,000
Pipe Pump Ditch	76,200	3198	4400	$26,800,000
Pipe Turbine Ditch	21,650	1745	2400	$6,000,000
Pipe Lateral SB 1.7	7,210	420	200	$1,400,000
Pipe Lateral SB 4.8	2,540	580	300	$700,000
Pipe Lateral SB 9.9	2,360	726	400	$800,000
Pipe Lateral SB 11.7	6,190	545	300	$1,300,000
Pipe Lateral SB 14.3	16,500	530	600	$3,700,000
Pipe SB Extension	12,390	1081	600	$3,800,000
Pipe **Totals**	**353,670**	**26,065**	**39,300**	**$119,500,000**

The future benefits to the environment through improvements in water quantity, water quality, ground water storage and instream flows in the Yakima River Basin will justify the proposed improvements. Although the KRD is in sound financial condition, project funding of the proposed conservation measures is beyond the ability of the water users to pay without external assistance. It is anticipated that funding agreements for the water conservation projects and/or groundwater storage projects will be developed for review by the KRD.

It is also important that the KRD continues to address other critical facilities in their system that are in need of costly maintenance and rehabilitation. These facilities were not addressed in this Feasibility Investigation because they are not water conservation projects. However failure of the Main Canal straight wall canal sections, Main Canal lining projects, Yakima Pressure Tunnel, and numerous other siphons and tunnels would impact the District's ability to accomplish fish habitat enhancement associated with ongoing creek water supplementation as well as potential future creek water supplementation and groundwater storage projects discussed in this Feasibility Investigation.

Introduction

The KRD's participation in the first phase of the Yakima River Basin Water Conservation Program (Basin Conservation Program) was completed with the submittal of the KRD's CWCP. The CWCP was submitted for review to the BOR and Ecology in February 1999. Following this the KRD completed Addendum No. 1 to the CWCP which identified the potential use for conserved water to enhance fish habitat in tributary streams. KRD has taken the initiative to begin the second phase of the Basin Conservation Program – this Feasibility Investigation of the water conservation measures proposed in the CWCP.

The purpose of this Feasibility Investigation is to provide the basis for implementation of the water conservation measures identified in KRD's CWCP. This is done in sufficient detail through an evaluation of the water conservation measures to determine the estimated costs, water savings, and environmental effects. This study provides updated information that was not available at the time the amended CWCP was completed.

This Feasibility Investigation also provides a basis for the final design of the proposed conservation measures. This report identifies final design criteria, develops a design data collection plan, outlines a water conservation monitoring program, and presents design and construction schedules.

This Feasibility Investigation is funded by Ecology, BOR, and KRD. On August 27, 2013, the KRD entered into an agreement with CH2M HILL to assist with development of the Feasibility Investigation.

History

The KRD, located in central Washington, was organized under RCW Title 87, Irrigation Laws of the State of Washington, on September 25, 1911, and in accordance with KRD's Federal Repayment Contract.

KRD is located in central Washington along the east edge of the Cascade Mountains in the upper Yakima River Basin. The KRD lands are located entirely within Kittitas County. The district boundary stretches from the Easton Diversion Dam, along both sides of the Yakima River to approximately 11 miles southeast of the city of Kittitas, with Ellensburg located centrally within the project.

The KRD encompasses approximately 104,588 acres and currently assesses 59,478 acres. Water is supplied to the KRD from two BOR storage reservoirs, Keechelus and Kachess. Irrigation water is diverted from the Yakima River at the Easton Diversion Dam.

Present Facilities and Operations

A detailed description of KRD facilities and operations was developed in the 1995 CWCP. The following is an overview of this material and includes recently completed improvements.

KRD currently has a single diversion point from the Yakima River located at Easton Dam. The diversion includes a drum gate, two radial gates, fish ladder, and fish screening facilities. The facility has a diversion capacity of approximately 1,320 cfs.

Irrigation water is conveyed from the river diversion through the Main Canal. The Main Canal is approximately 26 miles in length and mostly concrete lined. The Main Canal has an initial capacity of 1,320 cfs and includes 2 tunnels, 8 siphons, and 3 wasteways.

The North Branch Canal is 38 miles long from the bifurcation at the end of the Main Canal to the Wippel Pump Plant. There are 6 tunnels, 6 siphons, and one wasteway in this section. The initial capacity of the North Branch Canal is 925 cfs and reduces to 280 cfs at the Wippel Pump Plant. The Wippel Pump Plant is located at the end of the North Branch Canal.

The South Branch Canal is 14.2 miles long starting at the Main Canal bifurcation. There are 2 tunnels, 6 siphons, and 2 wasteways in this section. The initial capacity of the South Branch Canal is 250 cfs with a final capacity of 55 cfs.

The Wippel Pump Plant has two direct connected 500 horsepower horizontal hydraulic turbines driving two centrifugal pumps with a combined capacity of approximately 50 cfs. There are also two electric vertical turbine pumps. One electric pump is rated at 300 horsepower and 10 cfs, the other electric pump is rated at 150 horsepower and 5 cfs.

At the Wippel Pump Plant, the canal branches into three major laterals. The laterals include the Pump Lateral which is supplied by the hydro turbines and electric pumps in the Wippel Pump Plant, the Gravity Lateral which bypasses Wippel Pump Plant and is supplied by open ditch canal from the North Branch Canal, and the Turbine Lateral which is supplied from the tailwater used by the hydro turbines at the Wippel Pump Plant.

Besides the three laterals mentioned previously, there are also a total of 37 laterals that branch off the Main Canal, North, and South Branch canals. These laterals range from hundreds to thousands of feet long. Sub-laterals branch off of the laterals; there are approximately 22 sub-laterals that tend to be much shorter in length than the laterals.

A total of approximately 1,000 turnouts exist in the KRD conveyance system. The turnouts range in size from ¾- to 24-inch diameter pipe.

Engineering

General

The proposed conservation measures are discussed below, see also Appendix A for overall map identifying location of proposed improvements.

Canal Lining

North Branch Canal from Johnson Siphon to Wippel Pumping Plant & South Branch Canal from Swede Tunnel to Robinson Siphon

Site Suitability

The canal lining improvements will take place within the existing canal right of way. Existing KRD maintenance roads provide adequate site access. Therefore no further site suitability investigation is warranted.

Design

Canal Lining Standards and Criteria

The standards and criteria of the proposed canal lining measures for the conceptual design presented in this Feasibility Investigation adhere to engineering principles and state-of-the-art design as practiced by the irrigation industry. These criteria serve as a starting point for the design and cost estimation. They are subject to refinement during the final design phase of the project. The criteria used are described and developed in this section.

Canal Lining Hydraulic Criteria

The hydraulic sizing criteria for the canal lining features of the conceptual design match the original design criteria developed by the BOR during the original design of the open canal facilities. The proposed lining will match the existing canal cross section including bottom slope and side slopes. Hydraulics will be improved as the coefficient of friction decreases due to a smoother canal surface, as well as elimination of cross section irregularities (silt buildup, low spots, wide spots, debris accumulation, etc.).

Canal Lining Design Options

The following canal lining options were investigated for use on the irrigation system upgrades.

- Cast in place reinforced concrete lining
- Shotcrete reinforced concrete lining
- Exposed membrane lining
- Membrane lining with protective shotcrete cover

The cast in place reinforced concrete option is an overly conservative approach for a canal of this size and location. The reinforced shotcrete approach is much easier and less expensive to install than the concrete lining. The membrane liner is the least expensive alternative, however it is susceptible to damage if installed exposed to weather, animals, and fire.

Selected Canal Lining Design

The membrane lining with a shotcrete protective cover was selected for the canal lining. The membrane lining with shotcrete protective cover offers good compromise between cost, long term water loss prevention, and long term durability. Without the addition of the shotcrete lining cover, maintenance of the canal for cleaning out accumulated sediments and debris becomes a delicate and time consuming procedure. Wildlife such as deer in this somewhat remote area of the KRD system can easily puncture an exposed liner simply by walking on it. Additionally, by selecting a protective shotcrete cover, the waterproof membrane can be of lighter weight and strength than one exposed to the environmental conditions.

Canal Lining Materials Criteria

The shotcrete used in the lining system will be an easily flowable concrete mix design with minimum strength of 4,500 psi. Additional reinforcing such as polyester fiber and reinforcing steel will be investigated during final design to potentially increase long term durability. The membrane lining will also be evaluated during final design of lining materials such as PVC, HDPE, and geotextile/rubber lining are commonly used in canals and reservoirs. The membrane lining will need to be watertight, not be damaged by environmental conditions (fire, wildlife, and maintenance), maintain at least a 50 year life expectancy, and be easily repairable in the field.

Canal Lining Permits

Permits for lining the canal within the KRD right of way are not required.

Pipelines

Site Suitability

The proposed improvements for this project will replace many problematic open ditches that have extremely high water losses with buried pipes. The new underground pipes will eliminate canal bank erosion, seepage, and public risk to nearby farmland and residential communities. Other open ditches with lower losses that are not included in this Feasibility Investigation may be considered for piping and additional water savings in the future.

KRD's system of open irrigation canals and flumes has existed since construction and operation of the facilities began in the 1900's. Since the improvements to the irrigation system will be replacement of infrastructure in basically the same locations, an extensive site suitability survey is not warranted. The existing rights-of-way provide locations for pipelines to connect to the existing irrigation turnouts. These points of connection have been and will continue to define the limits of KRD's operation and maintenance responsibility.

Design

Pipelines Standards and Criteria

The standards and criteria of the proposed measures for the conceptual design presented in this Feasibility Investigation adhere to engineering principles and state-of-the-art design as practiced by the irrigation industry. These criteria serve as a starting point for the design and cost estimation. They are subject to refinement during the final design phase of the project. The criteria used are described and developed in this section.

Pipelines Hydraulic Sizing Criteria

See Appendix B, for pipeline hydraulic calculations.

The hydraulic sizing criteria, for all of the pipeline features of the design, are derived from the on-farm application flow rate. This flow rate is equal to the amount of water required per acre of farmland. The original USBR peak design for the open ditch laterals and sub laterals for the North and South Branch was 9.17 and 7.90 gpm per acre, respectively. These flow rates are based on the original BOR North Branch design of 925 cfs supplying 45,278 acres and the South Branch design of 220 cfs supplying 12,500 acres. The design capacity included the additional conveyance water lost due to system losses.

The hydraulic sizing criteria for new pipelines are derived from a goal of an average on-farm application flow rate of 7 gpm per acre on individual delivery laterals. Greater flexibility in individual instantaneous flow rates will be required based on local conditions and some accommodations for higher rates in the range of the original system design rates will be required. On average the application flow rate is slightly lower than the original open ditch hydraulic design. After completion of specific conservation improvements and successful operation of the improvements, the KRD will strive to set the future application flow rate in the area of an individual conservation improvement at 7 gpm per acre with the understanding that the conservation improvements will substantially reduce system losses and permit adequate flows to continue to be delivered to the farmland. The hydraulic sizing criteria will accommodate localized high demands created by shifting of water deliveries for operational convenience. All turnouts will have flow measuring devices.

In addition, a maximum pipeline water velocity 5 feet per second was identified for design and cost estimation purposes. This conservatively low velocity minimizes the potential for development of hydraulic transients (water hammer) and still provides sufficient velocity to move sediment through the system. The final design velocity for specific pipelines may be subject to refinement and change during the final design phase of the project.

Pipelines System Operating Pressure

The proposed gravity pipelines system takes advantage of the elevation differential between the lateral piping head works and the turnout locations along the lateral or sub laterals. Pipeline delivery pressures will vary from approximately 10 psi to a maximum of 85 psi. In some cases the gravity pressure developed within the pipeline will need pressure reduction to limit the delivery pressure to 85 psi. Accommodations will not be made for irrigators whose turnout does not have sufficient delivery pressure for sprinkler operation. These irrigators will need to continue using on-farm booster pump systems to produce sprinkler pressure or irrigate via low pressure (rill or otherwise).

Pipelines Material Selection

Since the piping system is a pressure system, low pressure gravity pipe such as reinforced concrete, corrugated polyethylene, or other low pressure products were ruled out. The following pipe materials were investigated for use on the irrigation system upgrades.

- Welded steel pipe
- Ductile iron pipe
- Polyvinyl chloride pipe

- High density polyethylene pipe
- Fiberglass Reinforced Pipe

Welded Steel Pipe: Welded steel pipe (WSP) is manufactured using two different processes, one process produces a straight seam weld, and the second process produces a spiral weld. Due to size considerations, straight seam welded pipe would not be applicable to this project. Spiral welded pipe is strong and flexible. It ranges in size from 10 inch to 156 inches in diameter. WSP requires corrosion protection, which is typically coal tar enamel, cement mortar lining, or dielectric coatings. WSP joints can be rubber gasketed bell spigot or welded. WSP is flexible and can also be subject to excessive deflection if improperly bedded. The pressure ratings of WSP would need to be identified during final design of pipe wall thickness. Wall thickness design would include internal pressure and also backfill and handling loads.

Ductile Iron Pipe: Ductile iron pipe (DIP) is commonly used for pipeline applications that will be subject to high backfill load conditions, and where long laying lengths are preferred. The advantages of DIP include high load-bearing capacity, high impact strength, and high beam strength. However, DIP requires an internal lining to prevent corrosion when used in water transport systems. A cement mortar lining would be needed to make the DIP suitable for this application. Mechanical or push-on gasketed joints can be used for pipeline construction. DIP is heavy and costly to install especially for the larger diameter pipe. Its strength makes it relatively insensitive to bedding conditions. Size ranges from 4 to 64 inches in diameter.

Polyvinyl Chloride Pipe: The advantages of polyvinyl chloride (PVC) pipe are its light weight, high impact strength, easy in-field cutting and installation, and resistance to internal and external corrosion. Conventional C900/C905 PVC and ASTM D2241 will be considered depending on the specific pressure and diameter of the pipeline. Joints for 4" and larger PVC pipe are push-on joints with elastomeric seal gaskets or mechanical joints. C900/905 PVC pipe and fittings are available up to 60-inch diameter, ASTM D2241 pipe is available up to 12-inch diameter.

High Density Polyethylene Pipe: High density polyethylene (HDPE) pipe is light weight, has high impact strength, is easily field cut, is corrosion resistant, and is less brittle than PVC. Because of HDPE pipe's low tensile strength and pipe stiffness, it is subject to excessive deflection if improperly bedded. Some advantages offered by HDPE for gravity pipelines are its watertight fusion joints, which minimizes leakage, and the ability of the pipe to be bent to different radii depending on the pipe size and wall thickness.

Fiberglass Reinforced Pipe: Fiberglass reinforced pipe (FRP) is a lightweight relatively flexible pipe. Although it does not have a long history of application for irrigation systems, it could be considered. It is available in sizes suitable for this project and is assembled using rubber gasketed joints.

Selected Pipeline Material

The pipe material selected for this project for the main lateral and sub lateral installations is C900/C905 or ASTM D2241 PVC. This selection is based on the availability of the PVC in larger sizes, its corrosion resistance, water tightness, and ability to follow the irregular canal alignment using joint deflection to minimum the number of fittings. In addition, PVC was

selected since it is a common pipe material that KRD staff and landowners will be able to work with for field modifications without specialized heat fusion or welding equipment.

The turnout installations will be constructed of SCHD 40 PVC for 2-inch and smaller diameters, and DIP will be used for turnouts larger than 2-inch diameter. The PVC and DIP will be used for its resistance to loading and simplification of fittings installation using industry standard solvent weld joints, fittings, flanges, and mechanical joints and also lends itself to future modifications without specialized heat fusion or welding equipment.

The Hazen-Williams friction coefficients (C) used for design will be a value of 140 for PVC, and 130 for DIP based on past experience and engineering judgment.

Turnouts

The turnouts were located based on information provided by KRD which generally match the existing irrigation water delivery points. Confirmation of the number, size, and location of active turnouts must be completed prior to final design.

Turnouts were designed based on the criteria developed in the Design Criteria Section of this study. Each farm turnout was sized to serve 7 gpm/acre at a maximum velocity of 7 fps.

Pipelines Valves and Appurtenances

Design criteria for valves and other piping appurtenances are detailed in the following:

Valves:

Valves ranging in size from 2 to 4 inches in diameter will be AWWA Resilient Wedge Gate Valves with the following characteristics: cast iron body, resilient wedge, bronze trim, flanged or mechanical joint ends, non-rising stem, and manufactured in accordance with AWWA C509. They will have a standard 2-inch square operating nut and be designed for buried service with a working water pressure of at least 150 psig. They will be protected from corrosion with a fusion-epoxy coating inside and outside per AWWA C550 standard.

Valves ranging in size from 6 to 14 inches in diameter will be AWWA Butterfly Valves with the following characteristics: short cast iron body, flanged or mechanical joint ends, cast or ductile iron disc, stainless steel shafts, and manufactured in accordance with AWWA C504. They will have a standard 2-inch square operating nut and be designed for buried service with a working water pressure of at least 150 psig. They will be protected from corrosion with a fusion-epoxy coating inside and outside per AWWA C550 standard.

Continuous Acting Air Vent / Vacuum Relief Valves: The pipelines will be fitted with air/vacuum valves suitable for irrigation water service. The valves will automatically exhaust large quantities of air during filling of the system and allow large quantities of air to re-enter during draining or when vacuum occurs such as during a surge or water hammer condition. The air release portion will also automatically exhaust entrained air that accumulates in the system while pressurized during operation. Construction includes cast or ductile iron body, stainless steel float and trim, and manufactured in accordance with AWWA C512.

Flow Meters: The headworks of each lateral and each turnout will include a standard mechanical propeller type flow meter or battery powered magnetic meter, direct drive meter heads, and a mechanical totalizer reading acre-feet and indicators reading CFS or GPM.

Irrigation Pipe Bedding Materials: Native materials will be used for pipe bedding and pipe zone material where suitable. Imported processed granular material will be used where the native material is found to be unsuitable. Native material for pipe bedding is required to be free from organic material, trash, and other deleterious material. Material needs to be free of frozen material and rocks larger than ¾"inch. Pipe zone material will be compacted to 90% in all areas except road crossings. Pipe zone and trench backfill material and below traveled roadway surfaces will be compacted to 92 percent relative compaction based on a modified proctor testing procedure, ASTM D1557. Backfill above the pipe zone and at locations other than roads will be compacted to 85% relative compaction.

Other Standards and Criteria for Pipelines

Water Hammer Considerations: The primary method to control water hammer in pipelines is to design the system with very low velocities. The maximum velocity in the irrigation pipe system will be 5 feet per second. Not only will this reduce water hammer concerns, it will also reduce head loss and pipe scouring damage. Additional protection against water hammer pressures will be provided by the installation of air vent / vacuum relief valves in strategic locations.

Suspended solids and bed loads: The North and South Branch canals do not have significant bed loads, however the lateral head works will be constructed to allow the majority of bed load to move down each canal and past the head works structure. Limited amounts of suspended solids will flow through the head works structures but minimum pipeline velocities of 2 feet per second will keep the solids suspended and discharge through the turnouts and drain valves.

Canal cross-drainage: The piped pressurized systems will eliminate the possibility of accepting drainage water into the lateral systems. Since the canal is not intended to serve as a facility for collecting storm water or irrigation runoff, KRD will approach those entities regarding the handling of the drains that currently come into the open lateral canals.

In some limited locations where no drainage channel exists to handle the canal cross-drainage flows, it may be necessary to take the water into a parallel drain pipe for discharge at the nearest downstream drainage area.

The drains that need to be extended or connected to downstream drainage areas will be sized based on the existing pipe sizes. If drainage flows need to be determined during final design, the calculations will be based on the Rational Method for drainage basins less than 10 acres in size. For basins that are larger than 10 acres the USDA Natural Resources Conservation Service (SCS method) to calculate storm water runoff will be used. In addition, the storm water guidelines for Kittitas County will be utilized.

Structural design criteria: Concrete structures such as the head works facilities will be designed to meet the requirements of local building codes.

Pipelines Permits

Construction within Kittitas County's road rights-of-way can be performed under an existing franchise agreement between KRD and the County along with a right-of-use permit for each specific location. KRD facilities constructed within the County right-of-way must meet County standards for road construction and repair when crossing County roads or working within the County right-of-way. This can include, but is not limited, to relocation of existing utilities at KRD's expense.

Specific pipeline installation locations within the County may require a floodplain development permit and a shoreline permit (although typically the laterals are exempt from a shoreline permit).

KRD lies entirely within Kittitas County and is considered a utility, therefore it is not required to obtain a building permit for construction projects that are within the County.

State permits anticipated for pipeline construction include the following:

- National Pollutant Discharge Elimination System (NPDES) – Stormwater Construction General Permit
- Joint Aquatic Resources Permit Application (JARPA)
- State Environmental Policy Act (SEPA) permit
- WSDFW Hydraulic Project Approval (HPA) if crossing waterway
- Cultural/Archaeology Survey

Federal permits anticipated for pipeline construction include the following:

- Section 106 and ESA consultation with USFWS / NOAA

Automation

A critical element for maximizing water conservation associated with the new facilities proposed is to allow the system to monitor and automatically accommodate changes in water demands that can occur over short periods of time. The current system consists of many miles of open canals and manually controlled structures. Many are manually operated or consist of fixed crest weirs. The result is that as flow rates are changed, water surface elevations in the canals vary significantly. Not only does the variation in level affect the water delivery rates, it causes time lags. Those time lags prevent water from being delivered when it is needed and contributes to increased operational spills.

Since it takes a day or more to accommodate flow changes at the end of the North and South Branch canals by making adjustments at the Easton Diversion, usually excess water is run down the canals and spilled until it is needed. The spill in itself is not bad as long as water is available and the water quality is not degraded. However, it would be better if the water could be managed so the spill is minimized so the saved water could be used for other beneficial purposes such as fish habitat enhancement.

Conversely, replacement of open ditch laterals and sub laterals with pipe will somewhat complicate operation of the open canal that the lateral is fed from. For example if wet

weather moves into the area and turnouts on the new pipeline are turned off by the irrigator, the level in the remaining open canal will immediately rise since previously used operational spills on the laterals and sub laterals are no longer available to spill the extra water.

A proven method to make water available when and where it is needed or save excess water is to install relatively small re-regulation reservoirs at several locations in the canal system. These reservoirs can be used to store excess water or supply water for canal shortages during the time that it takes to make overall system adjustments. These reservoirs are typically designed to be operated about one half full since it is unknown whether the mismatch in flow vs demand will be an excess or shortage. Typically excess water in the canal is gravity fed from the canal to the reservoir. Canal shortages are corrected by pumping stored reservoir water back into the canal when it is needed. The reservoir inflow and outflow can be controlled by a measurable parameter such as the amount of water spilling at an operational spillway such as the Manastash Creek Spill or the Johnson Siphon Spill.

The proposed automation facilities would consist of constructing two automated re-regulation reservoirs with associated automatic flow control structures on the North and South Branch canals, and automating the Wippel Pump Plant. The existing canal system would remain essentially unchanged other than the piping and lining work discussed previously. The basic concept of the re-regulation reservoirs is to minimize operational spills while meeting the full irrigation demand. The KRD would automate three separate sections of their conveyance system. The general concept for automation envisioned for the KRD is outlined below.

South Branch Canal: Seven manual or fixed crest check structures are located between the South Branch reservoir site and the Manastash Creek Spill. A considerable time lag, as much as 8 hours, results as flow rates are changed.

If the seven check structures at the lower end of the South Branch Canal were automated to keep the upstream water level at each structure constant, the response time to accommodate flow changes could be reduced to about 1 to 2 hours. Each of the check structures would have motorized gates and an upstream water level sensor as a standalone system not connected to or controlled by other facilities. The gates could be powered by local utility power or solar panels. If desired, the check structures could be monitored by a central SCADA system for failures or out of tolerance water levels.

Instrumentation at the Manastash spillway will monitor the level of water in the canal, which will also correspond to the amount of water being spilled. The instrumentation will send a signal to the South Branch reservoir control building PLC via radio. Based on PLC set points previously entered by the operator for the desired flow at the Manastash spillway, the reservoir pump station or motorized reservoir inlet gate will automatically operate. The pump station will pump water from the reservoir, discharging it to atmosphere in the South Branch canal when the water level at Manastash spillway flow is low. When the water level is high the instrumentation would send a signal to the motorized reservoir inlet gate, releasing water from the canal into the reservoir. The optimum amount of water in the reservoir is half of its capacity. Keeping the reservoir half full provides for extra capacity in

the event that a large amount of water needs to be spilled from the canal due to water users shutting off their water suddenly.

To facilitate the manual operation of the upper part of the South Branch Canal, it would be beneficial to transmit the reservoir water level to the District's SCADA system. Based on the rising or falling trend of the water level in the South Branch Reservoir, manual adjustments to the flow feeding the South Branch Canal could be made. Future automation of the South Branch flow could be considered.

A level sensor in the reservoir would monitor the South Branch Reservoir level and control the headgates to the South Branch canal or the Taneum Creek Chute spill. The headgate would be adjusted accordingly to keep the reservoir level constant. Water that would have gone into the South Branch canal either stays in the Main Canal or is discharged into the Taneum Creek Chute providing supplemental flow to Taneum Creek. This automation scenario provides for automatic control of the entire South Branch Canal.

North Branch Canal/Wippel Pump Plant: To automate the North Branch Canal, the first step is to control the major spills on the lower end of the canal after the Wippel Pump Plant. The turbine lateral spill just after the Wippel Pump Plant can be monitored with a level sensor that will send a signal to the wicket gates on the hydro turbine pumps. This signal will use an electric motor to adjust the wicket gates on the hydro turbines. The operational goal is to maintain the appropriate hydro turbine tail water flow.

Adjusting the wicket gates in this fashion will cause the hydro turbines to operate at less than full capacity. In that situation, the demand in the Pump Lateral may not be met during peak flow periods. A level sensor at the Pump Lateral (near the outlet of the hydro turbines), whose set point is controlled by the ditch rider, will determine if additional electric pumps at the Wippel Pump Plant need to be turned on. Existing electric pumps and a new electric pump controlled by a variable frequency drive will turn on automatically if the demand in the Pump Lateral is not being met. At this point in the automation, the Wippel Pump Plant and everything downstream of it is controlled automatically.

The next step in automating the North Branch canal is to minimize the spill at the intakes to the Wippel Pump Plant penstocks. This can be achieved by using a level sensor at the penstock intakes to send a signal upstream to the Johnson Siphon radial gates. The radial gates will adjust automatically to control the amount of flow to the penstocks intakes. Just upstream of the Johnson Siphon is the Johnson spillway. The canal level at this spillway is the parameter that will control flow into and out of the proposed North Branch Reservoir. A level sensor in the canal at this location will monitor the fluctuating level of the canal due to automation of the Johnson Siphon radial gate. If the level is high, water will automatically spill into the new North Branch Reservoir. If the canal level is low, the reservoir pump station will pump water into the canal.

Similar to the South Branch reservoir, the optimum level of water in the North Branch Reservoir is half full. To keep this level constant, a level sensor will send a signal to the SCADA system so the District can adjust the Main Canal flow at the Easton Diversion.

Supervisory Control and Data Acquisition

All major new facilities such as reservoirs, reservoirs pump stations, check structures, Wippel Automation, and lateral head works will include data acquisition components. A determination will be made on a case by case basis if the data will be tied in to the existing telemetry supervisory control and data acquisition (SCADA) system. The SCADA system will be a key component for backup and monitoring of the new KRD facilities.

Reregulation Reservoirs

Site Suitability

See Appendix C for reservoirs conceptual designs.

The reservoirs are off-channel reservoirs located adjacent to the existing North or South Branch Canals. The reservoirs will be lined with a geomembrane as the primary seepage barrier and will be constructed mainly of onsite soils.

Preliminary site suitability of the proposed reservoirs was performed as part of this Feasibility Investigation. An advantage of the selected reservoir locations is that they are both situated out of an active waterway and therefore do not need a substantial spillway to accommodate flood runoff. Although further geotechnical investigation is needed at each reservoir site, and subsequent land purchase, it appears that suitable land is available for constructing the reservoirs.

North Branch Reservoir

The North Branch Reservoir is sited east of Stevens Rd. approximately 1.5 miles north of the Stevens Rd. I-90 underpass. The reservoir site is on private land and generally bounded on the north, and east by the North Branch canal. The reservoir site slopes from east to west and is currently irrigated pasture land.

South Branch Reservoir

The South Branch Reservoir is sited on private land immediately north of the intersection of Robinson Canyon Rd. and the South Branch Canal. The reservoir is bounded on the west by the South Branch Canal. The proposed reservoir embankment will bound the north, east, and south side of the reservoir. The reservoir site slopes from west to east and is currently fallow land that appears to receive minor seepage from the South Branch Canal.

Design

Reservoirs Standards and Criteria

The reservoir embankment design falls under the jurisdiction of Ecology's Dam Safety Guidelines. In accordance with the Dam Safety Guidelines, the final design of the reservoirs will include identification of the reservoir classification, dam breach analysis, geotechnical, and groundwater investigations, slope protection design, and seismicity analysis. Ancillary facilities such as the pump station, and inlet/outlet piping will adhere to Hydraulic Institute Standards, engineering principles, and state-of-the-art design as practiced by the irrigation industry. These criteria serve as a starting point for the conceptual design and cost

estimation. They are subject to refinement during the final design phase of the project. The criteria used are described and developed in this section.

Reservoirs Sizing

Sizing for both reservoirs included an analysis of existing records of nearby operational spills. The control concept for each reservoir assumes that the water typically spilled to drains at these locations will instead be captured in the reservoir for later beneficial use. The analysis considered historical spill data at the North Branch Johnson Spill and the South Branch Manastash Spill along with river diversion adjustment coordination with BOR, and estimated travel time for water to flow from the diversion at Easton Dam to each reservoir location.

BOR water diversion requirements indicate that KRD cannot change their river diversion at Easton without providing a notice of 48 hours prior to the adjustment. Historically, the worst case time lag for adjustment of the KRD diversion is approximately 8 hours. The approximate travel time for water in the North Branch Canal to travel from Easton Dam to the North Branch Reservoir site is 31 hours. Similarly the travel time for water to travel from Easton Dam to the South Branch Reservoir site is 15 hours. Using these total diversion time lag and water travel times for each reservoir, the Johnson and Manastash spill data was analyzed on a 39 and 23 hour running average respectively to identify the average volume spilled over the time duration. It was determined that the North and South Branch reservoirs need a minimum volume of approximately 124 and 54 acre-feet, respectively. During normal operation, the reservoirs would be operated at half capacity; therefore minimum storage volume of the North and South Branch reservoirs would be approximately 250 and 100 acre-feet, respectively.

Reservoir capacity is also typically determined by a practical consideration of site geometry, below grade geotechnical data, and cost. Therefore the capacity and overall footprint of the reservoirs will likely be revised somewhat. Based on site geometry the minimum reservoir capacities identified should be achievable. The reservoir capacity will be attained by a combination of excavating into existing ground and building embankments to take advantage of the existing topography.

Reservoirs Geotechnical Exploration

Geotechnical exploration is beyond the scope of this Feasibility Investigation however it is crucial for confirming the reservoir sites are appropriate for reservoir construction. It is recommended that geotechnical evaluations are planned and implemented to collect data to confirm the geotechnical suitability. The geotechnical evaluation will include soil borings, soil sampling, and laboratory testing.

Reservoirs Embankment and Liner Concepts

The primary concept for the reservoirs is an earthen embankment with a geomembrane liner as the primary seepage barrier. The same concept has been used recently for similarly sized Yakima Basin irrigation district reservoirs and in accordance with Ecology's Dam Safety Guidelines.

The embankment will be a homogeneous embankment with slope protection on the interior of the reservoir. A self-healing chimney filter/drain is included within the embankment to provide protection against piping in the event that the liner is compromised.

The embankments material will consist of suitable onsite materials as confirmed by the geotechnical exploration. A riprap type material would be utilized for slope protection over the geomembrane liner and would most likely be obtained from a quarry near the project sites. The drainage and filter materials for the reservoir could potentially be obtained by screening existing material on the project site, otherwise it would need to be imported.

The embankment crest would be approximately 20 ft. wide and would include an operations and maintenance road around the full perimeter of the crest. The crest would be constructed at an elevation needed to obtain 4 ft. maximum freeboard above the maximum water pool surface elevation. The embankment slopes would be 4:1 inside the reservoir and 3:1 on slopes outside the reservoir.

Protection of the liner system integrity may require an underdrain system beneath the PVC liner in the event that the geotechnical exploration identifies a high groundwater table beneath the reservoir site. The underdrain would include drain trenches, a blanket drainage layer, and perforated drain pipes to collect and convey water from under the reservoir to a location down gradient of the reservoir.

The concept and the adequacy of on-site materials for their intended use will be evaluated during the future geotechnical exploration, the concepts presented herein should be considered preliminary until the completion of the geotechnical exploration.

Reservoirs Slope Protection

Riprap slope protection needs for the reservoirs will be determined based on the estimated wave and run-up conditions at each reservoir. Proper sizing of the riprap will prevent damage to the riprap slope protection during the design storm event. In addition, the stability of the bottom cover soils and rock protection will be evaluated to determine acceptable material gradations.

Reservoirs Seismicity

Each reservoir site will be evaluated from a seismicity standpoint to determine peak ground acceleration based on specific faults near the reservoir sites and in accordance with U.S. Geological Survey (USGS) probabilistic seismic hazard mapping. The ground surface level of shaking will be determined from a site-specific site-response study to be conducted after the geotechnical exploration is completed.

International Building Code (IBC) values for the ground surface design spectral response will be evaluated as well.

Reservoirs Inlet

Historical spill data and operations input have been reviewed, providing the data needed to analyze reservoir inlet needs. The reservoir inlet capacities are based on the maximum instantaneous spill rate recorded from historical spill data at Johnson and Manastash spillways. The maximum spill data indicates that an inlet capacity of 66 and 53 cfs is required for the North and South Branch reservoirs respectively. The inlet pipes for the

North and South Branch reservoirs will be approximately 48 and 36-inch diameter HDPE pipe, respectively. HDPE pipe is the preferred inlet pipe material due to its long term corrosion resistance and ability to bend without fittings between the two reinforced concrete reservoir inlet structures located in the canal and within the reservoir.

The reservoir inlet structure located in the canal will include an automated slide gate that controls the flow into the reservoir. Control concepts for the automated reservoir inlet slide gate are discussed below. The inlet structure within the reservoir will be sized to accommodate discharge of the maximum flow into the reservoir at a velocity that will not erode the reservoir bottom cover soils and rock protection.

Reservoirs Pump Station Facilities

The pump station facilities will include a pump station control building housing all electrical gear, reinforced concrete pump inlet structure with trash rack within the reservoir, WSP pump inlet piping, WSP pump cans, pumps, and WSP pump discharge piping.

The pump station configuration will utilize vertical turbine pumps set in vertical steel "cans". The pumps and pump station control building will be installed at grade between the canal and reservoir and sized in accordance with Hydraulic Institute Standards. Water from the reservoir will feed the pump cans via the concrete pump inlet structure within the reservoir.

Based on downstream canal flow demands, and operations input, a pump station capacity of 30 and 10 CFS has been selected for the North and South Branch reservoirs, respectively. The North Branch Reservoir pump station will include (3) 125 hp pumps manifolded together into a 30-inch WSP pipe that discharges into the North Branch Canal. The South Branch Reservoir pump station will include (2) 50 hp pumps manifolded together into a 20-inch WSP pipe that discharges into the South Branch Canal. Each pump will be controlled by a PLC via variable frequency drives. The pump stations allow for conveyance of water back to the canal as needed to meet downstream canal flow demands.

Reservoirs Drain

The reservoir will normally be drained by the use of the reservoir pump station, discharging into the canal. No separate and redundant gravity drain will be provided. Reasons for not providing a gravity drain include: concerns over a route for drained water downstream of the reservoir and the desire to avoid a large pipe penetration through the embankment. If an emergency situation occurred such that the reservoir needed to be drained during an extended power outage, a third-party firm would be retained to supply diesel-driven pumps to dewater the reservoir. The reservoir maximum water surface would match the maximum water surface in the adjacent canal. Configuring the reservoir in this manner precludes the possibility of overtopping the reservoir and the need for an engineered spillway.

Reservoirs Control Concepts

A Programmable Logic Controller (PLC) will be located at the pump station control building. The PLC at the pump station control building will monitor the water level at the associated downstream spills; Johnson Spill for the North Branch reservoir and Manastash Spill for the South Branch Reservoir. If the water level is not within a set-point as input by

the KRD, the PLC will either open or close the reservoir inlet gate or turn pumps on or off to achieve the desired water level at the spill. If excessive water continues to remain in the canal at the spills when the reservoir inlet is fully open, the excess water will simply spill as it has historically. Multiple sensors and accessories will also be monitored and controlled by the PLC at the pump station control building. Communications between the pump station control building PLC and the water level monitoring instrument will be via radio. Lag time for impacts of the reservoir inlet gate or pump station operation to be seen at the spill measuring device will be relatively short, due to the close proximity of the spill measuring device to the reservoir inlet and pump station discharge pipes. The PLC in the control building will further communicate with the KRD office in Ellensburg.

Reservoirs Mechanical

Mechanical appurtenances will include canal slide gates, butterfly valves, check valves, air/vacuum valves, and flowmeters similar to what is described above for *Pipelines Valves and Appurtenances*. The mechanical components will be manufactured to AWWA and ANSI standards and are irrigation and municipal water quality equipment that is generally off the shelf and does not require any special fabrication or construction.

Reservoirs Electrical

Applicable NEC codes and standards will be followed as part of the electrical design. The main service coming into the pump station control building will be 480 volt, three-phase power. Voltage will be stepped-down via transformers at each facility as necessary to power the equipment installed. Stand-by generation is not included, nor is the ability to use a generator to power the pumping equipment. Power supplied to pump motors will include harmonic filters and adjustable frequency drives. The PLC and other components with supervisory control and data acquisition (SCADA) or radio equipment will include a battery pack and charger to allow short term control and monitoring when there is a power outage.

Reservoirs Structural Criteria and Concepts

IBC code as amended by the State of Washington and local agencies will be adhered to for design of concrete structures and the pump station control building. Typical structure walls and floors range from 8 to 12 inches in thickness using double-mat rebar and 4,000 psi concrete. Structural safety factors range from 1.1 for sliding with seismic to 1.5 for overturning with seismic.

Reservoirs Permits

KRD lies entirely within Kittitas County and is considered a utility, therefore it is not required to obtain a building permit for construction projects that are within its or the County's right-of-way. Reservoir construction would take place within a future KRD right-of-way after purchase of the reservoir site land is complete. Although KRD must meet County standards for road construction and repair when crossing County roads or working within the County right-of-way, this is not anticipated for reservoir construction.

Specific construction locations within the County may require a floodplain development permit and a shoreline permit (although typically a shoreline permit will be exempt).

State permits anticipated for reservoir construction include the following:

- Ecology Dam Construction Permit
- National Pollutant Discharge Elimination System (NPDES) – Stormwater Construction General Permit
- Joint Aquatic Resources Permit Application (JARPA)
- State Environmental Policy Act (SEPA) permit
- Cultural/Archaeology Survey

Federal permits anticipated for reservoir construction include the following:

- Section 106 and ESA consultation with USFWS / NOAA

New Pipelines and Turnouts for Creek Water Supplementation

Addendum No. 1 of the CWCP investigated the potential for eliminating private diversions of irrigation water from tributary streams within the KRD, specifically Big, Little, Taneum, and Manastash Creeks. The recommended alternative was to construct 21 new laterals totaling approximately 28,850 feet of pipe.

Although some private diversions from Taneum Creek were eliminated by implementing the Bruton Ditch project several years ago, generally the remaining private diversion eliminations identified in Addendum No. 1 have been met with a lot of resistance from the creek water right holders. Issues associated with private diversion elimination include:

- Stock water would not be available year round since the KRD does not operate their system year round. Therefore groundwater and/or creek water would be needed during non-irrigation months.
- Much of the creek water rights are senior to KRDs more junior water rights.
- KRD is contractually obligated to have a district of a certain size. Adding acreage to the KRD requires that an equivalent amount of land be removed from the KRD. Landowners with KRD water rights are reluctant to give up that water right since it negatively affects the value of their land.
- Legal ramifications associated with priority dates.

A more straight forward approach for creek water supplementation could use the recently completed KRD South Branch Lateral 13.8 – Manastash Creek Conservation and Tributary Enhancement piping project that was accomplished through SEC. 1207 as an example. An agreement was made with KRD that a specific volume of conserved water would be spilled into Manastash Creek as a result of upgrades to the SB-13.8 Lateral. The additional water spilled into Manastash Creek allows the creek water to flow longer. Many other opportunities similar to the SB-13.8 Lateral project could be implemented throughout the KRD to supplement creeks. In addition, conserved water could be used for groundwater storage projects.

Construction Cost Estimates

Direct and Indirect Costs

An estimate of the construction costs associated with the proposed upgrades has been developed as shown in Table 1. The estimate is based on the total cost of each individual upgrade. The direct construction cost estimate is approximately $94,900.000, which includes contingency but no tax. Cost estimates for each individual water conservation project are shown in Appendix D.

The contingency estimate provides an allowance for costs that could be identified during final design as a result of additional information that becomes available. The contingency cost is estimated at 15 percent of the total direct construction costs, or approximately $13,700,000.

Indirect costs include tax at 8 percent, engineering and administration for final design, services during construction, topographic surveying, archaeological/cultural investigation, and legal will amount to approximately 26 percent of the direct construction costs plus the contingency cost. The indirect costs are estimated to be approximately $24,600,000.

The total cost of KRD upgrades for both direct and indirect costs including tax is approximately $119,500,000 in 2014 dollars.

Table 1
Proposed Upgrades Cost Estimate

Item Description	Cost
Lateral NB 4.1	$6,300,000
Lateral NB 5.8	$800,000
Lateral NB 6.4	$1,300,000
Lateral NB 7.7 Sub Laterals 1.59, 2.9R	$5,100,000
Lateral NB 8.3	$5,300,000
Sub Lateral 20.8-0.8	$2,200,000
Lateral NB 20.2	$2,200,000
Lateral NB 22.0	$4,300,000
Lateral NB 22.8	$300,000
Lateral NB 26.7 Sub Laterals 1.7, 3.1, 4.4, 4.61 Sub Sub Lateral 4.4-0.4	$10,300,000
Lateral NB 27.5	$1,000,000
Lateral NB 28.6	$500,000
New North Branch Reregulating Reservoir	$10,600,000
North Branch Canal lining between Johnson Siphon and Wippel Pumping Plant	$5,200,000

Table 1
Proposed Upgrades Cost Estimate

Item Description	Cost
Lateral NB 33.5 Sub Laterals 2.0, 3.0 Sub Sub Lateral 2.0-1.8	$7,400,000
Lateral NB 35.1	$900,000
Pump Ditch	$26,800,000
Turbine Ditch	$6,000,000
Lateral SB 1.7	$1,400,000
Lateral SB 4.8	$700,000
South Branch Canal lining between Swede Tunnel and Robinson Siphon	$3,200,000
New South Branch Reregulating Reservoir	$8,100,000
Lateral SB 9.9	$800,000
Lateral SB 11.7	$1,300,000
Lateral SB 14.3	$3,700,000
SB Extension	$3,800,000
Total Estimated Project Cost	**$119,500,000**

Construction Aspects Affecting Costs

The proposed upgrades consist of standard equipment, materials, and construction practices. Most equipment, materials, and construction forces will be locally available. Materials such as backfill will be obtained along the pipeline alignment since the system right of way will continue to be used for the majority of the proposed upgrades. Bedding material, gravel, asphalt, and concrete will be available from local Ellensburg area suppliers. The pipe is not manufactured locally but will be purchased through manufacturers' representatives. The availability of all of the types of pipe in the lengths and sizes required should not be a problem. However, the source of the pipe will most likely be determined based on a combination of cost and availability. The large quantities and sizes of pipe needed for the project will require significant lead times for delivery.

There are no special or unusual site conditions anticipated that would need to be dealt with during construction. Staging areas can be developed on or adjacent to KRD right of way and many access points to the proposed conservation measures will be available during construction.

Construction scheduling and, to some extent, costs, may be affected by the need to do much of the piping and canal lining work during the non-irrigation season. The limited construction season that is available occurs during the fall and winter months. Cold and snowy weather may impact excavation and backfill if the ground becomes frozen or is covered with snow for long periods of time.

The fluctuating cost of oil may affect the purchase cost of the PVC pipe since both depend on materials refined from oil. The cost of the PVC pipe is based on the market cost of oil when the construction estimate was developed.

Labor conditions are expected to remain fairly stable and should not have an unpredictable impact on the overall cost of the proposed project. The construction force will be paid prevailing wages since partial funding of the project is expected to be from state and federal money.

The contractor chosen for construction of the proposed upgrades will be selected based on the results of an advertised competitive bidding process. The contractor will enter into a unit price contract for furnishing and installing all equipment and materials necessary for construction of the complete and functional proposed upgrades.

Environmental controls will be part of the contract requirements and will be the responsibility of the contractor. Measures will be taken to control erosion, turbidity from de-watering water, dust, and noise. The majority of the construction will take place along the existing KRD rights of way, therefore impacts to wetlands and other land uses are not issues. Mitigation of impacts to the environment is not anticipated.

Construction Schedule

The implementation schedule of the proposed water conservation upgrades is dependent on the method of funding. The minimum duration for constructing the proposed water conservation measures is three years, however a more likely scenario would be to construct the water conservation measures over the course of approximately six to eight years.

Construction would be carried out in phases. The proposed timeframe would allow construction during irrigation and non-irrigation seasons. However, the proposed upgrades are designed for maximum flexibility. Implementation of the upgrades could be extended to best match availability of funding.

The construction schedule for replacement of open ditch canals with pipe or lining must be carefully planned during the non-irrigation season that lasts from October 15 to March 31. Any construction that demolishes or eliminates existing district irrigation facilities must be operational by March 31 to be ready for the irrigation season.

The majority of reservoir construction (embankment and liner installation) can take place during the irrigation season and is preferable to take advantage of warmer weather. Portions of the reservoir construction such as tie-in to existing open ditch canal with inlet and outlet piping must be performed during non-irrigation months.

Operation, Maintenance, and Replacement Cost Estimates

The proposed upgrades will significantly reduce operation and maintenance cost associated with KRD's open ditch canals that are converted to pipelines or concrete lined. Automation of the various facilities will also decrease operations and maintenance costs. Some additional operation and maintenance costs will be associated with the new reservoirs.

Activities associated with the proposed upgrades contributing to operational costs will include the following: daily monitoring of water measuring locations (inflows and spill),

monthly monitoring of flowmeters at turnouts, trash removal at the screen at the pipe inlet, and daily inspection of the pipeline alignment. Maintenance costs associated with the proposed upgrades will be insignificant for approximately the first 10 years after installation of the proposed upgrades. Maintenance costs will gradually increase as the valves and flowmeters associated with the turnouts begin to wear out and require repair and replacement.

Operational Capability

The operational capability of the proposed measures is analyzed from hydrologic data on system operation "with" and "without" the proposed measures implemented to provide an estimate of average monthly and annual water savings. The estimated water savings for each of the water conservation improvements are identified as follows:

Pipelines: The water savings identified for the conversion of open ditches to pipelines was based on the difference between the original BOR design flow (9.17 and 7.90 gpm/ac for the North and South Branch acreages respectively) and the new design flow of 7 gpm/ac.

Reservoirs: The water savings for the North Branch and South Branch reservoirs were determined using spill data from adjacent operational spillways that will not be needed once the reservoirs are installed since excess water will spill into the reservoir. Instrumentation at the Johnson spillway located downstream of the proposed North Branch Reservoir and the Manastash Spillway located downstream of the proposed South Branch Reservoir records the instantaneous flowrate of each spill every hour for the entire irrigation season. Water savings was identified as the average spill volume over each spill from 2005 through 2013.

Canal Lining:

North Branch Canal - Johnson Siphon to Wippel Pumping Plant:
Current metering was performed during the 2014 irrigation season between the Johnson Siphon and the Wippel Pumping Plant. Results of the current metering identified the losses in that reach of the North Branch Canal. It was assumed that 10% of the losses identified was due to evaporation, therefore 90% of the losses are estimated as the water savings associated with lining this reach of the North Branch Canal.

South Branch Canal – Swede Tunnel Outlet to Robinson Canyon Siphon:
Current metering was not feasible for the South Branch Canal. Water losses were calculated using open ditch losses of 25% due to infiltration, transpiration, and evaporation established during development of the CWCP. Water flow measurements taken at the head end of the South Branch Canal were used to calculate an estimated water loss per mile for the South Branch Canal. It was assumed that 10% of the losses identified from the Swede Tunnel Outlet to Robinson Canyon Siphon were due to evaporation, therefore 90% of the losses are estimated as the water savings associated with lining this reach of the South Branch Canal.

The annual water savings based on these estimates is 39,300 acre-feet. The estimated monthly water savings is shown in Table 2.

Table 2
Estimated Water Savings

April	May	June	July	August	September	October	Total
1,000	6,600	8,300	8,300	7,800	5,000	2,300	39,300

As mentioned previously, to develop the actual quantities of water saved, KRD will have to implement the Pre and Post Monitoring Program outlined in this Feasibility Investigation. An assessment of the actual conserved water resulting from the conservation improvements will be made based on the data from the monitoring program. The data will need to be collected over a number of years to take into account shifts in irrigation practices, differences in weather patterns, and restrictions caused by water short years.

It is also assumed that there will be on-farm savings made possible by improvements to the KRD system. This is based on the availability of gravity pressure in parts of the system, which will enable some landowners to install more efficient irrigation systems. This value is not quantifiable at this time since each landowner will make decisions to install their own improvements. Other measures can be implemented to encourage water conservation such as conservation rate structure programs along with promotion of farm irrigation system improvements funded by various agencies such as the United States Department of Agriculture which is administered by the United States Forest Service.

Water savings realized from conservation efforts could be used for supplementation of tributaries or groundwater storage. Water diversions would not be reduced because the conserved water would be diverted and “wheeled” through KRD facilities to locations where it can be discharged into tributaries or for groundwater storage.

Measuring, Monitoring, and Reporting

Pre-Implementation Program

Pre-implementation water measuring data is currently being collected to the maximum extent practical as baseline information from which future water savings can be evaluated. Not all open laterals that are planned to be piped have accurate flow measuring facilities at this time. At these locations estimates of pre-implementation monitoring will be made from ditch rider input. The pre-implementation data can be used to determine the water savings with the proposed water conservation measures. Data collected prior to implementation of the proposed upgrades will establish the basis for the post-implementation monitoring program. The pre-implementation measuring program will formalize the existing data collection and recording procedures.

Post-Implementation Program

The KRD anticipates using SEC. 1207 or as the section is amended consistent with the Integrated Plan to accomplish much of the savings in this Feasibility Investigation.

There are five objectives in the proposed post-implementation program:

- Gage the effectiveness of the water conservation measures
- Assure compliance with a future "Tributary Supplementation Agreement(s)"
- Document reductions in operational spills exiting KRD system
- Document flow and quality of water exiting the KRD system
- Document effectiveness of mitigation measures

All new facilities will include flow measuring facilities to measure water use as part of the post-implementation program. Measuring, monitoring and reporting will be consistent with SEC. 1207 requirements and subsequent agreements.

Measuring Points

Numerous existing measuring points are located at key locations within the KRD system to measure flow at the diversion, north and south branch canals bifurcation, open ditch laterals, and key operational spills. It is anticipated that few, if any, new measuring points will be required other than new flowmeters that will be installed at the head end of newly piped laterals, new turnouts, and reservoir pumps discharges.

Monitoring

Flow

Performing a water balance using the measuring devices described above, and monitoring of major return flows if appropriate, will allow the effectiveness of the water conservation measures to be quantified, and verify compliance with future creek water supplementation or groundwater storage agreement(s) that KRD will have associated with the proposed upgrades.

Water Quality

KRD performs extensive water quality monitoring at key return flow locations and will continue to do so after implementation of the proposed upgrades. Analysis of the data will allow the impact of the conservation measures to be evaluated. The water quality measurements will be in accordance with Washington DOE protocols. The frequency of the measurements will be taken as required by the DOE to provide data on early, peak and post irrigation season water quality conditions.

Equipment and Procedures

Standard measuring equipment and procedures conforming to DOE standards will continue to be used for the Post Measuring Program. Weirs at measuring points are constructed such that standard weir tables and field flow measurements can be used to develop accurate flow rating curves. The flowmeters identified as measuring points are or will be standard equipment accepted in the irrigation industry.

Measurement Accuracy

Equipment used for water flow monitoring at irrigation turnouts will be standard mechanical or magnetic flow meters. The manufacturer of the specific type of flowmeter used will provide factory calibration for each unit. Quality assurance checks will be performed on a regular basis to verify that the meters are monitoring and recording flow accurately.

The quality assurance checks for the measuring weirs will consist of manual current meter measurements and physical inspection of the structures.

Data Compilation and Reporting

The existing system for data compilation will be used for reporting the proposed pre- and post-monitoring programs where telemetry is already in place and the recorded information is automatically filed in an electronic database. For new data to be recorded where a system is not already in place, reporting will be developed for the proposed pre- and post-monitoring programs. A KRD operator will collect and record information on water usage using pre-printed forms specific to each water measuring location. The forms will essentially be "fill in the blank" format. The information on the forms will then be manually entered into an electronic filing system such as a Microsoft Excel spreadsheet. The spreadsheet will contain formulas that will automatically calculate a water balance for the irrigation system. The accuracy of data collection and data entry into the spreadsheet will be verified by the results of the water balance. The ongoing water balance calculation will allow errors in data management or problems with the flow measuring devices to be detected and corrected immediately.

The spreadsheet will include a summary report that can be printed for annual submittal to the Yakima Field Office of the Bureau of Reclamation. The annual summary report will be submitted in the format and date agreed to between the Bureau and KRD. The report will contain the water measurements taken at each of the locations. The results of the water quality data will be submitted at the same time.

Financial

Without the contributions from the public funding sources identified below, KRD will be unable to embark upon this project at this time. There is no practical alternative source of funds that is within the water users' ability to pay.

Yakima River Basin Water Enhancement Project (YRBWEP)

The BOR administers the YRBWEP program. The program provides federal and state grants up to 65 percent and 17.5 percent respectively of the project cost. The program facilitates the improvements of irrigation systems such as KRD's so that improved water quality, increased efficiency, and reduced diversions can be realized.

Yakima River Basin Integrated Water Resource Management Plan (Integrated Plan) – Initial Development Phase

The Integrated Plan program provides state grants for among other things, projects that provide water for agriculture, fish, and communities by modifying water system operation and infrastructure, implementing enhanced water conservation projects, enhancing and protecting habitat, and increasing in-stream flows.

The Integrated Plan Implementation Committee collaborated with the BOR and Ecology Office of Columbia River (OCR) concerning the composition of the Initial Development Phase of the Integrated Plan. This phase will span the time frame from passage of the state's Integrated Plan authorizing legislation in 2013 through the year 2023.

Consistent with the objectives of the Integrated Plan, the projects and activities that BOR and OCR are including in the Initial Development Phase will advance concurrently some portion of all seven elements of the Integrated Plan. The Initial Development Phase represents a set of projects and activities that will quickly achieve tangible improvements in stream flow, habitat, and fish passage as well as to provide increased security of existing out-of-stream water supplies.

The Initial Development Phase will involve requests for funding for a number of specific capital projects including:

- Kachess Drought Relief Pumping Plant – $205 million
- Fish Passage at Cle Elum Reservoir – $87 million
- Three-foot pool raise at Cle Elum Reservoir – $18 million

A fourth project, the $159 million Keechelus to Kachess Conveyance project, will likely be included as an adjunct to the Kachess Drought Relief Pumping Plant project, pending verification of its efficacy in improving the speed and reliability of Kachess Reservoir refill, or improving summer flow conditions in the Keechelus-to-Easton reach of the Yakima River, or both.

Other components of the Initial Development Phase include proposals for $85 million in agricultural conservation projects that would make available about one-half of the 170,000 acre-feet of conserved water envisioned by the Integrated Plan, $100 million in floodplain and tributary habitat restoration projects and acquisitions, $90 million for additional fish

passage projects, $6 million in aquifer storage and recovery projects, and $500,000 for fostering water banking and exchange programs. Attaining Wild and Scenic River designations for vital headwater stream reaches will also be advanced during the Initial Development Phase beginning with portions of the upper Cle Elum River system.

Subject to the results of an ongoing fatal flaw analysis, about $15 million will be sought in the latter half of the Initial Development Phase to conduct a feasibility study and prepare an environmental impact statement to ready one of the two large storage facilities identified in the Integrated Plan for possible inclusion in the plan's subsequent development phase. The subsequent or middle development phase would span the time frame from the year 2024 through 2034.

Funding

The estimated cost of the proposed upgrades are approximately $119,500,000. KRD is not capable of funding the proposed water conservation projects because of the required increase in assessment rate and long term debt that would be incurred by KRD. Large KRD conveyance facilities on the Main Canal portion of the KRD system need costly rehabilitation that will likely require an increase in landowner assessments if a funding mechanism cannot be identified for that work. These facilities are not directly related to conservation other than if they fail the impact could be catastrophic, resulting in minimal or no Yakima River tributaries creek water supplementation or groundwater storage. Therefore, it is KRDs expectation that their willingness to utilize their existing delivery system to wheel water for conservation projects in exchange for facility improvements will not require the need to raise landowner assessment rates.

The conservation measures in this Feasibility Investigation are consistent with the components in the Initial Development Phase of the Integrated Plan. The Initial Development Phase represents a set of projects and activities that will quickly achieve tangible improvements in stream flow, habitat, and fish passage as well as to provide increased security of existing out-of-stream water supplies. The KRD improvements in this Feasibility Investigation will play a crucial role in meeting some of the Integrated Plan Initial Development phase objectives. Some of the key components of the Initial Development Phase that will be sources of funding for these improvements include the Integrated Plan agricultural conservation projects component, the Integrated Plan flood plain and tributary habitat restoration project and acquisitions component, the Integrated Plan additional fish passage projects component, the Integrated Plan aquifer storage and recovery project component as well as the Integrated Plan water banking and exchange programs component. There also may be other funding sources available for these improvements in the initial development phase through other federal and state agencies in addition to Ecology and BOR funding sources.

Financial Analysis

KRD is in sound financial condition and maintains a moderate reserve fund. KRD is paying off loans from the BOR for original construction debt retirement, and Ecology for costs associated with the 1994 drought. KRD has been making annual payments to retire these obligations, and has made significant progress to pay off the loans, which will be fully repaid in the foreseeable future.

A significant amount of KRD operating expenses includes costs associated with staff labor. Labor costs associated with pipelines that get piped, and canals that are lined will be reduced. In addition, costs associated with the existing open ditch canals such as chemicals, equipment rental, canal excavation, and general O&M costs will decrease once the water conservation measures are implemented. Some additional labor costs and O&M costs associated with the reservoirs will be realized and will offset to some extent other saved labor and O&M costs. Overall operating expenses should be reduced and could potentially help offset the assessment rate increase resulting from implementation of the water conservation measures. At a minimum, the reduced operating expenses would provide surplus funds that would reduce the gradual assessment rate increases that will be necessary over time as material costs and wage requirements increase.

Environmental

An environmental review was conducted for this Feasibility Investigation (see Appendix E SEPA Environmental Checklist). The environmental review indicates that there will be minimal to no environmental impacts on the environmental elements considered.

During construction, there will generally be minor to no environmental impacts to earth (soils), air, plants, animals, energy and natural resources, environmental health (health hazards and noise), land and shoreline use, housing, aesthetics, light and glare, recreation, historic and cultural preservation, transportation, public services, and utilities. Moderate impacts noted to the environment were identified where seepage from the North and South Branch canals have produced saturated ground where vegetation has grown. Lining the canals in these areas will reduce the water available for this vegetation.

Once the updated irrigation system is operating, there will be an over-all positive effect to the environment, particularly to water. The following points summarize the anticipated status of the environment resulting from replacement of open canals with buried pipelines, reservoirs, and canal lining:

- Infiltration, evaporation, and transpiration will be reduced, thereby reducing the amount of water supply needed for the irrigation system.
- Saved water could continue to be diverted from the Yakima River and discharged into tributary streams within the KRD to supplement water in these streams that experience reduced flow in the summer months. In addition the saved water could be used for groundwater storage projects.
- Fish habitat will be enhanced since the water conservation project will improve water quality by reducing the discharge of pesticides, nutrients, and sediments (reduce turbidity) to the Yakima River.
- Soil erosion will be reduced since erosion of canal channels will be eliminated.
- Less energy will be needed to operate the irrigation system since it will be possible to operate the irrigation system with less water and a gravity-pressurized system will be constructed.
- Replacement of the canals will eliminate the need for burning vegetation (weeds) at the edges of the canals, lessening the potential for fire hazards, and improving weed control.

Conclusions

The proposed conservation measures in this Report seek to improve the Kittitas Reclamation District's irrigation system downstream of the Main Canal bifurcation into the North and South Branch Canals. These improvements will include concrete lining a portion of the existing North and South Branch Canals, laying miles of pipeline to replace existing open canals and ditches, and installation of two reservoirs. Also included is selective monitoring and automation of the system that will reduce operational spills by making the system react proactively to landowners' demand changes.

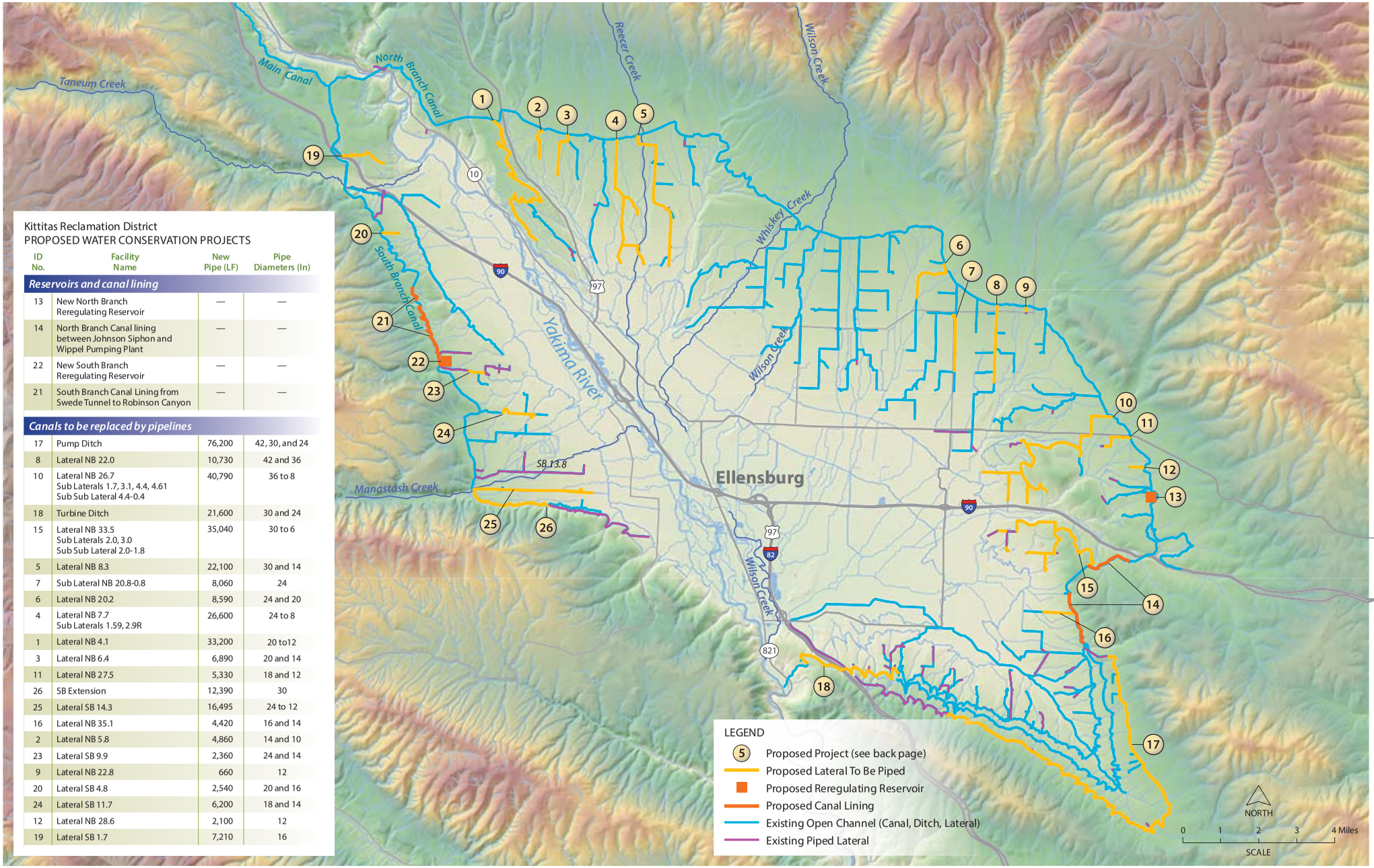
The estimated conserved water is 39,300 acre-feet annually. Currently some of the water lost due to operational spills by KRD simply returns back to the Yakima River and is available for use downstream. However, some of the diverted irrigation water is consumed by evaporation and vegetation in non-farmed areas (canal banks, drain channels, seepage areas).

The conservation measures have many positive impacts on the environment if they are to be constructed. The only potential impacts may be to vegetation near the canal that have been created by seepage from the existing facilities.

The estimated cost for these conservation measures is $119,500,000. The future benefits of the conservation measures to water quantity and quality in the Yakima River Basin and the environmental improvements make these improvements not only beneficial to KRD but also to those groups interested with increased in-stream flows and positive impacts to the environment.

A funding option is presented in the financial section of this study. However, various other potential funding mechanisms are available and are currently being investigated. Any combination of the funding option presented, as well as other funding options to be determined could allow the KRD to complete this project and gain its benefits as well as provide significant additional in-stream flows to Yakima River tributaries and groundwater storage projects.

Appendix A
Proposed Water Conservation Projects Locations



Kittitas Reclamation District
PROPOSED WATER CONSERVATION PROJECTS

ID No.	Facility Name	New Pipe (LF)	Pipe Diameters (In)
Reservoirs and canal lining			
13	New North Branch Reregulating Reservoir	—	—
14	North Branch Canal lining between Johnson Siphon and Wippel Pumping Plant	—	—
22	New South Branch Reregulating Reservoir	—	—
21	South Branch Canal Lining from Swede Tunnel to Robinson Canyon	—	—
Canals to be replaced by pipelines			
17	Pump Ditch	76,200	42, 30, and 24
8	Lateral NB 22.0	10,730	42 and 36
10	Lateral NB 26.7 Sub Laterals 1.7, 3.1, 4.4, 4.61 Sub Sub Lateral 4.4-0.4	40,790	36 to 8
18	Turbine Ditch	21,600	30 and 24
15	Lateral NB 33.5 Sub Laterals 2.0, 3.0 Sub Sub Lateral 2.0-1.8	35,040	30 to 6
5	Lateral NB 8.3	22,100	30 and 14
7	Sub Lateral NB 20.8-0.8	8,060	24
6	Lateral NB 20.2	8,590	24 and 20
4	Lateral NB 7.7 Sub Laterals 1.59, 2.9R	26,600	24 to 8
1	Lateral NB 4.1	33,200	20 to12
3	Lateral NB 6.4	6,890	20 and 14
11	Lateral NB 27.5	5,330	18 and 12
26	SB Extension	12,390	30
25	Lateral SB 14.3	16,495	24 to 12
16	Lateral NB 35.1	4,420	16 and 14
2	Lateral NB 5.8	4,860	14 and 10
23	Lateral SB 9.9	2,360	24 and 14
9	Lateral NB 22.8	660	12
20	Lateral SB 4.8	2,540	20 and 16
24	Lateral SB 11.7	6,200	18 and 14
12	Lateral NB 28.6	2,100	12
19	Lateral SB 1.7	7,210	16

Appendix B
Proposed Pipelines Hydraulics

Turnout ID		Station (feet)	Cumulative distance from headend (ft)	Elevation (feet)	Acres served per turnout	Delivery Requirement (cfs)	Delivery Requirement (925 cfs/45,278 acres) (cfs)		Delivery Requirement - Revised for Conservation (cfs)	Delivery Requirement - Revised for Conservation (gpm)	Pipe Sizing Flow (gpm)	Pipe Dia (in)	Velocity (ft/sec)	Pipe Static Pressure (psi)	Pipe Sizing Pressure 1.5x Static (psi)	Pipe Pressure Class	Pipe Length (ft)	Turnouts Diameter (in)
NB4.1		0	0	2072.1	**659**	11.89	13.46	total cfs	**10.28**	**4613**								
4.00	21120	18880	18880	2046.1	78	1.41	1.59		1.22	546	**4893**	20.49	4.76	11.26	17	DR 41 - 100 psi		6
4.10	21648	19361	19361	2046.0	20	0.36	0.41		0.31	140	4347	20.49	4.23	11.30	17	DR 41 - 100 psi		3
4.41	23285	21416	21416	2045.3	278	5.02	5.68		4.34	1946	4207	20.49	4.09	11.61	17	DR 41 - 100 psi	21416	12
4.55	24024	21932	21932	2044.0	45	0.81	0.92		0.70	315	2261	14.52	4.38	12.17	18	DR 41 - 100 psi		6
4.70	24816	23316	23316	2043.0	12	0.22	0.25		0.19	84	1946	14.52	3.77	12.60	19	DR 41 - 100 psi		3
5.10	26928	25019	25019	2042.0	1	0.02	0.02		0.02	7	1862	14.52	3.61	13.03	20	DR 41 - 100 psi		0.75
6.10	32208	29697	29697	2005.0	145	2.62	2.96		2.26	1015	1855	14.52	3.59	29.05	44	DR 41 - 100 psi	8281	8
6.60	34848	33228	33228	1960.0	80	1.44	1.63		1.25	560	840	12.09	2.35	48.53	73	DR 41 - 100 psi	3531	6
			33228	1960.0	40 Extra Acres for Conservatism						280					Total Pipe:	33228	
																	6.29	miles

Turnout Tally (diameter - in. & quantity)									
0.75	**1**	**1.5**	**2**	**3**	**4**	**6**	**8**	**10**	**12**
1				2		3	1		1

Turnout ID		Station (feet)	Cumulative distance from headend (ft)	Elevation (feet)	Acres served per turnout		Delivery Requirement (cfs)	Delivery Requirement (925 cfs/45,278 acres) (cfs)		Delivery Requirement - Revised for Conservation (cfs)	Delivery Requirement - Revised for Conservation (gpm)	Pipe Sizing Flow (gpm)	Pipe Dia (in)	Velocity (ft/sec)	Pipe Static Pressure (psi)	Pipe Sizing Pressure 1.5x Static (psi)	Pipe Pressure Class	Pipe Length (ft)	Turnouts Diameter (in)
NB5.8		0	0	2066.4	**344**		5.49	6.21	total cfs	**4.74**	**2128**								
0.01	53	200	200	2065.0	30		0.54	0.61		0.47	210	**2408**	14.52	4.67	0.60	1	DR 41 - 100 psi		4
0.02	106	250	250	2064.8	25		0.45	0.51		0.39	175	2198	14.52	4.26	0.68	1	DR 41 - 100 psi		4
0.18	950	955	955	2064.3	40		0.72	0.82		0.62	280	2023	14.52	3.92	0.90	1	DR 41 - 100 psi		6
0.28	1478	1770	1770	2042.8	117		2.11	2.39		1.82	819	1743	14.52	3.38	10.21	15	DR 41 - 100 psi	1770	8
0.40	2112	2220	2220	2039.0	58		1.05	1.18		0.90	406	924	10.195	3.63	11.85	18	DR 41 - 100 psi		6
0.70	3696	3927	3927	1997.0	5		0.09	0.10		0.08	35	518	10.195	2.04	30.03	45	DR 41 - 100 psi		6
0.80	4224	4857	4857	1980.0	29		0.52	0.59		0.45	203	483	10.195	1.90	37.39	56	DR 41 - 100 psi	3087	6
			4857	1980	40	Extra Acres for Conservatism						280					Total Pipe:	4857	
																		0.92	miles

Turnout Tally (diameter - in. & quantity)									
0.75	**1**	**1.5**	**2**	**3**	**4**	**6**	**8**	**10**	**12**
					2	4	1		

Turnout ID	Cumulative distance from headend (ft)	Elevation (feet)	Acres served per turnout		Delivery Requirement (cfs)	Delivery Requirement (925 cfs/45,278 acres) (cfs)		Delivery Requirement - Revised for Conservation (cfs)	Delivery Requirement - Revised for Conservation (gpm)	Pipe Sizing Flow (gpm)	Pipe Dia (in)	Velocity (ft/sec)	Pipe Static Pressure (psi)	Pipe Sizing Pressure 1.5x Static (psi)	Pipe Pressure Class	Pipe Length (ft)	Turnouts Diameter (in)
NB6.4	0	2065.9	**680**		11.55	13.07	total cfs	**9.98**	**4480.00**								
0.01	190	2064.2	17		0.31	0.35		0.27	119	**4760**	20.49	4.63	0.72	1	DR 41 - 100 psi		3
0.02	200	2064.1	13		0.23	0.27		0.20	91	4641	20.49	4.52	0.76	1	DR 41 - 100 psi		3
0.20	1077	2046.1	322		5.81	6.58		5.02	2254	4550	20.49	4.43	8.55	13	DR 41 - 100 psi	1077	12
0.21	1109	2046.0	14		0.25	0.29		0.22	98	2296	14.52	4.45	8.60	13	DR 41 - 100 psi		3
0.41	2165	2045.0	80		1.44	1.63		1.25	560	2198	14.52	4.26	9.03	14	DR 41 - 100 psi		6
.8R	4665	1990.0	79		1.43	1.61		1.23	553	1638	14.52	3.17	32.84	49	DR 41 - 100 psi		6
.8L	4665	1990.0	32		0.58	0.65		0.50	224	1085	14.52	2.10	32.84	49	DR 41 - 100 psi		4
1.40	6891	1970.0	83		1.50	1.70		1.29	581	861	14.52	1.67	41.50	62	DR 41 - 100 psi	5814	6
	6890.8	1970.0	40	Extra Acres for Conservatism						280					Total Pipe:	6890.8	
																1.31	miles

Turnout Tally (diameter - in. & quantity)									
0.75	**1**	**1.5**	**2**	**3**	**4**	**6**	**8**	**10**	**12**
				3	1	3			1

Turnout ID	Cumulative distance from headend (ft)	Elevation (feet)	Acres served per turnout		Delivery Requirement (cfs)	Delivery Requirement (925 cfs/45,278 acres) (cfs)		Delivery Requirement - Revised for Conservation (cfs)	Delivery Requirement - Revised for Conservation (gpm)	Pipe Sizing Flow (gpm)	Pipe Dia (in)	Velocity (ft/sec)	Pipe Static Pressure (psi)	Pipe Sizing Pressure 1.5x Static (psi)	Pipe Pressure Class	Pipe Length (ft)	Turnouts Diameter (in)
NB7.7	0	2064.8	**940**		16.97	19.20	total cfs	**14.66**	**6580.00**								
0.04	200	2064.5	8		0.14	0.16		0.12	56	**6860**	24.48	4.68	0.14	0	DR 41 - 100 psi		2
0.13	665	2058.8	83		1.50	1.70		1.29	581	6804	24.48	4.64	2.61	4	DR 41 - 100 psi		6
0.60	3303	1990.7	16		0.29	0.33		0.25	112	6223	24.48	4.24	32.09	48	DR 41 - 100 psi		3
0.90	4752	1925.0	69		1.25	1.41		1.08	483	6111	24.48	4.17	60.53	91	DR 41 - 100 psi		6
1.04	5491	1915.0	11		0.20	0.22		0.17	77	5628	24.48	3.84	64.86	97	DR 41 - 100 psi	5491	3
1.50	7950	1901.8	23		0.42	0.47		0.36	161	5551	24.12	3.90	70.57	106	DR 32.5 - 125 psi		3
1.59	8395	1895.0	70	see sublateral below	1.26	1.43		1.09	490	5390	24.12	3.78	73.52	110	DR 32.5 - 125 psi		
1.60	8448	1894.0	19		0.34	0.39		0.30	133	4900	24.12	3.44	73.95	111	DR 32.5 - 125 psi		3
1.90	10288	1865.0	62		1.12	1.27		0.97	434	4767	24.12	3.35	86.50	130	DR 32.5 - 125 psi	4797	6
2.4R	12465	1823.9	20		0.36	0.41		0.31	140	4333	19.77	4.53	104.29	156	DR 25 - 165 psi		3
2.4L	12465	1823.9	196		3.54	4.00		3.06	1372	4193	19.77	4.38	104.29	156	DR 25 - 165 psi		10
2.85	14858	1780.0	89		1.61	1.82		1.39	623	2821	19.77	2.95	123.30	185	DR 25 - 165 psi	4570	8
2.9R	15208	1766.5	43		0.78	0.88		0.67	301	2198	13.75	4.75	129.14	194	DR 21 - 200 psi		6
2.9L	15208	1766.5	136	see sublateral below	2.45	2.78		2.12	952	1897	13.75	4.10	129.14	194	DR 21 - 200 psi		
end	18091	1725.0	95		1.71	1.94		1.48	665	945	13.75	2.04	147.11	221	DR 21 - 200 psi	3233	8
	18091.00	1725.0	40	Extra Acres for Conservatism						280					Total Pipe:	18091	
																3.43	miles
1.59 sublateral	0	1895.0	**70**					**1.09**	**490.00**								
0.60	3553	1830.0	70		1.26	1.43		1.09	490	**490**	7.98	3.14	101.65	152	DR 18 - 235 psi	3553	6
																0.67	miles
2.9R sublateral	0	1766.5	**136**					**2.12**	**952.00**								
0.50	1745	1732.0	53		0.96	1.08		0.83	371	**952**	9.79	4.06	144.08	216	DR 18 - 235 psi		8
1.00	4995	1715.0	83		1.50	1.70		1.29	581	**581**	9.79	2.48	151.44	227	DR 18 - 235 psi	4995	6
																0.95	miles

Turnout Tally (diameter - in. & quantity)									
0.75	**1**	**1.5**	**2**	**3**	**4**	**6**	**8**	**10**	**12**
			1	5		6	3	1	

Turnout ID	Cumulative distance from headend (ft)	Elevation (feet)	Acres served per turnout		Delivery Requirement (cfs)	Delivery Requirement (925 cfs/45,278 acres) (cfs)		Delivery Requirement - Revised for Conservation (cfs)	Delivery Requirement - Revised for Conservation (gpm)	Pipe Sizing Flow (gpm)	Pipe Dia (in)	Velocity (ft/sec)	Pipe Static Pressure (psi)	Pipe Sizing Pressure 1.5x Static (psi)	Pipe Pressure Class	Pipe Length (ft)	Turnouts Diameter (in)
NB8.3	0	2064.4	**1486**		26.82	30.36	total cfs	**23.18**	**10402**								
0.02	130	2063.6	56		1.01	1.14		0.87	392	**10682**	30.35	4.74	0.34	1	DR 41 - 100 psi		6
0.24	1251	2039.0	39		0.70	0.80		0.61	273	10290	30.35	4.56	10.99	16	DR 41 - 100 psi		4
0.65	3700	2025.0	60		1.08	1.23		0.94	420	10017	30.35	4.44	17.05	26	DR 41 - 100 psi		6
0.70	3751	2023.9	102		1.84	2.08		1.59	714	9597	30.35	4.26	17.52	26	DR 41 - 100 psi		8
1.10	5875	1980.5	69		1.25	1.41		1.08	483	8883	30.35	3.94	36.31	54	DR 41 - 100 psi		6
1.20	6336	1975.0	141		2.54	2.88		2.20	987	8400	30.35	3.73	38.69	58	DR 41 - 100 psi		8
1.21	6389	1973.0	78		1.41	1.59		1.22	546	7413	30.35	3.29	39.56	59	DR 41 - 100 psi	6389	6
1.67	8790	1923.9	66		1.19	1.35		1.03	462	6867	24.48	4.68	60.81	91	DR 41 - 100 psi		6
1.70	9033	1920.0	146		2.64	2.98		2.28	1022	6405	24.48	4.37	62.50	94	DR 41 - 100 psi		8
1.71	9042	1920.0	166		3.00	3.39		2.59	1162	5383	24.48	3.67	62.50	94	DR 41 - 100 psi	2653	10
2.02	10666	1880.0	70		1.26	1.43		1.09	490	4221	19.77	4.41	79.82	120	DR 25 - 165 psi		6
2.10	11088	1859.0	74		1.34	1.51		1.15	518	3731	19.77	3.90	88.91	133	DR 25 - 165 psi		6
2.20	11616	1858.0	41		0.74	0.84		0.64	287	3213	19.77	3.36	89.34	134	DR 25 - 165 psi		6
2.70	14150	1845.9	32		0.58	0.65		0.50	224	2926	19.77	3.06	94.58	142	DR 25 - 165 psi		4
3.10	18185	1889.3	90		1.62	1.84		1.40	630	2702	19.77	2.82	75.79	114	DR 25 - 165 psi	9143	8
3.70	19485	1864.2	136		2.45	2.78		2.12	952	2072	14	4.32	86.66	130	DR 25 - 165 psi		8
3.90	20818	1836.9	77		1.39	1.57		1.20	539	1120	14	2.33	98.48	148	DR 25 - 165 psi		6
3.91	22110	1817.0	43		0.78	0.88		0.67	301	581	14	1.21	107.09	161	DR 25 - 165 psi	3925	6
	22110	1817.0	40	Extra Acres for Conservatism						280					Total Pipe:	22110	
																4.19	miles

Turnout Tally (diameter - in. & quantity)									
0.75	**1**	**1.5**	**2**	**3**	**4**	**6**	**8**	**10**	**12**
					2	10	5	1	

Turnout ID	Cumulative distance from headend (ft)	Elevation (feet)	Acres served per turnout		Delivery Requirement (cfs)	Delivery Requirement (925 cfs/45,278 acres) (cfs)		Delivery Requirement - Revised for Conservation (cfs)	Delivery Requirement - Revised for Conservation (gpm)	Pipe Sizing Flow (gpm)	Pipe Dia (in)	Velocity (ft/sec)	Pipe Static Pressure (psi)	Pipe Sizing Pressure 1.5x Static (psi)	Pipe Pressure Class	Pipe Length (ft)	Turnouts Diameter (in)
NB20.2	0	2055.4	**996**		17.98	20.35	total cfs	**15.53**	**6972**								
0.01	58	2053.6	40		0.72	0.82		0.62	280	**7252**	24.48	4.94	0.76	1	DR 41 - 100 psi		6
0.02	61	2053.6	40		0.72	0.82		0.62	280	6972	24.48	4.75	0.76	1	DR 41 - 100 psi		6
0.40	1760	2050.5	59		1.06	1.21		0.92	413	6692	24.48	4.56	2.10	3	DR 41 - 100 psi		6
0.50	2325	2039.5	128		2.31	2.61		2.00	896	6279	24.48	4.28	6.87	10	DR 41 - 100 psi		8
1.00	5442	1971.6	40		0.72	0.82		0.62	280	5383	24.48	3.67	36.26	54	DR 41 - 100 psi	5442	6
1.20	6175	1958.1	49		0.88	1.00		0.76	343	5103	20.49	4.97	42.10	63	DR 41 - 100 psi		6
pipe end above creek	8590	1928.4	640		11.55	13.07		9.98	4480	4760	20.49	4.63	54.96	82	DR 41 - 100 psi	3148	14
	8590	1928.4	40	Extra Acres for Conservatism						280							
															Total Pipe:	8590	
																1.63	miles

Turnout Tally (diameter - in. & quantity)									
0.75	**1**	**1.5**	**2**	**3**	**4**	**6**	**8**	**10**	**14**
						5	1		1

Turnout ID	Cumulative distance from headend (ft)	Elevation (feet)	Acres served per turnout		Delivery Requirement (cfs)	Delivery Requirement (925 cfs/45,278 acres) (cfs)		Delivery Requirement - Revised for Conservation (cfs)	Delivery Requirement - Revised for Conservation (gpm)	Pipe Sizing Flow (gpm)	Pipe Dia (in)	Velocity (ft/sec)	Pipe Static Pressure (psi)	Pipe Sizing Pressure 1.5x Static (psi)	Pipe Pressure Class	Pipe Length (ft)	Turnouts Diameter (in)
NB20.8-0.8	0	1973.2	**1036**		18.70	21.16	total cfs	**16.16**	**7252**								
0.70	3696	1921.0	20		0.36	0.41		0.31	140	**7532**	24.48	5.13	22.60	34	DR 41 - 100 psi		3
0.80	4224	1917.0	86		1.55	1.76		1.34	602	7392	24.48	5.04	24.33	36	DR 41 - 100 psi		6
1.00	5412	1876.9	130		2.35	2.66		2.03	910	6790	24.48	4.63	41.69	63	DR 41 - 100 psi		8
1.50	8062	1830.4	400		7.22	8.17		6.24	2800	5880	24.48	4.01	61.82	93	DR 41 - 100 psi		14
1.51	8063	1830.4	400		7.22	8.17		6.24	2800	3080	24.48	2.10	61.82	93	DR 41 - 100 psi	8063	14
	8063	1830.4	40	Extra Acres for Conservatism						280					Total Pipe:	8063	
																1.53	miles

Turnout Tally (diameter - in. & quantity)									
0.75	**1**	**1.5**	**2**	**3**	**4**	**6**	**8**	**10**	**14**
				1		1	1		2

Turnout ID	Cumulative distance from headend (ft)	Elevation (feet)	Acres served per turnout		Delivery Requirement (cfs)	Delivery Requirement (925 cfs/45,278 acres) (cfs)		Delivery Requirement - Revised for Conservation (cfs)	Delivery Requirement - Revised for Conservation (gpm)	Pipe Sizing Flow (gpm)	Pipe Dia (in)	Velocity (ft/sec)	Pipe Static Pressure (psi)	Pipe Sizing Pressure 1.5x Static (psi)	Pipe Pressure Class	Pipe Length (ft)	Turnouts Diameter (in)
NB22.0	0	2052.5	**2779**		50.16	56.77	total cfs	**43.34**	**19453**								
0.02L	100	2052.5	30		0.54	0.61		0.47	210	**19733**	42.18	4.53	0.0	0	DR 41 - 100 psi		4
0.02R	100	2052.5	15		0.27	0.31		0.23	105	19523	42.18	4.48	0.0	0	DR 41 - 100 psi		3
0.03	158	2050.0	2		0.04	0.04		0.03	14	19418	42.18	4.46	1.06	2	DR 41 - 100 psi		1
0.20	1038	2029.5	131		2.36	2.68		2.04	917	19404	42.18	4.46	9.94	15	DR 41 - 100 psi		8
0.23	1117	2029.4	118		2.13	2.41		1.84	826	18487	42.18	4.24	9.98	15	DR 41 - 100 psi		8
0.7R	3650	1973.7	100		1.80	2.04		1.56	700	17661	42.18	4.06	34.10	51	DR 41 - 100 psi		8
0.7L	3650	1973.7	108		1.95	2.21		1.68	756	16961	42.18	3.89	34.10	51	DR 41 - 100 psi		8
1.00	5280	1942.0	22		0.40	0.45		0.34	154	16205	42.18	3.72	47.82	72	DR 41 - 100 psi	5280	3
1.10	5800	1931.8	220		3.97	4.49		3.43	1540	16051	36.3	4.98	52.23	78	DR 41 - 100 psi		10
1.20	6475	1919.5	154		2.78	3.15		2.40	1078	14511	36.3	4.50	57.56	86	DR 41 - 100 psi		8
1.21	6495	1919.4	77		1.39	1.57		1.20	539	13433	36.3	4.16	57.60	86	DR 41 - 100 psi	1215	6
1.4R	7700	1895.7	44		0.79	0.90		0.69	308	12894	35.8	4.11	67.86	102	DR 32.5 - 125psi		6
1.4L	7700	1895.7	81		1.46	1.65		1.26	567	12586	35.8	4.01	67.86	102	DR 32.5 - 125psi		6
1.70	9151	1870.3	233		4.21	4.76		3.63	1631	12019	35.8	3.83	78.86	118	DR 32.5 - 125psi		10
1.80	9231	1869.5	44		0.79	0.90		0.69	308	10388	35.8	3.31	79.20	119	DR 32.5 - 125psi	2736	6
pipe end	10731	1844.0	1400		25.27	28.60		**21.83**	**9800**	**10080**	**29.29**	**4.80**	**90.24**	**135**	**DR 25 - 165psi**	**1500**	**24**
	10731	1844.0	40	Extra Acres for Conservatism						280						Total Pipe:	10731
																	2.03 miles

Turnout Tally (diameter - in. & quantity)									
0.75	**1**	**1.5**	**2**	**3**	**4**	**6**	**8**	**10**	**24**
	1			2	1	4	5	2	1

Turnout ID	Cumulative distance from headend (ft)	Elevation (feet)	Acres served per turnout		Delivery Requirement (cfs)	Delivery Requirement (925 cfs/45,278 acres) (cfs)		Delivery Requirement - Revised for Conservation (cfs)	Delivery Requirement - Revised for Conservation (gpm)	Pipe Sizing Flow (gpm)	Pipe Dia (in)	Velocity (ft/sec)	Pipe Static Pressure (psi)	Pipe Sizing Pressure 1.5x Static (psi)	Pipe Pressure Class	Pipe Length (ft)	Turnouts Diameter (in)
NB22.8	0	2052.1	**287**		4.46	5.05	total cfs	**3.85**	**1729**								
0.01L	100	2053.1	22		0.40	0.45		0.34	154	**2009**	12.091	5.61	0	-1	DR 41 - 100 psi		3
0.01R	100	2053.1	21		0.38	0.43		0.33	147	1855	12.091	5.18	0	-1	DR 41 - 100 psi		3
0.2L	652	2040.0	122	beginning of existing	2.20	2.49		1.90	854	1708	12.091	4.77	5.2	8	DR 41 - 100 psi		8
0.2R	652	2040.0	82	12" and 15" pipes	1.48	1.68		1.28	574	854	12.091	2.39	5.2	8	DR 41 - 100 psi	652	6
	652	2040.0	40	Extra Acres for Conservatism						280					Total Pipe:	652	
																0.12	miles

Turnout Tally (diameter - in. & quantity)									
0.75	**1**	**1.5**	**2**	**3**	**4**	**6**	**8**	**10**	**14**
				2		1	1		

Turnout ID	Cumulative distance from headend (ft)	Elevation (feet)	Acres served per turnout		Delivery Requirement (cfs)	Delivery Requirement (925 cfs/45,278 acres) (cfs)		Delivery Requirement - Revised for Conservation (cfs)	Delivery Requirement - Revised for Conservation (gpm)	Pipe Sizing Flow (gpm)	Pipe Dia (in)	Velocity (ft/sec)	Pipe Static Pressure (psi)	Pipe Sizing Pressure 1.5x Static (psi)	Pipe Pressure Class	Pipe Length (ft)	Turnouts Diameter (in)
NB26.7	0	2048.2	**2160**	total acres served by NB26.7	38.98	44.13	total cfs	**33.02**	**14819**								
0.02	100	2048.0	64		1.16	1.31		1.00	448	**15099**	36.3	4.68	0.10	0	DR 41 - 100 psi		6
0.50	2640	2009.7	302		5.45	6.17		4.71	2114	14651	36.3	4.54	16.68	25	DR 41 - 100 psi		12
0.51	2693	2009.6	79		1.43	1.61		1.23	553	12537	36.3	3.89	16.73	25	DR 41 - 100 psi		6
1.00	5551	1976.2	92		1.66	1.88		1.43	644	11984	36.3	3.72	31.19	47	DR 41 - 100 psi		8
1.30	6841	1957.0	46		0.83	0.94		0.72	322	11340	36.3	3.52	39.50	59	DR 41 - 100 psi		6
1.70	8750	1939.8	131	see sub-lateral below	2.36	2.68		2.04	917	11018	36.3	3.42	46.94	70	DR 41 - 100 psi		
2.00	9935	1938.1	18		0.32	0.37		0.28	126	10101	36.3	3.13	47.68	72	DR 41 - 100 psi		3
2.20	12800	1935.0	57		1.03	1.16		0.89	399	9975	36.3	3.09	49.02	74	DR 41 - 100 psi		6
2.50	13150	1933.3	30		0.54	0.61		0.47	210	9576	36.3	2.97	49.76	75	DR 41 - 100 psi		4
2.70	14256	1931.0	25		0.45	0.51		0.39	175	9366	36.3	2.90	50.75	76	DR 41 - 100 psi		4
3.09	16230	1928.7	15		0.27	0.31		0.23	105	9191	36.3	2.85	51.75	78	DR 41 - 100 psi		3
3.10	16253	1928.7	242	see sub-lateral below	4.37	4.94		3.77	1694	9086	36.3	2.82	51.75	78	DR 41 - 100 psi	16253	
3.16	16500	1928.2	45		0.81	0.92		0.70	315	7392	24.48	5.04	51.97	78	DR 41 - 100 psi		6
3.40	17600	1926.6	40		0.72	0.82		0.62	280	7077	24.48	4.82	52.66	79	DR 41 - 100 psi		6
4.10	21450	1920.8	50		0.90	1.02		0.78	350	6797	24.48	4.63	55.17	83	DR 41 - 100 psi		6
4.20	22176	1919.0	5		0.09	0.10		0.08	35	6447	24.48	4.39	55.95	84	DR 41 - 100 psi		1.5
4.21	22229	1919.0	6		0.11	0.12		0.09	42	6412	24.48	4.37	55.95	84	DR 41 - 100 psi		1.5
4.30	22984	1918.7	18		0.32	0.37		0.28	126	6370	24.48	4.34	56.08	84	DR 41 - 100 psi		3
4.40	23075	1918.2	496	see sub-lateral (and sub-sub lateral) below	8.95	10.13		7.74	3472	6244	24.48	4.26	56.29	84	DR 41 - 100 psi	6822	
4.45	23496	1918.0	50		0.90	1.02		0.78	350	2772	16.51	4.15	56.38	85	DR 41 - 100 psi		6
4.50	23760	1917.0	7		0.13	0.14		0.11	49	2422	16.51	3.63	56.81	85	DR 41 - 100 psi		2
4.55	24024	1916.5	9		0.16	0.18		0.14	63	2373	16.51	3.56	57.03	86	DR 41 - 100 psi		2
4.60	24525	1916.0	19		0.34	0.39		0.30	133	2310	16.51	3.46	57.25	86	DR 41 - 100 psi		3
4.61	24341	1916.0	185	see sub-lateral below	3.34	3.78		2.89	1295	2177	16.51	3.26	57.25	86	DR 41 - 100 psi	1266	
4.65	24552	1915.9	23		0.42	0.47		0.36	161	882	8.18	5.38	57.29	86	DR 41 - 100 psi		3
4.80	25344	1913.0	39		0.70	0.80		0.61	273	721	8.18	4.40	58.55	88	DR 41 - 100 psi		4
4.90	27225	1911.8	19		0.34	0.39		0.30	133	448	8.18	2.74	59.06	89	DR 41 - 100 psi		3
5.10	26928	1911.0	48		0.87	0.98		0.08	35	315	8.18	1.92	59.41	89	DR 41 - 100 psi	2587	1.5
	26928.00	1911.00	40	Extra Acres for Conservatism						280					Total Pipe:	26928	
																5.10	miles
1.7 sublateral	0		**131**					**2.04**	**917.00**								
0.20	1056	1939.0	58		1.05			0.90	406	**917**	8.18	5.60	47.29	71	DR 41 - 100 psi		6
0.30	1463	1938.1	63		1.14			0.98	441	511	8.18	3.12	47.68	72	DR 41 - 100 psi	1463	6
0.31	1480	1938.1	10		0.18			0.16	70	70	3.32	2.59	47.68	72	DR 41 - 100 psi	475	2
															Total Pipe:	1938.1	
																0.37	miles
3.1 sublateral	0		**242**					**3.77**	**1694.00**								
0.30	1500	1913.0	32		0.58			0.50	224	**1694**	12.091	4.73	58.55	88	DR 41 - 100 psi		4
	1510	1912.0		connects to existing 15" pipe				0.00	0	1470	12.091	4.11	58.98	88	DR 41 - 100 psi	1510	
0.70	3696	1885.0	210	end of existing pipe	3.79			3.28	1470	1470	11.919	4.23	70.67	106	DR 32.5- 125 ps	375	10
															Total Pipe:	1885	
																0.36	miles
4.4 sublateral	0		**496**					**7.74**	**3472.00**								
0.20	1215	1857.8	46		0.83			0.72	322	**3472**	16.51	5.20	82.44	124	DR 41 - 100 psi		6
0.40	1914	1826.5	164	see sub-lateral below	2.96			2.56	1148	3150	16.51	4.72	95.99	144	DR 41 - 100 psi	1914	
0.41	1930	1826.4	35		0.63			0.55	245	2002	14.3	4.00	96.03	144	DR 32.5- 125 psi		4
0.60	3250	1776.7	15		0.27			0.23	105	1757	14.3	3.51	117.55	176	DR 32.5- 125 psi		12
0.61	3221	1776.0	56		1.01			0.87	392	1652	14.3	3.30	117.85	177	DR 32.5- 125 ps	1307	10
1.1L	5806	1723.0	6		0.11			0.09	42	1260	11.711	3.75	140.80	211	DR 26- 160 psi		10
1.10	5808	1722.5	174		3.14			2.71	1218	1218	11.711	3.63	141.01	212	DR 26- 160 psi	2587	10
															Total Pipe:	5808	
																1.10	miles
4.61 sublateral	0		**185**					**2.89**	**1295.00**								
0.09	520	1894.0	38		0.69			0.59	266	**1295**	10.048	5.24	66.77	100	DR 32.5- 125 psi		4
0.1	528	1893	26		0.47			0.41	182	1029	10.048	4.16	67.20	101	DR 32.5- 125 psi		4
0.2	1165	1853.6	121		2.18			1.89	847	847	10.048	3.43	84.26	126	DR 32.5- 125 ps	1854	8
															Total Pipe:	1853.6	
																0.35	miles
4.4-0.4 sub-sublateral	0		**164**					**2.56**	**1148.00**								
0.1	528	1780	21		0.38			0.33	147	**1148**	9.667	5.02	116.12	174	DR 21- 200 psi		3
0.15	792	1760	37		0.67			0.58	259	1001	9.667	4.38	124.78	187	DR 21- 200 psi	792	4
0.3	1584	1740	7		0.13			0.11	49	742	7.553	5.31	133.44	200	DR 17- 250 psi		2
0.4	2112	1730	4		0.07			0.06	28	693	7.553	4.96	137.77	207	DR 17- 250 psi		1.5
0.45	2376	1724	95		1.71			1.48	665	665	7.553	4.76	140.36	211	DR 17- 250 psi	1584	8
															Total Pipe:	2376	
																0.45	miles

Turnout Tally (diameter - in. & quantity)											
0.75	1	1.5	2	3	4	6	8	10	12	14
		4	4	7	8	11	3	4	2	

Turnout ID	Cumulative distance from headend (ft)	Elevation (feet)	Acres served per turnout		Delivery Requirement (cfs)	Delivery Requirement (925 cfs/45,278 acres) (cfs)		Delivery Requirement - Revised for Conservation (cfs)	Delivery Requirement - Revised for Conservation (gpm)	Pipe Sizing Flow (gpm)	Pipe Dia (in)	Velocity (ft/sec)	Pipe Static Pressure (psi)	Pipe Sizing Pressure 1.5x Static (psi)	Pipe Pressure Class	Pipe Length (ft)	Turnouts Diameter (in)
NB27.5	0	2048.0	**502**		9.06	10.26	total cfs	**7.83**	**3514**								
0.01	60	2047.2	105		1.90	2.15		1.64	735	**3794**	18.5	4.53	0.35	1	DR 41 - 100 psi		8
0.02	75	2047.2	105		1.90	2.15		1.64	735	3059	18.5	3.65	0.35	1	DR 41 - 100 psi		8
0.20	1056	2020.0	73		1.32	1.49		1.14	511	2324	18.5	2.77	12.12	18	DR 41 - 100 psi	1056	6
0.50	2690	2007.2	55		0.99	1.12		0.86	385	1813	12.091	5.07	17.66	26	DR 41 - 100 psi		6
0.80	3988	1981.4	79		1.43	1.61		1.23	553	1428	12.091	3.99	28.83	43	DR 41 - 100 psi		6
0.91	4800	1978.0	5		0.09	0.10		0.08	35	875	12.091	2.44	30.30	45	DR 41 - 100 psi		1.5
	4820	1978.0		connect to existing 15" 100 psi pipe				0.00	0	840	12.091	2.35	30.30	45	DR 41 - 100 psi		
1.01	5331	1976.0	80		1.44	1.63		1.25	560	840	12.091	2.35	31.17	47	DR 41 - 100 psi	4275	6
	5331	1976	40	Extra Acres for Conservatism						280					Total Pipe:	5331	
																1.01	miles

Turnout Tally (diameter - in. & quantity)									
0.75	**1**	**1.5**	**2**	**3**	**4**	**6**	**8**	**10**	**14**
		1				4	2		

Turnout ID	Cumulative distance from headend (ft)	Elevation (feet)	Acres served per turnout		Delivery Requirement (cfs)	Delivery Requirement (925 cfs/45,278 acres) (cfs)		Delivery Requirement - Revised for Conservation (cfs)	Delivery Requirement - Revised for Conservation (gpm)	Pipe Sizing Flow (gpm)	Pipe Dia (in)	Velocity (ft/sec)	Pipe Static Pressure (psi)	Pipe Sizing Pressure 1.5x Static (psi)	Pipe Pressure Class	Pipe Length (ft)	Turnouts Diameter (in)
NB28.6	0	2050.0	**213**		3.12	3.53	total cfs	**2.70**	**1211**								
0.01	50	2045.0	93		1.68	1.90		1.45	651	**1491**	12.091	4.17	2.16	3	DR 41 - 100 psi		8
0.40	2100	2010.0	80		1.44	1.63		1.25	560	840	12.091	2.35	17.32	26	DR 41 - 100 psi	2100	6
	2100	2010	40	Extra Acres for Conservatism						280					Total Pipe:	2100	
																0.40	miles

Turnout Tally (diameter - in. & quantity)									
0.75	**1**	**1.5**	**2**	**3**	**4**	**6**	**8**	**10**	**14**
						1	1		

Turnout ID	Cumulative distance from headend (ft)	Elevation (feet)	Acres served per turnout		Delivery Requirement (cfs)	Delivery Requirement (925 cfs/45,278 acres) (cfs)		Delivery Requirement - Revised for Conservation (cfs)	Delivery Requirement - Revised for Conservation (gpm)	Pipe Sizing Flow (gpm)	Pipe Dia (in)	Velocity (ft/sec)	Pipe Static Pressure (psi)	Pipe Sizing Pressure 1.5x Static (psi)	Pipe Pressure Class	Pipe Length (ft)	Turnouts Diameter (in)
NB33.5	0	2022.0	**1565.8**	total acres served by NB33.5	28.26	31.99	total cfs	**24.42**	**10961**								
0.40	2200	2019.4	52.2		0.94	1.07		0.81	365.4	**11241**	30.35	4.98	1.13	2	DR 41 - 100 psi		6
0.60	3168	2017.0	77.9		1.41	1.59		1.21	545.3	10875	30.35	4.82	2.16	3	DR 41 - 100 psi		6
0.70	3870	2015.9	10		0.18	0.20		0.16	70	10330	30.35	4.58	2.64	4	DR 41 - 100 psi		2
0.80	4224	2014.0	5		0.09	0.10		0.08	35	10260	30.35	4.55	3.46	5	DR 41 - 100 psi		1.5
1.40	7392	2007.0	15		0.27	0.31		0.23	105	10225	30.35	4.53	6.49	10	DR 41 - 100 psi		3
1.60	8448	2005.0	6		0.11	0.12		0.09	42	10120	30.35	4.49	7.36	11	DR 41 - 100 psi		1.5
1.95	10300	2002.8	14		0.25	0.29		0.22	98	10078	30.35	4.47	8.31	12	DR 41 - 100 psi		3
2.00	10560	2002.0	881	see sub-lateral below	15.90	18.00		13.74	6167	9980	30.35	4.43	8.66	13	DR 41 - 100 psi	10560	
2.10	11088	2001.0	40		0.72	0.82		0.62	280	3813	18.5	4.55	9.09	14	DR 41 - 100 psi		6
2.40	12800	1998.9	90		1.62	1.84		1.40	630	3533	18.5	4.22	10.00	15	DR 41 - 100 psi		8
2.60	13728	1996.0	90		1.62	1.84		1.40	630	2903	18.5	3.46	11.26	17	DR 41 - 100 psi		8
2.74	14370	1994.2	32		0.58	0.65		0.50	224	2273	18.5	2.71	12.03	18	DR 41 - 100 psi	3810	4
3.00	16089	1820.1	129.2	see sub-lateral below	2.33	2.64		2.02	904.4	2049	14	4.27	87.40	131	DR 25 - 165 psi		
3.01	16106	1820.0	20.5		0.37	0.42		0.32	143.5	1145	14	2.39	87.45	131	DR 25 - 165 psi	1736	3
3.30	17538	1730.0	27		0.49	0.55		0.42	189	1001	9.667	4.38	126.41	190	DR 21 - 200 psi		4
3.50	18594	1705.0	76		1.37	1.55		1.19	532	812	9.667	3.55	137.23	206	DR 21 - 200 psi	2488	4
	18594.00	1705.00	40	Extra Acres for Conservatism						280							
															Total Pipe:	18594	
																3.52	miles
2.0 sublateral	0		**881**					**13.74**	**6167.00**								
0.20	1168	1916.0	14		0.25			0.22	98	**6167**	24.48	4.20	45.89	69	DR 41 - 100 psi	1168	3
0.85	4488	1840.0	31.5		0.57			0.49	220.5	6069	24.12	4.26	78.79	118	DR 32.5 - 125psi		4
1.00	5070	1832.3	104.5		1.89			1.63	731.5	5849	24.12	4.11	82.12	123	DR 32.5 - 125psi		8
1.01	5333	1832.0	112		2.02			1.75	784	5117	24.12	3.59	82.25	123	DR 32.5 - 125psi	4165	8
1.26	6670	1798.0	133		2.40			2.07	931	4333	19.77	4.53	96.97	145	DR 25 - 165 psi		8
1.27	6685	1798.0	67		1.21			1.04	469	3402	19.77	3.56	96.97	145	DR 25 - 165 psi	1352	6
1.60	8448	1750.0	79		1.43			1.23	553	2933	15.64	4.90	117.75	177	DR 21 - 200 psi		6
1.80	9504	1733.0	39	see sub-sub-lateral below	0.70			0.61	273	2380	15.64	3.97	125.11	188	DR 21 - 200 psi		
1.81	9690	1733.5	175		3.16			2.73	1225	2107	15.64	3.52	124.89	187	DR 21 - 200 psi	3005	10
2.30	12144	1690.0	50		0.90			0.78	350	882	9.41	4.07	143.72	216	DR 17 - 250 psi		6
W2.3	12385	1689.0	76		1.37			1.19	532	532	9.41	2.45	144.16	216	DR 17 - 250 psi	2695	6
															Total Pipe:	12385	
																2.35	miles
2.0-1.8 sublateral	0	1733.0	**39**					**0.61**	**273.00**								
0.23	1216	1700.0	39		0.70			0.61	273	**273**	5.803	3.31	139.39	209	DR 17 - 250 psi	1216	4
															Total Pipe:	1216	
																0.23	miles
3.0 sublateral	0	1820.1	**129.2**					**2.02**	**904.40**								
0.26	1375	1799.1	90.2		1.63			1.41	631.4	**904**	9.667	3.95	96.49	145	DR 21 - 200 psi	1375	8
0.50	2820	1757.0	6		0.11			0.09	42	273	5.955	3.14	114.72	172	DR 21 - 200 psi		1.5
W0.5	2850	1756.0	33		0.60			0.51	231	231	5.955	2.66	115.15	173	DR 21 - 200 psi	1475	4
															Total Pipe:	2850	
																0.54	miles

Turnout Tally (diameter - in. & quantity)										
0.75	**1**	**1.5**	**2**	**3**	**4**	**6**	**8**	**10**	**12**	**14**
		3	1	4	6	7	6	1		

Turnout ID	Cumulative distance from headend (ft)	Elevation (feet)	Acres served per turnout		Delivery Requirement (cfs)	Delivery Requirement (925 cfs/45,278 acres) (cfs)		Delivery Requirement - Revised for Conservation (cfs)	Delivery Requirement - Revised for Conservation (gpm)	Pipe Sizing Flow (gpm)	Pipe Dia (in)	Velocity (ft/sec)	Pipe Static Pressure (psi)	Pipe Sizing Pressure 1.5x Static (psi)	Pipe Pressure Class	Pipe Length (ft)	Turnouts Diameter (in)
NB35.1	0	2015.0	**411**	total acres served by NB35.1	6.70	7.58	total cfs	**5.79**	**2597**								
0.01	57	2009.0	48		0.87	0.98		0.75	336	**2877**	16.51	4.31	2.60	4	DR 41 - 100 psi		6
0.20	1840	1859.1	77		1.39	1.57		1.20	539	2541	16.51	3.81	67.49	101	DR 41 - 100 psi	1840	6
0.84	4416	1730.4	246		4.44	5.03		3.84	1722	2002	13.75	4.33	123.20	185	DR 32.5 - 200 psi	2576	12
	4416	1730	40	Extra Acres for Conservatism						280						Total Pipe:	4416	
																	0.84 miles

Turnout Tally (diameter - in. & quantity)									
0.75	**1**	**1.5**	**2**	**3**	**4**	**6**	**8**	**10**	**12**
						2			1

Turnout ID	Distance from headend (feet)	Elevation (feet)	Acres served per turnout	Delivery Requirement (cfs)	Delivery Requirement (925 cfs/45,278 acres) (cfs)		Delivery Requirement - Revised for Conservation (cfs)	Delivery Requirement - Revised for Conservation (gpm)	Pipe Sizing Flow (gpm)	Pipe Dia (in)	Velocity (ft/sec)	Pipe Static Pressure (psi)	Pipe Sizing Pressure 1.5x Static (psi)	Pipe Pressure Class	Pipe Length (ft)	Turnouts Diameter (in)
end of existing hancor pipe	0	2137.3	3198.4	57.73	65.34	total cfs	**49.88**	**22389**								
0.70	372	2137.0	27.8	0.50	0.57		0.43	195	**22669**	42.18	5.20	0.11	0	DR 41 - 100 psi		4
1.00	1472	2136.2	13.8	0.25	0.28		0.22	97	22474	42.18	5.16	0.45	1	DR 41 - 100 psi		3
1.10	2280	2136.0	18.9	0.34	0.39		0.29	132	22378	42.18	5.14	0.53	1	DR 41 - 100 psi		3
1.20	2808	2135.7	20.2	0.36	0.41		0.32	141	22245	42.18	5.11	0.69	1	DR 41 - 100 psi		3
1.40	3864	2134.9	109.7	1.98	2.24		1.71	768	22104	42.18	5.08	1.01	2	DR 41 - 100 psi		8
1.70	3819	2134.6	20.7	0.37	0.42		0.32	145	21336	42.18	4.90	1.15	2	DR 41 - 100 psi		3
1.90	6647	2132.6	80	1.44	1.63		1.25	560	21191	42.18	4.87	2.01	3	DR 41 - 100 psi		6
2.10	7560	2132.3	45.4	0.82	0.93		0.71	318	20631	42.18	4.74	2.13	3	DR 41 - 100 psi		6
2.30	8616	2131.6	46.7	0.84	0.95		0.73	327	20313	42.18	4.66	2.45	4	DR 41 - 100 psi		6
2.70	9842	2130.4	89	1.61	1.82		1.39	623	19986	42.18	4.59	2.97	4	DR 41 - 100 psi		8
3.00	12312	2129.0	41.8	0.75	0.85		0.65	293	19363	42.18	4.45	3.57	5	DR 41 - 100 psi		6
3.10	12697	2128.4	56.9	1.03	1.16		0.89	398	19071	42.18	4.38	3.83	6	DR 41 - 100 psi		6
3.30	13896	2127.9	84.8	1.53	1.73		1.32	594	18673	42.18	4.29	4.05	6	DR 41 - 100 psi		6
3.60	15622	2126.3	92.6	1.67	1.89		1.44	648	18079	42.18	4.15	4.74	7	DR 41 - 100 psi		8
3.80	16387	2125.7	54.9	0.99	1.12		0.86	384	17431	42.18	4.00	5.00	8	DR 41 - 100 psi		6
3.90	17064	2125.7	36	0.65	0.74		0.56	252	17046	42.18	3.91	5.01	8	DR 41 - 100 psi		4
4.00	17592	2125.3	42	0.76	0.86		0.66	294	16794	42.18	3.86	5.17	8	DR 41 - 100 psi		6
4.10	18120	2124.9	41	0.74	0.84		0.64	287	16500	42.18	3.79	5.33	8	DR 41 - 100 psi		6
4.20	18648	2124.6	201	3.63	4.11		3.13	1407	16213	42.18	3.72	5.49	8	DR 41 - 100 psi		10
4.40	19704	2123.8	33.7	0.61	0.69		0.53	236	14806	42.18	3.40	5.81	9	DR 41 - 100 psi		4
4.60	20760	2123.1	28.1	0.51	0.57		0.44	197	14571	42.18	3.35	6.13	9	DR 41 - 100 psi		4
4.70	21288	2122.7	22.9	0.41	0.47		0.36	160	14374	42.18	3.30	6.29	9	DR 41 - 100 psi		3
5.00	22878	2121.2	69.4	1.25	1.42		1.08	486	14214	42.18	3.26	6.95	10	DR 41 - 100 psi		6
5.30	24456	2120.5	39.2	0.71	0.80		0.61	274	13728	42.18	3.15	7.25	11	DR 41 - 100 psi		4
5.50	25512	2119.8	44.3	0.80	0.91		0.69	310	13453	42.18	3.09	7.57	11	DR 41 - 100 psi		6
5.60	25832	2119.0	40.3	0.73	0.82		0.63	282	13143	42.18	3.02	7.90	12	DR 41 - 100 psi		6
6.30	29530	2116.0	78.7	1.42	1.61		1.23	551	12861	42.18	2.95	9.20	14	DR 41 - 100 psi		6
6.50	30933	2115.0	144	2.60	2.94		2.25	1008	12310	42.18	2.83	9.63	14	DR 41 - 100 psi	30933	8
6.51	34872	2111.6	14.7	0.27	0.30		0.23	103	11302	30.35	5.01	11.10	17	DR 41 - 100 psi		3
7.30	35016	2113.1	27.2	0.49	0.56		0.42	190	11199	30.35	4.97	10.45	16	DR 41 - 100 psi		4
7.50	36072	2112.4	33.3	0.60	0.68		0.52	233	11009	30.35	4.88	10.77	16	DR 41 - 100 psi		4
7.70	36942	2110.2	20.6	0.37	0.42		0.32	144	10776	30.35	4.78	11.71	18	DR 41 - 100 psi		3
7.90	38184	2110.9	66	1.19	1.35		1.03	462	10632	30.35	4.71	11.41	17	DR 41 - 100 psi		6
8.50	41352	2108.7	16.3	0.29	0.33		0.25	114	10170	30.35	4.51	12.37	19	DR 41 - 100 psi		3
8.70	42182	2106.6	56.9	1.03	1.16		0.89	398	10056	30.35	4.46	13.27	20	DR 41 - 100 psi		6
8.90	43464	2107.2	59.1	1.07	1.21		0.92	414	9657	30.35	4.28	13.01	20	DR 41 - 100 psi		6
9.30	45382	2104.4	27.6	0.50	0.56		0.43	193	9243	30.35	4.10	14.22	21	DR 41 - 100 psi		4
9.70	47872	2102.7	108.8	1.96	2.22		1.70	762	9050	30.35	4.01	14.96	22	DR 41 - 100 psi		8
10.20	50262	2100.9	78.5	1.42	1.60		1.22	550	8289	30.35	3.68	15.74	24	DR 41 - 100 psi		6
10.40	51384	2101.7	35	0.63	0.72		0.55	245	7739	30.35	3.43	15.41	23	DR 41 - 100 psi		4
10.41	51437	2101.6	21.5	0.39	0.44		0.34	151	7494	30.35	3.32	15.42	23	DR 41 - 100 psi	20504	3
10.80	53501	2098.5	19	0.34	0.39		0.30	133	7344	24.48	5.01	16.77	25	DR 41 - 100 psi		3
11.00	54552	2099.4	20	0.36	0.41		0.31	140	7211	24.48	4.92	16.37	25	DR 41 - 100 psi		3
11.30	56272	2096.4	32	0.58	0.65		0.50	224	7071	24.48	4.82	17.68	27	DR 41 - 100 psi		4
11.40	56664	2098.0	33	0.60	0.67		0.51	231	6847	24.48	4.67	17.01	26	DR 41 - 100 psi		4
11.50	57192	2097.6	32	0.58	0.65		0.50	224	6616	24.48	4.51	17.17	26	DR 41 - 100 psi		4
11.60	57720	2097.2	31.4	0.57	0.64		0.49	220	6392	24.48	4.36	17.33	26	DR 41 - 100 psi		4
11.80	58776	2096.5	20	0.36	0.41		0.31	140	6172	24.48	4.21	17.65	26	DR 41 - 100 psi		3
11.90	59313	2094.2	21	0.38	0.43		0.33	147	6032	24.48	4.11	18.64	28	DR 41 - 100 psi		3
12.30	61422	2092.6	50.8	0.92	1.04		0.79	356	5885	24.48	4.01	19.33	29	DR 41 - 100 psi		6
12.50	62472	2093.9	37.6	0.68	0.77		0.59	263	5529	24.48	3.77	18.77	28	DR 41 - 100 psi		4
12.60	63128	2091.4	43.9	0.79	0.90		0.68	307	5266	24.48	3.59	19.85	30	DR 41 - 100 psi		6
13.00	64832	2091.0	22.4	0.40	0.46		0.35	157	4959	24.48	3.38	20.02	30	DR 41 - 100 psi		3
13.20	66168	2091.3	30.8	0.56	0.63		0.48	216	4802	24.48	3.27	19.89	30	DR 41 - 100 psi		4
13.40	67224	2090.6	12	0.22	0.25		0.19	84	4586	24.48	3.13	20.21	30	DR 41 - 100 psi		3
13.60	68190	2087.6	12	0.22	0.25		0.19	84	4502	24.48	3.07	21.49	32	DR 41 - 100 psi		3
13.70	68535	2087.3	40.5	0.73	0.83		0.63	284	4418	24.48	3.01	21.62	32	DR 41 - 100 psi		6
14.00	70392	2088.4	12.8	0.23	0.26		0.20	90	4135	24.48	2.82	21.17	32	DR 41 - 100 psi		3
14.20	71448	2087.6	36.8	0.66	0.75		0.57	258	4045	24.48	2.76	21.49	32	DR 41 - 100 psi		4
14.40	72347	2084.3	23.9	0.43	0.49		0.37	167	3788	24.48	2.58	22.92	34	DR 41 - 100 psi		4
14.70	74397	2082.7	19.4	0.35	0.40		0.30	136	3620	24.48	2.47	23.61	35	DR 41 - 100 psi		3
15.00	75672	2084.7	7.8	0.14	0.16		0.12	55	3485	24.48	2.38	22.77	34	DR 41 - 100 psi		2
15.10	76200	2084.3	450	8.12	9.19	beginning of current pipe	7.02	3150	3430	24.48	2.34	22.93	34	DR 41 - 100 psi	24763	14
			40						280					Total Pipe:	76200	

14.43 miles

Turnout Tally (diameter - in. & quantity)									
0.75	**1**	**1.5**	**2**	**3**	**4**	**6**	**8**	**10**	**14**
			1	18	17	20	5	1	1

Turnout ID	Distance from headend (feet)	Elevation (feet)	Acres served per turnout	Delivery Requirement (cfs)	Delivery Requirement (925 cfs/45,278 acres) (cfs)		Delivery Requirement - Revised for Conservation (cfs)	Delivery Requirement - Revised for Conservation (gpm)	Pipe Sizing Flow (gpm)	Pipe Dia (in)	Velocity (ft/sec)	Pipe Static Pressure (psi)	Pipe Sizing Pressure 1.5x Static (psi)	Pipe Pressure Class	Pipe Length (ft)	Turnouts Diameter (in)
Billiter spill - 12.0	0	1895.3	1745.32	31.50	35.66	total cfs	**27.22**	**12217**								
12.00	0	1895.25					0.00	0	**12497**	30.35	5.54	0.00	0	DR 41 - 100 psi		
12.20	1056	1894.3	88.14	1.59	1.80		1.37	617	12497	30.35	5.54	0.41	1	DR 41 - 100 psi		6
12.50	2640	1893.5	419.54	7.57	8.57		6.54	2937	11880	30.35	5.27	0.76	1	DR 41 - 100 psi		14
12.60	3168	1893.2	9.85	0.18	0.20		0.15	69	8943	30.35	3.97	0.89	1	DR 41 - 100 psi		2
12.65	3432	1893.0	5	0.09	0.10		0.08	35	8875	30.35	3.94	0.97	1	DR 41 - 100 psi		1.5
12.67	3538	1892.9	5	0.09	0.10		0.08	35	8840	30.35	3.92	1.02	2	DR 41 - 100 psi		1.5
12.68	3590	1892.7	5	0.09	0.10		0.08	35	8805	30.35	3.90	1.10	2	DR 41 - 100 psi		1.5
12.69	3643	1892.5	5	0.09	0.10		0.08	35	8770	30.35	3.89	1.19	2	DR 41 - 100 psi		1.5
12.70	3696	1892.3	11.33	0.20	0.23		0.18	79	8735	30.35	3.87	1.28	2	DR 41 - 100 psi		3
12.80	4224	1892.0	47.18	0.85	0.96		0.74	330	8655	30.35	3.84	1.41	2	DR 41 - 100 psi		6
13.30	6864	1888.4	34.08	0.62	0.70		0.53	239	8325	30.35	3.69	2.97	4	DR 41 - 100 psi		4
13.70	8976	1885.3	80.86	1.46	1.65		1.26	566	8086	30.35	3.59	4.31	6	DR 41 - 100 psi		6
13.80	9504	1885.0	7.82	0.14	0.16		0.12	55	7520	30.35	3.34	4.44	7	DR 41 - 100 psi		2
13.90	10032	1884.5	16.62	0.30	0.34		0.26	116	7466	30.35	3.31	4.65	7	DR 41 - 100 psi	10032	3
14.00	10560	1884.1	116.27	2.10	2.38		1.81	814	7349	24.48	5.01	4.83	7	DR 41 - 100 psi		8
14.30	12144	1883.0	9.66	0.17	0.20		0.15	68	6535	24.48	4.45	5.30	8	DR 41 - 100 psi		2
14.50	13200	1882.2	133.35	2.41	2.72		2.08	933	6468	24.48	4.41	5.65	8	DR 41 - 100 psi		8
14.60	13728	1882.0	307.57	5.55	6.28		4.80	2153	5534	24.48	3.77	5.74	9	DR 41 - 100 psi		12
14.90	15312	1880.9	4.28	0.08	0.09		0.07	30	3381	24.48	2.30	6.21	9	DR 41 - 100 psi		1.5
15.20	16896	1879.7	38.22	0.69	0.78		0.60	268	3351	24.48	2.28	6.73	10	DR 41 - 100 psi		4
15.70	19536	1878.0	50.95	0.92	1.04		0.79	357	3084	24.48	2.10	7.47	11	DR 41 - 100 psi		6
15.80	20064	1877.6	189.2	3.41	3.87		2.95	1324	2727	24.48	1.86	7.64	11	DR 41 - 100 psi		10
15.90	20592	1877.3	10.78	0.19	0.22		0.17	75	1403	24.48	0.96	7.77	12	DR 41 - 100 psi		3
16.00	21120	1877.0	22	0.40	0.45		0.34	154	1327	24.48	0.90	7.90	12	DR 41 - 100 psi		3
16.10	21648	1874.4	127.62	2.30	2.61		1.99	893	1173	24.48	0.80	9.03	14	DR 41 - 100 psi	11616	8
			40						280					Total Pipe:	21648	
															4.10	miles

Turnout Tally (diameter - in. & quantity)										
0.75	**1**	**1.5**	**2**	**3**	**4**	**6**	**8**	**10**	**12**	**14**
		5	3	4	2	4	3	1	1	1

Turnout ID	Cumulative distance from headend (ft)	Elevation (feet)	Acres served per turnout		Delivery Requirement (220 cfs/12,500 acres) (cfs)	**Delivery Requirement - Revised for Conservation (cfs)**	**Delivery Requirement - Revised for Conservation (gpm)**	**Pipe Sizing Flow (gpm)**	**Pipe Dia (in)**	**Velocity (ft/sec)**	**Pipe Static Pressure (psi)**	**Pipe Sizing Pressure 1.5x Static (psi)**	**Pipe Pressure Class**	**Pipe Length (ft)**	**Turnouts Diameter (in)**
SB1.71	0	2109.5	**420**		7.39	**6.55**	**2940**								
	1562	2093.0		outlet of existing syphon											
0.97	5120	2085.0	30		0.53	0.47	210	**3220**	16.51	4.83	3	5	DR 41 - 100 psi		4
1.66	8772	1955.0	390		6.86	6.08	2730	3010	16.51	4.51	60	90	DR 41 - 100 psi		14
	8772	1955.0	40					280	16.51	0.42	60	90	DR 41 - 100 psi	7210	
													Total Pipe:	7210	
														1.37	miles

Turnout Tally (diameter - in. & quantity)									
0.75	**1**	**1.5**	**2**	**3**	**4**	**6**	**8**	**10**	**14**
					1				1

Turnout ID	Cumulative distance from headend (ft)	Elevation (feet)	Acres served per turnout		Delivery Requirement (220 cfs/12,500 acres) (cfs)	Delivery Requirement - Revised for Conservation (cfs)	Delivery Requirement - Revised for Conservation (gpm)	Pipe Sizing Flow (gpm)	Pipe Dia (in)	Velocity (ft/sec)	Pipe Static Pressure (psi)	Pipe Sizing Pressure 1.5x Static (psi)	Pipe Pressure Class	Pipe Length (ft)	Turnouts Diameter (in)
SB4.8	0	2082.7	**580**		10.21	**9.05**	**4060**								
0.01L	20	2082.0	80		1.41	1.25	560	**4340**	20.49	4.22	0.30	0	DR 41 - 100 psi		6
0.01R	20	2082.0	80		1.41	1.25	560	3780	20.49	3.68	0.30	0	DR 41 - 100 psi	20	6
0.5L	978	2040.0	80		1.41	1.25	560	3220	16.51	4.83	18	28	DR 41 - 100 psi		6
0.90	2533	1950.0	80		1.41	1.25	560	2660	16.51	3.99	57	86	DR 41 - 100 psi		6
0.91	2534	1950.0	80		1.41	1.25	560	2100	16.51	3.15	57	86	DR 41 - 100 psi		6
0.92	2535	1950.0	90		1.58	1.40	630	1540	16.51	2.31	57	86	DR 41 - 100 psi		8
0.93	2536	1950.0	90		1.58	1.40	630	910	16.51	1.36	57	86	DR 41 - 100 psi		8
	2537	1950.0	40	Extra Acres for Conservatism				280	16.51	0.42	57	86	DR 41 - 100 psi	2517	
													Total Pipe:	2537	
														0.48	miles

Turnout Tally (diameter - in. & quantity)								
0.75	**1**	**1.5**	**2**	**3**	**4**	**6**	**8**	**10**
						5	2	

Turnout ID	Cumulative distance from headend (ft)	Elevation (feet)	Acres served per turnout		Delivery Requirement (220 cfs/12,500 acres) (cfs)	Delivery Requirement - Revised for Conservation (cfs)	Delivery Requirement - Revised for Conservation (gpm)	Pipe Sizing Flow (gpm)	Pipe Dia (in)	Velocity (ft/sec)	Pipe Static Pressure (psi)	Pipe Sizing Pressure 1.5x Static (psi)	Pipe Pressure Class	Pipe Length (ft)	Turnouts Diameter (in)
SB9.9	0	2164.4	**726**		12.78	**11.32**	**5082**								
	4088	1935		end of existing pipe		0.00	0	**5362**	14.51	10.40	99.31	148.96	Exst PIP - 100 psi assumed		
0.80	4215	1925.0	60		1.06	0.94	420	**5362**	23.61	3.93	103.64	155	DR 25 - 165 psi		6
0.90	4417	1920.0	28		0.49	0.44	196	4942	23.61	3.62	105.80	159	DR 25 - 165 psi	329	4
1.10	5486	1858.5	424		7.46	6.61	2968	4746	23.19	3.61	132.42	199	DR 21 - 200 psi	1069	14
1.30	6450	1854.5	214	connects to existing pipe*	3.77	3.34	1498	1778	13.75	3.84	134.16	201	DR 21 - 200 psi		10
	6450	1854.5	40	Extra acres for Conservatism				280	13.75	0.60	134.16	201	DR 21 - 200 psi	964	
														Total Pipe:	2362
															0.45 miles

*assumed 15" dia PIP, confirm pressure rating

Turnout Tally (diameter - in. & quantity)									
0.75	**1**	**1.5**	**2**	**3**	**4**	**6**	**8**	**10**	**14**
					1	1		1	1

Turnout ID	Cumulative distance from headend (ft)	Elevation (feet)	Acres served per turnout		Delivery Requirement (220 cfs/12,500 acres) (cfs)	Delivery Requirement - Revised for Conservation (cfs)	Delivery Requirement - Revised for Conservation (gpm)	Pipe Sizing Flow (gpm)	Pipe Dia (in)	Velocity (ft/sec)	Pipe Static Pressure (psi)	Pipe Sizing Pressure 1.5x Static (psi)	Pipe Pressure Class	Pipe Length (ft)	Turnouts Diameter (in)
SB11.7	0	1832.5	**545**		9.59	**8.50**	**3815**	**9.12 cfs**							
0.80	1268	1831.6	51		0.90	0.80	357	**4095**	18.5	4.89	0	1	DR 41 - 100 psi		6
1.00	2911	1790.0	82		1.44	1.28	574	3738	18.5	4.46	18	28	DR 41 - 100 psi		6
1.40	4200	1771.0	91		1.60	1.42	637	3164	18.5	3.78	27	40	DR 41 - 100 psi	4200	8
1.48	4300	1771.0	107		1.88	1.67	749	2527	14.52	4.90	27	40	DR 41 - 100 psi		8
1.70	6193	1751.5	214	continues in open ditch	3.77	3.34	1498	1778	14.52	3.45	35	53	DR 41 - 100 psi		10
	6193	1751.5	40	Extra acres for Conservatism				280	14.52	0.54		0	DR 41 - 100 psi	1993	
													Total Pipe:	6193	
														1.17	miles

Turnout Tally (diameter - in. & quantity)									
0.75	**1**	**1.5**	**2**	**3**	**4**	**6**	**8**	**10**	**14**
						2	2	1	

Turnout ID	Cumulative distance from headend (ft)	Elevation (feet)	Acres served per turnout	Delivery Requirement (220 cfs/12,500 acres) (cfs)	Conservatism	Delivery Requirement - Revised for Conservation (cfs)	Delivery Requirement - Revised for Conservation (gpm)	Pipe Sizing Flow (gpm)	Pipe Dia (in)	Velocity (ft/sec)	Pipe Static Pressure (psi)	Pipe Sizing Pressure 1.5x Static (psi)	Pipe Pressure Class	Pipe Length (ft)	Turnouts Diameter (in)
SB14.3	0	2007.0	**530**	**9.33**		**8.27**	**3710**	**11.94 cfs**							
0.30	1670	1980.0	15	0.26		0.23	105	**5361**	24.48	3.65	12	18	DR 41 - 100 psi		3
0.35	2013	1970.0	2	0.04		0.03	14	5256	24.48	3.58	16	24	DR 41 - 100 psi		1
0.40	2364	1965.0	1	0.02		0.02	7	5242	24.48	3.57	18	27	DR 41 - 100 psi		0.75
0.45	2570	1960.0	1	0.02		0.02	7	5235	24.48	3.57	20	31	DR 41 - 100 psi		0.75
0.60	2961	1955.0	6	0.11		0.09	42	5228	24.48	3.56	23	34	DR 41 - 100 psi		1.5
0.70	3523	1945.0	6	0.11		0.09	42	5186	24.48	3.53	27	40	DR 41 - 100 psi	3523	1.5
0.75	3818	1940.0	6	0.11		0.09	42	5144	20.49	5.00	29	44	DR 41 - 100 psi		1.5
0.80	4319	1930.8	55	0.97		0.86	385	5102	20.49	4.96	33	49	DR 41 - 100 psi		6
0.90	4720	1920.0	4	0.07		0.06	28	4717	20.49	4.59	38	56	DR 41 - 100 psi		1.5
1.10	5712	1905.0	14	0.25		0.22	98	4689	20.49	4.56	44	66	DR 41 - 100 psi		3
1.20	6151	1890.0	6	0.11		0.09	42	4591	20.49	4.47	51	76	DR 41 - 100 psi		1.5
1.30	6578	1880.0	6	0.11		0.09	42	4549	20.49	4.43	55	82	DR 41 - 100 psi		1.5
1.40	7145	1874.7	15	0.26		0.23	105	4507	20.49	4.38	57	86	DR 41 - 100 psi		3
1.50	7555	1874.2	70	1.23		1.09	490	4402	20.49	4.28	57	86	DR 41 - 100 psi	4032	6
1.51	7560	1874.0	20	0.35		0.31	140	3912	18.23	4.81	58	86	DR 32.5 - 125 psi		3
1.60	8439	1845.0	1	0.02		0.02	7	3772	18.23	4.64	70	105	DR 32.5 - 125 psi		0.75
1.70	8651	1835.0	2	0.04		0.03	14	3765	18.23	4.63	74	112	DR 32.5 - 125 psi		1
1.80	9201	1830.0	1	0.02		0.02	7	3751	18.23	4.61	77	115	DR 32.5 - 125 psi		0.75
1.90	9744	1820.0	1	0.02		0.02	7	3744	18.23	4.60	81	121	DR 32.5 - 125 psi	2189	0.75
2	10335	1805.0	4	0.07		0.06	28	3737	17.85	4.79	87	131	DR 25 - 165 psi		1.5
2.10	10610	1800.0	2	0.04		0.03	14	3709	17.85	4.75	90	134	DR 25 - 165 psi		1
2.18	10836	1795.0	3	0.05		0.05	21	3695	17.85	4.74	92	138	DR 25 - 165 psi		1.5
2.19	10838	1794.0	47	0.83		0.73	329	3674	17.85	4.71	92	138	DR 25 - 165 psi		6
2.25	11627	1785.0	7	0.12		0.11	49	3345	17.85	4.29	96	144	DR 25 - 165 psi		2
2.30	12108	1775.0	4	0.07		0.06	28	3296	17.85	4.23	100	151	DR 25 - 165 psi		1.5
2.36	12292	1770.0	34	0.60		0.53	238	3268	17.85	4.19	103	154	DR 25 - 165 psi	2548	4
2.50	12992	1762.0	10	0.18	1.00	0.16	70	3030	15.92	4.88	106	159	DR 25 - 165 psi		6
2.56	13333	1756.0	50	0.88	1.25	0.78	350	2581	15.92	4.16	109	163	DR 25 - 165 psi	1041	6
3.00	14705	1722.0	62	1.09	1.50	0.97	434	2020	13.75	4.36	123	185	DR 21 - 200 psi	1372	8
3.30	16495	1688.0	75	1.32	3.00	1.17	525	1346	11.65	4.05	138	207	DR 18 - 235 psi	1790	10
From KRD								0					16495	Total Pipe	
													3.1	Miles	

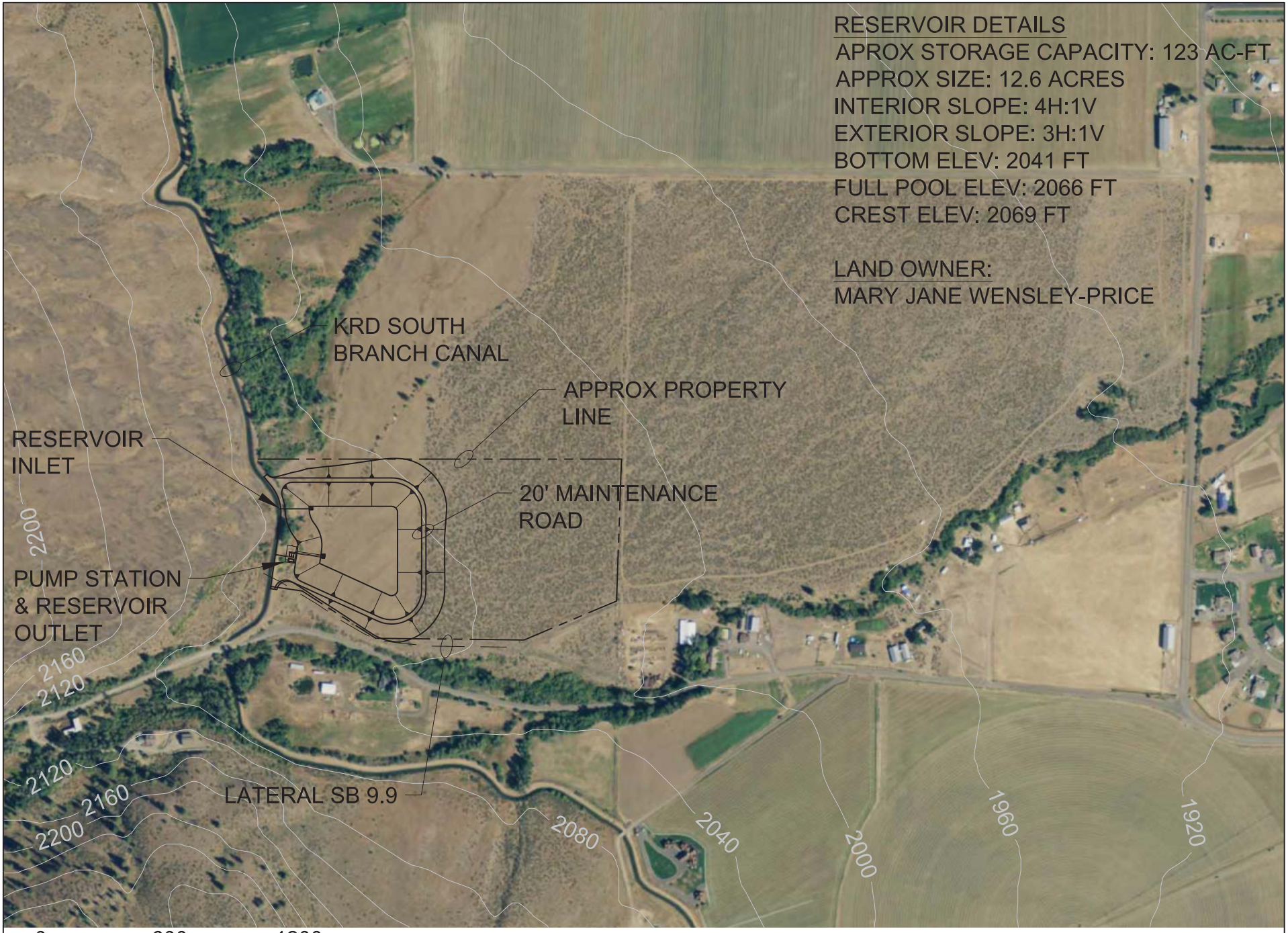
Turnout Tally (diameter - in. & quantity)								
0.75	**1**	**1.5**	**2**	**3**	**4**	**6**	**8**	**10**
5	3	9	1	4	1	5	1	1

Turnout ID	Cumulative distance from headend (ft)	Elevation (feet)	Acres served per turnout		Delivery Requirement (220 cfs/12,500 acres) (cfs)	Conservatism	Delivery Requirement - Revised for Conservation (cfs)	Delivery Requirement - Revised for Conservation (gpm)	Pipe Sizing Flow (gpm)	Pipe Dia (in)	Velocity (ft/sec)	Pipe Static Pressure (psi)	Pipe Sizing Pressure 1.5x Static (psi)	Pipe Pressure Class	Pipe Length (ft)		Turnouts Diameter (in)
SB extension	0	2008.0	**1081**	start at gagestation SB14.4	**19.03**		**16.86**	**7567**	**26.24**	**cfs**							
14.45	1134	2006.7	28		0.49		0.44	196	**11778**	30.35	5.22	1	1	DR 41 - 100 psi			4
14.50	2469	2004.7	5		0.09		0.08	35	11582	30.35	5.14	1	2	DR 41 - 100 psi			1.5
14.80	3010	2003.6	7		0.12		0.11	49	11547	30.35	5.12	2	3	DR 41 - 100 psi			2
14.85	3734	1985.0	41		0.72		0.64	287	11498	30.35	5.10	10	15	DR 41 - 100 psi			6
14.90	4200	1984.0	9		0.16		0.14	63	11211	30.35	4.97	10	16	DR 41 - 100 psi			2
15.00	4770	1960.5	12		0.21		0.19	84	11148	30.35	4.94	21	31	DR 41 - 100 psi			3
15.30	5087	1960.0	12		0.21		0.19	84	11064	30.35	4.91	21	31	DR 41 - 100 psi			3
15.40	5789	1959.5	12		0.21		0.19	84	10980	30.35	4.87	21	31	DR 41 - 100 psi			3
15.60	6864	1959.0	13		0.23		0.20	91	10896	30.35	4.83	21	32	DR 41 - 100 psi			3
15.80	7849	1949.0	27		0.48		0.42	189	10805	30.35	4.79	26	38	DR 41 - 100 psi			4
15.90	8255	1945.0	9		0.16		0.14	63	10616	30.35	4.71	27	41	DR 41 - 100 psi			2
15.91	8453	1930.0	35		0.62		0.55	245	10553	30.35	4.68	34	51	DR 41 - 100 psi			4
16.25	10058	1910.0	7		0.12		0.11	49	10308	30.35	4.57	42	64	DR 41 - 100 psi			2
16.45	11165	1860.6	8		0.14		0.12	56	10259	30.35	4.55	64	96	DR 41 - 100 psi			2
16.46	11256	1860.0	47		0.83		0.73	329	10203	30.35	4.52	64	96	DR 41 - 100 psi			6
16.70	12380	1859.9	500	Skyhook pipeline	8.80	16	7.80	3500	9874	30.35	4.38	64	96	DR 41 - 100 psi			24
16.71	12390	1859.9	309		5.44	6	4.82	2163	2693	30.35	1.19	64	96	DR 41 - 100 psi	12390		12
From KRD									0						12390	Total Pipe	
															2.3	Miles	

Turnout Tally (diameter - in. & quantity)								
0.75	**1**	**1.5**	**2**	**3**	**4**	**6**	**12**	**24**
		1	5	4	3	2	1	1

Appendix C
North and South Branch Reregulation Reservoirs Conceptual Layout


KRD NORTH
BRANCH CANAL
RESERVOIR
INLET
20' MAINTENANCE
ROAD
STEVENS RD
DRAINAGE SWALE
PUMP STATION &
RESERVOIR OUTLET
RESERVOIR DETAILS
APROX STORAGE CAPACITY: 287 AC-FT
APPROX SIZE: 19.9 ACRES
INTERIOR SLOPE: 4H:1V
EXTERIOR SLOPE: 3H:1V
BOTTOM ELEV: 2028 FT
FULL POOL ELEV: 2052 FT
CREST ELEV: 2055 FT
LANDOWNER:
CLERF FAMILY, LLC
2160
2160
2140
2120
2100
2080
2060
2040
2020
2000
0
800
1600
N
Scale in Feet
475645
NORTH BRANCH
REREGULATON RESERVOIR
CH2MHILL



SOUTH BRANCH
REREGULATION RESERVOIR

CH2MHILL

Appendix D
Projects Cost Estimates

KITTITAS RECLAMATION DISTRICT				
LATERAL NB 4.1				
PROPOSED UPGRADES COST ESTIMATE				
ITEM DESCRIPTION	ITEM QUANTITY	UNIT	UNIT COST	COST
Headgate Structure - Concrete	1	EA	$15,000	$15,000
Inlet Gate - Manual	1	EA	$6,000	$6,000
Screen Structure - Concrete	1	EA	$10,000	$10,000
Lateral Inlet Screen - Motorized Brush, 1/8" Mesh	2	EA	$4,500	$9,000
Lateral Flowmeter	1	EA	$10,000	$10,000
Electrical	1	EA	$20,000	$20,000
20" PVC C905, 100 psi	21416	LF	$113	$2,420,008
14" PVC C905, 100 psi	8281	LF	$78	$645,918
12" PVC C900, 100 psi	3531	LF	$69	$243,639
Turnout Assembly - 0.75 inch	1	EA	$600	$600
Turnout Assembly - 3 inch	2	EA	$3,000	$6,000
Turnout Assembly - 6 inch	3	EA	$5,000	$15,000
Turnout Assembly - 8 inch	1	EA	$5,600	$5,600
Turnout Assembly - 12 inch	1	EA	$8,000	$8,000
Combination Air Valve Assembly	13	EA	$8,000	$104,000
Drain Assembly	1	EA	$6,000	$6,000
Fencing	1	EA	$5,000	$5,000
Demolition	1	EA	$49,842	$49,842
Subtotal				$3,579,607
Overhead & Profit			15%	$536,941
Contingency			15%	$617,482
Bonds/Insurance			2%	$166,273
Mobilization			2%	$166,273
Total Estimated Construction Cost				$5,066,576
WA state sales tax			8.0%	$405,326
Design Engineering			9%	$455,992
Services During Construction Engineering			6%	$303,995
Surveying				$25,000
Archaelogical / Cultural Survey				$15,000
Legal				$5,000
Total Estimated Project Cost				$6,276,888

KITTITAS RECLAMATION DISTRICT				
LATERAL NB 5.8				
PROPOSED UPGRADES COST ESTIMATE				
ITEM DESCRIPTION	ITEM QUANTITY	UNIT	UNIT COST	COST
Headgate Structure - Concrete	1	EA	$15,000	$15,000
Inlet Gate - Manual	1	EA	$6,000	$6,000
Screen Structure - Concrete	1	EA	$10,000	$10,000
Lateral Inlet Screen - Motorized Brush, 1/8" Mesh	1	EA	$4,500	$4,500
Lateral Flowmeter	1	EA	$10,000	$10,000
Electrical	1	EA	$20,000	$20,000
14" PVC C905, 100 psi	1770	LF	$78	$138,060
10" PVC C900, 100 psi	3087	LF	$62	$191,394
Turnout Assembly - 4 inch	2	EA	$3,600	$7,200
Turnout Assembly - 6 inch	4	EA	$5,000	$20,000
Turnout Assembly - 8 inch	1	EA	$5,600	$5,600
Combination Air Valve Assembly	2	EA	$8,000	$16,000
Drain Assembly	1	EA	$6,000	$6,000
Fencing	1	EA	$5,000	$5,000
Demolition	1	EA	$7,286	$7,286
Subtotal				$462,040
Overhead & Profit			15%	$69,306
Contingency			15%	$79,702
Bonds/Insurance			2%	$21,462
Mobilization			2%	$21,462
Total Estimated Construction Cost				$653,971
WA state sales tax			8.0%	$52,318
Design Engineering			9%	$58,857
Services During Construction Engineering			6%	$39,238
Surveying				$25,000
Archaelogical / Cultural Survey				$15,000
Legal				$5,000
Total Estimated Project Cost				$849,384

KITTITAS RECLAMATION DISTRICT				
LATERAL NB 6.4				
PROPOSED UPGRADES COST ESTIMATE				
ITEM DESCRIPTION	ITEM QUANTITY	UNIT	UNIT COST	COST
Headgate Structure - Concrete	1	EA	$15,000	$15,000
Inlet Gate - Manual	1	EA	$6,000	$6,000
Screen Structure - Concrete	1	EA	$10,000	$10,000
Lateral Inlet Screen - Motorized Brush, 1/8" Mesh	2	EA	$4,500	$9,000
Lateral Flowmeter	1	EA	$10,000	$10,000
Electrical	1	EA	$20,000	$20,000
20" PVC C905, 100 psi	1077	LF	$113	$121,701
14" PVC C905, 100 psi	5814	LF	$78	$453,492
Turnout Assembly - 3 inch	3	EA	$3,000	$9,000
Turnout Assembly - 4 inch	1	EA	$3,600	$3,600
Turnout Assembly - 6 inch	3	EA	$5,000	$15,000
Turnout Assembly - 12 inch	1	EA	$8,000	$8,000
Combination Air Valve Assembly	3	EA	$8,000	$24,000
Drain Assembly	1	EA	$6,000	$6,000
Fencing	1	EA	$5,000	$5,000
Demolition	1	EA	$10,337	$10,337
Subtotal				$726,130
Overhead & Profit			15%	$108,919
Contingency			15%	$125,257
Bonds/Insurance			2%	$33,729
Mobilization			2%	$33,729
Total Estimated Construction Cost				$1,027,764
WA state sales tax			8.0%	$82,221
Design Engineering			9%	$92,499
Services During Construction Engineering			6%	$61,666
Surveying				$25,000
Archaelogical / Cultural Survey				$15,000
Legal				$5,000
Total Estimated Project Cost				$1,309,149

KITTITAS RECLAMATION DISTRICT				
LATERAL NB 7.7				
PROPOSED UPGRADES COST ESTIMATE				
ITEM DESCRIPTION	ITEM QUANTITY	UNIT	UNIT COST	COST
Headgate Structure - Concrete	1	EA	$15,000	$15,000
Inlet Gate - Manual	1	EA	$6,000	$6,000
Screen Structure - Concrete	1	EA	$10,000	$10,000
Lateral Inlet Screen - Motorized Brush, 1/8" Mesh	2	EA	$4,500	$9,000
Lateral Flowmeter	1	EA	$10,000	$10,000
Electrical	1	EA	$20,000	$20,000
24" PVC C905, 100 psi	5491	LF	$135	$741,285
24" PVC C905, 125 psi	4797	LF	$135	$647,595
20" PVC C905, 165 psi	4570	LF	$113	$516,410
14" PVC C905, 200 psi	3233	LF	$78	$252,174
10" PVC C900, 235 psi	4995	LF	$62	$309,690
8" PVC C900, 235 psi	3553	LF	$55	$195,415
Pressure Reducing Station	1	EA	$25,000	$25,000
Turnout Assembly - 2 inch	1	EA	$2,400	$2,400
Turnout Assembly - 3 inch	5	EA	$3,000	$15,000
Turnout Assembly - 6 inch	6	EA	$5,000	$30,000
Turnout Assembly - 8 inch	3	EA	$5,600	$16,800
Turnout Assembly - 10 inch	1	EA	$6,900	$6,900
Combination Air Valve Assembly	7	EA	$8,000	$56,000
Drain Assembly	1	EA	$6,000	$6,000
Fencing	1	EA	$5,000	$5,000
Demolition	1	EA	$27,137	$27,137
Subtotal				$2,922,806
Overhead & Profit			15%	$438,421
Contingency			15%	$504,184
Bonds/Insurance			2%	$135,764
Mobilization			2%	$135,764
Total Estimated Construction Cost				$4,136,939
WA state sales tax			8.0%	$330,955
Design Engineering			9%	$372,325
Services During Construction Engineering			6%	$248,216
Surveying				$25,000
Archaelogical / Cultural Survey				$15,000
Legal				$5,000
Total Estimated Project Cost				$5,133,435

KITTITAS RECLAMATION DISTRICT				
LATERAL NB 8.3				
PROPOSED UPGRADES COST ESTIMATE				
ITEM DESCRIPTION	ITEM QUANTITY	UNIT	UNIT COST	COST
Headgate Structure - Concrete	1	EA	$15,000	$15,000
Inlet Gate - Manual	1	EA	$6,000	$6,000
Screen Structure - Concrete	1	EA	$10,000	$10,000
Lateral Inlet Screen - Motorized Brush, 1/8" Mesh	3	EA	$4,500	$13,500
Lateral Flowmeter	1	EA	$10,000	$10,000
Electrical	1	EA	$20,000	$20,000
30" PVC C905, 100 psi	6389	LF	$156	$996,684
24" PVC C905, 100 psi	2653	LF	$135	$358,155
20" PVC C905, 165 psi	9143	LF	$113	$1,033,159
14" PVC C905, 165 psi	3925	LF	$78	$306,150
Pressure Reducing Station	1	EA	$25,000	$25,000
Turnout Assembly - 4 inch	2	EA	$3,600	$7,200
Turnout Assembly - 6 inch	10	EA	$5,000	$50,000
Turnout Assembly - 8 inch	5	EA	$5,600	$28,000
Turnout Assembly - 10 inch	1	EA	$6,900	$6,900
Combination Air Valve Assembly	9	EA	$8,000	$72,000
Drain Assembly	1	EA	$6,000	$6,000
Fencing	1	EA	$5,000	$5,000
Demolition	1	EA	$33,165	$33,165
Subtotal				$3,001,913
Overhead & Profit			15%	$450,287
Contingency			15%	$517,830
Bonds/Insurance			2%	$139,439
Mobilization			2%	$139,439
Total Estimated Construction Cost				$4,248,908
WA state sales tax			8.0%	$339,913
Design Engineering			9%	$382,402
Services During Construction Engineering			6%	$254,934
Surveying				$25,000
Archaelogical / Cultural Survey				$15,000
Legal				$5,000
Total Estimated Project Cost				$5,271,156

KITTITAS RECLAMATION DISTRICT				
LATERAL NB 20.2				
PROPOSED UPGRADES COST ESTIMATE				
ITEM DESCRIPTION	ITEM QUANTITY	UNIT	UNIT COST	COST
Headgate Structure - Concrete	1	EA	$15,000	$15,000
Inlet Gate - Manual	1	EA	$6,000	$6,000
Screen Structure - Concrete	1	EA	$10,000	$10,000
Lateral Inlet Screen - Motorized Brush, 1/8" Mesh	2	EA	$4,500	$9,000
Lateral Flowmeter	1	EA	$10,000	$10,000
Electrical	1	EA	$20,000	$20,000
24" PVC C905, 100 psi	5442	LF	$135	$734,670
20" PVC C905, 100 psi	3148	LF	$113	$355,724
Turnout Assembly - 6 inch	5	EA	$5,000	$25,000
Turnout Assembly - 8 inch	1	EA	$5,600	$5,600
Turnout Assembly - 14 inch	1	EA	$10,000	$10,000
Combination Air Valve Assembly	3	EA	$8,000	$24,000
Drain Assembly	1	EA	$6,000	$6,000
Fencing	1	EA	$5,000	$5,000
Demolition	1	EA	$12,885	$12,885
Subtotal				$1,248,879
Overhead & Profit			15%	$187,332
Contingency			15%	$215,432
Bonds/Insurance			2%	$58,010
Mobilization			2%	$58,010
Total Estimated Construction Cost				$1,767,663
WA state sales tax			8.0%	$141,413
Design Engineering			9%	$159,090
Services During Construction Engineering			6%	$106,060
Surveying				$25,000
Archaelogical / Cultural Survey				$15,000
Legal				$5,000
Total Estimated Project Cost				$2,219,226

KITTITAS RECLAMATION DISTRICT				
LATERAL NB 20.8-0.8				
PROPOSED UPGRADES COST ESTIMATE				
ITEM DESCRIPTION	ITEM QUANTITY	UNIT	UNIT COST	COST
Headgate Structure - Concrete	1	EA	$15,000	$15,000
Inlet Gate - Manual	1	EA	$6,000	$6,000
Screen Structure - Concrete	1	EA	$10,000	$10,000
Lateral Inlet Screen - Motorized Brush, 1/8" Mesh	2	EA	$4,500	$9,000
Lateral Flowmeter	1	EA	$10,000	$10,000
Electrical	1	EA	$20,000	$20,000
24" PVC C905, 100 psi	8063	LF	$135	$1,088,505
Turnout Assembly - 3 inch	4	EA	$3,000	$12,000
Turnout Assembly - 6 inch	5	EA	$5,000	$25,000
Turnout Assembly - 8 inch	1	EA	$5,600	$5,600
Turnout Assembly - 14 inch	1	EA	$10,000	$10,000
Combination Air Valve Assembly	3	EA	$8,000	$24,000
Drain Assembly	1	EA	$6,000	$6,000
Fencing	1	EA	$5,000	$5,000
Demolition	1	EA	$12,095	$12,095
Subtotal				$1,258,200
Overhead & Profit			15%	$188,730
Contingency			15%	$217,039
Bonds/Insurance			2%	$58,443
Mobilization			2%	$58,443
Total Estimated Construction Cost				$1,780,856
WA state sales tax			8.0%	$142,468
Design Engineering			9%	$160,277
Services During Construction Engineering			6%	$106,851
Surveying				$25,000
Archaelogical / Cultural Survey				$15,000
Legal				$5,000
Total Estimated Project Cost				$2,235,452

KITTITAS RECLAMATION DISTRICT				
LATERAL NB 22.0				
PROPOSED UPGRADES COST ESTIMATE				
ITEM DESCRIPTION	ITEM QUANTITY	UNIT	UNIT COST	COST
Headgate Structure - Concrete	1	EA	$15,000	$15,000
Inlet Gate - Manual	1	EA	$6,000	$6,000
Screen Structure - Concrete	1	EA	$10,000	$10,000
Lateral Inlet Screen - Motorized Brush, 1/8" Mesh	5	EA	$4,500	$22,500
Lateral Flowmeter	1	EA	$10,000	$10,000
Electrical	1	EA	$20,000	$20,000
42" PVC C905, 100 psi	5280	LF	$260	$1,372,800
36" PVC C905, 100 psi	1215	LF	$203	$246,645
36" PVC C905, 125 psi	2736	LF	$203	$555,408
Pressure Reducing Station	1	EA	$25,000	$25,000
Turnout Assembly - 1.0 inch	1	EA	$1,000	$1,000
Turnout Assembly - 3 inch	2	EA	$3,000	$6,000
Turnout Assembly - 4 inch	1	EA	$3,600	$3,600
Turnout Assembly - 6 inch	4	EA	$5,000	$20,000
Turnout Assembly - 8 inch	5	EA	$5,600	$28,000
Turnout Assembly - 10 inch	2	EA	$6,900	$13,800
Turnout Assembly - 24 inch	1	EA	$22,000	$22,000
Combination Air Valve Assembly	4	EA	$8,000	$32,000
Drain Assembly	1	EA	$6,000	$6,000
Fencing	1	EA	$5,000	$5,000
Demolition	1	EA	$13,847	$13,847
Subtotal				$2,434,600
Overhead & Profit			15%	$365,190
Contingency			15%	$419,968
Bonds/Insurance			2%	$113,087
Mobilization			2%	$113,087
Total Estimated Construction Cost				$3,445,932
WA state sales tax			8.0%	$275,675
Design Engineering			9%	$310,134
Services During Construction Engineering			6%	$206,756
Surveying				$25,000
Archaelogical / Cultural Survey				$15,000
Legal				$5,000
Total Estimated Project Cost				$4,283,497

KITTITAS RECLAMATION DISTRICT				
LATERAL NB 22.8				
PROPOSED UPGRADES COST ESTIMATE				
ITEM DESCRIPTION	ITEM QUANTITY	UNIT	UNIT COST	COST
Headgate Structure - Concrete	1	EA	$15,000	$15,000
Inlet Gate - Manual	1	EA	$6,000	$6,000
Screen Structure - Concrete	1	EA	$10,000	$10,000
Lateral Inlet Screen - Motorized Brush, 1/8" Mesh	1	EA	$4,500	$4,500
Lateral Flowmeter	1	EA	$10,000	$10,000
Electrical	1	EA	$20,000	$20,000
12" PVC C900, 100 psi	652	LF	$69	$44,988
Turnout Assembly - 3 inch	2	EA	$3,000	$6,000
Turnout Assembly - 6 inch	1	EA	$5,000	$5,000
Turnout Assembly - 8 inch	1	EA	$5,600	$5,600
Drain Assembly	1	EA	$6,000	$6,000
Fencing	1	EA	$5,000	$5,000
Demolition	1	EA	$978	$978
Subtotal				$139,066
Overhead & Profit			15%	$20,860
Contingency			15%	$23,989
Bonds/Insurance			2%	$6,460
Mobilization			2%	$6,460
Total Estimated Construction Cost				$196,834
WA state sales tax			8.0%	$15,747
Design Engineering			9%	$17,715
Services During Construction Engineering			6%	$11,810
Surveying				$25,000
Archaelogical / Cultural Survey				$15,000
Legal				$5,000
Total Estimated Project Cost				$287,106

KITTITAS RECLAMATION DISTRICT

LATERAL NB 26.7

PROPOSED UPGRADES COST ESTIMATE

ITEM DESCRIPTION	ITEM QUANTITY	UNIT	UNIT COST	COST
Headgate Structure - Concrete	1	EA	$15,000	$15,000
Inlet Gate - Manual	1	EA	$6,000	$6,000
Screen Structure - Concrete	1	EA	$10,000	$10,000
Lateral Inlet Screen - Motorized Brush, 1/8" Mesh	4	EA	$4,500	$18,000
Lateral Flowmeter	1	EA	$10,000	$10,000
Electrical	1	EA	$20,000	$20,000
36" PVC C905, 100 psi	16253	LF	$203	$3,299,359
24" PVC C905, 100 psi	6822	LF	$135	$920,970
16" PVC C905, 100 psi	3180	LF	$88	$279,840
14" PVC C905, 125 psi	1307	LF	$78	$101,946
12" PVC C900, 100 psi	1510	LF	$69	$104,190
12" PVC C900, 125 psi	375	LF	$69	$25,875
12" PVC C900, 160 psi	2587	LF	$69	$178,503
10" PVC C900, 125 psi	1854	LF	$62	$114,948
10" PVC C900, 200 psi	792	LF	$62	$49,104
8" PVC C900, 100 psi	4050	LF	$55	$222,750
8" PVC C900, 250 psi	1584	LF	$55	$87,120
4" PVC C900, 100 psi	475	LF	$46	$21,850
Pressure Reducing Station	1	EA	$25,000	$25,000
Turnout Assembly - 1.5 inch	4	EA	$1,500	$6,000
Turnout Assembly - 2 inch	4	EA	$2,400	$9,600
Turnout Assembly - 3 inch	7	EA	$3,000	$21,000
Turnout Assembly - 4 inch	8	EA	$3,600	$28,800
Turnout Assembly - 6 inch	11	EA	$5,000	$55,000
Turnout Assembly - 8 inch	3	EA	$5,600	$16,800
Turnout Assembly - 10 inch	4	EA	$6,900	$27,600
Turnout Assembly - 12 inch	2	EA	$8,000	$16,000
Combination Air Valve Assembly	16	EA	$8,000	$128,000
Drain Assembly	1	EA	$6,000	$6,000
Fencing	1	EA	$5,000	$5,000
Demolition	1	EA	$61,184	$61,184
Subtotal				$5,891,439
Overhead & Profit			15%	$883,716
Contingency			15%	$1,016,273
Bonds/Insurance			2%	$273,657
Mobilization			2%	$273,657
Total Estimated Construction Cost				$8,338,742
WA state sales tax			8.0%	$667,099
Design Engineering			9%	$750,487
Services During Construction Engineering			6%	$500,325
Surveying				$25,000
Archaelogical / Cultural Survey				$15,000
Legal				$5,000
Total Estimated Project Cost				$10,301,653

KITTITAS RECLAMATION DISTRICT				
LATERAL NB 27.5				
PROPOSED UPGRADES COST ESTIMATE				
ITEM DESCRIPTION	ITEM QUANTITY	UNIT	UNIT COST	COST
Headgate Structure - Concrete	1	EA	$15,000	$15,000
Inlet Gate - Manual	1	EA	$6,000	$6,000
Screen Structure - Concrete	1	EA	$10,000	$10,000
Lateral Inlet Screen - Motorized Brush, 1/8" Mesh	1	EA	$4,500	$4,500
Lateral Flowmeter	1	EA	$10,000	$10,000
Electrical	1	EA	$20,000	$20,000
18" PVC C905, 100 psi	1056	LF	$100	$105,600
12" PVC C900, 100 psi	4275	LF	$69	$294,975
Turnout Assembly - 1.5 inch	1	EA	$1,500	$1,500
Turnout Assembly - 6 inch	4	EA	$5,000	$20,000
Turnout Assembly - 8 inch	2	EA	$5,600	$11,200
Combination Air Valve Assembly	2	EA	$8,000	$16,000
Drain Assembly	1	EA	$6,000	$6,000
Fencing	1	EA	$5,000	$5,000
Demolition	1	EA	$7,997	$7,997
Subtotal				$533,772
Overhead & Profit			15%	$80,066
Contingency			15%	$92,076
Bonds/Insurance			2%	$24,794
Mobilization			2%	$24,794
Total Estimated Construction Cost				$755,500
WA state sales tax			8.0%	$60,440
Design Engineering			9%	$67,995
Services During Construction Engineering			6%	$45,330
Surveying				$25,000
Archaelogical / Cultural Survey				$15,000
Legal				$5,000
Total Estimated Project Cost				$974,265

KITTITAS RECLAMATION DISTRICT				
LATERAL NB 28.6				
PROPOSED UPGRADES COST ESTIMATE				
ITEM DESCRIPTION	ITEM QUANTITY	UNIT	UNIT COST	COST
Headgate Structure - Concrete	1	EA	$15,000	$15,000
Inlet Gate - Manual	1	EA	$6,000	$6,000
Screen Structure - Concrete	1	EA	$10,000	$10,000
Lateral Inlet Screen - Motorized Brush, 1/8" Mesh	1	EA	$4,500	$4,500
Lateral Flowmeter	1	EA	$10,000	$10,000
Electrical	1	EA	$20,000	$20,000
12" PVC C900, 100 psi	2100	LF	$69	$144,900
Turnout Assembly - 6 inch	1	EA	$5,000	$5,000
Turnout Assembly - 8 inch	1	EA	$5,600	$5,600
Combination Air Valve Assembly	1	EA	$8,000	$8,000
Drain Assembly	1	EA	$6,000	$6,000
Fencing	1	EA	$5,000	$5,000
Demolition	1	EA	$3,150	$3,150
Subtotal				$243,150
Overhead & Profit			15%	$36,473
Contingency			15%	$41,943
Bonds/Insurance			2%	$11,294
Mobilization			2%	$11,294
Total Estimated Construction Cost				$344,155
WA state sales tax			8.0%	$27,532
Design Engineering			9%	$30,974
Services During Construction Engineering			6%	$20,649
Surveying				$25,000
Archaelogical / Cultural Survey				$15,000
Legal				$5,000
Total Estimated Project Cost				$468,310

KITTITAS RECLAMATION DISTRICT

LATERAL NB 33.5

PROPOSED UPGRADES COST ESTIMATE

ITEM DESCRIPTION	ITEM QUANTITY	UNIT	UNIT COST	COST
Headgate Structure - Concrete	1	EA	$15,000	$15,000
Inlet Gate - Manual	1	EA	$6,000	$6,000
Screen Structure - Concrete	1	EA	$10,000	$10,000
Lateral Inlet Screen - Motorized Brush, 1/8" Mesh	3	EA	$4,500	$13,500
Lateral Flowmeter	1	EA	$10,000	$10,000
Electrical	1	EA	$20,000	$20,000
30" PVC C905, 100 psi	10560	LF	$156	$1,647,360
24" PVC C905, 100 psi	1168	LF	$135	$157,680
24" PVC C905, 125 psi	4165	LF	$135	$562,275
20" PVC C905, 165 psi	1352	LF	$113	$152,776
18" PVC C905, 100 psi	3810	LF	$100	$381,000
16" PVC C905, 200 psi	3005	LF	$88	$264,440
14" PVC C905, 165 psi	1736	LF	$78	$135,408
10" PVC C900, 200 psi	3863	LF	$62	$239,506
10" PVC C900, 250 psi	2695	LF	$62	$167,090
6" PVC C900, 200 psi	1475	LF	$50	$73,750
6" PVC C900, 250 psi	1216	LF	$50	$60,800
Pressure Reducing Station	1	EA	$25,000	$25,000
Turnout Assembly - 1.5 inch	3	EA	$1,500	$4,500
Turnout Assembly - 2 inch	1	EA	$2,400	$2,400
Turnout Assembly - 3 inch	4	EA	$3,000	$12,000
Turnout Assembly - 4 inch	6	EA	$3,600	$21,600
Turnout Assembly - 6 inch	7	EA	$5,000	$35,000
Turnout Assembly - 8 inch	6	EA	$5,600	$33,600
Turnout Assembly - 10 inch	1	EA	$6,900	$6,900
Combination Air Valve Assembly	14	EA	$8,000	$112,000
Drain Assembly	1	EA	$6,000	$6,000
Fencing	1	EA	$5,000	$5,000
Demolition	1	EA	$52,568	$52,568
Subtotal				$4,233,153
Overhead & Profit			15%	$634,973
Contingency			15%	$730,219
Bonds/Insurance			2%	$196,630
Mobilization			2%	$196,630
Total Estimated Construction Cost				$5,991,604
WA state sales tax			8.0%	$479,328
Design Engineering			9%	$539,244
Services During Construction Engineering			6%	$359,496
Surveying				$25,000
Archaelogical / Cultural Survey				$15,000
Legal				$5,000
Total Estimated Project Cost				$7,414,673

KITTITAS RECLAMATION DISTRICT				
LATERAL NB 35.1				
PROPOSED UPGRADES COST ESTIMATE				
ITEM DESCRIPTION	ITEM QUANTITY	UNIT	UNIT COST	COST
Headgate Structure - Concrete	1	EA	$15,000	$15,000
Inlet Gate - Manual	1	EA	$6,000	$6,000
Screen Structure - Concrete	1	EA	$10,000	$10,000
Lateral Inlet Screen - Motorized Brush, 1/8" Mesh	1	EA	$4,500	$4,500
Lateral Flowmeter	1	EA	$10,000	$10,000
Electrical	1	EA	$20,000	$20,000
16" PVC C905, 100 psi	1840	LF	$88	$161,920
14" PVC C905, 200 psi	2576	LF	$78	$200,928
Pressure Reducing Station	1	EA	$25,000	$25,000
Turnout Assembly - 6 inch	2	EA	$5,000	$10,000
Turnout Assembly - 12 inch	1	EA	$8,000	$8,000
Combination Air Valve Assembly	2	EA	$8,000	$16,000
Drain Assembly	1	EA	$6,000	$6,000
Fencing	1	EA	$5,000	$5,000
Demolition	1	EA	$6,624	$6,624
Subtotal				$504,972
Overhead & Profit			15%	$75,746
Contingency			15%	$87,108
Bonds/Insurance			2%	$23,456
Mobilization			2%	$23,456
Total Estimated Construction Cost				$714,737
WA state sales tax			8.0%	$57,179
Design Engineering			9%	$64,326
Services During Construction Engineering			6%	$42,884
Surveying				$25,000
Archaelogical / Cultural Survey				$15,000
Legal				$5,000
Total Estimated Project Cost				$924,127

KITTITAS RECLAMATION DISTRICT				
LATERAL Pump Ditch				
PROPOSED UPGRADES COST ESTIMATE				
ITEM DESCRIPTION	ITEM QUANTITY	UNIT	UNIT COST	COST
Headgate Structure - Concrete	1	EA	$15,000	$15,000
Inlet Gate - Manual	1	EA	$6,000	$6,000
Screen Structure - Concrete	1	EA	$10,000	$10,000
Lateral Inlet Screen - Motorized Brush, 1/8" Mesh	6	EA	$4,500	$27,000
Lateral Flowmeter	1	EA	$10,000	$10,000
Electrical	1	EA	$100,000	$100,000
42" PVC C905, 100 psi	30933	LF	$260	$8,042,580
30" PVC C905, 100 psi	20504	LF	$156	$3,198,624
24" PVC C905, 100 psi	24763	LF	$135	$3,343,005
Turnout Assembly - 2 inch	1	EA	$2,400	$2,400
Turnout Assembly - 3 inch	18	EA	$3,000	$54,000
Turnout Assembly - 4 inch	17	EA	$3,600	$61,200
Turnout Assembly - 6 inch	20	EA	$5,000	$100,000
Turnout Assembly - 8 inch	5	EA	$5,600	$28,000
Turnout Assembly - 10 inch	1	EA	$6,900	$6,900
Turnout Assembly - 14 inch	1	EA	$10,000	$10,000
Combination Air Valve Assembly	30	EA	$8,000	$240,000
Drain Assembly	1	EA	$6,000	$6,000
Fencing	1	EA	$5,000	$5,000
Demolition	1	EA	$114,300	$114,300
Subtotal				$15,380,009
Overhead & Profit			15%	$2,307,001
Contingency			15%	$2,653,052
Bonds/Insurance			2%	$714,401
Mobilization			2%	$714,401
Total Estimated Construction Cost				$21,768,865
WA state sales tax			8.0%	$1,741,509
Design Engineering			9%	$1,959,198
Services During Construction Engineering			6%	$1,306,132
Surveying				$25,000
Archaelogical / Cultural Survey				$15,000
Legal				$5,000
Total Estimated Project Cost				$26,820,704

KITTITAS RECLAMATION DISTRICT				
LATERAL Turbine Ditch				
PROPOSED UPGRADES COST ESTIMATE				
ITEM DESCRIPTION	ITEM QUANTITY	UNIT	UNIT COST	COST
Headgate Structure - Concrete	1	EA	$15,000	$15,000
Inlet Gate - Manual	1	EA	$6,000	$6,000
Screen Structure - Concrete	1	EA	$10,000	$10,000
Lateral Inlet Screen - Motorized Brush, 1/8" Mesh	4	EA	$4,500	$18,000
Lateral Flowmeter	1	EA	$10,000	$10,000
Electrical	1	EA	$20,000	$20,000
30" PVC C905, 100 psi	10032	LF	$156	$1,564,992
24" PVC C905, 100 psi	11616	LF	$135	$1,568,160
Turnout Assembly - 1.5 inch	5	EA	$1,500	$7,500
Turnout Assembly - 2 inch	3	EA	$2,400	$7,200
Turnout Assembly - 3 inch	4	EA	$3,000	$12,000
Turnout Assembly - 4 inch	2	EA	$3,600	$7,200
Turnout Assembly - 6 inch	4	EA	$5,000	$20,000
Turnout Assembly - 8 inch	3	EA	$5,600	$16,800
Turnout Assembly - 10 inch	1	EA	$6,900	$6,900
Turnout Assembly - 12 inch	1	EA	$8,000	$8,000
Turnout Assembly - 14 inch	1	EA	$10,000	$10,000
Combination Air Valve Assembly	9	EA	$8,000	$72,000
Drain Assembly	1	EA	$6,000	$6,000
Fencing	1	EA	$5,000	$5,000
Demolition	1	EA	$32,472	$32,472
Subtotal				$3,423,224
Overhead & Profit			15%	$513,484
Contingency			15%	$590,506
Bonds/Insurance			2%	$159,009
Mobilization			2%	$159,009
Total Estimated Construction Cost				$4,845,231
WA state sales tax			8.0%	$387,618
Design Engineering			9%	$436,071
Services During Construction Engineering			6%	$290,714
Surveying				$25,000
Archaelogical / Cultural Survey				$15,000
Legal				$5,000
Total Estimated Project Cost				$6,004,634

KITTITAS RECLAMATION DISTRICT				
LATERAL SB 1.7				
PROPOSED UPGRADES COST ESTIMATE				
ITEM DESCRIPTION	ITEM QUANTITY	UNIT	UNIT COST	COST
Headgate Structure - Concrete	1	EA	$15,000	$15,000
Inlet Gate - Manual	1	EA	$6,000	$6,000
Screen Structure - Concrete	1	EA	$10,000	$10,000
Lateral Inlet Screen - Motorized Brush, 1/8" Mesh	1	EA	$4,500	$4,500
Lateral Flowmeter	1	EA	$10,000	$10,000
Electrical	1	EA	$20,000	$20,000
16" PVC C905, 100 psi	7210	LF	$88	$634,480
Turnout Assembly - 4 inch	1	EA	$3,600	$3,600
Turnout Assembly - 14 inch	1	EA	$10,000	$10,000
Combination Air Valve Assembly	3	EA	$8,000	$24,000
Drain Assembly	1	EA	$6,000	$6,000
Fencing	1	EA	$5,000	$5,000
Demolition	1	EA	$10,815	$10,815
Subtotal				$759,395
Overhead & Profit			15%	$113,909
Contingency			15%	$130,996
Bonds/Insurance			2%	$35,274
Mobilization			2%	$35,274
Total Estimated Construction Cost				$1,074,848
WA state sales tax			8.0%	$85,988
Design Engineering			9%	$96,736
Services During Construction Engineering			6%	$64,491
Surveying				$25,000
Archaelogical / Cultural Survey				$15,000
Legal				$5,000
Total Estimated Project Cost				$1,367,063

KITTITAS RECLAMATION DISTRICT				
LATERAL SB 4.8				
PROPOSED UPGRADES COST ESTIMATE				
ITEM DESCRIPTION	ITEM QUANTITY	UNIT	UNIT COST	COST
Headgate Structure - Concrete	1	EA	$15,000	$15,000
Inlet Gate - Manual	1	EA	$6,000	$6,000
Screen Structure - Concrete	1	EA	$10,000	$10,000
Lateral Inlet Screen - Motorized Brush, 1/8" Mesh	2	EA	$4,500	$9,000
Lateral Flowmeter	1	EA	$10,000	$10,000
Electrical	1	EA	$20,000	$20,000
20" PVC C905, 100 psi	20	LF	$113	$2,260
16" PVC C905, 100 psi	2517	LF	$88	$221,496
Turnout Assembly - 6 inch	5	EA	$5,000	$25,000
Turnout Assembly - 8 inch	2	EA	$5,600	$11,200
Combination Air Valve Assembly	1	EA	$8,000	$8,000
Drain Assembly	1	EA	$6,000	$6,000
Fencing	1	EA	$5,000	$5,000
Demolition	1	EA	$3,806	$3,806
Subtotal				$352,762
Overhead & Profit			15%	$52,914
Contingency			15%	$60,851
Bonds/Insurance			2%	$16,386
Mobilization			2%	$16,386
Total Estimated Construction Cost				$499,299
WA state sales tax			8.0%	$39,944
Design Engineering			9%	$44,937
Services During Construction Engineering			6%	$29,958
Surveying				$25,000
Archaelogical / Cultural Survey				$15,000
Legal				$5,000
Total Estimated Project Cost				$659,137

KITTITAS RECLAMATION DISTRICT				
LATERAL SB 9.9				
PROPOSED UPGRADES COST ESTIMATE				
ITEM DESCRIPTION	ITEM QUANTITY	UNIT	UNIT COST	COST
Headgate Structure - Concrete	1	EA	$15,000	$15,000
Inlet Gate - Manual	1	EA	$6,000	$6,000
Screen Structure - Concrete	1	EA	$10,000	$10,000
Lateral Inlet Screen - Motorized Brush, 1/8" Mesh	2	EA	$4,500	$9,000
Lateral Flowmeter	1	EA	$10,000	$10,000
Electrical	1	EA	$20,000	$20,000
24" PVC C905, 165 psi	329	LF	$135	$44,415
24" PVC C905, 200 psi	1069	LF	$135	$144,315
14" PVC C905, 200 psi	964	LF	$78	$75,192
Pressure Reducing Station	1	EA	$25,000	$25,000
Turnout Assembly - 4 inch	1	EA	$3,600	$3,600
Turnout Assembly - 6 inch	1	EA	$5,000	$5,000
Turnout Assembly - 10 inch	1	EA	$6,900	$6,900
Turnout Assembly - 14 inch	1	EA	$10,000	$10,000
Combination Air Valve Assembly	1	EA	$8,000	$8,000
Drain Assembly	1	EA	$6,000	$6,000
Fencing	1	EA	$5,000	$5,000
Demolition	1	EA	$3,543	$3,543
Subtotal				$406,965
Overhead & Profit			15%	$61,045
Contingency			15%	$70,201
Bonds/Insurance			2%	$18,904
Mobilization			2%	$18,904
Total Estimated Construction Cost				$576,018
WA state sales tax			8.0%	$46,081
Design Engineering			9%	$51,842
Services During Construction Engineering			6%	$34,561
Surveying				$25,000
Archaelogical / Cultural Survey				$15,000
Legal				$5,000
Total Estimated Project Cost				$753,502

KITTITAS RECLAMATION DISTRICT				
LATERAL SB 11.7				
PROPOSED UPGRADES COST ESTIMATE				
ITEM DESCRIPTION	ITEM QUANTITY	UNIT	UNIT COST	COST
Headgate Structure - Concrete	1	EA	$15,000	$15,000
Inlet Gate - Manual	1	EA	$6,000	$6,000
Screen Structure - Concrete	1	EA	$10,000	$10,000
Lateral Inlet Screen - Motorized Brush, 1/8" Mesh	1	EA	$4,500	$4,500
Lateral Flowmeter	1	EA	$10,000	$10,000
Electrical	1	EA	$20,000	$20,000
18" PVC C905, 100 psi	4200	LF	$100	$420,000
14" PVC C905, 100 psi	1993	LF	$78	$155,454
Turnout Assembly - 6 inch	2	EA	$5,000	$10,000
Turnout Assembly - 8 inch	2	EA	$5,600	$11,200
Turnout Assembly - 10 inch	1	EA	$6,900	$6,900
Combination Air Valve Assembly	2	EA	$8,000	$16,000
Drain Assembly	1	EA	$6,000	$6,000
Fencing	1	EA	$5,000	$5,000
Demolition	1	EA	$9,290	$9,290
Subtotal				$705,344
Overhead & Profit			15%	$105,802
Contingency			15%	$121,672
Bonds/Insurance			2%	$32,763
Mobilization			2%	$32,763
Total Estimated Construction Cost				$998,343
WA state sales tax			8.0%	$79,867
Design Engineering			9%	$89,851
Services During Construction Engineering			6%	$59,901
Surveying				$25,000
Archaelogical / Cultural Survey				$15,000
Legal				$5,000
Total Estimated Project Cost				$1,272,962

KITTITAS RECLAMATION DISTRICT

LATERAL SB 14.3

PROPOSED UPGRADES COST ESTIMATE

ITEM DESCRIPTION	ITEM QUANTITY	UNIT	UNIT COST	COST
Headgate Structure - Concrete	1	EA	$15,000	$15,000
Inlet Gate - Manual	1	EA	$6,000	$6,000
Earthen Settling Basin & Associated Facilities (armor, overflow piping, SB inlet, MC inlet)	1	EA	$100,000	$100,000
Screen Structure - Concrete	1	EA	$10,000	$10,000
Lateral Inlet Screen - Motorized Brush, 1/8" Mesh	1	EA	$4,500	$4,500
Electrical	1	EA	$20,000	$20,000
24" PVC C905, 100 psi	3523	LF	$135	$475,605
20" PVC C905, 100 psi	4032	LF	$113	$455,616
18" PVC C905, 125 psi	2189	LF	$100	$218,900
18" PVC C905, 165 psi	2548	LF	$100	$254,800
16" PVC C905, 165 psi	1041	LF	$88	$91,608
14" PVC C905, 200 psi	1372	LF	$78	$107,016
12" PVC C900, 235 psi	1790	LF	$69	$123,510
Pressure Reducing Station	1	EA	$25,000	$25,000
Turnout Assembly - 0.75 inch	5	EA	$600	$3,000
Turnout Assembly - 1.0 inch	3	EA	$1,000	$3,000
Turnout Assembly - 1.5 inch	9	EA	$1,500	$13,500
Turnout Assembly - 2 inch	1	EA	$2,400	$2,400
Turnout Assembly - 3 inch	4	EA	$3,000	$12,000
Turnout Assembly - 4 inch	1	EA	$3,600	$3,600
Turnout Assembly - 6 inch	5	EA	$5,000	$25,000
Turnout Assembly - 8 inch	1	EA	$5,600	$5,600
Turnout Assembly - 10 inch	1	EA	$6,900	$6,900
Combination Air Valve Assembly	7	EA	$8,000	$56,000
Drain Assembly	1	EA	$6,000	$6,000
Fencing	1	EA	$20,000	$20,000
Demolition	1	EA	$24,743	$24,743
Subtotal				$2,089,298
Overhead & Profit			15%	$313,395
Contingency			15%	$360,404
Bonds/Insurance			2%	$97,048
Mobilization			2%	$97,048
Total Estimated Construction Cost				$2,957,192
WA state sales tax			8.0%	$236,575
Design Engineering			9%	$266,147
Services During Construction Engineering			6%	$177,432
Surveying				$25,000
Archaelogical / Cultural Survey				$15,000
Legal				$5,000
Total Estimated Project Cost				$3,682,346

KITTITAS RECLAMATION DISTRICT				
LATERAL SB EXTENSION				
PROPOSED UPGRADES COST ESTIMATE				
ITEM DESCRIPTION	ITEM QUANTITY	UNIT	UNIT COST	COST
Headgate Structure - Concrete	1	EA	$15,000	$15,000
Inlet Gate - Manual	1	EA	$6,000	$6,000
Screen Structure - Concrete	1	EA	$10,000	$10,000
Lateral Inlet Screen - Motorized Brush, 1/8" Mesh	2	EA	$4,500	$9,000
Lateral Flowmeter	1	EA	$10,000	$10,000
Electrical	1	EA	$20,000	$20,000
30" PVC C905, 100 psi	12390	LF	$156	$1,932,840
Turnout Assembly - 1.5 inch	1	EA	$1,500	$1,500
Turnout Assembly - 2 inch	5	EA	$2,400	$12,000
Turnout Assembly - 3 inch	4	EA	$3,000	$12,000
Turnout Assembly - 4 inch	3	EA	$3,600	$10,800
Turnout Assembly - 6 inch	2	EA	$5,000	$10,000
Turnout Assembly - 12 inch	1	EA	$8,000	$8,000
Turnout Assembly - 24 inch	1	EA	$22,000	$22,000
Combination Air Valve Assembly	5	EA	$8,000	$40,000
Drain Assembly	1	EA	$6,000	$6,000
Fencing	1	EA	$5,000	$5,000
Demolition	1	EA	$18,585	$18,585
Subtotal				$2,148,725
Overhead & Profit			15%	$322,309
Contingency			15%	$370,655
Bonds/Insurance			2%	$99,808
Mobilization			2%	$99,808
Total Estimated Construction Cost				$3,041,305
WA state sales tax			8.0%	$243,304
Design Engineering			9%	$273,717
Services During Construction Engineering			6%	$182,478
Surveying				$25,000
Archaelogical / Cultural Survey				$15,000
Legal				$5,000
Total Estimated Project Cost				$3,785,806

KITTITAS RECLAMATION DISTRICT				
SOUTH BRANCH RE-REGULATION RESERVOIR				
PROPOSED UPGRADES COST ESTIMATE				
ITEM DESCRIPTION	ITEM QUANTITY	UNIT	UNIT COST	COST
Mobilization/Demobilization	1	EA	$175,000	$175,000
Site Preparation	1	EA	$75,000	$75,000
Trench Excavation	1	EA	$90,000	$90,000
Reservoir Excavation	1	EA	$400,000	$400,000
Fill	1	EA	$500,000	$500,000
Geotextile	1,098,000	SF	$0.50	$549,000
Geomembrane	549,000	SF	$1.50	$823,500
Imported riprap	20,400	CY	$6.00	$122,400
1-inch minus onsite gravel	60,000	CY	$2.00	$120,000
Reservoir Inlet - Canal Structure	1	EA	$30,000	$30,000
48" HDPE Reservoir Inlet Pipe	120	LF	$260	$31,200
Reservoir Inlet Riser	1	EA	$20,000	$20,000
Pump Station Intake Structure	1	EA	$30,000	$30,000
Pump Station Equipment	1	EA	$80,000	$80,000
42" WSP Pump Intake Pipe	120	LF	$294	$35,280
36" WSP Pump Discharge Pipe	100	LF	$252	$25,200
Control Building	1	EA	$75,000	$75,000
Electrical / I&C / Automation	1	EA	$200,000	$200,000
Check Structures	6	EA	$25,000	$150,000
Subtotal				$3,531,580
Overhead & Profit			15%	$529,737
Contingency			40%	$1,624,527
Bonds/Insurance			2%	$113,716.88
Mobilization			2%	$113,716.88
Total Estimated Construction Cost				$5,913,278
WA state sales tax			8.0%	$473,062
Land Acquisition				$100,000
Geotechnical Boreholes & Engineering Eval				$300,000
Design Engineering			9%	$532,194.98
Services During Construction Engineering			6%	$354,796.65
Surveying				$200,000
Archaelogical / Cultural Survey				$100,000
Legal				$110,000
Total Estimated Project Cost				$8,083,331
Assumptions (approximate):				
Storage Capacity; 110 ac-ft				
Footprint: 13 acres				
Inflow: 50 cfs				
Outflow: 30 cfs				

KITTITAS RECLAMATION DISTRICT				
NORTH BRANCH RE-REGULATION RESERVOIR				
PROPOSED UPGRADES COST ESTIMATE				
ITEM DESCRIPTION	ITEM QUANTITY	UNIT	UNIT COST	COST
Mobilization/Demobilization	1	EA	$200,000	$200,000
Site Preparation	1	EA	$100,000	$100,000
Trench Excavation	1	EA	$90,000	$90,000
Reservoir Excavation	1	EA	$575,000	$575,000
Fill	1	EA	$700,000	$700,000
Geotextile	1,734,000	SF	$0.50	$867,000
Geomembrane	867,000	SF	$1.50	$1,300,500
Imported riprap	32,200	CY	$6.00	$193,200
1-inch minus onsite gravel	80,300	CY	$2.00	$160,600
Reservoir Inlet - Canal Structure	1	EA	$25,000	$25,000
48" HDPE Reservoir Inlet Pipe	120	LF	$260	$31,200
Reservoir Inlet Riser	1	EA	$20,000	$20,000
Pump Station Intake Structure	1	EA	$35,000	$35,000
Pump Station Equipment	1	EA	$100,000	$100,000
48" WSP Pump Intake Pipe	120	LF	$336	$40,320
42" WSP Pump Discharge Pipe	100	LF	$294	$29,400
Control Building	1	EA	$75,000	$75,000
Electrical / I&C / Automation	1	EA	$200,000	$200,000
Subtotal				$4,742,220
Overhead & Profit			15%	$711,333
Contingency			40%	$2,181,421
Bonds/Insurance			2%	$152,699.48
Mobilization			2%	$152,699.48
Total Estimated Construction Cost				$7,940,373
WA state sales tax			8.0%	$635,230
Land Acquisition				$100,000
Geotechnical Boreholes & Engineering Eval				$350,000
Design Engineering			9%	$714,633.59
Services During Construction Engineering			6%	$476,422.39
Surveying				$200,000
Archaelogical / Cultural Survey				$100,000
Legal				$110,000
Total Estimated Project Cost				$10,626,659
Assumptions (approximate):				
Storage Capacity; 250 ac-ft				
Footprint: 20 acres				
Inflow: 70 cfs				
Outflow: 50 cfs				

KITTITAS RECLAMATION DISTRICT				
NB JOHNSON SIPHON TO WIPPLE PUMPING PLANT CANAL LINING				
PROPOSED UPGRADES COST ESTIMATE				
ITEM DESCRIPTION	ITEM QUANTITY	UNIT	UNIT COST	COST
Earth Section No. 21a	1883	CY	$350	$659,146
Lined Earth Section No. 20	814	CY	$350	$284,949
Earth Section No. 23	1206	CY	$350	$422,032
Earth Section No. 24	2002	CY	$350	$700,672
Geomembrane Underlining	514,378	SF	$1.50	$771,567
Turnouts with Flow Monitoring	15	EA	$5,000	$75,000
Flow Measuring Structures	2	EA	$60,000	$120,000
Subtotal				$3,033,365
Overhead & Profit			15%	$455,005
Contingency			15%	$523,256
Bonds/Insurance			2%	$80,233
Mobilization			2%	$80,232.51
Total Estimated Construction Cost				$4,172,091
WA state sales tax			8.0%	$333,767
Design Engineering			9%	$375,488
Services During Construction Engineering			6%	$250,325
Surveying				$25,000
Archaelogical / Cultural Survey				$15,000
Legal				$5,000
Total Estimated Project Cost				$5,176,672

KITTITAS RECLAMATION DISTRICT				
SB SWEDE TUNNEL TO ROBINSON CANYON SIPHON CANAL LINING				
PROPOSED UPGRADES COST ESTIMATE				
ITEM DESCRIPTION	ITEM QUANTITY	UNIT	UNIT COST	COST
Earth Section No. 7	1128	CY	$350	$394,710
Earth Section No. 9	1236	CY	$350	$432,636
Earth Section No. 10	1183	CY	$350	$414,122
Lined Earth Section No. 11	62	CY	$350	$21,588
Earth Section No. 12	288	CY	$350	$100,940
Geomembrane Underlining	321,197	SF	$1.50	$481,795
Turnouts with Flow Monitoring	5	EA	$5,000	$25,000
Subtotal				$1,870,791
Overhead & Profit			15%	$280,619
Contingency			15%	$322,711
Bonds/Insurance			2%	$49,482
Mobilization			2%	$49,482.42
Total Estimated Construction Cost				$2,573,086
WA state sales tax			8.0%	$205,847
Design Engineering			9%	$231,578
Services During Construction Engineering			6%	$154,385
Surveying				$25,000
Archaelogical / Cultural Survey				$15,000
Legal				$5,000
Total Estimated Project Cost				$3,209,895

Appendix E
SEPA Environmental Checklist

SEPA ENVIRONMENTAL CHECKLIST
UPDATED 2014

Purpose of checklist:

Governmental agencies use this checklist to help determine whether the environmental impacts of your proposal are significant. This information is also helpful to determine if available avoidance, minimization or compensatory mitigation measures will address the probable significant impacts or if an environmental impact statement will be prepared to further analyze the proposal.

***Instructions for applicants*:**

This environmental checklist asks you to describe some basic information about your proposal. Please answer each question accurately and carefully, to the best of your knowledge. You may need to consult with an agency specialist or private consultant for some questions. You may use "not applicable" or "does not apply" only when you can explain why it does not apply and not when the answer is unknown. You may also attach or incorporate by reference additional studies reports. Complete and accurate answers to these questions often avoid delays with the SEPA process as well as later in the decision-making process.

The checklist questions apply to all parts of your proposal, even if you plan to do them over a period of time or on different parcels of land. Attach any additional information that will help describe your proposal or its environmental effects. The agency to which you submit this checklist may ask you to explain your answers or provide additional information reasonably related to determining if there may be significant adverse impact.

Instructions for Lead Agencies:

Please adjust the format of this template as needed. Additional information may be necessary to evaluate the existing environment, all interrelated aspects of the proposal and an analysis of adverse impacts. The checklist is considered the first but not necessarily the only source of information needed to make an adequate threshold determination. Once a threshold determination is made, the lead agency is responsible for the completeness and accuracy of the checklist and other supporting documents.

Use of checklist for non-project proposals:

For non-project proposals (such as ordinances, regulations, plans and programs), complete the applicable parts of sections A and B plus the SUPPLEMENTAL SHEET FOR NON-PROJECT ACTIONS (part D). Please completely answer all questions that apply and note that the words "project," "applicant," and "property or site" should be read as "proposal," "proponent," and "affected geographic area," respectively. The lead agency may exclude (for non-projects) questions in Part B - Environmental Elements –that do not contribute meaningfully to the analysis of the proposal.

A. BACKGROUND

1. Name of proposed project, if applicable:

   Water Conservation Upgrades

2. Name of applicant:

   Kittitas Reclamation District (KRD)

3. Address and phone number of applicant and contact person:

Kittitas Reclamation District
Contact: Ken Hasbrouck
P.O. Box 276
Ellensburg, WA 98926
Phone: (509) 925-6158

4. Date checklist prepared:

August 2014

5. Agency requesting checklist:

United States Bureau of Reclamation (USBR) / Washington State Department of Ecology (Ecology)

6. Proposed timing or schedule (including phasing, if applicable):

Schedule can vary to accommodate level of funding. Construction could be carried out over the course of approximately ten years or be completed within approximately four years from date of funding approval.

7. Do you have any plans for future additions, expansion, or further activity related to or connected with this proposal? If yes, explain.

No, once construction is complete, further activity will be limited to operation and maintenance of the system.

8. List any environmental information you know about that has been prepared, or will be prepared, directly related to this proposal.

Environmental information will be prepared as part of permit process.

9. Do you know whether applications are pending for governmental approvals of other proposals directly affecting the property covered by your proposal? If yes, explain.

No

10. List any government approvals or permits that will be needed for your proposal, if known.

State permits anticipated for reservoir construction include the following:

- Ecology Dam Construction Permit
- National Pollutant Discharge Elimination System (NPDES) – Stormwater Construction General Permit
- Joint Aquatic Resources Permit Application (JARPA)

- State Environmental Policy Act (SEPA) permit
- Cultural / Archaeology Survey

Federal permits anticipated for reservoir construction include the following:

Section 106 and ESA consultation with USFWS / NOAA

11. Give brief, complete description of your proposal, including the proposed uses and the size of the project and site. There are several questions later in this checklist that ask you to describe certain aspects of your proposal. You do not need to repeat those answers on this page. (Lead agencies may modify this form to include additional specific information on project description.)

This project is an improvements project for water conservation measures for the KRD, consisting of the following project elements:

Existing open ditches will be replaced with a buried, state-of-the-art, piped (gravity pressurized) system. All pipelines will be laid in existing canal right-of-ways. The new piped system will have turnouts to all existing turnouts.

Two new reregulation reservoirs will be built in order to control flow and operational spills on the North and South Branch canals.

The existing earth lined open ditch North Branch Canal from the Johnson Siphon outlet to the Wippel Pumping Plant will be concrete lined. Similarly, the existing earth lined open ditch South Branch Canal from the Swede Tunnel to the Robinson Canyon Siphon will be concrete lined.

New facilities will also be automated to the maximum extent practical to control flow and also tie the new system into the existing telemetry system.

The water in the irrigation system will be used to irrigate approximately 60,000 acres of farmland, mostly timothy hay, pasture, vineyards, and orchards throughout the KRD.

12. Location of the proposal. Give sufficient information for a person to understand the precise location of your proposed project, including a street address, if any, and section, township, and range, if known. If a proposal would occur over a range of area, provide the range or boundaries of the site(s). Provide a legal description, site plan, vicinity map, and topographic map, if reasonably available. While you should submit any plans required by the agency, you are not required to duplicate maps or detailed plans submitted with any permit applications related to this checklist.

The KRD is located in central Washington, near the cities of Cle Elum and Ellensburg. The KRD encompasses approximately 104,600 acres of land throughout the entire central area of Kittitas County.

B. ENVIRONMENTAL ELEMENTS

1. Earth

a. General description of the site

(Bold one): **Flat, rolling**, hilly, steep slopes, mountainous, other _____

b. What is the steepest slope on the site (approximate percent slope)?

30 percent

c. What general types of soils are found on the site (for example, clay, sand, gravel, peat, muck)? If you know the classification of agricultural soils, specify them and note any agricultural land of long-term commercial significance and whether the proposal results in removing any of these soils.

The KRD is made up of soil types that generally resulted from alluvial deposits and glacial outwash planes, along with some Aeolian deposits and lacustrine sediments. The Brickmill, Millhouse, and Selah soils dominate.

d. Are there surface indications or history of unstable soils in the immediate vicinity? If so, describe.

No, there does not appear to be any natural indication of unstable soils in the immediate vicinity, however the surface shows a history of soil movement in locations where a canal is perched on steep hillsides.

e. Describe the purpose, type, total area, and approximate quantities and total affected area of any filling, excavation, and grading proposed. Indicate source of fill.

Approximately 353,000 feet of pipe will be placed in existing canals. Most canals will need to be excavated and the materials excavated will be used for filling either in the canal beds or for reregulation reservoirs. Approximately 520,000 cubic yards of material will be excavated and approximately 192,900 cubic yards of imported material will be used as pipe bedding and reservoir bedding in areas where local materials are not suitable. The bedding will be obtained from nearby gravel pits or screened on site.

f. Could erosion occur as a result of clearing, construction, or use? If so, generally describe.

Minimal erosion is possible after clearing and grubbing work commences, however best management practices for erosion/sediment control will be in place to mitigate any possible erosion.

g. About what percent of the site will be covered with impervious surfaces after project construction (for example, asphalt or buildings)?

None

h. Proposed measures to reduce or control erosion, or other impacts to the earth, if any:

The Contractor will be responsible for erosion control and will implement proper best management construction practices to minimize erosion. Disturbed areas will be vegetated after construction.

2. Air

a. What types of emissions to the air would result from the proposal during construction, operation, and maintenance when the project is completed? If any, generally describe and give approximate quantities if known.

There are two potential sources of air pollution during the construction phase of the proposed project:
1) Dust from various earthmoving operations and construction activities
2) Pollutant emission from the operations of construction equipment

Potential dust pollution will be mitigated by contractor using dust control provisions and emissions should be relatively minor.

b. Are there any off-site sources of emissions or odor that may affect your proposal? If so, generally describe.

No.

c. Proposed measures to reduce or control emissions or other impacts to air, if any:

Dust will be controlled by watering the soil during construction, as needed.

3. Water

a. Surface Water:

1) Is there any surface water body on or in the immediate vicinity of the site (including year-round and seasonal streams, saltwater, lakes, ponds, wetlands)? If yes, describe type and provide names. If appropriate, state what stream or river it flows into.

Several small Yakima River tributaries and seeps flow within the KRD system.

2) Will the project require any work over, in, or adjacent to (within 200 feet) the described waters? If yes, please describe and attach available plans.

Pipelines will be laid in existing canal right-of-ways that are generally further than 200 feet from existing waters, however some pipelines may cross existing creeks or seeps.

3) Estimate the amount of fill and dredge material that would be placed in or removed from surface water or wetlands and indicate the area of the site that would be affected. Indicate the source of fill material.

No fill or dredge materials will be placed in surface water or wetlands. All excavation and fill will occur within the existing irrigation canal right of ways or newly acquired land (for reservoirs that does not have surface water or wetlands).

4) Will the proposal require surface water withdrawals or diversions? Give general description, purpose, and approximate quantities if known.

Although an existing water right authorizes up to 336,000 acre-feet of irrigation water for use by the KRD, no additional surface water withdrawal will be required for construction of this project.

5) Does the proposal lie within a 100-year floodplain? If so, note location on the site plan.

No.

6) Does the proposal involve any discharges of waste materials to surface waters? If so, describe the type of waste and anticipated volume of discharge.

No. The project will result in an improvement to the surface water quality in the surrounding tributaries and Yakima River because it will lessen discharges of pesticides, nutrients, and sediments (reduce turbidity), and will lessen the temperature of discharge waters from the irrigation outlet to the river.

b. Ground Water:

1) Will groundwater be withdrawn from a well for drinking water or other purposes? If so, give a general description of the well, proposed uses and approximate quantities withdrawn from the well. Will water be discharged to groundwater? Give general description, purpose, and approximate quantities if known.

No.

2) Describe waste material that will be discharged into the ground from septic tanks or other sources, if any (for example: Domestic sewage; industrial, containing the following chemicals. . . ; agricultural; etc.). Describe the general size of the system, the number of such systems, the number of houses to be served (if applicable), or the number of animals or humans the system(s) are expected to serve.

N/A

c. Water runoff (including storm water):

1) Describe the source of runoff (including storm water) and method of collection and disposal, if any (include quantities, if known). Where will this water flow? Will this water flow into other waters? If so, describe.

The storm water and cross-drainage that is currently discharging to the open canal system will be routed as needed to nearby existing stormwater swales or ditches.

2) Could waste materials enter ground or surface waters? If so, generally describe.

No. Waste materials (pesticides, nutrients, sediment) should lessen as a result of a piped irrigation system.

3) Does the proposal alter or otherwise affect drainage patterns in the vicinity of the site? If so, describe.

Yes, existing drains that discharge into open ditch canals that are being piped will be routed to drain elsewhere.

d. Proposed measures to reduce or control surface, ground, and runoff water, and drainage pattern impacts, if any:

Piping canals will eliminate canal discharges (spills) and will provide state-of-the-art management of KRD waters, eliminating detrimental effects of KRD canals on surface, ground, and runoff waters.

The piped irrigation system will reduce infiltration, evaporation, and transpiration, allowing diversion reduction from the BOR storage reservoirs.

The project will allow farmers to closely manage their water use, lessening runoff from agricultural activities.

4. **Plants**

a. Check the types of vegetation found on the site:

__X__deciduous tree: alder, maple, aspen, other
__X__evergreen tree: fir, cedar, pine, other
__X__shrubs
__X__grass
__X__pasture
__X__crop or grain
__X__ Orchards, vineyards or other permanent crops.
__X__ wet soil plants: cattail, buttercup, bullrush, skunk cabbage, other
__X__water plants: water lily, eelgrass, milfoil, other
_____other types of vegetation

b. What kind and amount of vegetation will be removed or altered?

During construction, vegetation within the KRD ROW will be cleared for pipeline construction. Vegetation is predominantly weeds.

c. List threatened and endangered species known to be on or near the site.

None.

d. Proposed landscaping, use of native plants, or other measures to preserve or enhance vegetation on the site, if any:

Hydroseeding with native grasses will be used where County right of ways are disturbed due to pipeline installation.

e. List all noxious weeds and invasive species known to be on or near the site.

No noxious weeds are known to be on or near the site, however noxious weeds have been found within the KRD including yellow flag iris, spurge myrtle, and butterflybush.

5. **Animals**

a. List any birds and other animals which have been observed on or near the site or are known to be on or near the site. Examples include:

Birds: **hawk, heron, songbirds**
Mammals: **deer**
Fish: **trout**

b. List any threatened and endangered species known to be on or near the site.

Salmon and Steelhead runs occur in the Yakima River, the location of all outflowing water from the KRD.

c. Is the site part of a migration route? If so, explain.

No.

d. Proposed measures to preserve or enhance wildlife, if any:

This water conservation project will enhance the instream flow of the Yakima River and improve water quality of water that is discharged from the irrigation system into the Yakima River. This will, in turn, improve the fish habitat.

e. List any invasive animal species known to be on or near the site.

None.

6. **Energy and natural resources**

a. What kinds of energy (electric, natural gas, oil, wood stove, solar) will be used to meet the completed project's energy needs? Describe whether it will be used for heating, manufacturing, etc.

The project will use electric energy to pump irrigation water at the reservoirs. The system will be designed to utilize gravity pressure wherever possible.

b. Would your project affect the potential use of solar energy by adjacent properties? If so, generally describe.

No.

c. What kinds of energy conservation features are included in the plans of this proposal? List other proposed measures to reduce or control energy impacts, if any:

Energy savings will be significant because existing landowners that use on-farm low efficiency pumps to pressurize their KRD irrigation water will be able to utilize gravity pressurized water instead.

7. **Environmental health**

a. Are there any environmental health hazards, including exposure to toxic chemicals, risk of fire and explosion, spill, or hazardous waste that could occur as a result of this proposal? If so, describe.

No

1) Describe any known or possible contamination at the site from present or past uses.

None

2) Describe existing hazardous chemicals/conditions that might affect project development and design. This includes underground hazardous liquid and gas transmission pipelines located within the project area and in the vicinity.

None

3) Describe any toxic or hazardous chemicals that might be stored, used, or produced during the project's development or construction, or at any time during the operating life of the project.

Maintenance of construction equipment will be needed during construction and therefore storage of typical petroleum products may be required such as fuel, oil, etc.

4) Describe special emergency services that might be required.

None

5) Proposed measures to reduce or control environmental health hazards, if any.

The piped irrigation system will reduce the potential for fires because the current practice of burning vegetation along canals will no longer be necessary. In addition, open ditch canal can present a drowning hazard that will be mitigated.

b. **Noise**

1) What types of noise exist in the area which may affect your project (for example: traffic, equipment, operation, other)?

None.

2) What types and levels of noise would be created by or associated with the project on a short-term or a long-term basis (for example: traffic, construction, operation, other)? Indicate which hours noise would come from the site.

Construction equipment, such as backhoes and bulldozers, will raise noise levels during construction. Construction will take place from approximately 8am to 5 pm on weekdays.

3) Proposed measures to reduce or control noise impacts, if any:

All noise from construction will be limited to daytime hours. No long-term noise reduction or control measures are anticipated.

8. **Land and shoreline use**

a. What is the current use of the site and adjacent properties? Will the proposal affect current land uses on nearby or adjacent properties? If so, describe.

Currently the site is open canals within the KRD right of way. The canals are surrounded by farmland, pasture, cropland, homes, and county roads. Land use will be affected where the two reregulation reservoirs are to be built on private property that will need to be acquired by KRD.

b. Has the project site been used as working farmlands or working forest lands? If so, describe. How much agricultural or forest land of long-term commercial significance will be converted to other uses as a result of the proposal, if any? If resource lands have not been designated, how many acres in farmland or forest land tax status will be converted to nonfarm or non-forest use?

The majority of the site is conversion of open ditch canals to pipelines and as such they are not farm or forest lands. The two reregulation reservoirs will be constructed on pasture land and fallow cropland.

1) Will the proposal affect or be affected by surrounding working farm or forest land normal business operations, such as oversize equipment access, the application of pesticides, tilling, and harvesting? If so, how:

No.

c. Describe any structures on the site.

None.

d. Will any structures be demolished? If so, what?

No structures will be demolished other than small concrete irrigation structures currently used to control irrigation flow.

e. What is the current zoning classification of the site?

Primarily agricultural with some residential usage.

f. What is the current comprehensive plan designation of the site?

Mainly agricultural usage, with some residential usage.

g. If applicable, what is the current shoreline master program designation of the site?

N/A

h. Has any part of the site been classified as a critical area by the city or county? If so, specify.

No.

i. Approximately how many people would reside or work in the completed project?

No change to existing KRD staff would be needed for project.

j. Approximately how many people would the completed project displace?

None.

k. Proposed measures to avoid or reduce displacement impacts, if any:

N/A

L. Proposed measures to ensure the proposal is compatible with existing and projected land uses and plans, if any:

The area is primarily agricultural, and the project will enhance the continuation of this land use.

m. Proposed measures to ensure the proposal is compatible with nearby agricultural and forest lands of long-term commercial significance, if any:

N/A

9. **Housing**

a. Approximately how many units would be provided, if any? Indicate whether high, middle, or low-income housing.

None.

b. Approximately how many units, if any, would be eliminated? Indicate whether high, middle, or low-income housing.

None.

c. Proposed measures to reduce or control housing impacts, if any:

None.

10. **Aesthetics**

a. What is the tallest height of any proposed structure(s), not including antennas; what is the principal exterior building material(s) proposed?

Control buildings at reservoirs would be approximately 15 ft. high.

b. What views in the immediate vicinity would be altered or obstructed?

Reservoir embankments could potentially obstruct view of agricultural land.

c. Proposed measures to reduce or control aesthetic impacts, if any:

None.

11. **Light and glare**

a. What type of light or glare will the proposal produce? What time of day would it mainly occur?

None.

b. Could light or glare from the finished project be a safety hazard or interfere with views?

No.

c. What existing off-site sources of light or glare may affect your proposal?

None.

d. Proposed measures to reduce or control light and glare impacts, if any:

N/A

12. **Recreation**

a. What designated and informal recreational opportunities are in the immediate vicinity?

None.

b. Would the proposed project displace any existing recreational uses? If so, describe.

No.

c. Proposed measures to reduce or control impacts on recreation, including recreation opportunities to be provided by the project or applicant, if any:

None.

13. **Historic and cultural preservation**

a. Are there any buildings, structures, or sites, located on or near the site that are over 45 years old listed in or eligible for listing in national, state, or local preservation registers located on or near the site? If so, specifically describe.

Small concrete irrigation structures within the existing canal right of way are older than 45 years old that will be demolished as part of construction.

b. Are there any landmarks, features, or other evidence of Indian or historic use or occupation? This may include human burials or old cemeteries. Are there any material evidence, artifacts,

or areas of cultural importance on or near the site? Please list any professional studies conducted at the site to identify such resources.

Culturally significant evidence of Indian occupation has been identified in the general vicinity of project although no human burials or old cemeteries. Professional studies have not been conducted at the specific sites but are anticipated prior to or during construction.

c. Describe the methods used to assess the potential impacts to cultural and historic resources on or near the project site. Examples include consultation with tribes and the department of archeology and historic preservation, archaeological surveys, historic maps, GIS data, etc.

It is likely that a culture resources representative will be onsite during excavation activities.

d. Proposed measures to avoid, minimize, or compensate for loss, changes to, and disturbance to resources. Please include plans for the above and any permits that may be required.

None anticipated. Other than reservoir sites, the project sites are on existing KRD right of ways that have been previously disturbed.

14. **Transportation**

a. Identify public streets and highways serving the site or affected geographic area and describe proposed access to the existing street system. Show on site plans, if any.

Numerous streets and county roads are in the vicinity of the various project sites. The project sites are predominantly on existing KRD canal right of way and will be accessed via traditional right of way access locations that have been used for decades.

b. Is the site or affected geographic area currently served by public transit? If so, generally describe. If not, what is the approximate distance to the nearest transit stop?

No.

c. How many additional parking spaces would the completed project or non-project proposal have? How many would the project or proposal eliminate?

None.

d. Will the proposal require any new or improvements to existing roads, streets, pedestrian, bicycle or state transportation facilities, not including driveways? If so, generally describe (indicate whether public or private).

No.

e. Will the project or proposal use (or occur in the immediate vicinity of) water, rail, or air transportation? If so, generally describe.

No.

f. How many vehicular trips per day would be generated by the completed project or proposal? If known, indicate when peak volumes would occur and what percentage of the volume would be trucks (such as commercial and non-passenger vehicles). What data or transportation models were used to make these estimates?

There will be no increase in vehicular trips per day.

g. Will the proposal interfere with, affect or be affected by the movement of agricultural and forest products on roads or streets in the area? If so, generally describe.

No, other than short duration lane closures while making road crossings.

h. Proposed measures to reduce or control transportation impacts, if any:

Approved traffic control measures will be used to keep traffic moving during construction.

15. **Public services**

a. Would the project result in an increased need for public services (for example: fire protection, police protection, public transit, health care, schools, other)? If so, generally describe.

No.

b. Proposed measures to reduce or control direct impacts on public services, if any.

None.

16. **Utilities**

a. Bold utilities currently available at the site:
Electricity, natural gas, water, refuse service, telephone, sanitary sewer, septic system, Other _____

b. Describe the utilities that are proposed for the project, the utility providing the service, and the general construction activities on the site or in the immediate vicinity which might be needed.

The only utilities needed for the project are electrical. Each open ditch canal to be piped will require a new electrical service for a screened headgate that will include an electrically actuated automatic traveling brush for screen cleaning. In addition, pumps at each reservoir will need new electrical services. The electrical utility is Pacific Power & Light.

C. SIGNATURE

The above answers are true and complete to the best of my knowledge. I understand that the lead agency is relying on them to make its decision.

Signature: _____

Name of signee: Ed Thomas

Position and Agency/Organization: Project Manager / CH2M HILL Engineers, Inc.

Date Submitted: September 2014

D. SUPPLEMENTAL SHEET FOR NON-PROJECT ACTIONS

(**IT IS NOT NECESSARY** to use this sheet for project actions)

Because these questions are very general, it may be helpful to read them in conjunction with the list of the elements of the environment.

When answering these questions, be aware of the extent the proposal, or the types of activities likely to result from the proposal, would affect the item at a greater intensity or at a faster rate than if the proposal were not implemented. Respond briefly and in general
terms.

1. How would the proposal be likely to increase discharge to water; emissions to air; production, storage, or release of toxic or hazardous substances; or production of noise?

   Discharge to water could be increased if dewatering is necessary during excavation, emissions to air could increase as a result of temporary power generators and heavy construction equipment emissions, noise will be increased only in the near vicinity of project during construction.

   Proposed measures to avoid or reduce such increases are:

   The contractor will be required to perform all work in accordance with best practices for erosion and sedimentation control for any potential water discharges or storm events.

2. How would the proposal be likely to affect plants, animals, fish, or marine life?

   Water entering the Yakima River would be cleaner than before the proposed project, therefore increasing water quality for fish. In addition the proposed projects will save a large volume of water each irrigation season which will all for reduced Yakima River diversions or supplementation of water in local tributaries that are water short.

   Proposed measures to protect or conserve plants, animals, fish, or marine life are:

   Contractor must perform work in accordance with best management practices for erosion and sediment control.

3. How would the proposal be likely to deplete energy or natural resources?

   N/A

   Proposed measures to protect or conserve energy and natural resources are:

   None.

4. How would the proposal be likely to use or affect environmentally sensitive areas or areas designated (or eligible or under study) for governmental protection; such as parks,

wilderness, wild and scenic rivers, threatened or endangered species habitat, historic or cultural sites, wetlands, floodplains, or prime farmlands?

Soil saturation and associated vegetation growth adjacent to existing open ditch irrigation canals will be eliminated or reduced by piping or relining the open ditch canals.

Proposed measures to protect such resources or to avoid or reduce impacts are:

The project is for water conservation, as a result the goal is to eliminate or reduce locations where water seepage occurs. Mitigation of these areas where existing vegetation may not have ample water in the future is inherent to the project since the conserved water will be used for beneficial use to most likely supplement local tributaries that are water short. The irrigation system improvements will result in an overall improvement to the water and habitat in the surrounding rivers that supports the viability of fish.

In addition, the vegetation at these seepage locations are not expected to disappear completely in every case because there are other possible water sources that include tail water from nearby fields and collection points for storm water.

5. How would the proposal be likely to affect land and shoreline use, including whether it would allow or encourage land or shoreline uses incompatible with existing plans?

   N/A

   Proposed measures to avoid or reduce shoreline and land use impacts are:

   None.

6. How would the proposal be likely to increase demands on transportation or public services and utilities?

   There will be no increase in demands on transportation.

   Proposed measures to reduce or respond to such demand(s) are:

   None.

7. Identify, if possible, whether the proposal may conflict with local, state, or federal laws or requirements for the protection of the environment.

   None identified.