CES
Synergy of Water and Science™

Port of
ARLINGTON

Economic Feasibility Assessment

Irrigated Agriculture for Lower Willow Creek Drainage

Port of Arlington
Arlington, Oregon
December 2018

4225 N Capitol Avenue
Pasco, WA 99301
Ph. (509) 547-1623
cascade-earth.com

Economic Feasibility Assessment
Irrigated Agriculture for Lower Willow Creek Drainage
Port of Arlington
Arlington, Oregon

Prepared For:	Mr. Peter Mitchell Port Manager/Economic Development Officer Port of Arlington 100 Port Island Road Arlington, OR 97812
Prepared By:	Cascade Earth Sciences 4225 N Capitol Avenue Pasco, WA 99301 (509) 547-1623
Author(s):	Zachary Booth, Project Engineer Doug Wanta, RG, CWRE Steven Venner, CCA-NW, Managing Scientist
Reviewed By:	Greg Thurman, PE, Principal Engineer
Report Date:	December 6, 2018
Project Number:	2018230015
Submitted By:	

Steve Venner, Managing Scientist

CONTENTS

TABLES

CONTENTS (continued)

FIGURES

APPENDICES

1.0 PURPOSE AND SCOPE

The Port of Arlington (Port) contracted with Cascade Earth Sciences (CES) to complete a first-order economic feasibility assessment for the development of additional irrigated acreage in Gilliam County to meet the general economic development strategy of increased grain and crop production. The lack of large scale irrigation infrastructure currently limits crop production primarily to dryland farming with only limited access to irrigated acreage in some areas. Important project resources for the Port include (1) Port ownership of several acres at the mouth of Willow Creek, (2) a municipal water right, and (3) local farmer interest from more than a dozen growers, some of whom are members of the Lower Willow Creek Irrigation Committee.

The project vision is for a pump station to be constructed near the mouth of Willow Creek to deliver water to the Willow Creek bench, Eight Mile bench, and, if possible, to the mesas above both areas. The farmers would pump water to their farms from diversion points (turnouts) along the main pipeline. If found to be affordable, the main pipeline could extend water to the adjoining farm land on the mesas above the Eight Mile bench toward the Rock Creek and Shuttler Flats areas. The Port and Irrigation Committee would like to determine the economic feasibility of supplying water to these areas in regards to distance, volume, and elevation based on capital and operating costs.

2.0 SITE LOCATION AND DESCRIPTION

The Site is located in Gilliam County, south of the Columbia River, at the mouth of Willow Creek. The pump station could be located along the bank of the Columbia River, west of Willow Lake, or at Willow Lake. The pipeline would run south into Eight Mile Canyon and/or to the Gilliam/Morrow County line. For the purposes of this assessment, the Eight Mile Canyon route would provide water to approximately 15,000 acres while the County Line route would service 2,280 acres (Appendix A). Most of the land being targeted is currently dry, although some areas have limited access to groundwater or surface water (i.e., Willow Creek). Converting this land to irrigated cropland would greatly improve the overall productivity and property values.

This assessment was completed on two proposed routes to distribute water from the Columbia River/Willow Lake through Eight Mile Canyon (Eight Mile Canyon distribution system) and one alternate route to deliver water along Willow Creek ending at the Gilliam/Morrow County line (County Line distribution system). Each of the Eight Mile Canyon routes will include a pump station at the Columbia River or Willow Lake with booster pump station somewhere along the line, depending on the route, to increase pressure enough to deliver water to about 15,000 acres. The County Line route would include a single pump station at the Columbia River or Willow Creek and distribute enough water to irrigate an estimated 2,280 acres.

3.0 EIGHT MILE CANYON DISTRIBUTION SYSTEM

The Eight Mile Canyon distribution system will begin at the Columbia River or Willow Lake, be routed through Eight Mile Canyon and end at a point before Eight Mile Canyon Road turns east. The water will be pumped through an appropriately sized pipeline approximately 18 miles south along Eight Mile Canyon. The pipeline pressure along its length and at the end must be enough to

adequately supply privately-owned pump stations at "turnouts" along the pipeline's route. Turnouts are proposed locations along the pipeline route from which water will be pumped to the fields.

The conceptual design includes two Eight Mile Canyon pipeline route options designated Option 1 and Option 2. Due to the length of the pipeline, and the increase in elevation along its length, each of the routes must include a booster pump station. The size and location of the booster station will depend on the route. Each route is described with a starting point that would be at one of two different main pump station locations (designated with "a" for the Columbia River and "b" for Willow Lake). The Columbia River pump station, located on the shore of the Columbia River on Port of Arlington property, would require boring and extending a pipeline beneath the railroad and Interstate-84. The second option is to locate the main pump station on the western shore of Willow Lake, close to, but south of Interstate-84. The Willow Lake pump station will not require boring under the railroad and interstate.

3.1 Pump Station Locations and Pipeline Routes

Each of the pipeline routes and pump station options are discussed in this section.

3.1.1 Pipeline Route Option 1a

Starting at the Columbia River pump station, the pipeline will be routed through an 86-inch micro-tunnel cut approximately 800 ft long to cross beneath the railroad and Interstate-84. After reaching the south side of the interstate, the pipeline will turn to the southwest and extend an additional 4,700 ft to reach Highway OR-74 (Figure 1). The pipeline will cross OR-74 then turn south and run adjacent to OR-74 for approximately 2 miles until reaching the northern intersection of OR-74 and Rhea Road.

Near the intersection of OR-74 and Rhea Road, the pipeline will head west-southwest and then south through the Caithness Shepherds Flat Wind Farm, continuing south toward Eight Mile Canyon. In this section, the pipeline will be routed to avoid Bureau of Land Management property and to avoid crossing as many windmill collection lines as possible.

Approximately 4.5 miles south-southwest of the intersection of OR-74 and Rhea Road, the pipeline will head down-hill to reach Eight Mile Canyon. From this point, the pipeline will follow Eight Mile Canyon approximately 9.5 miles south, and terminate before Eight Mile Canyon Road turns east.

3.1.2 Pipeline Route Option 1b

Option 1b is identical to Option 1a with the exception that instead of beginning with the Columbia River pump station location, this pipeline will begin at the Willow Lake pump station location.

3.1.3 Pipeline Route Option 2a

Pipeline route option 2 is shown on Figure 2. Starting at the Columbia River pump station location, the pipeline would be routed through an 86-inch micro-tunnel cut approximately 800 ft long to cross beneath the railroad and Interstate-84. After reaching the south side of the interstate, the pipeline will turn northeast and extend an additional 650 ft to reach the railroad property. Once on the railroad property, the pipeline will turn to head southeast, adjacent to the railroad. The railroad ends approximately 4,300 ft southeast of Interstate-84, however, an abandoned rail bed continues along

Willow Creek past the Gilliam/Morrow County line. After the rails terminate, the pipeline will be buried within the abandoned rail bed and will continue to follow the rail bed along Willow creek until reaching the intersection of Willow Creek and Eight Mile Canyon (southern intersection of OR-74 and Rhea Road). From this location, the pipeline will turn southwest and continue south to follow Eight Mile Canyon until terminating before Eight Mile Canyon Road turns east.

3.1.4 Pipeline Route Option 2b

Option 2b is identical to Option 2a with the exception that instead of beginning with the Columbia River pump station, this pipeline will begin at the Willow Lake pump station (Figure 2).

3.2 Pump Station Sizing

The change in elevation from the Columbia River or Willow Lake pump station locations (main pump station) to the end of the main pipeline will be approximately 485 feet. Coupled with pipeline losses, the total head loss in the system will be too great to be overcome by a single main pump station. For this reason, the distribution system must be designed with a booster pump station.

3.2.1 Main Pump Station

The main pump station will be required to pump approximately 113,000 gallons per minute (gpm) to supply 7.5 gpm per acre to 15,000 acres. This flow rate is equivalent to approximately 252 cubic feet per second. It will also require an operating pressure of 210 pounds per square inch (psi) to overcome the total head loss. The calculated motor horsepower (hp) to meet these system requirements is approximately 17,500 hp.

3.2.2 Booster Station Option 1

The allowable length of pipe between the main pump station and the booster station (i.e., booster station location) is dependent upon the pipeline route and its rate of increase in elevation.

Pipeline route option 1 elevation increases rapidly compared to pipeline route option 2. The location of the booster station for pipeline route option 1 (booster station option 1) is near the northern intersection of OR-74 and Rhea Road, which is about two miles south-southeast of Interstate-84. This will require approximately 16,610 ft of 72-inch cement mortar lined (CML) standard (STD) wall steel pipe from the Columbia River pump station (Figure 1).

Booster station option 1 is at an elevation of approximately 575 ft and will require an additional 78,247 ft of pipeline to reach the end of the line. This would include additional lengths and sizes of steel and polyvinyl chloride (PVC) pipe to meet the necessary flow rates as shown in Figure 1. The flow rates in each section of pipeline are the result of estimated end-user utilization along the length of the pipeline.

Using approximate elevations, pipeline length, and flow estimations, the booster station option 1 power requirement was calculated. The calculated motor hp to meet the booster station option 1 requirement is 12,500 hp.

3.2.3 Booster Station Option 2

The rate of elevation increase for pipeline route option 2 is less than pipeline route option 2. Therefore, the booster station option 2 can be located farther from the main pump station and will have different power requirements compared to booster pump station 1.

The total length of pipe required between the main pump station and booster station option 2 is 45,410 ft of 72-inch CML STD wall steel (Figure 2). Booster station option 2 is at an elevation of approximately 492 ft and will require an additional 48,336 ft of pipeline to reach the end of the line. This would include additional lengths and sizes of steel and PVC pipe to meet the necessary flow rates as shown in Figure 2. The flow rates in each section of pipeline are the result of estimated end-user utilization upstream.

Using approximate elevations, pipeline length, flow estimations, the booster station option 2 power requirement was calculated. The calculated motor hp to meet the booster station option 2 requirement is 13,750 hp.

3.2.4 Pump sizes and System Controls

The main pump station would likely include ten 1,500 hp turbine pumps, one 1,750 hp turbine pump, and one 1,000 hp turbine pumps, equating to 17,750 hp. This will allow for variable flow and pressure demands. System variability would be controlled by a variable frequency drive (VFD) installed to control the single 1,750 hp turbine pump. To protect the pump system and minimize load spikes on the electrical grid, the remaining turbine pumps would each be controlled by a soft-start. Control logic would command each of the single speed pumps on and off as required by system demand.

The booster station will be built to operate in unison with the main pump station and will have similar controls. The booster station option 1 would contain seven 1,500 hp turbine pumps, and one 1,750 hp turbine pump. The booster station option 2 would include eight 1,500 hp turbine pumps, and one 1,750 hp pump.

Booster station control would be achieved by operating the 1,750 hp turbine pump with a VFD. To protect the pump system and minimize load spikes on the electrical grid, the remaining turbine pumps would each be controlled by a soft-start. Control logic would command each of the single speed pumps on and off as required by system demand.

3.3 Pipeline

The location of the booster station is dependent upon the total head loss between the main pump station and the chosen booster station location. The system head loss between these two points is a combination of the increase in elevation and the frictional head loss experienced within the pipeline. The allowable length of pipe between the river station and the booster station was determined, in part, based on the pipeline diameter and the frictional head loss per foot of pipe.

3.3.1 Main Pipeline

To conserve energy and reduce system head loss due to friction, the pipeline between the main pump station at the Columbia River and the booster pump station will be sized to maintain flow

velocities of less than 10 feet per second (fps). The required inside diameter of the pipeline was 68 inches. The nearest available pipe size meeting this inside diameter requirement is a 72-inch STD wall steel, with an inside diameter of 71.25 inches.

Steel piping in this distribution system will be CML to increase pipeline life, reduce corrosion, and decrease frictional head loss. CML will increase the wall thickness of the pipe by approximately 0.25 inches, reducing the inside diameter of 72 in STD wall steel to 70.75 inches. The flow velocity at 113,000 gpm inside a CML 72 inch STD wall steel pipe will be approximately 9.2 ft/s.

3.3.2 Pipeline Transitions

Downstream of the booster station along each of the pipeline route options, the pipeline will transition from 72 inches down to 48 inches in several transitional stages (Figures 1 and 2).

3.3.3 Pipeline Specifications

All 72 and 66-inch pipe used in the system will be STD wall steel with a tensile strength of 60,000 pounds per square inch (60 kilopounds per square inch [ksi]) lined with cement mortar. The CML will greatly extend the life of the pipe and reduce frictional losses experienced by the distribution system.

The pressure rating for 72-inch STD wall 60 ksi steel pipe is approximately 335 pounds per square inch (psi) with a maximum surge pressure of 502 psi. The pressure rating for 66-inch STD wall 60-ksi steel is approximately 365 psi with a maximum surge pressure of 550 psi. The expected maximum operating pressure across the entire system will be less than 230 psi. The use of 60-ksi steel will allow for safe operation of the system under normal operating conditions and during most surge events. Additional surge protection must be provided to further protect the piping and pumps.

All 54 and 48 inch pipe used in the system will be C900 PVC DR-25 with a working pressure of 165 psi. Transitioning to PVC at the final reach of the pipeline will help to reduce the overall material and installation costs. Line pressures will be greatly reduced before flow reaches the PVC section of the pipeline.

3.4 Power Requirements

The power required to operate a 17,500 hp pump station is equal to approximately 10.4 Megawatts (MW). Based on rate quotes from the public utility district and high voltage electrical engineer, this level of power will require the construction of a substation to operate the main pump station.

The booster station power requirement (12,250 hp or 13,750 hp) would require a substation sized to supply between 9.4 MW and 10.5 MW depending on the booster station location.

3.4.1 Surge Protection

It is important to plan for pressure surges in a system of this size. In the event of a power failure and subsequent pump trip, several pressure waves will be experienced in the system and could reach pressure spikes of up to 600 psi, increasing the pressure near the pump station to nearly 830 psi.

This value is 280 psi above the maximum surge pressure of the steel pipe. This system will require a surge protection device to protect against damage due to such spikes in pressure. Pressure waves are not known to move past significant changes in pipeline direction such as 90° bends. Pressure waves

will rebound off pipe bends and reverse direction. Surge protection devices should be focused at opposing ends of long, straight sections of pipe. Generally, in pipelines increasing in elevation along their lengths, the lowest point will experience a spike in pressure while high points will experience severe decreases in pressure. For this reason, a surge tank or several pressure relief valves should be placed at the downhill side of long stretches of straight pipe in this system, before the pipe changes direction. Additionally, vacuum relief valves must be installed at the uphill sides of long stretches of straight pipe and at other high points throughout the system.

With pipeline route option 1, the logical placement of a surge tank for this system would be at the 90° bend after the pipeline turns uphill along Highway OR-74. Elevation changes rapidly after this point in the pipeline and there would be zero bends in the pipe between this point and the booster station option 1. Elevation continues to increase after this booster station. A second surge tank would need to be installed after booster station option 1 to protect the booster station discharge manifold.

For pipeline route option 2, a surge tank would be installed near the pipe bend after the pipeline crosses under the railroad and turns 90° to continue south. Additionally, a surge tank will be installed downstream of the booster station option 2 discharge manifold.

To further increase system protection against pressure surges, pressure relief valves at the discharge of each pump would be installed to quickly relieve excessive pressure in the system.

4.0 COUNTY LINE DISTRIBUTION SYSTEM

The conceptual design of the County Line pipeline route would take the pipeline to the Gilliam/Morrow County line by continuing along the rail bed past the southern intersection of Rhea Road and OR-74 for approximately 2.75 miles.

Because this route would include fewer user turnouts, it would be sized to distribute a smaller volume of water. Additionally, the overall increase in elevation along this pipeline route would be significantly less than the previously discussed options and would require a far shorter length of pipe.

The end-of-line elevation at the Gilliam/Morrow County line is approximately 460 ft. The total length of pipe required to reach the Gilliam/Morrow County line along this route would be approximately 46,581 ft (Figure 3).

The County Line pipeline route ending at the Gilliam/Morrow County line would not be easily accessible to the majority of the landowners identified in the Land Distribution map (Appendix A). It is estimated that only 2,280 acres of land could receive water from this pipeline route without the need to traverse long distances. The required flow rate to irrigate 2,280 acres would be approximately 17,100 gpm. This flow rate is equivalent to 38 cubic feet per second.

4.1 Pipeline

A 42-inch C900 DR-25 PVC pipeline would allow for a flow velocity of 4.21 fps to supply the necessary flow rate within the 46,581 ft of pipeline (Figure 3).

4.2 Pump Station

The pump station will deliver 30 psi at the end of the line with a required power of approximately 2,500 hp. To provide system variability and to maintain satisfactory operation in the event of an inoperable pump, the system would be made up of two 250 hp turbine pumps, two 500 hp turbine pumps, and a single 1,000 hp turbine pump. System variability would be achieved by operating the 1,000 hp pump with a VFD. To protect the pump system and minimize load spikes on the electrical grid, the remaining turbine pumps would each be controlled by a soft-start. Control logic will command each of the single speed pumps on and off as required by system demand.

4.3 Power Requirements

The electrical power required to operate this system would be approximately 1,500 kilowatt (kW). This would require a far less complicated electrical service than that required by the previously discussed systems. Unlike the other pump stations and booster stations, the pump station required for this system would not require a substation to be installed as the power load would be far smaller and could be controlled by transformers.

4.4 Surge Protection

Because flow velocities along the pipeline for the alternate system are much slower than those in the other two options, maximum surge pressure will be far less. The maximum surge pressure experienced in the County Line pipeline would be approximately 280 psi. According the JM Eagle (PVC manufacturer) DR-25 PVC has a minimum burst pressure of 535 psi. An increase in pressure of 280 psi above the normal operating pressure of 156 psi at the pump station would result in a surge pressure of less than 436 psi. However, to protect valves and pumps, surge protection valves would be installed downstream of the check valve on the discharge line for each pump.

5.0 CAPITAL AND OPERATING COST ESTIMATES

The following section summarizes the capital and operating cost estimates for each option (Tables 1 through 6). These cost summary tables were developed based on detailed information provided in Appendix B.

5.1 Capital Cost Estimates

The estimated capital cost for implementing the Eight Mile Canyon distribution system would be between $58,600,000 and $68,000,000 (Tables 1 through 4). The estimated capital cost for implementing the County Line distribution system is expected to range from $9,340,000 to $15,300,000 (Table 5 and 6).

The following assumptions apply for the capital cost estimates prepared for this assessment:

- All costs are budgetary in nature and commensurate with the level of accuracy for a planning report such as this with conceptual designs. Costs are likely to be within +/- 25% if executed today, given the limited level of project detail known at this time. It is likely that by teaming with a preferred contractor and vendor(s), value engineering on a selected option could further refine and reduce the cost.

- Geotechnical information for the construction sites is very limited at this time. There will be extensive quantities of rock to excavate, or hammer out, and depth to bedrock is shallow in many places. The cost estimates in this report do not fully incorporate costs for ripping and removal of large quantities of bedrock.
- Depth to groundwater is unknown through the proposed construction sites, and could impact constructability and cost.
- Typical of these types of projects, professional services (i.e., permitting, engineering design, project administration, etc.) were assumed to be 3% of the construction cost.
- A 10% contingency factor was added to the construction cost to account for variation in estimated cost for stated line items, and to account for costs that may have been missed in this first round, budgetary estimate.
- Cost estimates do not include any land purchases.

5.2 Operating and Maintenance Cost Estimates

Pacific Power and Light (PP&L) was contacted for guidance in determining the cost to operate pump stations of the sizes defined in previous sections. PP&L provided an estimated cost rate of $0.093 per kilowatt hour (kWh). The estimated operational cost for the main pump station and each booster station, assuming 24 hours per day and 7 days per week, is presented in this section. The monthly rates for spring and fall months will be less since total irrigation operation will be less compared to the summer months. Operating costs are based on 4,000 hour per year of pumping.

Main Pump Station (13.4×10^6 Watts)

The estimated cost to operate the main pump station is $897,264 per month.

Booster Station Option 1 (9.4×10^6 Watts)

The estimated costs to operate booster station option 1 is $629,424 per month.

Booster Station Option 2 (10.5×10^6 Watts)

The estimated cost to operate booster station option 2 is $703,080 per month.

County Line Pump Station (1,500 kW)

The estimated cost to operate the County Line pump station is $100,440 per month.

While power constitutes most of the operating costs associated with the system, additional funds were designated for an operator (2.5 full time equivalent employees), general repair and maintenance on the pumps (estimated at 3% of the intial purchase price), and miscellaneous upkeep of the pump stations, valves, etc., The estimated total operations and maintenance (O&M) cost for the pumping system is expected to range between 8,800,888 and 9,300,000 per year (Tables 1 through 4) while the O&M for the County Line option would be much lower at $663,000 (Table 5 and 6).

5.3 Turnout Pump Station/Field Development Cost Estimates

Most of the turnout locations along the main pipeline will require a privately-owned individual pump station to deliver water to the field areas to be irrigated. To estimate the cost of the individual pump stations at the turnout locations a matrix of potential flow rates, an elevation increase of 300 ft, and pipeline distances to the fields to be irrigated were summarized and the associated costs determined. The cost ranges used were ±20% of the median prices for a range of different sized pumps and variable frequency drives. Pipe prices were estimated at \$0.04 per in^3 of material. Electrical prices were estimated at a rate of \$0.08 per kWh. Total power cost per year is based on 4,000 hours per year of irrigation.

Examples of the individual pump station cost estimates are presented here so that the individual landowners can get an estimate of their potential capital and operating costs. The following flows and pipeline distances were used with an assumed elevation increase of 300 ft.

- 10,000 gpm over 5,000 ft = \$468,633 capital cost and \$422,905 per year power cost
- 5,000 gpm over 2,500 ft = \$175,990 capital cost and \$209,857 per year power cost
- 3,000 gpm over 1,000 ft = \$86,551 capital cost and \$123,857 per year power cost
- 1,000 gpm over 1,000 ft = \$43,896 capital cost and \$41,833 per year power cost

It was also assumed that all fields would have a new 100-acre center pivot installed, valued at \$100,000 for budgeting purposes.

To provide water from the main pipeline system to individual fields, the total combined capital cost to cover all 15,000 acres (i.e., 150 fields) was estimated at a little over \$20,000,000.

5.4 Economic Impact

The estimated average annual capital and operating outlays for a 30-year period were developed to assess the economic impact of irrigation development in this region. This assessment assumes that the project can be completed and be operational in one year (year 0). For this assessment, CES assumed the following:

- 30-year period
- 15-year service life on the pumps
- 25-year service life on the pivots
- No salvage value on pumps or pivots
- 100-year service life on the main pipeline and concrete
- An average annual inflation rate of 2.18% on the pumps

Details regarding this assessment are provided in Appendix C for each option reviewed. As shown, CES assumed that the pumps would need to be replaced in year 15 on the main pump system and the turnouts. The pivots would be replaced at year 25.

For income, CES assumed that the direct net return would be $425 per acre. Since this is the estimated land rental rate for irrigated cropland, the variable expenses associated with crop production (i.e., power, planting, fertilizer, etc.) were assumed to be already accounted for, hence there is no operating cost associated with "Land Owner". In addition to the direct income, CES reviewed various sources to ascertain the potential indirect income that could result from cropland conversion (i.e., the economic spillovers to supporting industries, labor and proprietor income). Based on information regarding the IMPLAN economic model, a multiplier of 1.85 would not be unrealistic (i.e., for every $1 realized in direct farm income, the community should see an additional $0.85 in indirect economic benefit).

A side-by-side comparison of the system options reviewed is shown on Table 7. This table indicates that the area could see a positive return after 30 years for Option 1 and after about 15 years for Option 3. Option 2, on the other hand, remains at a negative return after 30 years. Please note that this is a very general and broad method for ascertaining the economic benefit to the area. Additional assessments will be required to refine the potential for profitability on a County and individual farm basis.

6.0 WATER RIGHTS

The Port owns several acres along the Columbia River near the mouth of Willow Creek, and the City of Arlington (City) has a municipal surface water right (Appendix D). In addition, several landowners are interested in whether individual water rights could be utilized by the Port/City for the development of large-scale irrigation as described in this report.

Based on our review of the project, City municipal surface water right, Oregon Revised Statutes (ORS), and discussion with Oregon Water Resource Department (OWRD) staff, the following can be done:

- The City's new water right permit S-54814 (attached) grants the right to 8.16 cubic feet per second (cfs) from the Columbia River (surface water).
    - The use of the water is municipal. OWRD views municipal as the broadest of the water use categories as it includes irrigated agriculture among the many uses allowed.
    - The place of use is confined to specific quarter-quarters of Sections 21, 28, and 29 of Township 3 North, Range 21 East of the Willamette Meridian.
    - The water is subject to development limitations, of which is that any water beyond 2.67 cubic feet per second (cfs, non-limited water or referred to as "green-light water") shall only be authorized upon issuance of a final order approving a Water Management and Conservation Plan (WMCP) under OAR Chapter 690, Division 86 that authorizes access to a greater rate of diversion under the permit consistent with OAR 690-086-0130(7).
    - Anderson Perry & Associates, Inc. is working on the update of the WMCP. The Port may want to include interested landowners who want water rights (i.e., either new or those with existing surface water rights) to justify an increase in the development of the "green-light water" in the updated WMCP.

    - The City can provide water outside their recognized service area in accordance with ORS 540.510. An important limitation in the permit is a mandate for minimum flow conditions to maintain the persistence of listed fish in the Columbia River during two times of the year (April 10 to June 30 and July 1 to August 31). The periods coincide with the typical irrigation season. The respective minimum flows at the McNary Dam near Umatilla, Oregon are 260,000 and 200,000 cfs, respectively. At times when flows are low, the maximum amount of the undeveloped portion of the permit can be diverted (reduced) as a result of a fish persistence condition per the calculations provided in the permit (Appendix B).

- Surface water rights can be transferred between new and existing surface water rights through a permanent or time-limited point of diversion (POD) and place of use (POU) transfer from individual landowners to the Port. For the landowner to retain their water rights, their permit must be exercised to the full extent (irrigation of all acreage) once during a five-year cycle. Five years of non-use of their water right is subject to cancellation. Because, landowners may not have enough irrigation equipment to irrigate to the full acreage in one season, fulfilling the requirement of their permit would need to be completed over multiple years. In addition, managing this for several landowners can be complex.
- Groundwater rights can be transferred between new and existing groundwater rights through a permanent or time-limited point of appropriation (POA) and POU transfer from individual landowners to the Port if it can be proven that the water is drawn from the same source (aquifer). If the City or Port has a groundwater permit, this could be an option.
- Groundwater rights cannot be transferred to surface water rights.
- Transferring groundwater right POU to another piece of land that already has a water right can cause concerns for "stacking" water rights. This happens when the Department tends to treat them as joined and can result in the loss of the former water right. This should be avoided if possible. The best scenario is to transfer to virgin land with no water rights on it.
- If irrigating land with water requirement greater than 8.16 cfs is desired, then an additional source of permitted water will be needed.

The Eight Mile Canyon distribution system (pipeline route options 1 and 2) will require approximately 252 cubic feet per second, while the County Line distribution system (pipeline route option 3) will require approximately 38 cubic feet per second. Based on the assumptions and flow rate described above, additional permitted water sources of 244 or 30 cfs would be needed to meet the Eight Mile or County Line distribution system irrigation needs, respectively.

Keep in mind, that any water rights transaction will be scrutinized by the public through public comment notices, records review, or other less formal means.

7.0 CONCLUSIONS

The economic feasibility to develop additional irrigated agriculture in Gilliam County was assessed based on an estimated 15,000 acres of land identified by interested landowners along Willow Creek and Eight Mile Canyon; as well as an estimated 2,280 acres to the County Line along Willow

Creek. The preliminary goal was to determine the economic feasibility of supplying water to the identified areas in regards to distance, volume, and elevation based on capital and operating costs.

Based on a general economic assessment, the conversion of 15,000 acres of cropland to irrigated agriculture will require approximately over $60,000,000 of capital investment for the main water delivery system and another $20,000,000 in on-farm development. Combined with O&M costs in the range of $9,000,000 per year, the project may take over 30 years before a positive economic benefit is observed. The County Line option, although a much smaller project, has a faster potential for reaching a positive future return.

In addition, a discussion on water rights was required to understand what options the Port/City and landowners have for utilizing existing water rights. This assessment indicates that the current water right is significantly less than the amount of water needed. There is a need to develop additional sources of permitted water to meet the project vision.

As shown by this assessment, implementing this system is an expensive undertaking. Further design and analysis, including confirmation of the route, access to Willow Lake, obtaining additional water rights, etc., would be required to confirm that the initial preliminary cost estimates can be managed to acceptable levels. CES estimates that the design and permitting would take at least a year to complete. Assuming qualified contractors can be procured and scheduled, the work can most likely be completed within two years. The rate of irrigation uptake (i.e., the rate at which farmland is converted to irrigation based on accessibility to irrigation water service) will need to be assessed and incorporated into the economic analysis to determine a more realistic schedule of economic benefit.

TABLES

Table 1. Option 1a Cost Summary

Capital Costs	
Description	**Amount**
River Station Pumps	$ 3,792,100
Booster Station Pumps	$ 2,638,600
Infrastructure	$ 2,133,000
Piping	$ 48,024,100
Construction Services	$ 3,564,200
Construction Subtotal	**$ 60,152,000**
Contingency @ 10%	$ 6,015,200
Professional Services @ 3%	$ 1,805,000
TOTAL CAPITAL PROJECT COSTS	**$ 67,972,200**

Annual Operation and Maintenance Costs	
Description	**Amount**
Labor	$ 125,000
Materials	$ 20,400
Maintenance/Repairs	$ 209,000
Power	$ 8,396,800
Annual O&M Subtotal	**$ 8,751,200**
Contingency @ 1%	$ 88,000
TOTAL ANNUAL O&M COSTS	**$ 8,839,200**

NOTES:

Refer to Appendix B for cost source information and details.

Estimated costs do not include any land purchases or on-farm irrigation development.

All costs are in 2018 dollars.

Table 2. Option 1b Cost Summary

Capital Costs	
Description	**Amount**
River Station Pumps	$ 3,792,100
Booster Station Pumps	$ 2,638,600
Infrastructure	$ 2,133,000
Piping	$ 40,024,100
Construction Services	$ 3,564,200
Construction Subtotal	**$ 52,152,000**
Contengency @ 10%	$ 5,215,200
Professional Services @ 3%	$ 1,565,000
TOTAL CAPITAL PROJECT COSTS	**$ 58,932,200**

Annual Operation and Maintenance Costs	
Description	**Amount**
Labor	$ 125,000
Materials	$ 20,400
Maintenance/Repairs	$ 209,000
Power	$ 8,396,800
Annual O&M Subtotal	**$ 8,751,200**
Contengency @ 1.0%	$ 88,000
TOTAL ANNUAL O&M COSTS	**$ 8,839,200**

NOTES:

Refer to Appendix B for cost source information and details.

Estimated costs do not include any land purchases or on-farm irrigation development.

All costs are in 2018 dollars.

Table 3. Option 2a Cost Summary

Capital Costs	
Description	**Amount**
River Station Pumps	$ 3,792,100
Booster Station Pumps	$ 2,937,600
Infrastructure	$ 2,133,000
Piping	$ 47,488,900
Construction Services	$ 3,509,800
Construction Subtotal	**$ 59,861,400**
Contengency @ 10%	$ 5,986,100
Professional Services @ 3%	$ 1,796,000
TOTAL CAPITAL PROJECT COSTS	**$ 67,643,500**

Annual Operation and Maintenance Costs	
Description	**Amount**
Labor	$ 125,000
Materials	$ 21,300
Maintenance/Repairs	$ 218,000
Power	$ 8,801,900
Annual O&M Subtotal	**$ 9,166,200**
Contengency @ 1.0%	$ 92,000
TOTAL ANNUAL O&M COSTS	**$ 9,258,200**

NOTES:

Refer to Appendix B for cost source information and details.

Estimated costs do not include any land purchases or on-farm irrigation development.

All costs are in 2018 dollars.

Table 4. Option 2b Cost Summary

Capital Costs	
Description	**Amount**
River Station Pumps	$ 3,792,100
Booster Station Pumps	$ 2,937,600
Infrastructure	$ 2,133,000
Piping	$ 39,488,900
Construction Services	$ 3,509,800
Construction Subtotal	**$ 51,861,400**
Contengency @ 10%	$ 5,186,100
Professional Services @ 3%	$ 1,556,000
TOTAL CAPITAL PROJECT COSTS	**$ 58,603,500**

Annual Operation and Maintenance Costs	
Description	**Amount**
Labor	$ 125,000
Materials	$ 21,300
Maintenance/Repairs	$ 218,000
Power	$ 8,801,900
Annual O&M Subtotal	**$ 9,166,200**
Contengency @ 1.0%	$ 92,000
TOTAL ANNUAL O&M COSTS	**$ 9,258,200**

NOTES:

Refer to Appendix B for cost source information and details.

Estimated costs do not include any land purchases or on-farm irrigation development.

All costs are in 2018 dollars.

Table 5. Option 3a Cost Summary

Capital Costs	
Description	**Amount**
River Station Pumps	$ 632,300
Booster Station Pumps	$ -
Infrastructure	$ 918,000
Piping	$ 11,161,700
Construction Services	$ 753,800
Construction Subtotal	**$ 13,465,800**
Contengency @ 10%	$ 1,346,600
Professional Services @ 3%	$ 404,000
TOTAL CAPITAL PROJECT COSTS	**$ 15,216,400**

Annual Operation and Maintenance Costs	
Description	**Amount**
Labor	$ 75,000
Materials	$ 2,400
Maintenance/Repairs	$ 26,000
Power	$ 552,400
Annual O&M Subtotal	**$ 655,800**
Contengency @ 1.0%	$ 7,000
TOTAL ANNUAL O&M COSTS	**$ 662,800**

NOTES:

Refer to Appendix B for cost source information and details.

Estimated costs do not include any land purchases or on-farm irrigation development.

All costs are in 2018 dollars.

Table 6. Option 3b Cost Summary

Capital Costs		
Description		**Amount**
River Station Pumps	$	632,300
Booster Station Pumps	$	-
Infrastructure	$	918,000
Piping	$	5,961,700
Construction Services	$	753,800
Construction Subtotal	**$**	**8,265,800**
Contengency @ 10%	$	826,600
Professional Services @ 3%	$	248,000
TOTAL CAPITAL PROJECT COSTS	**$**	**9,340,400**

Annual Operation and Maintenance Costs		
Description		**Amount**
Labor	$	75,000
Materials	$	2,400
Maintenance/Repairs	$	26,000
Power	$	552,400
Annual O&M Subtotal	**$**	**655,800**
Contengency @ 1.0%	$	7,000
TOTAL ANNUAL O&M COSTS	**$**	**662,800**

NOTES:

Refer to Appendix B for cost source information and details.

Estimated costs do not include any land purchases or on-farm irrigation development.

All costs are in 2018 dollars.

Table 7. Captial and Operating Cost Summary

Option	Description	Main Pumping System[1]		Land Owner[2]	Total Revenue Balance (30 yrs)[3]
		Capital Cost	O&M Cost	Capital Cost	
1a	Eight Mile Canyon Distribution System via Wind Energy Route - River Source	$ 67,972,200	$ 8,839,200	$ 20,022,025	$ 2,623,320
1b	Eight Mile Canyon Distribution System via Wind Energy Route - Willow Lake Source	$ 58,932,200	$ 8,839,200	$ 20,022,025	$ 11,663,320
2a	Eight Mile Canyon Distribution System via BLM Road Route - River Source	$ 67,643,500	$ 9,258,200	$ 20,022,025	$ (15,327,964)
2b	Eight Mile Canyon Distribution System via BLM Road Route - Willow Lake Source	$ 58,603,500	$ 9,258,200	$ 20,022,025	$ (6,287,964)
3a	County Line Distribution System - River Source	$ 15,216,400	$ 662,800	$ 3,900,000	$ 21,281,044
3b	County Line Distribution System - Willow Lake Source	$ 9,340,400	$ 662,800	$ 3,900,000	$ 27,157,044

NOTES:

Abbreviations: O&M = operation and maintenance.

1 Refer to Appendix B for cost source information and details.

2 Landowner capital costs include pivots, piping, and pumps to deliver the water from the mainline to the irrigated fields for the entire system. The following systems (flow and distance) were used to estimate the average cost of the piping and pumps assuming a 300 foot elevation increase from pump to field: eight 10,000 gpm at 5,000 ft; three 5,000 gpm at 2,500 ft; one 3,000 gpm at 1,000 ft; and fifteen 1,000 gpm at 1,000 ft. The average was scaled from 15,000 acres to 2,280 acres for options 3a and 3b.

3 Refer to Appendix C for revenue balance information and details.

FIGURES

PUMP STATION LOCATION ON WILLOW LAKE
OR PORT OF ARLINGTON PROPERTY (17,500 HP)
113,000 GPM

WILLOW LAKE

COLUMBIA RIVER

HIGHWAY OR-74

72" CML STD WALL STEEL
16,610 FT

BOOSTER STATION OPTION 1 (12,500 HP)
95,410 GPM AT THE NORTHERN
INTERSECTION OF OR-74 AND RHEA RD.

CAITHNESS SHEPHERDS
FLAT WIND FARM

72" CML STD WALL STEEL
33,005 FT

TURNOUT
93,636 GPM

72" CML STD WALL STEEL
13,514 FT

66" CML STD WALL STEEL
2,108 FT

TURNOUT
82,416 GPM

54" C900 PVC DR-25
5,558 FT

TURNOUT
56,283 GPM

54" C900 PVC DR-25
7,382 FT

TURNOUT
54,363 GPM

54" C900 PVC DR-25
4,512 FT

TURNOUT
52,278 GPM

TURNOUT
41,418 GPM

48" C900 PVC DR-25
12,168 FT

END-OF-LINE
- 41,418 GPM
- TOTAL PIPELINE LENGTH: 94,857 FT

EXPLANATION

CML	CEMENT MORTAR LINED
STD	STANDARD
GPM	GALLONS PER MINUTE
FT	FEET
HP	HORSEPOWER
PVC	POLYVINYL CHLORIDE

N

0 1 MILE
1"=5280'

Figure 1. Pipline Route Option 1

PROJECT NUMBER: 2018230015	Economic Feasibility Assesment, Irrigated Agriculture for Lower Willow Creek Drainage
DATE: 11/07/2018	
DWG NO: 2018230015 ROUTE OPTION 1 MAP.DWG	Port of Arlington Arlington, Oregon
DWG BY: ZBB / PROJECT MANAGER: SV	
REVISED:	CASCADE EARTH SCIENCES

S:\Port Of Arlington\2018230015 Economic Assessment\Pipeline Route\2018230015 Route Option 1 Map.dwg December 4, 2018 DR702784

Figure 2. Pipeline Route Option 2

PROJECT NUMBER: 2018230015	Economic Feasibility Assesment, Irrigated Agriculture for Lower Willow Creek Drainage
DATE: 11/07/2018	
DWG NO: 2018230015 ROUTE OPTION 2 MAP.DWG	Port of Arlington Arlington, Oregon
DWG BY: ZBB / PROJECT MANAGER: SV	
REVISED:	CASCADE EARTH SCIENCES

S:\Port Of Arlington\2018230015 Economic Assessment\Pipeline Route\2018230015 Route Option 2 Map.dwg December 6, 2018 DR702784

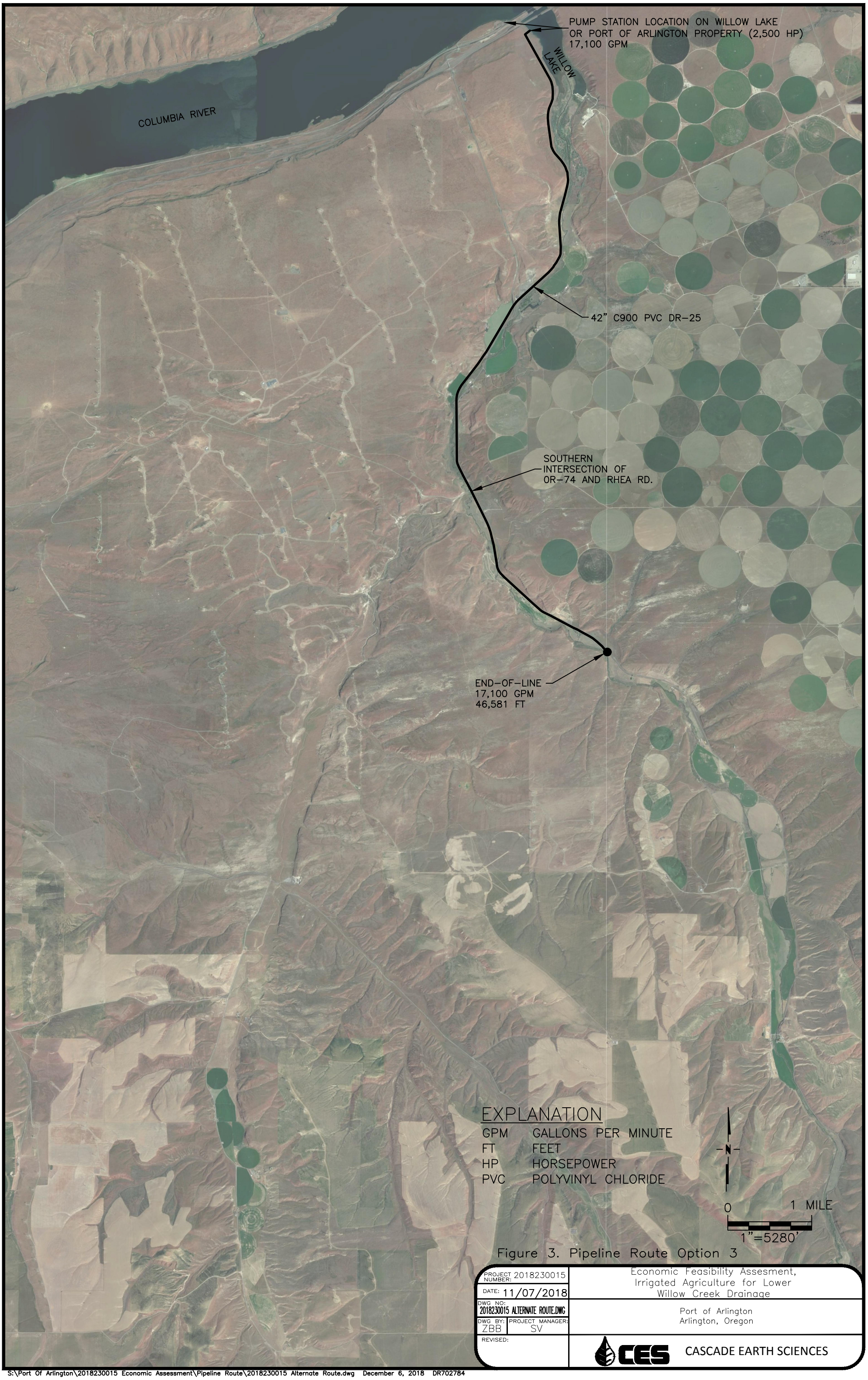


Figure 3. Pipeline Route Option 3

PROJECT NUMBER: 2018230015	Economic Feasibility Assesment, Irrigated Agriculture for Lower Willow Creek Drainage
DATE: 11/07/2018	
DWG NO: 2018230015 ALTERNATE ROUTE.DWG	Port of Arlington Arlington, Oregon
DWG BY: ZBB / PROJECT MANAGER: SV	
REVISED:	CASCADE EARTH SCIENCES

S:\Port Of Arlington\2018230015 Economic Assessment\Pipeline Route\2018230015 Alternate Route.dwg December 6, 2018 DR702784

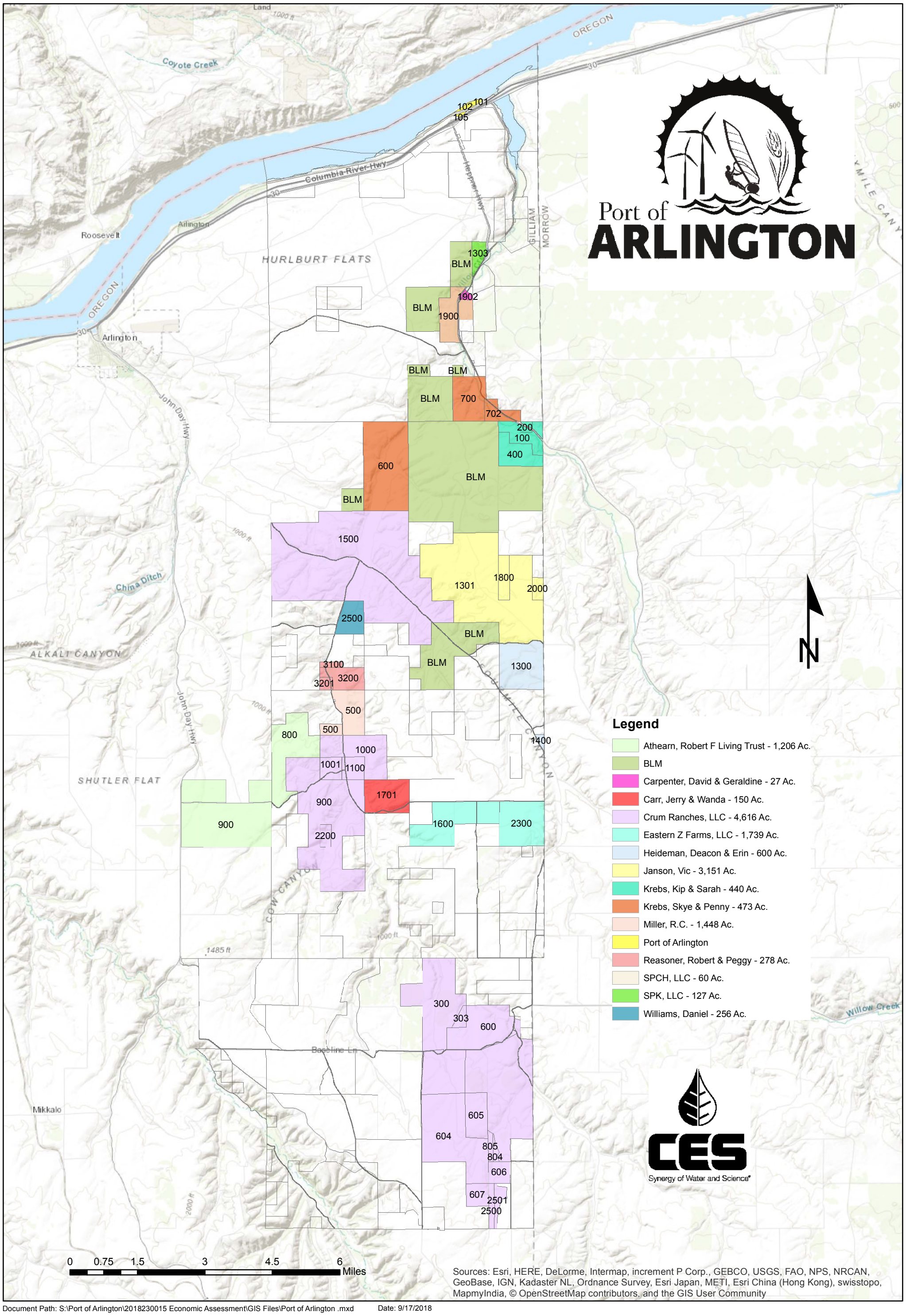
APPENDICES

Appendix A.

Potential Irrigated Agriculture for Lower Willow Creek Drainage

Port of Arlington Economic Feasibility Assessment

Irrigated Agriculture for Lower Willow Creek Drainage



Document Path: S:\Port of Arlington\2018230015 Economic Assessment\GIS Files\Port of Arlington .mxd Date: 9/17/2018

Appendix B.

Cost Details

Appendix B1. Cost Detail
Option 1a 8-Mile Canyon Distribution System

Capital Costs

Item	Qty	Unit Cost	Unit	Amount
River Station Pumps				
1750 hp Pump	1	$186,300	ea.	$186,300
1750 hp Motor	1	$109,250	ea.	$109,300
1500 hp Pump	10	$162,000	ea.	$1,620,000
1500 hp Motor	10	$95,000	ea.	$950,000
1000 hp Pump	1	$137,700	ea.	$137,700
1000 hp Motor	1	$80,750	ea.	$80,800
2000 hp VFD	1	$250,000	ea.	$250,000
1500 hp Soft Start	10	$42,000	ea.	$420,000
1000 hp Soft Start	1	$38,000	ea.	$38,000
River Station Pumps Subtotal:				**$3,792,100**
Booster Station Pumps				
1750 hp Pump	1	$186,300	ea.	$186,300
1750 hp Motor	1	$109,250	ea.	$109,300
1500 hp Pump	7	$162,000	ea.	$1,134,000
1500 hp Motor	7	$95,000	ea.	$665,000
2000 hp VFD	1	$250,000	ea.	$250,000
1500 hp Soft Start	7	$42,000	ea.	$294,000
Booster Station Pumps Subtotal:				**$2,638,600**
Infrastructure				
Block Building, Climate Controlled	580	$200	per ft^2	$116,000
Electrical Substation and Lines	2	$500,000	ea.	$1,000,000
Suction Screens	24	$33,000	ea.	$792,000
Surge Tank	2	$100,000	ea.	$200,000
14" Surge Valves	10	$2,500	ea.	$25,000
Infrastructure Subtotal:				**$2,133,000**
Piping				
72" STD Steel Pipe	63209	$294	per ft	$18,557,800
66" STD Steel Pipe	2108	$269	per ft	$567,100
24" STD Steel Pipe	180	$97	per ft	$17,400
54" PVC DR-25	17452	$342	per ft	$5,968,600
48" PVC DR-25	12167	$262	per ft	$3,187,800
Steel Pipe CML lining 72" Pipe	63209	$180	per ft	$11,377,600
Steel Pipe CML lining 66" Pipe	2108	$165	per ft	$347,800
86" Boring (72" pipe)	800	$10,000	per ft	$8,000,000
Piping Subtotal:				**$48,024,100**
Construction Services				
Excavation	95116	$15	per ft	$1,426,700
Welding/Construction	16800	$125	per hr	$2,100,000
Electrical	300	$125	per hr	$37,500
Construction Subtotal:				**$3,564,200**
Subtotal:				**$60,152,000**
Contingency:			**10%**	**$6,015,200**
Professional Services (Permitting, Design, Project Administration, etc.)			**3%**	**$1,805,000**
TOTAL CAPITAL PROJECT COSTS:				**$67,972,200**

NOTES:

Abbreviations: ea = each, ft = foot, ft^2 = square foot, hr = hour.

1 Cost estimates are considered Order of Magnitude in nature and are likely to be within +/- 25% to total cost presented.

2 Estimated costs do not include any land purchases or on-farm irrigation development.

3 Pricing based on vendor estimates and engineering scaling cost estimating techniques.

Appendix B1. Cost Detail
Option 1a 8-Mile Canyon Distribution System

Annual Operation and Maintenance Costs

Item	Qty	Unit Cost	Unit	Amount
River Station Pumps				
Labor	1	$50,000	fte	$50,000
Materials	1	$11,400	ls	$11,400
Maintenance/repairs	1	$114,000	ls	$114,000
Utilities	5.5	$897,264	ls	$4,935,000
			River Station Pumps Subtotal:	**$5,110,400**
Booster Station Pumps				
Labor	1	$50,000	fte	$50,000
Materials	1	$7,900	ls	$7,900
Maintenance/repairs	1	$79,000	ls	$79,000
Utilities	5.5	$629,424	ls	$3,461,800
			Booster Station Pumps Subtotal:	**$3,598,700**
Infrastructure				
Labor	0.5	$50,000	fte	$25,000
Materials	1	$1,100	ls	$1,100
Maintenance/repairs	1	$11,000	ls	$11,000
Utilities	0	$0	ea.	$0
			Infrastructure Subtotal:	**$37,100**
Piping				
Labor	0	$50,000	fte	$0
Materials	0	$0	ls	$0
Maintenance/repairs	1	$5,000	ls	$5,000
Utilities	0	$0	ls	$0
			Piping Subtotal:	**$5,000**
			Subtotal:	**$8,751,200**
			Contingency: **1%**	**$88,000**
			TOTAL ANNUAL O&M COSTS	**$8,839,200**

NOTES:

Abbreviations: fte = full-time employee, ls = lump sum.

1 Cost estimates are considered Order of Magnitude in nature and are likely to be within +/- 25% to total cost presented.

2 Labor requirement assumed to be at $40,000 per year plus 25% for fringe and benefits

3 Maintenance/repairs assumed at 3% of original pump cost and 1% of infrastucture cost.

4 Utilities is based on estimates provided by local power company.

Appendix B2. Cost Detail
Option 1b 8-Mile Canyon Distribution System

Capital Costs

Item	Qty	Unit Cost	Unit	Amount
River Station Pumps				
1750 hp Pump	1	$186,300	ea.	$186,300
1750 hp Motor	1	$109,250	ea.	$109,300
1500 hp Pump	10	$162,000	ea.	$1,620,000
1500 hp Motor	10	$95,000	ea.	$950,000
1000 hp Pump	1	$137,700	ea.	$137,700
1000 hp Motor	1	$80,750	ea.	$80,800
2000 hp VFD	1	$250,000	ea.	$250,000
1500 hp Soft Start	10	$42,000	ea.	$420,000
1000 hp Soft Start	1	$38,000	ea.	$38,000
River Station Pumps Subtotal:				**$3,792,100**
Booster Station Pumps				
1750 hp Pump	1	$186,300	ea.	$186,300
1750 hp Motor	1	$109,250	ea.	$109,300
1500 hp Pump	7	$162,000	ea.	$1,134,000
1500 hp Motor	7	$95,000	ea.	$665,000
2000 hp VFD	1	$250,000	ea.	$250,000
1500 hp Soft Start	7	$42,000	ea.	$294,000
Booster Station Pumps Subtotal:				**$2,638,600**
Infrastructure				
Block Building, Climate Controlled	580	$200	per ft^2	$116,000
Electrical Substation and Lines	2	$500,000	ea.	$1,000,000
Suction Screens	24	$33,000	ea.	$792,000
Surge Tank	2	$100,000	ea.	$200,000
14" Surge Valves	10	$2,500	ea.	$25,000
Infrastructure Subtotal:				**$2,133,000**
Piping				
72" STD Steel Pipe	63209	$294	per ft	$18,557,800
66" STD Steel Pipe	2108	$269	per ft	$567,100
24" STD Steel Pipe	180	$97	per ft	$17,400
54" PVC DR-25	17452	$342	per ft	$5,968,600
48" PVC DR-25	12167	$262	per ft	$3,187,800
Steel Pipe CML lining 72" Pipe	63209	$180	per ft	$11,377,600
Steel Pipe CML lining 66" Pipe	2108	$165	per ft	$347,800
86" Boring (72" pipe)	0	$10,000	per ft	$0
Piping Subtotal:				**$40,024,100**
Construction Services				
Excavation	95116	$15	per ft	$1,426,700
Welding/Construction	16800	$125	per hr	$2,100,000
Electrical	300	$125	per hr	$37,500
Construction Subtotal:				**$3,564,200**
Subtotal:				**$52,152,000**
Contingency:			**10%**	**$5,215,200**
Professional Services (Permitting, Design, Project Administration, etc.)			**3%**	**$1,565,000**
TOTAL CAPITAL PROJECT COSTS:				**$58,932,200**

NOTES:

Abbreviations: ea = each, ft = foot, ft^2 = square foot, hr = hour.

1 Cost estimates are considered Order of Magnitude in nature and are likely to be within +/- 25% to total cost presented.

2 Estimated costs do not include any land purchases or on-farm irrigation development.

3 Pricing based on vendor estimates and engineering scaling cost estimating techniques.

Appendix B2. Cost Detail
Option 1b 8-Mile Canyon Distribution System

Annual Operation and Maintenance Costs

Item	Qty	Unit Cost	Unit	Amount
River Station Pumps				
Labor	1	$50,000	fte	$50,000
Materials	1	$11,400	ls	$11,400
Maintenance/repairs	1	$114,000	ls	$114,000
Utilities	5.5	$897,264	ls	$4,935,000
River Station Pumps Subtotal:				**$5,110,400**
Booster Station Pumps				
Labor	1	$50,000	fte	$50,000
Materials	1	$7,900	ls	$7,900
Maintenance/repairs	1	$79,000	ls	$79,000
Utilities	5.5	$629,424	ls	$3,461,800
Booster Station Pumps Subtotal:				**$3,598,700**
Infrastructure				
Labor	0.5	$50,000	fte	$25,000
Materials	1	$1,100	ls	$1,100
Maintenance/repairs	1	$11,000	ls	$11,000
Utilities	0	$0	ea.	$0
Infrastructure Subtotal:				**$37,100**
Piping				
Labor	0	$50,000	fte	$0
Materials	0	$0	ls	$0
Maintenance/repairs	1	$5,000	ls	$5,000
Utilities	0	$0	ls	$0
Piping Subtotal:				**$5,000**
Subtotal:				**$8,751,200**
Contingency:			**1.0%**	**$88,000**
TOTAL ANNUAL O&M COSTS				**$8,839,200**

NOTES:

Abbreviations: fte = full-time employee, ls = lump sum.

1 Cost estimates are considered Order of Magnitude in nature and are likely to be within +/- 25% to total cost presented.

2 Labor requirement assumed to be at $40,000 per year plus 25% for fringe and benefits

3 Maintenance/repairs assumed at 3% of original pump cost and 1% of infrastucture cost.

4 Utilities is based on estimates provided by local power company.

Appendix B3. Cost Detail
Option 2a 8-Mile Canyon Distribution System

Capital Costs

Item	Qty	Unit Cost	Unit	Amount
River Station Pumps				
1750 hp Pump	1	$186,300	ea.	$186,300
1750 hp Motor	1	$109,250	ea.	$109,300
1500 hp Pump	10	$162,000	ea.	$1,620,000
1500 hp Motor	10	$95,000	ea.	$950,000
1000 hp Pump	1	$137,700	ea.	$137,700
1000 hp Motor	1	$80,750	ea.	$80,800
2000 hp VFD	1	$250,000	ea.	$250,000
1500 hp Soft Start	10	$42,000	ea.	$420,000
1000 hp Soft Start	1	$38,000	ea.	$38,000
River Station Pumps Subtotal:				**$3,792,100**
Booster Station Pumps				
1750 hp Pump	1	$186,300	ea.	$186,300
1750 hp Motor	1	$109,250	ea.	$109,300
1500 hp Pump	8	$162,000	ea.	$1,296,000
1500 hp Motor	8	$95,000	ea.	$760,000
2000 hp VFD	1	$250,000	ea.	$250,000
1500 hp Soft Start	8	$42,000	ea.	$336,000
Booster Station Pumps Subtotal:				**$2,937,600**
Infrastructure				
Block Building, Climate Controlled	580	$200	per ft^2	$116,000
Electrical Substation and Lines	2	$500,000	ea.	$1,000,000
Suction Screens	24	$33,000	ea.	$792,000
Surge Tank	2	$100,000	ea.	$200,000
14" Surge Valves	10	$2,500	ea.	$25,000
Infrastructure Subtotal:				**$2,133,000**
Piping				
72" STD Steel Pipe	62079	$294	per ft	$18,226,000
66" STD Steel Pipe	2108	$269	per ft	$567,100
24" STD Steel Pipe	180	$97	per ft	$17,400
54" PVC DR-25	17452	$342	per ft	$5,968,600
48" PVC DR-25	12167	$262	per ft	$3,187,800
Steel Pipe CML lining 72" Pipe	62079	$180	per ft	$11,174,200
Steel Pipe CML lining 66" Pipe	2108	$165	per ft	$347,800
86" Boring (72" pipe)	800	$10,000	per ft	$8,000,000
Piping Subtotal:				**$47,488,900**
Construction Services				
Excavation	93986	$15	per ft	$1,409,800
Welding/Construction	16500	$125	per hr	$2,062,500
Electrical	300	$125	per hr	$37,500
Construction Subtotal:				**$3,509,800**
Subtotal:				**$59,861,400**
Contingency:			**10%**	**$5,986,100**
Professional Services (Permitting, Design, Project Administration, etc.)			**3%**	**$1,796,000**
TOTAL CAPITAL PROJECT COSTS:				**$67,643,500**

NOTES:

Abbreviations: ea = each, ft = foot, ft^2 = square foot, hr = hour.

1 Cost estimates are considered Order of Magnitude in nature and are likely to be within +/- 25% to total cost presented.

2 Estimated costs do not include any land purchases or on-farm irrigation development.

3 Pricing based on vendor estimates and engineering scaling cost estimating techniques.

Appendix B3. Cost Detail
Option 2a 8-Mile Canyon Distribution System

Annual Operation and Maintenance Costs

Item	Qty	Unit Cost	Unit	Amount
River Station Pumps				
Labor	1	$50,000	fte	$50,000
Materials	1	$11,400	ls	$11,400
Maintenance/repairs	1	$114,000	ls	$114,000
Utilities	5.5	$897,264	ls	$4,935,000
River Station Pumps Subtotal:				**$5,110,400**
Booster Station Pumps				
Labor	1	$50,000	fte	$50,000
Materials	1	$8,800	ls	$8,800
Maintenance/repairs	1	$88,000	ls	$88,000
Utilities	5.5	$703,080	ls	$3,866,900
Booster Station Pumps Subtotal:				**$4,013,700**
Infrastructure				
Labor	0.5	$50,000	fte	$25,000
Materials	1	$1,100	ls	$1,100
Maintenance/repairs	1	$11,000	ls	$11,000
Utilities	0	$0	ea.	$0
Infrastructure Subtotal:				**$37,100**
Piping				
Labor	0	$50,000	fte	$0
Materials	0	$0	ls	$0
Maintenance/repairs	1	$5,000	ls	$5,000
Utilities	0	$0	ls	$0
Piping Subtotal:				**$5,000**
Subtotal:				**$9,166,200**
Contingency:			**1.0%**	**$92,000**
TOTAL ANNUAL O&M COSTS				**$9,258,200**

NOTES:

Abbreviations: fte = full-time employee, ls = lump sum.

1 Cost estimates are considered Order of Magnitude in nature and are likely to be within +/- 25% to total cost presented.

2 Labor requirement assumed to be at $40,000 per year plus 25% for fringe and benefits

3 Maintenance/repairs assumed at 3% of original pump cost and 1% of infrastucture cost.

4 Utilities is based on estimates provided by local power company.

Appendix B4. Cost Detail
Option 2b 8-Mile Canyon Distribution System

Capital Costs

Item	Qty	Unit Cost	Unit	Amount
River Station Pumps				
1750 hp Pump	1	$186,300	ea.	$186,300
1750 hp Motor	1	$109,250	ea.	$109,300
1500 hp Pump	10	$162,000	ea.	$1,620,000
1500 hp Motor	10	$95,000	ea.	$950,000
1000 hp Pump	1	$137,700	ea.	$137,700
1000 hp Motor	1	$80,750	ea.	$80,800
2000 hp VFD	1	$250,000	ea.	$250,000
1500 hp Soft Start	10	$42,000	ea.	$420,000
1000 hp Soft Start	1	$38,000	ea.	$38,000
River Station Pumps Subtotal:				**$3,792,100**
Booster Station Pumps				
1750 hp Pump	1	$186,300	ea.	$186,300
1750 hp Motor	1	$109,250	ea.	$109,300
1500 hp Pump	8	$162,000	ea.	$1,296,000
1500 hp Motor	8	$95,000	ea.	$760,000
2000 hp VFD	1	$250,000	ea.	$250,000
1500 hp Soft Start	8	$42,000	ea.	$336,000
Booster Station Pumps Subtotal:				**$2,937,600**
Infrastructure				
Block Building, Climate Controlled	580	$200	per ft^2	$116,000
Electrical Substation and Lines	2	$500,000	ea.	$1,000,000
Suction Screens	24	$33,000	ea.	$792,000
Surge Tank	2	$100,000	ea.	$200,000
14" Surge Valves	10	$2,500	ea.	$25,000
Infrastructure Subtotal:				**$2,133,000**
Piping				
72" STD Steel Pipe	62079	$294	per ft	$18,226,000
66" STD Steel Pipe	2108	$269	per ft	$567,100
24" STD Steel Pipe	180	$97	per ft	$17,400
54" PVC DR-25	17452	$342	per ft	$5,968,600
48" PVC DR-25	12167	$262	per ft	$3,187,800
Steel Pipe CML lining 72" Pipe	62079	$180	per ft	$11,174,200
Steel Pipe CML lining 66" Pipe	2108	$165	per ft	$347,800
86" Boring (72" pipe)	0	$10,000	per ft	$0
Piping Subtotal:				**$39,488,900**
Construction Services				
Excavation	93986	$15	per ft	$1,409,800
Welding/Construction	16500	$125	per hr	$2,062,500
Electrical	300	$125	per hr	$37,500
Construction Subtotal:				**$3,509,800**
Subtotal:				**$51,861,400**
Contingency:			**10%**	**$5,186,100**
Professional Services (Permitting, Design, Project Administration, etc.)			**3%**	**$1,556,000**
TOTAL CAPITAL PROJECT COSTS:				**$58,603,500**

NOTES:

Abbreviations: ea = each, ft = foot, ft^2 = square foot, hr = hour.

1 Cost estimates are considered Order of Magnitude in nature and are likely to be within +/- 25% to total cost presented.

2 Estimated costs do not include any land purchases or on-farm irrigation development.

3 Pricing based on vendor estimates and engineering scaling cost estimating techniques.

Appendix B4. Cost Detail
Option 2b 8-Mile Canyon Distribution System

Annual Operation and Maintenance Costs

Item	Qty	Unit Cost	Unit	Amount
River Station Pumps				
Labor	1	$50,000	fte	$50,000
Materials	1	$11,400	ls	$11,400
Maintenance/repairs	1	$114,000	ls	$114,000
Utilities	5.5	$897,264	ls	$4,935,000
River Station Pumps Subtotal:				**$5,110,400**
Booster Station Pumps				
Labor	1	$50,000	fte	$50,000
Materials	1	$8,800	ls	$8,800
Maintenance/repairs	1	$88,000	ls	$88,000
Utilities	5.5	$703,080	ls	$3,866,900
Booster Station Pumps Subtotal:				**$4,013,700**
Infrastructure				
Labor	0.5	$50,000	fte	$25,000
Materials	1	$1,100	ls	$1,100
Maintenance/repairs	1	$11,000	ls	$11,000
Utilities	0	$0	ea.	$0
Infrastructure Subtotal:				**$37,100**
Piping				
Labor	0	$50,000	fte	$0
Materials	0	$0	ls	$0
Maintenance/repairs	1	$5,000	ls	$5,000
Utilities	0	$0	ls	$0
Piping Subtotal:				**$5,000**
Subtotal:				**$9,166,200**
Contingency:			**1.0%**	**$92,000**
TOTAL ANNUAL O&M COSTS				**$9,258,200**

NOTES:

Abbreviations: fte = full-time employee, ls = lump sum.

1 Cost estimates are considered Order of Magnitude in nature and are likely to be within +/- 25% to total cost presented.

2 Labor requirement assumed to be at $40,000 per year plus 25% for fringe and benefits

3 Maintenance/repairs assumed at 3% of original pump cost and 1% of infrastucture cost.

4 Utilities is based on estimates provided by local power company.

Appendix B5. Cost Detail
Option 3a County Line Distribution System

Capital Costs

Item	Qty	Unit Cost	Unit	Amount
River Station Pumps				
1000 hp Pump	1	$137,700	ea.	$137,700
1000 hp Motor	1	$80,750	ea.	$80,800
500 hp Pump	2	$34,857	ea.	$69,700
500 hp Motor	2	$45,353	ea.	$90,700
250 hp Pump	2	$16,429	ea.	$32,900
250 hp Motor	2	$22,951	ea.	$45,900
1000 hp VFD	1	$118,000	ea.	$118,000
500 hp Soft Start	2	$17,717	ea.	$35,400
250 hp Soft Start	2	$10,616	ea.	$21,200
			River Station Pumps Subtotal:	**$632,300**
Booster Station Pumps				
			ea.	$0
			ea.	$0
			ea.	$0
			ea.	$0
			ea.	$0
			ea.	$0
			Booster Station Pumps Subtotal:	**$0**
Infrastructure				
Block Building, Climate Controlled	580	$200	per ft^2	$116,000
Electrical Substation and Lines	0	$500,000	ea.	$0
Suction Screens	24	$33,000	ea.	$792,000
Surge Tank	0	$100,000	ea.	$0
10" Surge Valves	5	$2,000	ea.	$10,000
			Infrastructure Subtotal:	**$918,000**
Piping				
48" STD Steel Pipe	40	$195	per ft	$7,800
24" STD Steel Pipe	80	$97	per ft	$7,700
42" PVC DR-25	46750	$127	per ft	$5,946,200
48" Boring (42" pipe)	800	$6,500	per ft	$5,200,000
				$0
				$0
				$0
				$0
			Piping Subtotal:	**$11,161,700**
Construction Services				
Excavation	47750	$15	per ft	$716,300
Welding/Construction	100	$125	per hr	$12,500
Electrical	200	$125	per hr	$25,000
			Construction Subtotal:	**$753,800**
			Subtotal:	**$13,465,800**
			Contingency:	**10%** **$1,346,600**
Professional Services (Permitting, Design, Project Administration, etc.)				**3%** **$404,000**
			TOTAL CAPITAL PROJECT COSTS:	**$15,216,400**

NOTES:

Abbreviations: ea = each, ft = foot, ft^2 = square foot, hr = hour.

1 Cost estimates are considered Order of Magnitude in nature and are likely to be within +/- 25% to total cost presented.

2 Estimated costs do not include any land purchases or on-farm irrigation development.

3 Pricing based on vendor estimates and engineering scaling cost estimating techniques.

Appendix B5. Cost Detail
Option 3a County Line Distribution System

Annual Operation and Maintenance Costs

Item	Qty	Unit Cost	Unit	Amount
River Station Pumps				
Labor	1	$50,000	fte	$50,000
Materials	1	$1,900	ls	$1,900
Maintenance/repairs	1	$19,000	ls	$19,000
Utilities	5.5	$100,440	ls	$552,400
River Station Pumps Subtotal:				**$623,300**
Booster Station Pumps				
Labor		$0	fte	$0
Materials		$0	ls	$0
Maintenance/repairs		$0	ls	$0
Utilities		$0	ls	$0
Booster Station Pumps Subtotal:				**$0**
Infrastructure				
Labor	0.5	$50,000	fte	$25,000
Materials	1	$500	ls	$500
Maintenance/repairs	1	$5,000	ls	$5,000
Utilities	0	$0	ea.	$0
Infrastructure Subtotal:				**$30,500**
Piping				
Labor	0	$50,000	fte	$0
Materials	0	$0	ls	$0
Maintenance/repairs	1	$2,000	ls	$2,000
Utilities	0	$0	ls	$0
Piping Subtotal:				**$2,000**
Subtotal:				**$655,800**
Contingency:			**1.0%**	**$7,000**
TOTAL ANNUAL O&M COSTS				**$662,800**

NOTES:

Abbreviations: fte = full-time employee, ls = lump sum.

1 Cost estimates are considered Order of Magnitude in nature and are likely to be within +/- 25% to total cost presented.

2 Labor requirement assumed to be at $40,000 per year plus 25% for fringe and benefits

3 Maintenance/repairs assumed at 3% of original pump cost and 1% of infrastucture cost.

4 Utilities is based on estimates provided by local power company.

Appendix B6. Cost Detail
Option 3b County Line Distribution System

Capital Costs

Item	Qty	Unit Cost	Unit	Amount
River Station Pumps				
1000 hp Pump	1	$137,700	ea.	$137,700
1000 hp Motor	1	$80,750	ea.	$80,800
500 hp Pump	2	$34,857	ea.	$69,700
500 hp Motor	2	$45,353	ea.	$90,700
250 hp Pump	2	$16,429	ea.	$32,900
250 hp Motor	2	$22,951	ea.	$45,900
1000 hp VFD	1	$118,000	ea.	$118,000
500 hp Soft Start	2	$17,717	ea.	$35,400
250 hp Soft Start	2	$10,616	ea.	$21,200
			River Station Pumps Subtotal:	**$632,300**
Booster Station Pumps				
			ea.	$0
			ea.	$0
			ea.	$0
			ea.	$0
			ea.	$0
			ea.	$0
			Booster Station Pumps Subtotal:	**$0**
Infrastructure				
Block Building, Climate Controlled	580	$200	per ft^2	$116,000
Electrical Substation and Lines		$500,000	ea.	$0
Suction Screens	24	$33,000	ea.	$792,000
Surge Tank	0	$100,000	ea.	$0
10" Surge Valves	5	$2,000	ea.	$10,000
			Infrastructure Subtotal:	**$918,000**
Piping				
48" STD Steel Pipe	40	$195	per ft	$7,800
24" STD Steel Pipe	80	$97	per ft	$7,700
42" PVC DR-25	46750	$127	per ft	$5,946,200
48" Boring (42" pipe)	0	$6,500	per ft	$0
				$0
				$0
				$0
				$0
			Piping Subtotal:	**$5,961,700**
Construction Services				
Excavation	47750	$15	per ft	$716,300
Welding/Construction	100	$125	per hr	$12,500
Electrical	200	$125	per hr	$25,000
			Construction Subtotal:	**$753,800**
			Subtotal:	**$8,265,800**
			Contingency:	**10%** **$826,600**
Professional Services (Permitting, Design, Project Administration, etc.)				**3%** **$248,000**
			TOTAL CAPITAL PROJECT COSTS:	**$9,340,400**

NOTES:

Abbreviations: ea = each, ft = foot, ft^2 = square foot, hr = hour.

1 Cost estimates are considered Order of Magnitude in nature and are likely to be within +/- 25% to total cost presented.

2 Estimated costs do not include any land purchases or on-farm irrigation development.

3 Pricing based on vendor estimates and engineering scaling cost estimating techniques.

Appendix B6. Cost Detail
Option 3b County Line Distribution System

Annual Operation and Maintenance Costs

Item	Qty	Unit Cost	Unit	Amount
River Station Pumps				
Labor	1	$50,000	fte	$50,000
Materials	1	$1,900	ls	$1,900
Maintenance/repairs	1	$19,000	ls	$19,000
Utilities	5.5	$100,440	ls	$552,400
River Station Pumps Subtotal:				**$623,300**
Booster Station Pumps				
Labor		$0	fte	$0
Materials		$0	ls	$0
Maintenance/repairs		$0	ls	$0
Utilities		$0	ls	$0
Booster Station Pumps Subtotal:				**$0**
Infrastructure				
Labor	0.5	$50,000	fte	$25,000
Materials	1	$500	ls	$500
Maintenance/repairs	1	$5,000	ls	$5,000
Utilities	0	$0	ea.	$0
Infrastructure Subtotal:				**$30,500**
Piping				
Labor	0	$50,000	fte	$0
Materials	0	$0	ls	$0
Maintenance/repairs	1	$2,000	ls	$2,000
Utilities	0	$0	ls	$0
Piping Subtotal:				**$2,000**
Subtotal:				**$655,800**
Contingency:			**1.0%**	**$7,000**
TOTAL ANNUAL O&M COSTS				**$662,800**

NOTES:

Abbreviations: fte = full-time employee, ls = lump sum.

1 Cost estimates are considered Order of Magnitude in nature and are likely to be within +/- 25% to total cost presented.

2 Labor requirement assumed to be at $40,000 per year plus 25% for fringe and benefits

3 Maintenance/repairs assumed at 3% of original pump cost and 1% of infrastructure cost.

4 Utilities is based on estimates provided by local power company.

Appendix C.

Valuation Schedule

Appendix C1. Valuation Schedule
Option 1a 8-Mile Canyon Distribution System

Year [1]	Inflation Factor [2]	Date [3]	Main Pumping System		Landowner		Income		Annual Revenue
			Capital Cost [4]	O&M Cost [5]	Capital Cost [6]	O&M Cost [7]	Direct [8]	Indirect [9]	Balance [10]
0	1.00	1-Jan-19	$ 67,972,200	$ -	$ 20,022,025		$ -	$ -	$ (87,994,225)
1	1.02	1-Jan-20		$ 9,031,895			$ 6,513,975	$ 5,533,047	$ 3,015,127
2	1.04	1-Jan-21		$ 9,228,790			$ 6,655,980	$ 5,653,667	$ 3,080,857
3	1.07	1-Jan-22		$ 9,429,977			$ 6,801,080	$ 5,776,917	$ 3,148,020
4	1.09	1-Jan-23		$ 9,635,551			$ 6,949,344	$ 5,902,854	$ 3,216,647
5	1.11	1-Jan-24		$ 9,845,606			$ 7,100,839	$ 6,031,536	$ 3,286,770
6	1.14	1-Jan-25		$ 10,060,240			$ 7,255,638	$ 6,163,024	$ 3,358,421
7	1.16	1-Jan-26		$ 10,279,553			$ 7,413,810	$ 6,297,378	$ 3,431,635
8	1.19	1-Jan-27		$ 10,503,648			$ 7,575,432	$ 6,434,661	$ 3,506,444
9	1.21	1-Jan-28		$ 10,732,627			$ 7,740,576	$ 6,574,936	$ 3,582,885
10	1.24	1-Jan-29		$ 10,966,599			$ 7,909,320	$ 6,718,270	$ 3,660,992
11	1.27	1-Jan-30		$ 11,205,670			$ 8,081,744	$ 6,864,728	$ 3,740,801
12	1.30	1-Jan-31		$ 11,449,954			$ 8,257,926	$ 7,014,379	$ 3,822,351
13	1.32	1-Jan-32		$ 11,699,563			$ 8,437,948	$ 7,167,293	$ 3,905,678
14	1.35	1-Jan-33		$ 11,954,613			$ 8,621,896	$ 7,323,540	$ 3,990,822
15	1.38	1-Jan-34	$ 8,886,827	$ 12,215,224	$ 604,048		$ 8,809,853	$ 7,483,193	$ (5,413,053)
16	1.41	1-Jan-35		$ 12,481,516			$ 9,001,908	$ 7,646,326	$ 4,166,718
17	1.44	1-Jan-36		$ 12,753,613			$ 9,198,149	$ 7,813,016	$ 4,257,553
18	1.47	1-Jan-37		$ 13,031,642			$ 9,398,669	$ 7,983,340	$ 4,350,367
19	1.51	1-Jan-38		$ 13,315,731			$ 9,603,560	$ 8,157,377	$ 4,445,206
20	1.54	1-Jan-39		$ 13,606,014			$ 9,812,918	$ 8,335,208	$ 4,542,111
21	1.57	1-Jan-40		$ 13,902,626			$ 10,026,839	$ 8,516,915	$ 4,641,129
22	1.61	1-Jan-41		$ 14,205,703			$ 10,245,424	$ 8,702,584	$ 4,742,306
23	1.64	1-Jan-42		$ 14,515,387			$ 10,468,775	$ 8,892,300	$ 4,845,688
24	1.68	1-Jan-43		$ 14,831,823			$ 10,696,994	$ 9,086,152	$ 4,951,324
25	1.71	1-Jan-44		$ 15,155,156	$ 25,718,090		$ 10,930,188	$ 9,284,231	$ (20,658,828)
26	1.75	1-Jan-45		$ 15,485,539			$ 11,168,467	$ 9,486,627	$ 5,169,555
27	1.79	1-Jan-46		$ 15,823,123			$ 11,411,939	$ 9,693,435	$ 5,282,251
28	1.83	1-Jan-47		$ 16,168,068			$ 11,660,719	$ 9,904,752	$ 5,397,404
29	1.87	1-Jan-48		$ 16,520,531			$ 11,914,923	$ 10,120,676	$ 5,515,067
30	1.91	1-Jan-49		$ 16,880,679			$ 12,174,668	$ 10,341,307	$ 5,635,296
Total:			**$ 76,859,027**	**$ 376,916,662**	**$ 46,344,163**	**NA**	**$ 271,839,501**	**$ 230,903,670**	**$ 2,623,320**

NOTES:

Abbreviations: ft = feet, gpm = gallons per minute, O&M = operation and maintenance, % = percent.

1 Project costs and income evaluated over a 30 year period. Project construction and installation assumed on year zero.

2 Average inflation factor assumed at 2.18 %. All cost and income values include the average inflation factor.

3 Dates are provided as example years for perspective.

4 Main pumping system capital costs include main and booster station pumps, infrastructure, piping, construction services, 10% contingency, and 3% for permitting, design, and project administration. It also includes the cost of replacing the main and booster station pumps in year 15. Refer to Appendix B.

5 O&M costs include labor, materials, repairs, and utilities for main and booster pumps stations, infrastructure, and piping. Refer to Appendix B.

6 Landowner capital costs include pivots, piping, and pumps to deliver the water from the mainline to the irrigated fields for the entire 15,000 acre system. A total of 150 pivots, each covering 100 acres, was assumed at $100,000 each. The following systems (flow and distance) were used to estimate the average costs of the piping and pumps assuming a 300 foot elevation increase from pump to field: eight 10,000 gpm at 5,000 ft; three 5,000 gpm at 2,500 ft; one 3,000 gpm at 1,000 ft; and fifteen 1,000 gpm at 1,000 ft.

7 Landowner O&M costs are zero in this analysis because they are accounted for within the direct income value (i.e., net income after variable expenses).

8 Direct income is assumed equivalent to the cash rental rate of $425 per irrigated acre.

9 Indirect income reflects the economic spillovers to supporting industries, labor and proprietor income. Based on information regarding the IMPLAN economic model used in may regions, an indirect income multiplier of 1.85 was assumed (i.e, 85% of the cash rental rate per irrigated acre, which is $361 per acre, would be generated in the area).

10 Total balance reflects all expenses minus all income each year corrected for inflation.

Appendix C2. Valuation Schedule
Option 1b 8-Mile Canyon Distribution System

Year [1]	Inflation Factor [2]	Date [3]	Main Pumping System		Landowner		Income		Annual Revenue
			Capital Cost [4]	O&M Cost [5]	Capital Cost [6]	O&M Cost [7]	Direct [8]	Indirect [9]	Balance [10]
0	1.00	1-Jan-19	$ 58,932,200	$ -	$ 20,022,025		$ -	$ -	$ (78,954,225)
1	1.02	1-Jan-20		$ 9,031,895			$ 6,513,975	$ 5,533,047	$ 3,015,127
2	1.04	1-Jan-21		$ 9,228,790			$ 6,655,980	$ 5,653,667	$ 3,080,857
3	1.07	1-Jan-22		$ 9,429,977			$ 6,801,080	$ 5,776,917	$ 3,148,020
4	1.09	1-Jan-23		$ 9,635,551			$ 6,949,344	$ 5,902,854	$ 3,216,647
5	1.11	1-Jan-24		$ 9,845,606			$ 7,100,839	$ 6,031,536	$ 3,286,770
6	1.14	1-Jan-25		$ 10,060,240			$ 7,255,638	$ 6,163,024	$ 3,358,421
7	1.16	1-Jan-26		$ 10,279,553			$ 7,413,810	$ 6,297,378	$ 3,431,635
8	1.19	1-Jan-27		$ 10,503,648			$ 7,575,432	$ 6,434,661	$ 3,506,444
9	1.21	1-Jan-28		$ 10,732,627			$ 7,740,576	$ 6,574,936	$ 3,582,885
10	1.24	1-Jan-29		$ 10,966,599			$ 7,909,320	$ 6,718,270	$ 3,660,992
11	1.27	1-Jan-30		$ 11,205,670			$ 8,081,744	$ 6,864,728	$ 3,740,801
12	1.30	1-Jan-31		$ 11,449,954			$ 8,257,926	$ 7,014,379	$ 3,822,351
13	1.32	1-Jan-32		$ 11,699,563			$ 8,437,948	$ 7,167,293	$ 3,905,678
14	1.35	1-Jan-33		$ 11,954,613			$ 8,621,896	$ 7,323,540	$ 3,990,822
15	1.38	1-Jan-34	$ 8,886,827	$ 12,215,224	$ 604,048		$ 8,809,853	$ 7,483,193	$ (5,413,053)
16	1.41	1-Jan-35		$ 12,481,516			$ 9,001,908	$ 7,646,326	$ 4,166,718
17	1.44	1-Jan-36		$ 12,753,613			$ 9,198,149	$ 7,813,016	$ 4,257,553
18	1.47	1-Jan-37		$ 13,031,642			$ 9,398,669	$ 7,983,340	$ 4,350,367
19	1.51	1-Jan-38		$ 13,315,731			$ 9,603,560	$ 8,157,377	$ 4,445,206
20	1.54	1-Jan-39		$ 13,606,014			$ 9,812,918	$ 8,335,208	$ 4,542,111
21	1.57	1-Jan-40		$ 13,902,626			$ 10,026,839	$ 8,516,915	$ 4,641,129
22	1.61	1-Jan-41		$ 14,205,703			$ 10,245,424	$ 8,702,584	$ 4,742,306
23	1.64	1-Jan-42		$ 14,515,387			$ 10,468,775	$ 8,892,300	$ 4,845,688
24	1.68	1-Jan-43		$ 14,831,823			$ 10,696,994	$ 9,086,152	$ 4,951,324
25	1.71	1-Jan-44		$ 15,155,156	$ 25,718,090		$ 10,930,188	$ 9,284,231	$ (20,658,828)
26	1.75	1-Jan-45		$ 15,485,539			$ 11,168,467	$ 9,486,627	$ 5,169,555
27	1.79	1-Jan-46		$ 15,823,123			$ 11,411,939	$ 9,693,435	$ 5,282,251
28	1.83	1-Jan-47		$ 16,168,068			$ 11,660,719	$ 9,904,752	$ 5,397,404
29	1.87	1-Jan-48		$ 16,520,531			$ 11,914,923	$ 10,120,676	$ 5,515,067
30	1.91	1-Jan-49		$ 16,880,679			$ 12,174,668	$ 10,341,307	$ 5,635,296
Total:			**$ 67,819,027**	**$ 376,916,662**	**$ 46,344,163**	**NA**	**$ 271,839,501**	**$ 230,903,670**	**$ 11,663,320**

NOTES:

Abbreviations: ft = feet, gpm = gallons per minute, O&M = operation and maintenance, % = percent.

1 Project costs and income evaluated over a 30 year period. Project construction and installation assumed on year zero.

2 Average inflation factor assumed at 2.18 %. All cost and income values include the average inflation factor.

3 Dates are provided as example years for perspective.

4 Main pumping system capital costs include main and booster station pumps, infrastructure, piping, construction services, 10% contingency, and 3% for permitting, design, and project administration. It also includes the cost of replacing the main and booster station pumps in year 15. Refer to Appendix B.

5 O&M costs include labor, materials, repairs, and utilities for main and booster pumps stations, infrastructure, and piping. Refer to Appendix B.

6 Landowner capital costs include pivots, piping, and pumps to deliver the water from the mainline to the irrigated fields for the entire 15,000 acre system. A total of 150 pivots, each covering 100 acres, was assumed at $100,000 each. The following systems (flow and distance) were used to estimate the average costs of the piping and pumps assuming a 300 foot elevation increase from pump to field: eight 10,000 gpm at 5,000 ft; three 5,000 gpm at 2,500 ft; one 3,000 gpm at 1,000 ft; and fifteen 1,000 gpm at 1,000 ft.

7 Landowner O&M costs are zero in this analysis because they are accounted for within the direct income value (i.e., net income after variable expenses).

8 Direct income is assumed equivalent to the cash rental rate of $425 per irrigated acre.

9 Indirect income reflects the economic spillovers to supporting industries, labor and proprietor income. Based on information regarding the IMPLAN economic model used in may regions, an indirect income multiplier of 1.85 was assumed (i.e, 85% of the cash rental rate per irrigated acre, which is $361 per acre, would be generated in the area).

10 Total balance reflects all expenses minus all income each year corrected for inflation.

Appendix C3. Valuation Schedule
Option 2a 8-Mile Canyon Distribution System

Year [1]	Inflation Factor [2]	Date [3]	Main Pumping System		Landowner		Income		Annual Revenue
			Capital Cost [4]	O&M Cost [5]	Capital Cost [6]	O&M Cost [7]	Direct [8]	Indirect [9]	Balance [10]
0	1.00	1-Jan-19	$ 67,643,500	$ -	$ 20,022,025		$ -	$ -	$ (87,665,525)
1	1.02	1-Jan-20		$ 9,460,029			$ 6,513,975	$ 5,533,047	$ 2,586,993
2	1.04	1-Jan-21		$ 9,666,257			$ 6,655,980	$ 5,653,667	$ 2,643,390
3	1.07	1-Jan-22		$ 9,876,982			$ 6,801,080	$ 5,776,917	$ 2,701,016
4	1.09	1-Jan-23		$ 10,092,300			$ 6,949,344	$ 5,902,854	$ 2,759,898
5	1.11	1-Jan-24		$ 10,312,312			$ 7,100,839	$ 6,031,536	$ 2,820,063
6	1.14	1-Jan-25		$ 10,537,121			$ 7,255,638	$ 6,163,024	$ 2,881,541
7	1.16	1-Jan-26		$ 10,766,830			$ 7,413,810	$ 6,297,378	$ 2,944,358
8	1.19	1-Jan-27		$ 11,001,547			$ 7,575,432	$ 6,434,661	$ 3,008,545
9	1.21	1-Jan-28		$ 11,241,380			$ 7,740,576	$ 6,574,936	$ 3,074,132
10	1.24	1-Jan-29		$ 11,486,442			$ 7,909,320	$ 6,718,270	$ 3,141,148
11	1.27	1-Jan-30		$ 11,736,847			$ 8,081,744	$ 6,864,728	$ 3,209,625
12	1.30	1-Jan-31		$ 11,992,710			$ 8,257,926	$ 7,014,379	$ 3,279,595
13	1.32	1-Jan-32		$ 12,254,151			$ 8,437,948	$ 7,167,293	$ 3,351,090
14	1.35	1-Jan-33		$ 12,521,292			$ 8,621,896	$ 7,323,540	$ 3,424,144
15	1.38	1-Jan-34	$ 9,300,026	$ 12,794,256	$ 604,048		$ 8,809,853	$ 7,483,193	$ (6,405,284)
16	1.41	1-Jan-35		$ 13,073,171			$ 9,001,908	$ 7,646,326	$ 3,575,064
17	1.44	1-Jan-36		$ 13,358,166			$ 9,198,149	$ 7,813,016	$ 3,653,000
18	1.47	1-Jan-37		$ 13,649,374			$ 9,398,669	$ 7,983,340	$ 3,732,635
19	1.51	1-Jan-38		$ 13,946,930			$ 9,603,560	$ 8,157,377	$ 3,814,007
20	1.54	1-Jan-39		$ 14,250,973			$ 9,812,918	$ 8,335,208	$ 3,897,152
21	1.57	1-Jan-40		$ 14,561,644			$ 10,026,839	$ 8,516,915	$ 3,982,110
22	1.61	1-Jan-41		$ 14,879,088			$ 10,245,424	$ 8,702,584	$ 4,068,920
23	1.64	1-Jan-42		$ 15,203,452			$ 10,468,775	$ 8,892,300	$ 4,157,623
24	1.68	1-Jan-43		$ 15,534,888			$ 10,696,994	$ 9,086,152	$ 4,248,259
25	1.71	1-Jan-44		$ 15,873,548	$ 25,718,090		$ 10,930,188	$ 9,284,231	$ (21,377,220)
26	1.75	1-Jan-45		$ 16,219,592			$ 11,168,467	$ 9,486,627	$ 4,435,502
27	1.79	1-Jan-46		$ 16,573,179			$ 11,411,939	$ 9,693,435	$ 4,532,196
28	1.83	1-Jan-47		$ 16,934,474			$ 11,660,719	$ 9,904,752	$ 4,630,998
29	1.87	1-Jan-48		$ 17,303,646			$ 11,914,923	$ 10,120,676	$ 4,731,953
30	1.91	1-Jan-49		$ 17,680,865			$ 12,174,668	$ 10,341,307	$ 4,835,110
Total:			**$ 76,943,526**	**$ 394,783,446**	**$ 46,344,163**	**NA**	**$ 271,839,501**	**$ 230,903,670**	**$ (15,327,964)**

NOTES:

Abbreviations: ft = feet, gpm = gallons per minute, O&M = operation and maintenance, % = percent.

1 Project costs and income evaluated over a 30 year period. Project construction and installation assumed on year zero.

2 Average inflation factor assumed at 2.18 %. All cost and income values include the average inflation factor.

3 Dates are provided as example years for perspective.

4 Main pumping system capital costs include main and booster station pumps, infrastructure, piping, construction services, 10% contingency, and 3% for permitting, design, and project administration. It also includes the cost of replacing the main and booster station pumps in year 15. Refer to Appendix B.

5 O&M costs include labor, materials, repairs, and utilities for main and booster pumps stations, infrastructure, and piping. Refer to Appendix B.

6 Landowner capital costs include pivots, piping, and pumps to deliver the water from the mainline to the irrigated fields for the entire 15,000 acre system. A total of 150 pivots, each covering 100 acres, was assumed at $100,000 each. The following systems (flow and distance) were used to estimate the average costs of the piping and pumps assuming a 300 foot elevation increase from pump to field: eight 10,000 gpm at 5,000 ft; three 5,000 gpm at 2,500 ft; one 3,000 gpm at 1,000 ft; and fifteen 1,000 gpm at 1,000 ft.

7 Landowner O&M costs are zero in this analysis because they are accounted for within the direct income value (i.e., net income after variable expenses).

8 Direct income is assumed equivalent to the cash rental rate of $425 per irrigated acre.

9 Indirect income reflects the economic spillovers to supporting industries, labor and proprietor income. Based on information regarding the IMPLAN economic model used in may regions, an indirect income multiplier of 1.85 was assumed (i.e, 85% of the cash rental rate per irrigated acre, which is $361 per acre, would be generated in the area).

10 Total balance reflects all expenses minus all income each year corrected for inflation.

Appendix C4. Valuation Schedule
Option 2b 8-Mile Canyon Distribution System

Year [1]	Inflation Factor [2]	Date [3]	Main Pumping System		Landowner		Income		Annual Revenue
			Capital Cost [4]	O&M Cost [5]	Capital Cost [6]	O&M Cost [7]	Direct [8]	Indirect [9]	Balance [10]
0	1.00	1-Jan-19	$ 58,603,500	$ -	$ 20,022,025		$ -	$ -	$ (78,625,525)
1	1.02	1-Jan-20		$ 9,460,029			$ 6,513,975	$ 5,533,047	$ 2,586,993
2	1.04	1-Jan-21		$ 9,666,257			$ 6,655,980	$ 5,653,667	$ 2,643,390
3	1.07	1-Jan-22		$ 9,876,982			$ 6,801,080	$ 5,776,917	$ 2,701,016
4	1.09	1-Jan-23		$ 10,092,300			$ 6,949,344	$ 5,902,854	$ 2,759,898
5	1.11	1-Jan-24		$ 10,312,312			$ 7,100,839	$ 6,031,536	$ 2,820,063
6	1.14	1-Jan-25		$ 10,537,121			$ 7,255,638	$ 6,163,024	$ 2,881,541
7	1.16	1-Jan-26		$ 10,766,830			$ 7,413,810	$ 6,297,378	$ 2,944,358
8	1.19	1-Jan-27		$ 11,001,547			$ 7,575,432	$ 6,434,661	$ 3,008,545
9	1.21	1-Jan-28		$ 11,241,380			$ 7,740,576	$ 6,574,936	$ 3,074,132
10	1.24	1-Jan-29		$ 11,486,442			$ 7,909,320	$ 6,718,270	$ 3,141,148
11	1.27	1-Jan-30		$ 11,736,847			$ 8,081,744	$ 6,864,728	$ 3,209,625
12	1.30	1-Jan-31		$ 11,992,710			$ 8,257,926	$ 7,014,379	$ 3,279,595
13	1.32	1-Jan-32		$ 12,254,151			$ 8,437,948	$ 7,167,293	$ 3,351,090
14	1.35	1-Jan-33		$ 12,521,292			$ 8,621,896	$ 7,323,540	$ 3,424,144
15	1.38	1-Jan-34	$ 9,300,026	$ 12,794,256	$ 604,048		$ 8,809,853	$ 7,483,193	$ (6,405,284)
16	1.41	1-Jan-35		$ 13,073,171			$ 9,001,908	$ 7,646,326	$ 3,575,064
17	1.44	1-Jan-36		$ 13,358,166			$ 9,198,149	$ 7,813,016	$ 3,653,000
18	1.47	1-Jan-37		$ 13,649,374			$ 9,398,669	$ 7,983,340	$ 3,732,635
19	1.51	1-Jan-38		$ 13,946,930			$ 9,603,560	$ 8,157,377	$ 3,814,007
20	1.54	1-Jan-39		$ 14,250,973			$ 9,812,918	$ 8,335,208	$ 3,897,152
21	1.57	1-Jan-40		$ 14,561,644			$ 10,026,839	$ 8,516,915	$ 3,982,110
22	1.61	1-Jan-41		$ 14,879,088			$ 10,245,424	$ 8,702,584	$ 4,068,920
23	1.64	1-Jan-42		$ 15,203,452			$ 10,468,775	$ 8,892,300	$ 4,157,623
24	1.68	1-Jan-43		$ 15,534,888			$ 10,696,994	$ 9,086,152	$ 4,248,259
25	1.71	1-Jan-44		$ 15,873,548	$ 25,718,090		$ 10,930,188	$ 9,284,231	$ (21,377,220)
26	1.75	1-Jan-45		$ 16,219,592			$ 11,168,467	$ 9,486,627	$ 4,435,502
27	1.79	1-Jan-46		$ 16,573,179			$ 11,411,939	$ 9,693,435	$ 4,532,196
28	1.83	1-Jan-47		$ 16,934,474			$ 11,660,719	$ 9,904,752	$ 4,630,998
29	1.87	1-Jan-48		$ 17,303,646			$ 11,914,923	$ 10,120,676	$ 4,731,953
30	1.91	1-Jan-49		$ 17,680,865			$ 12,174,668	$ 10,341,307	$ 4,835,110
Total:			**$ 67,903,526**	**$ 394,783,446**	**$ 46,344,163**	**NA**	**$ 271,839,501**	**$ 230,903,670**	**$ (6,287,964)**

NOTES:

Abbreviations: ft = feet, gpm = gallons per minute, O&M = operation and maintenance, % = percent.

1 Project costs and income evaluated over a 30 year period. Project construction and installation assumed on year zero.

2 Average inflation factor assumed at 2.18 %. All cost and income values include the average inflation factor.

3 Dates are provided as example years for perspective.

4 Main pumping system capital costs include main and booster station pumps, infrastructure, piping, construction services, 10% contingency, and 3% for permitting, design, and project administration. It also includes the cost of replacing the main and booster station pumps in year 15. Refer to Appendix B.

5 O&M costs include labor, materials, repairs, and utilities for main and booster pumps stations, infrastructure, and piping. Refer to Appendix B.

6 Landowner capital costs include pivots, piping, and pumps to deliver the water from the mainline to the irrigated fields for the entire 15,000 acre system. A total of 150 pivots, each covering 100 acres, was assumed at $100,000 each. The following systems (flow and distance) were used to estimate the average costs of the piping and pumps assuming a 300 foot elevation increase from pump to field: eight 10,000 gpm at 5,000 ft; three 5,000 gpm at 2,500 ft; one 3,000 gpm at 1,000 ft; and fifteen 1,000 gpm at 1,000 ft.

7 Landowner O&M costs are zero in this analysis because they are accounted for within the direct income value (i.e., net income after variable expenses).

8 Direct income is assumed equivalent to the cash rental rate of $425 per irrigated acre.

9 Indirect income reflects the economic spillovers to supporting industries, labor and proprietor income. Based on information regarding the IMPLAN economic model used in may regions, an indirect income multiplier of 1.85 was assumed (i.e, 85% of the cash rental rate per irrigated acre, which is $361 per acre, would be generated in the area).

10 Total balance reflects all expenses minus all income each year corrected for inflation.

Appendix C5. Valuation Schedule
Option 3a County Line Distribution System

Year [1]	Inflation Factor [2]	Date [3]	Main Pumping System		Landowner		Income		Annual Revenue
			Capital Cost [4]	O&M Cost [5]	Capital Cost [6]	O&M Cost [7]	Direct [8]	Indirect [9]	Balance [10]
0	1.00	1-Jan-19	$ 15,216,400	$ -	$ 3,900,000		$ -	$ -	$ (19,116,400)
1	1.02	1-Jan-20		$ 677,249			$ 990,124	$ 841,023	$ 1,153,898
2	1.04	1-Jan-21		$ 692,013			$ 1,011,709	$ 859,357	$ 1,179,053
3	1.07	1-Jan-22		$ 707,099			$ 1,033,764	$ 878,091	$ 1,204,757
4	1.09	1-Jan-23		$ 722,514			$ 1,056,300	$ 897,234	$ 1,231,020
5	1.11	1-Jan-24		$ 738,265			$ 1,079,328	$ 916,794	$ 1,257,857
6	1.14	1-Jan-25		$ 754,359			$ 1,102,857	$ 936,780	$ 1,285,278
7	1.16	1-Jan-26		$ 770,804			$ 1,126,899	$ 957,201	$ 1,313,297
8	1.19	1-Jan-27		$ 787,607			$ 1,151,466	$ 978,068	$ 1,341,927
9	1.21	1-Jan-28		$ 804,777			$ 1,176,568	$ 999,390	$ 1,371,181
10	1.24	1-Jan-29		$ 822,321			$ 1,202,217	$ 1,021,177	$ 1,401,073
11	1.27	1-Jan-30		$ 840,248			$ 1,228,425	$ 1,043,439	$ 1,431,616
12	1.30	1-Jan-31		$ 858,565			$ 1,255,205	$ 1,066,186	$ 1,462,825
13	1.32	1-Jan-32		$ 877,282			$ 1,282,568	$ 1,089,428	$ 1,494,715
14	1.35	1-Jan-33		$ 896,407			$ 1,310,528	$ 1,113,178	$ 1,527,300
15	1.38	1-Jan-34	$ 873,799	$ 915,948	$ 196,235		$ 1,339,098	$ 1,137,445	$ 490,560
16	1.41	1-Jan-35		$ 935,916			$ 1,368,290	$ 1,162,242	$ 1,594,616
17	1.44	1-Jan-36		$ 956,319			$ 1,398,119	$ 1,187,578	$ 1,629,378
18	1.47	1-Jan-37		$ 977,167			$ 1,428,598	$ 1,213,468	$ 1,664,899
19	1.51	1-Jan-38		$ 998,469			$ 1,459,741	$ 1,239,921	$ 1,701,193
20	1.54	1-Jan-39		$ 1,020,236			$ 1,491,563	$ 1,266,952	$ 1,738,279
21	1.57	1-Jan-40		$ 1,042,477			$ 1,524,080	$ 1,294,571	$ 1,776,174
22	1.61	1-Jan-41		$ 1,065,203			$ 1,557,305	$ 1,322,793	$ 1,814,895
23	1.64	1-Jan-42		$ 1,088,424			$ 1,591,254	$ 1,351,630	$ 1,854,459
24	1.68	1-Jan-43		$ 1,112,152			$ 1,625,943	$ 1,381,095	$ 1,894,886
25	1.71	1-Jan-44		$ 1,136,397	$ 6,686,703		$ 1,661,389	$ 1,411,203	$ (4,750,508)
26	1.75	1-Jan-45		$ 1,161,170			$ 1,697,607	$ 1,441,967	$ 1,978,404
27	1.79	1-Jan-46		$ 1,186,484			$ 1,734,615	$ 1,473,402	$ 2,021,533
28	1.83	1-Jan-47		$ 1,212,349			$ 1,772,429	$ 1,505,522	$ 2,065,603
29	1.87	1-Jan-48		$ 1,238,778			$ 1,811,068	$ 1,538,343	$ 2,110,633
30	1.91	1-Jan-49		$ 1,265,784			$ 1,850,550	$ 1,571,879	$ 2,156,645
Total:			**$ 16,090,199**	**$ 28,262,780**	**$ 10,782,939**	**NA**	**$ 41,319,604**	**$ 35,097,358**	**$ 21,281,044**

NOTES:

Abbreviations: ft = feet, gpm = gallons per minute, O&M = operation and maintenance, % = percent.

1 Project costs and income evaluated over a 30 year period. Project construction and installation assumed on year zero.

2 Average inflation factor assumed at 2.18 %. All cost and income values include the average inflation factor.

3 Dates are provided as example years for perspective.

4 Main pumping system capital costs include main and booster station pumps, infrastructure, piping, construction services, 10% contingency, and 3% for permitting, design, and project administration. It also includes the cost of replacing the main and booster station pumps in year 15. Refer to Appendix B.

5 O&M costs include labor, materials, repairs, and utilities for main and booster pumps stations, infrastructure, and piping. Refer to Appendix B.

6 Landowner capital costs include pivots, piping, and pumps to deliver the water from the mainline to the irrigated fields for the entire 2,280 acre system. A total of 22 pivots, each covering 100 acres, was assumed at $100,000 each. The following systems (flow and distance) were used to estimate the average costs of the piping and pumps assuming a 300 foot elevation increase from pump to field: eight 10,000 gpm at 5,000 ft; three 5,000 gpm at 2,500 ft; one 3,000 gpm at 1,000 ft; and fifteen 1,000 gpm at 1,000 ft with the average scaled from 15,000 acres to 2,280 acres.

7 Landowner O&M costs are zero in this analysis because they are accounted for within the direct income value (i.e., net income after variable expenses).

8 Direct income is assumed equivalent to the cash rental rate of $425 per irrigated acre.

9 Indirect income reflects the economic spillovers to supporting industries, labor and proprietor income. Based on information regarding the IMPLAN economic model used in may regions, an indirect income multiplier of 1.85 was assumed (i.e, 85% of the cash rental rate per irrigated acre, which is $361 per acre, would be generated in the area).

10 Total balance reflects all expenses minus all income each year corrected for inflation.

Appendix C6. Valuation Schedule
Option 3b County Line Distribution System

Year [1]	Inflation Factor [2]	Date [3]	Main Pumping System		Landowner		Income		Annual Revenue
			Capital Cost [4]	O&M Cost [5]	Capital Cost [6]	O&M Cost [7]	Direct [8]	Indirect [9]	Balance [10]
0	1.00	1-Jan-19	$ 9,340,400	$ -	$ 3,900,000		$ -	$ -	$ (13,240,400)
1	1.02	1-Jan-20		$ 677,249			$ 990,124	$ 841,023	$ 1,153,898
2	1.04	1-Jan-21		$ 692,013			$ 1,011,709	$ 859,357	$ 1,179,053
3	1.07	1-Jan-22		$ 707,099			$ 1,033,764	$ 878,091	$ 1,204,757
4	1.09	1-Jan-23		$ 722,514			$ 1,056,300	$ 897,234	$ 1,231,020
5	1.11	1-Jan-24		$ 738,265			$ 1,079,328	$ 916,794	$ 1,257,857
6	1.14	1-Jan-25		$ 754,359			$ 1,102,857	$ 936,780	$ 1,285,278
7	1.16	1-Jan-26		$ 770,804			$ 1,126,899	$ 957,201	$ 1,313,297
8	1.19	1-Jan-27		$ 787,607			$ 1,151,466	$ 978,068	$ 1,341,927
9	1.21	1-Jan-28		$ 804,777			$ 1,176,568	$ 999,390	$ 1,371,181
10	1.24	1-Jan-29		$ 822,321			$ 1,202,217	$ 1,021,177	$ 1,401,073
11	1.27	1-Jan-30		$ 840,248			$ 1,228,425	$ 1,043,439	$ 1,431,616
12	1.30	1-Jan-31		$ 858,565			$ 1,255,205	$ 1,066,186	$ 1,462,825
13	1.32	1-Jan-32		$ 877,282			$ 1,282,568	$ 1,089,428	$ 1,494,715
14	1.35	1-Jan-33		$ 896,407			$ 1,310,528	$ 1,113,178	$ 1,527,300
15	1.38	1-Jan-34	$ 873,799	$ 915,948	$ 196,235		$ 1,339,098	$ 1,137,445	$ 490,560
16	1.41	1-Jan-35		$ 935,916			$ 1,368,290	$ 1,162,242	$ 1,594,616
17	1.44	1-Jan-36		$ 956,319			$ 1,398,119	$ 1,187,578	$ 1,629,378
18	1.47	1-Jan-37		$ 977,167			$ 1,428,598	$ 1,213,468	$ 1,664,899
19	1.51	1-Jan-38		$ 998,469			$ 1,459,741	$ 1,239,921	$ 1,701,193
20	1.54	1-Jan-39		$ 1,020,236			$ 1,491,563	$ 1,266,952	$ 1,738,279
21	1.57	1-Jan-40		$ 1,042,477			$ 1,524,080	$ 1,294,571	$ 1,776,174
22	1.61	1-Jan-41		$ 1,065,203			$ 1,557,305	$ 1,322,793	$ 1,814,895
23	1.64	1-Jan-42		$ 1,088,424			$ 1,591,254	$ 1,351,630	$ 1,854,459
24	1.68	1-Jan-43		$ 1,112,152			$ 1,625,943	$ 1,381,095	$ 1,894,886
25	1.71	1-Jan-44		$ 1,136,397	$ 6,686,703		$ 1,661,389	$ 1,411,203	$ (4,750,508)
26	1.75	1-Jan-45		$ 1,161,170			$ 1,697,607	$ 1,441,967	$ 1,978,404
27	1.79	1-Jan-46		$ 1,186,484			$ 1,734,615	$ 1,473,402	$ 2,021,533
28	1.83	1-Jan-47		$ 1,212,349			$ 1,772,429	$ 1,505,522	$ 2,065,603
29	1.87	1-Jan-48		$ 1,238,778			$ 1,811,068	$ 1,538,343	$ 2,110,633
30	1.91	1-Jan-49		$ 1,265,784			$ 1,850,550	$ 1,571,879	$ 2,156,645
Total:			**$ 10,214,199**	**$ 28,262,780**	**$ 10,782,939**	**NA**	**$ 41,319,604**	**$ 35,097,358**	**$ 27,157,044**

NOTES:

Abbreviations: ft = feet, gpm = gallons per minute, O&M = operation and maintenance, % = percent.

1 Project costs and income evaluated over a 30 year period. Project construction and installation assumed on year zero.

2 Average inflation factor assumed at 2.18 %. All cost and income values include the average inflation factor.

3 Dates are provided as example years for perspective.

4 Main pumping system capital costs include main and booster station pumps, infrastructure, piping, construction services, 10% contingency, and 3% for permitting, design, and project administration. It also includes the cost of replacing the main and booster station pumps in year 15. Refer to Appendix B.

5 O&M costs include labor, materials, repairs, and utilities for main and booster pumps stations, infrastructure, and piping. Refer to Appendix B.

6 Landowner capital costs include pivots, piping, and pumps to deliver the water from the mainline to the irrigated fields for the entire 2,280 acre system. A total of 22 pivots, each covering 100 acres, was assumed at $100,000 each. The following systems (flow and distance) were used to estimate the average costs of the piping and pumps assuming a 300 foot elevation increase from pump to field: eight 10,000 gpm at 5,000 ft; three 5,000 gpm at 2,500 ft; one 3,000 gpm at 1,000 ft; and fifteen 1,000 gpm at 1,000 ft with the average scaled from 15,000 acres to 2,280 acres.

7 Landowner O&M costs are zero in this analysis because they are accounted for within the direct income value (i.e., net income after variable expenses).

8 Direct income is assumed equivalent to the cash rental rate of $425 per irrigated acre.

9 Indirect income reflects the economic spillovers to supporting industries, labor and proprietor income. Based on information regarding the IMPLAN economic model used in may regions, an indirect income multiplier of 1.85 was assumed (i.e, 85% of the cash rental rate per irrigated acre, which is $361 per acre, would be generated in the area).

10 Total balance reflects all expenses minus all income each year corrected for inflation.

Appendix D.

City of Arlington, Oregon Water Rights Permit

STATE OF OREGON, |
County of Marion, |ss.

This superseding permit, in the name of

CITY OF ARLINGTON
P.O. BOX 68
ARLINGTON OR 97812

is issued to describe an amendment for a change in point of diversion proposed under Permit Amendment Application T-11115 and approved by Special Order Vol. 89, Page 971-973, entered June 12th, 2013, and to describe an extension of time for complete application of water approved April 26, 2013. This permit supersedes Permit S-35058.

This is to certify that I have examined the foregoing application and do hereby grant the same, SUBJECT TO EXISTING RIGHTS and the following limitations and conditions:

The right herein granted is limited to the amount of water which can be applied to beneficial use and shall not exceed .....8.16..... *cubic feet per second measured at the point of diversion from the stream, or its equivalent in case of rotation with other water users, from* Columbia River.....

The use to which water is to be applied is municipal use.....

.....

The points of diversion are located:

Twp	Rng	Mer	Sec	Q-Q	GLot	Measured Distances
3 N	21 E	WM	21	NW SW	4	DIVERSION NO. 1 - 1320 FEET NORTH AND 800 FEET EAST OF THE SW CORNER OF SECTION 21
3 N	21 E	WM	20	SE SE	1	DIVERSION NO. 2 - 740 FEET NORTH AND 660 FEET WEST OF THE SE CORNER OF SECTION 20.
4 N	22 E	WM	35	NW NW	1	DIVERSION NO. 3 - 425 FEET SOUTH AND 4555 FEET WEST OF THE NE CORNER OF SECTION 35

The place of use is located:

MUNICIPAL USE (CITY OF ARLINGTON AND ENVIRONS)				
Twp	Rng	Mer	Sec	Q-Q
3 N	21 E	WM	21	NW NE
3 N	21 E	WM	21	SW NE
3 N	21 E	WM	21	NE SW
3 N	21 E	WM	21	SW SW
3 N	21 E	WM	21	SE SW
3 N	21 E	WM	21	NW SE
3 N	21 E	WM	21	SW SE
3 N	21 E	WM	28	NW NE
3 N	21 E	WM	28	SW NE
3 N	21 E	WM	28	NE NW
3 N	21 E	WM	28	NW NW
3 N	21 E	WM	28	SW NW
3 N	21 E	WM	28	SE NW
3 N	21 E	WM	28	NE SW
3 N	21 E	WM	28	NW SW
3 N	21 E	WM	28	NE SE
3 N	21 E	WM	28	NW SE
3 N	21 E	WM	29	NE NE
3 N	21 E	WM	29	SE NE
3 N	21 E	WM	29	NE SE

If for irrigation, this appropriation shall be limited to ..... of one cubic foot per second or its equivalent for each acre irrigated and shall further be limited to a diversion of not to exceed ..... acre feet per acre for each acre irrigated during the irrigation season of each year;

.....

.....

.....

.....

.....

.....

and shall be subject to such reasonable rotation system as may be ordered by the proper state officer.

Permit Amendment T-11115 Conditions

The quantity of water diverted at the new points of diversion shall not exceed the quantity of water lawfully available at the original point of diversion located 2000 feet North and 640 feet East from the SW Corner of Section 21, NW¼ SW¼, Section 21, T 3 N, R 21 E, W.M.

Water use measurement conditions:

a. Before water use may begin from the new points of diversion, the water user shall install a totalizing flow meter, or, with prior approval of the Director, another suitable measuring device, at each point of diversion.

b. The water user shall maintain the meters or measuring devices in good working order.

c. The water user shall allow the Watermaster access to the meters or measuring devices; provided however, where the meters or measuring devices are located within a private structure, the Watermaster shall request access upon reasonable notice.

Prior to diverting water, the water user shall install an approved fish screen at the new point of diversion and shall provide to the OWRD a written statement from Oregon Department of Fish and Wildlife (ODFW) that the installed screen meets the state's criteria, or that ODFW has determined a screen is not necessary.

The water user shall operate and maintain the fish screen at the new point of diversion consistent with ODFW's operational and maintenance standards. If ODFW determines the screen is not functioning properly, and is unsuccessful in working with the water user to meet ODFW standards, ODFW may request that OWRD regulate the use of water until OWRD receives notification from ODFW that the fish screen is functioning properly.

Water shall be acquired from the same surface water source (Columbia River) as the original point of diversion.

Extension of Time Conditions

1. Development Limitations

Diversion of any water beyond 2.67 cfs under Permit S-35058 (superseded by Permit S-54814) shall only be authorized upon issuance of a final order approving a Water Management and Conservation Plan (WMCP) under OAR Chapter 690, Division 86 that authorizes access to a greater rate of diversion under the permit consistent with OAR 690-086-0130(7). The required WMCP shall be submitted to the Department within 3 years of the final extension order. The amount of water used under Permit S-54814 must be consistent with this and subsequent WMCP's approved under OAR Chapter 690, on file with the Department.

The deadline established by the Extension of Time Final Order for submittal of a WMCP shall not relieve a permit holder of any existing or future requirement for submittal of a WMCP at an earlier date as established through other orders of the Department. A WMCP submitted to meet the requirements of the Extension of Time Final Order may also meet the WMCP requirements of other Department orders.

2. **Conditions to Maintain the Persistence of Listed Fish**

A. Minimum Fish Flow Needs

a. Minimum fish flow needs in the Columbia River as recommended by ODFW are in Table 1, below; flows are to be measured in the Columbia River at McNary Dam. Daily flow reports for McNary Dam are available from the Fish Passage Center (FPC) established by the Northwest Power Planning Council (NPPC) at http://www.fpc.org/currentdaily/flowspil.txt.

Table 1

ODFW'S RECOMMENDED MINIMUM FISH FLOW NEEDS IN THE COLUMBIA RIVER, MEASURED AT MCNARY DAM NEAR UMATILLA, OREGON	
Month	1000 Cubic Feet per Second
April 10 – June 30	260
July 1 – August 31	200

b. Alternate Streamflow Measurement Point

The location of a steamflow measurement point as established in these Conditions to Maintain the Persistence of Listed Fish may be revised if the City provides evidence in writing that ODFW has determined that persistence flows may be measured at an alternate streamflow measurement point and provides an adequate description of the location of the alternate streamflow measurement point, and the Water Resources Director concurs in writing.

B. Determining Water Use Reductions – Generally

The maximum amount of the undeveloped portion of Permit S-54814 that can be diverted as a result of this fish persistence condition is determined in proportion to the amount by which the flows shown in Table 1 are missed based on a seven day rolling average of average of mean daily flows measured in the Columbia River at McNary Dam. The percent of missed target flows is defined as:

$$(1 - [QA / QT]) \times 100\%,$$

where QA is the actual flow measured at the designated location based on the seven day rolling average, and QT is the target flow (from Table 1).

The percent missed target flows applied to the undeveloped portion of the permit provides the maximum amount of undeveloped water that can be diverted as a result of this fish persistence condition, and is defined as:

$$E - (E \times \% \text{ missed target flows}),$$

where E is the undeveloped portion of the permit as of this extension, being 5.49 cfs.

The maximum amount of undeveloped water that can be diverted as a result of this fish persistence condition may be adjusted by a Consumptive Use Percentage, when applicable, as per Item 2.C., below. The overall reduction to the amount of the undeveloped portion of the permit will not exceed 20%.

When $QA \geq QT$, the amount of the undeveloped portion of the permit that can be diverted would not need to be reduced as a result of this fish persistence condition.

C. Consumptive Use Percentages for Utilization in Columbia River Calculations

a. Initial Consumptive Use Percentages

The City of Arlington has not identified any Consumptive Use Percentages based on the return of flows to the Columbia River through effluent discharge. Thus, at this time the City may not utilize Consumptive Use Percentages for the purpose of calculating the maximum amount of the undeveloped portion of Permit S-54814 that can be diverted as a result of this fish persistence condition.

b. First Time Utilization of Consumptive Use Percentages

Utilization of Consumptive Use Percentages for the purpose of calculating the maximum amount of the undeveloped portion of Permit S-54814 that can be diverted as a result of this fish persistence condition may begin after the issuance of the Final Order for this extension of time.

First time utilization of Consumptive Use Percentages is contingent upon the City (1) providing evidence in writing that ODFW has determined that withdrawal points and effluent discharges are within reasonable proximity to each other, such that fish habitat between the two points is not impacted significantly, and (2) submitting monthly Consumptive Use Percentages and receiving the Water Resources Director's concurrence with the proposed Consumptive Use Percentages. Utilization of Consumptive Use Percentages is subject to an approval period described in 2.C.f., below.

Consumptive Use Percentages submitted to the Department for review must (1) be specified as a percentage (may be to the nearest 1/10 percent) for each month of the year and (2) include a description and justification of the methods utilized to determine the percentages. The proposed Consumptive Use Percentages should be submitted on the *Consumptive Use Percentages Update Form* provided with the Final Order for this extension of time.

c. Consumptive Use Percentages Updates

Continuing the utilization of Consumptive Use Percentages for the purpose of calculating the maximum amount of the undeveloped portion of Permit S-54814 that can be diverted as a result of this fish persistence condition beyond an approval period (as described in 2.C.f., below) is contingent upon the City submitting updated Consumptive Use Percentages and receiving the Water Resources Director's concurrence with the proposed Consumptive Use Percentages Updates. Utilization of Consumptive Use Percentages Updates is subject to an approval period described in 2.C.f., below.

The updates to the Consumptive Use Percentages must (1) be specified as a percentage (may be to the nearest 1/10 percent) for each month of the year and (2) include a description and justification of the methods utilized to determine the percentages. The updates should be submitted on the *Consumptive Use Percentages Update Form* provided with the Final Order for this extension of time.

d. Changes to Wastewater Technology and/or Wastewater Treatment Plant Practices

If there are changes to either wastewater technology or the practices at the City's waster water treatment facility resulting in 25% or more reductions in average monthly return flows to the Columbia River, then the Consumptive Use Percentages in effect at that time may no longer be utilized for the purposes of calculating the maximum amount of the undeveloped portion of Permit S-54814 that can be diverted as a result of this fish persistence condition. The 25% reduction is based on a 10-year rolling average of monthly wastewater return flows to the Columbia River as compared to the average monthly wastewater return flows from the 10 year period just prior to date of the first approval period described in 2.C.f., below.

If such changes to either wastewater technology or the practices at the City's waster water treatment facility occur resulting in 25% reductions, further utilization of Consumptive Use Percentages is contingent upon the City submitting Consumptive Use Percentages Updates as per 2.C.c., above, and receiving the Water Resources Director's concurrence with the proposed Consumptive Use Percentages.

e. Relocation of the Point(s) of Diversion(s) and/or Return Flows

If the point(s) of diversion(s) and/or return flows are relocated, Consumptive Use Percentages in effect at that time may no longer be utilized for the purposes of calculating the maximum amount of the undeveloped portion of Permit S-54814 that can be diverted as a result of this fish persistence condition.

After relocation of the point(s) of diversion(s) and/or return flows, further utilization of Consumptive Use Percentages is contingent upon the City (1) providing evidence in writing that ODFW has determined that any relocated withdrawal points and effluent discharge points are within reasonable proximity to each other, such that fish habitat between the two points is not impacted significantly, and (2) submitting Consumptive Use Percentages Updates as per 2.C.c., above, and receiving the Water Resources Director's concurrence with the proposed Consumptive Use Percentages.

f. Approval Periods for Utilization of Consumptive Use Percentages

The utilization of Consumptive Use Percentages for the purpose of calculating the maximum amount of the undeveloped portion of Permit S-54814 that can be diverted as a result of this fish persistence condition may continue for a 10 year approval period that begins 10 years from the Water Resources Director's most recent date of concurrence with Consumptive Use Percentages Updates as evidenced by the record, unless sections 2.C.d., or 2.C.e. (above) are applicable.

Consumptive Use Percentages (first time utilization or updates) which are submitted and receive the Director's concurrence will begin a new 10 year approval period. The approval period begins on the date of the Water Resources Director's concurrence with Consumptive Use Percentages Updates, as evidenced by the record. The City at its discretion may submit updates prior to the end of an approval period.

D. Examples

Example 1: Target flow met.

On April 15, the last seven mean daily flows in the Columbia River at McNary Dam[1] were 310K, 290K, 280K, 260K, 260K, 240K and 250K cfs. The seven day rolling average (QA) is 270K cfs. The amount of the undeveloped portion of the permit that can be diverted would not be reduced because the 7 day average of mean daily flows is greater than the 260K cfs target flow (QT) for April 15. In this example, QA $\geq$ QT.

Example 2: Target flow missed.

Step 1: If on July 15, the average of the last seven mean daily flows (QA) was 170K cfs, and the target flow (QT) is 200K, then the target flow would be missed by 15.0%.

$$(1 - (170 / 200)) \times 100\% = 15.0\%$$

Step 2: Assuming the Consumptive Use Percentage is 62.2%[2] during the month of July and the utilization of this percentage is authorized, and the target flow is missed by 15.0% (from Step 1), then the amount of the undeveloped portion of the permit that could be diverted would be reduced by 9.3%.

$$(62.2\% \times 15.0\%) / 100 = 9.3\%$$

(If adjustments are not to be made by a Consumptive Use Percentage, then the undeveloped portion of the permit would only be reduced by the % by which the target flow is missed – 15.0% in this example).

Step 3: The overall reduction of 9.3% of the amount of the undeveloped portion of the permit does not exceed 20%.

Step 4: The undeveloped portion of this permit as of this extension (E) is 5.49 cfs. Therefore, in this example, the maximum amount of the undeveloped portion of Permit S-35058 that can be diverted as a result of this fish persistence condition is 5.0 cfs.

$$5.49 - ((5.49 \times 9.3\%) / 100) = 5.0$$

Step 5: Given that the permitted quantity under this right is 8.16 cfs, and the undeveloped portion is 5.49 cfs, if the amount of water legally authorized for a diversion at a given point in time is 4.0 cfs, then only 1.33 cfs of undeveloped water would be used to satisfy the 4.0 cfs.

$$4.0 - (8.16 - 5.49) = 1.33$$

[Note: (8.16 – 5.49) equals the developed portion of the permit]

In this example, the 1.33 cfs of undeveloped water is less than the 5.0 cfs maximum undeveloped portion (from Step 4) that can be diverted as a result of this fish persistence condition. Therefore, there would be no required reduction in water use of the undeveloped portion under the permit.

---

[1] Daily flow data for McNary Dam is available at http://www.fpc.org/currentdaily/flowspil.txt.

[2] Currently, the City of Arlington may not utilize Consumptive Use Percentages for the purpose of calculating the amount of the undeveloped portion of Permit S-35058 that can be diverted as a result of this fish persistence condition. The utilization of the Consumptive Use Percentage 65.2% is only for illustrative purposes in this example.

Step 6: If the amount of water legally authorized for a diversion at a given point in time is 8.0 cfs, then 5.33 cfs of undeveloped water would be used to satisfy the 8.0 cfs.

$$8.0 - (8.16 - 5.49) = 5.33$$

In this example, the 5.33 cfs of undeveloped water is greater than the 5.0 cfs maximum undeveloped portion (from Step 4) that can be diverted as a result of this fish persistence condition. Therefore, the amount of undeveloped water diverted by the permit holder would need to be reduced by 0.33 cfs.

$$5.33 - 5.0 = 0.33$$

In this example, the maximum amount of water that could be appropriated is 7.67 cfs.

$$8.0 - 0.33 = 7.67$$

The priority date of this permit is .....December 1, 1970.....

Actual construction work shall begin on or before .....October 1, 1999..... *and shall thereafter be prosecuted with reasonable diligence and be completed on or before* October 1, 2030.....

Complete application of the water to the proposed use shall be made on or before October 1, 2030.....

WITNESS my hand this.....*day of* June, 2013.

.....

Dwight French, Water Right Services Administrator, for
PHILLIP C. WARD, DIRECTOR