APPRAISAL STUDY

DNR Paterson Irrigation Project

Prepared for: Washington State Department of Natural Resources

Project No. 120151 • November 27, 2012 Final

Aspect CONSULTING

J·U·B ENGINEERS, INC.

earth + water

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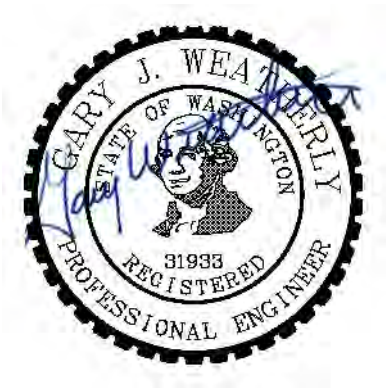
Aspect Consulting, LLC, JUB Engineers, Inc., and Mike Brady



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Executive Summary

Eight irrigation alternatives were considered as part of this study to develop an irrigation water system (either in whole or in part) under an existing permit (S4-25639(A)P) on Washington Department of National Resources (DNR) lands in the Horse Heaven Hills region of Benton County. Alternatives range from complete build-out of 3,875 acres of lands remaining to be developed to partial build out of 1,667 acres using only the most economically served DNR lands.

A variety of crops were considered in performing this assessment including typical seasonal and perennial crops grown in the Horse Heaven Hills. Due to site suitability criteria such as soil, slope, and climate, limited crop selection may be available in some areas, which has been reflected in the results.

Several alternatives focus on optimizing the use of water and infrastructure through capacity sharing and/or creative water rights strategies. Capacity sharing alternatives focus on using off-peak supply available in the new DNR system to meet other farm's needs, or to help solve a declining groundwater problem in the area. Water rights strategies include optimizing point of withdrawals from the Columbia River, proposing strategic sequencing of perfection, or spreading of acreage to maximize DNR's return on investment.

Project economics were evaluated for each alternative by determining average rental rate per acre required to achieve a target level of return of 5 percent. Also, net present value for each alternative was estimated, which discounts revenue received over time by the opportunity cost of capital (4 percent assumed).

Based on input from DNR, target (probable-maximum) rental rates of $600 per acre/year for circles and $358 per acre/year for corners were identified. Each alternative is capable of providing a positive rate of return within these reasonable land rental rates. The rates of return (internal rate of return, IRR) are based upon comparison of likely revenue (rental rates) of irrigated DNR land to estimated cost of new infrastructure and ongoing operations and maintenance (O&M).

The highest return on investment is associated with alternatives that either limit project improvements to the best available land, share infrastructure capacity to solve regional problems, or involve creative water rights strategies. The alternatives all produce cost / acre-foot values in the range of $1,000 to $3,000 / acre-foot, which is the valuation range of water supply projects currently being developed by the Office of Columbia River.

A qualitative assessment of environmental and permitting issues was also addressed. Alternatives that limited the footprint of the irrigation development, through use of existing pump stations and development of irrigation on lands closest to infrastructure corridors, had the lowest environmental impact. In most alternatives, permitting complexity increased conversely with decreasing environmental impact.

A summary of project alternatives including capital and O&M costs, minimum rental rates necessary to achieve a 5 percent rate of return, environmental assessments, and permitting complexity is shown in Table ES-1. Appendix A also includes a comparative analysis where

average rental rates were estimated based on prevailing marketability of land and associated proportion of crops in circle production versus corners for each alternative. This appendix includes additional information regarding the net present value analysis performed.

Table ES-1. Economic Analysis Results

Alt	Description	Perfected Acreage[1]	Permanently Irrigated Acreage	Banked Water	DNR Capital Cost / Acre[2]	DNR Capital Cost / Acre-ft [3]	Capital Cost			O&M Cost[5]			Rental Rate (Per Acre)[6]		Annual Return[7]	Return on Asset[8]	Environmental Impact (low, medium, high)[9]	Permitting Complexity (low, medium, high)[10]
							Total	DNR Share	Partner Share[4]	Total	DNR Share	Partner Share[4]						
1	Full Build-out of Land with Permanent Crops	3,875	3,875	0	$11,987	$3,035	$46,450,404	$46,450,404	$0	$682,499	$682,499	$0	$640	(+/-$95)	$2,480,000	5.3%	High	Low
2	Full Build-out of Land with Permanent/ Temporary Crop Mix	3,736	2,934	802	$7,925	$2,006	$29,609,112	$29,609,112	$0	$508,106	$508,106	$0	$536	(+/-$76)	$2,002,496	6.8%	Medium	Low
3	Partial Build-out with High Value Crops	1,667	1,667	0	$11,337	$2,870	$18,899,494	$18,899,494	$0	$274,400	$274,400	$0	$623	(+/-$83)	$1,038,541	5.5%	Low	Low
4a	Similar to Alt 2, with capacity sharing	3,736	2,934	802	$6,793	$1,720	$35,878,412	$25,377,321	$10,501,091	$752,212	$508,106	$244,106	$520	(+/-$101)	$1,942,720	7.7%	Medium	Medium
4b	Similar to Alt 2, with ASR	3,736	2,934	802	$6,653	$1,684	$56,987,651	$24,856,760	$32,130,891	$1,657,500	$508,106	$1,149,394	$520	(+/-$101)	$1,942,720	7.8%	Medium	High
5a	Based upon Alt 3, with serial perfection and partial proofs[11]	4,392	1,667	2,725	$4,303	$1,089	$18,899,494	$18,899,494	$0	$274,400	$274,400	$0	$419	(+/-$54)	$1,840,248	9.7%	Low	High
5b	Based upon Alt 1, with serial perfection and partial proofs[11]	4,844	2,769	2,075	$9,589	$2,428	$46,450,404	$46,450,404	$0	$682,499	$682,499	$0	$595	(+/-$95)	$2,882,180	6.2%	High	High
5c	Based upon Alt 1, with serial perfection and partial proofs[11]	6,420	2,769	3,651	$7,235	$1,832	$46,450,404	$46,450,404	$0	$682,499	$682,499	$0	$450	(+/-$75)	$2,889,000	6.2%	High	High

Notes:

1 Perfected Acreage is in addition to existing 517 acres of DNR land already in agricultural production under Permit S4-25639(A)P.

2 DNR Capital Cost / Acre is representative of DNR share of capital cost relative to ultimate perfected acreage.

3 DNR Capital Cost / Acre-ft is based on an average water duty of 3.95 ft / acre which is the average water duty represented in Permit S4-25639 (17,375.15 acre-ft / year / 4,392.1-acres). Actual water duty will depend on perfected acres and crops.

4 Partner Share represents capital costs paid by others to sharing excess DNR infrastructure capacity.

5 O&M Costs represent estimated power costs incurred for pumping and operation of farm watering equipment only.

6 Rental Rate reflects assumption of 5% rate of return associated with 2% annual rental rate increase, with a ± 1% rental rate sensitivity analysis.

7 Annual Return represents the annual revenue to DNR based on the average rental rate of return for the number of acres developed.

8 Return on Asset is the ratio of annual cash income (annual return) to total invested capital assets.

9 Environmental Impact is a qualitative rating based on projected impacts to aquatic and terrestrial habitat, primarily due to number and location of acres developed, and level of construction at the Columbia River.

10 Permitting Complexity is a qualitative rating based on water right strategies, SEPA, and the potential for federal permitting compliance with ESA.

11 Alternative 5 options are not mutually exclusive with Alternative 4, but could be combined for a higher Return on Asset.

Introduction

Appraisal Study

Project Statement

The Washington State Department of Natural Resources (DNR) holds water right Permit S4-25639(A)P with a priority date of April 1977 which allows for development of up to 17,375 acre-feet of irrigation water within the Wood Glade planning area of Water Resource Inventory Area (WRIA) 31 in Benton County (commonly referred to as the Horse Heaven Hills region). Due to the lack of water conveyance infrastructure in place, the majority of the water right is currently unperfected with only 517 acres (12 percent) of the 4,392-acre total being put to beneficial use. DNR would like to explore options related to perfecting their current water rights in order to meet multiple objectives including the following:

- Developing a block presence in a highly productive agricultural area near all modes of transportation (train, barge, truck) to worldwide markets.
- Ensuring that DNR lands are poised and able to adapt to climate change by developing a large block of water that can be used on these lands or moved to others.
- Providing for a substantial increase in revenue to the States Trust from DNR managed agricultural lands.

The intent of this appraisal study is to identify and evaluate potential alternatives that would allow for the perfection of their water rights in the most technical and economically feasible manner. Alternatives considered in this study include appraisal level evaluations of the following:

- Three Irrigation System Configuration Alternatives.
- One Shared Benefits Alternative.
- One Water Rights Alternative.

Some of the alternatives are interrelated and offer viable variants upon investigation. These variants are discussed topically and may be explored in greater detail in a subsequent feasibility or pre-design report, or in environmental review documents. Each of the alternatives developed consider plans for a water delivery system which will meet the following objectives:

1. Provide adequate water for a diverse range of crops including irrigated row crops, orchards and vineyards.
2. Provide for cost effective delivery of irrigation water.
3. Provide for a reliable, long-term means of irrigation water distribution.

The alternatives evaluation included the following as part of this appraisal-level assessment:

1. Appraisal-level engineer's opinion of probable costs including capital construction costs and yearly operation and maintenance costs (O&M) for each alternative.
2. Net present value and return on investment analysis for each alternative.
3. Instantaneous demand and annual consumptive use for each alternative including the design criteria for conveyance and distribution of water with associated pressure zones.
4. Identification of a preferred alternative which will optimize the combination of delivery system capacity versus irrigated acreage to provide the best economic return over a 50-year study period.

After completion of this appraisal study in November 2012, the project will progress into more detailed feasibility study of the preferred alternative(s) to better evaluate potential fatal flaws, if any. Precluding the presence of fatal flaws, the project will then move into environmental review, preliminary design, final design, permitting, public bidding, and construction phases, pending funding by the Legislature. The goal of the project is to have facilities constructed and operational in 2019 with perfection of the remaining water rights occurring over a 20-year development period.

Study Approach

The approach used for this assessment focused on developing and evaluating project alternatives from four interrelated perspectives. First, land use was considered by determining the optimal mix of new irrigated acreage verses land that is left undisturbed (shrub steppe). For land proposed for irrigation under each alternative, a crop mix was selected to optimize water use and economic benefit. Crops were also selected based on environmental conditions and, while a broad list of crops was originally selected, a more tailored list considering cold temperature constraints was used. Second, infrastructure (pumps and pipes) optimization was completed by determining the most cost-effective way to serve crops. Where possible, the leveraging of existing infrastructure (managed by DNR and/or others) was explored. Next, water right strategies for each alternative were considered in an attempt to utilize available water law policy that may result in streamlining water perfection and minimize required investment. Finally, an economics analysis was performed to determine benefit/cost ratios and return on investment for each alternative.

General Report Format

This appraisal report has been organized in the following three sections:

Project Background - Description of existing conditions including geographic setting, existing infrastructure, and Columbia River water availability. A discussion of the existing surface water permit including potential water rights strategies is also provided.

Development of Project Alternatives - Overview of project alternatives including discussion of alternative evaluation criteria. Additionally, eight potential alternatives are described in detail including an analysis of each.

Evaluation of Alternatives and Recommendation – Side-by-side comparison of alternatives based upon project economics, environmental impacts, and permitting difficulty. A preferred alternative for further study is recommended along with the next steps required to pursue the recommended alternative.

Project Background

DNR Agricultural Lease Program

Washington State Trust lands (state trust land) have been leased for agriculture and grazing by the State of Washington's Office of the Commissioner of Public Lands for more than 100 years, offering opportunities to private farmers and ranchers, orchardists, grape growers, other public agencies, and others. DNR offers state trust land leases at public auction to the highest bidder. DNR works with lessees to ensure that appropriate investments are made in the lands to keep them ecologically sustainable and more productive and, in doing so, also protective of public resources such as water, fish and wildlife (WA DNR 2012).

DNR manages approximately 1.1 million acres of state trust lands, including approximately 30,000 acres of irrigated land, which contributes significantly to the Washington State economy. Washington State continues to be a major contributor of agricultural goods to domestic and international markets, ranking 12th nationally. The Common School trust—which helps fund construction on kindergarten through 12th grade public schools statewide—is the main beneficiary of DNR-managed state trust land. DNR works with each lessee to gain the highest economically feasible return for the lessees and state trust beneficiaries (WA DNR 2012).

Generally, terms of a lease of DNR lands may not exceed 10 years (RCW 79.13.060); however, exceptions may be made for general agricultural purposes, with leases extended up to 25 years, or up to 35 years for tree fruit or grapes.

Existing Conditions

Geographic Setting

The defined place of use associated with water rights Permit S4-25639(A)P spans several property sections (and/or quarter sections) distributed throughout three survey townships (Township 7 North, Range 24 East; Township 7 North, Range 25 East; and Township 6 North, Range 24 East, Willamette Meridian [WM]) within a portion of WRIA 31 of Benton County (Figure 1). DNR also holds other lands nearby that are not currently authorized under S4-25639(A)P. The place of use lies entirely within the Wood Glade planning area of the WRIA which is commonly referred to as the Horse Heaven Hills region. This region is the broad agricultural center of the watershed and is defined by the Horse Heaven Hills on the north and east, the Columbia River on the South, and the Rock Creek watershed on the west.

Much of the place of use overlays a portion of the Wanapum Basalt (Columbia River Basalt Group) aquifer system that is faulted and has been subject to significant overdraft of groundwater supplies over the past several decades. Coupled with climate change,

dwindling groundwater supplies in this region may threaten sustainability of groundwater-irrigated agriculture in the area and require greater dependence on surface water supplies, specifically from the Columbia River. Several studies are evaluating the extent and scope of the groundwater declines and options for augmenting groundwater with aquifer storage and recovery, including the 2010 Water Storage Pre-Feasibility Assessment Report prepared by the WRIA 31 Planning and Advisory Committee (Aspect and Anchor 2010), and the Washington State Department of Ecology's (Ecology) Office of Columbia River's aquifer storage and recovery (ASR) feasibility evaluation on State lands[1].

Due to the long growing season and generally favorable soils, the Horse Heaven Hills region is one of Washington's prime agricultural regions. Irrigated agriculture is dominated primarily by seasonal row crops (potatoes, sweet corn, field corn, wheat, onions, sugar beets, and carrots) and permanent crops such as wine grapes, berries, and tree fruit. The Horse Heaven Hills region is home to Washington's largest wine grape producer, Ste. Michelle Wine Estates, Columbia Crest Winery. The Horse Heaven Hills American Viticulture Area was approved in 2005 to recognize the unique grape-growing conditions in the Horse Heaven Hills region.

Crop duties for various major crops grown in the Horse Heaven Hills were estimated using the Washington Irrigation Guide (WIG) methodology developed by the United States Department of Agriculture and Natural Resources Conservation Service (NRCS)[2]. Net crop irrigation requirements (inches) were determined for a close representative location (Kennewick). Coupled with irrigation-application-efficiency information available from Ecology's Water Resources Program Guidance No. 1210 (GUID-1210), gross irrigation requirements were determined based upon anticipated irrigation methods for each crop.

For the purpose of this study, seasonal crops such as alfalfa, potatoes, field corn, and wheat were assumed to be irrigated with various methods including moving sprinkler (big-gun), solid set, and center pivot assemblies equipped with spray heads (without end guns). The latter method is fairly efficient, with a tabulated average efficiency (Ea) value of 90 percent. Moving sprinkler (big-gun) has a much lower efficiency of 65 percent on average.

Permanent crops such as wine grapes and apples (with cover) were initially considered as possible crop options in the evaluation; however, these crops tend to be cold weather sensitive. Because the DNR land is located in the Glade Creek watershed through which cold weather is funneled and tends to sit, a number of area growers indicated the land would be less than optimal for these crops and were therefore excluded.

Results of the crop duties developed for various crops are provided in Table 1.

[1] http://www.ecy.wa.gov/programs/wr/cwp/ASRsiteEx.html.

[2] Note that the 1985 WIG is currently being updated by Washington State University and NRCS. Only provisional data is available and has not yet been adopted. However, that data shows that current crop irrigation requirements which take into account more recent climatological data (temperature, rainfall, wind) will likely increase by several inches in the Horse Heaven Hills area over the 1985 WIG estimates.

Table 1. Crop Duties

	Crop Net Irrigation Req. (in)	Irrigation Application Efficiency Ea (%)	Gross Irrigation Req. (in)	Gross Irrigation Req. (acre-ft / ac)
Alfalfa	39	90%	43	3.6
Wheat	25	90%	28	2.3
Potatoes	30	90%	33	2.8
Field Corn	31	90%	34	2.9

The vast majority of the DNR place of use (88 percent) is a mix of historically grazed or dryland farmed land and undisturbed land and shrub steppe habitat. The developed portion of the place of use covers approximately 517 acres (12 percent) and is currently farmed through lease to ConAgra (100 Circles Farm) who is presently irrigating row crops using center-pivot irrigation methods.

Existing Infrastructure

Irrigation water service to DNR land located northwest of Paterson, Washington will be from the John Day Dam pool (Lake Umatilla) of the Columbia River. Normal water surface elevations in the pool generally range from about 263 feet to 264 feet. The ordinary low water level elevation for the pool is 257 feet. Most of the pump stations were designed to operate at normal river water levels and would experience reductions in pumping capacity if the pool were operated at the ordinary low water level of 257 feet. East of the confluence with Glade Creek, the right bank (north side) of the river is generally shallow back water areas with the north river channel as much as 1,800 feet from the shoreline. In the Glade Creek area the river channel is located very near the north shoreline.

There are a total of eight irrigation water pump stations on the Washington side of the John Day Dam pool, six of which are located where they could be considered as options for delivery of water to the DNR property. The pump stations locations are as shown in Figure 1. Out of the eight total systems, both the AgriNorthwest/Prior Farm and the Carma Irrigation Company (Mercer Ranch) pump stations were eliminated from consideration due to their distance from the DNR land. The remaining six pump stations evaluated for delivery of water to DNR land include: 1) South Slope Irrigation Association (SSIA - ConAgra/Zirkle Fruit (DNR)), 2) Berg Farms, 3) Sunheaven Farms, 4) Columbia Water and Power Irrigation District (Ste. Michelle Wine Estates, 100 Circles Farm, and Wyckoff Farms), 5) Sandpiper Farms, and 6) ConAgra's 100 Circles Farm. Only a small area in the northeast corner of 100 Circles Farm is provided water from the Columbia Water and Power Irrigation District (CWPID) pump station. Of these six pump stations, the DNR already has an interest in both the South Slope Irrigation Association (SSIA) and Sandpiper Farm's pump stations.

The SSIA and Berg Farm's pump stations are located next to each other and are the most easterly and upstream of the pump stations considered. Intake screens for the SSIA pump station are located approximately 1,350 feet from shore. A 60-inch diameter intake pipe

extends from the pump station to the intake screens. Portions of the pipe would be exposed above water with the pool level at 257 feet. The pump station has six pump holes, all of which have pumps installed at this time. The station does not have excess capacity sufficient to benefit the DNR.

Berg Farm's pump station is located immediately adjacent to the SSIA pump station and, like the SSIA pump station, has a 1,350-foot-long intake pipe that extends into the river to the intake screens. The intake pipe is 42 inches in diameter and parallels the SSIA intake pipe. All of the pump holes in the Berg Farm's pump station currently have pumps installed in them. The Berg's have indicated they may have 5,000 to 6,000 gallons per minute (gpm) excess capacity in their 42-inch diameter penstock but delivering that excess capacity would require replacing existing lower-horsepower pumps with higher-horsepower pumps at their river pump station and booster pump stations. The Berg Farm irrigation system may offer some opportunities to convey water to the DNR land in relatively small quantities to perfect water rights but is probably not an option for permanently delivering water to significant areas of the DNR property.

Moving downstream the next pump station belongs to Sunheaven Farms. Sunheaven Farm's pump station has seven pump cans and a 60-inch diameter intake pipe that extends approximately 1,800 feet into the river where the intake screens are located. At low river water levels the intake pipe must function as a siphon to deliver water to the pump station. Sunheaven Farm's has pumps installed in all of their pump cans. Options for expansion of the pump station are very limited because there are no empty pump cans and the intake pipe is already operating at near its capacity at low river water levels.

The CWPID pump station has intake screens mounted on the face of the pump station structure, where they are accessible, and two empty pump holes. The pump station does have some excess pumping and penstock capacity although a cursory evaluation suggests it is not sufficient to meet the DNR's needs. Using the two empty pump holes and a separate penstock, the CWPID pump station does offer some opportunities to deliver water to the DNR property. Installation of a 1,500-horsepower (HP) pump in each of the two pump holes and operating at lower discharge pressures than the existing pumps would provide enough water for several of the options being considered. The river is relatively shallow in the area surrounding the CWPID pump station. At current and historical normal pool levels, water depth has been sufficient to allow full pump station operation. However, if the United States Army Corps of Engineers (USACE) were to begin operating the river at lower pool levels, the combination of higher pumping rates and lower water levels could result in approach water velocities above the maximum allowed by the National Oceanic and Atmospheric Administration (NOAA) Fisheries. If this situation occurred, the pumping rate would have to be reduced. Regardless of approach velocity criteria, at minimum pool level a number of the existing pumps would no longer have sufficient submergence to operate. The CWPID has established priorities for water delivery when pumping capacity is reduced. Ste. Michelle Wine Estates water has first priority, other perennial crops in the CWPID have second priority, row crops within the CWPID have third priority, and areas outside the CWPID have the lowest priority. The DNR land is located outside the CWPID and would have the lowest priority if the pumping rate had to be reduced due to pump station approach water velocity constraints. Because the DNR would have separate pumps and penstock, the effect of a loss in pumping capacity due to pump submergence issues may be reduced. Based on available information and pump station owner input, there has never been a time

when the CWPID pump station pumping rate has had to be reduced due to low river water levels. The CWPID pump station has the advantages of being the closest pump station to the majority of the DNR property, and using the two empty holes and a separate penstock pipe would allow the DNR to operate relatively independent of the other pump station users.

Further downstream (west) is the Sandpiper Farm's pump station. This pump station has one empty pump hole that Sandpiper Farm has no current plans to use. They do not believe they have any excess capacity in their penstock. The pump station is designed around flat panel intake screens hung from deck openings around each pump. Using intake screens that would fit the existing deck openings without modification could allow the withdrawal of up to about 24,500 gpm based on NOAA Fisheries maximum approach velocities; however, the intake screens are passive and would normally be designed for lower approach velocities to provide more uniform velocities across the screen and reduce plugging issues. Installation of a new penstock leaving the Sandpiper Farm pump station would likely encounter wetland and rock excavation issues and the pump station is located approximately 5,000 feet further from the bulk of the DNR land than the CWPID pump station.

The furthest downstream pump station adjacent to the DNR land is ConAgra's 100 Circles Farm pump station. The pump station was not seriously considered for use due to its distance from the DNR land; in addition, there are no vacant pump holes and the distribution system has no real excess capacity to deliver water north of the existing farm.

Columbia River Management

The Columbia River is closely managed to accommodate increasingly competitive uses of water and infrastructure including flood control, fish migration and habitat, electrical power generation, ship navigation, agricultural irrigation, recreation, domestic water supply, and cultural resources. Like all water resources in Washington, the competition amongst these uses is largely settled by the relative priority dates of the water rights. There are four general priorities of water rights to consider: senior tribal rights, senior State-issued rights, the State's instream flow rights, and junior interruptible water rights. Additionally, federal fisheries agencies have established biological opinion (BiOp) flows that the State considers under its public interest authority.

Tribal water rights on the Columbia River are generally unquantified in Washington and relate back to either the date of the signing of the relevant treaties, or "time immemorial" for fishing rights. Following adjudication, the effect these rights have on the Columbia River will be clearer, although the Tribes have significant influence today in Columbia River water management even absent quantification.

Senior State-issued water rights generally range from the mid-1880s to 1980, when the State adopted an instream flow rule. These water rights are currently satisfied each year.

Minimum instream flows were set by the State of Washington for the Columbia River for use in protecting instream values and regulating the issuance of new water rights. Those flows are described in Chapter 173-563 WAC, which was implemented in 1980 and subsequently amended in 1998. The rule effectively establishes a water right for beneficial use of water within the Columbia River itself with a priority date of 1980.

Water rights issued from the Columbia River after 1980 are junior to instream flows, and are subject to curtailment (interruption) when minimum instream flows (low flow conditions)

are not met. Curtailment based on low flow conditions occur when the March 1 forecast at The Dalles Dam on the lower Columbia River is less than 60-million acre-feet for April through September.

Since the implementation of instream flows on the Columbia in 1980 (32-years ago), curtailment has only been enacted one time (in 2001); this represents an observed frequency of 1:32 for curtailment of interruptible rights. Due to long-term hydrologic records and anticipated future trends, Ecology estimated that the actual risk of curtailment of interruptible rights is closer to a 1:20 yearly frequency, which it clarified as a provision on all interruptible water rights. Presently, there are dozens of interruptible rights within the Horse Heaven Hills region representing roughly 50,000 acre-feet (Aspect and Anchor 2010).

In addition to minimum instream flows that directly impact water rights, federal BiOp flows (target BiOp flows) in the Columbia River were also established as part of the 2004 BiOp for the Federal Columbia River Power System (FCRPS). The target BiOp flows facilitate spawning and downstream passage of juveniles and accommodate returning adult salmon and steelhead. While target BiOp flows generally do not trigger curtailment of existing water rights, they are considered when issuing new water rights under Ecology's public interest test. Target BiOp flows may also be considered if an irrigation project triggers Endangered Species Act (ESA) consultation, regardless of whether a project proponent already has a State-issued water right authorization. Furthermore, because target BiOp flows are used to manage the FCRPS, they are very important in determining when and where water is available in the Columbia River.

In order to address Columbia River water management issues in response to competing demands and growing seasonal shortages, the Washington State legislature passed the Engrossed Second Substitute House Bill 2860 (ESSHB 2860) in 2006. ESSHB 2860 effectively authorized the development of the Columbia River Basin Water Supply Development Program which is administered through the Ecology's Office of the Columbia River (OCR). This program, and its funding, is intended to pursue and develop new water supplies to benefit both instream and out-of-stream uses through creation of new storage facilities, conservation projects, or other actions.

Another management overlay for the Columbia River is a reservation of water for new uses. On August 8, 1978, the John Day/McNary Reserve (WAC 173-531) was created to set aside 1,320,000 acre-feet per year to provide a water supply for the 330,000 acres of irrigation projected to be developed in the Columbia Basin by the year 2020. Originally, the reserve was intended to forestall the diversion of the Columbia River to address out-of-state water needs. The reserve was also designed as a means to deliver water to lands under existing water rights permits, pending applications, and to land for which appropriation applications may not yet have been filed. In the last 22 years, about 85 permits have been issued from the John Day/McNary Reserve for 76,000 acre-feet a year—roughly 6 percent of the total set aside (OCR 2006). Scientific and public policy conflicts regarding the effects of additional water use on the health of the Columbia River's ecosystems have sharply limited the number of new permits issued from the reserve (OCR 2006).

DNR's water rights Permit S4-25639(A)P has the following attributes. First, it is a senior (pre-1980) State-issued water right. It is therefore not subject to curtailment when instream flows are not met. Unless ESA consultation is triggered through a federal permitting action,

it is also not subject to the target BiOp flows or other federal constraints. This report evaluates a number of alternatives and how permitting of those alternatives will affect development, cost, and internal rate of return of the DNR water rights permit.

Existing Water Rights

Context of Water Rights in Developing Project Alternatives

In the most basic sense, the perfection of water under the existing DNR permit is a water rights issue. The final solution to perfecting the water may require a mix of new infrastructure, use of existing infrastructure, participation from State agencies, participation from local growers, and consideration of optimal lands / crops—all of which are impacted by the various water rights strategies that are employed.

In order to perfect the water on DNR lands, water must first be brought to the land; however, the manner in which water is supplied, to which parcels, and in what sequence, are important questions that necessitate a sound water rights strategy. There are certain restrictions on what can be done from a water rights perspective based upon the limitations of the existing permit (place of use, point of diversion, season of use, etc.), but there are also tools that can be employed to add flexibility within the framework of the existing permit and to possibly change portions of the permit to facilitate more options.

Each project alternative developed in this study closely examines the limitations of the existing permit and explores the potential for maximizing water rights opportunities—either through proposing water right changes which would allow for more points of withdrawal from the Columbia River, through proposing a strategic sequencing of perfection of water in a way that limits required infrastructure, or through spreading of acres from high-to-low duty crops that increase the final footprint of irrigated land under the permit which affects return on investment.

History of Permit S4-25639(A)P

The current authorized water rights permit, S4-25639(A)P, has a priority date of April 22, 1977 and authorizes the diversion of up to 17,375.15 acre-feet per year at a maximum instantaneous rate of 72.15 cubic feet per second (cfs) from the Columbia River for the purpose of irrigation during the time period from February 1 through November 15. This permit was part of a larger parent permit (S4-25639), which was originally issued to Paterson Power and Water District which dissolved due to financial insolvency. Permit S4-25639 was administratively split and assigned to numerous landowners within the District, including DNR, which were then responsible for development of the resulting separate permits.

The attributes of Permit S4-25639(A)P are summarized in Table 2.

Table 2. Permit S4-25639(A)P Summary

Attribute	Specifics
Name on certificate, claim, permit:	State of Washington, Department of Natural Resources (DNR)
Water right document number:	S4-25639(A)P
As modified by certificate of change number:	N/A
Priority date, first use:	22-Apr-77
Water quantities:	Qi: 72.15 cfs Qa: 17,375.15 acre-feet
Source (well, river, etc.):	Columbia River
Point of diversion/withdrawal:	100 feet west and 250 feet south of the northeast corner of Section 4, Township N. 4, Range W.M. 24 E., WRIA 31, Benton County
Purpose of use:	Irrigation, 4,392.1 acres
Period of use:	February 1 to November 15
Place of use:	W1/2 and the NE1/4 of Section 15; Section 16; Section 21; W1/2 and the SE1/4 of Section 26; E1/2 and the SW1/4 of Section 28; W1/2 and the SE1/4 of Section 30; W1/2 and the SE1/4 of Section 32; W1/2 and the SE1/4 of Section 34; Section 36; all in T. 7 N., R. 25 E.W.M. Section 36; T. 7 N., R. 24 E.W.M. Section 16; Section 36; NE1/4 of Section 34; SW1/4 of Section 24, T. 6 N., R. 24 E.W.M.
Existing provisions:	Publicly Owned Land Permit
Previous transfers associated with this water right:	Three pending change applications

There are three water rights change applications associated with this permit pending with the Ecology (submitted in 1996, 2001, and 2011). Each change application is associated with additional proposed points of diversion from the Columbia River nearer to the authorized place of use. A summary of pending points of diversion based upon pending applications is provided in Table 3.

Table 3. Permit S4-25639(A)P Pending Change Applications

Record No.	Date	Proposed Point of Diversion				
		Qtr Sec	Sec	Twn	Rge	Diversion
CS4-25639(A)	8/21/1996	NE 1/4 of NE 1/4	28	5 N	25 E	Sandpiper Farms
CS4-25639(A)@1	7/9/2001	NW 1/4 of NW 1/4	18	5 N	26 E	Columbia River Water and Power District/Sunheaven Farms
		Govt. Lot 1	18	5 N	26 E	Columbia River Water and Power District/Sunheaven Farms
CS4-25639(A)@2	11/16/2011	NE 1/4 of NE 1/4	4	4 N	24 E	ConAgra (100 Circles) / DNR
		NW 1/4 of NW 1/4	18	5 N	26 E	Columbia River Water and Power District/Sunheaven Farms
		SW 1/4 of NE 1/4	8	5 N	26 E	South Slope Irrigation Association (SSIA) / Berg Farms

On November 14, 2011, DNR filed an extension in the Completion of Construction (CC) stage with Ecology on the basis of difficulty associated with serving its place of use using the existing point of diversion and projected implications of the passage of the "Pools Bill" legislation (RCW 90.03.397). On January 31, 2012, Ecology granted an extension to the CC stage with a new deadline of January 1, 2019. Ecology conditioned the extension requiring DNR to submit progress reports outlining the status of funding/budget development, design and permitting progress, and progress made toward CC of the permit. The first such progress status report is due on December 31, 2012 and this report is intended to assist DNR in complying with that requirement.

"Pools Bill" and Processing of DNR Change Applications

Like DNR, many of the farms shown on Figure 1 are irrigating under portions of the original ("parent") Paterson Power and Water District water right. These siblings of the parent permit have developed more rapidly because, unlike DNR, most of these farms have lands that are located closer to the Columbia River and in consolidated blocks. With the exception of 517 acres that DNR has developed to-date from the currently authorized point of diversion, DNR's lands are among the farthest from the river. These lands also include isolated blocks of land that are challenging to serve economically. Perhaps the greatest barrier to development of the permit is the conflict between the point of diversion authorized for DNR lands (which is aligned with DNR's western most authorized section) and land authorized for irrigation (5 or more miles to the east). The lands could be served more economically if an upstream pump station were authorized.

In 1996, DNR filed its first change application to move its point of diversion upstream. This application is one of the oldest Columbia River change applications on file with Ecology today, as it was filed unfortunately at a time when the current "backlog" of pending water right applications was beginning. The backlog in Columbia River permitting was primarily a result of two factors. First, Ecology had gone through a significant reduction in staff. Second, several salmon species were listed as threatened or endangered on the Columbia River under the ESA, which prompted Ecology to issue a moratorium on issuing new Columbia River permits.

DNR's application was also stymied because Ecology did not have specific legislative authority to alter unperfected surface water permits. In 1996, RCW 90.03.380 was the only statutory authority to alter surface water rights, but RCW 90.03.380 only altered those surface water rights that had "been applied to a beneficial use". This differed from the groundwater code (RCW 90.44.100) that allowed changes in points of withdrawal for both groundwater permits and certificates.

DNR's development plans were reinvigorated over the next few years due to significant changes in the water code by the Legislature. In 1997, the Legislature authorized conservancy boards to assist Ecology in transferring water rights. In 1999, the Legislature passed RCW 90.03.395 and 90.03.397, which provide express authority to change unperfected surface water permits in certain circumstances. Then in 2001 the Legislature appropriated significant new staff for Ecology, and separated new applications and change applications into "two lines", which allowed Ecology to work on Columbia River changes that weren't as affected by the ESA listings associated with new appropriations. By 2001, many local conservancy boards had been formed and were actively processing changes.

To that end, DNR applied again in 2001 to add points of diversion upstream, this time filing the change application with the Benton County Water Conservancy Board. The goal was to transfer the water right under the newly-adopted criteria of RCW 90.03.395 and 90.03.397. DNR requested technical assistance from Ecology on the transfer since the statutes were new and no transfers had yet been processed under those criteria. In the technical assistance meeting, one central issue emerged as a new barrier to the transfer: RCW 90.03.397 only authorized transfers to a "point of diversion that is located *downstream*". DNR's proposed points of diversion were upstream to allow more economic service of the bulk of its lands to the east.

Over the next few years, DNR and Ecology tried to determine whether the single "downstream" word was a prohibitive barrier to the transfer, or if the location of the diversion points in the John Day Dam Pool (which has a downstream gradient, if slight) could be addressed through policy, rulemaking, or other means. In 2006 DNR and Ecology determined that a statutory change would be necessary. In 2007, the first incarnation of the "Pools Bill" was introduced in the legislature.

Each year, dozens of water bills are introduced in the legislature, and most are not passed; this was the case for the Pools Bill as well. Its failure did provide some learning opportunities for DNR, particularly as it related to the scope of the bill and the level of pre-session stakeholder outreach necessary to be successful.

In 2010, DNR and Ecology collaborated on a more-limited version of the Pools Bill, targeted at the John Day Dam Pool and confined solely to point of diversion changes (the 2007 version also requested place of use and other alterations for unperfected surface water permits), and had numerous meetings with stakeholders to ensure their concerns were addressed. The Legislature passed amendments to RCW 90.03.397 that now allowed upstream transfers in the John Day Dam Pool. In 2011, DNR filed an updated change application to again begin processing its transfer.

Options for Changing Permit S4-25639(A)P to Maximize DNR Return on Investment

The following sections describe general options for making strategic alterations to Permit S4-25639(A)P to make the overall project more economical, and have a smaller environmental footprint. These strategies apply to multiple alternatives and may be used in coordination with one another.

Adding Points of Diversion

The 517 acres currently served under the permit utilizes the existing point of diversion at 100 Circles Farm. This diversion is located approximately 6 to 10 miles downstream of other existing surface water pumping stations which are more favorably located to serve the remaining DNR land and may have excess capacity. Serving the remainder of the DNR land from this pump station may be challenging, as discussed later in this report. Adding upstream surface water points of diversion closer to the center of the undeveloped land would allow for more economical development, greater flexibility of water delivery, and a reduction in required infrastructure.

Under RCW 90.03.395 and 90.03.397, Ecology may approve such changes to points of diversion for unperfected surface water rights if they are downstream, or upstream if they lie within the Columbia River between river miles 215.6 and 292. These river miles correspond to John Day Dam and McNary Dam. All of the proposed DNR pump stations sites lie within these river miles.

RCW 90.03.395 also specifies that changes in points of diversion of unperfected rights must provide both environmental benefits and water supply benefits. DNR requested technical assistance from Ecology on the interpretation of these criteria[3]. Because DNR understands that Ecology has not processed any change applications under theses statutes, there is little guidance to follow.

In DNR's case, the criteria for environmental and water supply benefits associated with a *change in point of diversion* should not be confused with a requirement for the *project* to have environmental and water supply benefits. Ecology already made a determination in 1978 that issuance of the parent water right for Paterson Power and Water District to irrigate 23,069 acres satisfied the 4-part test for issuance of a water right (water availability, beneficial use, impairment, and public interest). The baseline for comparison is all 4,392 acres of DNR land will be irrigated from the historic point of diversion. If transferring a portion of the demand to upstream pump stations will result in less environmental impact and more efficient water delivery over the baseline condition, then there will be environmental and water supply benefits.

Adding points of diversion using existing pumping facilities will have environmental and water supply benefits over the initial permitted authorization, including the following:

- Avoiding direct impact to shoreline and/or wetlands of the Columbia River.

[3] DNR and Ecology continue to collaborate on the interpretation of these statutes; however, Ecology's technical assistance response was not available at the time of publication of this report.

- Reducing pipeline length, which creates lower construction-related disturbances and opportunities for a superior alignment to the DNR lands for reduced disturbance of shrub steppe habitat.
- Reduced power demand, which lessens the regional power demand on the grid.
- Lower long-term operation and maintenance requirement, which lessens vehicle travel and other induced environmental impacts.
- More efficient water delivery to farms by combining with other pump stations.
- Shorter transmission distances, which reduce construction cost, power use, and long-term maintenance.

RCW 90.03.397 also requires that the proposed point of diversion must be an "approved intake structure with capacity to transport the additional diversion". DNR interprets this requirement to be associated with the "intake structure", rather than the pumps and pipes themselves. For example, if an existing pump deck has been constructed and approved by State and Federal agencies, and additional capacity exists on that pump deck, either from installed pumps or from a vacant pump space, then DNR believes this criteria is satisfied.

Adding Bankside Collection Points

Adding points of diversion/withdrawal in the form of bankside collectors (withdrawal from the Columbia River flood gravels) in lieu of direct river diversions may add operational, environmental, and water quality benefits. If a bankside collector in hydraulic continuity with the Columbia River were permitted, it could alleviate the need for the construction of a new surface water pumping station and obviate fish screen or river disturbance issues.

Furthermore, bankside collectors could reduce some of the challenges associated with Washington State's antidegradation policy in respect to potential water supply for ASR. Implementation of ASR (Alternative 4b) will require the use of all known available and reasonable technologies (AKART) to prevent and control pollution of groundwater. The implementation of AKART associated with surface water treatment for use in groundwater injection would be costly. In contrast, the use of bankside collectors in lieu of direct surface water supply could allow for a level of natural filtration to a point where degradation of groundwater quality through ASR would be limited to within acceptable standards, thereby reducing cost.

There are several ways that bankside collectors could be permitted for the project. These include constructing the collectors in a way that qualifies as a surface diversion, adding bankside collectors following perfection, or adding bankside collectors to the undeveloped permit.

Bankside collectors could be constructed in a way that qualifies as a surface diversion. A pond in bank gravels could be constructed with a pump intake drawing surface water; however, while a surface pond would be easiest from a water rights permitting standpoint, it may make an ASR project more difficult due to water quality issues. Alternatively, the pump intake could withdraw bank storage directly from the gravels via buried perforated pipes (e.g., Ranney well).

Adding bankside collectors (whether they are considered groundwater or surface water) is routine under RCW 90.03.380 for perfected water rights. It is possible the project could be phased in a way that would allow initial perfection with leased pump station capacity, and then transferred later to permanent bankside facilities. Finally, it may be possible to add these facilities before perfection occurs. Ecology relies on implied authority for all of its surface-to-groundwater (and groundwater-to-surface-water) transfers, such as RCW 90.54.020(9)[4] and RCW 90.44.020[5] to augment the explicit change authority in RCW 90.03.380/RCW 90.44.100.

Spreading

The concept of "spreading" involves the perfection of water using high-duty crops on smaller acreage and subsequent transfer of that water (once perfected) to low-duty crops on larger acreage. Spreading was originally authorized by the Legislature in 1997, and the criteria for spreading are outlined in RCW 90.03.380(1). Under that statute, spreading is permitted so long as the consumptive use on the new higher number of acres does not exceed the calculations of the "annual consumptive quantity" or ACQ. As defined in RCW 90.03.380, ACQ "*means the estimated or actual annual amount of water diverted pursuant to the water right, reduced by the estimated annual amount of return flows, averaged over the two years of greatest use within the most recent five-year period of continuous beneficial use of the water right*".

DNR could maximize the return on investment under the permit if some of the marginal or hard-to-serve lands are initially perfected in a high-water-duty crop, such as pasture, alfalfa, or a double-crop like sweet corn/peas, then spread that to additional DNR lands elsewhere. For example, spreading a two-year-average in pasture or sweet corn/peas to a potato rotation where potatoes were the peak use would increase irrigated acres by approximately 35 percent. If the spreading was to wine grapes, irrigated acres would more than double.

Partial Proof of Appropriation

Under RCW 90.03.330(1), in order to receive a certificate for Permit S4-25639C(A)P, DNR must file a Proof of Appropriation for the amount of water put to beneficial use. In the same way that the parent permit was split and certificated in parts, it may be advantageous to DNR to file Proof of Appropriations on portions of the water right that have been put to beneficial use in order to more quickly move water around through water right transfers.

Certificated surface water rights are much more adaptable to DNR's long-term plans than surface water permits. Whether the ultimate goal is transfer from marginal to superior lands, adding wells or spreading, a partial proof filing is likely the first step to accomplish each of these options. Ecology has typically accommodated this approach for large and complex agricultural irrigation rights.

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[4] "*Full recognition shall be given in the administration of water allocation and use programs to the natural interrelationships of surface and groundwaters.*"

[5] "*This chapter regulating and controlling groundwaters of the state of Washington shall be supplemental to chapter 90.03 RCW, which regulates the surface waters of the state, and is enacted for the purpose of extending the application of such surface water statutes to the appropriation and beneficial use of groundwaters within the state.*"

Serial Perfection

Once water has been put to beneficial use on a given irrigated parcel, it can be transferred to new uses or other parcels under RCW 90.03.380. Typically, the old irrigated parcel is excluded from the new place of use; however, for large irrigation permits, the farmer may wish to retain that land and rotate new crops back into that parcel over time. Such authority for rotation is found in RCW 90.03.390, provided Ecology approves that it will not impair existing rights.

In DNR's case, some lands make more sense than others to exclude from the permitted place of use. Prime farm land that has good soils, good climatological conditions, and is near conveyance corridors should be retained in the long-term. Conversely, it would not be in the public interest to temporarily farm prime shrub steppe land to perfect the right, only to transfer that water off to superior parcels. Rather, creating a sequence of short-term leases to perfect water on superior farmland paired with water right transfers, while removing an equal amount of shrub steppe land from the permitted area, would maximize both the return-on-investment and environmental benefit.

Development of Project Alternatives

This section provides an overview of the proposed alternatives and how they were evaluated and compared to develop a preferred alternative. Several alternatives have been developed ranging from those primarily focused on construction of new infrastructure to maximize irrigated acreage to those alternatives primarily focused on implementing water rights strategies to optimize cost.

Overview of Proposed Alternatives

The following eight alternatives can be grouped in three primary categories: irrigation system alternatives, shared benefit alternatives, and water rights alternatives.

Irrigation System Alternatives (Alternatives 1, 2, and 3)

Three irrigation system alternatives were developed as part of this study under conventional development assumptions. Each of these alternatives focuses primarily on perfection of water (either in full or in part) under the permit through direct irrigation of lands within the existing place of use by constructing/acquiring water supply and conveyance infrastructure capable of meeting peak demands. The alternatives range from full build-out of 4,392-acres of permanently irrigated crops (Alternative 1), a combination of permanently and temporarily irrigated crops (Alternative 2), to partial build-out of high-value crops (Alternative 3). Under these alternatives, the existing infrastructure would be utilized to the extent possible and, in some cases, water rights strategies would be implemented.

Shared Benefits Alternatives (Alternative 4a and 4b)

The shared benefits alternatives (Alternatives 4a and 4b) rely on the second alternative (Alternative 2) as a baseline, but seek to maximize DNR's infrastructure capacity to meet other local water needs for added benefit. Alternative 4a would use excess capacity in DNR's pumps and pipes during off-peak months (April, May, June, September, and October) to offer surface water supply to farmers who currently rely on groundwater in the

area where groundwater is declining. Under this scenario, when surface water is being used, their wells would be changed to standby/reserve status. This source substitution concept is similar to what is being proposed for the Odessa area whose farmers also rely on declining groundwater. The farmers benefitting[6] from DNR's supply would lease this capacity, creating an additional revenue stream to DNR's trust fund.

While this would reduce the groundwater declines, it would likely not reverse them because significant demands would still be present on the aquifer (July/August demand is about half of the irrigation water budget). Alternative 4b would address this by adding ASR to Alternative 4a. If pipes are winterized, bankside collectors are used, and injection wells are added, then water can be diverted in the winter from the Columbia River when flows are high and be pumped underground, which could help stabilize and reverse groundwater declines. The OCR is a potential funding partner for the ASR project, which would reduce the capital and O&M costs for the project.

Water Rights Alternatives (Alternatives 5a, 5b, and 5c)

The water rights alternatives would use Alternative 3 as a baseline to perfect the best DNR lands initially (best return on investment, lowest environmental risk), followed by full utilization of water rights using a combination of water rights strategies including partial proofs, serial perfection, and spreading.

Alternative Evaluation Criteria

In order to provide a reasonable "apples-to-apples" comparison between alternatives, the following evaluation criteria have been applied to all eight alternatives. Additionally, return on investment, or IRR, has been determined for each alternative over a 50 year life cycle.

1. **Capital and Operating Costs** – Appraisal-level capital construction opinion of probable costs and ongoing (yearly) O&M costs were developed for each alternative. Costs were converted to present value (2012 $) in order to estimate preliminary IRR.

2. **Points of Diversion Opportunities and Challenges** – Each alternative may utilize a different combination of points of diversion. In some cases, this may be the point of diversion identified in the permit or in pending applications. In other cases, an entirely new point of diversion may be proposed including new surface water pumping stations or bankside collectors.

3. **Environmental Benefits and Risks** – Environmental benefits and risks are discussed for each alternative on a qualitative basis (low, medium, and high). Environmental benefits and risks were evaluated in 1978 for the original project and the project was approved. Therefore, the alternatives compare environmental benefits and risks to that baseline development.

4. **Water Rights Limitations and Opportunities** – There are a variety of water rights strategies that may be employed in order to perfect water under this permit. The extent to which new infrastructure is required is directly related to the limitations on water rights strategies that may be employed. In contrast, the more flexibility and

[6] Benefit to the farmers could include prolonging their groundwater supply, deferred cost in deepening wells, ensuring irrigated agriculture on their land continues as opposed to dryland farming, and potential lower power/O&M costs from DNR's supply.

opportunities that exist related to water rights, the greater the potential for less costly infrastructure. This assessment of permitting complexity is also summarized for each alternative.

5. **Marketability of Land and Water Rights** – Ultimately, the extent to which the water right is perfected (either in part or in full) by the selected alternative affects the marketability of the DNR lands. Once perfected, many more opportunities for transfer of the water rights themselves exist than would otherwise be available. Each alternative was developed with consideration of these factors, identifying potential proposed crop mix, consumptive use, etc.

Additional Project Considerations

Land Ownership and Easements

Each of the alternatives proposes the construction of pipelines across private land. In some cases, DNR should expect to reimburse local landowners in exchange for required easements. In those cases, the price of individual easements will be negotiated for monetary values as is customary.

In other cases, the proposed infrastructure will have the potential to benefit landowners of proposed easement corridors. In these cases, DNR may be able to negotiate terms for easements based upon capacity or water supply in exchange for easements. In this study, it was assumed that capacity or water supply exchanges will be the form of compensation for easements.

Pump Stations

Many of the alternatives consider the use of existing pump stations through sharing of excess capacity where available. Typically these arrangements are based upon the owner of the existing station assessing a connection or buy-in charge in addition to ongoing compensation based upon proportionate share of the ongoing O&M costs. Estimates of buy-in charges were included in relevant cost estimates.

Aquatic and Terrestrial Habitat Mitigation

Development of the DNR lands under the eight alternatives will result in terrestrial impacts, aquatic impacts, or both. DNR plans to complete a State Environmental Policy Act (SEPA) checklist and make a threshold determination regarding foreseeable impacts of the project. At this appraisal stage, it is difficult to predict the level of mitigation that may be necessary through the SEPA process. All of the cost estimates include an additional 10 percent for terrestrial mitigation. Additionally, if aquatic impacts are likely (e.g., new pump station construction), an additional 15 percent was added.

Irrigation System Alternatives (Alternatives 1, 2, and 3)

Overview of Irrigation System Alternatives

General

DNR's water rights allow for the irrigation of up to 4,392 acres. Of this total, 517 acres is currently irrigated on land the DNR manages in and around ConAgra's 100 Circles Farm. The remaining 3,875 acres of water is available to apply to portions of the roughly 5,900 acres the DNR manages in the Horse Heaven Hills region. Most of the land is located in the Horrigan Road area west of Highway 221. The land the DNR manages is located low in the Glade Creek drainage and generally slopes gently to the north, east and west from Glade Creek. The land is bisected by numerous surface water drainage channels. Many of these channels are significant and make the land unfeasible for farming. Others are smaller and some land- leveling activities may allow them to be farmed using circle irrigation equipment typical in the Horse Heaven Hills region. Because of the drainage channels, many smaller and partial circles are required to maximize the acreage irrigated.

Circles were laid out on the DNR land using a Benton County aerial photograph that was overlaid with digital elevation model (DEM) contours. This method of circle layout is inexact but allowed the approximate acreage that could likely be farmed using circle irrigation machines to be established and an irrigation water distribution system to be laid out. If the project proceeds, it is anticipated that the final circle arrangement will differ from the arrangement used to prepare this report.

In general, drainage channels that began on the DNR property were assumed to be small enough that land-leveling work could improve the land and make circle irrigation possible. It was assumed that drainage channels beginning off the DNR property were larger, would convey off-site stormwater through the area, and could not be leveled and farmed.

Initially it was thought that the area might be suitable for growing perennial crops such as wine grapes, berries, and tree fruit that are typically irrigated using solid set irrigation systems. These crops can be farmed in odd-shaped areas where circle irrigation is not feasible. However, a number of growers in the region have indicated the DNR land is probably not a good choice for these crops because the land is located at relatively low elevations in the Glade Creek drainage and cold air, from higher elevation areas, is likely to flow through or settle in the area. The inability to grow these crops limits the options available for using land not suitable for circle irrigation. Solid set irrigation of row crops is non- existent in the Horse Heaven Hills region and the DNR will likely have to provide incentives to the leasee to farm row crops in any areas requiring solid set irrigation systems. The inability to farm permanent crops in solid set irrigation system areas will probably result in these areas being farmed only to the extent required to perfect the water right so it can be relocated.

Pipe Material

All of the alternatives evaluated are based on the use of large diameter AWWA C905 PVC pipe for the majority of the penstock. When the majority of the existing farms were constructed, steel pipe was used for the penstock. Today large diameter AWWA C905 PVC pipe is readily available, is less expensive, and has gained acceptance. One drawback to the PVC pipe is that it is only available in a few sizes. The initial study plan was to look at

different scenarios based on land quality and other criteria; however, it quickly became apparent that because of the penstock lengths the size of the first three alternatives would be largely based around the conveyance capacity of the nominal AWWA C905 pipe sizes available. Based on conceptual design pressures and the DEM contours, pipe pressure class requirements were established throughout the project and are reflected in the cost estimates.

There were some areas where the land is anticipated to be particularly rough or rocky where the use of steel pipe was included in the estimate.

Electrical Power

Power is available in the project area from both the Benton REA (REA) and Benton County PUD (PUD). Although the area along the river and Highway 14 is generally served by the REA, all of the existing river pump stations are provided power by the PUD. It is anticipated that any new river pump station or additions to an existing river pump station would also be supplied power by the PUD and the estimated electrical costs reflect this assumption.

The first booster pump station to the north in all of the alternatives is located in the PUD's service area and power cost estimates are based on their rate structure.

Almost all of the DNR land is located in an area not currently served by either the REA or PUD. The one exception is Section 36 located immediately northeast of the intersection of Horrigan Road and Lincoln Road. This westerly half of the section is currently in the REA's service area and it is anticipated that power for the circle irrigation machines in this section would be provided by the REA. The electrical load represented by the four circles in this section is very small compared to the rest of the projects power requirements so the power cost estimates for the circles in this section were estimated using PUD power rates along with the other circles.

The remaining three smaller pump stations and circles on the farm could be served by either the REA or PUD. The REA currently has power running north and south along Highway 221 that is closer to the DNR land than the PUD but they require the capital cost of new facilities be paid for up front and historically their annual power costs have been higher than the PUD. Because almost 80 percent of the estimated power costs, costs associated with the river pump station and largest booster pump station will be from the PUD the assumption was made that, excluding Section 36, the remaining farm facilities would also be served by the PUD. Capital costs for the electrical facilities necessary to bring the PUD power to the DNR land were accounted for in the economic analysis portion of the study.

The PUD has rate structures that allow the user to either pay the capital cost of the facilities initially or pay an annual facilities charge equal to 18 percent of the capital cost. The annual facilities charge is paid in perpetuity. While the annual facilities charge is significant, it is partially offset by lower per kilowatt hour rates. Almost all of the large irrigators the PUD services in the Horse Heaven Hills region use the rate structures that include the facilities charge. Based on cursory estimates suggested by the PUD, a capital facilities cost was estimated for use in determining what the annual facilities charge might be.

Estimated Construction Costs

Estimated current construction costs were developed using a combination of methods. Current material prices for major system components were provided by a number of

materials suppliers. Materials where current prices were received include all PVC pipe, all steel pipe, and the larger pumps. A local contractor who has considerable experience installing irrigation pipe in the Horse Heaven Hills region provided a current per foot price for installation of the pipe using Benton County prevailing wage rates. Circle irrigation machine prices were estimated based on current per foot of hardware length costs provide by a local circle dealer. Per foot of hardware length prices were provided for machines of different average lengths. The per foot of length estimated prices of shorter machines are higher than the longer machines. Current per acre prices for the installation of solid set irrigation systems were provided by a local supplier and installer.

Remaining portions of the cost estimates were prepared based on bid prices and prices quoted on other similar work. A relatively complete cursory design was completed for Alternative 1 so the system components could be identified and their cost estimated and established. Estimated prices for Alternatives 2 and 3 were based around the work completed for Alternative 1 modified to reflect their lower pumping horsepower requirements and smaller pipe sizes. Costs for off-site and on-farm infrastructure have been delineated separately in Appendix B.

Full Build Out Irrigation System Alternative (Alternative – 1)

Description of Alternative

Alternative 1 would provide water to permanently irrigate 3,875 acres of new DNR land from a new pump station constructed on the Columbia River. Based on the conceptual circle layout shown in Figure 2, there would be 38 circles irrigating approximately 2,769 acres. The remaining 1,106 acres would be irrigated using solid set irrigation systems. Areas making up the 1,106 acres include corner areas not irrigated by the circle irrigation machines, other areas whose shape is not conducive to circle irrigation and land with overhead power lines.

Alternative Analysis and Discussion

Points of Withdrawal Challenges, Environmental Risks and Water Rights

Alternative 1 includes new facilities to withdraw the DNR's surface water right from the Columbia River. The presence of anadromous fish listed under the ESA will make permitting this option difficult. The last new pump station to be constructed on the lower Snake and Columbia Rivers was installed in about 1996. The owner of the project had a valid Washington State water right but the process of getting USACE's Section 10 (Rivers and Harbors Act) and Section 404 (Clean Water Act) permits required a formal ESA consultation with NOAA Fisheries. NOAA Fisheries has a no net loss policy in the Snake and Columbia Rivers that forced the project owner to buy existing perfected water rights to complete the project. Similar issues should be anticipated on this project should an entirely new river pump station be proposed. The cost estimate for this alternative includes a large permitting budget but does not include the cost of buying existing perfected water rights and moving them to the site.

An alternate to the new river pump station would be to install bankside collectors on private land adjacent to the Columbia River. The bankside collectors would have to tap a formation (e.g., Columbia River flood gravels) that are in hydraulic continuity with the river. Using bankside collectors adjacent to the river could avoid the need to apply for a USACE's Section 404 Permit and the formal consultation with NOAA Fisheries that would result.

The proposed river pump station is located approximately 1,700 feet upstream from the confluence of Glade Creek at approximately Columbia River mile 273.8. The location was selected because the main river channel at this site is near the north bank; as a result a long intake pipe would not be required and in water work would be minimized. There is also existing access available to the site. The conceptual pump station proposed for the site would include stainless-steel, passive wedge wire screens installed on the end of a relatively short intake pipe laid on the river bottom. Vertical turbine pumps would be installed in vertical pump cans located on shore where they would be accessible. It is anticipated that approximately 5,000 HP would be required at the river to pump the DNR's full instantaneous water right less water already being withdrawn by 100 Circles Farm to irrigate 517 acres of DNR land. Pump station and penstock capacity would be approximately 28,600 gpm and would require the use of a 36-inch diameter penstock. The 36-inch pipe is slightly undersized for the design flow rate, but the next nominal pipe size larger is significantly too large and much more costly. Since the peak flow rate is only required for a few weeks each summer, the additional head loss the pipe causes is more cost effectively overcome with higher head pumps.

Approximately 26,300 feet north of the river pump station a booster pump station will be required to lift the water again. The booster pump station will require approximately 3,000 HP and will provide sufficient lift to get the water to Horrigan Road with a residual pressure of about 50 pounds per square inch (psi). Vertical turbine pumps are planned for use at this site.

Approximately 10,900 feet north of the booster pump station a tee will be installed to serve DNR's property in Section 16, Township 6 North, Range 24 E.W.M. The property is located approximately 32,800 feet west of the proposed penstock alignment. An 18-inch pipe and approximately 150-HP booster pump will be required to deliver water from the penstock to the approximately 517 acres that may be irrigable.

From the tee to Horrigan Road and the next booster pump station approximately 15,900 feet of penstock is required.

Piping from the river to Horrigan Road crosses private property and will require the acquisition of easements from the property owners. In general the pipe route follows property lines. However, across Wyckoff Farms, the pipeline will pass through existing circle irrigated land; installation will need to be completed during the winter and be coordinated with the farmer to avoid damage to crops such as winter wheat and damage to existing irrigation distribution piping and electrical. At this time it does not appear the pipe route passes through any areas with perennial crops.

Another booster pump station would be required at Horrigan Road. This pump station would boost the pressure sufficiently to irrigate DNR land in the southern half of Section 21 and Sections 26, 28, 30, 32, 34, and 36, Township 7 North, Range 25 E.W.M. and Section 36, Township 7 North, Range 24 E.W.M. The pump station would require approximately 1,500 HP. Pumps installed at the station are anticipated to be split case pumps because of the lower head required and their lower cost.

An additional 400-HP booster pump is required near the center of Section 21, Township 7 North, Range 25 E.W.M., to serve the north half of Section 21 and the DNR land in Sections 15 and 16. Several end suction centrifugal pumps are anticipated at this site.

North of Horrigan Road all pipe is either located on DNR property or in existing County road rights-of-way.

Permanent circles would be provided water from cluster points where the circle irrigation machine control valve and electrical equipment would be located. This arrangement is typical of circle irrigated farms in the Horse Heaven Hills region. Water for areas not irrigated with circle irrigation machines would also be provided at the clusters or with services off the circle irrigation distribution pipe.

Water and Power Use

Alternative 1 assumes the circle irrigated acreage is farmed in a 3-year rotation with potatoes, field corn, and wheat. There are approximately 923 acres in each crop. Solid set irrigation areas are all assumed to grow alfalfa. This alternative has 1,106 acres of solid set irrigation planted in alfalfa.

The 517 acres under circle irrigation on 100 Circles Farm was assumed to be in the same 3-year rotation. No power cost was calculated for the existing 100 Circles acreage. Irrigation efficiency on 100 Circles was assumed to be 90 percent.

Plant consumptive water use for the four crops used to estimate water use volumes and power costs are from the NRCS Irrigation Guide for a site in Kennewick, Washington. Estimated crop water requirements and total annual water use are shown in Table 4.

Table 4. Alternative 1 Estimated Crop Water Requirements and Annual Water Use

Crop	Consumptive Use (inches)	Irrigation Efficiency	Annual Volume (acre-feet)
Alfalfa	39	90%	3,945
Potatoes	31	90%	2,619
Field Corn	30	90%	2,604
Wheat	25	90%	2,157
		Subtotal	11,325
100 Circles Farm			1,378
		Total Water Use	12,703

Average monthly flow rates required to meet the crop consumptive use estimates were used to generate power requirements at each pump station on a monthly basis. Demand charges were based on the assumption that the peak monthly use exceeded the average monthly use by 25 percent. Estimated annual power requirements for Alternative 1 are 16,095,700 kilowatts per hour (kwh). Included in the calculation is the power required to drive the circle irrigation machines. Based on PUD power rates, the total annual cost of power for this alternative is $682,500.

Capital Costs

Alternative 1 requires the installation of a 36-inch penstock approximately 53,200 feet in length, approximately 181,050 feet of distribution piping ranging in size from 30-inch down to 6-inch, 38 circle irrigation machines, solid set irrigation systems and pumps with a total

of approximately 9,690 HP. The circle irrigation machines would irrigate a total of approximately 2,769 acres and the solid set irrigation systems would irrigate a total of approximately 1,106 acres.

The estimated construction cost for Alternative 1 is $46,450,404 and is equivalent to $11,987 per irrigated acre. A copy of the cost breakdown has been included in Appendix B. The total includes a 25 percent contingency, Washington State sales tax, engineering, aquatic and terrestrial mitigation funding, and permitting costs.

Project Economics

In order to achieve an IRR of 4 percent, a minimum rental rate of $640 per acre would be required for the full build-out alternative. The rate of return is based upon the assumption that a 2 percent (average minimum) growth in rental rate is achievable. A more thorough discussion of project economics and comparison among various alternatives is provided in the Economics Analysis section at the end of this report and in Appendix A.

Partial Build-Out Permanent/Temporary Crop Alternative (Alternative – 2)

Description of Alternative

Alternative 2 would provide water to permanently irrigate 2,934 acres of new DNR land from pumping facilities added to the existing CWPID pump station on the Columbia River. Based on the conceptual circle layout shown in Figure 3 there would be 34 circles irrigating approximately 2,463 acres. The remaining 471 acres would be irrigated using solid set irrigation systems. Areas making up the 471 acres include corner areas not irrigated by the circle irrigation machines, other areas whose shape is not conducive to circle irrigation, and land with overhead power lines. Alternative 2 is based on a 30-inch diameter penstock and a pumping capacity of 17,600 gpm.

In Alternative 1 the irrigation system was designed to use the DNR's remaining 28,600 gpm water right and simultaneously irrigate up to 3,875 acres. In Alternative 2 system capacity is below that required to fully utilize the remaining DNR water right. The Alternative 2 system capacity of 17,600 gpm is adequate to irrigate about 2,347 acres simultaneously. On larger farms, cropping patterns, crop water requirements, harvest and other on-farm activities require irrigation systems be shut down so something less than the entire farm is being watered simultaneously. Many farms are designed to simultaneously irrigate less than their full acreage. In Alternative 2 the assumption is made that only 80 percent of the farm will be watered simultaneously allowing the irrigated area to be increased to 2,934 acres. Using a simultaneous irrigation rate of 80 percent allows the capital cost of the facilities to be spread over more acreage.

Alternative Analysis and Discussion

Points of Withdrawal Challenges, Environmental Risks, and Water Rights

Alternative 2 is based around the concept of adding new pumps to an existing river pump station. This concept should eliminate many of the permitting issues associated with constructing a new river pump station. There are currently two pump stations along the river, adjacent to the DNR land, where there are vacant holes available for the installation of

pumps. Both pump stations were described earlier in the study. That description identified the CWPID pump station as the preferred site because two pump holes are available and the site is approximately 5,000 feet closer to the majority of the DNR land. The pump station has on-shore intake screens so the additional intake screens required can be installed with shore-based equipment. Installation of an 8,800 gpm, 1,500-HP pump in each hole would provide the capacity required for this alternative. Ordinarily there would be smaller pumps available to meet lower early and late season irrigation demands. Because of the limited number of pump holes available, regulating pumping capacity to match demand will have to be accomplished with an electrical or hydraulic variable speed drive or the construction of a relatively small storage reservoir on DNR land near Horrigan Road. Cost estimates for this study have assumed the use of a medium voltage (4,160 or 2,300 volt) electrical variable speed drive.

Approximately 21,500 feet north of the river pump station a booster pump station will be required to lift the water again. The booster pump station will require approximately 1,800 HP and will provide sufficient lift to get the water to Horrigan Road with a residual pressure of about 50 psi. Vertical turbine pumps are planned for use at this site.

From the booster pump station to Horrigan Road and the next booster pump station approximately 26,500 feet of 30-inch penstock is required.

Piping from the river to Horrigan Road crosses private property and will require the acquisition of easements from the property owners. In general the pipe route follows property lines. However, across Wyckoff Farms, the pipeline will pass through existing circle irrigated land so installation will need to be completed during the winter and be coordinated with the farmer to avoid crops such as winter wheat and existing irrigation distribution piping and electrical. At this time it does not appear the pipe route passes through any areas with perennial crops. The pipeline will also pass through Ste. Michelle Wine Estates but the route follows existing winery road alignments.

Another booster pump station would be required at Horrigan Road. This pump station would boost the pressure sufficiently to irrigate DNR land in the southern half of Section 21 and Sections 26, 28, 30, 32, 34, and 36, Township 7 North, Range 25 E.W.M. and Section 36, Township 7 North, Range 24 E.W.M. The pump station would require approximately 800 HP. Pumps installed at the station are anticipated to be split case pumps because of the lower head required and their lower cost.

An additional 350 HP booster pump is required near the center of Section 21, Township 7 North, Range 25 E.W.M., to serve the north half of Section 21 and the DNR land in Sections 15 and 16. Several end suction centrifugal pumps are anticipated at this site.

North of Horrigan Road all pipe is either located on DNR property or in existing County road rights-of-way.

Permanent circles would be provided water from cluster points where the circle irrigation machine control valve and electrical equipment would be located. This arrangement is typical of circle irrigated farms in the Horse Heaven Hills region. Water for areas not irrigated with circle irrigation machines would also be provided at the clusters or with services off the circle irrigation distribution pipe.

Alternative 2 includes the cost of irrigation facilities necessary to perfect the water right on approximately 378 acres of land located north of 100 Circles Farm in Section 16, Township 6 North, Range 24 E.W.M. The costs assume the land is perfected over a multi-year period using two smaller circles and beginning at the southeast corner of the property. As the water right is perfected the circles would be moved northwest and the pipe extended. ConAgra does not have system capacity to serve the land without fallowing land on 100 Circles Farm. They have indicated they would not fallow land scheduled for potato rotation but are receptive to the concept of fallowing land not scheduled for potatoes.

Four-inch diameter PVC pipe extending from the circle irrigation machine pivot to the circle perimeter has been included at each circle to facilitate the perfection of water rights in corner areas. The cost of some higher volume and range type sprinklers has also been included. Alternative 2 has the capacity to farm 471 acres of land beyond the acreage under circle irrigation. It is anticipated this capacity can be used to perfect water rights and then, once all of the water rights are perfected, be either used to permanently irrigate land at the site or moved to new land.

Water and Power Use

Alternative 2 also assumes the circle irrigated acreage is farmed in a 3-year rotation with potatoes, field corn, and wheat. There are approximately 821 acres in each crop. Solid set irrigation areas are all assumed to grow alfalfa. This alternative has 471 acres of permanent solid set irrigation planted in alfalfa. During the initial years of operation, water from a 200-acre portion of the permanent solid set system will be used to perfect water rights in corner areas and other areas not suitable for circle irrigation. During the period of time a portion of the water is used to perfect water rights in corners, the overall efficiency of the alfalfa irrigation was assumed to be 65 percent for corner areas and 90 percent in the permanent solid set areas. Although the power use would drop slightly following perfection of water rights the power use during perfection has been used in all calculations.

The 517 acres under circle irrigation on 100 Circles Farm was assumed to be in the same 3-year rotation. No power cost was calculated for the existing 100 Circles Farm acreage. Irrigation efficiency on 100 Circles Farm was assumed to be 90 percent.

Plant consumptive water use for the four crops used to estimate water use volumes and power costs are from the NRCS Irrigation Guide for a site in Kennewick, Washington. Estimated crop water requirements and total annual water use are shown in Table 5.

Table 5. Alternative 2 Estimated Crop Water Requirements and Annual Water Use

Crop	Consumptive Use (inches)	Irrigation Efficiency	Annual Volume (acre-feet)
Alfalfa	39	65% / 90%	1,914
Potatoes	31	90%	2,330
Field Corn	30	90%	2,316
Wheat	25	90%	1,919
		Sub-Total	8,479
100 Circles Farm			1,378
		Total Water Use	9,857

Average monthly flow rates required to meet the crop consumptive use estimates were used to generate power requirements at each pump station on a monthly basis. Demand charges were based on the assumption that the peak monthly use exceeded the average monthly use by 25 percent. Estimated power requirements for Alternative 2 are 12,217,100 kwh. Included in the calculation is the power required to drive the circle irrigation machines. Power cost estimates include the power to boost the water to perfect rights in Section 16, Township 6 North, Range 24 E.W.M. and operation of the two circle irrigation machines. These cost estimates do not include the cost of power to get the water to the 100 Circles Farm PQ-0 cluster where the connection would be made.

Based on Benton County PUD power rates, the total annual cost of power for this alternative is $508,100.

Capital Costs

Alternative 2 requires the installation of a 30-inch diameter penstock approximately 48,000 feet in length, approximately 152,590 feet of distribution piping ranging in size from 24-inch down to 4-inch, 34 permanent circle irrigation machines, two portable circle irrigation machines, pipe to serve corner areas, solid set irrigation systems and pumps with a total of approximately 6,010 HP. Permanent circle irrigation machines would irrigate a total of approximately 2,463 acres and the solid set irrigation systems would irrigate a total of approximately 471 acres. A total of 802 acres of water rights would be perfected using the two portable circle irrigation machines and the small diameter pipe extending from the pivots to the circle perimeters.

The estimated construction cost for Alternative 2 is $29,609,112 and is equivalent to $7,925 per permanently irrigated acre. A copy of the cost breakdown has been included in Appendix B. The total includes a 25 percent contingency, Washington State sales tax, engineering, terrestrial mitigation funding, and permitting costs.

Project Economics

In order to achieve an IRR of 4 percent, a minimum rental rate of $536 per acre would be required for Alternative 2. The rate of return is based upon the assumption that a 2 percent (average minimum) growth in rental rate is achievable. A more thorough discussion of project economics and comparison among various alternatives is provided in the Economics Analysis section at the end of this report and in Appendix A.

Partial Build-Out Permanent High Value Crops Alternative (Alternative – 3)

Description of Alternative

Alternative 3 would provide water to permanently irrigate 1,667 acres of new DNR land. Like Alternative 2 this alternative would add pumping facilities to the existing CWPID pump station on the Columbia River. Based on the conceptual circle layout shown in Figure 4, there would be 19 circles irrigating all of the land. There would be no solid set irrigation systems installed with this alternative because the water supply is inadequate to even serve

all of the circle land anticipated to be available. Alternative 3 is based on a 24-inch diameter penstock and a pumping capacity of 10,000 gpm.

The Alternative 3 system capacity of 10,000 gpm is adequate to irrigate about 1,333 acres simultaneously. Like Alternative 2, in Alternative 3 the assumption is made that only 80 percent of the farm will be watered simultaneously allowing the irrigated area to be increased to 1,667 acres. Using a simultaneous irrigation rate of 80 percent allows the capital cost of the facilities to be spread over more acreage.

Alternative Analysis and Discussion

Points of Withdrawal Challenges, Environmental Risks, and Water Rights

Alternative 3 is also based around the concept of adding new pumps to an existing river pump station. For the same reason described in Alternative 2, the CWPID pump station is proposed for use in this alternative. Installation of a 5,000 gpm, 900-HP pump in each hole would provide the capacity required for this alternative. Ordinarily there would be smaller pumps available to meet lower early and late season irrigation demands. Because of the limited number of pump holes available, regulating pumping capacity to match demand will have to be accomplished with an electrical or hydraulic variable speed drive or the construction of a relatively small storage reservoir on DNR land near Horrigan Road. Cost estimates for the study have assumed the use of a medium voltage (4,160 or 2,300 volt) electrical variable speed drive.

Approximately 21,500 feet north of the river pump station a booster pump station will be required to lift the water again. The booster pump station will require approximately 1,000 HP and will provide sufficient lift to get the water to Horrigan Road with a residual pressure of about 50 psi. Vertical turbine pumps are planned for use at this site.

From the booster pump station to Horrigan Road and the next booster pump station approximately 26,500 feet of 24-inch penstock is required.

Piping from the river to Horrigan Road crosses private property and will require the acquisition of easements from the property owners. In general the pipe route follows property lines. However, across Wyckoff Farms, the pipeline will pass through existing circle irrigated land so installation will need to be completed during the winter and be coordinated with the farmer to avoid crops such as winter wheat and existing irrigation distribution piping and electrical. At this time it does not appear the pipe route passes through any areas with perennial crops. The pipeline will also pass through Ste. Michelle Wine Estates but the route follows existing winery road alignments.

Another booster pump station would be required at Horrigan Road. This pump station would boost the pressure sufficiently to irrigate DNR land in the southern half of Section 21 and Sections 28, 32, and 34, Township 7 North, Range 25 E.W.M. Because of the lower system capacity, land located in Sections 26, 30, and 36, Township 7 North, Range 25 E.W.M. and Section 36, Township 7 North, Range 25 E.W.M., which were included in earlier alternatives, was eliminated. Land furthest from the penstock and least compatible with circle irrigation was eliminated. The pump station at Horrigan Road will require approximately 600 HP. Pumps installed at this station are anticipated to be split case pumps because of the lower head required and their lower cost.

An additional 350-HP booster pump is required near the center of Section 21, Township 7 North, Range 25 E.W.M., to serve the north half of Section 21 and the DNR land in Sections 15 and 16. Several end suction centrifugal pumps are anticipated at this site.

North of Horrigan Road all pipe is either located on DNR property or in existing Benton County road rights-of-way.

Permanent circles would be provided water from cluster points where the circle irrigation machine control valve and electrical equipment would be located. This arrangement is typical of circle irrigated farms in the Horse Heaven Hills region.

Alternative 3 includes the cost of irrigation facilities necessary to perfect the water right on approximately 378 acres of land located north of 100 Circles Farm in Section 16, Township 6 North, Range 24 E.W.M. The cost estimates assume the land is perfected over a multi-year period using two smaller circles and beginning at the southeast corner of the property. As the water right is perfected, the circles would be moved northwest and the pipe extended. ConAgra does not have system capacity to serve the land without fallowing land on 100 Circles Farm. They have indicated they would not fallow land scheduled for potato rotation but are receptive to the concept of fallowing land not scheduled for potatoes.

Water and Power Use

Alternative 3 also assumes the circle irrigated acreage is farmed in a 3-year rotation with potatoes, field corn, and wheat. There are approximately 556 acres in each crop.

The 517 acres under circle irrigation on 100 Circles Farm was assumed to be in the same 3-year rotation. No power cost was calculated for the existing 100 Circles Farm acreage. Irrigation efficiency on 100 Circles Farm was assumed to be 90 percent.

Plant consumptive water use for the three crops used to estimate water use volumes and power costs are from the NRCS Irrigation Guide for a site in Kennewick, Washington. Estimated crop water requirements and total annual water use are shown in Table 6.

Table 6. Alternative 3 Estimated Crop Water Requirements and Annual Water Use

Crop	Consumptive Use (inches)	Irrigation Efficiency	Annual Volume (acre-feet)
Potatoes	31	90%	1,578
Field Corn	30	90%	1,569
Wheat	25	90%	1,299
		Sub-total	4,446
100 Circles Farm			1,378
		Total Water Use	5,824

Average monthly flow rates required to meet the crop consumptive use estimates were used to generate power requirements at each pump station on a monthly basis. Demand charges were based on the assumption that the peak monthly use exceeded the average monthly use by 25 percent. Estimated power requirements for Alternative 3 are 6,638,100 kwh. Included in the calculation is the power required to drive the circle irrigation machines.

Power cost estimates include the power to boost the water to perfect rights in Section 16, Township 6 North, Range 24 E.W.M. and operation of the two circle irrigation machines. These estimates do not include the cost of power to get the water to the 100 Circles Farm PQ-0 cluster where the connection would be made.

Based on Benton County PUD power rates, the total annual cost of power for this alternative is $274,400.

Capital Costs

Alternative 3 requires the installation of a 24-inch diameter penstock approximately 48,000 feet in length, approximately 89,990 feet of distribution pipe ranging in size from 24-inch down to 6-inch, 19 permanent circle irrigation machines, two portable circle irrigation machines and pumps with a total of approximately 3,760 HP. Permanent circle irrigation machines would irrigate a total of approximately 1,667 acres and a total of 378 acres of water rights would be perfected using the two portable circle irrigation machines.

The estimated construction cost for Alternative 1 is $18,899,494 and is equivalent to $11,337 per permanently irrigated acre. A copy of the cost breakdown has been included in Appendix B. The total includes a 25 percent contingency, Washington State sales tax, engineering, terrestrial mitigation funding, and permitting costs.

Project Economics

In order to achieve an IRR of 4 percent, a minimum rental rate of $623 per acre would be required for Alternative 3. The rate of return is based upon the assumption that a 2 percent (average minimum) growth in rental rate is achievable. A more thorough discussion of project economics and comparison among various alternatives is provided in the Economics Analysis section at the end of this report and in Appendix A.

Shared Benefits Alternative (Alternative 4a and 4b)

Description of Alternative

The shared benefits alternative involves coordinated effort between local irrigators and growers, DNR, and Ecology in order to optimize the amount of new infrastructure required versus the amount and location of perfected land—with the overall objective of reducing cost. Recognizing that there are shared interests among the various stakeholders, the shared benefits concept leverages a comprehensive approach to optimize the use of infrastructure (both existing and new) in a way that minimizes cost and environmental impact.

This alternative would seek to increase environmental benefits through reducing impacts to the existing shrub steppe within DNR place of use and has the potential to reduce demand on dwindling groundwater sources. Additionally, due to the fact that much of the required infrastructure often has off-peak capacity, it can be leveraged to provide additional water supply benefits—beyond what DNR may need to meet their own demands.

Detailed Concept

The details of the shared benefit concept included in this study include consideration of source exchange (groundwater to surface water) and storage—both of which are closely tied to the fact that in any seasonal agricultural system there may be excess capacity at certain

times during the irrigation season. Other farms sharing in the benefits of the project could help pay for the capital cost, which would make the project more affordable. Alternatively, DNR could lease capacity in the pumps and pipes, obtaining a greater return on investment for the same initial capital cost.

Surface Source Exchange for Existing Groundwater Users

Source exchange involves utilizing the excess capacity in the planned infrastructure during off-peak irrigation periods (other than July/August) to provide new surface water supply, in lieu of existing groundwater, to other (non DNR) users. Participating groundwater irrigators currently relying on declining groundwater supplies could receive interruptible surface water rights sourced from the Columbia River during the early and late growing seasons in order to relieve pressure on their groundwater supply during that timeframe. Under this scenario, irrigators would continue to rely solely upon groundwater sources during peak irrigation periods and partially during non-peak periods; however, an overall benefit to the aquifer would be realized by slowing or reversing groundwater declines.

Surface Storage and Aquifer Storage and Recovery

Surface storage involves utilizing yet another layer of excess supply and conveyance system capacity in that during the non-irrigation season, excess water from surface water sources (when available) could be conveyed to storage—either surface or subsurface (Alternative 4b). Although not included in the Alternative 4a option evaluated, surface storage could be added to take greater advantage of excess capacity in the system during periods when capacity exceeds consumptive use.

Surface storage could be constructed in a variety of ways. On a small scale, surface storage could involve the construction of small (several hundred acre-feet) individual lined on-farm reservoirs primarily to address instantaneous (peaking) demand issues. Surface storage could also be created in large (several thousand acre-feet) impoundments by constructing an embankment across a canyon in the project vicinity. This surface storage could then be used to augment water supplied from groundwater during the peak summer months (July/August)—beyond which source exchange could address.

Alternatively, ASR could be utilized for seasonal storage—primarily to replenish diminishing groundwater supplies. Similar to surface storage, ASR would involve storing water pumped during the off-season. Generally during the winter months excess water from surface water sources (when available) could be directed to injection wells for storage in the aquifer. That water would then be extracted (recovered) during the growing season. The use of ASR requires a careful approach to water quality and would likely involve the use of bankside collectors in lieu of traditional surface water pumping supply in order to avoid costly surface water treatment.

Alternative 4a – Alternative Analysis and Discussion

Points of Withdrawal Challenges

Alternative 4a is based around the system design described in Alternative 2. The basic system would provide water to permanently irrigate 2,934 acres of new DNR land from pumping facilities added to the existing CWPID pump station on the Columbia River. Alternative 2 is based on a 30-inch diameter penstock and a pumping capacity of 17,600 gpm. For a further description of Alternative 2 refer to the Alternative 2 narrative.

Alternative 4a uses the excess capacity in the facilities installed in Alternative 2 to carry water that can be used to meet crop water needs on the declining groundwater region and existing DNR land in the area around the intersection of Alderdale Road and McKinley Springs Road where groundwater levels are dropping (Figure 5). Conveyance of the water to the area will require the installation of additional pipe and pump stations beyond those installed in Alternative 2. Excess capacity is available in the Alternative 2 system early and late in the irrigation season.

Based on a review of aerial photos of the area, an estimate was made of the monthly average water requirement for the land associated with declining groundwater. There are approximately 13 sections and 8,320 gross acres in the irrigated area. It appears about 1,869 acres of the total are being circle irrigated. In the circle areas, a crop rotation of potatoes, field corn, and wheat was assumed. Orchard appeared to cover approximately 280 acres and was assumed to be apples with a cover crop. The remaining acreage encompasses approximately 4,555 acres and appears to be in wine grapes. The remaining 20 percent of the acreage is dry and is comprised primarily of drainage channels and circle corners. Based on these acreage estimates, the monthly average irrigation flow rate was estimated for the region of declining groundwater to the west. The monthly average irrigation flow rate required for the land associated with declining groundwater was then compared to the excess capacity in the Alternative 2 system on a monthly basis. The monthly flow rates for each and the usable water are shown in Table 7.

Table 7. Alternative 4a Monthly Flow Rates and Usable Water

	April	May	June	July	Aug	Sept	Oct
Declining Groundwater Region Requirement (gpm)	2,923	6,762	17,758	29,737	29,230	15,007	4,835
Alt 2 Excess Capacity* (gpm)	13,572	9,645	5,064	0	3,995	11,431	16,061
Usable Excess Capacity (gpm)**	2,923	6,762	5,064	0	3,995	10,000	4,835
Usable Excess Quantity (acre-feet)**	388	926	671	0	547	1,326	662

Notes:

* Excess capacity was assumed to be zero because July is the peak average flow month and the time when higher peak daily flow rates are likely to occur. Peak flows may also occur in August.

** Excess usable capacity is limited in September to the estimated capacity of a 24-inch pipe.

The estimated total usable water that could be delivered to the declining groundwater region during the irrigation season to meet a portion of their irrigation demand is 4,521 acre-feet. During the course of the irrigation season, an estimated 8,056 acre-feet of excess pumping capacity is available in the system. The difference of 3,535 acre-feet could be utilized if surface storage was constructed.

Delivery of water to the declining groundwater regions in the McKinley area will require additional facilities beyond those required for Alternative 2. The additional facilities include approximately 46,200 feet of 24-inch diameter pipe, 15,700 feet of 12-inch diameter pipe, and two pump stations with a total of 900 HP. With these facilities up to 10,000 gpm

could be delivered to the declining groundwater region at 20 psi and up to 1,500 gpm could be delivered to the DNR property. The additional facilities required are shown in Figure 5.

Upsizing pipe along the Horrigan Road alignment and continuing it west to the southeast corner of the DNR land was considered for this alternative; however, it resulted in all of the water being pumped north to Horrigan Road, conveyed west, and then conveyed back to the south. With this option the total horsepower requirement didn't change but the water was being provided through the Horrigan Road pump station which adds to the power cost. If this alternative is selected for further evaluation, additional work should be undertaken to determine which route is most cost effective.

Piping from the penstock alignment west to the declining groundwater region and north to the DNR land will be across private property and will require the acquisition of easements from the property owners. In general the pipe route follows property lines. The pipe extending north to the DNR land could be routed along McKinley Springs Road to avoid easement issues without adding significantly to the project cost.

Where the pipes terminate in the declining groundwater region there would be approximately 20 psi; this is sufficient pressure to feed booster pump stations but not to irrigate. On-farm piping necessary to connect the new service to existing piping and booster pump stations necessary to irrigate have not been included in this study.

Water Rights

It is assumed in this alternative that the excess capacity delivered to regions of declining groundwater to the west will be authorized by a surface water right from the Columbia River. There are several ways this surface water right could be authorized, which would all be fact-specific inquiries requiring more detailed investigation in the feasibility stage. These include the following:

- A groundwater to surface water change authorization to add the CWPID pump station. Such an authorization could be processed either through the Benton County Water Conservancy Board or through Ecology (e.g., cost-reimbursement, priority processing, or the OCR, depending on project specifics). This alternative would need to demonstrate hydraulic continuity between the groundwater and surface water and that the groundwater right could still be managed the same in times of shortage (e.g., priority date is preserved).
- A new water right authorization from the CWPID pump station under a source-substitution model. Such an authorization could be processed by Ecology through priority processing or the OCR, depending on project specifics. For example, if hydraulic continuity exists, then it may be possible to priority process a new water right as a water budget neutral authorization under WAC 173-152-050(2)(g). Alternatively, if the project is not water budget neutral, then mitigation from the OCR may be possible.

Water and Power Use

Alternative 4a also assumes the circle irrigated acreage is farmed in a 3-year rotation with potatoes, field corn, and wheat. There are approximately 821 acres in each crop. Solid set irrigation areas are all assumed to grow alfalfa. This alternative has 471 acres of permanent solid set irrigation planted in alfalfa. During the initial years of operation, water for a 200-

acre portion of the permanent solid set system will be used to perfect water rights in corner areas and other areas not suitable for circle irrigation. During the period of time a portion of the water is used to perfect water rights in corner areas, the overall efficiency of the alfalfa irrigation was assumed to be 65 percent for corner areas and 90 percent in the permanent solid set areas. Although the power use would drop slightly following perfection of water rights, the power use during perfection has been used in all calculations.

The 517 acres under circle irrigation on 100 Circles Farm was assumed to be in the same 3-year rotation. No power cost was calculated for the existing 100 Circles Farm acreage. Irrigation efficiency on 100 Circles Farm was assumed to be 90 percent.

Plant consumptive water use for the four crops used to estimate water use volumes and power costs are from the NRCS Irrigation Guide for a site in Kennewick, Washington. Estimated crop water requirements and total annual water use are shown in Table 8.

Table 8. Alternative 4a Estimated Crop Water Requirements and Annual Water Use

Crop	Consumptive Use (Inches)	Irrigation Efficiency	Annual Volume (acre-feet)
Alfalfa	39	65% / 90%	1,914
Potatoes	31	90%	2,330
Field Corn	30	90%	2,316
Wheat	25	90%	1,919
		Sub-total	8,479
100 Circles Farm			1,378
		Total Water Use	9,857

In addition to water used on the DNR property, this alternative assumes excess capacity early and late in the irrigation season is used to deliver water to the region of declining groundwater to the west. The total quantity of water estimated to be pumped to the property is 4,521 acre-feet.

Average monthly flow rates required to meet the crop consumptive use estimates were used to generate power requirements at each pump station on a monthly basis. Demand charges were based on the assumption that the peak monthly use exceeded the average monthly use by 25 percent. Estimated annual power requirements for Alternative 4a are 12,217,100 kwh to pump water to the new DNR land and an additional 5,431,800 khw to deliver the water to the existing region of declining groundwater. Total annual power use is estimated at 17,648,900 kwh. Included in the calculation is the power required to drive the circle irrigation machines. Power cost estimates include the power to boost the water to perfect rights in Section 16, Township 6 North, Range 24 E.W.M. and operation of the two circle irrigation machines. These estimates do not include the cost of power to get the water to 100 Circle Farm PQ-0 cluster where the connection would be made.

Based on Benton County PUD power rates, the total annual cost of power for this alternative is $752,212.

Capital Costs

Alternative 4a requires all of the facilities installed in Alternative 2 along with the installation of 46,200 feet of 24-inch diameter pipe, 15,700 feet of 12-inch diameter pipe, and two pump stations with a total of 900 HP.

The estimated construction cost for Alternative 4a is $35,878,412. A copy of the cost breakdown has been included in Appendix B. The total includes a 25 percent contingency, Washington State sales tax, engineering, terrestrial mitigation funding, and permitting costs. The cost includes the $29,609,112 to construct Alternative 2 and the additional cost of $6,269,300 to deliver up to 10,000 gpm to the region of declining groundwater.

Project Economics

In order to achieve an IRR of 4 percent, a minimum rental rate of $520 per acre would be required for Alternative 4a. The rate of return is based upon the assumption that a 2 percent (average minimum) growth in rental rate is achievable. A more thorough discussion of project economics and comparison among various alternatives is provided in the Economics Analysis section at the end of this report and in Appendix A.

Alternative 4b– Alternative Analysis and Discussion

Alternative 4b is generally based around the system design described in Alternative 2. The basic system would provide water to permanently irrigate 2,934 acres of new DNR land from pumping facilities added to the existing CWPID pump station on the Columbia River. Alternative 4b is based on a 30-inch diameter penstock and a pumping capacity of 17,600 gpm. In the case of Alternative 4b, the water will be pumped from bankside collection systems installed along the Columbia River downstream from the Sandpiper Farm's pump station. Shallow groundwater wells located along the river are planned to avoid treatment costs that would be incurred if surface water were pumped for injection into the groundwater aquifer. The wells are proposed downstream from Sandpiper Farm's pump station where river depths near shore are greater and the location is closer to a known surface water well field. No geologic investigation has been completed to determine whether this option is feasible at the location shown on the drawings. The original concept centered on collection in the area of the existing gravel pit; however, the gravel pit owner has indicated that rock produced from the site is crushed basalt and not natural river rock. Whether a bankside collection system adjacent to the river will provide sufficient water for the project is unknown. Locating the wells downstream from the Sandpiper Farm's pump station means the penstock alignment used in Alternative 1, from the river to the new DNR land, will be used in Alternative 4b. For a further description of Alternative 1 and 2 refer to the Alternative 1 and 2 narratives.

Points of Withdrawal Challenges

Alternative 4b uses the excess capacity in the facilities installed to irrigate the land in Alternative 2 to carry water that can be used to either meet crop water needs or replenish groundwater on the existing DNR land and possibly other lands in the area around the intersection of Alderdale Road and McKinley Springs Road. Groundwater levels in this area have dropped significantly in recent years. Conveyance of the water to the area will require the installation of additional pipe and pump stations beyond those installed in Alternative 1 or 2. Full capacity is available in the system during the November through March time period and in reduced amounts early and late in the irrigation season.

Based on a review of aerial photos of the area, an estimate was made of the monthly average water requirement for the region of declining groundwater. A description of how that estimate was prepared is included in the Alternative 4a discussion. The monthly average irrigation flow rate required for the region of declining groundwater was then compared to the excess capacity in the Alternative 2 system on a monthly basis. The monthly flow rates for each and the usable water are shown in Table 9. The table also identifies the volume of water available to inject into the groundwater table during the irrigation season.

Table 9. Alternative 4b Monthly Flow Rates and Usable Water

	April	May	June	July	Aug	Sept	Oct
Region of Declining Groundwater Requirement (gpm)	2,923	6,762	17,758	29,737	29,230	15,007	4,835
Alt 2 Excess Capacity* (gpm)	13,572	9,645	5,064	0	3,995	11,431	16,061
Excess Capacity-Irrigation (gpm)**	2,923	6,762	5,064	0	3,995	10,000	4,835
Excess Capacity-Injection (gpm)	7,077	2,883	0	0	0	0	5,165
Usable Excess Quantity (acre-feet)**	1.326	1,321	671	0	547	1,326	1,370

Notes:

* Excess capacity was assumed to be zero because July is the peak average flow month and the time when higher peak daily flow rates are likely to occur. Peak flow may also occur in August.

** Excess usable capacity is limited in Sept to the estimated capacity of a 24 inch pipe.

The estimated water volume that could be delivered to the region of declining groundwater during the irrigation season to both meet irrigation demand and inject water into the aquifer is 6,562 acre-feet. Pumping at a rate of 10,000 gpm to the injection wells over the November through March time period would provide an additional 6,673 acre-feet of water for aquifer recharge. The total estimated quantity of water available annually to meet the water requirements of the declining groundwater region is 13,235 acre-feet. This volume is approximately 1,164 acre-feet less than the area's estimated 14,399 acre-feet annual water requirement. If this option were selected for further evaluation, it may be feasible to alter the conceptual design to increase capacity and fully meet the area's estimated water requirement without increasing the pipe size.

Delivery of water to the DNR land and other lands in the McKinley area will require additional facilities beyond those required for Alternative 1 or 2. The additional facilities include approximately 55,100 feet of 24-inch diameter pipe, 10,000 feet of 12-inch diameter pipe, two pump stations with a total of 2,300 HP and 10 injection wells. With these facilities up to 10,000 gpm could be delivered to roughly the center of Section 12, Township 6 North, Range 23 E.W.M. at a pressure of 80 psi. From this site the 12-inch pipe would be used to distribute the water to 10 injection wells. The additional facilities required are shown in Figure 5.

Piping from the penstock alignment west to the proximity of Alderdale Road and McKinley Springs Road will be across private property and will require the acquisition of easements from the property owners. In general the pipe route follows property lines. Piping was installed diagonally across DNR's property in Section 16, Township 6 North, Range 24 E.W.M. to get the pipe to a higher elevation over a shorter distance so the pressure class could be reduced.

Water and Power Use

Alternative 4b assumes the circle irrigated acreage is farmed in a 3-year rotation with potatoes, field corn, and wheat. There are approximately 821 acres in each crop. Solid set irrigation areas are all assumed to grow alfalfa. This alternative has 471 acres of permanent solid set irrigation planted in alfalfa. A more extensive description of the irrigation assumptions is available in the Alternative 2 narrative.

The 517 acres under circle irrigation on 100 Circles Farm was assumed to be in the same 3-year rotation. No power cost was calculated for the existing 100 Circles Farm acreage. Irrigation efficiency on 100 Circles Farm was assumed to be 90 percent.

Plant consumptive water use for the four crops used to estimate water use volumes and power costs are from the NRCS Irrigation Guide for a site in Kennewick, Washington. Estimated crop water requirements and total annual water use are shown in Table 10.

Table 10. Alternative 4b Estimated Crop Water Requirements and Annual Water Use

Crop	Consumptive Use (inches)	Irrigation Efficiency	Annual Volume (acre-feet)
Alfalfa	39	65% / 90%	1,914
Potatoes	31	90%	2,330
Field Corn	30	90%	2,316
Wheat	25	90%	1,919
		Sub-Total	8,479
100 Circles Farm			1,378
		Total Water Use	9,857

In addition to water used on the new DNR property, this alternative assumes excess capacity available during the irrigation season and 10,000 gpm during the non-irrigation season are available for use in the region of declining groundwater to the west. The water may be used to directly meet crop water requirements during the irrigation season and to recharge the aquifer during the non-irrigation season. The total estimated quantity of water pumped to the property is 13,235 acre-feet.

The total estimated quantity of water pumped by the system annually is 23,092 acre-feet.

Average monthly flow rates required to meet the crop consumptive use estimates were used to generate power requirements at each pump station on a monthly basis during the irrigation season. During the non-irrigation season, the system is assumed to run at a capacity of 10,000 gpm. Demand charges were based on the assumption that irrigation season peak monthly use exceeded the average monthly use by 25 percent. The estimated

total power requirements for Alternative 4b are 38,160,000 kwh to pump water to the new DNR land and to the region of declining groundwater. Included in the calculation is the power required to drive the circle irrigation machines. Power cost estimates include the power to boost the water to perfect rights in Section 16, Township 6 North, Range 24 E.W.M. and operation of the two circle irrigation machines. The cost estimates do not include the cost of power to get the water to 100 Circles Farm PQ-0 cluster where the connection would be made.

Power use is higher in this alternative because all of the water being delivered to the declining groundwater area to the west is being pumped to a higher elevation. The highest irrigated area on the new DNR property is approximately 930 feet in elevation and only a small portion of the water has to be pumped to that level. Elevations on the region of declining groundwater where injection wells would be installed are generally above 950 feet in elevation.

Based on Benton County PUD power rates, the total annual cost of power for this alternative is $1,657,500.

Capital and Operating Costs

Alternative 4b requires all of the facilities installed in Alternative 2 along with the installation of 55,100 feet of 24-inch diameter pipe, 10,000 feet of 12-inch diameter pipe, two pump stations with a total of 2,300 HP, and 10 injection wells with a capacity of 1,000 gpm each.

The estimated construction cost for Alternative 4b is $56,987,651. A copy of the cost breakdown has been included in Appendix B. The total includes a 25 percent contingency, Washington State sales tax, engineering, terrestrial mitigation funding, and permitting costs.

Project Economics

In order to achieve an IRR of 4 percent on the DNR's portion of the capital costs, a minimum rental rate of $520 per acre would be required for Alternative 4b. The rate of return is based upon the assumption that a 2 percent (average minimum) growth in rental rate is achievable. A more thorough discussion of project economics and comparison among various alternatives is provided in the Economics Analysis section at the end of this report and in Appendix A.

Water Rights Alternative (Alternatives 5a, 5b, and 5c)

Description of Alternative

The water rights alternative involves leveraging water rights strategies in an effort that minimizes the necessary infrastructure and subsequent environmental impact. By using administrative tools available through interpretation of the water code, flexibility related to source location, partial perfection, and transfer of water maximization of the irrigated acreage can be pursued.

Detailed Concept

Spreading

The concept of "spreading" from a water rights perspective on this project would involve perfecting water on high-duty crops (such as alfalfa or double-cropping) on a smaller

footprint, then transferring water to a larger footprint (spreading) at a lower water duty (grapes, potatoes, etc.). The benefit to spreading is that DNR could develop a larger block presence and have a higher proportion of their place of use in irrigated acreage.

Authority for such a concept is provide under RCW 90.03.380(1) which states that a change which enables irrigation of additional acreage may be permitted provided there is no net increase in annual consumptive quantity. That is, that portion of total water applied to a given crop (in acre-feet per year) which does not return (in close proximity) to the water source does not increase as a result of the change.

For example, if alfalfa is spread to potatoes, then 30 percent more land can be irrigated for the same consumptive use. If alfalfa is spread to grapes, than 115 percent more land could be irrigated.

Serial Perfection

Serial perfection of water could be employed as part of an overall water rights strategy in order to limit the water supply conveyance infrastructure required, and to reduce environmental impacts of the project by reducing constructed infrastructure and farmed land. Because the DNR place of use is "scattered" amongst a broad geographic region, some of the land is more easily served than others. For example, a central major transmission main may serve the sections in Township 7 North, Range 25 E.W.M. fairly well and would be a major investment. An equally major investment, might be required to serve some of the outlying sections in Township 6 North, Range 24 E.W.M..

Under the serial perfection concept, DNR could start with a small footprint project with the best lands served, as in Alternative 3. Following a short-term lease to perfect Parcel "A", it could move that water to other DNR lands. Then rather than fallowing Parcel "A" and developing "Parcel B", it could issue a new lease on "Parcel A" leaving "Parcel B" undisturbed, and remove "Parcel B" from the water right authorization. DNR could coordinate with Ecology on the types of infrastructure, lease, and land use controls under which such a program could be developed to avoid speculation concerns, and maximize public benefit. Ultimately under this scenario, the same amount of land would be developed—just in locations more easily served and with less environmental impact.

Alternative 5a (Serial Perfection and Partial Proofs to 4,392 acres)

Alternative 5a starts with the capital and operational costs of Alternative 3 (see Alternative 3 narrative and Figure 4). Approximately 1,667 acres of new high-value land, along with the existing 517 acres of 100 Circles Farm land would be irrigated. Every 5 years, 552 acres of land would be transferred to the trust water program, and eventually new DNR land developed in another location where it can be more readily served. That same 552 acres would again be leased but development of another 552 acres of raw land under the permitted place of use would be eliminated. After 20 years, 1,667 acres would have been permanently farmed by the Alternative 3 infrastructure, 517 acres would have been served by 100 Circles Farm, and an additional 2,208 acres would have been served on other DNR lands.

Project Economics

In order to achieve an IRR of 4 percent, a minimum rental rate of $419 per acre would be required for Alternative 5a. The rate of return is based upon the assumption that a 2 percent (average minimum) growth in rental rate is achievable. A more thorough discussion of

project economics and comparison among various alternatives is provided in the Economics Analysis section at the end of this report and in Appendix A.

Alternative 5b (Serial Perfection and Partial Proofs with Row Crop Spreading to 4,844 acres)

Alternative 5b starts with the capital and operational costs of Alternative 1 (see Alternative 1 narrative and Figure 2). This alternative has 517 acres farmed by 100 Circles Farm and the remaining 3,875 acres in new land. In years 1 through 5, DNR would irrigate 2,679 acres in circles with 2 years in potato rotation and the remaining 1,412 acres in hay (irregularly shaped fields) to maximize spreading (highest 2 years in 5 continuous years). In years 6 through 50, DNR would spread to 4,844 acres in row crop rotation (about a 25 percent increase). Spreading would be accomplished anticipating not more than 80 percent of the farm would require irrigation at any given time so the instantaneous water right would not be exceeded and the annual volume would be spread and duty reduced. Consumptive use would not increase through careful management of rotations and in some years there could be the potential for deficit irrigation.

Project Economics

In order to achieve an IRR of 4 percent, a minimum rental rate of $595 per acre would be required for Alternative 5b. The rate of return is based upon the assumption that a 2 percent (average minimum) growth in rental rate is achievable. A more thorough discussion of project economics and comparison among various alternatives is provided in the Economics Analysis section at the end of this report and in Appendix A.

Alternative 5c (Serial Perfection and Partial Proofs with Row Crop Spreading to 6,420 acres)

Alternative 5c starts with the capital and operational costs of Alternative 1 (see Alternative 1 narrative and Figure 2). This alternative has 517 acres farmed by 100 Circles Farm and the remaining 3,875 acres in new land. In years 1 through 5, DNR would irrigate 2,679 acres in circles with 2 years in potato rotation and the remaining 1,412 acres in alfalfa (irregularly shaped fields) to maximize spreading (highest 2 years in 5 continuous years). In years 6 through 50, DNR would spread to 3,079 acres in row crop rotation. Spreading would be accomplished anticipating not more than 80 percent of the farm would require irrigation at any given time so the instantaneous water right would not be exceeded and the annual volume would be spread and duty reduced. Consumptive use would not increase through careful management of rotations. DNR would also spread the 1,412 acres of alfalfa to 2,824 acres of grapes on the other sites. Total acres irrigated starting in Year 6 would be 6,420 acres, an increase in 46 percent.

Project Economics

In order to achieve an IRR of 4 percent, a minimum rental rate of $450 per acre would be required for Alternative 5c. The rate of return is based upon the assumption that a 2 percent (average minimum) growth in rental rate is achievable. A more thorough discussion of project economics and comparison among various alternatives is provided in the Economics Analysis section at the end of this report and in Appendix A.

Evaluation of Alternatives and Recommended Next Steps

Economic Analysis

Project economics were evaluated by calculating rental rates (revenue) necessary to achieve reasonable internal rates of return (IRR, rate of return) for each alternative based upon various assumptions. Per discussion with DNR, desirable rates of return for this project are on the order of 4 percent to 6 percent.

Assumptions used in determining rental rates include; discount rate, repayment period, annual growth rate (of rental rate), and capital recovery charges by PUD. These assumptions, when coupled with project costs (capital and ongoing O&M) produce a minimum required rental rate which can be used as a means to compare the relative value of each alternative.

For purposes of this study the following prevailing assumptions have been made:

- Target (probable-maximum) rental rates of $600 per acre (circles) and $200 per acre (corners), per year.
- Annual growth rate in rental rate of 2 percent.
- Discount rate of 4 percent.
- Repayment period of 50 years.
- PUD capital cost recovery = 18 percent annual payment in perpetuity.

Based upon the economic analysis performed, it was determined that each alternative can achieve favorable rates of return (at or above 5 percent) with rental rates at or below probable rates.

An additional analysis was performed to determine reasonable anticipated aggregate rental rates per-acre for each alternative based upon marketability of the land and proportion of crop that would be planted in circles versus corners. This analysis is useful in evaluating the reasonableness of calculated minimum average rental rates for each alternative. This analysis is presented in greater detail in Appendix A.

A summary of economic analysis results are provide in Table11.

Table 11. Economic Analysis Results

Alt	Description	Perfected Acreage[1]	Permanently Irrigated Acreage	Banked Water	DNR Capital Cost / Acre[2]	DNR Capital Cost / Acre-ft [3]	Capital Cost			O&M Cost[5]			Rental Rate (Per Acre)[6]		Annual Return[7]	Return on Asset[8]	Environmental Impact (low, medium, high)[9]	Permitting Complexity (low, medium, high)[10]
							Total	DNR Share	Partner Share[4]	Total	DNR Share	Partner Share[4]						
1	Full Build-out of Land with Permanent Crops	3,875	3,875	0	$11,987	$3,035	$46,450,404	$46,450,404	$0	$682,499	$682,499	$0	$640	(+/-$95)	$2,480,000	5.3%	High	Low
2	Full Build-out of Land with Permanent/ Temporary Crop Mix	3,736	2,934	802	$7,925	$2,006	$29,609,112	$29,609,112	$0	$508,106	$508,106	$0	$536	(+/-$76)	$2,002,496	6.8%	Medium	Low
3	Partial Build-out with High Value Crops	1,667	1,667	0	$11,337	$2,870	$18,899,494	$18,899,494	$0	$274,400	$274,400	$0	$623	(+/-$83)	$1,038,541	5.5%	Low	Low
4a	Similar to Alt 2, with capacity sharing	3,736	2,934	802	$6,793	$1,720	$35,878,412	$25,377,321	$10,501,091	$752,212	$508,106	$244,106	$520	(+/-$101)	$1,942,720	7.7%	Medium	Medium
4b	Similar to Alt 2, with ASR	3,736	2,934	802	$6,653	$1,684	$56,987,651	$24,856,760	$32,130,891	$1,657,500	$508,106	$1,149,394	$520	(+/-$101)	$1,942,720	7.8%	Medium	High
5a	Based upon Alt 3, with serial perfection and partial proofs[11]	4,392	1,667	2,725	$4,303	$1,089	$18,899,494	$18,899,494	$0	$274,400	$274,400	$0	$419	(+/-$54)	$1,840,248	9.7%	Low	High
5b	Based upon Alt 1, with serial perfection and partial proofs[11]	4,844	2,769	2,075	$9,589	$2,428	$46,450,404	$46,450,404	$0	$682,499	$682,499	$0	$595	(+/-$95)	$2,882,180	6.2%	High	High
5c	Based upon Alt 1, with serial perfection and partial proofs[11]	6,420	2,769	3,651	$7,235	$1,832	$46,450,404	$46,450,404	$0	$682,499	$682,499	$0	$450	(+/-$75)	$2,889,000	6.2%	High	High

Notes:

1 Perfected Acreage is in addition to existing 517 acres of DNR land already in agricultural production under Permit S4-25639(A)P.

2 DNR Capital Cost / Acre is representative of DNR share of capital cost relative to ultimate perfected acreage.

3 DNR Capital Cost / Acre-ft is based on an average water duty of 3.95 ft / acre which is the average water duty represented in permit S4-25639 (17,375.15 acre-ft / year / 4,392.1-acres). Actual water duty will depend on perfected acres and crops.

4 Partner Share represents capital costs paid by others to sharing excess DNR infrastructure capacity.

5 O&M Costs represent estimated power costs incurred for pumping and operation of farm watering equipment only.

6 Rental Rate reflects assumption of 5% rate of return associated with 2% annual rental rate increase, with a ± 1% rental rate sensitivity analysis.

7 Annual Return represents the annual revenue to DNR based on the average rental rate of return for the number of acres developed.

8 Return on Asset is the ratio of annual cash income (annual return) to total invested capital assets.

9 Environmental Impact is a qualitative rating based on projected impacts to aquatic and terrestrial habitat, primarily due to number and location of acres developed, and level of construction at the Columbia River.

10 Permitting Complexity is a qualitative rating based on water right strategies, SEPA, and the potential for federal permitting compliance with ESA.

11 Alternative 5 options are not mutually exclusive with Alternative 4, but could be combined for a higher Return on Asset.

Recommended Next Steps

This appraisal study is based upon readily available information and stops short of the detailed feasibility study necessary to proceed into final project development, including design and construction. The next step recommended for this project would be to build upon appraisal-level information through the completion of a detailed feasibility study of a preferred alternative or alternatives selected by DNR. The feasibility-level study would include more detailed evaluation of project details such as property and facility ownership, topography, hydraulic analysis, Columbia River water availability and water rights strategies, site investigations including geologic/geotechnical studies, environmental review, evaluation of permitting requirements, refined/preliminary engineering, and updated opinion of probable costs. Additional elements appropriate at the feasibility stage and beyond include developing a refined benefit cost analysis, pursuing funding through the Legislature, and meeting with relevant stakeholders to make decisions regarding how to move forward. If multiple alternatives are viable from DNR's perspective, then one process that could be used to solicit formal comments from affected agencies and adjacent land owners is SEPA scoping. This process could help provide greater structure to the qualitative assessment of permitting and environmental impacts in this appraisal study, which will be important in selecting a preferred alternative.

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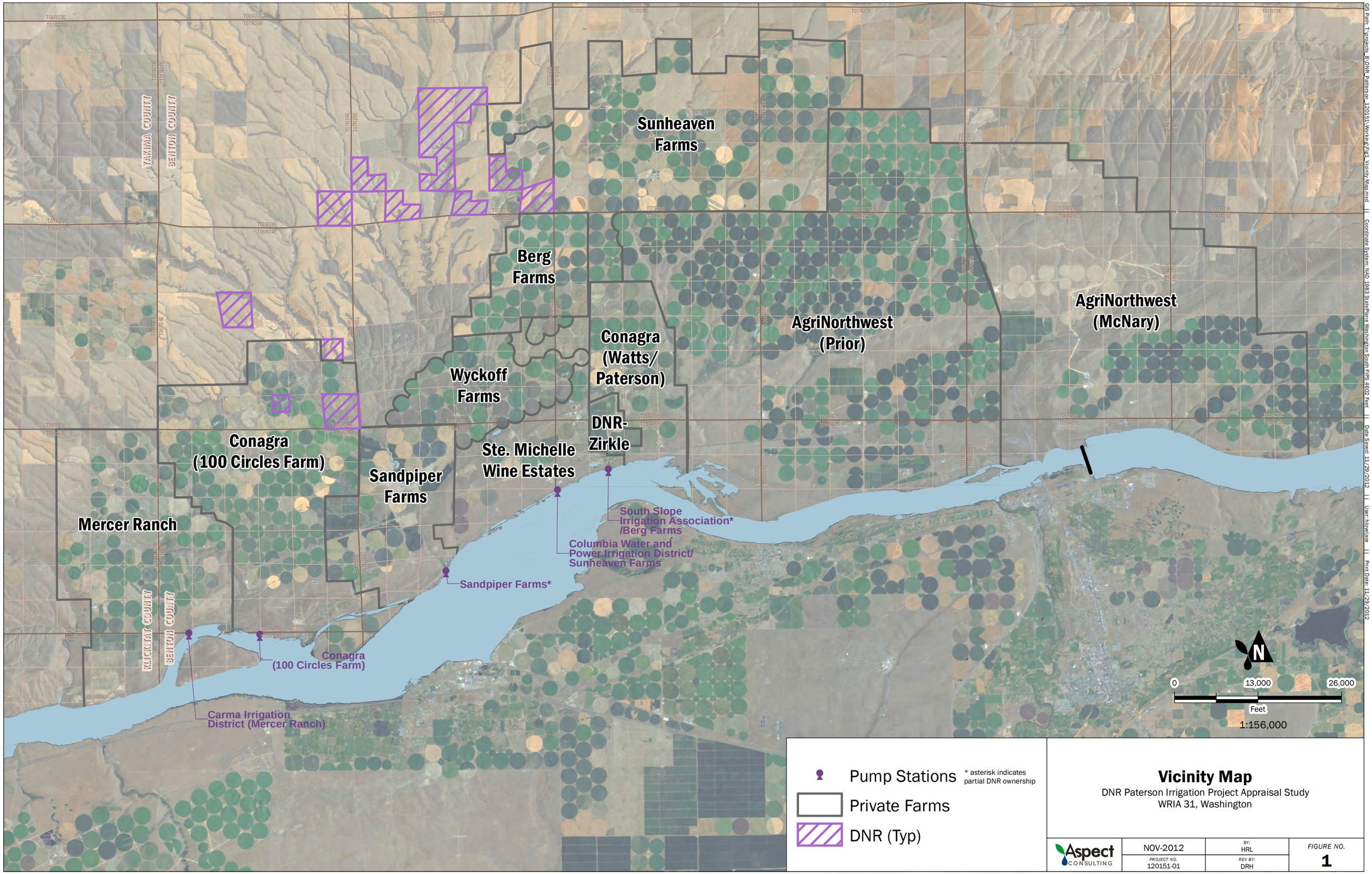
Limitations

Work for this project was performed and this report prepared in accordance with generally accepted professional practices for the nature and conditions of work completed in the same or similar localities, at the time the work was performed. This report does not represent a legal opinion. No other warranty, expressed or implied, is made.

All reports prepared by J-U-B Engineers/Aspect Consulting/Brady Consulting (Engineer) are intended solely for the Client and apply only to the services described in the Agreement with Client. Any use or reuse by Client for purposes outside of the scope of Client's Agreement is at the sole risk of Client and without liability to the Engineer. The Engineer shall not be liable for any third parties' use of the deliverables provided.. The Engineer's original files/reports shall govern in the event of any dispute regarding the content of electronic documents furnished to others.



Pump Stations * asterisk indicates partial DNR ownership

Private Farms

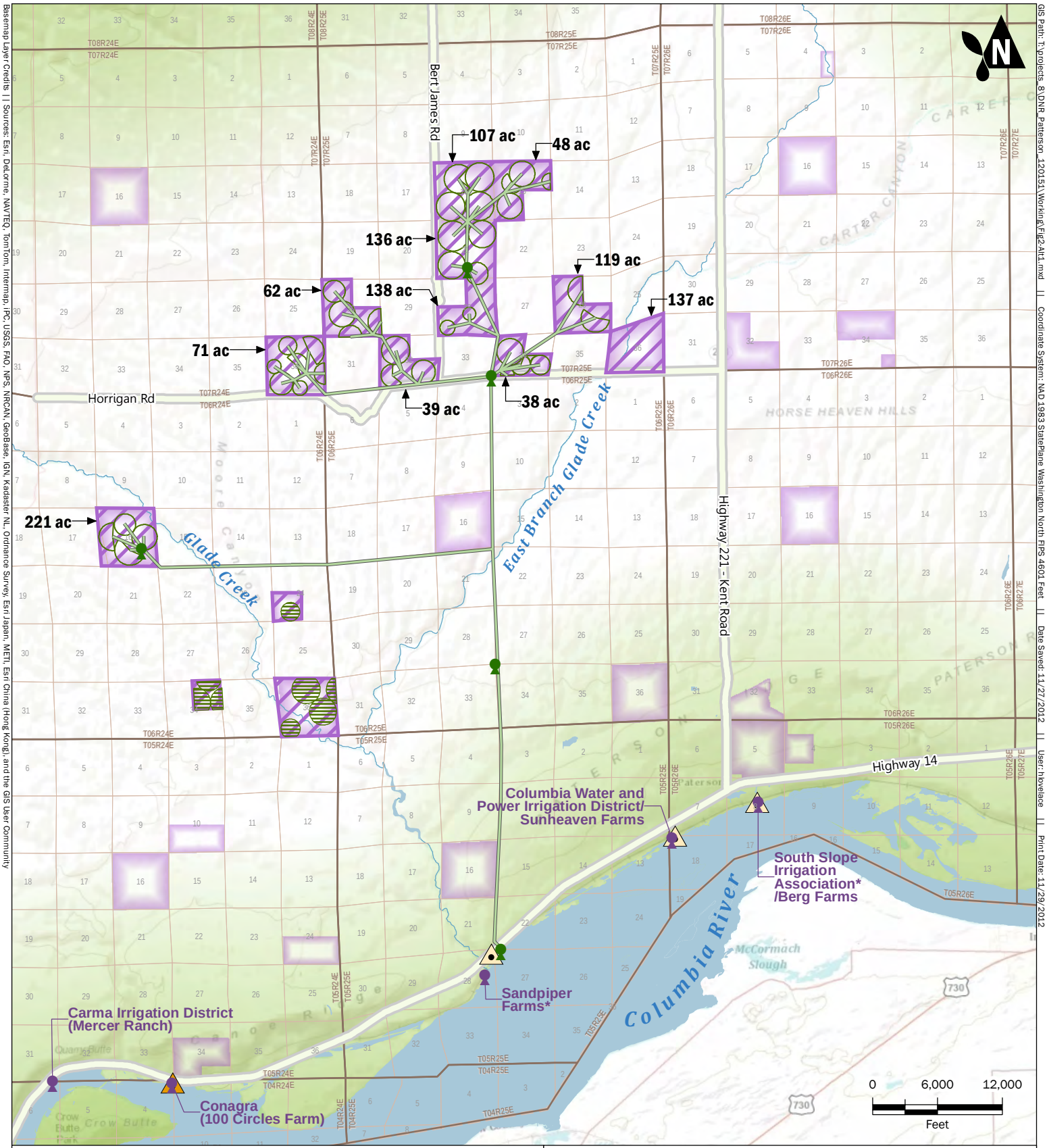
DNR (Typ)

Vicinity Map

DNR Paterson Irrigation Project Appraisal Study
WRIA 31, Washington

Aspect Consulting	NOV-2012	BY: HRL	FIGURE NO. 1
	PROJECT NO. 120151-01	REV BY: DRH	

GIS Path: T:\projects_8\DNR_Paterson_120151\Working\Fig1_Vicinity Map.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 11/29/2012 || User: hlowlace || Print Date: 11/29/2012



Basemap Layer Credits || Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, iPC, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), and the GIS User Community

GIS Path: T:\projects_8\DNR_Patterson_120151\Working\Fig2-Alt1.mxd || Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet || Date Saved: 11/27/2012 || User: hlovelace || Print Date: 11/29/2012

- Main Pipe Distribution System
- Existing Irrigated Acreage
- Proposed Irrigation Circles
- Permanent Solid-Set Irrigation in Acres → Lands Authorized by Permit S4-25639(A)P
- DNR managed Lands/ Agricultural Lease
- Point of Diversion
- Requestion Additional Diversion Point (Pending Application)
- Proposed Booster Pumps
- Pump Stations
  * asterisk indicates partial DNR ownership

Alternative 1
Full Irrigation Development
New Pump Station (4,392 acres)

DNR Paterson Irrigation Project Appraisal Study
WRIA 31, Washington

Aspect Consulting / JUB Engineers, Inc.	NOV-2012	BY: JSL/PPW	FIGURE NO. 2
	PROJECT NO. 120151-01	REV BY: DRH / EAH	

Basemap Layer Credits || Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, iPC, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), and the GIS User Community

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GIS Path: T:\projects_8\DNR_Patterson_120151\Working\Fig3-Alt2.mxd || Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet || Date Saved: 11/29/2012 || User: hlovelace || Print Date: 11/29/2012

Main Pipe Distribution System

Existing Irrigated Acreage

Proposed Irrigation Circles

Permanent Solid-Set Irrigation in Acres

Temporary Big Gun Irrigation in Acres

Lands Authorized by Permit S4-25639(A)P

DNR managed Lands/ Agricultural Lease

Point of Diversion

Requestion Additional Diversion Point (Pending Application)

Proposed Booster Pumps

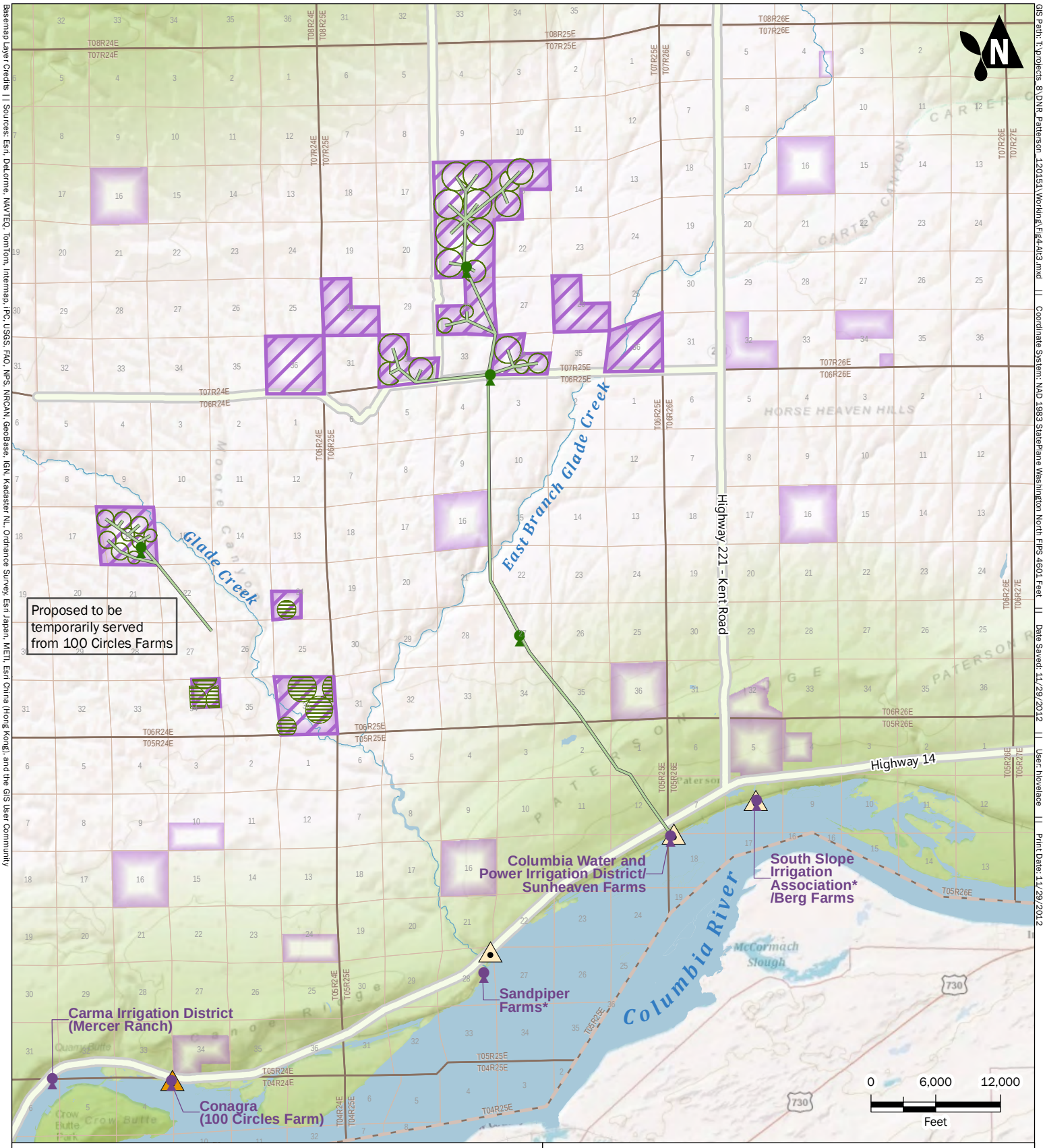
Pump Stations

* asterisk indicates partial DNR ownership

Alternative 2
Near-Full Irrigation Development
Existing Pump Station (4,253 acres)

DNR Paterson Irrigation Project Appraisal Study
WRIA 31, Washington

Aspect Consulting / JUB Engineers, Inc.	NOV-2012	BY: JSL/PPW	FIGURE NO. 3
	PROJECT NO. 120151-01	REV BY: DRH / EAH	



Main Pipe Distribution System

Existing Irrigated Acreage

Proposed Irrigation Circles

Lands Authorized by Permit S4-25639(A)P

DNR managed Lands/ Agricultural Lease

Point of Diversion

Requestion Additional Diversion Point (Pending Application)

Proposed Booster Pumps

Pump Stations

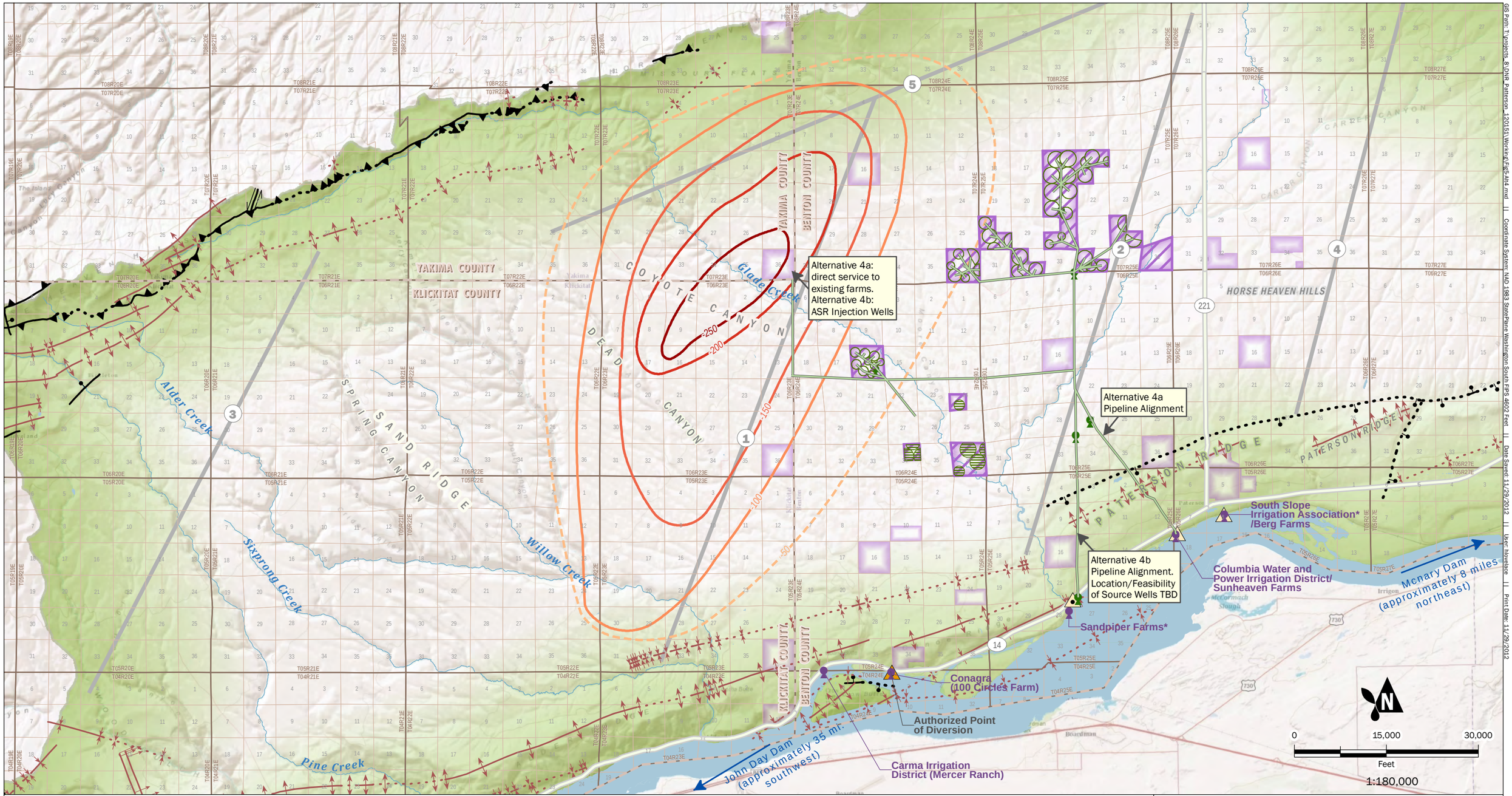
* asterisk indicates partial DNR ownership

Alternative 3
Best-Lands Irrigation Development
Existing Pump Station (2,562 acres)

DNR Paterson Irrigation Project Appraisal Study
WRIA 31, Washington

Aspect Consulting / JUB Engineers, Inc.	NOV-2012	BY: JSL/PPW	FIGURE NO. 4
	PROJECT NO. 120151-01	REV BY: DRH / EAH	

GIS Path: T:\projects_8\DNR_Patterson_120151\Working\Fig4-Alt3.mxd || Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet || Date Saved: 11/29/2012 || User: hlovelace || Print Date: 11/29/2012



Main Pipe Distribution System
Existing Irrigated Acreage
Proposed Irrigation
Proposed Booster Pumps
Pump Stations
* asterisk indicates partial DNR ownership

DNR Managed Lands/ Agricultural Lease
Lands Authorized by Permit S4-25639(A)P
Point of Diversion
Requested Additional Diversion Point (Pending Application)

Wood Glade Planning Area
Inferred barrier fault (Packard et al., 1996)
Change in groundwater elevation (1983-2009) contour, in feet (dashed where less certain)

Faults and Folds (WA DNR 1:100K, 2010)

Normal fault - location accurate, Bar and ball on downthrown block
Normal fault - location concealed, Bar and ball on downthrown block
Thrust fault - location accurate, Sawteeth on upper plate
Thrust fault - location approximate, Sawteeth on upper plate
Thrust fault - location concealed, Sawteeth on upper plate
Left-lateral strike-slip fault - location accurate. Arrows show relative motion
Left-lateral strike-slip fault - location concealed, Arrows show relative motion
Anticline, location accurate
Anticline, location concealed
Syncline, location accurate
Syncline, location concealed
Monocline, anticlinal bend, location accurate
Monocline, anticlinal bend, location concealed
Monocline, synclinal bend, location accurate
Monocline, synclinal bend, location concealed

Alternative 4 – Shared Benefits Options (Source Replacement or Aquifer Storage)

DNR Paterson Irrigation Project Appraisal Study
WRIA 31, Washington

Aspect Consulting | JUB Engineers, Inc.

NOV-2012	BY: JSL / PPW	FIGURE NO. 5
PROJECT NO. 120151-01	REV BY: DRH / EAH	

GIS Path: T:\projects_8\DNR_Paterson_120151\Working\Fig5-4ht4.mxd | Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet | Date Saved: 11/29/2012 | User: hlovelace | Print Date: 11/29/2012

APPENDIX A

Project Economics

Estimate of Return on Investment for Paterson Pipeline Project Development Options

Prepared by: Michael Brady, PhD

1. Summary of Results

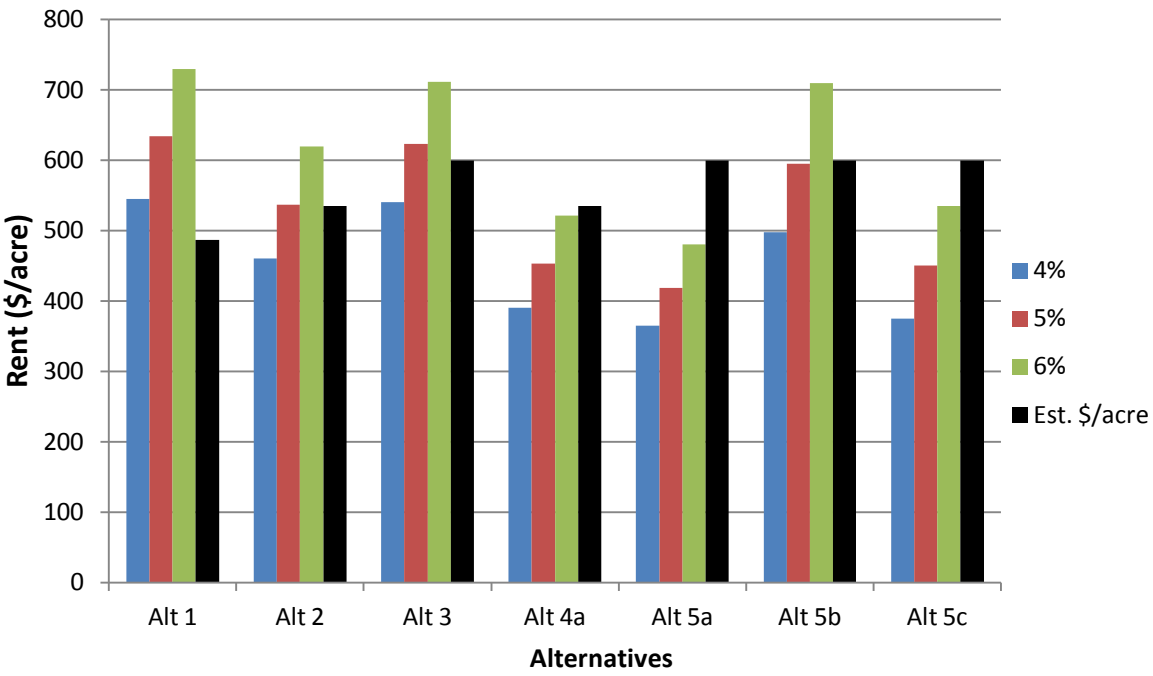
Five general alternatives were considered where two alternatives (alternatives 4 and 5) have multiple options. The economic analysis combines cost estimates with revenue estimates to compare the alternatives according to generally used methods for analyzing investment alternatives. The internal rate of return (IRR) is the primary tool used. IRR[1] is the standard approach for evaluating an investment opportunity because it explicitly accounts for the time value of money. Results of a net present value analysis are also provided which evaluates costs versus return on a total dollar basis. **The results show that alternatives 4 and 5 are likely to provide a greater return on investment compared to alternatives 1,2, and 3 by taking advantage of cost sharing and spreading. It is important to recognize that these estimates do not incorporate potentially higher legal, regulatory, and management costs, as well as risks, required for working with another party (alternative 4) and to achieve spreading (alternative 5).**

There is significant uncertainty over the rental rate that the DNR land is likely to command. Therefore, two approaches are taken in this analysis. The first approach is to find the average rental rate per acre required to achieve a target level of return. Rates of 4%, 5%, and 6% were chosen as the target rates of return because 4% was deemed to be a minimum required for consideration and any return over 6% is likely to be highly attractive. The second approach is to use available information on cash rental rates to estimate the average rental rate under each scenario. This incorporates differences amount of land with differing levels of productivity that are irrigated in each scenario (e.g. circles versus corners). This value can be compared to the results from the first approach.

The figure below shows the average rent required to achieve a rate of return of 4%, 5%, and 6%. Also shown is the estimated average rent per acre for each alternative given the best available information on rental rates in the area. The rent per acre for the land under circles and corners was assumed to be $600/acre and $200/acre, respectively. The rate for circles was taken from the most recent enterprise budget for potato production done by WSU Extension (2010). This represents an average across all land being used to grow potatoes in the Basin. There is much greater uncertainty for the land under corners. The estimated average rent per acre increases from alternative 1 to 3 as a larger share of land is under circles rather than corners.

[1] Internal rate of return calculates the rate r that solves the equation assuming rents are collected for n years. The calculated value for r is the value that equates the discounted value of costs and revenues.

$$\text{Initial Cost} = \frac{\text{Rent Payments}_1}{(1+r)^1} + \frac{\text{Rent Payments}_2}{(1+r)^2} + \ldots + \frac{\text{Rent Payments}_n}{(1+r)^n} \text{ for n years.}$$



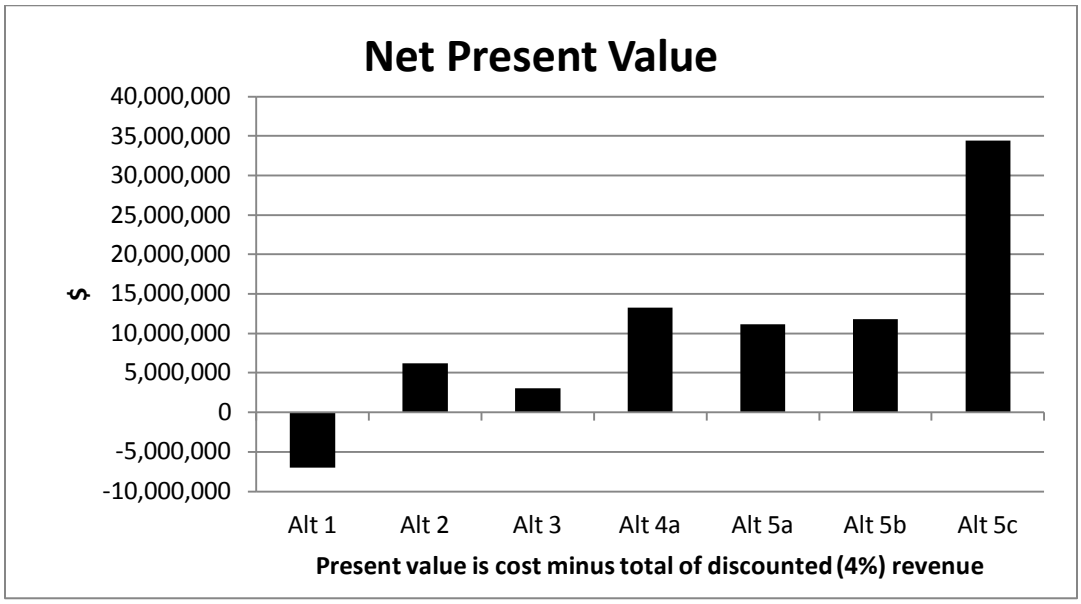
*Est $/acre is an estimate of the average rent per acre for the alternative. Rental rate for Alt 5b and 5c applies to years 6-50.

Alternative 4a achieves a higher rate of return at a lower rental rate by cost-sharing with Andrews. Alternative 4b is not included here because there is no difference on the revenue side. The rate of return for 4b depends on achieving a greater amount of cost-sharing from Andrews.

Alternative 5 focuses on spreading to additional land. Alternative 5a starts with Alternative 3 and adds 552 acres every five years in years 6-25 (4 stages). The same type of land, in terms rental rate, is assumed to be spread to in each stage. This follows from the fact that all land in Alternative 3 is under circles. Alternatives 5b and 5c differ slightly from 5a. Spreading starts in years 6-50 after irrigating the 3,875 acres considered in Alternative 1 in years 1-5. Alternative 5c spreads to more acres by assuming that the water is going exclusively to vineyards. It is difficult to project a rental rate on the additional land in 5b and 5c. Rental rates vary significantly across vineyards and it is uncertain exactly what land the water may be spread to. Based on existing enterprise budgets and some other sources of information, a rental rate of $600/acre was assumed for both 5b and 5c. While some vineyard land is likely to command a higher rate, $600/acre is in the range of what could be expected. Assuming $600/acre also allows for a direct evaluation of the benefit of spreading to additional acreage in 5c versus 5b.

A net present value analysis provides a useful comparison to IRR because it quantifies costs and returns on a total dollar basis rather than a percentage. It is also relatively simple and minimizes the need to gain information or make assumptions about borrowing costs. The NPV approach simply discounts revenue received over time by the opportunity cost of capital, which is assumed to be 4%. This is

consistent with the rest of the analysis which assumes that alternative investments that generate a 4% return are likely to exist.



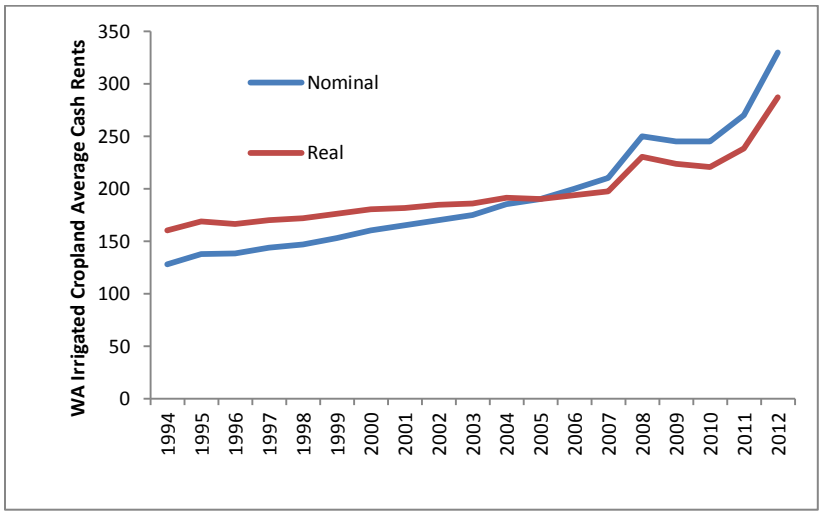
2. Background on Rental Rates

Revenue from the development of the Paterson project is derived from rental payments. Estimates of rental payments are driven by expectations of costs and returns for the crops projected to be grown on the relevant parcels. Our assumption is that the most likely cropping pattern is a three year rotation of potatoes, wheat, and grain corn. Farmers in the area believe that the parcels are too cold for orchards or vineyards. A source for cost and return estimates are enterprise budgets prepared by WSU and other extension agents in the region. However, enterprise budgets represent average conditions so values should be adjusted when a specific parcel is being considered.

The USDA also started a county level cash rental rate survey in 2009 that provides additional information on cash rents. Cash rents for irrigated land in Benton County were estimated to average $358/acre between 2008 and 2012. It is important to keep in mind that cash rents vary significantly in areas dominated by irrigated agriculture due to the diversity of crops and growing conditions. Vegetables, orchards, hay, cereal grains, and vineyards are all common in the area.

The most recent enterprise budget for potatoes (Taylor, 2010) assumed a land rental rate of $600/acre which includes property taxes, insurance, and irrigation equipment. It also already accounts for pumping costs paid by the tenant. Rents should only be adjusted downward for pumping costs for a situation where they are likely to be significantly higher than average. The potato enterprise budget done in 2006 assumed a rental rate of $450/acre. Extensive interviews with farmers in the area have created some uncertainty over a realistic rental rate for DNR's parcels. This uncertainty is greater for the larger development options that irrigated more land outside of the circles. Given this uncertainty, a prudent approach for analyzing return on investment is to identify an average rental rate across all the acres that would achieve a particular level of return. A 4% rate of return is conservative over the long run, so that is the lowest rate considered. To provide an additional reference point, the rental rate required to achieve 6% is also calculated.

It also makes sense to assume some real growth rate in cash rental rates given the historical time series for Washington. Average cash rents for the irrigated cropland for the state are deflated by the GDP deflator. The average rate of growth for this series is 3%. A more conservative estimate can be based on the real growth rate from 1994 to 2007, which is about 2% per annum. Results assuming both rates are discussed.



The investment horizon for this project was assumed to be 50 years. This is based on the lifespan of the physical infrastructure. Also, rental payments received more than 50 years into the future have relatively little influence on results due to discounting.

3. Summary of Cost Related Issues by Alternative

Alternative 1

The full development option allows for a maximum of 4,844 acres to be irrigated, although it is believed that 3,875 acres is more realistic. Up front capital costs per acre for the this option are estimated to be $45,655,100, or $11,781/acre. Circles account for 2,769 acres and corners account for 1,083 acres for a total of 3,875 acres. PUD capital costs, recovered assuming the 18% annual payment in perpetuity approach is taken, is $241/acre. Whether the PUD capital recovery charge drops the rental rate dollar for dollar has a significant influence on results across all scenarios.

Alternative 2

The partial development option for 2,934 acres eliminates some of the harder to irrigate pieces of land including some corners which have a higher average cost per acre than the circles. Circles account for 2,463 acres while corner acreage is 471 acres. The cost per acre is $8,041. PUD capital cost recovery is assumed to be $213/acre based on an initial cost of $3,480,000.

Scenario 3

The third option is for a 1,667 acre development where all land is under circles. The total capital cost is $18,059,100, or $10,833/acre. The associated PUD capital power cost is $2,574,000 for $277/acre per year.

Alternatives 4a and 4b:

Alternative 4A start with Alternative 2 as a base and then consider an expansion of capacity that could service the Andrews' sections. This would benefit DNR through cost share. The total cost of the project increases to $34,582,580, although DNR's share drops to $24,740,030. This is lessens DNR's cost by about $4 million compared to Alternative 2. The PUD capital cost is estimated to be $4,005,000. Assuming tenants on DNR land cover 70% of this amount, the per acre cost is $171/acre/year. The average cash rent per acre to achieve a 4% return under these assumptions is $390/acre. From DNR's perspective, Alternative 4b requires almost the same rent revenue stream as 4a. The total cost is much higher in 4b than in 4a, but DNR's share is about the same. The PUD costs are estimated to be $6,260,000, which comes to $268/acre/year to DNR land following the same assumption of 70% as in 4a. This significantly increases the required rental rate compared to 4a.

It is important to recognize that a cost-share approach is assumed in analyzing DNR's return on investment in this scenario. This should be viewed as a lower bound from DNR's perspective. An alternative that would likely generate a higher rate of return would be to base the cost-share on the farmers potential willingness-to-pay to replace groundwater with surface water. This approach would require identifying the next best alternative. If they are not likely to have any alternative other than going to dryland production then they may be willing to cover a greater share of costs than is assumed above given the difference between net returns for irrigated and dryland production in the area. If there is an alternative investment that could substitute for the DNR option then that should be the basis for determining their maximum cost-share. The fact that this is a lower bound is an important point to consider if the rental rate required for DNR to achieve their desired rate of return is deemed unobtainable. If this conclusion is reached then the farmers may be willing to cover a greater share depending on what they deem their alternative to be. If OCR is a potential partner then it will also be important to recognize the social benefits that accrue to the region from producing irrigated crops that stimulate additional economic activity post-farm gate compared to dryland crops via processing and packaging (e.g. potato and fruit packing, frozen potato products, wine production). A back-of-the-envelope calculation can provide an estimate of the decreased economic activity from this land switching from irrigated to dryland production. The value of production, on average, is assumed to be $5,000/acre for irrigated land and $500/acre for dryland then there is a decrease in the value of production on the Andrews land of $27 million per year on 6,000 acres. Economic multipliers are based on gross revenue from an industry because they capture all the additional activity that occurs when an industry makes purchases from other industries in the region as part of their operation (e.g. fertilizer sales). According to IMPLAN® the multiplier between for vegetable and grain production in this part of Washington is 1.3. Therefore, the total decrease in economic activity is estimated to be $35 million per year. The primary difference between Alternatives 4a and 4b will be via the multiplier effect where total economic impact is greater for irrigated production compared to dryland production.

Alternatives 5a, 5b, and 5c

Alternative 5a starts with Alternative 3 as a base (1,667 acres) and then serially perfects 552 acres every five years from years 5 through 25. This means that rents are based on 1,667 acres in years 1-5, 2,219 acres in years 6-10, 2,771 acres in years 11-15, 3,323 acres in years 16-20, and 3,875 acres in years 21-50. The annual PUD capital cost recovery charge is assumed to be $277/acre.

Alternative 5b starts with Alternative 1 as a base and then considers spreading in years 6 through 50 from a base of 2,463 acres in circles (potato rotation) and 1,412 acres in corners (hay). Annual PUD capital recovery cost is $928,800 (18%*$5,160,000), or $241/acre.

Alternative 5c is the same as 5b except that spreading extends to additional acres, which is achieved by spreading to wine grapes. It would be prudent to assume that this introduces greater uncertainty over the revenue stream.

APPENDIX B

Cost Estimates

ENGINEER'S OPINION OF PROBABLE COST

PROJECT: Paterson Irrigation Project Appraisal Study

DATE: November 15, 2012

PROJECT DESCRIPTION: Alternative 1, Full Build Out

CLIENT: Washington State Department of Natural Resources

CLIENT PROJ. NO.: J-U-B PROJ. NO.: 30-12-052

ITEM NO.	DESCRIPTION	SCHEDULE OF VALUES			
		QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	Mobilization	1	LS	$660,000	$660,000
2	River Pump Station	1	LS	$4,211,500	$4,211,500
3	Penstock Booster Pump Stations	1	LS	$3,228,340	$3,228,340
4	Penstock	1	LS	$6,521,750	$6,521,750
5	Section 16 Irrigation	1	LS	$2,229,010	$2,229,010
6	Sections 26, 34 and 36 Irrigation	1	LS	$1,550,840	$1,550,840
7	Sections 15, 16, 21 and 28 Irrigation	1	LS	$4,508,800	$4,508,800
8	Sections 30, 32 and 36 Irrigation	1	LS	$2,882,030	$2,882,030
	SUBTOTAL				**25,792,270**
Contingency				25.00%	$6,448,068
Sales Tax				8.30%	$2,675,948
	TOTAL ESTIMATED CONSTRUCTION COSTS				**$34,916,286**
Engineering				10.00%	**$3,224,034**
Aquatic/Terrestrial Mitigation				25.00%	**$8,060,084**
Permitting					**$250,000**
	TOTAL ESTIMATED PROJECT COSTS				**$46,450,404**

J-U-B ENGINEERS, INC.

SUITE 201, 2810 WEST CLEARWATER AVE., KENNEWICK, WASHINGTON 99336 (509) 783-2144

ENGINEER'S OPINION OF PROBABLE COST

PROJECT: Paterson Irrigation Project Appraisal Study

DATE: November 15, 2012

PROJECT DESCRIPTION: Alternative 2, Partial Build Out With Both Permanent and Temporary Crops

CLIENT: Washington State Department of Natural Resources

CLIENT PROJ. NO.

J-U-B PROJ. NO.: 30-12-052

ITEM NO.	DESCRIPTION	SCHEDULE OF VALUES			
		QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	Mobilization	1	LS	$450,000	$450,000
2	River Pump Station	1	LS	$2,327,100	$2,327,100
3	Penstock Booster Pump Stations	1	LS	$2,156,700	$2,156,700
4	Penstock	1	LS	$4,688,650	$4,688,650
5	Sections 26, 34 and 36 Irrigation	1	LS	$1,403,230	$1,403,230
6	Sections 15, 16, 21 and 28 Irrigation	1	LS	$3,946,620	$3,946,620
7	Sections 30, 32 and 36 Irrigation	1	LS	$2,857,300	$2,857,300
8	Section 16 Water Right Perfection	1	LS	$570,470	$570,470
	SUBTOTAL				**18,400,070**
Contingency				25.00%	$4,600,018
Sales Tax				8.30%	$1,909,007
	TOTAL ESTIMATED CONSTRUCTION COSTS				**$24,909,095**
Engineering				10.00%	**$2,300,009**
Aquatic/Terrestrial Mitigation				10.00%	**$2,300,009**
Permitting					**$100,000**
	TOTAL ESTIMATED PROJECT COSTS				**$29,609,112**

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ENGINEER'S OPINION OF PROBABLE COST

PROJECT: Paterson Irrigation Project Appraisal Study

DATE: November 15, 2012

PROJECT DESCRIPTION: Alternative 3, Partial Build Out Permanent High Value Crops

CLIENT: Washington State Department of Natural Resources

CLIENT PROJ. NO.

J-U-B PROJ. NO.: 30-12-052

ITEM NO.	DESCRIPTION	SCHEDULE OF VALUES			
		QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	Mobilization	1	LS	$300,000	$300,000
2	River Pump Station	1	LS	$1,763,100	$1,763,100
3	Penstock Booster Pump Stations	1	LS	$1,369,000	$1,369,000
4	Penstock	1	LS	$3,303,100	$3,303,100
5	Sections 34 Irrigation	1	LS	$428,500	$428,500
6	Sections 15, 16, 21 and 28 Irrigation	1	LS	$3,434,380	$3,434,380
7	Sections 32 Irrigation	1	LS	$553,660	$553,660
8	Section 16 Water Right Perfection	1	LS	$570,470	$570,470
	SUBTOTAL				**11,722,210**
Contingency				25.00%	$2,930,553
Sales Tax				8.30%	$1,216,179
	TOTAL ESTIMATED CONSTRUCTION COSTS				**$15,868,942**
Engineering				10.00%	**$1,465,276**
Aquatic/Terrestrial Mitigation				10.00%	**$1,465,276**
Permitting					**$100,000**
	TOTAL ESTIMATED PROJECT COSTS				**$18,899,494**

J-U-B ENGINEERS, INC.

SUITE 201, 2810 WEST CLEARWATER AVE., KENNEWICK, WASHINGTON 99336 (509) 783-2144

ENGINEER'S OPINION OF PROBABLE COST

PROJECT: Paterson Irrigation Project Appraisal Study

DATE: November 15, 2012

PROJECT DESCRIPTION: Alternative 4A, Irrigation Season Shared Benefit with Alternative 2

CLIENT: Washington State Department of Natural Resources

CLIENT PROJ. NO.

J-U-B PROJ. NO.: 30-12-052

ITEM NO.	DESCRIPTION	SCHEDULE OF VALUES			
		QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	Mobilization	1	LS	$540,000	$540,000
2	River Pump Station	1	LS	$2,327,100	$2,327,100
3	Penstock Booster Pump Stations	1	LS	$2,156,700	$2,156,700
4	Penstock	1	LS	$4,688,650	$4,688,650
5	Sections 26, 34 and 36 Irrigation	1	LS	$1,403,230	$1,403,230
6	Sections 15, 16, 21 and 28 Irrigation	1	LS	$3,946,620	$3,946,620
7	Sections 30, 32 and 36 Irrigation	1	LS	$2,857,300	$2,857,300
8	Section 16 Water Right Perfection	1	LS	$570,470	$570,470
9	Partial Service to Andrew's/Exst DNR	1	LS	$3,819,150	$3,819,150
	SUBTOTAL				**22,309,220**
Contingency				25.00%	$5,577,305
Sales Tax				8.30%	$2,314,582
	TOTAL ESTIMATED CONSTRUCTION COSTS				**$30,201,107**
Engineering				10.00%	**$2,788,653**
Aquatic/Terrestrial Mitigation				10.00%	**$2,788,653**
Permitting					**$100,000**
	TOTAL ESTIMATED PROJECT COSTS				**$35,878,412**

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SUITE 201, 2810 WEST CLEARWATER AVE., KENNEWICK, WASHINGTON 99336 (509) 783-2144

ENGINEER'S OPINION OF PROBABLE COST

PROJECT: Paterson Irrigation Project Appraisal Study

DATE: November 15, 2012

PROJECT DESCRIPTION: Alternative 4B, Year Around Shared Benefit with Alternative 2

CLIENT: Washington State Department of Natural Resources

CLIENT PROJ. NO.

J-U-B PROJ. NO.: 30-12-052

ITEM NO.	DESCRIPTION	SCHEDULE OF VALUES			
		QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	Mobilization	1	LS	$850,000	$850,000
2	Bankside Collectors	1	LS	$5,196,700	$5,196,700
3	Penstock Booster Pump Stations	1	LS	$2,321,200	$2,321,200
4	Penstock	1	LS	$5,878,850	$5,878,850
5	Sections 26, 34 and 36 Irrigation	1	LS	$1,403,230	$1,403,230
6	Sections 15, 16, 21 and 28 Irrigation	1	LS	$3,946,620	$3,946,620
7	Sections 30, 32 and 36 Irrigation	1	LS	$2,857,300	$2,857,300
8	Section 16 Water Right Perfection	1	LS	$570,470	$570,470
9	Andrew's/Exst DNR Service w/ ASR Well Field	1	LS	$12,447,275	$12,447,275
	SUBTOTAL				**35,471,645**
Contingency				25.00%	$8,867,911
Sales Tax				8.30%	$3,680,183
	TOTAL ESTIMATED CONSTRUCTION COSTS				**$48,019,739**
Engineering				10.00%	**$4,433,956**
Aquatic/Terrestrial Mitigation				10.00%	**$4,433,956**
Permitting					**$100,000**
	TOTAL ESTIMATED PROJECT COSTS				**$56,987,651**

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Table B1 - Estimated Costs of Off-site and On-site farm Infrastructure for Alternatives

Project 120151, DNR Paterson Appraisal Study, Horse Heaven Hill, WA

		Total Project Cost	Total Project Cost Less Irrigation Water Application Equipment	Difference
Alt 1				
	Hard Cost	$25,792,267	$22,078,799	$3,713,468
	Total Cost	$46,450,398	$39,798,649	$6,651,749
Alt 2				
	Hard Cost	$18,400,069	$15,084,841	$3,315,228
	Total Cost	$29,609,110	$24,292,313	$5,316,797
Alt 3				
	Hard Cost	$11,722,213	$10,244,037	$1,478,176
	Total Cost	$18,899,498	$16,528,874	$2,370,624
Alt 4A				
	Hard Cost	$22,309,219	$18,993,991	$3,315,228
	Total Cost	$35,878,410	$30,561,613	$5,316,797
Alt 4B				
	Hard Cost	$35,471,644	$32,156,416	$3,315,228
	Total Cost	$56,987,649	$51,670,852	$5,316,797

APPENDIX C

Site Photographs

Photograph 1 – DNR Property: Looking SE across Section 26, T. 7 N., R. 25 E., WM from Davis Rd

Photograph 2 – DNR Property: Looking N across Section 36, T. 7 N., R. 25 E., WM from Horrigan Rd

Photograph 3 – DNR Property: Looking NE across Section 21 and a portion of Section 28, T. 7 N., R. 25 E., WM from Bert James Rd

Photograph 4 – DNR Property: Looking N across Section 36, T. 7 N., R. 24 E., WM from Horrigan Rd