Aquifer Storage and Recovery/Shallow Aquifer Recharge in the Columbia River Basin

March 6, 2013

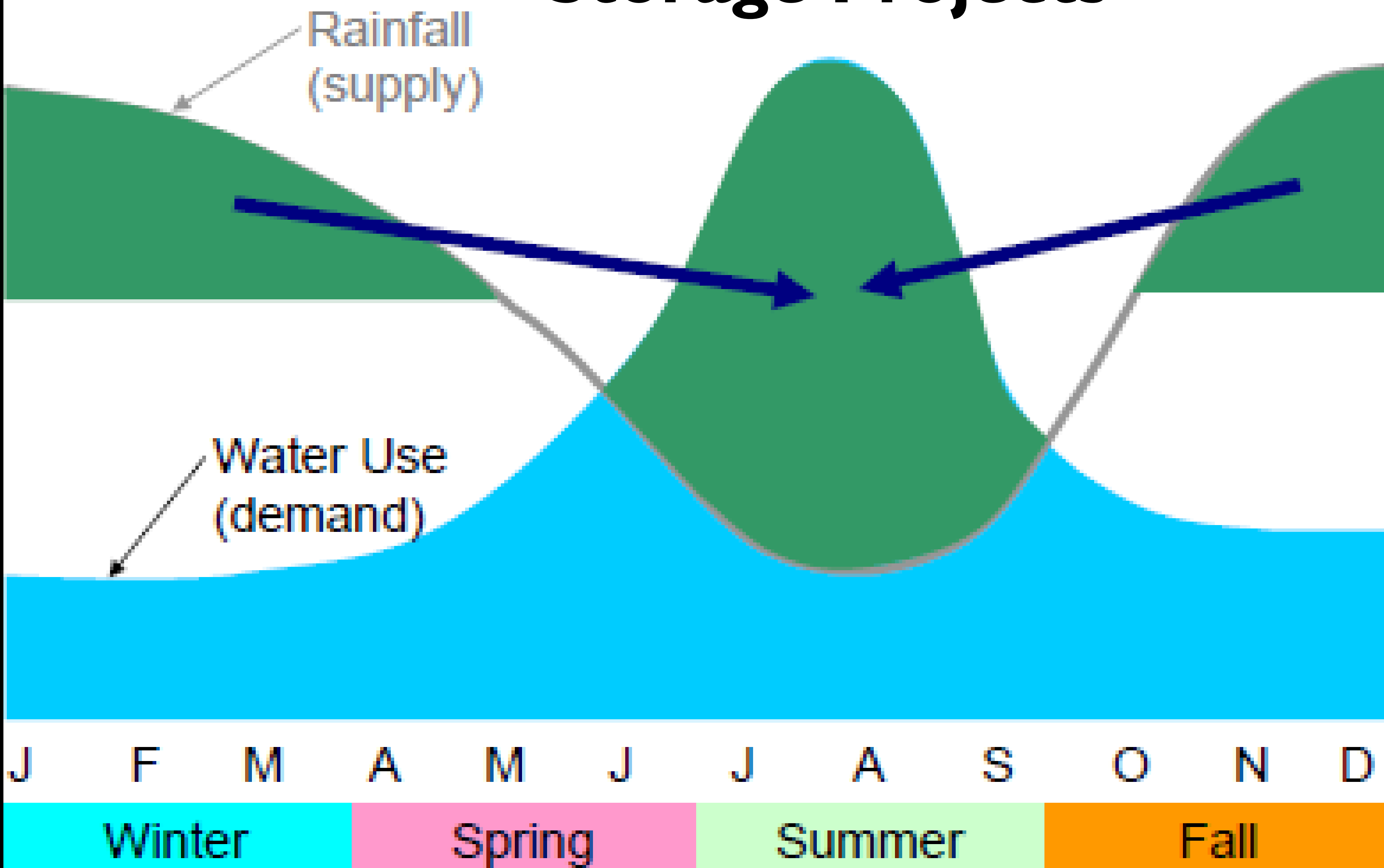
RCW 90.90 – 2006 Columbia River Legislation – Statutory Focus

- Find alternatives to groundwater for agricultural users in the Odessa groundwater subarea
- Develop sources of water supply for pending water right applications
- Create new uninterruptible supply of water for interruptible water right holders
- Meet new municipal, domestic, industrial and irrigation water needs of the basin
- Develop water for instream purposes

Columbia River Basin Long-Term Water Supply and Demand Forecast (2011)

Demand Type	Estimated Volume (ac-ft)	Source
2030 Irrigation Demand (new irrigation, Odessa replacement, Yakima Basin supply, and Columbia River interruptibles)	800,000 – 1.1 Million	WSU Integrated Model, Odessa EIS, Yakima EIS, and Ecology 2001 Drought Database
2030 New Municipal Demand (including municipally-supplied commercial and self-supplied domestic)	108,500	WSU Integrated Model
Unmet Tributary Instream Flows	500,000	Ecology Data, tributaries with adopted instream flows, 2001 drought year
2030 New Hydropower Demand	0	WSU Surveys and Planning Forecast Review

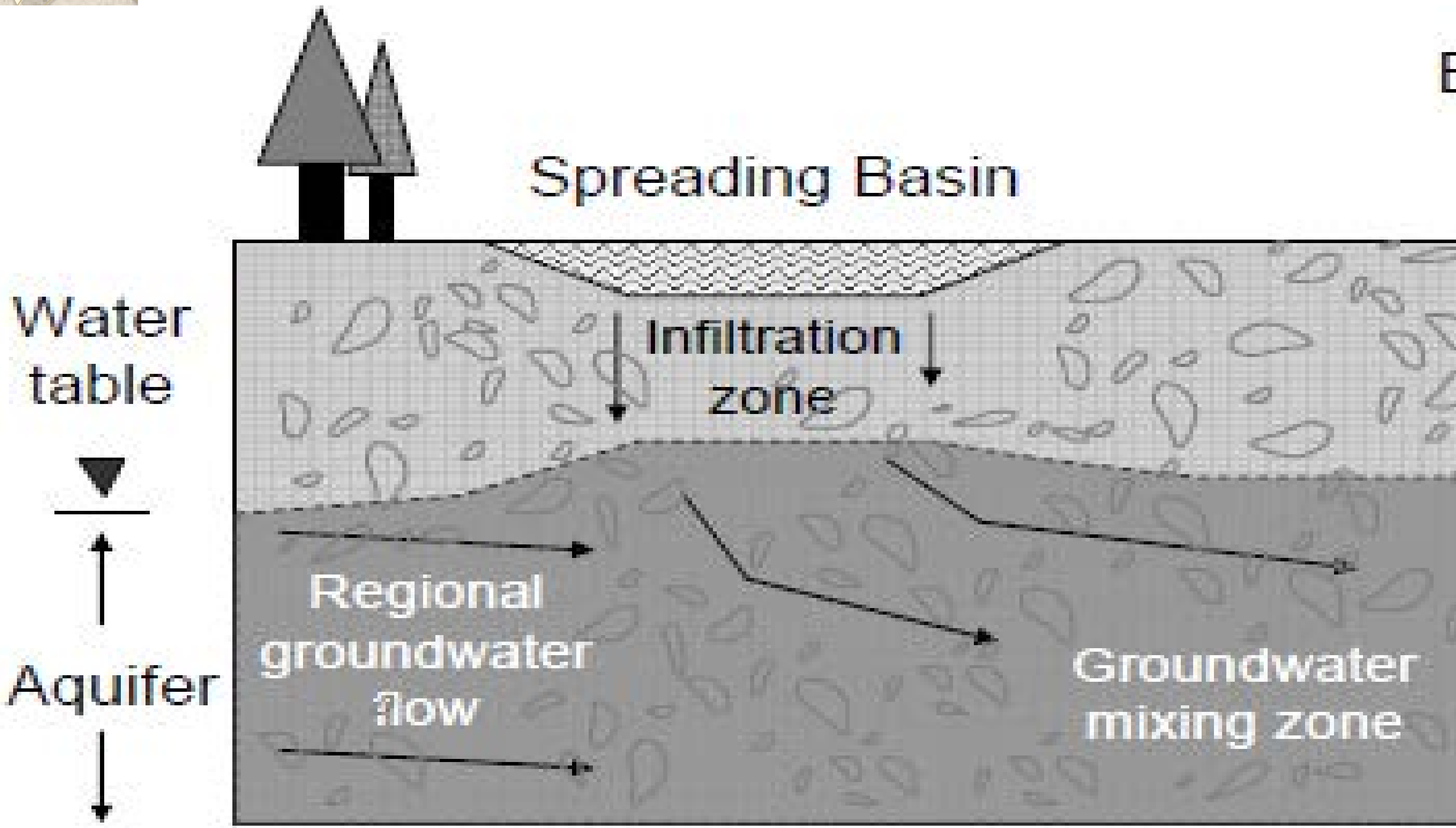
Storage Projects



Artificial Groundwater Recharge

Modified from: Brand, C., *An ASR Primer*, 2008, *Southwest Hydrology, Vol. 7, No. 3.*

Shallow Aquifer Recharge



After Woody, 2007

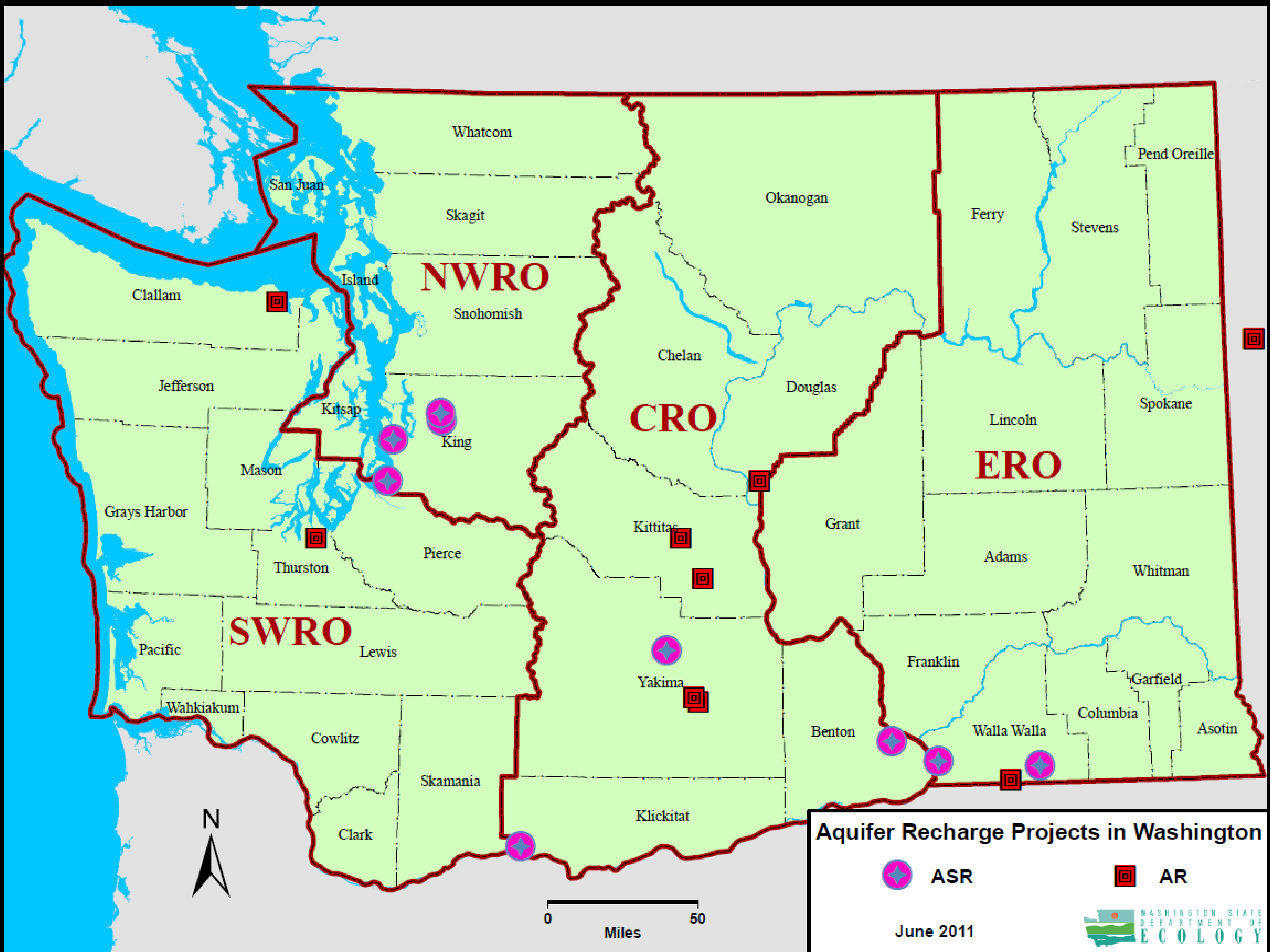
Shallow Aquifer Recharge

Purpose

- Improve discharge to streams
- Mitigation for ground or surface water use
- Restoration of streamflow
- Minimize effects of climate change

Costs

- Generally low operating costs, emphasis on monitoring
- Capital costs can be high


Whatcom
San Juan
Skagit
Okanogan
Ferry
Stevens
Pend Oreille
Island
NWRO
Snohomish
Clallam
Chelan
Douglas
Jefferson
Kitsap
King
CRO
Lincoln
Spokane
Mason
ERO
Grays Harbor
Kittitas
Grant
Pierce
Thurston
Adams
Whitman
SWRO
Pacific
Lewis
Yakima
Franklin
Garfield
Wahkiakum
Cowlitz
Benton
Walla Walla
Columbia
Asotin
Skamania
Klickitat
Clark
N
0
50
Miles
Aquifer Recharge Projects in Washington
ASR
AR
June 2011
WASHINGTON STATE DEPARTMENT OF ECOLOGY

Yakima River Basin Study

Groundwater Infiltration Appraisal-Level Study Technical Memorandum

U.S. Bureau of Reclamation
Contract No. 08CA10677A ID/IQ, Task 4.13

Prepared by

Golder Associates Inc.
HDR Engineering, Inc.

U.S. Department of the Interior
Bureau of Reclamation
Pacific Northwest Region
Columbia-Cascades Area Office

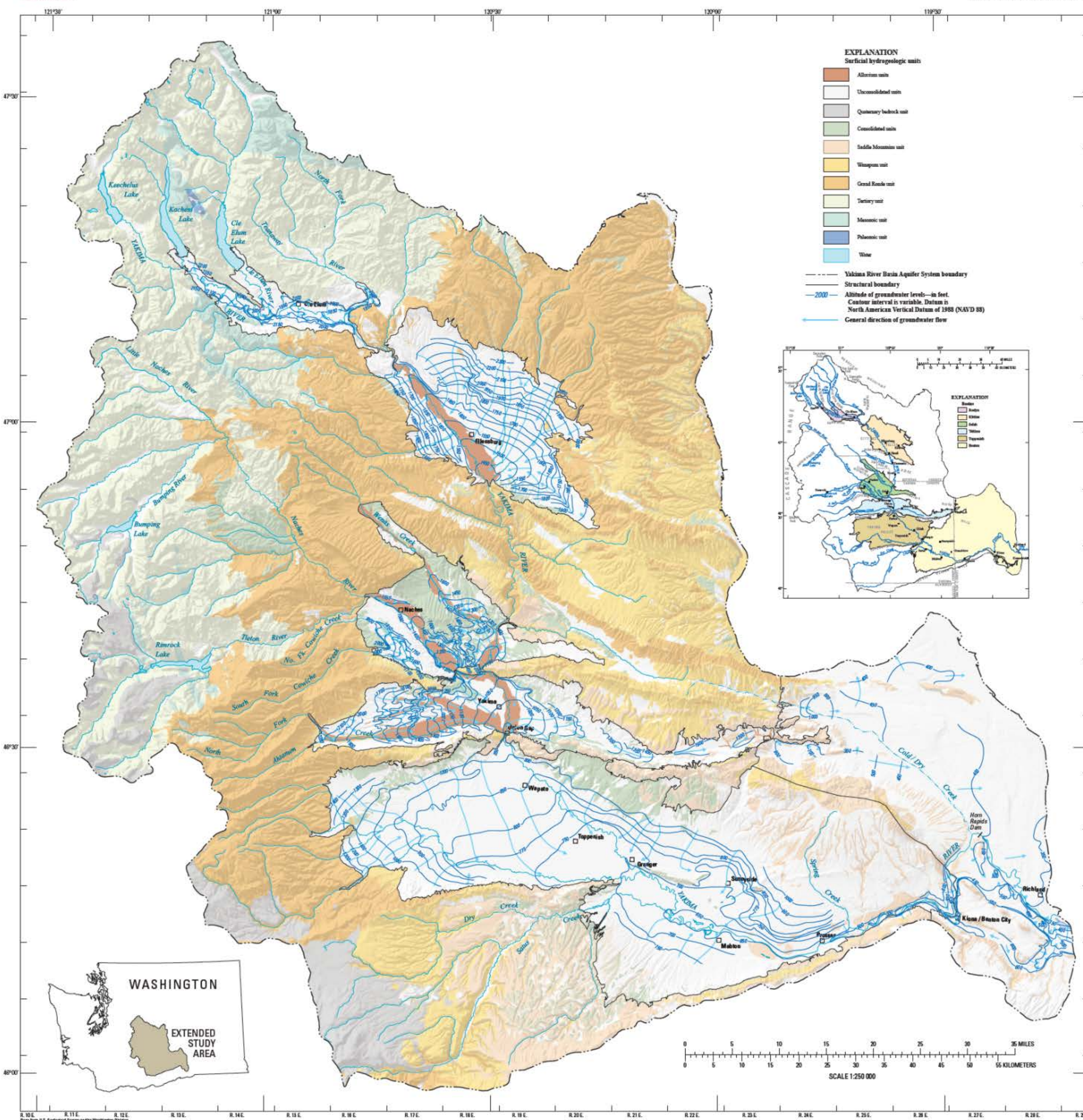
State of Washington
Department of Ecology
Office of Columbia River

March 2011

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Prepared in cooperation with the
BUREAU OF RECLAMATION, WASHINGTON STATE DEPARTMENT OF ECOLOGY, AND THE YAKAMA NATION

SCIENTIFIC INVESTIGATIONS REPORT 2009–5152
Altitude of groundwater levels in six structural basins—PLATE 3

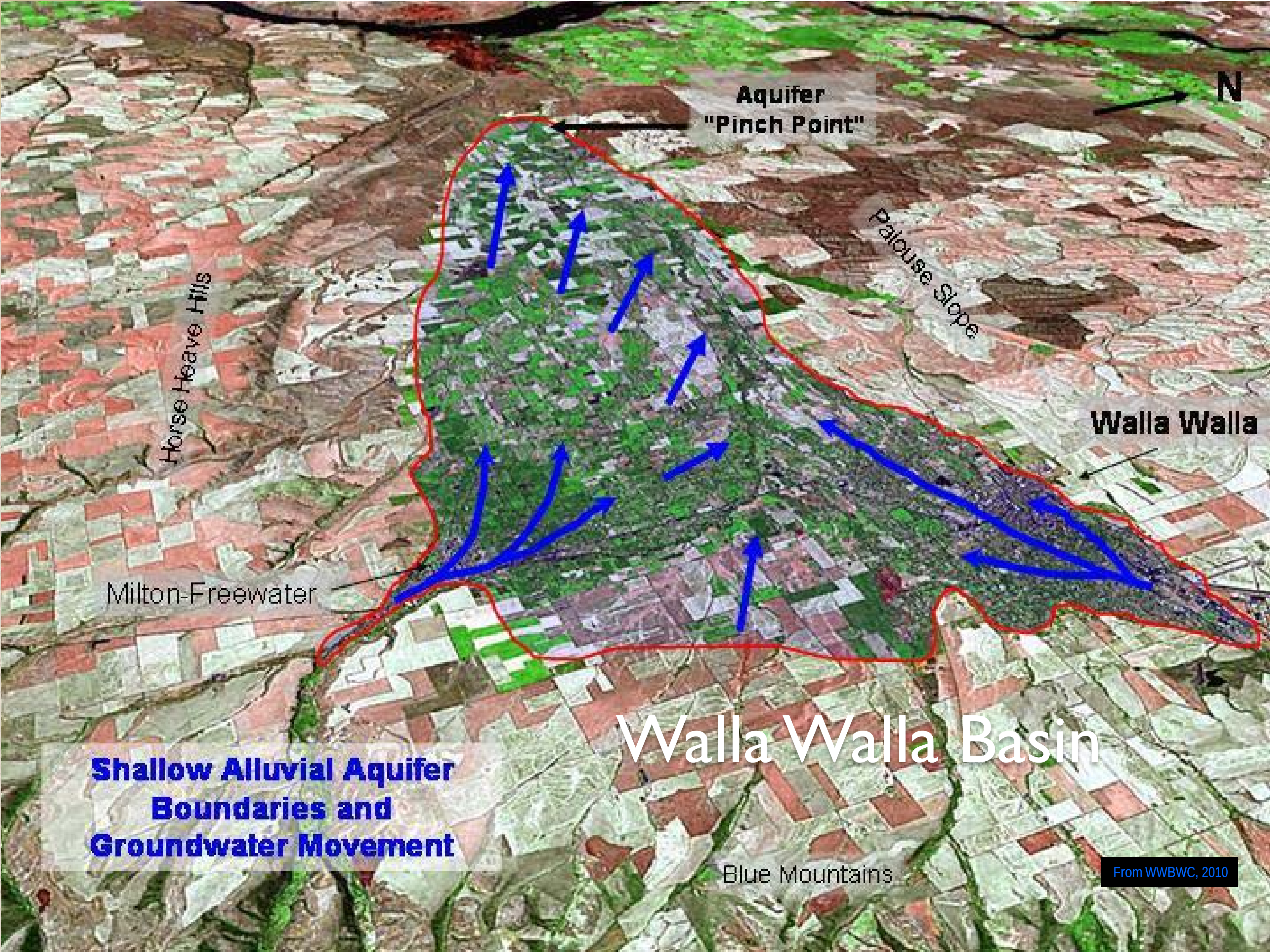


Map Showing Generalized Altitude of the Water Table in Six Structural Basins, Spring 2001, Yakima River Basin Aquifer System, Washington

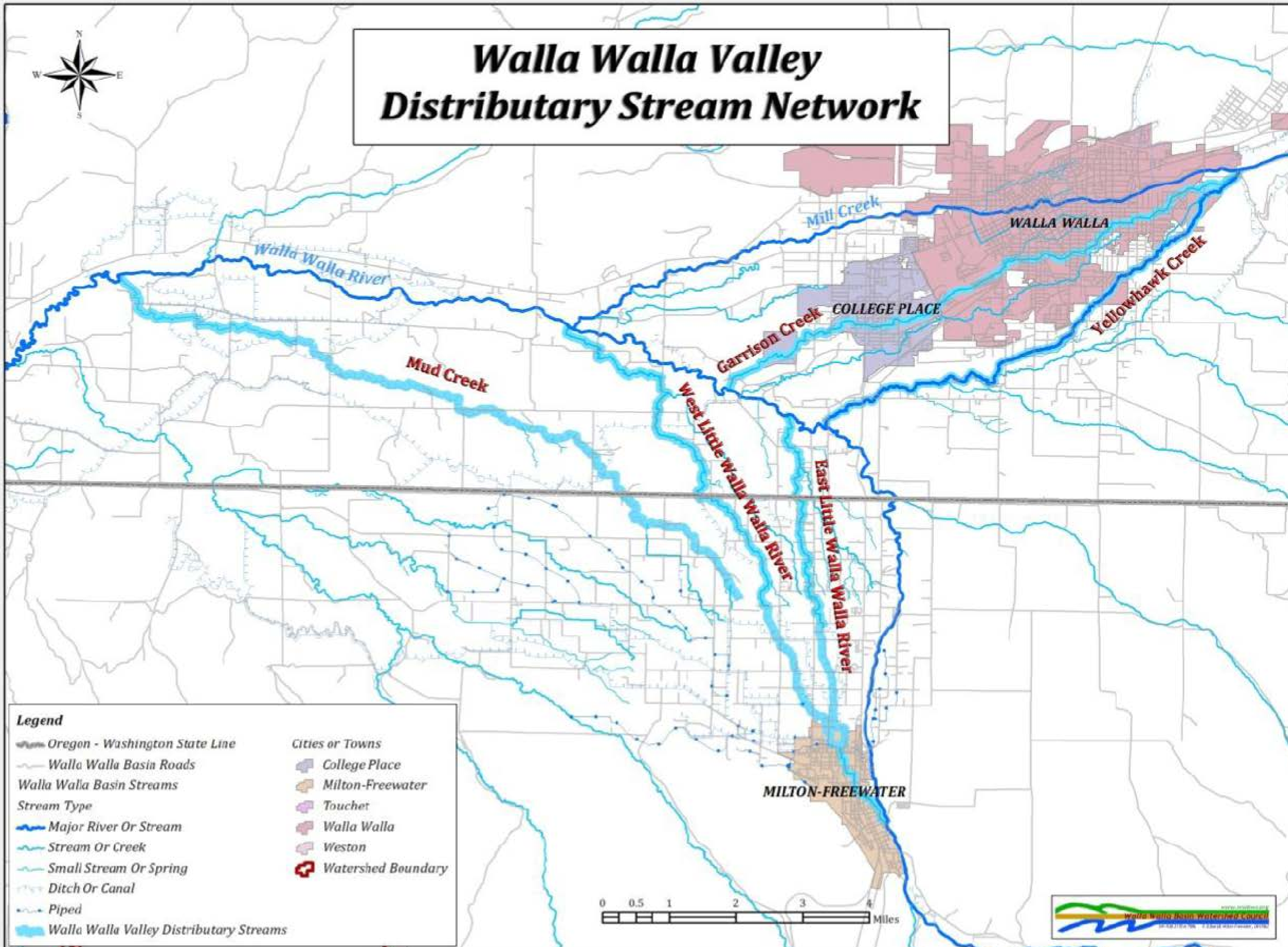
By
J.J. Vaccaro, M.A. Jones, D.M. Ely, M.E. Keys, T.D. Olsen, W.B. Welch, and S.E. Cox
2009

Table 3. Pilot Testing Cost Estimate (Per Study Area)

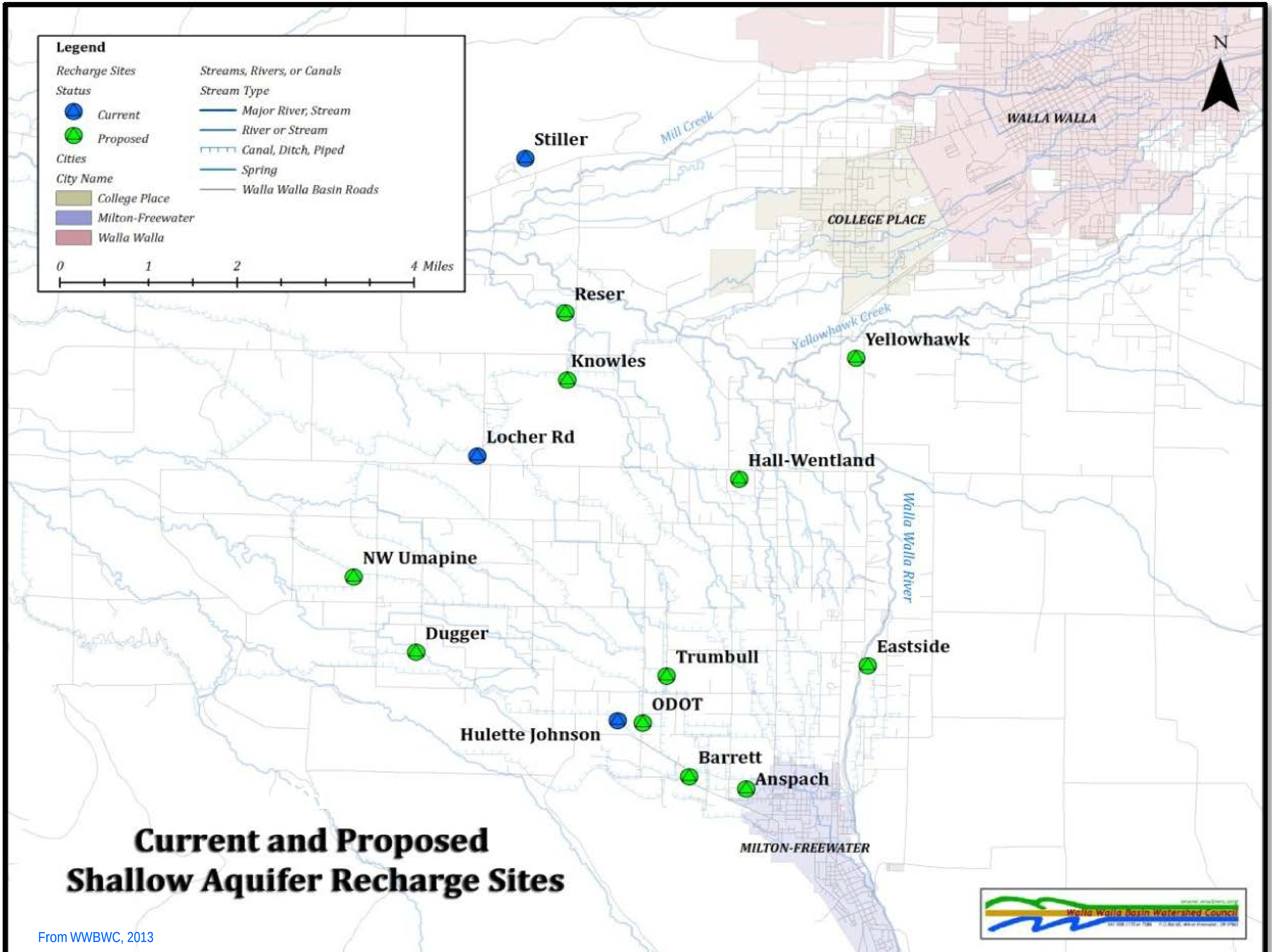
ITEM	QUANTITY	UNIT COST	COST	TOTAL
Hydrogeologic Characterization	1	$50,000	$50,000	
Test Existing Wells	10	$5,000	$50,000	
Install/Test New Wells	10	$10,000	$100,000	
New Wells Drilling (feet)	1000	$50	$50,000	
Monitoring Equipment	20	$1,000	$20,000	
Baseline Water Quality Sampling	20	$2,500	$50,000	
Lab	200	$300	$60,000	
Subtotal – Characterization				**$380,000**
Permitting/Access	2	$50,000	$100,000	
Pond Construction	2	$50,000	$100,000	
Piping and Components	2	$20,000	$40,000	
Design/CQA/Mob	1	35%	$49,000	
Subtotal – Construction				**$289,000**
Testing Phase (2 years)	2	$100,000	$200,000	
Operations	2	$100,000	$200,000	
Lab	400	$300	$120,000	
Subtotal - Testing/Operations				**$520,000**
Data Management	1	$100,000	$100,000	
Modeling	1	$100,000	$100,000	
Reporting	1	$100,000	$100,000	
Subtotal – Reporting				**$300,000**
Contingency	1	25%	$372,250	
Agency Support	1	25%	$465,313	
Sub-total Contingency and Agency				**$837,563**
Sub-total (per Study Area)				**$2,326,563**
Grand Total (Two Study Areas)				**$4,653,125**



Aquifer "Pinch Point"
N
Palouse Slope
Horse Heave Hills
Walla Walla
Milton-Freewater
Walla Walla Basin
Shallow Alluvial Aquifer Boundaries and Groundwater Movement
Blue Mountains
From WWBWC, 2010



From WWBWC, 2013



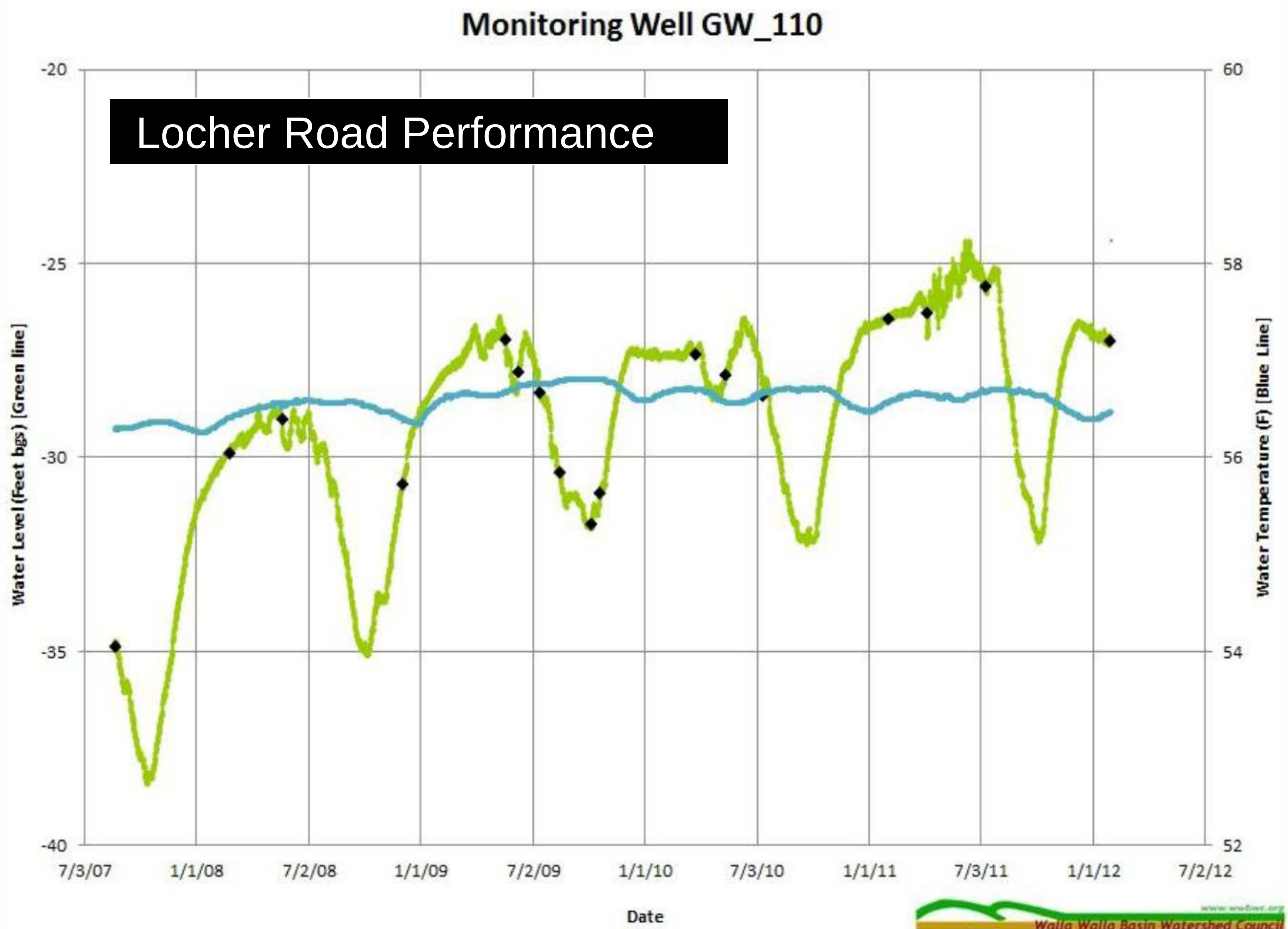
Current and Proposed Shallow Aquifer Recharge Sites

From WWBWC, 2013

Hudson Bay Improvement Company SAR

From WWBWC, 2013

Locher Road SAR



From WWBWC, 2013

Shallow Aquifer Recharge

Purpose

- Improve discharge to streams
- Mitigation for ground or surface water use
- Restoration of streamflow
- Minimize effects of climate change

Costs

- Generally low operating costs, emphasis on monitoring
- Capital costs can be high

Integrated Storage

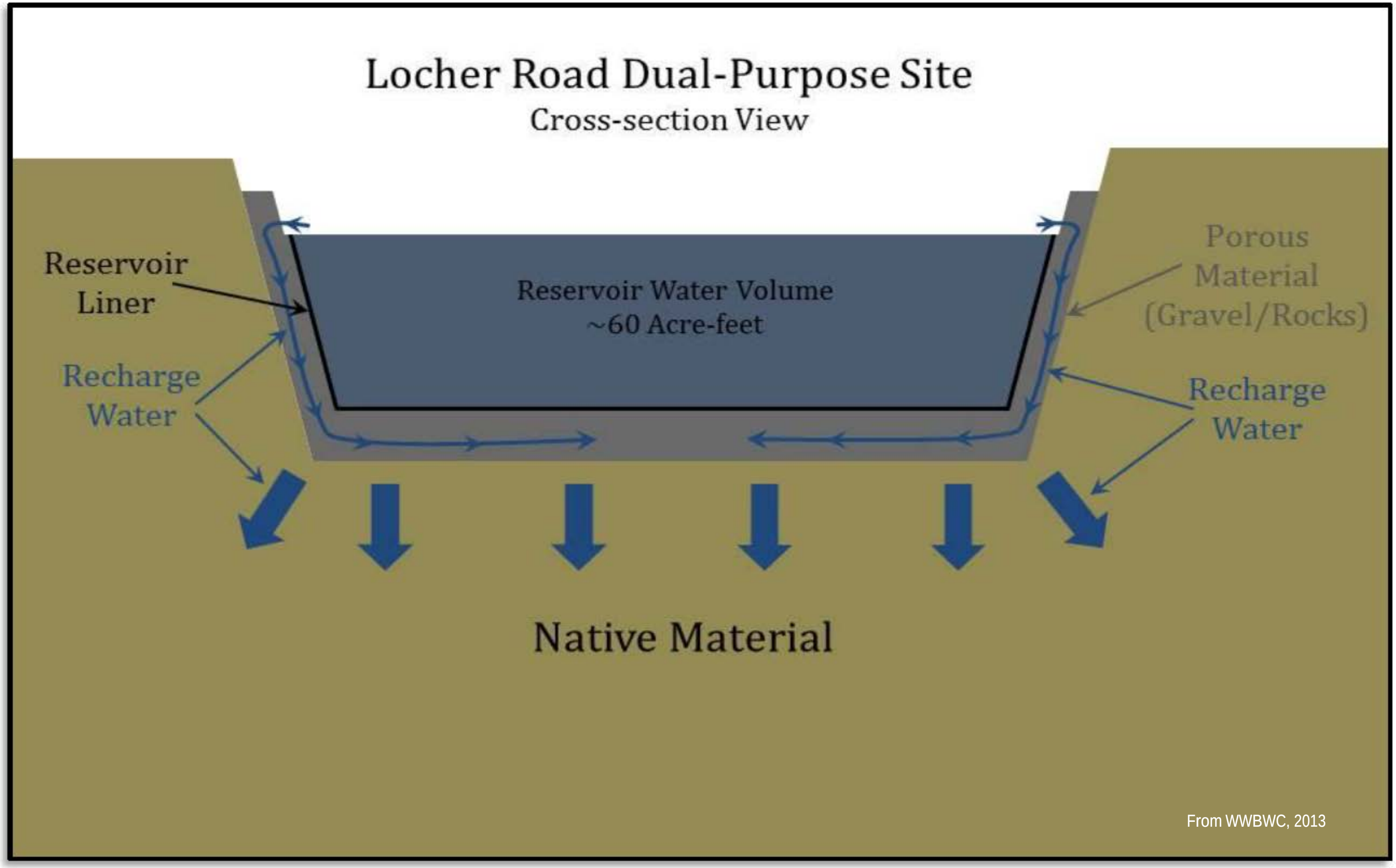


Figure 39 - Illustration of the Locher Road Dual-Purpose Site design. A similar design could be used at other gravel quarries in the valley.

SVRPA Optimized Recharge Assessment

Spokane Valley-Rathdrum Prairie Aquifer Optimized Recharge for Summer Flow Augmentation of the Columbia River

Submitted to:

Washington State Department of Ecology
Office of Columbia River
Yakima, Washington

Submitted by:

Dr. Michael E. Barber[1]
Dr. Md. Akram Hossain[2]
Dr. Cara J. Poor[3]
Mr. Colt Shelton[3]
Ms. Laura Garcia[3]
Mr. Matt McDonald[3]

[1]State of Washington Water Research Center, Pullman, WA 99164-3002
[2]Washington State University – Tricities, Richland, WA 99354-1671
[3]Washington State University, Pullman, WA 99164-2910

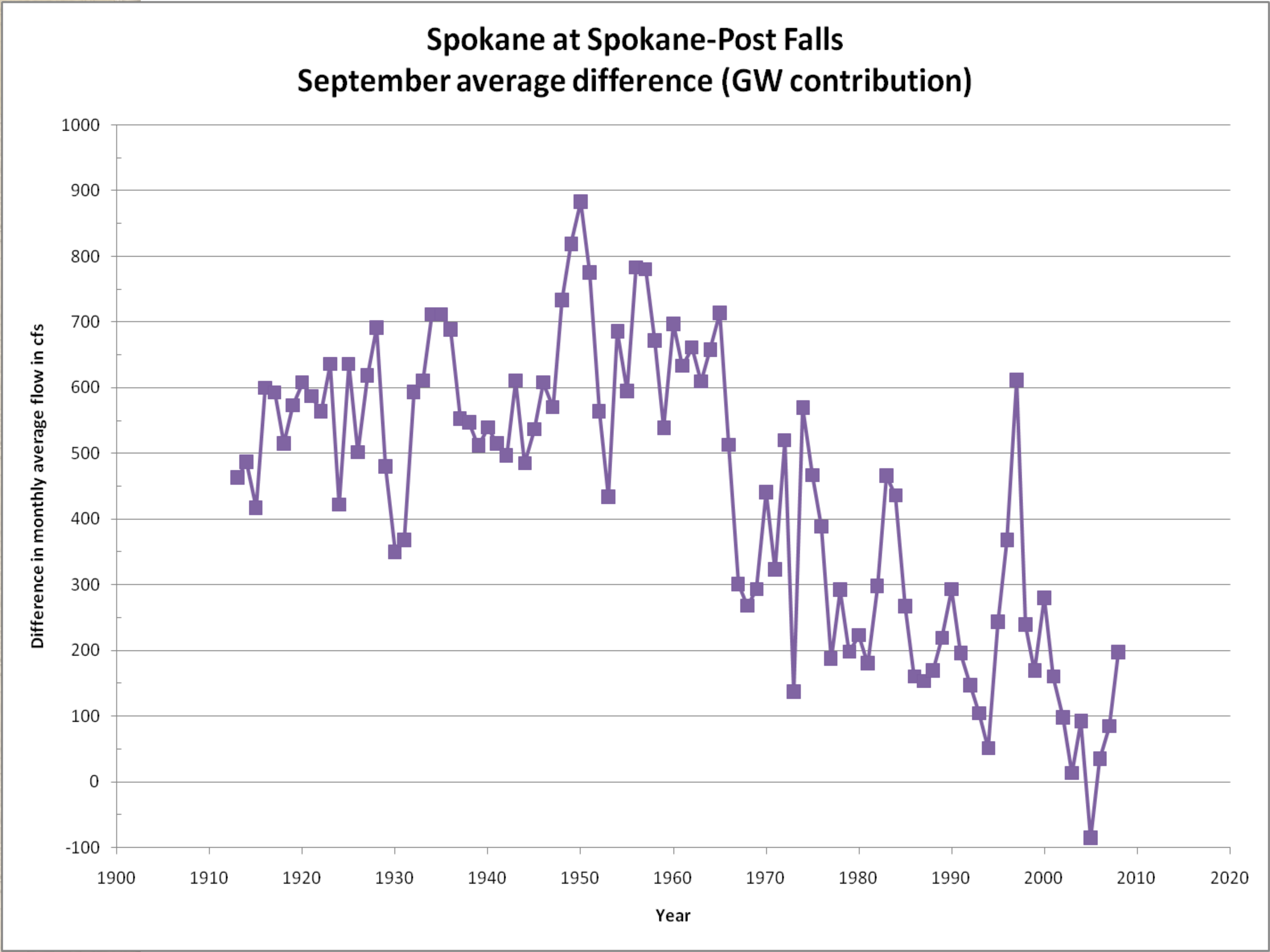
April 1, 2011

SCOPE OF WORK

This project is a comprehensive feasibility analysis of diverting water during high flow periods, injecting it into the SVRP, and letting gravity drain the water back into the Spokane River.

The following components will be included in this 18-month study:

1) **Needs Assessment,**
2) **Water Availability Assessment,**
3) **System Limitations,**
4) **Target Design Objectives,**
5) **Alternatives Evaluation,**
6) **Cost Estimates,**
7) **Benefits Estimate, and**
8) **Recommendations and Summary**


Spokane at Spokane-Post Falls
September average difference (GW contribution)
Difference in monthly average flow in cfs
1000
900
800
700
600
500
400
300
200
100
0
-100
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
Year

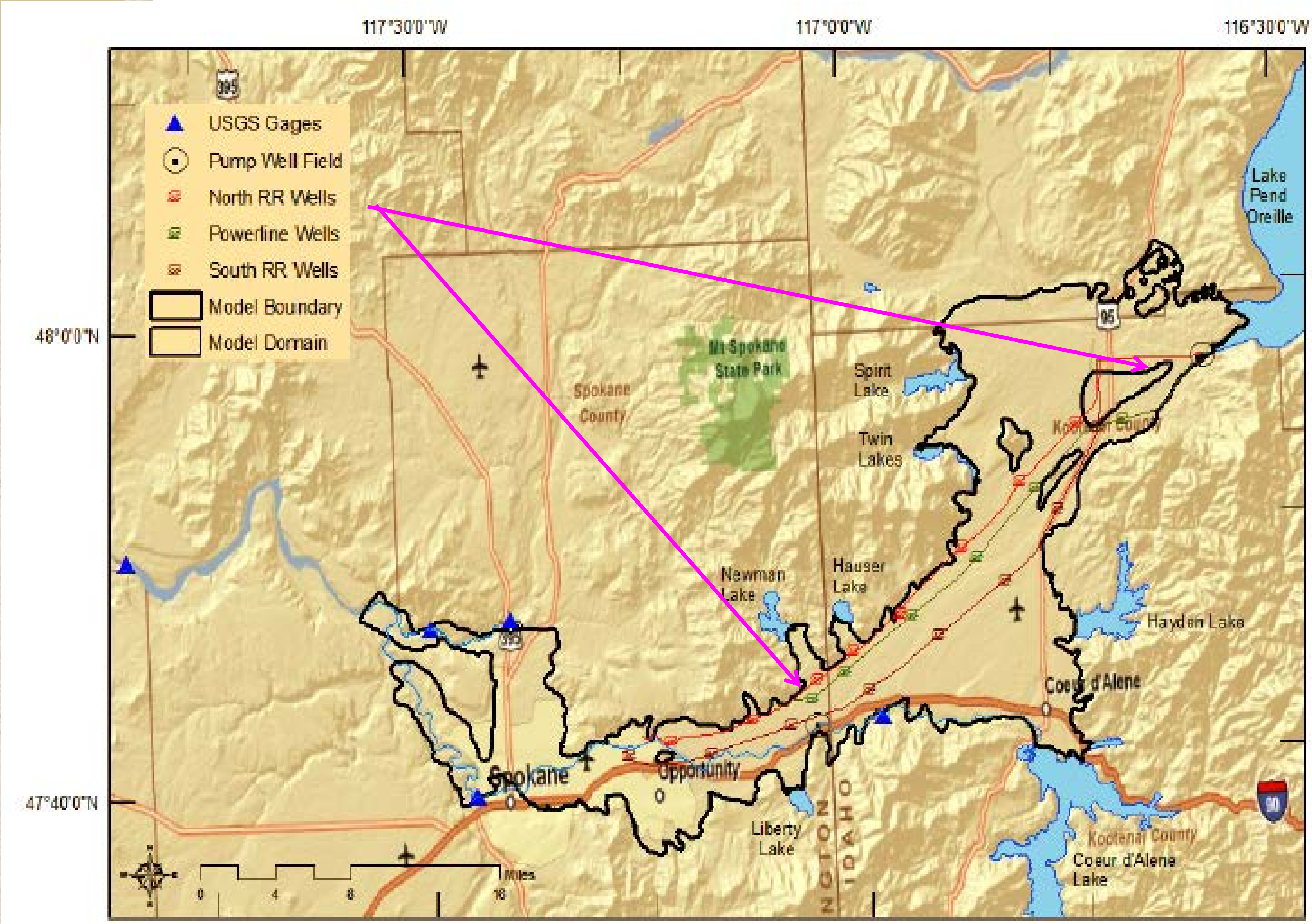


Figure 52. Well location map.

Partial Summary of Recharge Alternatives at NR2

Location	Starting Month	Rate (ft^3/s)	Length of Injection (Months)	Peak Monthly Return (ft^3/s)	Peak Monthly % Return	Average Yearly Return	Max Month	2nd Highest	3rd Highest
NR2	Apr	25	4	6.21	6.26%	58.15%	August	September	October
NR2	May	25	4	6.26	6.31%	58.08%	October	September	November
NR2	Apr	50	4	12.42	6.28%	58.19%	August	September	October
NR2	Apr	75	4	18.62	6.27%	58.15%	August	September	October
NR2	Apr	100	4	24.83	6.27%	58.13%	August	September	October
NR2	Apr	150	4	37.23	6.27%	58.08%	August	September	October
NR2	Apr	200	4	49.61	6.26%	58.01%	August	September	October
NR2	Apr	300	4	75.83	6.38%	59.36%	August	September	October

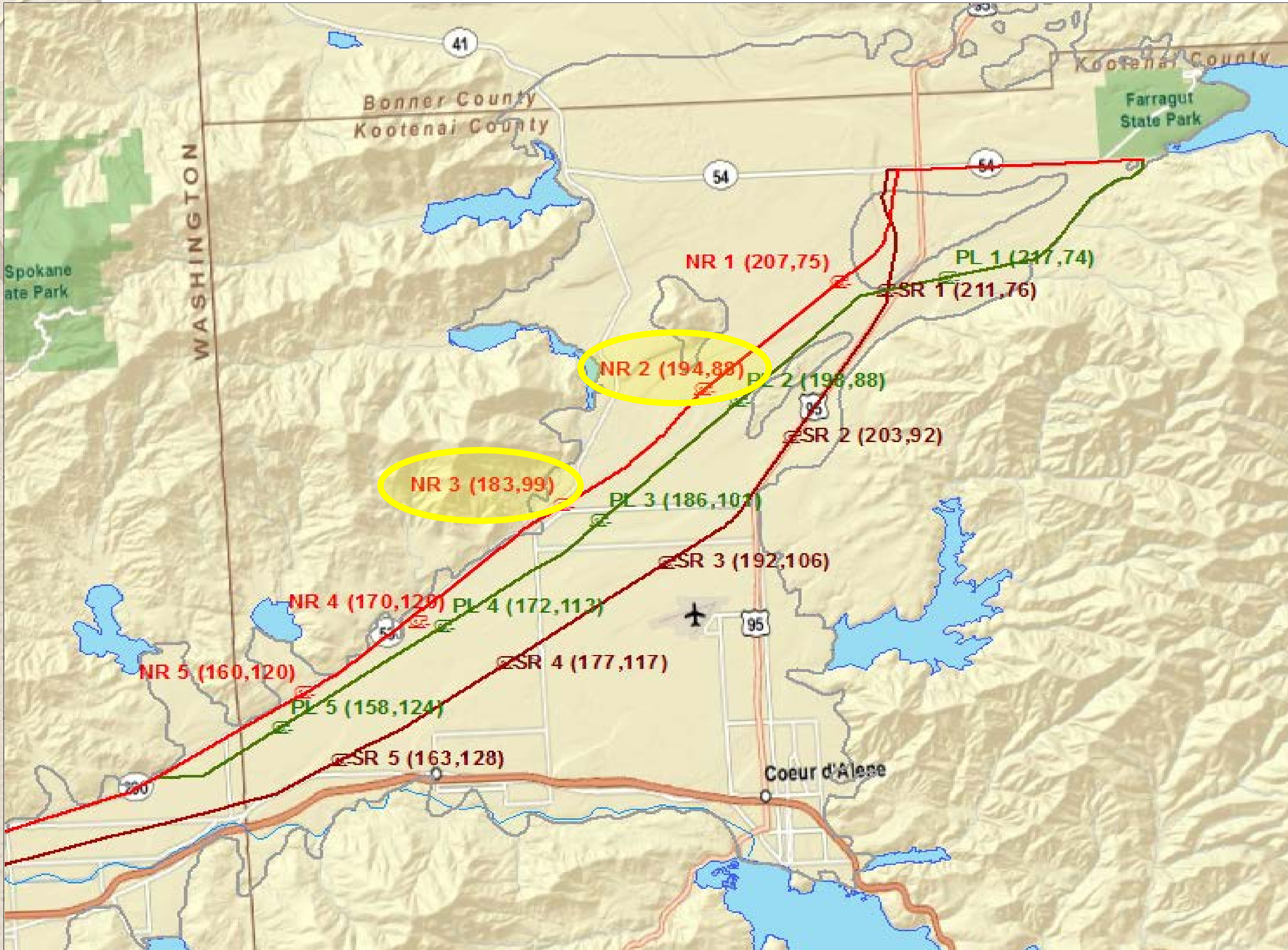
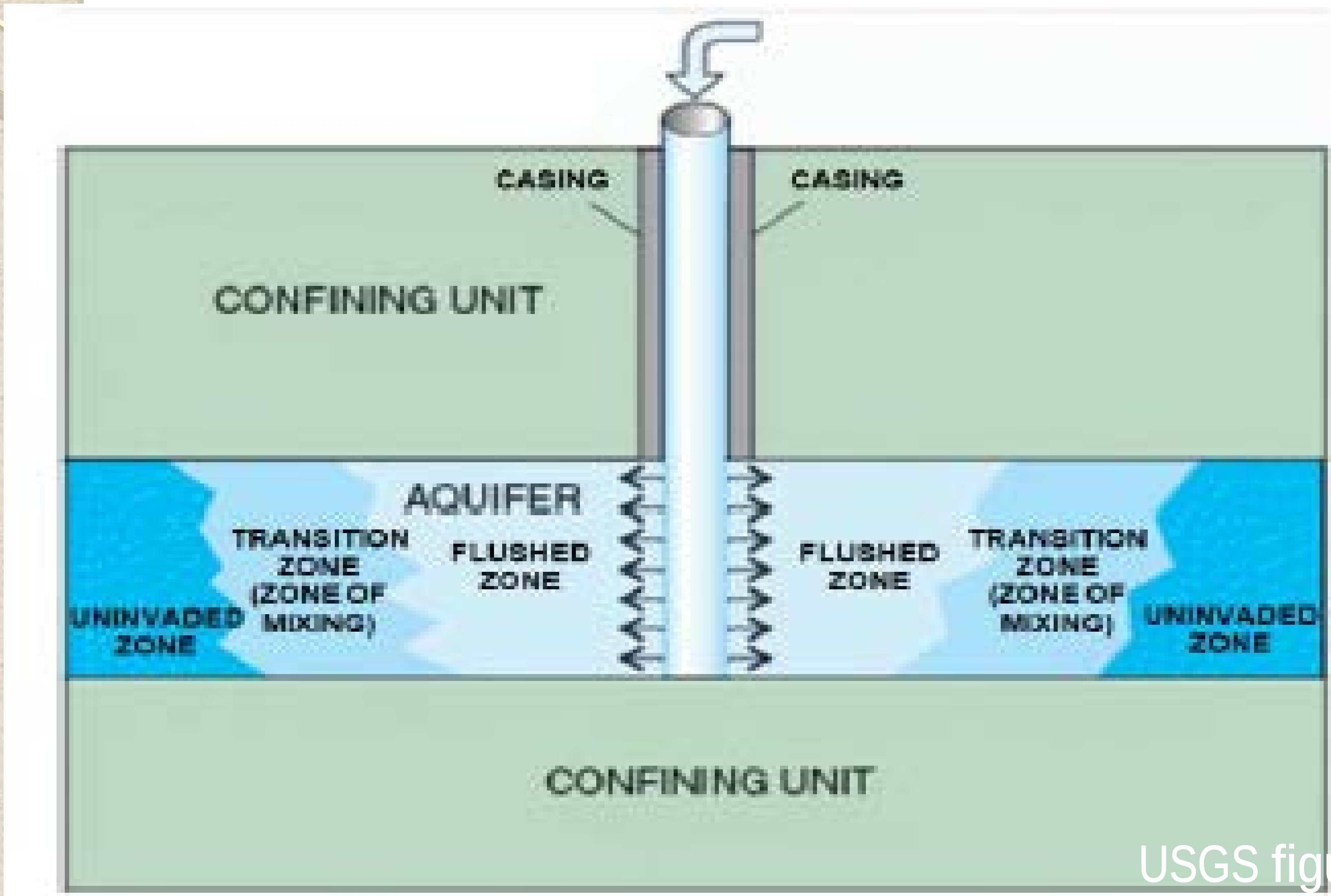


Figure 31. Well name, model coordinates, and right-of-way pipeline routes.

Table 48. Total construction and O&M costs.

Scenario	Construction Costs	Annual Operation Cost per Extraction Period (days)			
		30	61	91	122
LPO-NR2-60-18-200	$74,940,477	$5,588,000	$6,485,000	$7,352,000	$8,248,000
LPO-NR2-72-18-200	$70,427,417	$5,032,000	$5,647,000	$6,243,000	$6,858,000
LPO-NR2-72-18-300	$87,630,000	$6,733,000	$7,985,000	$9,197,000	$10,449,000
LPO-NR3-60-18-100	$73,813,000	$4,937,000	$5,233,000	$5,519,000	$5,815,000
LPO-NR3-60-18-300	$166,676,000	$13,067,000	$15,719,000	$18,285,000	$20,937,000
LPO-NR3-72-18-300	$122,041,000	$9,099,000	$10,557,000	$11,967,000	$13,425,000
LPO-NR4-24-18-25	$30,009,000	$2,119,000	$2,356,000	$2,585,000	$2,821,000
LPO-NR4-30-18-50	$52,004,000	$3,812,000	$4,365,000	$4,900,000	$5,454,000
LPO-NR4-48-18-100	$70,697,000	$4,972,000	$5,507,000	$6,025,000	$6,560,000
LPO-NR4-72-18-200	$115,028,000	$7,964,000	$8,705,000	$9,423,000	$10,164,000
LPO-NR4-72-18-300	$146,619,000	$10,849,000	$12,516,000	$14,128,000	$15,794,0000
LPO-NR5-72-18-300	$162,779,000	$12,001,000	$13,806,000	$15,552,000	$17,357,000
LPO-PL4-60-18-300	$198,393,000	$15,516,000	$18,634,000	$21,651,000	$24,769,000
SR-PL3-72-18-300	$464,299,000	$12,391,000	$13,008,000	$13,606,000	$14,223,000

Aquifer Storage and Recovery



The Main Drivers for ASR . . . .

- Environmental Benefits
  - Small footprint
  - Insignificant adverse impacts upon terrestrial and freshwater ecosystems
  - Reduced adverse impacts upon estuarine ecosystems
- Economic Benefits
  - Low cost relaiive to other water supply and water storage options (10 to 50%)
  - Can be built incrementally
- Proven Performance
  - About 400 operating ASR wells nationwide
  - Very few failures

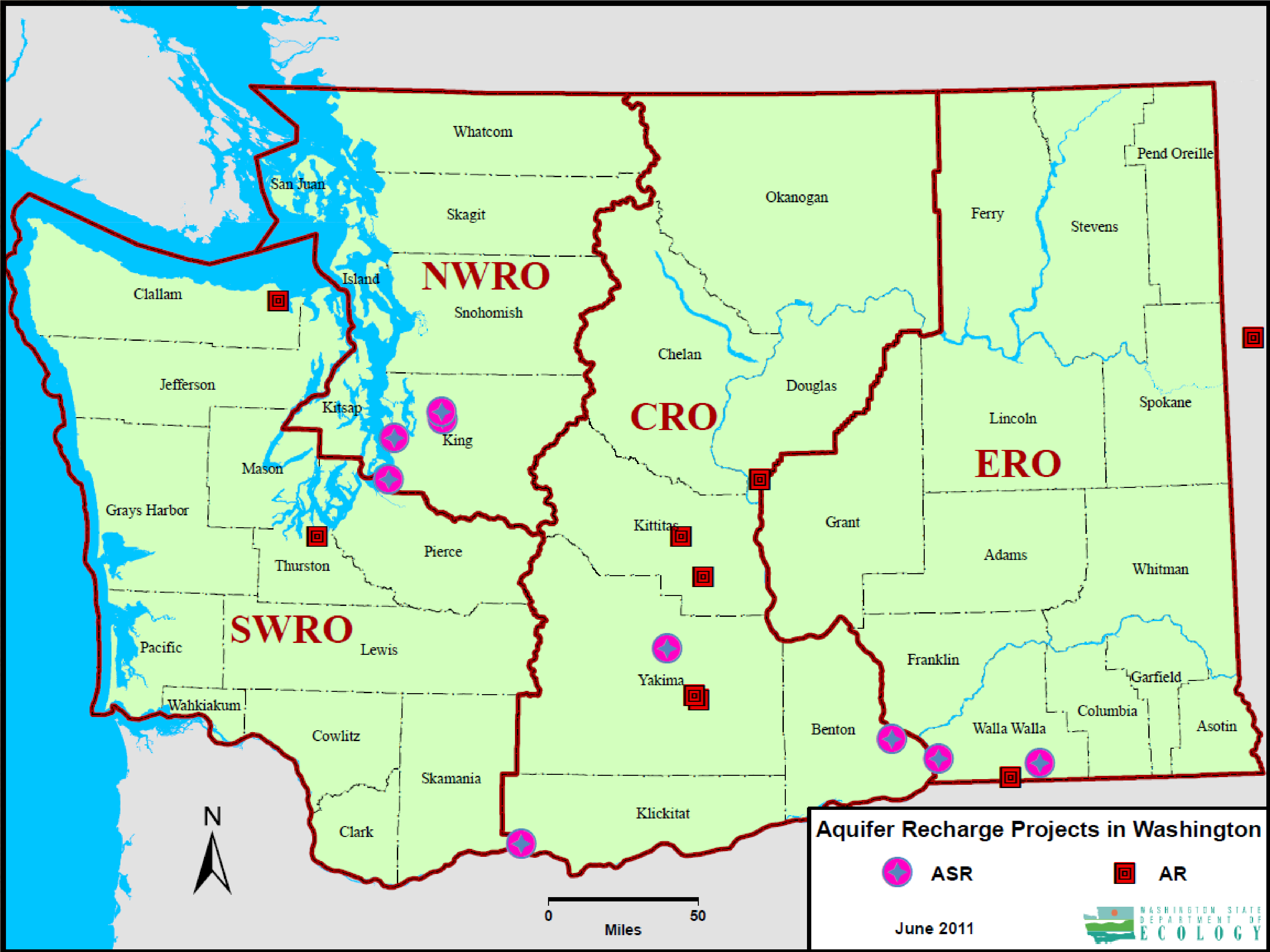
Capital and Operating Costs

Capital Costs

- **Average about $1.00 per gpd of recovery capacity, plus or minus $0.50**
- **Unit cost primarily impacted by well yield**
- **Other factors impacting unit costs**
  - **Shallow vs deep wells**
  - **New wells vs. retrofit of existing wells**
  - **Single vs. multiple wells ("economies of scale")**
  - **Exploratory/monitor wells, analytical costs, coring, etc.**

Operating Costs

- **About $15,000/yr/MGD of recovery capacity, +/- $10,000**
- **Monitoring requirements are driving up costs**



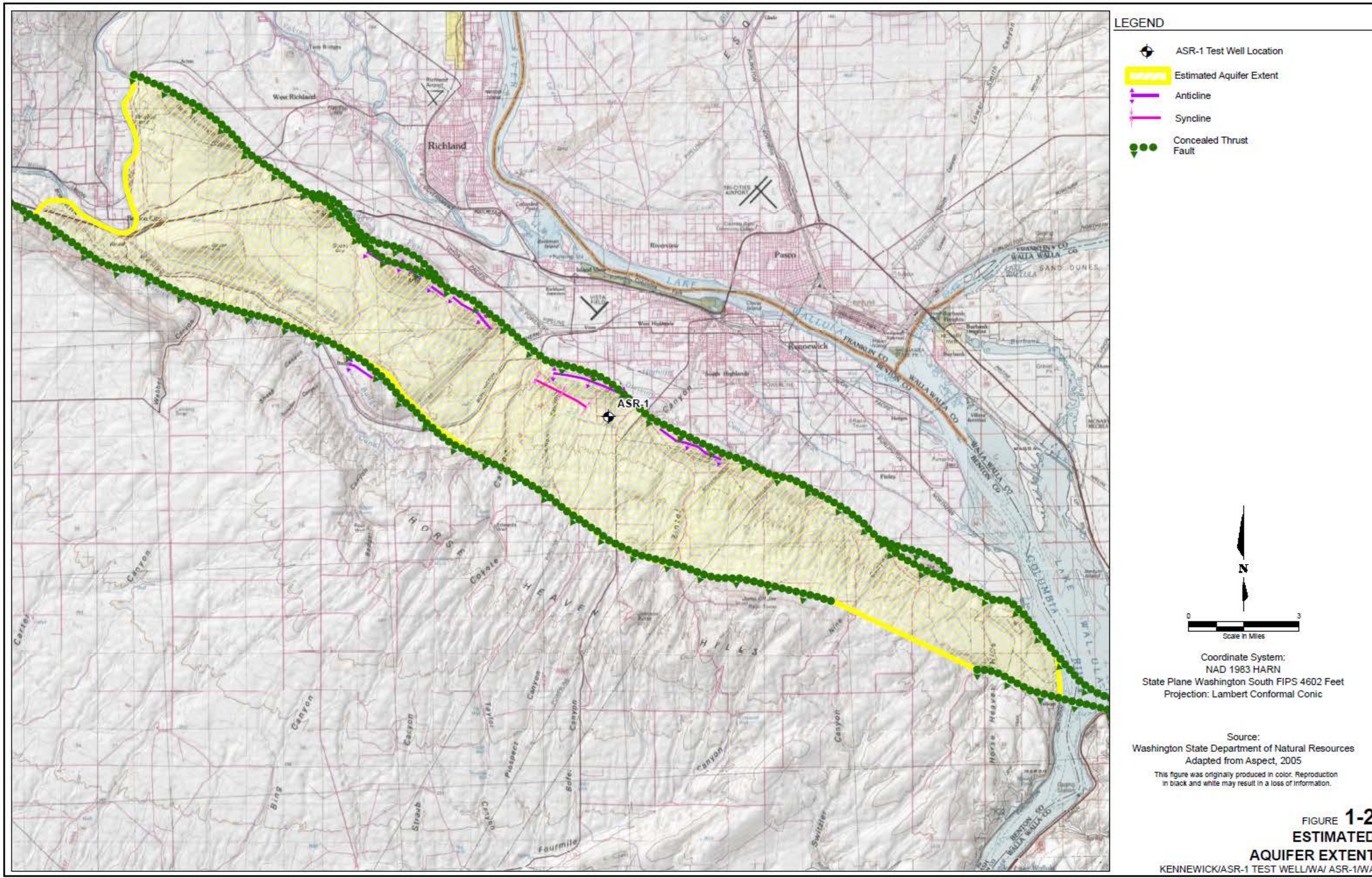
Aquifer Recharge Projects in Washington
ASR
AR
June 2011
WASHINGTON STATE DEPARTMENT OF ECOLOGY
N
0
50
Miles
NWRO
CRO
ERO
SWRO
Whatcom
San Juan
Skagit
Okanogan
Ferry
Stevens
Pend Oreille
Island
Clallam
Snohomish
Chelan
Douglas
Jefferson
Kitsap
King
Lincoln
Spokane
Mason
Grays Harbor
Kittitas
Grant
Thurston
Pierce
Adams
Whitman
Pacific
Lewis
Yakima
Franklin
Garfield
Wahkiakum
Cowlitz
Benton
Walla Walla
Columbia
Asotin
Skamania
Klickitat
Clark

Kennewick ASR

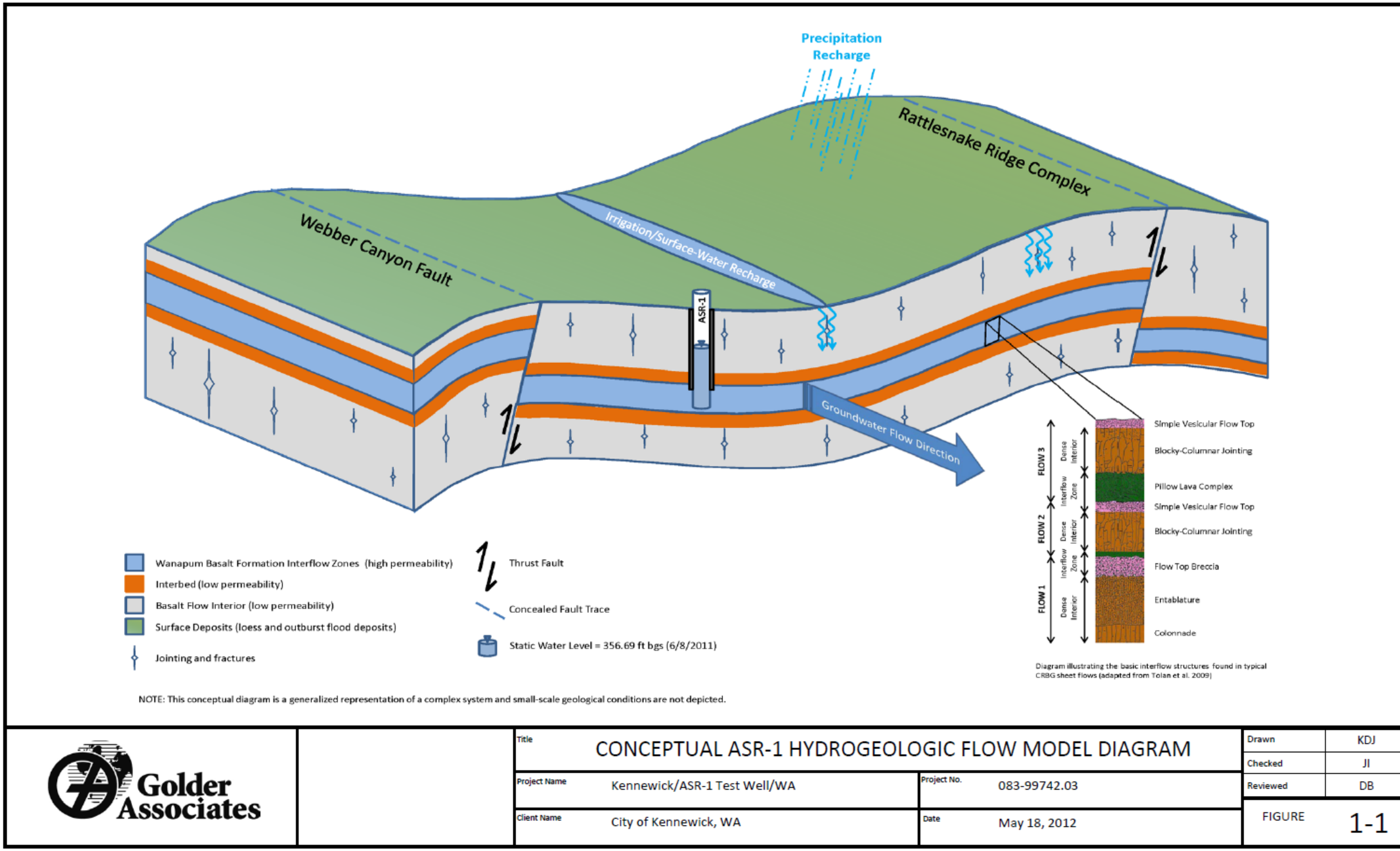
The project will be considered successful according to the following measures:

- **The project meets permitting requirements**
- **Water is captured during high-flow for later beneficial use during low-flow periods**
- **Measurable benefits to streamflow occur during low-flow periods**
- **Water quality issues are successfully addressed**
- **The ASR project remains economically feasible relative to other supply alternatives**

Kennewick ASR



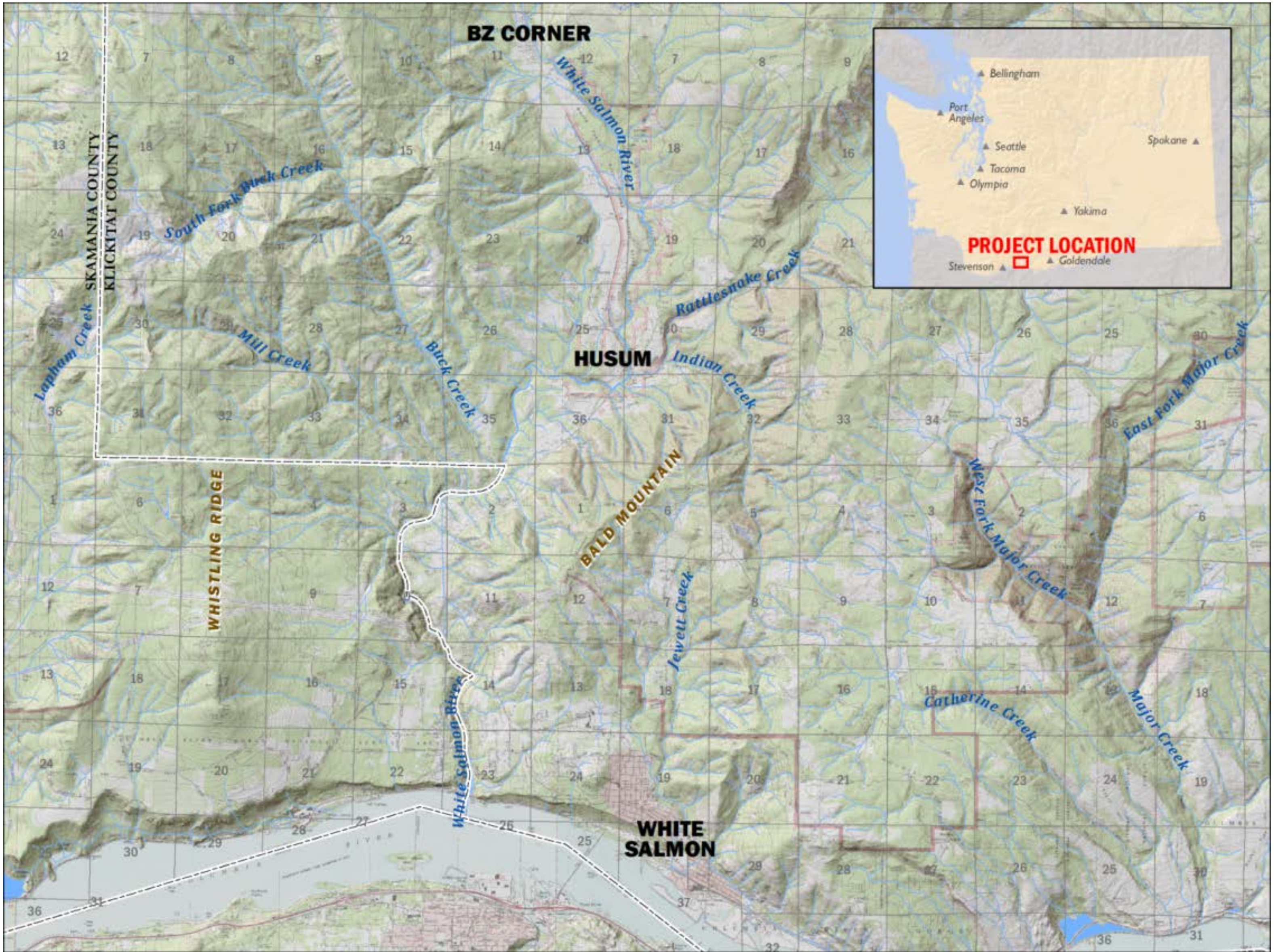
Kennewick ASR



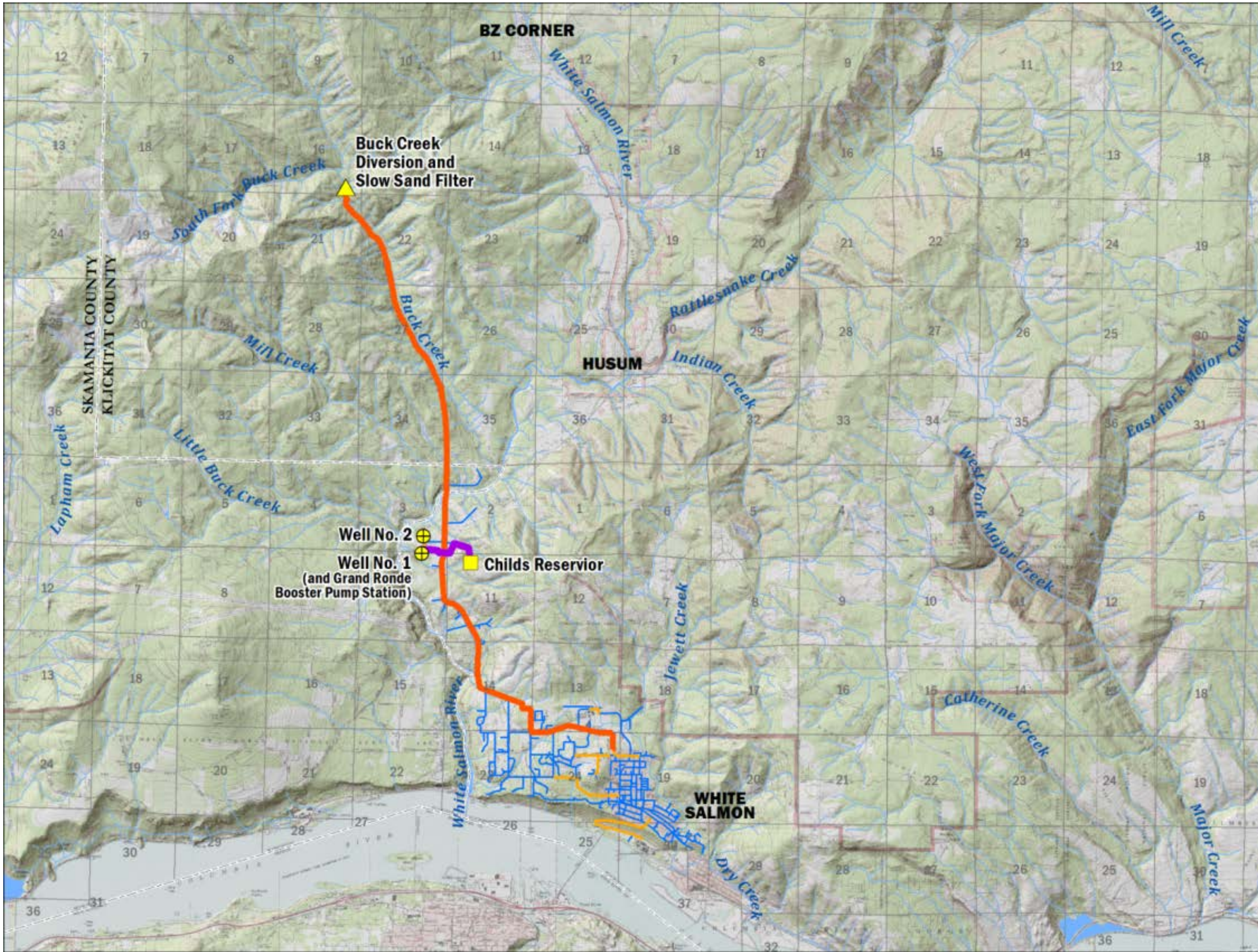

BOART LONGYEAR

City of White Salmon

White Salmon ASR – Project Location Map

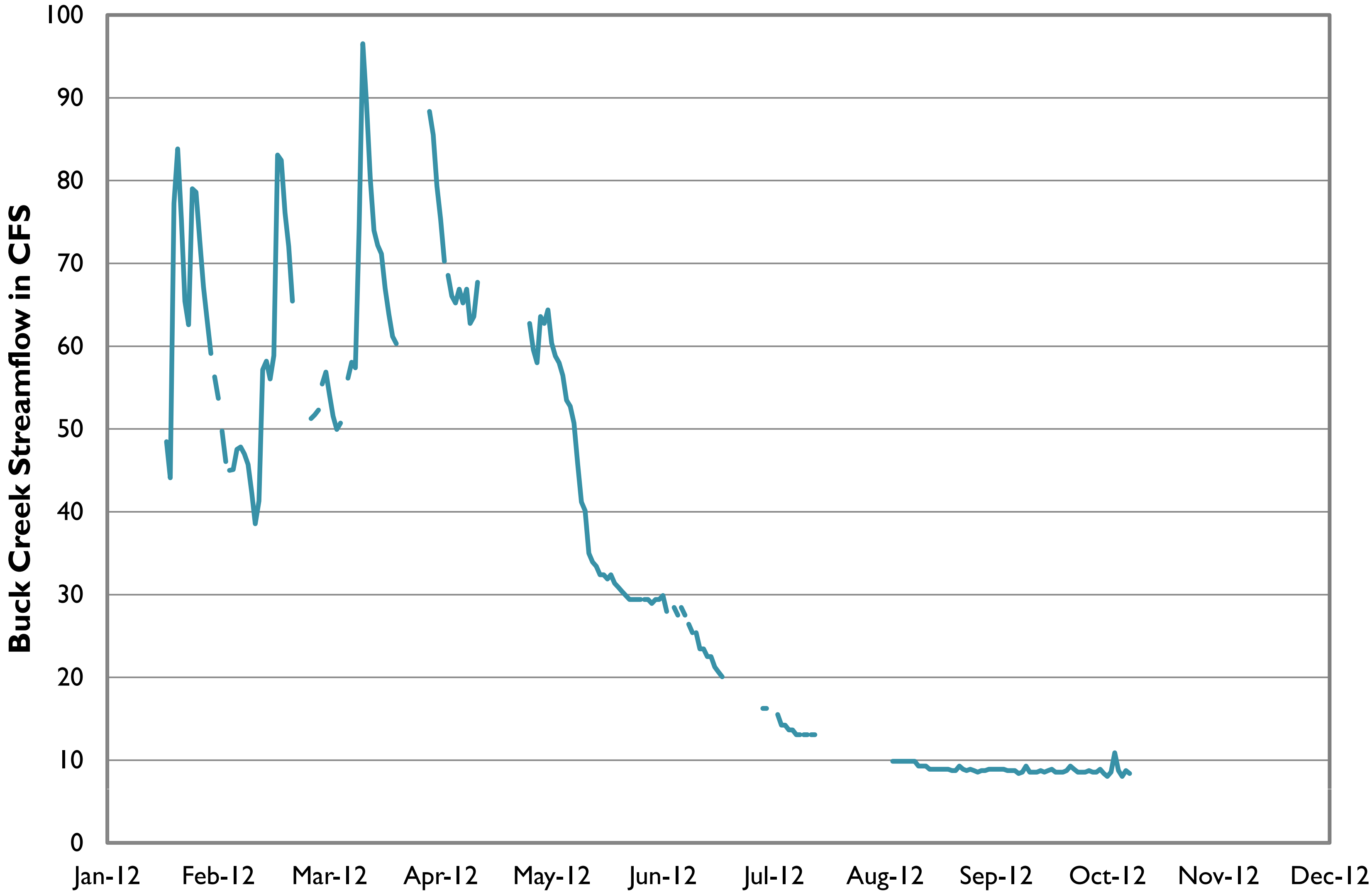


White Salmon Water System Infrastructure



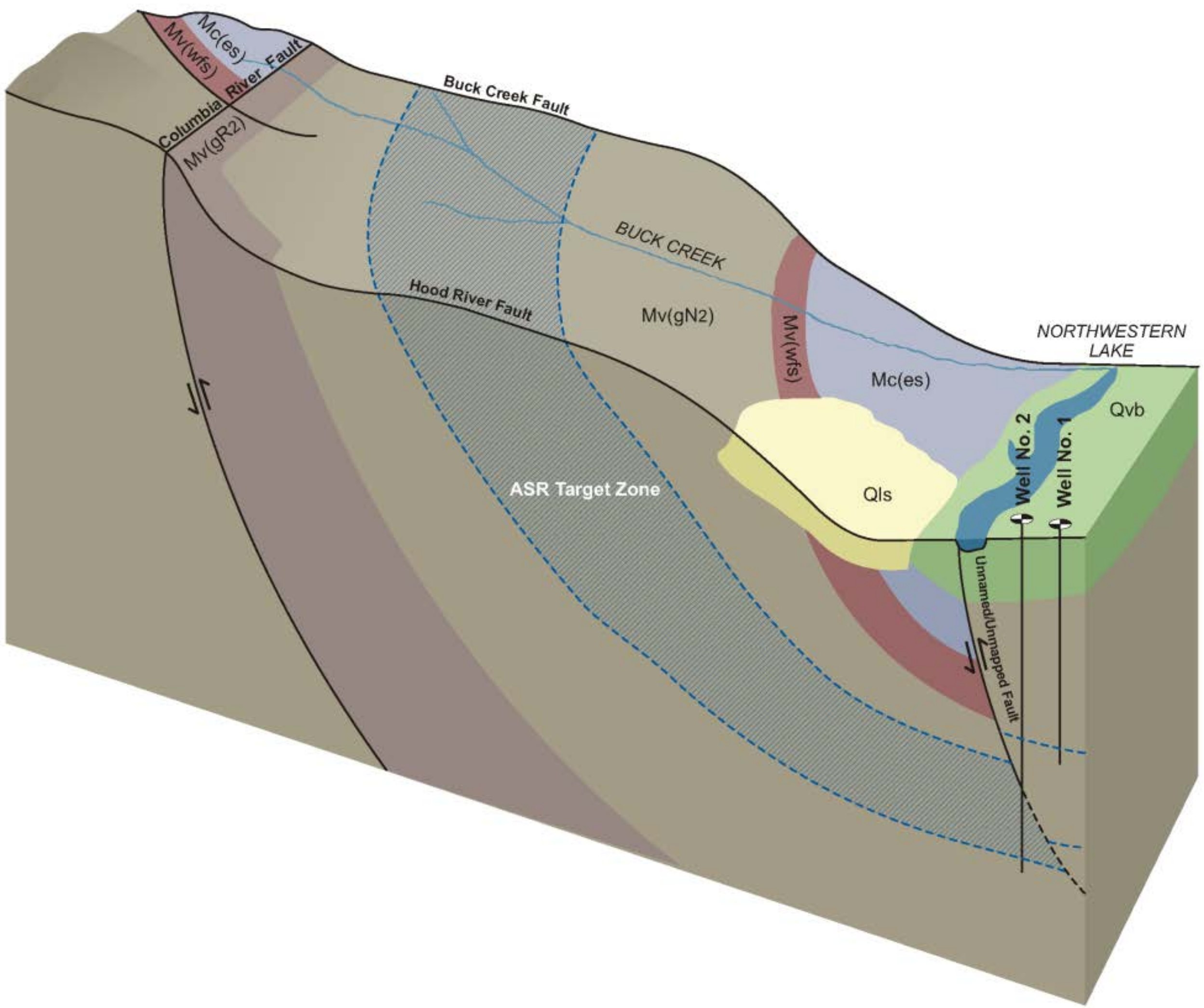
White Salmon - Buck Creek Diversion

White Salmon – Buck Creek Gaging Data



White Salmon

White Salmon ASR – Conceptual Model



Walla Walla ASR

- Permit Application for storage of 11750 AF/yr
- 2 Existing, 8 proposed wells
- Permit application 2010
- Draft permit in preparation
- WQ issues
- Recovery efficiency at issue

Walla Walla ASR

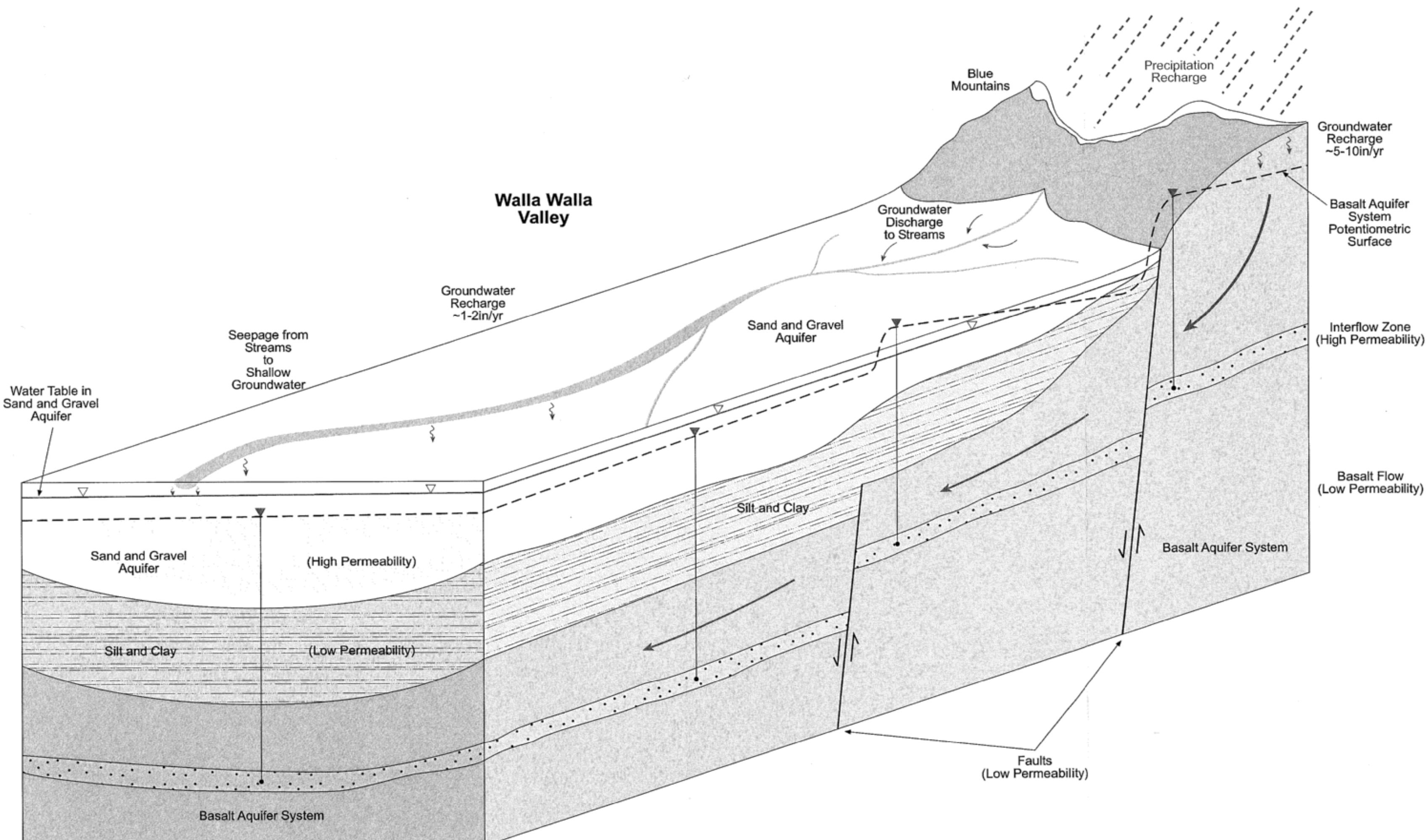
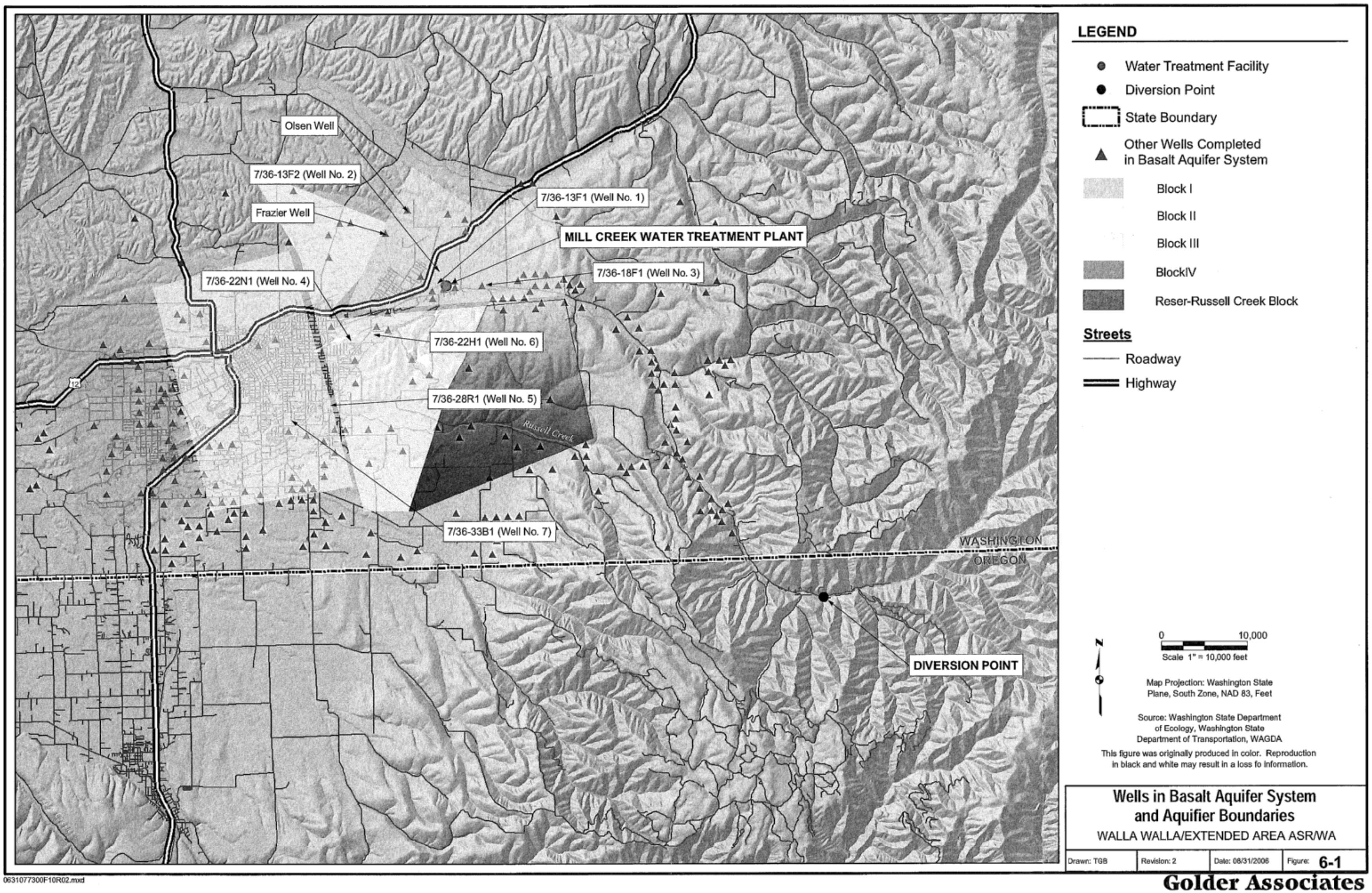


FIGURE 5-1
CONCEPTUAL HYDROGEOLOGIC MODEL
WALLA WALLA/ASR PERMIT APPLICATION/WA

0631077300fg01.fh11 | Mod: 07/18/06 | AMP

Golder Associates

Walla Walla ASR



Boise Wallula

Boise Wallula Pilot Test

Proposed Test

- Injection
  - 5-800 gpm, 5.5 months
- Recovery
  - 1000 gpm until recovered
- Recovered Water
  - To Boise process, then river

Test Actuals

- Injection
  - 492 gpm , 69 days
- Recovery
  - 872 gpm, split period
- Recovered Water
  - Not acceptable to Boise process

Boise Wallula ASR Well Locations

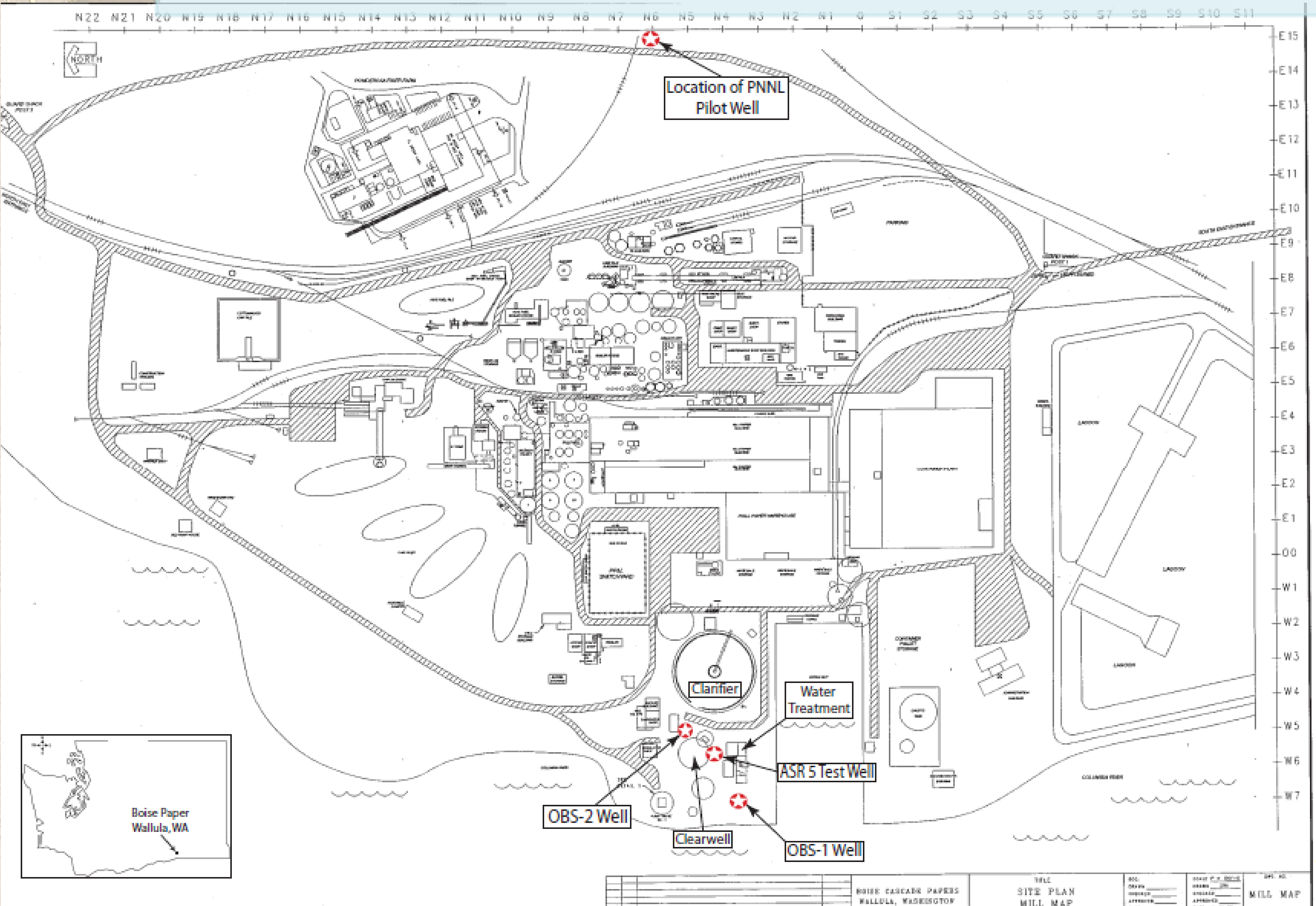
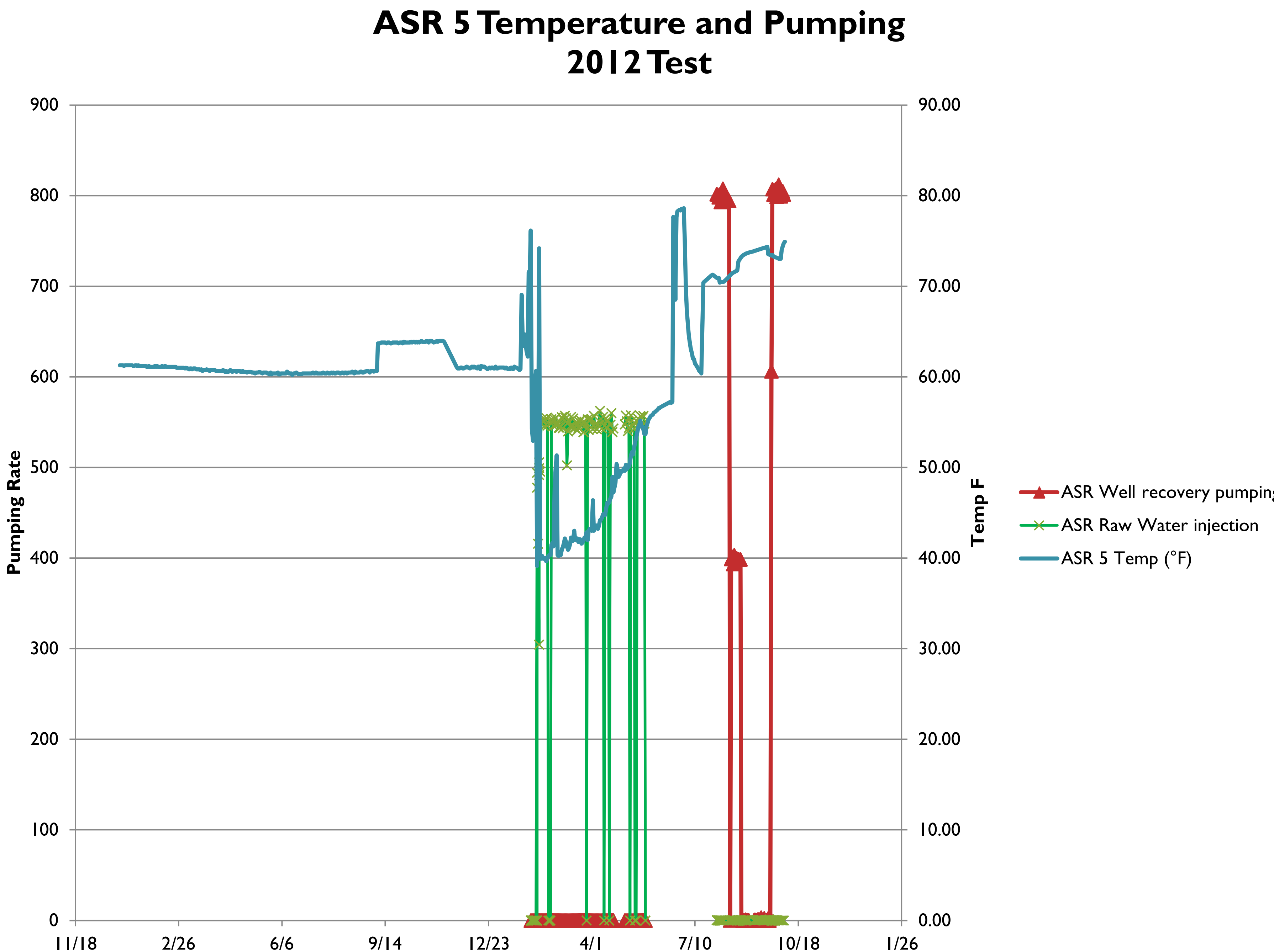
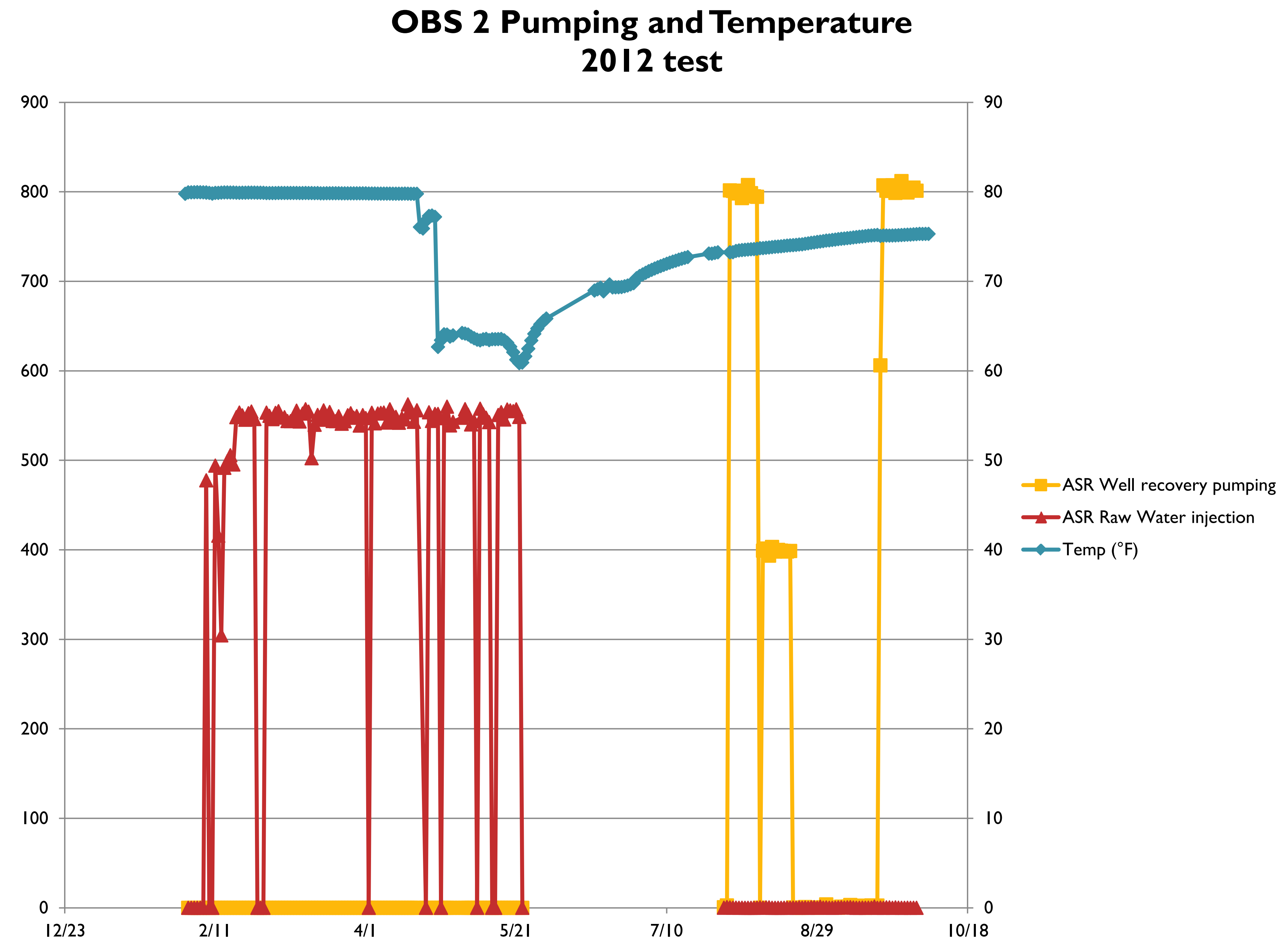


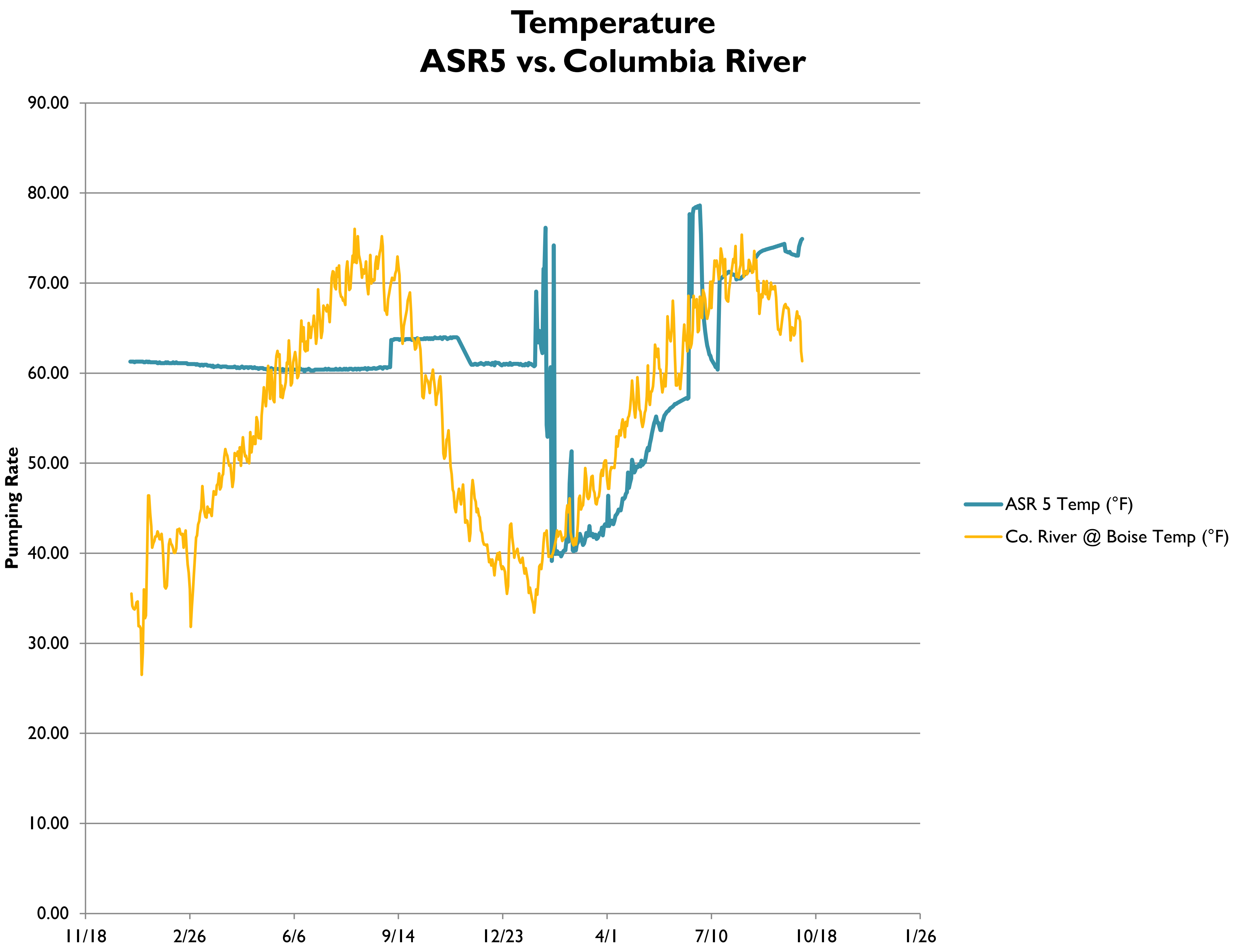
Figure 1-1. ASR observation wells, ASR 5 Test Well and PNNL Pilot Well location map


Well Shed Piping Schematic
(simplified)
A.R.I.
A.R.I.
940-090-016



ASR 5 Temperature and Pumping
2012 Test
900
800
700
600
500
400
300
200
100
0
Pumping Rate
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Temp F
11/18
2/26
6/6
9/14
12/23
4/1
7/10
10/18
1/26
ASR Well recovery pumping
ASR Raw Water injection
ASR 5 Temp (°F)


OBS 2 Pumping and Temperature
2012 test
900
800
700
600
500
400
300
200
100
0
90
80
70
60
50
40
30
20
10
0
12/23
2/11
4/1
5/21
7/10
8/29
10/18
ASR Well recovery pumping
ASR Raw Water injection
Temp (°F)


Temperature
ASR5 vs. Columbia River
Pumping Rate
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
11/18
2/26
6/6
9/14
12/23
4/1
7/10
10/18
1/26
ASR 5 Temp (°F)
Co. River @ Boise Temp (°F)

Cycle 2 Injection, Storage and Recovery

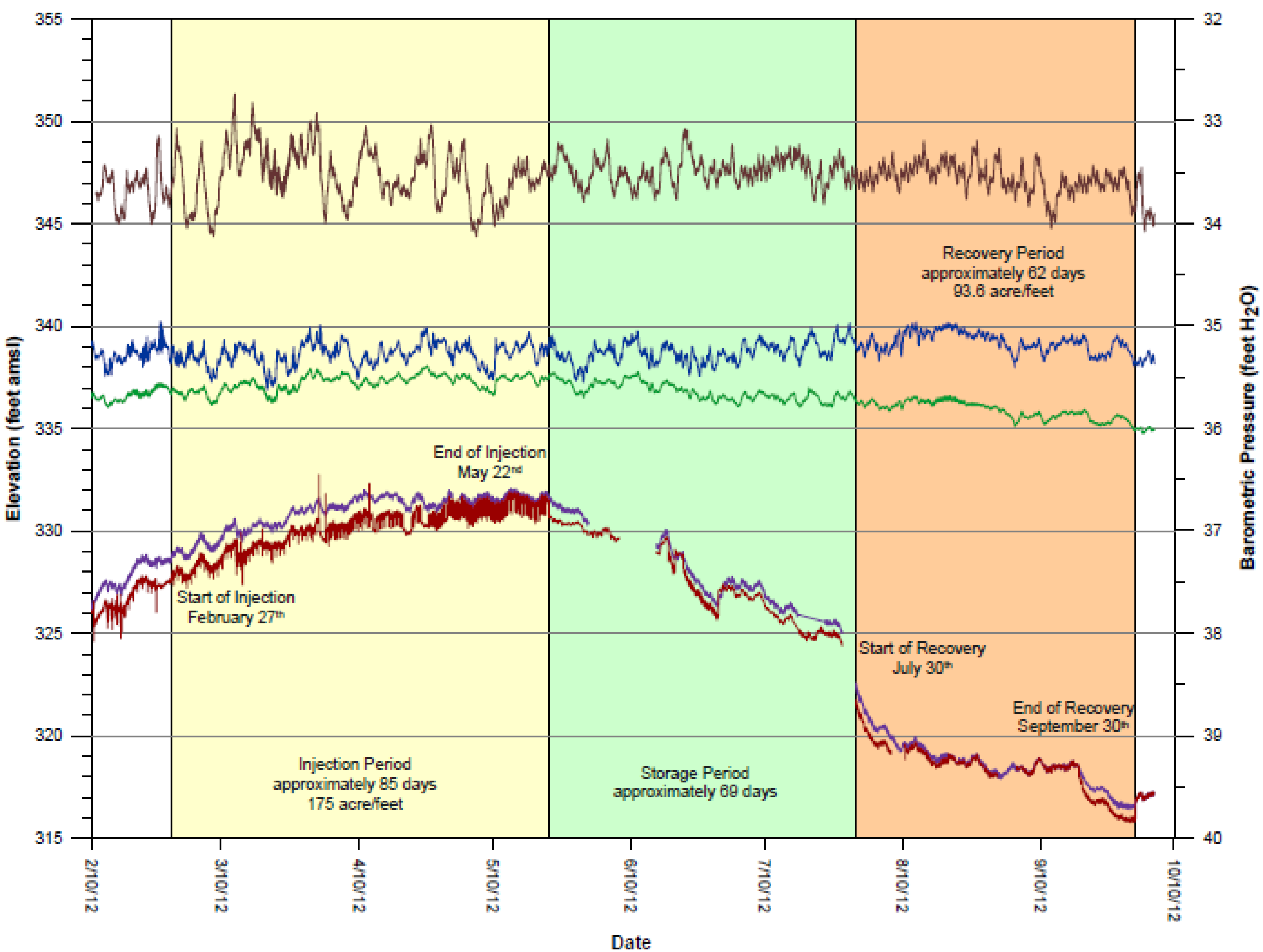


Figure 3
Cycle 2 Injection, Storage and Recovery Hydrograph

Cycle 2 Testing Results, Water Year 2012
Boise White Paper, Wallula

LEGEND

- ASR 5 Transducer
- OBS 1 Transducer
- OBS 2 Transducer
- Columbia River Transducer
- Barometric Pressure Transducer

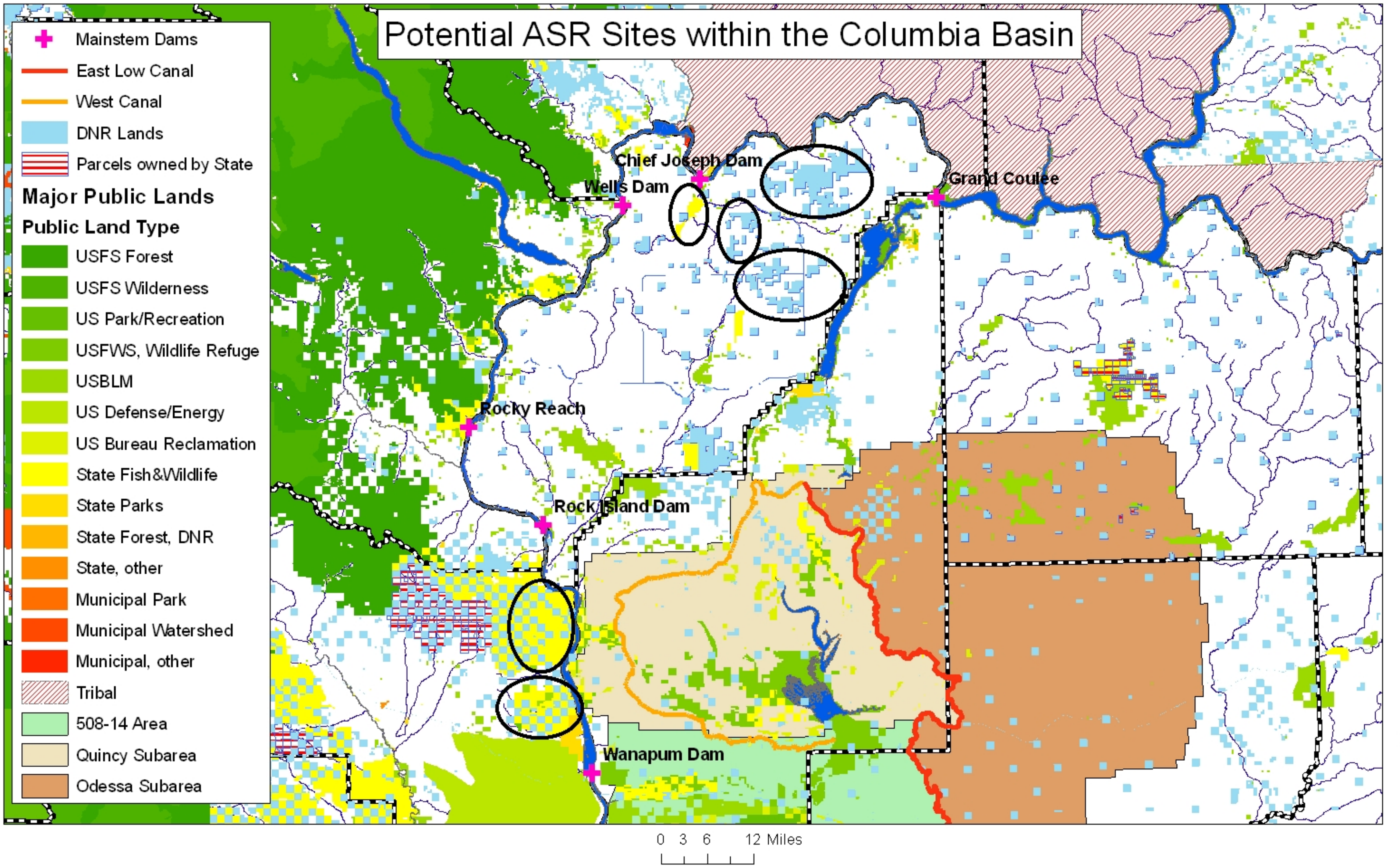
Note:
Injection started February 27th to May 22nd at an average injection rate of 492 gpm. The specific capacity (Q/s) observed at the end of injection was approximately 200 gpm/ft of drawup.

Recovery was from July 30th to September 30th. The target recovery rate from July 30th to August 10th was 800 gpm. On August 10th, the target rate was reduced to 400 gpm. From August 20th to September 17th, recovery was temporarily idle. From September 17th to September 30th, the target recovery rate was 800 gpm. The specific capacity (Q/s) observed at the end of recovery was approximately 325 gpm/ft of drawdown.

gpm = gallons per minute

GSI Water Solutions, Inc.
Date Modified: December 2012

Columbia River Off-Channel Aquifer Storage and Recovery Project



Target Site Phase

Project Criteria

General design objectives:

- **Minimize capital costs involved in investigation**
- **Investigate target sites with high facility potential**
- **Assess target sites at a scale capable of prioritizing feasibility testing**

A Successful Target Site Will Be

- **Ownership**
  - Publically owned
  - At least 1 sq. mile in size
- **Geographic**
  - Within a reasonable pumping lift (1500’ vertical) and distance (4 miles) of Columbia River/water source
  - As far upstream as practicable on the Columbia River in Washington
  - Isolated from municipalities
- **Geologic/Hydrogeologic**
  - Hosted by basalt flows of the Columbia River Basalt Group
  - Potential for flow to Columbia River in the immediate vicinity of the facility
  - At a depth at or above approximately 500’ bgs
- **Infrastructure**
  - Existing roads capable of supporting drill rig
  - Road access granted
  - Generator power for pumping tests
  - Project timing flexible enough to minimize road building or upgrading for inclement weather

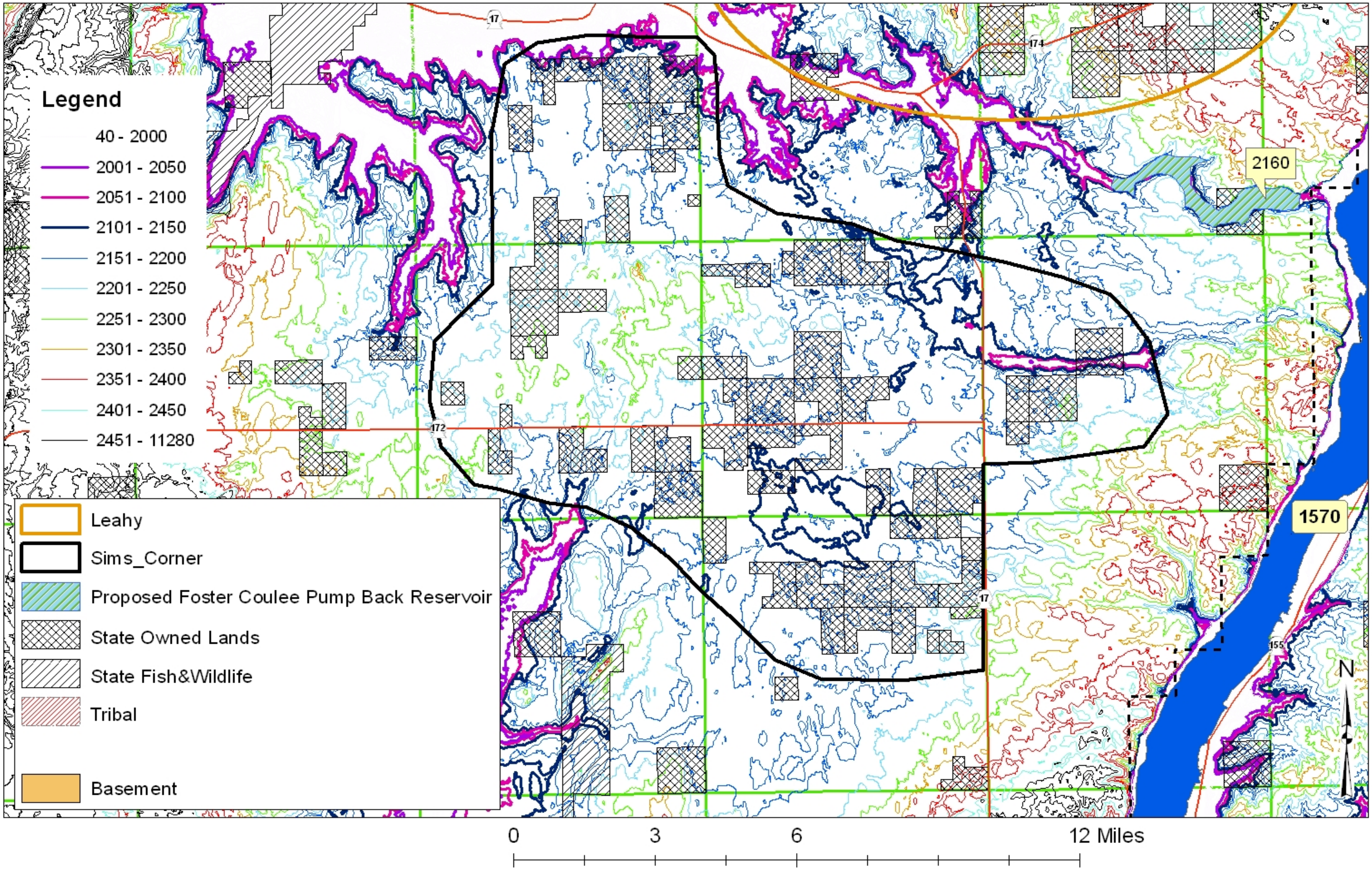
Initial Project Evaluation Criteria

Objective

Select feasibility scale assessment of candidate sites by priority. Candidate sites will:

- **Have a high potential of becoming a facility**
- **Require minimum capital costs**
- **Require minimum cost to local private landholders**
- **Not impair existing water rights**
- **Have minimal EIS concerns**

Rilette Project Area



Paterson ASR Area

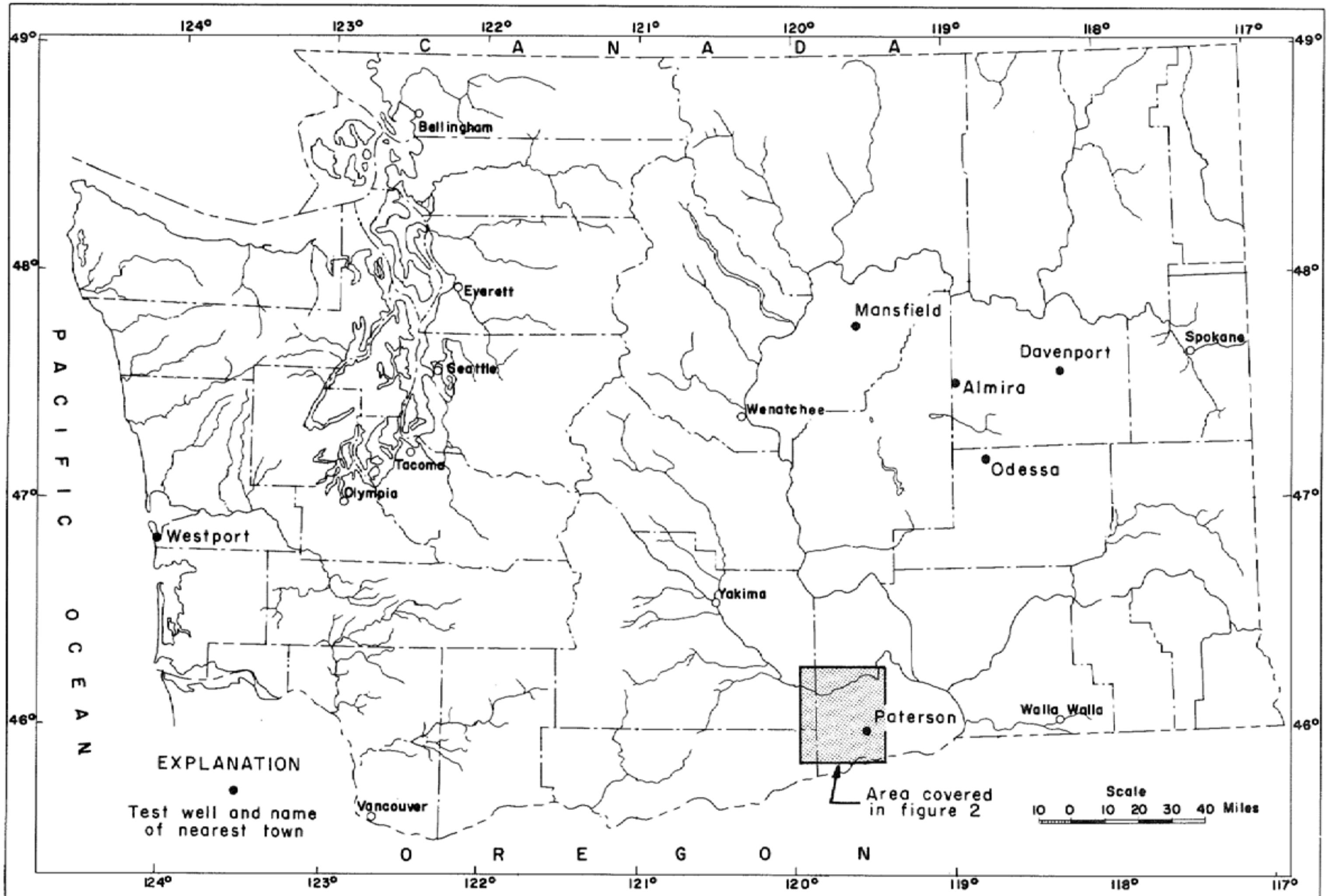
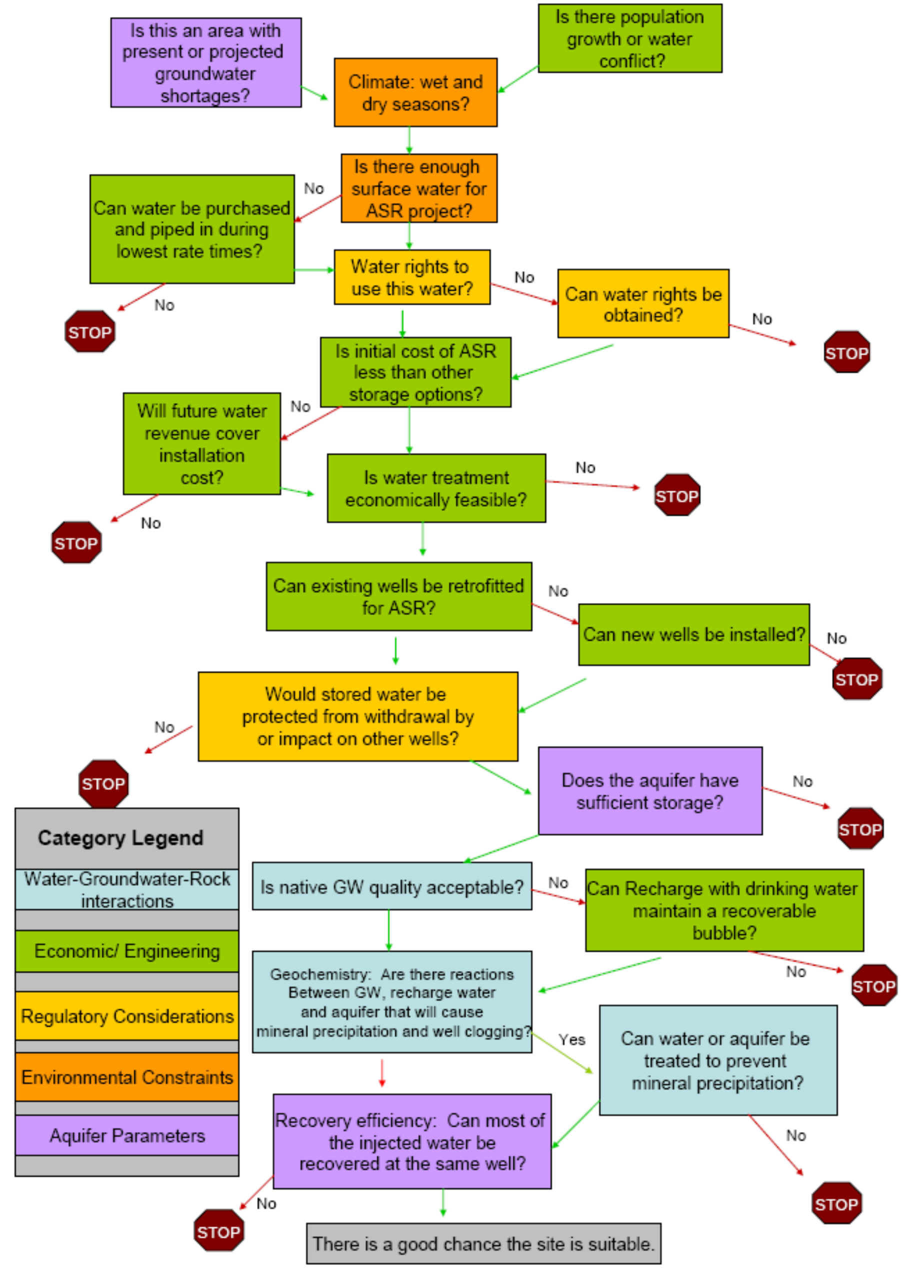


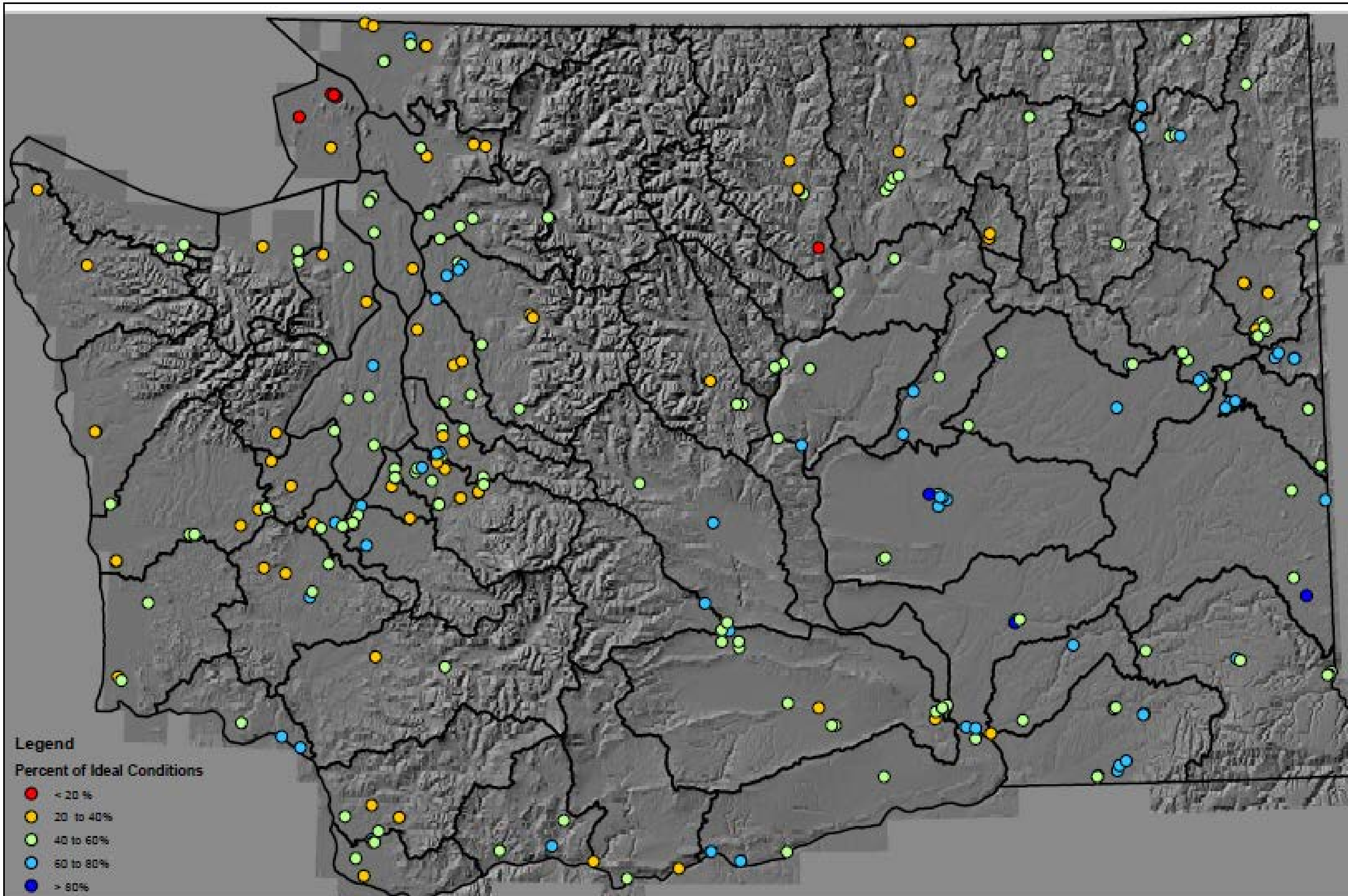
FIGURE 1.--Locations of test-observation wells in Washington.

Artificial Recharge Suitability Assessment

Figure 3-5: ASR Site Assessment Decision Tree: Is this a suitable ASR site?



Artificial Recharge Suitability Assessment



Twin Lakes

Aspect CONSULTING

BACKGROUND AND PURPOSE

Project Timeline

2006-2011	October, 2012	November 7, 2012	December 14, 2012	2013	2013-2014	2013-2014	2014	2014+	2024
Completed environmental studies and conceptual design	Environmental scoping begins under SEPA, Co-Lead Agencies Ecology and Okanogan County Issue Determination of Significance	SEPA Scoping Open House	Deadline for submitting written comments on Determination of Significance	Pilot testing to confirm conditions predicted through groundwater modeling	Well testing to confirm groundwater availability and analyze impairment potential	System design and construction	Project start up; begin pumping to increase storage volume	Hydrologic monitoring and adaptive management	Pumping reduced to maintain surface and groundwater levels

Twin Lakes Aquifer Coalition

Big Twin is a popular recreational lake with a trophy trout fishery.

Water levels have declined in Barnsley Lake and an adjacent depression known as "The Kettle" that were formerly wetted year-around. This photo was taken in July of 2004.

As with Big Twin, Little Twin Lake water levels have declined substantially since 2001.

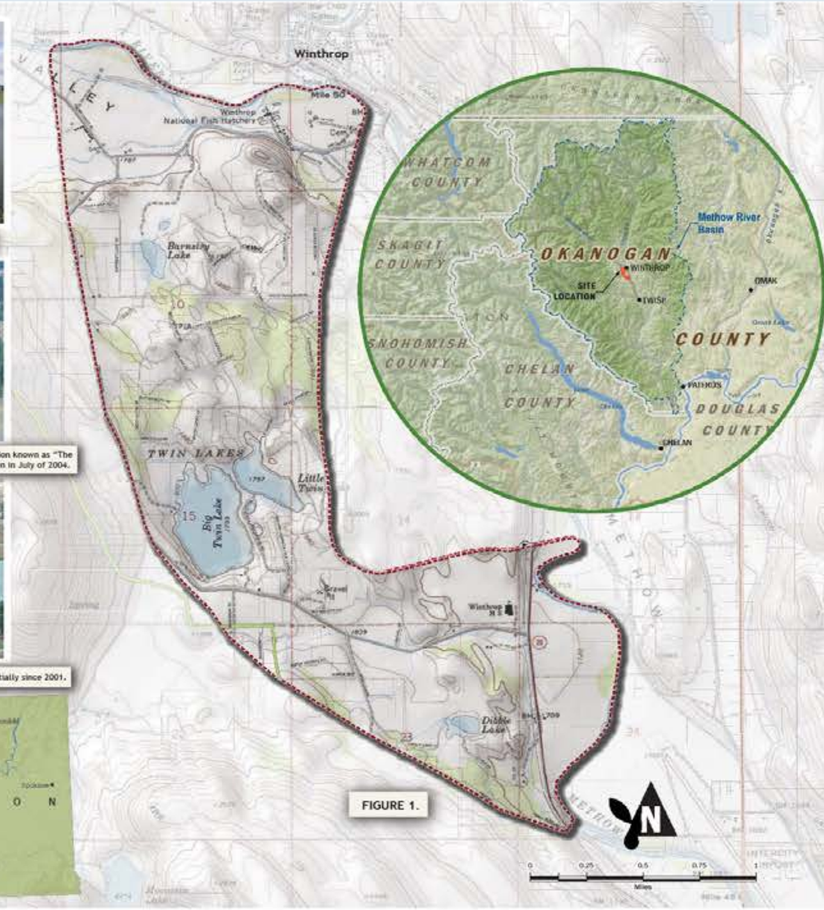


FIGURE 1.

The Twin Lakes Water Storage Project involves increasing water stored in surface water bodies and the aquifer associated with these water bodies located southeast of Winthrop, Washington (Figure 1). Declining lake levels observed in the Twin Lakes area of Okanogan County since 2001 (Figure 2) are due in part to conversion of unlined irrigation canals to pressurized pipe in the recharge area of the lakes. To address declining lake levels, the Twin lakes Aquifer Coalition (TLAC) applied for a groundwater right under application G4-34915 on October 7, 2003. Amended in August 2012, the application requests a maximum withdrawal rate of 2,000 gallons per minute (gpm) and an annual quantity of 800 acre-feet (AFY) for each of the first 10 years the project is operating and 550 AFY for long-term maintenance during subsequent years.

Through the proposed purpose of use identified in the amended water right application, the Twin Lakes Water Storage Project is anticipated to provide the following benefits:

- **Restore and maintain** Twin Lakes Aquifer levels
- **Restore and maintain** recreational trout fishing in Big and Little Twin Lakes
- **Restore and maintain** riparian habitat and lowland habitat for aquatic species and mammals that use Barnsley and Twin Lakes
- **Water storage enhancement** for increasing streamflow in the mainstem Methow River during low flow periods
- **Mitigation** for new out-of-stream uses through the Department of Ecology's Office of Columbia River Columbia River

In 2004, the Washington State Legislature provided $750,000 to Department of Ecology (Ecology) to evaluate and issue decisions on water right applications for restoration of Twin Lakes. Several scientific and engineering studies have been completed to evaluate the feasibility, impact and benefits to the environment of restoring Twin Lakes by increasing water storage.

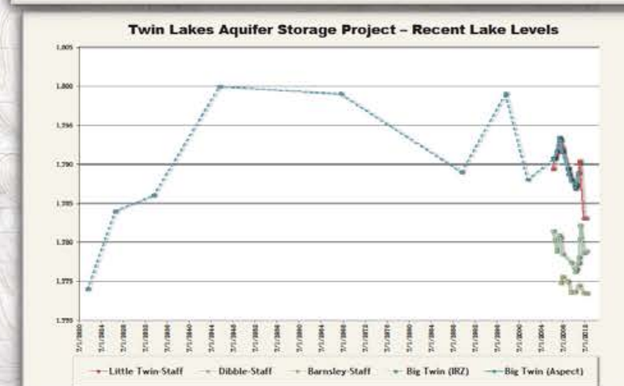


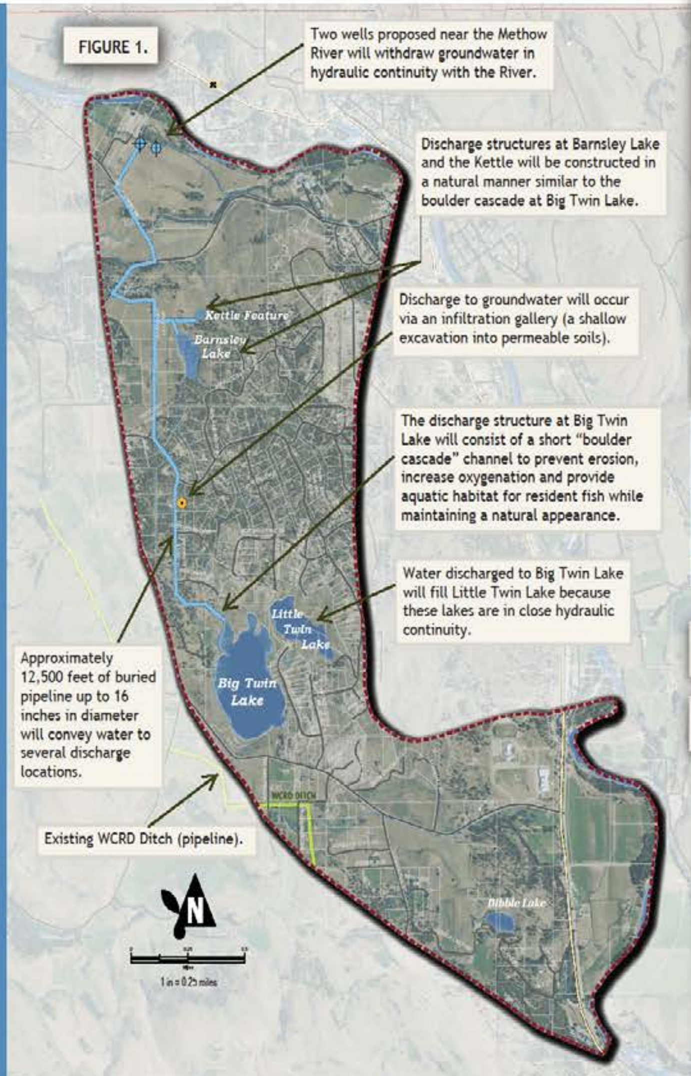
FIGURE 2. Historic water levels for Big Twin Lake estimated from air photo analysis (IRZ, 2003b) and observed water levels for Big Twin, Little Twin, Dibble and Barnsley Lakes measured by Aspect Consulting and TLAC beginning in 2006.

Aspect CONSULTING

PROJECT LAYOUT AND OPERATIONS

Twin Lakes Aquifer Coalition

FIGURE 1.



Proposed new infrastructure supporting the Twin Lakes Water Storage Project will consist of wells, conveyance pipeline and discharge structures to surface and groundwater (Figure 1). Water will be discharged alternately among the surface water and groundwater discharge locations.

Project Operations

Upon completion of the project infrastructure, pumping from the wells will begin to increase water storage in the lakes and aquifer to a maximum volume of 1,600 acre feet. Pumping at a rate of up to 2,000 gpm and a quantity up to 800 acre feet during each of the first 10 years is expected to be needed. Considering return flows to the Methow River and losses to evaporation, long-term maintenance pumping up to 550 acre feet annually is expected to sustain targeted water levels.

TABLE 1: Number of Pumping Days Required versus Number of Days Available Over Minimum Instream Flows (MIF)

	Years 1 - 10 (800 acre-feet/ year)*			Steady State > Year 10 (550 acre-feet/year)*		
	Actual Pumping Days at 1,000 gpm	Actual Pumping Days at 2,000 gpm**	Pumping Days Available Over MIF	Actual Pumping Days at 1,000 gpm	Actual Pumping Days at 2,000 gpm**	Pumping Days Available Over MIF
Wet Year	124	62	183	125	62	179
Average Year	145	73	177	121	60	151
Dry Year	80	40	98	28	14	34

* The analysis predicts steady state conditions will be reached in Year 10 if 800 acre-feet/year are delivered the first 10 years. If less water is available to be delivered to the lake/aquifer system during that time period, steady-state conditions and the reduction in pumping to 550 acre-feet/year will occur later in time. TLAC will operate an adaptive management program during the first 10 years of pumping to better understand groundwater storage and lake response to pumping.

** The analysis evaluated the TLAC project engineered to deliver 1,000 gpm, although the final design flow rate has not been determined. If the TLAC project could deliver 2,000 gpm, the pumping days would be approximately half for the same water balance schedule. The storage target could be achieved sooner each year by pumping at up to 2,000 gpm.

Water Pumping Under the MIF

Water will be pumped to storage only during high flows. In its application, TLAC proposed to pump from the Methow River only when flows are above the adopted minimum instream flows (MIF) in WAC 173-548 (i.e. an interruptable withdrawal). Pumping only when flows are above the MIF ensures the project will not impact instream uses and existing senior water rights.

Table 1 shows the number of days available for pumping observing the MIF versus the number of days of pumping proposed to support the Twin Lakes Water Storage Project.

Withdrawals will occur when Methow River flows are generally above the MIF between April and September (80% of the time).

ESTIMATED COSTS

TABLE 2: Capital Costs Assuming 12-inch Pipeline

ENGINEER'S OPINION OF PROBABLE COSTS — PLANNING LEVEL ESTIMATE

DIV NO.	ITEM DESCRIPTION	QUANTITY: NUMBER UNITS	QUANTITY: UNIT	MATERIAL: UNIT COST	MATERIAL: EXTEN	LABOR & EQUIPMENT: UNIT COST	LABOR & EQUIPMENT: EXTEN	Lump Sum	TOTALS
1	GENERAL								
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	SITE WORK								
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	CONCRETE								
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	METALS								
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
11	EQUIPMENT								
	Submersible Well Pump & Discharge Head	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
13	SPECIAL CONSTRUCTION								
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
15	MECHANICAL								
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
16	ELECTRICAL								
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]								[illegible]

This planning-level cost estimate assumes a 12-inch pipeline will be used to convey water from wells to discharge points. Pilot testing will be conducted to confirm actual pipeline diameter that may increase costs.

TABLE 3: Planning-level Long-term Operations and Maintenance Costs

Annual Volume Pumped (afy)	Annual Pumping Cost (at 1000 gpm)	Annual Maintenance/Operating Labor	Contingency (20%)	Total Annual O and M Cost (w/contingency) (1,000 gpm)
550	$12,000	$43,000	$11,000	$66,000

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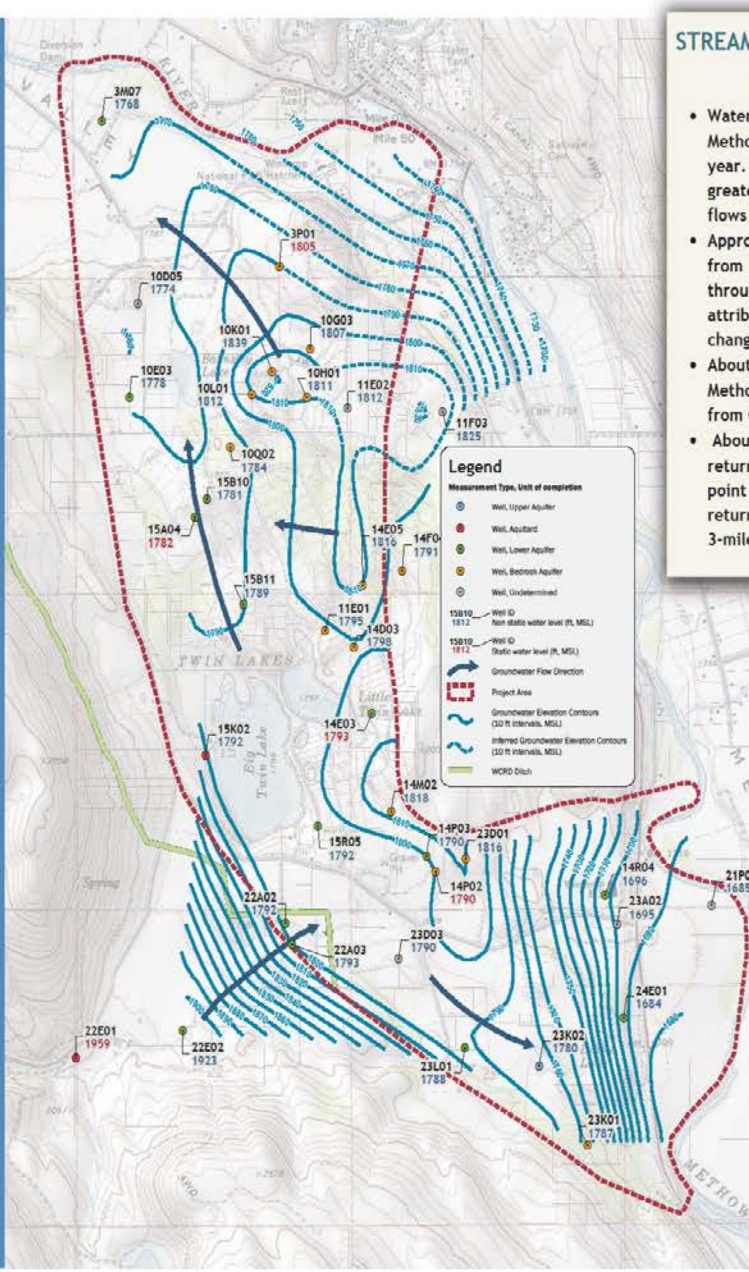
PROJECT BENEFITS: *Groundwater Storage and Streamflow Augmentation*

Twin Lakes Aquifer Coalition

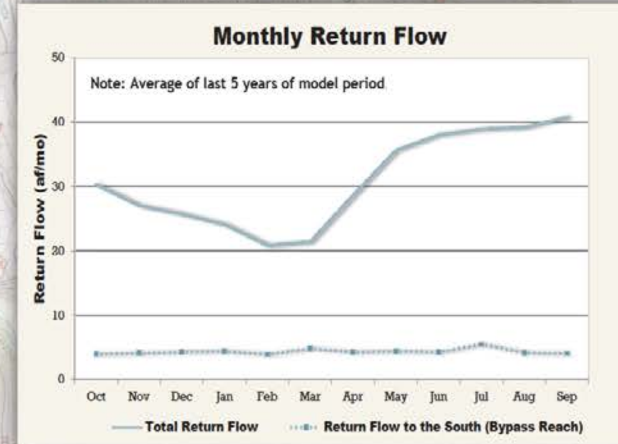


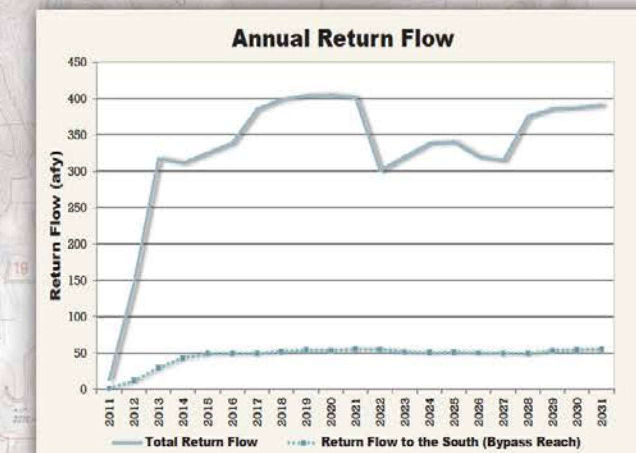
STREAMFLOW AUGMENTATION BENEFITS TO THE METHOW RIVER:

- Water from storage will augment flows in the Methow River at a rate of 0.5 cfs for most of the year. Streamflow augmentation will provide the greatest benefit from October through March when flows drop below the MIF 60% of the time.
- Approximately 370 afy or 70% of water withdrawn from the wells will return to the Methow River through the aquifer system. The balance is attributed to evpotranspiration and year-to-year changes in storage.
- About 150 afy of this return flow will augment Methow River flows during low flow winter months from October through March.
- About 86% of groundwater from storage will return to the Methow River to the north near the point where it was withdrawn. About 14% will return to the south near the high school creating a 3-mile bypass reach.

GROUNDWATER STORAGE PROVIDES BENEFITS INCLUDING:

- Reduced losses to evaporation
- Maintain cool water temperatures
- Less prone to contamination
- Volume of stored water is increased without consuming additional terrestrial lands
- Conveyance for return flow to the Methow River





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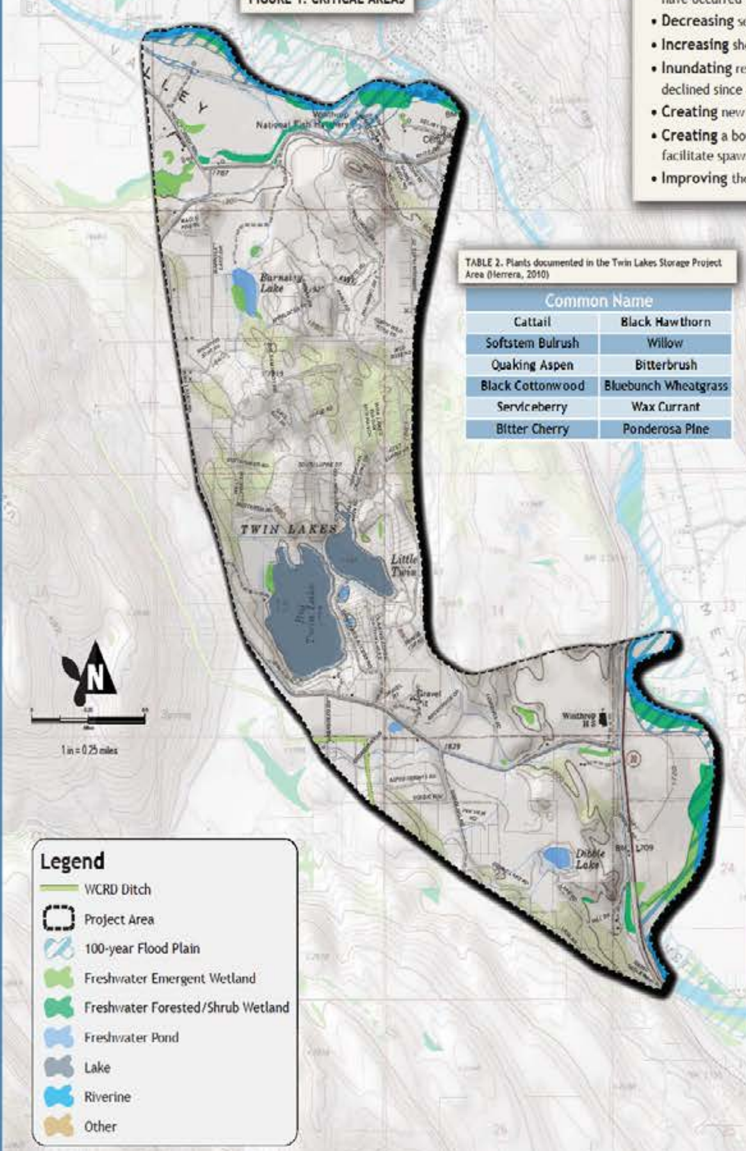
ENVIRONMENTAL IMPACTS

Twin Lakes Aquifer Coalition

FIGURE 1. CRITICAL AREAS



BENEFITS TO AQUATIC WILDLIFE

This project is intended to enhance aquatic habitat by:

- **Increasing** year-round water supplies in the Methow River.
- **Stabilizing** declining water levels in existing lakes (Big Twin, Little Twin, Dibble, Barnsley) that have occurred for over 10 years.
- **Decreasing** seasonal water level fluctuations in lakes (reservoir effect).
- **Increasing** shorelines and water volumes in lakes.
- **Inundating** reed-canary grass currently plaguing existing shorelines formed after water levels declined since about 2000.
- **Creating** new aquatic and wetland environment including a surface water body at the Kettle.
- **Creating** a boulder cascade discharge channel to Big Twin Lake that will be designed to facilitate spawning of resident fish from the lake.
- **Improving** the trout fishery at Big and Little Twin Lakes.

TABLE 1. Areas for discussion identified by the SEPA co-lead agencies and Proposed Mitigation Measures

Area Identified	Mitigation
Potential impacts of withdrawals from wells on groundwater and surface water bodies	Complete test well and analyze impacts to nearby wells prior to project build-out
	Pumping restricted to periods when flows are above the MIF
	70% of water withdrawn will return, augmenting Methow River flows during low-flow periods
Potential impacts of discharging water from wells to surface water bodies and to groundwater	Temperature modeling shows water quality will not be impacted
	Discharge structures designed and constructed to increase oxygenation
	Infiltration gallery to maintain groundwater quality
Possible long-term changes in water budget resulting from potential impacts and future groundwater development	Groundwater supplies to be enhanced
	Studies indicate will not result in increased well development allowed by existing zoning
Potential impacts of increased water levels on jurisdictional shoreline areas	Water levels restored to historic levels (pre-2001)
	"Reservoir Effect" minimized
Potential impacts of work occurring within or adjacent to jurisdictional shoreline areas	Obtain and conduct work under Permit
	"Boulder Cascade" discharge structures to minimize erosion

TABLE 2. Plants documented in the Twin Lakes Storage Project Area (Herrera, 2010)

Common Name	
Cattail	Black Hawthorn
Softstem Bulrush	Willow
Quaking Aspen	Bitterbrush
Black Cottonwood	Bluebunch Wheatgrass
Serviceberry	Wax Currant
Bitter Cherry	Ponderosa Pine

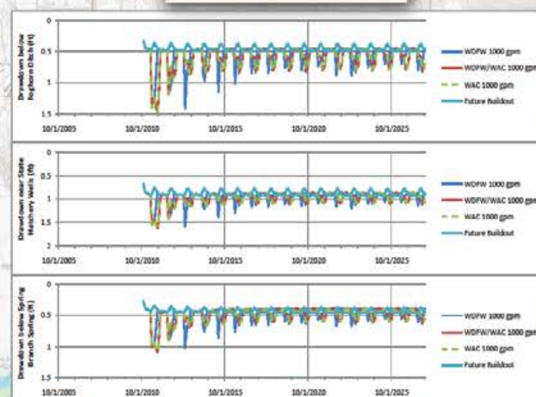
TABLE 3. Species listed under the Endangered Species Act known or suspected to occur in the Methow Watershed (from Fisher, 2010)

Common Name	Federal Status
Spring Chinook salmon	Endangered
Summer Steelhead	Endangered
Bull Trout	Threatened
Coho	Unlisted
Summer Chinook Salmon	Unlisted
Northern Spotted Owl	Threatened
Gray Wolf	Threatened
Grizzly Bear	Threatened
Canada Lynx	Threatened

TABLE 4. Animals documented in the Twin Lakes Storage Project Area (Herrera, 2010)

Common Name	
Mule Deer	Songbirds
Coyote	Pileated Woodpecker
Squirrels	Painted Turtle
Common Loon	Amphibians
Mallard	Bald Eagle
Canada Geese	Golden Eagle
Great Blue Heron	Osprey
Red Winged Blackbird	Red Tailed Hawk

FIGURE 2. Predicted Drawdown Hydrographs



A full bibliography of supporting environmental documents is available on the table and online at: http://www.ecy.wa.gov/programs/wr/cwp/tlws.html

SEPA (STATE ENVIRONMENTAL POLICY ACT)

In 2012, Ecology initiated project review under the State Environmental Policy Act (SEPA). Washington State Department of Ecology's Office of Columbia River and Okanogan County are co-lead agencies for the preparation of an Environmental Impact Statement.

Documents related to the SEPA process are available for review.

- SEPA Checklist
- Determination of Significance
- SEPA Co-Lead Memorandum of Understanding
- Conveyance for return flow to the Methow River

SUBMITTING COMMENTS

Under WAC 197-11-360 and -410, Ecology initiated scoping to evaluate the environmental impacts of the proposal. Written scoping comments will be accepted through Friday, December 14, 2012.

Option 1- Complete and submit forms available at this Open House

Option 2- Send written comments

Derek I. Sandison,
Washington Department of Ecology, Office of Columbia River
303 South Mission Street, Suite 200
Wenatchee, WA 98801
or by email to dsan461@ecy.wa.gov

Policy Questions

- **Compliance with Water Quality groundwater standards – AKART**

- **Recovery Efficiency – Is ASR success defined by its recovery efficiency?**

- **Costs - When does ASR become cost-effective as a water supply? Do water supply benefits outweigh water quality costs?**

- **Scale – What drives ASR capacity limitations (hydraulics, geology, economics, engineering)?**