STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY

PROTESTED REPORT OF EXAMINATION

TO APPROPRIATE PUBLIC WATERS OF THE STATE OF WASHINGTON

☐ Surface Water (Issued in accordance with the provisions of Chapter 117, Laws of Washington for 1917, and amendments thereto, and the rules and regulations of the Department of Ecology.)

☒ Ground Water (Issued in accordance with the provisions of Chapter 263, Laws of Washington for 1945, and amendments thereto, and the rules and regulations of the Department of Ecology.)

PRIORITY DATE	APPLICATION NUMBER	PERMIT NUMBER	CERTIFICATE NUMBER
June 16, 1992	G1-26617(A)		

NAME
City of North Bend

ADDRESS (STREET)	(CITY)	(STATE)	(ZIP CODE)
P.O. Box 896	North Bend	Washington	98045-0896

PUBLIC WATERS TO BE APPROPRIATED

SOURCE
Well NB-3

TRIBUTARY OF (IF SURFACE WATERS)

MAXIMUM CUBIC FEET PER SECOND	MAXIMUM GALLONS PER MINUTE	MAXIMUM ACRE FEET PER YEAR
	2,646	3,094

PURPOSE OF USE, PERIOD OF USE

Municipal Water Supply Purposes - Year-round, as needed

Water right is subject to WAC 173-507-020 instream flow levels for the following control points unless mitigated:

Snoqualmie River near Snoqualmie (USGS #12144500)
Snoqualmie River near Carnation (USGS #12149000)
Snohomish River near Monroe (USGS #12150800)

LOCATION OF DIVERSION/WITHDRAWAL

APPROXIMATE LOCATION OF DIVERSION--WITHDRAWAL

NB-3 - 566 feet north and 410 feet west from the south quarter corner of Section 10

LOCATED WITHIN (SMALLEST LEGAL SUBDIVISION)	SECTION	TOWNSHIP N.	RANGE, (E. OR W.) W.M.	W.R.I.A.	COUNTY
SE 1/4, SW 1/4	10	23N	8E	7	King

RECORDED PLATTED PROPERTY

LOT	BLOCK	OF (GIVE NAME OF PLAT OR ADDITION)

LEGAL DESCRIPTION OF PROPERTY ON WHICH WATER IS TO BE USED

The place of use of this water right is the service area described in the Water System Plan approved by the Washington State Department of Health in April 2002 and the North Bend Urban Growth Area described in the King County Growth Management Planning Council's Urban Growth Area Boundary Map (June 2005). Future Water System Plan updates may have the effect of revising the place of use of this water right, so long as the City of North Bend is and remains in compliance with the criteria in RCW 90.03.386.

DESCRIPTION OF PROPOSED WORKS

Well NB-3 was completed in sand and gravel deposits between 153-203 feet below land surface using a 20-inch, stainless steel, telescopic well screen

This system is identified by the Washington State Department of Health by Public Water System ID 60100.

DEVELOPMENT SCHEDULE

BEGIN PROJECT BY THIS DATE:	COMPLETE PROJECT BY THIS DATE:	WATER PUT TO FULL USE BY THIS DATE:
Started	January 1, 2054	January 1, 2059

REPORT

1. INTRODUCTION

1.1 Background

Under the provisions of Chapters 90.03 and 90.44 Revised Code of Washington (RCW), on June 16, 1992, the City of North Bend (North Bend) applied for a permit to appropriate public ground water. The City seeks additional water to meet its municipal demand for the next 50 years. The application was amended on March 31, 2004. The points of withdrawal requested include 4 production wells and 2 deep mitigation wells. The points of withdrawal and service area of North Bend are located in King County within the Snohomish River Basin, Water Resource Inventory Area (WRIA) 7. A withdrawal rate of 2,646 gallons per minute was requested for municipal water supply purposes, and an additional 1,614 gpm for streamflow augmentation from the deep mitigation well(s) – for a total instantaneous withdrawal (Qi) of 4,260 gpm. **Attachment 1** shows the locations of these sources.

Since new appropriations from the Snoqualmie River watershed are subject to minimum instream flow levels established at control stations located downstream at Snoqualmie Falls, Carnation and Monroe, (WAC 173-507-020(2)), the City has proposed a mitigation plan that replaces flows in the Snoqualmie River from alternate sources to offset the impacts that result from additional ground water withdrawals during those times when instream flows are not met.

The City proposes to use several sources of water to offset the impacts of their ground water withdrawals on the Snoqualmie River system:

1. Surface water from Seattle Public Utility's (SPU) Hobo Springs;
2. Ground water from the wells operated by the Sallal Water Association;
3. Surface water from the Tolt River purchased from SPU; and,
4. Ground water from the upper Snoqualmie Deep Aquifer, to the extent scheduled testing and analysis support its availability.

Attachment 2 shows the locations of the Hobo Springs and Sallal Water Association mitigation sources.

Given the complexities of this project, North Bend has requested that the original application be split into two applications with Ecology making a decision on the Record A application while the Record B application will remain pending. The Record B application will be handled in a separate future Report of Examination after receipt of additional supporting information and contingent upon Ecology having the resources to process it. It is anticipated that additional information will be ready for review in approximately one to three years. While it is not typical that water right applications are split into multiple records, neither the Water Code nor Department of Ecology regulations prohibit the issuance of multiple reports of examination on what was originally a single application. Details of the split application can be found below in Table 1.

Table 1 Summary of Split Water Right Application No. G1-26617

Attributes	G1-26617(A) (Record A)	G1-26617(B) (Record B)
Name	North Bend	North Bend
Priority Date	June 16, 1992	June 16, 1992
Instantaneous Quantity	2,646 gpm for production wells	1,614 gpm from mitigation wells Non-additive to Record A from production well
Annual Quantity	3,094 afy for production wells	874 afy from mitigation wells Non-additive to Record A from production well
Sources	NB-1, NB-2, and NB-3	NB-4 (production well), MW-1 and MW-2 (mitigation wells)
Points of Withdrawal	NB-1: SW ¼, NW ¼, Sec. 10 T23N, R8E NB-2: SW ¼, NE ¼, Sec. 9 T23N, R8E NB-3: SE ¼, SW ¼, Sec. 10 T23N, R8E	NB-4: Govt Lot 4, Sec. 35, T24N, R8E MW-1: Sec. 10, T23N, R8E MW-2: Sec. 14, T23N, R8E
Purpose of Use	Municipal Water Supply Purposes	Municipal Water Supply Purposes (NB-4), Mitigation for Streamflow Augmentation (Wells MW-1 and MW-2)
Period of Use	Year-round	Year-round
Place of Use	Area served by the City of North Bend within its existing service area approved by the Washington Department of Health in their 2002 Water System Comprehensive Plan and also the entirety of the North Bend Urban Growth Area	Area served by the City of North Bend within its existing service area approved by the Washington Department of Health in their 2002 Water System Comprehensive Plan and also the entirety of the North Bend Urban Growth Area

This Report of Examination is only for the investigation and decision by Ecology on Application G1-26617(A) under the four-part test of RCW 90.03.290, and includes the following elements:

1. North Bend's 50-year projected growth demands for the North Bend Water Service Area and Urban Growth Area (UGA);
2. Current and projected return flows from North Bend's wastewater treatment plant;
3. Pump testing of Well NB-3 and hydrogeologic characterization related to availability of water from this source and its relation to Snoqualmie River flows;
4. Analysis of stream depletion from pumping Well NB-3 and related mitigation requirements (mitigation algorithm) to prevent impairment of instream flows and senior water rights;

5. Establishment of the suitability of mitigation water supply from the Hobo Springs and Sallal water sources available by contract to North Bend that could supplement the flow of the Snoqualmie River to mitigate for the instream flow impacts of the new municipal ground water withdrawals, to the extent of North Bend's 50-year projected growth demands;
6. Identification of future Tolt River pipeline source pending additional analysis;
7. Determination of the capacity of mitigation sources currently available to North Bend (Hobo Springs and Sallal wells), for which projects to deliver mitigation water supply have been engineered and will be constructed concurrently with the installation of new water production facilities for Well NB-3;
8. The operations, monitoring and reporting requirements necessary to confirm that North Bend is mitigating the impacts of its new ground water withdrawals in real time, whenever instream flows are not met;
9. The technical requirements and process for adding new production well sources NB-1 and NB-2;
10. Adaptive management requirements to respond to new information or changed circumstances;
11. The potential for impacts to senior water rights and mitigation for such impacts; and
12. Public interest factors relating to this application.

If warranted, a Superseding Permit may be issued to integrate the two records of the project into a single document if the Record B application can be approved.

1.2 Cost Reimbursement Contract

Based on the provisions of RCW 43.21A.690 and RCW 90.03.265, Pacific Groundwater Group, is under contract to Ecology to process water right application G1-26617(A) and any competing senior applications. PGG reviewed all available documents pertaining to the City of North Bend's application including site conditions, historical water use, existing right-holders, and seniority of pending applications potentially affected by the application.

PGG evaluated pending senior applications in the general area and determined that reservoir application R1-26218, with a priority date of May 9, 1991, predated North Bend's filing. While this application would generally need to be processed prior to North Bend's request, applicant Puget Sound Energy, through their attorney Tom McDonald of Perkins Coie LLP, submitted a letter to Ecology dated May 4, 2004, allowing for the processing of North Bend's junior application ahead of their senior application. PSE also agreed that when Ecology processes their application in the future, the conditions in the river at that time will determine if their application can be approved.

1.3 Public Notice

The most recent public notice of the proposed appropriation was published in the Snoqualmie Valley Record on May 25th and June 1, 2005. In response to that notice, Ecology received a protest letter from the following party:

- Obe Healea, Jr. – June 3, 2005 - a resident of North Bend. Mr. Healea indicated that he felt that North Bend's current source of supply at Mt. Si Springs was a preferable source, and that the development of wells was costly and unnecessary.

Protest/comment letters were also submitted to Ecology based on previous public notices published for this application:

- William Francis – April 26, 2004 - a resident of North Bend. Mr. Francis is concerned that the operation of North Bend's proposed well NB-1 could impact local domestic wells.

- Ewing Stringfellow – July 28, 1998 – a resident of North Bend. Mr. Stringfellow is concerned that North Bend's proposed well NB-1 will cause his stockwatering well to go dry and those of his neighbors.

These protests and comments will be addressed in Section 2.7 of this report titled Considerations of Protests and Comments. In addition to the formal protest period afforded by statute, other parties were consulted in the process of formulating the mitigation plan for this project.

1.4 Compliance with State Environmental Policy Act (SEPA)

The City of North Bend acted as lead agency for SEPA review of this application and construction of the Hobo Springs to Boxley Creek mitigation project. A Mitigated Determination of Non-Significance (MDNS) was issued on March 9, 2007. Mitigation measures identified in the MDNS included all mitigation measures described in the following documents which are discussed elsewhere in this decision:

1. Revised and Updated Mitigation Plan for North Bend Water Right Application, Memorandum from Thomas M. Pors to Dan Swenson, Washington State Department of Ecology, dated March 7, 2007;

2. North Bend Mitigation Supply from Hobo Springs and Sallal Wells, Golder & Associates, Inc., February 28, 2007; and

3. Preliminary Engineering Plan for Hobo Springs/Sallal Wells Mitigation Project, Gray & Osborne Consulting Engineers, March 7, 2007.

Only two comments were received on the MDNS. One was a favorable comment from Obe M. Healea, Jr. The other was a comment from Anne Savery on behalf of the Tulalip Tribes relating to the location of mitigation sources and effects on the food web in the Middle Fork Snoqualmie River. This comment letter and North Bend's response is discussed in Section 2.7.

1.5 Statutory Authority

Under the provisions of RCW 90.03.290 and 90.44.050, a water right shall be issued upon findings that water is available for appropriation for a beneficial use and that the appropriation, as proposed in the application, will not impair existing rights or be detrimental to the public welfare.

2. INVESTIGATION

The evaluation of this application included, but was not limited to, research and/or review of the following:

- Department of Ecology records of surface and ground water rights and claims and well construction reports within the vicinity of the subject production wells;
- Documents and reports applicable to the area as referenced following the conclusions of this report;
- Field visits by Ecology and Pacific Groundwater Group staff to Well NB-3 and the Hobo Springs mitigation source; and,
- Revised Code of Washington 90.03, 90.44 and 90.54, and Chapter 173-507 Washington Administrative Code

2.1 North Bend Water System

The City of North Bend is located in the Snoqualmie Valley between the confluence of the Middle and South Forks of the Snoqualmie River and Interstate 90. The points of withdrawal and service area of North Bend are located in King County within the Snohomish River Basin, Water Resource Inventory Area (WRIA) 7. North Bend is a Group A municipal water system that supplies water to approximately 1,700 connections. North Bend's water system is identified by the Washington Department of Health (WADOH) as Public Water System ID 60100.

Attachment 1 shows the location of Well NB-3 and also proposed points of withdrawal NB-1 and NB-2. This figure also shows the current boundary of the North Bend Water Service Area (Water System Plan, April 2002) and the North Bend UGA.

2.1.1 Service Area

North Bend's water service area covers approximately 8.5 square miles. Additionally, North Bend's service area includes and specifically designates the wholesaling of water to the Sallal Water Association for service within the North Bend UGA (**Attachment 1**).

2.1.2 Existing Water Right

In addition to the subject application, North Bend holds one surface water certificate. The water right information is presented in Table 2.

Table 2. Water Right Currently Held by North Bend						
Water Right Number	**Document Type**	**Purpose of Use**	**Point of Diversion**	**Priority Date**	**Instantaneous Withdrawal Rate (Qi)**	**Annual Water Quantity (Qa)**
S1-00620C	Certificate	Municipal	Mount Si Springs Govt Lot 4, Sec. 35, T24N, R8E, W.M.	March 17, 1965	5 cfs	336 acre-feet

This water source is the Mount Si Springs located to the northeast of town, at the base of Mt. Si (WADOH Source S01). The intake facilities capture subsurface spring flow. Any excess flow from the system discharges to a tributary of the North Fork of the Snoqualmie River. The water right requires that a minimum of 3 cfs be allowed to bypass the diversion for discharge to the river system.

2.1.3 Current Water Use and Future Demand Projections

North Bend's annual water use as reported from 2000 through 2006 is shown in Figure 1. For each of these years North Bend has exceeded their annual water right limit. North Bend initiated a self-imposed development moratorium in April 1999, which they have decided not to lift until such time as they can secure additional water rights.

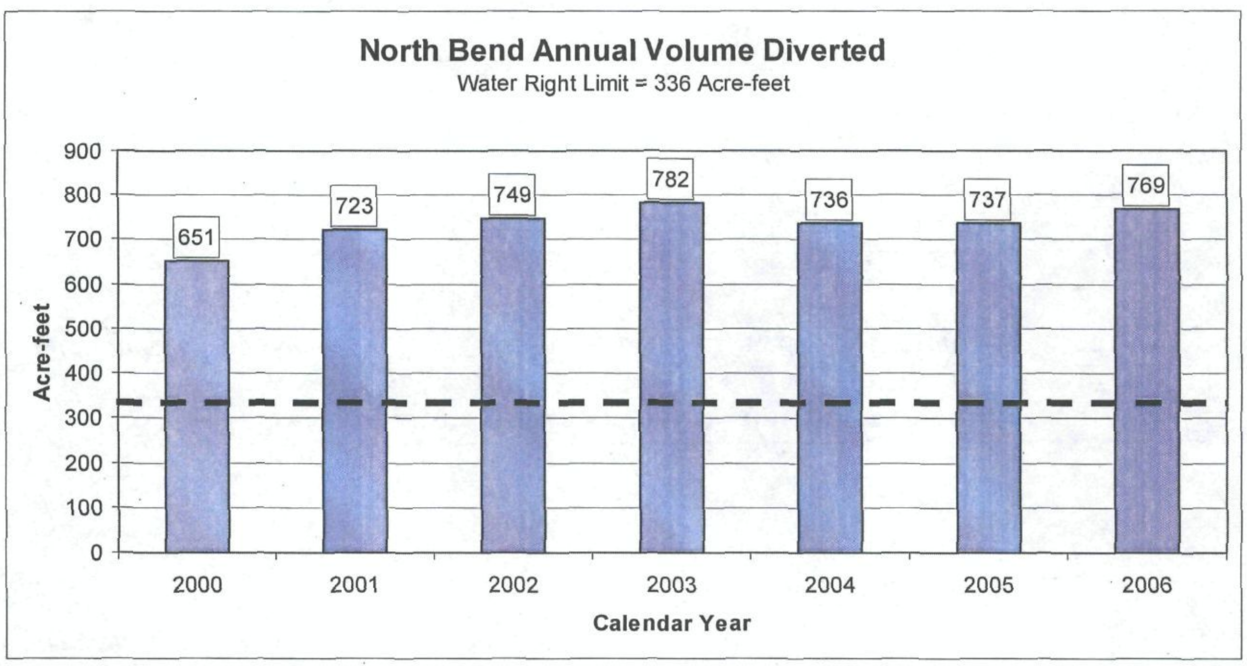


Figure 1. Water diverted by North Bend from Mount Si Springs over the past 7 years. Annual volume authorized under S1-00620C is 336 acre-feet per year (shown on graph as dashed black line).

North Bend currently has a single intertie with the Sallal Water Association for emergency use (WADOH Source S02). In the future, the two systems will be configured to supply water to each other on a more regular basis, with North Bend serving portions of Sallal's service area that are within the North Bend UGA. North Bend will provide wholesale deliveries of water to the Sallal Water Association until North Bend's water service area expands to include all property within the UGA. Eventually this wholesale supply will return to a retail supply when North Bend annexes that portion of the UGA service area from Sallal.

The projected future water demand for the North Bend Service Area and the North Bend UGA was determined by North Bend (2004) and reported by Golder (2007c) over a 51-year growth period based on current land use and zoning. These projections include converting the water supply of all existing structures within the UGA currently served by Sallal and the anticipated existing structures in the North Bend service area to the North Bend water supply.

Demand projections were completed for the first 11 years (year 11), the following 25 years (year 36), and the last 15 years (year 51) of a 51-year period (Golder, 2007c). The projected total new water right demand for the time periods specified, excluding the existing Mount Si Springs water right, is shown below. The numbers account for 10 percent savings from water conservation initiatives.

Table 3. Projected future demand above existing water rights for the North Bend Water System (North Bend, 2004)

Growth Year (Calendar Year)	Projected Demand (mgd)	Projected Demand (afy)
1 (2008)	0.35	390
11 (2018)	0.58	652
36 (2043)	2.07	2,316
51 (2058)	2.76	3,093

2.1.4 Wastewater Treatment Plant

Wastewater collected by North Bend from its residential and commercial customers is treated at it's wastewater treatment plant (WWTP) and then discharged into the South Fork Snoqualmie River in the NW ¼, NE ¼, Sec. 9, T23N, R8E, W.M., just downstream of the State Route 202 bridge (**Attachment 1**). North Bend uses secondary treatment methods to meet or exceed applicable standards established by Ecology and U.S. Environmental Protection Agency (US EPA). The water discharged is monitored in accordance with the Ecology-issued National Pollutant Discharge Elimination System permit (Waste Discharge Permit No. WA-002935-1). North Bend maintains a flow meter on the outfall pipe. This flow meter (totalizer) is read daily, in the mornings, with flows measured to the nearest 10,000 gallons. The results are recorded manually on a Discharge Monitoring Report (DMR), along with other information, and sent to Ecology's Water Quality Program each month.

Discharge from the WWTP varies seasonally based on relative proportions of sewage and infiltration and inflow (I&I). Sewage is generated by homes and businesses, and is assumed to remain constant year-round. I&I is generated by surface-water runoff routed to sewer pipes and ground water inflow into leaky pipes, and varies between seasons and is higher during the wet-season.

Golder (2006a) analyzed WWTP return flow during the four driest months (July-October) between 2000 and 2003. The 4-year average summer flow of 0.42 mgd was assumed to reflect the "base" return flow through the WWTP, excluding I&I. This base return flow represents about 60% of the annual pumped volume during the same time period. For projections of return flow from the WWTP, 60% of the annual pumped volume is used year round.

2.1.5 Proposed New Source(s)

Application G1-26617(A), seeks approval for three production wells (NB-1, NB-2, and NB-3), however only Well NB-3 is authorized pursuant to this first phase Report of Examination. Wells NB-1 and NB-2 can be added as production sources under this water right only after complying with the technical and procedural requirements outlined in Section 5.4.1.

North Bend has drilled and tested the new water supply well referenced in this Report of Examination (Well NB-3). The well was completed in sand and gravel deposits between 153-203 feet below land surface using a 20-inch, stainless steel, telescopic well screen. The testing indicated that the well can sustain long-term pumping rates of at least 2,500 gpm. The specific capacity of the well is between 35 and 37 gpm/ft (Golder, 2007a). Aquifer properties estimated from the testing are further discussed in Section 2.2.2.

The new ground water supply will cause stream depletion because the shallow aquifer in which Well NB-3 is completed is in hydraulic continuity with the Snoqualmie River. Mitigation will be required to replace the new stream depletion when minimum instream flows are not met. North Bend assumes that 100 percent of the pumped volume from Well NB-3 results in baseflow reduction in the Snoqualmie River. Depletion associated with the other sources will be evaluated on a case-by-case basis, as discussed in Section 5.4.1.

While this Report of Examination addresses only Well NB-3, North Bend may develop 2 other wells under this portion of the water right application. The process for securing authorization to use additional wells is detailed in Section 5.4.1. Prior to receiving Ecology's authorization to bring NB-1 and NB-2 into production, North Bend will be required to prepare a detailed description of the new source(s) and how they will be operated consistent with this permit. Ecology shall review the information and any comments received from interested parties and determine whether or not the new production well meet(s) the conditions of this Report of Examination as an addition of a new production well.

2.2 Background Hydrology and Hydrogeology

The new water supply source referenced in this Report of Examination will withdraw water from the Snoqualmie Valley Aquifer System. The mitigation sources approved in this Report of Examination (Hobo Springs and the Sallal wells) are derived from the Cedar Moraine aquifer system.

2.2.1 *Surface-Water Hydrology*

The Snohomish River Watershed (WRIA 7) is located in the north-central Puget Sound region of Washington and includes portions of Snohomish and King Counties. Elevations in the watershed range from sea level to 8,000 feet. The watershed includes three major rivers, the Skykomish, the Snoqualmie, and the Snohomish, which flow west through broad, glaciated lowland valleys and enter Puget Sound near Everett. There are 720 miles of streams in WRIA 7 that are known to support anadromous salmonids and bull trout/Dolly Varden (Haring, Donald 2002)

The City of North Bend is located with the Snoqualmie River sub-basin, three miles upstream of Snoqualmie Falls, which is an impassible barrier to the upstream migration of anadromous fish in the Snoqualmie River. Three major forks converge to form the mainstem Snoqualmie River. The South Fork Snoqualmie River begins near Snoqualmie Pass and flows generally northwest for 35 miles to its confluence with the mainstem upstream of Snoqualmie Falls. It has a drainage area of 82 square miles, and (over 67 years of record) has an average discharge of 546 cfs and a minimum discharge of 63 cfs (U.S. Geological Survey, 2007c). The Middle Fork, which begins in the Mt. Daniel-Mt. Roosevelt-Big Snow Mountain area of the Cascade Mountains, flows west and southwest 40 miles to its confluence with the North Fork about five miles upstream of Snoqualmie Falls. It has a drainage area of 154 square miles, and (over 45 years of record) has an average discharge of 1,221 cfs and a minimum discharge of 91 cfs (U.S. Geological Survey, 2007a). The North Fork originates in the Lennox Mountain area of the high Cascades and flows 26 miles to its confluence with the Middle Fork. It has a drainage area of 64 square miles, and (over 65 years of record) has an average discharge of 500 cfs and a minimum discharge of 30 cfs (U.S. Geological Survey, 2007b). The combined Middle and North Forks join the South Fork about 4.5 miles upstream from Snoqualmie Falls. According to the Washington Department of Fish & Wildlife "Washington Lakes and Rivers Information System Database - Salmonid Stock Inventory" GIS coverage (Date Modified – August 16, 2006), anadromous salmonids or bull trout/Dolly Varden are not found in the Middle and South Forks of the Snoqualmie River near North Bend. However, Snohomish Coastal Cutthroat is present in all streams and rivers in the vicinity of North Bend.

The Snoqualmie River downstream of the forks, flows over Snoqualmie Falls, then generally northwest and north, leaving King County just north of the town of Duvall. Important tributaries are Tokul, Skunk, Patterson, Griffin, Harris, Ames and Cherry Creeks and the Tolt and Raging Rivers.

The Instream Resource Protection Program (IRPP) for the Snohomish River Basin (Chapter 173-507 WAC) was enacted in 1979. The intent, in accordance with RCW 90.54 and 90.22, is to retain base flows in perennial streams, rivers, and lakes at levels necessary to protect wildlife, fish, scenic, aesthetic, recreation, environmental, and navigational values.

The IRPP for the Snohomish River Basin establishes instream flow requirements at nine control stations within the WRIA. The IRPP also lists twenty streams which are closed to diversions when their flows drop below single specified levels, as well as two streams which must have at least one-half of their low flow bypassed.

Given the location of the Hobo Springs and Sallal wells mitigation sources, this Report of Examination also references the surface water features of the Cedar Moraine. The moraine is located several miles southeast of North Bend. The most prominent surface water features on the moraine are a direct result of SPU's Cedar River water supply project, which was created over a hundred years ago to supply the municipal needs of the City of Seattle. The watershed contains the 1,680-acre Chester Morse Lake, formed behind the Masonry Dam. The lake serves as a reservoir for 15.8 billion gallons (48,500 acre-feet) of water, which is partially stored above its natural gravity outlet.

As a result of the impoundment, some of the Cedar River source water is lost from the Masonry Pool, the portion of the reservoir between the Overflow Dike and Masonry Dam, via seepage into a moraine on the Pool's northern bank. Water leaks out of the Masonry Pool predominantly in the spring and early summer when water levels are the highest. About 75 percent of the water that leaks from Masonry Pool finds its way back to the Cedar River, while the remainder ends up in the Snoqualmie River Basin. Seepage return occurs from springs and small streams that emanate from the moraine aquifer as well as subsurface return flow pathways.

Springs which issue from the Cedar Moraine aquifer system include Hobo Springs, Canyon Creek Springs, and Railroad Springs which discharge to the Cedar River system, and Upper Boxley Creek Springs and West Boxley Springs which are tributary to the Snoqualmie basin.

2.2.2 Snoqualmie Valley Aquifer System

The hydrogeology of the Upper Snoqualmie Basin was recently summarized by Golder in a document prepared for the East King County Regional Water Association (Golder, 2007d). The basin occupies a drainage area of around 375 square miles and includes all three forks of the Snoqualmie River as well as the main stem above Snoqualmie Falls. Much of the sediment in the basin was deposited during the Vashon Stade of the Fraser Glaciation, which advanced to its maximum extent about 15,000 years before present. Alpine glaciation also sculpted the landscape and deposited sediments, particularly during periods of the Pleistocene when continental glaciers were less prominent. Sediments were deposited in ice-dammed lakes (finer grained lacustrine deposits and coarser grained deltas), along the edges of glaciers (stream deposited embankments and ice-contact deposits) and beneath ice bodies (glacial till). In some cases sediments were reworked during periods of glacial advance.

All three forks of the Snoqualmie River have aquifers that occupy the respective river valleys, referred to by Golder (2007d) as "channel" aquifers. The South Fork and Middle Fork channel aquifers are relatively thick (200-400 feet), are typically unconfined, and are composed of moderate-to-high permeability sands and gravels. These two aquifers are included in what is termed the "shallow aquifer", which is also present where the channel aquifers converge in the vicinity of North Bend. The shallow aquifer near North Bend is unconfined, highly productive, and (like the two channel aquifers) exhibits significant hydraulic connection to adjacent reaches of the Snoqualmie River. The Snoqualmie River and its respective forks in the upper Snoqualmie basin generally gain water from ground water. In parts of the basin, the shallow aquifer overlies a deep aquifer, which is separated by intervening till in places.

Hydrogeologic conditions in the main portion of the valley near North Bend show a thick sequence of coarse sand and gravel (shallow aquifer) that directly overlies fine-to-medium grained sand (deep aquifer) and silty clay (lacustrine deposits). East King County Regional Water Association's Test Well TW-4 (located in the NE ¼, SW ¼, Section 10, T23N, R8E) penetrated about 300 feet of coarse sand, gravel, and cobbles; followed by about 200 feet of uniform gray fine sand with varying silt and organic content, followed by 200 feet of gray silty clay. North Bend Well NB-3 was drilled to 216 feet and predominantly encountered sand and gravel with minor occurrences of silt or clay. Well NB-3 is completed in the shallow aquifer, which exhibits unconfined conditions. The valley aquifer system receives recharge from precipitation and responds to stage variations in the Snoqualmie River. The aquifer system also receives recharge from adjacent areas, such as the Middle Fork embankment and the Cedar embankment.

A 5-hour step-pumping test was performed on Well NB-3 on October 4, 2006, followed by a 72-hour constant-rate pumping test performed between October 5th and 8th, 2006. During the constant-rate test, 10.6 million gallons were pumped from the aquifer at a reported rate of 2,530 gpm. Interpretation of the test data by Golder (2007a), along with supplemental interpretation by PGG (noted), indicates the following:

- Well NB-3 can sustain long-term pumping rates of at least 2,500 gpm; and the specific capacity of the well is between 35 and 37 gpm/ft;
- Data collected during the constant rate test in various observation wells are sufficient for estimating aquifer properties; however, aquifer boundary responses cannot be determined with the available data;
- The transmissivity of the shallow aquifer was estimated to be between 99,400 and 316,000 ft^2/day. PGG interprets this transmissivity value to represent aquifer properties in the local vicinity of Well NB-3. Assuming 250 feet of saturated thickness, these transmissivity values correspond to hydraulic conductivity values between approximately 400 to 1,260 ft/d;
- Storativity estimates were based on diffusivity calculations from ground water level responses to river-stage variations in various wells. This approach to estimating storativity considers aquifer responses over several days. A median storativity of approximately 0.05 was estimated assuming a mean transmissivity of 240,000 ft^2/day;
- During testing, drawdown ceased after about 100 minutes and water levels began to rise in the production well and nearby monitoring wells. This rise was likely associated with re-infiltration of discharge water into the shallow aquifer from a stormwater detention pond about 500 feet from the well. PGG's interpretation of aquifer test results suggests that data collected after 100 minutes are not particularly useful for estimating aquifer parameters or drawdowns in neighboring wells.

Although the aquifer test was affected by re-infiltration of the discharge water after 100 minutes, similar values of hydraulic conductivity have been observed during testing of the Golf Course well and Well NB-1 (Golder, 2007d). Testing results from Well NB-1, however, may also have been affected by re-infiltration of discharge water (Golder, 2007d). As discussed in Section 5.5, North Bend will perform and analyze a second constant-rate test on Well NB-3 (designed to avoid re-infiltration of discharge water) within two years of new system operation. Based on the aquifer properties calculated during this test, North Bend will update the streamflow depletion and mitigation analyses associated with this water right for Well NB-3 if the new test results differ from the original test results (see Section 5.5).

2.2.3 Cedar Moraine Aquifer System

The Cedar Falls glacial moraine aquifer lies downgradient of the Masonry Pool. It includes an embankment area located between the pool and Rattlesnake Lake, and a lower moraine area which encompasses the area in vicinity of Rattlesnake Lake.

The glacial moraine includes a complex assemblage of recessional outwash, ice contact, till, and lacustrine deposits that were laid down as part of the last continental ice advance and retreat (Vashon). In general, the deposits become finer with depth. The upper and lower moraine areas include significant thicknesses of high permeability outwash deposits. The soils near the embankment area consist of both lower permeability till and lacustrine as well as more highly permeable outwash deposits. The occurrence of springs along the embankment face is likely controlled in part by the arrangement of the various soil types.

Seepage from the north abutment of the Masonry Pool provides a major source of recharge to the moraine aquifer. Average seepage into the moraine aquifer is estimated to be approximately 185 cfs (Hart Crowser, 1984). Most all of the hydrologic features that lie downgradient of the pool in the Cedar Falls area are influenced by the seepage losses. Seepage rates increase significantly in response to rising pool conditions and conversely decline as pool levels fall. The downgradient features respond in a similar manner as seepage rates, with increased spring activity, creek flow, and higher lake and aquifer water level conditions as pool levels rise.

A ground water divide exists downgradient of the Masonry Pool. This divide separates seepage return to the Cedar River basin from seepage to the Snoqualmie River basin. Approximately 75 percent of the total seepage loss to the moraine aquifer is estimated to return to the Cedar River basin, with the remaining 25 percent discharging to the Snoqualmie River basin (SPU, 2007). As seepage enters the moraine aquifer and moves downgradient on the south side of the divide, a portion is returned to the Cedar River via Canyon Creek. The remaining seepage on the south side of the divide, moves further downgradient to supply water to the Hobo Springs area, Rattlesnake Lake and eventually returns to the Cedar River by means of subsurface return flow south of Rattlesnake Lake.

Seepage which enters the glacial moraine aquifer on the north side of the ground water divide moves downgradient where a portion discharges to the upper reaches of Boxley Creek. The remaining seepage on the north side of the divide moves further downgradient to supply water to embankment springs, small lakes (Christmas Lake and Rainbow Lake), and eventually returns to the lower reaches of Boxley Creek by means of Rattlesnake Ditch (when lake elevations cause overflow of water to the north) and subsurface return flow on the north side of Rattlesnake Lake. A portion of the subsurface seepage return flow also discharges directly to the South Fork of the Snoqualmie River

There are three major areas of spring activity in vicinity of the embankment including Hobo Springs, Canyon Creek Springs, and Upper Boxley Creek Springs. Canyon Creek and Upper Boxley Creek Springs occur at elevations of around 1,350 to 1,400 feet. Hobo Springs occur lower on the embankment at an elevation of approximately 1,100 feet.

Ground water movement through the embankment includes both horizontal and vertical components of flow. The total head drop between Masonry Pool and Rattlesnake Lake is approximately 650 feet over a distance of 1.5 to 2.0 miles. Vertical gradients within the embankment are highly variable and are dependant on local geologic conditions.

Hobo Springs and Boxley Springs are two of the largest springs associated with seepage from Masonry Pool. Water seeps from Masonry Pool through a glacial moraine and emerges down gradient as springs that discharge to Rattlesnake Lake and Boxley Creek. Hobo Springs flows to Rattlesnake Lake, and Boxley Springs flows to Boxley Creek, a tributary to the Snoqualmie River.

Water quality at Hobo Springs and Boxley Springs is distinctly different than water quality at the Masonry Pool. Water quality at the springs is much higher in dissolved anions and cations, indicating a long residence time in the subsurface. The similarity in water quality between Hobo Springs and Boxley Springs also indicates that they have a common source (Masonry Pool) and similar residence time (Golder, 2006b).

2.3 Streamflow Depletion Associated with Pumping Well NB-3

The hydraulic connection between the Snoqualmie Valley Aquifer System and the Snoqualmie River indicates that associated base flows will be depleted due to pumping Well NB-3. Golder (2007c) performed calculations to estimate the depletion associated with pumping Well NB-3 based on estimated aquifer properties and distances between the well and the South Fork and the Middle Fork of the Snoqualmie River. The calculations employed a spreadsheet model (IGARF v4) published by The Environment Agency in the U.K. (EA, 2004). The IGARF spreadsheet used the method of Hunt (1999) to estimate the timing and magnitude of depletion on both forks of the river due to a single-day of pumping. Hunt's method calculates the effect of pumping a fully-penetrating well in a homogeneous, isotropic aquifer on a partially penetrating stream with a streambed permeability lower than the aquifer permeability. Because the Hunt equation is linear, it can be scaled to any operational ground water withdrawal rates and summed by superposition to calculate the depletion associated with any given pumping schedule.

Aquifer and streambed properties control the timing and magnitude of streamflow depletion predicted by the Hunt equation. Golder incorporated uncertainty in aquifer property estimates in estimating streamflow depletion by applying a range of aquifer property values. As described in Section 2.2.2, aquifer transmissivity estimates ranged from 99,400 to 316,000 ft^2/day. In addition, storativity values ranged from 0.01 to 0.12 and streambed conductivity was assumed to be one-tenth the horizontal conductivity of the aquifer based on limited field measurements and literature review. Based on this range of variation, Golder (2007c) defined 27 combinations of aquifer properties to reflect associated uncertainties. These parameter sets were input to the Hunt Equation to develop 27 depletion curves for single-day pumping. The IGARF spreadsheet model calculated depletion over a 20-day period. Most of the depletion to the Snoqualmie River for a single day of pumping is estimated to occur during the first (pumping) day and the following several (non-pumping) days (Golder, 2007c). Small quantities of residual depletion were calculated after 20 days (about 4% to 8% of the total volume pumped). As discussed in Section 2.4.2, in order to conform to the concept that 100% of the pumped volume will be expressed as stream depletion, the remaining 4%-8% was added evenly back into the 20-day period to estimate the mitigation requirement for each pumping day.

2.4 Mitigation Plan

Water appropriated from Well NB-3 is in hydraulic continuity with the Snoqualmie River and is therefore subject to minimum instream flow requirements established for the three control stations located farther downstream. North Bend has proposed that when regulatory instream flow requirements established for the Snoqualmie River at Snoqualmie Falls or Carnation, or for the Snohomish River at Monroe are not met, water from another source will be added to the river to replace the net streamflow depletion due to pumping associated with this water right.

Water production from North Bend's new water right will be limited to the capability of mitigation sources to offset net streamflow depletion caused by pumping Well NB-3 (or other sources added under this water right at a later date) when instream flow levels at the downstream control points are not met.

Documentation of water-supply sources, mitigation sources and transmission, return flows from the WWTP, the algorithm used to estimate mitigation requirements and control mitigation deliveries, and monitoring/reporting requirements will be contained in the Mitigation Operation and Monitoring Plan (e.g. Golder, 2007e). The plan may be updated to reflect changes in sources or available information based on an order from Ecology. A system of monitoring and reporting will be maintained to ensure that the mitigation plan is being followed (Sections 5.1 and 5.3). The mitigation reports will also provide the City with early warning if required mitigation volumes approach available mitigation capacity faster than anticipated so that development of new mitigation sources can be accelerated if required.

2.4.1 *Mitigation Sources*

The mitigation sources proposed in North Bend's plan related to G1-26617(A) are: (1) surface water at Hobo Springs purchased from Seattle Public Utilities (SPU); (2) ground water from Sallal wells purchased from the Sallal Water Association; and (3) surface water from the Tolt Pipeline purchased from SPU.

North Bend's preferred sources for mitigation supply water are water purchased from SPU via Hobo Springs and surplus water provided by the Sallal Water Association. Hobo Springs is an existing municipal point of diversion in the Upper Cedar Watershed, and has been designated as a point of diversion via an administrative claim amendment under the City of Seattle's Cedar River Claim (Water Right Claim 68624). The Sallal Water Association holds water rights for municipal water right supply purposes that also will be contracted to North Bend for water supply and mitigation.

The mitigation supplies that will be under contract are existing water rights from sources suitable for direct discharge to the Snoqualmie River or its tributaries. The infrastructure to deliver those supplies to the Snoqualmie River for mitigation will be constructed concurrently with increasing demand for municipal water supply, and will be ready to deliver mitigation water to mitigate the impacts of North Bend's new ground water withdrawals.

The SPU water supply contract will be structured so that North Bend has the ability to purchase the entire quantity of mitigation water from SPU under a worst case mitigation scenario at the maximum projected 50-year growth demand. To the extent of any seasonal supply limitations in the Hobo Springs source, the Sallal wells will be used to make up the necessary mitigation quantity pursuant to a water sharing and pricing agreement between North Bend and the Sallal Water Association. This will extend the period during which North Bend can rely on Hobo Springs as a primary mitigation source for its initial period of growth until it needs to construct another mitigation source to meet additional future growth.

The initial sources used to meet the mitigation requirement are surface water purchased from Seattle Public Utilities (SPU) via Hobo Springs and ground water purchased from the Sallal Water Association via existing wells. These two sources are available immediately. Surface water from the Tolt Pipeline (also covered under the SPU contract) can also be made available to meet future growth demands. However, while water from the Tolt Pipeline is legally available as a mitigation source, the timing associated with its introduction into the system is somewhat different than Hobo Springs and the Sallal wells, and will need to be further evaluated via an amendment to the City's Mitigation Plan as described in Section 5.4.2.

In operating its surface water supply sources, including the water from Hobo Springs and the Tolt River that have been contracted for North Bend's mitigation needs, SPU is obligated to meet instream flow requirements on the Cedar and South Fork Tolt Rivers to protect fisheries resources and aquatic habitat. On the Cedar River, instream flow management is governed by the Cedar River Instream Flow Agreement (IFA), a component of the Cedar River Watershed Habitat Conservation Plan (HCP). The IFA specifies a guaranteed flow regime as measured at the USGS stream gage below the Landsburg Dam.

Hobo Springs

Hobo Springs emanates from a hillside located approximately 7,000 feet northwest of the Masonry Pool, and were historically used by the Milwaukee Railroad and to supply the Town of Cedar Falls. Hobo Springs was also used to supply municipal water to the Sallal Water Association in conjunction with a pipeline from the Masonry Pool from 1970 until the Sallal wells were completed in 1986. Flows at Hobo Springs are captured through a large covered concrete spring box with a weir at the outlet.

The Hobo Springs project will use the existing spring collection box but will replace (and extend) existing pipeline to provide 8,700 feet of 16-inch pipe from the springs to a discharge structure on Boxley Creek just downstream of USGS gage 12143700. The 16-inch pipe will originate at the collection box and follow the Iron Horse Trail to the discharge structure. The pipe will initially provide 1,800 gpm (4.0 cfs) to the discharge structure via gravity flow, but will ultimately include a booster pump that will increase the capacity to 2,500 gpm (5.6 cfs). The Sallal wells will be connected into this system using an existing 12-inch pipeline and will therefore discharge at the same point on Boxley Creek.

Historical flow data for Hobo Springs were collected at the outlet weir. Historical data prior to 2006 were collected by SPU and are not well documented. The data are divided into three periods of record: 1976 to 1981, 2000 to 2005, and June 2006 forward. The older dataset consists of monthly average and monthly minimum values; the frequency of the data collection is unknown. The more recent dataset (2000 to 2005) consists of 179 measurements taken on a weekly to monthly basis. Of the 179 measurements, only 35 were taken during June through October, when flows below minimum instream flow requirements are most likely to occur in the Snoqualmie River. Continuous flow monitoring of the springs by North Bend began in June 2006 to obtain higher-resolution flow data.

The weir does not capture all of the flow discharging from Hobo Springs. Small channels were observed flowing around the weir during the field visit on March 9, 2006. Visual inspection suggests that the weir was capturing 60% to 70% of the flow during the field visit. The flow outside of the weir converges with the flow through the weir to form Hobo Creek below the intake structure and piping that historically transferred water to the Sallal water main. Golder (2007c) suggests that the actual flow available for diversion may be 20% to 40% more than what the weir data indicate. However, this estimate is subject to revision as more data become available, capturing this flow would require structural improvements and the amount of excess flow could vary seasonally.

Hobo Springs flow varies throughout the year, ranging from zero to almost 6 cubic feet per second (cfs) at the weir. Flow statistics from the springs are summarized on **Attachment 3**. Peak flows have historically occurred between May and August, with minimum flows occurring between November and March. Among the available flow data, data from 2001 to 2005 indicate slightly higher flows than the older record from 1976 to 1981. Minimum daily flows recorded on a monthly basis from the 2001-2005 record ranged from 5.0 cfs in July to 0.2 cfs in February and March. In contrast, minimum daily flows during the 1976-1981 record showed high values of 3.8 cfs in May, June and July and low values of 0 cfs in December and 0.007 cfs in January. Minimum average monthly flows are typically higher than minimum daily flows per month. During the 2001-2005 period they ranged from 0.3 cfs (March) to 5.0 cfs (July); and during the 1976-1981 period from 0.02 cfs (December) to 5.0 cfs (June). While recent (2006) monitoring suggests that flows vary little from day-to-day, the unknown number of measurements supporting flow statistics from the 1976-1981 period makes it difficult to ascertain the relative duration (per month) of the minimum daily flows versus the minimum average monthly flows. Minimum average monthly flows are further exceeded by average monthly flows, but are subject to the same statistical limitation for the 1976-1981 period. A possible explanation for the differences in flows between 1976-1981 and 2001-2005 records is that Sallal withdrawals were not accounted for in the weir estimates during the earlier Hobo Springs record.

The travel time for water flowing from the mitigation system discharge point on Boxley Creek to the South Fork of the Snoqualmie River confluence with the Snoqualmie River was predicted to range from 7.8 to 13.2 hours (Golder, 2007c). In general, the predicted travel times increase as streamflow decreases. Therefore, it will take the mitigation water that is added to Boxley Creek longer to reach the South Fork of the Snoqualmie River during low flow periods in Boxley Creek.

Sallal Wells

A second source of mitigation is being made available to North Bend by agreement with the Sallal Water Association. Two of Sallal's existing wells are located in close proximity to the 16-inch pipeline that will connect Hobo Springs to Boxley Creek, and will be tied into the 16-inch pipeline via a 12-inch pipeline to deliver mitigation water whenever the supply from Hobo Springs is inadequate for the full mitigation requirement. Up to 35% of Sallal's water right, 243.6 AFY, is available to North Bend from Sallal wells 1 and 2 for mitigation purposes as a supplement to the Hobo Springs source. The Sallal mitigation source provides reliability to insure that the impacts of the new North Bend water right can be mitigated even with one of the mitigation sources temporarily off-line.

The Sallal wells are located in the Snoqualmie River watershed near Rattlesnake Lake. The ground water source for these wells is the Recessional Outwash deposits which are part of the Cedar Moraine Aquifer System (Section 2.2.3).

The Sallal Water Association is a private cooperative system that serves water to approximately 2,000 connections. Water is supplied from 4 production wells, and the majority of its water comes from Wells 1 and 2 located in the Snoqualmie River Watershed. These two wells supply over 80 percent of the total water system demand. Well 3 is located near the Edgewick Reservoir. Sallal's current water rights consist of a single right to withdraw 696 acre-feet annually, with a maximum withdrawal rate of 1,600 gpm from Wells 1 and 2. The Association also has a non-additive (supplemental) water right to 102 acre-feet per year with a maximum withdrawal rate of 91 gpm for Well 3. The Sallal Water Association holds the following water rights:

Table 4. Water Rights held by Sallal Water Association

Water Right #	Qi (gpm)	Qa (afy)	Source	*Comment*
G1-24671	1600	696	Wells 1 & 2	
G1-24975	91	102	Well 3	Annual volume is non-additive
Total	1691	696		

During periods when low flows are anticipated from Hobo Springs, Sallal will designate one of the wells listed under G1-24671 to mitigation production and 20 to 25% of production from the second well as necessary. To accomplish this, Sallal anticipates two phases of construction. The initial installation will include a 12-inch pipeline from Sallal Well 2 to the 16-inch pipeline between Hobo Springs and Boxley Creek. The second phase, if necessary, will include a new pipe to Sallal Well 1 with the valving needed to allow some of the production to be added to the mitigation system. With all of the Sallal Well capacity in place, North Bend will have instantaneous access to at least 800 gpm during phase one construction with expansion to 1,000 gpm during phase two. The 12-inch pipeline has a design capacity of 1,000 gpm (2.2 cfs).

Tolt Mitigation Pipeline

When the City's demand approaches the capacity of Hobo Springs and the Sallal wells, North Bend will be able to add additional mitigation capacity by purchasing and delivering water from SPU's Tolt Pipeline to the North Fork Snoqualmie River via a 4-mile pipeline along Deep Creek.

As North Bend plans, engineers, and constructs additional mitigation source capacity beyond Hobo Springs and the Sallal wells, it will need to document the new mitigation sources and update the Mitigation Operation and Monitoring Plan (including the mitigation algorithm) to account for the operation of additional mitigation sources. These updates shall be submitted to Ecology for review and approval consistent with the conditions set forth in this Report of Examination (Section 5.4.2). Changes to the mitigation planning documents should also be incorporated into North Bend's CWSP updates and/or amendments.

2.4.2 *Calculating Streamflow Depletion for Mitigation*

On days when mitigation is required, the mitigation requirement will be calculated by aggregating streamflow depletion generated by pumping withdrawals over the prior 20 days. In addition, the mitigation requirement will be based on the *net* impact of streamflow depletion, which accounts for return flow from the wastewater treatment plant. The concepts of aggregate streamflow depletion and net streamflow depletion are discussed below.

Aggregate Streamflow Depletion

The IGARF spreadsheet model calculated streamflow depletion due to a single day of pumping over a 20-day calculation period. As mentioned above, only small quantities of residual depletion existed beyond 20 days (about 4% to 8% of the total volume pumped) after pumping. To limit calculated streamflow depletion values to operationally plausible rates and avoid rounding errors on small values, North Bend proposed to divide the remaining percentage beyond 20 days by 20 and add that volume evenly add back into the 20-day period, thus ensuring that the pumping streamflow depletion equals the associated daily volume of ground water pumping within 20 days of pumping the well.

The streamflow depletion curves can be used to calculate depletion on any given day based on pumping during that day and the preceding 20 days. All of these depletion curves can be summed to obtain an "aggregate streamflow depletion curve". However, for the practical purpose of mitigating depletion, it is impossible to calculate the depletion volume resulting from the same day of pumping until that day is complete and the actual pumping volume is known. North Bend proposed to address this problem by modifying the depletion curves to transfer the "same-day" depletion volume into the second day of the 20-day curve. Therefore, for any given day, streamflow depletion can be estimated based on the depletion curves for the prior 20 days of pumping.

In order to account for aquifer property uncertainties, Golder (2007c) developed 27 depletion curves that correspond to various combinations of aquifer property estimates. By considering all 27 aggregated depletion curves, the maximum of the curves can be used to define the "maximum predicted aggregated depletion". Initially, the "aggregate streamflow depletion" will be considered to equal the "maximum potential aggregate depletion". See Section 5.5 to determine how the numbers used to calculate the "aggregate streamflow depletion" can be updated.

Net Streamflow Depletion

North Bend has proposed that while the depletion curves can be used to estimate the maximum potential aggregated depletion associated with pumping, the quantity of depletion that must be mitigated is less than the total aggregated depletion due to discharge from the wastewater treatment plant (WWTP) associated with pumping the new water right. This depletion quantity, herein termed "net stream depletion", is defined with the following equation:

Net Stream Depletion = Aggregate Streamflow Depletion – WWTP Return Flow

The daily volume of WWTP return flow is calculated with the following equation:

$$V_{wwtp} = V_{NRA} * f_{wwtp}, \text{ where}$$

V_{wwtp} = daily volume of water returned from wastewater treatment plant [gallons per day]

V_{NRA} = annual volume of water from new water right [gallons]

f_{wwtp}, = percentage of annual produced volume from new water right that is returned to the river on a daily basis as WWTP flow. [1/day]

V_{NRA} represents a running total of gallons pumped over the preceding 365 days. The f_{wwtp} factor is based on the fraction of total annual water demand that is returned to the river, and is normalized to a daily basis by dividing the annual return flow fraction by 365. Initially f_{wwtp} will be equal to 0.001644 (an annual value of 0.60, as discussed in Section 2.1.4, divided by 365 days); however, f_{wwtp} may change as new residences are constructed which rely on the WWTP instead of septic tanks. Therefore, f_{wwtp} may be updated periodically with revisions to the mitigation operation plan or more frequently if necessary using the last six years of continuous data.

2.4.3 Mitigation Algorithm

The mitigation algorithm defines the rules and calculation methods for determining the daily mitigation requirement under reasonably foreseeable scenarios. The algorithm is capable of implementation under the operational conditions of North Bend's water system, and is summarized in **Attachment 4**. The algorithm was developed for withdrawals from Well NB-3 with Hobo Springs and Sallal Well mitigation sources, but can be expanded to include additional sources at a later date.

The first step in the algorithm is to determine the source of the water produced by North Bend in the preceding 24 hours. If 100 percent of the produced water (V_{24}) was from the senior Mt. Si Springs water right, then there is no mitigation requirement from this withdrawal. However, if any of the produced water (V_{24}) is from the new water right (i.e. Well NB-3), then it is necessary to calculate the volume of the water produced from the new water right over the past 24 hours (V_{NR}). The pumping history of Well NB-3 is then used to calculate the aggregated stream depletion based on ground water withdrawals from the previous 20 days.

The streamflow and instream flow requirements at each of the three USGS gages during the preceding 24 hours are also compared each day to determine if the minimum instream flow requirements at each of the three USGS gauges have been met. If the instream flows have been met consistently for the 24-hour period, then there is no mitigation requirement. However, if the minimum measured streamflow at any of the 3 gages during the preceding 24 hours was below the minimum instream flow requirement, instream flows were not met and it is necessary to determine the daily volume of mitigation water needed to offset net stream impacts.

The daily mitigation volume is equal to net stream depletion as defined above. The aggregated streamflow depletion resulting from ground water withdrawal is calculated based on the pumping history from approved points of withdrawal under this water right over the past 20 days. The daily volume of WWTP return flow is calculated by updating the annual volume of water pumped from the new water right (V_{NRA}) on a daily basis as a 12-month running total and is based on the most recent value of f_{wwtp} approved by Ecology.

The City will input the necessary data into a database at the beginning of each 24-hour period, and the database will calculate the net stream depletion. Data required to perform this calculation include V_{NR} and minimum streamflows measured at the 3 instream flow control points over the past 24 hours. The database will store all of the necessary water system information to calculate mitigation needs and assist the water system operators in decision making related to the mitigation system. The database will also store information regarding mitigation requirements and mitigation deliveries during preceding recent days, and will add any prior mitigation shortfalls to the mitigation requirement for the current day.

The daily mitigation volume (net stream depletion) is converted into a daily rate (Q_M) so it can be compared to the Hobo Springs flow. If there is adequate Hobo Springs flow ($Q_h > Q_M$) then Hobo Springs can supply the entire mitigation requirement. However, if there is inadequate flow from Hobo Springs, then it is necessary to calculate the volume of mitigation water needed from the Sallal wells. The daily rate of mitigation water needed from the Sallal wells (Q_s) is the difference between Hobo Springs flow and the daily mitigation requirement. The instantaneous rate (Q_s) is compared to the instantaneous portion of Sallal's water right contracted to North Bend for mitigation. If Q_s is less than the contracted portion of the water right, then the two mitigation sources can mitigate 100 percent of the net stream depletion resulting from the new water right. If Q_s is greater than the contracted instantaneous portion of the water right, the production from Well NB-3 will be limited to the mitigation capacity provided by Hobo Springs and the instantaneous portion of Sallal's water right contracted to North Bend. Q_s is then converted to a volume (V_s) and added to the total volume of water produced by Sallal for North Bend's mitigation during the calendar year thus far (V_{st}). The accumulated total volume (V_{st}) is compared to the annual portion of Sallal's water right contracted to North Bend for mitigation. If V_{st} is less than the contracted portion of the water right, then the two mitigation sources can mitigate 100 percent of the net stream depletion resulting from the new water right. If V_{st} is greater than the contracted annual portion of the water right, the production from Well NB-3 will be limited to the mitigation capacity provided by Hobo Springs. Additional mitigation capacity could be obtained by development of additional mitigation sources or implementation of the City's water consumption curtailment plan.

2.4.4 Mitigation Monitoring and Operations

Every morning, the City will monitor production during the previous 24 hours at Mt. Si Springs, Well NB-3, WWTP flows, USGS streamflow gages on the Snoqualmie River and Boxley Creek, Hobo Springs flow, mitigation water pumped from Hobo Springs and Sallal mitigation pipeline flows. The data will be conveyed via telemetry to the Public Works Department from Mt. Si Springs, Well NB-3, the USGS gauges, Hobo Springs (consecutive data from both the weir and the mitigation intake) and the Sallal Water System. Relevant data will be processed by the database to calculate the mitigation requirement for that day.

Under normal operating procedures, the City will supply the calculated volume of mitigation water (V_M) within the next 24 hours. Any delays in obtaining the necessary information to calculate the previous day's mitigation requirement will require Q_M to be recalculated from V_M using a smaller amount of time and will be available through the database calculations. For example, if the calculations are completed two hours late, then Q_M is calculated using a period of 22 hours or 1320 minutes: $Q_M = V_M /1320$. If normal operating procedures are not possible to maintain (e.g., there is an emergency), then the part of the daily aggregated mitigation requirement that is unfulfilled is added to the mitigation requirement for the next possible day. The rate and volume of mitigation water from each mitigation source will be monitored when in use. Water delivery to Boxley Creek will also be monitored. If monitoring indicates that the City has under-mitigated during normal operations, then the unmitigated volume is added to the next day's mitigation requirement.

Mitigation water will be supplied from either Hobo Springs or from Sallal wells. The aggregate volume of mitigation water will be added using remote switches and valves at one or both of the available mitigation sources to provide flows to the South Fork of the Snoqualmie River via Boxley Creek.

Emergencies that would require contingency responses range from a lack of supply to mechanical failure of the system. Mechanical failures will be promptly addressed and repaired. The Mitigation Operation and Monitoring Plan (Golder, 2007e) describes responses to power failures, gage or metering failures, and engineering failures. Specifically, the plan describes how mitigation quantities would be estimated in response to missing data and how any unmet mitigation requirements would be introduced on the first possible day after a mechanical failure. While the City's access to multiple mitigation sources (Hobo Springs and the Sallal wells) provides some redundancy in case of mitigation-source failure; insufficient mitigation capacity will result in alerting customers of the situation, implementation of the City's emergency water shortage plan and activation of the Sallal/North Bend intertie for flow into North Bend. The City's emergency response plan is described in its Comprehensive Water System Plan (North Bend, 2002).

2.4.5 Mitigation Capacity

Golder (2007c) performed a series of analyses to estimate the total mitigation requirement associated with this new water right and the capacity of Hobo Springs and the Sallal wells to meet this requirement

Golder (2006a) first employed a probabilistic (Monte Carlo) model to simulate the total annual mitigation requirement regardless of source. The model distributes projected growth in annual demand into average monthly pumping rates based on monthly demand profiles consistent with the actual 2003 production, and assumes that the impact from pumping is realized instantaneously in the Snoqualmie River. WWTP flows are assumed equal to 60% of annual pumping. Actual streamflow record was modeled with random selection of the first year of record (subsequent years followed, and the streamflow record was permitted to "wrap" around back to the beginning), and was compared on a daily basis to minimum instream flow requirements. Mitigation volume probability distributions at full build out (51 years of growth) indicate average 5% and 95% percentile values varied from 101 to 1020 AFY (0.09 to 0.91 mgd) respectively with a median value (50th percentile) of 482 AFY (0.43 mgd). This compares to a net mean annual consumptive use (pumping minus WWTP return flow) of 1,230 AFY (1.10 mgd) at full build out.

While the probabilistic model prepared by Golder (2006a) estimated total required mitigation volumes, it did not evaluate the capacity of currently available sources (Hobo Springs and the Sallal wells) to meet the mitigation requirement over time. Such evaluation of source capacity further required that the model consider day-to-day variations in pumping (instead of using monthly averages) and the timing of estimated streamflow depletion curves (rather than assuming instantaneous depletion). In order to reliably evaluate the mitigation capacity of Hobo Springs and the Sallal wells, Golder (2007c) adopted a simple, comprehensive, and very conservative spreadsheet model developed by Pacific Groundwater Group (PGG, 2006).

PGG's model incorporates daily variations in pumping (peaks) and can be used to represent estimated streamflow depletion schedules derived from actual pumping schedules. The model employs similar assumptions regarding monthly pumping distribution and WWTP return flow as Golder's probabilistic model, but also assumes that instream flow requirements are not met on the *maximum* number of days per month that flow requirements were historically not met at *any* of the 3 downstream gages over a 30-year record (1970-1999), and that Hobo Springs discharge occurs at the *minimum* observed daily rate for each month (every day of the month). These assumptions imply that PGG's model will underestimate the mitigation capacity of the two mitigation sources for any given streamflow depletion relationship.

Golder (2007c) applied the maximum aggregated streamflow depletion to PGG's model and determined that the City of North Bend has an adequate supply of water using Hobo Springs and Sallal wells for 27 years. At 27 years, the average mitigation requirement from the new water right will be approximately 0.63 mgd (701 AFY), of which approximately 226 AFY was predicted to come from the Sallal wells and 475 AFY from Hobo Springs. The projected mitigation supply is very sensitive to the volume assigned to Hobo Springs discharge because most of the mitigation water will be provided by Hobo Springs. Golder (2007c) performed a less conservative analysis in which the model assumed *minimum average monthly* Hobo Springs discharge rather than *absolute minimum* observed discharge for each month. As discussed in

Section 2.4.1, statistical interpretation of existing spring flow data is limited by sparse and/or irregular data frequency. Use of minimum average monthly discharge values increased the capacity of the two sources to 34 years of build-out.

PGG's model was originally designed to evaluate how far along North Bend's projected growth in water demand could be supported by existing mitigation supplies. The model specified Hobo Springs flow on a monthly basis and treated Sallal pumping as an annual "bank account" that could be drawn upon as needed. However, Sallal's contribution is limited to both the annual volume contracted with North Bend (243.6 af) and the maximum instantaneous capacity available from its sources (1,000 gpm). Golder (2007c) modified PGG's model to allow comparison of the peak daily mitigation requirement from Sallal's wells for each month with the instantaneous mitigation capacity from the wells. Golder's analysis conservatively employed the absolute minimum observed values of Hobo Springs discharge for each month to estimate the maximum likely instantaneous flow needed from the Sallal wells for each month. Estimating streamflow depletion with the maximum aggregated value suggests that the mitigation capacity of Sallal's wells would be fully exercised after 21 years of growth.

It is worth noting that the streamflow depletion curves may be updated within two years of Well NB-3 being brought into production based on additional aquifer testing at Well NB-3. Refinement of the 27 curves may change the results of mitigation capacity modeling performed with PGG's model. In order to evaluate a more conservative scenario, Golder (2007c) used PGG's model to evaluate mitigation source capacity based on *instantaneous streamflow depletion* rather than the maximum aggregated depletion derived from the Hunt model. This analysis differs from Golder's probabilistic model because it considers peak daily pumping behavior and requires full mitigation of all pumping peaks (regardless of whether they occur on days when instream flow requirements are not met). Using these assumptions, Golder's analysis indicates that the City of North Bend has an adequate supply of water using Hobo Springs and Sallal wells for 23 years (based on the maximum *annual volume* of water available from the Sallal wells) and 16 years (based on the maximum *instantaneous capacity* of the Sallal wells). This highly conservative analysis serves as a minimum endpoint for the capacity of the two mitigation sources. Even with possible changes to the streamflow depletion curves, depletion from Well NB-3 will never be instantaneous (there will always be some time lag). Golder's analysis therefore demonstrates that even under the most conservative depletion assumptions, North Bend has a sufficient time period to develop new mitigation capacity as water demand increases.

2.5 Fishery Related Issues

While Snoqualmie Falls forms a natural barrier to upstream migration of anadromous salmon, the system above the falls provide habitat for resident fish populations, including cutthroat and rainbow trout, white fish and sculpin, (Haring 2005).

Below the falls, the Snoqualmie River system support significant runs of anadromous salmonids, including coho, chinook, chum, and pink salmon, steelhead trout, as well as bull trout/Dolly Varden, and other resident trout species. NOAA Fisheries has identified Snoqualmie populations of Chinook as threatened under the Endangered Species Act. Thus water quality and quantity–related impacts to the Snoqualmie River resulting from activities in the City of North Bend could contribute to cumulative impacts on Chinook downstream of the falls.

Since North Bend's withdrawals will be mitigated on a real-time basis, when instream flows are not met, this project should be neutral to fishery conditions. Under this first phase of the project, mitigation water will be delivered directly into the Snoqualmie system via Boxley Creek, which is a natural tributary to the South Fork Snoqualmie River. Boxley Creek is fed in part by Boxley Spring, which has very similar water quality parameters to Hobo Springs.

This application and the associated mitigation proposal have been reviewed by Steve Boessow of the Washington Department of Fish and Wildlife (WDFW). The WDFW originally had two areas of concern; the first being the potential risk of disease transmittal between the Cedar and Snoqualmie River Basins, and second being a reduction of instream flows in the Snoqualmie system.

Since the use of Hobo Springs as a source of mitigation water to the Snoqualmie River was originally proposed, extensive investigation has been done to rule out the transmittal of Infectious Hematopoietic Necrosis Virus (IHNV) from the Cedar River into the Snoqualmie River basin. It has been concluded, with the Washington Department of Fish and Wildlife in concurrence, that the risk of transmittal is negligible (Conrecode, 2006). The evidence for reaching that conclusion is based, in part on the following factors:

- IHNV is transmitted by anadromous salmon especially sockeye, and no anadromous fish go above Cedar Falls, so it is very unlikely IHNV is in the Masonry Pool.
- Masonry Pool water travels through a glacial moraine consisting of sand and gravel, and IHNV has a very limited life span outside of a host. As it passes through the glacial material multiple factors work to inactivate or remove IHNV; time, water quality changes, and substrate composition.
- A hydraulic connection has existed between the two basins for over 100 years, since SPU developed the Cedar as a water source. As a result of the Cedar River water supply project, water from the Cedar River already discharges into the Snoqualmie River system via Boxley Springs which feed Boxley Creek. There has been no previous detection of IHNV in the Snoqualmie Basin.

Mr. Boessow has indicated that he has no objections to the proposal based on concerns about disease transmittal. Nor does the agency object to North Bend's plan to mitigate on a real-time basis with imported water, provided that the applicant can manage the mitigation system such that instream flows are not adversely impacted (Boessow, 2007)

2.6 Effects to Existing Water Rights

Ground Water:

Golder's aquifer test report for Well NB-3 did not include estimation of long-term drawdown associated with using the well at the rates requested in North Bend's water right application. However, Golder (2007c) performed additional calculations to estimate drawdowns in neighboring wells using the production capacity of Well NB-3 (2,500 gpm). Ecology's well log database lists 165 wells within 10,000 feet of Well NB-3. The current status of these wells is unknown. No wells are noted in the Ecology database within 500 feet of the Well NB-3. Golder (2007c) estimated the potential range of drawdown for each well after 120 days of pumping at 2,500 gpm. Drawdown estimates were generated using lowest transmissivity (T=99,400 ft2/d) and storativity (S=0.05) values cited in the well report (Golder, 2007b) and the highest transmissivity (T=316,000 ft2/d) and storativity (S=0.12) values to bound the range of potential impacts to neighboring wells. The drawdown estimates may over-predict actual drawdown because they were generated using the Jacob equation, which assumes isotropic, homogenous aquifer properties and no influence of river boundaries. Upper-end estimates of drawdown typically ranged from 1 to 3 feet, and lower-end estimates were typically smaller than 0.8 feet. Based on this analysis, it appears that there are no ground water users in the vicinity of NB-3 that will be impaired by the operation of the well.

Surface Water:

Department of Ecology's records indicate that downstream from North Bend on the Snoqualmie River 56 surface water certificates have been issued and 47 surface water claims were filed. The certificates were generally issued for irrigation, and the claims generally were filed for general domestic purposes. Since North Bend intends to provide a continuous source of mitigation water to the Snoqualmie River, when the instream flows are not met, this project will be neutral and not affect downstream water right holders at lower stream flows. There are, however, two larger surface water rights located downstream of the City of North Bend's production well that should be addressed in more detail, specifically the Snohomish River Regional Water Authority's water supply project, and Puget Sound Energy's Snoqualmie Falls hydro-electric project.

The Snohomish River Regional Water Authority (RWA) holds surface water certificate 10617, priority date August 20, 1951, to divert 27,219.5 acre-feet per year from Ebey Slough, which is a distributary of the Snohomish River near its mouth, at an instantaneous diversion rate of 56 cfs. Under this authorization, diversions between the months of July through October are subject to increased regulation and partial curtailment. Additionally, the RWA's ability to divert is limited by Total Maximum Daily Load (TMDL) considerations when Snohomish River flow at the Monroe gauge is 1350 cfs or lower. Without North Bend's mitigation program, the RWA's ability to divert water could be impaired if North Bend's withdrawals were to increase the duration of time that flows dropped below 1350 cfs from July through October.

However, since North Bend will be augmenting flows in the river to offset their consumptive streamflow depletion if the streamflow at the Monroe gauge was to drop below 1350 cfs (lowest instream flow level for this gauge is 2000 cfs), there will be no impact to the RWA. The continued monitoring of the Monroe station is a condition of this permit's issuance. Water quality is anticipated to remain neutral.

An additional consideration is Puget Sound Energy's existing water right claim (water right claim number 160814) to utilize the Snoqualmie River for hydroelectric power generation at its Snoqualmie Falls powerhouses. While actual impacts to the flow of the river are very minor in proportion to overall flows, there is still a reduction in total stream flow available to PSE. PSE and the City of North Bend have reached a private agreement to compensate for the reduction in power generating capacity.

2.7 Consideration of Protests and Comments

Ecology received two protest letters during the public notice process, from local residents William Francis and Obe Healea, Jr. Ecology also has a letter of concern on file from Ewing Stringfellow. Mr. Francis and Mr. Stringfellow's primary concerns were that North Bend's proposed new wells could impact local domestic, irrigation, and stockwatering wells. In particular they were concerned about the operation of NB-1 which was found to effect neighboring domestic wells during initial pump-testing. Since the first phase of this project addresses only NB-3, which is situated nearly a half mile south of NB-1 it is not anticipated that Mr. Francis or Mr. Stringfellow's wells will be affected. Future consideration of whether NB-1 can be operated without impact to neighboring water users will need to be thoroughly addressed when that well is considered whether it can be added to this water right.

Mr. Healea, Jr. a resident of North Bend and former Mayor indicated in his letter that the Mt. Si Spring source provided sufficient water to meet North Bend's needs. He indicated that the water right issued for the springs did not restrict the amount of water that could be put to beneficial use. His position, however, is not consistent with the Department of Ecology's interpretation of the right which limits the total annual usage to only 336 acre-feet per year.

When allocating water for a beneficial use, it is generally assumed that Ecology authorizes a specific amount deemed adequate to satisfy the specific intent of the application. Thus while the quantities allocated for any given permit address future need, that future demand is not open-ended, and it is assumed that communities will seek additional water rights as the need arises. In the case of surface water certificate S1-00620C the application was reviewed by Ecology in 1965, and it was determined that to meet the projected future needs of a 1980 population a total of 336 acre-feet per year would be needed. The calculation supporting the annual allocation are discussed in the original Report of Examination, and included as provisions in the Permit issued to North Bend.

North Bend has acknowledged the annual allocation of the surface water right, imposed strict conservation standards and actively sought additional rights to meet future needs.

Tulalip Tribes

While not formal objectors to North Bend's application, the Tulalip Tribes have been actively engaged in the process and has submitted several comment letters to the Department of Ecology. North Bend is within the Snoqualmie River Basin which is within a portion of the Tulalip Tribes' treaty-protected usual and accustomed hunting, fishing and gathering area. The Tulalip Tribes have remained actively engaged in the review of North Bend's water right application.

Comments received from Tulalip Tribes technical staff have been addressed and incorporated in the preparation of North Bend's mitigation proposal. In particular, the Tribes comments have been used to shape the monitoring and reporting requirements of this project.

Comment letters of significance from the Tribe include:

1. *March 26, 2007, letter from Anne Savery on behalf of the Tribe to Gina Estep in response to North Bend's issuance of a MDNS for the SEPA determination.* Ms. Savery noted in her comment letter that impacts of pumping ground water from Well NB-3 are reported to be fairly evenly distributed between the Middle and South Forks of the Snoqualmie River, and that mitigation water from Hobo Springs and the Sallal wells will be introduced to Boxley Creek, a tributary to the South Fork, leaving impacts in the Middle Fork unmitigated. The Tribes' concern regarding the location of the mitigation is due to the impact of withdrawing shallow ground water and surface water from the river on the food web in the Middle Fork. They are concerned that primary productivity of the Middle Fork may be disrupted by the operation of Well NB-3, especially if the pumping rate is not constant, or if the pump cycles on and off frequently.

   North Bend responded that the mitigation flows will enhance the ecosystem of both the South Fork Snoqualmie River and Boxley Creek by adding water to the interstitial spaces of the hyporheic zone to further improve the habitat for primary producers and macroinvertebrates during times of low flows by helping to maintain the wetted width of a continuous river reach that is 2.5 times longer than the bypass reach on the Middle Fork Snoqualmie River. The City anticipates that the proposed mitigation measures for withdrawals at Well NB-3 will result in no net impact to the primary productivity on the Snoqualmie River watershed.

2. *April 9, 2007, letter from Anne Savery to the Department of Ecology regarding the draft version of the Mitigation Supply Report (Golder, 2007c).* The Tribe expressed a variety

of concerns, including: potential impacts of no-flow boundaries not represented by the streamflow depletion modeling; assumptions regarding streambed permeability in depletion estimation; uncertainties in aquifer properties remaining from the Well NB-3 pumping test; consideration of a zero-time lag scenario for the mitigation algorithm; the distribution of depletion between the South and Middle Forks of the Snoqualmie River; potential impacts to the food chain of the hyporheic zone of the Middle Fork Snoqualmie River; and the fact that the depletion curves used for mitigation move the first-day-of-pumping depletion impacts to the subsequent day. The Tribe's letter also included a technical memorandum from their consultant Joel Massmann. On behalf of North Bend, Golder responded in a detailed matrix format to the Tribes questions on May 10, 2007.

3. *May 18, 2007, letter from Anne Savery to Nicole DeNovio (Golder) regarding the draft version of the Mitigation Operations and Monitoring Report (Golder, 2007e).* The Tribe submitted comments regarding the timing for bringing the Sallal mitigation wells online, updating calculations regarding the WWTP return flows, releasing mitigation water, and additional aquifer testing on Well NB-3. Other comments generally addressed mitigation reporting. On behalf of North Bend, Golder addressed these comments in a response to both Ecology and the Tribe dated May 24, 2007.

2.8 Quantities Recommended For Permit / Supply And Demand Analysis

North Bend's 50-year water demand projection is detailed in a March 23, 2004, report by Ron Garrow, North Bend Public Works Director, titled, "North Bend Water System Water Demand Forecast" (Demand Forecast). Appendix A presents the City's projection of additional 50-year water demand for North Bend and the UGA, which excludes existing water rights and shows the reduction in demand due to implementation of North Bend's conservation plan (North Bend, 2004).

The UGA growth demands are included in this application because North Bend will ultimately be the water service provider for all of the UGA. North Bend will provide wholesale deliveries of water to Sallal Water Association until North Bend's water service area expands to include all property within the UGA. Including the UGA demand within Application G1-26617 insures that new development will be served from a water source with mitigated impacts on stream flow.

North Bend has calculated a projected 50-year demand of 3,061,375 gallons per day (average daily demand) or 3,430 acre-feet per year. Since the City already holds rights to 336 acre-feet per year they need to secure additional rights in the amount of 3,094 acre-feet per year. This is the annual quantity recommended for this permit. The instantaneous quantity recommended for this permit is 2,646 gpm, as originally requested by North Bend.

These projections are consistent with other regional water planning efforts, specifically the 1989 East King County Coordinated Water System Plan, which was developed to assess water supply needs within East King County. The Plan projects that the region will have a 20 to 30 million gallon per day shortfall by the year 2025 if current growth rates are sustained and no new water rights are granted.

3. FINDINGS AND CONCLUSIONS

Chapter 90.03 RCW and Chapter 90.44 RCW authorize the appropriation of public surface and ground water for beneficial use and describe the process for obtaining water rights including the process to amend or change existing rights. Laws specifically governing the water right permitting process are Chapter RCW 90.03.250 through 90.03.340 RCW and Chapter 90.44.050 through 90.44.080 RCW.

Under state law the following four criteria must be met for an application to be approved:

- Water must be available
- There must be no impairment of existing rights
- The water use must be beneficial
- The water use must not be detrimental to the public welfare

3.1 Water Availability

Water must be both physically and legally available for appropriation.

> Physical Availability: Well NB-3 has been constructed, tested, and its potential effects have been evaluated and modeled. A pumping test has indicated that the well can produce 2,500 gpm. Based on the results from the pumping test and other hydrogeologic investigations, it is reasonable to conclude that the aquifer is physically capable of providing the requested 2646 gpm.
>
> Legal Availability: Under the provisions of WAC 173-507-030 the State has made a determination that water is not available for appropriation from the Snoqualmie River tributaries of Griffin, Harris and, Patterson Creeks and also the Raging River. These sources are closed to further appropriation. All of these sources enter the Snoqualmie River downstream of the City of North Bend and in evaluating the City's proposal it has been determined that these water bodies are beyond the extent of any impacts from the operation of the City's wells.

Water is therefore available for appropriation under existing Ecology regulations. It is physically available and also legally available in that this withdrawal will not affect surface water closures contrary to the intent of WAC 173-507.

3.2 Impairment of Existing Rights

For the Washington Department of Ecology (Ecology) to determine that water is available for appropriation, the City of North Bend must demonstrate that they can provide mitigation for their impacts such that the provisions of the instream flow regulations are not violated. It has been determined that the approval of this application will not impair existing rights. Potential impairment of both senior water right holders and instream flow levels has been adequately addressed.

The City has entered into an agreement with Puget Sound Energy to compensate for lost revenue associated with diminished generating capacity, related to impairment of the surface water claim, at the Snoqualmie Falls hydro-electric facility. No other surface water rights will be impaired.

Wells in the vicinity of NB-3 may experience interference drawdown due to pumping of the production well. However, this interference is calculated to not be large enough to cause impairment of any existing wells that adequately penetrate the aquifer.

New appropriations from the Snoqualmie River watershed at North Bend are subject to minimum instream flow levels established at control stations located downstream at Snoqualmie Falls, Carnation and Monroe, (WAC 173-507-020(2)). While operation of this source will affect flows in the Snoqualmie River system, the applicant has secured sources of mitigation water that will be used to offset any adverse impacts on a daily basis when instream flows are not being met.

3.3 Beneficial Use

According to RCW 90.03.015(4), RCW 90.14.031(2), and RCW 90.54.020(1), municipal water supply purposes is considered a beneficial use of water.

3.4 Public Interest

No detriment to the public interest was identified during the investigation of the subject application. The following were considered in reaching this conclusion:

Public Interest Test Criteria	Comments
Impacts to water quality in hydraulically connected surface water.	Since this proposal provides real-time mitigation water to offset impacts to the Snoqualmie system, the withdrawals authorized by this appropriation will not adversely affect regulated surface waters in the basin.
Population growth and lack of alternative supply	This appropriation is for a beneficial use in a municipal area, it is intended to provide a safe reliable supply to an existing municipal population.
Economic development and lack of alternative supply	This appropriation proposal supports additional economic development in the area. Water will be available to meet new industrial, commercial and domestic needs.
Human health needs	This public water system supplies safe potable water to an existing domestic population.
Promotion of regional public supply systems	This application promotes regional water supply serving the City's urban growth area, as well as the Sallal area,
Potential for aquifer contamination/pollution	The approval of this application is not expected to result in aquifer contamination or pollution. North Bend has an established wellhead protection program associated with Mt. Si Springs, and samples on a regular basis. Monitoring of any new sources will be required by the Dept. of Health.

Potential for cumulative impacts to other water users	There are numerous water rights that have been issued for this general area, Ecology has evaluated these rights and determined that these rights are not redundant and do not conflict with each other.
Consistency with water resource fundamentals of RCW 90.54	This permit meets the fundamentals of state water law, specifically: RCW 90.54.005 – Objectives to provide water for residential needs RCW 90.54.020 – Protect stream baseflows RCW 90.54.920 – No impairment of existing rights
Impacts to perennial base flows or established minimum instream flows	Base flows should not be impacted by this permit, and will be increased in Boxely Creek.
Impacts to aquatic habitat	Aquatic habitat will not be impacted by the approval of this application.
Impacts to recreation or navigation uses	There is no detriment to recreation or navigation uses expected under this proposal.
The extent to which the proposal advances water conservation and efficient use	North Bend has an existing conservation program, and intends to remain in compliance with all new standards for systems on this size as required under WAC 246-290.
The extent to which the proposed use would create new burdens on the public for monitoring, oversight and regulation.	This proposal would require ongoing monitoring and reporting of multiple water management parameters and detailed in the provisions of this Report of Examination. Since the responsibility of collecting, organizing and reporting the data is the applicant's, this would not create unnecessary burden for monitoring by public agencies.

Without additional water rights, North Bend's water system cannot connect any additional customers or add new water sources to benefit the public health and security of its water supply. The absence of an available public water supply creates a demand for new privately developed water systems based on small wells using less than 5,000 gallons per day that are exempt from the water right permit requirement. The proliferation of these so-called "exempt wells" can lead to incrementally greater impacts on the Snoqualmie River because of the absence of mitigation and conservation requirements that are only required for larger municipal water sources.

In conclusion, the proposed appropriation will be for a beneficial use and, as long as North Bend follows the mitigation plan in this report, its water use will not result in the impairment of downstream minimum instream flows. Furthermore, the appropriation will not impair existing surface or ground water rights. After considering these criteria, no detriment to the public welfare could be identified during the investigation of this application.

Under the provisions of RCW 90.03 and 90.44, the State of Washington promotes the use of public waters in a manner that provides maximum net benefits arising from both diversionary and uses and retention of waters within lakes, rivers and streams. Under RCW 90.54.010(a), it is recognized that water resources need to be utilized to meet the needs of public health and to ensure the economic well-being of the State. At the same time, in-stream resources and values must be preserved and protected for future generations.

Under the provisions of RCW 90.03.290 and 90.44, a water right shall be issued upon findings that water is available for appropriation for a beneficial use and that the appropriation thereof, as proposed in the application, will not impair existing rights or be detrimental to the public welfare.

4. RECOMMENDATIONS

I recommend approval of this application and issuance of a permit authorizing withdrawal of up to 2,646 gpm, and 3,094 acre-feet per year from North Bend's Production Well NB-3 for municipal water supply purposes. The period of use shall be year-round, as needed, with mitigation for net streamflow depletion when instream flows are not met farther downstream. The place of use is the City of North Bend's water service area and the North Bend Urban Growth Area described in the King County Growth Management Planning Council's Urban Growth Area Boundary Map (June 2005).

5. PROVISIONS

The following provisions are required as part of this water right approval.

5.1 Monitoring

North Bend will monitor water production, return flows from the WWTP, streamflow, and mitigation contributions using remote sensors and data loggers that will be connected to the mitigation and production sources. North Bend will be responsible for monitoring and data collection on a daily basis regardless of whether Well NB-3 was pumped or if instream flows were met. Monitoring must occur on a daily basis because mitigation water, when needed, will be discharged on a daily basis, and the mitigation requirement is based on aggregated impacts from the previous 20 days. The daily (24-hour) time period begins at the onset of each work day (approximately 8:00 AM). The City will input monitoring data into a database at the beginning of each day, and the database will calculate the mitigation requirement for the day.

The City will also collect data on a weekly basis to confirm various daily measurements and obtain supplemental information for their own analyses. The North Bend Operation and Monitoring Plan (Golder, 2007e) describes all of the City's monitoring activities in detail. The remainder of this section describes the monitoring activities required as part of this Report of Examination.

Water Production

Well NB-3 will be monitored with a totalizer meter and daily production volume will be recorded. Pump run times or instantaneous flow from the well will also be recorded electronically by the telemetry system. The telemetry system will monitor a transducer to record water levels during pumping and non-pumping conditions. The following daily data will be transmitted to the Public Works Department telemetrically each morning: volume pumped; hours pumped or average pumping rate; maximum and minimum ground water level.

WWTP Flow Monitoring

Flow from the WWTP to the South Fork Snoqualmie River is measured by a flow meter on the outfall pipe. This flow meter (totalizer) is read daily in the mornings with flows measured to the nearest 10,000 gallons. The readings will be recorded manually and transmitted to the Public Works Department in the morning of each day by e-mail or other reliable means.

Streamflow Monitoring

Monitoring streamflow at the three instream flow control points (USGS gages 12144500, 12149000 and 12150800) is required to perform the mitigation algorithm. The minimum measurement during the previous 24 hours will be compared to the minimum instream flow requirement for that day at each site to determine if the instream flow requirement was met. The City telemetry system will access the three gages to obtain the real-time streamflow data. If the telemetry system malfunctions, then the City staff would download the data available online. The USGS gage data that will be used is provisional and subject to revision. However, it is the best available source of data at that time and will be used to determine mitigation triggers. Mitigation will not be subject to revised data.

The mitigation plan requires that flows are monitored at three instream flow control points downstream of North Bend. Specifically, the USGS currently monitors flow at Carnation, Monroe, and Snoqualmie Falls. If the USGS were ever to discontinue monitoring at all of these three gauges, the City would be responsible for monitoring flow at the nearest control point (Snoqualmie Falls) in a manner similar to the USGS protocol.

Hobo Springs Monitoring

Water levels behind the existing weir will continue to be monitored using a pressure transducer to determine flow rates over the weir. The water level at the weir will be translated into a flow rate using a weir equation developed from previous analyses of Hobo Springs data. The transducer will take measurements at a preset time increment of 60 minutes and the data will be transmitted via telemetry. The telemetry system will be used to record average, minimum and maximum daily flow.

Mitigation Water Monitoring

The City will monitor the flow through the outfall pipe into Boxley Creek using a totalizer that will be read at least weekly. In addition, the instantaneous flow though the mitigation transmission pipeline at Hobo Springs and the intertie with Sallal will be monitored via telemetry. Daily mitigation volumes will be calculated by summing the instantaneous flow data. The amount of time per day that mitigation water is delivered will be tracked for each source. Field inspections will be completed at least monthly to identify potential maintenance issues.

5.2 Mitigation

Mitigation shall be performed in accordance with the procedures outlined in the Mitigation Operations and Monitoring Plan (Golder, 2007e) and the provisions outlined in this Report of Examination.

To the extent practical, the City must attempt to deliver mitigation flows uniformly over the course of the "mitigation day". This may not be possible when the mitigation requirement is less than the minimum daily delivery capacity of either mitigation source. However, when either of the mitigation sources can be controlled in such a manner to provide uniform delivery of mitigation water over the mitigation day, this approach shall be employed. The City shall monitor and report the timing of mitigation deliveries to show compliance with this provision.

5.3 Reporting

Reporting will be required to summarize the monitoring data, evaluate the performance of the mitigation system, and assess the capacity of the mitigation system relative to current and future demand. Various reports will be generated, including initial system reports, annual system reports, and event reports. In addition, reporting includes periodic update of the Mitigation Operation and Monitoring Plan as new information becomes available, new approaches to managing the mitigation system developed, and/or new water-supply or mitigation sources are placed on line.

Initial System Reports

Quarterly reports will be generated for the first two years of operation. Quarterly reports will coincide with the quarter-periods of the calendar year, and the first quarterly report will be issued only after at least six weeks of data collection (otherwise data will be reported in the next quarter). Reporting will be on an annual basis after the first two years. Reports will be sent to Ecology, the Tulalip Tribes, the Snoqualmie Tribe, and made available to other interested parties upon request.

Initial system reports will contain summary information about the mitigation operations on a daily and annual basis. The summary information will include a table detailing daily and year-to-date cumulative values of: 1) water produced from Well NB-3; 2) assumed WWTP return flow; 3) the net stream depletion (i.e. mitigation requirement) of the volume of water produced from Well NB-3; 4) the number of days that mitigation water was required; 5) the volume of mitigation delivered from each mitigation source; 6) the timing (hours per day) of mitigation water delivered from each mitigation source; 7) the difference between the volume of mitigation required and the volume delivered; and 8) total Hobo Springs flow captured by the collection box. In addition, the report should discuss any planned improvements to mitigation sources, additional evaluation of mitigation capacity as Qi (instantaneous quantity) and Qa (annual quantity) limitations approach, the status of the availability of the mitigation sources, and any update to the mitigation algorithm (as approved by Ecology).

Initial system reports will also be generated quarterly during the first two years operation of any new water supply or mitigation source. These reports will be sent within 30 days of the end of the quarter.

Annual System Report

Annual reports will contain summary information about the mitigation operations on a daily and annual basis. The annual reports will contain the same information as the initial system reports; however, they will present all the data collected over a complete calendar year of operation. The annual system report will replace the initial system report that occurs on the fourth quarter of the calendar year. These reports will be sent to Ecology, the Tulalip Tribes, and the Snoqualmie Tribe within 30 days of the end of the year. Annual System Reports will be made available to other interested parties by Ecology upon request.

Event Reports

Event reports will be generated when the City misses a mitigation day, supplies insufficient mitigation volume, or has a water system failure. If the City misses a mitigation day or supplies insufficient mitigation volume, then the City will add that volume of water to the total mitigation volume required for the next day. A water system failure is any problem that compromises the ability to compute the mitigation algorithm. If the total volume of water produced in the preceding 24 hours is unknown (i.e., the totalizer number is unknown), then the City would mitigate using the highest level of pumping in the last three days. A report explaining the details of the event, the actions taken to ensure that mitigation was implemented, and how the City can prevent this problem in the future will be sent to Ecology, the Tulalip Tribes, and the Snoqualmie Tribe within 30 days of the event. Event reports will be made available to other interested parties by Ecology upon request.

Mitigation Operations and Monitoring Plan Update

The mitigation operations plan will be updated after the first two years of operation. All of the water monitoring and operations data from the mitigation supply system will be used to update the mitigation operations plan. The update may include revision of the streamflow depletion functions used by the mitigation algorithm if additional aquifer testing revises existing values of aquifer properties (see Section 5.5 below). The update may also include revised assumptions regarding the fraction of annual pumpage returned to the Snoqualmie River as WWTP return flow (f_{wwtp}, as described in Section 2.4.2)

After the initial 2-year update, the mitigation operations plan will be updated once every six years to coincide with other water system plan updates. Optimization of the mitigation system will occur as more data are collected during operation, especially during the first 5 years.

5.4 Adaptive Management Amendments

Adaptive management includes adding production sources NB-1 and NB-2 to this water right, adding the Tolt pipeline as a mitigation source, and modifying elements of the mitigation approach (These include updating aquifer properties at NB-3 to be used in the IGARF model of streamflow depletion and updating the wastewater treatment plant return flow function).

For each adaptive management amendment, North Bend shall submit the required documents to Ecology, the Tulalip Tribes, the Snoqualmie Tribe, and other interested parties who have requested notification. Ecology shall review the reports along with any comments received, and determine whether or not the proposed amendment meets the conditions of this Report of Examination.

If Ecology determines that the proposed amendment does not comply with the conditions of this Report of Examination, it shall give notice in writing to North Bend, with a copy to interested parties, of the factors causing the non-compliance and allow North Bend to resubmit the documents with the appropriate corrections.

Ecology's determination regarding any adaptive management amendments to this water right shall be in the form of an order to North Bend and shall be delivered with a notice to the Tulalip Tribes, Snoqualmie Tribe, and all other parties of interest (who have requested notification) of the right to appeal the order to the Pollution Control Hearings Board as prescribed by chapters 34.05 and 43.21B RCW.

After the appeal period of the order has passed, Ecology will issue an amended permit containing the new information.

5.4.1 Adding Production Sources

This permit authorizes use of Well NB-3 for municipal water supply purposes. However, the city ultimately wishes to add production sources NB-1 and NB-2. This section details the process needed to include NB-1 and NB-2 as approved points of withdrawal.

The City's future municipal production wells can generally be placed into one of two groups:

(1) Withdrawals far from the river(s) that will result in multiple days of surface water depletion; and

(2) Withdrawals close to the river(s) that will cause effectively instantaneous surface water depletion.

Well NB-1 falls in the first category, as does Well NB-3. Well NB-2 most likely falls in the second category. Well NB-1 is already constructed but requires additional testing, and Well NB-2 has not yet been constructed. To add either Well NB-1 or NB-2 as an approved source of supply under water right G1-26617(A), the following process must be followed:

North Bend must request a preliminary permit from Ecology before any future drilling or testing of NB-1 or NB-2. This is to insure that all parties agree with what should be tested and monitored.

It is anticipated that North Bend will be required to submit two reports to Ecology, the Tulalip Tribes, and the Snoqualmie Tribe: a "New Source Report" and an update to the Mitigation Operations and Monitoring Plan. The New Source Report must include the following:

- Description of well drilling and well construction (for NB-2 only);
- Description of well testing, estimated well yield, and estimated aquifer properties, aquifer boundaries, and additional characterization of local streambed conductivity;
- Analysis of potential for impairment of nearby wells,
- Estimation of the schedule of maximum daily stream depletion resulting from new source withdrawal; and,
- Description of how this new source will be operated along with other sources authorized by this permit such that the overall quantities allocated by this permit are not exceeded.

The updated Operations and Monitoring Plan must include an updated system description, monitoring requirements, mitigation operations and algorithm, other operational considerations and reporting requirements.

Ecology will process the request for additional source wells (NB-1 and NB-2) consistent with the requirements of RCW 90.44 in effect at the time the sources are requested to be added.

5.4.2 Adding Mitigation Sources

This permit authorizes the use of Hobo Springs and the Sallal wells for sources of mitigation. However, the city may ultimately seek to add the Tolt pipeline source to its mitigation options. To add the Tolt pipeline as an approved source of mitigation under water right G1-26617(A), the following process must be followed:

North Bend must submit two reports to Ecology, the Tulalip Tribes, and the Snoqualmie Tribe: a "New Mitigation Source Report" and an update to the Mitigation Operations and Monitoring Plan. The New Mitigation Source Report must include description of the following:

- Design, construction and SEPA permitting of the Tolt pipeline mitigation source;
- The location of discharge to the Snoqualmie River system;
- The transmitting capacity of the Tolt mitigation pipeline; and,
- Travel times between the control valve and the point of discharge.

The updated Operations and Monitoring Plan must include an updated system description, monitoring requirements, mitigation operations and algorithm, other operational considerations and reporting requirements.

5.4.3 *Modifying the Mitigation Algorithm*

In addition to regular updates of the Mitigation Operations and Monitoring Plan (see Section 5.3), the City may desire to update the plan based on new information or development of more optimized mitigation routines. In this instance, the City shall submit a draft version of the modified Mitigation Operations and Monitoring Plan to Ecology, the Tulalip Tribes, the Snoqualmie Tribe, and interested parties who have requested notification. Ecology shall review the updated Operations and Monitoring Plan, along with any comments received and determine whether or not the new updated plan meets the conditions of this Report of Examination.

5.5 Special Provisions

Mitigation Contracts

Once the final contracts for supply of mitigation water from the City of Seattle and the Sallal Water Association have been approved, copies of those contracts must be submitted to Ecology.

Future NB-3 Aquifer Test

The City will conduct a 72-hour constant rate pump test within the first two years of setting Well NB-3 into operation and implementing the mitigation system. During the pump test, Well NB-3 will be pumped at the maximum safe capacity that can be received by the water system and all of the pumped water will be discharged to a closed water system or outside the radius of influence of the well. The pump test data will be analyzed to update estimated transmissivity and storativity and will be reported to Ecology, the Tulalip Tribes, and the Snoqualmie Tribe. Future testing will use a similar monitoring system to previous Well NB-3 testing authorized under the preliminary permit issued on September 16, 2004. Results will be used to update transmissivity and storativity, reported to Ecology, the Tulalip Tribes, and the Snoqualmie Tribe, and if necessary used to update the mitigation algorithm and mitigation functions.

Conservation Planning Requirements

The water right holder must comply with the water use efficiency requirements as defined in Washington Department of Health WAC 246-290 for this size Group A public water system.

Health

The water appropriated under this application will be used for public water supply. The State Board of Health rules require public water supply owners to obtain written approval from the Department of Health's Office of Drinking Water Supply, prior to any new construction or alterations of a public water supply system.

The benefits and requirements of this water right authorization shall be reflected in future water system plan updates.

Hydraulic Project Approval

Contact the Washington Department of Fish and Wildlife to obtain hydraulic project approval for construction of the discharge point in Boxley Creek.

Tribal Rights

This authorization to make use of public waters of the state is subject to existing tribal rights, including any existing rights held by the United States for the benefit of Indian tribes under treaty, reservation, or settlement.

Certificate

The applicant is advised that notice of Proof of Appropriation of water (under which the final certificate of water right is issued) should not be filed until the permanent distribution system has been constructed and that quantity of water allocated by the permit to the extent water is required, has been put to full beneficial use.

FINDINGS OF FACT AND DECISION GROUND WATER

FINDINGS OF FACT AND DECISION

Upon reviewing the above report, I find all facts, relevant and material to the subject application, have been thoroughly investigated. Furthermore, I find water is available for appropriation and the appropriation as recommended is a beneficial use and will not be detrimental to existing rights or the public welfare.

Therefore, I ORDER a permit be issued under Ground Water Application Number G1-26617(A), subject to existing rights and indicated provisions, to allow appropriation of public ground water for the amount and uses specified in the foregoing report.

Signed at Bellevue, Washington, this 27th day of SEPTEMBER, 2007.

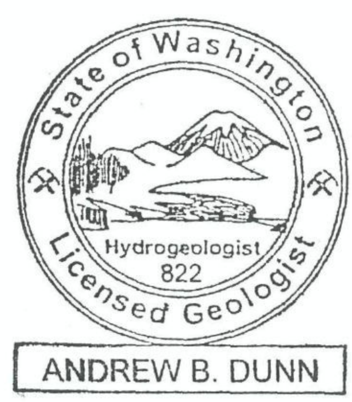
Dan Swenson
Water Resources Section Manager
Northwest Regional Office

Report by:

Peter Schwartzman
Pacific Groundwater Group

Reviewed by:

Andrew B. Dunn
Water Resources Program
Northwest Regional Office



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APPENDIX A

Average Day Water Demand Projections for Next 50 Years

(Gallons Per Day)

		Calculated Existing*	Actual Hook-ups**	First 10-Yr Increase	Next 25-Yr Increase	Last 15-Yr Increase
Existing NB Service Area	GIS Calculated Demand	784,302	533,325	70,837	522,529	294,880
	Conversion distribution			83,659	167,318	0
	Subtotal		533,325	154,496	689,847	294,880
UGA	GIS Calculated Demand	256,078	0	6,351	404,752	179,921
	Conversion distribution			32,010	128,039	96,029
	Subtotal		0	38,361	532,791	275,950
	Subtotal all areas		533,325	192,857	1,222,638	570,830
	Seasonal Effect Factor		1.35	1.35	1.35	1.35
	Average Annual Demand Increase		719,989	260,357	1,650,561	770,621
	Cumulative Demand		719,989	980,345	2,630,907	3,401,528
	10% Conservation Factor		71,999	98,035	263,091	340,153
	Total Cumulative Demand		**647,990**	**882,311**	**2,367,816**	**3,061,375**
	Existing Water Rights (336 Ac. Ft.)					299,941
	Min. Water Rights Needed (Not Including Mitigation)					**2,761,434**

* Assumes all structures are hooked up to public water

** 68% of existing structures in North Bend service area are hooked up to North Bend water

Seasonal Factor Calculation:

GIS Estimate	533,325
2003 annual average	696,430

Factor = 696,430/533,325 = 1.31 (say 1.35)

Conversion Assumptions:

NB
1. A third of the North Bend service area structures not currently hooked up would be hooked up in the first 10 years.
2. The remaining two thirds of North Bend service area structures not currently hooked up would be hooked up in the following 25 years.

UGA
1. One eighth of the existing Sallal area structures in the UGA would be hooked up to North Bend water in the first 10 years.
2. Another half of the existing Sallal area structures in the UGA would be hooked up to North Bend water in the next 25 years.
3. The remaining three-eighths of the existing Sallal area structures in the UGA would be hooked up to North Bend water in the last 15 years.

TABLES

FIGURES

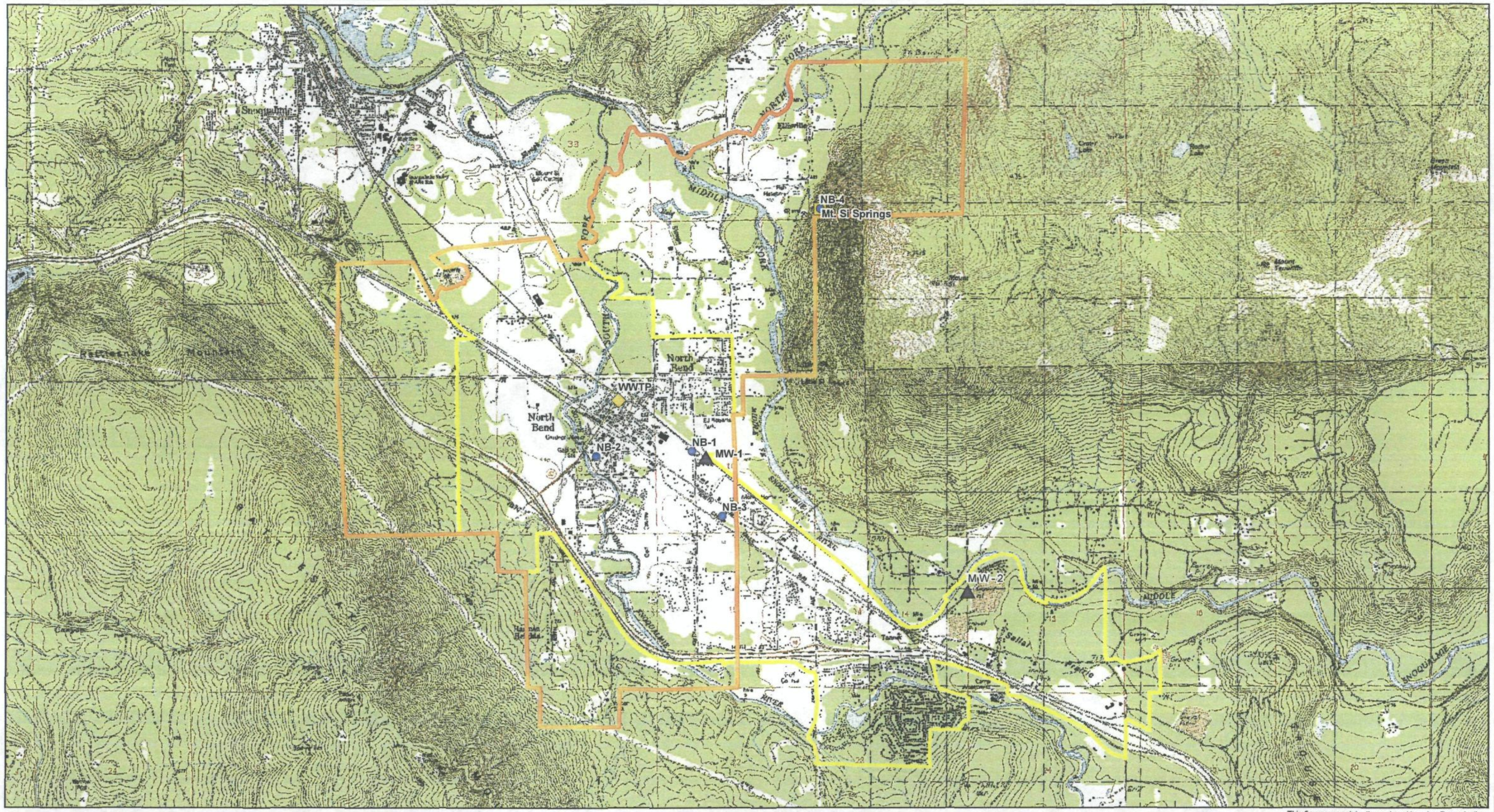
ATTACHMENTS

Attachment 1 - Water Supply and Mitigation Sources in the Snoqualmie River Valley

Attachment 2 - Mitigation Sources on the Cedar Moraine

Attachment 3 - Hobo Springs Flow Summary

Attachment 4 - Mitigation Algorithm



LEGEND

- Proposed Production Well
- Spring
- Proposed Mitigation Well
- Wastewater Treatment Plant
- North Bend Water Service Area
- North Bend UGA

0 3200
Scale in Feet

Map Projection:
Washington State Plane,
North Zone, NAD 1983, Feet

Source:
USGS, City of North Bend,
Golder Associates, Inc.

N

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

ATTACHMENT **1**

SNOQUALMIE VALLEY
WATER SUPPLY SOURCES
AND PROPOSED MITIGATION SOURCES

PORS/NORTH BEND 2006 MITIGATION/WA

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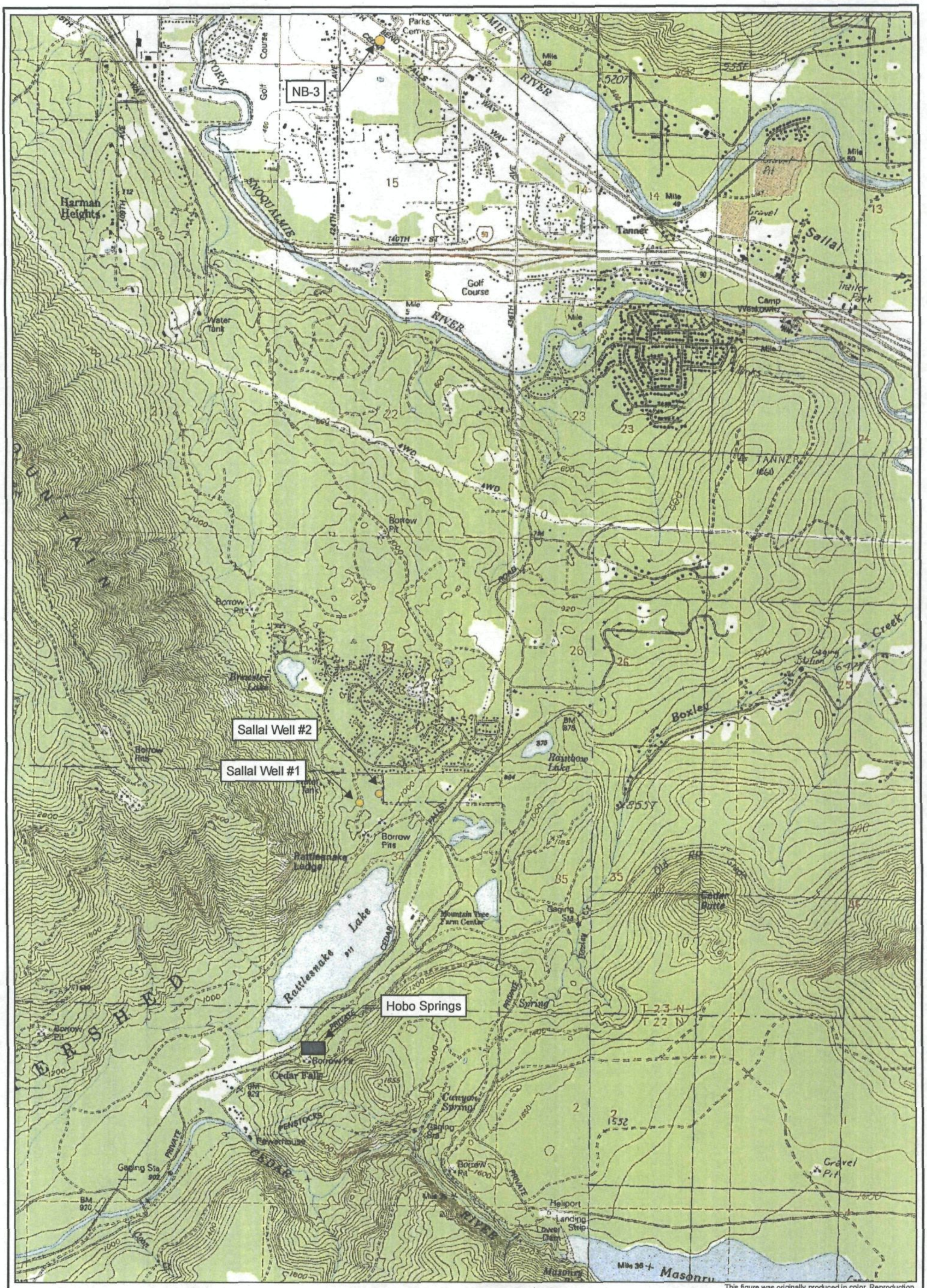
Golder Associates



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

LEGEND

- Well Location
- Hobo Springs

0 2000

Scale in Feet

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

Source: USGS

N

ATTACH. 2

SOURCES FOR MITIGATION VIA BOXLEY CREEK

PORS/NORTH BEND 2006 MITIGATION/WA

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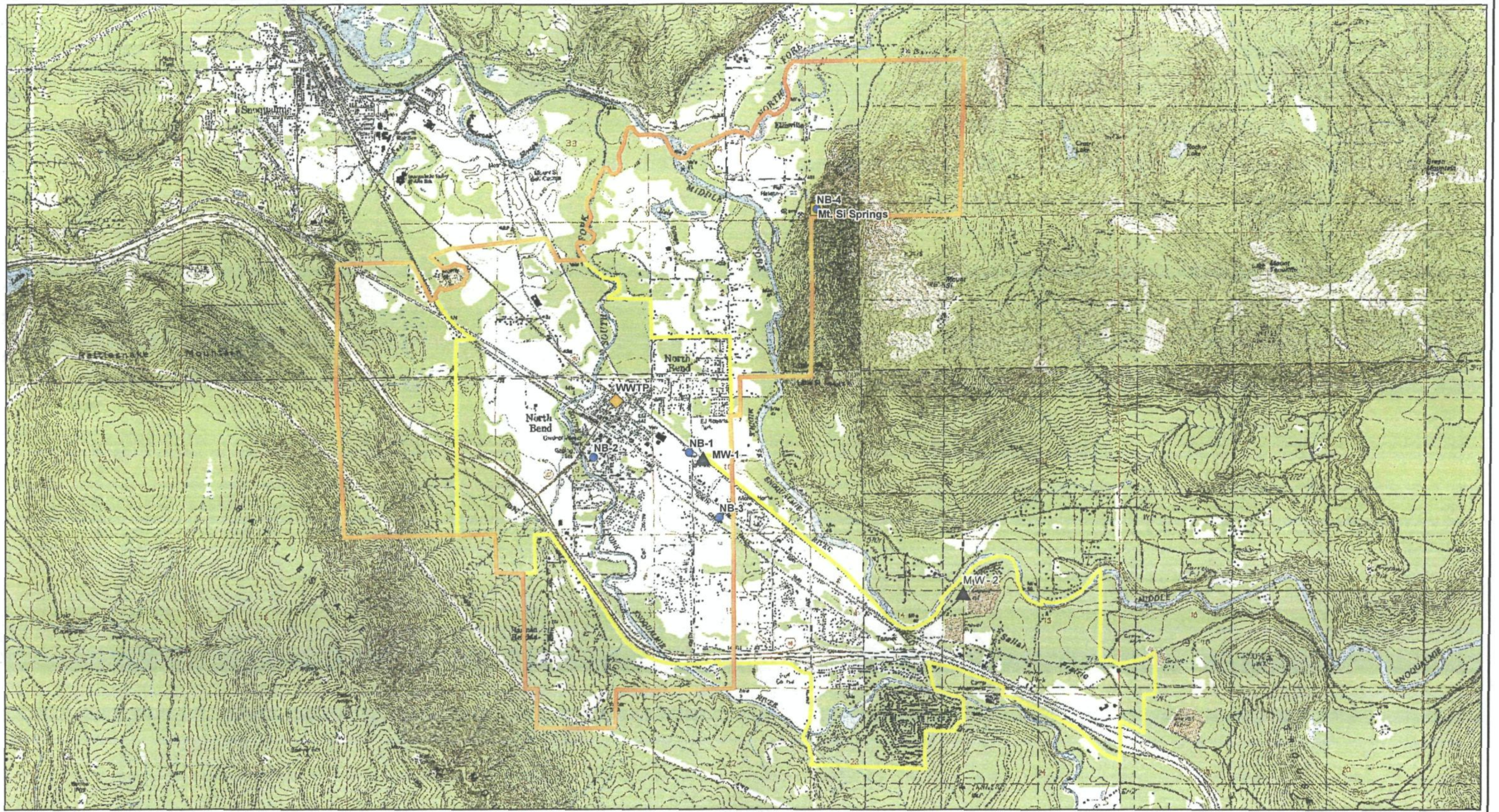
Golder Associates



LEGEND

- Proposed Production Well
- Spring
- Proposed Mitigation Well
- Wastewater Treatment Plant
- North Bend Water Service Area
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Scale in Feet

Map Projection:
Washington State Plane,
North Zone, NAD 1983, Feet

Source:
USGS, City of North Bend,
Golder Associates, Inc.

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ATTACHMENT 1

SNOQUALMIE VALLEY WATER SUPPLY SOURCES AND PROPOSED MITIGATION SOURCES

PORS/NORTH BEND 2006 MITIGATION/WA

Golder Associates

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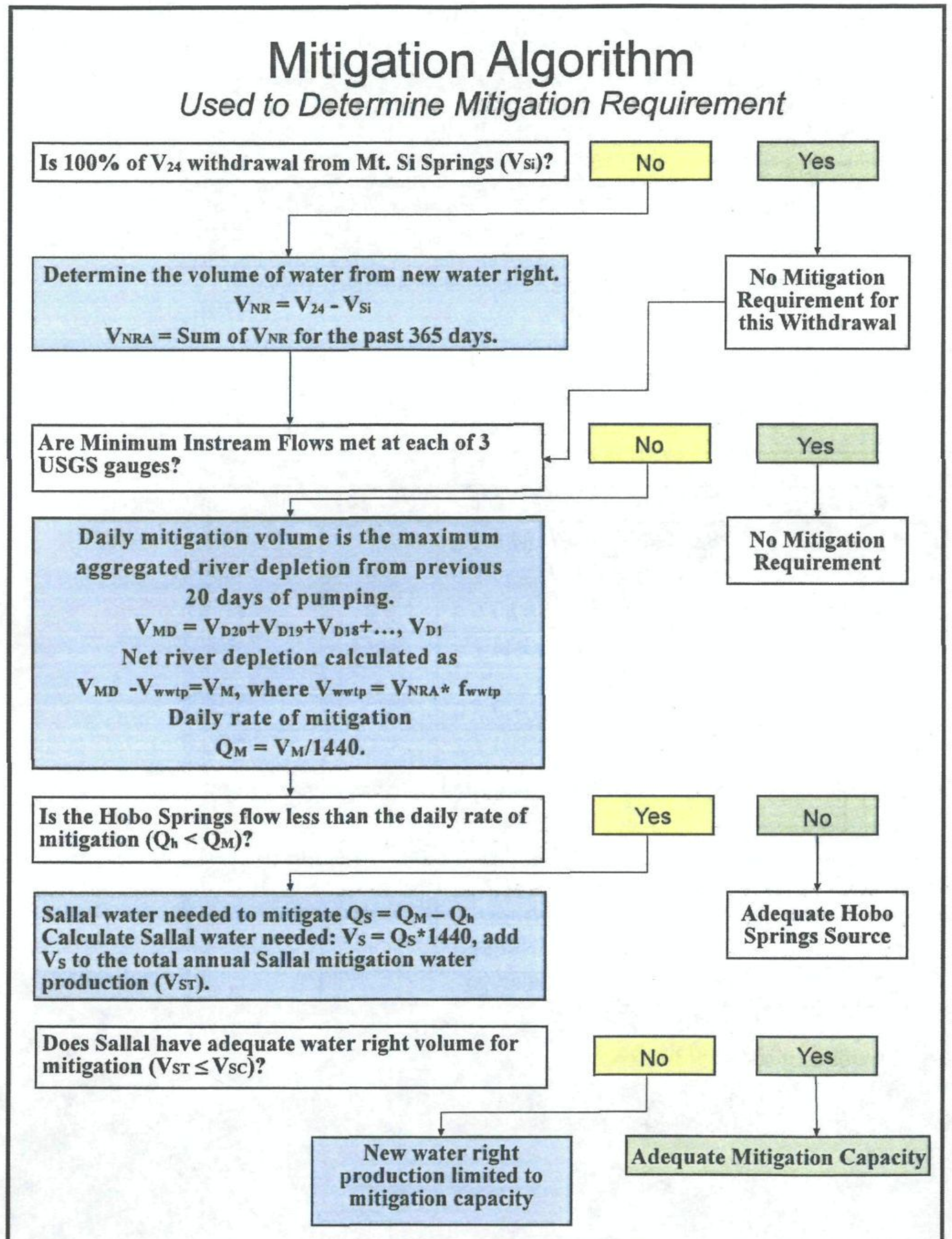
ATTACHMENT 3

Monthly discharge through the Hobo Springs Weir, in cubic feet per second (cfs).

Month	1976-1981[1]			2001-2005[2]			June - Nov. 2006 [3]			All three periods of record[4]	
	Average Monthly	Minimum Average Monthly[5]	Minimum Daily[5]	Average Monthly	Minimum Average Monthly[5]	Minimum Daily[5]	Average Monthly	Minimum Average Monthly	Minimum Daily	Minimum Average Monthly[5]	Minimum Daily[5]
January	3.4	0.9 (1977)	0.007 (1977)	2.9	0.5 (2003)	0.5 (2003)	No data	N/A	No data	0.5 (2003)	0.007 (1977)
February	3.3	2.4 (1979)	2.0 (1977)	2.7	0.4 (2001)	0.2 (2001)	No data	N/A	No data	0.4 (2001)	0.2 (2001)
March	3.5	2.7 (1980)	2.4 (1978, 1979, 1980)	3.7	0.3 (2001)	0.2 (2001)	No data	N/A	No data	0.3 (2001)	0.2 (2001)
April	3.6	3.0 (1978)	2.4 (1978)	3.8	1.4 (2001)	0.4 (2001)	No data	N/A	No data	1.4 (2001)	0.4 (2001)
May	5	4.7 (1980)	3.8 (1976, 1978)	4.8	3.5 (2002)	3.5 (2002)	No data	N/A	No data	3.5 (2002)	3.5 (2002)
June	5.4	5.0 (1977)	3.8 (1978)	5.1	4.7 (2004)	4.0 (2002)	6.1	N/A	5.9	4.7 (2004)	3.8 (1978)
July	4.9	4.1 (1978)	3.8 (1979)	5.4	5.0 (2005)	5.0 (2005)	5.9	N/A	5.5	4.1 (1978)	3.8 (1979)
August	4.2	2.8 (1978)	2.4 (1978)	4.8	4.2 (2003)	4.2 (2003)	5.1	N/A	4.5	2.8 (1978)	2.4 (1978)
September	3.2	1.0 (1978)	0.5 (1978)	4.1	3.1 (2003)	3.1 (2003)	4.2	N/A	3.6	1.0 (1978)	0.5 (1978)
October	2.3	0.5 (1978)	0.5 (1978)	3.3	1.4 (2003)	1.4 (2003)	2.9	N/A	2.0	0.5 (1978)	0.5 (1978)
November	1.8	0.4 (1979)	0.17(1979)	2.9	1.5 (2003)	1.5 (2003)	1.9	N/A	1.5	0.4 (1979)	0.17 (1979)
December	2.1	0.02 (1979)	0 (1979)	3.5	1.2 (2002)	1.2 (2002)	Incomplete	N/A	Incomplete	0.02 (1979)	0 (1979)

Notes:

1. The 1976-1981 data were provided by Seattle Public Utilities (Appendix D). The data were provided as a table of average and minimum monthly values. The number of measurements and sampling frequency of the data used to calculate the average and minimum values is unknown.
2. The number of measurements and sampling frequency of the 2001-2005 data for each month is inconsistent. The number of monthly measurements ranges from zero to eleven. Some measurements have a weekly sampling frequency and others do not have a consistent period of time between measurements. Calculating monthly averages using data with an inconsistent sampling frequency can skew the results. See Appendix D for the complete dataset.
3. The 2006 data were collected on an hourly basis from June 20 to December 13 using a transducer to measure the depth of the water flowing through the weir. The rating curve used to convert the feet of water measured by the transducer into the depth of water flowing through the weir has not been perfected yet.
4. Includes the 1976-1981, 2001-2005, and June - November 2006 data.
5. The number in parentheses is the year in which the measurement was made.



Mitigation Algorithm Key

V_{24} = Daily volume of water produced by NB in preceding 24 hours.
V_{Si} = Daily volume of water produced from Mt. Si Springs.
V_{NR} = Daily volume of water from new water right in the preceding 24 hours.
V_{NRA} = Total volume of water produced from new water right during previous 365 days.
V_{MD} = Daily maximum aggregated depletion calculated using mitigation curves.
V_{D1} = Daily volume of stream depletion occurring from pumping one day ago.
V_{wwtp} = Daily volume of water returned from waste water treatment plant associated with new water rights.
V_M = Daily mitigation volume, the net stream depletion from previous 20 days.
f_{wwtp} = Percentage of annual produced volume from new water right returned to river on a daily basis as WWTP flow.
Q_M = Daily rate of required mitigation water discharge for next 24 hours (gpm).
Q_h = Daily flow rate at Hobo Springs (gpm).
Q_S = Daily rate of discharge to Boxley Creek from Sallal Wells (gpm).
V_S = Daily volume of mitigation water from Sallal Wells.
V_{ST} = Total annual Sallal mitigation water production.
V_{SC} = Total annual Sallal contracted water volume for mitigation.

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December	2.1	0.02 (1979)	0 (1979)	3.5	1.2 (2002)	1.2 (2002)	Incomplete	N/A	Incomplete	0.02 (1979)	0 (1979)

Notes:

1. The 1976-1981 data were provided by Seattle Public Utilities (Appendix D). The data were provided as a table of average and minimum monthly values. The number of measurements and sampling frequency of the data used to calculate the average and minimum values is unknown.
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