



State of Washington
DRAFT
 Report of Examination
To Appropriate Public Waters

WR File NR G4-35179
 WR Doc ID 4505990

PRIORITY DATE	WATER RIGHT NUMBER
May 27, 2008	G4-35179

APPLICANT	SITE ADDRESS (IF DIFFERENT)
Battelle Memorial Institute P.O. Box 999, Richland WA 99352	902 Battelle Boulevard, Richland WA 99352

Total Quantity Authorized for Withdrawal or Diversion	
WITHDRAWAL	ANNUAL QUANTITY (acre-feet per year)
1,900 gallons per minute	3,064.7

Purpose

1900 gallons per minute, 3,064.7 acre-feet per year continuously for the purpose of industrial/heat exchange uses associated with an open-loop groundwater source heat pump (GSHP) system. This water use is non-consumptive, and must be injected back to the aquifer.

Source Location							
SOURCE FACILITY/DEVICE	PARCEL	TWN	RNG	SEC	QQ Q	LATITUDE	LONGITUDE
Wells	114083000002010	10 N	28 E	14	W½SW¼	46°20'50.41"N	119°16'53.87"W
Datum: NAD83/WGS84							

SOURCE FACILITY/DEVICE	WELL TAG ID #	LOCATION
Extraction Well 1	BAE 703	1,050 feet north and 40 feet east from the southwest corner of Sec. 14
Extraction Well 2	APG 742	1,215 feet north and 25 feet east from the southwest corner of Sec. 14
Extraction Well 3	ALE 911	1,400 feet north and 15 feet east from the southwest corner of Sec. 14
Extraction Well 4	APG 737	1,570 feet north and 5 feet east from the southwest corner of Sec. 14

Place of Use (See Attached Map)
PARCELS (NOT LISTED FOR SERVICE AREAS)
114083000002010

LEGAL DESCRIPTION OF AUTHORIZED PLACE OF USE

Section 14, Township 10, Range 28, Quarter SW; That portion of the West half of the Southwest quarter of Section 14 and that portion of the East half of the Southeast quarter of Section 15, Township 10 North, Range 28 East, Willamette Meridian, Benton County, Washington, more accurately as follows: Commencing at the intersection of the East Right-of-Way of Stevens Drive and the North Right-of-Way of Battelle Blvd; Thence North 5°13'6" West 178 feet; thence North 6°6'45" West 792 feet to THE TRUE POINT OF BEGINNING; thence North 6°6'45" West 332 feet; thence North 5°9'32" West 189 feet; thence North 3°15'7" West 98 feet; thence North 89°50'11" East 917 feet; thence South 1°2'41" East 616 feet; thence South 89°48'41" West 870 feet to the TRUE POINT OF BEGINNING. Containing 12.6 acres.

Proposed Works

Battelle Memorial Institute has applied for an appropriation of public groundwater from four wells located north of Richland, Washington, directly adjacent to the Hanford Site boundary, approximately 4,200 feet west of the Columbia River. The appropriation will be for a non-consumptive use in an open-loop groundwater source heat pump (GSHP) system. The four proposed points of withdrawal (extraction wells) are completed to depths of 102 to 121 feet below ground surface (bgs) in the Ringold Formation. Groundwater will be withdrawn from the extraction wells, passed through a non-contact heat exchange, then returned to the same aquifer through one of four injection wells, completed to depths of 100 to 125 feet bgs, located approximately 800 feet east of the extraction wells.

Development Schedule

BEGIN PROJECT	COMPLETE PROJECT	PUT WATER TO FULL USE
Complete	Complete	June 10, 2015

Measurement of Water Use

How often must water use be measured?	Daily
How often must water use data be reported to Ecology?	Annually on January 31 st of each year
What volume should be reported?	Maximum daily volume
What rate should be reported?	Maximum daily rate of withdrawal (gpm)

Provisions

WATER QUALITY PERMIT

Issuance of a Water Right Certificate and use of water under this permit is contingent on obtaining and maintaining a companion State Waste Discharge Permit or NPDES permit from Ecology's Water Quality Program, including all its associated conditions.

WELLS, WELL LOGS AND WELL CONSTRUCTION STANDARDS

All wells constructed in the state must meet the construction requirements of WAC 173-160 titled "Minimum Standards for the Construction and Maintenance of Wells" and RCW 18.104 titled "Water Well Construction". Installation and maintenance of an access port is required as described in WAC 173-160-291(3).

All wells must be tagged with a Department of Ecology unique well identification number. If you have an existing well and it does not have a tag, please contact the well-drilling coordinator at the regional Department of Ecology office issuing this decision. This tag must remain attached to the well. If you are required to submit water measuring reports, reference this tag number.

In addition to the required access port, the applicant must install and maintain, in operating condition, an airline and pressure gage. The pressure gage must be equipped with a standard tire valve and placed in a location accessible to Department of Ecology personnel. The airline must extend from land surface to the top of the pump bowls and the total airline length must be reported to the Department of Ecology upon completion of the pump system.

MEASUREMENTS, MONITORING, METERING AND REPORTING

An approved measuring device must be installed and maintained for each of the sources identified by this water right in accordance with the rule "Requirements for Measuring and Reporting Water Use", WAC 173-173, which describes the requirements for data accuracy, device installation and operation, and information reporting. It also allows a water user to petition the Department of Ecology for modifications to some of the requirements. <http://www.ecy.wa.gov/programs/wr/measuring/measuringhome.html>

Recorded water use data shall be submitted via the Internet. To set up an Internet reporting account, contact the Central Region Office. If you do not have Internet access, you can still submit hard copies by contacting the Central Region Office for forms to submit your water use data.

SCHEDULE AND INSPECTIONS

Department of Ecology personnel, upon presentation of proper credentials, shall have access at reasonable times, to the project location, and to inspect at reasonable times, records of water use, wells, diversions, measuring devices and associated distribution systems for compliance with water law.

Project Completion

The water right holder shall file the notice of Proof of Appropriation of water (under which the certificate of water right is issued) when the permanent distribution system has been constructed and the quantity of water required by the project has been put to full beneficial use. The certificate will reflect the extent of the project perfected within the limitations of the water right. Elements of a proof inspection may include, as appropriate, the source(s), system instantaneous capacity, beneficial use(s), annual quantity, place of use, and satisfaction of provisions.

Findings of Facts

Upon reviewing the investigator's report, I find all facts, relevant and material to the subject application, have been thoroughly investigated. Furthermore, I concur with the investigator that water is available from the source in question; that there will be no impairment of existing rights; and that the purpose(s) of use are beneficial.

Therefore, I ORDER approval of Application No. G4-35179, subject to existing rights and the provisions specified above.

YOUR RIGHT TO APPEAL

You have a right to appeal this decision to the Pollution Control Hearing Board (PCHB) within 30 days of the date of receipt of this decision. The appeal process is governed by chapter 43.21B RCW and chapter 371-08 WAC. "Date of receipt" is defined in RCW 43.21B.001(2).

To appeal you must do the following within 30 days of the date of receipt of this decision:

- File your appeal and a copy of this decision with the PCHB (see addresses below). Filing means actual receipt by the PCHB during regular business hours.
- Serve a copy of your appeal and this decision on Ecology in paper form - by mail or in person. (See addresses below.) E-mail is not accepted.

You must also comply with other applicable requirements in chapter 43.21B RCW and chapter 371-08 WAC.

ADDRESS AND LOCATION INFORMATION

Street Addresses	Mailing Addresses
<p>Department of Ecology Attn: Appeals Processing Desk 300 Desmond Drive SE Lacey WA 98503</p>	<p>Department of Ecology Attn: Appeals Processing Desk PO Box 47608 Olympia WA 98504-7608</p>
<p>Pollution Control Hearings Board 1111 Israel Road SW, Ste 301 Tumwater WA 98501</p>	<p>Pollution Control Hearings Board PO Box 40903 Olympia WA 98504-0903</p>

*For additional information visit the Environmental Hearings Office Website: <http://www.eho.wa.gov>
To find laws and agency rules visit the Washington State Legislature Website: <http://www.leg.wa.gov/CodeReviser>*

Signed at Yakima, Washington, this _____ day of _____ 2011.

Mark C. Schuppe, Section Manager
Water Resources Program/CRO

BACKGROUND

On May 27, 2008, Battelle Memorial Institute (Battelle) filed an Application for a Water Right Permit (G4-35179) with the Washington State Department of Ecology (Ecology) requesting an appropriation of public groundwater. The applicant requested authorization for an instantaneous withdrawal (Q_i) of 3,000 gallons per minute (gpm) with no specified total annual withdrawal volume (Q_a).

The planned purpose of use of the appropriation is for industrial use in supplying non-contact cooling water to an open-loop groundwater source heat pump (GSHP). The non-consumptive use of water in a GSHP is one design element to the new Biological Science Facility and Computational Science Facility (BSF/CSF) recently built on the Pacific Northwest National Laboratory (PNNL) campus. The BSF is located on the northern half of the building, providing office and biological laboratory space, while the CSF occupies the southern half and will host office and computer laboratory space. Due to the volume of computer equipment housed in the CSF, the building will require cooling year round. This excess energy will either be used to heat the adjacent BSF building, or be injected to the ground via the GSHP.

Groundwater for the GSHP is withdrawn from the four extraction wells, passed through a non-contact heat exchanger and then returned to the same aquifer through one of four injection wells. It is anticipated that the average monthly injection temperature will be approximately 2.5 degrees Centigrade ($^{\circ}\text{C}$) above ambient, while peak GSHP injection temperatures may exceed 30°C for short periods of time. Ambient groundwater temperature at the BSF/CSF site is 16.4°C .

The Columbia River, located approximately 5,000 feet downgradient, is on the State's 303(d) listing as being impaired for temperature.

A Preliminary Permit was issued by Ecology on January 22, 2009. The permit authorized Battelle to complete drilling and testing of the four injection and four extraction wells and required Battelle to present the testing results in a draft report. Additional reporting elements required by the permit included the identification of nearby contaminants of concern associated with the Hanford Site, numerical modeling evaluating the hydraulic continuity between the wells and the Columbia River, potential hydraulic and downgradient temperature impacts, and to develop a long-term Sampling and Analysis Plan (SAP).

Battelle submitted an initial draft GSHP hydrogeologic evaluation report to Ecology in June 2009. Following several review and comment cycles, a final report was issued in March 2010 and was accepted by Ecology as meeting the minimum requirements of the Preliminary Permit. Based on the findings of the final report, Ecology issued a Temporary State Waste Discharge Permit (No. ST-9274) governing the near-term operation and monitoring of the GSHP system conditioned on the approved SAP. Ecology will determine the requirements of long-term water quality permitting (i.e. permanent State Waste Discharge or National Pollutant Discharge Elimination System (NPDES)) pending evaluation of data collected under the SAP.

The open-loop system is proposed to have no net consumptive use. This use of groundwater meets the definition of nonconsumptive use of groundwater provided by POL-1020 (Ecology 1991). Therefore, the subject application will not diminish water availability to senior applicants and meets the criterion for expedited review under RCW 90.03.265(1)(b).

Table 1: Summary of Application No. G4-35179

<i>Attributes</i>	<i>Proposed</i>
Applicant	Battelle Memorial Institute
Date of Application	May 27, 2008
Instantaneous Quantity	3,000 gallons per minute (gpm)
Annual Quantity	Not Specified
Source	Four Wells (Nos. 1 through 4)
Point of Diversion/Withdrawal	W1/2, SW1/4 Section 14, Township 10 North, Range 28 E.W.M.
Purpose of Use	Industrial
Period of Use	Year-round, non-consumptive use
Place of Use	BSF/CSF Building W1/2, SW1/4 Section 14, Township 10 North, Range 28 E.W.M.

Legal Requirements for Application Processing

The following requirements must be met prior to processing a water right application:

- Public Notice**
 Notice of the proposed appropriation was published in *Tri-City Herald* of Pasco, Washington, on August 20 and 27, 2008. No protests were received by Ecology.
- State Environmental Policy Act (SEPA)**
 A SEPA review of the proposed diversion was completed by the City of Richland and concluded with a Determination of Nonsignificance issued on March 12, 2008. The SEPA review was amended by Ecology to specifically address use of the GSHP and concluded with a Mitigated Determination of Nonsignificance issued on December 14, 2009. During the two week comment period following publication, no comments were received.
- Water Resources Statutes and Case Law**
 Chapters 90.03 and 90.44 RCW authorize the appropriation of public water for beneficial use and describe the process for obtaining a water right. Laws governing the water right permitting process are contained in RCW 90.03.250 through 90.03.340. Based on the provisions of RCW 43.21A.690 and RCW 90.03.265, this application has been processed by Aspect Consulting, LLC (Aspect Consulting) under Ecology Cost-Reimbursement Agreement No. ASP001 (master contract No. C1000185).

INVESTIGATION

In consideration of this application, Aspect Consulting reviewed available documents pertaining to the application's site conditions, projected system demand, and the potential effect on existing water rights and water quality. This included information submitted by the applicant and pertinent Ecology records including well logs, water rights records, and water resource policy and guidance documents.

A site visit was performed on September 9, 2009. Tyson Carlson of Aspect Consulting and Kelsey Collins representing Ecology visited the site including an inspection of the proposed extraction well(s) location, place of use, and an interview with the applicant. Since the site visit, multiple meetings and teleconferences were held to discuss the groundwater modeling approach and the predicted temperature impacts to the Columbia River. The meetings included Ecology's Water Quality Program staff to discuss their concerns relating to the applicant's request.

Using this information, Aspect Consulting evaluated water availability and potential effects of the proposed appropriation upon existing groundwater and surface water rights, including instream flows, and water quality. Each of the four requirements specified in RCW 90.03.290 were individually examined and findings presented below.

Project and Site Description

The BSF/CSF building and proposed GSHP wells are located north of the City of Richland, approximately 1,000 feet south of the Department of Energy's Hanford Site boundary, in the western half of the southwest quarter of Section 14, Township 10 North, Range 28 East Willamette Meridian. The site is approximately 5,000 feet upgradient of the Columbia River, in the Lower Yakima Water Resource Inventory Area (WRIA 37), in Benton County.

The place of use is the 33,000 square foot (ft²) office and the 16,000 ft² biological laboratory space of the BSF and the 19,000 ft² office and 22,300 ft² computer laboratory space of the CSF located on the Pacific Northwest National Laboratory (PNNL) campus. The site elevation is approximately 400 feet above mean sea level (msl).

The four extraction wells (Nos. 1 through 4) are completed with 10- to 12-inch diameter casing with multiple sections of 10- to 80-slot well screen to a total depth of 102 to 121 feet below ground surface (bgs). Total screen lengths range from approximately 30 to 45 feet, not including sections of blank casing separating screened intervals. Well logs are available at <http://apps.ecy.wa.gov/welllog/>.

The injection wells (Nos. 5 thru 8) are aligned along the eastern property boundary, approximately 800 feet east of the extraction wells. The injection wells are completed similar to the extraction wells; 12-inch casing with 25 to 40 feet of 60- to 100-slot well screen. Total depth of the injection wells range from 100 to 125 bgs. One extraction and three injection wells were constructed with screens extending above the water table. The well tag numbers associated with the extraction and injection wells are listed below.

Extraction Well 1	BAE 703	Injection Well 1	ALE 907
Extraction Well 2	APG 742	Injection Well 2	APG 738
Extraction Well 3	ALE 911	Injection Well 3	BAE 706
Extraction Well 4	APG 737	Injection Well 4	ALE 906

Year round heat injection will be required following full build out of the facility. Average seasonal demand will range from 418 gpm (February) to 727 gpm (July), with a short-term peak flow rate of 1,900 gpm. Water will be injected at an average temperature of 18.9°C year round, with temperatures exceeding 30°C for short periods during peak cooling needs. Background groundwater temperature is 16.4°C (PNNL 2010a).

The facilities' potable water will be provided through the City of Richland's municipal supply. Irrigation of up to 200 acres of landscaping and agriculture surrounding the PNNL campus is supplied by Surface Water Certificate No. CS4-SWC10176 and Groundwater Certificate No. CG4-27499C.

Instream Flow Requirements

To provide for preservation of wildlife, fish, aesthetic, and other environmental values, and navigational uses, Chapter 173-563 Washington Administrative Code (WAC) defines minimum instantaneous and minimum weekly average flows throughout the year at seven mainstem Columbia River locations. However, Chapter 173-563 WAC instream flow rules do not apply to applications for new Columbia River water rights for which Ecology makes a decision on or after July 27, 1997. Water right applications considered for approval or denial after that date are evaluated for possible impacts to fish and existing water rights in consultation with appropriate local, state, and federal agencies and Native American tribes pursuant to WAC 173-563-020(4).

This use of groundwater meets the definition of nonconsumptive provided by POL-1020 (Ecology 1991) and will not affect flows in the Columbia River; therefore, no consultation was conducted.

Water Quality

Groundwater Quality

The BSF/CSF building is located directly south of the Hanford Site – a decommissioned nuclear production complex operated by the Department of Energy. The Hanford Site reservation consists of approximately 570 square miles, which during the cold war, hosted up to nine nuclear reactors and five plutonium processing complexes. As the result of historic waste stream disposal practices, the Hanford Site has become one of the nation's most significant environmental cleanup efforts.

Contaminants of concern historically detected in monitoring wells on the Hanford Site near the BSF/CSF building include: uranium, volatile organic compounds (e.g. tetrachloroethene (PCE), trichloroethene (TCE), and 1,2-dichloroethene (DCE)), nitrogen compounds (nitrate and ammonia), and radionuclides. Tritium is also detected in groundwater across much of the Hanford Site.

In the immediate proximity of the BSF/CSF building, nearby areas and associated contaminants of concern include:

300 Area – Located approximately 5,000 feet northeast of the BSF/CSF site, the 300 Area was the location of plutonium production beginning in 1943. Large amounts of uranium and other contaminants were disposed of at the site in liquid wastes stream for more than three decades. The most significant contaminant of concern in groundwater is uranium, detected at concentrations up to 200 µg/L (cleanup level is 30 µg/L); and

Horn Rapids Landfill – The landfill is located approximately 4,000 feet northwest of the BSF/CSF site and was used for disposal of asbestos. The landfill has been officially closed; however, industrial solvents (TCE) originating from the adjacent AREVA facility have migrated downgradient to within 2,600 feet of the BSF/CSF site. TCE originally entered the subsurface as spillage during installation, cleaning, and repairing of lagoon liners.

Several groundwater quality samples were collected from Battelle's GSHP production wells during testing. Results of the analysis indicate no significant exceedance of water quality criteria, except for nitrate and two secondary contaminants including iron and total dissolved solids.

Additional information on the occurrence and extent of each contaminant of concern can be found in Hanford Site Groundwater Monitoring Report for Fiscal Year 2007 (DOE 2008). This information is summarized in the project's hydrogeologic evaluation report (PNNL 2010a).

Surface Water Quality

The mainstem of the Columbia River is on the State's 303(d) listing as being impaired for temperature. In addition, the Environmental Protection Agency (EPA) is currently considering a Total Maximum Daily Load (TMDL) for temperature for the Columbia River, which is known to exceed the preference zone for migrating salmon and steelhead from July to September. The overall goal of the Columbia River TMDL would be to lower the temperatures by reducing thermal loading to the river.

Hydrologic/Hydrogeologic Evaluation

The geology of the Pasco basin is dominated by repeated ice-age cataclysmic floods, transporting and depositing massive amount of sediment over the volcanic bedrock. The Pasco Basin was an area of significant sediment accumulation because of the ponding of floodwaters behind Wallula Gap. Due to the unique deposition environment, the sediments deposited from the flooding have a wide range in grain sizes (Bjornstad and Fecht 2002).

The local stratigraphy beneath the BSF/CSF site is dominated by 2 basic hydrostratigraphic units. From the ground surface down, these units are described as:

Hanford Formation – The Hanford Formation is an informal name assigned to the cataclysmic flood deposits within the Pasco Basin. The Hanford Formation consists predominantly of unconsolidated sediments covering a wide range of grain size and sorting, depending on the energy of the flood waters. Construction logs from wells completed on site indicate the upper sand and gravel extend to approximately 43 to 50 feet bgs, dipping slightly to the east. Where saturated, the upper sand and gravels of the Hanford Formation can be highly transmissive; and

Ringold Formation – This unit is classified as the fluvial-lacustrine sediment associated with the ancestral Columbia River drainage following the last eruption of basalt near Richland. The Ringold Formation blankets much of the Pasco Basin, but may be absent in areas of intense incision and erosion. The Ringold Formation consists of semi-indurated clay, silt, fine to coarse-grained sand and variably cemented sand to cobble (Bjornstad and Lanigan 2007). Locally, the Ringold Formation ranges in thickness from 155 to 180 feet, consisting of several fine and coarse grained subunits.

The extraction wells supporting the GSHP are completed in coarse, gravel dominated sections of the Ringold Formation, designated as units E and/or C (PNNL 2010a). The Hanford Formation is mostly unsaturated in three of the four extraction wells, with limited (one to three feet) saturated thickness in the injection wells.

The Ringold Formation aquifer is predominantly semi- to unconfined, responding quickly to precipitation and irrigation and to diurnal stage fluctuations in the Columbia River. No regionally extensive confining units or aquitards are typically observed separating the Hanford Formation from the underlying Ringold Formation. The saturated thickness of the Hanford Formation generally increases with proximity to the Columbia River. Horizontal hydraulic gradients in the regional aquifer are toward the Columbia River at 0.001 to 0.002 feet/foot to the northwest. Regional groundwater gradients and flow directions are affected by nearby irrigation to the west, the City of Richland recharge ponds to the south, and the stage of the Columbia River where near-shore, groundwater gradients reverse with rising stage within the river's large hyporheic zone (PNNL 2010a).

Preliminary Permit

A Preliminary Permit was issued by Ecology on March 27, 2008 authorizing Battelle to complete drilling and testing of GSHP wells. The objective of the testing performed under the Preliminary Permit was to obtain sufficient hydrogeologic and water quality data to support a decision on the water right application. Results of the testing are summarized in the Hydrogeologic Evaluation of a Ground-Source Cooling System at the BSF/CSF on the Battelle Campus (PNNL 2010a).

Pumping tests were completed in each of the eight GSHP wells. The pumping tests included a step-rate pumping test to evaluate well performance and yields, and a constant rate pumping or injection test to estimate aquifer parameters and longer-term sustainability. Reduction of the pumping test data from the extraction wells (Nos. 1 through 4) indicates a hydraulic conductivity of 155 to 467 feet/day (5.5×10^{-2} to 1.7×10^{-1} cm/sec), with an average of 275 feet/day (9.7×10^{-2} cm/sec). The values are representative of an aquifer with a medium to coarse sand and gravel matrix with few fines. Evaluation of the injection test data (Nos. 5 through 8) yielded higher values for hydraulic conductivity of 190 to 1,167 feet/day (6.7×10^{-2} to 4.1×10^{-1} cm/sec), likely the result of mounding into the Hanford Formation gravels. No value for storativity was reported.

Based on the results of the testing, it was determined that the maximum long-term sustainable flow rate of the GSHP system is approximately 1,400 gpm, with short-term peak pumping capacity of up to 1,900 gpm.

PNNL (2010a) evaluated the change in groundwater temperature and possible downgradient effects to the Columbia River. The evaluation included simulation of the groundwater regime with a numerical groundwater flow model and a thermal transport model using a proprietary program developed at PNNL for the Hanford Site. The Subsurface Transport Over Multiple Phases (STOMP) model domain included the BSF/CSF building site as well as nearby areas of concern, including the Horn Rapids landfill and the 300 Area. The Columbia River was included as a downgradient boundary condition.

Simulations were run using two different values of saturated hydraulic conductivity for the Ringold Formation, 197 and 492 feet/day (6.9×10^{-2} and 1.7×10^{-1} cm/sec), under several different operational scenarios requiring different flow rates (1,400 and 1,900 gpm). During actual system operation, GSHP pumping rates are continuously changing based on fluctuating system demand. Therefore, these modeling scenarios likely represent the maximum hydraulic impact to the regional aquifer since the system will likely never reach a steady state condition at the modeled assumptions. Travel times between the GSHP injection wells and the Columbia River range from 4 to 6 months (PNNL 2010a).

Particle tracking analyses indicate a maximum radial GSHP system capture zone of 1,200 feet. Groundwater flow beyond this distance may not contribute flow to the GSHP system; however, local groundwater flow directions may still be affected due to drawdown. Modeling results indicate that up to 1.3 feet of drawdown may occur near historical contamination associated with the Horn Rapids landfill under steady state conditions at 1,900 gpm.

When the BSF/CSF is fully equipped, continuous cooling of the building will be required, resulting in continuous heat injection to the subsurface. PNNL (2010a) evaluated the downgradient effects of several likely operational scenarios using the average monthly pumping rates and injection temperatures. The analysis used the same values for hydraulic conductivity as the hydraulic analysis presented above. Results indicate that under average conditions, the temperature of the groundwater discharging to the Columbia River is as much as 0.65°C higher than background. Temperature simulations using representative short-term peak injection temperatures and pumping rates were not presented in the report.

During the water right investigation, Battelle requested authorization to run a short (30 day) pilot test to demonstrate the GSHP system's effectiveness. Ecology agreed by authorizing a short-term Temporary State Waste Discharge Permit (No. ST-9270), provisioned on the collection and reporting of total flow rate and temperature data from both extraction and injection wells. The data was later presented to Ecology in a summary report (PNNL 2010b). Inspection of the data indicate that both background groundwater temperatures (15.6 to 15.8°C) and average weekly injection temperatures (17.8 to 18.5°C) were lower than what was presented in the hydrogeologic evaluation report (PNNL 2010a). However, the change in groundwater temperature as the result of GSHP operation was higher than previously predicted for both the weekly average (up to 2.7°C) and daily maximum (up to 7.4°C). The hydrogeologic evaluation report assumed an average monthly change in groundwater temperature of 2.5°C year round and a maximum of 3.5°C in July following full build out of the facilities.

APPLICATION EVALUATION

This Report of Examination (ROE) evaluates the application based on the conceptual model presented above. To approve the application, Ecology must issue written findings of fact and determine that each of the following four requirements of RCW 90.03.290(3) has been satisfied:

- (1) Beneficial Use: the proposed appropriation would be put to a beneficial use;
- (2) Availability: water is available for appropriation;
- (3) Impairment: the proposed appropriation would not impair existing water rights; and
- (4) Public Interest: the proposed appropriation would not be detrimental to the public interest.

Beneficial Use

In accordance with RCW 90.54.020(1) and POL-2020, the use of water as a source for heat or to dissipate heat is a beneficial use of water. This proposed appropriation will serve as the only source of water for the building's GSHP system and is classified, by definition, as industrial.

Availability

Based on the collective information summarized above, the quantity of water requested for use in this application is available for appropriation. Groundwater withdrawals from the Ringold Formation will not impact long-term groundwater levels. Drawdown in the Ringold Formation near the extraction wells would be largely overcome by the formation's high transmissivity, quickly attenuated by injection of water through the injection wells and/or leakage from the nearby Columbia River. The appropriation is defined as non-consumptive.

Testing of the GSHP indicates a maximum sustainable pumping rate of 1,400 gpm, with short-term peak capacity up to 1,900 gpm.

Potential for Impairment

RCW 90.03.290 and RCW 90.44.060 require a determination that a new appropriation will not impair existing water rights.

The area of consideration for assessing the potential for impairment is based on the location of the proposed points of withdrawal and the hydraulic groundwater modeling conducted by PNNL (2010a), including downgradient surface water. Consideration of permits, certificates, and claims (see Table 1 below) within the area of predicted drawdown conservatively inclusive of all potentially affected senior rights.

The open-loop GSHP is nonconsumptive – groundwater is withdrawn from the extraction well, then injected within relatively close proximity (800 feet) into the same aquifer; therefore, the net hydraulic effect on the regional aquifer system is expected to be negligible. Examination of the predicted change in water table elevation from operation of the GSHP system (PNNL 2010a) indicate that a small amount of drawdown is expected to occur to the full lateral extent of the model domain. However, significant drawdown (greater than 0.65 feet) is predicted to occur no further than an approximate 2,000 foot radius upgradient while pumping at 1,900 gpm under steady state conditions. Operation of the GSHP will require ever-changing average flow rates of 400 to 730 gpm, with only short-term peak pumping rates reaching 1,900 gpm. The groundwater system is not likely to ever reach a steady state hydraulic condition; therefore, these drawdown estimates are considered worst case and will not impair any senior groundwater withdrawal. Furthermore, drawdown is not predicted to propagate downgradient of the injection wells; therefore, no impairment of senior surface water diverters on the Columbia River is anticipated.

No existing water right permits lie within the area of predicted drawdown; however, two water right permits are located downgradient of the subject application's proposed points of withdrawal. Both are surface water permits to the Columbia River. One permit (S4-29941) belongs to the City of Richland for irrigation supply and the other (S4-30976) is the "Quad Cities" water right belonging to the cities of Kennewick, Pasco, Richland, and West Richland for general municipal supply. Quantities authorized by the two surface water permits are significant, with a Q_i of 45 and 178 cfs and a Q_a of 12,000 and 96,619 acre-feet per year, respectively;

Two certificated water rights – one groundwater and one surface water – are also located within the area of consideration. As previously mentioned both certificates belong to PNNL and are used for irrigation of approximately 200 acres of landscaping and surrounding agriculture.

Table 2: Certificated and permitted water rights, their authorized quantities and the point of withdrawal/diversion locations within the predicted area of drawdown.

Water Right #	Name	Purpose	Priority Date	Qi	Qa (ac-ft/yr)	POW/POD
S4-*18937CWRIS	Battelle Richland City	IR	4/6/1965	4.4 cfs	880	Sec 14 T10N R28E
S4-29941	(Aldrich)	IR	6/24/1980	45 cfs	12,000	Sec 14 T10N R28E
G4-27499CWRIS	PNNL/Battelle Kennewick Pasco W	IR	6/1/1981	500 gpm	464	Sec 23 T10N R28E
S4-30976	Richland City	MU,CI	9/23/1991	178 cfs	96,619	Sec 2 T10N R28E

There are also two Chapter 90.14 RCW claims to groundwater within the predicted area of drawdown.

In addition to certificated, permitted, and claims to water rights, Ecology’s database was queried for well logs within a 0.5-mile radius of the subject application to identify permit-exempt wells. Only one potential permit-exempt domestic water supply well was identified (excluding resource protection wells and known permitted water supply wells).

Based on the collective information, impairment of existing groundwater or surface water rights is not anticipated with full use of the requested quantity.

Water Quality

Effects on Nearby Groundwater Contamination

The Preliminary Permit (Ecology 2009) was conditioned to require collection and water quality analysis of groundwater samples from GSHP wells. PNNL (2010a) reported detections of nitrate at concentrations above the applicable screening levels, along with two secondary contaminants. With respect to each identified area of concern (see Water Quality Section above for location descriptions):

300 Area - The small net downgradient change in water table elevations created by the open-loop system should have little influence on groundwater flow patterns in the regional aquifer, especially downgradient of the injection wells, and therefore, little influence on contaminant transport. The groundwater regime surrounding the 300 Area is dominated by significant diurnal fluctuations in the stage of the Columbia River.

Horn Rapids Landfill – Some drawdown of water levels from GSHP operation is predicted to occur near Horn Rapids Landfill. However, recent communication between Ecology and Dave Einan, EPA Site Manager for the Horn Rapids landfill, indicate they have no concerns regarding Battelle’s GSHP application. Groundwater concentrations of contaminants of concern (primarily TCE) are below cleanup levels at all locations and groundwater monitoring has been suspended.

Based on this information, no negative effects to areas of known groundwater contamination are anticipated.

Open-Loop Groundwater Source Heat Pumps

A GSHP relies on the relatively constant temperature of the subsurface to act as either a heat source or sink. The temperature of the subsurface is typically warmer than the ambient outside air in the winter and cooler than the outside air in the summer. Therefore, the open-loop GSHP typically transfers heat (via groundwater) to the subsurface during the summer months, and extracts heat from the subsurface during the winter. Larger commercial/industrial buildings, due to their low surface to volume ratio and increased heat loads from lights and equipment, typically have greater cooling requirement than smaller residential structures.

Due to the unusual high cooling demand of the BSF/CSF building, injection of excess heat will be required year round. Groundwater modeling results indicate that under average conditions, the temperature of groundwater discharging to the Columbia River may be elevated as much as 0.65 °C above background.

Based on operational data submitted documenting the 30-day pilot test (PNNL 2010b), representative peak conditions were not evaluated in the report. In addition, assumptions related to change in average and peak injection temperatures used in groundwater modeling were lower than observed, which could contribute to under predicting downgradient temperature impacts. This is especially true when evaluating future impact from full CSF build out under peak summer cooling conditions.

Research on long-term impacts to groundwater quality or ecological effects associated with injection of higher temperature water have largely been inconclusive, but short-term impacts include increased microbial activity with elevated temperatures. Increased microbial activity is typically associated with increased fouling or reduced efficiency of the injection well, resulting in increased well maintenance, but otherwise no other significant consequences. The studies indicated that bacteria populations returned to normal levels when groundwater temperatures returned to background levels (EBN 2000).

Water Quality Permitting

Based on the findings of the hydrogeologic evaluation report (PNNL 2010a) and data presented in the summary report (PNNL 2010b), Ecology has determined that operation of the GSHP may adversely impact surface water quality of the Columbia River, which is included on the 303(d) list for temperature. Therefore, Ecology's Water Quality Program has required Battelle to conduct an analysis of All Known, Available, and Reasonable methods of prevention, control, and Treatment (AKART) of cooling groundwater prior to injection and to develop a detailed long-term Sampling Analysis Plan (SAP) which was also required by the Preliminary Permit. The SAP provides procedures, locations, and schedule for monitoring of background contaminants at the GSHP extraction wells and temperature in groundwater at the GSHP extraction and injection wells and downgradient at several sentinel groundwater monitoring locations. Results will be reported to Ecology on a monthly basis.

The SAP will be a condition of the Temporary State Waste Discharge Permit (No. ST-9274) governing the near-term operation of the GSHP. Following data collection and evaluation, a decision on a permanent water quality permit (permanent State Waste Discharge or NPDES) will be made by Ecology's Water Quality Program.

The four injection wells are registered under Ecology's Underground Injection Control (UIC) Program (Site No. 30838).

Public Welfare

The proposed appropriation will support the new BSF/CSF building for continued research at the PNNL campus. No detriment to the public welfare was identified.

CONCLUSIONS

The conclusions based on the above investigation are as follow:

1. The proposed appropriation for industrial use as non-contact cooling water in a GSHP is a beneficial use of water.
2. The quantity of water requested for non-consumptive use in this application is available for appropriation. However, the permit will only authorize the maximum short-term peak flow rate (1,900 gpm) of the GSHP system.
3. The proposed non-consumptive appropriation will not impair senior water rights. However, groundwater modeling results indicate temperature impacts to the Columbia River; therefore, the water right permit will be conditioned on a permanent State Waste Discharge or NPDES permit from Ecology’s Water Quality Program.
4. The proposed appropriation will not be detrimental to the public interest.

RECOMMENDATIONS

Based on the above investigation and conclusions, I recommend Application No. G4-35179 be authorized, in the amounts and within the limitations listed below and subject to the provisions beginning on Page 2.

Purpose of Use and Authorized Quantities

The amount of water recommended is a maximum limit and the water user may only use that amount of water within the specified limit that is reasonable and beneficial.

- 1,900 gallons per minute
- 3,064.7 acre-feet per year for non-consumptive industrial use in a GSHP

Point of Withdrawal

W½, SW¼, Section 14, Township 10 North, Range 28 E.W.M.

Place of Use

As described on page 1 under LEGAL DESCRIPTION OF PROPERTY ON WHICH WATER IS TO BE USED.

Report by: _____
Tyson D. Carlson, LHG, Aspect Consulting, LLC

Date

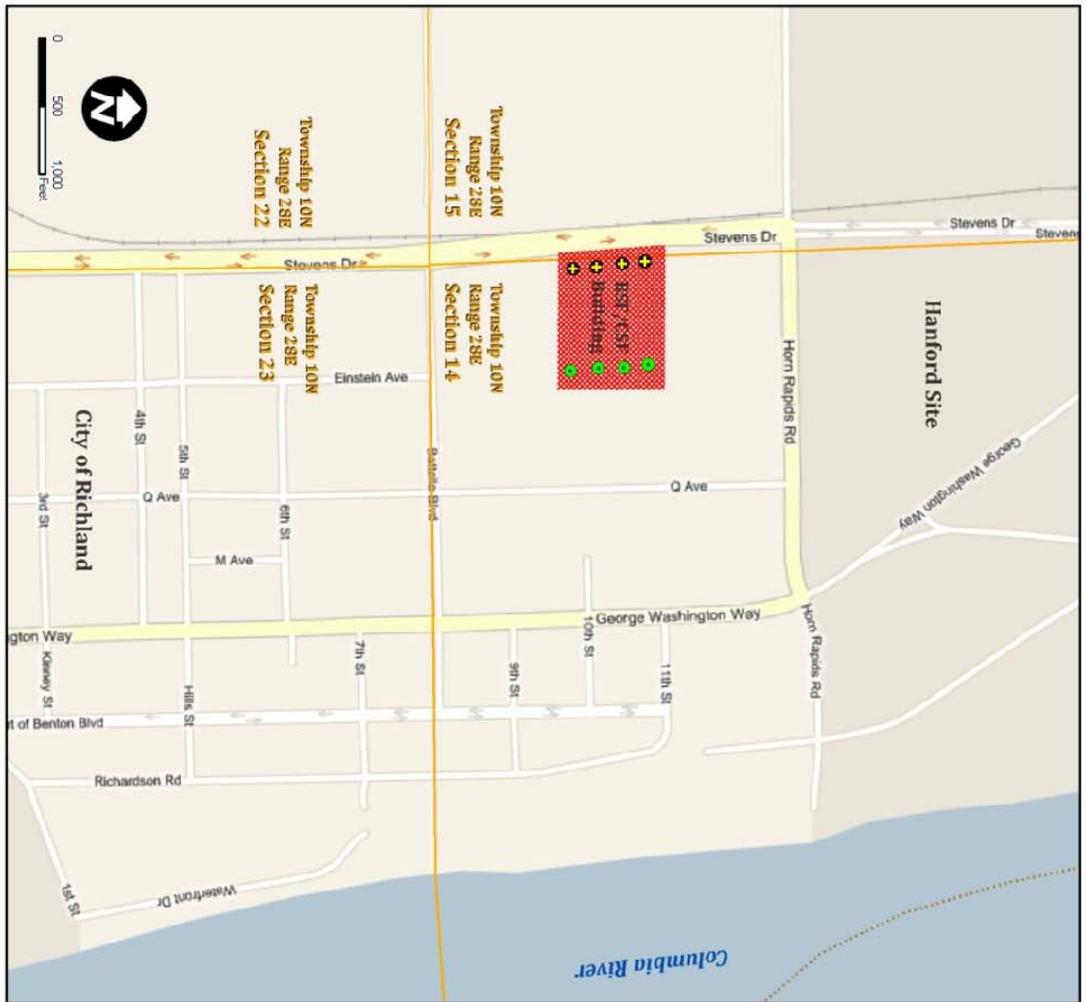
Reviewed by: _____
Kelsey Collins, Water Resources Program

Date

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CITATIONS

- Bjornstad, B. and Fecht, K. 2002. *Ice-Age Floods Features in the Vicinity of the Pasco Basin and the Hanford Reach National Monument*. Sponsored by the Ice-Age Floods Institute and the Columbia River Exhibition of History, Science, and Technology (CREHST). October 19, 2002.
- Bjornstad, B.N. and Lanigan, D.C. 2007. *Geologic Descriptions for the Solid-Waste Low Level Burial Grounds*. Prepared for the U.S. Department of Energy. Pacific Northwest National Laboratory. September 2007.
- Department of Energy 2008. *Hanford Site Groundwater Monitoring Report for Fiscal Year 2007*. DOE/RL-2008-01.
- Environmental Building News 2000. *Ground-Source Heat Pumps: Are They Green?* Published by Building Green, Inc. July/August 2000.
- Pacific Northwest national Laboratory 2010a. *Hydrogeologic Evaluation of a Ground-Source Cooling System at the BSF/CSF on the Battelle Campus: Final Report*. March 2010.
- Pacific Northwest national Laboratory 2010b. *Temporary State Waste Discharge Permit No. ST-9270 Summary Report for the Biological Sciences Facility/Computational Sciences Facility Ground Source Heat Pump*. April 15, 2010
- Washington State Department of Ecology 1991. *Water Resources Program Policy POL 1020; Consumptive and Nonconsumptive Water Use*. October 31, 1991.
- Washington State Department of Ecology 2007. *Water Resources Program Policy POL 2020; Priority Processing of Heat Pump Applications*. May 14, 2007.
- Washington State Department of Ecology 2008. *Preliminary Permit to drill eight test production wells, conduct testing to characterize aquifer parameters, assess potential for use as a water source geothermal heating/cooling system, and provide for long-term ground water monitoring under Ground Water Application G4-35179*. January 22, 2009.



Comments: Place of use and points of withdrawal are defined on the cover sheet under the heading "LEGAL DESCRIPTION OF PROPERTY ON WHICH WATER IS TO BE USED."

- Legend**
- Injection Wells
 - + Authorized Points of Withdrawal (Extraction Well)
 - Authorized Place of Use
 - Water Body or Watercourse
 - Section Lines

Battelle Memorial Institute		No. G4-35179	
VR1A.37, Benton County, Washington		T10N R28E, Sec 14	
Aspec consulting www.aspecconsulting.com a Battelle subsidiary		PROJECT NO 090180	
May 2010		ATTACHMENT NO 1	
TDC		SCG	

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