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2016 HOT WATER FLUSHING REMEDIATION PERFORMANCE REPORT

HOT WATER FLUSHING REMEDIATION
SKYKOMISH SCHOOL
BNSF FORMER MAINTENANCE AND FUELING FACILITY
SKYKOMISH, WASHINGTON
CONSENT DECREE NO. 07-2-33672-9 SEA

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ACRONYMS AND ABBREVIATIONS

°F	degrees Fahrenheit
2011 Design Report	*Hot Water Flushing Design Report, Skykomish School, 105 6th Street, Skykomish, Washington* dated June 6, 2011, prepared by Farallon Consulting, L.L.C., and Aquifer Solutions, Inc.
2015 CMP	*Addendum #3 to 2010 Compliance Monitoring Plan Update, BNSF Former Maintenance and Fueling Facility, Skykomish, Washington* dated February 17, 2015, prepared by Farallon Consulting, L.L.C.
APH	air-phase petroleum hydrocarbons
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
AWF	ambient water flushing
BNSF	BNSF Railway Company
CAP	*Cleanup Action Plan for BNSF Former Maintenance and Fueling Facility, Skykomish, Washington* dated October 18, 2007, prepared by the Washington State Department of Ecology
CWF	cold water flushing
dP	differential pressure
DRO	total petroleum hydrocarbons as diesel-range organics
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
Farallon	Farallon Consulting, L.L.C.
GAC	granular activated carbon
gpm	gallons per minute
HWF	hot water flushing
HWF O&M Plan	*Operation and Maintenance Plan, Hot Water Flushing System, Skykomish School, BNSF Former Maintenance and Fueling Facility, Skykomish, Washington* dated November 10, 2016, prepared by Farallon Consulting, L.L.C.
ITRC	Interstate Technology Regulatory Council
IWC	inches water column
LNAPL	light nonaqueous-phase liquid
NAPL	nonaqueous-phase liquid
OWS	oil-water separator

PID	photoionization detector
PLC	programmable logic controller
ppm	parts per million
PSCAA	Puget Sound Clean Air Agency
School Site	the area beneath and adjacent to all sides of the Skykomish School building within the sheet pile barrier wall, as shown on Figure 1
Site	BNSF Former Maintenance and Fueling Facility in Skykomish, Washington
SSD	subslab depressurization
SVE	soil vapor extraction
TPH	total petroleum hydrocarbons
Trihydro	Trihydro Corporation
VOCs	volatile organic compounds

EXECUTIVE SUMMARY

This 2016 Hot Water Flushing Remediation Performance Report presents the remediation activities, major accomplishments, and lessons learned during 2016 hot water flushing (HWF) operations conducted at the Skykomish School Site in Skykomish, Washington to evaluate the effectiveness of the HWF system in meeting design goals and compliance monitoring requirements. During summer HWF operations, overall system performance is monitored by the measurement of NAPL recovery. NAPL recovery will be used to measure compliance with Cleanup Action Plan (CAP) treatment requirements. Specifically, the objective of treatment is to reduce the amount of petroleum beneath the School to the extent technically possible. The School Site is defined as the area beneath and adjacent to all sides of the School building within the sheet pile barrier wall.

During 2016, HWF performance data were collected for School building temperatures, indoor air quality, noise, odor, heat removal by soil vapor extraction, mass removal by liquid-phase carbon treatment, NAPL recovery, groundwater elevations and temperatures, system flow rates, and operation and maintenance daily narrative logs. Capacities for HWF system performance that were identified in the 2011 Design Report as design quality objectives for equipment design were verified during HWF system startup, including the ability of the system to attain heated groundwater injection temperatures of 160 degrees Farrenheit (^{o}F) at a groundwater flow rate of 50 gallons per minute. A measured approach was taken to groundwater heating during the 2016 HWF operations, to gradually assess operating optimization and secondary factors such as the effects on the temperature of the school floor. School floor temperatures were within expected ranges, and the observed increase in average groundwater temperature in the treatment zone was consistent with design expectations for the heat input applied, with an average temperature in the mid-120s ^{o}F after 63 days of heating. Based on the operational data obtained in 2016, higher flow rates and a greater level of heating will be applied during 2017 in order to attain the maximum NAPL recovery possible. Additionally, an early-start HWF schedule is proposed, consisting of weekends-only injection of heated groundwater during May 2017. The early-start schedule would ultimately result in an extended duration of HWF treatment, and potentially further NAPL recovery, although it was not approved by the Skykomish School Board.

The 2016 NAPL recovery trends demonstrated a strong correlation that enhanced recoverability of NAPL is achieved through groundwater heating. Multiple lines of evidence are recommended as performance metrics to evaluate future progress toward meeting the primary treatment objective. Potential performance metrics include pore volumes analysis, and a recovery and/or decline curve analysis of NAPL recovery volume. These analyses account for groundwater temperature and groundwater gradient effects on maximum NAPL recovery. The decline curve analysis will involve analysis of future NAPL recovery rates that are expected to occur sometime during sustained maximum groundwater temperatures. Evaluation of asymptotically declining NAPL recovery rates, in the future, can be done by extrapolating then-current data into the future to assess if NAPL recovery trends indicate that additional NAPL recovery would be significant. Determining when the cleanup objective has been achieved will be determined in conjunction with the Washington Department of Ecology, and will depend on the analysis of multiple lines of evidence from the data obtained from future HWF system operations.

1.0 INTRODUCTION

This 2016 Hot Water Flushing Remediation Performance Report has been prepared on behalf of BNSF Railway Company (BNSF) for the hot water flushing (HWF) remediation system at the Skykomish School Site in Skykomish, Washington (School Site). The School Site is defined as the area beneath and adjacent to all sides of the School building within the sheet pile barrier wall, as shown on Figure 1. The remediation system is part of the remedial action underway at the BNSF Former Maintenance and Fueling Facility (herein referred to as the Site). The primary objective of the HWF system is to reduce the amount of petroleum nonaqueous-phase liquid (NAPL) from the subsurface beneath the School Site to the extent technically possible, with the treatment goal of removing separate-phase mobile or volatile liquid petroleum components or NAPL.

The purpose of this 2016 Hot Water Flushing Remediation Performance Report is to summarize remediation activities, major accomplishments achieved, and lessons learned at the School Site during HWF operations from May through October 2016. This report also identifies opportunities to optimize system performance in 2017, and presents metrics for assessing future progress with respect to the primary treatment objective. The Draft 2016 Hot Water Flushing Remediation Report submitted to Ecology on February 23, 2017 has been revised to reflect the April, 21, 2017 comments provided by Ecology and the meeting between Ecology, BNSF, and Farallon at Farallon's office on May 8, 2017. The comments received and the responses to the comments are presented in Appendix A, Response to Comments.

The work is being conducted in accordance with the *Cleanup Action Plan for BNSF Former Maintenance and Fueling Facility, Skykomish, Washington* dated October 18, 2007, prepared by the Washington State Department of Ecology (Ecology) (2007) (CAP). The remediation activities were approved by Ecology and undertaken by BNSF pursuant to Consent Decree No. 07-2-33672-9 SEA between BNSF and Ecology, and are part of an integrated and comprehensive remedial action for the Site. The HWF system was designed by Farallon Consulting, L.L.C. (Farallon) and Trihydro Corporation (Trihydro) and is described in the Hot Water Flushing Design Report dated June 6, 2011 prepared by Farallon and Aquifer Solutions Inc. (2011) (2011 Design Report).

Operations and monitoring were performed in accordance with *Addendum #3 to 2010 Compliance Monitoring Plan Update, BNSF Former Maintenance and Fueling Facility, Skykomish, Washington* dated February 17, 2015 prepared by Farallon (2015b) (2015 CMP) and the *Operation and Maintenance Plan, Hot Water Flushing System, Skykomish School, BNSF Former Maintenance and Fueling Facility, Skykomish, Washington* dated November 10, 2016 prepared by Farallon (2016) (HWF O&M Plan). The system was operated by Glacier Environmental Services, Inc.; Farallon provided management and oversight; Trihydro provided system design and optimization.

The following firms provided BNSF with the services listed below in support of this project:

- Farallon: project management and engineering design of remediation construction plans and specifications, construction management, compliance monitoring in accordance with the 2015 CMP, and BNSF liaison activities with local stakeholders;
- Glacier Environmental Services, Inc.: contracting services described in the 2015 construction plans and specifications, including system construction, installation, start-up, operation, and maintenance; and
- Trihydro: HWF system design, and technical support during system start-up and operation.

1.1 HOT WATER FLUSHING REMEDIATION GOALS

The primary objective of HWF treatment as described in the CAP is “to reduce the amount of petroleum beneath the school to the extent technically possible, with the treatment goal of removing separate-phase mobile or volatile liquid petroleum components or NAPL.” This objective is being accomplished by operating a closed-loop subsurface groundwater recirculation system, and heating groundwater to reduce NAPL viscosity, thereby mobilizing NAPL for recovery via a groundwater extraction system. The end point for system operation is the recovery of the maximum NAPL volume possible, which generally is interpreted to mean that a graph of cumulative volume of NAPL recovered over time attains an asymptotic level, beyond which significant further NAPL recovery is impractical (Interstate Technology & Regulatory Council [ITRC] 2009).

Additional objectives include controlling petroleum constituents mobilized or volatilized by the HWF system, which is accomplished using the soil vapor extraction (SVE) system installed beneath the slab of the School building. The SVE system depressurizes the subsurface beneath the School building during system operation, precluding vapor intrusion into the School building. A sheet pile barrier wall was installed to contain NAPL and enhance groundwater heating by limiting movement of heated water to outside the recirculation zone of the HWF treatment area (Figure 2).

The HWF treatment area consists of the School Site, which includes the School building footprint plus approximately 20 feet in all directions, extending to the sheet pile barrier wall, as shown on Figure 2. Areas outside the sheet pile barrier wall were previously excavated as part of the cleanup action along Sixth Street to the east, Railroad Avenue to the south, the Schoolyard to the west, and the Teacherage to the north.

1.2 DESIGN QUALITY OBJECTIVES

Design quality objectives (DQOs) developed to establish criteria for system and subsystem functionality, reliability, performance, safety/security, and operations monitoring were presented in the 2011 Design Report (Table 1). Design quality objectives presented in the 2011 Design Report do not represent specific field operational settings, but rather identify capabilities of the individual HWF subsystems to meet overall design objectives. The design quality objectives were established to ensure adequate design criteria and system capabilities to achieve overall treatment goals, and to identify critical engineering and equipment specifications. DQOs were reviewed to provide a framework to assess the effectiveness of current operations, and were used to develop remediation metrics for the evaluation of system performance and progress toward treatment goals.

A HWF system equipment performance DQO was established in the 2011 Design Report for the maximum groundwater temperature that might be encountered, for the purpose of ensuring the compatibility and safety of groundwater pumps and other materials in contact with heated groundwater. The DQO established for the maximum groundwater temperature was 140 degrees Fahrenheit (°F), which operationally represents a maximum value that might be attained for a brief time during the period of maximum groundwater heating effects.

A measured approach was taken to groundwater heating during the 2016 HWF operations, to gradually assess operating optimization and secondary factors such as the effects on the temperature of the school floor. An average groundwater temperature in the treatment zone in the mid-120s °F was attained after 63 days of heating. Operations during 2017 will be conducted at maximum feasible groundwater injection rates and temperatures, which is anticipated to result in higher groundwater temperatures than in 2016.

Attainment of the equipment DQOs by the HWF system and related subsystems was verified through monitoring of various operational data, and comparing these data to the design requirements defined in Table 1. DQOs that represent key operational system capacities include the groundwater recirculation flow rate capacity (50 gpm maximum) and the groundwater injection temperature capacity (160^{o}F maximum). These system capacities were verified during HWF system startup on June 16 and 17, 2016, including the measurement of system capacities as follows:

- June 16, 2016: 159^{o}F injection temperature at a groundwater flow rate of 47 gpm, with boiler inlet temperature of 58^{o}F (temperature rise of 101^{o}F at 47 gpm)

- June 16, 2016: 150^{o}F injection temperature at a groundwater flow rate of 60 gpm, with boiler inlet temperature of 58^{o}F (temperature rise of 90^{o}F at 60 gpm)

- June 17, 2016: boiler inlet temperatures of 66^{o}F resulted in injection capability of 160^{o}F at 60 gpm, exceeding DQO requirements for system capacity.

2.0 TREATMENT SYSTEM OPERATIONS OVERVIEW

As the 2016 operating season was the initial start-up period for the HWF remediation system, operations included equipment and operational troubleshooting, and a gradual ramp-up of operations over the first 3 weeks of the operating period. During the 2016 operational period, a range of operating conditions were undertaken that allowed evaluation of the system to meet various objectives and criteria. For example, the balance between groundwater heating and maintaining School building floor temperatures was evaluated over a range of conditions. Air quality and soil vapor conditions also were evaluated and compared to design criteria. The HWF system operational sequence over the 2016 operating season is described in the sections that follow.

2.1 FLUSHING SYSTEM OPERATIONAL MODES

The HWF system has the capability to operate in several modes: HWF, cold water flushing (CWF), and ambient water flushing (AWF). The primary differences between these modes is the temperature of the water, and the equipment used. Figure 3 provides a schematic of the groundwater treatment system and its major components.

In HWF mode, water is heated prior to injection to approximately 140 °F or higher using a diesel-powered boiler. The injected hot water transfers sufficient heat to groundwater and soil to increase the subsurface temperature and thereby reduce the viscosity of subsurface NAPL, allowing it to flow toward the groundwater recovery trench and the skimmers.

CWF may be used to accelerate cooling of subsurface temperatures at the School Site as needed to protect the School building and occupied spaces from high temperatures, or to otherwise reduce heat transfer to the School building prior to the start of the school year. In CWF mode, an electric-powered chiller cools the water prior to injection to a temperature of between 45 and 60°F. CWF operation was not needed and was not undertaken during 2016 because the School building basement slab and indoor temperatures were within American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) standards. Basement temperatures are discussed in further detail in Section 3.1, School Building Temperatures.

AWF involves flushing without heating (boiler operation) or cooling (chiller operation). The AWF mode of operation is used prior to the start of HWF to establish hydraulic recirculation, and following HWF to retain heat while recovering residual NAPL mobilized during the preceding HWF operations.

Following the remediation system operational season, the entire system is shut down and winterized. The winter shut-down phase is necessary to protect treatment system components from high groundwater associated with local flooding events, and to protect against freeze damage during extended cold periods experienced in Skykomish over the winter months. The HWF O&M Plan established baseline expectations for the sequence and duration of operational phases associated with the different modes. Operational schedules implemented in 2016 are described below.

2.2 2016 HOT WATER FLUSHING OPERATION

This section describes the overall operational schedule that was implemented for HWF operations during 2016, including operating events, modes, and system milestones (Table 2).

2.2.1 Start-Up and Intermittent Operations with Ambient Water Flushing

During initial start-up and commissioning activities conducted from June 6 through June 15, 2016, the groundwater treatment system was operated intermittently under ambient temperature conditions during daytime periods while the system was attended. Commissioning activities included flow balancing, calibration of system controls, and performance testing on system components.

2.2.2 Hot Water Flushing Operational Period

Initiation and calibration of the HWF boiler system began on June 16, 2016 following the last day of the school year, when students were no longer present at the School Site. HWF operations initially were conducted only during operator-attended daytime periods, until all system controls and safety interlocks were confirmed to be fully operational. As described in Section 1.2, HWF system capacities were verified during the initial three days of operation. During the 63 day long HWF period groundwater was injected at between 140°F and 160°F for 38 days. During these 38 days the average injection temperatures was 144°F. Weekly average injection temperatures are shown in Figure 4. The weekly average injection temperatures dropped to below 140°F in late July and August due to frequent boiler shutdowns. These frequent shutdowns were due to a combination of low system flowrates and higher groundwater extraction temperatures, which caused the boiler to operate at the low end of its turndown capacity.

Overnight continuous HWF system operations started on June 23, 2016. The HWF system subsequently was shut down from June 25 through July 10, 2016 due to biological fouling of the granular activated carbon (GAC) filters. Modifications to the system were made, and disinfection pretreatment measures were applied, which successfully limited biofouling over the remainder of the operating period. Further discussion of the biofouling shutdown is provided in Section 6.3, System Geochemical and Biological Fouling. Operation of the boiler and HWF was discontinued for the season on August 17, 2016, commensurate with the start of the school year.

2.2.3 Fall Cool-Down

The original design of the HWF system anticipated that School building floor slab temperatures may be elevated above the ASHRAE Standard of 84°F, and included CWF capabilities to reduce temperatures to an acceptable level prior to the start of the school year, if needed. During 2016 operations, the SVE system proved very effective in removing heat from beneath the School building floor slab, and prevented average basement floor temperatures from reaching 84°F. CWF was not needed because average floor temperatures remained below action limits. On August 17, 2016, the boiler was removed, and the HWF system transitioned to AWF, which allowed groundwater temperatures to decline gradually as enhanced NAPL recovery continued while the elevated subsurface temperatures established during HWF were sustained.

3.0 COMPLIANCE MONITORING RESULTS

The 2015 CMP outlined criteria specific to HWF when the School building is unoccupied in the summer, and during the 10-week transitional period following HWF when the School building is occupied. The 2015 CMP specified more-protective action limits and monitoring activities to be met prior to occupancy of the School building for the academic school year (school occupancy criteria), and recognized that certain criteria (e.g., floor slab temperatures) may be exceeded in unoccupied rooms during HWF. During the 2016 operation period, the school occupancy criteria were met with very limited exceptions, not only at the end of the summer, but throughout the period of active heating, as described in the sections below. A summary of compliance monitoring data collected during HWF operations, and associated action levels is provided in the Compliance Monitoring Matrix presented as Table 3.

3.1 SCHOOL BUILDING TEMPERATURES

In accordance with the 2015 CMP, basement room and floor temperatures in the School building were monitored during flushing activities. Monitoring results are summarized below.

3.1.1 Basement Floor Temperature

During HWF operations, the basement floor temperature was measured daily using a General IRT-206 Infrared Thermometer. Floor temperature readings were collected in six locations directly above the HWF system pipe corridor as shown on Appendix B Figure 1. Floor temperature readings were collected above the pipe corridor to represent localized worst-case conditions.

ASHRAE standards described in the 2015 CMP require that floor temperatures in occupied spaces not exceed 84°F. The maximum average floor temperature in the School building on any single date was 83.5°F, measured on August 2, 2016. The maximum floor temperature at any individual location in the School building was 88.1°F on August 12, 2016. When elevated temperatures occurred, they were mitigated by opening doors and windows to provide passive ventilation. The maximum floor temperature at any individual measurement location after teachers returned to the School building on August 24, 2016 was 80.6°F on August 26 and 29, 2016. Floor temperature measurements are summarized in Table 4.

3.1.2 Basement Room Temperatures

During HWF operations, basement room temperatures in the cafeteria and the southwest hallway were automatically data-logged every 30 minutes at the monitoring locations shown on Appendix B Figure 1.

ASHRAE standards require that room temperatures in occupied spaces not exceed 80°F or be more than 10°F higher than the outdoor ambient temperature. HWF operations were conducted in the summer months while the basement was unoccupied. The average basement room temperature during HWF operations was 72.4°F. The maximum room temperature was 84.5°F, recorded in the cafeteria on August 19, 2016. Doors and windows to the cafeteria were opened to allow cooling ventilation. Room temperatures are summarized in Table 5. Measurements that exceeded 80°F in occupied spaces are shown in bold. Basement floor and room temperatures over time are presented on Figure 5.

3.2 INDOOR AIR QUALITY

Indoor air quality monitoring was conducted in accordance with the 2015 CMP, which included monitoring with a photoionization detector (PID), and indoor air sampling of volatile organic compounds (VOCs) in the School building. The objective of the PID monitoring is to provide for notification of potential intrusion of volatile petroleum constituents from beneath the School building for the project duration. VOC monitoring was accomplished using continuously monitored RaeGuard 2 PID instruments with 10.6 eV lamps in three locations. RaeGuard 2 PIDs are installed in the School building in the following locations:

- Cafeteria (basement floor);
- Kindergarten (basement floor); and
- Main office (2nd floor).

VOC levels were continuously recorded by the programmable logic controller (PLC) remote monitoring system. The system's human-machine interface enabled VOC levels to be monitored remotely by School personnel and Ecology staff. None of the notification levels described in the 2015 CMP were triggered as a result of HWF activities.

Indoor air quality project action limits were exceeded in three instances. All three exceedances were determined to be the result of School maintenance activities, and are presented below by date:

- August 5, 2016: PID 1, located in the School building office, sustained readings of more than 5 parts per million (ppm) from 12:45 p.m. to 12:49 p.m. during office carpet cleaning.
- August 19, 2016: PID 3, located in the kindergarten area, sustained readings of more than 5 ppm from 10:25 a.m. to 10:34 a.m. during polishing of the School building gym floor.
- August 19, 2016: PID 1, located in the School building office, sustained readings of more than 5 ppm from 10:39 a.m. to 2:07 p.m. during polishing of the School building gym floor.

School personnel were notified at each exceedance, and windows were opened to ventilate rooms. Subsequent PID readings were within compliance limits. Summaries of air-phase petroleum hydrocarbon (APH) and PID data are provided in Tables 6 and 7, respectively.

3.3 NOISE

In accordance with the 2015 CMP, noise monitoring was conducted throughout the Skykomish School property on June 15, 2016 to create an updated noise map. Noise monitoring also was conducted continuously for 1 week following HWF system start-up.

Results from the noise monitoring are presented on Appendix C Figures 1 through 4. Noise data were collected throughout the Skykomish School property using a Quest Model 2200 sound level meter on June 16, 2016 while the SVE and HWF systems were in operation. Project action limits were not exceeded.

Continuous noise monitoring was conducted at the equipment compound from June 15 through June 22, 2016. Noise data were provided to Ecology and School personnel in the Week 2 Air, Odor, and Noise Monitoring Report. Noise mitigation measures were not required for treatment operations at the School Site because project action limits were not exceeded.

3.4 ODOR

Odor monitoring was performed continuously during periods when operating personnel were present on the Site. Level 1 odors as defined in the Hot Water Flushing Air, Noise, and Odor Monitoring Plan prepared by EMB Consulting (2015) (i.e., odors barely detected) were encountered during initial start-up and balancing of the boiler equipment on June 16, 2016. These odors were investigated by the boiler operator, who notified the team that the odors were a temporary condition during initial boiler start-up and balancing. Because this was only a temporary occurrence, odor mitigation was not required.

3.5 SVE SYSTEM COMPLIANCE MONITORING

Protection of indoor spaces from potential vapor intrusion of volatile substances related to HWF operations was accomplished by the SVE system, which ran continuously during 2016 HWF and AWF operations. SVE system compliance monitoring results are presented below. SVE system engineering performance is summarized in Section 4, Soil Vapor Extraction System Performance. SVE operational data for the complete 2016 HWF operational period are provided in Table 8.

SVE system data were evaluated early in the 2016 operational period and were reported in the memo regarding Soil Vapor Extraction System Performance and Optimization, Skykomish School Hot Water Flush System Project, Skykomish, Washington from John Pietz and Wilson Clayton of Trihydro (2016) to Jeff Hamlin and Andrew Vining of Farallon, provided in Appendix D.

Soil vapor samples were collected from SVE system influent on June 28, August 17, and September 23, 2016 prior to carbon treatment, and were analyzed for VOCs by Method TO-15. These samples were collected to document compliance with Puget Sound Clean Air Agency (PSCAA) requirements, and to characterize soil vapors beneath the School building. APH was detected at concentrations less than the Washington State Model Toxics Control Act Cleanup Regulation Method B Subslab Soil Base Screen Level. Soil vapor sample laboratory reports are provided in Appendix E. Table 9 provides a summary of SVE system influent sample results.

3.5.1 Mass Removal by Soil Vapor Extraction

Results from SVE system influent samples and SVE system flow rates were used to calculate pounds of APH and benzene extracted by the SVE system during 2016 system operation. The mass removal by SVE is shown in Table 8. A total of 6.6 pounds of APH and 0.003 pound of benzene were removed from the subsurface during 2016 system operation. These data show that the SVE system is not exceeding PSCAA Regulation I, 6.03(c)(94) annual discharge limitations of more than 15 pounds per year of benzene, or more than 1,000 pounds per year of toxic air contaminants. Further discussion of PSCAA compliance is provided in Section 4.2, SVE Petroleum Removal and Treatment.

3.6 TOTAL PETROLEUM HYDROCARBON CONCENTRATIONS AT LIQUID-PHASE CARBON VESSELS

Process water samples were collected weekly during flushing operations from June 15 through October 30, 2016 to determine the condition of the GAC. Compliance monitoring samples were collected from the lead carbon influent, lag carbon influent, and the lag carbon effluent of the HWF system, and were analyzed for total petroleum hydrocarbons (TPH) as diesel-range organics (DRO) by Northwest Method NWTPH-Dx at TestAmerica Laboratories of Tacoma, Washington.

The lag-vessel carbon effluent samples collected on June 16 and August 24, 2016 exceeded the Site Remediation Level for Groundwater of 477 micrograms per liter NWTPH-Dx. The results for these effluent samples were higher than those for upstream influent samples and subsequent effluent samples. It was determined that an error in labeling of sample containers occurred in the field, and therefore these samples were rejected. Additional labeling of carbon vessels and connection hoses was provided to clarify treatment system configuration.

Results from all other lag carbon effluent samples were less than the Site Remediation Level for Groundwater referenced in the 2015 CMP. Process water sample results are summarized in Table 10; laboratory analytical reports and the data validation report are provided in Appendices E and F, respectively.

On August 19, 2016, a third (spare) GAC vessel was implemented to provide for reduced system shutdown time needed for carbon changeout. Carbon changeout events were determined based on lag carbon effluent samples and biofouling conditions observed, and were scheduled on July 21, August 19, and September 26, 2016 as shown in Table 2.

Approximately 5,453,000 gallons of extracted groundwater were treated during 2016 operations, from which approximately 93 pounds of dissolved-phase DRO were removed by carbon treatment (approximately 13 gallons of NAPL, assuming 7.2 pounds per gallon of NAPL). Weekly dissolved-phase DRO recovery is shown in Table 11.

3.7 NAPL RECOVERY MONITORING

NAPL thickness in each of the 10 recovery wells was measured weekly during HWF operations. A profile of the 10 recovery wells located in the recovery trench is provided on Figure 6. Prior to measurement, NAPL was removed from the oil storage tank associated with each oil skimmer. Oil skimmer belts collect a volume of water along with oil during operation. Water present in the oil storage tank was removed and passed through the HWF treatment system, and is not included in the weekly NAPL recovery measurements recorded in Table 11. Measurable NAPL recovered during HWF operations in 2016 was collected from recovery well RW-9 (Figure 2), which is consistent with the prior understanding of NAPL distribution beneath the School building.

Previous explorations at the Site indicated that NAPL distribution was evident primarily at the northeastern corner of the School building, as described in the 2011 Design Report. A total of 40.2 gallons of NAPL was recovered from recovery well RW-9 during 2016 HWF operations. As of October 31, 2016 (the date of seasonal shutdown), the NAPL recovery rate had diminished to zero gallons per week. Further discussion of NAPL recovery activities and results is provided in Section 5.5, NAPL Recovery.

3.8 GROUNDWATER ELEVATIONS AND TEMPERATURES

Instrumentation for measuring groundwater elevations and temperatures is installed in 21 groundwater monitoring wells at the School, shown on Figure 2. The monitoring instruments for monitoring wells GWM-1 through GWM-7 are connected to the system's PLC. The remaining monitoring wells were outfitted with standalone Levelogger Junior Edge Model 3001 dataloggers. Following installation, the instruments were calibrated and field-verified using manual water-level gauges. The seven monitoring wells that connect to the PLC continuously record groundwater level and temperature readings, which are displayed in real time via the PLC, and are logged every 30 and 60 minutes, respectively.

The groundwater elevation and temperature monitoring elements are used beneath the School, along the hydraulic containment wall, and inside the recovery trench during HWF system operation to help balance and maintain operational efficiency. Data from the dataloggers and the PLC were uploaded every 2 weeks during HWF.

The typical ambient groundwater temperature within the containment area around the School site is approximately 55°F. HWF operations increased average groundwater temperatures in the treatment area (monitoring wells GWM-6 through GWM-8) to above 120°F. A summary of daily groundwater elevations and temperatures is provided in Tables 12 and 13, respectively.

During 2016 HWF operations average groundwater temperature in the treatment zone were sustained above 100°F for 35 days and above 120 °F for 9 days. The treatment zone average groundwater temperatures, durations, and pore volumes treated during each period are summarized in the table below:

Summary of 2016 Operational Milestones

Treatment Zone Average Temperature (°F)[1]	Reduction in Viscosity (Percent)	Duration (Days)	Pore Volumes Treated[2] (-)
100+	90	35	7.4
110+	94	20	4.5
120+	96	9	2.1

[1] Average groundwater temperature in treatment zone is based on a daily average of data from submerged wells located inside targeted treatment zone, GWM 6, 7, and 8.

[2] A pore volume has been defined as the volume of water in the saturated portion of the aquifer. At the School Site a pore volume consists of the footprint of the School building and approximately 20 feet adjacent to all sides of the building, with an average thickness spanning 5.5 feet from 917 ft msl (average groundwater elevation) to 911.5 ft msl (elevation of deepest contamination). See calculation below.

30,000 ft^2 * (917 ft msl - 911.5 ft msl) * .25 porosity * 7.48 gallons/ ft^3 = 310,000 gallons

4.0 SOIL VAPOR EXTRACTION SYSTEM PERFORMANCE

SVE system performance relative to design objectives and operational expectations is presented in this section. The SVE system started operation on June 15, 2016, and was tested prior to start-up of the HWF system. SVE compliance monitoring results are presented in Section 3.5, SVE System Compliance Monitoring.

4.1 SVE FLOW AND VACUUM PERFORMANCE

According to the U.S. Environmental Protection Agency (EPA) (2008, 2015) guidance, subslab depressurization (SSD) systems for control of vapor intrusion can reverse the potential for air flow through the slab (SSD systems) or dilute the concentrations of air (subslab ventilation systems). Based on these guidance documents, a target average differential pressure (dP) was established at approximately 4 to 10 pascal, or 0.016 to 0.040 inch water column (IWC).

Maintenance of at least 0.025 IWC in all soil gas probes was specified in 2015 CMP as an operating goal. The dP data presented in the Appendix D memo indicate only partial compliance with this goal, with the average dP ranging from 0.0 to 0.04 IWC. However, according to EPA (2008, 2015) guidance, dP is only one metric used to gauge the effectiveness of vapor intrusion mitigation, and other factors such as air flow rate and soil vapor concentrations should be considered. Taken together, the dP data, air flow rates of 500 to 600 standard cubic feet per minute within the subsurface beneath the School building floor (Table 8), room air analytical results (Table 6), SVE airflow concentrations below risk standards (Table 9), and room air PID results (Table 7) strongly support the conclusion that the SVE system is an effective vapor intrusion mitigation system.

A likely explanation for the lower-than-anticipated vacuum readings is the presence of a void space of 1 to 5 inches between the School building floor slab and underlying soil, which was discovered during system construction. This gap allows transmission of large amounts of air flow without development of the anticipated magnitude of SVE vacuum pressure beneath the slab. The increase in SVE air flow also enhances SVE performance in removing subslab heat. A detailed discussion of SVE performance is provided in the Appendix D memo.

4.2 SVE PETROLEUM REMOVAL AND TREATMENT

As shown in Table 8, the SVE system removed approximately 6.6 pounds of total APH during the 2016 operational period. PSCAA Regulation I, 6.03(c)(94) requires that gas- or odor-control measures be installed for any soil or groundwater remediation project that emits more than 15 pounds of benzene per year, or more than 1,000 pounds of toxic air contaminants per year. The SVE system at the School building emitted only 6.6 pounds of APH, which is a total summation of applicable toxic air contaminants defined by PSCAA, and includes benzene. The 2016 SVE operation clearly met the PSCAA criteria prior to any carbon treatment. Monthly monitoring of SVE emissions will continue during 2017 system operation.

4.3 SVE THERMAL PERFORMANCE

An important function of the SVE system is removal of excess heat associated with HWF operations from beneath the floor slab, and prevention of School building floors from reaching temperatures over 84°F. As shown on Figure 5, average floor temperatures were maintained below the 84°F threshold. The temperature of the soil vapor removed from the SVE system was consistently above 80°F, indicating that the system removed a significant amount of heat from beneath the School building.

5.0 GROUNDWATER FLUSHING SYSTEM PERFORMANCE

Groundwater flushing system performance, including hydraulic and groundwater heating performance, is presented in this section. Also discussed are system geochemical and biological fouling, and groundwater treatment. NAPL recovery by the HWF system is described, and NAPL recovery rates are provided. NAPL mobility and recovery in the subsurface is a complicated process involving factors such as the hydraulic gradient, soil permeability, and NAPL characteristics (ITRC 2009). Section 7, Conclusions and Recommendations, discusses the progress toward attaining the Site objective of NAPL recovery to the extent practical with respect to these factors and others using available system performance data.

5.1 HYDRAULIC PERFORMANCE

The HWF system generally was operated at flow rates of 13 to 60 gallons per minute (gpm). During HWF activities the system operated at an average flow rate of 36 gpm (10 week duration), which is generally consistent with the expected design range of 30 to 50 gpm (Farallon 2011). During CWF activities, coincident with lower groundwater the system operated at an average flow rate of 23 gpm (10 week duration). A summary of average daily flow rates is provided in Table 14, and shown on Figure 7. Flow rate values provided are weekly averages and at times actual flowrates may been slightly higher or lower than values shown.

Hydraulic gradients and flow directions are provided as contour plots representing the beginning, middle, and end of the HWF operating period. These plots are presented as Figures 8, 9, and 10 for June, July, and August 2016, respectively. Contour plots developed using Surfer Version 8.04 were produced using groundwater levels at 12 monitoring well locations within the sheet pile barrier wall. These contour plots indicate strong hydraulic control over the treatment area, with flow gradients consistently toward the recovery trench. System balancing via adjustment of flows to the injection wells was performed throughout the operating period to optimize hydraulic control. The 2011 Design Report indicated that expected groundwater mounding likely would be less than 2 feet, and drawdown would be less than 1 foot, which is consistent with the groundwater monitoring data observed during the 2016 season. Groundwater gradient provides the driving force for NAPL migration, and is maintained between the recovery trench and the subsurface injection points by depressing the water level in the recovery trench. During 2016 HWF, the hydraulic gradient developed across the northeastern corner of the School site, where NAPL recovery is greatest, eventually reaching a maximum of approximately 0.025 during mid-summer (Figures 8 through 10).

The maximum operational groundwater elevation recorded in monitoring wells across the Site during HWF in 2016 was 918.2 feet above mean sea level, recorded at monitoring well GWM-7 on July 13, 2016, which is 7.3 feet below the School building slab floor elevation. The minimum operational groundwater elevation during HWF was 914.6 feet above mean sea level, 10.9 feet below the School building slab floor level, recorded at monitoring well GWM-17 on August 17, 2016.

During the latter portion of the summer dry season, decreasing water levels made it difficult to operate several recovery wells at the design flow rate. During the week of September 21, 2016, coincident with the low groundwater elevation period, the flow rate was reduced to 13 gpm, and was shifted primarily to wells in the area of the recovery trench where most of the NAPL was present. This action reduced the risk of damaging the pumps or shutting down the system when pumps would run dry.

The effectiveness of the sheet pile barrier wall in minimizing groundwater movement into or out of the treatment zone was evident in the difference of temperatures and groundwater levels at paired monitoring well locations (one well inside, and one well outside the sheet pile barrier wall). At the paired location at the southeastern corner of the Site (monitoring wells GWM16 and GWM17), groundwater temperatures were consistently 20 to 30° higher, and groundwater levels were consistently 2 feet lower inside the containment area during HWF between July 10 and August 17, 2016.

Flow balancing among the different injection wells was optimized weekly based on groundwater monitoring well levels and temperatures. Initially, hot water injection was preferentially directed into the injection wells along the eastern side of the School building to establish elevated groundwater temperatures, which facilitated initial NAPL flow near and within the recovery trench. As treatment progressed throughout the 2016 HWF operating period, flow rates to the injection wells were adjusted and gradually directed into wells located farther north and west, to increase the temperature over the entire treatment zone.

5.2 GROUNDWATER HEATING PERFORMANCE

Figures 11, 12, and 13 depict groundwater heating performance as color contour maps representing early, middle, and late HWF periods, respectively.

Groundwater temperatures measured prior to HWF system start-up typically were below 55^{o}F (Figure 11). Intermittent heating of groundwater was initiated on June 16, 2016; continuous heating was started on July 10, 2016. Groundwater temperatures beneath the School building eventually reached temperatures ranging from 90 to 125^{o}F from July 15, 2016 through discontinuation of heating on August 17, 2016, representing an approximately 50 to 75^o increase over ambient conditions. Groundwater temperatures declined gradually after heating was discontinued, and groundwater temperatures in the general range of 80 to 90^{o}F were maintained throughout September 2016, representing an approximately 30 to 40^o increase over initial conditions.

Figure 14 shows the laboratory-measured relationship between temperature and viscosity using a NAPL sample collected from the Site (2011 Design Report). This curve shows that an approximately 10- to 100-fold reduction in viscosity was attained by the HWF system in the 90 to 125^{o}F operational range of groundwater temperatures that were attained during active heating in 2016. At a temperature of 100^{o}F, NAPL viscosity is reduced by approximately 90 percent compared to starting conditions. At 120^{o}F, a viscosity reduction of 96 percent is achieved. A further reduction from 96 to 98 percent would be achieved at 135^{o}F, which was not attainted during the 2016 operating season. It is unlikely that an additional 2 percent viscosity reduction would yield significant results in NAPL recovery. The NAPL viscosity reduction achieved translated into a proportional increase in subsurface NAPL flow rates and recovery that was observed during the operational period, as described in Section 5.5, NAPL Recovery.

Figure 15 shows the average groundwater temperatures in the treatment zone, and results from a numerical model simulation of the HWF groundwater heating process during the 2016 operating season. The numerical model is a proprietary model that simulates heat inputs and outputs and associated changes in average temperature over time within a specific volume. Heating inputs used in the model consisted of actual daily groundwater injection temperature data at the observed average groundwater recirculation flow rate over the period. Heating outputs included SVE soil gas mass/temperature removal, leakage of heated groundwater to the outside of the sheet pile area, and thermal conduction outward into the surrounding groundwater region. The numerical model results provide a reasonable approximation of the actual measured average groundwater temperatures during the 2016 operating season. The discontinuous heating and conservative injection water heat management that occurred during 2016 HWF operations limited maximum groundwater temperatures attained. Application of the model to predict potential average groundwater temperatures over the recommended 2017 HWF season, inclusive of recommended earlier start, continuous operations, maximized groundwater injection rates, and increased injection water temperatures, indicates higher average groundwater temperatures will be attained in 2017. This is further discussed in Section 5.5, NAPL Recovery.

5.3 SYSTEM GEOCHEMICAL AND BIOLOGICAL FOULING

Geochemical and biological fouling was observed in the recovery wells and the groundwater treatment system. The degree of system performance impact due to geochemical and biofouling was not anticipated, and the system was shut down between June 25 and July 10, 2016 for application of countermeasures.

With approval from Ecology, a chlorine shock treatment was administered on July 10 to address biofouling. The dosing regimen involved placement of trichloroisocyanuric acid tablets in the recovery wells. Residual chlorine concentrations were maintained through the treatment system at 2 to 5 ppm free chlorine. Free chlorine was measured at the GAC vessel effluent, and was consistently 0.1 ppm or less prior to heating and re-injection, well below the Washington State drinking water standard of 4.0 ppm free chlorine.

System operation improved following the chlorine treatments, which were continued throughout the remaining 2016 operating period. There is some caution about continued use of chlorine, as it can cause corrosion of metals, which was evident in the oil-water separator (OWS), where concentrated chlorine caused pitting of the OWS floor, which required repair. Dosing methods for the OWS subsequently were adjusted to protect against localized high-chlorine concentrations and associated metal corrosion.

Geochemical fouling experienced in the treatment system was primarily due to iron and manganese precipitation, which was mitigated by application of a sequestrant solution (CARUSQUEST 101) that was implemented on August 11, 2016. The sequestrant is a phosphate-based compound with a design dosage concentration of 5.5 ppm After sequestrant dosing began, total phosphorus analysis was performed on extracted groundwater to monitor for accumulation of phosphorus in groundwater. Phosphorus was not detected at a concentration exceeding the laboratory detection limit of 0.25 milligrams per liter in any of the groundwater samples collected. Analytical results for total phosphorus are presented in Table 15.

A down-hole camera was deployed to assess the condition of the recovery wells. This assessment indicated that the metal drop pipe and foot valves in the recovery wells were not overly corroded or otherwise affected by the chlorine. The video footage, photographs, and localized drawdown behavior suggest that a combination of geochemical and biological fouling is present within the well screens and in the soil surrounding the recovery wells. The combination of low groundwater levels, biofouling, and geochemical fouling resulted in difficulty balancing the recovery well pumping rates.

During the week of April 3, 2017 coincident with School spring break and prior to resuming HWF system operations in 2017 Farallon performed well cleaning using a combination of physical and chemical methods. The purpose of cleaning the recovery wells was to reduce or eliminate the risk of system shut-downs due to clogged well screen and to maximize well recharge rates.

The recovery well cleaning included shock dosing wells using a solid phase granular acid and in accordance with the Nu-Well 110 Granular Acid and Nu-Well 310 Bioacid Dispersant Application guides. Immediately following the chemical dosing the acid was agitated in the well using a rigid well brush. The well was scrubbed using the well brush and surged using a well surge block. Following 24 hours of contact time the wells were purged of the acid using a vacuum truck.

The HWF injection wells were able to accept flow totals in excess of 50 gpm for the School Site. It is unlikely that the injection wells will need any redevelopment or treatment. Flowmeters at each injection zone header were reliable for use in balancing system flows and controlling groundwater gradients.

5.4 GROUNDWATER TREATMENT

The groundwater treatment system employs several components to progressively remove NAPL (Figure 3). Primary treatment consists of NAPL recovery components, including recovery well belt skimmers and an OWS to remove NAPL. NAPL recovery performance is discussed in Section 5.5, NAPL Recovery. Following liquid-phase NAPL recovery, some dissolved-phase TPH and mineral and organic constituents remain in the water, which require progressive treatment measures to remove.

The bag filter system provides filtration of the groundwater stream to remove mineral precipitates and organic particulates. The primary function of the bag filter system is to protect and preserve the carbon in the GAC vessels, which provide polishing treatment for removal of dissolved TPH. As part of the system adjustments implemented to manage biofouling, bag filter sizing was reduced from 20 to 5 microns to provide enhanced filtration, and to prolong the life of the GAC. During 2016 HWF operations and prior to sequestrant implementation, bag filters were replaced daily.

Application of the sequestrant solution reduced mineral precipitation and the need to replace bag filters from daily to once or twice weekly.

5.5 NAPL RECOVERY

During 2016 operation, 40.2 gallons of NAPL was recovered by the HWF system, all from recovery well RW-9. Trace NAPL was observed in recovery well RW-7 and in the OWS, but did not accumulate to a volume recoverable by skimmer belts or the weir drain on the OWS. Additional discussion of NAPL recovery measurements is provided in Section 3.7, NAPL Recovery Monitoring.

Following chlorine dosing of recovery wells during July 2016, several skimmer belts showed signs of decay of the surface coating, likely due to a combination of the higher temperatures and residual chlorine inside the well casing. Spare skimmer belts were available on the site to allow for replacement as needed.

During August 2016 operations, the OWS coalescing media showed signs of clogging, which resulted in higher concentrations of dissolved-phase TPH passing through the OWS to the bag filters and the GAC vessels. The system was shut down and the OWS media pack was removed for thorough cleaning. Cleaning reduced the concentrations of dissolved-phase TPH passing through the OWS to acceptable levels. To limit system shut-down events associated with OWS maintenance, the coalescing media will be replaced for subsequent HWF seasons with new UNIPACK media less prone to clogging.

The NAPL recovery rate observed over the 2016 HWF operational period, measured in gallons per week, is shown on Figure 16. The NAPL recovery rate increased and decreased roughly parallel to increasing and decreasing groundwater temperatures (Figures 16). The maximum observed NAPL recovery rate was 7.1 gallons, which occurred during the week prior to August 31, 2016. Maximum removal rates were observed approximately 1 month following the maximum groundwater temperatures and corresponding minimum NAPL viscosity values. Heating was discontinued on August 17, 2016; maximum NAPL recovery rates of more than 7 gallons per week were observed the week of August 26 through 31, 2016. The time lag between peak ground temperature and maximum recovery rate is attributed primarily to initial establishment of NAPL coating and flow within the gravel trench backfill. NAPL recovery rates diminished gradually after August 31, 2016 as groundwater temperatures slowly decreased and corresponding NAPL viscosity increased throughout September and October 2016.

The lag between minimum viscosity values and maximum NAPL removal rates is a function of the time required for NAPL movement into the recovery trench system, and to the dynamics of NAPL movement in a porous media (i.e., pore pressure, gradient, residual saturation, etc.). Maximum removal rates will be achieved by maintaining minimum NAPL viscosity for as long as possible. It is inconclusive whether the maximum achievable NAPL recovery rate was reached in 2016 because the maximum recovery rate occurred during the last week of August after heating had been discontinued. Following HWF, NAPL viscosity increased as groundwater temperatures decreased.

The HWF thermal numerical model described in Section 5.2, Groundwater Heating Performance, was used to predict the approximate groundwater temperatures expected to be accomplished during 2017 with an optimized HWF operational plan. Because the model was calibrated to actual 2016 results, the predicted temperature trends for 2017 determined from the model are expected to be a reasonably accurate approximation. Two operational scenarios for 2017 are presented (Figure 17), (a) the recommended scenario for an early start to HWF operations where groundwater heating would be applied for approximately 36 hours each weekend from May 7 to June 14, 2017, and (b) the Skykomish School Board approved scenario without an early start to groundwater heating. In each scenario , 2 weeks over the summer period were simulated without heat addition, to account for operational maintenance and/or possible downtime. The 2017 model predictions are also based on maintaining groundwater injection temperatures between 155°F and the design maximum of 160°F, which is greater than the injection temperatures applied during 2016 operations that were in the range of 145°F for much of the summer, while effects on school floor temperatures were evaluated.. The numerical simulation results presented on Figure 17 show the benefit of starting weekend-only hot water injection during May. By raising groundwater temperatures earlier in the operating season, the effective period of HWF operations will be significantly extended. The recommended 2017 operating plan would essentially triple the 2016 operation period during which temperatures increase to above 100°F from approximately 1 month to approximately 3 months. The 100°F criteria is a reasonable metric to assess the overall duration of HWF enhancement of NAPL recovery, as this is the temperature at which a 90 percent reduction in NAPL viscosity is achieved. However, 100°F is not a performance metric for HWF system performance, and heating will be continued to attain the maximum average groundwater temperatures that are possible during HWF operations. The modeling of 2017 groundwater heating represents a tapering of heat addition to keep average groundwater temperatures below 135°F, so that the maximum design rating of 140°F is not exceeded at any particular location.

Weekend-only heating operations in May 2017 would provide a carefully measured application of heat and a running start to warming the ground formation without impacting School activities. Higher groundwater temperatures than those realized during 2016 operations may be obtained by extending the HWF season. The longer operating duration at elevated temperatures is expected to increase NAPL removal and recovery, and provide a better basis for evaluating system performance and determining when cleanup objectives are met. While the 2017 scenario without an early start (Figure 17) has a smaller duration of elevated temperatures, it will still result in greater average groundwater temperatures than in 2016, since greater injection temperature will be applied in June 2017, at the inception of HWF, than were applied in June 2016.

6.0 HOT WATER FLUSHING PERFORMANCE METRICS

This section outlines the goals and metrics that will be used to evaluate progress toward completion of HWF based on the goal of removal of NAPL to "the extent technically possible". During summer HWF operations, overall system performance will be monitored by the measurement of NAPL recovery which will be evaluated to determine compliance with the primary cleanup objective. *As stated in the O&M Plan:*

"The primary cleanup objective associated with the design of the HWF treatment system is to reduce the amount of petroleum beneath the School to the extent technically possible, with the goal of removing separate-phase mobile or volatile petroleum constituents or NAPL. Operation of the treatment system will be complete based on coordination with Ecology."

Inherent in the evaluation of progress toward completion of NAPL recovery is the recognition that all NAPL recovery technologies exhibit a nonlinear declining trend in NAPL recovery, and that the NAPL cumulative recovery volume curve as a function of time eventually flattens toward an asymptotic level, beyond which further recovery is not practical (ITRC 2009). The Site-specific declining NAPL recovery rates will be evaluated consistent with ITRC (2009) guidance, along with evaluation of the following multiple lines of evidence to determine that cleanup objectives have been met:

- Graphs of NAPL cumulative recovery volume with respect to time and groundwater temperature in the treatment zone, to assess progress toward asymptotic NAPL recovery rates, which are an indicator of technical impracticability of further NAPL recovery (ITRC 2009).
- The number of pore volume exchanges of groundwater during hot water flushing with respect to time and groundwater temperature in the treatment zone, may be a relevant alternative metric for plotting and evaluating declining NAPL recovery rates (Davis 1995; O'Carroll and Sleep 2007).
- NAPL recovery rates as a function of groundwater hydraulic gradient and groundwater temperature, as additional metrics of the completeness of NAPL recovery attained.

6.1 EVALUATION OF COMPLETION OF NAPL RECOVERY

6.1.1 NAPL Recovery Rate Decline Curve Analysis

The ITRC (2009) technical/regulatory guidance for NAPL recovery goals states that decline curve analysis is an appropriate performance metric for evaluating the performance of NAPL removal. The ITRC guidance elaborates, "decline curve analysis indicates that based on LNAPL [light nonaqueous-phase liquid] recovered, the remaining LNAPL is either small or the time to recover relative to the remaining volume may be impractical." Because ITRC guidance does not include specific details for evaluating a thermal system that cycles on and off, the decline curve analysis will be evaluated in context of groundwater temperatures in the treatment zone. Decline curve analysis, along with other lines of evidence, is an appropriate basis for evaluating completion objectives for the Skykomish School project based on technical considerations reflected in the ITRC technical/regulatory guidance, and given the goal of community stakeholders to complete the remediation within a reasonable time frame.

This metric will be assessed by plotting weekly NAPL recovery rates versus time and cumulative NAPL volume, and cumulative volume versus elapsed time. Attainment of asymptotic recovery rates or extrapolation of these plots to a recovery rate that indicates the attainment of a reasonable maximum recoverable volume and associated time for recovery are both appropriate endpoints.

6.1.2 Subsurface Pore Volume Exchanges

The number of pore volumes of groundwater that are flushed through a target treatment zone is also a useful metric in assessing the progress of NAPL recovery. A review of the remediation literature identified several HWF remediation bench studies or site remediation case histories that used this metric (Davis 1995; O'Carroll and Sleep 2007; Leuschner et al. 1997). An HWF site remediation project involving No. 6 oil in Colorado also was identified (Clayton 2009). In these reports, the number of pore volume exchanges required for NAPL recovery and project closure ranged from 10 to 55, dependent on factors such as NAPL characteristics, hydraulic conductivity, and hydraulic gradient. As shown on Figure 7, approximately 18 pore volume exchanges were achieved during 2016. Operational data for 2017 will be evaluated to assess whether NAPL recovery rates as a function of pore volume exchanges are representative of decline trends, either in addition to or in place of duration-based trends.

6.1.3 Groundwater Gradient and Temperature

Groundwater gradient and temperature are significant variables influencing NAPL migration. Hot water injection serves to reduce the viscosity of NAPL, as shown on Figure 15. Average treatment zone temperatures reached over 120^{o}F. As shown on Figure 14, an approximately 10- to 100-fold reduction in viscosity was attained by the HWF system in the 90 to 125^{o}F operational range of groundwater temperatures attained during active heating in 2016, as discussed in Section 5.2, Groundwater Heating Performance. To ensure the compatibility and safety of groundwater pumps and other materials in contact with groundwater, the DQO established in the 2011 Design Report that the maximum groundwater temperature that might be attained was 140^{o}F. Since a measured approach was taken to groundwater heating during the 2016 HWF operations to gradually assess operating optimization and secondary factors such as the effects on the temperature of the school floor, the highest average groundwater temperature attained in the treatment zone was approximately 125^{o}F. The recommended earlier start and maximized groundwater injection rates and temperatures during hot water flushing in 2017 will result in a longer period of elevated groundwater temperatures than were attained in 2016 , as discussed in Section 5.5, NAPL Recovery. The NAPL recovery data obtained over this extended 2017 operational period will be evaluated as a function of groundwater temperature and hydraulic gradient to assess whether declining NAPL recovery trends result from changes in operational variables, or progresses toward the maximum extent of NAPL recovery possible.

NAPL residual saturation represents the threshold fraction of NAPL-filled pore space below which NAPL becomes discontinuous and immobile. As described in the 2011 Design Report, NAPL residual saturation is reduced at elevated temperatures and roughly proportional to lower NAPL viscosities observed at elevated temperatures. NAPL that otherwise would be immobile and unrecoverable becomes mobile and recoverable at elevated temperatures. After heating is discontinued and temperatures decrease, residual saturation shifts, NAPL viscosity increases, and remaining oil may become immobilized. It is anticipated that remaining NAPL will be essentially immobile following discontinuation of HWF operations, and diminishing returns have been reached under active heating conditions. This outcome ultimately will be reflected empirically by an absence of NAPL recovery under groundwater recirculation at ambient temperatures.

7.0 CONCLUSIONS AND RECOMMENDATIONS

The HWF system is an effective means of NAPL recovery from the School Site. Although injection of hot water and corresponding elevated ground temperatures produced a correlated, measurable response in NAPL recovery during the 2016 operating season, operating data from a single season are insufficient to estimate the total quantity of NAPL that ultimately may be removed.

HWF system operations during 2016 met equipment design goals and compliance monitoring requirements. A total of 40.2 gallons of NAPL was recovered as a result of HWF. The 2016 operational period represented the initial operating season, in which meeting critical operating criteria and objectives was confirmed. HWF groundwater temperature increases during 2016 were consistent with design expectations for the heat input applied. A measured approach was taken to groundwater heating during the 2016 HWF operations to gradually assess operating optimization and secondary factors such as the effects on the temperature of the school floor. The 2016 NAPL recovery trends demonstrate that enhanced recovery of NAPL is achieved through groundwater heating.

The SVE system is an effective means of vapor-phase petroleum recovery, and of reducing heat transfer to the School building. Results from indoor air and temperature monitoring demonstrated that the system was operating in compliance with prescribed operating objectives. The SVE system successfully removed soil vapors and heat to control School building floor slab temperatures. Operational adjustments and activities recommended for HWF system optimization in 2017 are presented in the following sections. Operation of the treatment system will be complete based on coordination with Ecology.

7.1 RECOMMENDATIONS TO OPTIMIZE NAPL REMOVAL

A longer operational season and maximized groundwater injection rates and temperatures are recommended to facilitate maximum NAPL removal rates for as long as possible in the upcoming 2017 operating season.

An earlier start to the treatment season would allow for controlled pre-heating and setup of hydraulic configurations. Initial start-up of HWF operations would be gradual, with HWF occurring only on weekends, when school is not in session. A May 1, 2017 start-up (4 to 6 weeks earlier than the 2016 start-up) will increase groundwater temperatures sooner. An earlier start is expected to produce the maximum groundwater temperature of greater than 130^{o}F by mid-July 2017, and to extend it to the end of the HWF season in mid-August 2017 (Figure 17). Once the groundwater temperature reaches above 130^{o}F, heating will be tapered to level out groundwater temperature so that the maximum design rating of 140°F is not exceeded at any particular location. The 2017 maximum NAPL recovery rate is anticipated to occur sometime during the maximum groundwater temperature period of mid-July to mid-August.

Recovery well cleaning is recommended to reduce or eliminate the risk of system shut-downs due to clogged well screen. Limiting the number of shutdowns will result in a longer heating duration and higher temperatures which will increase potential for NAPL recovery.

Maximized groundwater injection rates and temperatures during hot water flushing in 2017 are recommended to achieve higher average groundwater temperatures for a longer duration than were achieved in 2016. Specifically, the HWF system equipment will be operated at the upper range of the equipment performance DQOs to achieve maximum feasible injection rates and temperatures.

Most significantly, the recommended 2017 operating schedule would essentially triple the period over which temperatures are elevated above 100°F in comparison to the 2016 operating season, from approximately 1 month to approximately 3 months. The additional operating duration at elevated temperatures is anticipated to maximize potential for NAPL removal and recovery, and provide a better basis for evaluation of system performance.

If the treatment season is extended, it is recommended that mechanical cooling capabilities be retained for at least 1 additional year (2017 operating season) to address the potential for higher floor slab temperatures related to a longer heating duration. Ventilation equipment also will be available for use in the School building as needed to address the potential for elevated room and floor temperatures. Following the HWF heating cycle, the treatment system will be operated under ambient conditions to slowly bring temperatures down and maintain enhanced NAPL recovery. If NAPL recovery rates approach zero during 2017 ambient flushing conditions, the treatment system will be shut down.

7.2 RECOMMENDED 2017 OPERATING SCHEDULE

The recommended operating schedule for 2017 includes an earlier start that will not interfere with school operation, with SVE and groundwater re-circulation beginning on a 24/7 basis on May 1, 2017, and hot water injection beginning on a weekend-only basis on May 6, 2017. The proposed 2017 HWF schedule is summarized in the following table.

Proposed 2017 Hot Water Flushing Schedule

Date	Proposed 2017 Milestone	Notes
April 1	Recovery Well Cleaning	Scheduled Coincident with School Spring Break. Recovery Wells were physically and chemically cleaned as described in Section 5.3
May 1	Start SVE and AWF operations	Starting up the system will not require as much operator time in the School building because the system was commissioned in 2016, and most activities can be performed on weekends or after school hours.
May 6	Start weekend-only HWF operations	This schedule provides 5 weeks of gradual ramp-up of groundwater temperatures without affecting school activities or negatively affecting indoor temperatures
June 14	Last day of school year	
June 15	Start full-time HWF operations	
August 15	End HWF operations, start AWF operations (remove boiler, activate chiller as needed)	Same as 2016, when transition from HWF mode was made 2 weeks before start of school year. Mobilize chiller as needed.
August 31	First day of school	
October 31	System shut-down for winterization	Exact date to be determined by weather conditions or absence of NAPL recovery.

Notes:
AWF = ambient water flushing
HWF = hot water flushing
SVE = soil vapor extraction

8.0 REFERENCES

Clayton, W.S. 2009. "Thermal Hot Water Flood Remediation and Closure of Free Product Viscous #6 Oil at a U.S. Site." CleanUp 09 Conference, Adelaide, Australia. September 27-30.

Davis, Eva L. 1995. "Hot Water Enhanced Remediation of Hydrocarbon Spills." Emerging Technologies in Hazardous Waste Management V. November 9: 237-250.

EMB Consulting. 2015. *Hot Water Flushing Air, Noise, and Odor Monitoring Plan, 2015 to 2019, Skykomish School, 105 6th Street, Skykomish, Washington*. Prepared for BNSF Railway Company and Farallon Consulting, L.L.C. February 10.

———. 2015b. *Addendum #3 to 2010 Compliance Monitoring Plan Update, BNSF Former Maintenance and Fueling Facility, Skykomish, Washington*. Prepared for BNSF Railway Company, Seattle, Washington. February 17.

———. 2016. *Operation and Maintenance Plan, Hot Water Flushing System, Skykomish School, BNSF Former Maintenance and Fueling Facility, Skykomish, Washington*. Prepared for BNSF Railway. November 10.

Farallon Consulting, L.L.C., and Aquifer Solutions, Inc. 2011. *Hot Water Flushing Design Report, Skykomish School, 105 6th Street, Skykomish, Washington.* Prepared for BNSF Railway Company, Seattle, Washington. June 6.

Interstate Technology & Regulatory Council (ITRC). 2009. *Evaluating LNAPL Remedial Technologies for Achieving Project Goals.* Washington, D.C. December 2009.

Leuschner A.P., M.W. Moeller, J.A. Gerrishe, and L.A. Johnson 1997. "Case Study: MGP Site Remediation Using Enhanced DNAPL Recovery." *Contaminated Soils*. 607-620.

O'Carroll, Denis M. and Brent. E. Sleep. 2007. "Hot water flushing for immiscible displacement of a viscous NAPL." *Journal of Contaminant Hydrology*. 91: 247-266.

Trihydro Corporation (Trihydro). 2016. Memo Regarding Soil Vapor Extraction System Performance and Optimization, Skykomish School Hot Water Flush System Project, Skykomish, Washington. From John Pietz, P.E., and Wilson Clayton, PhI [*sic*]. To Jeff Hamlin, P.E., and Andrew Vining, P.E., Farallon Consulting, L.L.C. August 19.

U.S. Environmental Protection Agency (EPA). 2008. *Engineering Issue: Indoor Air Vapor Intrusion Mitigation Approaches.* Office of Research and Development. EPA/600/R-08-115. October.

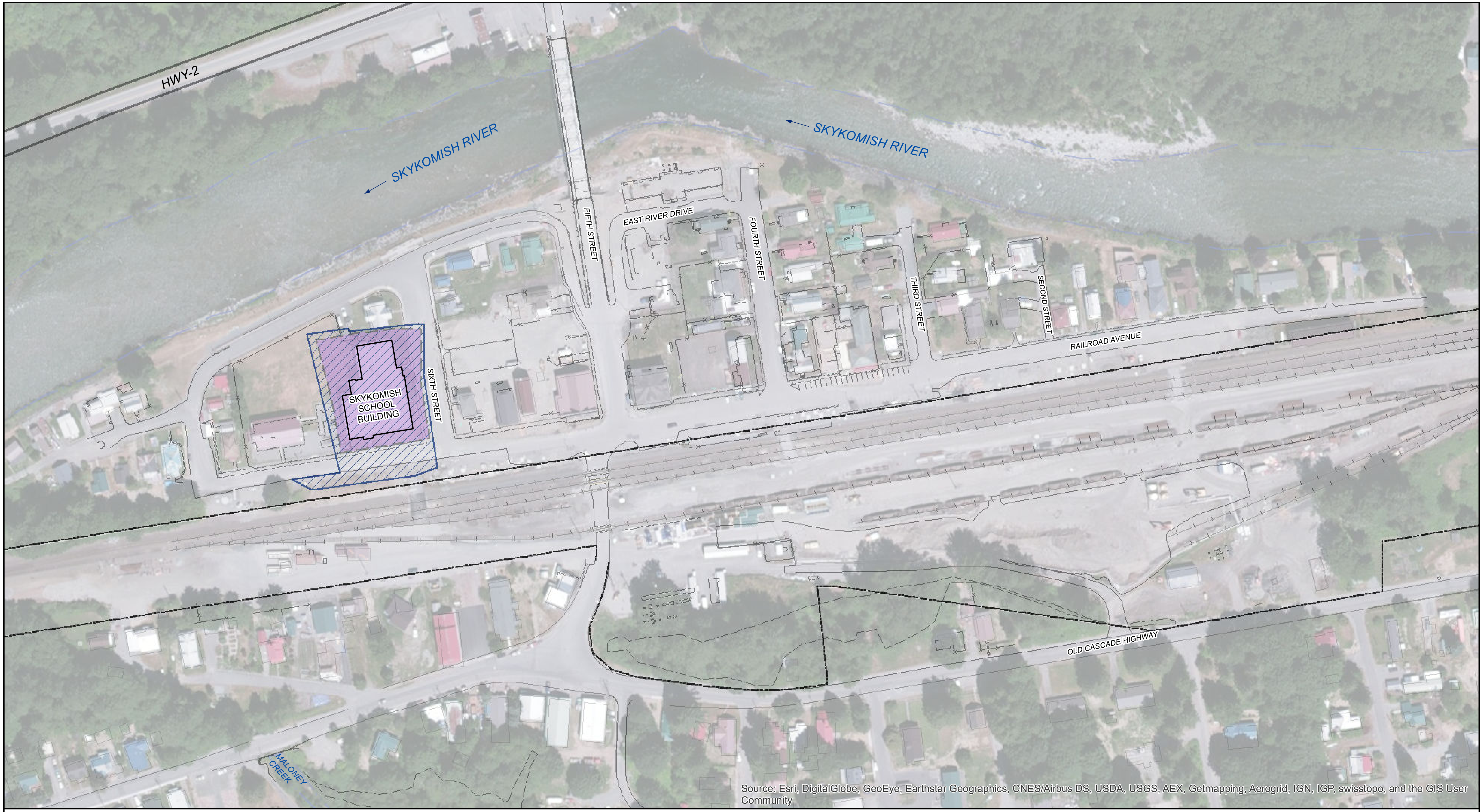
———. 2015. *OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air.* Office of Solid Waste and Emergency Response. OSWER Publication 9200.2-154. June.

Washington State Department of Ecology. 2007. *Cleanup Action Plan for BNSF Former Maintenance and Fueling Facility, Skykomish, Washington*. Exhibit B of Consent Decree No. 07-2-33672-9 SEA between the Washington State Department of Ecology and BNSF. October 18.

FIGURES

2016 HOT WATER FLUSHING REMEDIATION
PERFORMANCE REPORT
Skykomish School
BNSF Former Maintenance and Fueling Facility
Skykomish, Washington

Farallon PN: 683-057



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

LEGEND

▨	SCHOOL SITE
▨	HOT WATER FLUSHING SYSTEM AT THE SCHOOL SITE
-·-·-	BNSF PROPERTY LINE

IMAGERY SOURCE: USDA FARM SERVICE AGENCY(FSA)
NATIONAL AGRICULTURE IMAGERY PROGRAM (NAIP) 2015

0 160
SCALE IN FEET

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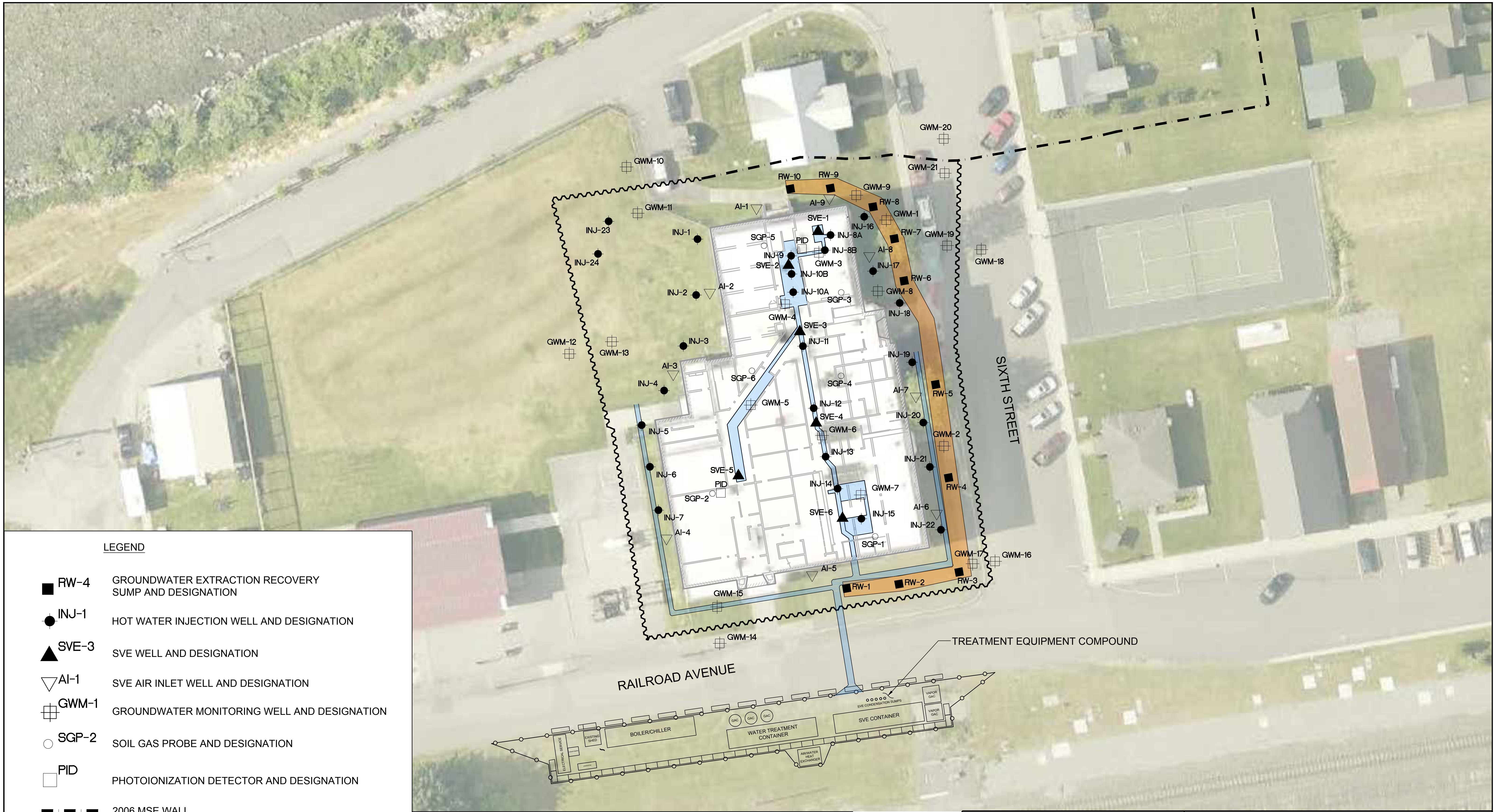
FIGURE 1
SITE LAYOUT
2016 HOT WATER FLUSHING REMEDIATION
PERFORMANCE REPORT
SKYKOMISH SCHOOL
BNSF FORMER MAINTENANCE AND FUELING FACILITY
SKYKOMISH, WASHINGTON
FARALLON PN: 683-057

Drawn By: tperrin
Checked By: AW
Date: 12/29/2016
Disc Reference:
Document Path: G:\Projects\683 BNSF\683043 Skykomish Ongoing Cleanup Activities\GIS\HWF Construct\FIGURE1_683057_site.mxd



LEGEND

■ RW-4	GROUNDWATER EXTRACTION RECOVERY SUMP AND DESIGNATION
● INJ-1	HOT WATER INJECTION WELL AND DESIGNATION
▲ SVE-3	SVE WELL AND DESIGNATION
▽ AI-1	SVE AIR INLET WELL AND DESIGNATION
⊞ GWM-1	GROUNDWATER MONITORING WELL AND DESIGNATION
○ SGP-2	SOIL GAS PROBE AND DESIGNATION
☐ PID	PHOTOIONIZATION DETECTOR AND DESIGNATION
▬ · ▬ · ▬	2006 MSE WALL
∿∿∿	SHEET PILE BARRIER WALL
🟧	GROUNDWATER AND LNAPL RECOVERY TRENCH
🟦	TREATMENT PIPING CORRIDOR

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Scale in feet

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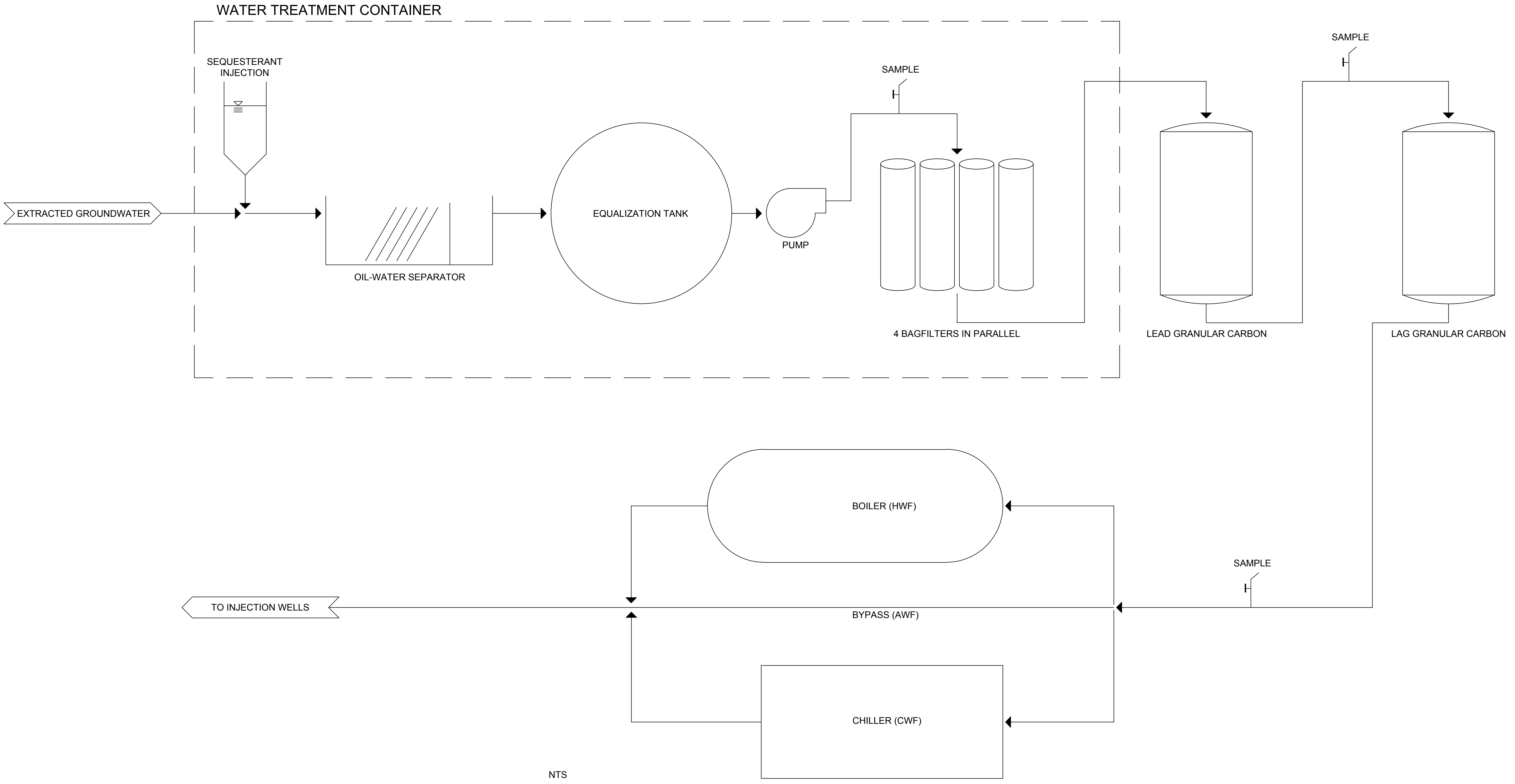
FIGURE 2

HOT WATER FLUSHING SYSTEM LAYOUT
2016 AS-BUILT COMPLETION REPORT
BNSF FORMER MAINTENANCE
AND FUELING FACILITY
SKYKOMISH, WASHINGTON

FARALLON PN: 683-057

Drawn By: JS Checked By: AV Date: 2/13/2017 File: FIGURE 2



GROUNDWATER FLUSHING SYSTEM PROCESS FLOW SCHEMATIC

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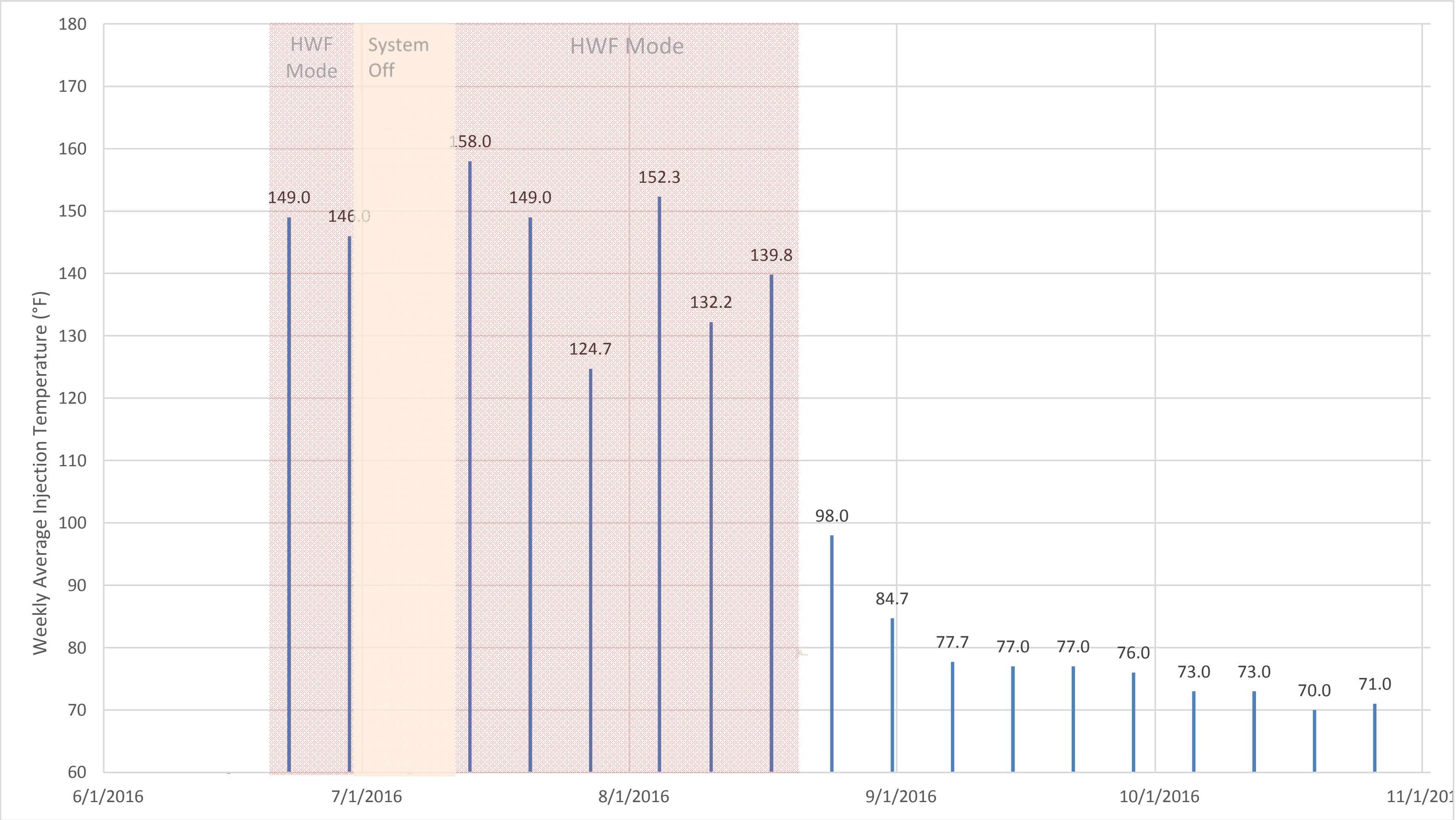
FIGURE 3
GROUNDWATER FLUSHING SYSTEM PROCESS FLOW SCHEMATIC
2016 HOT WATER FLUSHING REMEDIATION PERFORMANCE REPORT
SKYKOMISH SCHOOL
BNSF FORMER MAINTENANCE AND FUELING FACILITY
SKYKOMISH, WASHINGTON
FARALLON PN: 683-057

Drawn By: JS
Checked By: AV
Date: 12/08/16
File: FIGURE 3

Figure 4
Weekly Average Injection Temperatures
Skykomish School Hot Water Flushing Remediation
Skykomish, Washington
Farallon PN: 683-057

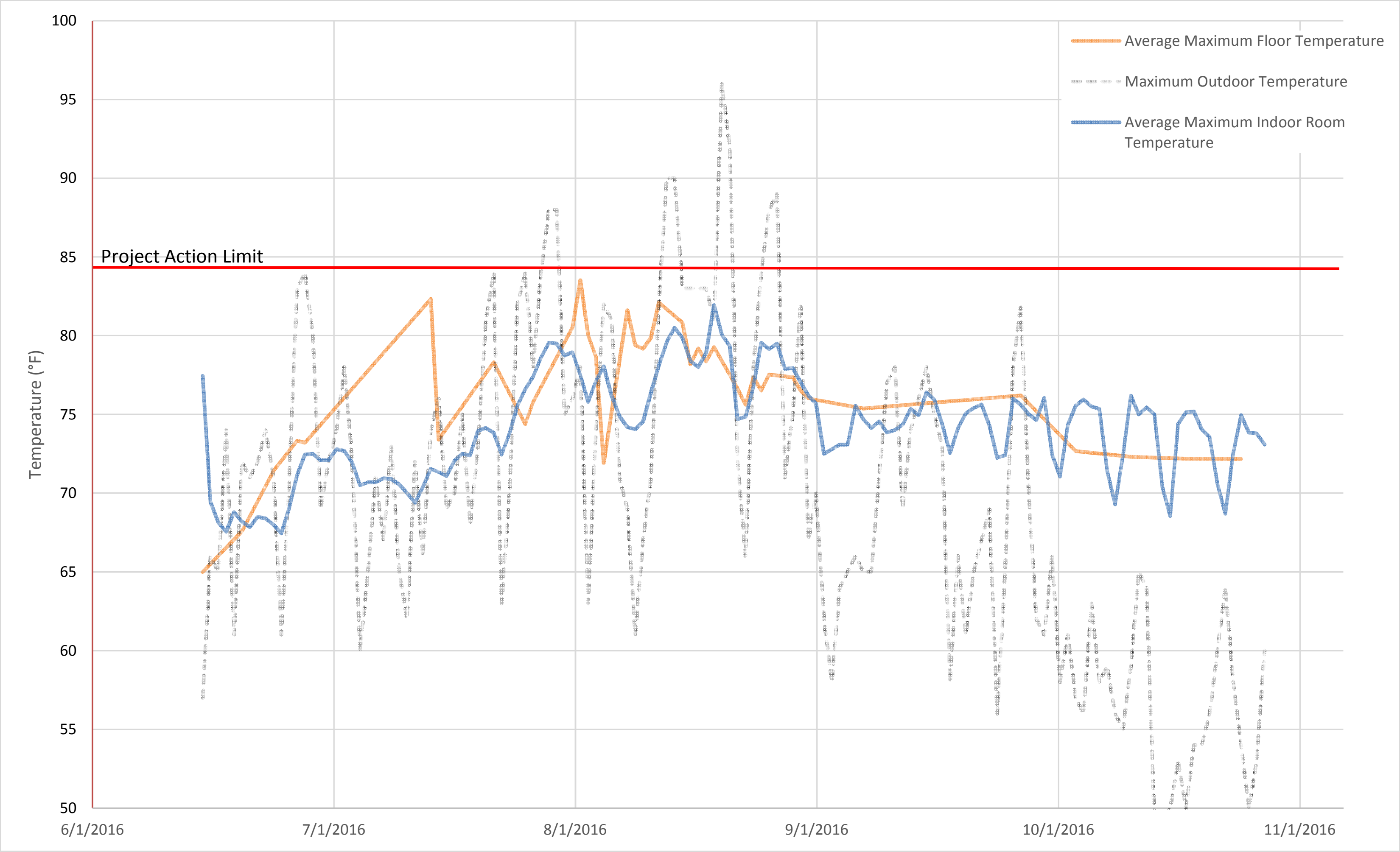


NOTES:

The hot water flushing system was not in operation from June 25 through July 10, 2016, due to biofouling of the granular activated carbon filters.

F = Fahrenheit

Figure 5
Site Temperatures
2016 Hot Water Flushing Remediation Performance Report
Skykomish School
BNSF Former Maintenance and Fueling Facility
Skykomish, Washington
Farallon PN: 683-057

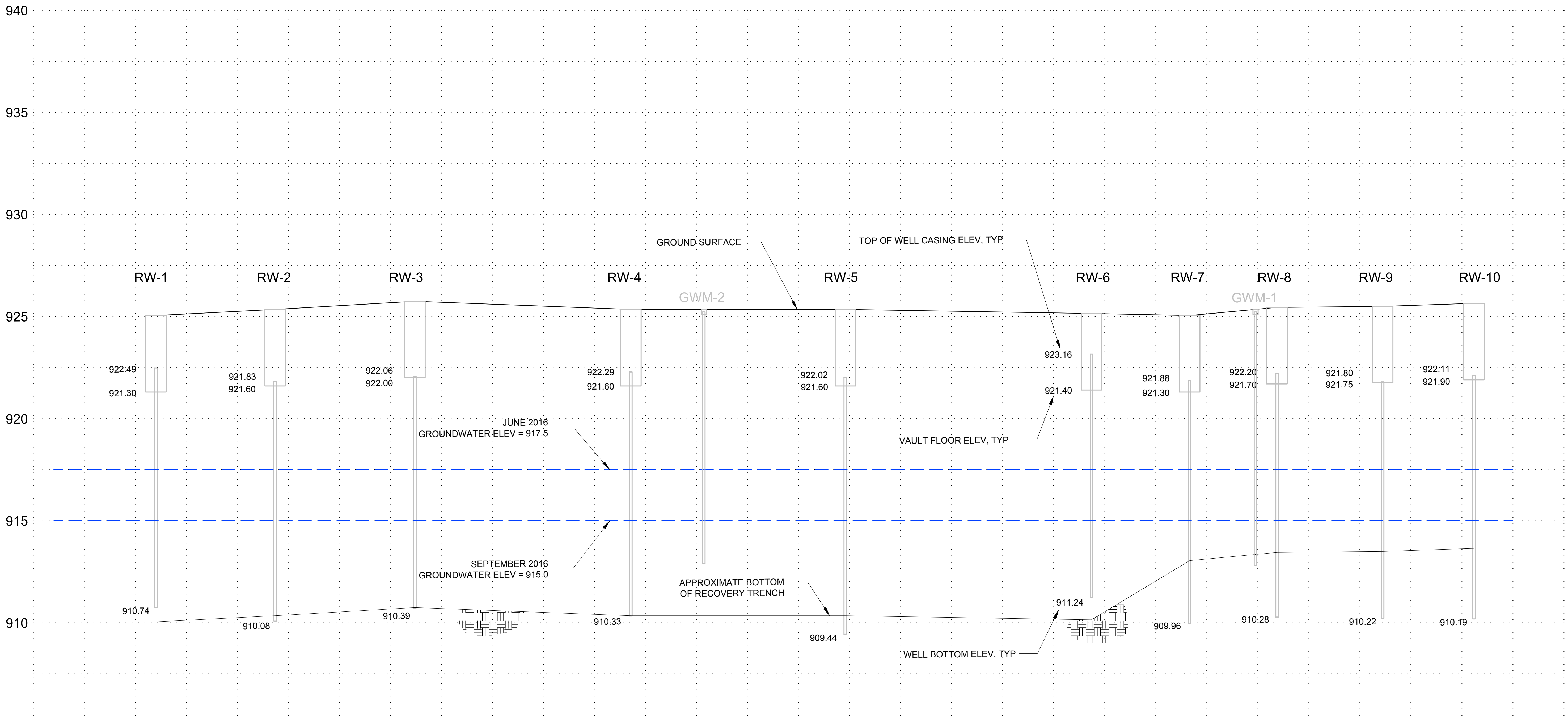


NOTES:

Temperatures were collected using Log Tag HAXO-8 Humidity and Temperature Recorder thermometers.

Outdoor temperatures were measured at National Oceanic and Atmospheric Administration weather station Baring, WA US GHCND:USC00450456.

Project limits are defined in Addendum No. 3 to 2010 Compliance Monitoring Plan Update dated February 17, 2015, prepared by Farallon Consulting, L.L.C. The basement was generally unoccupied prior to August 24, 2016. Project limits apply only to occupied rooms.



PROFILES - RECOVERY WELLS

HORIZONTAL 1" = 20'
VERTICAL 1" = 5'

DATUM
NAVD88

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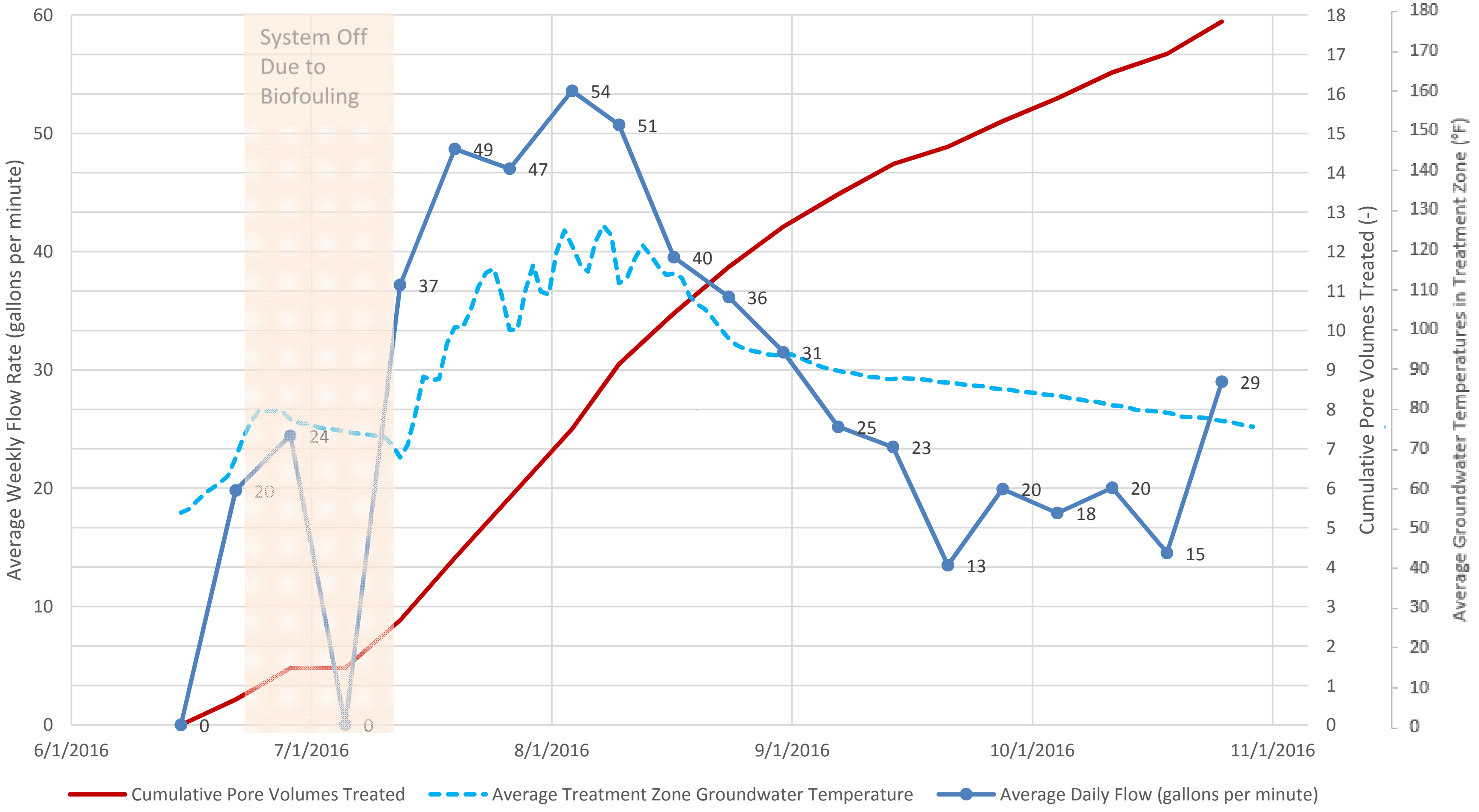
FIGURE 6

RECOVERY TRENCH CROSS SECTION
2016 HOT WATER FLUSHING REMEDIATION
PERFORMANCE REPORT
SKYKOMISH SCHOOL
BNSF FORMER MAINTENANCE AND FUELING FACILITY
SKYKOMISH, WASHINGTON
FARALLON PN: 683-057

Drawn By: MB
Checked By: AV
Date: 7/31/17
File: RECOVERY WELL PROFILES

Figure 7
System Flows, Pore Volumes, and Groundwater Temperatures
2016 Annual Hot Water Flushing System Operations Report
Skykomish School Hot Water Flushing Remediation
Skykomish, Washington
Farallon PN: 683-057



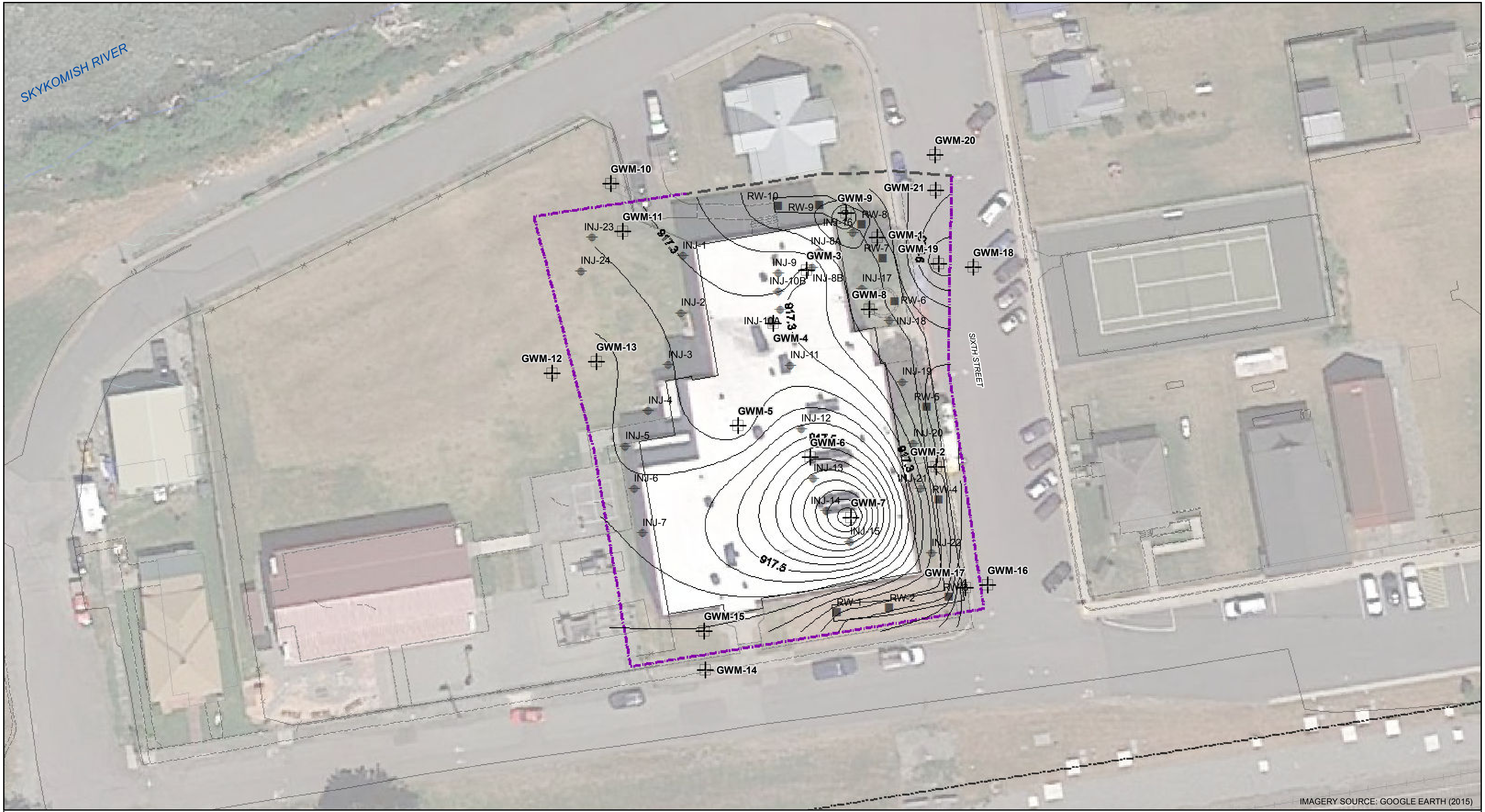
<u>NOTES</u>:

The hot water flushing system was not in operation from June 25 through July 10, 2016, due to biofouling of the granular activated carbon filters.

Average groundawter temperature in treatment zone is based on daily average of data from submerged wells located inside targeted treatment zone, GWM 6, 7, and 8.

[2] A pore volume has been defined as the volume of water in the saturated portion of the aquifer. At the School Site a pore volume consists of the footprint of the School building and approximately 20 feet adjacent to all sides of the building, with an average thickness spanning 5.5 feet from 917 ft msl (average groundwater elevation) to 911.5 ft msl (elevation of deepest contamination). See calculation below.

30,000 ft^2 * (917 ft msl - 911.5 ft msl) * .25 porosity * 7.48 gallons/ ft^3 = 310,000 gallons



LEGEND

✛ WELL

■ GROUNDWATER EXTRACTION RECOVERY WELL

◆ INJECTION WELL

-·-·- BNSF RIGHT-OF-WAY

— GROUNDWATER ELEVATION CONTOUR

-·-·- SHEET PILE BARRIER WALL

- - - MECHANICALLY STABILIZED EARTH WALL

NOTE:
GROUNDWATER CONTOURS PRESENTED ARE BASED ON SUBMERGED GROUNDWATER MONITORING WELLS. GROUNDWATER ELEVATIONS FOR UNSUBMERGED WELLS GWM-3, GWM-4, AND GWM-5 ARE BASED ON THE AVERAGE OF ADJACENT WELLS GWM-6 AND GWM-7

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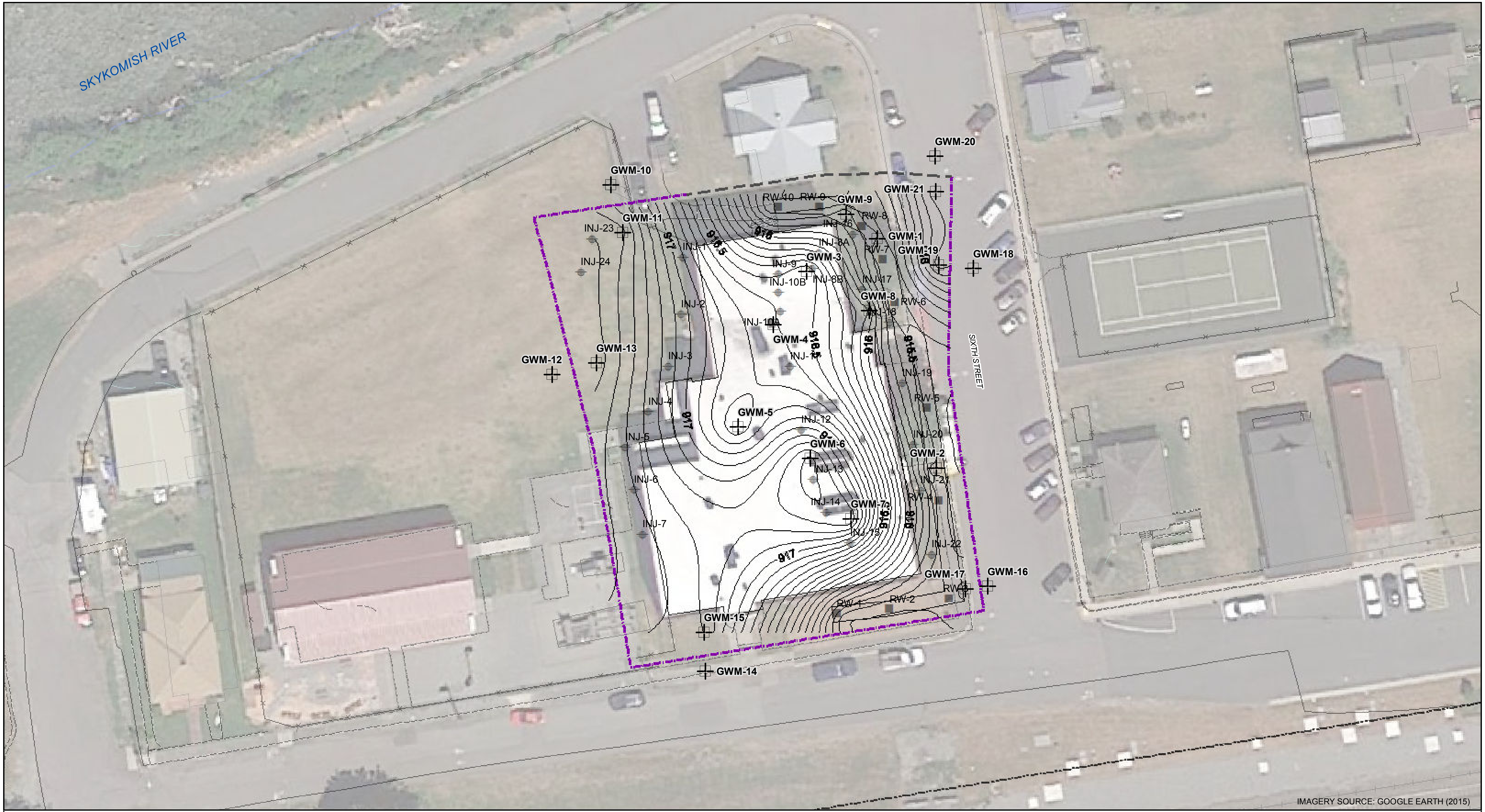
FIGURE 8

JUNE 15, 2016 GROUNDWATER ELEVATIONS
2016 HOT WATER FLUSHING REMEDIATION
PERFORMANCE REPORT
SKYKOMISH SCHOOL
BNSF FORMER MAINTENANCE AND FUELING FACILITY
SKYKOMISH, WASHINGTON
FARALLON PN: 683-057

Drawn By: tperrin
Checked By:AV
Date: 6/8/2017
Disc Reference:
Document Path: Q:\Projects\683 BNSF\057 HWF_CONSTRUCTION\FIGURE 8_HWC_GW_JUNE.mxd



LEGEND

✛	WELL
■	GROUNDWATER EXTRACTION RECOVERY WELL
⊕	INJECTION WELL
-·-·-	BNSF RIGHT-OF-WAY
——	GROUNDWATER ELEVATION CONTOUR
-·-·-	SHEET PILE BARRIER WALL
— —	MECHANICALLY STABILIZED EARTH WALL

NOTE:
GROUNDWATER CONTOURS PRESENTED ARE BASED ON SUBMERGED GROUNDWATER MONITORING WELLS. GROUNDWATER ELEVATIONS FOR UNSUBMERGED WELLS GWM-3, GWM-4, AND GWM-5 ARE BASED ON THE AVERAGE OF ADJACENT WELLS GWM-6 AND GWM-7

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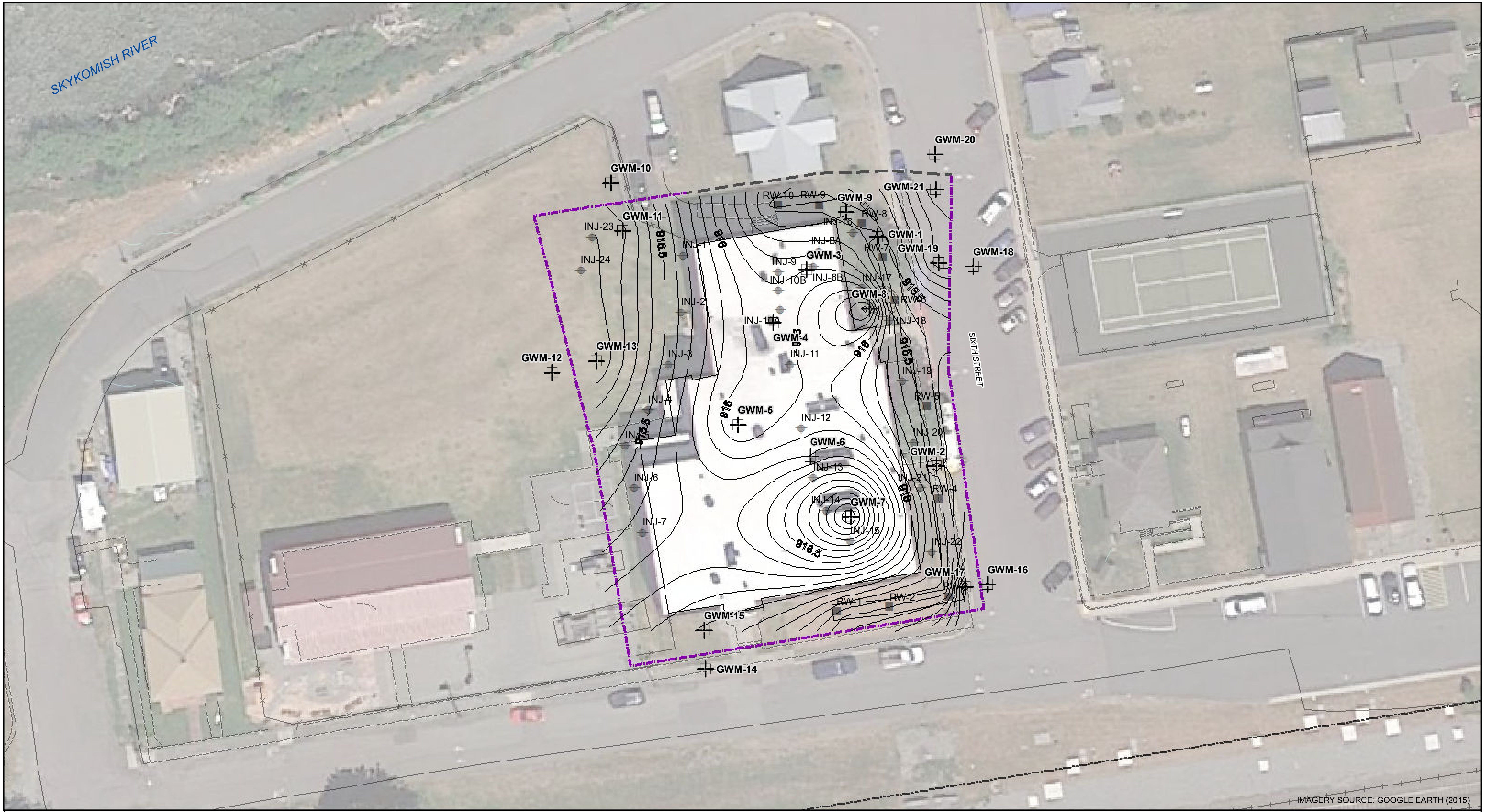
FIGURE 9

JULY 15, 2016 GROUNDWATER ELEVATIONS
2016 HOT WATER FLUSHING REMEDIATION
PERFORMANCE REPORT
SKYKOMISH SCHOOL
BNSF FORMER MAINTENANCE AND FUELING FACILITY
SKYKOMISH, WASHINGTON
FARALLON PN: 683-057

Drawn By: tperrin
Checked By:AV
Date: 6/12/2017
Disc Reference:
Document Path: Q:\Projects\683 BNSF\057 HWF_CONSTRUCTION\FIGURE 9_HWC GW_JULY.mxd



LEGEND

✛	WELL
■	GROUNDWATER EXTRACTION RECOVERY WELL
●	INJECTION WELL
-··-··-	BNSF RIGHT-OF-WAY
———	GROUNDWATER ELEVATION CONTOUR
-·-·-	SHEET PILE BARRIER WALL
— — —	MECHANICALLY STABILIZED EARTH WALL

NOTE:
GROUNDWATER CONTOURS PRESENTED ARE BASED ON SUBMERGED GROUNDWATER MONITORING WELLS. GROUNDWATER ELEVATIONS FOR UNSUBMERGED WELLS GWM-3, GWM-4, AND GWM-5 ARE BASED ON THE AVERAGE OF ADJACENT WELLS GWM-6 AND GWM-7

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SCALE IN FEET

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FIGURE 10
AUGUST 9, 2016 GROUNDWATER ELEVATIONS
2016 HOT WATER FLUSHING REMEDIATION
PERFORMANCE REPORT
SKYKOMISH SCHOOL
BNSF FORMER MAINTENANCE AND FUELING FACILITY
SKYKOMISH, WASHINGTON
FARALLON PN: 683-057

Drawn By: tperrin
Checked By:AV
Date: 6/12/2017
Disc Reference:
Document Path: Q:\Projects\683 BNSF\057 HWF_CONSTRUCTION\FIGURE 10_HWF GW AUG.mxd

LEGEND

✛	WELL
■	GROUNDWATER EXTRACTION RECOVERY WELL
✛	INJECTION WELL
-·-·-	BNSF RIGHT-OF-WAY
-·-·-	SHEET PILE BARRIER WALL
— —	MECHANICALLY STABILIZED EARTH WALL

NOTE
TEMPERATURES PRESENTED ARE BASED ON SUBMERGED GROUNDWATER MONITORING WELLS. GROUNDWATER TEMPERATURES FOR UNSUBMERGED WELLS GWM-3, GWM-4, AND GWM-5 ARE BASED ON THE AVERAGE OF ADJACENT WELLS GWM-6 AND GWM-7.

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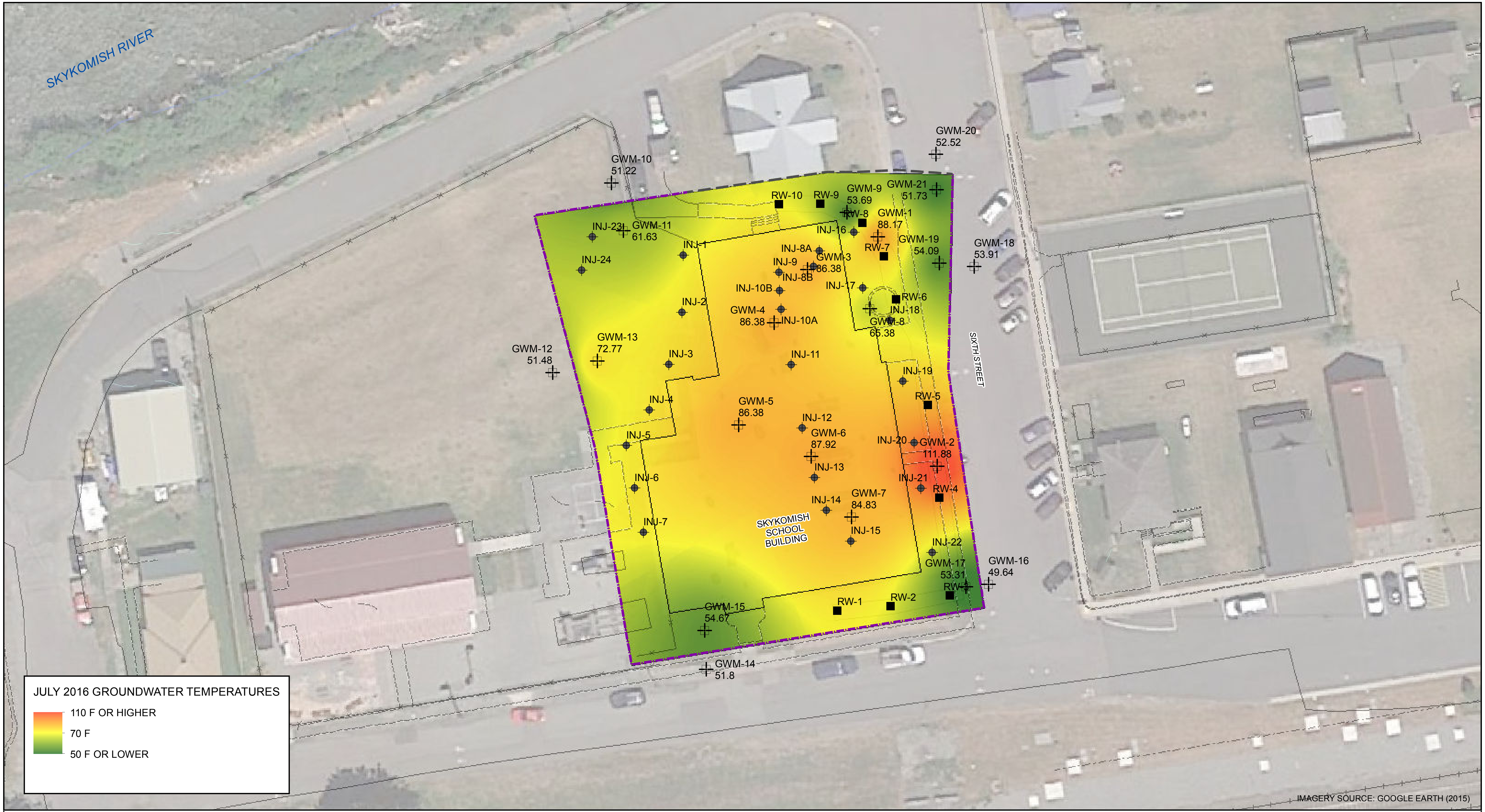
FIGURE 11

JUNE 15, 2016 GROUNDWATER TEMPERATURES
2016 HOT WATER FLUSHING REMEDIATION
PERFORMANCE REPORT
SKYKOMISH SCHOOL
BNSF FORMER MAINTENANCE AND FUELING FACILITY
SKYKOMISH, WASHINGTON
FARALLON PN: 683-057

Drawn By: tperrin
Checked By:AV
Date: 6/12/2017
Disc Reference:
Document Path: Q:\Projects\683 BNSF\057 HWF_CONSTRUCTION\FIGURE 11_HWC_JUNE16.mxd



LEGEND

- ✛ WELL
- ■ GROUNDWATER EXTRACTION RECOVERY WELL
- ⊕ INJECTION WELL
- -··-··- BNSF RIGHT-OF-WAY
- -·-·- SHEET PILE BARRIER WALL
- — — MECHANICALLY STABILIZED EARTH WALL

NOTE
TEMPERATURES PRESENTED ARE BASED ON SUBMERGED GROUNDWATER MONITORING WELLS. GROUNDWATER TEMPERATURES FOR UNSUBMERGED WELLS GWM-3, GWM-4, AND GWM-5 ARE BASED ON THE AVERAGE OF ADJACENT WELLS GWM-6 AND GWM-7.

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SCALE IN FEET

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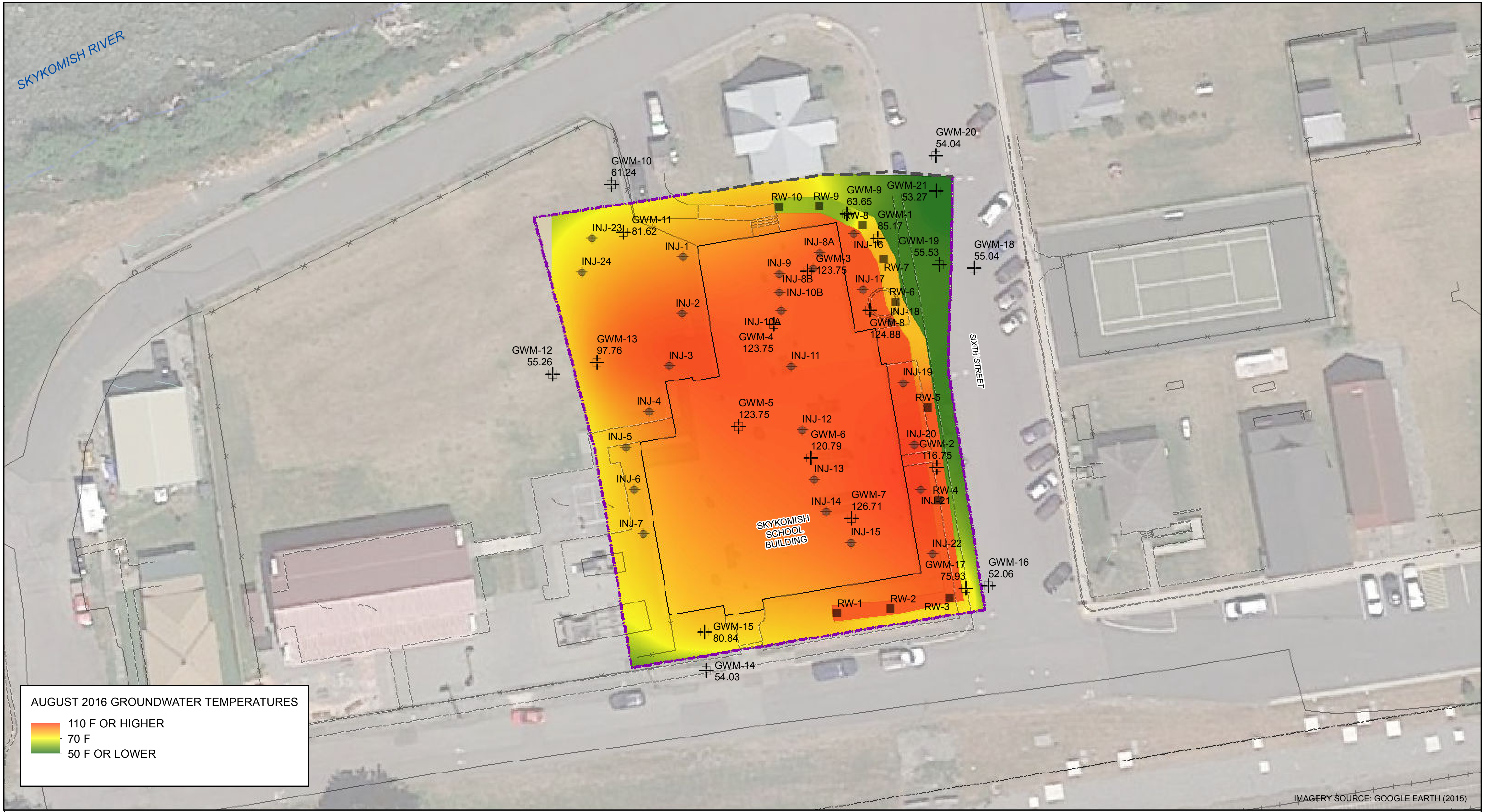
FIGURE 12
JULY 15, 2016 GROUNDWATER TEMPERATURES
2016 HOT WATER FLUSHING REMEDIATION PERFORMANCE REPORT
SKYKOMISH SCHOOL
BNSF FORMER MAINTENANCE AND FUELING FACILITY
SKYKOMISH, WASHINGTON

FARALLON PN: 683-057

Drawn By: tperrin
Checked By:AV
Date: 6/12/2017
Disc Reference:
Document Path: Q:\Projects\683 BNSF\057 HWF_CONSTRUCTION\FIGURE 12_HWC_JULY.mxd



LEGEND

⌖	WELL
■	GROUNDWATER EXTRACTION RECOVERY WELL
◈	INJECTION WELL
-·-·-·-	BNSF RIGHT-OF-WAY
-·-·-·-	SHEET PILE BARRIER WALL
— — —	MECHANICALLY STABILIZED EARTH WALL

NOTE
TEMPERATURES PRESENTED ARE BASED ON SUBMERGED GROUNDWATER MONITORING WELLS. GROUNDWATER TEMPERATURES FOR UNSUBMERGED WELLS GWM-3, GWM-4, AND GWM-5 ARE BASED ON THE AVERAGE OF ADJACENT WELLS GWM-6 AND GWM-7.

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FIGURE 13

AUGUST 9, 2016 GROUNDWATER TEMPERATURES
2016 HOT WATER FLUSHING REMEDIATION
PERFORMANCE REPORT
SKYKOMISH SCHOOL
BNSF FORMER MAINTENANCE AND FUELING FACILITY
SKYKOMISH, WASHINGTON
FARALLON PN: 683-057

Drawn By: tperrin
Checked By:AV
Date: 6/12/2017
Disc Reference:
Document Path: Q:\Projects\683 BNSF\057 HWF_CONSTRUCTION\FIGURE 13_HWF AUG.mxd

Figure 14
NAPL Viscosity vs. Temperature
2016 Hot Water Flushing Remediation Performance Report
Skykomish School
BNSF Former Maintenance and Fueling Facility
Skykomish, Washington

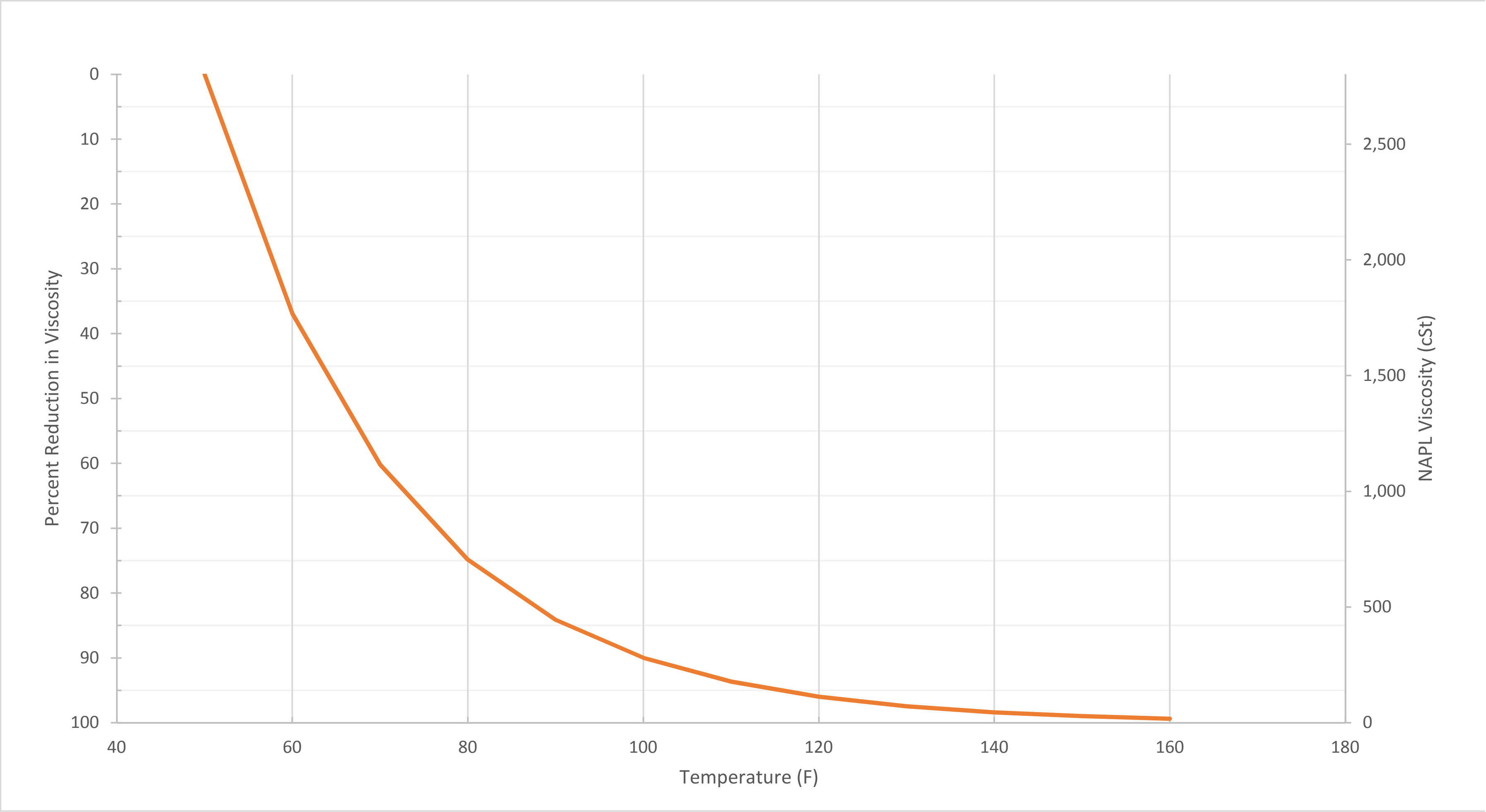
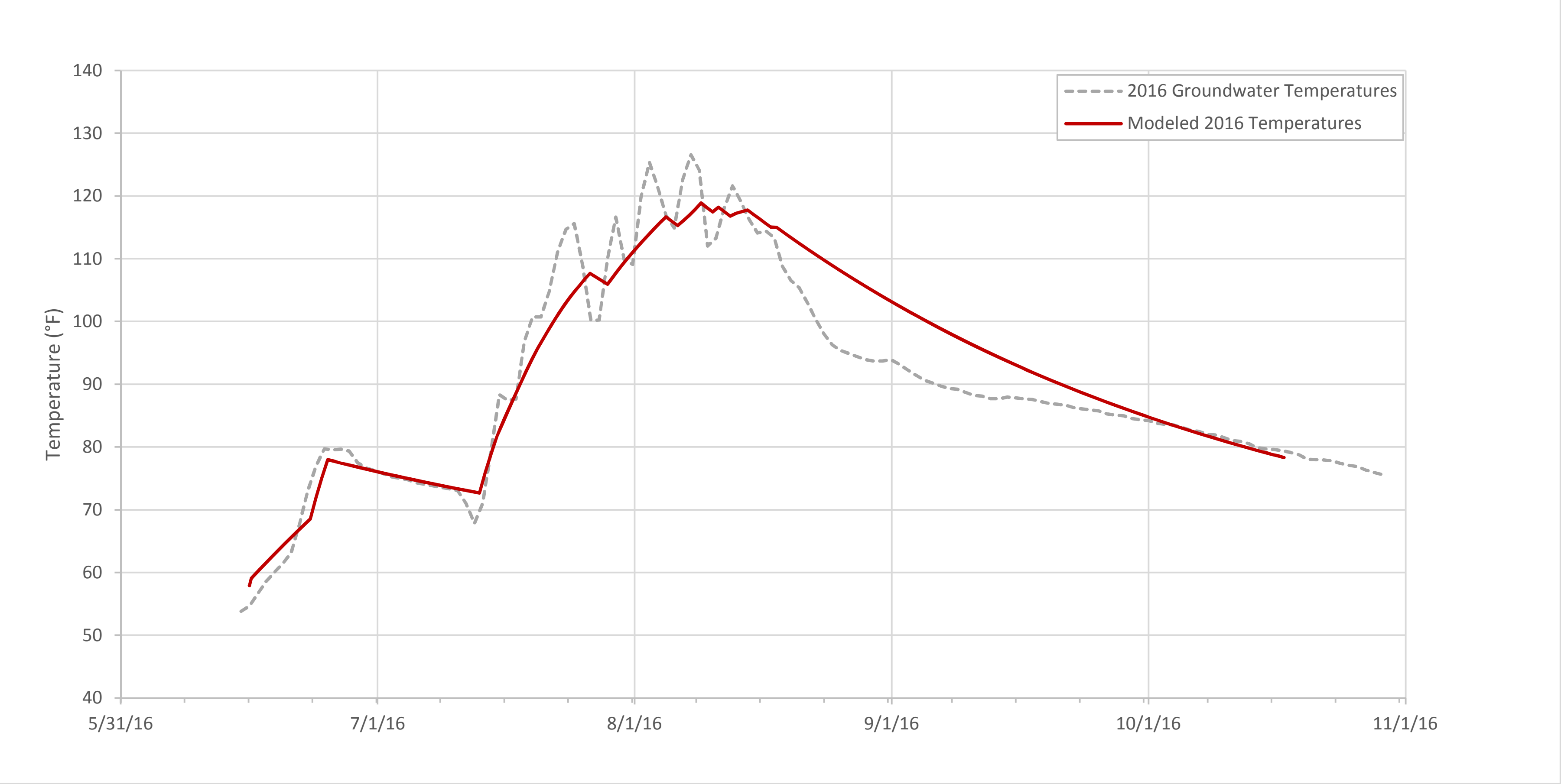


Figure 15
Comparison of Modeled and Actual 2016 Groundwater Temperatures
2016 Hot Water Flushing Remediation Performance Report
Skykomish School
Skykomish, Washington
Farallon PN: 683-057



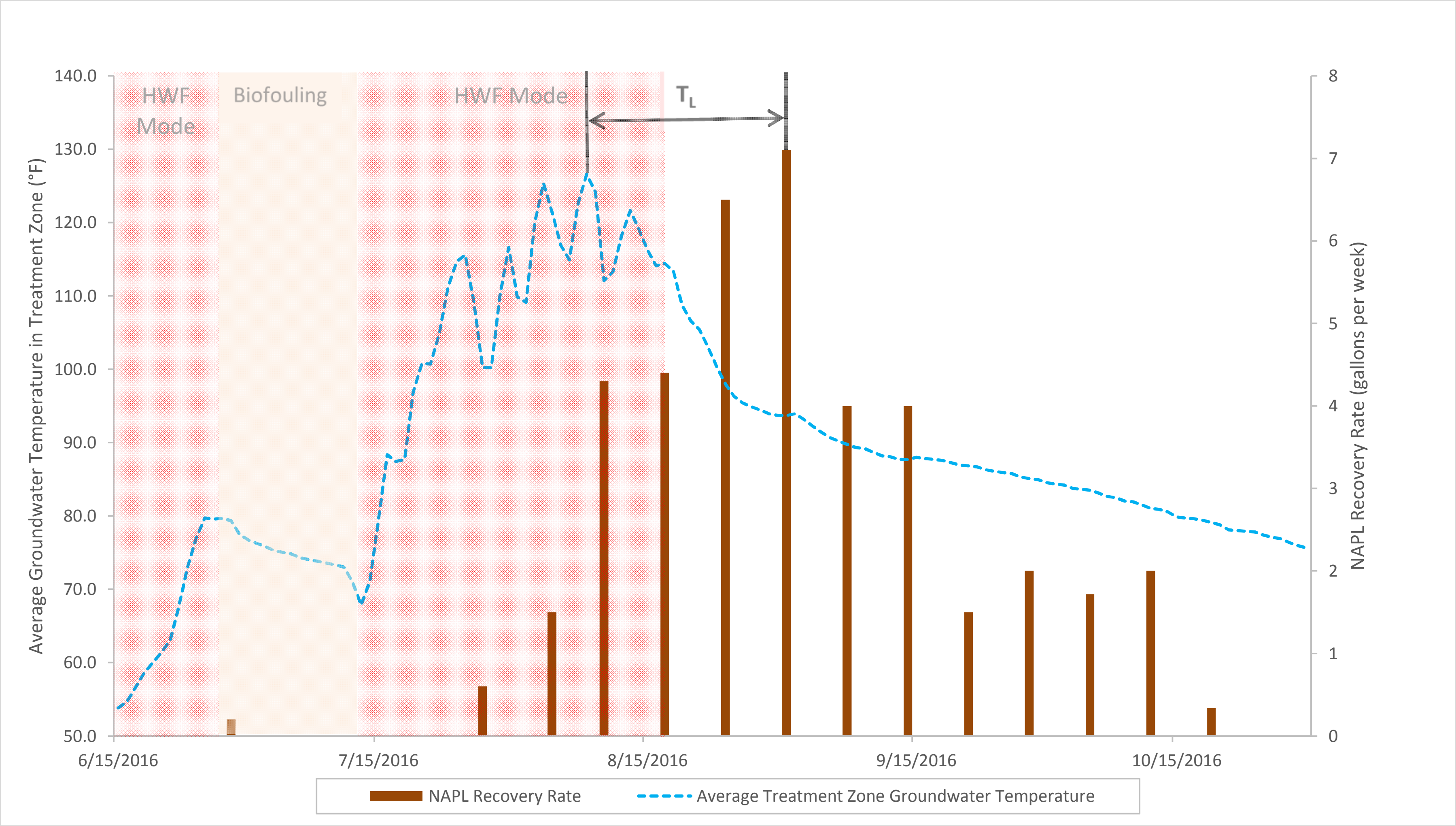
NOTES:

2016 temperature data are based on a daily average of data from wells in the treatment area beneath the School (wells GWM-6, GWM-7, and GWM-8).

F = Fahrenheit

GWM = groundwater monitoring well

Figure 16
NAPL Recovery and Groundwater Temperatures
2016 Hot Water Flushing Performance Report
Skykomish School
BNSF Former Maintenance and Fueling Facility
Skykomish, Washington
Farallon PN: 683-057



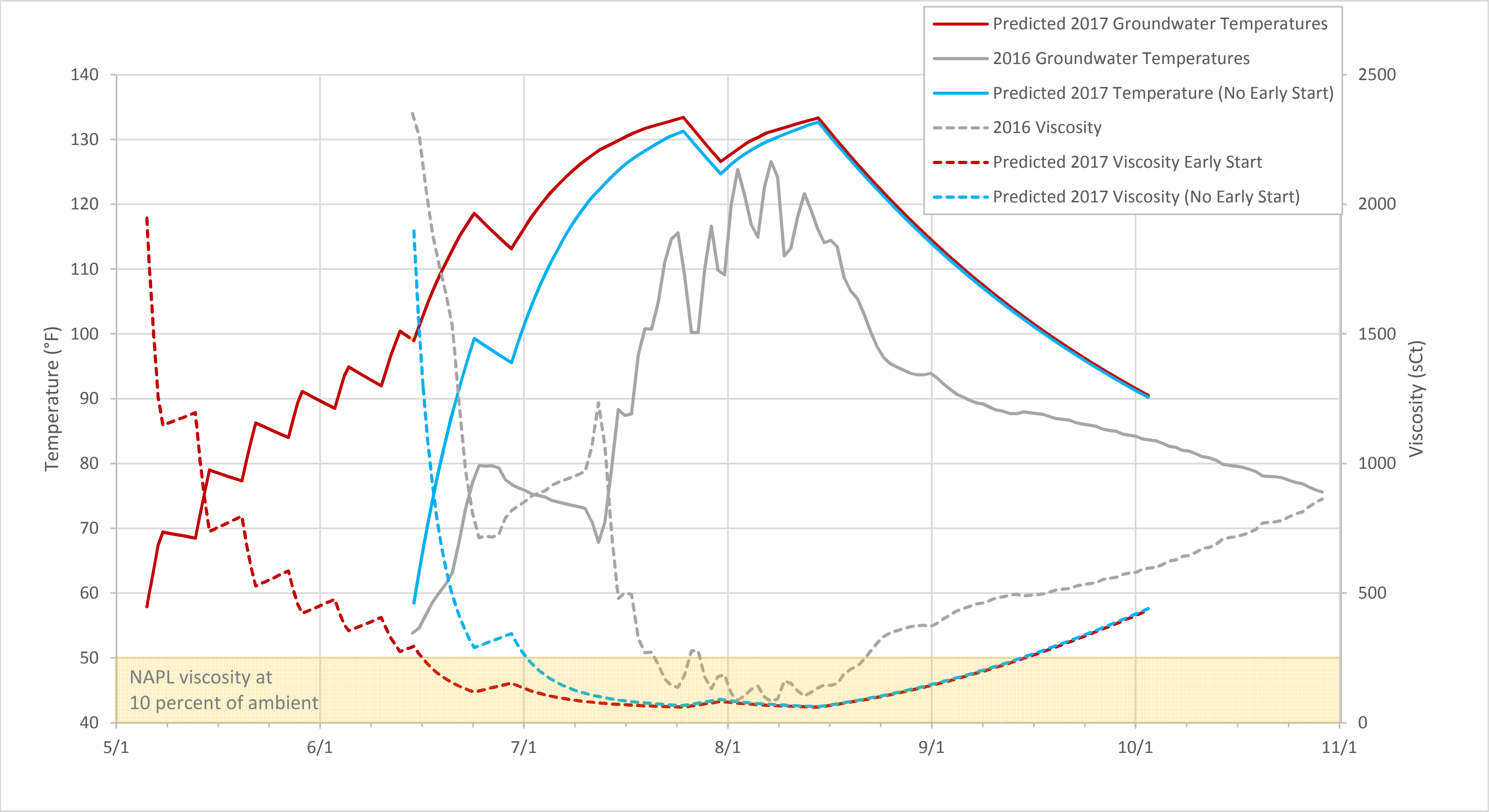
NOTES:

Average groundwater temperature in treatment zone is based on a daily average of data from submerged wells located inside targeted treatment zone, GWM 6, 7, and 8.

T_L = Time Lag; Approximate 24 day time lag between maximum groundwater temperature and maximum NAPL recovery.

F = Fahrenheit
GWM = groundwater monitoring well

Figure 17
Actual 2016 and Predicted 2017 Groundwater Temperatures and Viscosities
2016 Hot Water Flushing Remediation Performance Report
Skykomish School
Skykomish, Washington
Farallon PN: 683-057



NOTES:
F = Fahrenheit
sCt = centistokes

2016 temperature data is based on a daily average of data from wells in the treatment area beneath the school (GWMs 6,7,8).

Predicteded 2017 temperatures are based on thermal numerical modeling.

Viscosities based on the properties of a sample collected from the site in 2009.

TABLES

2016 HOT WATER FLUSHING REMEDIATION PERFORMANCE REPORT
Skykomish School
BNSF Former Maintenance and Fueling Facility
Skykomish, Washington

Farallon PN: 683-057

Table 1
Design Quality Objectives from 2011 Design Report
2016 Hot Water Flushing Remediation Performance Report
Skykomish School
Skykomish, Washington
Farallon PN: 683-057

Requirements		**Overall Remedy**	**Major Subsystems**			
Design Requirements	**Definition**	**Overall Subsurface Treatment**	**GW Recirculation and NAPL Recovery**	**Subsurface Heating**	**SVE/Subslab Depressurization**	**Subsurface Sheet Pile Barrier**
Functional	The overall purpose of the portion of the system.	Reduce the amount of petroleum beneath the school to the extent technically possible, with the goal of removing separate phase mobile or volatile liquid petroleum components or NAPL.	Provide gradient toward the eastern side of the school for NAPL recovery along Sixth Street and at southeastern and northeastern corners of school building.	Provide subsurface heating to reduce NAPL viscosity, reduce NAPL residual saturation, and enhance removal of separate phase mobile petroleum and NAPL.	Remove volatile petroleum constituents and prevent vapor intrusion into occupied space or outdoors by maintaining a negative soil gas pressure in the subsurface and using vapor barriers as required. Provide mechanism for removal of heat from directly beneath building slab.	Provide hydraulic control and prevent migration of contaminated groundwater or NAPL.
Reliability	The ability of a system or component to perform its required functions under stated conditions for a specified period of time.	Reliability provided by aggressive technology approach (hot water) to achieve functional requirements within project time frames. Consideration of system components will include an expected operational duration of 3 to 5 years.	Conservative design to achieve a high level of reliability.	Conservative design to achieve a high level of reliability.	Conservative design to achieve a high level of reliability. Backup power required.	Conservative design to achieve a high level of reliability by sealing sheet pile joints and keying into low permeable material at the toe of the sheet piles.
Performance	Stated operational goals.	Treatment area footprint consists of school building plus 20 feet. Vertical interval of treatment is focused on impacted NAPL and smear zones. Achieve heating goals within summer-only operational approach.	50 GPM flow throughput capability includes factor of safety on flow rates to account for subsurface variability. Leak testing with zero-tolerance for leaks. Separate groundwater and NAPL recovery to increase NAPL removal efficiency and minimize groundwater treatment requirements.	Target maximum 140°F average temperature in target treatment zone. For summer treatment approach, reach target temperature within each summer operational period. Temperatures can be reduced by injection of cold water, below 75°F, to prevent potential for heat impacts outside treatment zone.	SVE system sized to 500 SCFM, including factor of safety. Must handle extraction of potential soil gases. Provide measurable soil vacuum beneath slab floor to achieve a negative pressure below the floor slab.	Toe of barrier will be keyed into the low permeable silt layer and the joints of the sheet pile will be sealed to prevent leakage.
Safety/Security	Safety considerations for authorized workers and general public.	Limit system component access to authorized personnel and ensure training and protective measures are in place.	Specified for system components.	Specified for system components.	Specified for system components.	Safety/security buffer zone will be required during installation and removal of sheet pile.
Environmental	Requirements related to potential impacts to areas, objects, and people outside the treatment zone.	Acceptable temperature, vapor, and sound impacts on school and surrounding areas.	Prevent groundwater mounding to level of school slab or ground surface.	Exterior surface of system components exposed to non-project personnel limited to 100°F.	Meet vapor discharge requirements of 1,346 ug/m^3 APH at perimeter of equipment compound. Provide acceptable sound levels. Cap unpaved (grassy) areas outside school within containment. Cap crawl space areas within building exposed to soil.	Barrier to allow for utility crossing.
Operations Monitoring Needs	Identifies measurements needed to verify performance with respect to design.	Measure NAPL and vapor recovery.	Measure water levels, drawdown and mounding, and NAPL recovery.	Measure subsurface temperatures.	Soil vacuum monitoring, SVE off-gas monitoring.	Piezometers to be installed for monitoring of water levels on either side of the barrier to evaluate water balance and flow hydraulics.

NOTES:

APH = air phase petroleum hydrocarbons

GPM = gallons per minute

ug/m^3 = micrograms per cubic meter

NAPL = nonaqueous-phase liquid

SCFM = standard cubic feet per minute

SVE = soil vapor extraction

Table 2
2016 Operational Milestones
2016 Hot Water Flushing Remediation Performance Report
Skykomish School
Skykomish, Washington
Farallon PN: 683-057

Date	Project Milestone	Description
4/1/2016	Primary Equipment Inspection	Design team meet at Contractor's facility to inspect equipment prior to delivery and installation.
5/15/2016	Equipment Delivery	Treatment system equipment delivered on the site; begin installation.
6/1/2016	Begin Commissioning	Treatment system installation complete; begin commissioning, performance testing, and flow balancing with cold water injection.
6/15/2016	System Startup	Begin HWF and SVE treatment.
6/25/2016	System Shutdown	HWF system shut down due to biofouling; implement system cleanout and disinfection protocols; SVE system continues to function through shutdown.
7/10/2016	Fouling Mitigation	Shock-dose recovery wells using chlorine. Begin continuous recovery well disinfection using chlorine.
7/11/2016	System Restart	HWF system restarted.
7/11/2016	SVE System Optimization	SVE system adjustment; removed well caps to better capture air flow from subslab void space and improve pressure differentials at soil gas probes.
7/13/2016	Equipment Modification	Retrofit boiler with pressure relief valve to reduce risks associated with steam buildup during shutdowns.
7/18/2016	Temporary Shutdown	High system pressure; temporarily shutdown to scrape carbon bed.
7/21/2016	Carbon Changeout	Temporary system shutdown to replace carbon in GAC canisters.
7/28/2016	Temporary Shutdown	Temporary system shutdown due to electrical controls malfunction; implement repairs to system controls; SVE system continuous operation.
7/31/2016	Equipment Modification	Adjust system alarm shutdown pressure to 35 psi.
8/1/2016	Equipment Delivery	Electric chiller delivered on the site and tested.
8/9/2016	Temporary Shutdown	Temporary HWF system shutdown for maintenance.
8/11/2016	Geochemical Fouling Mitigation	Install sequesterant dose pump and chemical storage. Begin continuous sequesterant dosing to mitigate mineral fouling of the treatment media.
8/17/2016	Transition to Ambient Water Flushing	Boiler removed; continue flushing with ambient water; cool slowly with SVE system and natural attenuation.
8/19/2016	Carbon Changeout	Temporary system shutdown to replace carbon in GAC canisters.
8/20/2016	Temporary Shutdown	System shutdown (24 hours) to repair pump control malfunction.
8/31/2016	Temporary Shutdown	System shutdown (48 hours) for repairs to oil-water separator.
9/19/2016	Temporary Shutdown	System shutdown (48 hours) for repairs to pump drive components.
9/26/2016	Carbon Changeout	Temporary system shutdown to replace carbon in GAC canisters.
10/9/2016	Temporary Shutdown	System shutdown (48 hours); control fault; flooded injection well in school yard due to intense rainfall event.
10/13/2016	Temporary Shutdown	System shutdown (96 hours); intentional shutdown to avoid damage from seasonal storm flood event.
10/31/2016	Begin Seasonal Shutdown	Shut down and winterize treatment system; cleanup and secure site.

NOTES:

GAC = granular activated carbon
HWF = hot water flushing
psi = pounds per square inch
SVE = soil vapor extraction

Table 3
Compliance Monitoring Matrix
2016 Hot Water Flushing Remediation Performance Report
Skykomish School
Skykomish, Washington
Farallon PN: 683-057

	HWF			Transition			CWF			Winter Shutdown		
	Events	Action Levels		Events	Action Levels		Events	Action Levels		Events	Action Levels	
APH												
Inside First Floor (Basement)	8 hour weekly (1 location)	Ref Section 3.2 ANO Plan		8 hour weekly (3 locations)	Ref Section 3.2 ANO Plan		8 hour monthly (3 locations)	Ref Section 3.2 ANO Plan		8 hour monthly (3 locations)	Ref Section 3.2 ANO Plan	
Inside Second Floor	8 hour weekly (1 location)	Ref Section 3.2 ANO Plan		8 hour weekly (2 locations)	Ref Section 3.2 ANO Plan		8 hour monthly (2 locations)	Ref Section 3.2 ANO Plan		8 hour monthly (2 locations)	Ref Section 3.2 ANO Plan	
Inside Third Floor	8 hour weekly (1 location)	Ref Section 3.2 ANO Plan		8 hour weekly (1 location)	Ref Section 3.2 ANO Plan		8 hour monthly (1 location)	Ref Section 3.2 ANO Plan		8 hour monthly (1 location)	Ref Section 3.2 ANO Plan	
VOC												
Inside First Floor and Second Floor	Continuously, Upload Weekly (3 locations)	>5ppm for 5 min	=R,I(4)	Continuously, Upload Weekly (3 locations)	>5ppm for 5 min	=R,I(4)	Continuously, Upload Weekly (3 locations)	>5ppm for 5 min	=R,I(4)	Continuously, Upload Weekly (3 locations)	>5ppm for 5 min	=R,I(4)
		>10ppm for 5 min at 2 locations	=R,E,I(4)		>10ppm for 5 min at 2 locations	=R,E,I(4)		>10ppm for 5 min at 2 locations	=R,E,I(4)		>10ppm for 5 min at 2 locations	=R,E,I(4)
ROOM TEMPERATURE												
Inside First Floor (Basement)	Daily Occupied Rooms (Upload Weekly)	>/= 10 degrees F above ambient	=A, M	Daily Occupied Rooms (Upload Weekly)	>/= 10 degrees F above ambient	=A, M	Daily Occupied Rooms (Upload Weekly)	> 78.5 F @ 60% RH > 80.0 F @30 % RH	=A, M	None proposed	None proposed	NA
NOISE												
Outside- At Introduced Equipment	Continuous first week of operation	>65 dB(A) @ nrearest occ. property	=M	First week of operation	>65 dB(A) @ nearest occ. property	=M	First week of operation	>65 dB(A) @ nearest occ. property	=M	None proposed	None proposed	NA
Inside - Noise Map	Initial Survey ANO Plan Section 2.3.2	>40dB(A) or 70 dB windows closed. >45 dB(A) or 70 dB windows open. If school occupied	=M	Initial Survey ANO Plan Section 2.3.2	>40dB(A) or 70 dB windows closed. >45 dB(A) or 70 dB windows open. If school occupied	=M	Initial Survey ANO Plan Section 2.3.2	>40dB(A) or 70 dB windows closed. >45 dB(A) or 70 dB windows open.	=M	None proposed	None proposed	NA
WATER TREATMENT												
After Primary GAC	Weekly	Any Detection TPH	=C	Weekly	Any Detection TPH	=C	Weekly	Any Detection TPH	=C	None proposed	None proposed	NA
System Effluent	Weekly	>/= 477 µg/l TPH	=SD, C	Weekly	>/= 477 µg/l TPH	=SD, C	Weekly	>/= 477 µg/l TPH	=SD, C	None proposed	None proposed	NA

Table 3
Compliance Monitoring Matrix
2016 Hot Water Flushing Remediation Performance Report
Skykomish School
Skykomish, Washington
Farallon PN: 683-057

	HWF			Transition			CWF			Winter Shutdown		
	Events	**Action Levels**		**Events**	**Action Levels**		**Events**	**Action Levels**		**Events**	**Action Levels**	
FLOOR TEMPERATURE												
First Floor (Basement) Temperature	Weekly Occupied Areas	>/= 80 F	=A, M	Weekly Occupied Areas	>/= 80 F	=A, M	Weekly Occupied Areas	>/= 80 F	=A, M	Weekly Occupied	>/= 80 F	=A, M
SVE OPERATION												
Sub-Slab Pressure Differential	Continuously (Upload Weekly)	> 0.025 IWC vacuum	=A, M	Continuously (Upload	> 0.025 IWC vacuum	=A, M	Continuously (Upload	> 0.025 IWC vacuum	=A, M	None proposed	None proposed	NA
ODOR												
Inside School	Continuous monitoring by all occupants	Level 1 (barely detectable)	=R,I(24)	Continuous monitoring by all occupants	Level 1 (barely detectable)	=R,I(24)	Continuous monitoring by all occupants	Level 1 (barely detectable)	=R,I(24)	Continuous monitoring by all occupants	Level 1 (barely detectable)	=R,I(24)
		Level 2 (distinct and definite)	=R,I		Level 2 (distinct and definite)	=R,I		Level 2 (distinct and definite)	=R,I		Level 2 (distinct and definite)	=R,I
		Level 3 (strong, avoided areas)	=R,E,I		Level 3 (strong, avoided areas)	=R,E,I		Level 3 (strong, avoided areas)	=R,E,I		Level 3 (strong, avoided areas)	=R,E,I
		Level 4 (very strong, areas avoided)	=R,E,I		Level 4 (very strong, areas avoided)	=R,E,I		Level 4 (very strong, areas avoided)	=R,E,I		Level 4 (very strong, areas avoided)	=R,E,I

NOTES:

A = HWF/SVE system adjustment
ANO Plan: Hot Water Flushing Air, Noise, and Odor Monitoring Plan, 2015 to 2019 dated February 10, 2015, prepared by EMB Consulting.
C = schedule carbon changeout
CWF = cold and ambient water flushing period
dB = decibels
dB(A) = decibels A
E = evacuate school
F = degrees Fahrenheit
HWF = hot water flushing
I(4) = investigate source (within X hours of alarm)
IWC = inches water column
μg/l = micrograms per liter
M = HWF and/or school modification
ppm = parts per million
R = report to Ecology and/or Skykomish School District
RH = relative humidity
SD = system shut down
SVE = soil vapor extraction
TPH = total petroleum hydrocarbons
Transition = 8 weeks following last day of HWF period

Table 4
Basement Floor Temperatures
2016 Hot Water Flushing Remediation Performance Report
Skykomish School
Skykomish, Washington
Farallon PN: 683-057

Date	FLOOR TEMPERATURE (DAILY)				
	Cafeteria Central	Basement Hallway North	Basement Hallway South	Basement Hallway West	Wood Shop
	Temperature (°F)	Temperature (°F)	Temperature (°F)	Temperature (°F)	Temperature (°F)
6/15/2016	65.6	64.7	64.7	64.7	65.3
6/20/2016	68.9	67.4	68.3	64.1	69.3
6/24/2016	69.2	70.1	74.9	69.2	73.7
6/27/2016	73.4	74.6	77.9	64.4	76.4
6/28/2016	73.7	71.9	71.3	73.7	75.5
7/14/2016	83	80.9	82.1	81.8	83.9
7/15/2016	79.1	71.3	72.5	70.4	73.7
7/22/2016	82.4	77.3	79.7	74.3	77.9
7/26/2016	77.5	75.7	74.9	69.5	74.3
7/27/2016	80	77	74.6	71.9	75.5
8/1/2016	**86**	81.5	79.1	78.2	77.9
8/2/2016 [1]	**86.9**	**85.1**	**84.8**	78.8	82.1
8/3/2016	77.8[2]	82.4	81.5	77.3	78.8
8/4/2016	**84.2**	80	77.3	75.8	76.1
8/5/2016	73.2	74.3	70.4	69.2	72.5
8/8/2016	**84.2**	83.3	80.9	77.3	82.4
8/9/2016	77.4[2]	83.3	79.1	75.5	79.7
8/10/2016	82.1	81.5	78.2	75.2	78.9
8/11/2016	**84.5**	79.7	80	76.4	78.8
8/12/2016 [1]	**88.1**	82.1	82.7	76.4	81.2
8/15/2016	80.6	81.8	81.5	77.9	82.4
8/16/2016	79.7	79.1	78.2	75.2	78.8
8/17/2016	**85.1**	78.2	77.2	75.8	79.7
8/18/2016	79	77.3	80	76.4	79.1
8/19/2016	81.2	78.2	80	77.3	79.7
8/22/2016	77.9	76.4	77.3	73.4	78.2
8/23/2016	77.9	76.4	75.8	73.7	74.3
8/24/2016	80.6	77.9	77	75.8	75.5
8/25/2016	80	76.1	76.4	74.6	75.5
8/26/2016	79.1	77.3	77.9	77	76.4
8/29/2016	80.6	77.3	77	75.5	76.4
8/30/2016	76.4	77.9	77	75.8	75.5
8/31/2016	76.4	76.1	77.9	74.3	75.5
9/1/2016	76.4	77.3	77	73.4	75.5
9/7/2016	74.3	75.8	77.3	75.2	74.3
9/27/2016	73.4	78.8	75.8	76.1	77
10/4/2016	71	69.2	74.6	73.7	74.9
10/11/2016	71.6	70.1	72.5	73.7	73.7
10/18/2016	70.7	71.6	72.5	73.4	72.8
10/25/2016	73	70.2	72.5	73.5	71.7
Project Action Limits	**84.0**	**84.0**	**84.0**	**84.0**	**84.0**

NOTES:

Project Limits are based on American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) Standard 55-2004, Thermal Environmental Conditions for Human Occupancy.

°F = degrees Fahrenheit

Data were collected manually using a General IRT-206 Infrared Thermometer. Floor temperatures were measured at locations directly above the system piping trench to represent warmest conditions unless otherwise noted.

[1] Conditions were mitigated by opening doors and windows to provide passive ventilation.

[2] Room floor temperatures were collected manually every 100 square feet. The value presented represents the average of room floor temperatures collected.

[3] Project action limits are defined in Addendum No. 3 to 2010 Compliance Monitoring Plan Update dated February 17, 2015, prepared by Farallon Consulting, L.L.C.

Table 5
Basement Room Temperatures
2016 Hot Water Flushing Remediation Performance Report
Skykomish School
Skykomish, Washington
Farallon PN: 683-057

	Location				
	Cafeteria (B10)[1]		**Southwest Hallway[1]**		**Outside[2]**
Date	**Average Temperature (°F)**	**Maximum Temperature (°F)**	**Average Temperature (°F)**	**Maximum Temperature (°F)**	**Maximum Temperature (°F)**
6/15/2016	70.1	73.3	68.4	**81.6**	57
6/16/2016	66.7	71.2	67.3	67.7	66
6/17/2016	67.8	69	66.9	67.3	65
6/18/2016	67.1	68	66.5	67.1	74
6/19/2016	67.1	68.9	65.6	68.7	61
6/20/2016	68.7	70.2	62.8	66.2	72
6/21/2016	67.8	68.4	66.7	67.3	71
6/22/2016	68.1	69.1	67.3	67.9	72
6/23/2016	67.5	68.8	67.7	68	74
6/24/2016	68.0	68.4	66.9	67.6	71
6/25/2016	67.8	68.3	66.3	66.6	61
6/26/2016	69.3	70.2	66.8	67.9	71
6/27/2016	71.5	72.5	68.7	69.8	83
6/28/2016	73.2	74	70.1	70.9	84
6/29/2016	73.1	73.5	70.9	71.5	80
6/30/2016	72.6	73	70.9	71.2	69
7/1/2016	72.5	73	70.9	71.2	72
7/2/2016	73.3	73.9	71.1	71.7	74
7/3/2016	73.2	73.8	71.2	71.6	78
7/4/2016	71.9	72.8	70.4	71.1	72
7/5/2016	70.5	71.2	69.2	69.8	60
7/6/2016	71.4	72.2	68.7	69.2	65
7/7/2016	71.4	72	69.2	69.4	71
7/8/2016	71.9	72.5	69.0	69.4	67
7/9/2016	72.2	72.5	69.0	69.3	73
7/10/2016	71.7	72.1	68.6	69	65
7/11/2016	69.9	71.5	68.3	68.5	62
7/12/2016	69.1	70.3	67.3	68.5	72
7/13/2016	70.4	71.4	68.3	69.4	66
7/14/2016	72.5	73.2	69.2	69.9	74
7/15/2016	71.9	72.9	69.7	69.8	76
7/16/2016	72.2	72.5	69.6	69.7	69
7/17/2016	73.2	73.9	69.7	70.2	70
7/18/2016	73.8	74.8	70.0	70.2	75
7/19/2016	73.7	74.3	70.0	70.5	68
7/20/2016	74.9	76.2	70.7	71.7	73
7/21/2016	75.8	76.5	71.5	71.8	81
7/22/2016	74.8	75.9	71.4	71.8	84
7/23/2016	73.5	73.9	70.7	71	63
7/24/2016	74.8	75.7	71.0	71.9	70
7/25/2016	76.8	77.7	72.4	73.4	82
Project Limits[3]	**80**	**80**	**80**	**80**	

Table 5
Basement Room Temperatures
2016 Hot Water Flushing Remediation Performance Report
Skykomish School
Skykomish, Washington
Farallon PN: 683-057

	Location				
	Cafeteria (B10)[1]		Southwest Hallway[1]		Outside[2]
Date	Average Temperature (°F)	Maximum Temperature (°F)	Average Temperature (°F)	Maximum Temperature (°F)	Maximum Temperature (°F)
7/26/2016	78.0	78.7	73.7	74.5	84
7/27/2016	78.9	79.7	74.5	75.1	78
7/28/2016	80.3	81	75.3	76.2	84
7/29/2016	81.4	82.1	76.0	77	88
7/30/2016	81.3	81.9	76.8	77.1	88
7/31/2016	80.0	80.6	76.3	76.9	75
8/1/2016	79.5	81.1	76.2	76.8	76
8/2/2016	77.7	78.5	75.6	76.5	78
8/3/2016	76.4	76.8	74.0	74.8	63
8/4/2016	77.4	78.8	74.6	75.4	74
8/5/2016	78.2	79.4	75.4	76.7	82
8/6/2016	77.0	77.8	73.1	74.6	81
8/7/2016	76.0	76.5	72.5	73.3	71
8/8/2016	75.3	75.6	72.3	72.8	69
8/9/2016	75.0	75.5	72.2	72.6	61
8/10/2016	75.4	75.9	72.6	73.2	67
8/11/2016	77.1	78.1	73.3	74.7	71
8/12/2016	78.7	79.6	75.1	76.7	82
8/13/2016	80.3	81.1	77.2	78.1	90
8/14/2016	81.3	82.3	78.0	78.7	90
8/15/2016	78.0	81.2	76.1	78.5	83
8/16/2016	76.9	79.5	74.9	77.3	83
8/17/2016	77.2	79.2	74.5	76.8	83
8/18/2016	77.0	79.4	75.7	78.4	83
8/19/2016	80.1	84.5	77.2	79.4	81
8/20/2016	80.6	81.2	77.3	78.9	96
8/21/2016	78.7	80.5	75.2	78.2	92
8/22/2016	73.7	76.8	69.4	72.6	72
8/23/2016	74.4	75.8	72.2	73.9	66
8/24/2016	76.6	77.6	73.9	76	78
8/25/2016	78.2	79.2	75.9	79.9	84
8/26/2016	78.8	81.2	75.9	77.1	88
8/27/2016	81.2	82	75.7	77	89
8/28/2016	79.8	80.6	74.5	75.2	71
8/29/2016	78.7	79.9	73.9	76	75
8/30/2016	76.4	78.9	74.3	75.2	82
8/31/2016	77.3	78.3	73.3	74.1	67
9/1/2016	75.1	77.7	72.5	73.7	70
9/2/2016	72.3	73.6	70.3	71.4	62
9/3/2016	73.1	73.5	71.5	72.1	58
9/4/2016	73.3	73.8	72.0	72.4	64
Project Limits[3]	**80**	**80**	**80**	**80**	

Table 5
Basement Room Temperatures
2016 Hot Water Flushing Remediation Performance Report
Skykomish School
Skykomish, Washington
Farallon PN: 683-057

	Location				
	Cafeteria (B10)[1]		Southwest Hallway[1]		Outside[2]
Date	**Average Temperature (°F)**	**Maximum Temperature (°F)**	**Average Temperature (°F)**	**Maximum Temperature (°F)**	**Maximum Temperature (°F)**
9/5/2016	73.2	73.8	72.1	72.4	65
9/6/2016	74.6	77.7	72.6	73.4	66
9/7/2016	73.6	75.2	73.1	74.2	65
9/8/2016	74.0	74.8	73.0	73.5	65
9/9/2016	74.1	75.9	72.6	73.2	71
9/10/2016	73.8	74.4	72.5	73.3	77
9/11/2016	73.9	74.3	72.9	73.7	78
9/12/2016	73.5	74.9	72.9	73.8	69
9/13/2016	74.2	76.5	73.0	74.2	74
9/14/2016	74.2	75.6	73.1	74.3	76
9/15/2016	74.7	77.4	73.3	75.4	78
9/16/2016	75.4	77.2	73.6	74.7	75
9/17/2016	73.8	75.2	72.9	73.6	73
9/18/2016	72.1	72.6	72.0	72.5	58
9/19/2016	72.7	75.3	72.0	72.9	66
9/20/2016	73.2	75.7	72.7	74.4	61
9/21/2016	73.1	76.2	73.1	74.6	65
9/22/2016	73.6	76.6	73.4	74.7	67
9/23/2016	72.6	74.2	73.1	74.4	69
9/24/2016	71.0	72.1	72.0	72.4	56
9/25/2016	71.1	72	72.1	72.8	65
9/26/2016	74.2	77.1	73.5	74.9	78
9/27/2016	74.3	76.4	73.7	74.8	82
9/28/2016	72.4	76.1	72.9	73.9	70
9/29/2016	72.6	76	72.6	73.3	62
9/30/2016	74.0	78.8	72.5	73.3	61
10/1/2016	70.2	73.1	71.1	71.8	66
10/2/2016	68.5	71.4	69.9	70.7	58
10/3/2016	72.1	77.2	70.3	71.5	61
10/4/2016	73.1	77.5	71.5	73.6	57
10/5/2016	73.9	77.3	71.9	74.6	56
10/6/2016	74.1	77.3	72.1	73.7	63
10/7/2016	73.6	77.4	71.9	73.3	58
10/8/2016	69.8	71.9	69.6	70.9	59
10/9/2016	68.3	70	68.3	68.6	56
10/10/2016	71.1	75.5	68.4	69.3	55
10/11/2016	73.5	**80.2**	69.8	72.2	59
10/12/2016	72.7	78.1	69.6	71.9	65
10/13/2016	72.7	78.2	70.4	72.7	64
10/14/2016	73.0	77.7	70.5	72.3	49
10/15/2016	68.3	71.6	68.3	69.2	49
Project Limits[3]	**80**	**80**	**80**	**80**	

Table 5
Basement Room Temperatures
2016 Hot Water Flushing Remediation Performance Report
Skykomish School
Skykomish, Washington
Farallon PN: 683-057

	Location				
	Cafeteria (B10)[1]		Southwest Hallway[1]		Outside[2]
Date	**Average Temperature (°F)**	**Maximum Temperature (°F)**	**Average Temperature (°F)**	**Maximum Temperature (°F)**	**Maximum Temperature (°F)**
10/16/2016	66.6	69.6	67.0	67.5	50
10/17/2016	72.1	78.2	68.4	70.6	53
10/18/2016	73.4	78.6	69.1	71.7	50
10/19/2016	73.2	78.2	69.8	72.2	54
10/20/2016	72.4	76.1	69.8	72	54
10/21/2016	72.5	76.2	69.5	70.9	56
10/22/2016	69.4	72.4	68.1	68.8	60
10/23/2016	66.7	69.5	67.0	67.9	64
10/24/2016	70.5	74.4	68.6	70.7	58
10/25/2016	71.5	77.7	70.0	72.2	54
10/26/2016	71.7	75.3	70.0	72.4	50
10/27/2016	72.4	75.8	69.7	71.8	53
10/28/2016	71.2	74.3	69.5	71.9	60
Project Limits[3]	**80**	**80**	**80**	**80**	

NOTES:

[1] Temperatures were collected using Log Tag HAXO-8 Humidity and Temperature Recorder thermometers.

°F = degrees Fahrenheit

[2] Temperatures were measured at National Oceanic and Atmospheric Administration weather station Baring, WA US GHCND:USC00450456.

[3] Project limits are defined in Addendum No. 3 to 2010 Compliance Monitoring Plan Update dated February 17, 2016, prepared by Farallon Consulting, L.L.C. The basement was generally unoccupied prior to August 24, 2016. Project limits apply only to occupied rooms.

Table 6
Air-Phase Petroleum Hydrocarbons
2016 Hot Water Flushing Remediation Performance Report
Skykomish School
Skykomish, Washington
Farallon PN: 683-057

Sample Date	Sample No.	Sample Location	1,3-Butadiene[1] (μg/m^3)	Methyl tert butyl ether (μg/m^3)	Benzene[1] (μg/m^3)	Toluene (μg/m^3)	Ethylbenzene (μg/m^3)	Xylene, p,m (μg/m^3)	Xylene, o (μg/m^3)	Naphthalene[1] (μg/m^3)	Aliphatics, C5 to C8 (μg/m^3)	Aliphatics, C9 to C12 (μg/m^3)	Aromatics, C9 to C10 (μg/m^3)	Total APH[4] (μg/m^3)
Occupied School Baseline Monitoring Data														
5/28/2015	052815-BNE	Basement - Northeast	<0.044	<2.0	**1.33**	17	<2.0	6.1	<2.0	0.551	320	420	<10	773.0
5/28/2015	052815-BSW	Basement - Southwest	<0.044	<2.0	**.447**	150	<2.0	<4.0	<2.0	0.267	150	92	<10	402.7
5/28/2015	052815-BC	Basement - Central	<0.044	<2.0	**1.04**	230	2.2	6.7	2.4	0.54	250	340	<10	838.9
5/28/2015	052816-1NE	First Floor - Northeast	<0.044	<2.0	**0.492**	12	<2.0	5.2	2	0.461	120	280	<10	427.2
5/28/2015	052815-1SW	First Floor - Southwest	<0.044	<2.0	**0.521**	12	<2.0	4.7	<2.0	0.094	170	250	<10	445.3
5/28/2015	052815-1C	First Floor- Central	<0.044	<2.0	**0.700**	9	<2.0	<4.0	<2.0	0.461	100	150	<10	270.2
5/28/2015	052815-2NE	Second Floor - Northeast	<0.044	<2.0	**1.63**	12	<2.0	6.2	2	0.456	170	270	<10	469.3
5/28/2015	052815-2SW	Second Floor - Southwest	<0.044	<2.0	**0.470**	4.7	<2.0	<4.0	<2.0	0.467	83	100	<10	198.6
Project Action Limits (μg/m^3)			**0.083**[2]	**9.6**[2]	**0.32**[2]	**2,290**[2]	**460**[2]	**46**[2]	**46**[2]	**1.4**[2]	**No CLARC criteria available**			**1,346**[3]
Weekly Monitoring Data														
6/15/2016	BASE_061516	Room B10	< 0.044	< 0.70	**0.572**[5]	4.7	< 0.90	1.8	< 0.90	< 0.262	110	300	< 10	423.5
6/15/2016	FIRST_061516	Room 170	< 0.044	< 0.70	**0.895**[5]	8.1	< 0.90	3.5	1.0	< 0.262	110	220	< 10	349.4
6/15/2016	SECOND_061516	Outside Room 210	< 0.044	< 0.70	**1.36**[5]	13	1.4	5.9	1.7	< 0.262	160	320	<10	508.8
6/22/2016	BASE_062216	Room B10	< 0.044	< 0.70	**3.14**[5]	36	3.9	16	4.8	0.477	310	180	16	570.7
6/22/2016	FIRST_062216	Room 170	< 0.044	< 0.70	**2.12**[5]	28	2.9	12	3.6	0.456	220	190	13	472.4
6/22/2016	SECOND_062216	Outside Room 210	< 0.044	< 0.70	**1.66**[5]	22	2.2	9	2.8	0.425	180	180	10	408.4
6/28/2016	BASE_062816	Room B10	< 0.044	< 0.70	**0.907**[5]	11	2	8.1	2.7	0.76	170	220	< 10	420.8
6/28/2016	FIRST_062816	Room 170	< 0.044	< 0.70	**0.518**[5]	5.1	< 0.90	2.8	0.94	0.32	46	100	< 10	161.5
6/28/2016	SECOND_062816	Outside Room 210	< 0.044	< 0.70	**0.457**[5]	3.7	< 0.90	2.3	<0.90	< 0.262	37	73	<10	122.8
7/6/2016	BASE_070616	Room B10	< 0.044	< 0.70	**0.748**[5]	7	1.1	4.2	1.8	0.514	58	39	< 10	117.7
7/6/2016	FIRST_070616	Room 170	< 0.044	< 0.70	**1.22**[5]	13	1.9	7.3	2.70	0.446	94	24	< 10	149.9
7/6/2016	SECOND_070616	Outside Room 210	< 0.044	< 0.70	**1.23**[5]	12	1.7	6.9	2.8	0.404	76	22	<10	128.4
7/13/2016	BASE_071316	Room B10	< 0.044	< 0.70	**0.885**[5]	9.7	1.1	4.3	1.3	0.398	55	150	< 10	228.0
7/13/2016	FIRST_071316	Room 170	< 0.044	< 0.70	**0.703**[5]	7.8	< 0.90	3.1	0.91	0.309	34	68	< 10	120.6
7/13/2016	SECOND_071316	Outside Room 210	< 0.044	< 0.70	**1.44**[5]	14	1.7	7	2.1	0.419	79	120	<10	231.0
7/20/2016	BASE_072016	Room B10	< 0.044	< 0.70	**0.623**[5]	6.9	1.1	3.7	1.12	0.409	34	<10	< 10	58.2
7/20/2016	FIRST_072016	Room 170	< 0.044	< 0.70	**0.556**[5]	6.4	1.3	4.3	1.24	0.320	22	<10	< 10	46.5
7/20/2016	SECOND_072016	Outside Room 210	< 0.044	< 0.70	**0.674**[5]	22	1.6	5.3	1.66	0.477	59	80	<10	176.1
7/27/2016	BASE_072716	Room B10	< 0.044	< 0.70	< 0.319	2.1	< 0.90	< 0.90	< 0.90	<0.262	< 10	< 10	< 10	19.1
7/27/2016	FIRST_072716	Room 170	< 0.044	< 0.70	< 0.319	1.4	< 0.90	1.1	< 0.90	<0.262	< 10	< 10	< 10	19.0
7/27/2016	SECOND_072716	Outside Room 210	< 0.044	< 0.70	< 0.319	1.6	< 0.90	1.4	<0.90	<0.262	13	< 10	< 10	27.5
8/4/2016	BASE_080416	Room B10	< 0.044	< 0.70	**0.454**[5]	5.1	< 0.90	3.0	0.92	< 0.262	25	80	< 10	120.4
8/4/2016	FIRST_080416	Room 170	< 0.044	< 0.70	**0.329**[5]	2.8	< 0.90	1.6	< 0.90	< 0.262	16	23	< 10	50.1
8/4/2016	SECOND_080416	Outside Room 210	< 0.044	< 0.70	**0.428**[5]	5.5	< 0.90	3.1	1.0	< 0.262	27	38	<10	81.0
8/10/2016	BASE_081016	Room B10	< 0.044	< 0.70	**0.949**[5]	13	1.7	7.3	2.3	0.283	65	62	< 10	157.9
8/10/2016	FIRST_081016	Room 170	< 0.044	< 0.70	**0.974**[5]	15	2	8.1	2.50	0.372	78	130	< 10	242.3
8/16/2016	BASE_081616	Room B10	< 0.044	< 0.70	< 0.319	< 0.90	< 0.90	< 0.90	< 0.90	< 0.262	< 10	< 10	< 10	17.4
8/16/2016	FIRST_081616	Room 170	< 0.044	< 0.70	< 0.319	1.8	< 0.90	< 0.90	< 0.90	< 0.262	13	14	< 10	36.2
8/16/2016	SECOND_081616	Outside Room 210	< 0.044	< 0.70	< 0.319	< 0.90	< 0.90	< 0.90	< 0.90	< 0.262	< 10	11	< 10	23.4
Project Action Limits (μg/m^3)			**0.083**[2]	**9.6**[2]	**0.32**[2]	**2,290**[2]	**460**[2]	**46**[2]	**46**[2]	**1.4**[2]	**No CLARC criteria available**			**1,346**[3]

Table 6
Air-Phase Petroleum Hydrocarbons
2016 Hot Water Flushing Remediation Performance Report
Skykomish School
Skykomish, Washington
Farallon PN: 683-057

Sample Date	Sample No.	Sample Location	1,3-Butadiene[1] (μg/m^3)	Methyl tert butyl ether (μg/m^3)	Benzene[1] (μg/m^3)	Toluene (μg/m^3)	Ethylbenzene (μg/m^3)	Xylene, p,m (μg/m^3)	Xylene, o (μg/m^3)	Naphthalene[1] (μg/m^3)	Aliphatics, C5 to C8 (μg/m^3)	Aliphatics, C9 to C12 (μg/m^3)	Aromatics, C9 to C10 (μg/m^3)	Total APH[4] (μg/m^3)
8/24/2016	082416-BNE	Basement - Northeast	< 0.044	< 0.70	**0.377**[5]	2.5	< 0.90	1.4	<0.90	<0.262	23	130	< 10	163.7
8/24/2016	082416-BSW	Basement - Southwest	< 0.044	< 0.70	< 0.319	1.4	< 0.90	< 0.90	< 0.90	<0.262	16	45	< 10	69.4
8/24/2016	082416-BC	Basement - Central	< 0.044	< 0.70	< 0.319	1.4	< 0.90	< 0.90	< 0.90	<0.262	12	300	< 10	320.4
8/24/2016	082416-1SE	First Floor - Southeast	< 0.044	< 0.70	< 0.319	1.2	< 0.90	0.92	< 0.90	<0.262	23	110	< 10	141.7
8/24/2016	082416-1C	First Floor - Central	< 0.044	< 0.70	< 0.319	1.8	< 0.90	2	< 0.90	0.482	28	160	< 10	198.7
8/24/2016	082416-2SE	Second Floor - Southeast	< 0.044	< 0.70	**0.393**[5]	6.8	0.9	3.7	2.3	**3.44**	62	240	11	330.9
9/1/2016	090116-BNE	Basement - Northeast	< 0.044	< 0.70	< 0.319	< 0.90	< 0.90	< 0.90	<0.90	0.288	28	120	< 10	155.6
9/1/2016	090116-BSW	Basement - Southwest	< 0.044	< 0.70	< 0.319	2.3	< 0.90	< 0.90	< 0.90	< 0.262	20	14	< 10	43.3
9/1/2016	090116-BC	Basement - Central	< 0.044	< 0.70	< 0.319	1.6	< 0.90	< 0.90	< 0.90	< 0.262	21	< 10	< 10	34.6
9/1/2016	090116-1SE	First Floor - Southeast	< 0.044	< 0.70	< 0.319	1.8	< 0.90	0.92	< 0.90	< 0.262	37	36	< 10	82.3
9/1/2016	090116-1C	First Floor - Central	< 0.044	< 0.70	**0.371**[5]	3.2	< 0.90	1.5	< 0.90	< 0.262	38	< 10	< 10	54.5
9/1/2016	090116-2SE	Second Floor - Southeast	< 0.044	< 0.70	**0.783**[5]	10	1.0	4.2	1.2	< 0.262	85	49	< 10	156.7
9/8/2016	090816-BNE	Basement - Northeast	0.051	< 0.70	< 0.319	1.9	< 0.90	< 0.90	< 0.90	< 0.262	46	< 10	< 10	59.9
9/8/2016	090816-BSW	Basement - Southwest	< 0.044	< 0.70	< 0.319	1.9	< 0.90	1.0	< 0.90	< 0.262	< 10	< 10	< 10	19.4
9/8/2016	090816-BC	Basement - Central	< 0.044	< 0.70	**0.355**[5]	4.3	< 0.90	2.6	0.91	0.467	36	10	< 10	60.4
9/8/2016	090816-1SE	First Floor - Southeast	< 0.044	< 0.70	**0.498**[5]	6.3	0.97	3.7	1.2	0.425	45	54	< 10	117.4
9/8/2016	090816-1C	First Floor - Central	< 0.044	< 0.70	**0.591**[5]	7.3	1.0	4.4	1.4	0.367	41	19	< 10	80.4
9/8/2016	090816-2SE	Second Floor - Southeast	< 0.044	< 0.70	**0.901**[5]	12	1.7	7.3	2.3	0.451	56	22	< 10	108.0
9/15/2016	091516-BNE	Basement - Northeast	0.044	< 0.70	**0.450**[5]	1.3	< 0.90	< 0.90	<0.90	< 0.262	12	30	< 10	50.6
9/15/2016	091516-BSW	Basement - Southwest	< 0.044	< 0.70	**0.454**[5]	3.4	< 0.90	1.7	< 0.90	< 0.262	13	31	< 10	55.9
9/15/2016	091516-BC	Basement - Central	< 0.044	< 0.70	**0.530**[5]	5.9	< 0.90	2.7	1	0.451	26	210	< 10	252.4
9/15/2016	091516-1SE	First Floor - Southeast	< 0.044	< 0.70	**0.716**[5]	7.7	0.98	3.7	1.2	0.378	29	170	< 10	219.0
9/15/2016	091516-1C	First Floor - Central	< 0.044	< 0.70	**0.815**[5]	7.6	0.96	3.8	1.2	0.362	34	36	< 10	90.1
9/15/2016	091516-2SE	Second Floor - Southeast	< 0.044	< 0.70	**0.824**[5]	8.4	1.1	4.5	1.3	0.378	34	44	< 10	99.9
9/22/2016	092216-BNE	Basement - Northeast	< 0.044	< 0.70	**0.348**[5]	2.4	< 0.90	1.5	< 0.90	< 0.262	29	< 10	< 10	44.6
9/22/2016	092216-BSW	Basement - Southwest	< 0.044	< 0.70	**0.693**[5]	6.3	< 0.90	3.4	1.0	< 0.262	46	13	< 10	76.3
9/22/2016	09216-BC	Basement - Central	< 0.044	< 0.70	**0.866**[5]	8.2	1.1	4.3	1.4	0.278	64	13	< 10	98.5
9/22/2016	092216-1SE	First Floor - Southeast	< 0.044	< 0.70	**0.719**[5]	6.3	0.91	3.4	1.0	0.299	51	27	< 10	96.0
9/22/2016	092216-1C	First Floor - Central	< 0.044	< 0.70	**0.764**[5]	9.5	1.1	4.1	1.5	0.278	62	30	< 10	114.6
9/22/2016	092216-2SE	Second Floor - Southeast	< 0.044	< 0.70	**1.21**[5]	13	1.6	6.7	2.0	0.309	87	17	< 10	134.2
9/28/2016	092816-BNE	Basement - Northeast	< 0.044	< 0.70	< 0.319	5.8	< 0.90	0.99	< 0.90	< 0.262	11	34	< 10	58.3
9/28/2016	092816-BSW	Basement - Southwest	< 0.044	< 0.70	**0.390**[5]	7.1	< 0.90	1.7	< 0.90	< 0.262	13	17	< 10	45.6
9/28/2016	092816-BC	Basement - Central	< 0.044	< 0.70	**0.591**[5]	14	< 0.90	3.0	1.0	0.320	32	24	< 10	80.7
9/28/2016	092816-1SE	First Floor - Southeast	< 0.044	< 0.70	**0.569**[5]	12	< 0.90	2.9	0.94	0.288	33	38	< 10	93.5
9/28/2016	092816-1C	First Floor - Central	< 0.044	< 0.70	**0.572**[5]	14	< 0.90	2.8	0.94	0.294	55	25	< 10	104.4
9/28/2016	092816-2SE	Second Floor - Southeast	< 0.044	< 0.70	**0.773**[5]	22	0.95	3.7	1.2	< 0.262	50	18	< 10	102.1
10/5/2016	100516_BNE	Basement - Northeast	0.044	< 0.70	**0.562**[5]	4.4	< 0.90	2.6	< 0.90	< 0.262	38	16	< 10	67.9
10/5/2016	100516_BSW	Basement - Southwest	< 0.044	< 0.70	**0.652**[5]	6.0	1.1	4.2	1.3	0.273	32	16	< 10	66.9
10/5/2016	100516_BC	Basement - Central	< 0.044	< 0.70	**0.895**[5]	8.5	1.5	6.2	2.0	0.388	50	21	< 10	95.8
10/5/2016	100516_1SE	First Floor - Southeast	< 0.044	< 0.70	**0.671**[5]	5.6	1.2	4.7	1.4	0.262	49	16	< 10	84.2
10/5/2016	100516_1C	First Floor - Central	< 0.044	< 0.70	**0.987**[5]	10	2.0	8.5	2.5	< 0.262	88	11	< 10	128.5
10/5/2016	100516_2SE	Second Floor - Southeast	< 0.044	< 0.70	**1.25**[5]	14	2.6	11	3.3	0.357	96	17	< 10	150.9
Project Action Limits (μg/m^3)			**0.083**[2]	**9.6**[2]	**0.32**[2]	**2,290**[2]	**460**[2]	**46**[2]	**46**[2]	**1.4**[2]	**No CLARC criteria available**			**1,346**[3]

Table 6
Air-Phase Petroleum Hydrocarbons
2016 Hot Water Flushing Remediation Performance Report
Skykomish School
Skykomish, Washington
Farallon PN: 683-057

Sample Date	Sample No.	Sample Location	1,3-Butadiene[1] (µg/m^3)	Methyl tert butyl ether (µg/m^3)	Benzene[1] (µg/m^3)	Toluene (µg/m^3)	Ethylbenzene (µg/m^3)	Xylene, p,m (µg/m^3)	Xylene, o (µg/m^3)	Naphthalene[1] (µg/m^3)	Aliphatics, C5 to C8 (µg/m^3)	Aliphatics, C9 to C12 (µg/m^3)	Aromatics, C9 to C10 (µg/m^3)	Total APH[4] (µg/m^3)
10/12/2016	101216_BNE	Basement - Northeast	**0.10**	< 0.70	**0.834**[5]	3.5	< 0.90	1.7	< 0.90	< 0.262	28	18	< 10	58.4
10/12/2016	101216_BSW	Basement - Southwest	0.077	< 0.70	**0.799**[5]	6.2	< 0.90	2.2	< 0.90	< 0.262	25	18	< 10	58.6
10/12/2016	101216_BC	Basement - Central	**0.10**	< 0.70	**0.910**[5]	5.4	< 0.90	2.7	0.91	0.262	28	25	< 10	69.0
10/12/2016	101216_1SE	First Floor - Southeast	0.047	< 0.70	**0.559**[5]	3.3	< 0.90	1.7	< 0.90	< 0.262	< 10	15	< 10	31.9
10/12/2016	101216_1C	First Floor - Central	< 0.044	< 0.70	**0.821**[5]	6.8	< 0.90	3.6	1.1	< 0.262	34	19	< 10	71.3
10/12/2016	101216_2SE	Second Floor - Southeast	0.075	< 0.70	**1.05**[5]	7.9	1.0	4.1	1.3	< 0.262	35	21	< 10	76.8
11/10/2016	111016_BNE	Basement - Northeast	< 0.044	< 0.70	**1.26**[5]	7.4	0.90	3.7	1.2	< 0.262	59	15	< 10	93.9
11/10/2016	111016_BSW	Basement - Southwest	< 0.044	< 0.70	**1.23**[5]	7.3	< 0.90	3.2	1.1	0.330	92	110	< 10	221.0
11/10/2016	111016_BC	Basement - Central	< 0.044	< 0.70	**1.37**[5]	7.5	1.0	4.1	1.3	0.294	62	13	< 10	95.9
11/10/2016	111016_1SE	First Floor - Southeast	< 0.044	< 0.70	**1.50**[5]	8.1	1.1	4.3	1.4	< 0.262	73	13	< 10	107.9
11/10/2016	111016_1C	First Floor - Central	< 0.044	< 0.70	**1.55**[5]	9.0	1.2	4.8	1.5	0.288	77	12	< 10	112.7
11/10/2016	111016_2SE	Second Floor - Southeast	< 0.044	< 0.70	**1.62**[5]	9.4	1.2	5.2	1.6	0.325	75	11	< 10	110.7
12/15/2016	121516_BNE	Basement - Northeast	0.060	< 0.70	**0.604**[5]	2.8	< 0.90	1.6	< 0.90	< 0.262	< 10	< 10	< 10	21.8
12/15/2016	121516_BSW	Basement - Southwest	< 0.044	< 0.70	**0.543**[5]	2.0	< 0.90	1.4	< 0.90	< 0.262	< 10	12	< 10	27.3
12/15/2016	121516_BC	Basement - Central	0.051	< 0.70	**0.617**[5]	2.7	< 0.90	1.4	< 0.90	< 0.262	10	< 10	< 10	26.1
12/15/2016	121516_1SE	First Floor - Southeast	0.044	< 0.70	**0.607**[5]	3.0	< 0.90	1.5	< 0.90	< 0.262	12	< 10	< 10	28.5
12/15/2016	121516_1C	First Floor - Central	0.053	< 0.70	**0.696**[5]	4.3	< 0.90	2.2	< 0.90	0.273	14	< 10	< 10	32.7
12/15/2016	121516_2SE	Second Floor - Southeast	0.053	< 0.70	**0.802**[5]	5.3	< 0.90	2.8	0.96	< 0.262	37	< 10	< 10	57.8
Project Action Limits (µg/m^3)			**0.083**[2]	**9.6**[2]	**0.32**[2]	**2,290**[2]	**460**[2]	**46**[2]	**46**[2]	**1.4**[2]	**No CLARC criteria available**			**1,346**[3]

NOTES:

< denotes compounds not detected at concentrations exceeding laboratory reported detection limits (RDLs).

[1] Laboratory RDLs for these compounds were attained using TO-15 SIM analysis to lower the detection limits below CLARC criteria.

[2] CLARC Method B values for protection of all populations.

[3] Risk-based cleanup level established for Town of Skykomish and private property during this project by the Washington State Department of Ecology. Project limits are defined in Addendum No. 3 to 2010 Compliance Monitoring Plan Updated dated February 17, 2015, prepared by Farallon Consulting, L.L.C.

[4] Total APH is derived by summing all individual compounds and ranges, excluding 1,3-butadiene. Compounds not detected at concentrations exceeding the laboratory RDL are added at half of the RDL.

[5] Benzene is included as part of the analysis for total APH, although benzene is not expected as a constituent of concern.

APH = air-phase petroleum hydrocarbons

CLARC = Washington State Department of Ecology Cleanup Levels and Risk Calculations

µg/m^3 = micrograms per cubic meter

SIM = Selective Ion Monitoring

Table 7
Photoionization Detector Summary Data
2016 Hot Water Flushing Remediation Performance Report
Skykomish School
Skykomish, Washington
Farallon PN: 683-057

Location	Week No.	Date	Average Data Value (ppm)	Peak Data Value (ppm)
Room B10 (Cafeteria)	1	6/15/2016	1	3
	2	6/22/2016	1	1
	3	6/29/2016	2	2
	4	7/6/2016	1	2
	5	7/13/2016	1	1
	6	7/20/2016	2	2
	7	7/27/2016	0	2
	8	8/3/2016	0	0
	9	8/10/2016	0	1
	10	8/17/2016	0	1
	11	8/24/2016	0	2
	12	8/31/2016	1	2
	13	9/7/2016	1	2
	14	9/14/2016	1	2
	15	9/21/2016	1	2
	16	9/28/2016	1	2
Room B70 (Kindergarten)	1	6/15/2016	1	2
	2	6/22/2016	2	2
	3	6/29/2016	2	2
	4	7/6/2016	2	2
	5	7/13/2016	2	2
	6	7/20/2016	2	2
	7	7/27/2016	2	2
	8	8/3/2016	2	2
	9	8/10/2016	2	2
	10	8/17/2016	2	**8** [2]
	11	8/24/2016	2	2
	12	8/31/2016	2	2
	13	9/7/2016	2	2
	14	9/14/2016	2	2
	15	9/21/2016	2	2
	16	9/28/2016	2	2
Project Action Limits [3]			**5**	**5**

Table 7
Photoionization Detector Summary Data
2016 Hot Water Flushing Remediation Performance Report
Skykomish School
Skykomish, Washington
Farallon PN: 683-057

Location	Week No.	Date	Average Data Value (ppm)	Peak Data Value (ppm)
Room 170 (Office)	1	6/15/2016	0	1
	2	6/22/2016	1	1
	3	6/29/2016	1	1
	4	7/6/2016	1	1
	5	7/13/2016	1	1
	6	7/20/2016	1	1
	7	7/27/2016	0	1
	8	8/3/2016	0	**6.3** [1]
	9	8/10/2016	0	1
	10	8/17/2016	0	**8** [2]
	11	8/24/2016	0	2
	12	8/31/2016	1	2
	13	9/7/2016	1	1
	14	9/14/2016	1	2
	15	9/21/2016	1	1
	16	9/28/2016	1	1
Project Action Limits [3]			**5**	**5**

NOTES:

Measurements were obtained using a RAEGuard 2 Fixed photoionization detector, except in Rooms 170 and B10 from August 1 through 26, 2016 when a MiniRae 3000 was used as a temporary replacement.

ppm = parts per million

[1] Local exceedance due to carpet cleaning scheduled by Skykomish School.

[2] Local exceedance due to gym floor polishing scheduled by Skykomish School.

[3] Project action limits are based on a 5-minute consecutive reading at or exceeding the action limit. Project limits are defined in Addendum No. 3 to 2010 Compliance Monitoring Plan Updated dated February 15, 2015, prepared by Farallon Consulting, L.L.C.

Table 8
Soil Vapor Extraction Operational Data
2016 Hot Water Flushing Remediation Performance Report
Skykomish School
Skykomish, Washington
Farallon PN: 683-057

Date	Soil Vapor Extraction Flow Data							
	SVE-1,2 FLOW / FE301 (scfm)	SVE-3 FLOW / FE302 (scfm)	SVE-4 FLOW / FE303 (scfm)	SVE-5 FLOW / FE304 (scfm)	SVE-6 HORZ FLOW / FE305 (scfm)	System Flow (scfm)	System Vacuum (IWC)	Total APH Removal (lbs)[3]
6/15/2016	87.15	REPLACE	14.82	70.03	68.04	240.04[1]	42	0.33
6/20/2016	>95	49	0	>95	>95	>334[1]	60	
6/24/2016	92.58	>99		>99	>99	>389[1]	59	
6/27/2016	92.9	>99	65.5	>99	>99	>455[1]	49	
6/28/2016	92.8	>99	31	>99	>99	>420[1]	49	
7/6/2016	40.5	93.3	>99	>99	>99	>430[1]	40	2.16
7/11/2016	70.2	-0.007	>99	>99	>99	>367[1]	32	
7/12/2016	>99	-0.008	>99	>99	80.4	>377[1]	31	
7/13/2016	83.6	>99	>99	>99	>99	>479[1]	32	
7/14/2016	85.5	>99	>99	>99	>99	>481[1]	32	
7/15/2016	81.4	>99	>99	>99	>99	>477[1]	32	
7/20/2016	37.05[2]	115.18[2]	148.19[2]	128.33[2]	137.29[2]	566.04[2]	NM	
7/22/2016	19.79[2]	116.77[2]	153.24[2]	131.92[2]	136.91[2]	558.63[2]	33.6	
7/26/2016	10	>99	>99	>99	>99	>406[1]	32	
7/27/2016	15.7	>99	>99	>99	>99	>411[1]	34	
8/1/2016	20	>99	>99	>99	>99	>416[1]	34	
8/2/2016	16.5	>99	>99	>99	>99	>412[1]	34	
8/3/2016	15	>99	>99	>99	>99	>411[1]	34	
8/4/2016	94.3	>99	>99	>99	>99	>490[1]	33	
8/5/2016	20.56	>99	>99	>99	>99	>416[1]	34	
8/8/2016	92.98	>99	>99	>99	>99	>488[1]	38	
8/9/2016	92.9	>99	>99	>99	>99	>488[1]	30	
8/10/2016	151.24[2]	122.5[2]	157.75[2]	133.92[2]	143.8[2]	709.21[2]	30	
8/11/2016	93.1	>99	>99	>99	>99	>489[1]	29	
8/12/2016	93.2	>99	>99	>99	>99	>489[1]	29	
8/15/2016	93.1	>99	>99	>99	>99	>489[1]	29	
8/16/2016	93.2	>99	>99	>99	>99	>489[1]	29	
8/17/2016	93.2	>99	>99	>99	>99	>489[1]	26	
8/18/2016	93.3	>99	>99	>99	>99	>489[1]	26	2.12
8/19/2016	93	>99	>99	>99	>99	>489[1]	28	
8/22/2016	93.1	>99	>99	>99	>99	>489[1]	30	
8/23/2016	93.2	>99	>99	>99	>99	>489[1]	30	
8/24/2016	93.2	>99	>99	>99	>99	>489[1]	30	
8/25/2016	93.3	>99	>99	>99	>99	>489[1]	30	
8/26/2016	93.5	>99	>99	>99	>99	>489[1]	30	
8/29/2016	>99	>99	>99	>99	>99	>495[1]	31	
8/30/2016	>99	>99	>99	>99	>99	>495[1]	30	
8/31/2016	93.2	>99	>99	>99	>99	>489[1]	26	
9/1/2016	151.09[2]	106.23[2]	96.57[2]	115.08[2]	130.42[2]	599.39[2]	23	
9/6/2016	93.3	>99	70.4	>99	>99	>460[1]	26	
9/7/2016	93.2	>99	79.5	>99	>99	>469[1]	26	
9/27/2016	93	>99	>99	>99	>99	>489[1]	27	1.98
10/4/2016	92.9	>99	>99	>99	92.8	>482[1]	27	
10/5/2016	179.46[2]	113.99[2]	148.19[2]	120.99[2]	91.75[2]	654.38[2]	NM	
10/11/2016	92.9	>99	>99	>99	>99	>488[1]	29	
10/12/2016	145.7[2]	108.22[2]	139.28[2]	114.79[2]	129.75[2]	637.74[2]	NM	
10/18/2016	93.4	>99	>99	>99	>99	>489[1]	26	
10/21/2016	173.77[2]	108.22[2]	141.88[2]	113.18[2]	128.33[2]	665.38[2]	NM	
Date	93.3	>99	>99	>99	>99	>489[1]	26	
10/28/2016	111.55[2]	136.62[2]	69.64[2]	117.15[2]	122.87[2]	557.83[2]	NM	
Total	NA	NA	NA	NA	NA	NA	NA	6.6
PSCAA[4]								**1,000**

NOTES:

[1] Flow measurements collected using Dwyer MS2 Magnesense II Differential Pressure Transmitter.

[2] Denotes low measurements collected manually using Dwyer 477AV Handheld Digital Manometer.

[3] $$Total\ APH\ Removal = \frac{Avg\ Concentration * Avg\ System\ Flow * 1440\frac{min}{day} * Days}{453600000\frac{ug}{lb} * 35.31\frac{ft^3}{m^3}}$$

[4] PSCAA Regulation I. 6.03 (c) (94) requires that gas or odor control be installed for any soil and groundwater remediation projects which emit >15 pounds per year of benzene or > 1,000 pound per year of toxic air contaminants. Total APH calculated as a summation of applicable TACs, which include benzene.

APH = air-phase petroleum hydrocarbons
IWC = inches of water column
lbs = pounds
NA = not applicable
NM = not measured
PSCAA = Puget Sound Clean Air Agency
scfm = standard cubic feet per minute
SVE = soil vapor extraction
TACs = total aromatic compounds

Table 9
System Influent Vapor-Phase Petroleum Hydrocarbon Concentrations
2016 Hot Water Flushing Remediation Performance Report
Skykomish School
Skykomish, Washington
Farallon PN: 683-057

Sample No.	Sample Date	1,3-Butadiene[1] (µg/m^3)	Methyl tert butyl ether (µg/m^3)	Benzene[1] (µg/m^3)	Toluene (µg/m^3)	Ethylbenzene (µg/m^3)	Xylene, p,m (µg/m^3)	Xylene, o (µg/m^3)	Naphthalene[1] (µg/m^3)	Aliphatics, C5 to C8 (µg/m^3)	Aliphatics, C9 to C12 (µg/m^3)	Aromatics, C9 to C10 (µg/m^3)	Total APH[4] (µg/m^3)
SYSTEM_INF_062816	6/28/2016	< 0.044	< 0.7	< 0.319	2.3	< 0.9	1.7	< 0.9	0.802	120	330	< 10	461.2
SYSTEM_INF_081716	8/17/2016	< 1.11	< 0.45	< 0.128	< 0.74	< 0.69	3.29	< 1.15	< 1.57	622	504	< 4.54	1,134
SYSTEM_INF_092316	9/23/2016	<0.044	< 0.7	.537	4.3	<0.90	3.1	1.1	1.50	200	770	< 10	986
MTCA Method B Subslab Soil Gas Screening Level (µg/m^3) [5]		**2.78**	**321**	**10.7**	**76,200**	**15,200**	**1,520**	**1,520**	**2.45**	**90,000**	**4,700**	**6,000**	**NE**

NOTES:

< denotes compounds not detected at concentrations exceeding laboratory reported detection limits (RDLs).

[1] Laboratory RDLs for these compounds were attained using TO-15 SIM analysis to lower the detection limits below CLARC criteria.

[2] CLARC Method B values for protection of all populations.

[3] Risk-based cleanup level established for Town of Skykomish and private property during this project by the Washington State Department of Ecology.

[4] Total APH is derived by summing all individual compounds and ranges, excluding 1,3-butadiene. Compounds not detected at concentrations exceeding the laboratory RDL are added at half of the RDL.

[5] Washington State Model Toxics Control Act Cleanup Regulation (MTCA) Method B Cleanup and Screening Levels, Table B-1 of Appendix B of the Guidance for Evaluating Soil Vapor Intrusion in Washington State: Investigation and Remedial Action revised February 2016.

APH = air-phase petroleum hydrocarbons
CLARC = Washington State Department of Ecology Cleanup Levels and Risk Calculations
µg/m^3 = micrograms per cubic meter
NE = not established
SIM = Selective Ion Monitoring

Table 10
Total Petroleum Hydrocarbon Concentrations in Process Water
2016 Hot Water Flushing Remediation Performance Report
Skykomish School
Skykomish, Washington
Farallon PN: 683-057

	DRO (micrograms per liter)[1]			ORO (micrograms per liter)[1]			Calculated NWTPH-Dx[2] (µg/l)	DRO (micrograms per liter)[1]			ORO (micrograms per liter)[1]			Calculated NWTPH-Dx[2] (µg/l)	DRO (micrograms per liter)[1]			ORO (micrograms per liter)[1]			Calculated NWTPH-Dx[2] (µg/l)
	Result	MDL	MRL	Result	MDL	MRL		Result	MDL	MRL	Result	MDL	MRL		Result	MDL	MRL	Result	MDL	MRL	
Sample Date	LEAD INFLUENT							LAG INFLUENT							LAG EFFLUENT						
6/16/2016	2,100	14	100	1,100	9.3	240	3,200	150 R	14	100	< 240 R	9.3	240	R[3]	140 R	14	100	1,800 R	9.3	240	R[3]
6/22/2016	1,300	14	100	430	9.3	240	1,730	< 100	14	100	< 240	9.3	240	< 11.65	100	14	100	< 240	9.3	240	104.65
6/28/2016	1,400	15	110	710	9.8	250	2,110	< 110	14	110	< 240	9.4	240	< 11.7	< 110	14	110	< 240	9.4	240	< 11.7
7/13/2016	910	14	24	470	9.6	49	1,380	410	14	24	180	9.4	48	590	73	14	24	51	9.4	48	124
7/20/2016	810	14	24	320	9.6	49	1,130	280	14	24	83	9.3	48	363	73	14	24	89	9.4	48	162
7/27/2016	980	14	100	< 240	9.3	240	985	140	14	110	< 240	9.5	240	144.75	< 110	14	110	< 240	9.4	240	< 11.7
8/4/2016	630	14	24	240	9.5	48	870	57	14	24	< 48	9.3	48	61.65	44	14	24	52	9.4	48	96
8/10/2016	4,600	14	24	4,800	9.6	49	9,400	550	14	24	520	9.4	48	1,070	240	14	24	210	9.3	48	450
8/17/2016	1,000	14	110	920	9.4	240	1,920	750	14	100	850	9.3	240	1,600	210	14	100	< 240	9.3	240	214.65
8/24/2016	1,900 J	14	110	1,900 J	9.4	240	3,800	200 R	14	100	250 R	9.3	240	R[3]	810 R	14	100	840 R	9.3	240	R[3]
9/1/2016	950	15	110	520	9.9	250	1,470	380	14	110	< 240	9.5	240	384.75	< 110	15	110	< 260	10	260	< 12.5
9/8/2016	470	14	100	280	9.3	240	750	200	14	100	< 240	9.3	240	204.65	< 100	14	100	< 240	9.3	240	< 11.65
9/15/2016	510	14	100	370 J	9.3	240	880	220	14	110	240 J	9.4	240	460	270	14	100	< 240	9.3	240	274.65
9/22/2016	1,600	14	110	630 J	9.4	240	2,230	640	14	110	310 J	9.4	240	950	110	14	100	< 240	9.3	240	114.65
9/28/2016	440	14	100	< 240	9.3	240	444.65	< 100	14	100	< 240	9.3	240	< 11.65	< 100	14	100	< 240	9.3	240	< 11.65
10/5/2016	390	14	100	< 240	9.3	240	394.65	< 100	14	100	< 240	9.3	240	< 11.65	< 100	14	100	< 240	9.3	240	< 11.65
10/12/2016	1,500	14	100	600	9.3	240	2,100	350	14	100	< 240	9.3	240	354.65	< 100	14	100	< 240	9.3	240	< 11.65
10/21/2016	1,100	14	100	890	9.3	240	1,990	660	14	100	530	9.3	240	1,190	100	14	100	< 240	9.3	240	104.65
10/28/2016	1,300 J	14	100	490 J	9.3	240	1,790	590 J	14	100	250 J	9.3	240	840	140 J	14	100	< 240 UJ	9.3	240	144.65
Remediation Level for Groundwater																					**477**

NOTES:

Results in **bold** denote concentrations exceeding the site-specific TPH remediation level of 477 µg/l.

< denotes analyte not detected at or exceeding the laboratory method detection limit listed.

[1] Analyzed by Northwest Method NWTPH-Dx.

[2] The total NWTPH-Dx calculation uses one-half the MDL for non-detectable concentrations to derive the sum of the DRO and ORO results obtained using Northwest Method NWTPH-Dx. If either DRO or ORO was reported as a detect, the calculated total NWTPH-Dx concentration is indicated as a detect. If both DRO and ORO were reported as non-detect, the calculated total NWTPH-Dx concentration is indicated as a non-detect. Note that in some instances, data validation resulted in additional data qualification and/or updates to laboratory data. If, for example, data validation caused an update to a non-detect result value because of laboratory blank contamination and the data validator concluded that the result should be non-detect instead of detect, the laboratory-given method detection limit and reporting limit were updated to match the validated non-detect result value.

[3] Effluent result is significantly higher than upstream influent result. Sample container labeling error suspected between the two samples. Sample results deemed unusable and rejected.

DRO = total petroleum hydrocarbons as diesel-range organics

J = The analyte was positively identified. The associated numerical value is the approximate concentration of the analyte in the sample.

MDL = laboratory-specified method detection limit

µg/l = micrograms per liter

MRL = laboratory-specified method reporting limit

ORO = total petroleum hydrocarbons as oil-range organics

R = rejected result

TPH = total petroleum hydrocarbons

UJ = The analyte was not detected and the reporting limit is an estimate.

Table 11
Weekly NAPL Recovery
2016 Hot Water Flushing Remediation Performance Report
Skykomish School
Skykomish, Washington
Farallon PN: 683-057

Date[1]	Week No.	NAPL Recovery (gallons)	Total NAPL Recovery (gallons)	Dissolved-Phase DRO Removed Via GAC (lbs)[2]	Total Dissolved-Phase DRO Removed Via GAC (lbs)
6/15/2016	0	0	0.0	0.0	0.0
6/20/2016	1	0	0.0	4.1	4.1
6/28/2016	2	0.2	0.2	3.9	8.0
7/5/2016	3	0	0.2	0.1	8.1
7/13/2016	4	0	0.2	5.1	13.2
7/20/2016	5	0	0.2	4.5	17.7
7/27/2016	6	0.6	0.8	3.5	21.3
8/4/2016	7	1.5	2.3	3.7	25.0
8/10/2016	8	4.3	6.6	21.5	46.5
8/17/2016	9	4.4	11.0	18.1	64.5
8/24/2016	10	6.5	17.5	7.7	72.2
8/31/2016	11	7.1	24.6	4.8	77.0
9/7/2016	12	4	28.6	2.3	79.3
9/14/2016	13	4	32.6	1.3	80.6
9/21/2016	14	1.5	34.1	1.5	82.2
9/28/2016	15	2	36.1	2.1	84.3
10/5/2016	16	1.7	37.8	0.6	84.9
10/12/2016	17	2	39.8	2.1	87.0
10/19/2016	18	0.3	40.2	2.4	89.4
10/26/2016	19	0.0	40.2	3.7	93.2

NOTES:

[1] The hot water flushing system was not in operation from June 25 through July 10, 2016 due to biofouling of the GAC filters.

[2] Dissolved-Phase DRO removal via GAC is calculated using the following formula:
(Average Lead Influent Concentration- Average Lag Effluent Concentration)*(Total Weekly Flow) * 3.78 / 453,592,000
Where Lead Influent and Lag Effluent Concentrations are from Table 10 and Weekly Flow is from Table 14.
Below is an example from Week 5:
{[(1,130+1,380)/2]-[(124+162)/2]} µg/L *490,651 gallons* 3.78 / 453,598,000 = 4.5 lbs

DRO = total petroleum hydrocarbons as diesel-range organics
GAC = granular activated carbon
lbs = pounds
NAPL = nonaqueous-phase liquid

Table 12
Summary Groundwater Elevations
2016 Hot Water Flushing Remediation Performance Report
Skykomish School
Skykomish, Washington
Farallon PN: 683-057

Date	GWM1	GWM2	GWM3	GWM4	GWM5	GWM6	GWM7	GWM8	GWM9	GWM10	GWM11	GWM12	GWM13	GWM14	GWM15	GWM16	GWM17	GWM18	GWM19	GWM20	GWM21	Average[1]
6/15/2016	917.2	917.1	917.3	917.3	917.3	917.6	917.9	917.2	917.0	916.7	917.3	916.9	917.4	918.0	917.3	917.6	916.9	917.7	917.4	917.3	917.3	917.3
6/16/2016	917.0	916.8	917.3	917.3	917.3	917.7	917.9	917.1	916.9	916.8	917.4	916.9	917.5	918.1	917.4	917.6	916.8	917.8	917.3	917.2	917.4	917.3
6/17/2016	916.8	916.8	917.3	917.3	917.3	917.7	917.8	917.1	916.9	916.7	917.3	916.9	917.5	918.1	917.4	917.6	916.8	917.8	917.3	917.2	917.3	917.3
6/18/2016	917.4	917.2	917.3	917.3	917.3	917.3	917.3	917.3	917.4	916.9	917.4	917.1	917.4	918.2	917.4	917.7	917.3	917.9	917.7	917.6	917.5	917.3
6/19/2016	917.6	917.5	917.5	917.5	917.5	917.2	917.5	917.7	917.8	917.3	917.7	917.5	917.7	918.5	917.8	918.1	917.7	918.3	918.1	918.0	917.9	917.6
6/20/2016	917.3	917.2	917.4	917.4	917.4	917.5	917.8	917.4	917.3	917.0	917.5	917.1	917.6	918.3	917.6	917.9	917.2	918.1	917.7	917.6	917.6	917.5
6/21/2016	916.8	916.7	917.5	917.5	917.5	918.0	918.2	917.2	917.0	917.1	918.1	917.3	918.2	918.4	917.9	917.9	916.8	918.2	917.4	917.4	917.7	917.7
6/22/2016	916.5	916.4	917.1	917.1	917.1	917.9	918.1	916.7	916.4	916.9	917.9	917.0	918.1	918.1	917.7	917.7	916.3	917.9	916.9	916.8	917.5	917.4
6/23/2016	916.3	916.3	917.0	917.0	917.0	917.8	918.0	916.8	916.1	916.8	918.1	916.9	918.2	918.1	917.7	917.6	916.2	917.9	916.7	916.6	917.4	917.4
6/24/2016	916.6	916.6	917.3	917.3	917.3	917.9	918.2	917.2	916.6	917.1	918.3	917.3	918.5	918.3	918.2	918.0	916.8	918.1	917.1	917.0	917.7	917.7
6/25/2016	917.2	917.1	917.4	917.4	917.4	917.6	917.8	917.4	917.2	917.2	917.9	917.3	918.0	918.4	917.9	918.1	917.2	918.2	917.6	917.5	917.8	917.6
6/26/2016	917.5	917.4	917.4	917.4	917.4	917.3	917.4	917.4	917.5	917.0	917.4	917.1	917.4	918.3	917.5	917.9	917.4	918.1	917.8	917.7	917.6	917.4
6/27/2016	917.1	917.0	917.3	917.3	917.3	917.6	917.8	917.3	917.0	916.9	917.4	917.1	917.5	918.2	917.5	917.8	917.0	918.0	917.5	917.4	917.5	917.4
6/28/2016	917.2	917.0	917.3	917.3	917.3	917.5	917.6	917.2	917.1	917.0	917.5	917.1	917.5	918.2	917.5	917.8	917.1	918.0	917.4	917.3	917.6	917.4
6/29/2016	917.4	917.3	917.3	917.3	917.3	917.2	917.3	917.3	917.4	916.9	917.3	917.1	917.3	918.2	917.4	917.8	917.3	918.0	917.7	917.6	917.6	917.3
6/30/2016	917.4	917.3	917.2	917.2	917.2	917.1	917.3	917.3	917.4	916.9	917.3	917.1	917.3	918.2	917.4	917.8	917.3	918.0	917.7	917.6	917.5	917.3
7/1/2016	917.3	917.2	917.1	917.1	917.1	917.0	917.3	917.2	917.3	916.8	917.1	916.9	917.2	918.1	917.2	917.7	917.1	917.9	917.6	917.5	917.4	917.2
7/2/2016	917.3	917.1	917.0	917.0	917.0	916.9	917.2	917.1	917.1	916.6	917.0	916.8	917.0	918.0	917.1	917.5	917.0	917.7	917.5	917.4	917.2	917.0
7/3/2016	917.3	917.1	917.0	917.0	917.0	916.8	917.2	917.1	917.2	916.7	917.0	916.8	917.1	918.1	917.1	917.6	917.1	917.8	917.5	917.4	917.3	917.1
7/4/2016	917.2	917.1	917.0	917.0	917.0	916.7	917.1	917.1	917.2	916.7	917.0	916.8	917.1	918.1	917.1	917.6	917.1	917.8	917.5	917.4	917.3	917.1
7/5/2016	917.1	917.0	916.9	916.9	916.9	916.7	917.1	917.0	917.1	916.6	917.0	916.7	917.0	918.1	917.1	917.5	917.0	917.7	917.4	917.3	917.2	917.0
7/6/2016	917.0	917.0	916.8	916.8	916.8	916.6	917.0	916.9	917.0	916.5	916.8	916.6	916.9	918.0	916.9	917.4	916.9	917.6	917.3	917.2	917.1	916.9
7/7/2016	917.0	916.9	916.7	916.7	916.7	916.6	917.0	916.7	916.8	916.3	916.7	916.5	916.7	917.9	916.8	917.3	916.7	917.5	917.2	917.1	916.9	916.8
7/8/2016	917.0	917.0	916.7	916.7	916.7	916.5	917.0	916.7	916.8	916.3	916.7	916.4	916.7	917.8	916.8	917.2	916.7	917.4	917.2	917.0	916.9	916.7
7/9/2016	917.2	917.0	916.7	916.7	916.7	916.5	917.1	916.8	916.9	916.5	916.9	916.6	916.9	917.8	916.9	917.3	916.8	917.5	917.3	917.2	917.1	916.9
7/10/2016	917.1	917.0	916.7	916.7	916.7	916.5	917.0	916.8	917.0	916.5	916.8	916.6	916.9	917.8	916.9	917.4	916.8	917.6	917.3	917.2	917.1	916.8
7/11/2016	916.6	916.6	916.8	916.8	916.8	917.2	917.6	916.7	916.5	916.5	917.0	916.6	917.1	917.8	917.1	917.4	916.5	917.6	917.0	916.9	917.1	917.0
7/12/2016	915.9	916.3	916.9	916.9	916.9	918.0	918.1	916.5	915.7	916.4	917.3	916.5	917.4	917.8	917.3	917.3	916.2	917.5	916.4	916.3	917.0	917.1
7/13/2016	915.7	916.2	916.9	916.9	916.9	918.0	918.2	916.6	915.8	916.6	917.7	916.7	917.8	917.9	917.5	917.5	916.4	917.7	916.4	916.4	917.2	917.3
7/14/2016	915.6	916.0	916.7	916.7	916.7	917.7	918.0	916.2	915.7	916.5	917.7	916.7	917.8	917.9	917.5	917.5	916.1	917.7	916.3	916.3	917.1	917.1
7/15/2016	915.7	915.3	916.6	916.6	916.6	917.4	917.4	916.1	915.8	916.4	917.5	916.6	917.7	917.8	917.3	917.4	915.7	917.6	916.3	916.3	917.0	916.9
7/16/2016	915.6	915.1	916.4	916.4	916.4	917.2	916.8	916.0	915.6	916.3	917.4	916.4	917.5	917.7	917.2	917.3	915.5	917.5	916.1	916.1	916.9	916.6
7/17/2016	915.6	915.1	916.2	916.2	916.2	916.9	916.8	915.7	915.4	916.2	917.3	916.3	917.4	917.6	917.0	917.2	915.4	917.3	915.9	916.0	916.8	916.5
7/18/2016	916.3	916.1	916.4	916.4	916.4	916.7	917.0	916.2	916.1	916.3	917.0	916.4	917.0	917.7	916.8	917.2	916.0	917.4	916.5	916.5	916.9	916.6
7/19/2016	915.7	915.3	916.3	916.3	916.3	916.8	917.1	ND	915.7	916.4	917.5	916.6	917.6	917.8	917.2	917.4	915.6	917.6	916.2	916.3	917.0	916.8
7/20/2016	915.8	915.4	916.2	916.2	916.2	916.7	916.8	ND	915.8	916.4	917.3	916.5	917.4	917.8	917.0	917.3	915.6	917.5	916.2	916.2	917.0	916.7
7/21/2016	916.3	916.2	916.4	916.4	916.4	916.6	917.0	ND	916.3	916.3	916.8	916.4	916.9	917.8	916.7	917.3	916.2	917.5	916.7	916.6	916.9	916.6
7/22/2016	915.7	915.5	916.2	916.2	916.2	916.7	917.6	ND	915.7	916.5	917.5	916.6	917.5	918.0	917.1	917.4	915.5	917.6	916.3	916.4	917.1	916.8
7/23/2016	915.7	915.4	916.4	916.4	916.4	916.8	917.4	ND	915.9	916.5	917.4	916.6	917.5	918.0	916.8	917.5	915.0	917.6	916.3	916.4	917.1	916.7
7/24/2016	915.7	915.4	916.3	916.3	916.3	916.8	917.3	ND	915.7	916.3	917.2	916.4	917.2	917.8	916.5	917.3	914.8	917.5	916.2	916.2	916.9	916.5
7/25/2016	915.9	915.7	916.3	916.3	916.3	916.8	917.0	ND	915.8	916.2	917.0	916.3	917.0	917.8	916.4	917.2	915.3	917.4	916.2	916.2	916.8	916.5
7/26/2016	916.3	916.2	916.4	916.4	916.4	916.6	917.0	ND	916.3	916.2	916.7	916.4	916.8	917.8	916.7	917.3	916.1	917.5	916.7	916.7	916.9	916.6
7/27/2016	915.7	915.5	916.2	916.2	916.2	916.7	917.5	ND	915.7	916.2	917.1	916.4	917.2	917.8	916.6	917.3	915.0	917.4	916.2	916.2	916.9	916.6
7/28/2016	915.8	915.5	916.3	916.3	916.3	916.8	917.3	ND	915.7	916.2	917.0	916.3	917.1	917.8	916.5	917.2	915.1	917.4	916.3	916.2	916.8	916.5
7/29/2016	915.7	915.4	916.2	916.2	916.2	916.8	917.3	ND	915.5	916.0	916.9	916.2	917.0	917.6	916.3	917.1	914.7	917.3	916.1	916.0	916.7	916.4
7/30/2016	915.8	915.5	916.1	916.1	916.1	916.7	917.1	ND	915.5	915.9	916.7	916.1	916.8	917.5	916.2	917.0	915.0	917.2	916.0	916.0	916.6	916.3
7/31/2016	915.6	915.3	916.1	916.1	916.1	916.7	917.4	ND	915.5	916.0	916.9	916.2	916.9	917.6	916.2	917.1	914.7	917.3	916.0	916.1	916.7	916.3
8/1/2016	915.6	915.2	916.1	916.1	916.1	916.7	917.2	ND	915.5	916.0	916.9	916.2	917.0	917.6	916.3	917.1	914.8	917.3	916.0	916.1	916.7	916.3
8/2/2016	915.6	915.2	916.1	916.1	916.1	916.6	917.2	ND	915.6	916.0	917.0	916.2	917.2	917.7	916.3	917.2	914.9	917.3	916.1	916.2	916.7	916.4
8/3/2016	915.8	915.4	916.2	916.2	916.2	916.6	917.2	ND	915.9	916.2	917.1	916.4	917.3	917.8	916.4	917.3	915.2	917.5	916.3	916.3	916.8	916.5
8/4/2016	915.8	915.5	916.1	916.1	916.1	916.5	917.2	ND	915.7	915.9	916.8	916.1	917.0	917.6	916.1	917.1	914.8	917.2	916.2	916.2	916.6	916.3
8/5/2016	915.8	915.5	916.0	916.0	916.0	916.4	917.1	ND	915.6	915.7	916.6	915.9	916.8	917.4	915.8	917.0	914.7	917.0	916.0	916.0	916.4	916.1
8/6/2016	915.7	915.5	915.9	915.9	915.9	916.4	917.1	ND	915.5	915.7	916.7	915.9	916.9	917.4	915.8	917.0	914.7	917.1	915.9	916.0	916.4	916.1
8/7/2016	915.7	915.5	915.9	915.9	915.9	916.3	917.0	ND	915.5	915.6	916.6	915.8	916.8	917.3	915.8	916.9	914.6	917.0	915.9	915.9	916.3	916.1
8/8/2016	915.8	915.3	915.9	915.9	915.9	916.2	917.0	ND	915.6	915.7	916.6	915.9	916.8	917.4	915.8	917.0	914.7	917.0	916.0	916.0	916.4	916.1
8/9/2016	915.7	915.3	915.9	915.9	915.9	916.2	917.2	916.5	915.6	916.0	916.8	916.1	917.0	917.4	916.0	917.1	914.7	917.2	916.0	916.1	916.6	916.3
8/10/2016	915.6	915.2	915.9	915.9	915.9	916.2	917.2	916.3	915.5	915.9	916.9	916.1	917.1	917.4	916.1	917.1	914.8	917.2	915.9	916.1	916.5	916.3
8/11/2016	915.6	915.3	915.8	915.8	915.8	916.1	916.9	916.2	915.6	915.9	916.8	916.0	917.0	917.4	916.2	917.1	914.9	917.2	915.9	916.1	916.5	916.2
8/12/2016	915.5	915.1	915.8	915.8	915.8	916.1	917.0	916.0	915.4	915.8	916.8	916.0	917.0	917.4	916.2	917.0	914.8	917.1	915.8	916.0	916.4	916.2
8/13/2016	915.7	915.1	915.8	915.8	915.8	916.0	916.6	916.1	915.6	915.7	916.7	915.9	916.9	917.3	916.0	916.9	914.7	917.1	915.8	916.0	916.4	916.1
8/14/2016	915.7	915.1	915.7	915.7	915.7	915.8	915.9	916.2	915.6	915.7	916.6	915.8	916.8	917.2	915.9	916.9	914.7	917.0	915.9	916.0	916.3	916.0
8/15/2016	915.6	915.1	915.6	915.6	915.6	915.7	916.0	916.1	915.6	915.7	916.6	915.9	916.9	917.3	916.0	917.0	914.8	917.1	915.9	916.0	916.4	916.0
8/16/2016	915.5	915.1	915.5	915.5	915.5	915.6	916.2	916.0	915.5	915.7	916.6	915.8	916.9	917.2	915.9	916.9	914.8	917.1	915.8	916.0	916.3	915.9
8/17/2016	915.4	915.1	915.5	915.5	915.5	915.6	916.8	915.8	915.3	915.6	916.5	915.8	916.8	917.2	916.0	916.9	914.8	917.0	915.6	915.9	916.3	916.0
8/18/2016	915.4	915.1	915.5	915.5	915.5	915.6	917.1	915.8	915.3	915.6	916.2	915.7	916.4	917.1	916.0	916.8	914.8	917.0	915.6	915.9	916.2	915.9
8/19/2016	915.5	915.3	915.6	915.6	915.6	915.7	916.9	915.8	915.4	915.5	916.2	915.7	916.4	917.0	916.0	916.8	915.1	916.9	915.7	915.9	916.2	915.9
8/20/2016	916.1	916.0	915.7	915.7	915.7	915.6	916.0	916.1	915.9	915.4	915.7	915.5	915.8	916.9	915.8	916.7	915.7	916.8	916.2	916.0	916.0	915.8
8/21/2016	915.7	915.5	915.5	915.5	915.5	915.5	916.6	915.9	915.6	915.3	915.8	915.5	915.9	916.8	915.9	916.6	915.2	916.7	915.9	915.9	916.0	915.8
8/22/2016	915.4	915.1	915.5	915.5	915.5	915.6	917.1	915.8	915.4	915.5	916.1	915.7	916.3	917.0	916.0	916.8	914.8	916.9	915.7	915.9	916.1	915.9
8/23/2016	915.4	915.1	915.5	915.5	915.5	915.7	917.2	915.8	915.4	915.6	916.2	915.7	916.4	917.0	916.1	916.9	914.9	917.0	915.7	915.9	916.2	916.0
8/24/2016	915.4	915.1	915.5	915.5	915.5	915.7	917.3	915.8	915.4	915.6	916.2	915.7	916.4	917.0	916.2	916.9	915.0	917.1	915.7	915.9	916.2	916.0
8/25/2016	915.4	915.1	915.5	915.5	915.5	915.8	917.2	915.7	915.3	915.4	916.1	915.6	916.3	916.9	915.9	916.7	914.8	916.9	915.6	915.8	916.1	915.9

Table 12
Summary Groundwater Elevations
2016 Hot Water Flushing Remediation Performance Report
Skykomish School
Skykomish, Washington
Farallon PN: 683-057

Date	GWM1	GWM2	GWM3	GWM4	GWM5	GWM6	GWM7	GWM8	GWM9	GWM10	GWM11	GWM12	GWM13	GWM14	GWM15	GWM16	GWM17	GWM18	GWM19	GWM20	GWM21	Average[1]
8/26/2016	915.4	915.1	915.3	915.3	915.3	915.7	917.1	915.5	914.9	915.2	916.1	915.4	916.4	916.7	915.5	916.5	914.6	916.7	915.5	915.6	915.9	915.7
8/27/2016	915.4	915.2	915.2	915.2	915.2	915.6	917.0	915.4	914.7	915.1	916.0	915.3	916.3	916.6	915.4	916.5	914.6	916.6	915.3	915.5	915.8	915.6
8/28/2016	915.4	915.3	915.3	915.3	915.3	915.5	916.9	915.7	915.0	915.4	916.2	915.5	916.5	916.8	915.6	916.7	914.8	916.8	915.5	915.7	916.0	915.8
8/29/2016	915.4	915.3	915.2	915.2	915.2	915.4	916.7	915.6	915.0	915.3	916.1	915.5	916.4	916.7	915.6	916.6	914.7	916.8	915.5	915.6	915.9	915.7
8/30/2016	915.4	915.3	915.1	915.1	915.1	915.3	916.6	915.6	914.9	915.2	916.0	915.4	916.3	916.7	915.6	916.5	914.7	916.7	915.5	915.6	915.9	915.6
8/31/2016	915.6	915.5	915.3	915.3	915.3	915.2	915.7	915.7	915.4	915.2	915.8	915.4	915.9	916.6	915.5	916.5	915.2	916.7	915.7	915.7	915.9	915.5
9/1/2016	915.6	915.5	915.3	915.3	915.3	915.2	916.2	915.8	915.4	915.3	915.7	915.5	915.8	916.6	915.7	916.5	915.2	916.7	915.8	915.8	915.9	915.6
9/2/2016	915.4	915.3	915.2	915.2	915.2	915.3	916.9	915.6	915.1	915.4	916.2	915.6	916.1	916.6	915.9	916.5	914.9	916.7	915.6	915.7	916.1	915.7
9/3/2016	915.4	915.5	915.4	915.4	915.4	915.4	917.0	915.9	915.3	915.7	916.4	915.9	916.4	916.8	916.2	916.7	915.3	916.9	915.8	915.9	916.3	916.0
9/4/2016	915.4	915.5	915.4	915.4	915.4	915.6	916.9	915.7	915.2	915.5	916.2	915.7	916.3	916.8	916.1	916.7	915.3	916.9	915.7	915.8	916.2	915.9
9/5/2016	915.4	915.4	915.4	915.4	915.4	915.6	916.9	915.7	915.1	915.4	916.1	915.6	916.2	916.8	916.0	916.7	915.1	916.9	915.6	915.7	916.1	915.8
9/6/2016	915.4	915.3	915.3	915.3	915.3	915.5	916.9	915.6	915.0	915.3	916.0	915.5	916.1	916.7	915.8	916.6	914.9	916.8	915.6	915.7	916.0	915.7
9/7/2016	915.4	915.3	915.3	915.3	915.3	915.5	916.7	915.8	915.2	915.4	916.1	915.6	916.2	916.9	915.9	916.7	915.0	916.9	915.7	915.8	916.1	915.8
9/8/2016	915.4	915.3	915.4	915.4	915.4	915.4	916.8	915.9	915.3	915.6	916.3	915.8	916.3	917.0	916.0	916.9	915.1	917.0	915.8	915.9	916.2	915.9
9/9/2016	915.4	915.3	915.4	915.4	915.4	915.4	916.8	916.0	915.4	915.6	916.3	915.8	916.4	917.0	916.0	916.9	915.1	917.1	915.9	916.0	916.3	915.9
9/10/2016	915.4	915.3	915.3	915.3	915.3	915.3	916.8	915.7	915.2	915.3	916.0	915.5	916.1	916.8	915.7	916.7	914.8	916.9	915.7	915.8	916.0	915.7
9/11/2016	915.4	915.3	915.3	915.3	915.3	915.3	916.8	915.7	915.2	915.3	916.0	915.5	916.0	916.8	915.7	916.7	914.9	916.9	915.7	915.8	916.0	915.7
9/12/2016	915.4	915.3	915.3	915.3	915.3	915.3	916.8	915.8	915.3	915.4	916.0	915.6	916.1	916.8	915.7	916.7	914.9	916.9	915.8	915.8	916.0	915.7
9/13/2016	915.4	915.3	915.2	915.2	915.2	915.2	916.5	915.7	915.2	915.2	915.8	915.4	915.9	916.6	915.5	916.5	914.8	916.8	915.7	915.7	915.9	915.6
9/14/2016	915.4	915.2	915.2	915.2	915.2	915.1	915.3	915.7	915.2	915.2	915.7	915.4	915.9	916.6	915.4	916.5	914.8	916.7	915.6	915.7	915.8	915.4
9/15/2016	915.4	915.2	915.2	915.2	915.2	915.0	915.1	915.8	915.3	915.3	915.8	915.5	915.9	916.7	915.3	916.6	914.9	916.8	915.7	915.8	915.9	915.4
9/16/2016	915.4	915.2	915.1	915.1	915.1	915.0	915.1	915.7	915.2	915.2	915.7	915.4	915.8	916.6	915.2	916.5	914.8	916.7	915.7	915.6	915.8	915.3
9/17/2016	915.7	915.4	915.2	915.2	915.2	915.0	915.5	915.8	915.4	915.5	916.2	915.6	916.2	916.6	915.7	916.4	915.0	916.6	915.7	915.7	916.1	915.6
9/18/2016	916.4	916.2	915.8	915.8	915.8	915.3	916.4	916.7	916.3	916.5	917.1	916.6	917.1	917.3	916.8	917.2	916.2	917.5	916.6	916.5	917.1	916.5
9/19/2016	916.6	916.5	916.1	916.1	916.1	915.7	916.5	916.9	916.6	916.2	916.8	916.4	916.9	917.6	916.7	917.3	916.5	917.5	916.8	916.7	916.9	916.6
9/20/2016	916.9	916.8	916.4	916.4	916.4	915.8	916.7	917.2	916.9	916.4	916.7	916.5	916.8	917.7	916.8	917.3	916.8	917.6	917.2	917.1	917.0	916.7
9/21/2016	916.6	916.5	916.2	916.2	916.2	915.9	916.6	916.8	916.6	916.1	916.6	916.2	916.7	917.6	916.7	917.2	916.4	917.4	916.9	916.8	916.7	916.5
9/22/2016	916.0	915.9	915.9	915.9	915.9	915.9	916.3	916.4	915.9	915.9	916.7	916.0	916.8	917.5	916.7	917.1	915.8	917.2	916.3	916.2	916.5	916.3
9/23/2016	915.8	915.6	915.8	915.8	915.8	915.8	916.1	916.2	915.8	915.8	916.6	915.9	916.7	917.5	916.6	917.1	915.6	917.2	916.1	916.1	916.4	916.2
9/24/2016	915.7	915.5	915.9	915.9	915.9	915.8	916.1	916.5	916.0	916.1	916.8	916.2	917.0	917.8	916.8	917.4	915.8	917.5	916.4	916.3	916.7	916.3
9/25/2016	915.7	915.4	915.8	915.8	915.8	915.7	916.0	916.4	916.0	916.0	916.8	916.2	917.0	917.8	916.7	917.4	915.7	917.5	916.4	916.4	916.7	916.3
9/26/2016	915.7	915.4	915.6	915.6	915.6	915.6	915.9	916.1	915.7	915.7	916.4	915.8	916.6	917.5	916.3	917.0	915.3	917.1	916.1	916.1	916.3	916.0
9/27/2016	915.6	915.3	915.6	915.6	915.6	915.5	915.8	916.1	915.7	915.7	916.3	915.8	916.5	917.5	916.3	917.1	915.2	917.1	916.0	916.1	916.3	915.9
9/28/2016	915.6	915.3	915.5	915.5	915.5	915.4	915.7	916.0	915.5	915.6	916.2	915.7	916.4	917.3	916.1	917.0	915.0	917.0	915.9	916.0	916.2	915.8
9/29/2016	915.5	915.3	915.4	915.4	915.4	915.3	915.6	915.9	915.5	915.5	916.1	915.6	916.3	917.3	916.0	916.9	914.9	917.0	915.9	915.9	916.1	915.7
9/30/2016	915.5	915.3	915.3	915.3	915.3	915.2	915.5	915.8	915.4	915.4	916.0	915.5	916.1	917.1	915.8	916.8	914.8	916.9	915.8	915.8	916.0	915.6
10/1/2016	915.4	915.3	915.2	915.2	915.2	915.2	915.5	915.8	915.3	915.3	915.9	915.5	916.0	917.1	915.8	916.8	914.7	916.9	915.8	915.8	915.9	915.5
10/2/2016	915.4	915.3	915.2	915.2	915.2	915.1	915.5	915.7	915.2	915.2	915.8	915.4	916.0	917.0	915.7	916.7	914.6	916.8	915.8	915.7	915.9	915.5
10/3/2016	915.4	915.3	915.1	915.1	915.1	915.1	915.5	915.6	915.1	915.1	915.7	915.3	915.9	916.9	915.7	916.6	914.7	916.7	915.7	915.6	915.8	915.4
10/4/2016	915.4	915.3	915.1	915.1	915.1	915.1	915.5	915.6	915.1	915.1	915.6	915.3	915.8	916.8	915.7	916.6	914.8	916.7	915.7	915.6	915.7	915.4
10/5/2016	915.4	915.3	915.1	915.1	915.1	915.1	915.5	915.7	915.2	915.2	915.7	915.4	915.9	916.8	915.8	916.6	914.8	916.7	915.7	915.7	915.8	915.5
10/6/2016	915.4	915.3	915.2	915.2	915.2	915.1	915.6	915.8	915.2	915.3	915.8	915.5	916.0	916.9	915.9	916.7	915.0	916.8	915.8	915.8	915.9	915.6
10/7/2016	915.6	915.4	915.3	915.3	915.3	915.1	915.8	916.0	915.5	915.7	916.3	915.9	916.4	916.9	916.3	916.7	915.3	916.9	915.9	915.9	916.3	915.8
10/8/2016	916.3	916.1	915.7	915.7	915.7	915.4	916.3	916.4	916.0	916.2	917.3	916.3	917.3	917.2	917.0	917.0	915.9	917.2	916.3	916.2	916.8	916.4
10/9/2016	917.8	917.6	916.8	916.8	916.8	916.0	917.7	917.9	917.5	917.5	918.1	917.7	918.2	918.4	918.2	918.2	917.4	918.5	917.8	917.7	918.1	917.6
10/10/2016	917.3	917.1	916.9	916.9	916.9	916.6	917.5	917.6	917.2	917.0	917.7	917.1	917.8	918.3	917.9	918.1	917.0	918.3	917.5	917.4	917.6	917.4
10/11/2016	916.8	916.7	916.8	916.8	916.8	916.7	917.0	917.3	916.9	916.8	917.5	917.0	917.6	918.4	917.7	917.9	916.7	918.1	917.2	917.1	917.5	917.2
10/12/2016	916.5	916.3	916.5	916.5	916.5	916.6	916.7	916.9	916.4	916.5	917.2	916.6	917.3	918.1	917.3	917.5	916.2	917.7	916.8	916.7	917.1	916.8
10/13/2016	916.7	916.6	916.3	916.3	916.3	916.4	916.8	916.5	916.1	916.2	917.0	916.3	917.0	917.6	916.9	917.0	916.0	917.2	916.4	916.3	916.8	916.6
10/14/2016	918.3	918.2	917.3	917.3	917.3	917.0	918.0	917.7	917.5	917.4	917.8	917.5	917.8	918.1	917.6	917.9	917.4	918.1	917.7	917.6	917.9	917.6
10/15/2016	919.0	918.9	918.2	918.2	918.2	918.2	918.9	918.5	918.2	917.6	918.0	917.7	918.0	918.6	918.2	918.5	918.1	918.9	918.5	918.4	918.3	918.3
10/16/2016	918.9	918.8	918.1	918.1	918.1	918.1	918.8	918.4	918.1	917.4	917.8	917.5	917.9	918.4	918.0	918.3	918.0	918.7	918.4	918.3	918.1	918.1
10/17/2016	918.6	918.4	918.0	918.0	918.0	917.9	918.5	918.4	918.1	917.5	918.1	917.6	918.2	918.5	918.2	918.3	917.9	918.7	918.3	918.3	918.1	918.2
10/18/2016	918.0	917.9	917.8	917.8	917.8	917.7	918.2	918.4	917.9	917.9	918.7	918.0	918.8	919.0	918.4	918.8	917.8	919.1	918.3	918.2	918.6	918.2
10/19/2016	917.8	917.7	917.8	917.8	917.8	917.6	918.0	918.4	918.0	918.1	918.9	918.3	919.0	919.1	918.5	918.9	917.8	919.3	918.3	918.2	918.8	918.3
10/20/2016	919.6	919.4	919.1	919.1	919.1	918.8	919.3	919.6	919.3	919.6	920.0	919.7	920.0	920.2	919.6	920.5	919.3	920.7	919.6	919.5	920.3	919.5
10/21/2016	920.3	920.2	919.9	919.9	919.9	919.7	920.3	920.4	920.2	919.2	920.1	919.2	920.2	920.4	920.2	920.7	919.9	921.2	920.5	920.4	920.0	920.1
10/22/2016	919.0	918.9	918.7	918.7	918.7	918.6	919.1	919.2	918.8	918.3	919.2	918.3	919.2	919.3	919.1	919.4	918.6	919.9	919.1	919.0	919.0	919.0
10/23/2016	918.1	918.0	917.8	917.8	917.8	917.8	918.3	918.3	917.9	917.7	918.6	917.8	918.6	918.8	918.3	918.7	917.6	919.1	918.2	918.1	918.4	918.2
10/24/2016	917.6	917.4	917.3	917.3	917.3	917.4	917.8	917.5	917.1	917.2	918.1	917.3	918.2	918.3	917.6	918.1	916.9	918.5	917.4	917.3	917.8	917.6
10/25/2016	917.3	917.1	917.2	917.2	917.2	917.3	917.5	917.6	917.1	917.3	918.3	917.4	918.3	918.4	917.6	918.3	917.0	918.5	917.5	917.4	918.0	917.6
10/26/2016	917.3	917.1	917.1	917.1	917.1	917.2	917.4	917.4	917.0	917.3	918.4	917.5	918.3	918.3	917.6	918.2	916.9	918.4	917.3	917.2	918.0	917.5
10/27/2016	917.9	917.7	917.5	917.5	917.5	917.5	918.0	918.0	917.6	917.9	918.6	918.0	918.7	918.7	918.1	918.6	917.4	919.0	917.9	917.8	918.5	918.0
10/28/2016	917.6	917.5	917.5	917.5	917.5	917.4	917.8	917.9	917.5	917.6	918.5	917.7	918.5	918.6	917.9	918.5	917.3	918.9	917.8	917.7	918.2	917.8
10/29/2016	917.3	917.2	917.2	917.2	917.2	917.3	917.5	917.6	917.1	917.4	918.3	917.5	918.4	918.4	917.6	918.2	917.0	918.5	917.5	917.4	918.0	917.6
10/30/2016	917.4	917.2	917.1	917.1	917.1	917.2	917.4	917.3	916.9	916.9	917.7	917.1	917.7	918.0	917.2	917.9	916.8	918.1	917.2	917.1	917.6	917.3

NOTES:

Values provided as daily average at each GWM.

Elevation is given in feet above mean sea level.

[1] Average based only on GWMs 6 ,7, 8, 9, 11, 13, 15, and 17.

GWM = groundwater monitoring well

Table 13
Summary Groundwater Temperatures
2016 Hot Water Flushing Remediation Performance Report
Skykomish School
Skykomish, Washington
Farallon PN: 683-057

Date	GWM1	GWM2	GWM3	GWM4	GWM5	GWM6	GWM7	GWM8	GWM9	GWM10	GWM11	GWM12	GWM13	GWM14	GWM15	GWM16	GWM17	GWM18	GWM19	GWM20	GWM21	Average[1]	Treatment Zone Average[2]
6/15/2016	49.0	49.2	53.7	53.7	53.7	55.0	54.0	52.5	52.1	48.7	52.1	49.0	52.7	50.2	50.9	48.2	50.4	52.3	52.1	52.3	50.6	51.8	53.8
6/16/2016	50.2	50.0	55.0	55.0	55.0	55.3	54.0	54.7	51.8	48.9	52.2	49.1	52.8	50.4	50.9	48.2	50.7	52.4	52.2	52.1	50.6	52.3	54.7
6/17/2016	56.2	53.7	57.8	57.8	57.8	57.2	54.3	58.4	51.3	48.9	52.3	49.3	53.8	50.4	50.9	48.0	51.1	52.5	52.2	52.0	50.6	53.9	56.7
6/18/2016	58.8	57.0	59.8	59.8	59.8	61.8	56.2	57.8	52.9	48.9	52.8	49.3	56.5	50.5	51.0	48.2	50.4	52.6	52.3	52.0	50.7	55.5	58.6
6/19/2016	58.3	58.0	61.1	61.1	61.1	63.8	57.9	58.5	54.7	48.9	52.7	49.3	57.0	50.5	51.3	48.4	50.5	52.3	52.4	52.3	50.7	56.3	60.0
6/20/2016	57.8	57.8	62.4	62.4	62.4	64.8	59.3	60.1	56.1	48.9	52.9	49.4	56.3	50.6	51.2	48.6	50.9	52.5	52.5	52.6	50.7	56.7	61.4
6/21/2016	58.7	62.0	64.0	64.0	64.0	67.8	61.5	60.1	53.3	49.1	53.6	49.5	57.6	50.7	51.2	48.4	55.6	52.5	52.6	52.4	50.6	58.1	63.1
6/22/2016	60.2	69.9	66.9	66.9	66.9	74.5	69.3	59.3	50.7	49.4	54.0	49.5	69.8	50.7	51.4	48.6	64.3	52.5	52.5	51.7	50.5	62.3	67.7
6/23/2016	65.0	63.3	69.5	69.5	69.5	81.0	80.0	58.0	52.8	49.5	54.7	49.7	74.0	50.7	51.2	48.6	64.9	52.7	52.5	51.5	50.5	64.5	73.0
6/24/2016	69.5	53.4	71.6	71.6	71.6	85.4	87.7	57.8	66.4	49.5	55.1	50.0	78.4	50.7	51.6	48.7	54.5	52.7	52.5	51.4	50.5	66.0	77.0
6/25/2016	67.4	55.5	73.0	73.0	73.0	88.0	93.2	58.0	61.1	49.5	55.6	50.9	79.4	50.7	52.1	48.9	52.8	52.7	52.5	51.5	50.6	66.3	79.7
6/26/2016	66.0	60.4	72.7	72.7	72.7	87.1	93.3	58.3	60.1	49.4	56.5	51.8	75.8	50.7	52.2	48.9	53.0	52.7	52.5	52.1	50.9	66.3	79.6
6/27/2016	66.4	57.8	73.0	73.0	73.0	86.3	93.0	59.7	63.7	49.5	57.2	51.7	72.3	50.7	52.2	48.9	53.0	52.8	52.7	52.6	50.9	66.2	79.7
6/28/2016	64.0	56.3	72.6	72.6	72.6	84.8	92.9	60.4	57.0	49.7	57.8	51.3	70.8	50.8	52.3	48.9	52.2	52.9	52.7	52.1	50.8	64.8	79.4
6/29/2016	62.3	60.0	70.9	70.9	70.9	81.4	90.8	60.4	57.6	49.5	58.5	51.1	70.3	50.9	52.6	48.9	52.5	52.9	52.8	52.4	51.1	64.6	77.5
6/30/2016	62.0	60.9	70.6	70.6	70.6	80.3	89.0	60.8	59.9	49.6	59.1	51.1	69.2	50.9	52.7	48.9	52.7	52.9	52.9	52.8	51.2	64.7	76.7
7/1/2016	61.0	61.0	70.6	70.6	70.6	80.0	87.6	61.2	61.3	49.6	59.5	51.0	68.4	50.9	52.9	48.9	52.8	52.9	53.0	53.0	51.3	64.6	76.3
7/2/2016	61.0	60.7	70.6	70.6	70.6	79.7	86.3	61.4	62.2	49.6	59.8	50.9	67.7	51.0	53.0	48.9	52.9	53.0	53.1	53.2	51.3	64.5	75.8
7/3/2016	60.1	60.0	70.3	70.3	70.3	79.0	85.2	61.7	62.6	49.6	60.0	50.9	67.2	51.1	53.1	48.9	52.9	53.1	53.1	53.3	51.4	64.2	75.3
7/4/2016	60.0	60.0	70.4	70.4	70.4	79.0	84.3	61.9	62.8	49.6	60.1	50.8	66.7	51.1	53.2	48.9	52.9	53.1	53.2	53.4	51.4	64.1	75.0
7/5/2016	60.0	60.0	70.5	70.5	70.5	79.0	83.4	62.0	63.0	49.7	60.2	50.7	66.4	51.2	53.3	48.9	52.9	53.2	53.2	53.5	51.4	64.0	74.8
7/6/2016	59.9	60.0	70.1	70.1	70.1	78.1	82.6	62.2	63.0	49.8	60.3	50.7	66.1	51.3	53.4	49.0	52.9	53.2	53.3	53.6	51.6	63.8	74.3
7/7/2016	59.2	60.0	70.1	70.1	70.1	78.0	81.8	62.3	63.0	49.8	60.3	50.7	65.8	51.3	53.6	49.1	52.9	53.3	53.4	53.8	51.6	63.7	74.0
7/8/2016	59.0	60.0	70.2	70.2	70.2	78.0	81.0	62.4	63.0	49.8	60.2	50.7	65.6	51.4	53.7	49.1	52.9	53.4	53.4	53.9	51.7	63.6	73.8
7/9/2016	59.0	60.0	70.2	70.2	70.2	78.0	80.3	62.4	59.6	49.8	60.2	50.7	65.7	51.5	53.8	49.2	53.0	53.4	53.6	54.0	51.8	63.2	73.6
7/10/2016	59.0	60.0	70.0	70.0	70.0	77.4	80.0	62.6	60.9	49.8	60.1	50.6	65.4	51.6	53.9	49.3	53.1	53.5	53.7	54.1	51.8	63.2	73.3
7/11/2016	60.6	55.6	70.0	70.0	70.0	77.0	79.1	63.1	63.2	49.9	60.1	50.7	64.8	51.7	53.8	49.4	52.8	53.6	53.8	54.2	51.7	63.0	73.1
7/12/2016	60.6	51.5	68.6	68.6	68.6	73.7	75.8	63.5	63.8	50.2	60.6	50.7	65.1	51.8	53.6	49.5	52.0	53.7	53.8	53.1	51.5	62.0	71.0
7/13/2016	69.0	52.6	66.1	66.1	66.1	67.7	71.4	64.4	57.4	50.5	60.8	50.8	66.6	51.8	53.8	49.5	52.2	53.8	53.9	52.7	51.6	61.6	67.8
7/14/2016	88.7	63.2	68.8	68.8	68.8	73.6	75.8	63.9	55.5	50.8	61.2	51.1	69.6	51.8	54.2	49.5	52.6	53.8	54.0	52.5	51.6	65.8	71.1
7/15/2016	88.2	111.9	76.6	76.6	76.6	87.9	84.8	65.4	53.7	51.2	61.6	51.5	72.8	51.8	54.7	49.6	53.3	53.9	54.1	52.5	51.7	73.4	79.4
7/16/2016	98.5	131.0	85.7	85.7	85.7	90.0	93.6	81.4	53.7	51.8	61.6	51.8	76.2	52.0	55.4	49.6	54.3	54.0	54.1	52.5	51.8	79.6	88.3
7/17/2016	102.1	130.6	81.1	81.1	81.1	84.7	100.0	77.5	53.8	52.6	61.6	52.2	79.7	52.0	56.4	49.6	55.3	54.0	54.1	52.5	51.8	80.2	87.4
7/18/2016	67.1	98.4	79.9	79.9	79.9	82.3	103.2	77.5	54.1	52.5	62.1	52.5	82.2	52.0	57.8	49.7	55.9	54.0	54.1	52.7	51.9	74.1	87.7
7/19/2016	86.7	123.2	88.0	88.0	88.0	88.0	105.6	ND	53.9	53.8	62.4	52.7	81.5	52.0	58.2	49.8	57.1	54.0	54.1	52.7	51.8	79.6	96.8
7/20/2016	95.4	121.3	93.4	93.4	93.4	93.4	108.2	ND	54.9	54.8	63.3	52.9	87.2	52.0	59.3	49.8	59.3	54.0	54.1	52.7	51.8	82.5	100.8
7/21/2016	78.5	95.8	93.4	93.4	93.4	93.4	108.1	ND	61.6	54.1	64.6	53.3	90.0	52.0	60.7	49.8	61.6	54.1	54.3	53.1	52.0	79.4	100.7
7/22/2016	97.4	108.8	98.5	98.5	98.5	98.5	111.2	ND	72.7	55.6	65.5	53.4	88.4	52.0	61.4	50.0	68.7	54.1	54.3	53.1	52.0	85.8	104.9
7/23/2016	95.5	121.0	105.7	105.7	105.7	105.7	116.5	ND	56.6	56.1	66.7	53.6	93.1	52.2	63.0	50.0	65.8	54.1	54.3	52.9	52.0	87.1	111.1
7/24/2016	97.5	120.3	109.6	109.6	109.6	109.6	119.7	ND	57.4	56.6	67.9	53.9	96.7	52.2	64.8	50.0	62.0	54.1	54.4	52.9	52.1	88.5	114.7
7/25/2016	79.3	105.8	110.2	110.2	110.2	110.2	121.0	ND	57.6	56.8	69.3	54.2	100.1	52.2	66.7	50.2	64.8	54.2	54.5	53.0	52.2	86.1	115.6
7/26/2016	72.0	99.5	102.0	102.0	102.0	102.0	116.0	ND	60.5	55.7	70.6	54.3	99.8	52.3	68.3	50.2	76.2	54.3	54.5	53.4	52.3	85.0	109.0
7/27/2016	80.9	97.3	94.4	94.4	94.4	94.4	106.0	ND	57.2	56.6	70.9	54.2	99.2	52.3	69.4	50.3	76.8	54.3	54.5	53.2	52.3	83.6	100.2
7/28/2016	93.4	116.3	96.4	96.4	96.4	96.4	104.0	ND	59.9	57.2	71.6	54.2	101.9	52.5	70.5	50.4	78.7	54.3	54.6	53.1	52.3	88.1	100.2
7/29/2016	107.2	120.9	110.7	110.7	110.7	110.7	109.3	ND	60.9	58.2	72.1	54.4	103.1	52.5	71.9	50.5	74.4	54.3	54.7	53.3	52.3	92.3	110.0
7/30/2016	94.6	115.4	117.3	117.3	117.3	117.3	116.0	ND	61.9	58.8	72.9	54.6	103.9	52.7	73.5	50.7	77.2	54.4	54.7	53.4	52.3	92.5	116.6
7/31/2016	90.0	104.7	106.4	106.4	106.4	106.4	113.3	ND	59.5	59.3	73.6	54.7	103.8	52.7	75.0	50.8	75.6	54.5	54.7	53.6	52.5	89.1	109.9
8/1/2016	110.6	124.3	107.3	107.3	107.3	107.3	110.9	ND	62.5	60.0	74.3	54.9	104.9	52.9	76.3	50.9	70.2	54.5	54.9	53.7	52.5	93.5	109.1
8/2/2016	111.8	127.8	122.0	122.0	122.0	122.0	117.8	ND	62.5	61.1	74.9	55.0	104.7	53.0	77.5	51.1	69.8	54.6	54.9	53.8	52.7	96.5	119.9
8/3/2016	98.5	117.0	126.9	126.9	126.9	126.9	123.8	ND	62.2	62.0	75.9	55.1	100.6	53.1	78.6	51.2	77.4	54.7	54.9	53.4	52.7	95.7	125.4
8/4/2016	97.5	109.8	118.9	118.9	118.9	118.9	124.0	ND	62.7	61.8	77.3	55.3	98.0	53.3	79.4	51.3	80.4	54.7	55.0	53.5	52.9	94.2	121.4
8/5/2016	91.8	110.0	113.7	113.7	113.7	113.7	120.1	ND	66.0	61.7	78.5	55.4	96.6	53.4	79.9	51.4	77.8	54.8	55.1	53.7	53.0	92.7	116.9
8/6/2016	105.1	115.6	113.0	113.0	113.0	113.0	116.8	ND	67.9	61.8	79.4	55.5	95.8	53.6	80.2	51.6	74.6	54.9	55.2	54.1	53.1	94.3	114.9
8/7/2016	103.1	127.3	123.8	123.8	123.8	123.8	121.5	ND	69.7	62.1	80.3	55.6	95.8	53.8	80.5	51.7	73.1	54.9	55.3	54.2	53.3	97.2	122.6
8/8/2016	92.3	129.4	126.5	126.5	126.5	126.5	126.7	ND	68.0	62.3	81.1	55.6	97.0	53.9	80.7	51.8	74.4	55.0	55.4	53.9	53.5	97.3	126.6
8/9/2016	85.2	116.8	122.8	122.8	122.8	120.8	126.7	124.9	63.6	61.2	81.6	55.3	97.8	54.0	80.8	52.1	75.9	55.0	55.5	54.0	53.3	97.4	124.1

Table 13
Summary Groundwater Temperatures
2016 Hot Water Flushing Remediation Performance Report
Skykomish School
Skykomish, Washington
Farallon PN: 683-057

Date	GWM1	GWM2	GWM3	GWM4	GWM5	GWM6	GWM7	GWM8	GWM9	GWM10	GWM11	GWM12	GWM13	GWM14	GWM15	GWM16	GWM17	GWM18	GWM19	GWM20	GWM21	Average[1]	Treatment Zone Average[2]
8/10/2016	92.5	108.7	110.9	110.9	110.9	107.5	114.3	114.4	61.8	62.7	82.5	55.6	97.2	54.2	81.1	52.3	77.1	55.1	55.6	54.8	53.4	93.7	112.0
8/11/2016	82.6	117.3	113.4	113.4	113.4	110.6	113.0	116.2	66.5	63.4	83.4	55.6	96.2	54.3	81.4	52.4	83.2	55.2	55.6	54.8	53.4	95.0	113.3
8/12/2016	80.9	118.9	119.0	119.0	119.0	115.4	116.3	122.7	77.1	64.2	83.8	55.6	95.4	54.5	81.9	52.5	82.0	55.2	55.6	55.6	53.5	97.5	118.1
8/13/2016	77.4	118.7	123.3	123.3	123.3	120.3	118.3	126.3	68.3	64.3	84.6	55.7	95.1	54.6	82.7	52.7	81.1	55.3	55.6	55.0	53.6	97.3	121.6
8/14/2016	76.2	114.0	119.1	119.1	119.1	117.1	119.0	121.2	70.7	64.7	85.3	55.7	94.9	54.7	83.7	52.8	80.8	55.4	55.7	54.7	53.8	96.3	119.1
8/15/2016	75.3	111.3	115.5	115.5	115.5	112.9	117.8	118.0	71.9	65.2	85.7	55.8	94.4	54.8	84.7	52.9	80.5	55.4	55.8	55.1	53.9	95.2	116.2
8/16/2016	72.5	109.3	113.1	113.1	113.1	110.7	116.0	115.6	73.2	65.8	86.1	55.8	93.8	54.9	85.7	53.1	80.2	55.4	55.9	55.6	54.0	94.3	114.1
8/17/2016	68.6	110.1	114.4	114.4	114.4	111.0	114.6	117.7	75.4	66.3	86.5	55.9	93.3	55.0	86.6	53.2	79.9	55.4	55.8	55.8	54.1	94.4	114.4
8/18/2016	66.2	106.3	113.9	113.9	113.9	112.1	112.4	115.6	76.6	66.0	86.9	55.9	92.8	55.0	87.4	53.3	80.0	55.4	55.8	55.9	54.2	93.6	113.4
8/19/2016	67.3	99.1	110.1	110.1	110.1	108.7	106.1	111.5	73.5	65.9	87.1	55.8	95.2	55.0	88.2	53.5	82.9	55.4	55.8	55.8	54.3	91.9	108.8
8/20/2016	75.7	97.8	107.8	107.8	107.8	106.4	104.2	109.2	68.5	65.0	87.4	55.8	97.2	55.2	88.7	53.7	85.1	55.4	55.9	55.0	54.4	92.0	106.6
8/21/2016	75.1	94.9	106.4	106.4	106.4	105.0	103.4	107.9	72.1	64.1	87.6	55.7	95.6	55.2	89.0	53.8	84.3	55.4	56.0	55.8	54.7	91.5	105.4
8/22/2016	68.3	91.6	104.8	104.8	104.8	102.8	99.4	106.8	74.9	63.3	87.4	55.6	99.5	55.4	88.8	54.0	82.7	55.6	56.1	55.8	54.7	90.2	103.0
8/23/2016	70.5	90.2	103.0	103.0	103.0	100.5	94.9	105.5	70.8	62.7	87.3	55.6	101.4	55.4	88.6	54.2	80.6	55.6	56.1	55.4	54.8	89.0	100.3
8/24/2016	77.0	89.3	101.2	101.2	101.2	97.8	91.5	104.5	68.2	63.1	87.2	55.5	100.5	55.5	88.9	54.4	79.5	55.6	56.1	55.2	54.9	88.5	98.0
8/25/2016	79.9	89.4	99.6	99.6	99.6	95.4	89.7	103.8	71.6	64.1	87.0	55.4	98.8	55.6	89.2	54.6	78.5	55.6	56.1	55.2	55.0	88.3	96.3
8/26/2016	79.5	91.3	98.7	98.7	98.7	94.0	88.9	103.3	79.0	65.2	86.7	55.4	95.4	55.7	89.6	54.8	77.7	55.6	56.1	55.4	55.0	88.5	95.4
8/27/2016	78.0	92.2	98.4	98.4	98.4	94.0	87.9	102.8	79.9	66.0	86.6	55.4	92.5	55.8	89.8	55.0	77.4	55.7	56.2	55.4	55.0	88.1	94.9
8/28/2016	78.4	91.7	98.1	98.1	98.1	94.0	87.0	102.3	77.8	66.9	86.5	55.4	90.5	55.9	89.7	55.1	77.1	55.8	56.3	55.4	55.1	87.5	94.4
8/29/2016	78.0	90.6	97.9	97.9	97.9	94.0	86.1	101.7	76.6	67.3	86.4	55.5	89.0	55.9	89.5	55.3	76.8	55.8	56.3	55.4	55.2	86.9	93.9
8/30/2016	78.0	90.0	97.6	97.6	97.6	94.0	86.0	101.1	73.8	67.4	86.2	55.6	87.8	56.1	89.1	55.4	76.5	55.8	56.3	55.4	55.3	86.3	93.7
8/31/2016	74.7	89.3	97.5	97.5	97.5	94.5	86.0	100.5	69.1	68.0	85.9	55.6	87.5	56.1	88.8	55.6	77.1	55.8	56.3	55.4	55.4	85.3	93.7
9/1/2016	74.4	88.1	97.5	97.5	97.5	95.0	86.8	100.0	69.3	67.5	85.6	55.5	86.6	56.2	88.6	55.7	78.0	55.9	56.5	55.8	55.4	85.2	93.9
9/2/2016	73.0	88.2	96.7	96.7	96.7	94.0	86.1	99.5	66.2	65.2	84.9	55.2	87.2	56.3	88.1	55.9	77.4	55.9	56.5	55.8	55.0	84.5	93.2
9/3/2016	64.0	85.6	96.2	96.2	96.2	93.5	84.5	98.9	58.3	60.3	84.3	54.7	88.0	56.4	87.6	56.0	79.4	55.9	56.5	55.6	54.2	82.4	92.3
9/4/2016	68.1	84.1	95.5	95.5	95.5	92.9	83.3	98.2	61.3	59.6	84.0	55.3	88.2	56.6	87.2	56.2	80.8	55.9	56.7	55.8	54.1	82.8	91.5
9/5/2016	71.0	83.5	94.8	94.8	94.8	92.0	82.5	97.5	67.4	63.3	83.8	55.4	88.3	56.7	87.0	56.3	79.2	56.0	56.7	55.7	54.3	83.2	90.7
9/6/2016	72.0	83.0	94.3	94.3	94.3	91.7	82.0	97.0	63.8	65.5	83.7	55.2	88.3	56.7	86.7	56.3	77.5	56.1	56.7	55.6	54.7	82.6	90.2
9/7/2016	72.0	83.0	93.7	93.7	93.7	91.0	81.8	96.5	61.9	66.2	83.4	55.2	88.2	56.8	86.4	56.3	76.4	56.1	56.7	55.6	54.9	82.1	89.7
9/8/2016	72.0	82.9	93.5	93.5	93.5	91.0	81.0	96.0	63.7	66.5	83.2	55.0	87.9	56.8	86.1	56.3	75.7	56.1	56.7	55.6	54.9	81.9	89.3
9/9/2016	72.0	82.0	93.3	93.3	93.3	91.0	81.0	95.5	61.8	66.9	83.0	55.0	87.5	56.8	85.7	56.5	75.0	56.1	56.7	55.6	54.9	81.5	89.2
9/10/2016	72.9	81.1	92.6	92.6	92.6	90.2	80.8	95.1	62.1	67.0	82.7	55.2	87.1	56.8	85.3	56.5	74.3	56.1	56.7	55.8	55.2	81.2	88.7
9/11/2016	73.0	81.0	92.3	92.3	92.3	90.0	80.0	94.6	65.7	67.1	82.5	55.2	86.7	56.8	84.9	56.5	73.7	56.1	56.7	55.8	55.2	81.2	88.2
9/12/2016	73.0	80.5	92.1	92.1	92.1	90.0	80.0	94.2	67.7	67.3	82.3	55.2	86.4	56.8	84.5	56.5	73.1	56.1	56.7	55.8	55.3	81.2	88.1
9/13/2016	73.0	79.9	91.6	91.6	91.6	89.3	80.0	93.8	68.4	67.1	82.0	55.2	86.0	56.8	84.0	56.5	72.5	56.1	56.7	55.8	55.4	80.9	87.7
9/14/2016	73.5	81.1	91.5	91.5	91.5	89.5	80.1	93.4	67.9	67.1	81.7	55.2	85.8	56.8	83.6	56.5	72.0	55.9	56.7	55.8	55.4	80.9	87.7
9/15/2016	73.0	81.1	91.5	91.5	91.5	90.0	81.0	93.0	66.9	67.1	81.4	55.2	85.6	56.8	83.1	56.5	71.5	55.9	56.7	55.8	55.2	80.7	88.0
9/16/2016	73.3	81.0	91.0	91.0	91.0	89.5	81.4	92.5	68.2	67.0	81.1	55.2	85.0	56.8	82.7	56.5	71.0	55.9	56.7	55.8	55.2	80.6	87.8
9/17/2016	65.5	80.0	90.6	90.6	90.6	89.0	82.0	92.1	64.8	64.8	80.6	54.9	84.0	56.9	82.6	56.7	71.5	55.9	56.7	55.6	55.0	79.2	87.7
9/18/2016	64.1	78.5	90.4	90.4	90.4	89.0	82.0	91.7	62.6	57.9	79.6	54.0	81.3	57.3	81.9	56.8	76.3	55.5	56.6	54.9	53.5	78.7	87.6
9/19/2016	65.0	79.1	89.9	89.9	89.9	88.5	82.0	91.3	61.4	57.4	78.8	55.5	80.1	57.6	81.4	56.8	77.1	55.7	56.5	55.0	53.1	78.5	87.3
9/20/2016	66.6	79.4	89.4	89.4	89.4	88.0	82.0	90.8	61.8	54.9	78.6	55.6	79.6	57.6	81.2	56.5	75.0	55.7	56.5	55.5	53.1	78.3	86.9
9/21/2016	68.6	79.0	89.2	89.2	89.2	88.0	82.0	90.4	63.7	54.9	78.3	55.8	79.4	57.7	81.0	56.2	73.7	55.8	56.6	56.0	53.1	78.4	86.8
9/22/2016	62.2	78.3	89.0	89.0	89.0	88.0	82.0	90.1	62.0	55.5	77.5	55.7	79.9	57.7	80.6	55.9	74.8	55.9	56.5	55.6	53.1	77.5	86.7
9/23/2016	58.9	79.0	88.4	88.4	88.4	87.2	82.0	89.7	62.2	55.1	77.2	55.7	80.1	57.7	80.3	55.6	75.5	56.0	56.3	55.1	53.5	77.2	86.3
9/24/2016	57.0	79.0	88.1	88.1	88.1	87.0	82.0	89.2	61.9	55.3	76.9	55.4	79.9	57.7	80.0	55.4	75.9	55.9	56.3	54.9	53.8	76.9	86.1
9/25/2016	58.4	79.5	87.9	87.9	87.9	87.0	82.0	88.8	61.2	56.9	76.6	55.2	79.6	57.7	79.7	55.2	75.7	55.9	56.3	54.9	54.1	76.8	85.9
9/26/2016	61.8	79.8	87.6	87.6	87.6	87.0	82.0	88.3	61.5	58.9	76.4	55.2	79.2	57.7	79.4	55.1	74.9	55.9	56.3	55.2	54.1	77.0	85.8
9/27/2016	62.1	79.8	86.9	86.9	86.9	86.1	82.0	87.8	62.4	60.3	76.1	55.2	78.9	57.7	79.0	55.0	74.0	55.9	56.3	55.5	54.1	76.8	85.3
9/28/2016	63.8	79.4	86.7	86.7	86.7	86.0	82.0	87.3	63.2	61.2	75.8	55.2	78.5	57.6	78.6	54.9	72.9	55.8	56.3	55.5	54.2	76.8	85.1
9/29/2016	68.5	79.0	86.4	86.4	86.4	86.0	82.0	86.9	64.4	62.0	75.5	55.0	78.2	57.5	78.2	54.8	72.0	55.8	56.3	55.4	54.3	77.1	85.0
9/30/2016	71.3	79.0	85.8	85.8	85.8	85.2	82.0	86.4	65.5	62.7	75.3	55.0	77.9	57.4	77.8	54.7	71.2	55.7	56.1	55.2	54.3	77.2	84.5
10/1/2016	70.0	78.9	85.5	85.5	85.5	85.0	82.0	86.0	66.2	63.1	75.0	55.0	77.6	57.2	77.4	54.7	70.7	55.6	56.1	55.2	54.3	76.9	84.3
10/2/2016	70.7	78.0	85.3	85.3	85.3	85.0	82.0	85.6	67.4	63.3	74.8	54.9	77.4	57.2	77.0	54.7	70.2	55.6	56.1	55.0	54.3	76.8	84.2
10/3/2016	70.5	78.0	84.6	84.6	84.6	84.0	82.0	85.3	68.5	63.3	74.6	54.9	77.0	57.0	76.7	54.7	70.0	55.6	56.1	55.0	54.4	76.7	83.8
10/4/2016	71.9	78.0	84.4	84.4	84.4	84.0	82.0	84.9	68.1	63.3	74.4	54.8	76.7	57.0	76.4	54.7	69.8	55.6	56.1	55.0	54.5	76.6	83.6
10/5/2016	76.4	77.9	84.3	84.3	84.3	84.0	82.0	84.5	68.2	63.3	74.2	54.7	76.2	56.8	76.1	54.7	69.5	55.4	56.1	55.0	54.4	76.9	83.5

Table 13
Summary Groundwater Temperatures
2016 Hot Water Flushing Remediation Performance Report
Skykomish School
Skykomish, Washington
Farallon PN: 683-057

Date	GWM1	GWM2	GWM3	GWM4	GWM5	GWM6	GWM7	GWM8	GWM9	GWM10	GWM11	GWM12	GWM13	GWM14	GWM15	GWM16	GWM17	GWM18	GWM19	GWM20	GWM21	Average[1]	Treatment Zone Average[2]
10/6/2016	77.1	77.4	83.7	83.7	83.7	83.2	81.9	84.2	66.9	63.2	74.0	54.5	75.8	56.8	75.8	54.7	69.3	55.4	56.1	55.0	54.3	76.6	83.1
10/7/2016	69.2	76.3	83.4	83.4	83.4	83.0	81.0	83.9	61.9	61.1	73.8	54.0	75.2	56.7	75.6	54.7	69.2	55.3	56.1	54.8	53.8	74.9	82.6
10/8/2016	54.0	72.8	83.2	83.2	83.2	82.9	81.0	83.5	59.8	57.4	71.4	53.9	73.9	56.9	75.4	54.9	69.9	55.2	55.9	54.3	53.0	72.5	82.5
10/9/2016	57.6	71.8	82.6	82.6	82.6	82.0	81.0	83.1	59.9	54.9	67.5	55.0	71.6	57.3	75.2	54.7	68.2	54.6	56.1	54.3	52.8	71.8	82.0
10/10/2016	59.5	72.9	82.4	82.4	82.4	82.0	81.0	82.8	58.9	54.8	69.4	55.8	71.8	57.2	75.3	53.4	68.6	54.6	55.9	54.4	52.6	72.2	81.9
10/11/2016	58.8	73.7	82.2	82.2	82.2	82.0	80.1	82.4	60.0	55.0	69.8	55.9	72.3	57.2	74.8	53.5	69.2	54.9	55.6	54.3	52.6	72.3	81.5
10/12/2016	58.0	74.0	81.6	81.6	81.6	81.0	80.0	82.1	60.8	55.5	69.5	55.8	72.6	57.2	74.1	53.5	69.8	55.1	55.3	54.2	52.9	72.2	81.0
10/13/2016	54.5	72.7	81.4	81.4	81.4	81.0	80.0	81.7	59.4	55.6	68.5	55.6	72.2	57.2	73.6	53.3	70.0	55.4	55.2	54.0	52.9	71.4	80.9
10/14/2016	53.8	70.4	81.0	81.0	81.0	80.8	79.6	81.3	56.1	53.4	64.7	55.5	69.3	57.2	72.7	52.8	68.1	55.0	55.3	54.1	52.8	69.7	80.5
10/15/2016	54.5	69.7	80.3	80.3	80.3	80.0	79.0	80.6	55.1	52.0	64.2	55.9	69.4	56.9	71.9	52.9	66.9	54.4	55.4	54.5	53.0	69.1	79.9
10/16/2016	57.6	69.3	80.1	80.1	80.1	80.0	79.0	80.2	54.6	51.2	64.8	55.5	69.0	56.7	71.3	53.1	66.4	54.1	55.4	55.0	53.1	69.2	79.7
10/17/2016	58.3	69.0	79.9	79.9	79.9	80.0	79.0	79.8	54.1	51.5	62.9	54.9	68.3	56.6	70.9	53.1	66.1	54.3	55.4	55.3	53.1	68.8	79.6
10/18/2016	55.6	70.3	79.6	79.6	79.6	79.7	79.0	79.6	56.3	52.0	61.5	55.3	67.2	56.4	71.4	53.1	66.9	54.5	55.3	54.6	52.9	68.7	79.4
10/19/2016	56.0	71.0	79.2	79.2	79.2	79.1	79.0	79.3	59.8	51.8	61.4	55.4	67.2	56.3	71.4	53.0	68.4	54.5	55.1	54.1	52.7	69.3	79.1
10/20/2016	52.0	67.3	79.0	79.0	79.0	79.0	78.4	78.9	58.7	51.3	57.8	54.8	65.1	56.3	70.2	52.5	68.5	54.1	54.9	53.8	52.5	67.6	78.8
10/21/2016	53.0	67.3	78.1	78.1	78.1	78.2	78.0	78.0	57.9	51.1	57.3	54.8	66.1	56.1	68.4	53.3	65.3	53.5	54.7	53.8	52.8	67.0	78.1
10/22/2016	53.8	68.5	78.0	78.0	78.0	78.0	78.0	78.0	56.7	51.5	59.8	55.5	65.9	55.9	68.6	53.7	65.2	53.5	54.4	53.8	52.9	67.3	78.0
10/23/2016	54.0	69.5	77.9	77.9	77.9	78.0	78.0	77.8	58.6	51.6	61.1	55.6	65.6	55.8	69.2	53.8	66.0	54.1	54.2	53.5	52.8	67.8	77.9
10/24/2016	55.0	70.3	77.8	77.8	77.8	78.0	77.8	77.6	60.2	51.9	62.3	55.1	65.5	55.6	69.3	53.4	67.7	54.3	54.0	53.1	52.6	68.4	77.8
10/25/2016	55.3	71.0	77.6	77.6	77.6	77.8	77.0	77.5	60.9	52.2	63.1	54.7	65.3	55.4	69.2	53.0	69.4	54.0	53.9	52.9	52.5	68.6	77.4
10/26/2016	53.7	70.4	77.1	77.1	77.1	77.0	77.0	77.2	60.3	52.6	62.1	54.8	64.8	55.2	68.8	52.9	70.5	53.9	53.8	52.8	52.3	68.2	77.1
10/27/2016	54.1	69.6	76.8	76.8	76.8	77.0	77.0	76.7	59.4	52.0	61.0	55.3	64.3	55.0	68.4	53.0	70.7	53.6	53.6	52.7	52.2	67.8	76.9
10/28/2016	54.2	70.1	76.1	76.1	76.1	76.1	76.8	76.1	58.4	51.8	61.5	55.4	65.0	54.7	68.0	53.1	70.7	53.5	53.6	52.7	52.2	67.7	76.4
10/29/2016	54.5	71.0	75.9	75.9	75.9	76.0	76.0	75.8	57.5	52.1	62.6	54.8	65.1	54.5	67.8	52.8	70.9	53.4	53.4	52.6	52.2	67.7	75.9
10/30/2016	54.7	71.0	75.4	75.4	75.4	75.4	76.0	75.4	57.0	52.2	63.6	54.5	65.0	54.3	67.5	52.9	70.9	53.4	53.3	52.5	52.2	67.7	75.6

NOTES:

Values provided as daily average at each GWM.

Temperature provided in Fahrenheit.

[1] Average based only on GWMs 1,2,6,7,8,9,11,13,15, and 17.

[2] Average treatment zone temperature based on submerged wells located inside targeted treatment zone, GWM 6,7, and 8.

GWM = groundwater monitoring well

ND = no data

Table 14
Hot Water Flushing System Flow Data
2016 Hot Water Flushing Remediation Performance Report
Skykomish School
Skykomish, Washington
Farallon PN: 683-057

Date[1]	Week No.	Total Weekly Flow (gallons)	Average Daily Flow (gallons per minute)	Pore Volumes Treated[2]	Cumulative Pore Volumes Treated
6/15/2016	0	0	0	0	0
6/22/2016	1	199,738	20	0.6	0.6
6/29/2016	2	246,408	24	0.8	1.4
7/6/2016	3	437	0	0.0	1.4
7/13/2016	4	374,858	37	1.2	2.6
7/20/2016	5	490,651	49	1.6	4.2
7/27/2016	6	473,287	47	1.5	5.8
8/4/2016	7	540,135	54	1.7	7.5
8/10/2016	8	511,242	51	1.6	9.2
8/17/2016	9	398,312	40	1.3	10.4
8/24/2016	10	364,554	36	1.2	11.6
8/31/2016	11	317,409	31	1.0	12.6
9/7/2016	12	253,906	25	0.8	13.5
9/14/2016	13	236,736	23	0.8	14.2
9/21/2016	14	135,999	13	0.4	14.7
9/28/2016	15	200,924	20	0.6	15.3
10/5/2016	16	180,522	18	0.6	15.9
10/12/2016	17	201,968	20	0.7	16.5
10/19/2016	18	146,518	15	0.5	17.0
10/26/2016	19	254,095	29	0.8	17.8

NOTES:

[1] The hot water flushing system was not in operation from June 25 through July 10, 2016 due to biofouling of the granular activated carbon filters.

[2] A pore volume has been defined as the volume of water in the saturated portion of the aquifer that contains contamination above allowable levels. At the School Site a pore volume consists of the footprint of the School building and approximately 20 feet adjacent to all sides of the building, with an average thickness spanning 5.5 feet from 917 ft msl (average groundwater elevation) to 911.5 ft msl (elevation of deepest contamination). See calculation below.

30,000 ft^2 * (917 ft msl - 911.5 ft msl) * .025 porosity * 7.48 gallons/ ft^3 = 310,000 gallons

Table 15
Groundwater Analytical Results for Phosphorus
2016 Hot Water Flushing Remediation Performance Report
Skykomish School
Skykomish, Washington
Farallon PN: 683-057

Sample Location	Sample Date	Sample Identification	Analytical Results (milligrams per liter)[1]
			Phosphorus
RW-1	9/15/2016	RW-1_091516	< 0.25
RW-4	10/12/2016	RW4-101216	< 0.25

NOTES:

< denotes analyte not detected at or exceeding the reporting limit listed.

[1] Analyzed by U.S. Environmental Protection Agency Method 365.1.

APPENDIX A
RESPONSE TO COMMENTS

2016 HOT WATER FLUSHING REMEDIATION
PERFORMANCE REPORT
Skykomish School
BNSF Former Maintenance and Fueling Facility
Skykomish, Washington

Farallon PN: 683-057

RESPONSE TO COMMENTS
2016 HWF REMEDIATION PERFORMANCE REPORT
FARALLON PN: 683-057

Draft 2016 HWF Remediation Performance Report	Ecology Comment	BNSF Response
Draft- Issued for Ecology Review dated February 23, 2017 **Table of Contents, page iii**	Add final version of Response to Comments matrix as an appendix to the final report and revise Table of Content accordingly.	Added Appendix A, Response to Comments. Table of Contents revised. Section 1.0, second paragraph, has been revised as follows: ***The Draft 2016 Hot Water Flushing Remediation Performance Report submitted to Ecology on February 23, 2017 has been revised to reflect the April 21, 2017 comments provided by Ecology and the meeting between Ecology, BNSF, and Farallon at Farallon's office on May 8, 2017. The comments received and the responses to the comments are presented in Appendix A, Response to Comments.***
Executive Summary page vi	Revise to address the following: Make clear the 2011 Design Report contains Design Quality Objectives (DQO) that serve to identify the specific design objectives in terms of performance requirements. DQOs are used to guide the design process by identifying the relevant system requirements to ensure that all elements of the design are addressed (see 2011 Design Report Section 3.2 and Table 1). Identify the two Performance Design Requirements that were not achieved in 2016. Specifically, Groundwater Recirculation and NAPL Recover did not maintain 50 GPM flow throughput during the low groundwater period of late summer; and Subsurface Heating did not achieve target maximum 140º F average temperature in target treatment zone. It is technically possible to achieve both of these Performance Design Requirements. For example, one could; 1) Optimize the boiler to achieve 140ºF at the target treatment zone, increase the duration of hot water injection, and maintain the treatment zone temperature at 140ºF. 2) Redevelop the recovery wells to remove the geochemical and biological fouling known to be	Executive Summary paragraph two has been revised as follows: *During 2016, HWF performance data were collected for School building temperatures, indoor air quality, noise, odor, heat removal by soil vapor extraction, mass removal by liquid-phase carbon treatment, NAPL recovery, groundwater elevations and temperatures, system flow rates, and operation and maintenance daily narrative logs.* ***Capacities for HWF system performance that were identified in the Hot Water Flushing Design Report dated June 6, 2011 (2011 Design Report) as design quality objectives for equipment design were verified during HWF system startup, including the ability of the system to attain heated groundwater injection temperatures of 160ºF at a groundwater flow rate of 50 gallons per minute. A measured approach was taken to groundwater heating during the 2016 HWF operations, in order to gradually assess operating optimization and secondary factors such as the effects on the temperature of the school floor. School floor temperatures were within expected ranges, and the observed increase in average groundwater temperature in the treatment zone was consistent with design expectations for the heat input applied, with an average temperature in the mid-120's degrees Fahrenheit after 63 days of heating. Based on the operational data obtained in 2016, higher flow rates and a greater level of heating will be applied during 2017 in order to attain the maximum NAPL recovery possible. Additionally, an early-start HWF schedule was proposed, consisting of weekends-only injection of heated groundwater during May 2017. The early-start schedule would ultimately result in an extended duration of HWF treatment, and potentially further NAPL recovery. The proposed early start was not approved by the Skykomish School Board.*** *The 2016 NAPL recovery trends demonstrated a strong correlation that enhanced recoverability of NAPL is achieved through groundwater heating.* ~~***Operational and monitoring data collected during 2016 demonstrated that the soil vapor extraction system is effective at reducing heat transfer to the School building, and recovery vapor phase petroleum.***~~

Draft 2016 HWF Remediation Performance Report	Ecology Comment	BNSF Response
This report also presents key performance metrics established to evaluate progress toward the primary treatment objective, defined as reducing the amount of petroleum nonaqueous-phase liquid (NAPL) from the subsurface at the School Site to the extent technically possible. *The decline curve analysis relies on data extrapolation using NAPL recovery rates that are expected to occur sometime during sustained maximum groundwater temperatures.* *Determining when the cleanup objective has been achieved will depend on the analysis of at least one of the lines of evidence from the data obtained from future HWF system operations*	present within the well screens to maximize flow into the wells. Revise appropriate sections in this report to make recommendations for achieving these Performance Design Requirements in 2017, and include statement in the Executive Summary that says this report contains recommendations for meeting these Performance Design Requirements in 2017. Revise italicized text to include the following from 2015 CMP Addendum No. 3: During summer HWF operations, overall system performance will be monitored by measurement of NAPL recovery (see Section 4.2.1 Scope of Work). NAPL recovery will be used to measure compliance with CAP treatment requirements. Specifically, the objective of treatment is to reduce the amount of petroleum beneath the School to the extent technically possible, with the treatment goal of removing separate-phase mobile or volatile liquid petroleum components or NAPL (see Section 4.2.3 Data Evaluation and Response). Revise italicized text to use existing data (no extrapolation) to evaluate decline curve analysis. The timeframe to achieve asymptotic removal cannot be accurately predicted.	Executive Summary paragraph one has been revised as follows: ~~**This report also presents key performance metrics established to evaluate progress toward the primary treatment objective, defined as reducing the amount of petroleum nonaqueous-phase liquid (NAPL) from the subsurface at the School Site to the extent technically possible.**~~ ***During summer HWF operations, overall system performance will be monitored by the measurement of NAPL recovery. NAPL recovery will be used to measure compliance with Cleanup Action Plan (CAP) treatment requirements. Specifically, the objective of treatment is to reduce the amount of petroleum beneath the School to the extent technically possible, with the treatment goal of removing separate-phase mobile or volatile liquid petroleum components or NAPL.*** Executive Summary paragraph three has been revised as follows: *Multiple lines of evidence are recommended as performance metrics to evaluate* ***future*** *progress toward meeting the primary treatment objective. Potential performance metrics include pore volumes analysis, and a recovery and/or decline curve analysis of NAPL recovery volume. These analyses account for groundwater temperature and groundwater gradient effects on maximum NAPL recovery. The decline curve analysis* ***will involve analysis of future*** ~~***relies on data extrapolation using***~~ ***NAPL*** *recovery rates that are expected to occur sometime during sustained maximum groundwater temperatures.* ***Evaluation of asymptotically declining NAPL recovery rates, in the future, can be done by extrapolating then-current data into the future to assess if NAPL recovery trends indicate that additional NAPL recovery would be significant.*** ~~***An early start up schedule is recommended for 2017 to achieve the maximum NAPL recovery rate by reaching higher maximum groundwater temperatures sooner, and by increasing the duration of groundwater heating***~~. *Determining when the cleanup objective has been achieved* ***will be determined in conjunction with the Washington State Department of Ecology, and will*** *depend on the analysis of* ~~***at least one***~~ ***multiple*** *lines of evidence from the data obtained from future HWF system operations.*

Draft 2016 HWF Remediation Performance Report	Ecology Comment	BNSF Response
	Determining when the HWF system can be shut down will require an observational approach and evaluation of existing data. Replace italicized text with: Determining when the cleanup objective has been achieved will be based on coordination with the Department of Ecology (Ecology) and will depend on the analysis of all lines of evidence from data obtained after the HWF system has been optimized and satisfies the DQO requirements. Note: The system must first be optimized and shown to be operating as designed before it can be evaluated for final shut-down.	
Section 1.2, Design Quality Objectives, page 1-3		

RESPONSE TO COMMENTS
2016 HWF REMEDIATION PERFORMANCE REPORT
FARALLON PN: 683-057

Draft 2016 HWF Remediation Performance Report	Ecology Comment	BNSF Response
Section 1.2 Design Quality Objectives, page 1-3 *Attainment of the design quality objectives by the HWF system and related subsystems was verified through monitoring of various operational data, and comparing these data to the design requirements defined in Table 1.*	Delete italicized text. Monitoring data verified DQO Performance Design Requirements were not achieved for Groundwater Recirculation and Subsurface Heating. Revise section to make clear DQOs serve to identify the specific design objectives in terms of performance requirements and are used to guide the design process by identifying the relevant system requirements to ensure that all elements of the design are addressed (see 2011 HWF Design Report, Section 3.2 and Table 1). Revise section to identify the two Performance Design Requirements that were not achieved in 2016. Specifically, Groundwater Recirculation and NAPL Recover did not maintain 50 GPM flow throughput during the low groundwater period of late summer; and Subsurface Heating did not achieve target maximum 140º F average temperature in target treatment zone. Revise appropriate sections in this report to make recommendations for achieving these Performance Design Requirements in 2017. The 2011 Design does not have DQOs for treatment time/duration for the target maximum 140ºF average temperature in target treatment zone. Please revise test with proposed treatment time/duration and supporting rational/data. These revisions do not adequately address Ecology's comments. Specifically, the DQO/Performance Design Requirement for Subsurface Heating must be called out, identified as a key performance requirement, and made clear that the target maximum 140°F average temperature in the target treatment zone was not achieved in 2016, and the system will be optimized in 2017.	Section 1.2 has been modified as follows to include Ecology comments from June 27, 2017: *Design quality objectives developed to establish criteria for system and subsystem functionality, reliability, performance, safety/security, and operations monitoring were presented in the 2011 Design Report (Table 1).* ***Design quality objectives presented in the 2011 Design Report do not represent specific field operational settings, but rather identify capabilities of the individual HWF subsystems to meet overall design objectives.*** *The design quality objectives were established to ensure adequate design criteria and system capabilities to achieve overall treatment goals, and to identify critical engineering and equipment specifications. Design quality objectives* ***(DQOs)*** *were reviewed to provide a framework to assess the effectiveness of current operations, and were used to develop remediation metrics for the evaluation of system performance and progress toward treatment goals.* ***A HWF system equipment performance DQO was established in the 2011 Design Report for the maximum groundwater temperature that might be encountered, for the purpose of ensuring the compatibility and safety of groundwater pumps and other materials in contact with heated groundwater. The DQO established for the maximum groundwater temperature was 140 degrees Fahrenheit (°F), which operationally represents a maximum value that might be attained for a brief time during the period of maximum groundwater heating effects.*** ***A measured approach was taken to groundwater heating during the 2016 HWF operations, to assess operating optimization and secondary factors such as the effects on the temperature of the School floor. An average groundwater temperature in the treatment zone in the mid-120s °F was attained after 63 days of heating. Operations during 2017 will be conducted at maximum feasible groundwater injection rates and temperatures, which is anticipated to result in higher groundwater temperatures than in 2016.*** ***Attainment of the equipment DQOs by the HWF system and related subsystems was verified through monitoring of various operational data, and comparing these data to the design requirements defined in Table 1. DQOs that represent key operational system capacities include the groundwater recirculation flow rate capacity (50 gpm maximum) and the groundwater injection temperature capacity (160ºF maximum). These system capacities were verified during HWF system startup on June 16 and 17, 2016, including the measurement of system capacities as follows:*** - ***6/16/2016: 159ºF injection temperature at a groundwater flow rate of 47 gpm, with boiler inlet temperature of 58ºF (temperature rise of 101ºF at 47 gpm)*** - ***6/16/2016: 150ºF injection temperature at a groundwater flow rate of 60 gpm, with boiler inlet temperature of 58ºF (temperature rise of 90ºF at 60 gpm)*** - ***6/17/2016: boiler inlet temperatures of 66ºF resulted in injection capability of 160ºF at 60 gpm, exceeding DQO requirements for system capacity.*** ~~***Design quality objectives presented in the 2011 Design Report do not represent specific specific field operations settings, but rather identify capabilities of the individual HWF subsystems to meet overall design objectives. Attainment of the design quality objectives by the HWF system and related subsystems was verified through monitoring of various operational data, and comparing these data to the design requirements in Table 1.***~~

RESPONSE TO COMMENTS
2016 HWF REMEDIATION PERFORMANCE REPORT
FARALLON PN: 683-057

Draft 2016 HWF Remediation Performance Report	Ecology Comment	BNSF Response
Section 2.1 Flushing System Operational Modes, page 2-1		
In HWF mode, water is heated prior to injection to approximately 140 degrees Fahrenheit (°F) or higher using a diesel-powered boiler.	2011 Design is based on injecting water at 160ºF and achieving a groundwater temperature of 140ºF (see Sections 5.2 & 5.3). Section 5.5 NAPL Recovery – of this document uses 160ºF for modeling/predicting results for 2017 and states 160ºF is consistent with 2016 operations. Revise text accordingly.	No revisions made to this section of text. Revisions made to Section 1.2 regarding attainment of DQO's.
	Expand section to provide details on 2016 boiler performance. Include how many days the system delivered injection water at 160ºF.	The following text has been added to Section 2.2.2: ***As described in Section 1.2, HWF system capacities were verified during the initial three days of operation. During the 63 day long HWF period groundwater was injected at between 140°F and 160°F for 38 days. During these 38 days the average injection temperatures was 144°F. Weekly average injection temperatures are shown in Figure 4. The weekly average injection temperatures dropped to below 140°F in late July and August due to frequent boiler shutdowns. These frequent shutdowns were due to a combination of low system flowrates and higher groundwater extraction temperatures, which caused the boiler to operate at the low end of its turndown capacity.***
	Add new figure (graph) to show injection temperature vs. time.	

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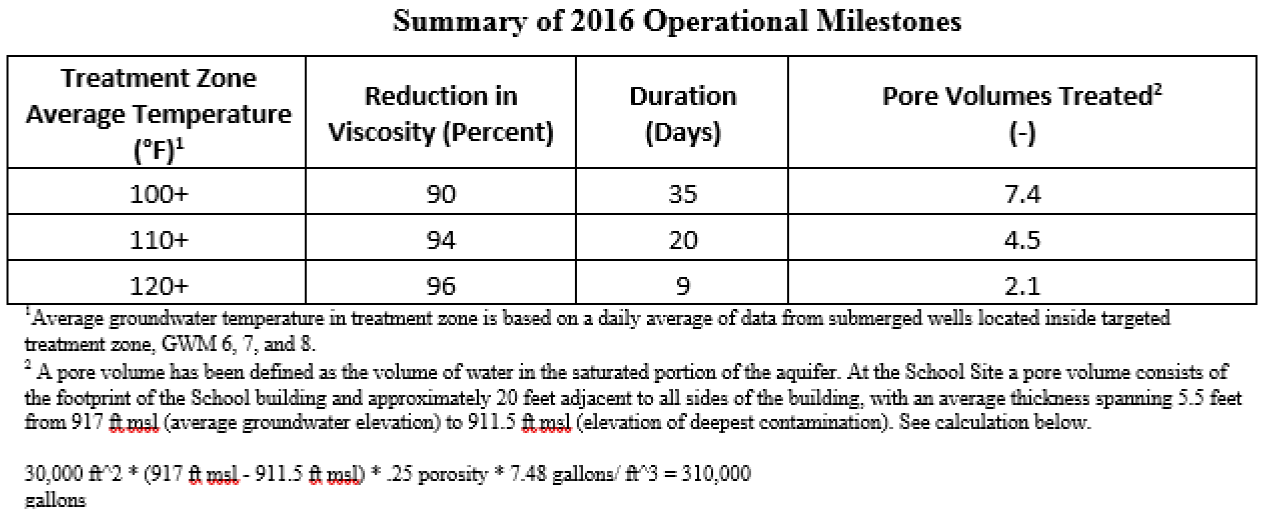
<table>
<tr><th>Draft 2016 HWF Remediation Performance Report</th><th>Ecology Comment</th><th>BNSF Response</th></tr>
<tr>
<td>Section 3.8 Groundwater Elevations and Temperatures, page 3-7</td>
<td>Revise section to explain the HWF system maintained treatment zone average groundwater temperatures at 120ºF or above for about 7 days.</td>
<td>The following text and embedded table has been adding to section 3.8:

<i>During 2016 HWF operations average groundwater temperature in the treatment zone were sustained above 100°F for 35 days and above 120 °F for 9 days. The treatment zone average groundwater temperatures, durations, and pore volumes treated during each period are summarized in the table below:</i>


Summary of 2016 Operational Milestones
<table>
<tr><th>Treatment Zone Average Temperature (°F)[1]</th><th>Reduction in Viscosity (Percent)</th><th>Duration (Days)</th><th>Pore Volumes Treated[2] (-)</th></tr>
<tr><td>100+</td><td>90</td><td>35</td><td>7.4</td></tr>
<tr><td>110+</td><td>94</td><td>20</td><td>4.5</td></tr>
<tr><td>120+</td><td>96</td><td>9</td><td>2.1</td></tr>
</table>
[1] Average groundwater temperature in treatment zone is based on a daily average of data from submerged wells located inside targeted treatment zone, GWM 6, 7, and 8.
[2] A pore volume has been defined as the volume of water in the saturated portion of the aquifer. At the School Site a pore volume consists of the footprint of the School building and approximately 20 feet adjacent to all sides of the building, with an average thickness spanning 5.5 feet from 917 ft msl (average groundwater elevation) to 911.5 ft msl (elevation of deepest contamination). See calculation below.

30,000 ft^2 * (917 ft msl - 911.5 ft msl) * .25 porosity * 7.48 gallons/ ft^3 = 310,000 gallons</td>
</tr>
</table>

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Section 5.1 Hydraulic Performance, page 5-1 & 5-2 *HWF system generally was operated at flow rates of 20 to 60 gallons per minute (gpm), which is generally consistent with the expected design range of 30 to 50 gpm (Farallon 2011). A summary of average daily flow rates is provided in Table 14, and shown on Figure 6.*	Replace 20 to 60 gallons with 13 to 54 gallons. Revise italicized text to explain the HWF system operated below 30 gpm for more than half the time (12 out of 20 weeks) in 2016 with a 28 gpm average.	Section 5.1 paragraph 1, revised as follows: The HWF system generally was operated at flow rates of 13 20 to 60 gallons per minute (gpm). During HWF activities the system operated at an average flow rate of 36 gpm (10 week duration), which is generally considered within the expected design range of 30 to 50 gpm (Farallon 2011). During AWF activities, coincident with lower groundwater elevations the system operated at an average flow rate of 23 gpm (10 week duration). A summary of average daily flow rates is provided in Table 14 and shown on Figure 6. Flow rate values provided are weekly averages and at times actual flowrates may have been slightly higher or lower than values shown.
During the latter portion of the summer dry season, decreasing water levels made it difficult to operate several recovery wells at the design flow rate. During the lowest groundwater elevation periods, the flow rate was reduced to 20 gpm, and was shifted primarily to wells in the area of the recovery trench where most of the NAPL was present. This action reduced the risk of damaging the pumps or shutting down the system when pumps would run dry.	Replace 20 gpm with 13 gpm. The highlighted revision has not been made. Revise italicized text to explain the HWF system did not meet the Performance Design Requirement for Groundwater Recirculation and NAPL Recovery of 50 gpm flow throughput. Revise appropriate section(s) of this report with recommendations to achieve DQO Performance Design Requirement of 50 gpm.	Section 5.1 paragraph 4, revised as follows to address Ecology highlighted June 27, 2017 revision: During the week of September 21, 2016, coincident with the low groundwater elevation period, the flow rate was reduced to 2013 gpm, and was shifted primarily to wells in the area of the recovery trench where most of the NAPL was present. No revisions made to this section of text. Revisions made to Section 1.2 regarding attainment of DQO's.

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Section 5.2 Groundwater Heating Performance, page 5-3 *Groundwater temperatures beneath the School building eventually reached temperatures ranging from 90 to 125ºF from July 15, 2016 through discontinuation of heating on August 17, 2016, representing an approximately 50 to 75º increase over ambient conditions.*	Revise italicized text to explain that in 2016, the HWF system maintained treatment zone average groundwater temperatures above 120ºF for about 7 days and did not meet the Performance Design Requirement of 140ºF target maximum average temperature in the target treatment zone. Revise appropriate sections to include recommendations for achieving Performance Design Requirement of 140ºF in 2017. Revise this section to make clear the DQO/Performance Design Requirement for Subsurface Heating was not achieved in 2016 and the system will be optimized in 2017.	No revisions made to this section of text. Revisions made to section 1.2 regarding attainment of DQO's. The following revisions were made to Section 5.2, paragraph four, in response to Ecology's June 27, 2017 comments: *The numerical model results provide a reasonable approximation of the actual measured average groundwater temperatures during the 2016 operating season.* ***The discontinuous heating and conservative injection water heat management that occurred during 2016 HWF operations limited maximum groundwater temperatures attained.*** *Application of the model to predict* **potential** *average groundwater temperatures over the recommended 2017 HWF* ***season***, ~~*operational schedule is*~~ ***inclusive of recommended earlier start, continuous operations, maximized groundwater injection rates, and increased injection water temperatures, indicates higher average groundwater temperatures will be attained in 2017. This is further*** *discussed in Section 5.5, NAPL Recovery.*

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Section 5.3 Geochemical and Biological Fouling, page 5-5 *The video footage, photographs, and localized drawdown behavior suggest that a combination of geochemical and biological fouling is present within the well screens and in the soil surrounding the recovery wells. The combination of low groundwater levels, biofouling, and geochemical fouling resulted in difficulty balancing the recovery well pumping rates.*	The down-hole camera assessment indicates geochemical and biological fouling is already present (since last year) and justifies the need to redevelop the extraction wells. Typo – report has incorrect date of April 3, 2016 Another purpose of cleaning the recovery wells is to maximize the well recharge rates. Please add the following to the text: Section 4.2.2 of O & M Plan states "To maximize well recharge rates, extraction wells will be cleaned and/or redeveloped as needed annually to remove buildup of scale and biological growth. Table 1 of O&M Plan states "Extraction wells need to be redeveloped annually to remove buildup of scale or biological growth. This will prevent pump damage caused by low recharge rate. Flow rates were reduced to 13 gpm during the low groundwater period late summer. The combination of low groundwater levels, biofouling, and geochemical fouling resulted in difficulty balancing the recover well pumping rates. The extraction wells need to be redeveloped in order to maximize the recharge rates (50 gpm). Please revise this section and table in Section 7.2 to include annual redevelopment of the extraction wells.	Text added to Section 5.3 paragraph five as follows to include Ecology's June 27, 2017 comments: During the week of April 3, 2017~~6~~ coincident with School spring break and prior to resuming HWF system operations in 2017 Farallon performed well cleaning using a combination of physical and chemical methods. The purpose of cleaning the recovery wells was to reduce or eliminate the risk of system shut-downs due to clogged well screens and to maximize well recharge rates. The recovery well cleaning included shock dosing wells using a solid phase granular acid and in accordance with the Nu-Well 110 Granular Acid and Nu-Well 310 Bioacid Dispersant Application guides. Immediately following the chemical dosing the acid was agitated in the well and the well was scrubbed using a rigid well brush. The well was surged using a well surge block. Following 24 hours of contact time the wells were purged of the acid using a vacuum truck. The following row has been added to table in Section 7.2: April 1, 2017; Recovery Well Cleaning; Scheduled Coincident with School Spring Break. Recovery wells were physically and chemically cleaned as described in Section 5.3.

5.5 NAPL Recovery, page 5-7 & 5-8	Delete “(approximately 250 centistokes or less, or temperatures of greater than approximately 100º Fahrenheit)”. Not necessary to place limits on removal rates.	The following text has been deleted from paragraph five, Section 5.5: ***Maximum removal rates will be achieved by maintaining minimum NAPL viscosity ~~(approximately 250 centistokes or less, or temperatures of greater than approximately 100° Fahrenheit)~~ for as long as possible.***
It is inconclusive whether the maximum achievable NAPL recovery rate was reached in 2016 because the maximum recovery rate occurred during the last week of August after heating had been discontinued.	Delete “(approximately 250 centistokes or less, or temperatures of greater than approximately 100º Fahrenheit)”. Revise italicized text to explain that the maximum achievable NAPL recovery rate will be evaluated after the system has been optimized and satisfies the DQO requirements. Note: The groundwater temperature and duration in the treatment zone, along with the extraction flow rates need to be increased and will influence the maximum achievable NAPL recovery rate. Evaluating whether or not cleanup objectives have been met cannot occur until the system is operating as designed.	The following text has been added to paragraph six, Section 5.5: ***The 100°F criteria is a reasonable metric to assess the overall duration of HWF enhancement of NAPL recovery, as this is the temperature at which a 90 percent reduction in NAPL viscosity is achieved. However, 100°F is not a performance metric for HWF system performance, and heating will be continued to attain the maximum average groundwater temperatures that are possible during HWF operations. The modeling of 2017 groundwater heating represents a tapering of heat addition to keep average groundwater temperatures below 135°F, so that the maximum design rating of 140°F is not exceeded at any particular location.*** No revisions made to this section of text regarding DQOs. Revisions made to Section 1.2 regarding attainment of DQO’s. Text and a table summarizing groundwater temperatures in the treatment zone and durations have been added to Section 3.8.
The 2017 model prediction is based on a maximum groundwater injection temperature of 160ºF, consistent with 2016 operations and within the design limitations of the system.	How many days of heating at 160ºF does the 2017 model use?	The following revisions have been made to paragraph six, Section 5.5:
The recommended 2017 operating plan would essentially triple the 2016 operation period during which temperatures increase to above 100°F from approximately 1 month to approximately 3 months.	Revise italicized text to present number of days during which temperatures increase to above 120ºF (not 100ºF).	*The HWF thermal numerical model described in Section 5.2, Groundwater Heating Performance, was used to predict the approximate groundwater temperatures expected to be accomplished during 2017* ***with an optimized HWF operational plan****.* ***Because the model was calibrated to actual 2016 results, the predicted temperature trends for 2017 determined from the model are expected to be a reasonably accurate approximation. Two operational scenarios for 2017 are presented (Figure 16), (a) the recommended scenario for an early start to HWF operations where groundwater heating would be applied for approximately 36 hours each weekend from May 7 to June 14, 2017, and (b) the Skykomish School Board approved scenario without an early start to groundwater heating. In each scenario,*** ~~*In addition*~~ ***2 weeks over the summer period were simulated without heat addition, to account for operational maintenance and/or possible downtime.*** ~~*If a longer treatment season could be implemented (Figure 16). Because the model was calibrated to actual 2016 results, the predicted temperature trends for 2017 determined from the model are expected to be a reasonably accurate approximation.*~~ *The 2017 model prediction****s are also*** ~~*is*~~ *also based on* ~~*a maximum*~~ *maintaining groundwater injection temperature****s between 155°F and the design maximum*** *of 160°F,* ***which is greater than the injection temperatures applied during*** *2016 operations* ***that were in the range of 145°F for much of the summer, while effects on school floor temperatures were evaluated.*** ~~and within the design limitations of the system equipment. The model assumes that groundwater heating would be applied for approximately 36 hours each weekend from May 7 to June 14,~~

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Higher groundwater temperatures than those realized during 2016 operations may be obtained by extending the HWF season, although the additional reduction in viscosity at temperatures higher than approximately 120ºF are negligible. *The longer operating duration at elevated temperatures is expected to maximize NAPL removal and recovery, and provide a better basis for evaluating system performance and determining whether cleanup objectives have been met.*	Delete text: "although the additional reduction in viscosity at temperatures higher than approximately 120ºF are negligible". This contradicts DQO Performance Design Requirement of 140ºF. Section 5.1 of 2011 Design Report states "A 100-fold reduction in NAPL viscosity is attained at a temperature of approximately 140ºF. Diminishing gains are attained at temperatures above 140ºF." Replace "maximize" with "increase". Replace "whether" with "when". Replace "have been" with "are".	~~2017. In addition, 2 weeks over the summer period were simulated without heat addition, to account for operational maintenance and/ or possible downtime.~~ The following revisions were made to paragraph seven, Section 5.5: *Weekend-only heating operations in May 2017 ~~would~~* ***will*** *provide a carefully measured application of heat and a running start to warming the ground formation without impacting School activities. Higher groundwater temperatures than those realized during 2016 operations may be obtained by extending the HWF season. ~~although the additional reduction in viscosity at temperatures higher than approximately 120°F are negligible.~~ The longer operating duration at elevated temperatures is expected to ~~maximize~~* ***increase*** *NAPL removal and recovery, and provide a better basis for evaluating system performance and determining* ***when*** *~~whether~~ cleanup objectives ~~have been~~* ***are*** *met.* ***While the 2017 scenario without an early start (Figure 16) has a smaller duration of elevated temperatures, it will still result in greater average groundwater temperatures than in 2016, since greater injection temperature will be applied in June 2017, at the inception of HWF, than were applied in June 2016.***

Section 6.0 Hot Water Flushing Performance Metrics, page 6-1 *As stated in the CAP:* *“Operation of the treatment system will be completed based on coordination with Ecology”*	Delete italicized text. This comes from the O&M Plan, Section 7.2 Completion of Operations and Closure. Insert the entire text: The primary cleanup objective associated with the design of the HWF treatment system is to reduce the amount of petroleum beneath the School to the extent technically possible, with the goal of removing separate-phase mobile or volatile petroleum constituents or NAPL. Operation of the treatment system will be complete based on coordination with Ecology.	The following revisions were made to Section 6.0, paragraph one: ~~*As stated in the CAP:*~~ ~~*“Operation of the treatment system will be completed based on coordination with Ecology”.*~~ ***As stated in the O&M Plan:*** ***“The primary cleanup objective associated with the design of the HWF treatment system is to reduce the amount of petroleum beneath the School to the extent technically possible, with the goal of removing separate-phase mobile or volatile petroleum constituents or NAPL. Operation of the treatment system will be complete based on coordination with Ecology.”***
This section outlines the goals and metrics that will be used to evaluate progress toward completion of HWF based on the goal of removal of NAPL to “the extent technically possible”.	Revise italicized text to include the following text from 2015 CMP Addendum No. 3: Section 4.2.1 Scope of Work During summer HWF operations, overall system performance will be monitored by measurement of NAPL recovery. Section 4.2.3 Data Evaluation and Response NAPL recovery will be used to measure compliance with CAP treatment requirements. Specifically, the objective of treatment is to reduce the amount of petroleum beneath the School to the extent technically possible, with the treatment goal of removing separate-phase mobile or volatile liquid petroleum components or NAPL.	The following text has been added to Section 6.0, paragraph two: *This section outlines the goals and metrics that will be used to evaluate progress toward completion of HWF based on the goal of removal of NAPL to “the extent technically possible”.* ***During summer HWF operations, overall system performance will be monitored by measurement of NAPL recovery which will be evaluated to determine compliance with the primary cleanup objective.***
The Site-specific declining NAPL recovery rates will be evaluated consistent with ITRC (2009) guidance, along with the lines of evidence, any one of which can be used to determine that cleanup objectives have been met.	The highlighted revision has not been made. Replace “any one” with “all”. Replace “can” with “will”. Delete “average” ITRC guidance (Evaluating LNAPL Remedial Technologies for Achieving Project Goals, Dec. 2009) does not include specific details for evaluating a thermal (HWF) system that cycles on and off. Recovery volume curves need to be	The following revisions have been made to Section 6.0, paragraph three in response to Ecology’s suggested revisions dated June 27, 2017: *The Site-specific declining NAPL recovery rates will be evaluated consistent with ITRC (2009) guidance, along with evaluation of the following multiple lines of evidence to determine that cleanup objectives have been met:~~.~~* The following text has been made to Section 6.1.1., paragraph one to include Ecology’s June 27, 2017 comments: ***Because ITRC guidance does not include specific details for evaluating a thermal (HWF) system that cycles on and off, the decline curve analysis will be evaluated in context of groundwater temperatures in the treatment zone****.*

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The lines of evidence include:	evaluated as a function of temperature (max. average temp. in treatment zone) and time. Please revise text accordingly. Also revise text to make clear BNSF will continue to operate HWF System and terminating operations will be based on coordination with Ecology. Add or revise bullets to make clear: Graphs of NAPL cumulative recovery volume needs to be evaluated with respect to time when the HWF system is operating at the target maximum 140ºF average temperature in target treatment zone. Revise bullet to make clear the graphs of NAPL cumulative recovery volumes will be evaluated with respect to time and groundwater temperature in the treatment zone. The number of pore volume exchanges of groundwater during hot water flushing needs to track pore volumes when the system is operating at the target maximum 140ºF average temperature in the target treatment zone. Revise bullet to make clear the number of pore volume exchanges need to be evaluated with respect to time and groundwater temperature in the treatment zone. Revise Section 6.2 as necessary	See revisions were made to Section 6.0, paragraph one above. Revisions made to Section 1.2 regarding attainment of DQO's. Text and a table summarizing groundwater temperatures in the treatment zone and durations have been added to Section 3.8. The following revisions were made to Section 6.0 bullet points, in response to Ecology's June 27, 2017 comments: • Graphs of NAPL cumulative recovery volume with respect to time **and groundwater temperature in the treatment zone** to assess progress toward asymptotic NAPL recovery rates, which are an indicator of technical impracticability of further NAPL recovery (ITRC 2009). • The number of pore volume exchanges of groundwater during HWF with **respect to** ~~which along with duration~~ **time and groundwater temperature in the treatment zone** may be a relevant alternative metric for plotting and evaluating declining NAPL recovery rates (Davis 1995; O'Carroll and Sleep 2007).

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Section 6.1 Regulatory and Stakeholder Goals, page 6-1 & 6-2	Revise section to explain the CAP objectives of the treatment are to reduce the amount of petroleum beneath the school to the extent technically possible, with the goal of removing separate phase mobile or volatile liquid petroleum components or nonaqueous phase liquid (NAPL). Delete bullets – those are compliance monitoring requirements.	CAP reference is stated in revision to Section 6.0 paragraph one. The following text has been deleted from Section 6.1. The table of contents has been updated accordingly. ~~*In addition to the primary treatment objective of reducing the amount of petroleum beneath the School building to the extent technically possible, the CAP outlines treatment goals associated with exposure pathways. Regulatory goals provided in the CAP include the following monitoring for closure metrics:*~~ ~~• *Vapor monitoring in the School building to measure air quality, comparing the results against the Site's air cleanup level for APH of 1,346 micrograms per cubic meter. Vapor monitoring performed prior to HWF operations and during 2016 HWF operations indicates that the School building basement meets Site air cleanup levels (Table 6).*~~ ~~• *Quarterly monitoring of down-gradient wells for the presence of NAPL to monitor NAPL migration following treatment operations. If NAPL is present, BNSF would take action to remove it, and to stop NAPL migration toward the Skykomish River. Compliance wells in the levee would be monitored to ensure that the NWTPH-Dx cleanup level of 208 micrograms per liter and the requirement of absence of sheen or free product are met at and down-gradient of the levee.*~~

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Section 6.2.1 NAPL Recovery Rate Decline Curve Analysis, page 6-2	Revise section to acknowledge ITRC guidance document does not contain specific details for evaluating a thermal (HWF) system that cycles on and off or the site specific criteria of removing petroleum beneath the school to the extent technically possible. Revise section to use existing data (no extrapolation) for decline curve analysis. Timeframe to achieve asymptotic removal cannot be accurately predicted. Number of hot water pore flushes needed to reach asymptote response for NAPL removal cannot be accurately predicted. Determining when the HWF system will be shut down will require an observational approach and evaluation of existing data (not extrapolated).	See revisions to Section 5.5, paragraph six, and Section 6.2, paragraph one.
	Revise section to include evaluation of recovery volume curves as a function of temperature (max. average temp. in treatment zone) and time.	Text and a table summarizing groundwater temperatures in the treatment zone and durations have been added to Section 3.8.

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Section 6.2.2 Subsurface Pore Volume Exchanges, page 6-3 *As shown on Figure 6, approximately 18 pore volume exchanges were achieved during 2016.*	Revise section to acknowledge number of pore flushes needed to reach asymptote response for NAPL cannot be accurately predicted and "pore volumes" are based on hot water flushing (at target maximum average temperature in treatment zone). Revise italicized text to explain 18 pore volumes represents total duration of operations and majority of this time was not at treatment zone maximum temperatures achieved in 2016. Also provide number of pore volumes exchanged when system was at or above 120 °F for comparison (about 3 pore volumes?) Also revise Figure 6 to show pore volumes removed when treatment zone temperature was at 120 °F or above.	Agree that NAPL recovery needs to be considered in context of groundwater temperature and duration at elevated temperature, and for this reason the NAPL recovery and groundwater temperature are shown together vs. time on Figure 15. Revisions made to Section 1.2 regarding attainment of DQO's. Text and a table summarizing groundwater temperatures in the treatment zone and durations have been added to Section 3.8. Figure 6 has been revised to show pore volumes treated, average groundwater temperature in treatment zone, and flow rates on a single graph. Text and a table summarizing groundwater temperatures in the treatment zone and durations have been added to Section 3.8.

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Section 6.2.3 Groundwater Gradient and Temperature, page 6-3 & 6-4	Revise section to explain average treatment zone temperatures reached 120ºF or higher for about 7 days in 2016 compared to performance design requirement 140ºF and 90-days used in design modeling. Revise text to make clear that the DQO/Performance Design Requirement for Subsurface Heating is a target maximum 140ºF average temperature in the target treatment zone, that this was not achieved in 2016, and that the system will be optimized in 2017.	Revisions made to Section 1.2 regarding attainment of DQO's. The following revisions were made to Section 6.1.3, Groundwater Gradient and Temperature, paragraph one in response to Ecology's June 27, 2017 comments: *As shown on Figure 14, an approximately 10- to 100-fold reduction in viscosity was attained by the HWF system in the 90 to 125ºF operational range of groundwater temperatures attained during active heating in 2016, as discussed in Section 5.2, Groundwater Heating Performance.* ***The DQO established in the 2011 Design Report for the maximum groundwater temperature that might be attained, for the purpose of ensuring the compatibility and safety of groundwater pumps and other materials in contact with groundwater was 140 ºF. Since a measured approach was taken to groundwater heating during the 2016 HWF operations to gradually assess operating optimization and secondary factors such as the effects on the temperature of the School floor, the highest average groundwater temperature attained in the treatment zone was approximately 125 ºF.*** *The recommended earlier start* ***and maximized groundwater injection rates and temperatures during*** *~~to~~ hot water flushing in 2017 will result* ***in a longer period of elevated groundwater temperatures than were attained in 2016*** *~~temperatures being maintained at the upper end of this range for a longer period~~, as discussed in Section 5.5, NAPL Recovery.* Text and a table summarizing groundwater temperatures in the treatment zone and durations have been added to Section 3.8.

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Section 7.0 Conclusions and Recommendations, page 7-1 *HWF system operations during 2016 met design goals and compliance monitoring requirements*	Replace italicized text to explain the HWF system did not meet the DQO Performance Design Requirements for Groundwater Recirculation and NAPL Recovery (50 gpm) and Subsurface Heating (140ºF). Revise text to make clear the DQO/Performance Design Requirement for Subsurface Heating was not achieved in 2016 (conclusion). Add text to make clear the HWF system will continue to operate and flush hot water beneath the school during summers and terminating operations will be based on coordination with Ecology.	Revisions made to Section 1.2 regarding attainment of DQO's. The following text is added to Section 7.0 in response to Ecology's June 27, 2017 comments: *HWF system operations during 2016 met **equipment** design goals and compliance monitoring requirements. A total of 40.2 gallons of NAPL was recovered as a result of HWF. The 2016 operational period represented the initial operating season in which meeting critical operating criteria and objectives was confirmed. HWF groundwater temperature increases during 2016 were consistent with design expectations for the heat input applied. **A measured approach was taken to groundwater heating during the 2016 HWF operations to gradually assess operating optimization and secondary factors such as the effects on the temperature of the School floor.*** The following text has been added to Section 7.0, paragraph three: ***Operation of the treatment system will be complete based on coordination with Ecology.***

Section 7.1 Recommendations to Optimize NAPL Removal, page 7-1	Revise section to explain what recommendations are made to optimize NAPL removal in 2017 to meet the DQO requirements.	The following text was added to Section 7.1 in response to Ecology's June 27, 2017 comments: *A longer operational season* ***and maximized groundwater injection rates and temperatures*** *are recommended to facilitate maximum NAPL removal rates* ***for*** *as long as possible* ***in the upcoming 2017 operating season.*** ***Maximized groundwater injection rates and temperatures during hot water flushing in 2017 are recommended to achieve higher average groundwater temperatures for a longer duration than were achieved in 2016. Specifically, the HWF system equipment will be operated at the upper range of the equipment performance DQOs to achieve maximum feasible injection rates and temperatures.*** Revisions made to Section 1.2 regarding attainment of DQO's.
An earlier start is expected to produce the maximum groundwater temperature of approximately 120ºF by mid-July 2017, and extend to the end of the HWF season in mid-August 2017 (Figure 16). *Once the groundwater temperature reaches 120ºF, heating will be tapered to level out groundwater temperature at a constant of approximately 120ºF.*	Modeling work described in Section 5.5 and Fig. 16 of this document shows max. temp. of 135ºF is reached in late July. Replace "120ºF" with "135ºF".	The following revisions have been made to Section 7.1, paragraph one: *An earlier start is expected to produce the maximum groundwater temperature of* ***greater than*** ~~*120*~~ ***130****ºF by mid-July 2017, and to extend it to the end of the HWF season in mid-August 2017 (Figure 16). Once the groundwater temperature reaches* ~~*120*~~ ***above 130****ºF, heating will be tapered to level out groundwater temperature* ~~*at a constant of approximately 120 ºF*~~ ***so that the maximum design rating of 140°F is not exceeded at any particular location***.
Most significantly, the recommended 2017 operating schedule would essentially triple the period over which temperatures are elevated above 100°F in comparison to the 2016 operating season, from approximately 1 month to approximately 3 months.	Delete italicized text. The Performance Design Requirement for Subsurface Heating is 140ºF. Turning down the heat to maintain 120ºF in the treatment zone is not acceptable. Replace with text that explains the system will be adjusted to maintain maximum groundwater temperature in the treatment zone (140ºF). Revise italicized text with an evaluation of how long the system would operate at 140ºF (not 100ºF) in comparison to the 7 days at or above 120ºF in 2016.	
The additional operating duration at elevated temperatures is anticipated to maximize potential for NAPL removal and recovery, and provide a better basis for evaluation of system performance.	Replace "maximize" with "increase".	The following revisions have been made to Section 7.1, paragraph two: *The additional operating duration at elevated temperatures is anticipated to* ***increase*** *potential for NAPL removal and recovery, and provide a better basis for evaluation of system performance.*
If the treatment season is extended, it is recommended that mechanical cooling capabilities be retained for at least 1 additional year (2017 operating season) to address the potential for higher floor slab temperatures related to a longer heating duration and higher temperatures.	Insert "and higher temperatures"	The following revisions have been made to Section 7.1, paragraph three: *If the treatment season is extended, it is recommended that mechanical cooling capabilities be retained for at least 1 additional year (2017 operating season) to address the potential for higher floor slab temperatures related to a longer heating duration* ***and higher temperatures***.
Although the chiller equipment likely will be unnecessary to maintain acceptable temperatures		

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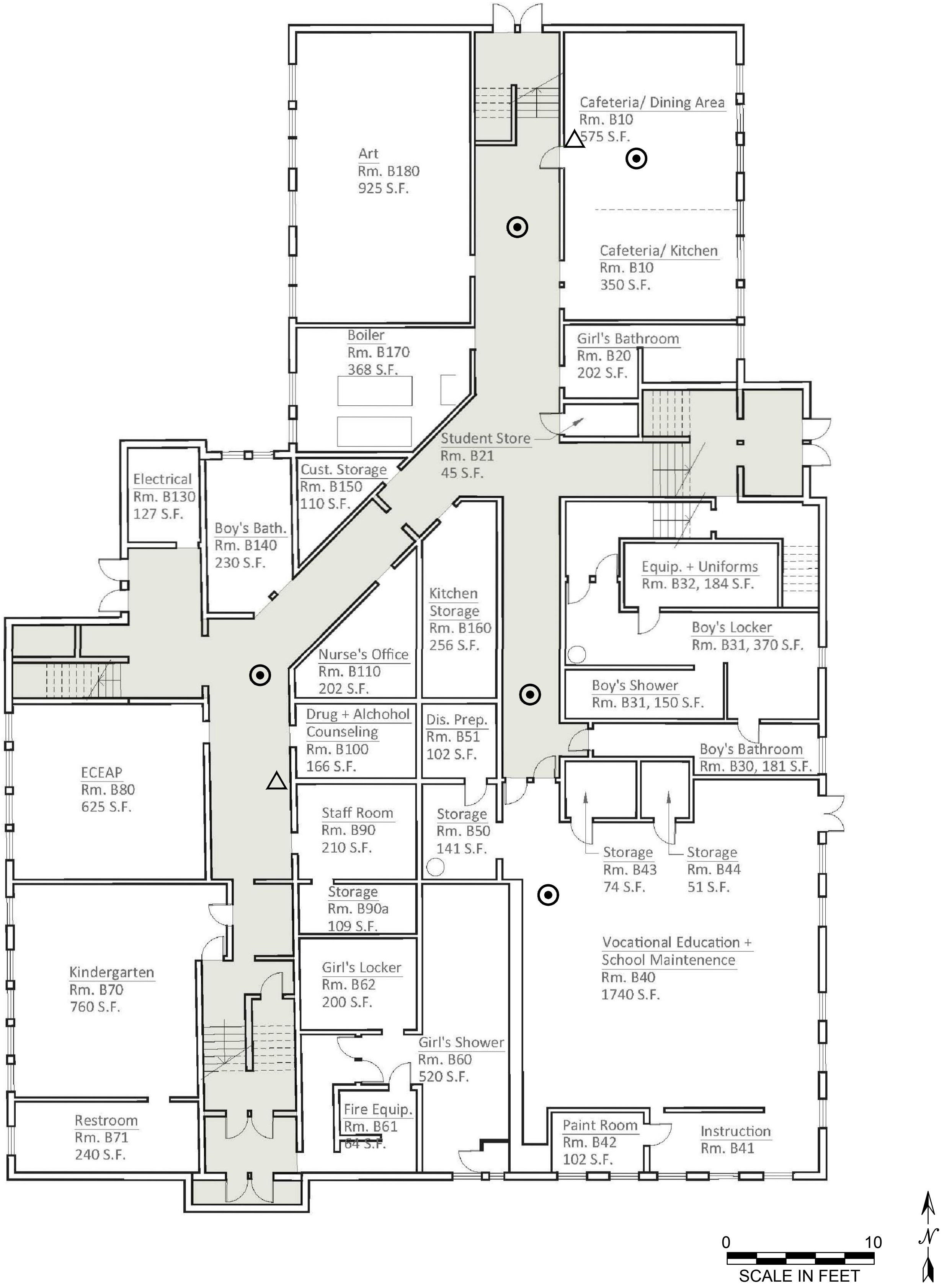
in the School building, it will be available for use if needed.	Delete italicized text. Need for chiller equipment is not known for optimized HWF system. Add text to explain redeveloping recovery wells will help optimize NAPL removal.	The following text has been deleted from Section 7.1,: ~~*Although the chiller equipment likely will be unnecessary to maintain acceptable temperatures in the School building, it will be available for use if needed.*~~ The following text has been added to Section 7.1, paragraph: *Recovery well cleaning is recommended to reduce or eliminate the risk of system shut-downs due to clogged well screen. Limiting the number of shutdowns will result in a longer heating duration and higher temperatures which will increase potential for NAPL recovery.*
Section 7.2 Recommended 2017 Operating Schedule, page 7-3	Revise table to include well redevelopment	The following text has been added to table, Proposed 2017 in Section 7.2: *April 1, 2017; Recovery Well Cleaning; Scheduled Coincident with School Spring Break. Recovery wells will be physically and chemically cleaned as described in Section 5.3.*

Draft 2016 HWF Remediation Performance Report	Ecology Comment	BNSF Response
	Create new figure (graph) to show injection temperature vs. time.	Figure 4 showing weekly average injection temperatures has been added the report.
Figure 6 System Flows and Pore Volumes	Revise figure to show average treatment zone groundwater temperatures (superimpose from Fig. 15) and how many pore volumes were treated while the system was at temperatures of 120ºF or above (3 pore volumes?)	Figure 6 has been revised to show pore volumes treated, average groundwater temperature in treatment zone, and flow rates on a single graph. Text and a table summarizing groundwater temperatures in the treatment zone and durations have been added to Section 3.8.

APPENDIX B
TEMPERATURE MONITORING LOCATIONS

2016 HOT WATER FLUSHING REMEDIATION
PERFORMANCE REPORT
Skykomish School
BNSF Former Maintenance and Fueling Facility
Skykomish, Washington

Farallon PN: 683-057



LEGEND

△ INDOOR AIR TEMPERATURE MONITORING LOCATION

⊙ FLOOR TEMPERATURE MONITORING LOCATION

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Washington
Issaquah | Bellingham | Seattle

Oregon
Portland | Bend | Baker City

California
Oakland | Sacramento | Irvine

FIGURE 1

BASEMENT FLOOR AND ROOM TEMPERATURE LOCATIONS
HWF MONTHLY SUMMARY REPORT - JULY 2016
SKYKOMISH SCHOOL
SKYKOMISH, WASHINGTON

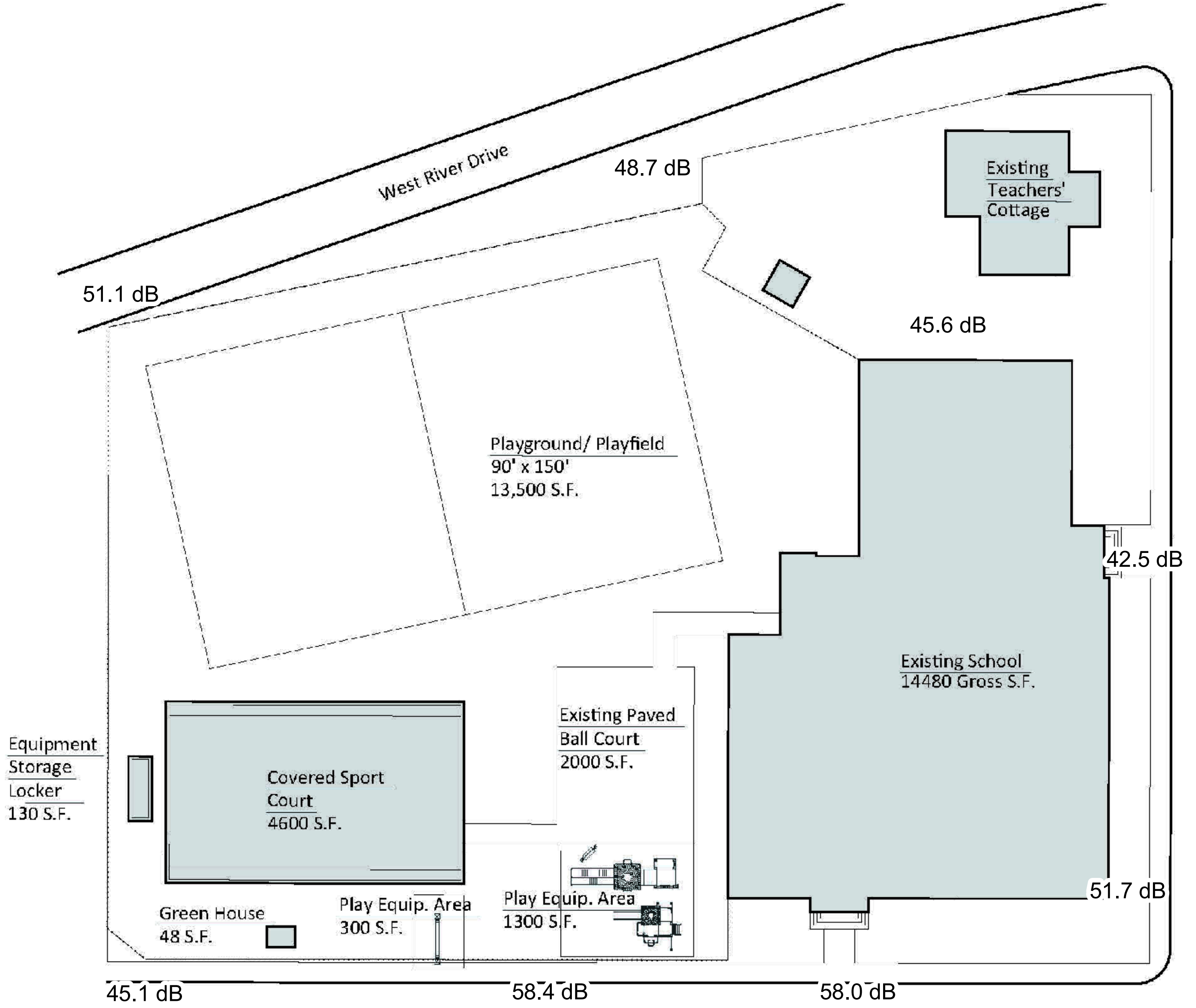
FARALLON PN: 683-057

Drawn By: JS | Checked By: AV | Date: 7/19/2016 | Disk Reference: 683-057

APPENDIX C
SITE NOISE MAPS

2016 HOT WATER FLUSHING REMEDIATION
PERFORMANCE REPORT
Skykomish School
BNSF Former Maintenance and Fueling Facility
Skykomish, Washington

Farallon PN: 683-057



LEGEND

dB = DECIBEL
NM = NOT MONITORED

0 100
SCALE IN FEET

N

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Oregon
Portland | Bend | Baker City

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Oakland | Sacramento | Irvine

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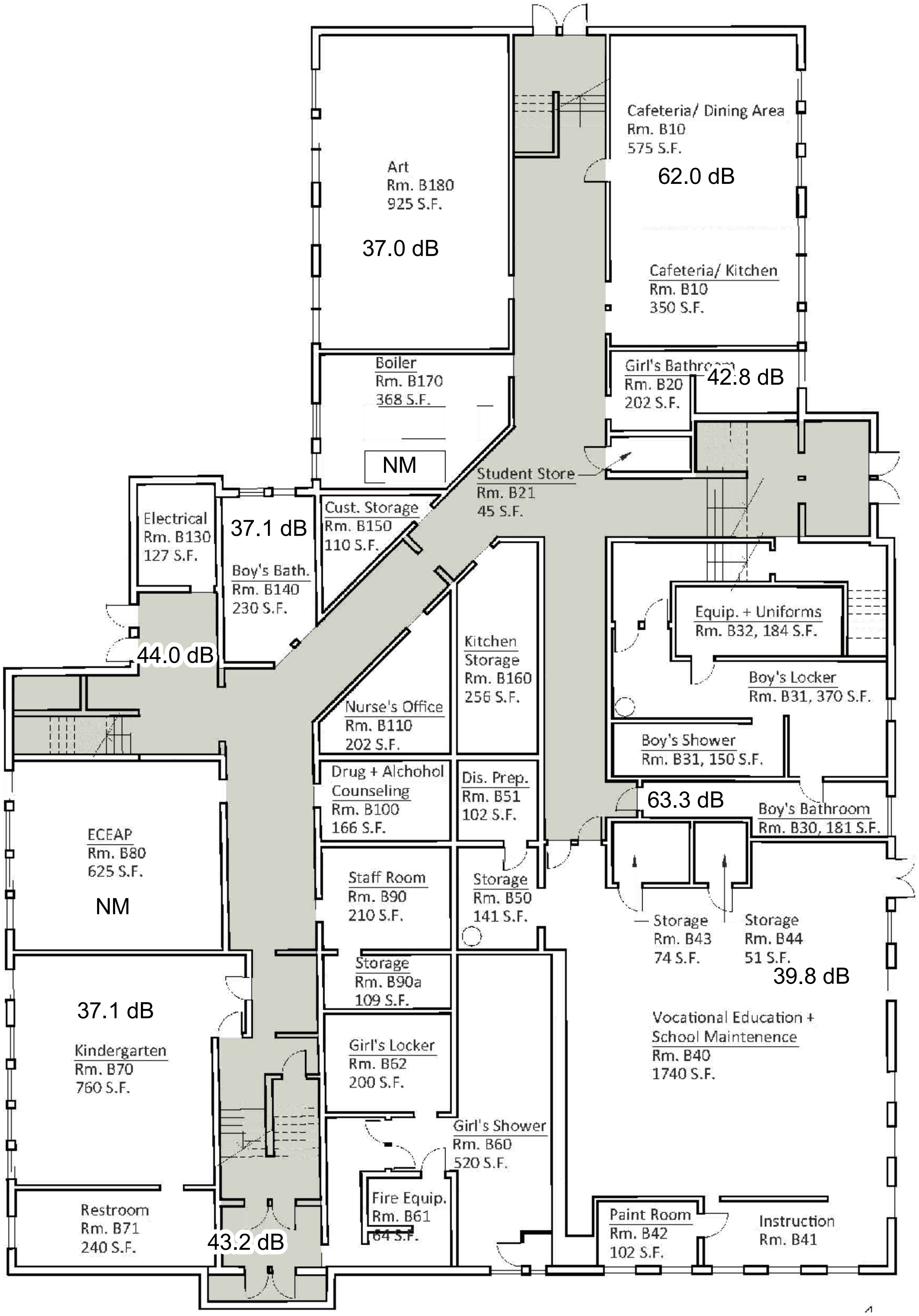
FIGURE 1
SITE PLAN WITH NOISE MONITORING DATA
WEEK 1
SKYKOMISH SCHOOL
SKYKOMISH, WASHINGTON

FARALLON PN: 555-002

Drawn By: tperrin
Checked By: CS
Date: 6/24/2016
Disc Reference:
Document Path: G:\Projects\683_BNSF\683057 Skykomish School HWF Construction\GIS\FIGURE 1-4_SKYKOMISH.mxd



LEGEND

dB = DECIBEL
NM = NOT MONITORED

N

0 100
SCALE IN FEET

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Oregon
Portland | Bend | Baker City

California
Oakland | Sacramento | Irvine

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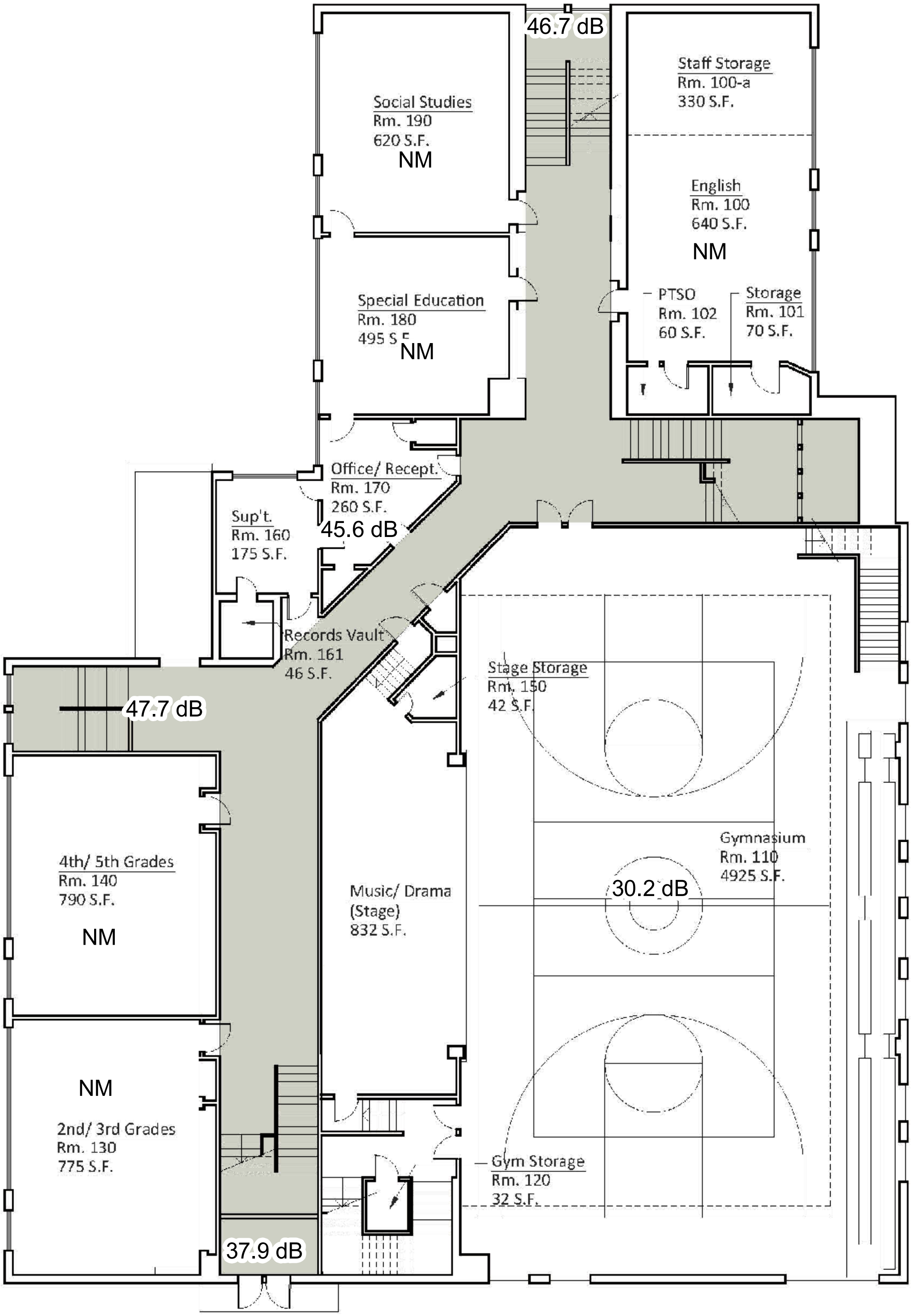
FIGURE 2

GROUND FLOOR WITH NOISE MONITORING DATA
WEEK 1
SKYKOMISH SCHOOL
SKYKOMISH, WASHINGTON

FARALLON PN: 555-002

Drawn By: tperrin
Checked By: CS
Date: 6/24/2016
Disc Reference:
Document Path: G:\Projects\683_BNSF\683057 Skykomish School HWF Construction\GIS\FIGURE 1-4_SKYKOMISH.mxd



LEGEND

dB = DECIBEL
NM = NOT MONITORED

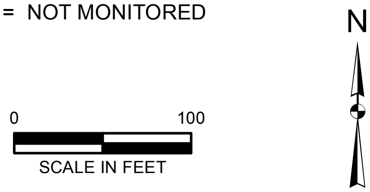


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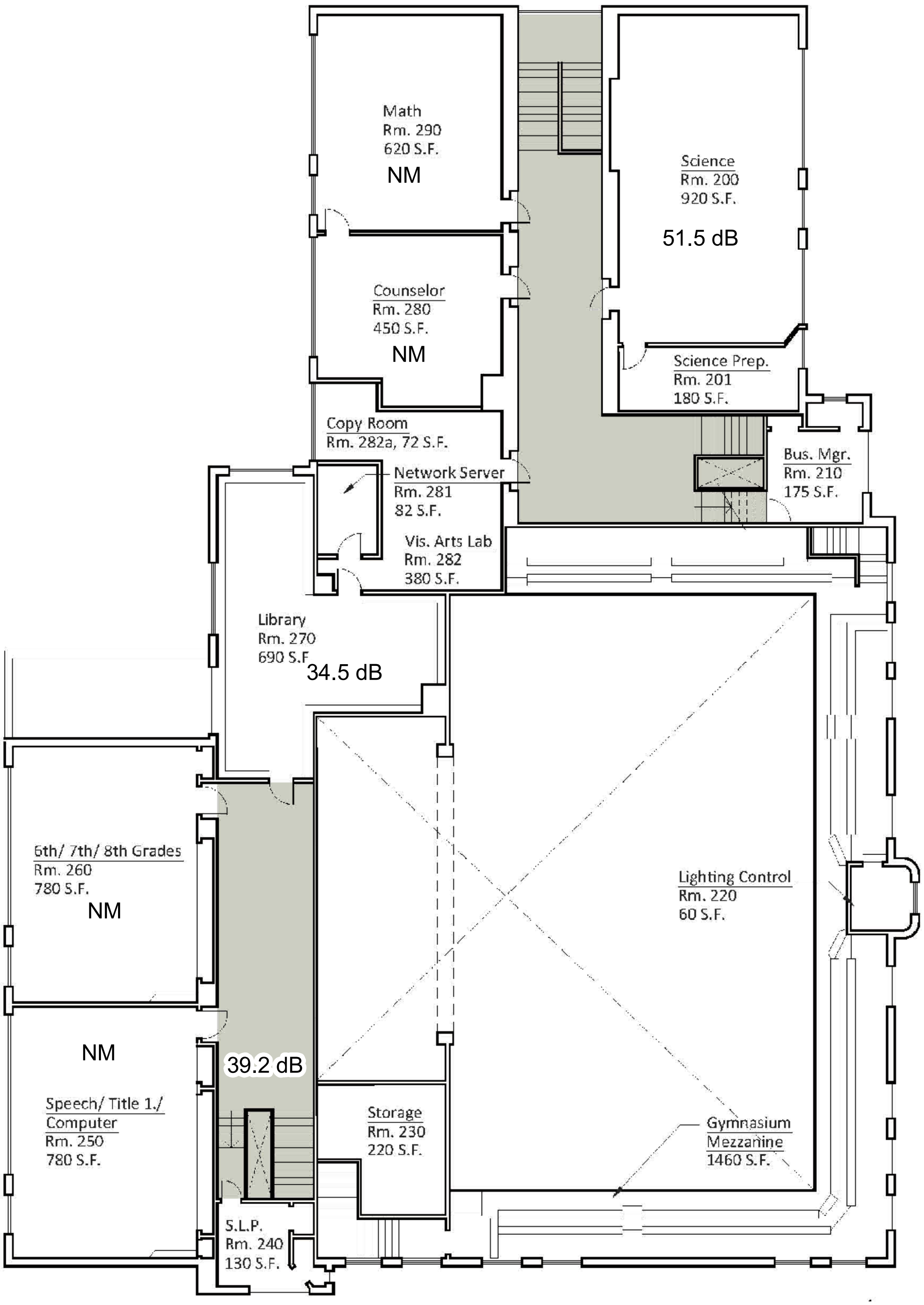
FIGURE 3

FIRST FLOOR WITH NOISE MONITORING DATA
WEEK 1
SKYKOMISH SCHOOL
SKYKOMISH, WASHINGTON

FARALLON PN: 555-002

Drawn By: tperrin
Checked By: CS
Date: 6/24/2016
Disc Reference:
Document Path: G:\Projects\683_BNSF\683057 Skykomish School HWF Construction\GIS\FIGURE 1-4_SKYKOMISH.mxd



LEGEND

dB = DECIBEL
NM = NOT MONITORED

0 100
SCALE IN FEET

N

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Washington
Issaquah | Bellingham | Seattle

Oregon
Portland | Bend | Baker City

California
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FIGURE 4

SECOND FLOOR WITH NOISE MONITORING DATA
WEEK 1
SKYKOMISH SCHOOL
SKYKOMISH, WASHINGTON

FARALLON PN: 555-002

Drawn By: tperrin Checked By: CS Date: 6/24/2016 Disc Reference:
Document Path: G:\Projects\683_BNSF\683057 Skykomish School HWF Construction\GIS\FIGURE 1-4_SKYKOMISH.mxd

APPENDIX D
SOIL VAPOR EXTRACTION MEMO

2016 HOT WATER FLUSHING REMEDIATION
PERFORMANCE REPORT
Skykomish School
BNSF Former Maintenance and Fueling Facility
Skykomish, Washington

Farallon PN: 683-057

Trihydro
CORPORATION

August 19, 2016

Mr. Jeff Hamlin P.E. and Mr. Andrew Vining P.E.
Farallon Consulting, L.L.C.
975 5th Avenue Northwest
Issaquah, WA 98027

RE: Soil Vapor Extraction System Performance and Optimization, Skykomish School Hot Water Flush System Project, Skykomish, Washington

Dear Mr. Hamlin and Mr. Vining:

As requested, Trihydro has prepared this memo regarding the performance and optimization of the soil vapor extraction (SVE) system at the Skykomish School. The memo reviews system performance attained to date and identifies possible system optimization steps that may enhance system performance. The SVE system started operation on June 15, 2016. For reference, Figure 1 presents an as-built map of the Skykomish School with the layout of the SVE system and soil gas probe (SGP) differential pressure (dP) monitoring points.

SVE System Performance Objectives

The performance objectives of the SVE system were established during the design basis and include:

- Maintain a subsurface air flow rate of approximately 500 cubic feet per minute (cfm), especially during the cool down phase of the heating-cooling cycle to remove heat prior to the start of school.
- Operate the SVE system so that adequate sub-slab dP is maintained beneath the School to prevent vapor intrusion (VI).

SVE System Air Flow Rate

As shown in Table 1, the SVE system has achieved >400 standard cubic feet per minute (SCFM) flow rate from the six SVE wells and one horizontal SVE trench. The flow rate in several SVE legs exceeds the range of the flow meter (100 cfm).

Sub-Slab Differential Pressure

Table 2 shows dP data from the six SGPs installed in the school floor (see Figure 1), and includes averages from automated data logging and a hand-held digital manometer accurate to 0.001 inches water column (IWC). As shown, the digital manometer readings generally agree with the logged data.

The predicted SGP dPs calculated during the design phase of 1 to 5 IWC have not been realized. A likely explanation for the lower than anticipated vacuum readings is the presence of a void space in between the soil and the school floor slab, which transmits large amounts of air flow without development of the anticipated magnitude of SVE vacuum below the slab. Evidence to support this includes:

- Observation of a 1 to 5 inch void space in several areas beneath the slab during interior trench installation.
- Removal of the SVE well caps within the SVE well vault resulted in an increase in sub-slab dP to presently observed values, most likely because air flow was directed into the sub-slab void space through the floor of the vault.
- Measurable vacuum ranging from 0.01 to 0.06 IWC in air inlet (AI) wells screened 4 to 6 ft below grade and located on the perimeter of the school building when the horizontal SVE trench is closed and all SVE well caps are in place. This suggests an SVE radius of influence within the design predictions for the subsurface, although not reflected in the SGP dP data.
- From approximately July 11 to the present, the SVE system has been operated with the SVE well caps off, to direct air flow into the sub-slab void space. As a result, floor temperatures have not increased significantly above 80 °F, suggesting adequate ventilation and cooling beneath the sub-slab caused by >400 SCFM sub-slab air flow.

Vapor Intrusion Assessment and Findings

The Washington State Department of Ecology (Ecology) and U.S. Environmental Protection Agency (EPA) vapor intrusion guidance (EPA 2008 and EPA 2015) were reviewed regarding monitoring of the effectiveness of VI mitigation systems. These citations and corresponding SVE system performance data should be considered in assessing the potential for VI at the School, as follows:

- SVE influent concentration analytical (TO-15) data from a sample collected June 28, 2016 and summarized in Table 3 show constituent concentrations below the Ecology VI action levels (Ecology 2016).
- According to EPA guidance, sub-slab depressurization systems for control of VI can reverse the potential for air flow through the slab (sub-slab depressurization system or SDS) or dilute the concentrations of air (sub-slab ventilation system or SVS). Based on dP and air flow rate data, as well as the above SVE influent concentration data, the SVE system at the Skykomish School is effective in both regards.
- For an SDS, average depressurization is approximately 4 to 10 pascal (EPA 2008) or 0.016 to 0.040 IWC. Maintenance of at least 0.025 IWC in all SGPs was specified as an operating goal in an addendum to the Compliance Monitoring Plan (Farallon 2015). The dP data shown in Table 1 indicates only partial compliance with this goal; however, according to the above EPA guidance, dP is only one metric used to gage the effectiveness of VI mitigation, and other factors, such as air flow rate and soil vapor concentrations, should be considered. Taken together, the dP data in conjunction

with air flow rate and SVE concentration data strongly support our conclusion that the SVE system is an effective VI mitigation system.

Proposed Path Forward for SVE System Operation

1. Increase SVE influent analytical testing (TO-15) to one sampling event monthly during system operating periods.
2. Continue to operate the system with the SVE well caps off to maximize air flow from the sub-slab void space.
3. Inspect the school basement for unsealed penetrations (such as crawl spaces) and seal these penetrations.
4. Replace existing flow meters with units rated for a higher range (~200 SCFM), or drill and tap ¼-inch monitoring ports for use with a sensitive handheld flow meter that will accurately measure flows through a broad range of operating conditions.
5. Seal the SVE well vaults using weather stripping and/or silicone caulk.
6. If additional increases in dPs at the SGPs are necessary, assess whether the activated carbon system can be removed from the system (direct discharge) to increase subsurface airflow from the current SVE blower, or alternately upsize the blower. If the blower is upsized, a unit with a different vacuum-flow performance curve can be selected to accommodate the low vacuum/high flow system characteristics.

References

Farallon Consulting (Farallon) 2015. Compliance Monitoring Plan, Addendum 3, Skykomish School Remediation Project, February 17, 2015

US Environmental Protection Agency (EPA) 2015. OSWER Technical Guide for Assessing and mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air., OSWER Publication 9200.2-154

US Environmental Protection Agency (EPA) 2008. Engineering Issue Indoor Air Vapor Intrusion Mitigation Approaches

Washington State Department of Ecology (Ecology) 2016. Guidance for Evaluating Soil Vapor Intrusion in Washington State: Investigation and Remedial Action

If there are any outstanding questions or concerns, please feel free to contact me via email (jpietz@trihydro.com), or by office phone at (307) 399-0977.

Sincerely,
Trihydro Corporation

John Pietz, PE
Project Manager

W.S. Clayton, Ltd.

Wilson Stone Clayton
State of Washington
46282
Registered Professional Engineer
8-19-16

Wilson Clayton, PhI
Senior Consultant

18D-003-004

Attachments

TABLES

TABLE 1. SKYKOMISH SCHOOL SVE SYSTEM FLOWRATE DATA

Date	SVE System Leg Flowrate, SCFM					Total, SCFM
	SVE-1,2	SVE-3	SVE-4	SVE-5	SVE-6/Horizontal well	
6/15/2016	87.15	NM	14.82	70.03	68.04	240.04
6/20/2016	>95	49	0	>99	>99	>346
6/24/2016	92.58	>99	0	>99	>99	>390
6/27/2016	92.9	>99	-65.5	>99	>99	>455
6/28/2016	92.8	>99	31	>99	>99	>421
7/6/2016	40.5	93.3	>99	>99	>99	>431
7/11/2016	70.2	NM	>99	>99	>99	>367
7/12/2016	>99	NM	>99	>99	80.4	>297
7/13/2016	83.6	>99	>99	>99	>99	>480
7/14/2016	85.5	>99	>99	>99	>99	>482
7/15/2016	81.4	>99	>99	>99	>99	>477
7/16/2016	NM	NM	NM	NM	NM	NM
7/17/2016	NM	NM	NM	NM	NM	NM
7/18/2016	NM	NM	NM	NM	NM	NM
7/19/2016	NM	NM	NM	NM	NM	NM
7/22/2016	19.79	116.77	153.24	131.92	136.91	558.63
7/26/2016	10	>99	>99	>99	>99	>406
7/27/2016	15.7	>99	>99	>99	>99	>412
7/28/2016	NM	NM	NM	NM	NM	>396
8/1/2016	20	>99	>99	>99	>99	>416
8/2/2016	16.5	>99	>99	>99	>99	>413
8/3/2016	15	>99	>99	>99	>99	>411

Notes:

NM - not measured

SCFM - standard cubic feet per minute

TABLE 2. SKYKOMISH SCHOOL SUB-SLAB DIFFERENTIAL PRESSURE DATA

Week or Day	Sub-slab Differential Pressure, Inches Water Column					
	SGP-1	**SGP-2**	**SGP-3**	**SGP-4**	**SGP-5**	**SGP-6**
7/30/16-8/6/16	-0.02	-0.01	-0.01	-0.02	0	-0.02
7/24/16-7/30/16	-0.02	-0.01	-0.01	-0.03	0	-0.02
7/17/16-7/24/16	-0.02	-0.01	-0.02	-0.02	0	-0.02
Average	**-0.02**	**-0.01**	**-0.01**	**-0.02**	**0**	**-0.02**
8/5/2016 (13:00 - 14:00)	-0.02/-0.01[a]	-0.02[a]	-0.02/-0.01[a]	-0.03/-0.02[a]	-0.01[a]	-0.02[a]
8/5/2016 (13:00 - 14:00)	-0.026[b]	-0.032[b]	-0.013[b]	-0.030[b]	-0.013[b]	-0.016[b]

Notes:

SGP - soil gas probe

[a] - Range of flow meter readings over approximate 8 sec period of digital manometer time average.

[b] - Data collected using digital manometer with 8 sec time average, accurate to 0.001 inches water column.

Data are from SGP data logging over the indicated time period, unless otherwise noted.

Negative reading indicates sub-slab air space is negative with respect to the room above.

TABLE 3. SVE SYSTEM INFLUENT VAPOR PHASE PETROLEUM HYDROCARBONS

Sample No.	Sample Date	1,3-Butadiene[1] (µg/m^3)	Methyl tert butyl ether (µg/m^3)	Benzene[1] (µg/m^3)	Toluene (µg/m^3)	Ethylbenzene (µg/m^3)	Xylene, p,m (µg/m^3)	Xylene, o (µg/m^3)	Naphthalene[1] (µg/m^3)	Aliphatics, C5 to C8 (µg/m^3)	Aliphatics, C9 to C12 (µg/m^3)	Aromatics, C9 to C10 (µg/m^3)	Total APH[4] (µg/m^3)
SYSTEM_INF_062816	6/28/2016	< 0.044	< 0.7	< 0.319	2.3	< 0.9	1.7	< 0.9	0.802	120	330	< 10	461.2
Project Action Limits (µg/m^3)		**0.083[2]**	**9.6[2]**	**0.32[2]**	**2,290[2]**	**460[2]**	**46[2]**	**46[2]**	**1.4[2]**	**No CLARC criteria available**			**1,346[3]**
MTCA Method B Sub-Slab Soil Gas Screening Level (µg/m^3)		**2.78**	**321**	**10.7**	**76,200**	**15,200**	**1,520**	**1,520**	**2.45**	**90,000**	**4,700**	**6,000**	**NE**

Notes:

< indicates compounds not detected at concentrations exceeding laboratory reported detection limits (RDLs).

[1] Laboratory RDLs for these compounds were attained using TO-15 SIM analysis to lower the detection limits below CLARC criteria.

[2] CLARC Method B values for protection of all populations.

[3] Risk-based cleanup level established for Town of Skykomish and private property during this project by the Washington State Department of Ecology.

[4] Total APH is derived by summing all individual compounds and ranges, excluding 1,3-butadiene. Compounds not detected at concentrations exceeding the laboratory RDL are added at half of the RDL.

[5] Washington State Model Toxics Control Act Cleanup Regulation Method B Cleanup and Screening Levels, Table B-1 of Appendix B of the Guidance for Evaluating Soil Vapor Intrusion in Washington State: Investigation and Remedial Action. Revised February 2016.

APH = air-phase petroleum hydrocarbons

CLARC = Cleanup Levels and Risk Calculations

µg/m^3 = micrograms per cubic meter

SIM = Selective Ion Monitoring

NE = not established

FIGURE

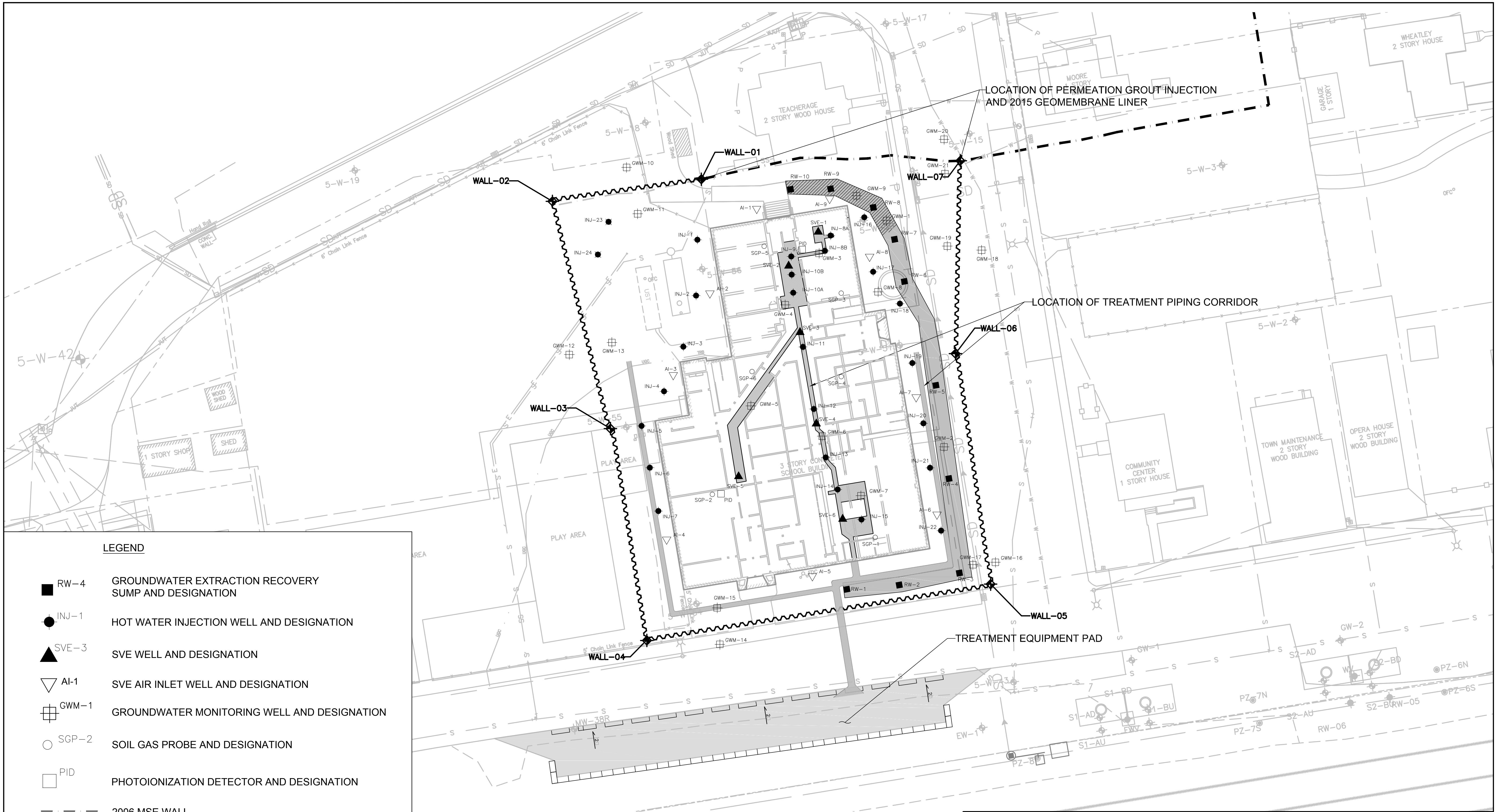

FIGURE 1

HOT WATER FLUSHING SYSTEM LAYOUT PLAN
2015 AS-BUILT COMPLETION REPORT
BNSF FORMER MAINTENANCE AND FUELING FACILITY
SKYKOMISH, WASHINGTON

FARALLON PN: 683-057

LEGEND

■ RW-4	GROUNDWATER EXTRACTION RECOVERY SUMP AND DESIGNATION
● INJ-1	HOT WATER INJECTION WELL AND DESIGNATION
▲ SVE-3	SVE WELL AND DESIGNATION
▽ AI-1	SVE AIR INLET WELL AND DESIGNATION
⊞ GWM-1	GROUNDWATER MONITORING WELL AND DESIGNATION
○ SGP-2	SOIL GAS PROBE AND DESIGNATION
☐ PID	PHOTOIONIZATION DETECTOR AND DESIGNATION
▬ ▬ ▬	2006 MSE WALL
∿∿∿	SHEET PILE BARRIER WALL
▩	GROUNDWATER AND LNAPL RECOVERY TRENCH
▨	GROUNDWATER AND LNAPL RECOVERY TRENCH INSTALLED TO 10'-13' BELOW GROUND SURFACE

0 40
Scale in feet

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Drawn By: MB Checked By: AV Date: 3/4/16 Disk Reference: 683-038AS

APPENDIX E
SOIL VAPOR LABORATORY ANALYTICAL REPORTS

2016 HOT WATER FLUSHING REMEDIATION
PERFORMANCE REPORT
Skykomish School
BNSF Former Maintenance and Fueling Facility
Skykomish, Washington

Farallon PN: 683-057

ANALYTICAL REPORT

Lab Number:	L1620464
Client:	Farallon Consulting, L.L.C. 975 5th Avenue Northwest Issaquah, WA 98027
ATTN:	Russell Luiten
Phone:	(425) 394-4147
Project Name:	BNSF SKYKOMISH
Project Number:	683-057
Report Date:	07/11/16

Certifications & Approvals: NY (11627), CT (PH-0141), NH (2206), NJ NELAP (MA015), RI (LAO00299), ME (MA00030), PA (68-02089), VA (460194), LA NELAP (03090), FL (E87814), TX (T104704419), WA (C954), USFWS (Permit #LE2069641), USDA (Permit #P330-11-00109), US Army Corps of Engineers.

320 Forbes Boulevard, Mansfield, MA 02048-1806
508-822-9300 (Fax) 508-822-3288 800-624-9220 - www.alphalab.com

Project Name: BNSF SKYKOMISH
Project Number: 683-057

Lab Number: L1620464
Report Date: 07/11/16

Alpha Sample ID	Client ID	Matrix	Sample Location	Collection Date/Time	Receive Date
L1620464-01	SYSTEM_INF_062816	SOIL_VAPOR	SKYKOMISH, WA	06/28/16 10:52	07/01/16
L1620464-02	BASE_062816	AIR	SKYKOMISH, WA	06/28/16 12:51	07/01/16
L1620464-03	FIRST_062816	AIR	SKYKOMISH, WA	06/28/16 15:32	07/01/16
L1620464-04	SECOND_062816	AIR	SKYKOMISH, WA	06/28/16 15:30	07/01/16

Case Narrative

The samples were received in accordance with the Chain of Custody and no significant deviations were encountered during the preparation or analysis unless otherwise noted. Sample Receipt, Container Information, and the Chain of Custody are located at the back of the report.

Results contained within this report relate only to the samples submitted under this Alpha Lab Number and meet NELAP requirements for all NELAP accredited parameters unless otherwise noted in the following narrative. The data presented in this report is organized by parameter (i.e. VOC, SVOC, etc.). Sample specific Quality Control data (i.e. Surrogate Spike Recovery) is reported at the end of the target analyte list for each individual sample, followed by the Laboratory Batch Quality Control at the end of each parameter. Tentatively Identified Compounds (TICs), if requested, are reported for compounds identified to be present and are not part of the method/program Target Compound List, even if only a subset of the TCL are being reported. If a sample was re-analyzed or re-extracted due to a required quality control corrective action and if both sets of data are reported, the Laboratory ID of the re-analysis or re-extraction is designated with an "R" or "RE", respectively. When multiple Batch Quality Control elements are reported (e.g. more than one LCS), the associated samples for each element are noted in the grey shaded header line of each data table. Any Laboratory Batch, Sample Specific % recovery or RPD value that is outside the listed Acceptance Criteria is bolded in the report. All specific QC information is also incorporated in the Data Usability format of our Data Merger tool where it can be reviewed along with any associated usability implications. Soil/sediments, solids and tissues are reported on a dry weight basis unless otherwise noted. Definitions of all data qualifiers and acronyms used in this report are provided in the Glossary located at the back of the report.

In reference to questions H (CAM) or 4 (RCP) when "NO" is checked, the performance criteria for CAM and RCP methods allow for some quality control failures to occur and still be within method compliance. In these instances the specific failure is not narrated but noted in the associated QC table. The information is also incorporated in the Data Usability format of our Data Merger tool where it can be reviewed along with any associated usability implications.

Please see the associated ADEx data file for a comparison of laboratory reporting limits that were achieved with the regulatory Numerical Standards requested on the Chain of Custody.

HOLD POLICY
For samples submitted on hold, Alpha's policy is to hold samples (with the exception of Air canisters) free of charge for 21 calendar days from the date the project is completed. After 21 calendar days, we will dispose of all samples submitted including those put on hold unless you have contacted your Client Service Representative and made arrangements for Alpha to continue to hold the samples. Air canisters will be disposed after 3 business days from the date the project is completed.

Please contact Client Services at 800-624-9220 with any questions.

Case Narrative (continued)

Volatile Organics in Air and Petroleum Hydrocarbons in Air

Canisters were released from the laboratory on June 20 and 27, 2016. The canister certification results are provided as an addendum.

I, the undersigned, attest under the pains and penalties of perjury that, to the best of my knowledge and belief and based upon my personal inquiry of those responsible for providing the information contained in this analytical report, such information is accurate and complete. This certificate of analysis is not complete unless this page accompanies any and all pages of this report.

Authorized Signature: Christopher J. Anderson Christopher J. Anderson

Title: Technical Director/Representative Date: 07/11/16

AIR

SAMPLE RESULTS

Lab ID:	L1620464-01	Date Collected:	06/28/16 10:52
Client ID:	SYSTEM_INF_062816	Date Received:	07/01/16
Sample Location:	SKYKOMISH, WA	Field Prep:	Not Specified
Matrix:	Soil_Vapor		
Anaytical Method:	48,TO-15-SIM		
Analytical Date:	07/08/16 09:58		
Analyst:	RY		

	ppbV			ug/m3				
Parameter	**Results**	**RL**	**MDL**	**Results**	**RL**	**MDL**	**Qualifier**	**Dilution Factor**
Volatile Organics in Air by SIM - Mansfield Lab								
1,3-Butadiene	ND	0.020	--	ND	0.044	--		1
Benzene	ND	0.100	--	ND	0.319	--		1
Naphthalene	0.153	0.050	--	0.802	0.262	--		1

Internal Standard	**% Recovery**	**Qualifier**	**Acceptance Criteria**
1,4-difluorobenzene	84		60-140
bromochloromethane	92		60-140
chlorobenzene-d5	78		60-140

Project Name:	BNSF SKYKOMISH	**Lab Number:**	L1620464
Project Number:	683-057	**Report Date:**	07/11/16

SAMPLE RESULTS

Lab ID:	L1620464-02	Date Collected:	06/28/16 12:51
Client ID:	BASE_062816	Date Received:	07/01/16
Sample Location:	SKYKOMISH, WA	Field Prep:	Not Specified
Matrix:	Air		
Anaytical Method:	48,TO-15-SIM		
Analytical Date:	07/08/16 01:37		
Analyst:	RY		

	ppbV			ug/m3				
Parameter	**Results**	**RL**	**MDL**	**Results**	**RL**	**MDL**	**Qualifier**	**Dilution Factor**
Volatile Organics in Air by SIM - Mansfield Lab								
1,3-Butadiene	ND	0.020	--	ND	0.044	--		1
Benzene	0.284	0.100	--	0.907	0.319	--		1
Naphthalene	0.145	0.050	--	0.760	0.262	--		1

Internal Standard	**% Recovery**	**Qualifier**	**Acceptance Criteria**
1,4-difluorobenzene	87		60-140
bromochloromethane	92		60-140
chlorobenzene-d5	89		60-140

SAMPLE RESULTS

Lab ID:	L1620464-03	Date Collected:	06/28/16 15:32
Client ID:	FIRST_062816	Date Received:	07/01/16
Sample Location:	SKYKOMISH, WA	Field Prep:	Not Specified
Matrix:	Air		
Anaytical Method:	48,TO-15-SIM		
Analytical Date:	07/08/16 02:46		
Analyst:	RY		

	ppbV			ug/m3				
Parameter	**Results**	**RL**	**MDL**	**Results**	**RL**	**MDL**	**Qualifier**	**Dilution Factor**
Volatile Organics in Air by SIM - Mansfield Lab								
1,3-Butadiene	ND	0.020	--	ND	0.044	--		1
Benzene	0.162	0.100	--	0.518	0.319	--		1
Naphthalene	0.061	0.050	--	0.320	0.262	--		1

Internal Standard	**% Recovery**	**Qualifier**	**Acceptance Criteria**
1,4-difluorobenzene	82		60-140
bromochloromethane	88		60-140
chlorobenzene-d5	80		60-140

SAMPLE RESULTS

Lab ID: L1620464-04
Client ID: SECOND_062816
Sample Location: SKYKOMISH, WA
Matrix: Air
Anaytical Method: 48,TO-15-SIM
Analytical Date: 07/08/16 03:20
Analyst: RY

Date Collected: 06/28/16 15:30
Date Received: 07/01/16
Field Prep: Not Specified

	ppbV			ug/m3				
Parameter	**Results**	**RL**	**MDL**	**Results**	**RL**	**MDL**	**Qualifier**	**Dilution Factor**
Volatile Organics in Air by SIM - Mansfield Lab								
1,3-Butadiene	ND	0.020	--	ND	0.044	--		1
Benzene	0.143	0.100	--	0.457	0.319	--		1
Naphthalene	ND	0.050	--	ND	0.262	--		1

Internal Standard	% Recovery	Qualifier	Acceptance Criteria
1,4-difluorobenzene	80		60-140
bromochloromethane	86		60-140
chlorobenzene-d5	78		60-140

Method Blank Analysis
Batch Quality Control

Analytical Method: 48,TO-15-SIM

Analytical Date: 07/07/16 15:25

	ppbV			ug/m3				
Parameter	**Results**	**RL**	**MDL**	**Results**	**RL**	**MDL**	**Qualifier**	**Dilution Factor**
Volatile Organics in Air by SIM - Mansfield Lab for sample(s): 01-04 Batch: WG911224-4								
Propylene	ND	0.500	--	ND	0.861	--		1
Dichlorodifluoromethane	ND	0.200	--	ND	0.989	--		1
Chloromethane	ND	0.200	--	ND	0.413	--		1
1,2-Dichloro-1,1,2,2-tetrafluoroethane	ND	0.050	--	ND	0.349	--		1
Vinyl chloride	ND	0.020	--	ND	0.051	--		1
1,3-Butadiene	ND	0.020	--	ND	0.044	--		1
Bromomethane	ND	0.020	--	ND	0.078	--		1
Chloroethane	ND	0.020	--	ND	0.053	--		1
Ethyl Alcohol	ND	5.00	--	ND	9.42	--		1
Vinyl bromide	ND	0.200	--	ND	0.874	--		1
Acetone	ND	1.00	--	ND	2.38	--		1
Trichlorofluoromethane	ND	0.050	--	ND	0.281	--		1
iso-Propyl Alcohol	ND	0.500	--	ND	1.23	--		1
Acrylonitrile	ND	0.500	--	ND	1.09	--		1
1,1-Dichloroethene	ND	0.020	--	ND	0.079	--		1
Methylene chloride	ND	0.500	--	ND	1.74	--		1
3-Chloropropene	ND	0.200	--	ND	0.626	--		1
Carbon disulfide	ND	0.200	--	ND	0.623	--		1
1,1,2-Trichloro-1,2,2-Trifluoroethane	ND	0.050	--	ND	0.383	--		1
Halothane	ND	0.050	--	ND	0.404	--		1
trans-1,2-Dichloroethene	ND	0.020	--	ND	0.079	--		1
1,1-Dichloroethane	ND	0.020	--	ND	0.081	--		1
Methyl tert butyl ether	ND	0.200	--	ND	0.721	--		1
Vinyl acetate	ND	1.00	--	ND	3.52	--		1
2-Butanone	ND	0.500	--	ND	1.47	--		1

Method Blank Analysis
Batch Quality Control

Analytical Method: 48,TO-15-SIM
Analytical Date: 07/07/16 15:25

	ppbV			ug/m3				
Parameter	**Results**	**RL**	**MDL**	**Results**	**RL**	**MDL**	**Qualifier**	**Dilution Factor**
Volatile Organics in Air by SIM - Mansfield Lab for sample(s): 01-04 Batch: WG911224-4								
cis-1,2-Dichloroethene	ND	0.020	--	ND	0.079	--		1
Ethyl Acetate	ND	0.500	--	ND	1.80	--		1
Chloroform	ND	0.020	--	ND	0.098	--		1
Tetrahydrofuran	ND	0.500	--	ND	1.47	--		1
1,2-Dichloroethane	ND	0.020	--	ND	0.081	--		1
n-Hexane	ND	0.200	--	ND	0.705	--		1
1,1,1-Trichloroethane	ND	0.020	--	ND	0.109	--		1
Benzene	ND	0.100	--	ND	0.319	--		1
Carbon tetrachloride	ND	0.020	--	ND	0.126	--		1
Cyclohexane	ND	0.200	--	ND	0.688	--		1
1,2-Dichloropropane	ND	0.020	--	ND	0.092	--		1
Bromodichloromethane	ND	0.020	--	ND	0.134	--		1
1,4-Dioxane	ND	0.100	--	ND	0.360	--		1
Trichloroethene	ND	0.020	--	ND	0.107	--		1
2,2,4-Trimethylpentane	ND	0.200	--	ND	0.934	--		1
Heptane	ND	0.200	--	ND	0.820	--		1
cis-1,3-Dichloropropene	ND	0.020	--	ND	0.091	--		1
4-Methyl-2-pentanone	ND	0.500	--	ND	2.05	--		1
trans-1,3-Dichloropropene	ND	0.020	--	ND	0.091	--		1
1,1,2-Trichloroethane	ND	0.020	--	ND	0.109	--		1
Toluene	ND	0.050	--	ND	0.188	--		1
2-Hexanone	ND	0.200	--	ND	0.820	--		1
Dibromochloromethane	ND	0.020	--	ND	0.170	--		1
1,2-Dibromoethane	ND	0.020	--	ND	0.154	--		1
Tetrachloroethene	ND	0.020	--	ND	0.136	--		1

Method Blank Analysis
Batch Quality Control

Analytical Method: 48,TO-15-SIM
Analytical Date: 07/07/16 15:25

	ppbV			ug/m3				
Parameter	**Results**	**RL**	**MDL**	**Results**	**RL**	**MDL**	**Qualifier**	**Dilution Factor**
Volatile Organics in Air by SIM - Mansfield Lab for sample(s): 01-04 Batch: WG911224-4								
1,1,1,2-Tetrachloroethane	ND	0.020	--	ND	0.137	--		1
Chlorobenzene	ND	0.100	--	ND	0.461	--		1
Ethylbenzene	ND	0.020	--	ND	0.087	--		1
p/m-Xylene	ND	0.040	--	ND	0.174	--		1
Bromoform	ND	0.020	--	ND	0.207	--		1
Styrene	ND	0.020	--	ND	0.085	--		1
1,1,2,2-Tetrachloroethane	ND	0.020	--	ND	0.137	--		1
o-Xylene	ND	0.020	--	ND	0.087	--		1
Isopropylbenzene	ND	0.200	--	ND	0.983	--		1
4-Ethyltoluene	ND	0.020	--	ND	0.098	--		1
1,3,5-Trimethylbenzene	ND	0.020	--	ND	0.098	--		1
1,2,4-Trimethylbenzene	ND	0.020	--	ND	0.098	--		1
Benzyl chloride	ND	0.200	--	ND	1.04	--		1
1,3-Dichlorobenzene	ND	0.020	--	ND	0.120	--		1
1,4-Dichlorobenzene	ND	0.020	--	ND	0.120	--		1
sec-Butylbenzene	ND	0.200	--	ND	1.10	--		1
p-Isopropyltoluene	ND	0.200	--	ND	1.10	--		1
1,2-Dichlorobenzene	ND	0.020	--	ND	0.120	--		1
n-Butylbenzene	ND	0.200	--	ND	1.10	--		1
1,2,4-Trichlorobenzene	ND	0.050	--	ND	0.371	--		1
Naphthalene	ND	0.050	--	ND	0.262	--		1
1,2,3-Trichlorobenzene	ND	0.050	--	ND	0.371	--		1
Hexachlorobutadiene	ND	0.050	--	ND	0.533	--		1

Lab Control Sample Analysis
Batch Quality Control

Project Name: BNSF SKYKOMISH
Project Number: 683-057

Lab Number: L1620464
Report Date: 07/11/16

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
Volatile Organics in Air by SIM - Mansfield Lab Associated sample(s): 01-04 Batch: WG911224-3								
Propylene	91		-		70-130	-		25
Dichlorodifluoromethane	107		-		70-130	-		25
Chloromethane	113		-		70-130	-		25
1,2-Dichloro-1,1,2,2-tetrafluoroethane	**134**	Q	-		70-130	-		25
Vinyl chloride	124		-		70-130	-		25
1,3-Butadiene	129		-		70-130	-		25
Bromomethane	**132**	Q	-		70-130	-		25
Chloroethane	124		-		70-130	-		25
Ethyl Alcohol	117		-		70-130	-		25
Vinyl bromide	**138**	Q	-		70-130	-		25
Acetone	129		-		70-130	-		25
Trichlorofluoromethane	**140**	Q	-		70-130	-		25
iso-Propyl Alcohol	122		-		70-130	-		25
Acrylonitrile	117		-		70-130	-		25
1,1-Dichloroethene	97		-		70-130	-		25
Methylene chloride	100		-		70-130	-		25
3-Chloropropene	87		-		70-130	-		25
Carbon disulfide	92		-		70-130	-		25
1,1,2-Trichloro-1,2,2-Trifluoroethane	105		-		70-130	-		25
Halothane	104		-		70-130	-		25
trans-1,2-Dichloroethene	86		-		70-130	-		25

Lab Control Sample Analysis

Batch Quality Control

Project Name: BNSF SKYKOMISH

Project Number: 683-057

Lab Number: L1620464

Report Date: 07/11/16

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
Volatile Organics in Air by SIM - Mansfield Lab Associated sample(s): 01-04 Batch: WG911224-3								
1,1-Dichloroethane	97		-		70-130	-		25
Methyl tert butyl ether	91		-		70-130	-		25
Vinyl acetate	100		-		70-130	-		25
2-Butanone	92		-		70-130	-		25
cis-1,2-Dichloroethene	102		-		70-130	-		25
Ethyl Acetate	94		-		70-130	-		25
Chloroform	102		-		70-130	-		25
Tetrahydrofuran	87		-		70-130	-		25
1,2-Dichloroethane	96		-		70-130	-		25
n-Hexane	88		-		70-130	-		25
1,1,1-Trichloroethane	95		-		70-130	-		25
Benzene	89		-		70-130	-		25
Carbon tetrachloride	98		-		70-130	-		25
Cyclohexane	86		-		70-130	-		25
1,2-Dichloropropane	95		-		70-130	-		25
Bromodichloromethane	98		-		70-130	-		25
1,4-Dioxane	95		-		70-130	-		25
Trichloroethene	99		-		70-130	-		25
2,2,4-Trimethylpentane	94		-		70-130	-		25
cis-1,3-Dichloropropene	98		-		70-130	-		25
4-Methyl-2-pentanone	99		-		70-130	-		25

Lab Control Sample Analysis

Batch Quality Control

Project Name: BNSF SKYKOMISH

Project Number: 683-057

Lab Number: L1620464

Report Date: 07/11/16

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
Volatile Organics in Air by SIM - Mansfield Lab Associated sample(s): 01-04 Batch: WG911224-3								
trans-1,3-Dichloropropene	84		-		70-130	-		25
1,1,2-Trichloroethane	102		-		70-130	-		25
Toluene	98		-		70-130	-		25
2-Hexanone	98		-		70-130	-		25
Dibromochloromethane	106		-		70-130	-		25
1,2-Dibromoethane	106		-		70-130	-		25
Tetrachloroethene	103		-		70-130	-		25
1,1,1,2-Tetrachloroethane	100		-		70-130	-		25
Chlorobenzene	105		-		70-130	-		25
Ethylbenzene	98		-		70-130	-		25
p/m-Xylene	101		-		70-130	-		25
Bromoform	106		-		70-130	-		25
Styrene	101		-		70-130	-		25
1,1,2,2-Tetrachloroethane	111		-		70-130	-		25
o-Xylene	103		-		70-130	-		25
Isopropylbenzene	101		-		70-130	-		25
4-Ethyltoluene	106		-		70-130	-		25
1,3,5-Trimethylbenzene	97		-		70-130	-		25
1,2,4-Trimethylbenzene	112		-		70-130	-		25
Benzyl chloride	96		-		70-130	-		25
1,3-Dichlorobenzene	122		-		70-130	-		25

Lab Control Sample Analysis
Batch Quality Control

Project Name: BNSF SKYKOMISH
Lab Number: L1620464
Project Number: 683-057
Report Date: 07/11/16

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
Volatile Organics in Air by SIM - Mansfield Lab Associated sample(s): 01-04 Batch: WG911224-3								
1,4-Dichlorobenzene	111		-		70-130	-		25
sec-Butylbenzene	105		-		70-130	-		25
p-Isopropyltoluene	97		-		70-130	-		25
1,2-Dichlorobenzene	114		-		70-130	-		25
n-Butylbenzene	112		-		70-130	-		25
1,2,4-Trichlorobenzene	121		-		70-130	-		25
Naphthalene	114		-		70-130	-		25
1,2,3-Trichlorobenzene	111		-		70-130	-		25
Hexachlorobutadiene	104		-		70-130	-		25

Lab Duplicate Analysis

Batch Quality Control

Project Name: BNSF SKYKOMISH
Project Number: 683-057

Lab Number: L1620464
Report Date: 07/11/16

Parameter	Native Sample	Duplicate Sample	Units	RPD	Qual	RPD Limits
Volatile Organics in Air by SIM - Mansfield Lab Associated sample(s): 01-04 QC Batch ID: WG911224-5 QC Sample: L1620464-02 Client ID: BASE_062816						
1,3-Butadiene	ND	ND	ppbV	NC		25
Benzene	0.284	0.285	ppbV	0		25
Naphthalene	0.145	0.143	ppbV	1		25

SAMPLE RESULTS

Lab ID:	L1620464-01	Date Collected:	06/28/16 10:52
Client ID:	SYSTEM_INF_062816	Date Received:	07/01/16
Sample Location:	SKYKOMISH, WA	Field Prep:	Not Specified
Matrix:	Soil_Vapor		
Analytical Method:	96,APH		
Analytical Date:	07/08/16 09:58		
Analyst:	RY		

Quality Control Information

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
Petroleum Hydrocarbons in Air - Mansfield Lab						
1,3-Butadiene	ND		ug/m3	0.50	--	1
Methyl tert butyl ether	ND		ug/m3	0.70	--	1
Benzene	ND		ug/m3	0.60	--	1
C5-C8 Aliphatics, Adjusted	120		ug/m3	10	--	1
Toluene	2.3		ug/m3	0.90	--	1
Ethylbenzene	ND		ug/m3	0.90	--	1
p/m-Xylene	1.7		ug/m3	0.90	--	1
o-Xylene	ND		ug/m3	0.90	--	1
Naphthalene	ND		ug/m3	1.1	--	1
C9-C12 Aliphatics, Adjusted	330		ug/m3	10	--	1
C9-C10 Aromatics Total	ND		ug/m3	10	--	1

Internal Standard	% Recovery	Qualifier	Acceptance Criteria
1,4-Difluorobenzene	85		50-200
Bromochloromethane	90		50-200
Chlorobenzene-d5	78		50-200

SAMPLE RESULTS

Lab ID:	L1620464-02	Date Collected:	06/28/16 12:51
Client ID:	BASE_062816	Date Received:	07/01/16
Sample Location:	SKYKOMISH, WA	Field Prep:	Not Specified
Matrix:	Air		
Analytical Method:	96,APH		
Analytical Date:	07/08/16 01:37		
Analyst:	RY		

Quality Control Information

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
Petroleum Hydrocarbons in Air - Mansfield Lab						
1,3-Butadiene	ND		ug/m3	0.50	--	1
Methyl tert butyl ether	ND		ug/m3	0.70	--	1
Benzene	1.0		ug/m3	0.60	--	1
C5-C8 Aliphatics, Adjusted	170		ug/m3	10	--	1
Toluene	11		ug/m3	0.90	--	1
Ethylbenzene	2.0		ug/m3	0.90	--	1
p/m-Xylene	8.1		ug/m3	0.90	--	1
o-Xylene	2.7		ug/m3	0.90	--	1
Naphthalene	ND		ug/m3	1.1	--	1
C9-C12 Aliphatics, Adjusted	220		ug/m3	10	--	1
C9-C10 Aromatics Total	ND		ug/m3	10	--	1

Internal Standard	% Recovery	Qualifier	Acceptance Criteria
1,4-Difluorobenzene	87		50-200
Bromochloromethane	89		50-200
Chlorobenzene-d5	87		50-200

SAMPLE RESULTS

Lab ID:	L1620464-03	Date Collected:	06/28/16 15:32
Client ID:	FIRST_062816	Date Received:	07/01/16
Sample Location:	SKYKOMISH, WA	Field Prep:	Not Specified
Matrix:	Air		
Analytical Method:	96,APH		
Analytical Date:	07/08/16 02:46		
Analyst:	RY		

Quality Control Information

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
Petroleum Hydrocarbons in Air - Mansfield Lab						
1,3-Butadiene	ND		ug/m3	0.50	--	1
Methyl tert butyl ether	ND		ug/m3	0.70	--	1
Benzene	0.61		ug/m3	0.60	--	1
C5-C8 Aliphatics, Adjusted	46		ug/m3	10	--	1
Toluene	5.1		ug/m3	0.90	--	1
Ethylbenzene	ND		ug/m3	0.90	--	1
p/m-Xylene	2.8		ug/m3	0.90	--	1
o-Xylene	0.94		ug/m3	0.90	--	1
Naphthalene	ND		ug/m3	1.1	--	1
C9-C12 Aliphatics, Adjusted	100		ug/m3	10	--	1
C9-C10 Aromatics Total	ND		ug/m3	10	--	1

Internal Standard	% Recovery	Qualifier	Acceptance Criteria
1,4-Difluorobenzene	82		50-200
Bromochloromethane	85		50-200
Chlorobenzene-d5	80		50-200

SAMPLE RESULTS

Lab ID:	L1620464-04	Date Collected:	06/28/16 15:30
Client ID:	SECOND_062816	Date Received:	07/01/16
Sample Location:	SKYKOMISH, WA	Field Prep:	Not Specified
Matrix:	Air		
Analytical Method:	96,APH		
Analytical Date:	07/08/16 03:20		
Analyst:	RY		

Quality Control Information

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
Petroleum Hydrocarbons in Air - Mansfield Lab						
1,3-Butadiene	ND		ug/m3	0.50	--	1
Methyl tert butyl ether	ND		ug/m3	0.70	--	1
Benzene	ND		ug/m3	0.60	--	1
C5-C8 Aliphatics, Adjusted	37		ug/m3	10	--	1
Toluene	3.7		ug/m3	0.90	--	1
Ethylbenzene	ND		ug/m3	0.90	--	1
p/m-Xylene	2.3		ug/m3	0.90	--	1
o-Xylene	ND		ug/m3	0.90	--	1
Naphthalene	ND		ug/m3	1.1	--	1
C9-C12 Aliphatics, Adjusted	73		ug/m3	10	--	1
C9-C10 Aromatics Total	ND		ug/m3	10	--	1

Internal Standard	% Recovery	Qualifier	Acceptance Criteria
1,4-Difluorobenzene	81		50-200
Bromochloromethane	83		50-200
Chlorobenzene-d5	78		50-200

Method Blank Analysis
Batch Quality Control

Analytical Method: 96,APH
Analytical Date: 07/07/16 15:25
Analyst: RY

Parameter	Result	Qualifier	Units	RL	MDL
Petroleum Hydrocarbons in Air - Mansfield Lab for sample(s): 01-04 Batch: WG911227-4					
1,3-Butadiene	ND		ug/m3	0.50	--
Methyl tert butyl ether	ND		ug/m3	0.70	--
Benzene	ND		ug/m3	0.60	--
C5-C8 Aliphatics, Adjusted	ND		ug/m3	10	--
Toluene	ND		ug/m3	0.90	--
Ethylbenzene	ND		ug/m3	0.90	--
p/m-Xylene	ND		ug/m3	0.90	--
o-Xylene	ND		ug/m3	0.90	--
Naphthalene	ND		ug/m3	1.1	--
C9-C12 Aliphatics, Adjusted	ND		ug/m3	10	--
C9-C10 Aromatics Total	ND		ug/m3	10	--

Lab Control Sample Analysis

Batch Quality Control

Project Name: BNSF SKYKOMISH
Lab Number: L1620464
Project Number: 683-057
Report Date: 07/11/16

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
Petroleum Hydrocarbons in Air - Mansfield Lab Associated sample(s): 01-04 Batch: WG911227-3								
1,3-Butadiene	123		-		70-130	-		
Methyl tert butyl ether	96		-		70-130	-		
Benzene	98		-		70-130	-		
C5-C8 Aliphatics, Adjusted	98		-		70-130	-		
Toluene	94		-		70-130	-		
Ethylbenzene	96		-		70-130	-		
p/m-Xylene	97		-		70-130	-		
o-Xylene	102		-		70-130	-		
Naphthalene	114		-		50-150	-		
C9-C12 Aliphatics, Adjusted	100		-		70-130	-		
C9-C10 Aromatics Total	90		-		70-130	-		

Lab Duplicate Analysis

Batch Quality Control

Project Name: BNSF SKYKOMISH
Project Number: 683-057

Lab Number: L1620464
Report Date: 07/11/16

Parameter	Native Sample	Duplicate Sample	Units	RPD	Qual	RPD Limits
Petroleum Hydrocarbons in Air - Mansfield Lab Associated sample(s): 01-04 QC Batch ID: WG911227-5 QC Sample: L1620498-02 Client ID: DUP Sample						
1,3-Butadiene	ND	ND	ug/m3	NC		30
Methyl tert butyl ether	ND	ND	ug/m3	NC		30
Benzene	ND	ND	ug/m3	NC		30
C5-C8 Aliphatics, Adjusted	24	31	ug/m3	25		30
Toluene	2.3	2.3	ug/m3	0		30
Ethylbenzene	ND	ND	ug/m3	NC		30
p/m-Xylene	ND	ND	ug/m3	NC		30
o-Xylene	ND	ND	ug/m3	NC		30
Naphthalene	ND	ND	ug/m3	NC		30
C9-C12 Aliphatics, Adjusted	ND	ND	ug/m3	NC		30
C9-C10 Aromatics Total	ND	ND	ug/m3	NC		30

Canister and Flow Controller Information

Samplenum	Client ID	Media ID	Media Type	Date Prepared	Bottle Order	Cleaning Batch ID	Can Leak Check	Initial Pressure (in. Hg)	Pressure on Receipt (in. Hg)	Flow Controler Leak Chk	Flow Out mL/min	Flow In mL/min	% RPD
L1620464-01	SYSTEM_INF_062816	532	2.7L Can	06/20/16	224120	L1618074-01	Pass	-29.7	-15.6	-	-	-	-
L1620464-02	BASE_062816	0388	#16 AMB	06/20/16	224120		-	-	-	Pass	4.2	3.3	24
L1620464-02	BASE_062816	236	2.7L Can	06/20/16	224120	L1618074-01	Pass	-29.6	-1.7	-	-	-	-
L1620464-03	FIRST_062816	0117	#16 AMB	06/27/16	223830		-	-	-	Pass	4.5	4.5	0
L1620464-03	FIRST_062816	322	2.7L Can	06/27/16	223830	L1614964-01	Pass	-29.8	-7.1	-	-	-	-
L1620464-04	SECOND_062816	0286	#16 AMB	06/20/16	224120		-	-	-	Pass	4.5	4.4	2
L1620464-04	SECOND_062816	2031	2.7L Can	06/20/16	224120	L1618074-01	Pass	-29.7	-7.7	-	-	-	-

Project Name: BATCH CANISTER CERTIFICATION **Lab Number:** L1614964
Project Number: CANISTER QC BAT **Report Date:** 07/11/16

Air Canister Certification Results

Lab ID: L1614964-01
Client ID: CAN 322 SHELF 2
Sample Location:
Matrix: Air
Anaytical Method: 48,TO-15
Analytical Date: 05/18/16 17:38
Analyst: RY

Date Collected: 05/17/16 16:00
Date Received: 05/18/16
Field Prep: Not Specified

	ppbV			ug/m3				
Parameter	**Results**	**RL**	**MDL**	**Results**	**RL**	**MDL**	**Qualifier**	**Dilution Factor**
Volatile Organics in Air - Mansfield Lab								
Chlorodifluoromethane	ND	0.200	--	ND	0.707	--		1
Propylene	ND	0.500	--	ND	0.861	--		1
Propane	ND	0.500	--	ND	0.902	--		1
Dichlorodifluoromethane	ND	0.200	--	ND	0.989	--		1
Chloromethane	ND	0.200	--	ND	0.413	--		1
Freon-114	ND	0.200	--	ND	1.40	--		1
Methanol	ND	5.00	--	ND	6.55	--		1
Vinyl chloride	ND	0.200	--	ND	0.511	--		1
1,3-Butadiene	ND	0.200	--	ND	0.442	--		1
Butane	ND	0.200	--	ND	0.475	--		1
Bromomethane	ND	0.200	--	ND	0.777	--		1
Chloroethane	ND	0.200	--	ND	0.528	--		1
Ethanol	ND	5.00	--	ND	9.42	--		1
Dichlorofluoromethane	ND	0.200	--	ND	0.842	--		1
Vinyl bromide	ND	0.200	--	ND	0.874	--		1
Acrolein	ND	0.500	--	ND	1.15	--		1
Acetone	ND	1.00	--	ND	2.38	--		1
Acetonitrile	ND	0.200	--	ND	0.336	--		1
Trichlorofluoromethane	ND	0.200	--	ND	1.12	--		1
Isopropanol	ND	0.500	--	ND	1.23	--		1
Acrylonitrile	ND	0.500	--	ND	1.09	--		1
Pentane	ND	0.200	--	ND	0.590	--		1
Ethyl ether	ND	0.200	--	ND	0.606	--		1
1,1-Dichloroethene	ND	0.200	--	ND	0.793	--		1
Tertiary butyl Alcohol	ND	0.500	--	ND	1.52	--		1

Project Name: BATCH CANISTER CERTIFICATION
Lab Number: L1614964
Project Number: CANISTER QC BAT
Report Date: 07/11/16

Air Canister Certification Results

Lab ID: L1614964-01
Client ID: CAN 322 SHELF 2
Sample Location:
Date Collected: 05/17/16 16:00
Date Received: 05/18/16
Field Prep: Not Specified

	ppbV			ug/m3				
Parameter	**Results**	**RL**	**MDL**	**Results**	**RL**	**MDL**	**Qualifier**	**Dilution Factor**
Volatile Organics in Air - Mansfield Lab								
Methylene chloride	ND	0.500	--	ND	1.74	--		1
3-Chloropropene	ND	0.200	--	ND	0.626	--		1
Carbon disulfide	ND	0.200	--	ND	0.623	--		1
Freon-113	ND	0.200	--	ND	1.53	--		1
trans-1,2-Dichloroethene	ND	0.200	--	ND	0.793	--		1
1,1-Dichloroethane	ND	0.200	--	ND	0.809	--		1
Methyl tert butyl ether	ND	0.200	--	ND	0.721	--		1
Vinyl acetate	ND	1.00	--	ND	3.52	--		1
2-Butanone	ND	0.500	--	ND	1.47	--		1
cis-1,2-Dichloroethene	ND	0.200	--	ND	0.793	--		1
Ethyl Acetate	ND	0.500	--	ND	1.80	--		1
Chloroform	ND	0.200	--	ND	0.977	--		1
Tetrahydrofuran	ND	0.500	--	ND	1.47	--		1
2,2-Dichloropropane	ND	0.200	--	ND	0.924	--		1
1,2-Dichloroethane	ND	0.200	--	ND	0.809	--		1
n-Hexane	ND	0.200	--	ND	0.705	--		1
Diisopropyl ether	ND	0.200	--	ND	0.836	--		1
tert-Butyl Ethyl Ether	ND	0.200	--	ND	0.836	--		1
1,1,1-Trichloroethane	ND	0.200	--	ND	1.09	--		1
1,1-Dichloropropene	ND	0.200	--	ND	0.908	--		1
Benzene	ND	0.200	--	ND	0.639	--		1
Carbon tetrachloride	ND	0.200	--	ND	1.26	--		1
Cyclohexane	ND	0.200	--	ND	0.688	--		1
tert-Amyl Methyl Ether	ND	0.200	--	ND	0.836	--		1
Dibromomethane	ND	0.200	--	ND	1.42	--		1
1,2-Dichloropropane	ND	0.200	--	ND	0.924	--		1
Bromodichloromethane	ND	0.200	--	ND	1.34	--		1
1,4-Dioxane	ND	0.200	--	ND	0.721	--		1

Project Name: BATCH CANISTER CERTIFICATION
Project Number: CANISTER QC BAT
Lab Number: L1614964
Report Date: 07/11/16

Air Canister Certification Results

Lab ID: L1614964-01
Client ID: CAN 322 SHELF 2
Sample Location:
Date Collected: 05/17/16 16:00
Date Received: 05/18/16
Field Prep: Not Specified

	ppbV			ug/m3				
Parameter	**Results**	**RL**	**MDL**	**Results**	**RL**	**MDL**	**Qualifier**	**Dilution Factor**
Volatile Organics in Air - Mansfield Lab								
Trichloroethene	ND	0.200	--	ND	1.07	--		1
2,2,4-Trimethylpentane	ND	0.200	--	ND	0.934	--		1
Methyl Methacrylate	ND	0.500	--	ND	2.05	--		1
Heptane	ND	0.200	--	ND	0.820	--		1
cis-1,3-Dichloropropene	ND	0.200	--	ND	0.908	--		1
4-Methyl-2-pentanone	ND	0.500	--	ND	2.05	--		1
trans-1,3-Dichloropropene	ND	0.200	--	ND	0.908	--		1
1,1,2-Trichloroethane	ND	0.200	--	ND	1.09	--		1
Toluene	ND	0.200	--	ND	0.754	--		1
1,3-Dichloropropane	ND	0.200	--	ND	0.924	--		1
2-Hexanone	ND	0.200	--	ND	0.820	--		1
Dibromochloromethane	ND	0.200	--	ND	1.70	--		1
1,2-Dibromoethane	ND	0.200	--	ND	1.54	--		1
Butyl acetate	ND	0.500	--	ND	2.38	--		1
Octane	ND	0.200	--	ND	0.934	--		1
Tetrachloroethene	ND	0.200	--	ND	1.36	--		1
1,1,1,2-Tetrachloroethane	ND	0.200	--	ND	1.37	--		1
Chlorobenzene	ND	0.200	--	ND	0.921	--		1
Ethylbenzene	ND	0.200	--	ND	0.869	--		1
p/m-Xylene	ND	0.400	--	ND	1.74	--		1
Bromoform	ND	0.200	--	ND	2.07	--		1
Styrene	ND	0.200	--	ND	0.852	--		1
1,1,2,2-Tetrachloroethane	ND	0.200	--	ND	1.37	--		1
o-Xylene	ND	0.200	--	ND	0.869	--		1
1,2,3-Trichloropropane	ND	0.200	--	ND	1.21	--		1
Nonane	ND	0.200	--	ND	1.05	--		1
Isopropylbenzene	ND	0.200	--	ND	0.983	--		1
Bromobenzene	ND	0.200	--	ND	0.793	--		1

Project Name: BATCH CANISTER CERTIFICATION **Lab Number:** L1614964
Project Number: CANISTER QC BAT **Report Date:** 07/11/16

Air Canister Certification Results

Lab ID: L1614964-01
Client ID: CAN 322 SHELF 2
Sample Location:

Date Collected: 05/17/16 16:00
Date Received: 05/18/16
Field Prep: Not Specified

	ppbV			ug/m3				
Parameter	**Results**	**RL**	**MDL**	**Results**	**RL**	**MDL**	**Qualifier**	**Dilution Factor**
Volatile Organics in Air - Mansfield Lab								
2-Chlorotoluene	ND	0.200	--	ND	1.04	--		1
n-Propylbenzene	ND	0.200	--	ND	0.983	--		1
4-Chlorotoluene	ND	0.200	--	ND	1.04	--		1
4-Ethyltoluene	ND	0.200	--	ND	0.983	--		1
1,3,5-Trimethylbenzene	ND	0.200	--	ND	0.983	--		1
tert-Butylbenzene	ND	0.200	--	ND	1.10	--		1
1,2,4-Trimethylbenzene	ND	0.200	--	ND	0.983	--		1
Decane	ND	0.200	--	ND	1.16	--		1
Benzyl chloride	ND	0.200	--	ND	1.04	--		1
1,3-Dichlorobenzene	ND	0.200	--	ND	1.20	--		1
1,4-Dichlorobenzene	ND	0.200	--	ND	1.20	--		1
sec-Butylbenzene	ND	0.200	--	ND	1.10	--		1
p-Isopropyltoluene	ND	0.200	--	ND	1.10	--		1
1,2-Dichlorobenzene	ND	0.200	--	ND	1.20	--		1
n-Butylbenzene	ND	0.200	--	ND	1.10	--		1
1,2-Dibromo-3-chloropropane	ND	0.200	--	ND	1.93	--		1
Undecane	ND	0.200	--	ND	1.28	--		1
Dodecane	ND	0.200	--	ND	1.39	--		1
1,2,4-Trichlorobenzene	ND	0.200	--	ND	1.48	--		1
Naphthalene	ND	0.200	--	ND	1.05	--		1
1,2,3-Trichlorobenzene	ND	0.200	--	ND	1.48	--		1
Hexachlorobutadiene	ND	0.200	--	ND	2.13	--		1

	Results	**Qualifier**	**Units**	**RDL**	**Dilution Factor**
Tentatively Identified Compounds					
No Tentatively Identified Compounds					

Project Name:	BATCH CANISTER CERTIFICATION	**Lab Number:**	L1614964
Project Number:	CANISTER QC BAT	**Report Date:**	07/11/16

Air Canister Certification Results

Lab ID:	L1614964-01	Date Collected:	05/17/16 16:00
Client ID:	CAN 322 SHELF 2	Date Received:	05/18/16
Sample Location:		Field Prep:	Not Specified

	ppbV			ug/m3				
Parameter	**Results**	**RL**	**MDL**	**Results**	**RL**	**MDL**	**Qualifier**	**Dilution Factor**
Volatile Organics in Air - Mansfield Lab								

Internal Standard	% Recovery	Qualifier	Acceptance Criteria
1,4-Difluorobenzene	91		60-140
Bromochloromethane	95		60-140
chlorobenzene-d5	87		60-140

Project Name: BATCH CANISTER CERTIFICATION
Lab Number: L1614964
Project Number: CANISTER QC BAT
Report Date: 07/11/16

Air Canister Certification Results

Lab ID: L1614964-01
Client ID: CAN 322 SHELF 2
Sample Location:
Matrix: Air
Anaytical Method: 48,TO-15-SIM
Analytical Date: 05/18/16 17:38
Analyst: RY

Date Collected: 05/17/16 16:00
Date Received: 05/18/16
Field Prep: Not Specified

	ppbV			ug/m3				
Parameter	**Results**	**RL**	**MDL**	**Results**	**RL**	**MDL**	**Qualifier**	**Dilution Factor**
Volatile Organics in Air by SIM - Mansfield Lab								
Dichlorodifluoromethane	ND	0.200	--	ND	0.989	--		1
Chloromethane	ND	0.200	--	ND	0.413	--		1
Freon-114	ND	0.050	--	ND	0.349	--		1
Vinyl chloride	ND	0.020	--	ND	0.051	--		1
1,3-Butadiene	ND	0.020	--	ND	0.044	--		1
Bromomethane	ND	0.020	--	ND	0.078	--		1
Chloroethane	ND	0.020	--	ND	0.053	--		1
Acetone	ND	1.00	--	ND	2.38	--		1
Trichlorofluoromethane	ND	0.050	--	ND	0.281	--		1
Acrylonitrile	ND	0.500	--	ND	1.09	--		1
1,1-Dichloroethene	ND	0.020	--	ND	0.079	--		1
Methylene chloride	ND	0.500	--	ND	1.74	--		1
Freon-113	ND	0.050	--	ND	0.383	--		1
trans-1,2-Dichloroethene	ND	0.020	--	ND	0.079	--		1
1,1-Dichloroethane	ND	0.020	--	ND	0.081	--		1
Methyl tert butyl ether	ND	0.200	--	ND	0.721	--		1
2-Butanone	ND	0.500	--	ND	1.47	--		1
cis-1,2-Dichloroethene	ND	0.020	--	ND	0.079	--		1
Chloroform	ND	0.020	--	ND	0.098	--		1
1,2-Dichloroethane	ND	0.020	--	ND	0.081	--		1
1,1,1-Trichloroethane	ND	0.020	--	ND	0.109	--		1
Benzene	ND	0.100	--	ND	0.319	--		1
Carbon tetrachloride	ND	0.020	--	ND	0.126	--		1
1,2-Dichloropropane	ND	0.020	--	ND	0.092	--		1
Bromodichloromethane	ND	0.020	--	ND	0.134	--		1

Project Name: BATCH CANISTER CERTIFICATION
Lab Number: L1614964
Project Number: CANISTER QC BAT
Report Date: 07/11/16

Air Canister Certification Results

Lab ID: L1614964-01
Client ID: CAN 322 SHELF 2
Sample Location:
Date Collected: 05/17/16 16:00
Date Received: 05/18/16
Field Prep: Not Specified

	ppbV			ug/m3				
Parameter	**Results**	**RL**	**MDL**	**Results**	**RL**	**MDL**	**Qualifier**	**Dilution Factor**
Volatile Organics in Air by SIM - Mansfield Lab								
1,4-Dioxane	ND	0.100	--	ND	0.360	--		1
Trichloroethene	ND	0.020	--	ND	0.107	--		1
cis-1,3-Dichloropropene	ND	0.020	--	ND	0.091	--		1
4-Methyl-2-pentanone	ND	0.500	--	ND	2.05	--		1
trans-1,3-Dichloropropene	ND	0.020	--	ND	0.091	--		1
1,1,2-Trichloroethane	ND	0.020	--	ND	0.109	--		1
Toluene	ND	0.050	--	ND	0.188	--		1
Dibromochloromethane	ND	0.020	--	ND	0.170	--		1
1,2-Dibromoethane	ND	0.020	--	ND	0.154	--		1
Tetrachloroethene	ND	0.020	--	ND	0.136	--		1
1,1,1,2-Tetrachloroethane	ND	0.020	--	ND	0.137	--		1
Chlorobenzene	ND	0.100	--	ND	0.461	--		1
Ethylbenzene	ND	0.020	--	ND	0.087	--		1
p/m-Xylene	ND	0.040	--	ND	0.174	--		1
Bromoform	ND	0.020	--	ND	0.207	--		1
Styrene	ND	0.020	--	ND	0.085	--		1
1,1,2,2-Tetrachloroethane	ND	0.020	--	ND	0.137	--		1
o-Xylene	ND	0.020	--	ND	0.087	--		1
Isopropylbenzene	ND	0.200	--	ND	0.983	--		1
4-Ethyltoluene	ND	0.020	--	ND	0.098	--		1
1,3,5-Trimethybenzene	ND	0.020	--	ND	0.098	--		1
1,2,4-Trimethylbenzene	ND	0.020	--	ND	0.098	--		1
1,3-Dichlorobenzene	ND	0.020	--	ND	0.120	--		1
1,4-Dichlorobenzene	ND	0.020	--	ND	0.120	--		1
sec-Butylbenzene	ND	0.200	--	ND	1.10	--		1
p-Isopropyltoluene	ND	0.200	--	ND	1.10	--		1
1,2-Dichlorobenzene	ND	0.020	--	ND	0.120	--		1
n-Butylbenzene	ND	0.200	--	ND	1.10	--		1

Project Name:	BATCH CANISTER CERTIFICATION	**Lab Number:**	L1614964
Project Number:	CANISTER QC BAT	**Report Date:**	07/11/16

Air Canister Certification Results

Lab ID:	L1614964-01	Date Collected:	05/17/16 16:00
Client ID:	CAN 322 SHELF 2	Date Received:	05/18/16
Sample Location:		Field Prep:	Not Specified

	ppbV			**ug/m3**				
Parameter	**Results**	**RL**	**MDL**	**Results**	**RL**	**MDL**	**Qualifier**	**Dilution Factor**
Volatile Organics in Air by SIM - Mansfield Lab								
1,2,4-Trichlorobenzene	ND	0.050	--	ND	0.371	--		1
Naphthalene	ND	0.050	--	ND	0.262	--		1
1,2,3-Trichlorobenzene	ND	0.050	--	ND	0.371	--		1
Hexachlorobutadiene	ND	0.050	--	ND	0.533	--		1

Internal Standard	**% Recovery**	**Qualifier**	**Acceptance Criteria**
1,4-difluorobenzene	92		60-140
bromochloromethane	95		60-140
chlorobenzene-d5	90		60-140

Project Name: BATCH CANISTER CERTIFICATION **Lab Number:** L1618074
Project Number: CANISTER QC BAT **Report Date:** 07/11/16

Air Canister Certification Results

Lab ID: L1618074-01
Client ID: CAN 326 SHELF 2
Sample Location:
Matrix: Air
Anaytical Method: 48,TO-15
Analytical Date: 06/14/16 16:02
Analyst: RY

Date Collected: 06/13/16 16:00
Date Received: 06/14/16
Field Prep: Not Specified

	ppbV			ug/m3				
Parameter	**Results**	**RL**	**MDL**	**Results**	**RL**	**MDL**	**Qualifier**	**Dilution Factor**
Volatile Organics in Air - Mansfield Lab								
Chlorodifluoromethane	ND	0.200	--	ND	0.707	--		1
Propylene	ND	0.500	--	ND	0.861	--		1
Propane	ND	0.500	--	ND	0.902	--		1
Dichlorodifluoromethane	ND	0.200	--	ND	0.989	--		1
Chloromethane	ND	0.200	--	ND	0.413	--		1
Freon-114	ND	0.200	--	ND	1.40	--		1
Methanol	ND	5.00	--	ND	6.55	--		1
Vinyl chloride	ND	0.200	--	ND	0.511	--		1
1,3-Butadiene	ND	0.200	--	ND	0.442	--		1
Butane	ND	0.200	--	ND	0.475	--		1
Bromomethane	ND	0.200	--	ND	0.777	--		1
Chloroethane	ND	0.200	--	ND	0.528	--		1
Ethanol	ND	5.00	--	ND	9.42	--		1
Dichlorofluoromethane	ND	0.200	--	ND	0.842	--		1
Vinyl bromide	ND	0.200	--	ND	0.874	--		1
Acrolein	ND	0.500	--	ND	1.15	--		1
Acetone	ND	1.00	--	ND	2.38	--		1
Acetonitrile	ND	0.200	--	ND	0.336	--		1
Trichlorofluoromethane	ND	0.200	--	ND	1.12	--		1
Isopropanol	ND	0.500	--	ND	1.23	--		1
Acrylonitrile	ND	0.500	--	ND	1.09	--		1
Pentane	ND	0.200	--	ND	0.590	--		1
Ethyl ether	ND	0.200	--	ND	0.606	--		1
1,1-Dichloroethene	ND	0.200	--	ND	0.793	--		1
Tertiary butyl Alcohol	ND	0.500	--	ND	1.52	--		1

Air Canister Certification Results

Lab ID: L1618074-01
Client ID: CAN 326 SHELF 2
Sample Location:

Date Collected: 06/13/16 16:00
Date Received: 06/14/16
Field Prep: Not Specified

	ppbV			ug/m3				
Parameter	**Results**	**RL**	**MDL**	**Results**	**RL**	**MDL**	**Qualifier**	**Dilution Factor**
Volatile Organics in Air - Mansfield Lab								
Methylene chloride	ND	0.500	--	ND	1.74	--		1
3-Chloropropene	ND	0.200	--	ND	0.626	--		1
Carbon disulfide	ND	0.200	--	ND	0.623	--		1
Freon-113	ND	0.200	--	ND	1.53	--		1
trans-1,2-Dichloroethene	ND	0.200	--	ND	0.793	--		1
1,1-Dichloroethane	ND	0.200	--	ND	0.809	--		1
Methyl tert butyl ether	ND	0.200	--	ND	0.721	--		1
Vinyl acetate	ND	1.00	--	ND	3.52	--		1
2-Butanone	ND	0.500	--	ND	1.47	--		1
cis-1,2-Dichloroethene	ND	0.200	--	ND	0.793	--		1
Ethyl Acetate	ND	0.500	--	ND	1.80	--		1
Chloroform	ND	0.200	--	ND	0.977	--		1
Tetrahydrofuran	ND	0.500	--	ND	1.47	--		1
2,2-Dichloropropane	ND	0.200	--	ND	0.924	--		1
1,2-Dichloroethane	ND	0.200	--	ND	0.809	--		1
n-Hexane	ND	0.200	--	ND	0.705	--		1
Diisopropyl ether	ND	0.200	--	ND	0.836	--		1
tert-Butyl Ethyl Ether	ND	0.200	--	ND	0.836	--		1
1,1,1-Trichloroethane	ND	0.200	--	ND	1.09	--		1
1,1-Dichloropropene	ND	0.200	--	ND	0.908	--		1
Benzene	ND	0.200	--	ND	0.639	--		1
Carbon tetrachloride	ND	0.200	--	ND	1.26	--		1
Cyclohexane	ND	0.200	--	ND	0.688	--		1
tert-Amyl Methyl Ether	ND	0.200	--	ND	0.836	--		1
Dibromomethane	ND	0.200	--	ND	1.42	--		1
1,2-Dichloropropane	ND	0.200	--	ND	0.924	--		1
Bromodichloromethane	ND	0.200	--	ND	1.34	--		1
1,4-Dioxane	ND	0.200	--	ND	0.721	--		1

Project Name: BATCH CANISTER CERTIFICATION
Lab Number: L1618074
Project Number: CANISTER QC BAT
Report Date: 07/11/16

Air Canister Certification Results

Lab ID: L1618074-01
Client ID: CAN 326 SHELF 2
Sample Location:
Date Collected: 06/13/16 16:00
Date Received: 06/14/16
Field Prep: Not Specified

	ppbV			ug/m3				
Parameter	**Results**	**RL**	**MDL**	**Results**	**RL**	**MDL**	**Qualifier**	**Dilution Factor**
Volatile Organics in Air - Mansfield Lab								
Trichloroethene	ND	0.200	--	ND	1.07	--		1
2,2,4-Trimethylpentane	ND	0.200	--	ND	0.934	--		1
Methyl Methacrylate	ND	0.500	--	ND	2.05	--		1
Heptane	ND	0.200	--	ND	0.820	--		1
cis-1,3-Dichloropropene	ND	0.200	--	ND	0.908	--		1
4-Methyl-2-pentanone	ND	0.500	--	ND	2.05	--		1
trans-1,3-Dichloropropene	ND	0.200	--	ND	0.908	--		1
1,1,2-Trichloroethane	ND	0.200	--	ND	1.09	--		1
Toluene	ND	0.200	--	ND	0.754	--		1
1,3-Dichloropropane	ND	0.200	--	ND	0.924	--		1
2-Hexanone	ND	0.200	--	ND	0.820	--		1
Dibromochloromethane	ND	0.200	--	ND	1.70	--		1
1,2-Dibromoethane	ND	0.200	--	ND	1.54	--		1
Butyl acetate	ND	0.500	--	ND	2.38	--		1
Octane	ND	0.200	--	ND	0.934	--		1
Tetrachloroethene	ND	0.200	--	ND	1.36	--		1
1,1,1,2-Tetrachloroethane	ND	0.200	--	ND	1.37	--		1
Chlorobenzene	ND	0.200	--	ND	0.921	--		1
Ethylbenzene	ND	0.200	--	ND	0.869	--		1
p/m-Xylene	ND	0.400	--	ND	1.74	--		1
Bromoform	ND	0.200	--	ND	2.07	--		1
Styrene	ND	0.200	--	ND	0.852	--		1
1,1,2,2-Tetrachloroethane	ND	0.200	--	ND	1.37	--		1
o-Xylene	ND	0.200	--	ND	0.869	--		1
1,2,3-Trichloropropane	ND	0.200	--	ND	1.21	--		1
Nonane	ND	0.200	--	ND	1.05	--		1
Isopropylbenzene	ND	0.200	--	ND	0.983	--		1
Bromobenzene	ND	0.200	--	ND	0.793	--		1

Project Name: BATCH CANISTER CERTIFICATION
Lab Number: L1618074
Project Number: CANISTER QC BAT
Report Date: 07/11/16

Air Canister Certification Results

Lab ID: L1618074-01
Client ID: CAN 326 SHELF 2
Sample Location:
Date Collected: 06/13/16 16:00
Date Received: 06/14/16
Field Prep: Not Specified

	ppbV			ug/m3				
Parameter	**Results**	**RL**	**MDL**	**Results**	**RL**	**MDL**	**Qualifier**	**Dilution Factor**
Volatile Organics in Air - Mansfield Lab								
2-Chlorotoluene	ND	0.200	--	ND	1.04	--		1
n-Propylbenzene	ND	0.200	--	ND	0.983	--		1
4-Chlorotoluene	ND	0.200	--	ND	1.04	--		1
4-Ethyltoluene	ND	0.200	--	ND	0.983	--		1
1,3,5-Trimethylbenzene	ND	0.200	--	ND	0.983	--		1
tert-Butylbenzene	ND	0.200	--	ND	1.10	--		1
1,2,4-Trimethylbenzene	ND	0.200	--	ND	0.983	--		1
Decane	ND	0.200	--	ND	1.16	--		1
Benzyl chloride	ND	0.200	--	ND	1.04	--		1
1,3-Dichlorobenzene	ND	0.200	--	ND	1.20	--		1
1,4-Dichlorobenzene	ND	0.200	--	ND	1.20	--		1
sec-Butylbenzene	ND	0.200	--	ND	1.10	--		1
p-Isopropyltoluene	ND	0.200	--	ND	1.10	--		1
1,2-Dichlorobenzene	ND	0.200	--	ND	1.20	--		1
n-Butylbenzene	ND	0.200	--	ND	1.10	--		1
1,2-Dibromo-3-chloropropane	ND	0.200	--	ND	1.93	--		1
Undecane	ND	0.200	--	ND	1.28	--		1
Dodecane	ND	0.200	--	ND	1.39	--		1
1,2,4-Trichlorobenzene	ND	0.200	--	ND	1.48	--		1
Naphthalene	ND	0.200	--	ND	1.05	--		1
1,2,3-Trichlorobenzene	ND	0.200	--	ND	1.48	--		1
Hexachlorobutadiene	ND	0.200	--	ND	2.13	--		1

	Results	**Qualifier**	**Units**	**RDL**	**Dilution Factor**
Tentatively Identified Compounds					
No Tentatively Identified Compounds					

Project Name:	BATCH CANISTER CERTIFICATION	**Lab Number:**	L1618074
Project Number:	CANISTER QC BAT	**Report Date:**	07/11/16

Air Canister Certification Results

Lab ID:	L1618074-01	Date Collected:	06/13/16 16:00
Client ID:	CAN 326 SHELF 2	Date Received:	06/14/16
Sample Location:		Field Prep:	Not Specified

	ppbV			ug/m3				
Parameter	**Results**	**RL**	**MDL**	**Results**	**RL**	**MDL**	**Qualifier**	**Dilution Factor**
Volatile Organics in Air - Mansfield Lab								

Internal Standard	% Recovery	Qualifier	Acceptance Criteria
1,4-Difluorobenzene	92		60-140
Bromochloromethane	92		60-140
chlorobenzene-d5	90		60-140

Air Canister Certification Results

Lab ID: L1618074-01
Client ID: CAN 326 SHELF 2
Sample Location:
Matrix: Air
Anaytical Method: 48,TO-15-SIM
Analytical Date: 06/14/16 16:02
Analyst: RY

Date Collected: 06/13/16 16:00
Date Received: 06/14/16
Field Prep: Not Specified

	ppbV			**ug/m3**				
Parameter	**Results**	**RL**	**MDL**	**Results**	**RL**	**MDL**	**Qualifier**	**Dilution Factor**
Volatile Organics in Air by SIM - Mansfield Lab								
Dichlorodifluoromethane	ND	0.200	--	ND	0.989	--		1
Chloromethane	ND	0.200	--	ND	0.413	--		1
Freon-114	ND	0.050	--	ND	0.349	--		1
Vinyl chloride	ND	0.020	--	ND	0.051	--		1
1,3-Butadiene	ND	0.020	--	ND	0.044	--		1
Bromomethane	ND	0.020	--	ND	0.078	--		1
Chloroethane	ND	0.020	--	ND	0.053	--		1
Acetone	ND	1.00	--	ND	2.38	--		1
Trichlorofluoromethane	ND	0.050	--	ND	0.281	--		1
Acrylonitrile	ND	0.500	--	ND	1.09	--		1
1,1-Dichloroethene	ND	0.020	--	ND	0.079	--		1
Methylene chloride	ND	0.500	--	ND	1.74	--		1
Freon-113	ND	0.050	--	ND	0.383	--		1
Halothane	ND	0.050	--	ND	0.404	--		1
trans-1,2-Dichloroethene	ND	0.020	--	ND	0.079	--		1
1,1-Dichloroethane	ND	0.020	--	ND	0.081	--		1
Methyl tert butyl ether	ND	0.200	--	ND	0.721	--		1
2-Butanone	ND	0.500	--	ND	1.47	--		1
cis-1,2-Dichloroethene	ND	0.020	--	ND	0.079	--		1
Chloroform	ND	0.020	--	ND	0.098	--		1
1,2-Dichloroethane	ND	0.020	--	ND	0.081	--		1
1,1,1-Trichloroethane	ND	0.020	--	ND	0.109	--		1
Benzene	ND	0.100	--	ND	0.319	--		1
Carbon tetrachloride	ND	0.020	--	ND	0.126	--		1
1,2-Dichloropropane	ND	0.020	--	ND	0.092	--		1

Project Name: BATCH CANISTER CERTIFICATION
Lab Number: L1618074
Project Number: CANISTER QC BAT
Report Date: 07/11/16

Air Canister Certification Results

Lab ID: L1618074-01
Client ID: CAN 326 SHELF 2
Sample Location:
Date Collected: 06/13/16 16:00
Date Received: 06/14/16
Field Prep: Not Specified

	ppbV			ug/m3				
Parameter	**Results**	**RL**	**MDL**	**Results**	**RL**	**MDL**	**Qualifier**	**Dilution Factor**
Volatile Organics in Air by SIM - Mansfield Lab								
Bromodichloromethane	ND	0.020	--	ND	0.134	--		1
1,4-Dioxane	ND	0.100	--	ND	0.360	--		1
Trichloroethene	ND	0.020	--	ND	0.107	--		1
cis-1,3-Dichloropropene	ND	0.020	--	ND	0.091	--		1
4-Methyl-2-pentanone	ND	0.500	--	ND	2.05	--		1
trans-1,3-Dichloropropene	ND	0.020	--	ND	0.091	--		1
1,1,2-Trichloroethane	ND	0.020	--	ND	0.109	--		1
Toluene	ND	0.050	--	ND	0.188	--		1
Dibromochloromethane	ND	0.020	--	ND	0.170	--		1
1,2-Dibromoethane	ND	0.020	--	ND	0.154	--		1
Tetrachloroethene	ND	0.020	--	ND	0.136	--		1
1,1,1,2-Tetrachloroethane	ND	0.020	--	ND	0.137	--		1
Chlorobenzene	ND	0.100	--	ND	0.461	--		1
Ethylbenzene	ND	0.020	--	ND	0.087	--		1
p/m-Xylene	ND	0.040	--	ND	0.174	--		1
Bromoform	ND	0.020	--	ND	0.207	--		1
Styrene	ND	0.020	--	ND	0.085	--		1
1,1,2,2-Tetrachloroethane	ND	0.020	--	ND	0.137	--		1
o-Xylene	ND	0.020	--	ND	0.087	--		1
Isopropylbenzene	ND	0.200	--	ND	0.983	--		1
4-Ethyltoluene	ND	0.020	--	ND	0.098	--		1
1,3,5-Trimethybenzene	ND	0.020	--	ND	0.098	--		1
1,2,4-Trimethylbenzene	ND	0.020	--	ND	0.098	--		1
1,3-Dichlorobenzene	ND	0.020	--	ND	0.120	--		1
1,4-Dichlorobenzene	ND	0.020	--	ND	0.120	--		1
sec-Butylbenzene	ND	0.200	--	ND	1.10	--		1
p-Isopropyltoluene	ND	0.200	--	ND	1.10	--		1
1,2-Dichlorobenzene	ND	0.020	--	ND	0.120	--		1

Project Name: BATCH CANISTER CERTIFICATION **Lab Number:** L1618074

Project Number: CANISTER QC BAT **Report Date:** 07/11/16

Air Canister Certification Results

Lab ID: L1618074-01 Date Collected: 06/13/16 16:00

Client ID: CAN 326 SHELF 2 Date Received: 06/14/16

Sample Location: Field Prep: Not Specified

	ppbV			ug/m3				
Parameter	**Results**	**RL**	**MDL**	**Results**	**RL**	**MDL**	**Qualifier**	**Dilution Factor**
Volatile Organics in Air by SIM - Mansfield Lab								
n-Butylbenzene	ND	0.200	--	ND	1.10	--		1
1,2,4-Trichlorobenzene	ND	0.050	--	ND	0.371	--		1
Naphthalene	ND	0.050	--	ND	0.262	--		1
1,2,3-Trichlorobenzene	ND	0.050	--	ND	0.371	--		1
Hexachlorobutadiene	ND	0.050	--	ND	0.533	--		1

Internal Standard	**% Recovery**	**Qualifier**	**Acceptance Criteria**
1,4-difluorobenzene	87		60-140
bromochloromethane	90		60-140
chlorobenzene-d5	89		60-140

AIR Petro Can Certification

AIR CAN CERTIFICATION RESULTS

Lab ID: L1614964-01
Client ID: CAN 322 SHELF 2
Sample Location: Not Specified
Matrix: Air
Analytical Method: 96,APH
Analytical Date: 05/18/16 17:38
Analyst: RY

Date Collected: 05/17/16 16:00
Date Received: 05/18/16
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
Petroleum Hydrocarbons in Air						
1,3-Butadiene	ND		ug/m3	0.50	--	1
Methyl tert butyl ether	ND		ug/m3	0.70	--	1
Benzene	ND		ug/m3	0.60	--	1
C5-C8 Aliphatics, Adjusted	ND		ug/m3	10	--	1
Toluene	ND		ug/m3	0.90	--	1
Ethylbenzene	ND		ug/m3	0.90	--	1
p/m-Xylene	ND		ug/m3	0.90	--	1
o-Xylene	ND		ug/m3	0.90	--	1
Naphthalene	ND		ug/m3	1.1	--	1
C9-C12 Aliphatics, Adjusted	ND		ug/m3	10	--	1
C9-C10 Aromatics Total	ND		ug/m3	10	--	1

AIR CAN CERTIFICATION RESULTS

Lab ID:	L1618074-01	Date Collected:	06/13/16 16:00
Client ID:	CAN 326 SHELF 2	Date Received:	06/14/16
Sample Location:	Not Specified	Field Prep:	Not Specified
Matrix:	Air		
Analytical Method:	96,APH		
Analytical Date:	06/15/16 17:42		
Analyst:	RY		

Parameter	**Result**	**Qualifier**	**Units**	**RL**	**MDL**	**Dilution Factor**
Petroleum Hydrocarbons in Air						
1,3-Butadiene	ND		ug/m3	0.50	--	1
Methyl tert butyl ether	ND		ug/m3	0.70	--	1
Benzene	ND		ug/m3	0.60	--	1
C5-C8 Aliphatics, Adjusted	ND		ug/m3	10	--	1
Toluene	ND		ug/m3	0.90	--	1
Ethylbenzene	ND		ug/m3	0.90	--	1
p/m-Xylene	ND		ug/m3	0.90	--	1
o-Xylene	ND		ug/m3	0.90	--	1
Naphthalene	ND		ug/m3	1.1	--	1
C9-C12 Aliphatics, Adjusted	ND		ug/m3	10	--	1
C9-C10 Aromatics Total	ND		ug/m3	10	--	1

Project Name:	BNSF SKYKOMISH	**Lab Number:**	L1620464
Project Number:	683-057	**Report Date:**	07/11/16

Sample Receipt and Container Information

Were project specific reporting limits specified? YES

Cooler Information **Cooler**	**Custody Seal**
N/A	Absent

Container Information

Container ID	Container Type	Cooler	pH	Temp deg C	Pres	Seal	Analysis(*)
L1620464-01A	Canister - 2.7 Liter	N/A	N/A	N/A	Y	Absent	APH-10(30)
L1620464-02A	Canister - 2.7 Liter	N/A	N/A	N/A	Y	Absent	APH-10(30),TO15-SIM(30)
L1620464-03A	Canister - 2.7 Liter	N/A	N/A	N/A	Y	Absent	APH-10(30),TO15-SIM(30)
L1620464-04A	Canister - 2.7 Liter	N/A	N/A	N/A	Y	Absent	APH-10(30),TO15-SIM(30)

*Values in parentheses indicate holding time in days

GLOSSARY

Acronyms

EDL - Estimated Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the reporting limit (RL). The EDL includes any adjustments from dilutions, concentrations or moisture content, where applicable. The use of EDLs is specific to the analysis of PAHs using Solid-Phase Microextraction (SPME).

EPA - Environmental Protection Agency.

LCS - Laboratory Control Sample: A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes.

LCSD - Laboratory Control Sample Duplicate: Refer to LCS.

LFB - Laboratory Fortified Blank: A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes.

MDL - Method Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the reporting limit (RL). The MDL includes any adjustments from dilutions, concentrations or moisture content, where applicable.

MS - Matrix Spike Sample: A sample prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available.

MSD - Matrix Spike Sample Duplicate: Refer to MS.

NA - Not Applicable.

NC - Not Calculated: Term is utilized when one or more of the results utilized in the calculation are non-detect at the parameter's reporting unit.

NDPA/DPA - N-Nitrosodiphenylamine/Diphenylamine.

NI - Not Ignitable.

NP - Non-Plastic: Term is utilized for the analysis of Atterberg Limits in soil.

RL - Reporting Limit: The value at which an instrument can accurately measure an analyte at a specific concentration. The RL includes any adjustments from dilutions, concentrations or moisture content, where applicable.

RPD - Relative Percent Difference: The results from matrix and/or matrix spike duplicates are primarily designed to assess the precision of analytical results in a given matrix and are expressed as relative percent difference (RPD). Values which are less than five times the reporting limit for any individual parameter are evaluated by utilizing the absolute difference between the values; although the RPD value will be provided in the report.

SRM - Standard Reference Material: A reference sample of a known or certified value that is of the same or similar matrix as the associated field samples.

STLP - Semi-dynamic Tank Leaching Procedure per EPA Method 1315.

TIC - Tentatively Identified Compound: A compound that has been identified to be present and is not part of the target compound list (TCL) for the method and/or program. All TICs are qualitatively identified and reported as estimated concentrations.

Footnotes

1 - The reference for this analyte should be considered modified since this analyte is absent from the target analyte list of the original method.

Terms

Total: With respect to Organic analyses, a 'Total' result is defined as the summation of results for individual isomers or Aroclors. If a 'Total' result is requested, the results of its individual components will also be reported. This is applicable to 'Total' results for methods 8260, 8081 and 8082.

Analytical Method: Both the document from which the method originates and the analytical reference method. (Example: EPA 8260B is shown as 1,8260B.) The codes for the reference method documents are provided in the References section of the Addendum.

Data Qualifiers

A - Spectra identified as "Aldol Condensation Product".

B - The analyte was detected above the reporting limit in the associated method blank. Flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank. For MCP-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank. For DOD-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank AND the analyte was detected above one-half the reporting limit (or above the reporting limit for common lab contaminants) in the associated method blank. For NJ-Air-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte above the reporting limit. For NJ-related projects (excluding Air), flag only applies to associated field samples that have detectable concentrations of the analyte, which was detected above the reporting limit in the associated method blank or above five times the

Data Qualifiers

reporting limit for common lab contaminants (Phthalates, Acetone, Methylene Chloride, 2-Butanone).

C	- Co-elution: The target analyte co-elutes with a known lab standard (i.e. surrogate, internal standards, etc.) for co-extracted analyses.
D	- Concentration of analyte was quantified from diluted analysis. Flag only applies to field samples that have detectable concentrations of the analyte.
E	- Concentration of analyte exceeds the range of the calibration curve and/or linear range of the instrument.
G	- The concentration may be biased high due to matrix interferences (i.e, co-elution) with non-target compound(s). The result should be considered estimated.
H	- The analysis of pH was performed beyond the regulatory-required holding time of 15 minutes from the time of sample collection.
I	- The lower value for the two columns has been reported due to obvious interference.
M	- Reporting Limit (RL) exceeds the MCP CAM Reporting Limit for this analyte.
NJ	- Presumptive evidence of compound. This represents an estimated concentration for Tentatively Identified Compounds (TICs), where the identification is based on a mass spectral library search.
P	- The RPD between the results for the two columns exceeds the method-specified criteria.
Q	- The quality control sample exceeds the associated acceptance criteria. For DOD-related projects, LCS and/or Continuing Calibration Standard exceedences are also qualified on all associated sample results. Note: This flag is not applicable for matrix spike recoveries when the sample concentration is greater than 4x the spike added or for batch duplicate RPD when the sample concentrations are less than 5x the RL. (Metals only.)
R	- Analytical results are from sample re-analysis.
RE	- Analytical results are from sample re-extraction.
S	- Analytical results are from modified screening analysis.
J	- Estimated value. This represents an estimated concentration for Tentatively Identified Compounds (TICs).
ND	- Not detected at the reporting limit (RL) for the sample.

REFERENCES

48 Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air. Second Edition. EPA/625/R-96/010b, January 1999.

96 Method for the Determination of Air-Phase Petroleum Hydrocarbons (APH), MassDEP, December 2009, Revision 1 with QC Requirements & Performance Standards for the Analysis of APH by GC/MS under the Massachusetts Contingency Plan, WSC-CAM-IXA, July 2010.

LIMITATION OF LIABILITIES

Alpha Analytical, Inc. ID No.:**17873**
Facility: **Company-wide** Revision 6
Department: **Quality Assurance** Published Date: 2/3/2016 10:23:10 AM
Title: **Certificate/Approval Program Summary** Page 1 of 1

Certification Information

The following analytes are not included in our Primary NELAP Scope of Accreditation:

Westborough Facility
EPA 524.2: 1,2-Dibromo-3-chloropropane, 1,2-Dibromoethane, m/p-xylene, o-xylene
EPA 624: 2-Butanone (MEK), 1,4-Dioxane, tert-Amylmethyl Ether, tert-Butyl Alcohol, m/p-xylene, o-xylene
EPA 625: Aniline, Benzoic Acid, Benzyl Alcohol, 4-Chloroaniline, 3-Methylphenol, 4-Methylphenol.
EPA 1010A: NPW: Ignitability
EPA 6010C: NPW: Strontium; SCM: Strontium
EPA 8151A: NPW: 2,4-DB, Dicamba, Dichloroprop, MCPA, MCPP; SCM: 2,4-DB, Dichloroprop, MCPA, MCPP
EPA 8260C: NPW: 1,2,4,5-Tetramethylbenzene; 4-Ethyltoluene, Azobenzene, Isopropanol; SCM: Iodomethane (methyl iodide), Methyl methacrylate (soil); 1,2,4,5-Tetramethylbenzene; 4-Ethyltoluene.
EPA 8270D: NPW: Pentachloronitrobenzene, 1-Methylnaphthalene, Dimethylnaphthalene,1,4-Diphenylhydrazine; SCM: Pentachloronitrobenzene, 1-Methylnaphthalene, Dimethylnaphthalene,1,4-Diphenylhydrazine.
EPA 9010: NPW: Amenable Cyanide Distillation, Total Cyanide Distillation
EPA 9038: NPW: Sulfate
EPA 9050A: NPW: Specific Conductance
EPA 9056: NPW: Chloride, Nitrate, Sulfate
EPA 9065: NPW: Phenols
EPA 9251: NPW: Chloride
SM3500: NPW: Ferrous Iron
SM4500: NPW: Amenable Cyanide, Dissolved Oxygen; SCM: Total Phosphorus, TKN, NO2, NO3.
SM5310C: DW: Dissolved Organic Carbon

Mansfield Facility
EPA 8270D: NPW: Biphenyl; SCM: Biphenyl, Caprolactam
EPA 8270D-SIM Isotope Dilution: SCM: 1,4-Dioxane
SM 2540D: TSS
SM2540G: SCM: Percent Solids
EPA 1631E: SCM: Mercury
EPA 7474: SCM: Mercury
EPA 8081B: NPW and SCM: Mirex, Hexachlorobenzene.
EPA 8082A: NPW: PCB: 1, 5, 31, 87,101, 110, 141, 151, 153, 180, 183, 187.
EPA 8270-SIM: NPW and SCM: Alkylated PAHs.
EPA TO-15: Halothane, 2,4,4-Trimethyl-2-pentene, 2,4,4-Trimethyl-1-pentene, Thiophene, 2-Methylthiophene, 3-Methylthiophene, 2-Ethylthiophene, 1,2,3-Trimethylbenzene, Indan, Indene, 1,2,4,5-Tetramethylbenzene, Benzothiophene, 1-Methylnaphthalene, n-Butylbenzene, n-Propylbenzene, sec-Butylbenzene, tert-Butylbenzene.
Biological Tissue Matrix: ***8270D-SIM; 3050B; 3051A; 7471B; 8081B; 8082A; 6020A:*** Lead***; 8270D:*** bis(2-ethylhexyl)phthalate, Butylbenzylphthalate, Diethyl phthalate, Dimethyl phthalate, Di-n-butyl phthalate, Di-n-octyl phthalate, Fluoranthene, Pentachlorophenol.

The following analytes are included in our Massachusetts DEP Scope of Accreditation, Westborough Facility:

Drinking Water
EPA 200.8: Sb,As,Ba,Be,Cd,Cr,Cu,Pb,Ni,Se,Tl; **EPA 200.7**: Ba,Be,Ca,Cd,Cr,Cu,Na; **EPA 245.1:** Mercury;
EPA 300.0: Nitrate-N, Fluoride, Sulfate; **EPA 353.2**: Nitrate-N, Nitrite-N; **SM4500NO3-F**: Nitrate-N, Nitrite-N; **SM4500F-C, SM4500CN-CE, EPA 180.1, SM2130B, SM4500Cl-D, SM2320B, SM2540C, SM4500H-B**
EPA 332: Perchlorate.
Microbiology: **SM9215B; SM9223-P/A, SM9223B-Colilert-QT, Enterolert-QT.**

Non-Potable Water
EPA 200.8: Al,Sb,As,Be,Cd,Cr,Cu,Pb,Mn,Ni,Se,Ag,Tl,Zn;
EPA 200.7: Al,Sb,As,Be,Cd,Ca,Cr,Co,Cu,Fe,Pb,Mg,Mn,Mo,Ni,K,Se,Ag,Na,Sr,Ti,Tl,V,Zn;
EPA 245.1, SM4500H,B, EPA 120.1, SM2510B, SM2540C, SM2340B, SM2320B, SM4500CL-E, SM4500F-BC, SM426C, SM4500NH3-BH, **EPA 350.1**: Ammonia-N, **LACHAT 10-107-06-1-B**: Ammonia-N, **SM4500NO3-F,**
EPA 353.2: Nitrate-N**, SM4500NH3-BC-NES, EPA 351.1, SM4500P-E, SM4500P-B, E, SM5220D, EPA 410.4, SM5210B, SM5310C, SM4500CL-D, EPA 1664, SM14 510AC, EPA 420.1, SM4500-CN-CE, SM2540D.**
EPA 624: Volatile Halocarbons & Aromatics,
EPA 608: Chlordane, Toxaphene, Aldrin, alpha-BHC, beta-BHC, gamma-BHC, delta-BHC, Dieldrin, DDD, DDE, DDT, Endosulfan I, Endosulfan II, Endosulfan sulfate, Endrin, Endrin Aldehyde, Heptachlor, Heptachlor Epoxide, PCBs
EPA 625: SVOC (Acid/Base/Neutral Extractables), **EPA 600/4-81-045**: PCB-Oil.
Microbiology: **SM9223B-Colilert-QT; Enterolert-QT, SM9222D-MF**.

For a complete listing of analytes and methods, please contact your Alpha Project Manager.

AIR ANALYSIS

PAGE 1 OF 1

CHAIN OF CUSTODY

ALPHA ANALYTICAL
320 Forbes Blvd, Mansfield, MA 02048
TEL: 508-822-9300 FAX: 508-822-3288

Date Rec'd in Lab: 7/1/16

ALPHA Job #: L1620464

Client Information

Client: FARALLON
Address: 975 5th AVE NW
ISSAQUAH WA 98027
Phone: (425)295 0800
Fax: (425)295 0850
Email: RLutton@FARALLONCONSULTING.com
☐ These samples have been previously analyzed by Alpha

Project Information

Project Name: BNSF SKYKOMISH
Project Location: SKYKOMISH, WA
Project #: 683-057
Project Manager: R. LUTTON
ALPHA Quote #:

Turn-Around Time

☐ Standard ☐ RUSH *(only confirmed if pre-approved!)*

Date Due: Time:

Report Information - Data Deliverables

☐ FAX
☐ ADEx
Criteria Checker:
(Default based on Regulatory Criteria Indicated)
Other Formats:
☒ EMAIL (standard pdf report)
☒ Additional Deliverables: EDD
Report to: (if different than Project Manager)

Billing Information

☐ Same as Client info PO #:

Regulatory Requirements/Report Limits

State/Fed	Program	Res / Comm

Other Project Specific Requirements/Comments:

Project-Specific Target Compound List: ☐ TO-15 SIM FOR 1,3-BUTADIENE, BENZENE, NAPHTHALENE

All Columns Below Must Be Filled Out

ALPHA Lab ID (Lab Use Only)	Sample ID	COLLECTION End Date	Start Time	End Time	Initial Vacuum	Final Vacuum	Sample Matrix*	Sampler's Initials	Can Size	I D Can	I D - Flow Controller	ANALYSIS TO-15	TO-15 SIM	APH ☐ Subtract Non-petroleum HCs	Fixed Gases	Sulfides & Mercaptans by TO-15			Sample Comments (i.e. PID)
20464-01	SYSTEM_INF_062816	6/28/16	1052	1052	720.0	4.0	SV	RL	2.7	532	—		✓	✓					
-02	BASE_062816	6/28/16	0752	1251	29.15	1.16	AA	RL	2.7	236	388		↓	↓					
-03	FIRST_062816	6/28/16	0754	1532	-29.24	-6.60	AA	RL	2.7	322	117		↓	↓					
-04	SECOND_062816	6/28/16	0755	1530	-29.30	-6.97	AA	RL	2.7	201	286		↓	↓					

***SAMPLE MATRIX CODES**
AA = Ambient Air (Indoor/Outdoor)
SV = Soil Vapor/Landfill Gas/SVE
Other = Please Specify

Container Type

Relinquished By:	Date/Time	Received By:	Date/Time:
	6/28/16 1630	UPS	
UPS			7/1/16 12:51

Please print clearly, legibly and completely. Samples can not be logged in and turnaround time clock will not start until any ambiguities are resolved. All samples submitted are subject to Alpha's Terms and Conditions. See reverse side.

Form No: 101-02 Rev (25-Sep-15)

Fremont Analytical
3600 Fremont Ave. N.
Seattle, WA 98103
T: (206) 352-3790
F: (206) 352-7178
info@fremontanalytical.com

Farallon Consulting
Andrew Vining
975 5th Ave NW
Issaquah, WA 98027

RE: SKY HWF SYSTEM
Lab ID: 1608161

August 25, 2016

Attention Andrew Vining:

Fremont Analytical, Inc. received 1 sample(s) on 8/18/2016 for the analyses presented in the following report.

Petroleum Fractionation by EPA Method TO-15

Volatile Organic Compounds-EPA Method TO-15 (SIM)

This report consists of the following:

- Case Narrative
- Analytical Results
- Applicable Quality Control Summary Reports
- Chain of Custody

All analyses were performed consistent with the Quality Assurance program of Fremont Analytical, Inc. Please contact the laboratory if you should have any questions about the results.

Thank you for using Fremont Analytical.

Sincerely,

Michael C. Ridgeway

Mike Ridgeway
Laboratory Director

DoD/ELAP Certification #L2371, ISO/ICC 17025:2005
ORELAP Certification: WA 100009-007 (NELAP Recognized)

Date: *08/25/2016*

CLIENT: Farallon Consulting
Project: SKY HWF SYSTEM
Lab Order: 1608161

Work Order Sample Summary

Lab Sample ID	Client Sample ID	Date/Time Collected	Date/Time Received
1608161-001	SYSTEM_INF_081716	08/17/2016 12:00 PM	08/18/2016 11:34 AM

Note: If no "Time Collected" is supplied, a default of 12:00AM is assigned

Case Narrative

WO#: **1608161**
Date: **8/25/2016**

CLIENT: Farallon Consulting
Project: SKY HWF SYSTEM

WorkOrder Narrative:
I. SAMPLE RECEIPT:
Samples receipt information is recorded on the attached Sample Receipt Checklist.

II. GENERAL REPORTING COMMENTS:
Air samples are reported in ppbv and/or ug/m3.

The validity of the analytical procedures for which data is reported in this analytical report is determined by the Laboratory Control Sample (LCS) and the Method Blank (MB). The LCS and the MB are processed with the samples to ensure method criteria are achieved throughout the entire analytical process.

III. ANALYSES AND EXCEPTIONS:
Exceptions associated with this report will be footnoted in the analytical results page(s) or the quality control summary page(s) and/or noted below.

Standard temperature and pressure assumes 24.45 = (25C and 1 atm).

Qualifiers:

* - Flagged value is not within established control limits
B - Analyte detected in the associated Method Blank
D - Dilution was required
E - Value above quantitation range
H - Holding times for preparation or analysis exceeded
I - Analyte with an internal standard that does not meet established acceptance criteria
J - Analyte detected below Reporting Limit
N - Tentatively Identified Compound (TIC)
Q - Analyte with an initial or continuing calibration that does not meet established acceptance criteria (<20%RSD, <20% Drift or minimum RRF)
S - Spike recovery outside accepted recovery limits
ND - Not detected at the Reporting Limit
R - High relative percent difference observed

Acronyms:

%Rec - Percent Recovery
CCB - Continued Calibration Blank
CCV - Continued Calibration Verification
DF - Dilution Factor
HEM - Hexane Extractable Material
ICV - Initial Calibration Verification
LCS/LCSD - Laboratory Control Sample / Laboratory Control Sample Duplicate
MB or MBLANK - Method Blank
MDL - Method Detection Limit
MS/MSD - Matrix Spike / Matrix Spike Duplicate
PDS - Post Digestion Spike
Ref Val - Reference Value
RL - Reporting Limit
RPD - Relative Percent Difference
SD - Serial Dilution
SGT - Silica Gel Treatment
SPK - Spike
Surr - Surrogate

Client: **Farallon Consulting**
WorkOrder: 1608161
Project: SKY HWF SYSTEM

Client Sample ID:	SYSTEM_INF_081716	**Date Sampled:**	8/17/2016
Lab ID:	1608161-001A	**Date Received:**	8/18/2016
Sample Type:	Summa Canister		

Volatile Organic Compounds-EPA Method TO-15 (SIM)

Analyte	**Concentration**		**Reporting Limit**		**Qual**	**Method**	**Date/Analyst**	
	(ppbv)	**(ug/m^3)**	**(ppbv)**	**(ug/m^3)**				
1,3-Butadiene	<0.500	<1.11	0.500	1.11		EPA-TO-15SIM	08/23/2016	BC
Benzene	<0.0400	<0.128	0.0400	0.128		EPA-TO-15SIM	08/23/2016	BC
Naphthalene	<0.300	<1.57	0.300	1.57		EPA-TO-15SIM	08/23/2016	BC
Surr: 4-Bromofluorobenzene	112 %Rec	--	70-130	--		EPA-TO-15SIM	08/23/2016	BC

Analytical Report

WO#: **1608161**
Date Reported: **8/25/2016**

Client: Farallon Consulting
Collection Date: 8/17/2016 12:00:00 PM
Project: SKY HWF SYSTEM
Lab ID: 1608161-001
Matrix: Air
Client Sample ID: **SYSTEM_INF_081716**

Petroleum Fractionation by EPA Method TO-15

Batch ID: R31368 Analyst: BC

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
1,2,3-Trimethylbenzene	ND	1.41		µg/m³	1	8/24/2016 11:56:00 AM
1,3,5-Trimethylbenzene	ND	1.27		µg/m³	1	8/24/2016 11:56:00 AM
1-methyl-3-ethylbenzene	ND	1.29		µg/m³	1	8/24/2016 11:56:00 AM
2,3-Dimethylheptane	ND	1.04		µg/m³	1	8/24/2016 11:56:00 AM
2,3-Dimethylpentane	ND	0.970		µg/m³	1	8/24/2016 11:56:00 AM
Aliphatic Hydrocarbon (EC5-8)	622	147		µg/m³	1	8/24/2016 11:56:00 AM
Aliphatic Hydrocarbon (EC9-12)	504	94.2		µg/m³	1	8/24/2016 11:56:00 AM
Aromatic Hydrocarbon (EC9-10)	ND	4.54		µg/m³	1	8/24/2016 11:56:00 AM
Butylcyclohexane	ND	2.21		µg/m³	1	8/24/2016 11:56:00 AM
Cyclohexane	ND	1.18		µg/m³	1	8/24/2016 11:56:00 AM
Decane	ND	1.26		µg/m³	1	8/24/2016 11:56:00 AM
Dodecane	ND	8.35		µg/m³	1	8/24/2016 11:56:00 AM
Ethylbenzene	ND	0.690		µg/m³	1	8/24/2016 11:56:00 AM
Heptane	ND	0.650		µg/m³	1	8/24/2016 11:56:00 AM
Hexane	ND	0.630		µg/m³	1	8/24/2016 11:56:00 AM
Isopentane	38.6	1.02	*	µg/m³	1	8/24/2016 11:56:00 AM
Isopropylbenzene	ND	0.850		µg/m³	1	8/24/2016 11:56:00 AM
m,p-Xylene	3.29	0.730		µg/m³	1	8/24/2016 11:56:00 AM
Methyl tert-butyl ether (MTBE)	ND	0.450		µg/m³	1	8/24/2016 11:56:00 AM
Nonane	ND	1.24		µg/m³	1	8/24/2016 11:56:00 AM
Octane	ND	1.13		µg/m³	1	8/24/2016 11:56:00 AM
o-Xylene	ND	1.15		µg/m³	1	8/24/2016 11:56:00 AM
p-isopropyltoluene	ND	1.83		µg/m³	1	8/24/2016 11:56:00 AM
Toluene	ND	0.740		µg/m³	1	8/24/2016 11:56:00 AM
Undecane	ND	2.69		µg/m³	1	8/24/2016 11:56:00 AM
Surr: 4-Bromofluorobenzene	128	70-130		%Rec	1	8/24/2016 11:56:00 AM

NOTES:
* - Flagged value is not within established control limits.

Work Order: 1608161
CLIENT: Farallon Consulting
Project: SKY HWF SYSTEM

QC SUMMARY REPORT

Petroleum Fractionation by EPA Method TO-15

Sample ID **LCS-R31368** SampType: **LCS** Units: **µg/m³** Prep Date: **8/24/2016** RunNo: **31368**
Client ID: **LCSW** Batch ID: **R31368** Analysis Date: **8/24/2016** SeqNo: **591636**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
1,2,3-Trimethylbenzene	23.4	1.41	24.58	0	95.0	70	130				
1,3,5-Trimethylbenzene	22.8	1.27	24.58	0	92.6	70	130				
1-methyl-3-ethylbenzene	24.9	1.29	24.58	0	101	70	130				
2,3-Dimethylheptane	30.8	1.04	26.23	0	118	70	130				
2,3-Dimethylpentane	26.3	0.970	20.49	0	128	70	130				
Aliphatic Hydrocarbon (EC5-8)	110	147	113.9	0	96.9	70	130				
Aliphatic Hydrocarbon (EC9-12)	178	94.2	177.0	0	101	70	130				
Aromatic Hydrocarbon (EC9-10)	117	4.54	125.8	0	93.0	70	130				
Butylcyclohexane	31.1	2.21	28.69	0	108	70	130				
Cyclohexane	27.1	1.18	17.21	0	157	70	130				S
Decane	35.5	1.26	29.10	0	122	70	130				
Dodecane	43.0	8.35	34.83	0	124	70	130				
Ethylbenzene	22.4	0.690	21.71	0	103	70	130				
Heptane	28.4	0.650	20.49	0	139	70	130				S
Hexane	25.7	0.630	17.62	0	146	70	130				S
Isopentane	22.5	1.02	14.75	0	152	70	130				S
Isopropylbenzene	25.3	0.850	24.58	0	103	70	130				
m,p-Xylene	45.5	0.730	43.42	0	105	70	130				
Methyl tert-butyl ether (MTBE)	20.8	0.450	18.03	0	115	70	130				
Nonane	35.8	1.24	26.23	0	136	70	130				S
Octane	30.6	1.13	23.36	0	131	70	130				S
o-Xylene	20.8	1.15	21.71	0	95.7	70	130				
p-isopropyltoluene	28.8	1.83	27.45	0	105	70	130				
Toluene	19.7	0.740	18.84	0	104	70	130				
Undecane	38.5	2.69	31.97	0	120	70	130				
Surr: 4-Bromofluorobenzene	10.3		10.00		103	70	130				

NOTES:

S - Outlying spike recovery observed (high bias). Detections will be qualified with a *.

Work Order: 1608161
CLIENT: Farallon Consulting
Project: SKY HWF SYSTEM

QC SUMMARY REPORT

Petroleum Fractionation by EPA Method TO-15

Sample ID **MB-R31368** SampType: **MBLK** Units: **µg/m³** Prep Date: **8/24/2016** RunNo: **31368**
Client ID: **MBLKW** Batch ID: **R31368** Analysis Date: **8/24/2016** SeqNo: **591637**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
1,2,3-Trimethylbenzene	ND	1.41									
1,3,5-Trimethylbenzene	ND	1.27									
1-methyl-3-ethylbenzene	ND	1.29									
2,3-Dimethylheptane	ND	1.04									
2,3-Dimethylpentane	ND	0.970									
Aliphatic Hydrocarbon (EC5-8)	ND	147									
Aliphatic Hydrocarbon (EC9-12)	ND	94.2									
Aromatic Hydrocarbon (EC9-10)	ND	4.54									
Butylcyclohexane	ND	2.21									
Cyclohexane	ND	1.18									
Decane	ND	1.26									
Dodecane	ND	8.35									
Ethylbenzene	ND	0.690									
Heptane	ND	0.650									
Hexane	ND	0.630									
Isopentane	ND	1.02									
Isopropylbenzene	ND	0.850									
m,p-Xylene	ND	0.730									
Methyl tert-butyl ether (MTBE)	ND	0.450									
Nonane	ND	1.24									
Octane	ND	1.13									
o-Xylene	ND	1.15									
p-isopropyltoluene	ND	1.83									
Toluene	ND	0.740									
Undecane	ND	2.69									
Surr: 4-Bromofluorobenzene	10.2		10.00		102	70	130				

Work Order: 1608161
CLIENT: Farallon Consulting
Project: SKY HWF SYSTEM

QC SUMMARY REPORT

Petroleum Fractionation by EPA Method TO-15

Sample ID **1608190-001AREP** SampType: **REP** Units: **µg/m³** Prep Date: **8/24/2016** RunNo: **31368**
Client ID: **BATCH** Batch ID: **R31368** Analysis Date: **8/24/2016** SeqNo: **591634**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
1,2,3-Trimethylbenzene	ND	1.41						0		30	
1,3,5-Trimethylbenzene	ND	1.27						0		30	
1-methyl-3-ethylbenzene	ND	1.29						0		30	
2,3-Dimethylheptane	ND	1.04						0		30	
2,3-Dimethylpentane	ND	0.970						0		30	
Aliphatic Hydrocarbon (EC5-8)	157	147						150.2	4.16	30	
Aliphatic Hydrocarbon (EC9-12)	ND	94.2						254.4	107	30	R
Aromatic Hydrocarbon (EC9-10)	ND	4.54						0		30	
Butylcyclohexane	ND	2.21						0		30	
Cyclohexane	ND	1.18						0		30	
Decane	ND	1.26						0		30	
Dodecane	ND	8.35						0		30	
Ethylbenzene	ND	0.690						0		30	
Heptane	ND	0.650						0		30	
Hexane	ND	0.630						0		30	
Isopentane	25.7	1.02						25.68	0	30	*
Isopropylbenzene	ND	0.850						0		30	
m,p-Xylene	ND	0.730						0		30	
Methyl tert-butyl ether (MTBE)	ND	0.450						0		30	
Nonane	ND	1.24						0		30	
Octane	ND	1.13						0		30	
o-Xylene	ND	1.15						0		30	
p-isopropyltoluene	ND	1.83						0		30	
Toluene	ND	0.740						0		30	
Undecane	ND	2.69						0		30	
Surr: 4-Bromofluorobenzene	10.6		10.00		106	70	130		0		

NOTES:
R - High RPD observed. The method is in control as indicated by the LCS.
* - Flagged value is not within established control limits.

Work Order: 1608161
CLIENT: Farallon Consulting
Project: SKY HWF SYSTEM

QC SUMMARY REPORT

Volatile Organic Compounds-EPA Method TO-15 (SIM)

Sample ID **LCS-R31353** SampType: **LCS** Units: **ppbv** Prep Date: **8/23/2016** RunNo: **31353**
Client ID: **LCSW** Batch ID: **R31353** Analysis Date: **8/23/2016** SeqNo: **591342**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
1,3-Butadiene	2.21	0.500	2.500	0	88.4	70	130				
Benzene	2.25	0.0400	2.500	0	90.0	70	130				
Naphthalene	2.20	0.300	2.500	0	88.0	70	130				
Surr: 4-Bromofluorobenzene	9.92		10.00		99.2	70	130				

Sample ID **MB-R31353** SampType: **MBLK** Units: **ppbv** Prep Date: **8/23/2016** RunNo: **31353**
Client ID: **MBLKW** Batch ID: **R31353** Analysis Date: **8/23/2016** SeqNo: **591343**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
1,3-Butadiene	ND	0.500									
Benzene	ND	0.0400									
Naphthalene	ND	0.300									
Surr: 4-Bromofluorobenzene	9.57		10.00		95.7	70	130				

Sample ID **1608161-001AREP** SampType: **REP** Units: **ppbv** Prep Date: **8/23/2016** RunNo: **31353**
Client ID: **SYSTEM_INF_081716** Batch ID: **R31353** Analysis Date: **8/23/2016** SeqNo: **591341**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
1,3-Butadiene	ND	0.500						0		30	
Benzene	ND	0.0400						0		30	
Naphthalene	ND	0.300						0		30	
Surr: 4-Bromofluorobenzene	11.8		10.00		118	70	130		0		

Fremont Analytical

Sample Log-In Check List

Client Name: **FARA**
Logged by: **Erica Silva**
Work Order Number: **1608161**
Date Received: **8/18/2016 11:34:00 AM**

Chain of Custody

1. Is Chain of Custody complete? Yes ☑ No ☐ Not Present ☐
2. How was the sample delivered? Courier

Log In

3. Coolers are present? Yes ☐ No ☑ NA ☐
   Air sample
4. Shipping container/cooler in good condition? Yes ☑ No ☐
5. Custody Seals present on shipping container/cooler? (Refer to comments for Custody Seals not intact) Yes ☐ No ☐ Not Required ☑
6. Was an attempt made to cool the samples? Yes ☐ No ☐ NA ☑
7. Were all items received at a temperature of >0°C to 10.0°C* Yes ☐ No ☐ NA ☑
8. Sample(s) in proper container(s)? Yes ☑ No ☐
9. Sufficient sample volume for indicated test(s)? Yes ☑ No ☐
10. Are samples properly preserved? Yes ☑ No ☐
11. Was preservative added to bottles? Yes ☐ No ☑ NA ☐
12. Is there headspace in the VOA vials? Yes ☐ No ☐ NA ☑
13. Did all samples containers arrive in good condition(unbroken)? Yes ☑ No ☐
14. Does paperwork match bottle labels? Yes ☑ No ☐
15. Are matrices correctly identified on Chain of Custody? Yes ☑ No ☐
16. Is it clear what analyses were requested? Yes ☑ No ☐
17. Were all holding times able to be met? Yes ☑ No ☐

Special Handling (if applicable)

18. Was client notified of all discrepancies with this order? Yes ☐ No ☐ NA ☑

Person Notified: ______ Date ______
By Whom: ______ Via: ☐ eMail ☐ Phone ☐ Fax ☐ In Person
Regarding: ______
Client Instructions: ______

19. Additional remarks:

Item Information

* Note: DoD/ELAP and TNI require items to be received at 4°C +/- 2°C

Fremont Analytical
3600 Fremont Ave N.
Seattle, WA 98103
Tel: 206-352-3790
Fax: 206-352-7178

Air Chain of Custody Record & Laboratory Services Agreement

Laboratory Project No (Internal): 1608161

Date: 8-17-16 Page: 1 of: 1

Project Name: SKY HWF SYSTEM

Project No: 683-057 Collected by: A. Vinino

Location: Skykomish, WA

Reports To (PM): Andrew Vinino

Email (PM): avining@farallonconsulting.com

Client: Farallon Consulting

Address: 975 5TH Ave. NW

City, State, Zip: Issaquah, WA 98027

Telephone: 425-765-4501 Fax: 425-295-0850

* Gas Matrix Codes: I = Indoor SS = Subslab L = Landfill SG = Soil Gas M = Plume Mapping Q = Fuel Gas Quality L = LEED (Consult Client Services)

** Container Codes: 6L = Six Liter Canister (Summa) TB = Tedlar Bag BV = 1 Liter Bottle Vac MC = 1 Liter MiniCan HP = High Pressure Cylinder HJ = Glass Headspace Jar

							Internal						Internal	
Sample Name	Canister / Flow Reg Serial #	Sample Date & Time	Gas Matrix Code *	Anticipated Fill Time	Sample Volume	Container Type **	Evacuation Pressure (mtorr)	Pressure at Time of Pick-up (" Hg)	Equipment Certificaton Code	Field Initial Sample Pressure (" Hg)	Field Final Sample Pressure (" Hg)	Analysis Requested	Receipt Date	Final Pressure ("Hg)
1 SYSTEM_INF_081716	17242 Canister NA Flow Reg	8-17-16 12:00 Date 12:00 Time	SG	Grab	6L	Summa	10mtorr Pressure 7/27/16 12:00 Date	~~29~~ av Pressure Date/Time	Container Regulator	29 Pressure ~~12~~ av 11:59 Time	6 Pressure 12:00 Time	APH Fractionation & TO-15 SIM - 1,3-Butadiene, Benzene, Naphthalene	8/18	-7
4	Canister Flow Reg	Date Time					Pressure Date	Pressure Date/Time	Container Regulator	Pressure Time	Pressure Time			
4	Canister Flow Reg	Date Time					Pressure Date	Pressure Date/Time	Container Regulator	Pressure Time	Pressure Time			
4	Canister Flow Reg	Date Time					Pressure Date	Pressure Date/Time	Container Regulator	Pressure Time	Pressure Time			
5	Canister Flow Reg	Date Time					Pressure Date	Pressure Date/Time	Container Regulator	Pressure Time	Pressure Time			

Condition:

Seals Intact: Y N N/A

Turn-around times for samples received after 4:00pm will begin on the following business day.

Special Remarks:

I represent that I am authorized to enter into this Agreement with Fremont Analytical on behalf of the Client named above, that I have verified Client's agreement to each of the terms on the front and backside of this Agreement.

Relinquished x Date/Time 8-18-16 Received x Date/Time 8/18/16 11:34

Relinquished x Date/Time Received x Date/Time

TAT --> STD Rush (specify)

ANALYTICAL REPORT

Lab Number:	L1630490
Client:	Farallon Consulting, L.L.C. 975 5th Avenue Northwest Issaquah, WA 98027
ATTN:	Andrew Vining
Phone:	(425) 295-0800
Project Name:	SKYKOMISH HWF
Project Number:	683-057
Report Date:	10/04/16

Certifications & Approvals: NY (11627), CT (PH-0141), NH (2206), NJ NELAP (MA015), RI (LAO00299), ME (MA00030), PA (68-02089), VA (460194), LA NELAP (03090), FL (E87814), TX (T104704419), WA (C954), USFWS (Permit #LE2069641), USDA (Permit #P330-11-00109), US Army Corps of Engineers.

320 Forbes Boulevard, Mansfield, MA 02048-1806
508-822-9300 (Fax) 508-822-3288 800-624-9220 - www.alphalab.com

Project Name: SKYKOMISH HWF
Project Number: 683-057

Lab Number: L1630490
Report Date: 10/04/16

Alpha Sample ID	Client ID	Matrix	Sample Location	Collection Date/Time	Receive Date
L1630490-01	SYSTEM_INF_092316	AIR	SKYKOMISH, WA	09/23/16 09:36	09/27/16

Case Narrative

The samples were received in accordance with the Chain of Custody and no significant deviations were encountered during the preparation or analysis unless otherwise noted. Sample Receipt, Container Information, and the Chain of Custody are located at the back of the report.

Results contained within this report relate only to the samples submitted under this Alpha Lab Number and meet NELAP requirements for all NELAP accredited parameters unless otherwise noted in the following narrative. The data presented in this report is organized by parameter (i.e. VOC, SVOC, etc.). Sample specific Quality Control data (i.e. Surrogate Spike Recovery) is reported at the end of the target analyte list for each individual sample, followed by the Laboratory Batch Quality Control at the end of each parameter. Tentatively Identified Compounds (TICs), if requested, are reported for compounds identified to be present and are not part of the method/program Target Compound List, even if only a subset of the TCL are being reported. If a sample was re-analyzed or re-extracted due to a required quality control corrective action and if both sets of data are reported, the Laboratory ID of the re-analysis or re-extraction is designated with an "R" or "RE", respectively. When multiple Batch Quality Control elements are reported (e.g. more than one LCS), the associated samples for each element are noted in the grey shaded header line of each data table. Any Laboratory Batch, Sample Specific % recovery or RPD value that is outside the listed Acceptance Criteria is bolded in the report. All specific QC information is also incorporated in the Data Usability format of our Data Merger tool where it can be reviewed along with any associated usability implications. Soil/sediments, solids and tissues are reported on a dry weight basis unless otherwise noted. Definitions of all data qualifiers and acronyms used in this report are provided in the Glossary located at the back of the report.

In reference to questions H (CAM) or 4 (RCP) when "NO" is checked, the performance criteria for CAM and RCP methods allow for some quality control failures to occur and still be within method compliance. In these instances the specific failure is not narrated but noted in the associated QC table. The information is also incorporated in the Data Usability format of our Data Merger tool where it can be reviewed along with any associated usability implications.

Please see the associated ADEx data file for a comparison of laboratory reporting limits that were achieved with the regulatory Numerical Standards requested on the Chain of Custody.

HOLD POLICY

For samples submitted on hold, Alpha's policy is to hold samples (with the exception of Air canisters) free of charge for 21 calendar days from the date the project is completed. After 21 calendar days, we will dispose of all samples submitted including those put on hold unless you have contacted your Client Service Representative and made arrangements for Alpha to continue to hold the samples. Air canisters will be disposed after 3 business days from the date the project is completed.

Please contact Client Services at 800-624-9220 with any questions.

Case Narrative (continued)

Volatile Organics in Air

Canisters were released from the laboratory on September 19, 2016. The canister certification results are provided as an addendum.

Petroleum Hydrocarbons in Air

Sample L1630490-01: Isopropyl Alcohol, Trichloromethane, and multiple siloxanes are present in the C5-C8 Aliphatic Hydrocarbon range. The response for these analytes was not included in the calculation of the C5-C8 range result since they are not petroleum hydrocarbons.

Sample L1630490-01: Multiple siloxanes are present in the C9-C12 Aliphatic Hydrocarbon range. The response for these analytes was not included in the calculation of the C9-C12 range result since they are not petroleum hydrocarbons.

I, the undersigned, attest under the pains and penalties of perjury that, to the best of my knowledge and belief and based upon my personal inquiry of those responsible for providing the information contained in this analytical report, such information is accurate and complete. This certificate of analysis is not complete unless this page accompanies any and all pages of this report.

Authorized Signature: Christopher J Anderson Christopher J. Anderson

Title: Technical Director/Representative Date: 10/04/16

AIR

SAMPLE RESULTS

Lab ID: L1630490-01
Client ID: SYSTEM_INF_092316
Sample Location: SKYKOMISH, WA
Matrix: Air
Anaytical Method: 48,TO-15-SIM
Analytical Date: 09/30/16 22:16
Analyst: RY

Date Collected: 09/23/16 09:36
Date Received: 09/27/16
Field Prep: Not Specified

	ppbV			ug/m3				
Parameter	**Results**	**RL**	**MDL**	**Results**	**RL**	**MDL**	**Qualifier**	**Dilution Factor**
Volatile Organics in Air by SIM - Mansfield Lab								
1,3-Butadiene	ND	0.020	--	ND	0.044	--		1
Benzene	0.168	0.100	--	0.537	0.319	--		1
Naphthalene	0.287	0.050	--	1.50	0.262	--		1

Internal Standard	**% Recovery**	**Qualifier**	**Acceptance Criteria**
1,4-difluorobenzene	78		60-140
bromochloromethane	87		60-140
chlorobenzene-d5	84		60-140

Method Blank Analysis
Batch Quality Control

Analytical Method: 48,TO-15-SIM
Analytical Date: 09/30/16 15:29

	ppbV			ug/m3				Dilution Factor
Parameter	**Results**	**RL**	**MDL**	**Results**	**RL**	**MDL**	**Qualifier**	
Volatile Organics in Air by SIM - Mansfield Lab for sample(s): 01 Batch: WG937665-4								
Propylene	ND	0.500	--	ND	0.861	--		1
Dichlorodifluoromethane	ND	0.200	--	ND	0.989	--		1
Chloromethane	ND	0.200	--	ND	0.413	--		1
1,2-Dichloro-1,1,2,2-tetrafluoroethane	ND	0.050	--	ND	0.349	--		1
Vinyl chloride	ND	0.020	--	ND	0.051	--		1
1,3-Butadiene	ND	0.020	--	ND	0.044	--		1
Bromomethane	ND	0.020	--	ND	0.078	--		1
Chloroethane	ND	0.020	--	ND	0.053	--		1
Ethyl Alcohol	ND	5.00	--	ND	9.42	--		1
Vinyl bromide	ND	0.200	--	ND	0.874	--		1
Acetone	ND	1.00	--	ND	2.38	--		1
Trichlorofluoromethane	ND	0.050	--	ND	0.281	--		1
iso-Propyl Alcohol	ND	0.500	--	ND	1.23	--		1
Acrylonitrile	ND	0.500	--	ND	1.09	--		1
1,1-Dichloroethene	ND	0.020	--	ND	0.079	--		1
tert-Butyl Alcohol	ND	0.500	--	ND	1.52	--		1
Methylene chloride	ND	0.500	--	ND	1.74	--		1
3-Chloropropene	ND	0.200	--	ND	0.626	--		1
Carbon disulfide	ND	0.200	--	ND	0.623	--		1
1,1,2-Trichloro-1,2,2-Trifluoroethane	ND	0.050	--	ND	0.383	--		1
Halothane	ND	0.050	--	ND	0.404	--		1
trans-1,2-Dichloroethene	ND	0.020	--	ND	0.079	--		1
1,1-Dichloroethane	ND	0.020	--	ND	0.081	--		1
Methyl tert butyl ether	ND	0.200	--	ND	0.721	--		1
Vinyl acetate	ND	1.00	--	ND	3.52	--		1

Method Blank Analysis
Batch Quality Control

Analytical Method: 48,TO-15-SIM
Analytical Date: 09/30/16 15:29

	ppbV			ug/m3				
Parameter	**Results**	**RL**	**MDL**	**Results**	**RL**	**MDL**	**Qualifier**	**Dilution Factor**
Volatile Organics in Air by SIM - Mansfield Lab for sample(s): 01 Batch: WG937665-4								
2-Butanone	ND	0.500	--	ND	1.47	--		1
cis-1,2-Dichloroethene	ND	0.020	--	ND	0.079	--		1
Ethyl Acetate	ND	0.500	--	ND	1.80	--		1
Chloroform	ND	0.020	--	ND	0.098	--		1
Tetrahydrofuran	ND	0.500	--	ND	1.47	--		1
1,2-Dichloroethane	ND	0.020	--	ND	0.081	--		1
n-Hexane	ND	0.200	--	ND	0.705	--		1
1,1,1-Trichloroethane	ND	0.020	--	ND	0.109	--		1
Benzene	ND	0.100	--	ND	0.319	--		1
Carbon tetrachloride	ND	0.020	--	ND	0.126	--		1
Cyclohexane	ND	0.200	--	ND	0.688	--		1
Dibromomethane	ND	0.200	--	ND	1.42	--		1
1,2-Dichloropropane	ND	0.020	--	ND	0.092	--		1
Bromodichloromethane	ND	0.020	--	ND	0.134	--		1
1,4-Dioxane	ND	0.100	--	ND	0.360	--		1
Trichloroethene	ND	0.020	--	ND	0.107	--		1
2,2,4-Trimethylpentane	ND	0.200	--	ND	0.934	--		1
Heptane	ND	0.200	--	ND	0.820	--		1
cis-1,3-Dichloropropene	ND	0.020	--	ND	0.091	--		1
4-Methyl-2-pentanone	ND	0.500	--	ND	2.05	--		1
trans-1,3-Dichloropropene	ND	0.020	--	ND	0.091	--		1
1,1,2-Trichloroethane	ND	0.020	--	ND	0.109	--		1
Toluene	ND	0.050	--	ND	0.188	--		1
2-Hexanone	ND	0.200	--	ND	0.820	--		1
Dibromochloromethane	ND	0.020	--	ND	0.170	--		1

Method Blank Analysis
Batch Quality Control

Analytical Method: 48,TO-15-SIM
Analytical Date: 09/30/16 15:29

	ppbV			ug/m3				
Parameter	**Results**	**RL**	**MDL**	**Results**	**RL**	**MDL**	**Qualifier**	**Dilution Factor**
Volatile Organics in Air by SIM - Mansfield Lab for sample(s): 01 Batch: WG937665-4								
1,2-Dibromoethane	ND	0.020	--	ND	0.154	--		1
Tetrachloroethene	ND	0.020	--	ND	0.136	--		1
1,1,1,2-Tetrachloroethane	ND	0.020	--	ND	0.137	--		1
Chlorobenzene	ND	0.100	--	ND	0.461	--		1
Ethylbenzene	ND	0.020	--	ND	0.087	--		1
p/m-Xylene	ND	0.040	--	ND	0.174	--		1
Bromoform	ND	0.020	--	ND	0.207	--		1
Styrene	ND	0.020	--	ND	0.085	--		1
1,1,2,2-Tetrachloroethane	ND	0.020	--	ND	0.137	--		1
o-Xylene	ND	0.020	--	ND	0.087	--		1
1,2,3-Trichloropropane	ND	0.020	--	ND	0.121	--		1
Isopropylbenzene	ND	0.200	--	ND	0.983	--		1
Bromobenzene	ND	0.200	--	ND	0.793	--		1
4-Ethyltoluene	ND	0.020	--	ND	0.098	--		1
1,3,5-Trimethylbenzene	ND	0.020	--	ND	0.098	--		1
1,2,4-Trimethylbenzene	ND	0.020	--	ND	0.098	--		1
Benzyl chloride	ND	0.200	--	ND	1.04	--		1
1,3-Dichlorobenzene	ND	0.020	--	ND	0.120	--		1
1,4-Dichlorobenzene	ND	0.020	--	ND	0.120	--		1
sec-Butylbenzene	ND	0.200	--	ND	1.10	--		1
p-Isopropyltoluene	ND	0.200	--	ND	1.10	--		1
1,2-Dichlorobenzene	ND	0.020	--	ND	0.120	--		1
n-Butylbenzene	ND	0.200	--	ND	1.10	--		1
1,2,4-Trichlorobenzene	ND	0.050	--	ND	0.371	--		1
Naphthalene	ND	0.050	--	ND	0.262	--		1

Method Blank Analysis
Batch Quality Control

Analytical Method: 48,TO-15-SIM
Analytical Date: 09/30/16 15:29

	ppbV			ug/m3				
Parameter	**Results**	**RL**	**MDL**	**Results**	**RL**	**MDL**	**Qualifier**	**Dilution Factor**
Volatile Organics in Air by SIM - Mansfield Lab for sample(s): 01 Batch: WG937665-4								
1,2,3-Trichlorobenzene	ND	0.050	--	ND	0.371	--		1
Hexachlorobutadiene	ND	0.050	--	ND	0.533	--		1

Lab Control Sample Analysis

Batch Quality Control

Project Name: SKYKOMISH HWF

Project Number: 683-057

Lab Number: L1630490

Report Date: 10/04/16

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
Volatile Organics in Air by SIM - Mansfield Lab Associated sample(s): 01 Batch: WG937665-3								
Propylene	118		-		70-130	-		25
Dichlorodifluoromethane	103		-		70-130	-		25
Chloromethane	112		-		70-130	-		25
1,2-Dichloro-1,1,2,2-tetrafluoroethane	110		-		70-130	-		25
Vinyl chloride	106		-		70-130	-		25
1,3-Butadiene	114		-		70-130	-		25
Bromomethane	105		-		70-130	-		25
Chloroethane	97		-		70-130	-		25
Ethyl Alcohol	102		-		70-130	-		25
Vinyl bromide	103		-		70-130	-		25
Acetone	99		-		70-130	-		25
Trichlorofluoromethane	116		-		70-130	-		25
iso-Propyl Alcohol	99		-		70-130	-		25
Acrylonitrile	100		-		70-130	-		25
1,1-Dichloroethene	110		-		70-130	-		25
tert-Butyl Alcohol[1]	87		-		70-130	-		25
Methylene chloride	104		-		70-130	-		25
3-Chloropropene	118		-		70-130	-		25
Carbon disulfide	94		-		70-130	-		25
1,1,2-Trichloro-1,2,2-Trifluoroethane	107		-		70-130	-		25
Halothane	94		-		70-130	-		25

Lab Control Sample Analysis

Batch Quality Control

Project Name: SKYKOMISH HWF

Lab Number: L1630490

Project Number: 683-057

Report Date: 10/04/16

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
Volatile Organics in Air by SIM - Mansfield Lab Associated sample(s): 01 Batch: WG937665-3								
trans-1,2-Dichloroethene	105		-		70-130	-		25
1,1-Dichloroethane	109		-		70-130	-		25
Methyl tert butyl ether	106		-		70-130	-		25
Vinyl acetate	130		-		70-130	-		25
2-Butanone	108		-		70-130	-		25
cis-1,2-Dichloroethene	118		-		70-130	-		25
Ethyl Acetate	101		-		70-130	-		25
Chloroform	111		-		70-130	-		25
Tetrahydrofuran	103		-		70-130	-		25
1,2-Dichloroethane	113		-		70-130	-		25
n-Hexane	114		-		70-130	-		25
1,1,1-Trichloroethane	127		-		70-130	-		25
Benzene	108		-		70-130	-		25
Carbon tetrachloride	130		-		70-130	-		25
Cyclohexane	113		-		70-130	-		25
Dibromomethane[1]	112		-		70-130	-		25
1,2-Dichloropropane	116		-		70-130	-		25
Bromodichloromethane	126		-		70-130	-		25
1,4-Dioxane	109		-		70-130	-		25
Trichloroethene	114		-		70-130	-		25
2,2,4-Trimethylpentane	126		-		70-130	-		25

Lab Control Sample Analysis

Batch Quality Control

Project Name: SKYKOMISH HWF

Project Number: 683-057

Lab Number: L1630490

Report Date: 10/04/16

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
Volatile Organics in Air by SIM - Mansfield Lab Associated sample(s): 01 Batch: WG937665-3								
cis-1,3-Dichloropropene	123		-		70-130	-		25
4-Methyl-2-pentanone	**132**	Q	-		70-130	-		25
trans-1,3-Dichloropropene	111		-		70-130	-		25
1,1,2-Trichloroethane	122		-		70-130	-		25
Toluene	96		-		70-130	-		25
2-Hexanone	113		-		70-130	-		25
Dibromochloromethane	109		-		70-130	-		25
1,2-Dibromoethane	106		-		70-130	-		25
Tetrachloroethene	101		-		70-130	-		25
1,1,1,2-Tetrachloroethane	98		-		70-130	-		25
Chlorobenzene	102		-		70-130	-		25
Ethylbenzene	104		-		70-130	-		25
p/m-Xylene	104		-		70-130	-		25
Bromoform	108		-		70-130	-		25
Styrene	102		-		70-130	-		25
1,1,2,2-Tetrachloroethane	109		-		70-130	-		25
o-Xylene	105		-		70-130	-		25
1,2,3-Trichloropropane[1]	101		-		70-130	-		25
Isopropylbenzene	98		-		70-130	-		25
Bromobenzene[1]	98		-		70-130	-		25
4-Ethyltoluene	100		-		70-130	-		25

Lab Control Sample Analysis

Batch Quality Control

Project Name: SKYKOMISH HWF
Project Number: 683-057

Lab Number: L1630490
Report Date: 10/04/16

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
Volatile Organics in Air by SIM - Mansfield Lab Associated sample(s): 01 Batch: WG937665-3								
1,3,5-Trimethylbenzene	105		-		70-130	-		25
1,2,4-Trimethylbenzene	103		-		70-130	-		25
Benzyl chloride	101		-		70-130	-		25
1,3-Dichlorobenzene	106		-		70-130	-		25
1,4-Dichlorobenzene	104		-		70-130	-		25
sec-Butylbenzene	99		-		70-130	-		25
p-Isopropyltoluene	91		-		70-130	-		25
1,2-Dichlorobenzene	107		-		70-130	-		25
n-Butylbenzene	107		-		70-130	-		25
1,2,4-Trichlorobenzene	109		-		70-130	-		25
Naphthalene	105		-		70-130	-		25
1,2,3-Trichlorobenzene	109		-		70-130	-		25
Hexachlorobutadiene	111		-		70-130	-		25

Surrogate	LCS %Recovery	Qual	LCSD %Recovery	Qual	Acceptance Criteria
1,2-Dichloroethane-d4	111				70-130
Toluene-d8	86				70-130
Bromofluorobenzene	87				70-130

Lab Duplicate Analysis
Batch Quality Control

Project Name: SKYKOMISH HWF
Project Number: 683-057

Lab Number: L1630490
Report Date: 10/04/16

Parameter	Native Sample	Duplicate Sample	Units	RPD	Qual	RPD Limits
Volatile Organics in Air by SIM - Mansfield Lab Associated sample(s): 01 QC Batch ID: WG937665-5 QC Sample: L1630490-01 Client ID: SYSTEM_INF_092316						
1,3-Butadiene	ND	ND	ppbV	NC		25
Benzene	0.168	0.161	ppbV	4		25
Naphthalene	0.287	0.285	ppbV	1		25

SAMPLE RESULTS

Lab ID:	L1630490-01	Date Collected:	09/23/16 09:36
Client ID:	SYSTEM_INF_092316	Date Received:	09/27/16
Sample Location:	SKYKOMISH, WA	Field Prep:	Not Specified
Matrix:	Air		
Analytical Method:	96,APH		
Analytical Date:	09/30/16 22:16		
Analyst:	RY		

Quality Control Information

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
Petroleum Hydrocarbons in Air - Mansfield Lab						
1,3-Butadiene	ND		ug/m3	0.50	--	1
Methyl tert butyl ether	ND		ug/m3	0.70	--	1
Benzene	ND		ug/m3	0.60	--	1
C5-C8 Aliphatics, Adjusted	200		ug/m3	10	--	1
Toluene	4.3		ug/m3	0.90	--	1
Ethylbenzene	ND		ug/m3	0.90	--	1
p/m-Xylene	3.1		ug/m3	0.90	--	1
o-Xylene	1.1		ug/m3	0.90	--	1
Naphthalene	1.8		ug/m3	1.1	--	1
C9-C12 Aliphatics, Adjusted	770		ug/m3	10	--	1
C9-C10 Aromatics Total	ND		ug/m3	10	--	1

Internal Standard	% Recovery	Qualifier	Acceptance Criteria
1,4-Difluorobenzene	78		50-200
Bromochloromethane	91		50-200
Chlorobenzene-d5	81		50-200

Method Blank Analysis
Batch Quality Control

Analytical Method: 96,APH
Analytical Date: 09/30/16 15:29
Analyst: RY

Parameter	Result	Qualifier	Units	RL	MDL
Petroleum Hydrocarbons in Air - Mansfield Lab for sample(s): 01 Batch: WG937664-4					
1,3-Butadiene	ND		ug/m3	0.50	--
Methyl tert butyl ether	ND		ug/m3	0.70	--
Benzene	ND		ug/m3	0.60	--
C5-C8 Aliphatics, Adjusted	ND		ug/m3	10	--
Toluene	ND		ug/m3	0.90	--
Ethylbenzene	ND		ug/m3	0.90	--
p/m-Xylene	ND		ug/m3	0.90	--
o-Xylene	ND		ug/m3	0.90	--
Naphthalene	ND		ug/m3	1.1	--
C9-C12 Aliphatics, Adjusted	ND		ug/m3	10	--
C9-C10 Aromatics Total	ND		ug/m3	10	--

Lab Control Sample Analysis
Batch Quality Control

Project Name: SKYKOMISH HWF

Project Number: 683-057

Lab Number: L1630490

Report Date: 10/04/16

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
Petroleum Hydrocarbons in Air - Mansfield Lab Associated sample(s): 01 Batch: WG937664-3								
1,3-Butadiene	120		-		70-130	-		
Methyl tert butyl ether	106		-		70-130	-		
Benzene	112		-		70-130	-		
C5-C8 Aliphatics, Adjusted	113		-		70-130	-		
Toluene	97		-		70-130	-		
Ethylbenzene	99		-		70-130	-		
p/m-Xylene	99		-		70-130	-		
o-Xylene	100		-		70-130	-		
Naphthalene	109		-		50-150	-		
C9-C12 Aliphatics, Adjusted	104		-		70-130	-		
C9-C10 Aromatics Total	85		-		70-130	-		

Lab Duplicate Analysis
Batch Quality Control

Project Name: SKYKOMISH HWF
Project Number: 683-057

Lab Number: L1630490
Report Date: 10/04/16

Parameter	Native Sample	Duplicate Sample	Units	RPD	Qual	RPD Limits
Petroleum Hydrocarbons in Air - Mansfield Lab Associated sample(s): 01 QC Batch ID: WG937664-5 QC Sample: L1630490-01 Client ID: SYSTEM_INF_092316						
1,3-Butadiene	ND	ND	ug/m3	NC		30
Methyl tert butyl ether	ND	ND	ug/m3	NC		30
Benzene	ND	ND	ug/m3	NC		30
C5-C8 Aliphatics, Adjusted	200	200	ug/m3	0		30
Toluene	4.3	4.2	ug/m3	2		30
Ethylbenzene	ND	ND	ug/m3	NC		30
p/m-Xylene	3.1	3.0	ug/m3	3		30
o-Xylene	1.1	1.1	ug/m3	0		30
Naphthalene	1.8	1.7	ug/m3	6		30
C9-C12 Aliphatics, Adjusted	770	740	ug/m3	4		30
C9-C10 Aromatics Total	ND	ND	ug/m3	NC		30

Canister and Flow Controller Information

Samplenum	Client ID	Media ID	Media Type	Date Prepared	Bottle Order	Cleaning Batch ID	Can Leak Check	Initial Pressure (in. Hg)	Pressure on Receipt (in. Hg)	Flow Controler Leak Chk	Flow Out mL/min	Flow In mL/min	% RPD
L1630490-01	SYSTEM_INF_092316	448	2.7L Can	09/19/16	227361	L1629036-01	Pass	-29.8	-8.1	-	-	-	-

Air Canister Certification Results

Lab ID:	L1629036-01	Date Collected:	09/14/16 16:00
Client ID:	CAN 551 SHELF 1	Date Received:	09/15/16
Sample Location:		Field Prep:	Not Specified
Matrix:	Air		
Anaytical Method:	48,TO-15		
Analytical Date:	09/15/16 10:02		
Analyst:	MB		

	ppbV			ug/m3				
Parameter	**Results**	**RL**	**MDL**	**Results**	**RL**	**MDL**	**Qualifier**	**Dilution Factor**
Volatile Organics in Air - Mansfield Lab								
Chlorodifluoromethane	ND	0.200	--	ND	0.707	--		1
Propylene	ND	0.500	--	ND	0.861	--		1
Propane	ND	0.500	--	ND	0.902	--		1
Dichlorodifluoromethane	ND	0.200	--	ND	0.989	--		1
Chloromethane	ND	0.200	--	ND	0.413	--		1
Freon-114	ND	0.200	--	ND	1.40	--		1
Methanol	ND	5.00	--	ND	6.55	--		1
Vinyl chloride	ND	0.200	--	ND	0.511	--		1
1,3-Butadiene	ND	0.200	--	ND	0.442	--		1
Butane	ND	0.200	--	ND	0.475	--		1
Bromomethane	ND	0.200	--	ND	0.777	--		1
Chloroethane	ND	0.200	--	ND	0.528	--		1
Ethanol	ND	5.00	--	ND	9.42	--		1
Dichlorofluoromethane	ND	0.200	--	ND	0.842	--		1
Vinyl bromide	ND	0.200	--	ND	0.874	--		1
Acrolein	ND	0.500	--	ND	1.15	--		1
Acetone	ND	1.00	--	ND	2.38	--		1
Acetonitrile	ND	0.200	--	ND	0.336	--		1
Trichlorofluoromethane	ND	0.200	--	ND	1.12	--		1
Isopropanol	ND	0.500	--	ND	1.23	--		1
Acrylonitrile	ND	0.500	--	ND	1.09	--		1
Pentane	ND	0.200	--	ND	0.590	--		1
Ethyl ether	ND	0.200	--	ND	0.606	--		1
1,1-Dichloroethene	ND	0.200	--	ND	0.793	--		1
Tertiary butyl Alcohol	ND	0.500	--	ND	1.52	--		1

Air Canister Certification Results

Lab ID: L1629036-01
Client ID: CAN 551 SHELF 1
Sample Location:

Date Collected: 09/14/16 16:00
Date Received: 09/15/16
Field Prep: Not Specified

	ppbV			**ug/m3**				
Parameter	**Results**	**RL**	**MDL**	**Results**	**RL**	**MDL**	**Qualifier**	**Dilution Factor**
Volatile Organics in Air - Mansfield Lab								
Methylene chloride	ND	0.500	--	ND	1.74	--		1
3-Chloropropene	ND	0.200	--	ND	0.626	--		1
Carbon disulfide	ND	0.200	--	ND	0.623	--		1
Freon-113	ND	0.200	--	ND	1.53	--		1
trans-1,2-Dichloroethene	ND	0.200	--	ND	0.793	--		1
1,1-Dichloroethane	ND	0.200	--	ND	0.809	--		1
Methyl tert butyl ether	ND	0.200	--	ND	0.721	--		1
Vinyl acetate	ND	1.00	--	ND	3.52	--		1
2-Butanone	ND	0.500	--	ND	1.47	--		1
cis-1,2-Dichloroethene	ND	0.200	--	ND	0.793	--		1
Ethyl Acetate	ND	0.500	--	ND	1.80	--		1
Chloroform	ND	0.200	--	ND	0.977	--		1
Tetrahydrofuran	ND	0.500	--	ND	1.47	--		1
2,2-Dichloropropane	ND	0.200	--	ND	0.924	--		1
1,2-Dichloroethane	ND	0.200	--	ND	0.809	--		1
n-Hexane	ND	0.200	--	ND	0.705	--		1
Diisopropyl ether	ND	0.200	--	ND	0.836	--		1
tert-Butyl Ethyl Ether	ND	0.200	--	ND	0.836	--		1
1,1,1-Trichloroethane	ND	0.200	--	ND	1.09	--		1
1,1-Dichloropropene	ND	0.200	--	ND	0.908	--		1
Benzene	ND	0.200	--	ND	0.639	--		1
Carbon tetrachloride	ND	0.200	--	ND	1.26	--		1
Cyclohexane	ND	0.200	--	ND	0.688	--		1
tert-Amyl Methyl Ether	ND	0.200	--	ND	0.836	--		1
Dibromomethane	ND	0.200	--	ND	1.42	--		1
1,2-Dichloropropane	ND	0.200	--	ND	0.924	--		1
Bromodichloromethane	ND	0.200	--	ND	1.34	--		1
1,4-Dioxane	ND	0.200	--	ND	0.721	--		1

Air Canister Certification Results

Lab ID:	L1629036-01	Date Collected:	09/14/16 16:00
Client ID:	CAN 551 SHELF 1	Date Received:	09/15/16
Sample Location:		Field Prep:	Not Specified

	ppbV			ug/m3				
Parameter	**Results**	**RL**	**MDL**	**Results**	**RL**	**MDL**	**Qualifier**	**Dilution Factor**
Volatile Organics in Air - Mansfield Lab								
Trichloroethene	ND	0.200	--	ND	1.07	--		1
2,2,4-Trimethylpentane	ND	0.200	--	ND	0.934	--		1
Methyl Methacrylate	ND	0.500	--	ND	2.05	--		1
Heptane	ND	0.200	--	ND	0.820	--		1
cis-1,3-Dichloropropene	ND	0.200	--	ND	0.908	--		1
4-Methyl-2-pentanone	ND	0.500	--	ND	2.05	--		1
trans-1,3-Dichloropropene	ND	0.200	--	ND	0.908	--		1
1,1,2-Trichloroethane	ND	0.200	--	ND	1.09	--		1
Toluene	ND	0.200	--	ND	0.754	--		1
1,3-Dichloropropane	ND	0.200	--	ND	0.924	--		1
2-Hexanone	ND	0.200	--	ND	0.820	--		1
Dibromochloromethane	ND	0.200	--	ND	1.70	--		1
1,2-Dibromoethane	ND	0.200	--	ND	1.54	--		1
Butyl acetate	ND	0.500	--	ND	2.38	--		1
Octane	ND	0.200	--	ND	0.934	--		1
Tetrachloroethene	ND	0.200	--	ND	1.36	--		1
1,1,1,2-Tetrachloroethane	ND	0.200	--	ND	1.37	--		1
Chlorobenzene	ND	0.200	--	ND	0.921	--		1
Ethylbenzene	ND	0.200	--	ND	0.869	--		1
p/m-Xylene	ND	0.400	--	ND	1.74	--		1
Bromoform	ND	0.200	--	ND	2.07	--		1
Styrene	ND	0.200	--	ND	0.852	--		1
1,1,2,2-Tetrachloroethane	ND	0.200	--	ND	1.37	--		1
o-Xylene	ND	0.200	--	ND	0.869	--		1
1,2,3-Trichloropropane	ND	0.200	--	ND	1.21	--		1
Nonane	ND	0.200	--	ND	1.05	--		1
Isopropylbenzene	ND	0.200	--	ND	0.983	--		1
Bromobenzene	ND	0.200	--	ND	0.793	--		1

Project Name:	BATCH CANISTER CERTIFICATION	**Lab Number:**	L1629036
Project Number:	CANISTER QC BAT	**Report Date:**	10/04/16

Air Canister Certification Results

Lab ID:	L1629036-01	Date Collected:	09/14/16 16:00
Client ID:	CAN 551 SHELF 1	Date Received:	09/15/16
Sample Location:		Field Prep:	Not Specified

	ppbV			ug/m3				
Parameter	**Results**	**RL**	**MDL**	**Results**	**RL**	**MDL**	**Qualifier**	**Dilution Factor**
Volatile Organics in Air - Mansfield Lab								
2-Chlorotoluene	ND	0.200	--	ND	1.04	--		1
n-Propylbenzene	ND	0.200	--	ND	0.983	--		1
4-Chlorotoluene	ND	0.200	--	ND	1.04	--		1
4-Ethyltoluene	ND	0.200	--	ND	0.983	--		1
1,3,5-Trimethylbenzene	ND	0.200	--	ND	0.983	--		1
tert-Butylbenzene	ND	0.200	--	ND	1.10	--		1
1,2,4-Trimethylbenzene	ND	0.200	--	ND	0.983	--		1
Decane	ND	0.200	--	ND	1.16	--		1
Benzyl chloride	ND	0.200	--	ND	1.04	--		1
1,3-Dichlorobenzene	ND	0.200	--	ND	1.20	--		1
1,4-Dichlorobenzene	ND	0.200	--	ND	1.20	--		1
sec-Butylbenzene	ND	0.200	--	ND	1.10	--		1
p-Isopropyltoluene	ND	0.200	--	ND	1.10	--		1
1,2-Dichlorobenzene	ND	0.200	--	ND	1.20	--		1
n-Butylbenzene	ND	0.200	--	ND	1.10	--		1
1,2-Dibromo-3-chloropropane	ND	0.200	--	ND	1.93	--		1
Undecane	ND	0.200	--	ND	1.28	--		1
Dodecane	ND	0.200	--	ND	1.39	--		1
1,2,4-Trichlorobenzene	ND	0.200	--	ND	1.48	--		1
Naphthalene	ND	0.200	--	ND	1.05	--		1
1,2,3-Trichlorobenzene	ND	0.200	--	ND	1.48	--		1
Hexachlorobutadiene	ND	0.200	--	ND	2.13	--		1

	Results	**Qualifier**	**Units**	**RDL**	**Dilution Factor**
Tentatively Identified Compounds					
No Tentatively Identified Compounds					

Project Name:	BATCH CANISTER CERTIFICATION	**Lab Number:**	L1629036
Project Number:	CANISTER QC BAT	**Report Date:**	10/04/16

Air Canister Certification Results

Lab ID:	L1629036-01	Date Collected:	09/14/16 16:00
Client ID:	CAN 551 SHELF 1	Date Received:	09/15/16
Sample Location:		Field Prep:	Not Specified

	ppbV			ug/m3				
Parameter	**Results**	**RL**	**MDL**	**Results**	**RL**	**MDL**	**Qualifier**	**Dilution Factor**
Volatile Organics in Air - Mansfield Lab								

Internal Standard	**% Recovery**	**Qualifier**	**Acceptance Criteria**
1,4-Difluorobenzene	96		60-140
Bromochloromethane	97		60-140
chlorobenzene-d5	100		60-140

Project Name: BATCH CANISTER CERTIFICATION **Lab Number:** L1629036

Project Number: CANISTER QC BAT **Report Date:** 10/04/16

Air Canister Certification Results

Lab ID: L1629036-01
Client ID: CAN 551 SHELF 1
Sample Location:
Matrix: Air
Anaytical Method: 48,TO-15-SIM
Analytical Date: 09/15/16 10:02
Analyst: MB

Date Collected: 09/14/16 16:00
Date Received: 09/15/16
Field Prep: Not Specified

	ppbV			ug/m3				
Parameter	**Results**	**RL**	**MDL**	**Results**	**RL**	**MDL**	**Qualifier**	**Dilution Factor**
Volatile Organics in Air by SIM - Mansfield Lab								
Dichlorodifluoromethane	ND	0.200	--	ND	0.989	--		1
Chloromethane	ND	0.200	--	ND	0.413	--		1
Freon-114	ND	0.050	--	ND	0.349	--		1
Vinyl chloride	ND	0.020	--	ND	0.051	--		1
1,3-Butadiene	ND	0.020	--	ND	0.044	--		1
Bromomethane	ND	0.020	--	ND	0.078	--		1
Chloroethane	ND	0.020	--	ND	0.053	--		1
Acetone	ND	1.00	--	ND	2.38	--		1
Trichlorofluoromethane	ND	0.050	--	ND	0.281	--		1
Acrylonitrile	ND	0.500	--	ND	1.09	--		1
1,1-Dichloroethene	ND	0.020	--	ND	0.079	--		1
Methylene chloride	ND	0.500	--	ND	1.74	--		1
Freon-113	ND	0.050	--	ND	0.383	--		1
Halothane	ND	0.050	--	ND	0.404	--		1
trans-1,2-Dichloroethene	ND	0.020	--	ND	0.079	--		1
1,1-Dichloroethane	ND	0.020	--	ND	0.081	--		1
Methyl tert butyl ether	ND	0.200	--	ND	0.721	--		1
2-Butanone	ND	0.500	--	ND	1.47	--		1
cis-1,2-Dichloroethene	ND	0.020	--	ND	0.079	--		1
Chloroform	ND	0.020	--	ND	0.098	--		1
1,2-Dichloroethane	ND	0.020	--	ND	0.081	--		1
1,1,1-Trichloroethane	ND	0.020	--	ND	0.109	--		1
Benzene	ND	0.100	--	ND	0.319	--		1
Carbon tetrachloride	ND	0.020	--	ND	0.126	--		1
1,2-Dichloropropane	ND	0.020	--	ND	0.092	--		1

Serial_No:10041614:44

Project Name: BATCH CANISTER CERTIFICATION
Lab Number: L1629036
Project Number: CANISTER QC BAT
Report Date: 10/04/16

Air Canister Certification Results

Lab ID: L1629036-01
Client ID: CAN 551 SHELF 1
Sample Location:
Date Collected: 09/14/16 16:00
Date Received: 09/15/16
Field Prep: Not Specified

	ppbV			ug/m3				
Parameter	**Results**	**RL**	**MDL**	**Results**	**RL**	**MDL**	**Qualifier**	**Dilution Factor**
Volatile Organics in Air by SIM - Mansfield Lab								
Bromodichloromethane	ND	0.020	--	ND	0.134	--		1
1,4-Dioxane	ND	0.100	--	ND	0.360	--		1
Trichloroethene	ND	0.020	--	ND	0.107	--		1
cis-1,3-Dichloropropene	ND	0.020	--	ND	0.091	--		1
4-Methyl-2-pentanone	ND	0.500	--	ND	2.05	--		1
trans-1,3-Dichloropropene	ND	0.020	--	ND	0.091	--		1
1,1,2-Trichloroethane	ND	0.020	--	ND	0.109	--		1
Toluene	ND	0.050	--	ND	0.188	--		1
Dibromochloromethane	ND	0.020	--	ND	0.170	--		1
1,2-Dibromoethane	ND	0.020	--	ND	0.154	--		1
Tetrachloroethene	ND	0.020	--	ND	0.136	--		1
1,1,1,2-Tetrachloroethane	ND	0.020	--	ND	0.137	--		1
Chlorobenzene	ND	0.100	--	ND	0.461	--		1
Ethylbenzene	ND	0.020	--	ND	0.087	--		1
p/m-Xylene	ND	0.040	--	ND	0.174	--		1
Bromoform	ND	0.020	--	ND	0.207	--		1
Styrene	ND	0.020	--	ND	0.085	--		1
1,1,2,2-Tetrachloroethane	ND	0.020	--	ND	0.137	--		1
o-Xylene	ND	0.020	--	ND	0.087	--		1
Isopropylbenzene	ND	0.200	--	ND	0.983	--		1
4-Ethyltoluene	ND	0.020	--	ND	0.098	--		1
1,3,5-Trimethybenzene	ND	0.020	--	ND	0.098	--		1
1,2,4-Trimethylbenzene	ND	0.020	--	ND	0.098	--		1
1,3-Dichlorobenzene	ND	0.020	--	ND	0.120	--		1
1,4-Dichlorobenzene	ND	0.020	--	ND	0.120	--		1
sec-Butylbenzene	ND	0.200	--	ND	1.10	--		1
p-Isopropyltoluene	ND	0.200	--	ND	1.10	--		1
1,2-Dichlorobenzene	ND	0.020	--	ND	0.120	--		1

Air Canister Certification Results

Lab ID:	L1629036-01	Date Collected:	09/14/16 16:00
Client ID:	CAN 551 SHELF 1	Date Received:	09/15/16
Sample Location:		Field Prep:	Not Specified

	ppbV			ug/m3				
Parameter	**Results**	**RL**	**MDL**	**Results**	**RL**	**MDL**	**Qualifier**	**Dilution Factor**
Volatile Organics in Air by SIM - Mansfield Lab								
n-Butylbenzene	ND	0.200	--	ND	1.10	--		1
1,2,4-Trichlorobenzene	ND	0.050	--	ND	0.371	--		1
Naphthalene	ND	0.050	--	ND	0.262	--		1
1,2,3-Trichlorobenzene	ND	0.050	--	ND	0.371	--		1
Hexachlorobutadiene	ND	0.050	--	ND	0.533	--		1

Internal Standard	% Recovery	Qualifier	Acceptance Criteria
1,4-difluorobenzene	102		60-140
bromochloromethane	99		60-140
chlorobenzene-d5	105		60-140

AIR Petro Can Certification

Project Name:	BATCH CANISTER CERTIFICATION	**Lab Number:**	L1629036
Project Number:	CANISTER QC BAT	**Report Date:**	10/04/16

AIR CAN CERTIFICATION RESULTS

Lab ID:	L1629036-01	Date Collected:	09/14/16 16:00
Client ID:	CAN 551 SHELF 1	Date Received:	09/15/16
Sample Location:	Not Specified	Field Prep:	Not Specified
Matrix:	Air		
Analytical Method:	96,APH		
Analytical Date:	09/15/16 10:02		
Analyst:	MB		

Parameter	**Result**	**Qualifier**	**Units**	**RL**	**MDL**	**Dilution Factor**
Petroleum Hydrocarbons in Air						
1,3-Butadiene	ND		ug/m3	0.50	--	1
Methyl tert butyl ether	ND		ug/m3	0.70	--	1
Benzene	ND		ug/m3	0.60	--	1
C5-C8 Aliphatics, Adjusted	ND		ug/m3	10	--	1
Toluene	ND		ug/m3	0.90	--	1
Ethylbenzene	ND		ug/m3	0.90	--	1
p/m-Xylene	ND		ug/m3	0.90	--	1
o-Xylene	ND		ug/m3	0.90	--	1
Naphthalene	ND		ug/m3	1.1	--	1
C9-C12 Aliphatics, Adjusted	ND		ug/m3	10	--	1
C9-C10 Aromatics Total	ND		ug/m3	10	--	1

Sample Receipt and Container Information

Were project specific reporting limits specified? YES

Cooler Information Cooler	**Custody Seal**
N/A	Present/Intact

Container Information

Container ID	**Container Type**	**Cooler**	**pH**	**Temp deg C**	**Pres**	**Seal**	**Analysis(*)**
L1630490-01A	Canister - 2.7 Liter	N/A	N/A	N/A	Y	Absent	APH-10(30),TO15-SIM(30)

*Values in parentheses indicate holding time in days

GLOSSARY

Acronyms

EDL - Estimated Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the reporting limit (RL). The EDL includes any adjustments from dilutions, concentrations or moisture content, where applicable. The use of EDLs is specific to the analysis of PAHs using Solid-Phase Microextraction (SPME).

EPA - Environmental Protection Agency.

LCS - Laboratory Control Sample: A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes.

LCSD - Laboratory Control Sample Duplicate: Refer to LCS.

LFB - Laboratory Fortified Blank: A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes.

MDL - Method Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the reporting limit (RL). The MDL includes any adjustments from dilutions, concentrations or moisture content, where applicable.

MS - Matrix Spike Sample: A sample prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available.

MSD - Matrix Spike Sample Duplicate: Refer to MS.

NA - Not Applicable.

NC - Not Calculated: Term is utilized when one or more of the results utilized in the calculation are non-detect at the parameter's reporting unit.

NDPA/DPA - N-Nitrosodiphenylamine/Diphenylamine.

NI - Not Ignitable.

NP - Non-Plastic: Term is utilized for the analysis of Atterberg Limits in soil.

RL - Reporting Limit: The value at which an instrument can accurately measure an analyte at a specific concentration. The RL includes any adjustments from dilutions, concentrations or moisture content, where applicable.

RPD - Relative Percent Difference: The results from matrix and/or matrix spike duplicates are primarily designed to assess the precision of analytical results in a given matrix and are expressed as relative percent difference (RPD). Values which are less than five times the reporting limit for any individual parameter are evaluated by utilizing the absolute difference between the values; although the RPD value will be provided in the report.

SRM - Standard Reference Material: A reference sample of a known or certified value that is of the same or similar matrix as the associated field samples.

STLP - Semi-dynamic Tank Leaching Procedure per EPA Method 1315.

TIC - Tentatively Identified Compound: A compound that has been identified to be present and is not part of the target compound list (TCL) for the method and/or program. All TICs are qualitatively identified and reported as estimated concentrations.

Footnotes

1 - The reference for this analyte should be considered modified since this analyte is absent from the target analyte list of the original method.

Terms

Total: With respect to Organic analyses, a 'Total' result is defined as the summation of results for individual isomers or Aroclors. If a 'Total' result is requested, the results of its individual components will also be reported. This is applicable to 'Total' results for methods 8260, 8081 and 8082.

Analytical Method: Both the document from which the method originates and the analytical reference method. (Example: EPA 8260B is shown as 1,8260B.) The codes for the reference method documents are provided in the References section of the Addendum.

Data Qualifiers

A - Spectra identified as "Aldol Condensation Product".

B - The analyte was detected above the reporting limit in the associated method blank. Flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank. For MCP-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank. For DOD-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank AND the analyte was detected above one-half the reporting limit (or above the reporting limit for common lab contaminants) in the associated method blank. For NJ-Air-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte above the reporting limit. For NJ-related projects (excluding Air), flag only applies to associated field samples that have detectable concentrations of the analyte, which was detected above the reporting limit in the associated method blank or above five times the

Data Qualifiers

reporting limit for common lab contaminants (Phthalates, Acetone, Methylene Chloride, 2-Butanone).

C	- Co-elution: The target analyte co-elutes with a known lab standard (i.e. surrogate, internal standards, etc.) for co-extracted analyses.
D	- Concentration of analyte was quantified from diluted analysis. Flag only applies to field samples that have detectable concentrations of the analyte.
E	- Concentration of analyte exceeds the range of the calibration curve and/or linear range of the instrument.
G	- The concentration may be biased high due to matrix interferences (i.e, co-elution) with non-target compound(s). The result should be considered estimated.
H	- The analysis of pH was performed beyond the regulatory-required holding time of 15 minutes from the time of sample collection.
I	- The lower value for the two columns has been reported due to obvious interference.
M	- Reporting Limit (RL) exceeds the MCP CAM Reporting Limit for this analyte.
NJ	- Presumptive evidence of compound. This represents an estimated concentration for Tentatively Identified Compounds (TICs), where the identification is based on a mass spectral library search.
P	- The RPD between the results for the two columns exceeds the method-specified criteria.
Q	- The quality control sample exceeds the associated acceptance criteria. For DOD-related projects, LCS and/or Continuing Calibration Standard exceedences are also qualified on all associated sample results. Note: This flag is not applicable for matrix spike recoveries when the sample concentration is greater than 4x the spike added or for batch duplicate RPD when the sample concentrations are less than 5x the RL. (Metals only.)
R	- Analytical results are from sample re-analysis.
RE	- Analytical results are from sample re-extraction.
S	- Analytical results are from modified screening analysis.
J	- Estimated value. This represents an estimated concentration for Tentatively Identified Compounds (TICs).
ND	- Not detected at the reporting limit (RL) for the sample.

REFERENCES

48 Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air. Second Edition. EPA/625/R-96/010b, January 1999.

96 Method for the Determination of Air-Phase Petroleum Hydrocarbons (APH), MassDEP, December 2009, Revision 1 with QC Requirements & Performance Standards for the Analysis of APH by GC/MS under the Massachusetts Contingency Plan, WSC-CAM-IXA, July 2010.

LIMITATION OF LIABILITIES

Serial_No:10041614:44

Alpha Analytical, Inc. ID No.:**17873**
Facility: **Company-wide** Revision 7
Department: **Quality Assurance** Published Date: 8/5/2016 11:25:56 AM
Title: **Certificate/Approval Program Summary** Page 1 of 1

Certification Information

The following analytes are not included in our Primary NELAP Scope of Accreditation:

Westborough Facility
EPA 624: m/p-xylene, o-xylene
EPA 8260C: NPW: 1,2,4,5-Tetramethylbenzene; 4-Ethyltoluene, Azobenzene; SCM: Iodomethane (methyl iodide), Methyl methacrylate, 1,2,4,5-Tetramethylbenzene; 4-Ethyltoluene.
EPA 8270D: NPW: Dimethylnaphthalene,1,4-Diphenylhydrazine; SCM: Dimethylnaphthalene,1,4-Diphenylhydrazine.
EPA 300: DW: Bromide
EPA 6860: NPW and SCM: Perchlorate
EPA 9010: NPW and SCM: Amenable Cyanide Distillation
EPA 9012B: NPW: Total Cyanide
EPA 9050A: NPW: Specific Conductance
SM3500: NPW: Ferrous Iron
SM4500: NPW: Amenable Cyanide, Dissolved Oxygen; SCM: Total Phosphorus, TKN, NO2, NO3.
SM5310C: DW: Dissolved Organic Carbon

Mansfield Facility
SM 2540D: TSS
EPA 3005A NPW
EPA 8082A: NPW: PCB: 1, 5, 31, 87,101, 110, 141, 151, 153, 180, 183, 187.
EPA TO-15: Halothane, 2,4,4-Trimethyl-2-pentene, 2,4,4-Trimethyl-1-pentene, Thiophene, 2-Methylthiophene, 3-Methylthiophene, 2-Ethylthiophene, 1,2,3-Trimethylbenzene, Indan, Indene, 1,2,4,5-Tetramethylbenzene, Benzothiophene, 1-Methylnaphthalene.
Biological Tissue Matrix: ***EPA 3050B***

The following analytes are included in our Massachusetts DEP Scope of Accreditation

Westborough Facility:

Drinking Water
EPA 300.0: Nitrate-N, Fluoride, Sulfate; **EPA 353.2**: Nitrate-N, Nitrite-N; **SM4500NO3-F**: Nitrate-N, Nitrite-N; **SM4500F-C, SM4500CN-CE, EPA 180.1, SM2130B, SM4500Cl-D, SM2320B, SM2540C, SM4500H-B**
EPA 332: Perchlorate; **EPA 524.2:** THMs and VOCs; **EPA 504.1:** EDB, DBCP.
Microbiology: **SM9215B; SM9223-P/A, SM9223B-Colilert-QT,SM9222D**.

Non-Potable Water
SM4500H,B, EPA 120.1, SM2510B, SM2540C, SM2320B, SM4500CL-E, SM4500F-BC, SM4500NH3-BH, **EPA 350.1**: Ammonia-N, **LACHAT 10-107-06-1-B**: Ammonia-N, **SM4500NO3-F, EPA 353.2**: Nitrate-N**, EPA 351.1, SM4500P-E, SM4500P-B, E, SM4500SO4-E, SM5220D, EPA 410.4, SM5210B, SM5310C, SM4500CL-D, EPA 1664, EPA 420.1, SM4500-CN-CE, SM2540D.**
EPA 624: Volatile Halocarbons & Aromatics,
EPA 608: Chlordane, Toxaphene, Aldrin, alpha-BHC, beta-BHC, gamma-BHC, delta-BHC, Dieldrin, DDD, DDE, DDT, Endosulfan I, Endosulfan II, Endosulfan sulfate, Endrin, Endrin Aldehyde, Heptachlor, Heptachlor Epoxide, PCBs
EPA 625: SVOC (Acid/Base/Neutral Extractables), **EPA 600/4-81-045**: PCB-Oil.
Microbiology: **SM9223B-Colilert-QT; Enterolert-QT, SM9222D-MF**.

Mansfield Facility:

Drinking Water
EPA 200.7: Ba, Be, Cd, Cr, Cu, Ni, Na, Ca. **EPA 200.8:** Sb, As, Ba, Be, Cd, Cr, Cu, Pb, Ni, Se, TL. **EPA 245.1** Hg.

Non-Potable Water
EPA 200.7: Al, Sb, As, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Se, Ag, Na, Sr, TL, Ti, V, Zn.
EPA 200.8: Al, Sb, As, Be, Cd, Cr, Cu, Pb, Mn, Ni, Se, Ag, TL, Zn.
EPA 245.1 Hg.
SM2340B

For a complete listing of analytes and methods, please contact your Alpha Project Manager.

ALPHA ANALYTICAL

AIR ANALYSIS

PAGE OF

CHAIN OF CUSTODY

320 Forbes Blvd, Mansfield, MA 02048
TEL: 508-822-9300 FAX: 508-822-3288

Date Rec'd in Lab: 9/27/16

ALPHA Job #: L1630490

Project Information

Project Name: Skykomish HWF

Project Location: Skykomish, Washington

Project #: 683-057

Project Manager: Andrew Vining

ALPHA Quote #:

Client Information

Client: Farallon Consulting

Address: 975 5th Avenue Northwest

Issaquah, Washington 98027

Phone: 425-295-0800

Fax: 425-295-0850

Email: avining@farallonconsulting.com

Turn-Around-Time

☒ Standard ☐ Rush (only confirmed if pre-approved)

Date Due: Time:

Report/Data Deliverables Information

☐ FAX ☐ EMAIL

☐ ADEx ☐ Add'l Deliverables

Billing Information

☐ Same as Client info PO #:

Regulatory Requirements/Report Limits

State/Fed	Program	Residential/Commercial
S		

☐ These samples have been Previously analyzed by Alpha

Other Project Specific Requirements/Comments:

☒ Project-Specific Target Compound List

SIM: BENZENE, NAPTHALENE, 1,3 BUTADIENE

Analysis

All Columns Below Must Be Filled Out

Alpha Lab Use Only	Sample ID	Collection End Date	Collection Start Time	Collection End Time	Collection Initial Vac	Collection Final Vac	Sample Matrix*	Sampler Initials	Can Size	ID Can	ID Flow Controller	TO-15	TO-15 SIM	APH (☐ Subtract non-petroleum HCs)	FIXED GASES	Sulfides & Mercaptans by TO-15			Sample Specific Comments (i.e. PID)
30490-01	SYSTEM_INF_092316	9/23/16	9:36	9:36	28.0	4.0	AA	AV	2.7	448	NA	☐	☒	☒	☐	☐	☐	☐	
												☐	☐	☐	☐	☐	☐	☐	
												☐	☐	☐	☐	☐	☐	☐	
												☐	☐	☐	☐	☐	☐	☐	
												☐	☐	☐	☐	☐	☐	☐	
												☐	☐	☐	☐	☐	☐	☐	
										Container Type		-	-	-	-	-	-	-	

***SAMPLE MATRIX CODES:**

AA = Ambient Air (Indoor/Outdoor)
SV = Soil Vapor/Landfill Gas/SVE
Other = Please Specify

Relinquished By	Date/Time	Received By:	Date/Time
		Fedex	
Fedex			9/27/16 10:00am

Please print clearly & legibly and completely. Samples cannot be logged in and turn around time clock will not start until any ambiguities are resolved. All samples submitted are subject to Alpha's Payment Terms.

Form 101-02 (I) Rev: 25-Sept-15

APPENDIX F
PROCESS WATER LABORATORY ANALYTICAL REPORTS

2016 HOT WATER FLUSHING REMEDIATION
PERFORMANCE REPORT
Skykomish School
BNSF Former Maintenance and Fueling Facility
Skykomish, Washington

Farallon PN: 683-057

Provided as a separate file.

APPENDIX G
DATA VALIDATION REPORT

2016 HOT WATER FLUSHING REMEDIATION
PERFORMANCE REPORT
Skykomish School
BNSF Former Maintenance and Fueling Facility
Skykomish, Washington

Farallon PN: 683-057

Sayler Data Solutions, Inc.
14257 93rd Court NE Kirkland, Washington 98034 (425) 820-7504 cari.say@saylerdata.com

DATA VALIDATION REPORT

Skykomish Hot Water Flushing June through October 2016 Data

Prepared for:
Farallon Consulting, LLC
975 5th Avenue NW
Issaquah, Washington 98027

December 30, 2016

1.0 Introduction

Data Validation was performed on the following water samples:

Sample ID	Sample Date/Time	Lab ID	Analyses
LAG_EFFLUENT_061616	06/16/2016 14:35	580-60413-1	TPHD
LAG_INFLUENT_061616	06/16/2016 14:40	580-60413-2	TPHD
LEAD_INFLUENT_061616	06/16/2016 14:45	580-60413-3	TPHD
LAG_EFF_062216	06/22/2016 09:20	580-60590-1	TPHD
LAG_INF_062216	06/22/2016 09:15	580-60590-2	TPHD
LEAD_INF_062216	06/22/2016 09:10	580-60590-3	TPHD
LAG-EFF_062816	06/28/2016 12:00	580-60688-1	TPHD
LAG-INF_062816	06/28/2016 12:05	580-60688-2	TPHD
LEAD-INF_062816	06/28/2016 12:10	580-60688-3	TPHD
LAG_EFF_071316	07/13/2016 15:05	580-61042-1	TPHD
LAG_INF_071316	07/13/2016 15:00	580-61042-2	TPHD
LEAD_INF_071316	07/13/2016 14:55	580-61042-3	TPHD
LEAD_INF_072016	07/20/2016 13:25	580-61211-1	TPHD
LAG_INF_072016	07/20/2016 13:30	580-61211-2	TPHD
LAG_EFF_072016	07/20/2016 13:35	580-61211-3	TPHD
LAG_EFF_072716	07/27/2016 14:20	580-61354-1	TPHD
LAG_INF_072716	07/27/2016 14:15	580-61354-2	TPHD
LEAD_INF_072716	07/27/2016 14:10	580-61354-3	TPHD
LAG_EFF_080416	08/04/2016 13:30	580-61585-1	TPHD
LAG_INF_080416	08/04/2016 13:35	580-61585-2	TPHD
LEAD_INF_080416	08/04/2016 13:40	580-61585-3	TPHD
LAG_EFF_081016	08/10/2016 10:20	580-61682-1	TPHD
LAG_INF_081016	08/10/2016 10:15	580-61682-2	TPHD
LEAD_INF_081016	08/10/2016 10:10	580-61682-3	TPHD
LAG_EFF_081716	08/17/2016 11:10	580-61915-1	TPHD
LAG_INF_081716	08/17/2016 11:15	580-61915-2	TPHD
LEAD_INF_081716	08/17/2016 11:20	580-61915-3	TPHD
LAG_EFF_082416	08/24/2016 15:20	580-62048-1	TPHD
LAG_INF_082416	08/24/2016 15:25	580-62048-2	TPHD
LEAD_INF_082416	08/24/2016 15:30	580-62048-3	TPHD
LAG_EFF_090116	09/01/2016 15:35	580-62193-1	TPHD
LAG_INF_090116	09/01/2016 15:40	580-62193-2	TPHD
LEAD_INF_090116	09/01/2016 15:45	580-62193-3	TPHD
LAG_EFF_090816	09/08/2016 08:40	580-62422-1	TPHD

Sample ID	Sample Date/Time	Lab ID	Analyses
LAG_INF_090816	09/08/2016 08:35	580-62422-2	TPHD
LEAD_INF_090816	09/08/2016 08:30	580-62422-3	TPHD
LAG_EFF_091516	09/15/2016 14:55	580-62540-1	TPHD
LAG_INF_091516	09/15/2016 15:00	580-62540-2	TPHD
LEAD_INF_091516	09/15/2016 15:05	580-62540-3	TPHD
LAG_EFF_092216	09/22/2016 13:30	580-62718-1	TPHD
LAG_INF_092216	09/22/2016 13:35	580-62718-2	TPHD
LEAD_INF_092216	09/22/2016 13:40	580-62718-3	TPHD
LAG_EFF_092816	09/28/2016 10:30	580-62908-1	TPHD
LAG_INF_092816	09/28/2016 10:35	580-62908-2	TPHD
LEAD_INF_092816	09/28/2016 10:40	580-62908-3	TPHD
LAG_EFF_100516	10/05/2016 10:35	580-63074-1	TPHD
LAG_INF_100516	10/05/2016 10:40	580-63074-2	TPHD
LEAD_INF_100516	10/05/2016 10:45	580-63074-3	TPHD
LAG_EFF_101216	10/12/2016 11:00	580-63293-1	TPHD
LAG_INF_101216	10/12/2016 11:05	580-63293-2	TPHD
LEAD_INF_101216	10/12/2016 11:10	580-63293-3	TPHD
LAG_EFF_102116	10/21/2016 10:20	580-63549-1	TPHD
LAG_INF_102116	10/21/2016 10:25	580-63549-2	TPHD
LEAD_INF_102116	10/21/2016 10:30	580-63549-3	TPHD
LAG_EFF_102816	10/28/2016 11:25	580-63751-1	TPHD
LAG_INF_102816	10/28/2016 11:30	580-63751-2	TPHD
LEAD_INF_102816	10/28/2016 11:35	580-63751-3	TPHD

The sample IDs in the laboratory report matched the chain of custody with the following exceptions:

1) The samples from 8/4/2016 did not include the date suffix on the chain of custody or in the laboratory report. The date suffix of 080416 has been included in the sampleID throughout this report.
2) The sampleIDs used in the laboratory report for the 8/17/2016 samples were not listed in all uppercase as was shown on the chain of custody. The correct IDs have been used throughout this report.
3) The chain of custody was not present in the laboratory report for the 8/24/2016 samples, and these sample IDs could not be verified.
4) The samples from 9/8/2016 did not include the date suffix on the chain of custody. The sampleID used in the laboratory report appropriately included the 090816 suffix.
5) Sample LEAD_INF_092216 was listed in the laboratory report as LEAD_IN_-092216. The correct ID has been used throughout this report.
6) Sample IDs for the 10/28/2016 samples contained a dash instead of an underscore. The correct IDs are used in this report.

Analyses: Analysis was performed by TestAmerica Laboratories Inc, in Tacoma, Washington. The following methods were utilized:

Analysis	Analysis method	Preparation method
Diesel Range Petroleum Hydrocarbons (TPHD)	NWTPH-Dx	SW3510C

Please note: TPHD analysis was performed without silica gel cleanup meeting consent decree requirements.

Validation: A stage 2A summary validation was performed on the electronic data deliverable and the hardcopy (portable document format) analytical results, earning EPA OSWER validation label code S2AVEM. Validation was performed by Cari Sayler.

Data qualifiers are assigned based only on the criteria reviewed and do not include calibration or instrument performance issues unless noted in the laboratory narrative. Validation qualifiers are summarized in section 3.0.

2.0 Diesel Range Petroleum Hydrocarbon Analysis

Quality control analysis frequencies: The method specifies that a method blank must be analyzed one per analytical batch or one per twenty samples, whichever is more frequent and a laboratory duplicate must be analyzed one per ten samples. In addition, surrogate compounds must be measured in each field and quality control sample.

Each batch included a method blank, LCS, and LCSD, as well as appropriate surrogates. No qualifiers are assigned based on the absence of a matrix duplicate.

Holding times: Water samples must be extracted within 7 days of collection if unpreserved and within 14 days of collection if preserved. Extracts must be analyzed within 40 days of extraction. All samples were preserved. Analyses were extracted and analyzed within holding time with the following exceptions:

Sample ID	Days, Sample to Extraction	Days, Extraction to Analysis	Days, Sample to Analysis
LEAD_INF_082416	16	0	16
LAG_INF_082416	16	0	16
LAG_EFF_082416	16	0	16

Results in these samples are qualified as estimated.

Cooler temperatures upon receipt at the laboratory exceeded the acceptable range as follows:

Sample ID	Cooler receipt temperature, °C	Acceptable Temperature Range, °C
LAG_EFF_102816	6.6	0-6
LAG_INF_102816	6.6	0-6
LEAD_INF_102816	6.6	0-6

Results in these samples are qualified as estimated.

Laboratory blank results: Criteria for blanks are that analyte concentrations must be below the PQL, or below 5% of the lowest associated sample concentration. No target analytes were detected in the method blanks.

Surrogate recoveries: Laboratory control limits were 50-150%. Surrogate recoveries were within limits.

LCS recoveries: Laboratory control limits ranged from 53-129 to 59-120%. LCS recoveries were within limits.

LCS/LCSD RPDs: The laboratory control limits for RPDs were 19 and 27%. RPDs were within limits with the following exceptions:

QC ID	Analyte	RPD	Lab Control Limit
LCSD 580-227808/3-A	Motor Oil (>C24-C36)	31	19
LCSD 580-228960/3-A	Motor Oil (>C24-C36)	24	19

Detected results for motor oil in the associated samples are qualified as estimated.

Reporting limits: The reporting limit goals are 0.1 mg/L for both diesel range hydrocarbons and oil range hydrocarbons. Target reporting limits were exceeded as follows:

Analyte	Highest RL (mg/L)	Target RL (mg/L)	Remediation Level (mg/L)
#2 Diesel (C10-C24)	0.11	0.1	0.477
Motor Oil (>C24-C36)	0.26	0.1	

The remediation level was met for each sample and data are considered unaffected.

Laboratory narrative and flags: No other qualifiers were assigned based on a review of the laboratory narrative or data flags.

Diesel range petroleum hydrocarbon data are acceptable for use as qualified.

3.0 Qualifier Summary Table

Client ID	Analyte(s)	Qualifier	Reason
LAG_EFF_082416	#2 Diesel (C10-C24), Motor Oil (>C24-C36)	J	Extraction hold time exceeded
LAG_EFF_102816	#2 Diesel (C10-C24)	J	High cooler receipt temperature
LAG_EFF_102816	Motor Oil (>C24-C36)	UJ	High cooler receipt temperature
LAG_INF_082416	#2 Diesel (C10-C24), Motor Oil (>C24-C36)	J	Extraction hold time exceeded
LAG_INF_091516	Motor Oil (>C24-C36)	J	High LCS/LCSD RPD
LAG_INF_092216	Motor Oil (>C24-C36)	J	High LCS/LCSD RPD
LAG_INF_102816	#2 Diesel (C10-C24), Motor Oil (>C24-C36)	J	High cooler receipt temperature
LEAD_INF_082416	#2 Diesel (C10-C24), Motor Oil (>C24-C36)	J	Extraction hold time exceeded
LEAD_INF_091516	Motor Oil (>C24-C36)	J	High LCS/LCSD RPD
LEAD_INF_092216	Motor Oil (>C24-C36)	J	High LCS/LCSD RPD
LEAD_INF_102816	#2 Diesel (C10-C24), Motor Oil (>C24-C36)	J	High cooler receipt temperature

4.0 Abbreviations and Definitions

DV Qualifier	Definition
U	The material was analyzed for, but was not detected above the level of the associated value.
J	The analyte was positively identified. The associated numerical value is the approximate concentration of the analyte in the sample.
N	The analysis indicates the presence of an analyte for which there is presumptive evidence to make a tentative identification.
UJ	The material was analyzed for, but was not detected. The associated value is an estimate and may be inaccurate or imprecise.
R	The sample result is rejected. The presence or absence of the analyte cannot be verified and data are not usable.
R1	This sample result has been rejected in favor of a more accurate, precise or conservative result. The other result should be used.
R2	This sample result has been rejected in favor of a more accurate, precise or conservative result from another analytical method. The other result should be used.

Abbreviation	Definition
DV	Data validation
LCS	Laboratory control sample
LCSD	Laboratory control sample duplicate
MS	Matrix spike
MSD	Matrix spike duplicate
RL	Reporting limit
RPD	Relative percent difference
RSD	Relative standard deviations
SDG	Sample Delivery Group
SRM	Standard reference material

5.0 References

USEPA Contract Laboratory Program National Functional Guidelines For Superfund Organic Methods Data Review, Office of Superfund Remediation and Technology Innovation, U.S. Environmental Protection Agency, June 2008, USEPA-540-R-008-01.

USEPA Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, January 2009, EPA 540-R-08-005.