MISSION CREEK WATER QUALITY RESTORATION PHASE I

Streamflow Augmentation and Water Right Conversion Pilot Project

July 9, 2018

Washington Department of Ecology • Contract No. WQC-2016-ChCoNR-00239

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CHELAN COUNTY
Natural Resources
Department

MEMORANDUM

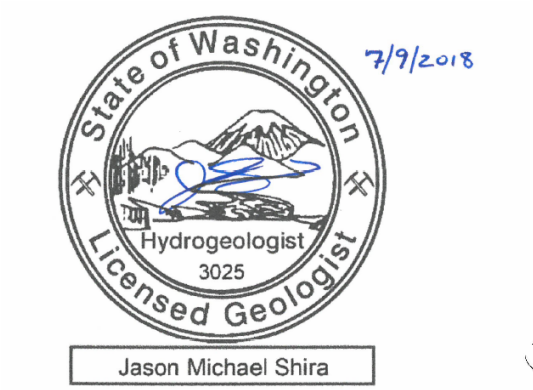
Project No.: 120045-011

July 9, 2018

To: Mike Kaputa, Chelan County Natural Resources Department

Pete Cruickshank, Chelan County Natural Resources Department

From:



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Re: **Mission Basin Streamflow Augmentation and Water Right Conversion Pilot Project**

Aspect Consulting, LLC (Aspect) prepared this memorandum to summarize observations and findings regarding surface water and aquifer testing in the Mission Basin. The purpose of the study is to evaluate the feasibility of using groundwater as a water supply source for streamflow augmentation (augmentation) and potential change in source (surface water to groundwater) for irrigation water rights.

This memorandum was prepared for the Chelan County Natural Resources Department (CCNRD) to support an alternative (Alternative 5) evaluation under their Mission Creek Flow Improvement Appraisal (Appraisal). This study was funded by a Water Resources Watershed Plan Implementation and Flow Achievement grant (WRPIFA-CHCONR-00047) and a Centennial Clean Water Program grant (WQC-2016-ChCoNR-00239).

Introduction

Limited water availability for out-of-stream uses and low streamflow in the Mission Creek Watershed were identified as high-priority issues by the Wenatchee Watershed Planning Unit (WWPU) in their 2006 Wenatchee Watershed Plan (Plan; WWPU, 2006). The Plan made recommendations that resulted in the updated Wenatchee Instream Resource Protection Program (Washington Administrative Code [WAC] 173-545) that established minimum instream flows and set aside a reservation of water for future development (reserve). In this rule, the Mission Creek

Subbasin is subject to an interim reserve of 0.03 cubic feet per second (cfs). CCNRD and the WWPU conducted water-storage assessments and engaged local stakeholders to help identify viable solutions to the water supply issues in Mission Creek. Though opportunities are somewhat limited, targeted improvements are possible for streamflow, habitat, and water quality, and for out-of-stream domestic uses.

Pumping groundwater to augment streamflow and mitigate other water use is sometimes an effective strategy to create streamflow benefit. The objective of this study was to determine if the aquifer(s) are suitable for augmenting streamflow and supporting irrigation in the Mission Creek Watershed during periods of low streamflow (June to September; Project). CCNRD met with local landowners to discuss this alternative and Alternative 2 (Surface to Ground Transfer) of the Appraisal.

The landowners were very receptive to gaining greater clarity on how significantly their wells were connected to Mission Creek, their long-term reliability, aquifer characteristics, and the potential for implementation of these alternatives. In cooperation with willing landowners, a long-term aquifer test was envisioned as a first step that could transition into a long-term harvest-time pump augmentation program. The concept is that landowners could help augment streamflow with groundwater discharges from their existing wells when their pumps would otherwise be shut off to harvest fruit. Existing wells used in the Project were not optimum for the overall investigation goals; however, due to available grant funding and landowner interest, the infrastructure was sufficient (with modifications) to meet feasibility-level data-quality objectives.

CCNRD met with the Washington State Department of Ecology (Ecology), Washington Department of Fish and Wildlife (WDFW), and the Yakama Nation to explore options on evaluating this alternative. As a result, CCNRD applied for and received a preliminary permit to pilot this effort in 2016.

Summary of Results

Previous hydrogeologic studies of the Mission Creek Basin have been limited to surface water and groundwater interaction (Ecology, 2003 and AMEC, 2010). The primary purpose of this study was to evaluate hydrogeologic conditions to determine if streamflow augmentation and conversion of surface water right diversions to groundwater withdrawals were feasible.

Our findings suggest pumping groundwater to augment streamflow is best suited for providing mitigation (e.g., temperature or critical ripple depth) for fish passage at select areas during fish windows or during periods of drought. Pumping groundwater into Mission Creek to satisfy minimum instream flows is not an effective solution due to the following factors:

- Groundwater pumping effects on surface water are likely to occur above the Yaksum Creek confluence; therefore, the ability to disperse impacts from pumping groundwater out of the Mission Creek Basin and into the greater Wenatchee River Basin is limited above Yaksum Creek.
- Groundwater level recovery from pumping is slow where the aquifer is semiconfined. This limits the run time and density of wells to augment streamflow, due to pumping interference

or year-to-year carry over of pumping effects that can lead to long-term declining groundwater levels.

- Surface water infiltrates through the streambed below the Yaksum Creek, which creates a challenge to see flow benefit at Ecology station 45E070 because a larger discharge of water to the stream is necessary to satisfy the minimum instream flow deficit.
- The low transmissivity of the semiconfined Chumstick aquifer increases the potential for pumping interference and impairment. Additionally, water is not available from the semiconfined alluvial aquifer due to the low transmissivity and extent.
- Suboptimal water quality, due to reducing conditions (e.g., low dissolved oxygen) in the semiconfined aquifer, requires additional study to determine if emergency drought relief application of streamflow augmentation is advisable for reducing fish mortality.

Based on results of the pilot Project, we find that streamflow augmentation with groundwater is not well suited in the Mission Creek Watershed, due to the necessary quantity and size of wells to improve streamflow. Augmenting streamflow with groundwater is effective when the source aquifer can produce a sufficient quantity of water, and the stream and source aquifer are separated by a very low-hydraulic conductivity unit (clay or sandstone). Augmentation is less effective when the adequate groundwater is not available, groundwater recovery from pumping is slow, and the stream loses water to ground—which is the case in the Mission Basin. However, there is potential for streamflow augmentation using groundwater wells to provide short-term emergency drought relief along priority habitat reaches. Additional study is necessary to identify priority reaches, characterize groundwater quality to determine suitability for aquatic health, and model the location and timing of streamflow improvements and deficits.

The permitting pathway to convert water rights from surface water diversions to groundwater withdrawals is dependent on Ecology's administration of groundwater bodies in the Mission Basin (Revised Code of Washington [RCW] 90.44.100). The Wenatchee Watershed Management Plan (WWPU, 2006) implies conjunctive management of surface water and groundwater resources. If Ecology administers groundwater and surface water as two separate sources, then a two-step permitting process is necessary, where the claim is placed into the Trust Water Right Program and used to mitigate the new groundwater withdrawal.

The low transmissivity of the Chumstick aquifer requires well completion depths capable of producing 320 feet of available drawdown and sufficient separation or pumping schedule to limit pumping interference and impairment to surrounding groundwater users. The semiconfined alluvial aquifer is limited in extent, which makes the aquifer susceptible to impairment. It is feasible to convert surface water diversions to groundwater withdrawals via the two-step permitting process, withdrawal with a properly drilled and constructed well, and an intermittent pumping schedule that allows for groundwater level recovery. The conversion is more feasible if peaking is satisfied with a surface water withdrawal during spring runoff or combined with small reservoir storage.

A summary of the technical results is provided below:

- The Chumstick aquifer has a transmissivity of approximately 50 square feet per day (ft2/day) and hydraulic conductivity of 0.2 feet per day (ft/d). The alluvial aquifer has a transmissivity of approximately 1,250 ft2/day and a hydraulic conductivity of 100 ft/d.

- Test Wells (TWs) were representative of both unconfined (TW-1, -2, and -6) and semiconfined conditions (TWs-4 and -5).
- Samples collected from TWs and the upper and lower surface water stations were analyzed for Dichlorodiphenyltrichloroethane (DDT)/ Dichlorodiphenyldichloroethane (DDD)/Dichlorodiphenyldichloroethylene (DDE), fecal coliform, orthophosphate, total phosphorous, nitrate, nitrite, total kjeldahl nitrogen, and total suspended solids. All results were below water quality screening levels or detection limits, with the following exceptions:
  - 4,4-DDE was detected at TW-1 at 2.3 and 2.1 nanogram per liter (ng/L), which is above the state surface water criteria for protection of aquatic organisms of 1 ng/L, but below the groundwater standard of 300 ng/L. While groundwater at TW-1 is suitable for potable use, it is not suitable for augmentation of streamflow.
  - Nitrate-N was detected in TW-1 and -2 at concentrations below groundwater standard of 10 mg/L.
- Average daily streamflow along the study corridor ranged from 8 to 30 cubic feet per second (cfs) during the duration of the Project. The streamflow at the Ecology gaging station ranged from 0 to 56 cfs during the same period.
- Comparison of streamflow between surface water stations indicate a losing condition between MC-Upper and MC-03 and gaining condition between MC-03 and MC-02. A losing condition appears to occur between MC-02 and MC-Lower Mission Creek.
- A basaltic dike was identified in the field near the location of OW-2 and MC-02. The location coincides with a measured increase in streamflow and a very low-yield water supply well that was used as an observation well (OW-2). OW-2 was the only well monitored with no influence from stream stage. The outcrop is not shown on publicly available geologic maps; however, basaltic dikes and sills are mapped elsewhere within the Chumstick Formation. This extrusion appears to behave as a barrier to groundwater flow, and results in localized compartmentalization of the Chumstick aquifer.

The stream response factors (time to induce pumping effects) for the wells completed in unconfined aquifers (TW-1, -2, and -6) are higher (1 to 270 days) than the semiconfined aquifers (0.03 to 0.5 days). The higher stream response factors and relatively quick recovery times (0.75 to 6 hours) of TW-1 and -2 suggest streamflow augmentation is more feasible in the lower unconfined aquifer.

Geological Framework

Structural setting, geologic history, and occurrence of groundwater provide the basis for our interpretation of the hydrogeology of the Project area. The Project area is sited in the Chiwaukum graben within the Cascade Crystalline Core of the North Cascades geologic province. Today, the sedimentary rocks of the Eocene Chumstick Formation are bounded by two major northwest-southeast trending fault zones: the Leavenworth Fault to the west and the Entiat Fault to the east. These faults separate the mainly sedimentary deposits of the Chumstick Formation from the surrounding metamorphic rocks and flood basalts of the Columbia River Basalt Group found to the south as shown on Figure C-1. The structural basin is internally folded and faulted and includes the Eagle Creek Fault Zone.

The Chumstick Formation is a nonmarine sedimentary deposit formed during a period of extensional tectonics after the cessation of the Late Cretaceous Laramide orogeny. The structural basin(s) hosting the Chumstick Formation were characterized by rapid subsidence and sediment accumulation, rapid lateral and vertical changes in sediment facies, changing paleocurrent pattern and sediment provenance, and syndepositional magmatism. Estimates on the depositional age of the Chumstick Formation range from 48 to 41 mega-annum (Ma) to less than 51 to 37 Ma (Enkelmann et al., 2015). Silling (1979) estimated the basin at 2km thick based on a gravity survey.

The Chumstick Formation is a white sandstone with varying amounts of shale, conglomerate, fanglomerate, and rare siliceous tuff (Tabor et al., 1982). Gresens (1983) notes several mafic to intermediate igneous rocks intruding the Chumstick Formation. Gresens (1983) also mapped basaltic (horneblende andesite) dikes in the Chumstick Formation in the upper portion of the Mission Creek basin. Field reconnaissance during the Project located an unmapped hornblende andesite dike (142^{o}/45^{o} NE) located near surface water station MC-02 and observation well OW-02 as indicated on Figure C-2. Based on comparison of upstream and downstream continuous flow measurements and aquifer tests, this structure likely is a barrier to groundwater flow and compartmentalizes the aquifer.

Overlying the Chumstick Formation are alluvial sediments derived from subsequent erosion of the Chumstick Formation, resulting in an angular unconformity. Today, the channel of Mission Creek is an incised sand- to cobble- to bedrock-dominated channel within the valley bottom alluvial deposits. The Mission Creek valley is situated within the deeply-incised Chumstick Formation forming a NNE-SSW trending canyon. The canyon roughly follows the strike of the 20 to 50 degree west-northwest dipping beds, with the Mission Creek channel crossing multiple dipping sandstone beds.

A shallow alluvial aquifer is present in the Project area. In the lower reach observation well, OW-01 is a dug well completed in the water table aquifer. In the upper reach of the Project area the alluvial aquifer has a clayey confining unit overlying a sand and gravel layer. The clayey layer creates semiconfined aquifer condition. The underlying Chumstick Formation aquifer is semiconfined due to the alternating sequence of sandstone, shale, and tuffs where fine-grained beds and low-grade metamorphism form confining units. Evaluation of groundwater and surface water elevations and aquifer testing indicate the Chumstick Formation aquifer is in hydraulic continuity with the overlying alluvial aquifer and Mission Creek along the project area.

Well Selection and Permitting

The following section describes the methodology used in completing the Project. Implementation of the Project was greatly influenced by willingness of landowners and voluntary use of their existing well infrastructure and equipment to perform aquifer testing. Without their involvement, an augmentation study requiring new infrastructure would have required hundreds of thousands of dollars in drilling costs alone. To conform to available grant funding and landowner interest, existing wells were used that were not necessarily optimum for the overall investigation goals, but nevertheless advanced the learning of this proof-of-concept option.

Well Selection

Well selection began with a meeting held on May 20, 2015, with Mission Creek Basin landowners and CCNRD to discuss flow improvement concepts and collect feedback as part of an ongoing County-led watershed planning process. Four landowners expressed interest in pursuing future projects with CCNRD. A reconnaissance-level site visit was performed in November 2015 to evaluate seven irrigation wells for inclusion in a hydrogeologic evaluation. From the seven wells evaluated, six wells were selected for initial testing in April 2016. The six wells were selected based on landowner involvement, completion depths (wells completed in the Chumstick Formation were preferred over alluvium wells) and used solely for irrigation purposes. Following the April 2016 testing, it was determined that to meet standard data-quality objectives for the Project, sounding tubes and a video scan of each well was necessary to collect water-level data and well-construction details. One well, TW-3, was excluded from the Project due to sedimentation of the well.

Permitting

CCNRD submitted preliminary permit application materials for authorization to test wells on July 15, 2016. A preliminary permit for Water Right Application No. G4-33175 was issued October 31, 2016. The overall objective of the preliminary permit is to obtain sufficient hydrogeologic data to support a decision on the water right application for Ecology to evaluate water availability, impairment of existing rights, and whether the proposed withdrawal would be detrimental to the public welfare. CCNRD's application for a preliminary permit was to facilitate aquifer testing with the intent to collect necessary information to evaluate streamflow augmentation with groundwater and surface-to-groundwater transfers as alternatives in the Appraisal.

A Project planning meeting between CCNRD, WDFW, Yakama Nation, and Ecology took place in June 2016 to discuss the project goals and permitting pathway. CCNRD developed a quality assurance project plan (QAPP; Aspect, 2016) and obtained a construction stormwater general permit (WAR304325) to authorize discharge of dewatering water to Mission Creek, a preliminary permit (G4-33175) for approval to complete pumping tests in each irrigation well, and hydraulic project approval (2016-2-97+01) for the installation and maintenance of the temporary discharge structures.

Field Measurements

The following sections provide an overview of the deviations from the QAPP; locations of surface water stations, observations, and test wells; and a general description of well completions.

Acquisition of data primarily relied on dataloggers to collect pressure and flow rate readings from pressure sensors and flow meters. Field measurements were collected for quality assurance, quality control, and as back-up measurements in the event of data loss or equipment failure.

QAPP Deviations

The QAPP details the procedures for data collection and evaluation of aquifer parameters and water quality. During implementation of the project, three deviations from the QAPP occurred, including:

1. Elimination of TW-3 from study
2. Additional surface water gaging stations

3. Shorter duration pumping tests on TW-1 and -2

Surface Water Monitoring Locations

Surface water gaging stations were established along a 3.6-mile-long corridor of Mission Creek that ranges in elevation from 1,300 to 980 feet above mean sea level. Details and locations are presented in Table C-1 and on Figure C-2. The upstream and downstream surface water monitoring stations, MC-Upper and MC-Lower, were established to measure water quality parameters, stream stage, and flow. The surface water monitoring stations established within monitored corridor (MC-01, MC-02, and MC-03) were established to measure stream stage and change in stream flow between gaging stations. These stations were added after development of the QAPP, based on stakeholder input and anecdotal evidence of gaining and losing reaches along the corridor.

The distance between each of the gaging stations was approximately 1 mile, except for the distance between MC-02 and MC-03, which was 0.6 mile. The downstream gaging station (MC-Lower) bounds lower end of the project area to above Tripp Canyon, approximately 2.8 river miles from the Wenatchee River confluence. The upstream gaging station (MC-Upper) was located below the Wenatchee National Forest boundary adjacent to the uppermost orchard in Mission Creek, approximately 6.4 river miles upstream from the Wenatchee River confluence.

Groundwater Monitoring Wells

Groundwater monitoring occurred at two different well types: test wells (TW) and observation wells (OW). Water quality and continuous measurement of groundwater levels and discharge rates were collected at TWs and continuous water level measurements were collected at the OWs. Table C-2 provides an overview of the locations and observations made at the TWs and OWs.

Groundwater Well Locations

The TWs and OWs were located longitudinally along Mission Creek (Figure C-2). Mission Creek was broken into two reaches—upper and lower—based on field observation of a basaltic dike, stream discharge measurements, and static water level measurements:

- **Lower Reach –** TW-1 and -2 were located 170 feet apart, with OW-1 located between the two test wells. These wells were located at the downgradient portion of the lower reach (Figure C-2).
- **Upper Reach –** OW-3 was a domestic supply well located along the lower one-third of the upper reach. TW-4 was located approximately 1,200 feet south of OW-3. TWs-4, -5, and -6 were located along the upper one-half of the upper reach (Figure C-2). OW-4 was located 60 feet to the northeast of TW-6.

Well Construction

The TWs were completed in either alluvium or the Chumstick Formation. Detail on well construction and aquifer completion are provided in Table C-3 and Attachment C-1. A summary of well construction and water bearing units is provided below:

- TW-1 was drilled and cased to 43 feet below ground surface (bgs) and completed as open hole to 254 feet bgs via cable tool. The casing was driven 2 feet into sandstone of the Chumstick Formation and was sealed to 30 feet bgs. The casing does not provide a sufficient seal to prevent water from the overlying alluvium from entering the open hole. TW-1

captures water from the Chumstick Formation with a minor contribution from the overlying alluvium.

- TW-2 was initially drilled to 40 feet via air rotary. The well was cased and completed with 5 feet of well screen from 32 to 37 feet bgs. Subsequently, the steel casing and stainless-steel screen were removed. The well was deepened to 218 feet bgs via air rotary. An 8-inch-diameter PVC casing was installed and sealed to 45 feet bgs, approximately 4 feet into sandstone of the Chumstick Formation. A 7-inch-diameter PVC liner is perforated beginning at 70 feet bgs and extends to 228 feet bgs. TW-2 captures water from the Chumstick Formation with a minor contribution from the overlying alluvium (i.e., water from the overlying alluvium audibly cascades into the well).
- TW-3 was removed from the Project. The well was full of sediment and the pump was heavily damaged from pumping sand.
- TW-4 was drilled to 52.5 feet bgs via air rotary. Casing was installed to a depth of 41 feet bgs, perforated from 31 to 40 feet bgs, and sealed to 18 feet bgs. The bottom 12.5 feet of the well was completed as an open hole in sandstone and shale of the Chumstick Formation. TW-4 captures water from a sand and gravel unit located above the Chumstick Formation.
- TW-5 was drilled to a depth of 320 feet bgs via air rotary. The well was completed as open hole in the Chumstick Formation except for a 19-foot surface casing and seal through a sandy alluvium. TW-5 captures water from multiple water-bearing zones (bedding planes and primary porosity) within the Chumstick Formation.
- TW-6 was deepened to 340 feet bgs via air rotary from 280 feet bgs. The original driller's report was not located, and the 6-inch-diameter PVC liner prevented video of the formation and well construction details. Based on construction of neighboring wells, it is presumed an 8-inch-diameter casing extends at least 40 feet through alluvium and the well is open to the Chumstick Formation. TW-6 captures water from the Chumstick Formation with a minor contribution from the overlying alluvium.

The OWs were completed as either alluvium or Chumstick Formation wells, and have construction details as follows:

- OW-1 was a dug well completed in alluvium. A driller's log was not available.
- OW-2 was drilled to 400 feet bgs via air rotary. Casing and surface seal extend to 22 feet bgs. The well was completed as an open-hole and captures water from the Chumstick Formation.
- OW-3 was drilled to 79 feet bgs via air rotary. A casing extends through the alluvium to 39 feet bgs and is perforated from 21 to 34 feet bgs. The bottom 40 feet was completed as open hole in the Chumstick Formation. OW-3 captures water from a sand and gravel unit and the Chumstick Formation.
- OW-4 was drilled to 38 feet bgs via air rotary. A casing extends the entire length of the well and captures water from the alluvium through an open bottom.

Aquifer Tests

Short (less than 8-hour) pumping tests were conducted on the lower reach TWs (TW-1 and -2). The upper reach TWs (TW-4, -5, and -6) were continuously pumped for at least 26 days. During the

pumping tests, water levels were collected in the nonpumping TWs and OWs. Table C-4 provides an overview of the aquifer testing conditions.

Data Analysis

The use of groundwater to augment streamflow depends on a sufficient quantity of water that meets water quality objectives and will not impact streamflow in an unacceptable time nor place. This section details the methods used to analyze the data collected during the field study. Field data was collected to evaluate hydraulic continuity between the aquifer and Mission Creek, aquifer characteristics, boundary conditions, and water quality with respect to Mission Creek's water quality impact listings (i.e., 303d listings).

Surface Water and Groundwater Hydrographs

Hydrographs, which illustrate rate of flow (discharge) or water level over time, are used to evaluate changes in streamflow and groundwater level due to influences from changes in climatic conditions (precipitation and barometric pressure), geography, and human activity (groundwater pumping). Continuous data was collected to enable evaluation of surface water and groundwater hydrographs.

Stream Stage and Flow

Surface water hydrographs were generated from 15-minute stage measurements. Table C-5 is the rating table used for continuous streamflow measurements. A rating curve describes the unique relationship between depth and streamflow for each gaging station. A rating curve for each temporarily established gaging station was used to convert the 15-minute stage measurements to a discharge. Discharge measurements were made over varying flow rates. Streamflow measurements made on October 28, 2016, were flagged as having "possible equipment malfunction;" these stage and flow rate measurements were excluded from the rating curves.

Due to the limited number of discharge-stage measurements and narrow range of discharges measured, a simple linear regression was used to describe the relationship between stream stage and flow rate. Average daily streamflow measured at the temporary gaging stations during the Project ranged from 8 to 30 cfs, as shown on Figure C-3. Ecology gaging station 45E070, located at the mouth of Mission Creek near the confluence with the Wenatchee River, measured 0 to 56 cfs during the same period.

Simultaneous measurement of stream flow at multiple locations allows for estimation of losing and gaining reaches along the stream corridor. To quantify gaining and losing reaches, a more detailed study was necessary to account for contributions from tributaries and return flow, and losses from withdrawals and evapotranspiration along the reach. Review of Figure C-3 suggests the stream loses flow along the length of the stream. An exception occurs between stations MC-03 and MC-02 where a greater amount of flow is observed in Mission Creek. This coincides with the location of an observed outcrop of a basaltic dike, suggesting that diking is perhaps constricting flow through the alluvium to the surface.

Groundwater Levels

The static groundwater levels in the TWs prior to conducting the aquifer tests are presented on Figure C-4. The relative barometric effect to total drawdown is small; therefore, a correction for barometric efficiency was not applied to the dataset. The influence of stream stage on groundwater

levels was not apparent in the static water levels. Longer-term ambient groundwater monitoring may provide additional insight on well response and aquifer recharge due to changes in stream stage during peak-flow and low-flow events.

The full hydrograph for the OWs is presented on Figure C-5. The hydrograph shows recharge was occurring in OW-4, -3, and -1. However, the hydrograph for OW-2 is flat, which is an indication that OW-2 was not rapidly recharged. Due to the lack of recharge or response to stream stage OW-2 is interpreted as completed in a compartmentalized body of groundwater with little connection to Mission Creek, nor to the greater alluvial or Chumstick aquifers.

Pumping effects are discernable in the hydrographs for OW-1, -3, and -4. Pumping TW-1 and -2 had a rapid response on OW-1; whereas, the pumping effect on OW-3 from pumping TW-4 showed a delayed pumping effect due to removing water from storage and depressing the potentiometric surface in the alluvial aquifer.

Aquifer Characteristics

Aquifer parameters (hydraulic conductivity and transmissivity) and presence of boundary conditions are often determined by analysis of time-drawdown and recovery curves. Aquifer parameters were derived by calculating transmissivity using Jacob's straight-line method (Kruseman and de Ridder, 2000). Storativity was estimated based on aquifer condition (confined, semiconfined, or unconfined) and lithology for the unconfined condition. The presence of boundary conditions is presented as inflections in drawdown curves (Driscoll, 1986).

Aquifer Parameters

The hydraulic conductivity of the alluvial sediments is approximately 100 feet/day, and a transmissivity of 1,270 feet^2/day, assuming a saturated thickness of 13 feet. The underlying Chumstick Formation sandstone has a hydraulic conductivity of approximately 0.2 feet/day, and a transmissivity of 50 feet^2/day, assuming an average saturated thickness of 265 feet is captured by wells.

TW-1, -2, and -6 are completed in an unconfined aquifer, and TW-4 and -5 are completed in semiconfined aquifers. Storativity of the semiconfined aquifer is estimated at $1x10^{-3}$, and 0.15 for the unconfined aquifer. Table C-6 presents the aquifer characteristics derived from aquifer testing.

Drawdown curves for TW-1 and TW-2 were not analyzed due to excessive drawdown during pumping tests resulting in pump cavitation and high pressure at the wellhead discharge. Recovery curves for TW-1 and TW-2 were captured to facilitate analysis of aquifer parameters (see Figures C-6 and C-7 for recovery curves).

Boundary Conditions

The presence of boundary conditions was evaluated by analysis of drawdown curves. A positive boundary condition is indicative of a recharge boundary (e.g., stream), and a negative boundary condition indicates a potential barrier to groundwater flow (Driscoll, 1986). Figures C-8 thru C-10 present the drawdown and recovery curves used for analysis of these wells. Time-drawdown curves for TW-4, -5, and -6 indicate the presence of a potential recharge boundary following 2 to 8 days of testing.

The Project drawdown and recovery curves present a characteristic S-shaped-curve. TWs-1, -2, -5, and -6 were completed in Chumstick sandstone. The shape of the drawdown curves suggests that discharge from the aquifer is satisfied by double-porosity aquifer framework. For example, early in the pumping cycle, flow towards the well is entirely through fractures, or bedding planes, which have higher hydraulic conductivity and lower storage capacity. Later, the primary porosity of the sandstone layers (which have lower hydraulic conductivity and higher storage capacity) contributes flow to the fractures, which stabilizes drawdown. Finally, late in the pumping cycle, flow is entirely from the primary porosity of the sandstone layers.

The alluvial well TW-4 also shows a characteristic S-shaped curve; however, the mechanism is different due to the unconsolidated nature of the aquifer matrix. For TW-4, the early pumping is typical for a semiconfined aquifer, but later the curve flattens as flow drains from the pores in the overlying silty clay unit, then discharge is entirely from storage.

Well Yield

The well yield is derived as the specific capacity and available drawdown within the well. Specific capacity is a measure of well yield per unit drawdown, expressed as gallons per minute per foot (gpm/ft), and available drawdown is the height of water above the pump intake, minus 10 feet (to keep water above the intake). The yield of the alluvial well is approximately 90 gpm and the sandstone wells have a lower average yield of approximately 60 gpm. Table C-7 provides the specific capacity, available drawdown, and yield of the TWs.

Water Quality

Surface water sample results indicate an increase in fecal coliform count and nitrate from upstream to downstream. Surface water and groundwater quality sample results are presented in Table C-8 and laboratory reports are provided in Attachment 2.

Groundwater quality results indicate variability concerning the oxidation-reduction potential (ORP) and dissolved oxygen (DO) content. ORP and DO are often positively correlated. TW-6 and TW-5 indicate reducing conditions exists. This is consistent with field observation of weak sulfurous odor from TW-6 and strong odor from TW-5 during pumping.

Pesticide 4,4-DDE was detected in TW-1 at a concentration of 2.3 ng/L, and in the duplicate sample (BCC615) at 2.1 ng/L. These concentrations are above surface water quality criteria for protection of aquatic health (1.0 ng/L).

All other parameters for samples collected not mentioned above were either below detection limits or detected at levels below regulatory criteria.

Postcalibration of the conductivity sensor revealed that the measurements collected on November 7, 2016, were not accurate; actual conductivity of the stream is lower than measured.

Additional steps should be taken to characterize the water quality of potential streamflow augmentation wells for aquatic health, and geochemically “type” the water for purposes of understanding recharge pathways.

Surface Water Diversion to Groundwater Point of Withdrawal

Authority to convert a surface water right to a groundwater right is derived through several laws, including RCW 90.03.380, 90.44.100, and 90.54.020(9), provided the change occurs within the same source of water, water is available, in the public interest, and will not impair existing rights.

Same Source of Water

Figure C-4 shows the fluctuation of static water levels in the test wells, barometric pressure, and streamflow over a 1-week period. The hydrograph suggests the Chumstick (semiconfined and unconfined) and semiconfined alluvial aquifers are not in direct hydraulic continuity with Mission Creek, and likely not considered to be the same source of water.

A determination on water right administration is a consideration of both management and technical considerations. WWPU (2006) implies a conjunctive management of surface and groundwater resources. Alternatively, it is possible to obtain a new groundwater right by transferring a certificated surface water right to the Trust Water Right Program (TWRP) and using the trusted water right as mitigation for a new water budget neutral (WBN) groundwater right.

Based on local geology, aquifer conditions, and observed well yields, we have assumed the average well can produce about 75 gpm, which implies that one well will be required for every 8.3-acre orchard block at an average water duty of 9 gpm/acre.

Impairment Analysis

RCW 90.03.290 and RCW 90.44.060 require a determination that a water right change will not impair existing rights. Impairment was evaluated by calculating drawdown in a hypothetical neighboring well using the aquifer parameters in Table C-6, a storativity of $1x10^{-3}$ for semiconfined aquifers, an assumed distance of 400 feet between a proposed point of withdrawal and neighboring permitted or permit-exempt well, and the governing Theis equation (Theis, 1935). We assumed that an instantaneous quantity (Qi) of 75 gpm was necessary for an 8.3-acre orchard (or about 9 gpm/acre).

Continuously pumping a well completed in the Chumstick aquifer was calculated to result in approximately 7 feet and 68 feet of drawdown over a 1-day and 1-month period, respectively. For a well completed in the semiconfined alluvial aquifer, continuous pumping resulted in 2.6 feet and 5.6 feet of drawdown over a 1-day and 1-month period, respectively. Pumping groundwater from the Chumstick or alluvial aquifers for 1 day is not a cause for impairment. Due to the thickness of the Chumstick Formation 68 feet of additional drawdown may not constitute impairment; however, an additional 68 feet of drawdown in existing wells, which may not have sufficient available drawdown, may constitute impairment. An additional 5.6 feet of drawdown in the alluvial aquifer may constitute impairment due to the limited thickness of the semiconfined alluvial aquifer. Any impacts to surface water would be offset by the nondiversion of surface water.

Water Availability

Water availability is considered as two parts: legal availability and physical availability.

The specific capacity of tested wells is relatively low (average of 0.3 gpm/ft) for wells completed in the Chumstick Formation. The specific capacity for the TW-4, completed in the semiconfined alluvial aquifer, is higher at 3.9 gpm/ft; however, groundwater level decline was observed in OW-2,

which suggests the semi-confined alluvial aquifer is limited in extent. The limited extent of the semiconfined alluvial aquifer makes it susceptible to impairment.

To satisfy peak demand (i.e., instantaneous quantity) for an 8.3-acre orchard, approximately 75 gpm is required. This instantaneous quantity requires a minimum of 250 feet and 19 feet of available drawdown in the Chumstick and alluvial aquifers, respectively. Given thinness of the semiconfined alluvial aquifer and observed decline during testing, it is reasonable to assume water is not available. Given the thickness of the Chumstick Formation water may be available; however, a reduction is water quality is anticipated with depth that may limit availability.

Regarding the legal availability of water, review of surface water rights in the Mission Basin revealed that most water rights are claims. Transfer of claims will require Ecology to review extent and validity of the water right and make a tentative determination of the beneficial use, and public notice.

While water may be legally available for groundwater withdrawal by mitigation with a surface water right, water physical availability is very limited.

Streamflow Augmentation

The goal for augmenting streamflow with groundwater in the Mission Basin was to increase streamflow during the low-flow season (e.g., June to September) and offset impacts from permit-exempt well withdrawals. Augmenting streamflow with groundwater is effective when the source aquifer can produce a sufficient quantity of water, and the stream and source aquifer are separated by a very low hydraulic conductivity unit (clay or sandstone). Augmentation is less effective when the source aquifer cannot produce sufficient quantities of water, groundwater recovery from pumping is slow, and the stream loses water to ground.

Stream depletion due to groundwater pumping is evaluated by calculating a stream response factor, which indicates how rapidly streamflow depletion will occur in response to pumping (Barlow and Leake, 2012). The stream response factors and recovery times for the Project are presented in Table C-9. The stream response factors for the wells completed in unconfined aquifers (TW-1, -2, and -6) were higher (1 to 270 days) than the semiconfined aquifers (0.03 to 0.5 days). The higher stream response factors and relatively quick recovery times (0.75 to 6 hours) of TW-1 and -2 suggest streamflow augmentation is more feasible in the lower unconfined aquifer.

The quantity of water necessary to increase streamflow to the minimum instream flow (WAC 173-545-60) during June for steelhead spawning (24.2 cfs) is 9.2 cfs during a median year and approximately 15.8 cfs during the 2015 drought year, as measured at Ecology gaging station 45E070. Augmenting the streamflow with wells would require 55 to 95 wells (of similar construction to those tested) pumping 75 gpm. This does not account for water that would be lost to ground prior to reaching Ecology's gaging station.

Streamflow augmentation in the Mission Basin is not considered an effective solution for improving low-flow season flows due to the quantity of water necessary to meet the minimum instream flow criteria, potential for impairment to neighboring water rights, and groundwater availability.

The applicability of pumping groundwater to augment streamflow is more applicable to improving flow conditions for targeted reaches. Especially, for providing mitigation (e.g., temperature or critical ripple depth) for fish passage at select areas during certain times or during periods of drought. Additional study is necessary to identify priority reaches, characterize groundwater quality to determine suitability for aquatic health, and model the location and timing of streamflow improvements and deficits.

References

Aspect Consulting, LLC (Aspect), 2016, Quality Assurance Project Plan: Mission Creek Flow Augmentation Pilot Project, dated October 12, 2016.

AMEC Geomatrix, Inc. (AMEC), 2010, Memo: Piezometer Monitoring in Chumstick and Mission Creeks, Prepared for Chelan County Natural Resources Department, Ecology Grant No. G0800335, June 24, 2010.

Barlow, P.M., and S.A. Leake, 2012, Streamflow depletion by wells—understanding and managing the effects of groundwater pumping on streamflow: U.S. Geological Survey Circular 1376, 84 p.

Driscoll, F.G., 1986, Groundwater and Wells, 2nd Ed., Johnson Division, St. Paul, MN 55112.

Enkelmann, E., T.A. Ehlers, G. Merli, and K. Methner, 2015, Thermal and exhumation history of the Eocene Chumstick Basin, Washington State, USA, Tectonics, 34, 951–969.

Gresens, R.L, 1983, Geology of the Wenatchee and Monitor Quadrangles, Chelan and Douglas Counties, Washington, Washington Department of Natural Resources, Bulletin 75.

Kruseman, G.P. and N.A. de Ridder, 2000, Analysis and Evaluation of Pumping Test Data, Second Edition, International Institute for Land Reclamation and Improvement, The Netherlands.

Silling, R., 1979, A gravity study of the Chiwaukum graben, Washington, University of Washington, Seattle, MS thesis, 100 pp.

Tabor, R.W, R.B. Waitt, Jr., V.A. Frizzell, Jr., D.A. Swanson, G.R. Byerly, and R.D. Bentley, 1982, Geologic Map of the Wenatchee 1:100,000 Quadrangle, Central Washington, U.S. Geological Survey, Miscellaneous Investigations Series Map 1-1311.

Theis, C.V., 1935, The lowering of the piezometer surface and the rate and discharge of a well using ground-water storage, Transactions, American Geophysical Union, 16:519-24.

Washington State Department of Ecology (Ecology), 2003, Powerpoint Presentation: Preliminary Assessment of Surface Water and Ground-Water Interactions Within the Wenatchee River Watershed (WRIA 45), Investigations Conducted in Support of the Wenatchee River Temperature TMDL.

Wenatchee Watershed Planning Unit (WWPU), 2006, Phase III Wenatchee Watershed Management Plan, April 2006.

Limitations

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

All reports prepared by Aspect Consulting for the Client apply only to the services described in the Agreement(s) with the Client. Any use or reuse by any party other than the Client is at the sole risk of that party, and without liability to Aspect Consulting. Aspect Consulting's original files/reports shall govern in the event of any dispute regarding the content of electronic documents furnished to others.

Attachments

Attachment C-1 – Well Logs
Attachment C-2 – Laboratory Reports
Table C-1 – Surface Water Stations
Table C-2 – Groundwater Monitoring and Test Locations
Table C-3 – Well Construction
Table C-4 – Aquifer Test Conditions
Table C-5 – Rating Table
Table C-6 – Aquifer Parameters
Table C-7 – Well Yield
Table C-8 – Water Quality Results
Table C-9 – Stream Response Factor
Figure C-1 – Mission Creek Basin Surficial Geology
Figure C-2 – Monitoring Locations
Figure C-3 – Surface Water Hydrographs
Figure C-4 – TWs Static Water Levels
Figure C-5 – OWs Water Levels
Figure C-6 – TW-1 Recovery Curves
Figure C-7 – TW-2 Recovery Curves
Figure C-8 – TW-4 Drawdown and Recovery Curves
Figure C-9 – TW-5 Drawdown and Recovery Curves
Figure C-10 – TW-6 Drawdown and Recovery Curves

V:\120045 Chelan County\Deliverables\Mission Creek\Centennial Grant Reporting\C_Streamflow Augmentation\Streamflow Augmentation Pilot Project.docx

ATTACHMENT 1

Well Logs

TW-1

File—Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT
STATE OF WASHINGTON

Application No. 24-25491

Permit No. .....

(1) **OWNER:** Name Ken Ahrens Address Rt 1 Cashmere Wash.

(2) **LOCATION OF WELL:** County Chelan NW¼ SW¼ NE¼ Sec. 17 T. 23 N., R. 19 W.M.

Bearing and distance from section or subdivision corner See Application G

(3) **PROPOSED USE:** Domestic ☐ Industrial ☐ Municipal ☐
Irrigation ☒ Test Well ☐ Other ☐

(4) **TYPE OF WORK:** Owner's number of well (if more than one) .....
New well ☒ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☑ Driven ☐
Reconditioned ☐ Rotary ☐ Jetted ☐

(5) **DIMENSIONS:** Diameter of well 8 inches.
Drilled 153 ft. Depth of completed well 153 ft.

(6) **CONSTRUCTION DETAILS:**
Casing installed: 8 " Diam. from +1 ft. to 43 ft.
Threaded ☐ ..... " Diam. from ..... ft. to ..... ft.
Welded ☒ ..... " Diam. from ..... ft. to ..... ft.

Perforations: Yes ☐ No ☒
Type of perforator used .....
SIZE of perforations ..... in. by ..... in.
..... perforations from ..... ft. to ..... ft.
..... perforations from ..... ft. to ..... ft.
..... perforations from ..... ft. to ..... ft.

Screens: Yes ☐ No ☒
Manufacturer's Name .....
Type ..... Model No. .....
Diam. ..... Slot size ..... from ..... ft. to ..... ft.
Diam. ..... Slot size ..... from ..... ft. to ..... ft.

Gravel packed: Yes ☐ No ☒ Size of gravel: .....
Gravel placed from ..... ft. to ..... ft.

Surface seal: Yes ☑ No ☐ To what depth? 30 ft.
Material used in seal Bentonite
Did any strata contain unusable water? Yes ☐ No ☒
Type of water? ..... Depth of strata .....
Method of sealing strata off .....

(7) **PUMP:** Manufacturer's Name .....
Type: ..... H.P. .....

(8) **WATER LEVELS:** Land-surface elevation above mean sea level .... ft.
Static level 20 ft. below top of well Date .....
Artesian pressure ..... lbs. per square inch Date .....
Artesian water is controlled by ..... (Cap, valve, etc.)

(9) **WELL TESTS:** Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☑ No ☐ If yes, by whom? Bendickson
Yield: 75 gal./min. with 142 ft. drawdown after 2 hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test .....
Bailer test ..... gal./min. with 50 ft. drawdown after 2 hrs.
Artesian flow ..... g.p.m. Date .....
Temperature of water ..... Was a chemical analysis made? Yes ☐ No ☒

(10) **WELL LOG:**

Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

MATERIAL	FROM	TO
Topsoil Brown	0	2
Boulders & gravel	2	41
Sandstone grey	41	56
Water at 56' Dark grey sandstone	56	80
Dark grey shale	80	135
Sandstone light grey	135	153
Bedrock	153	
Picked up water from 56' on down		

RECEIVED
AUG 25 1971
DEPARTMENT OF ECOLOGY
CENTRAL OPERATIONAL OFFICE

Work started 7-1, 19 71 Completed 7-12, 19 71

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Turnwater Drilling Inc.
(Person, firm, or corporation) (Type or print)

Address Rt 1 Box 133-C Leavenworth Wash.

[Signed] John Gunn
(Well Driller)

License No. 0353 Date 7-12, 19 71

(USE ADDITIONAL SHEETS IF NECESSARY)

ECY 050-1-20

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT
STATE OF WASHINGTON

Application No. .....
Permit No. G4-25191P

(1) OWNER: Name Ken Ahrens Address RT 1 Box 348 Cashmere

(2) LOCATION OF WELL: County Chelan — SW ¼ NE ¼ Sec. 17 T. 23 N., R. 19 W.M.
Bearing and distance from section or subdivision corner

(3) PROPOSED USE: Domestic ☐ Industrial ☐ Municipal ☐
Irrigation ☒ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one) ....
New well ☐ Method: Dug ☐ Bored ☐
Deepened ☒ Cable ☐ Driven ☐
Reconditioned ☐ Rotary ☒ Jetted ☐

(5) DIMENSIONS: Diameter of well 8 inches.
Drilled ..... ft. Depth of completed well 254 ft.

(6) CONSTRUCTION DETAILS:

Casing installed: ..... " Diam. from ..... ft. to ..... ft.
Threaded ☐ ..... " Diam. from ..... ft. to ..... ft.
Welded ☐ ..... " Diam. from ..... ft. to ..... ft.

Perforations: Yes ☐ No ☒
Type of perforator used .....
SIZE of perforations ..... in. by ..... in.
..... perforations from ..... ft. to ..... ft.
..... perforations from ..... ft. to ..... ft.
..... perforations from ..... ft. to ..... ft.

Screens: Yes ☐ No ☒
Manufacturer's Name .....
Type ..... Model No. .....
Diam. ..... Slot size ..... from ..... ft. to ..... ft.
Diam. ..... Slot size ..... from ..... ft. to ..... ft.

Gravel packed: Yes ☐ No ☒ Size of gravel: .....
Gravel placed from ..... ft. to ..... ft.

Surface seal: Yes ☐ No ☐ To what depth? ..... ft.
Material used in seal .....
Did any strata contain unusable water? Yes ☐ No ☐
Type of water? ..... Depth of strata .....
Method of sealing strata off .....

(7) PUMP: Manufacturer's Name .....
Type: ..... H.P. .....

(8) WATER LEVELS: Land-surface elevation above mean sea level .... ft.
Static level 101 ft. below top of well Date 2-16-80
Artesian pressure ..... lbs. per square inch Date .....
Artesian water is controlled by ..... (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☐ If yes, by whom? .....
Yield: ..... gal./min. with ..... ft. drawdown after ..... hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test .....
Bailer test 120 gal./min. with ..... ft. drawdown after ..... hrs.
Artesian flow ..... g.p.m. Date .....
Temperature of water ..... Was a chemical analysis made? Yes ☐ No ☐

(10) WELL LOG:

Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

MATERIAL	FROM	TO
Shale	154	164
Sand Stone	164	174
Shale	174	180
Sandstone	180	230
shale	230	234
Sandstone	234	254

RECEIVED
APR 17 1980
DEPARTMENT OF ECOLOGY
CENTRAL REGION OFFICE

Work started ....., 19..... Completed 2/16, 1980

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Glessner Well Drilling
(Person, firm, or corporation) (Type or print)

Address 142 S Texas E Wenatchee

[Signed] Wesley Glessner
(Well Driller)

License No. 0154 Date 2/18, 1980

DK 4.22.80

(USE ADDITIONAL SHEETS IF NECESSARY)

ECY 050-1-20

TW-2

WATER WELL RE. ORT

State of Washington Date Printed: 31-Aug-2010 Log No. 0

Construction / Decommission: Original Construction Notice of Intent #: 415904

Construction

PROPOSED USE: IRRIGATION

TYPE OF WORK: Owners's Well Number: (If more than one well) 2

NEW WELL Method: ROTARY

DIMENSIONS: Diameter of well: 8 inches

Drilled 40 ft. Depth of completed well 37 ft.

CONSTRUCTION DETAILS:

Liner installed:

" Dia from ft. to ft.

Casing installed: WELDED

8 " Dia from +3 ft. to 33 ft.

" Dia from ft. to ft.

" Dia from ft. to ft.

Perforations: No Used In:

Type of perforator used

SIZE of perforations in. by in.

Perforations from ft. to ft.

Perforations from ft. to ft.

Perforations from ft. to ft.

Screens: 1 K-Pac Location: 31

Manufacture's Name JOHNSON

Type: STAINLESS Model No. SLOTTED

Diam. 8 slot size: 40 from 32 ft. to 37 ft.

Diam. slot size: from ft. to ft.

Gravel/Filter packed: No Size of Gravel

Material placed from ft. to ft.

Surface seal: Yes To what depth 33 ft.

Seal method: Material used in seal BENT/CASING

Did any strata contain unusable water? No

Type of water: Depth of strata

Method of sealing strata off

PUMP: Manufacture's name

Type: H.P. 0

WATER LEVELS: Land-surface elevation above mean sea level: 0 ft.

Static level 10 ft. below top of well Date 06/08/2010

Artesian Pressure lbs per square inch Date

Artesian water controlled by

WELL TESTS: Drawdown is amount water level is lowered below static level.

Was a pump test made? No If yes, by whom

Yield: gal/min with ft drawdown after

Yield: gal/min with ft drawdown after

Yield: gal/min with ft drawdown after

Recovery data (time taken as zero when pump turned off)(water level measured from well top to water level

Time:	Water Level	Time:	Water Level	Time:	Water Level

Date of test:

Bailer test gal/min ft drawdown after hrs.

Air test 30+ gal/min w/ stem set at 25 ft. for 2 hours

Artesian flow gpm Date

Temperature of water Was a chemical analysis made No

CURRENT

Notice of Intent No.: W267184

Unique Ecology Well I.D. No. BCC614

Water Right Permit Number: G4-25191C

OWNER: AHRENS, KEVIN

OWNER ADDR 3916 MISSION CREEK RD

CASHMERE, WA 98815

Well Add: 3916 MISSION CREEK RD

City: Cashmere, WA 98815 County: Chelan

Location: SE 1/4 NW 1/4 Sec 17 T 23 R 19E EWM

Lat/Long: (s, t, r still REQUIRED) Lat Deg Lat Min/Sec Long Deg Long Min/Se

Tax Parcel No.: 231917240050

CONSTRUCTION OR DECOMMISSION PROCEDURE

Formation: Describe by color, character, size of material and structure. Show thickness of aquifers and the kind and nature of the material in each stratum penetrated. Show at least one entry for each change in formation.

Material	From	To
LOAM BLACK	0	9
COBBLES GRAVEL WET	9	26
CLAY SAND DAMP	26	28
COBBLES GRAVEL WET	28	38
SAND BROWN DAMP	38	40

RECEIVED

JUN 15 2011

Notes: DEPARTMENT OF ECOLOGY - CENTRAL REGIONAL OFFICE

Work started 06/07/2010 Completed 06/08/2010

WELL CONSTRUCTION CERTIFICATION:

I constructed and/or accept responsibility for construction of this well and its compliance with all Washington well construction standards. Materials used and the information reported are true to my best knowledge and belief.

☑ Driller ☐ Engineer ☐ Trainee

Name: AUDIE MCCURDY License No.: 2690

Signature:

If trainee, Licensed driller is: License No.:

Licensed Driller Signature:

Drilling Company:

NAME: FOGLE PUMP & SUPPLY, INC. Shop: REPUBLIC

ADDRESS: PO Box 456

Republic, WA 99166

Phone: 5097752878 Toll Free: 8008453500

E-Mail: leslie@foglepump.com

FAX: 5097750498 WEB Site: www.foglepump.com

Contractor's Registration No.: FOGLEPS095L4 Date Log Created: 06/16/2010

WATER WELL REPORT

State of Washington Date Printed: 31-Aug-2010 Log No. 0 41590S

Construction / Decommission: Original Construction

Construction Notice of Intent #: W267184

CURRENT

Notice of Intent No.: W266808

Unique Ecology Well I.D. No.: BCC614

Water Right Permit Number: G4-25191C

RECEIVED

JUN 15 2011

DEPARTMENT OF ECOLOGY - CENTRAL REGIONAL OFFICE

OWNER: AHRENS, KEVIN

OWNER ADDR 3916 MISSION CR RD
CASHMERE, WA 98815

Well Add: 3916 MISSION CREEK RD

City: Cashmere, WA 98815 County: Chelan

Location: SE 1/4 NW 1/4 Sec 17 T 23 R 19 EWM

Lat/Long: (s, t, r still REQUIRED) Lat Deg Lat Min/Sec Long Deg Long Min/Se

Tax Parcel No.: 231917240050

PROPOSED USE: IRRIGATION

TYPE OF WORK: Owner's Well Number: (If more than one well)
DEEPENED Method: ROTARY

DIMENSIONS: Diameter of well: 8 inches
Drilled 244 ft. Depth of completed well 244 ft.

CONSTRUCTION DETAILS:

Liner installed: PVC
6 " Dia from 9 ft. to 244 ft.

Casing installed: WELDED
8 " Dia from +2 ft. to 45 ft.
" Dia from ft. to ft.
" Dia from ft. to ft.

Perforations: Yes Used In: LINER
Type of perforator used SKILL SAW
SIZE of perforations 1/8 in. by 7 in.
192 Perforations from 71 ft. to 228 ft.
Perforations from ft. to ft.
Perforations from ft. to ft.

Screens: 0 K-Pac Location:
Manufacture's Name
Type: Model No.
Diam. slot size: from ft. to ft.
Diam. slot size: from ft. to ft.

Gravel/Filter packed: No Size of Gravel
Material placed from ft. to ft.

Surface seal: Yes To what depth 45 ft.
Seal method: Material used in seal BENTONITE
Did any strata contain unusable water? No
Type of water: Depth of strata
Method of sealing strata off

PUMP: Manufacture's name
Type: H.P. 0

WATER LEVELS: Land-surface elevation above mean sea level: 0 ft.
Static level 40 ft. below top of well Date 08/02/2010
Artesian Pressure lbs per square inch Date
Artesian water controlled by

WELL TESTS: Drawdown is amount water level is lowered below static level.
Was a pump test made? No If yes, by whom
Yield: gal/min with ft drawdown after
Yield: gal/min with ft drawdown after
Yield: gal/min with ft drawdown after

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level

Time:	Water Level:	Time:	Water Level	Time:	Water Level

Date of test:
Bailer test gal/min ft drawdown after hrs.
Air test 100+ gal/min w/ stem set at 243 ft. for 1 hours
Artesian flow gpm Date
Temperature of water Was a chemical analysis made No

CONSTRUCTION OR DECOMMISSION PROCEDURE

Formation: Describe by color, character, size of material and structure. Show thickness of aquifers and the kind and nature of the material in each stratum penetrated. Show at least one entry for each change in formation.

Material	From	To
EXISTING	0	37
GRAVEL	37	40
SAND	40	41
SANDSTONE GRAY	41	60
SANDSTONE BROWN SOFT WET	60	63
SANDSTONE GRAY MEDIUM	63	75
SANDSTONE BROWN SOFT	75	80
SANDSTONE GRAY MEDIUM	80	87
SANDSTONE BROWN SOFT	87	114
SANDSTONE GRAY MEDIUM	114	166
SANDSTONE BROWN SOFT	166	169
SANDSTONE BROWN SOFT	169	172
SANDSTONE GRAY MEDIUM	172	218

Notes:

Work started 07/27/2010 Completed 08/02/2010

WELL CONSTRUCTION CERTIFICATION:

I constructed and/or accept responsibility for construction of this well and its compliance with all Washington well construction standards. Materials used and the information reported are true to my best knowledge and belief.

☑ Driller ☐ Engineer ☐ Trainee

Name: AUDIE MCCURDY License No.: 2690

Signature:

If trainee, Licensed driller is: License No.:

Licensed Driller Signature:

Drilling Company:

NAME: FOGLE PUMP & SUPPLY, INC. Shop: REPUBLIC

ADDRESS: PO Box 456
Republic, WA 99166

Phone: 5097752878 Toll Free: 8008453500

E-Mail: leslie@foglepump.com

FAX: 5097750498 WEB Site: www.foglepump.com

Contractor's Registration No.: FOGLEPS095L4 Date Log Created: 08/31/2010

Water Well Log - Page 2

41590S

FOGLE PUMP & SUPPLY, INC.

Log No. 0

Notice of Intent No.: W266808

Unique Well I.D. No.: BCC614

Well Construction Details Continued:

Material	From	To
SANDSTONE BROWN SOFT	218	230
SANDSTONE GRAY MEDIUM	230	244

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT
STATE OF WASHINGTON

Application No. [illegible]
Permit No
TW-3

(1) **OWNER:** Name Richard L. Turnbull Address

(2) **LOCATION OF WELL:** County Chelan NE¼ NW¼ Sec. 29 T. 23 N., R. 19 W.
Bearing and distance from section or subdivision corner See Attached

(3) **PROPOSED USE:** Domestic ☐ Industrial ☐ Municipal ☐
Irrigation ☑ Test Well ☐ Other ☐

(4) **TYPE OF WORK:** Owner's number of well (if more than one)
New well ☑ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☑ Driven ☐
Reconditioned ☐ Rotary ☐ Jetted ☐

(5) **DIMENSIONS:** Diameter of well 8 inches.
Drilled 200 ft. Depth of completed well 200 ft.

(6) **CONSTRUCTION DETAILS:**
Casing installed: 8" Diam. from +1 ft. to 360 ft.
Threaded ☐ " Diam. from ft. to ft.
Welded ☐ " Diam. from ft. to ft.

Perforations: Yes ☐ No ☑
Type of perforator used
SIZE of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

Screens: Yes ☐ No ☑
Manufacturer's Name Model No
Type
Diam. Slot size from ft. to ft.
Diam. Slot size from ft. to ft.

Gravel packed: Yes ☐ No ☑ Size of gravel:
Gravel placed from ft. to ft.

Surface seal: Yes ☑ No ☐ To what depth? 25 ft.
Material used in seal [illegible]
Did any strata contain unusable water? Yes ☐ No ☐
Type of water? Depth of strata
Method of sealing strata off

(7) **PUMP:** Manufacturer's Name
Type: H.P.

(8) **WATER LEVELS:** Land-surface elevation above mean sea level ft.
Static level ft. below top of well Date
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) **WELL TESTS:** Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☐ If yes, by whom?
Yield: gal./min. with ft. drawdown after hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test
Bailer test 25 gal./min. with 27 ft. drawdown after 15 hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? Yes ☐ No ☐

450 gal in 15 min

(10) **WELL LOG:**
Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.

MATERIAL	FROM	TO
[illegible]		
[illegible]	2	25
[illegible]	25	36
[illegible]	36	45
[illegible]	45	60
[illegible]	60	70
[illegible]	70	115
[illegible]	115	120
[illegible]	120	140
[illegible]	140	165
[illegible]	165	180
[illegible]	180	200

RECEIVED
OCT 13 1977
[illegible]

Work started 8-19 19 Completed 9-1 19

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Tamwater Drilling Inc.
(Person, firm, or corporation) (Type or print)

Address Rt 1 Box 133C Leavenworth

[Signed] [illegible]
(Well Driller)

License No. 0353 Date 9-1 19 77

(USE ADDITIONAL SHEETS IF NECESSARY)

ECY 050-1-20

TW-4

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Start Card No. W36792
UNIQUE WELL I.D. # AAJ 531
Water Right Permit No. 414475

(1) OWNER: Name ROBERT A. McWILLIAMS Address 2425 MISSIONCREEK RD. CASHMERE WA 98815

(2) LOCATION OF WELL: County CHELAN SE 1/4 NW 1/4 Sec 29 T. 23 N, R. 19 W.M.

(2a) STREET ADDRESS OF WELL (or nearest address) (SAME)

(3) PROPOSED USE: ☐ Domestic ☒ Irrigation ☐ DeWater ☐ Industrial ☐ Municipal ☐ Test Well ☐ Other ☐
REPLACEMENT WELL

(4) TYPE OF WORK: Owner's number of well (if more than one)
Abandoned ☐ New well ☒ Deepened ☐ Reconditioned ☐ Method: Dug ☐ Cable ☐ Rotary ☒ Bored ☐ Driven ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 8 inches. Drilled 53 feet. Depth of completed well 52½ ft.

(6) CONSTRUCTION DETAILS:
Casing Installed: 8" Diam. from +1½ ft. to 41 ft.
Welded ☒ Liner Installed ☐ Threaded ☐
" Diam. from ft. to ft.
" Diam. from ft. to ft.

Perforations: Yes ☒ No ☐
Type of perforator used MOUNTAIN MILLS KNIFE
SIZE of perforations .098 in. by in.
312 perforations from 31 ft. to 40 ft.
perforations from ft. to ft.
perforations from ft. to ft.

Screens: Yes ☐ No ☒
Manufacturer's Name
Type Model No.
Diam. Slot size from ft. to ft.
Diam. Slot size from ft. to ft.

Gravel packed: Yes ☐ No ☒ Size of gravel
Gravel placed from ft. to ft.

Surface seal: Yes ☒ No ☐ To what depth? 18 ft.
Material used in seal BENTONITE
Did any strata contain unusable water? Yes ☐ No ☒
Type of water? Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name
Type: H.P.

(8) WATER LEVELS: Land-surface elevation above mean sea level
Static level 11½ ft. below top of well Date 3-8-94
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☒ If yes, by whom?
Yield: gal./min. with ft. drawdown after hrs.
" " " "
" " " "
Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test
Bailer test gal./min. with ft. drawdown after hrs.
Airlift 20± gal./min. with 45 ft. drawdown after 1 hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? Yes ☐ No ☒

(10) WELL LOG or ABANDONMENT PROCEDURE DESCRIPTION

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information.

MATERIAL	FROM	TO
BROWN CLAY	0	8
GRAVEL, CLAY, COBBLES —WATER BEARING—	8	15
BROWN LOAMY CLAY	15	28
GRAVELS WATER BEARING	28	40½
GREY SANDSTONE + SHALE	40½	53

RECEIVED
MAR 28 1994
DEPARTMENT OF ECOLOGY

Work Started 3-8 19 Completed 3-8 19 94

WELL CONSTRUCTOR CERTIFICATION:

I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

NAME TUMWATER DRILLING INC.
(PERSON, FIRM, OR CORPORATION) (TYPE OR PRINT)
Address LEAVENWORTH, WASH.
(Signed) (WELL DRILLER) License No. 1249
Date 3-[illegible] 19 94

(USE ADDITIONAL SHEETS IF NECESSARY)

ECL 050-1-20 (2/93)

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT
STATE OF WASHINGTON

Application No. TW-5
Permit No. 7740470 81

(1) OWNER: Name Gerald Doyle Address

(2) LOCATION OF WELL: County Chelan SW ¼ SW ¼ Sec 29 T 33 N., R 19 W.M.
Bearing and distance from section or subdivision corner

(3) PROPOSED USE: Domestic ☐ Industrial ☐ Municipal ☐
Irrigation ☑ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one)
New well ☑ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☐ Driven ☐
Reconditioned ☐ Rotary ☑ Jetted ☐

(5) DIMENSIONS: Diameter of well 8 inches.
Drilled 320 ft. Depth of completed well 320 ft.

(6) CONSTRUCTION DETAILS:
Casing installed: 5 " Diam. from +1 ft. to 18 ft.
Threaded ☐ " Diam. from ft. to ft.
Welded ☑ " Diam. from ft. to ft.

Perforations: Yes ☐ No ☑
Type of perforator used
SIZE of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

Screens: Yes ☐ No ☑
Manufacturer's Name
Type Model No
Diam. Slot size from ft. to ft.
Diam. Slot size from ft. to ft.

Gravel packed: Yes ☐ No ☑ Size of gravel:
Gravel placed from ft. to ft.

Surface seal: Yes ☑ No ☐ To what depth? 19 ft.
Material used in seal Bentonite
Did any strata contain unusable water? Yes ☐ No ☑
Type of water? Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name
Type: H.P

(8) WATER LEVELS: Land-surface elevation above mean sea level
Static level 10 ft. below top of well Date 11-12-87
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☑ If yes, by whom?
Yield: 150 gal./min. with ft. drawdown after hrs.
" " " "
" EST AIR LIFT " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test
bailer test gal./min. with ft. drawdown after hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? Yes ☐ No ☐

(10) WELL LOG:
Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.

MATERIAL	FROM	TO
BROWN SAND	0	14
BROWN SANDSTONE	14	42
GRAY CLAY STONE TRACE OF WATER	42	68
GRAY SANDSTONE	68	180
BROKEN SANDSTONE TRACE OF WATER	180	181
GRAY SANDSTONE	181	220
GRAY SANDSTONE BROKEN TRACE OF WATER	220	221
GRAY SANDSTONE	221	315
BROKEN GRAY SANDSTONE WATER BEARING	315	320

Work started 11-9, 19 87 Completed 11-12, 19 87

WELL DRILLER'S STATEMENT:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Fogle Pump & Supply (Person, firm, or corporation) (Type or print)
Address 326 West 5th Colville Wa
[Signed] Robert E Fouch (Well Driller)
License No 1405 Date 11-12, 19 87

(USE ADDITIONAL SHEETS IF NECESSARY)

ECY 050-1-20

11/20/87

WATER WELL REPORT

TW-6

State of Washington Date Printed: **25-Apr-2005** Log No. **5605**

Construction/Decommission Original Construction Notice

Construction 174805

CURRENT

Notice of Intent No.: W168633

Unique Ecology Well I.D. No AKM224

Water Right Permit Number:

OWNER: **MILLER, KAMERON**

OWNER ADDR: **1425 MISSION CR. RD. CASHMERE, WA 98815**

Well Street Address: **MISSION CR. RD.** D

City: **Cashmere, WA 98815** County: **CHELAN**

Location: **NW** 1/4 **NW** 1/4 Sec **32** T **23** R **19E** EW

Lat/Long: (s, t, r still REQUIRED) Lat Deg Lat Min/Sec Long Deg Long Min/Se

Tax Parcel No.:

PROPOSED USE: **DOMESTIC**

TYPE OF WOR Owners's Well Number: (If more than one well) **2**

DEEPENED Method: **ROTARY**

DIMENSIONS Diameter of well: **8** inches

Drilled **60** ft. Depth of completed well **340** ft.

CONSTRUCTION DETAILS:

Liner installed:

6 " Dia from **5** ft. to **340** ft.

Casing installed **EXISTING**

" Dia from ft. to ft.

" Dia from ft. to ft.

" Dia from ft. to ft.

Perforations: **Yes** Used In: **Liner**

Type of perforator used **SKILL SAW**

SIZE of perforations **6** in. b **1/8** in.

150 Perforation from **260** ft. to **340** ft.

Perforation from ft. to ft.

Perforation from ft. to ft.

Screens: **No** K-Pac Location

Manufacture's Name

Type: Model No

Diam. slot size from ft. to ft.

Diam. slot size from ft. to ft.

Gravel/Filter packed: **No** Size of Gravel

Material placed fro ft. to ft.

Surface seal: **No** To what depth ft.

Seal method: Material used in seal **EXISTING**

Did any strata contain unusable water **No**

Type of water Depth of strata

Method of sealing strata off

PUMP: Manufacture's name

Type: H.P. **0**

WATER LEVELS Land-surface elevation above mean sea level: **0** ft.

Static level **20** ft. below top of well Date **03/22/2005**

Artesian Pressure lbs per square inch Date

Artesian water controlled by

WELL TESTS: Drawdown is amount water level is lowered below static level.

Was a pump test made **No** If yes, by whom

Yield gal/min with ft drawdown after

Yield gal/min with ft drawdown after

Yield gal/min with ft drawdown after

Recovery data (time taken as zero when pump turned off)(water level measured from well top to water level

Time:	Water Leve	Time:	Water Leve	Time:	Water Leve

Date of test:

Bailer test gal/min ft drawdown after hrs.

Air test **50** gal/min w/ stem set at **340** ft. for **1** hours

Artesian flow gpm Date

Temperature of water Was a chemical analysis made **No**

CONSTRUCTION OR DECOMMISSION PROCEDURE

Formation: Describe by color, character, size of material and structure. Show thickness of aquifiers and the kind and nature of the material in each stratum penetrated. Show at least one entry for each change in formation.

Material	From	To
EXISTING WELL	0	280
GRANITE HARD GRAY	280	340

Notes:

Work starte **03/21/2005** Complete **03/22/2005**

WELL CONSTRUCTION CERTIFICATION:

I constructed and/or accept responsibility for construction of this well and its compliance with all Washington well construction standards. Materials used and the information reported are true to my best knowledge and belief.

☑ Driller ☐ Engineer ☐ Trainee

Name: **MARTY RUGO** License No.: **2038**

Signature: Marty Rugo

If trainee, Licensed driller is: License No.:

Licensed Driller Signature

Drilling Company:

NAME: **FOGLE PUMP & SUPPLY, INC.** Shop: **REPUBLIC**

ADDRESS: **PO Box 456**

Republic, WA 99166

Phone: **5097752878** Toll Free: **8008453500**

E-Mail: **foglewest@rcabletv.com**

FAX: **5097750498** WEB Site: **www.foglepump.com**

Contractor's Registration No.: **FOGLEPS095L4** Date Log Created: **04/25/200**

OW-2

WATER WELL REPORT

State of Washington Date Printed: **26-May-2015** Log No. **0**

Construction / Decommission: Original Construction Notice

Construction

PROPOSED USE: **DOMESTIC**

TYPE OF WORK: Owners's Well Number: (If more than one well)

NEW WELL Method: **ROTARY**

DIMENSIONS: Diameter of well: **8** inches

Drilled **400** ft. Depth of completed well **400** ft.

CONSTRUCTION DETAILS:

Liner installed:

" Dia from ft. to ft.

Casing installed **WELDED**

8 " Dia from **+2** ft. to **22** ft.

" Dia from ft. to ft.

" Dia from ft. to ft.

Perforations: **No** Used In:

Type of perforator used

SIZE of perforations in. by in.

Perforations from ft. to ft.

Perforations from ft. to ft.

Perforations from ft. to ft.

Screens: **0** K-Pac Location:

Manufacture's Name

Type: Model No

Diam. slot size: from ft. to ft.

Diam. slot size: from ft. to ft.

Gravel/Filter packed: **No** Size of Gravel

Material placed fro ft. to ft.

Surface seal: **Yes** To what depth **22** ft.

Seal method: Material used in seal **BENT/CASING**

Did any strata contain unusable water **No**

Type of water Depth of strata

Method of sealing strata off

PUMP: Manufacture's name

Type: H.P. **0**

WATER LEVELS Land-surface elevation above mean sea level: **0** ft.

Static level **2** ft. below top of well Date **05/20/2015**

Artesian Pressure lbs per square inch Date

Artesian water controlled by

WELL TESTS: Drawdown is amount water level is lowered below static level.

Was a pump test made **No** If yes, by whom

Yield: gal/min with ft drawdown after

Yield: gal/min with ft drawdown after

Yield: gal/min with ft drawdown after

Recovery data (time taken as zero when pump turned off)(water level measured from well top to water level

Time:	Water Level	Time:	Water Level	Time:	Water Level

Date of test:

Bailer test gal/min ft drawdown after hrs.

Air test **7** gal/min w/ stem set at **399** ft. for **1** hours

Artesian flow gpm Date

Temperature of water Was a chemical analysis made **No**

CURRENT

Notice of Intent No.: **WE20787**

Unique Ecology Well I.D. No **BIN376**

Water Right Permit Number:

OWNER: **TURNBULL, RICHARD**

OWNER ADD **2255 MISSION CRK RD**

CASHMERE, WA 98815

Well Add **2255 MISSION CRK RD**

City: **Cashmere, WA 98815** County: **Chelan**

Location: **SW** 1/4 **SW** 1/4 Sec **20** T **23** R **19** EW

Lat/Long: (s, t, r still REQUIRED) Lat Deg Lat Min/Sec

Long Deg Long Min/Se

Tax Parcel No.: **231920330050**

CONSTRUCTION OR DECOMMISSION PROCEDURE

Formation: Describe by color, character, size of material and structure. Show thickness of aquifiers and the kind and nature of the material in each stratum penetrated. Show at least one entry for each change in formation.

Material	From	To
LOME BROWN	0	3
COBBLES/CLAY GRAVEL/BRN/ SAND	3	17
SANDSTONE BROWN MED	17	26
SANDSTONE GRAY MED	26	31
SANDSTONE BROWN MED	31	40
SANDSTONE GRAY/SOFT DAMP	40	41
SANDSTONE GRAY MED	41	89
SANDSTONE GRAY/SOFT DAMP	89	90
SANDSTONE GRAY MED	90	158
SANDSTONE GRAY SOFT	158	159
SANDSTONE GRAY MED	159	208
SANDSTONE GRAY SOFT	208	209
SANDSTONE LT GRAY MED	209	216

Notes:

DEPT OF ECOLOGY Received DEC 14 2015 CENTRAL REGION OFFICE

Work starte **05/14/2015** Complete **05/20/2015**

WELL CONSTRUCTION CERTIFICATION:

I constructed and/or accept responsibility for construction of this well and its compliance with all Washington well construction standards. Materials used and the information reported are true to my best knowledge and belief.

☑ Driller ☐ Engineer ☐ Trainee

Name: **AUDIE MCCURDY** License No.: **2690**

Signature: Audie McCurdy

If trainee, Licensed driller is: License No.:

Licensed Driller Signature

Drilling Company:

NAME: **FOGLE PUMP & SUPPLY, INC.** Shop: **REPUBLIC**

ADDRESS: **PO Box 456**

Republic, WA 99166

Phone: **5097752878** Toll Free: **8008453500**

E-Mail: **cathys@foglepump.com**

FAX: **5097750498** WEB Site: **www.foglepump.com**

Contractor's Registration No.: **FOGLEPS095L4** Date Log Created: **5/26/2015**

Water Well Log - Page 2

FOGLE PUMP & SUPPLY, INC.

Log No. 0

Notice of Intent No.: WE20787

Unique Well I.D. No.: BIN376

Well Construction Details Continued:

Material	From	To
SANDSTONE BROWN SOFT	216	218
SANDSTONE GRAY MED	218	246
SANDSTONE COAL GRAY/MED	246	251
SANDSTONE GRAY MED	251	275
COAL BLACK SOFT	275	276
SANSTONE GRAY MED	276	299
SHALE GRAY MED/SOFT	299	308
SANDSTONE GRAY MED/SOFT	308	400

OW-3

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Application No. DC

Permit No. .....

(1) OWNER: Name ROBERT McWILLIAMS Address 2425 MISSION CK RD. CASHMERE

(2) LOCATION OF WELL: County CHELAN N1/2 ¼ NW ¼ Sec. 29 T. 23 N., R. 19 W.M.

...ing and distance from section or subdivision corner

(3) PROPOSED USE: Domestic [X] Industrial [ ] Municipal [ ]
Irrigation [X] Test Well [ ] Other [ ]

(4) TYPE OF WORK: Owner's number of well (if more than one) .....
New well [X] Method: Dug [ ] Bored [ ]
Deepened [ ] Cable [ ] Driven [ ]
Reconditioned [ ] Rotary [X] Jetted [ ]

(5) DIMENSIONS: Diameter of well 8 inches.
Drilled 79 ft. Depth of completed well 78½ ft.

(6) CONSTRUCTION DETAILS:
Casing installed: 8 " Diam. from +1½ ft. to 39 ft.
Threaded [ ] " Diam. from ... ft. to ... ft.
Welded [X] " Diam. from ... ft. to ... ft.

Perforations: Yes [X] No [ ]
Type of perforator used ¼ ROTARY STAR
SIZE of perforations ¼ in. by ¾ in.
200 perforations from 21 ft. to 34 ft.
... perforations from ... ft. to ... ft.
... perforations from ... ft. to ... ft.

Screens: Yes [ ] No [X]
Manufacturer's Name ...
Type ... Model No. ...
Diam. ... Slot size ... from ... ft. to ... ft.
Diam. ... Slot size ... from ... ft. to ... ft.

Gravel packed: Yes [ ] No [X] Size of gravel: ...
Gravel placed from ... ft. to ... ft.

Surface seal: Yes [X] No [ ] To what depth? 18 ft.
Material used in seal BENTONITE
Did any strata contain unusable water? Yes [ ] No [ ]
Type of water? ... Depth of strata ...
Method of sealing strata off ...

(7) PUMP: Manufacturer's Name ...
Type: ... H.P. ...

(8) WATER LEVELS: Land-surface elevation above mean sea level ....
Static level 5½ ft. below top of well Date 3-23-87
Artesian pressure ... lbs. per square inch Date ...
Artesian water is controlled by ... (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes [ ] No [X] If yes, by whom? ...
Yield: ... gal./min. with ... ft. drawdown after ... hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test ...
Bailer test 25 gal./min. with ... ft. drawdown after 1 hrs.
Artesian flow ... g.p.m. Date 3-26-87
Temperature of water ... Was a chemical analysis made? Yes [ ] No [X]

(10) WELL LOG:

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.

MATERIAL	FROM	TO
BROWN SANDY LOAM	0	6
BROWN HARD CLAY & GRAVEL	6	13
SANDSTONE	13	15
CLAY, BIG GRAVEL & SAND	15	39
BROWN SANDSTONE	39	42
GREY SANDSTONE	42	56
FRACTURED SHALE	56	61
GREY SANDSTONE	61	79

RECEIVED
APR 13 1987
DEPARTMENT OF ECOLOGY
CENTRAL REGION OFFICE

Work started 3-20, 19 87 Completed 3-23, 19 87

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME TUMWATER DRILLING INC.
(Person, firm, or corporation) (Type or print)

Address LEAVENWORTH, WASH.

[Signed] ... (Well Driller)

License No. 1249 Date 4-13, 19 87

(USE ADDITIONAL SHEETS IF NECESSARY)

SCX 050-1-20

OW-4

WATER WELL REPORT

STATE OF WASHINGTON

Start Card No. W112290
Unique Well I.D. # AEH437
Water Right Permit No.

(1) OWNER: Name **MILLER, SHEREL & LANITA** Address **1425 MISSION CR. RD. CASHMERE, WA 98815-**

(2) LOCATION OF WELL: County **CHELAN** - **SW** 1/4 **NW** 1/4 Sec **32** T **23** N., R **19E** WM

(2a) STREET ADDRESS OF WELL (or nearest address) ,

(3) PROPOSED USE: **DOMESTIC**

(4) TYPE OF WORK: Owner's Number of well (If more than one) **2**
NEW WELL Method: **ROTARY**

(5) DIMENSIONS: *Diameter of well* **8** *inches*
Drilled **38** ft. Depth of completed well **38** ft.

(6) CONSTRUCTION DETAILS:
Casing installed: **8** " Dia. from **+2** ft. to **38** ft.
WELDED " Dia. from ft. to ft.
" Dia. from ft. to ft.

Perforations: **NO**
Type of perforator used
SIZE of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

Screens: **NO**
Manufacturer's Name
Type Model No.
Diam. slot size from ft. to ft.
Diam. slot size from ft. to ft.

Gravel packed: **YES** Size of gravel **5/8**
Gravel placed from **35** ft. to **38** ft.

Surface seal: **YES** To what depth? **18** ft.
Material used in seal **BENTONITE**
Did any strata contain unusable water? **NO**
Type of water? Depth of strata ft.
Method of sealing strata off **CASING**

(7) PUMP: Manufacturer's Name
Type **NONE** H.P.

(8) WATER LEVELS: Land-surface elevation above mean sea level ... ft.
Static level **12** ft. below top of well Date **07/01/99**
Artesian Pressure lbs. per square inch Date
Artesian water controlled by **CAP**

(9) WELL TESTS: Drawdown is amount water level is lowered below static level.
Was a pump test made? **NO** If yes, by whom?
Yield: gal./min with ft. drawdown after hrs.

Recovery data
Time Water Level Time Water Level Time Water Level

Date of test / /
Bailer test gal/min. ft. drawdown after hrs.
Air test **30** gal/min. w/ stem set at **37** ft. for 1 hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? **NO**

(10) WELL LOG

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change in formation.

MATERIAL	FROM	TO
CLAY BROWN	**0**	**12**
CLAY BROWN GRAVEL	**12**	**24**
W/WATER	**24**	
DECOMPOSED SANDSTONE GRAY	**24**	**33**
SAND BROWN FINE	**33**	**38**
GRAVEL W/WATER	**38**	

CENTRAL REGION OFFICE DEPT. OF ECOLOGY Received JUL 21 1999

Work started 07/01/99 Completed 07/01/99

WELL CONSTRUCTOR CERTIFICATION:
I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

NAME **FOGLE PUMP & SUPPLY, INC.**
(Person, firm, or corporation) (Type or print)

ADDRESS **REPUBLIC,WA 800-845-3500**

[SIGNED] Jon S. Ricard II License No. **2341**

Contractor's
Registration No. **FOGLEPS095L4** Date 07/12/99

ATTACHMENT 2

Laboratory Reports

CASCADE ANALYTICAL, INC.
1-800-545-4206

(509) 662-1888
Fax: (509) 662-8183
3019 G. S. Center Road
Wenatchee, WA 98801

(509) 452-7707
Fax: (509) 452-7773
1008 W. Ahtanum Rd
Union Gap, WA 98903

Batch: 648827
Client: Aspect Consulting/Yakima
Account: 17821
Sampler: Jason
PO Number:

--- Water Analytical Report ---

Report Date: 11/10/16

Aspect Consulting/Yakima
123 E Yakima Ave Suite 200
Yakima, WA 98901

Laboratory Number: 16-E033480
Sample Identification: MC-Lower 110716

Date Received: 11/ 7/16
Date Sampled: 11/ 7/16

Test Requested	Results	Units	RL	Method	Date Analyzed	Flags
Fecal Coliform MPN Water	330.	MPN/100mL		SM9221-E	11/ 7/16	

Approved By Name: Brianna Buschbach Signature:

Function: Quality Manager

Cascade Analytical uses procedures established by EPA, AOAC, APHA, ASTM, and FDA/BAM. Cascade Analytical makes no warranty of any kind the client assumes all risk and liability from the use of these results. Cascade Analytical, Inc.'s liability to the client as a result of use of Cascade's test results shall be limited to a sum equal to the fees paid by the client to Cascade Analytical, Inc. for analysis. PLEASE REVIEW YOUR DATA IN A TIMELY MANNER. DATA GAPS OR ERRORS AFTER THREE MONTHS WILL NOT BE OUR RESPONSIBILITY. THOUGH WE DO KEEP ALL ANALYTICAL DATA FOR SEVERAL YEARS, SAMPLES ARE DISPOSED OF AFTER SIX WEEKS.

CASCADE ANALYTICAL, INC.
1-800-545-4206

(509) 662-1888
Fax: (509) 662-8183
3019 G. S. Center Road
Wenatchee, WA 98801

(509) 452-7707
Fax: (509) 452-7773
1008 W. Ahtanum Rd
Union Gap, WA 98903

Batch: 648827
Client: Aspect Consulting/Yakima
Account: 17821
Sampler: Jason
PO Number:

--- Water Analytical Report ---

Report Date: 11/10/16

Aspect Consulting/Yakima
123 E Yakima Ave Suite 200
Yakima, WA 98901

Laboratory Number: 16-E033481
Sample Identification: AAJ531110716

Date Received: 11/ 7/16
Date Sampled: 11/ 7/16

Test Requested	Results	Units	RL	Method	Date Analyzed	Flags
Fecal Coliform MPN Water	< 1.8	MPN/100mL		SM9221-E	11/ 7/16	

Approved By Name: Brianna Bachbach Signature:

Function: Quality Manager

Cascade Analytical uses procedures established by EPA, AOAC, APHA, ASTM, and FDA/BAM. Cascade Analytical makes no warranty of any kind the client assumes all risk and liability from the use of these results. Cascade Analytical, Inc.'s liability to the client as a result of use of Cascade's test results shall be limited to a sum equal to the fees paid by the client to Cascade Analytical, Inc. for analysis. PLEASE REVIEW YOUR DATA IN A TIMELY MANNER. DATA GAPS OR ERRORS AFTER THREE MONTHS WILL NOT BE OUR RESPONSIBILITY. THOUGH WE DO KEEP ALL ANALYTICAL DATA FOR SEVERAL YEARS, SAMPLES ARE DISPOSED OF AFTER SIX WEEKS.

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Fax: (509) 452-7773
1008 W. Ahtanum Rd
Union Gap, WA 98903

Batch: 648827
Client: Aspect Consulting/Yakima
Account: 17821
Sampler: Jason
PO Number:

--- Water Analytical Report ---

Report Date: 11/10/16

Aspect Consulting/Yakima
123 E Yakima Ave Suite 200
Yakima, WA 98901

Laboratory Number: 16-E033482
Sample Identification: Gerry 110716

Date Received: 11/ 7/16
Date Sampled: 11/ 7/16

Test Requested	Results	Units	RL	Method	Date Analyzed	Flags
Fecal Coliform MPN Water	< 1.8	MPN/100mL		SM9221-E	11/ 7/16	

Approved By Name: Dianna Rockbach Signature:

Function: Quality Manager

CASCADE ANALYTICAL, INC.
1-800-545-4206

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Fax: (509) 662-8183
3019 G. S. Center Road
Wenatchee, WA 98801

(509) 452-7707
Fax: (509) 452-7773
1008 W. Ahtanum Rd
Union Gap, WA 98903

Batch: 648827
Client: Aspect Consulting/Yakima
Account: 17821
Sampler: Jason
PO Number:

--- Water Analytical Report ---

Report Date: 11/10/16

Aspect Consulting/Yakima
123 E Yakima Ave Suite 200
Yakima, WA 98901

Laboratory Number: 16-E033483
Sample Identification: AKM224110716

Date Received: 11/ 7/16
Date Sampled: 11/ 7/16

Test Requested	Results	Units	RL	Method	Date Analyzed	Flags
Fecal Coliform MPN Water	< 1.8	MPN/100mL		SM9221-E	11/ 7/16	

Approved By Name: Brianna Bachbach Signature:

Function: Quality Manager

CASCADE ANALYTICAL, INC.
1-800-545-4206

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Wenatchee, WA 98801

(509) 452-7707
Fax: (509) 452-7773
1008 W. Ahtanum Rd
Union Gap, WA 98903

Batch: 648827
Client: Aspect Consulting/Yakima
Account: 17821
Sampler: Jason
PO Number:

--- Water Analytical Report ---

Report Date: 11/10/16

Aspect Consulting/Yakima
123 E Yakima Ave Suite 200
Yakima, WA 98901

Laboratory Number: 16-E033484
Sample Identification: MC-Upper 110716

Date Received: 11/ 7/16
Date Sampled: 11/ 7/16

Test Requested	Results	Units	RL	Method	Date Analyzed	Flags
Fecal Coliform MPN Water	6.80	MPN/100mL		SM9221-E	11/ 7/16	

Approved By Name: Brianna Buschbach Signature:

Function: Quality Manager

Cascade Analytical uses procedures established by EPA, AOAC, APHA, ASTM, and FDA/BAM. Cascade Analytical makes no warranty of any kind the client assumes all risk and liability from the use of these results. Cascade Analytical, Inc.'s liability to the client as a result of use of Cascade's test results shall be limited to a sum equal to the fees paid by the client to Cascade Analytical, Inc. for analysis. PLEASE REVIEW YOUR DATA IN A TIMELY MANNER. DATA GAPS OR ERRORS AFTER THREE MONTHS WILL NOT BE OUR RESPONSIBILITY. THOUGH WE DO KEEP ALL ANALYTICAL DATA FOR SEVERAL YEARS, SAMPLES ARE DISPOSED OF AFTER SIX WEEKS.

CASCADE ANALYTICAL, INC.

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Union Gap, WA 98903
(509) 452-7707
Fax: (509) 452-7773

WATER ANALYSIS ORDER FORM

Batch#

SAMPLE # 1 2 3 4 5

SEND RESULTS TO
1) Client 2) Billing 3) Both — X

SAMPLE REPRESENTS
1) Irrigation 2) Waste Water 3) Other GW + SW

SAMPLE BY
1) Client 2) Quality Control 3) Cascade 4) Other

New Acct. # 1782

CLIENT NAME/ADDRESS	BILLING NAME/ADDRESS
Aspect Consulting, LLC	Same
123 E. Yakima Ave Suite 200	
Yakima WA 98901	
SAMPLER'S NAME: Jason Shira	PHONE

E-mail jshira@aspectconsulting.com E-mail

RELINQUISHED BY: (Signature) 1	DATE	RELINQUISHED BY: (Signature) 2	DATE	RELINQUISHED BY: (Signature) 3	DATE
	11/07/16				
(Printed) Jason Shira	TIME 14:55	(Printed)	TIME	(Printed)	TIME
RECEIVED BY: (Signature)	DATE	RECEIVED BY: (Signature)	DATE	RECEIVED FOR LAB BY: (Signature)	DATE
					11/7/16
(Printed)	TIME	(Printed)	TIME	(Printed)	TIME

FORM MUST BE COMPLETED BEFORE ANALYSIS WILL BE PERFORMED.

1	MC-Lower 110716	Sample Date 11/07/16
		Sample Time 13:15
2	AAJ531 110716	Sample Date 11/07/16
		Sample Time 12:20
3	Gerry 110716	Sample Date 11/07/16
		Sample Time 11:00
4	AKM224 110716	Sample Date 11/07/16
		Sample Time 10:00
5	MC-Upper 110716	Sample Date 11/07/16
		Sample Time 09:00

***METALS - circle type of analysis - T=total or D=dissolved**

Total N package = TKN, NO_3, NO_2, NH_3

Sample container received by client was sealed Yes ✓ No

Sample container received by laboratory was sealed Yes No

Disclaimer:

Cascade Analytical, Inc., makes no warranty of any kind, expressed or implied, and customer assumes all risk and liability from the use of Cascade's test results. Cascade neither assumes nor authorizes any person to assume for Cascade any other liability in connection with the testing done by Cascade Analytical, Inc., and there are no other oral agreements or warranties collateral to or affecting this agreement.

Cascade Analytical Inc.'s liability to customer as a result of customers use of Cascade's test results shall be limited to a sum equal to the fees paid by customer to Cascade Analytical, Inc. for the testing work.

Customer Signature: _____ Date 11/07/16

This form also serves as "Chain of Custody."

CAICOF - 03

REV. 04/26/2013

(see legend on back)

		SAMPLE # 1	2	3	4	5
IRRIGATION WATER						
	Standard					
GENERAL CHEMISTRY						
1135	pH					
1140	Conductivity					
1200	Solids-Dis. (TDS)					
1230	Solids-Susp. (TSS)					
1240	Tot. Phosphorus					
1250	Orthophosphate					
1260	Kjeldahl Nitrogen (TKN)					
1170	Nitrate+Nitrite					
1265	NO_3 (As N)					
1280	Ammonia					
1300	Biol. Oxy. Demand					
1310	Chem. Oxy. Demand					
1190	Sulfate (SO4)					
1180	Chloride (Cl)					
1150	Turbidity					
220	Hexane Ext. Mat.					
1340	Alkalinity					
217	Total N Pkg					
MICROBIOLOGY						
10040	Total Coliform MF					
10010	Fecal Coliform MF					
10041	Total Coliform MPN					
10011	Fecal Coliform MPN	X				
METALS - TOTAL OR DISSOLVED						
1391	Antimony (Sb)					
1011	Arsenic (As)					
1025	Barium (Ba)					
1405	Beryllium (Be)					
1031	Cadmium (Cd)					
1045	Chromium (Cr)					
1215	Copper (Cu)					
1065	Iron (Fe)					
1075	Manganese (Mn)					
1081	Mercury (Hg)					
1435	Molybdenum (Mo)					
1051	Lead (Pb)					
1335	Nickel (Ni)					
1091	Selenium (Se)					
1105	Silver (Ag)					
1381	Thallium (Tl)					
1225	Zinc (Zn)					
MINERALS						
1120	Calcium (Ca)					
1130	Magnesium (Mg)					
1115	Potassium (K)					
1110	Sodium (Na)					

CASCADE ANALYTICAL, INC.

Sample Receipt Form

Date Received: 11/7/16 Time Received: 2:58 Initials: AR

Client Name: Aspect Consulting Project Name: WW

Temperature of cooler upon receipt: 11 °C Thermometer ID: #1

Custody seals: Intact Broken (None) N/A

Chain of Custody Completed:

Client name, address, and phone number;	Yes	(No)
Date and time of sampling;	(Yes)	No
Test requests clear;	(Yes)	No
Completed in ink;	(Yes)	No
Signed by client;	(Yes)	No

All samples received:		(Yes)	No
All samples intact:		(Yes)	No
Sample ID's match COC form:		(Yes)	No
Appropriate containers used:		(Yes)	No
Sufficient amount of sample for analysis:		(Yes)	No
Correct preservative verified:	N/A	(Yes)	No
Air bubbles in VOC, TTHM, or HAA5 samples:	(N/A)	Yes	No
Sample(s) exceed hold time:		Yes	(No)

Type of coolant: ? Ice Blue Ice None Other Comment: _____

Shipping Method: FedEx UPS USPS Brett & Sons (Hand Delivered) CAI Sampled

Shipping Container: ? CAI Cooler CAI Cooler Box Client's Cooler None Other _____

Samples accepted for analysis: (Yes) No

Reason for Rejection: _____

Name of Person Contacted: _____ Date Contacted: _____

Comments: _____

ALS Environmental
ALS Group USA, Corp
1317 South 13th Avenue
Kelso, WA 98626
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F : +1 360 636 1068
www.alsglobal.com

November 16, 2016

Analytical Report for Service Request No: K1613678

Jason Shira
Aspect Consulting
123 E Yakima Avenue, Suite 200
Yakima, WA 98901

RE: Chelan County Natural Resources Dept#120045-11a-05 / 120045.011a

Dear Jason,

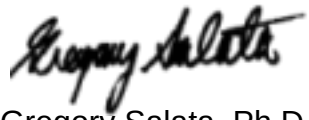
Enclosed are the results of the sample(s) submitted to our laboratory November 08, 2016
For your reference, these analyses have been assigned our service request number **K1613678.**

Analyses were performed according to our laboratory's NELAP-approved quality assurance program. The test results meet requirements of the current NELAP standards, where applicable, and except as noted in the laboratory case narrative provided. For a specific list of NELAP-accredited analytes, refer to the certifications section at www.alsglobal.com. All results are intended to be considered in their entirety, and ALS Group USA Corp. dba ALS Environmental (ALS) is not responsible for use of less than the complete report. Results apply only to the items submitted to the laboratory for analysis and individual items (samples) analyzed, as listed in the report.

Please contact me if you have any questions. My extension is 3376. You may also contact me via email at gregory.salata@alsglobal.com.

Respectfully submitted,

ALS Group USA, Corp. dba ALS Environmental



Gregory Salata, Ph.D.
Senior Project
Manager

ALS Environmental
ALS Group USA, Corp
1317 South 13th Avenue
Kelso, WA 98626
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Table of Contents

Acronyms

ASTM	American Society for Testing and Materials
A2LA	American Association for Laboratory Accreditation
CARB	California Air Resources Board
CAS Number	Chemical Abstract Service registry Number
CFC	Chlorofluorocarbon
CFU	Colony-Forming Unit
DEC	Department of Environmental Conservation
DEQ	Department of Environmental Quality
DHS	Department of Health Services
DOE	Department of Ecology
DOH	Department of Health
EPA	U. S. Environmental Protection Agency
ELAP	Environmental Laboratory Accreditation Program
GC	Gas Chromatography
GC/MS	Gas Chromatography/Mass Spectrometry
LOD	Limit of Detection
LOQ	Limit of Quantitation
LUFT	Leaking Underground Fuel Tank
M	Modified
MCL	Maximum Contaminant Level is the highest permissible concentration of a substance allowed in drinking water as established by the USEPA.
MDL	Method Detection Limit
MPN	Most Probable Number
MRL	Method Reporting Limit
NA	Not Applicable
NC	Not Calculated
NCASI	National Council of the Paper Industry for Air and Stream Improvement
ND	Not Detected
NIOSH	National Institute for Occupational Safety and Health
PQL	Practical Quantitation Limit
RCRA	Resource Conservation and Recovery Act
SIM	Selected Ion Monitoring
TPH	Total Petroleum Hydrocarbons
tr	Trace level is the concentration of an analyte that is less than the PQL but greater than or equal to the MDL.

Inorganic Data Qualifiers

*	The result is an outlier. See case narrative.
#	The control limit criteria is not applicable. See case narrative.
B	The analyte was found in the associated method blank at a level that is significant relative to the sample result as defined by the DOD or NELAC standards.
E	The result is an estimate amount because the value exceeded the instrument calibration range.
J	The result is an estimated value.
U	The analyte was analyzed for, but was not detected ("Non-detect") at or above the MRL/MDL. *DOD-QSM 4.2 definition* : Analyte was not detected and is reported as less than the LOD or as defined by the project. The detection limit is adjusted for dilution.
i	The MRL/MDL or LOQ/LOD is elevated due to a matrix interference.
X	See case narrative.
Q	See case narrative. One or more quality control criteria was outside the limits.
H	The holding time for this test is immediately following sample collection. The samples were analyzed as soon as possible after receipt by the laboratory.

Metals Data Qualifiers

#	The control limit criteria is not applicable. See case narrative.
J	The result is an estimated value.
E	The percent difference for the serial dilution was greater than 10%, indicating a possible matrix interference in the sample.
M	The duplicate injection precision was not met.
N	The Matrix Spike sample recovery is not within control limits. See case narrative.
S	The reported value was determined by the Method of Standard Additions (MSA).
U	The analyte was analyzed for, but was not detected ("Non-detect") at or above the MRL/MDL. *DOD-QSM 4.2 definition* : Analyte was not detected and is reported as less than the LOD or as defined by the project. The detection limit is adjusted for dilution.
W	The post-digestion spike for furnace AA analysis is out of control limits, while sample absorbance is less than 50% of spike absorbance.
i	The MRL/MDL or LOQ/LOD is elevated due to a matrix interference.
X	See case narrative.
+	The correlation coefficient for the MSA is less than 0.995.
Q	See case narrative. One or more quality control criteria was outside the limits.

Organic Data Qualifiers

*	The result is an outlier. See case narrative.
#	The control limit criteria is not applicable. See case narrative.
A	A tentatively identified compound, a suspected aldol-condensation product.
B	The analyte was found in the associated method blank at a level that is significant relative to the sample result as defined by the DOD or NELAC standards.
C	The analyte was qualitatively confirmed using GC/MS techniques, pattern recognition, or by comparing to historical data.
D	The reported result is from a dilution.
E	The result is an estimated value.
J	The result is an estimated value.
N	The result is presumptive. The analyte was tentatively identified, but a confirmation analysis was not performed.
P	The GC or HPLC confirmation criteria was exceeded. The relative percent difference is greater than 40% between the two analytical results.
U	The analyte was analyzed for, but was not detected ("Non-detect") at or above the MRL/MDL. *DOD-QSM 4.2 definition* : Analyte was not detected and is reported as less than the LOD or as defined by the project. The detection limit is adjusted for dilution.
i	The MRL/MDL or LOQ/LOD is elevated due to a chromatographic interference.
X	See case narrative.
Q	See case narrative. One or more quality control criteria was outside the limits.

Additional Petroleum Hydrocarbon Specific Qualifiers

F	The chromatographic fingerprint of the sample matches the elution pattern of the calibration standard.
L	The chromatographic fingerprint of the sample resembles a petroleum product, but the elution pattern indicates the presence of a greater amount of lighter molecular weight constituents than the calibration standard.
H	The chromatographic fingerprint of the sample resembles a petroleum product, but the elution pattern indicates the presence of a greater amount of heavier molecular weight constituents than the calibration standard.
O	The chromatographic fingerprint of the sample resembles an oil, but does not match the calibration standard.
Y	The chromatographic fingerprint of the sample resembles a petroleum product eluting in approximately the correct carbon range, but the elution pattern does not match the calibration standard.
Z	The chromatographic fingerprint does not resemble a petroleum product.

ALS Group USA Corp. dba ALS Environmental (ALS) - Kelso
State Certifications, Accreditations, and Licenses

Agency	Web Site	Number
Alaska DEC UST	http://dec.alaska.gov/applications/eh/ehllabreports/USTLabs.aspx	UST-040
Arizona DHS	http://www.azdhs.gov/lab/license/env.htm	AZ0339
Arkansas - DEQ	http://www.adeq.state.ar.us/techsvs/labcert.htm	88-0637
California DHS (ELAP)	http://www.cdph.ca.gov/certlic/labs/Pages/ELAP.aspx	2795
DOD ELAP	http://www.denix.osd.mil/edqw/Accreditation/AccreditedLabs.cfm	L14-51
Florida DOH	http://www.doh.state.fl.us/lab/EnvLabCert/WaterCert.htm	E87412
Hawaii DOH	Not available	-
ISO 17025	http://www.pjlabs.com/	L16-57
Louisiana DEQ	http://www.deq.louisiana.gov/portal/DIVISIONS/PublicParticipationandPermitSupport/LouisianaLaboratoryAccreditationProgram.aspx	03016
Maine DHS	Not available	WA01276
Minnesota DOH	http://www.health.state.mn.us/accreditation	053-999-457
Montana DPHHS	http://www.dphhs.mt.gov/publichealth/	CERT0047
Nevada DEP	http://ndep.nv.gov/bsdw/labservice.htm	WA01276
New Jersey DEP	http://www.nj.gov/dep/oqa/	WA005
North Carolina DWQ	http://www.dwqlab.org/	605
Oklahoma DEQ	http://www.deq.state.ok.us/CSDnew/labcert.htm	9801
Oregon – DEQ (NELAP)	http://public.health.oregon.gov/LaboratoryServices/EnvironmentalLaboratoryAccreditation/Pages/index.aspx	WA100010
South Carolina DHEC	http://www.scdhec.gov/environment/envserv/	61002
Texas CEQ	http://www.tceq.texas.gov/field/qa/env_lab_accreditation.html	T104704427
Washington DOE	http://www.ecy.wa.gov/programs/eap/labs/lab-accreditation.html	C544
Wyoming (EPA Region 8)	http://www.epa.gov/region8/water/dwhome/wyomingdi.html	-
Kelso Laboratory Website	www.alsglobal.com	NA

Analyses were performed according to our laboratory's NELAP-approved quality assurance program. A complete listing of specific NELAP-certified analytes, can be found in the certification section at www.ALSGlobal.com or at the accreditation bodies web site.
Please refer to the certification and/or accreditation body's web site if samples are submitted for compliance purposes. The states highlighted above, require the analysis be listed on the state certification if used for compliance purposes and if the method/anlayte is offered by that state.

Case Narrative

ALS Environmental—Kelso Laboratory
1317 South 13th Avenue, Kelso, WA 98626
Phone (360)577-7222 Fax (360)636-1068
www.alsglobal.com

ALS ENVIRONMENTAL

Client:	Aspect Consulting	**Service Request No.:**	K1613678
Project:	Chelan County Natural Resources Dept# 120045-1	**Date Received:**	11/08/16
Sample Matrix:	Water		

Case Narrative

All analyses were performed consistent with the quality assurance program of ALS Environmental. This report contains analytical results for samples designated for Tier IV validation deliverables including summary forms and all of the associated raw data for each of the analyses. When appropriate to the method, method blank results have been reported with each analytical test.

Sample Receipt

Five water samples were received for analysis at ALS Environmental on 11/08/16. The samples were received in good condition and consistent with the accompanying chain of custody form. The samples were stored in a refrigerator at 4ºC upon receipt at the laboratory.

General Chemistry Parameters

Orthophosphate as Phosphorus by EPA Method 365.3:
The Relative Percent Difference (RPD) criterion for the replicate analysis in sample Batch QC was not applicable because the analyte concentration was not significantly greater than the Method Reporting Limit (MRL). Analytical values derived from measurements close to the detection limit are not subject to the same accuracy and precision criteria as results derived from measurements higher on the calibration range for the method.

No other anomalies associated with the analysis of these samples were observed.

Organochlorine Pesticides by EPA Method 8081

Elevated Detection Limits:
Insufficient sample volume was received to perform a Matrix Spike/Matrix Spike Duplicate (MS/MSD). A Laboratory Control Sample/Duplicate Laboratory Control Sample (LCS/DLCS) was analyzed and reported in lieu of the MS/MSD for these samples.

No other anomalies associated with the analysis of these samples were observed.

Approved by_____

Chain of Custody

ALS Environmental—Kelso Laboratory
1317 South 13th Avenue, Kelso, WA 98626
Phone (360)577-7222 Fax (360)636-1068
www.alsglobal.com

ALS Environmental

CHAIN OF CUSTODY
74887

001

SR# K1613678

COC Set 1 of 1

COC#

1317 South 13th Ave, Kelso, WA 98626 Phone (360) 577-7222 / 800-695-7222 / FAX (360) 636-1068
www.alsglobal.com

Project Name: Chelan County Natural Resources	Project Number: 120045 - 01a
Project Manager: Jason Shira	
Company: Aspect Consulting	
Address: 123 E. Yakima Ave Suite 200 Yakima WA	
Phone #: 509 895-5470	email: jshira@aspectconsulting.com
Sampler Signature:	Sampler Printed Name: Jason Shira

CLIENT SAMPLE ID	LABID	SAMPLING Date	SAMPLING Time	Matrix	NUMBER OF CONTAINERS	48H: 300.0 / NO2	48H: 300.0 / NO3	48H: 365.3 / O Phos T	7D: 8081B / Pest OC ULL	7D: SM 2540 D / TSS LL	28D: 353.2 / NO2 NO3 T	28D: 365.3 / Phos T	28D: ASTM D1426-08B / TKN	1	2	3	4	5	Remarks
1. MC-Upper 110716		11/07/16	09:00	WI	6	X	X	X	X	X	X	X	X						
2. AKM224 110716			10:00		6														
3. Gerry 110716			11:00		6														
4. AAS31 110716			12:20		6														
5. MC-Lower 110716			13:15		6														
6.																			
7.																			
8.																			
9.																			
10.																			

Report Requirements

- ___ I. Routine Report: Method Blank, Surrogate, as required
- X II. Report Dup., MS, MSD as required
- ___ III. CLP Like Summary (no raw data)
- ___ IV. Data Validation Report
- X V. EDD

Invoice Information

P.O.#

Bill To: Aspect Consulting

Turnaround Requirements

- ___ 24 hr.
- X 48 hr.
- ___ 5 Day
- ___ Standard

Requested Report Date

Circle which metals are to be analyzed

Total Metals: Al As Sb Ba Be B Ca Cd Co Cr Cu Fe Pb Mg Mn Mo Ni K Ag Na Se Sr Tl Sn V Zn Hg

Dissolved Metals: Al As Sb Ba Be B Ca Cd Co Cr Cu Fe Pb Mg Mn Mo Ni K Ag Na Se Sr Tl Sn V Zn Hg

Special Instructions/Comments: Two Coolers

*Indicate State Hydrocarbon Procedure: AK CA WI Northwest Other____(Circle One)

Relinquished By:	Received By:	Relinquished By:	Received By:	Relinquished By:	Received By:
Signature	Signature	Signature	Signature	Signature	Signature
Printed Name: Jason Shira	Printed Name: AS	Printed Name	Printed Name	Printed Name	Printed Name
Firm: Aspect	Firm: 11-8-16 10:30	Firm	Firm	Firm	Firm
Date/Time: 11/7/16 14:15	Date/Time	Date/Time	Date/Time	Date/Time	Date/Time

PC Greg

Cooler Receipt and Preservation Form

Client Aspect Consultings Service Request K16 136678

Received: 11-8-16 Opened: 11-8-16 By: CS Unloaded: 11-8-16 By: CS

1. Samples were received via? *USPS* *Fed Ex* (*UPS*) *DHL* *PDX* *Courier* *Hand Delivered*
2. Samples were received in: (circle) (*Cooler*) *Box* *Envelope* *Other* _____ *NA*
3. Were custody seals on coolers? NA (Y) N If yes, how many and where? 1-front
   If present, were custody seals intact? (Y) N If present, were they signed and dated? (Y) N

Raw Cooler Temp	Corrected Cooler Temp	Raw Temp Blank	Corrected Temp Blank	Corr. Factor	Thermometer ID	Cooler/COC ID NA	Tracking Number NA	Filed
1.9	2.1	3.1	3.3	+0.2	360		FedEx 1-Day J687660 7029	
0.7	0.6	1.3	1.2	-0.1	366		J187660 7010	

4. Packing material: (*Inserts*) (*Baggies*) *Bubble Wrap* *Gel Packs* (*Wet Ice*) *Dry Ice* *Sleeves* _____
5. Were custody papers properly filled out (ink, signed, etc.)? NA (Y) N
6. Were samples received in good condition (temperature, unbroken)? *Indicate in the table below.* NA (Y) N
   If applicable, tissue samples were received: *Frozen* *Partially Thawed* *Thawed*
7. Were all sample labels complete (i.e analysis, preservation, etc.)? NA (Y) N
8. Did all sample labels and tags agree with custody papers? *Indicate major discrepancies in the table on page 2.* NA (N)
9. Were appropriate bottles/containers and volumes received for the tests indicated? NA (Y) N
10. Were the pH-preserved bottles (*see SMO GEN SOP*) received at the appropriate pH? *Indicate in the table below* NA (Y) N
11. Were VOA vials received without headspace? *Indicate in the table below.* (NA) Y N
12. Was C12/Res negative? (NA) Y N

Sample ID on Bottle	Sample ID on COC	Identified by:

Sample ID	Bottle Count Bottle Type	Out of Temp	Head-space	Broke	pH	Reagent	Volume added	Reagent Lot Number	Initials	Time

Notes, Discrepancies, & Resolutions:

Rec'd 5 bottles per sample, not 6.

RUSH

7/25/16 *Page* ____ *of* ____

General Chemistry

ALS Environmental—Kelso Laboratory
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Phone (360)577-7222 Fax (360)636-1068
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Analytical Report

Client:	Aspect Consulting	**Service Request:**	K1613678
Project:	Chelan County Natural Resources Dept#120045-11a-05/120045.011a	**Date Collected:**	11/7/16
Sample Matrix:	Water	**Date Received:**	11/8/16
Analysis Method:	300.0	**Units:**	mg/L
Prep Method:	Method	**Basis:**	NA

Nitrite as Nitrogen

Sample Name	Lab Code	Result	MRL	Dil.	Date Analyzed	Date Extracted	Q
MC - Upper 110716	K1613678-001	ND U	0.10	2	11/08/16 16:08	11/8/16	
AKM224 110716	K1613678-002	ND U	0.10	2	11/08/16 15:29	11/8/16	
Gerry 110716	K1613678-003	ND U	0.10	2	11/08/16 15:39	11/8/16	
AAJ531 110716	K1613678-004	ND U	0.10	2	11/08/16 15:49	11/8/16	
MC - Lower 110716	K1613678-005	ND U	0.10	2	11/08/16 15:59	11/8/16	
Method Blank	K1613678-MB1	ND U	0.050	1	11/08/16 10:02	11/8/16	

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Analytical Report

Client:	Aspect Consulting	**Service Request:**	K1613678
Project:	Chelan County Natural Resources Dept#120045-11a-05/120045.011a	**Date Collected:**	11/7/16
Sample Matrix:	Water	**Date Received:**	11/8/16
Analysis Method:	300.0	**Units:**	mg/L
Prep Method:	Method	**Basis:**	NA

Nitrate as Nitrogen

Sample Name	Lab Code	Result	MRL	Dil.	Date Analyzed	Date Extracted	Q
MC - Upper 110716	K1613678-001	ND U	0.10	2	11/08/16 16:08	11/8/16	
AKM224 110716	K1613678-002	**2.24**	0.10	2	11/08/16 15:29	11/8/16	
Gerry 110716	K1613678-003	ND U	0.10	2	11/08/16 15:39	11/8/16	
AAJ531 110716	K1613678-004	**4.06**	0.10	2	11/08/16 15:49	11/8/16	
MC - Lower 110716	K1613678-005	**0.25**	0.10	2	11/08/16 15:59	11/8/16	
Method Blank	K1613678-MB1	ND U	0.050	1	11/08/16 10:02	11/8/16	

Analytical Report

Client:	Aspect Consulting	**Service Request:**	K1613678
Project:	Chelan County Natural Resources Dept#120045-11a-05/120045.011a	**Date Collected:**	11/7/16
Sample Matrix:	Water	**Date Received:**	11/8/16
Analysis Method:	353.2	**Units:**	mg/L
Prep Method:	Method	**Basis:**	NA

Nitrate+Nitrite as Nitrogen

Sample Name	Lab Code	Result	MRL	Dil.	Date Analyzed	Date Extracted	Q
MC - Upper 110716	K1613678-001	ND U	0.050	1	11/10/16 10:56	11/10/16	
AKM224 110716	K1613678-002	**2.22**	0.10	2	11/10/16 10:56	11/10/16	
Gerry 110716	K1613678-003	**0.055**	0.050	1	11/10/16 10:56	11/10/16	
AAJ531 110716	K1613678-004	**3.80**	0.10	2	11/10/16 10:56	11/10/16	
MC - Lower 110716	K1613678-005	**0.250**	0.050	1	11/10/16 10:56	11/10/16	
Method Blank	K1613678-MB1	ND U	0.050	1	11/10/16 10:56	11/10/16	

Analytical Report

Client:	Aspect Consulting	**Service Request:**	K1613678
Project:	Chelan County Natural Resources Dept#120045-11a-05/120045.011a	**Date Collected:**	11/7/16
Sample Matrix:	Water	**Date Received:**	11/8/16
Analysis Method:	365.3	**Units:**	mg/L
Prep Method:	None	**Basis:**	NA

Orthophosphate as Phosphorus

Sample Name	Lab Code	Result	MRL	Dil.	Date Analyzed	Q
MC - Upper 110716	K1613678-001	ND U	0.010	1	11/08/16 13:02	
AKM224 110716	K1613678-002	ND U	0.010	1	11/08/16 13:02	
Gerry 110716	K1613678-003	ND U	0.010	1	11/08/16 13:02	
AAJ531 110716	K1613678-004	ND U	0.010	1	11/08/16 13:02	
MC - Lower 110716	K1613678-005	ND U	0.010	1	11/08/16 13:02	
Method Blank	K1613678-MB1	ND U	0.010	1	11/08/16 13:02	

Analytical Report

Client:	Aspect Consulting	**Service Request:**	K1613678
Project:	Chelan County Natural Resources Dept#120045-11a-05/120045.011a	**Date Collected:**	11/7/16
Sample Matrix:	Water	**Date Received:**	11/8/16
Analysis Method:	365.3	**Units:**	mg/L
Prep Method:	Method	**Basis:**	NA

Phosphorus, Total

Sample Name	Lab Code	Result	MRL	Dil.	Date Analyzed	Date Extracted	Q
MC - Upper 110716	K1613678-001	**0.037**	0.010	1	11/08/16 16:20	11/8/16	
AKM224 110716	K1613678-002	ND U	0.010	1	11/08/16 16:20	11/8/16	
Gerry 110716	K1613678-003	ND U	0.010	1	11/08/16 16:20	11/8/16	
AAJ531 110716	K1613678-004	ND U	0.010	1	11/08/16 16:20	11/8/16	
MC - Lower 110716	K1613678-005	**0.034**	0.010	1	11/08/16 16:20	11/8/16	
Method Blank	K1613678-MB1	ND U	0.010	1	11/08/16 16:20	11/8/16	

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Analytical Report

Client:	Aspect Consulting	**Service Request:**	K1613678
Project:	Chelan County Natural Resources Dept#120045-11a-05/120045.011a	**Date Collected:**	11/7/16
Sample Matrix:	Water	**Date Received:**	11/8/16
Analysis Method:	ASTM D1426-08B	**Units:**	mg/L
Prep Method:	ASTM D3590-02(2006)(A)	**Basis:**	NA

Nitrogen, Total Kjeldahl (TKN)

Sample Name	Lab Code	Result	MRL	Dil.	Date Analyzed	Date Extracted	Q
MC - Upper 110716	K1613678-001	**0.44**	0.20	1	11/11/16 10:30	11/9/16	
AKM224 110716	K1613678-002	**0.57**	0.20	1	11/11/16 10:30	11/9/16	
Gerry 110716	K1613678-003	**0.49**	0.20	1	11/11/16 10:30	11/9/16	
AAJ531 110716	K1613678-004	**0.66**	0.20	1	11/11/16 10:30	11/9/16	
MC - Lower 110716	K1613678-005	**0.53**	0.20	1	11/11/16 10:30	11/9/16	
Method Blank	K1613678-MB1	ND U	0.20	1	11/11/16 10:30	11/9/16	

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Analytical Report

Client:	Aspect Consulting	**Service Request:**	K1613678
Project:	Chelan County Natural Resources Dept#120045-11a-05/120045.011a	**Date Collected:**	11/7/16
Sample Matrix:	Water	**Date Received:**	11/8/16
Analysis Method:	SM 2540 D	**Units:**	mg/L
Prep Method:	None	**Basis:**	NA

Solids, Total Suspended (TSS)

Sample Name	Lab Code	Result	MRL	Dil.	Date Analyzed	Q
MC - Upper 110716	K1613678-001	**33.7**	1.0	1	11/09/16 14:03	
AKM224 110716	K1613678-002	**10.3**	1.0	1	11/09/16 14:03	
Gerry 110716	K1613678-003	**9.8**	1.0	1	11/09/16 14:03	
AAJ531 110716	K1613678-004	**2.4**	1.0	1	11/09/16 14:03	
MC - Lower 110716	K1613678-005	**38.9**	1.0	1	11/09/16 14:03	
Method Blank	K1613678-MB1	ND U	1.0	1	11/09/16 14:03	
Method Blank	K1613678-MB2	ND U	1.0	1	11/09/16 14:03	

Organochlorine Pesticides

ALS Environmental—Kelso Laboratory
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Client: Aspect Consulting **Service Request:** K1613678
Project: Chelan County Natural Resources Dept#120045-11a-05/120045.011a

Cover Page - Organic Analysis Data Package
Organochlorine Pesticides

Sample Name	Lab Code	Date Collected	Date Received
MC - Upper 110716	K1613678-001	11/07/2016	11/08/2016
AKM224 110716	K1613678-002	11/07/2016	11/08/2016
Gerry 110716	K1613678-003	11/07/2016	11/08/2016
AAJ531 110716	K1613678-004	11/07/2016	11/08/2016
MC - Lower 110716	K1613678-005	11/07/2016	11/08/2016

Analytical Results

Client:	Aspect Consulting	**Service Request:**	K1613678
Project:	Chelan County Natural Resources Dept#120045-11a-05/120045.011a	**Date Collected:**	11/07/2016
Sample Matrix:	Water	**Date Received:**	11/08/2016

Organochlorine Pesticides

Sample Name:	MC - Upper 110716	**Units:**	ng/L
Lab Code:	K1613678-001	**Basis:**	NA
Extraction Method:	EPA 3535A	**Level:**	Low
Analysis Method:	8081B		

Analyte Name	Result	Q	MRL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Note
4,4'-DDE	ND	U	0.98	1	11/08/16	11/11/16	KWG1610173	
4,4'-DDD	ND	U	0.98	1	11/08/16	11/11/16	KWG1610173	
4,4'-DDT	ND	U	0.98	1	11/08/16	11/11/16	KWG1610173	

Surrogate Name	%Rec	Control Limits	Date Analyzed	Note
Tetrachloro-m-xylene	81	20-106	11/11/16	Acceptable
Decachlorobiphenyl	75	19-127	11/11/16	Acceptable

Comments:

Analytical Results

Client:	Aspect Consulting	**Service Request:**	K1613678
Project:	Chelan County Natural Resources Dept#120045-11a-05/120045.011a	**Date Collected:**	11/07/2016
Sample Matrix:	Water	**Date Received:**	11/08/2016

Organochlorine Pesticides

Sample Name:	AKM224 110716	**Units:**	ng/L
Lab Code:	K1613678-002	**Basis:**	NA
Extraction Method:	EPA 3535A	**Level:**	Low
Analysis Method:	8081B		

Analyte Name	Result	Q	MRL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Note
4,4'-DDE	ND	U	1.1	1	11/08/16	11/11/16	KWG1610173	
4,4'-DDD	ND	U	1.1	1	11/08/16	11/11/16	KWG1610173	
4,4'-DDT	ND	U	1.1	1	11/08/16	11/11/16	KWG1610173	

Surrogate Name	%Rec	Control Limits	Date Analyzed	Note
Tetrachloro-m-xylene	87	20-106	11/11/16	Acceptable
Decachlorobiphenyl	81	19-127	11/11/16	Acceptable

Comments:

Analytical Results

Client:	Aspect Consulting	**Service Request:**	K1613678
Project:	Chelan County Natural Resources Dept#120045-11a-05/120045.011a	**Date Collected:**	11/07/2016
Sample Matrix:	Water	**Date Received:**	11/08/2016

Organochlorine Pesticides

Sample Name:	Gerry 110716	**Units:**	ng/L
Lab Code:	K1613678-003	**Basis:**	NA
Extraction Method:	EPA 3535A	**Level:**	Low
Analysis Method:	8081B		

Analyte Name	Result	Q	MRL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Note
4,4'-DDE	ND	U	0.98	1	11/08/16	11/11/16	KWG1610173	
4,4'-DDD	ND	U	0.98	1	11/08/16	11/11/16	KWG1610173	
4,4'-DDT	ND	U	0.98	1	11/08/16	11/11/16	KWG1610173	

Surrogate Name	%Rec	Control Limits	Date Analyzed	Note
Tetrachloro-m-xylene	88	20-106	11/11/16	Acceptable
Decachlorobiphenyl	81	19-127	11/11/16	Acceptable

Comments:

Analytical Results

Client:	Aspect Consulting	**Service Request:**	K1613678
Project:	Chelan County Natural Resources Dept#120045-11a-05/120045.011a	**Date Collected:**	11/07/2016
Sample Matrix:	Water	**Date Received:**	11/08/2016

Organochlorine Pesticides

Sample Name:	AAJ531 110716	**Units:**	ng/L
Lab Code:	K1613678-004	**Basis:**	NA
Extraction Method:	EPA 3535A	**Level:**	Low
Analysis Method:	8081B		

Analyte Name	Result	Q	MRL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Note
4,4'-DDE	ND	U	0.99	1	11/08/16	11/11/16	KWG1610173	
4,4'-DDD	ND	U	0.99	1	11/08/16	11/11/16	KWG1610173	
4,4'-DDT	ND	U	0.99	1	11/08/16	11/11/16	KWG1610173	

Surrogate Name	%Rec	Control Limits	Date Analyzed	Note
Tetrachloro-m-xylene	86	20-106	11/11/16	Acceptable
Decachlorobiphenyl	78	19-127	11/11/16	Acceptable

Comments:

Analytical Results

Client:	Aspect Consulting	**Service Request:**	K1613678
Project:	Chelan County Natural Resources Dept#120045-11a-05/120045.011a	**Date Collected:**	11/07/2016
Sample Matrix:	Water	**Date Received:**	11/08/2016

Organochlorine Pesticides

Sample Name:	MC - Lower 110716	**Units:**	ng/L
Lab Code:	K1613678-005	**Basis:**	NA
Extraction Method:	EPA 3535A	**Level:**	Low
Analysis Method:	8081B		

Analyte Name	Result	Q	MRL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Note
4,4'-DDE	ND	U	0.96	1	11/08/16	11/11/16	KWG1610173	
4,4'-DDD	ND	U	0.96	1	11/08/16	11/11/16	KWG1610173	
4,4'-DDT	ND	U	0.96	1	11/08/16	11/11/16	KWG1610173	

Surrogate Name	%Rec	Control Limits	Date Analyzed	Note
Tetrachloro-m-xylene	82	20-106	11/11/16	Acceptable
Decachlorobiphenyl	75	19-127	11/11/16	Acceptable

Comments:

Analytical Results

Client:	Aspect Consulting	**Service Request:**	K1613678
Project:	Chelan County Natural Resources Dept#120045-11a-05/120045.011a	**Date Collected:**	NA
Sample Matrix:	Water	**Date Received:**	NA

Organochlorine Pesticides

Sample Name:	Method Blank	**Units:**	ng/L
Lab Code:	KWG1610173-3	**Basis:**	NA
Extraction Method:	EPA 3535A	**Level:**	Low
Analysis Method:	8081B		

Analyte Name	Result	Q	MRL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Note
4,4'-DDE	ND	U	0.96	1	11/08/16	11/11/16	KWG1610173	
4,4'-DDD	ND	U	0.96	1	11/08/16	11/11/16	KWG1610173	
4,4'-DDT	ND	U	0.96	1	11/08/16	11/11/16	KWG1610173	

Surrogate Name	%Rec	Control Limits	Date Analyzed	Note
Tetrachloro-m-xylene	81	20-106	11/11/16	Acceptable
Decachlorobiphenyl	76	19-127	11/11/16	Acceptable

Comments:

QA/QC Reports and Raw Data
Available Upon Request

TABLES

Table C-1. Surface Water Stations

Project No. 120045, Mission Creek Augmentation Pilot Project, Cashmere, WA

LocID	River Mile	Latitude	Longitude	Parameters
MC-Lower	2.8	47.488353	-120.481679	WQ, S, F
MC-01	3.8	47.476769	-120.492246	S & F
MC-02	4.7	47.466062	-120.491899	S & F
MC-03	5.3	47.458476	-120.490121	S & F
MC-Upper	6.4	47.44375	-120.495549	WQ, S, F

Notes

WQ sampled for water quality parameters

S stream stage continuously measured

F stream flow measured

`

Table C-2. Groundwater Monitoring and Test Locations

Project No. 120045, Mission Creek Augmentation Pilot Project, Cashmere, WA

LocID	Latitude	Longitude	Parameters
Test Wells			
TW-1	47.488551	-120.483096	WQ, WL, Q
TW-2	47.488043	-120.483194	WQ, WL, Q
TW-4	47.457599	-120.491428	WQ, WL, Q
TW-5	47.453703	-120.492344	WQ, WL, Q
TW-6	47.44616	-120.495892	WQ, WL, Q
Observation Wells			
OW-1	47.488456	-120.483103	WL
OW-2	47.465966	-120.492160	WL
OW-3	47.460896	-120.491308	WL
OW-4	47.446264	-120.495682	WL

Notes

WQ sampled for water quality parameters

WL groundwater Level

Q discharge flow rate

Table C-3. Well Construction

Project No. 120045, Mission Creek Augmentation Pilot Project, Cashmere, WA

LocID	Ecology Well Tag	Diameter inches	Depth feet	Casing Depth feet - bgs	Seal feet-bgs	Open Interval feet - bgs	Source	Pump Setting feet - bgs	Static Water Level feet - bgs	TOC feet - ags	Landsurface Elevation feet - amsl	Cascading Well	Notes
TW-1	BCC613	8	254	42.5	30	open hole	Chumstick	236.8	16.6	1.9	981	Y	
TW-2	BCC614	8	244	45	33	70 - 90; 150 - 170; 190 - 208; 227 - 244	Chumstick	211.5	9.5	2	983	Y	iron staining below pump set
TW-4	AAJ531	8	53	41	18	21.5; 32.5; 43 - 53 open hole	Alluvium	43.3	10	2	1188	N	Fe/Mn scaling on casing
TW-5	NA	8	320	19	19	open hole	Chumstick	296.3	0	1.5	1212	N	"keyed" borehole
TW-6	AMK224	8	340	unknown	unknown	165 - 183: 205 - 223; 245 - 263; 285 - 302; 326 - 343	Chumstick	317.7	15.5	1.0	1276	N	
Observation Wells													
OW-1	NA	72	<40	<40	unknown	open bottom	Alluvium	--	12.6	2	981	--	
OW-2	BIN376	8	400	22	22	open hole	Chumstick	--	2.3	1.5	1135	--	
OW-3	NA	8	79	39	18	21 - 34; 39 - 79 open hole	Alluvium Chumstick	--	8.8	2	1167	--	
OW-4	AEH437	8	38	38	18	open bottom	Alluvium	--	13.2	2	1274	--	

Table C-4. Aquifer Test Conditions

Project No. 120045, Mission Creek Augmentation Pilot Project, Cashmere, WA

LocID	Number	Phase Captured	Pumping Duration (days)	Average Pumping Flow Rate (gpm)	Flow Rate Stable
TW-1	1	Recovery	0.21	90	N
TW-1	2	Recovery	0.15	104	N
TW-2	1	Recovery	0.02	125	N
TW-2	2	Recovery	0.33	95	N
TW-2	3	Recovery	0.27	118	N
TW-4	1	Drawdown & Recovery	28.1	69	Y[1]
TW-5	1	Drawdown & Recovery	26.8	49	Y[2]
TW-6	1	Drawdown & Recovery	27.0	37	Y[3]

Notes

1 stable within 10% of average flow rate after 1st hour

2 stable within 10% of average flow rate after 2 days

3 stable within 10% of average flow rate after 1.5 days

gpm - gallons per minute

`

Table C-5. Rating Table

Project No. 120045, Mission Creek Augmentation Pilot Project, Cashmere, WA

LocID	Date	Flow (cfs)	Staff Gague (ft)	Notes
MC-Lower	10/18/2016	11.1	0.71	During pizo install, check JS for staff data
MC-Lower	10/28/2016	11.1	0.85	Possible Equipment Malfunction
MC-Lower	10/31/2016	15.4	0.85	
MC-Lower	11/1/2016	15.6	0.80	
MC-Lower	11/7/2016	12.8	0.75	
MC-Lower	11/15/2016	17.0	0.91	
MC-Lower	11/22/2016	11.1	0.69	
MC-Lower	11/28/2016	10.9	0.70	
MC-01	10/19/2016	10.1	0.40	During pizo install, check JS for staff data
MC-01	10/26/2016	20.1	0.74	
MC-01	11/1/2016	17.8	0.60	
MC-01	11/7/2016	11.8	0.50	
MC-01	11/22/2016	10.8	0.46	
MC-02	10/19/2016	10.4	0.60	During pizo install, check JS for staff data
MC-02	10/28/2016	11.3	0.76	Possible Equipment Malfunction
MC-02	11/1/2016	18.1	0.75	
MC-02	11/8/2016	12.4	0.66	
MC-02	11/16/2016	13.6	0.68	
MC-02	11/22/2016	11.1	0.61	
MC-03	10/19/2016	10.4	0.61	During pizo install, check JS for staff data
MC-03	11/1/2016	16.7	0.85	
MC-03	11/8/2016	11.1	0.72	
MC-03	11/16/2016	13.6	0.71	
MC-03	11/22/2016	11.0	0.68	
MC-Upper	10/18/2016	12.8	0.65	During pizo install, check JS for staff data
MC-Upper	10/28/2016	11.5	0.69	Possible Equipment Malfunction
MC-Upper	10/31/2016	22.9	0.80	Ran twice bc high flow #'s, both 22.9
MC-Upper	11/7/2016	14.3	0.68	
MC-Upper	11/15/2016	18.1	0.80	
MC-Upper	11/22/2016	11.6	0.63	
MC-Upper	11/28/2016	11.8	0.64	

Notes

cfs - cubic feet per second

ft - feet

Table C-6. Aquifer Parameters

Project No. 120045, Mission Creek Augmentation Pilot Project, Cashmere, WA

LocID	Average Transmissivity	Aquifer Thickness	Hydraulic Conductivity	
	ft^2/d	ft	ft/d	cm/s
Alluvium	1270	13	100	4E-02
Chumstick	50	265	0.2	6E-05

Notes

a drawdown water level not stable or below measurement device, overprediction of specific capacity

NA not analyzed due to short pumping duration

cm/s - cubic meters per day

ft - feet

ft/d - feet per day

ft^2/d - square feet per day

Table C-7. Well Yield

Project No. 120045, Mission Creek Augmentation Pilot Project, Cashmere, WA

Test Well	Specific Capacity	Available Drawdown	Yield
	gpm/ft	feet	gpm
TW-1	0.3	210	70
TW-2	0.4	192	80
TW-4	3.9	23	90
TW-5	0.2	286	50
TW-6	0.1	292	40

Notes

gpm - gallons per minute

gpm/ft - gallons per minute per foot

Table C-8. Water Quality Results

Project No. 120045, Mission Creek Augmentation Pilot Project, Cashmere, WA

Analyte	Unit	LocID	TW-1	TW-1	TW-2	TW-4	TW-5	TW-5	TW-6	TW-6	MC-LOWER	MC-UPPER
		Sampling Date	11/1/2016	11/1/2016	11/1/2016	11/7/2016	10/31/2016	11/7/2016	10/31/2016	11/7/2016	11/7/2016	11/7/2016
		Sample Type	N	FD	N	N	N	N	N	N	N	N
Bacteria												
Fecal Coliform	cfu/100mL		< 2.0 UJ	< 2.0 UJ	< 2.0 UJ							
Fecal Coliform	MPN/100mL					< 1.8 U		< 1.8 U		< 1.8 U	**330**	**6.8**
Conventionals												
Nitrate as Nitrogen	mg/L		**2.69**	**2.7**	**3.16**	**4.06**		< 0.10 U		**2.24**	**0.25**	< 0.10 U
Nitrate-Nitrite	mg/L		**2.94**	**2.92**	**3.48**	**3.8**		**0.055**		**2.22**	**0.25**	< 0.050 U
Nitrite as Nitrogen	mg/L		< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U		< 0.10 U		< 0.10 U	< 0.10 U	< 0.10 U
ortho-Phosphate	mg/L		< 0.010 U	< 0.010 U	< 0.010 U	< 0.010 U		< 0.010 U		< 0.010 U	< 0.010 U	< 0.010 U
Phosphorus	mg/L		< 0.010 U	< 0.010 U	< 0.010 U	< 0.010 U		< 0.010 U		< 0.010 U	**0.034**	**0.037**
Total Kjeldahl Nitrogen	mg/L		**0.65**	**0.74**	**0.48**	**0.66**		**0.49**		**0.57**	**0.53**	**0.44**
Total Suspended Solids	mg/L		**3**	**2.9**	**1.4**	**2.4**		**9.8**		**10.3**	**38.9**	**33.7**
Field Parameters												
Dissolved Oxygen	mg/L		**12.6**		**10.9**	**4.0**	**0.1**	**0.2**	**3.5**	**4.2**	**11.3**	**11.3**
Oxidation Reduction Potential	mV		**32**		**44**	**35**	**-79**	**14**	**-29**	**40**	**39**	**40**
pH	pH units		**7.2**		**7.3**	**6.9**	**8.3**	**8.2**	**7.6**	**7.6**	**8.4**	**8.2**
Specific Conductance	uS/cm		**303**		**315**	**728**[a]	**289**	**751**[a]	**376**	**834**[a]	**444**[a]	**420**[a]
Temperature	deg C		**12.0**		**11.3**	**12.1**	**13.4**	**13.5**	**11.1**	**11.9**	**8.0**	**6.4**
Turbidity	NTU		**4**		**4**	**1**	**12**	**1**	**3.7**	**1**	**10**	**8**
Pest/Herbicides												
4,4'-DDD	ng/L		< 0.99 U	< 1.0 U	< 0.96 U	< 0.99 U		< 0.98 U		< 1.1 U	< 0.96 U	< 0.98 U
4,4'-DDE	ng/L		**2.3**	**2.1**	< 0.96 U	< 0.99 U		< 0.98 U		< 1.1 U	< 0.96 U	< 0.98 U
4,4'-DDT	ng/L		< 1.4 UJ	< 1.4 UJ	< 0.96 U	< 0.99 U		< 0.98 U		< 1.1 U	< 0.96 U	< 0.98 U

Notes

a - calibration error, measured value higher than actual due to

Bold - detected

cfu/100 mL - colony forming units per 100 milliliters

MPN/100 mL - most probable number per 100 milliliters

MPN/100 mL - most probable number per 100 milliliters

mg/L - milligrams per liter

mV - millivolts

uS/cm - microsiemens per centimeter

deg C - degrees Celsius

NTU - Nephelometric Turbidity Units

ng/L - nanograms per liter

Table C-9. Stream Response Factor

Project No. 120045, Mission Creek Augmentation Pilot Project, Cashmere, WA

Test Well	Aquifer Type	Aquifer	Transmissivity ft^2/d	Storativity --	Hydraulic Diffusivity ft^2/d	Distance to Stream[1] ft	Stream Response Factor days	Recovery[2] days
TW-1	unconfined	Chumstick	50	0.15	3E+02	300	270	0.03
TW-2						40	4.8	0.1
TW-4	semi-confined	Alluvial	1270	1E-03	1E+06	200	0.03	5.1
TW-5		Chumstick	50		5E+04	150	0.5	14.8
TW-6	unconfined			0.15	3E+02	250	1.25	1.3

Notes

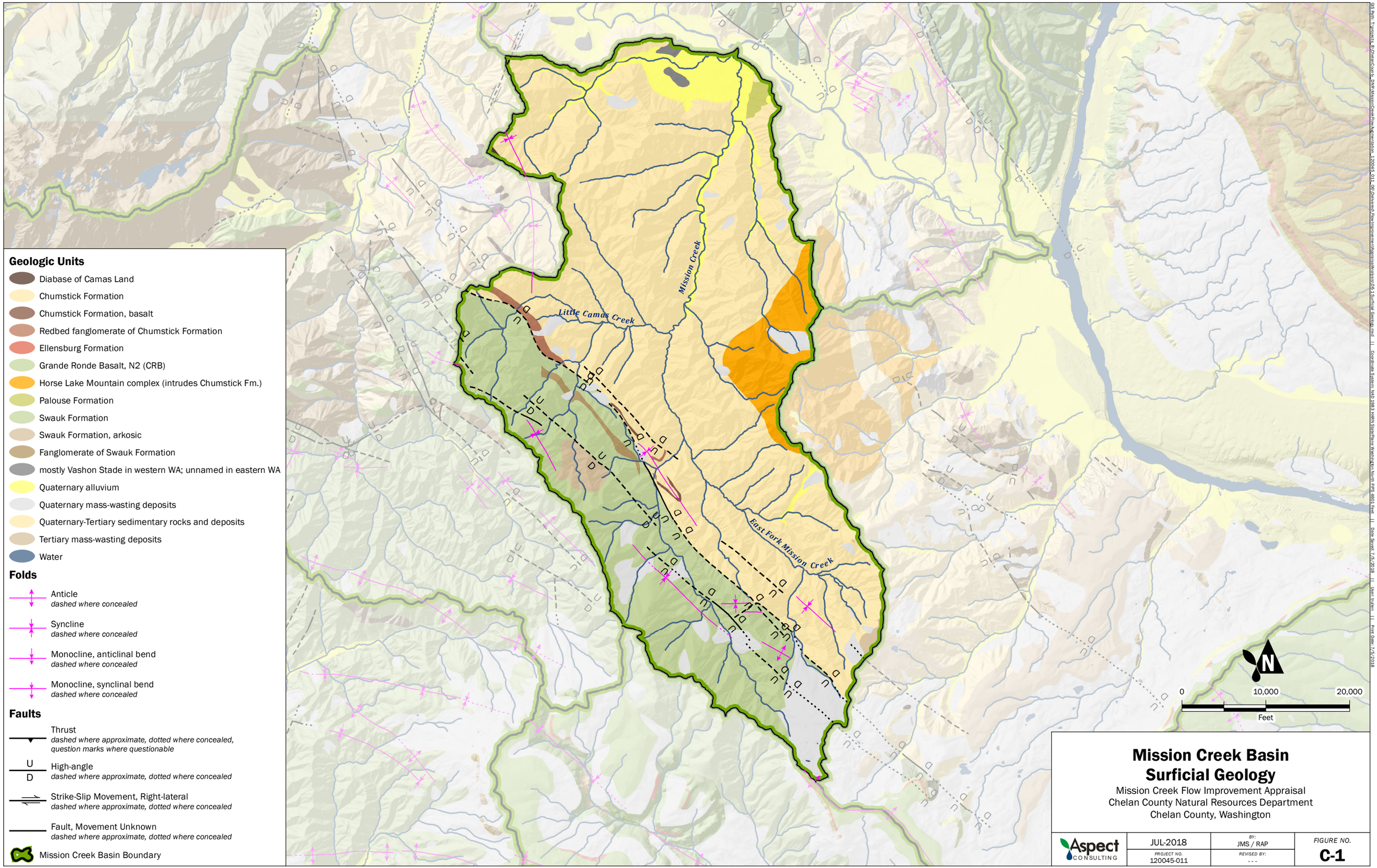
1) Distance to stream is the shortest distance

2) Recovery as 95% of drawdown, except TW-6 at 93% of drawdown

ft - feet

ft^2/d - square feet per day

FIGURES



Geologic Units

- Diabase of Camas Land
- Chumstick Formation
- Chumstick Formation, basalt
- Redbed fanglomerate of Chumstick Formation
- Ellensburg Formation
- Grande Ronde Basalt, N2 (CRB)
- Horse Lake Mountain complex (intrudes Chumstick Fm.)
- Palouse Formation
- Swauk Formation
- Swauk Formation, arkosic
- Fanglomerate of Swauk Formation
- mostly Vashon Stade in western WA; unnamed in eastern WA
- Quaternary alluvium
- Quaternary mass-wasting deposits
- Quaternary-Tertiary sedimentary rocks and deposits
- Tertiary mass-wasting deposits
- Water

Folds

- Anticle
  dashed where concealed
- Syncline
  dashed where concealed
- Monocline, anticlinal bend
  dashed where concealed
- Monocline, synclinal bend
  dashed where concealed

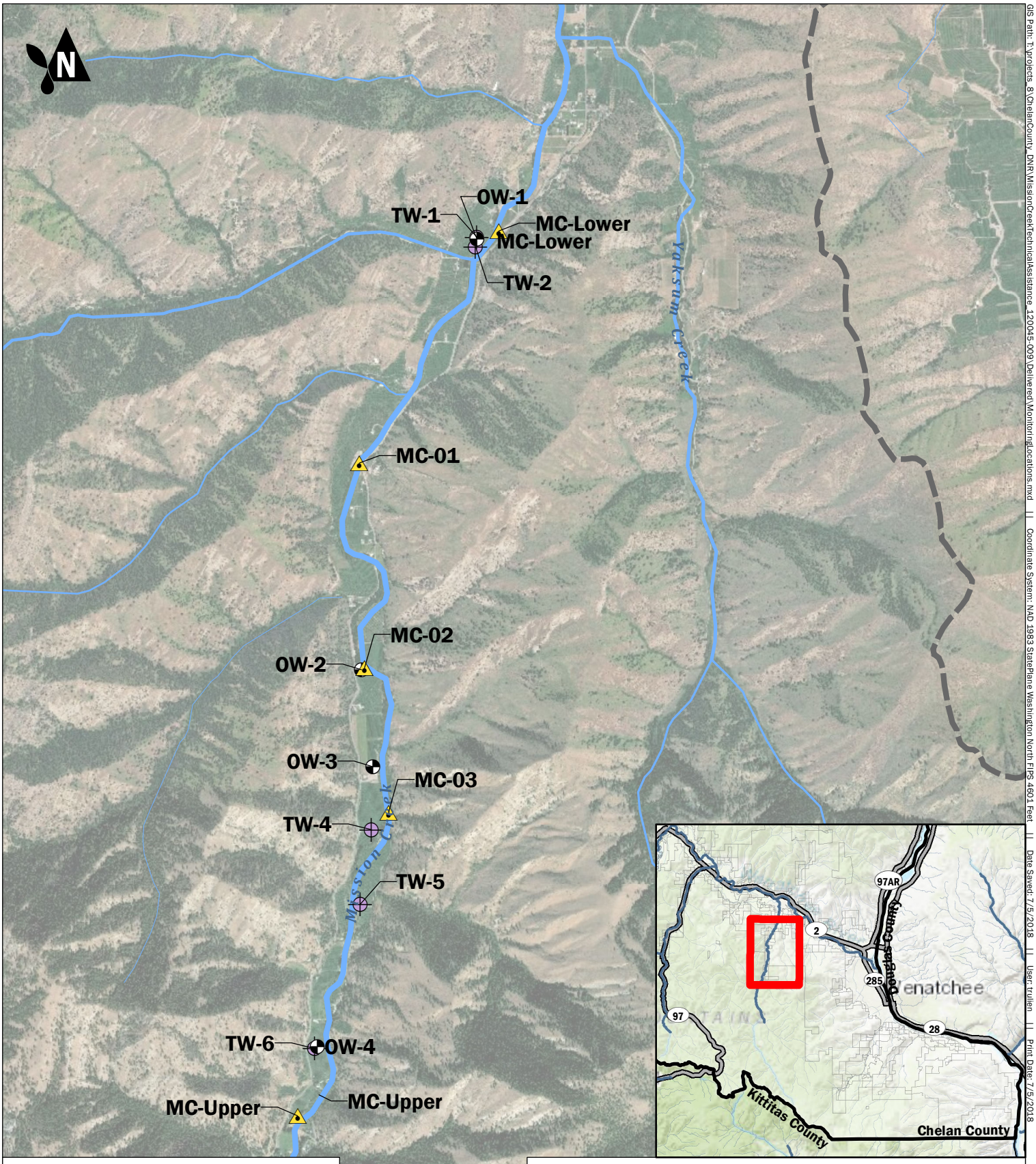
Faults

- Thrust
  dashed where approximate, dotted where concealed, question marks where questionable
- U / D High-angle
  dashed where approximate, dotted where concealed
- Strike-Slip Movement, Right-lateral
  dashed where approximate, dotted where concealed
- Fault, Movement Unknown
  dashed where approximate, dotted where concealed
- Mission Creek Basin Boundary

Mission Creek Basin Surficial Geology

Mission Creek Flow Improvement Appraisal
Chelan County Natural Resources Department
Chelan County, Washington

Aspect CONSULTING	JUL-2018	BY: JMS / RAP	FIGURE NO. C-1
	PROJECT NO. 120045-011	REVISED BY: ---	



Monitoring Locations

Mission Creek Streamflow Augmentation Pilot Project
Chelan County Natural Resources Department
Chelan County, Washington

Aspect Consulting	JUL-2018	BY: PPW	FIGURE NO. C-2
	PROJECT NO. 120045-11a	REVISED BY: JMS / RAP / EAC	

GIS Path: T:\projects_8\ChelanCounty_DNR\MissionCreekTechnicalAssistance_120045-009\Delivered\MonitoringLocations.mxd || Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet || Date Saved: 7/5/2018 || User: trullen || Print Date: 7/5/2018

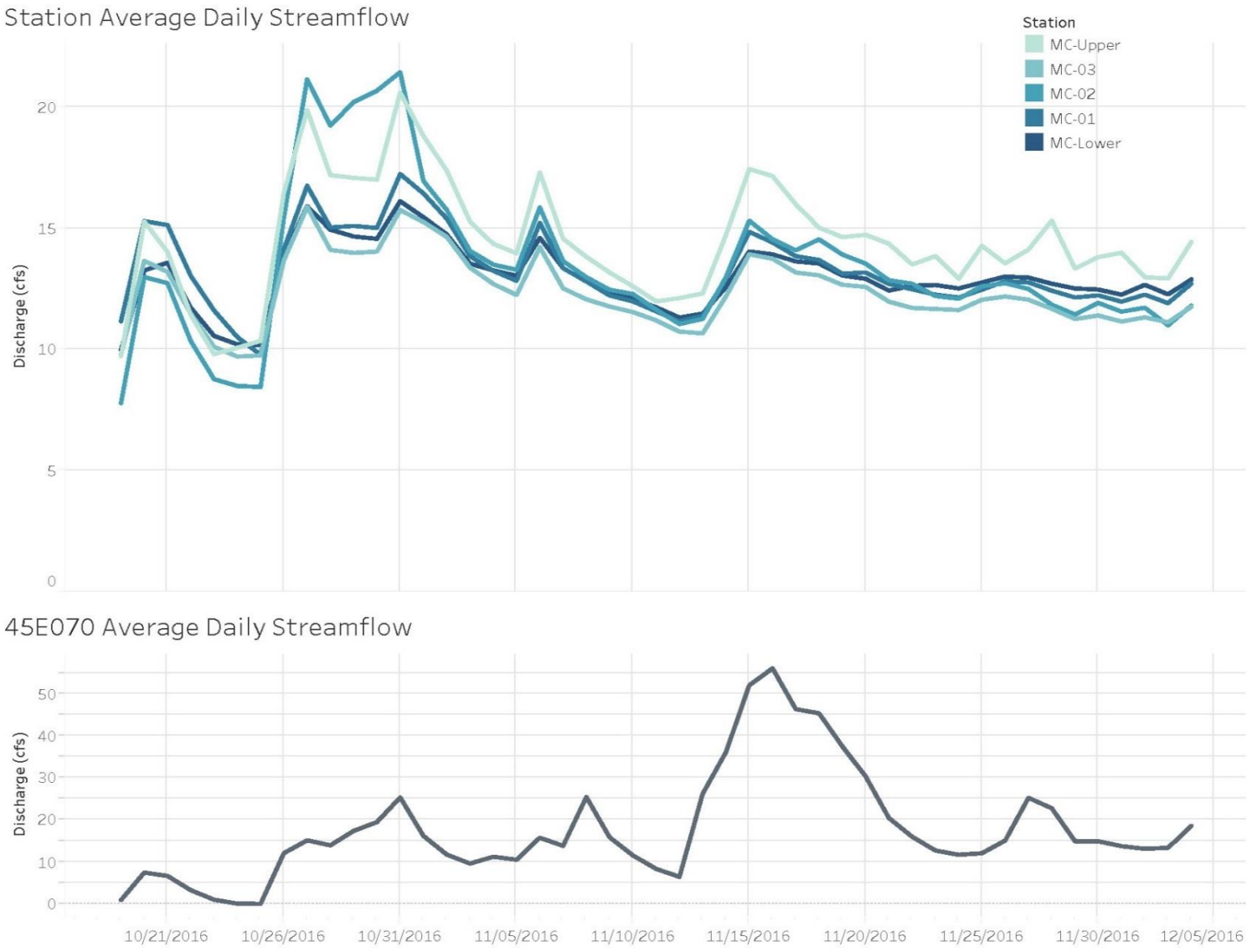


Figure C-3
Surface Water Hydrographs

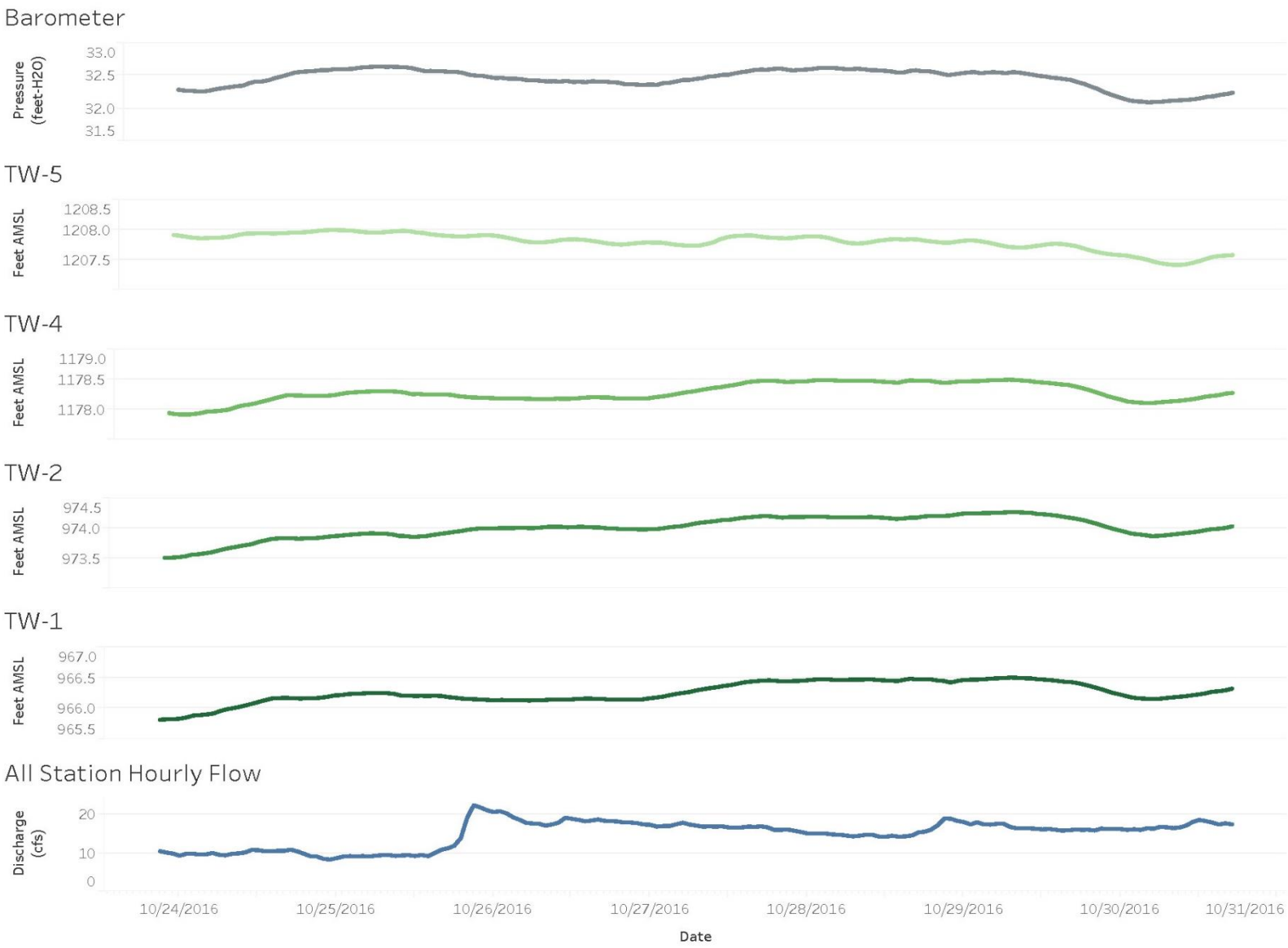


Figure C-4

TWs Static Water Levels

Project No. 120045, Mission Creek Augmentation Pilot Project, Cashmere, WA

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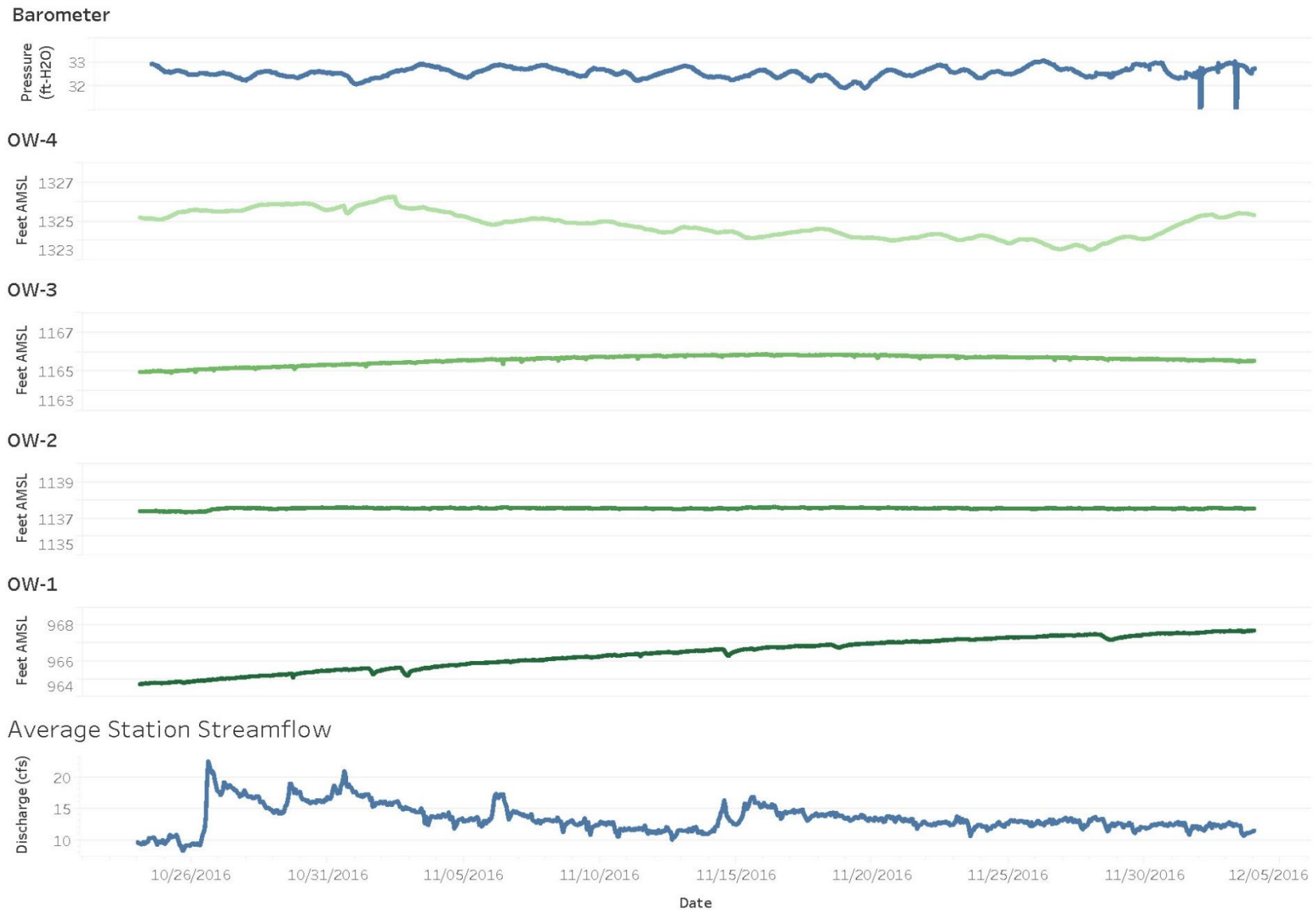

Figure C-5
OWs Water Levels

Aspect Consulting
07/06/2018
Project No. 120045, Mission Creek Augmentation Pilot Project, Cashmere, WA
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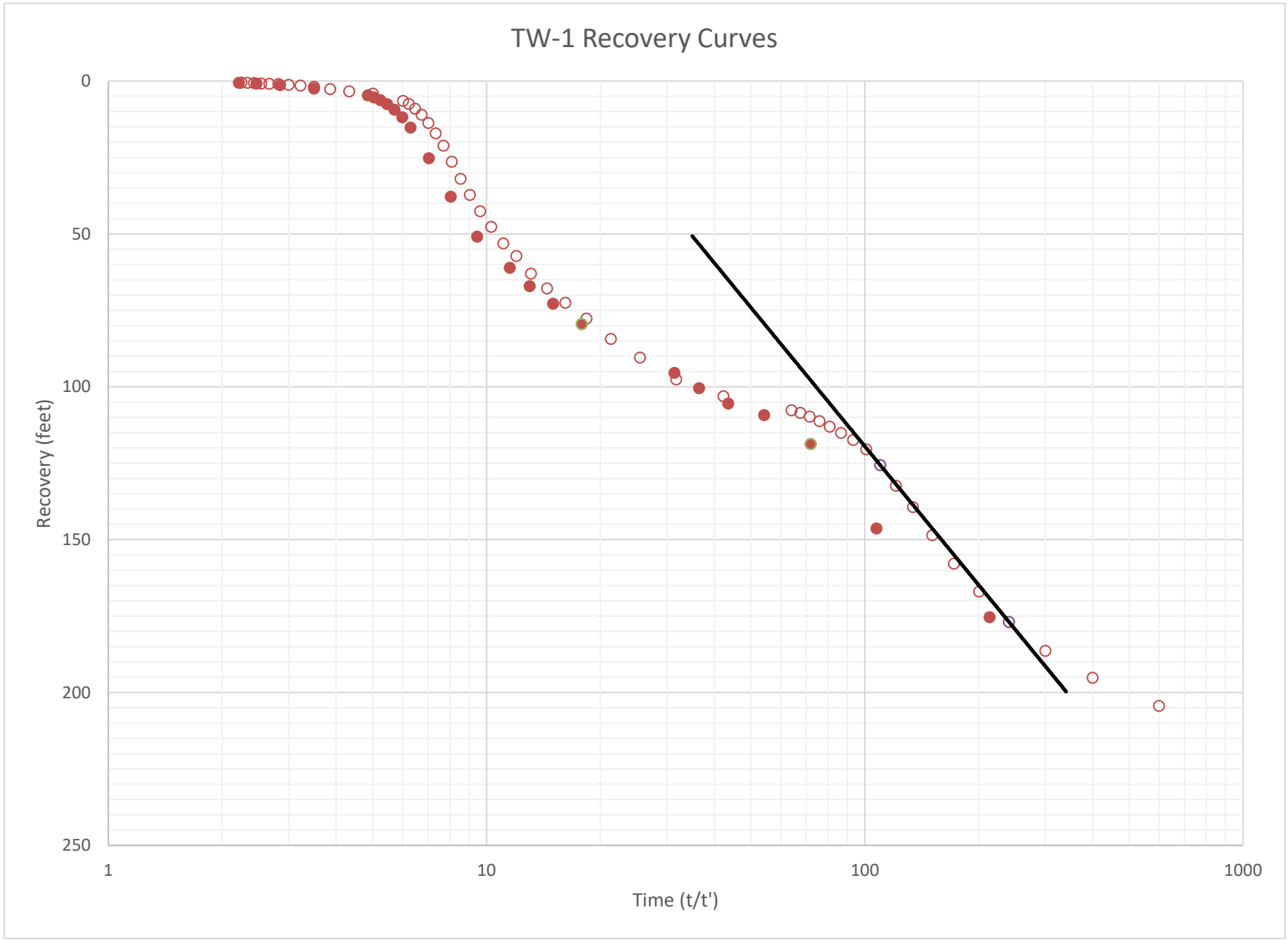

Figure C-6

TW-1 Recovery Curves

Project No. 120045, Mission Creek Augmentation Pilot Project, Cashmere, WA

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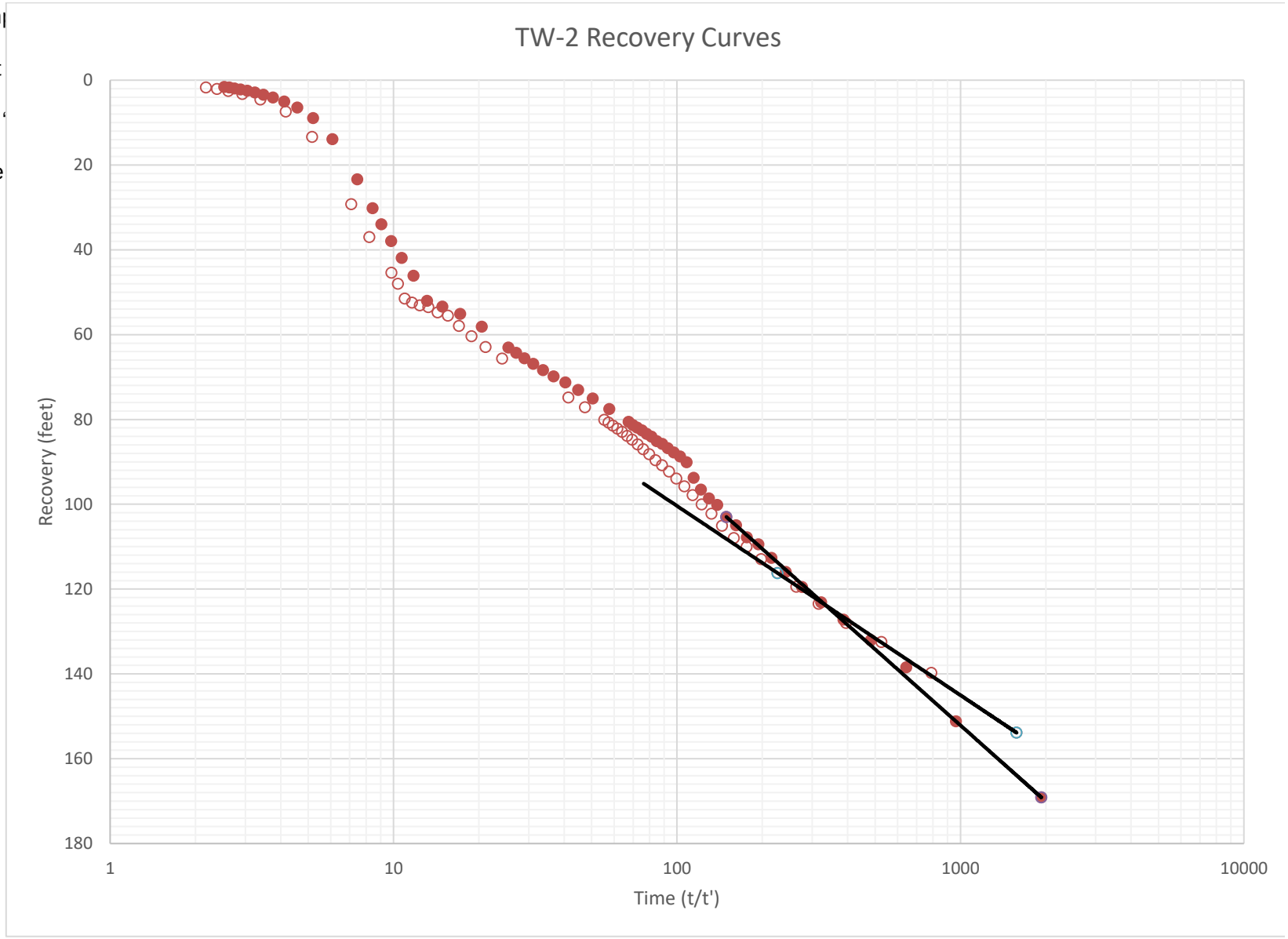

Figure C-7

TW-2 Recovery Curves

Project No. 120045, Mission Creek Augmentation Pilot Project, Cashmere, WA

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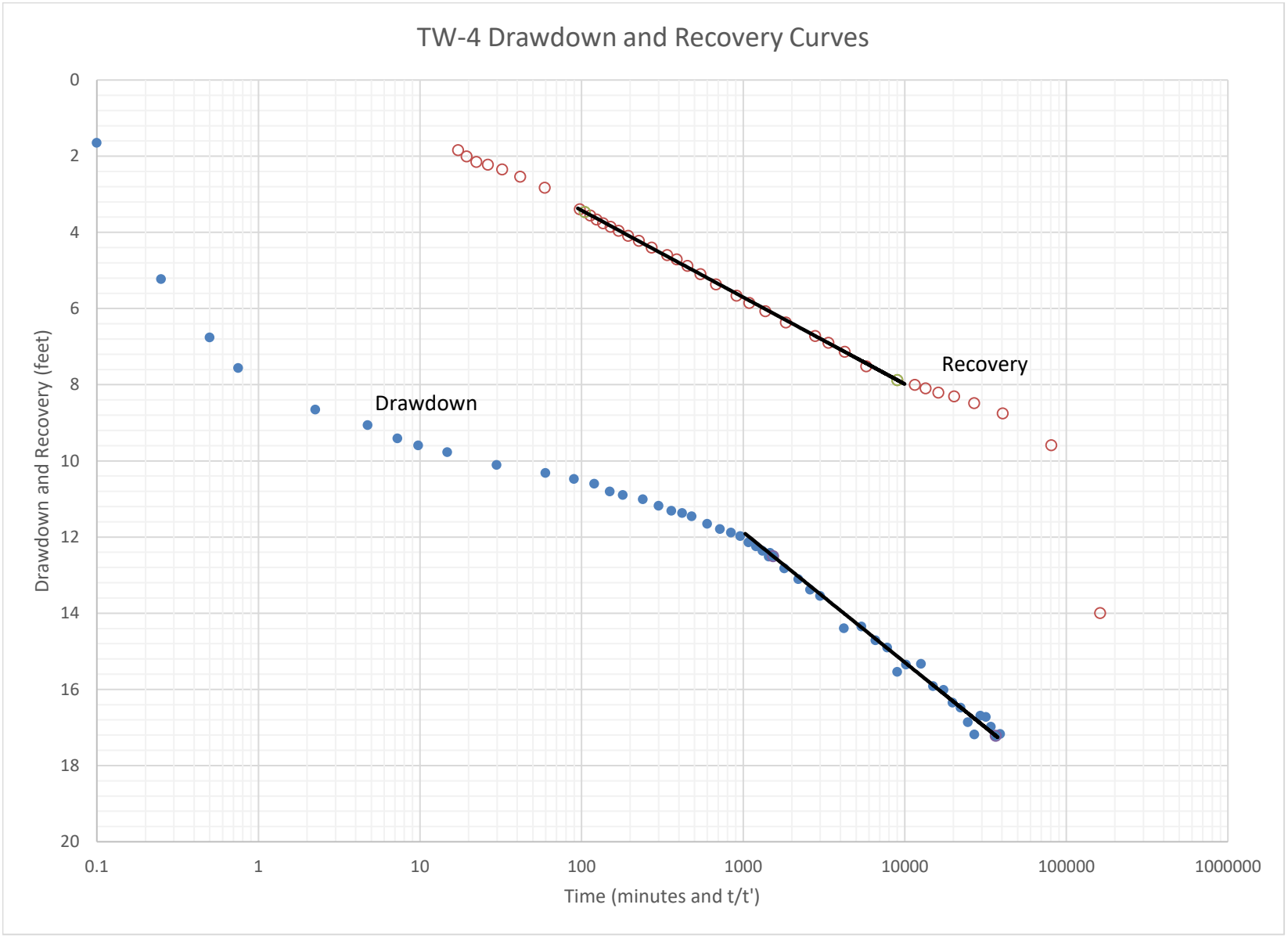

Figure C-8

TW-4 Drawdown and Recovery Curves

Project No. 120045, Mission Creek Augmentation Pilot Project, Cashmere, WA

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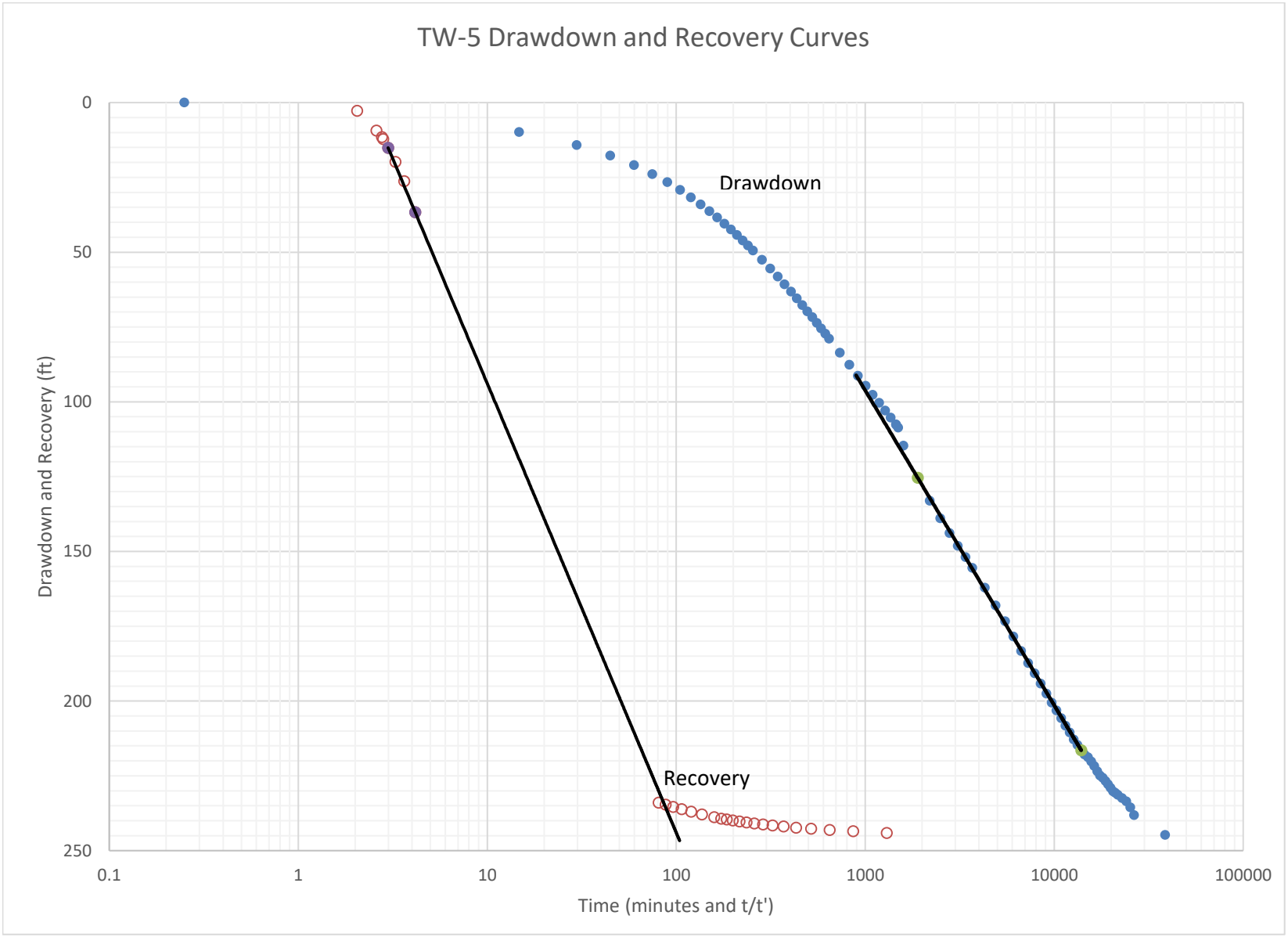

Figure C-9

TW-5 Drawdown and Recovery Curves

Project No. 120045, Mission Creek Augmentation Pilot Project, Cashmere, WA

Aspect Consulting

07/06/2018

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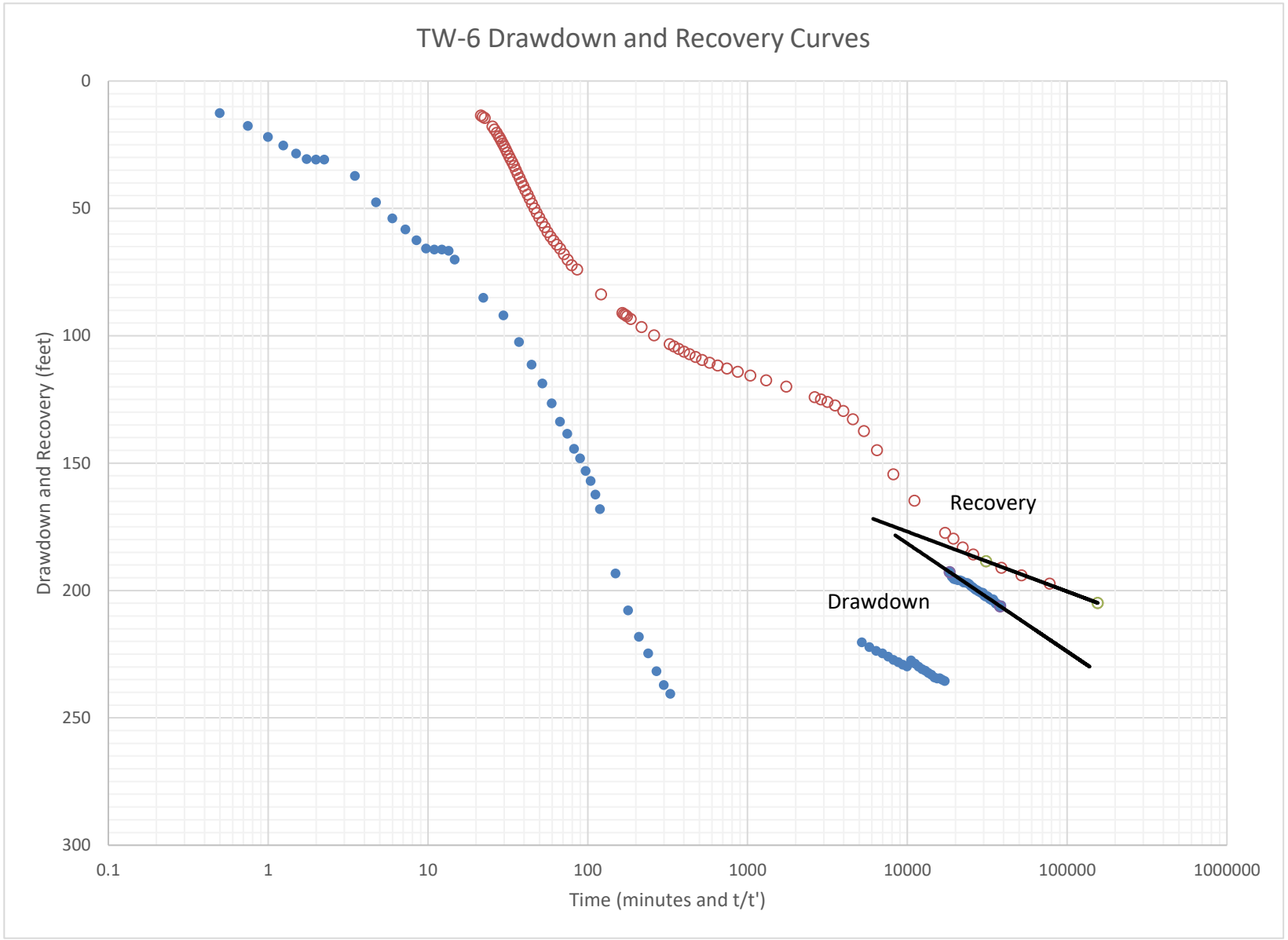

Figure C-10

TW-6 Drawdown and Recovery Curves

Project No. 120045, Mission Creek Augmentation Pilot Project, Cashmere, WA

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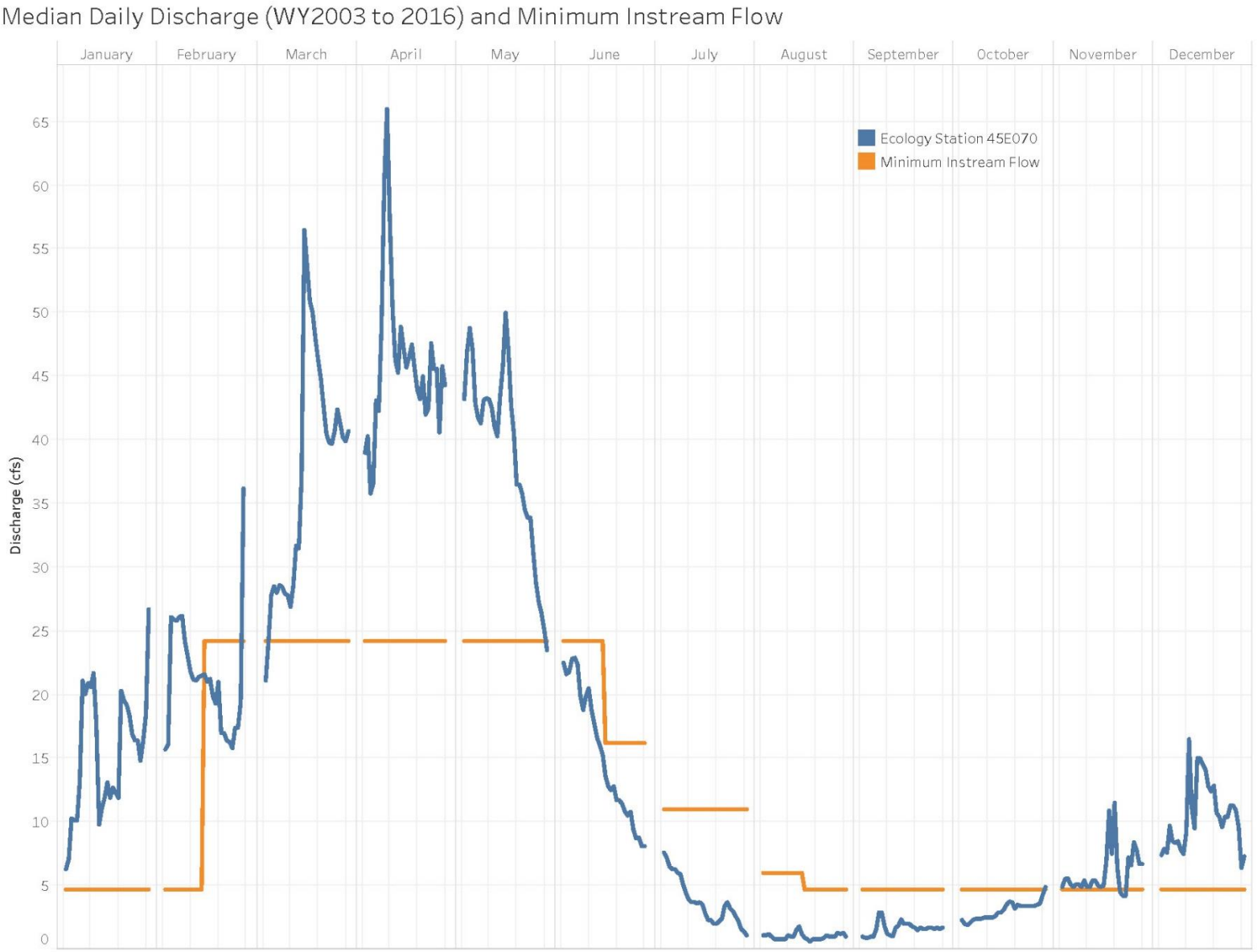

Figure C-11

Ecology Station 45E070 Hydrograph

Project No. 120045, Mission Creek Augmentation Pilot Project, Cashmere, WA

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