

EXISTING CONDITIONS REPORT

LORENZAN CREEK STORMWATER IMPROVEMENT PROJECT

**Prepared for
Skagit County Public Works**

**Prepared by
Herrera Environmental Consultants, Inc.**



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**Prepared for
Skagit County Public Works
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Mount Vernon, WA 98273**

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January 24, 2022

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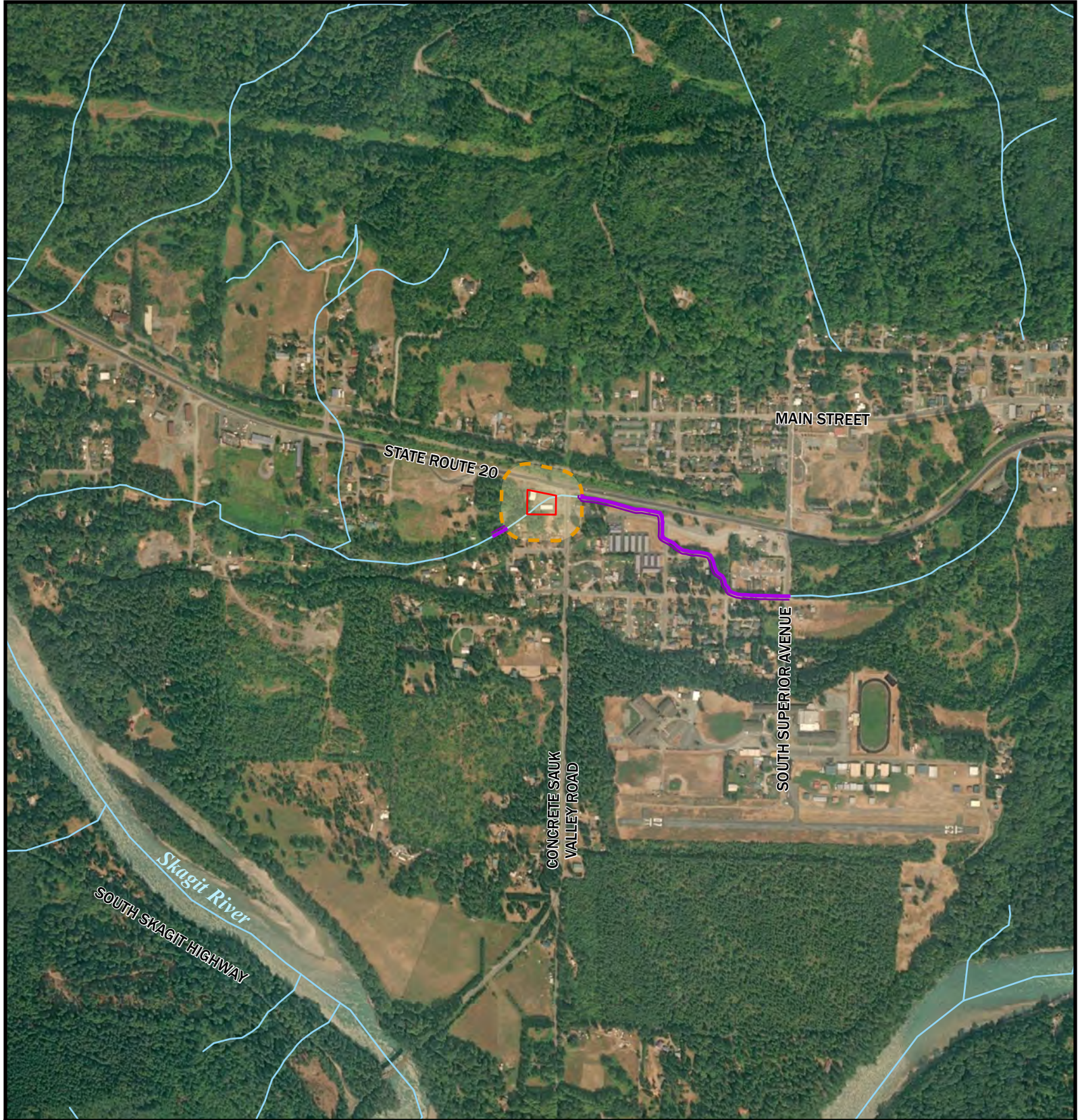
PROJECT OVERVIEW

Lorenzan Creek is a salmon bearing stream that flows under Skagit County's East County Road Shop parcel 0.8 miles upstream of its confluence with the Skagit River near Concrete, Washington. Water quality of the runoff from the shop parcel is a concern, as multiple storm drains collect runoff from the site and discharge directly to the creek. The shop parcel has a decommissioned fueling station and fuel tank, heavy machinery, covered material storage areas for sand and salt, uncovered materials storage areas for gravel and crushed surfacing, a washout station, and a shop building. These facilities and related maintenance activities contribute pollutants to the runoff from the site. Additionally, the culvert conveying Lorenzan Creek beneath the site is undersized for both fish passage, per a Washington State Department of Fish and Wildlife (WDFW) assessment, and for flood conveyance in large storm events, exacerbating flooding in the town of Concrete. Figure 1 is a vicinity map.

The goal of this project is to analyze the existing stormwater infrastructure at the Shop parcel and provide recommendations to improve water quality, allow for improved fish passage, and reduce upstream flooding. Skagit County was awarded grant funding from the Washington State Department of Ecology's (Ecology) Water Quality Combined Funding Program to support the analysis, design and permitting of water quality improvements, as well as funding from Puget Sound Energy (PSE) to support the analysis, design, and permitting of fish passage improvements. Stakeholders and key partners within and near the project area will be involved throughout its duration.

The alternatives analysis phase of the Lorenzan Creek Stormwater Improvement Project will involve close collaboration with Skagit County (the County) and stakeholders to develop critical evaluation criteria against which to compare the potential alternatives, and conceptual design alternatives. The alternatives to be evaluated will include a "no action" alternative, an alternative in which the County sells the parcel as-is, and three design alternatives to meet the project goals.

Based on the evaluation criteria developed in collaboration with stakeholders, a preferred alternative will be selected by the County and detailed design and permitting documents will be prepared for use in future funding requests and eventual construction.



- Legend**
- Stream Survey Limits
 - Stream
 - Critical Areas Study Area
 - Project Area (County Parcel)

Figure 1.
Lorenzan Creek Stormwater Improvements
Project Vicinity Map.



KICKOFF MEETING

The County hosted a project kickoff meeting on July 12, 2021 at the project site to observe existing site conditions with project partners and stakeholders, review project goals and constraints, and discuss future site usage and nearby development. The meeting began with introductions, followed by a brief overview of the project history and current status, then transitioned to an open discussion amongst the stakeholders regarding observations, opinions and concerns related to the project and the Lorenzan Creek watershed. Following the discussion, the project team walked around the facility to observe existing conditions. The following summarizes the topics of conversation and key observations from the site meeting. See Appendix A for the complete meeting minutes.

STAKEHOLDER INPUT

Facility

- The current facility supports east Skagit County public works operations, providing storage for salt, sand and equipment. Without the facility in Concrete, County staff would need to travel to Burlington for re-supply and equipment transfer.
- The current facility is the minimum footprint required for the staff's current operations and truck maneuverability. County staff expressed the need for a larger facility, and would be interested in relocating the site from the current location as the existing site does not have room for future needs.
- A decommissioned fuel tank is buried in the Northeast corner of the site. The County does not refuel vehicles at the site anymore and the underground tank may be a liability due to environmental contamination risk. The County plans to remove the fuel tank and associated appurtenances prior to the construction of any other site improvements.
- The site is located within the urban growth area (UGA) of the Town of Concrete. The Town of Concrete would be supportive of development that connects to or enhances economic growth and/or community connectedness.
- If the project needed to redirect or alter the shoulder area/runoff from State Route 20 (SR 20) in the Washington State Department of Transportation (WSDOT) right-of-way (ROW), WSDOT's hydraulics group would review the design and be involved. Any water quality improvements within the SR 20 ROW would be a WSDOT-led effort separate from this project.

Lorenzan Creek

- It is understood that the Town of Concrete has repeatedly experienced flooding along Lorenzan Creek upstream of the project site south of SR 20, particularly in recent years following the development of a large storage facility which added fill to a low-lying area that previously provided some storage for Lorenzan Creek overbank flow during high flow events. The site work from that development shifted the regional low point to Pine Street, and now the roads and neighboring homes experience flooding from Lorenzan Creek during heavy rains. See Appendix B for photos the Mayor of Concrete shared of flooding in this area that occurred in 2015.
- In 2016 the Town of Concrete dredged a section of Lorenzan Creek upstream of the project site along Fir Street and a downstream section near Cedar and Pine streets. The creek channel consistently aggrades with a continuing sediment supply from the upper watershed after dredging, however no extensive flooding has been observed at Fir Street since 2016.
- Attendees shared seasonal observations of the creek and fish sightings
- During a drought in 2015, Lorenzan Creek began to flow below the surface downstream of the project site in the summer months. Lorenzan Creek still flows in its historic path from the site to its confluence with the Skagit River during winter months.
- Coho salmon have not been observed in Lorenzan Creek since the creek began to flow subsurface in the summer of 2015. Other types of fish have been observed in recent years.
- Beaver use has been observed downstream of the project site.

Site Visit Observations

- On the day of the kickoff meeting, no water was observed in the creek upstream nor downstream of the property.
- Dense vegetation growth and sediment was observed in the creek channel near the culvert entrance on the east side of Concrete Sauk Valley Road.

Shop Stormwater Facilities

- The catch basin in the parking area with inlet pipes from the building roof downspouts and from a culvert in the SR 20 ROW had standing water in it above the outlet pipe invert elevation, indicating a potential backwater condition

- The catch basin in the furthest SW corner by the wash station has an oil trap (downturned pipe elbow). The outlet pipe from this structure that discharges runoff into the creek could not be located.

CULTURAL RESOURCES EVALUATION

The project team estimated the area of potential effect (APE) for cultural resources, described the methods, activities and depths for which land disturbing activities may occur, and developed an Inadvertent Discovery Plan (IDP) outlining steps to be taken in case of the discovery of cultural resources during land disturbing activities. These documents were submitted to the Washington State Department of Ecology (Ecology) for review and to initiate consultation with local and interested Tribal representatives. The response from Ecology and the Washington State Department of Archaeology and Historic Preservation (DAHP) confirmed that the site is considered to have a high probability of containing cultural resources underground. Due to this, an archeological monitor is required during all land disturbing activities associated with this project. The IDP and the monitoring plan are included in Appendix C of this report.

TOPOGRAPHIC SURVEY DATA

A detailed topographic and land survey was conducted including the County Shop parcel and areas within a 200-foot radius of the parcel perimeter. The survey data collected includes topography, land cover, utilities, structures, site features, parcel boundary lines, delineated critical areas (wetlands, ordinary high-water limits), and other site features.

A stream survey was conducted beyond the bounds of the detailed survey of the County parcel, starting approximately 100 feet downstream of where Lorenzan Creek crosses beneath Concrete Road, and extending east to approximately 100 feet upstream of where Lorenzan Creek crosses beneath South Superior Avenue. The stream survey includes all culverts, as well as stream cross-sections spaced approximately every 50 feet along the length of channel surveyed.

The resultant survey basemap is included in Appendix D.

CRITICAL AREAS

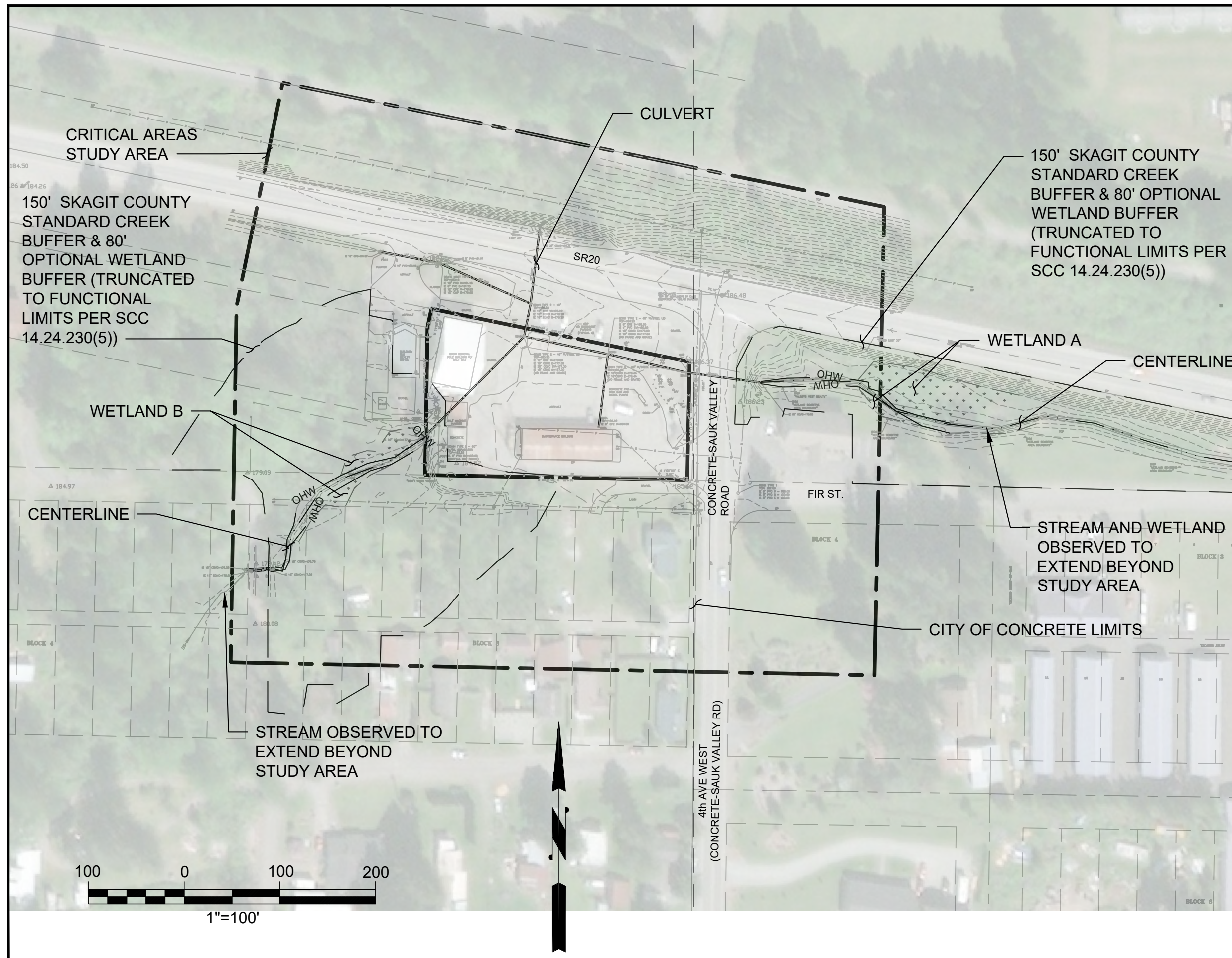
This section describes the results of a critical areas assessment (wetlands and fish and wildlife habitat conservation areas) of the project site and its general vicinity (200 feet radius beyond the Shop parcel perimeter), as required by Section 14.24.520 of Skagit County Code (SCC). The results and conclusions in this section represent the professional opinion of Herrera Environmental Consultants, Inc. (Herrera). They are based upon examination of public domain environmental information concerning the study area, an on-site field delineation, and data analysis.

Herrera completed a preliminary review of relevant and available environmental information about the site (e.g., surveys, studies), followed by an onsite wetland and stream delineation within the study area. Details regarding the findings of the preliminary literature data review and field investigation are described in the following sections. Methods for wetland and stream channel delineation are found in Appendix E. A thorough review of wetland conditions including soils and climate data will be provided in a future phase of this project.

Critical Areas Study Area

The County's Shop facility, located at the intersection of Concrete Sauk Valley Road and the North Cascades Highway (SR 20), is situated in Sections 9 and 10 of Township 35 north, Range 08 east (W.M). The critical areas study area for the project site, roughly 5 acres in size, includes approximately 200 feet length of the Lorenzan Creek riparian corridor that extends east (upstream) of Concrete Sauk Valley Road and 200 feet west (downstream) of the Shop parcel to the Lorenzan Creek crossing of Concrete Road (Figure 2). Within the project site, Lorenzan Creek is conveyed underground through a piped system for a distance of approximately 280 linear feet.

Figure 2.
Delineated Critical Areas



Preliminary Literature Data Review

A literature review was performed to determine the historical and potential current presence of wetlands and streams in and near the study area. Sources of information include:

- National Wetlands Inventory map (USFWS 2021b)
- Critical Areas on Skagit County iMap (Skagit County 2021)
- USGS hydrographic data (USGS 2021)
- Fish, wildlife, and habitat maps (WDFW 2021a, 2021b, 2021c)
- Washington State priority habitat and species (PHS) data (WDFW 2021a)
- Washington Department of Natural Resources Water Type (WDNR 2021a)
- Ecology water quality assessment tools and maps (Ecology 2021a, 2021b)
- Washington State Natural Heritage data (WDNR 2021b)
- Skagit County soil survey maps, soil descriptions, and hydric soils list (NRCS 2021b, 2021c, 2021d)
- Precipitation and climate data (NRCS 2021a)

Previously Mapped Wetlands and Streams

The National Wetlands Inventory describes Lorenzan Creek as a riverine system with no mapped wetlands in the study area. WDNR maps Lorenzan Creek as a Type F (fish bearing) water (WDNR 2021a).

Publicly available maps show differing alignments and tributaries of Lorenzan Creek. WDNR mapping shows two tributaries originating from foothills north of SR 20 joining south of SR 20 within the study area. The USGS mapping shows the stream originating in foothills northeast of the study area and flowing through residential and urban areas north of SR 20 (USGS 2021). A portion of the upper watershed is dominated by coniferous forest which is leased for logging operations. The lower watershed is dominated by rural residential development, and higher intensity development within the downtown area of Concrete and on the south side of SR 20 northeast and east of the project site, respectively.

Fish and Wildlife Habitat Use

Skagit County defines Type F streams as providing fish habitat and uses the definition in Washington Administrative Code (WAC) 222-13-030(5)(h). Under this definition fish habitat is described as “used by any fish at any life stage at any time of the year, including potential habitat likely to be used by fish which could be recovered by restoration or management.”

Based on WDFW's SalmonScape and Priority Habitat and Species (PHS) mapping, Lorenzan Creek has documented occurrences of coho salmon (*Oncorhynchus kisutch*) and cutthroat trout (*O. clarkii*). Lorenzan Creek is shown as gradient accessible (i.e., not too steep to swim in) to Chinook salmon (*O. tshawytscha*), chum salmon (*O. keta*), pink salmon (*O. gorbuscha*), and steelhead trout (*O. mykiss*) (WDFW 2021a, 2021b). However, the current flow regime may limit the distribution and year-round occurrence of salmonids in the creek. The USFWS also maps the study area as the generalized location for the occurrence of threatened bull trout (*Salvelinus confluentus*) (USFWS 2021a). No critical habitat is mapped within the study area, however the Skagit River downstream of the confluence with Lorenzan Creek contains critical habitat for Puget Sound evolutionarily significant unit (ESU) Chinook salmon, Puget Sound distinct population segment (DPS) steelhead trout, and bull trout (70 FR 52630, 81 FR 9252, 75 FR 63898). Table 1 summarizes documented use of fish in the project area vicinity and their state and federal listing statuses (WDFW 2020, 2021a, and 2021b; USFWS 2021a).

Table 1. Documented Fish Use in Lorenzan Creek.			
Species	Documented Use and Location	Federal Listing Status	State Listing Status
Chinook salmon	Gradient accessible in Lorenzan Creek; documented in Skagit River	Threatened	Candidate
Coho salmon	Documented presence in Lorenzan Creek; documented in Skagit River	None	Candidate
Fall chum salmon	Gradient accessible in Lorenzan Creek; documented in Skagit River	None	None
Pink salmon	Gradient accessible in Lorenzan Creek; documented in Skagit River	None	None
Steelhead trout	Gradient accessible in Lorenzan Creek; documented in Skagit River	Threatened	None
Cutthroat trout	Documented presence in Lorenzan Creek	None	None
Bull trout	Generalized watershed location	Threatened	Candidate

The USFWS also maps the study area as being amid the generalized location that provides habitat for four ESA threatened non-fish species: marbled murrelet (*Brachyramphus marmoratus*), northern spotted owl (*Strix occidentalis*), yellow-billed cuckoo (*Coccyzus americanus*), and Oregon spotted frog (*Rana pretiosa*) (USFWS 2021a). Other than the fish described above, no state priority species or habitats were mapped or observed in the study area. No Species of Local Importance, as designated by Skagit County, were observed during the site visit (SCC 14.24.500(4)). Some snags were present in the southwest portion of the study area when the field work described below occurred in early fall 2021. Snags are important habitat

features for pileated woodpecker (*Dryocopus pileatus*), a State Candidate and WDFW priority species (Larsen et al. 2004, WDFW 2020), but no direct observations were made of this species. No evidence of pileated woodpecker excavations were observed on the snags in the study area.

There are no documented state rare plant populations in the study area (WDNR 2021b).

Field Investigation Findings

Herrera biologists Danielle Rapoza, PWS and Tina Mirabile, PWS conducted the field investigation on September 30 and October 1, 2021. They conducted the wetlands and stream delineation in accordance with current federal, state, and Skagit County regulations and guidance. The weather conditions during the field work included rain with daytime high temperatures in the mid-50's (degrees Fahrenheit). For the purposes of delineating the study area wetlands, the dates of the field work were determined to be within the growing season (as defined in Appendix E), because above ground growth of vascular plants was occurring. Representative photographs of the wetlands identified in the study area are included in Appendix F.

Lorenzan Creek

The ordinary high water mark (OHWM) of the open channel segments of Lorenzan Creek located upstream and downstream of the County's Shop facility within the study area was delineated (Figure 2) using the definition provided in WAC 173-22-030(11), which has been adopted by Skagit County. According to this definition, the OHWM of streams is "that mark that will be found by examining the bed and banks and ascertaining where the presence and action of waters are so common and usual, and so long continued in all ordinary years, as to mark upon the soil a character distinct from that of the abutting upland, in respect to vegetation." Appendix E provides detailed methods for evaluating field conditions that were followed in performing the OHWM delineation.

Onsite OHWM indicators included:

- A scour line indicated by clean gravel and lack of leaf litter (below OHWM)
- Exposed tree roots (below OHWM)
- Overbank sediment deposits (above OHWM)
- Sediment lines on vegetation, tree bark, and other fixed objects (at OHWM)
- A topographic bench located at the top of bank (at OHWM)
- Darker stain lines indicated on large rocks and culvert walls (at OHWM)

Indicators were strong throughout the study area but became somewhat obscured where the stream flows through riverine wetlands. Vegetation indicators were not a reliable means of determining the OHWM as there is a monoculture of reed canarygrass growing in the channel east and northeast parts of study area (*Phalaris arundinacea*) and in the southwest portion of the study area there is reed canarygrass growth mixed with other wetland vegetation. However, one or more OHWM indicators were present throughout the length of the creek channel surveyed within the study area.

The OHWM was flagged in the field using sequentially numbered, brightly colored survey ribbon or flags in preparation for a professional survey (Figure 2). Herrera's field delineation of the OHWM was reviewed and approved by the Upper Skagit Indian Tribe on October 1, 2021.

The Lorenzan Creek channel upstream of the project site is obscured in many areas by dense reed canary grass and has been altered due to past dredging. Portions of the upstream channel are armored with rock, especially near the entrance to the 18-inch-diameter culvert that conveys the creek under Concrete Sauk Valley Road and the County Shop facility. The average width of the creek channel is approximately 6 feet near the outlet of this long culvert on the west side of the County's facility. The banks are relatively low, ranging in height between 6 inches and 1 foot. The creek is conveyed under Concrete Road downstream via two culverts that are 18 inches and 12 inches in diameter. All culverts in the critical areas study area are mapped by WDFW as partial fish barriers (WDFW 2021c). Several other partial fish barriers are mapped upstream of the study area. Approximately 0.5 miles upstream, a total fish barrier culvert under SR 20 is currently being replaced by WSDOT.

Within the study area, Lorenzan Creek was observed to have ephemeral to intermittent flows. During the morning of September 30, 2021, standing water was present at the base of the culvert outlet immediately west of the project site, but was absent in the channel. Heavy precipitation throughout the morning contributed to bankfull flows by the early afternoon on that day. On the second day of the field investigation (October 1, 2021), less than 24 hours later, there was no longer flow in the channel. The field investigation was conducted at the end of the dry season/beginning of the wet season. Due to this timing, it was unclear at the time of the visit if the water regime is intermittent (seasonal) or ephemeral (during precipitation events). Regular flow monitoring or additional field visits conducted during the wet season are needed to determine the water regime.

Riparian Functions

In accordance with WDNR definitions outlined in WAC 222-16-030, Lorenzan Creek is a Type F (fish) stream and is afforded a 80-foot buffer by Skagit County (SCC 14.25.530(1)(C). Table 2 summarizes the existing Lorenzan Creek buffer functions present within the study area.

Table 2. Evaluation of Lorenzan Creek Riparian Buffer Functions.					
Location Within Study Area	Bank Stability	Temperature Moderation (Shade)	Runoff Infiltration	Wildlife Habitat	Recruitment of Large Woody Debris
Upstream of County Shop facility (Geomorphic Reach 3, northeast portion of study area)	Stable	Low	Moderate	Low/Poor	Low
On-site (Skagit County Facility, Geomorphic Reach 4)	Not Applicable – piped segment	No natural shade (underground conveyance)	None	Poor, with passage for some aquatic organisms only	None
Downstream of County Shop facility (Geomorphic reach 5, southwest portion of study area)	Stable	High	High	High	Moderate

Based on the presence of fish, and the channel width of greater than 5 feet, Skagit County's regulated buffer for Lorenzan Creek is 150 feet (SCC 14.25.530(1)(C)). Due to the proximity of State Route 20 and other land use, functional buffer is truncated at the edge of the developed area (SCC 14.24.230(5)). In the southwestern portion of the study area the buffer consisted of upland and wetland forested conditions during the site visit. The vegetated Lorenzan Creek corridor in this area likely functions as a connectivity network for wildlife to access surrounding habitat patches and adjacent wetlands. The plant community supports stream habitat functions, including shading of the stream channel, and bank integrity by means of root reinforcement. In addition, the forest canopy and underlying shrubs function to filter stormwater runoff from nearby developed land and provide some wildlife habitat.

Buffer vegetation in the northeastern portion of the study area is dominated by a monoculture of reed canarygrass. Uplands in this part of the study area contained mowed lawn, weeds, and a small patch of native forest at the time of the field visit. The stream channel is surrounded by development on all sides including SR 20, Concrete Sauk Valley Road, and retail businesses. Residential backyards, Concrete Road, and the County Shop parcel are representative of development inside the buffer.

Wetlands

Wetlands observed within the study area were classified according to the US Fish and Wildlife Service classification system (FGDC 2013) (Table 3). This system is based on an evaluation of attributes such as vegetation class, hydrologic regime, salinity, and substrate. The wetlands were also classified according to the Hydrogeomorphic (HGM) system, which is based on an evaluation of attributes such as the position of the wetland within the surrounding landscape, the source and location of water just before it enters the wetland, and the pattern of water movement in the wetland (Brinson 1993).

Herrera conducted the wetland delineation in accordance with the *Regional Supplement to the US Army Corps of Engineers Wetlands Delineation Manual: Western Mountains, Valleys, and Coast Region* (Environmental Laboratory 2010), which is supplemental to the *1987 Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987). The methods in the guidance manuals use a three-parameter approach for identifying and delineating wetlands and rely on the presence of field indicators for hydrophytic vegetation, hydric soils, and hydrology. The detailed methods for evaluating these three parameters and for performing the wetland delineation are described in Appendix E.

Herrera biologists delineated two riverine wetlands (Wetlands A and B) in association with Lorenzan Creek within the study area (Figure 2). Test plots were established to document conditions in wetlands and in adjacent uplands. For each test plot, data on dominant plant species, soil conditions, and evidence of hydrologic conditions were recorded on wetland determination data forms. The wetland boundaries were flagged using sequentially numbered, brightly colored survey ribbon and flagging in preparation for a professional survey.

Table 3. Wetlands Delineated in the Critical Areas Study Area.

Wetland Name	Approximate Wetland Size (acre)	USFWS Classification ^a	HGM Classification ^b	Estimated Wetland Rating Category (2014) ^c	Skagit County Standard Buffer Width (feet) ^d	Skagit County Optional Buffer Width (feet) ^e
A	0.59	PEM	Riverine	III	150	80
B	0.37	PFO	Riverine	III	150	80

^a US Fish and Wildlife Service classification is based on Federal Geographic Data Committee (FGDC) (2013): palustrine forested (PFO), palustrine scrub-shrub (PSS), and palustrine emergent (PEM).

^b Hydrogeomorphic classification is based on Brinson (1993).

^c Wetland Category is based on the Washington State Department of Ecology (Ecology) wetland rating system (Hruby 2014), which is required by Skagit County Code (SCC 14.24.210)

^d Standard wetland buffer widths are based on the Ecology wetland rating and land use impacts (high), per Skagit County Code (SCC 14.24.230(1)(a)).

^e Optional wetland buffer widths are based on the Ecology rating, habitat score, and land use impacts (high), per SCC 14.24.230(1)(b).

Wetland A is dominated by palustrine emergent vegetation, primarily reed canarygrass. It is adjacent to Lorenzan Creek upstream of Concrete Sauk Valley Road. Wetland B, a palustrine

forested wetland with a scrub-shrub understory, is present in association with the segment of Lorenzan Creek downstream of the County's Shop facility.

A formal rating of the two wetlands according to Ecology's *Washington State–Wetland Rating System for Western Washington* (Hruby 2014) was not completed at the time of the field investigation. This task is proposed for completion during the next phase of contract work, which will also evaluate the project for potential critical areas/environmental impacts and compensatory mitigation, as applicable.

Based on their experience in formally assessing wetlands according to Ecology's 2014 Rating system, Herrera biologists estimated appropriate rating classifications and associated habitat for the two according to best professional judgement. Both of the wetlands were informally evaluated to meet Ecology's rating criteria as Category III wetlands (Hruby, T, 2014).

Wetland Functions

The Washington State Wetland Rating System for Western Washington: 2014 Update (Hruby 2014) provides a qualitative functional rating (high, moderate, or low) for each of the functions (water quality, hydrology, and habitat) provided by wetlands. Using the 2014 rating forms as a guide, Herrera's informal evaluation of the wetlands' ability or potential to perform water quality and hydrology functions is moderate and habitat quality is low. Details regarding Herrera's review of the wetland functions for the two wetlands delineated in the study area are provided below.

Runoff from the surrounding developed areas provides a high potential for both wetlands to provide water quality improvement functions on site. The wetlands have a moderate to high potential to improve water quality at the site due to small surface depressions and high cover of vegetation which can trap sediments and filter pollutants. This function is performed slightly better at Wetland B due to the high cover of trees and shrubs versus emergent vegetation. Both wetlands have a high potential to reduce flooding and erosion due to capacity to provide overbank flow storage, and the high cover of vegetation can slow flood velocities. However, there were few visual indications that Wetland A or Wetland B performs this function on site. Both wetlands have a low potential to provide habitat. This is due to having only one hydroperiod which limits the diversity of wildlife that may require a diversity of water regimes. In addition, the plant communities lack a diverse species assemblage and a diversity of structures (emergent and forested only) which limit the habitat potential on site. A large area of undisturbed habitat is available in the surrounding region but is generally disconnected from the wetlands by higher intensity development which includes SR 20 and residential and commercial land uses. The narrow riparian corridor surrounding Lorenzan Creek provides some habitat connectivity to Wetland B.

Wetland Buffers

Skagit County standard buffer widths are informed by wetland rating and the land use of the surrounding uplands (SCC 14.24.230(1)(a)). Skagit County also provides optional wetland buffer

widths for Category I, II, and III wetlands, which incorporates the habitat score as determined by the Ecology wetland rating (SCC 14.24.230(1)(b)). Both wetlands are surrounded by high impact land uses defined as "*...including, but not limited to, medium- and high-density residential (more than one home per five acres), multifamily residential, some agricultural practices, and commercial and industrial uses.*" Based on the preliminary rating described above, both wetlands are afforded a standard Skagit County buffer width of 150 feet, and an optional buffer width of 80 feet based on the low-quality habitat present. Due to the proximity of State Route 20 and other land use, functional buffer is truncated at the edge of the developed area (SCC 14.24.230(5)).

GEOTECHNICAL CONDITIONS

Geotechnical conditions were evaluated by both desktop research and field investigation. Six test pits were excavated, soil conditions were observed, soil samples were collected, and laboratory testing was conducted. The results of that evaluation are included in Appendix G of this report.

HYDROLOGIC CONDITIONS

Streamflow gauge data are not available for Lorenzan Creek. To support the hydraulic analysis of existing flooding conditions, the hydrologic conditions at the project site were estimated by delineating and characterizing the contributing watershed area and using a hydrologic model to approximate the peak flow rates for a range of mean recurrence intervals as described below.

SUBBASIN CHARACTERIZATION

Three subbasins of Lorenzan Creek upstream of the project site were delineated for the hydrologic analysis. The downstream ends for each of these subbasins are referred to as hydrologic analysis points, and include drainage from the following areas:

1. Drainage from the northwest portion of the Lorenzan Creek watershed contributing to a culvert that crosses underneath SR 20 and joins the culverted segment of Lorenzan Creek within the project site,
2. Local drainage to Lorenzan Creek between SR 20 and the project site, and
3. Drainage from the northeast portion of the Lorenzan Creek watershed, upstream of SR 20, which enters the creek before it passes through another culvert under SR 20.

The three subbasins were delineated in ArcGIS using LiDAR topography (USGS North Puget 2017 LiDAR dataset)), as well as GIS shapefiles of the stormwater conveyance system and field observations provided by County staff. Aerial imagery was used to coarsely characterize the land cover within each subbasin as forest, lawn, or impervious surface. Soil survey information was derived from the United States Department of Agriculture Natural Resources Conservation Service (NRCS) web soil survey data. Figure 3 shows the delineated boundaries and land cover types for the three subbasins.

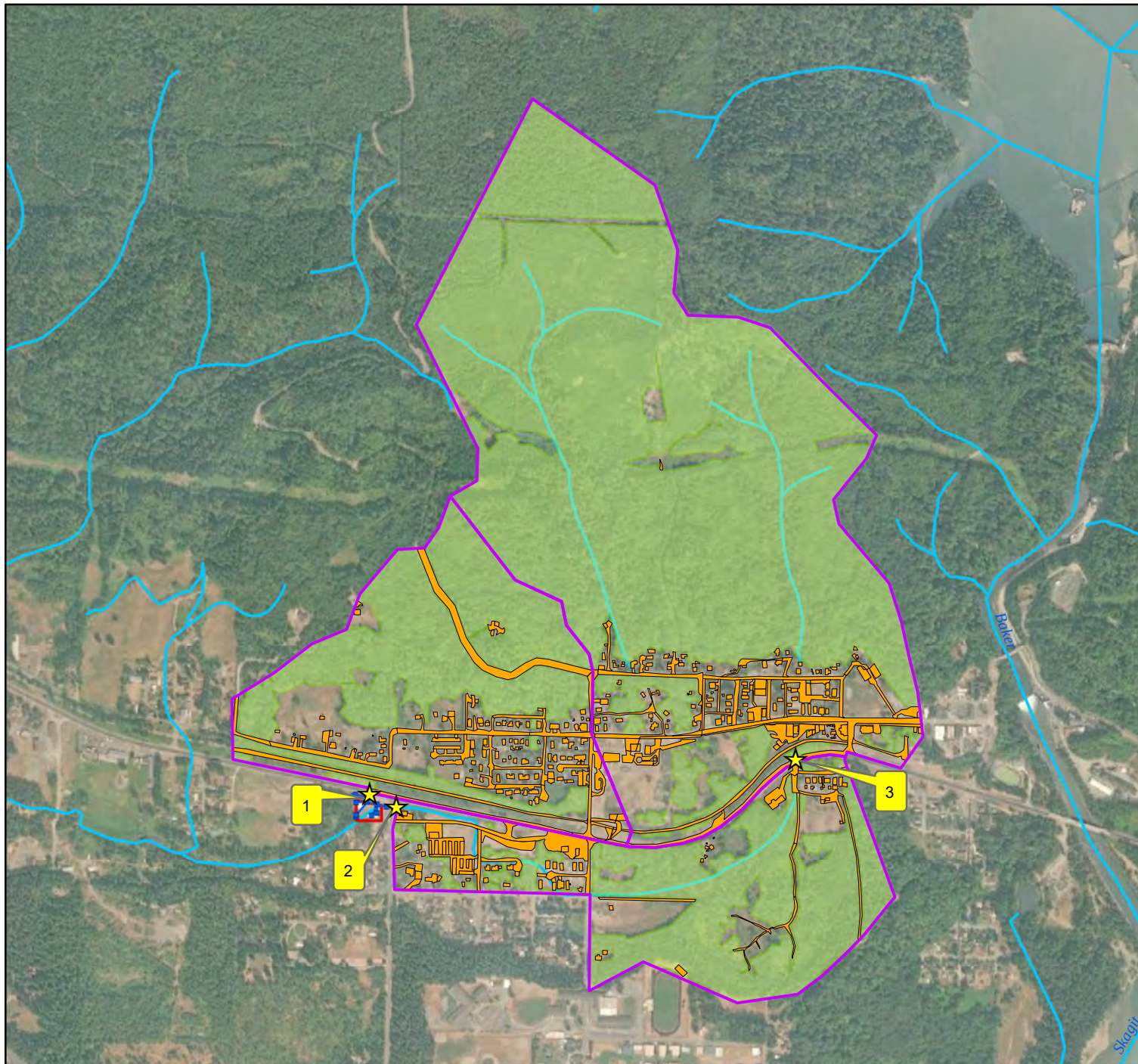


Figure 3.
Lorenzan Creek Tributary
Basin Delineation

Legend

- ★ Point of Hydrologic Analysis
- ▭ Basin Boundaries
- ▭ Forest
- ▭ Impervious
- ▭ Site Parcel
- Stormwater Structures
- Storm Drain
- Streams/Rivers



0 625 1,250
Feet

Table 4 summarizes the land cover within each of the subbasins. Based on soil data from the NRCS, the soil type throughout all the basins is understood to be predominately well-drained, hydrologic group A/B.

Table 4. Land Cover in Subbasins for Hydrologic Analysis				
Subbasin	Land Cover (Acre)			
	Forest	Lawn	Impervious Surface	Total
1	68.8	40.0	18.5	127.3
2	62.7	32.3	12.7	107.7
3	278.0	50.6	20.4	349.0

HYDROLOGIC MODELING ANALYSIS

The Western Washington Hydrology Model 2012 Version 4.2.18 (WWHM) was then used to evaluate the hydrology and estimate peak flow rates generated in various mean recurrence interval storms for the three subbasins of interest. The WWHM is an Ecology-approved long term hydrology model based on the industry standard Hydrologic Simulation Program – FORTRAN (HSPF).

Table 5 summarizes the resultant peak flows in cubic feet per second (cfs) corresponding to a range of mean recurrence intervals modeled for each hydrologic analysis point. See Appendix H for the complete WWHM modeling report.

Table 5. WWHM Estimated Peak Flows (cfs) for Hydrologic Analysis Points.						
Subbasin	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
1	13.9	21.9	28.5	38.5	47.3	57.3
2 + 3 ^a	26.2	43.6	59.0	83.4	106.0	132.8
3	16.8	28.9	39.7	57.2	73.7	93.4

^a Hydrologic analysis point 3 is upstream of point 2, so the flows tributary to point 2 include runoff from basins tributary to points 2 and 3.

GEOMORPHIC CONDITIONS

The geomorphic conditions of Lorenzan Creek within and near the project site are a product of the topography, geology, and soil conditions, combined with the hydrology and hydromodifications associated with local land use and land cover changes in the creek's watershed in the last century. This section provides a concise summary of the geomorphic conditions based on a review of watershed geology and soil characteristics as well as field observations of channel and floodplain conditions at, upstream, and downstream of the project site.

GEOLOGY AND SOILS

The surface geology in the upper portions of the Lorenzan Creek watershed, including the areas north of SR 20 and north of the town of Concrete where the slopes range from 50 to 80 percent, is primarily comprised of advance glacial outwash, deposited during the Vashon Stade of the Fraser glaciation (Haugerud and Tabor 2009). The predominant soil type that has formed within the outwash is Birdsvie loamy sand that is highly porous, characterized as Hydrologic Soil Group type A. This soil is somewhat excessively drained and has a high capacity for infiltration (NRCS 2021c). The town of Concrete and SR 20 are located at the base of a hillslope and are mostly sitting on top of the Lorenzan Creek alluvial fan, which is comprised of alluvium deposits and Kline very gravelly sandy loam soil (NRCS 2021c) that has formed above those deposits. Typical of alluvial fans and alluvium, these soils are also Hydrologic Soil Group Type A, and somewhat excessively drained, thus with a high capacity for infiltration when these soils are not covered by impervious surface. Downstream (south) of SR 20, Lorenzan Creek decreases in slope as it joins the Skagit River terrace underlain primarily by alluvium. Various silt loams and loamy sands are present along this stretch of Lorenzan Creek including the Indianola loamy sand that underlies the project site. These loamy sands are also Hydrologic Soil Group Type A, and somewhat excessively drained, so they have a high capacity for infiltration where these soils are not covered by impervious surface.

GEOMORPHIC FIELD ASSESSMENT

A Herrera stream engineer and geomorphologist (Christina Avolio and Ellen McClure, respectively) conducted a rapid assessment of geomorphic and physical habitat conditions of Lorenzan Creek on September 30, 2021. The weather was rainy during the fieldwork, which allowed them to observe flowing conditions along the extended stream network. They started at the upstream end of the study area (upstream of South Superior Avenue) and observed conditions along the channel to the downstream end of the study area at Concrete Road.

Herrera staff identified five reaches in the study area, including one culverted reach under the County Shop parcel and four open channel reaches, and characterized stream conditions in each of the open channel reaches. The reach boundaries are shown in Figure 4, and conditions are summarized in Table 6. Photographs of each reach are provided in Appendix F. In each open channel reach, bankfull widths were recorded with a measuring tape based on field indicators such as woody vegetation and morphologic features like stream side benches and the tops of banks. Reach 5 was selected as a reference reach and a pebble count was collected there to characterize the substrate, approximately 15 feet downstream of the outlet of the culvert conveying Lorenzan Creek beneath the County Shop parcel. Pebble count results are provided in Figure 5.

Table 6. Summary of Selected Geomorphic Conditions by Reach.						
Reach	Channel Type ^a	Bankfull Width (feet)	Reach Slope	Geomorphic Stability	Functional Large Wood	Reference Reach Potential
1 (Upstream of S. Superior Avenue)	Planebed	4.0	0.9%	Incising and Widening; Eroding bed and banks	No	No
2 (S. Superior Avenue to to Fir Street)	Dune-Ripple; Excavated/Constructed	11.0	0.7%	Stable banks with active bed aggradation	No	No
3 (Fir Street to Concrete Sauk Valley Road)	Wetland; Excavated/Constructed	11.5	0.6%	Stable banks with active bed aggradation	No	No
4 (piped section beneath County Shop parcel)	Culvert	n/a	0.4	n/a	n/a	No
5 (County Shop parcel pipe outlet to Concrete Road)	Wetland; pool-riffle	3.5 - 5.0 (upstream end) 7.0 (midreach) 9.0 (lower reach/wetland area)	0.4%	Stable banks and bed with floodplain connection	Minor	Yes

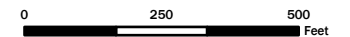
^a Channel type based on reach morphology classification per Montgomery and Buffington 1997 n/a = not applicable



Figure 4.
Lorenzan Creek Geomorphic
Assessment Reaches.

Legend

- Stream Reach Break
- Stream Survey Limits
- Stream
- Parcels
- Project Area (County Parcel)



Maxar

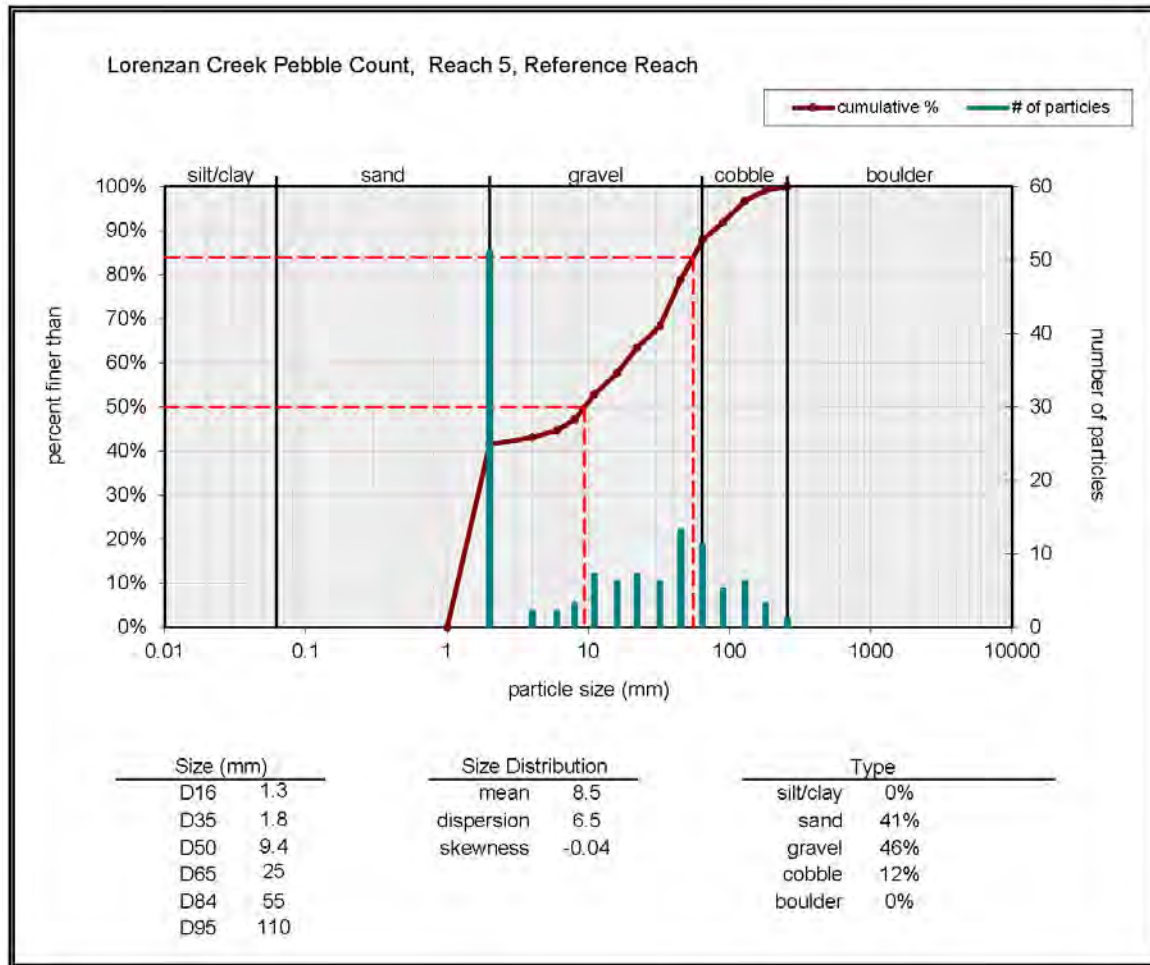


Figure 5. Lorenzan Creek Reference Reach Pebble Count Results.

Reach 1

Reach 1 extends upstream from the Lorenzan Creek culvert under South Superior Road. The channel was historically hydromodified (realigned, straightened, and dredged) and remnant dredge spoils have been placed to form a berm along the top of the right bank near the downstream end of the reach. Straightened and disconnected from its floodplain, the channel has actively incised, and that has led to steep banks. Instream habitat is poor, with no complexity, with a simplified plane bed (uniform) channel morphology and no large wood interacting with flow. Bed material is largely sand and finer. Eroded banks are composed of sands and fines but include coarser deposits of gravel and cobble. Bankfull width was measured at 4 feet in this reach.

Reach 2

Reach 2 extends from the South Superior Road culvert outlet downstream to the entrance of another culvert under Fir Street. The channel has been straightened and reshaped along its length in this reach. The channel is confined along neighborhood roadways: flow is parallel to

the north of Cedar Street in upstream sections, parallel and to the south of Pine Street, and parallel and to the west of South Park Avenue. In the upstream sections adjacent to Cedar Street, the channel is wider, with active siltation/aggradation and aquatic vegetation colonizing the stream bed. There were a few localized sections of stream bank erosion. Bankfull width was measured at 11 feet in this area. Mid-reach in the vicinity of Pine Street, channel morphology is slightly more variable in response to planform pattern (i.e., channel bends) and shifts in riparian vegetation and associated root strength and bank cover. Bed material is dominated by fine material, like silt and clay, with sand. In the downstream portion of the reach (west of South Park Avenue), the riparian area is largely managed turfgrass.

Reach 3

Reach 3 is confined between Fir Street to the south and the road embankment of SR 20 to the north. Similar to Reach 2, the channel geometry reflects historic hydromodifications (realignment, straightened, dredged) with a wider shape (i.e., a higher bankfull width-to-depth ratio in comparison to reaches 1 and 5), and a bankfull width of 11.5 feet. The active channel bed and nearby riparian vegetation is dominated by reed canarygrass. Bed material is composed of fines and sands and reflective of the stagnant, low-slope channel. Aquatic habitat is poor given the lack of channel complexity and woody riparian vegetation. The channel banks and bed are stable, and no significant bank erosion was noted.

Reach 4

Reach 4 extends from the culvert on the east side of Concrete Sauk Valley Road, through the underground culvert pipes at the County Shop parcel, and to the culvert outfall that is close to the western property line. There is no open channel to characterize in this reach.

Reach 5

Reach 5 extends from the culvert outfall on the west side of the County Shop parcel to the entrance of a culvert under Concrete Road. The stream gradient of Reach 5 (0.4%) is slightly lower than that of upstream reaches (0.6-0.9%) and the channel has pool-riffle and wetland channel morphology. This reach has strong floodplain connection; during the site visit, Herrera staff observed flow overtopping the channel banks due to a substantial rainstorm. Bankfull widths generally increased from 4 to 9 feet in this reach, with wider channel conditions where the slope is locally flatter and vice versa. In the mid-reach area, where the channel has the greatest connection to its floodplain and is not influenced by backwater from the Concrete Road culvert, bankfull width was measured as 9 feet. Bed material includes patches of sand and gravel in steeper sections but is otherwise dominated by sand and silt. One pebble count was taken near the upstream end of the reach, where bed material is coarser. In this area, the median grain-size measured is 9 millimeters (medium gravel).

Aquatic habitat is of higher quality than in the other four reaches assessed, with more woody riparian vegetation interacting with the low flows and frequent flood flows. However, there are only a few pieces of large wood present, which limits pool development and variability, so

overall habitat complexity is only fair. As riparian vegetation matures and large wood is recruited into the channel, aquatic habitat is expected to improve over the long-term. Reach 5 is the only assessed reach that is appropriate for use as a reference reach to serve as a basis for conditions to consider restoring in the study area.

HYDRAULIC ANALYSIS

The hydraulic analysis was completed by Watershed Science & Engineering (WSE) and included a site assessment, data collection, hydraulic model development, and existing conditions modeling of the 2-, 10-, and 100-year flood events on Lorenzan Creek.

HYDRAULIC SITE ASSESSMENT

WSE conducted a site assessment on September 21, 2021, to collect information on channel, flow, and culvert characteristics to inform development of the hydraulic model. The assessment covered a portion of Lorenzan Creek, starting just upstream of South Superior Ave to just downstream of Concrete Road. Observations of vegetation type and coverage were recorded to determine model roughness. The effective size of each culvert was determined by measuring the size of the culvert opening (later confirmed by survey) and the accumulated sediment within the opening (see Table 7). It was noted that most culverts within the project area had measurable sediment accumulation, and both the culvert under South Superior Avenue and the outlet of the culvert network under the County shop parcel had substantial accumulated sediment depths ranging from 35% to 62% of the culvert diameters.

Table 7. Summary of Observed Culvert Conditions.				
Road	Culvert Type	Culvert Diameter	Accumulated Sediment	
			At Inlet	At Outlet
South Superior Avenue	Concrete Pipe	30"	14"	18.5"
Pine Street	Concrete Pipe	30"	2"	3.5"
Fir Street	Concrete Pipe	30"	3"	6"
Concrete Sauk Valley Road (County shop parcel)	Concrete Pipe Network	18" to 30"	1-2"	10.5"
Concrete Road	Corrugated	18"	Trace	Trace
	Metal Pipes (2)	10"	Trace	Trace

Additional measurements of approximate channel dimensions and observations of terrain features were recorded to validate surveyed elevation data used in the hydraulic model. No visible signs of flooding or high water were observed.

HYDRAULIC DATA COLLECTION & MODEL DEVELOPMENT

A variety of data sets were used to develop the existing conditions HEC-RAS 2D (ver. 6.1.0) hydraulic model. Data included LiDAR and topographic survey, aerial imagery, and site photos. Data were collected and a hydraulic model was developed for an area that extends along

Lorenzan Creek and its adjacent floodplain from State Route 20 (SR 20) at the upstream end to approximately 400 feet downstream of Concrete Road (see Figure 6). This area is intentionally larger than the overall project area to capture areas of significant floodplain storage above and below the County shop parcel that were expected to impact hydraulic routing at the facility.

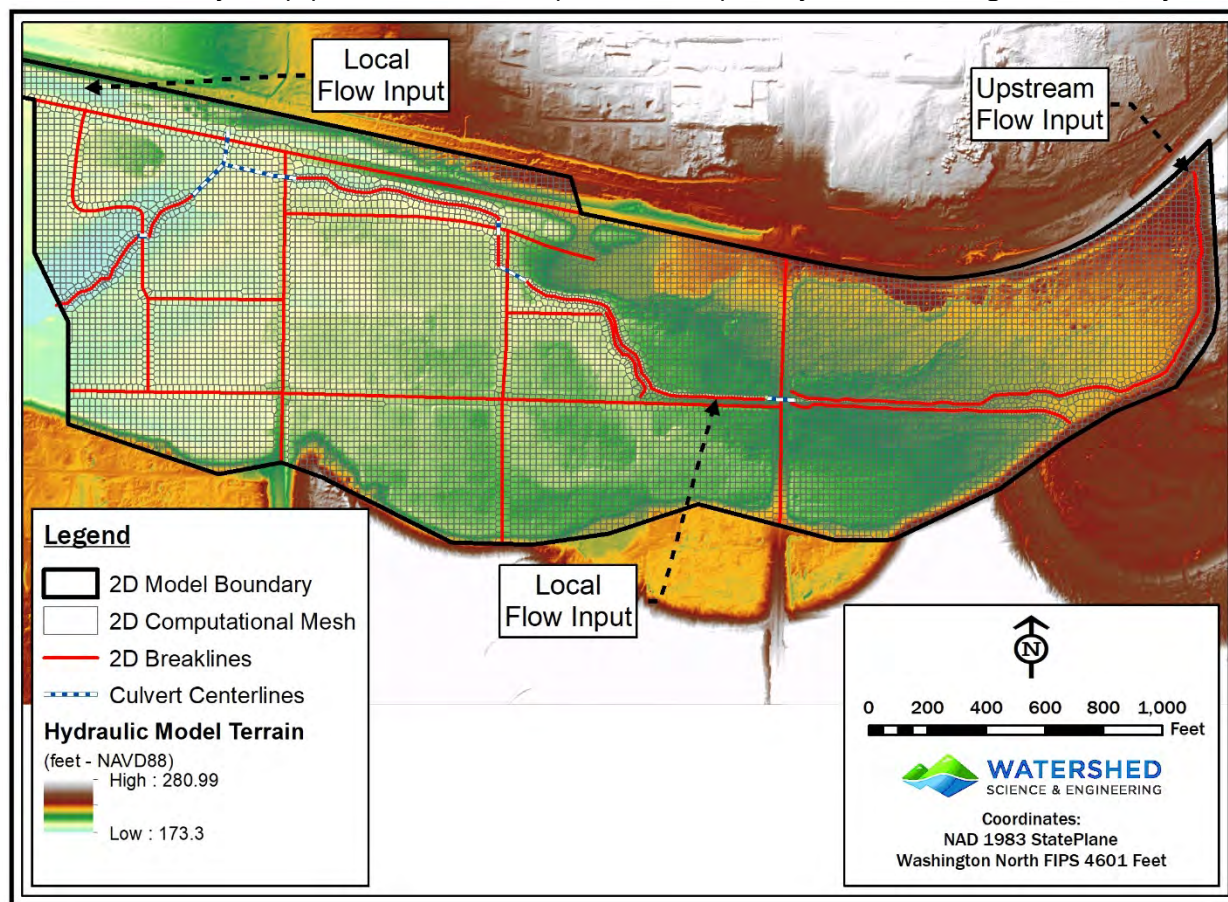


Figure 6. Hydraulic Model Layout

Model terrain data was developed from a mosaic of USGS 3DEP LiDAR collected in 2017, a survey surface generated by Semrau Engineering & Surveying in 2021 for the project area, and a channel bed upstream of the surveyed area approximated from LiDAR and survey. A computational mesh was created with 20-foot nominal grid spacing and refined using break lines along areas of high ground at 10 to 20-foot grid spacing to better represent floodplain topography in the model (see Figure 6).

Land cover types were delineated from 2019 NAIP aerial imagery and refined using topographic data to create a spatial layer of surface roughness. Manning's 'n' values were determined for each land cover type based on observed site conditions and applied to the hydraulic model (see Table 8). Site photos collected by WSE and Herrera staff were used to revise and confirm the information provided by the terrain and land cover input layers. Culverts were configured in the model using invert elevations, pipe sizes, and sediment depth from survey and site measurements.

Table 8. Land Cover & Surface Roughness	
Land Cover Type	Manning's 'n' Value
Creek Channel	0.05
Field	0.06
Forest	0.10
Road	0.02
Buildings	1.00

The primary hydrologic inflow location in the model is at the upstream end where Lorenzan Creek crosses under SR 20. Secondary flow inputs were added downstream of South Superior Avenue and on the north side of State Route 20 adjacent to the County shop parcel to best represent local drainage to Lorenzan Creek.

County staff and residents of Concrete provided photos taken during Lorenzan Creek flood events that were used to help calibrate model inputs and validate results. Additional anecdotal information from stakeholders during the kickoff meeting provided insight into additional flood-prone areas, including upstream of South Superior Avenue, upstream of Concrete Sauk Valley Road above the County shop parcel, and downstream of Concrete Road.

Existing conditions model results were qualitatively confirmed by these flood photos and observations. Photos along Pine Street from storm events in 2014 and 2015 were particularly useful to confirm the extent and depth of water overtopping the road. Quantitative validation of the model was not possible due to lack of gauging along this reach of Lorenzan Creek and absence of high-water evidence during the hydraulic assessment that could be tied to discrete flood events.

HYDRAULIC MODELING OF EXISTING CONDITIONS

The HEC-RAS 2D hydraulic model was used to evaluate the 2-, 10-, and 100-year recurrence interval flood events under existing conditions along Lorenzan Creek. These floods were simulated by scaling the unsteady flow record generated from hydrologic modeling (completed by Herrera and described above) to match the 2-, 10-, and 100-year flood peaks (see Figure 7 for the scaled unsteady hydrograph used as model input for Subbasin 3). Inundation extents for the three flood events are displayed in Figure 8 with peak flow values and local flow input locations labeled. Additional model results showing flood depth, velocity, and water surface elevation for the 2-, 10-, and 100-year events are included in Appendix H.

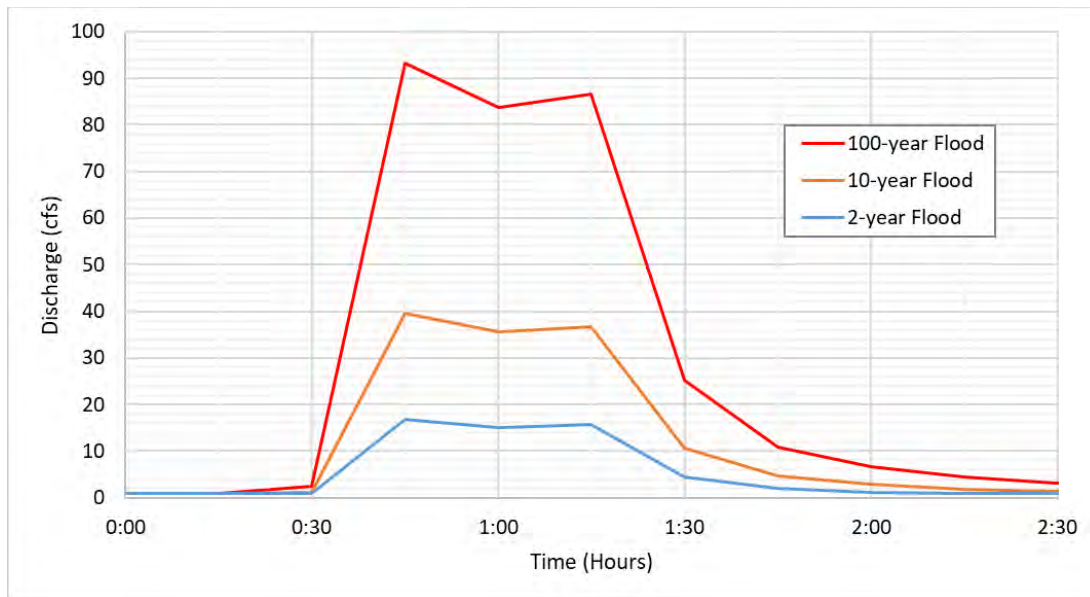


Figure 7. Lorenzan Creek - Upstream Model Input Hydrograph

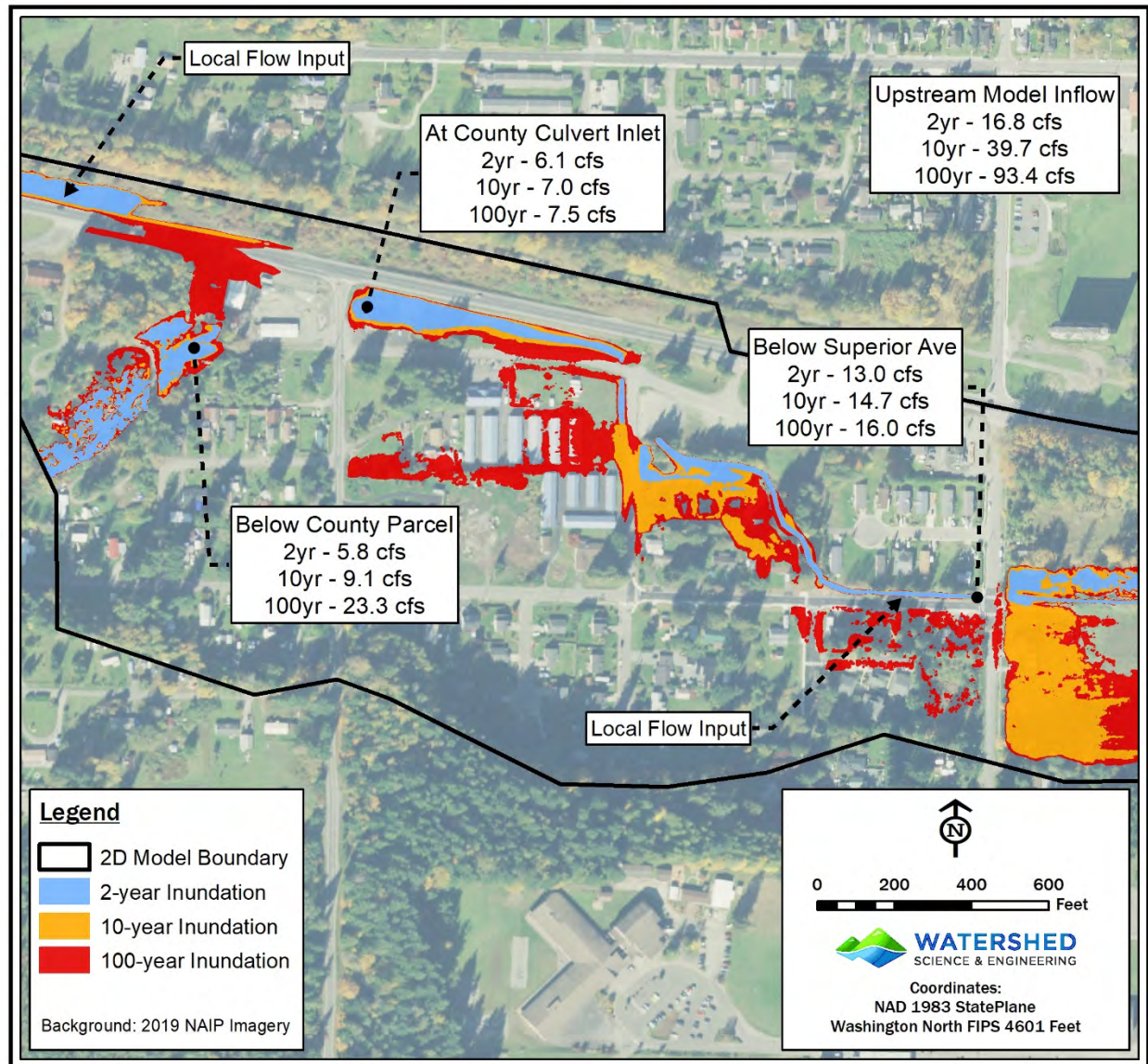


Figure 8. Existing Conditions Flood Inundation Extents with Peak Flow Data

The existing conditions model results shown in Figure 8 indicate that the Lorenzan Creek channel and series of culverts upstream of the County shop site cannot adequately convey peak flows without overtopping the channel banks and adjacent roadways. The capacity-constrained culverts and road prism fills push water away from the creek channel into the relatively flat floodplain, creating disconnected flow paths throughout the project area where water has filled low-elevation areas but is unable to fully drain, especially in the 100-year flood event. These hydraulic conditions result in flow attenuation moving downstream, as shown by decreasing peak flows between the Upstream Model Inflow, Below Superior Ave, County Culvert Inlet locations in the figure.

The most significant area of floodplain storage resulting from a capacity-constrained culvert under an elevated road prism is upstream of South Superior Avenue. At this location, water

quickly overwhelms the small and partially-sedimented culvert, flowing south into the low-elevation area created by the road during the 10- and 100-year flood events. Additional smaller areas of floodplain storage created by capacity-constrained culverts and road prisms exist near the intersection of South Park Avenue and Pine Street, upstream of the County shop parcel, and north of SR 20 adjacent to the County shop. It should be noted that many of these floodplain storage areas overlap private properties, paved roadways, and driveways.

At the County shop parcel, drainage from the north side of SR 20 (subbasin 1) adds flow to the pipe network via the culvert under SR 20 during the 10- and 100-year flood events. The model also shows water overtopping SR 20 during the 100-year event, likely due to the constrained capacity of the culvert under SR 20.

These results indicate that the size and condition of culverts upstream of the County shop parcel are driving factors determining the peak flow at, and total volume of water reaching, the County shop parcel culvert inlets for each flood event.

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APPENDIX A

Kickoff Meeting Notes

Lorenzan Creek Kick-off Meeting Notes

July 12th, 2021: 3:00–5:00

ATTENDEES:

- Skagit County:
 - Emily Derenne, County PM
 - Jason Quigley, County PM Stormwater
 - Shaun Tawes, Operations
 - John Davidson, Operations Division Manager
 - Mike See, Natural Resources Division Manager
 - Rick Owens, ER&R Division Manager
- Herrera
 - Colleen Mitchell, Consultant PM
 - Tina Mirabile, Permitting
 - Ellen McClure, Habitat
 - Annie Saunders
- Concrete: Jason Miller (Mayor)
- USIT: Rick Hartson
- WSDOT: Jeff Kamps
- WDFW: Wayne Watne
- Veda: Maie Rothlis Berger

MEETING NOTES:

(grouped by stakeholder and theme, not necessarily in chronological order)

Town of Concrete (represented by Mayor)

- Future Plans
 - Project is outside of the Town, but inside the Urban Growth Area (UGA)
 - Concrete Sauk Valley road is start of Concrete's UGA--very invested in the project connecting with the Town's long-term economic growth and planning
 - The western edge of the UGA is near the Red Apple grocery store
 - Would like to replace the County's contracted Sheriff program with the Town's own Sheriff system. This may impact the Sheriff's willingness to share a new County property should relocating be the preferred alternative. Ideally Concrete wants the County to relocate their services outside of the town's limits and the UGA and would not be supportive of adding any additional County operations/property within the Town of Concrete's limits.
- Lorenzan Creek project history
 - Wishes this project was actually re-routing upstream because about 900 ft of the river is underground at main street
 - The mayor had previously supported plans to route the stream through Silo Park and create an inviting park in conjunction with a daylighted riverbed
 - Emily mentioned grading restriction (can't dig deeper than 5-feet), inhospitable ground (Silo Park was an old dumping ground for concrete), cost, ideal habitat that would be lost by re-routing, etc. as barriers to this plan. She believes a past study was completed and will ask around.
- Flooding issues
 - Developer built a large storage facility east of the project site in wetlands--against Concrete's clearly communicated wishes
 - The development pushed the low point on to Pine Street, which now experiences severe flooding (Mayor showed picture from 2015 of entire road in front of houses turned into a pond)

- o Town dredged Lorenzan Creek upstream of the project site along Fir Street in 2016, and a downstream section near Cedar and Pine Streets later. Extensive flooding hasn't been observed at Fir Street since then.
- o Creek consistently silts up again. Reed canary grass traps sediment in the low slope section. Their emergency permit did require planting that appears to not have occurred.
 - Not much info on downstream flooding, but knows secondhand that there are wetlands that will pond water in the winter. Nothing that is currently causing any properties problems.

Skagit County

- Current uses
 - o Supports east county operations--salt/sand storage, equipment drop-off, reduces travel to Burlington
 - o ~1 full-time employee
 - o Floor drains are currently plugged which does cause water to pond inside the truck bays; everything on site though eventually drains to Lorenzan Creek
 - o Everything works, just "40s vintage old"
 - o Fuel tanks are under temporary closure--fuel is within 1" of the bottom and the current fuel level monitor shows that nothing is leaking. County intends to decommission and remove the tanks.
 - o County discourages washing of vehicles at SW corner of the property site near the outlet of the stream, but still a popular activity; there is an oil trap in the CB which can't function correctly with soap
- Future plans
 - o Would prefer a larger site for their operations
 - Ideally would have a 5-10 acre site. This site is too small to be useful and can't be expanded.
- The existing site cannot be made any smaller, as the existing loop is smallest size possible for their trucks to be able to turn around

- The size of the site either needs to remain, increase, or be relocated. Shifting structures or reducing their size won't work.
 - Hoping to remove fuel tanks by 2024 (nothing in 2022 budget), but needs \$. Herrera mentioned that all their alternatives will assume the tanks have been removed.
 - Some discussion with the County's Sheriff in Concrete about sharing a facility at a new location, but there aren't any plans or financing options on the table at this point, only willingness to discuss

WDFW

- Apparently, after the drought (2015?), part of Lorenzan Creek began going subsurface during the summer months. No current understanding of where the creek connects back into the Skagit River during low flow months. Lorenzan still flows in its historic path during winter months.
- Haven't seen coho in the stream since the downstream portion of the river disappeared-- seen other types of fish. Appears to rewater after the adults require access however fish runs are also lower.
- Beaver use has been observed downstream of the project site.

WSDOT

- Construction of the SR20 culvert upstream of the project site will be happening the summer of 2021. There will also be a new crossing at Fish Creek. This is important because the confluence is downstream of the project site and will likely be adding additional water to Lorenzan Creek.
- WSDOT can share plans and information on the culvert design with project team
- No plans to change the SR20 frontage along the project site
- No plans to replace the culvert that crosses SR20 and connects into the project site's drainage system. They would be open to addressing their runoff as part of this project so that all treatment wouldn't need to occur on County property. Herrera would identify options for this but WSDOT design team would take the lead on development of design.

Permitting/Coordination

- WSDOT:
 - Skagit owns the culvert, and WSDOT will likely only need to conduct a simple review of the plans; mostly only concerned with line of site, such as in the case that the County installs native vegetation as a protected creek buffer landscaped area, and would expect the shoulder to remain as is.
 - If the project needed to redirect or alter the shoulder area/runoff from SR20 in the WSDOT right-of-way, WSDOT's hydraulics group would review plan.
- Town: no permitting required
- Geotech can coordinate with Emily for planning pit explorations and connecting with the right resource at the county

General projects that people like/dislike?

- Mayor:
 - Ideally would like the project site to be developable land, or in some way supportive of their economic growth. Also supportive of a park feature.
 - Like the aesthetics and community/human benefit of the Red Cabin Creek design on Hwy 20 near Lyman (although WSDOT mentioned this project didn't solve their problem, as flooding just goes around the structure which is not functioning properly - alluvial fan setting with sediment infill, so isn't necessarily a good example for the technical design)
- County
 - No BMP preference or strong dislikes
 - Only have added 5 or 6 BMP structures recently which require changing filters, so at this point no strong opinions for specific BMP's from a maintenance efficiency across the County perspective

APPENDIX B

Photos of Past Flooding Upstream

EXISTING CONDITIONS REPORT— LORENZAN CREEK STORMWATER IMPROVEMENT PROJECT: PHOTOS OF NEIGHBORHOOD FLOODING UPSTREAM OF SITE

Photo Number	Photo Description
1a	Photo from January 1, 2014 - Intersection of Pine and South Park
1b	Photo from January 1, 2014 - Intersection of Pine and South Park
1c	Photo from January 1, 2014 - Intersection of Pine and South Park
1d	Photo from January 1, 2014 - Intersection of Pine and South Park
2a	Photo from January 5, 2015 - Intersection of Pine and South Park
2b	Photo from January 5, 2015 - Intersection of Pine and South Park
2c	Photo from January 5, 2015 - Intersection of Pine and South Park
2d	Photo from January 5, 2015 - Intersection of Pine and South Park
3a	Photo from November 17, 2015 - Intersection of Pine and South Park
3b	Photo from November 17, 2015 - Intersection of Pine and South Park
3c	Photo from November 17, 2015 - Intersection of Pine and South Park







2d



3a



3b



APPENDIX C

Cultural Documentation

APPENDIX 1: DEPARTMENT OF ECOLOGY PLAN AND PROCEDURES FOR THE UNANTICIPATED DISCOVERY OF CULTURAL RESOURCES AND HUMAN SKELETAL REMAINS

PROJECT TITLE: Lorenzan Creek Stormwater Improvements

COUNTY: Skagit

Section, Township, Range: 90, 100-35-8

1. INTRODUCTION

The following Inadvertent Discovery Plan (IDP) outlines procedures to perform in the event of discovering archaeological materials or human remains, in accordance with state and federal laws.

2. RECOGNIZING CULTURAL RESOURCES

A cultural resource discovery could be prehistoric or historic. Examples include:

- a. An accumulation of shell, burned rocks, or other food related materials.
- b. Bones or small pieces of bone.
- c. An area of charcoal or very dark stained soil with artifacts.
- d. Stone tools or waste flakes (i.e. an arrowhead. or stone chips).
- e. Clusters of tin cans or bottles, logging or agricultural equipment that appears to be older than 50 years.
- f. Buried railroad tracks, decking, or other industrial materials.

When in doubt, assume the material is a cultural resource.

3. ON-SITE RESPONSIBILITIES

STEP 1: *Stop Work.* If any employee, contractor or subcontractor believes that he or she has uncovered a cultural resource at any point in the project, all work must stop immediately. Notify the appropriate party(s). Leave the surrounding area untouched, and provide a demarcation adequate to provide the total security, protection, and integrity of the discovery. The discovery location must be secured at all times by a temporary fence or other onsite security.

STEP 2: *Notify Archaeological Monitor or Licensed Archaeologist.* If there is an Archaeological Monitor for the project, notify that person. If there is a monitoring plan in place, the monitor will follow the outlined procedure.

STEP 3: *Notify the Project Manager* of this project and contact the Ecology Staff Project Manager, or other applicable contacts:

Project Manager: Name: Emily Derenne Phone:360-416-1449 Email: emilyjd@co.skagit.wa.us	Ecology Staff Project Manager Name: Sylvia Graham Phone:360-255-4393 Email: sygr461@ECY.WA.GOV
---	---

Assigned Alternates:

Assigned Project Manager Alternate: Name: Michael See Phone:360-416-1455 Email: michael.s@co.skagit.wa.us	Ecology Cultural Resource Specialist (Alternate): Name: Michelle Myers Phone:360-628-4067 email: michellemyers@ecy.wa.gov
--	---

The Project Manager or applicable staff will make all calls and necessary notifications. **If human remains are encountered**, treat them with dignity and respect at all times. Cover the remains with a tarp or other materials (not soil or rocks) for temporary protection and to shield them from being photographed. **Do not call 911 or speak with the media. Do not take pictures unless directed to do so by DAHP. See Section 5.**

4. FURTHER CONTACTS AND CONSULTATION

A. Project Manager's Responsibilities:

- *Protect Find:* The Project Manager is responsible for taking appropriate steps to protect the discovery site. All work will stop immediately in a surrounding area adequate to provide for the complete security of location, protection, and integrity of the resource. Vehicles, equipment, and unauthorized personnel will not be permitted to traverse the discovery site. Work in the immediate area will not resume until treatment of the discovery has been completed following provisions for treating archaeological/cultural material as set forth in this document.
- *Direct Construction Elsewhere on-Site:* The Project Manager may direct construction away from cultural resources to work in other areas prior to contacting the concerned parties.
- *Contact Senior Staff:* If the Senior Staff person has not yet been contacted, the Project Manager must do so.

B. Senior Staff Responsibilities:

- *Identify Find:* The Senior Staff (or a delegated Cultural Resource Specialist), will ensure that a qualified professional archaeologist examines the area to determine if there is an archaeological find.
 - o If it is determined not to be of archaeological, historical, or human remains, work may proceed with no further delay.
 - o If it is determined to be an archaeological find, the Senior Staff or Cultural Resource Specialist will continue with all notifications.

- o If the find may be human remains or funerary objects, the Senior Staff or Cultural Resource Specialist will ensure that a qualified physical anthropologist examines the find. **If it is determined to be human remains, the procedure described in Section 5 will be followed.**
- *Notify DAHP:* The Senior Staff (or a delegated Cultural Resource Specialist) will contact the involved federal agencies (if any) and the Washington Department of Archaeology and Historic Preservation (DAHP).
- *Notify Tribes:* If the discovery may be of interest to Native American Tribes, the DAHP and Ecology Supervisor or Coordinator will coordinate with the interested and/or affected tribes.

General Contacts

Federal Agencies:

Agency: N/A
Name
Title
Number
Email

State Agencies:

Agency: Dept of Ecology
Name Sylvia Graham
Title
Number
Email

Department of Archaeology and Historic Preservation:

Dr. Allyson Brooks State Historic Preservation Officer 360-586-3066 Assigned Alternate:	Rob Whitlam, Ph.D. State Archaeologist 360-586-3050 Assigned Alternate:
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The DAHP or appropriate Ecology Staff will contact the interested and affected Tribes

Tribes consulted on this project are:

<u>Tribe: Upper Skagit Indian Tribe</u> Scott Schuyler Cultural Resources 360-854-7009 sschuyler@upperskagit.com	<u>Tribe: Sauk-Suiattle</u> Kevin Joseph THPO 360-436-1124 bjoseph@sauk-suiattle.com
<u>Tribe: Samish</u> Jacquelyn Ferry Cultural Resources 360-293-6404 ext 126 jferry@samishtribe.nsn.us	<u>Tribe: Swinomish Tribe</u> Josephine Jefferson THPO 360-466-7352 jjefferson@swinomish.nsn.us
<u>Tribe: Stillaguamish</u> Kerry Lyste Cultural Resources 360-572-3072 KLyste@stillaguamish.com	<u>Tribe: Stillaguamish</u> Sam Barr Cultural Resources 360-622-7055 SBarr@stillaguamish.com
<u>Tribe: Tulalip</u> Richard Young Cultural Resources 425-239-0182 ryoung@tulaliptribes-nsn.gov	<u>Tribe: Lummi</u> Leno Tso Cultural Resources 360-312-2257 lenat@lummi-nsn.gov

Further Activities

- Archaeological discoveries will be documented as described in Section 6.
- Construction in the discovery area may resume as described in Section 7.

5. SPECIAL PROCEDURES FOR THE DISCOVERY OF HUMAN SKELETAL MATERIAL

Any human skeletal remains, regardless of antiquity or ethnic origin, will at all times be treated with dignity and respect. Do not take photographs by any means, unless you are pre-approved to do so.

If the project occurs on federal lands or receives federal funding (e.g., national forest or park, military reservation) the provisions of the Native American Graves Protection and Repatriation Act of 1990 apply, and the responsible federal agency will follow its provisions. Note that state highways that cross federal lands are on an easement and are not owned by the state.

If the project occurs on non-federal lands, the Project Manager will comply with applicable state and federal laws, and the following procedure:

A. In all cases you must notify a law enforcement agency or Coroner's Office:

In addition to the actions described in Sections 3 and 4, the Project Manager will immediately notify the local law enforcement agency or medical examiner/coroner's office.

The Coroner (with assistance of law enforcement personnel) will determine if the remains are human, whether the discovery site constitutes a crime scene, and will then notify DAHP.

Skagit County Coroner
360-416-1998

B. Participate in Consultation:

Per RCW 27.44.055, RCW 68.50, and RCW 68.60, DAHP will have jurisdiction over non-forensic human remains. Ecology staff will participate in consultation.

C. Further Activities:

- Documentation of human skeletal remains and funerary objects will be agreed upon through the consultation process described in RCW 27.44.055, RCW 68.50, and RCW 68.60.
- When consultation and documentation activities are complete, construction in the discovery area may resume as described in Section 7.

6. DOCUMENTATION OF ARCHAEOLOGICAL MATERIALS

Archaeological deposits discovered during construction will be assumed eligible for inclusion in the National Register of Historic Places under Criterion D until a formal Determination of Eligibility is made. This means all work will stop and the project archaeologist will provide enough information to the County, Ecology, the tribes, and DAHP to make management decisions.

All prehistoric and historic cultural material discovered during project construction will be recorded by a professional archaeologist on a cultural resource site or isolate form using standard and approved techniques. Site overviews, features, and artifacts will be photographed; stratigraphic profiles and soil/sediment descriptions will be prepared for minimal subsurface exposures. Discovery locations will be documented on scaled site plans and site location maps.

If assessment activity exposes human remains (burials, isolated teeth, or bones), the process described in Section 5 will be followed.

7. PROCEEDING WITH WORK

Work outside any discovery location may continue while documentation and assessment of the cultural resources proceed. A professional archaeologist must determine the boundaries of the discovery location. In consultation with the County, Project Archaeologist, Ecology, the Tribes, and DAHP will determine the appropriate level of documentation and treatment of the resource.

Work may continue at the discovery location only after the process outlined in this plan is followed and Ecology has determined that compliance with state law is complete.

8. RECIPIENT/PROJECT PARTNER RESPONSIBILITY

The Project Recipient/Project Partner is responsible for implementing this IDP. The Project Manager and staff will review the IDP during a project kickoff or pre-construction meeting.

We recommend that you print images in color for accuracy.

Implement the IDP / UDP if ...

You see chipped stone artifacts.



- Glass-like material
- Angular
- “Unusual” material for area
- “Unusual” shape
- Regularity of flaking
- Variability of size



Implement the IDP / UDP if ...

You see ground or pecked stone artifacts.



- Striations or scratching
- Unusual or unnatural shapes
- Unusual stone
- Etching
- Perforations
- Pecking
- Regularity in modifications
 - Variability of size, function, and complexity



Implement the IDP / UDP if ...

You see bone or shell artifacts.



- Often smooth
- Carved
- Often pointed if used as a tool
- Often wedge shaped like a “shoehorn”



Implement the IDP / UDP if ...

You see bone or shell artifacts.



- Often smooth
- Unusual shape
- Perforated
- Variability of size



Implement the IDP / UDP if ...

You see fiber or wood artifacts.



- Wet environments needed for preservation
- Variability of size, function, and complexity
- Rare



Implement the IDP / UDP if ...

You see historic period artifacts.



Implement the IDP / UDP if ...



- Human activities leave traces in the ground that may or may not have artifacts associated with them
- “Unusual” accumulations of rock (especially fire-cracked rock)
- “Unusual” shaped accumulations of rock (e.g., similar to a fire ring)
- Charcoal or charcoal-stained soils
- Oxidized or burnt-looking soil
- Accumulations of shell

Implement the IDP / UDP if ...



- Accumulations of bones or artifacts
- Look for the “unusual” or out of place (e.g., rock piles or accumulations in areas with few rock)
 - “Unusual” accumulations of rock (especially fire-cracked rock)
- “Unusual” shaped accumulations of rock (e.g., similar to a fire ring)
- Look for the “unusual” or out of place (e.g., rock piles or accumulations in areas with few rock)

Implement the IDP / UDP if ...



Historic Debris

- Often have a layered or “layer cake” appearance
- Often associated with black or blackish soil
- Often have very crushed and compacted shells



Implement the IDP / UDP if ...

You see historic foundations or buried structures.



CULTURAL RESOURCES REPORT COVER SHEET

DAHP Project Number:

Author: Kelly R Bush and Aleta R. Baxley

Title of Plan: Archaeological Monitoring Plan for Lorenzan Creek Stormwater Improvement Project, Concrete, Skagit County, Washington

Date of Report: August 19, 2021

County: Skagit Section: 9 Township: 35 N Range: 8 E
Section: 10 Township: 35 N Range: 8 E

Quad: Grandy Lake Acres: ~6.5

PDF of report submitted (REQUIRED) ☒ Yes

Historic Property Inventory Forms to be Approved Online? ☐ Yes ☒ No

Archaeological Site(s)/Isolate(s) Found or Amended? ☐ Yes ☒ No

TCP(s) found? ☐ Yes ☒ No

Replace a draft? ☐ Yes ☒ No

Satisfy a DAHP Archaeological Excavation Permit requirement? ☐ Yes # ☒ No

Were Human Remains Found? ☐ Yes DAHP Case # ☒ No

DAHP Archaeological Site #:

ARCHAEOLOGICAL MONITORING PLAN FOR LORENZAN CREEK STORMWATER IMPROVEMENT PROJECT, CONCRETE, SKAGIT COUNTY, WASHINGTON

Prepared for: Skagit County
Under contract to Herrera Inc



August 25, 2021

Prepared by:



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INTRODUCTION

This Monitoring Plan for the Lorenzan Creek Stormwater Improvement project (Figure 1-Figure 2) is provided to help guide the archaeological monitor, the reviewers and provide context for the construction crew. Archaeological monitoring is required for any ground disturbance associated with this project during planning or construction (Figure 3).

County	Skagit
TRS	Township 35N, Range 8 E, Section 90 Township 35 N, Range 8 E, Section 100
Quad	Grandy Lake
Parcel ID	P70966, P70967, P70968, P70969, P70970, P70971, P70972, P70973, P70974, P70975, P70984, P43706, P70940, P70937, P70947
Address	N/A, N/A 44942 State Route 20, Concrete, WA 98237 44510 Concrete Sauk Valley Rd, Concrete, WA 98237 N/A 44516 Concrete Sauk Valley Road, Concrete, WA 98237 N/A, N/A, N/A 44937 Concrete Rd, Concrete, WA 98237 44906 Concrete Rd, Concrete, WA 98237 44511 Concrete Sauk Valley Rd, Concrete, WA 98237 N/A 45218 Fir Street, Concrete, WA 98237 N/A
Property Owner	Boots and Spurs LLC, Closser Marital Trust, Closser Marital Trust, Skagit County, Skagit County, Robert E & Judy A Stafford, Bradley D II & Amber D, Marilyn Frances Smith, Christopher Flores, Christopher Flores, John & Michelle Zitkovich, Theo Investments LLC, George J Theodoratus, George J Theodoratus, Thompson Family Trust
Property Owner Address	27931 W Gilligan Creek Rd Sedro-Woolley, WA 98284 PO Box 2479, Everett, WA 98213 PO Box 2479, Everett, WA 98213 1800 Continental Pl, Mount Vernon, WA 98273 1800 Continental Pl, Mount Vernon, WA 98273 44531 Concrete Sauk Valley Rd, Concrete, WA 98237 44987 Concrete Rd, Concrete, WA 98237 9704 Simpson Rd, Sedro Woolley, WA 98284 20610 Rocky Ridge Ln, Sedro Woolley, WA 98284 20610 Rocky Ridge Ln, Sedro Woolley, WA 98284 PO Box 118, Concrete, WA 98237 37921 State Route 20, Concrete, WA 98237 37921 State Hwy 20, Concrete, WA 98237 37921 State Hwy 20, Concrete, WA 98237 49304 Skagit Ridge Rd, Concrete, WA 98237

Area	~6.5 acres
Lat/Long	48° 32' 11.8" N/ 121° 46' 0.26" W
UTM	Zone 10 591036.8 Easting 5376679.38 Northing
Elevation	179-192'
Nearest Water Body	Skagit River & Lake Shannon
Nearest Arch Site	45SK599 – ~0.31 mile
Soils	Indianola loamy sand, Norma silt loam
Geology	Quaternary alluvium

A copy of this Monitoring plan and the associated Inadvertent Discovery Protocol must be maintained on the site during construction and follow procedures herein. These procedures ensure consideration and protection of cultural resources affected by this project.

Staff members of Skagit County and their contractors or subcontractors are required to halt construction if they observe or identify any cultural materials. Staff will allow adequate time for a professional archaeologist to assess, record, and potentially analyze any resources that may have been uncovered. DAHP must and will be promptly notified of any discoveries that occur during construction. (See contact list at the end of the document.)

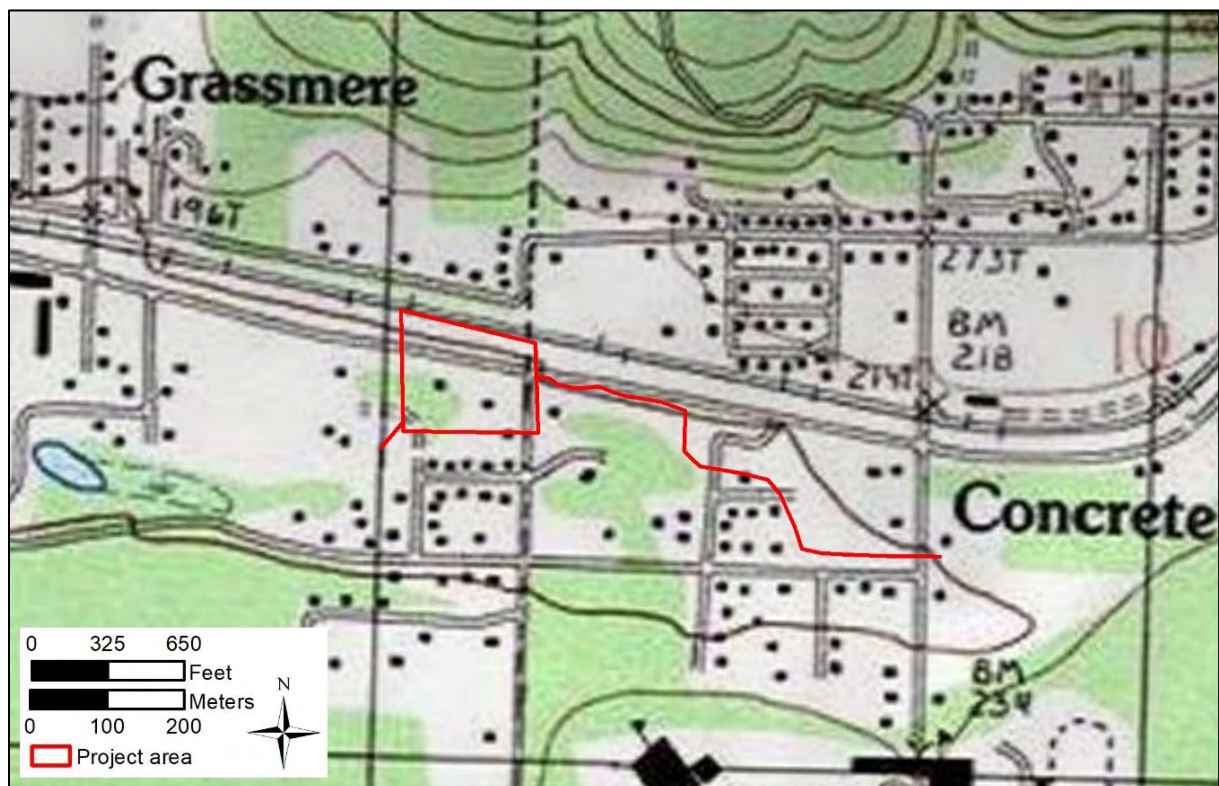


Figure 1: USGS Anacortes North 7.5-minute quadrangle with Project area outlined in red.

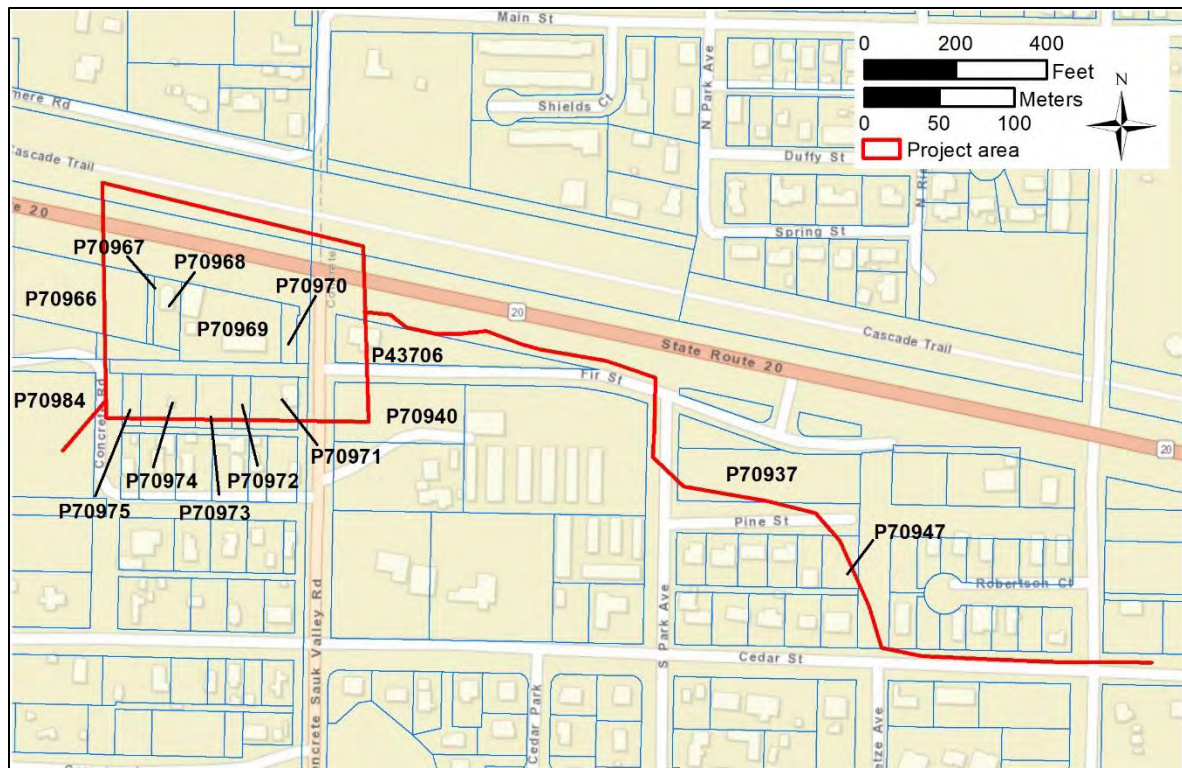


Figure 2: Skagit County Assessor's map with Project area outlined in red.

This plan is intended to provide guidance to Skagit County personnel and contractors so they can:

- Comply with federal, state and county regulations regarding cultural resources.
- Describe to regulatory and review agencies the procedures that Skagit County will follow to prepare for and deal with unanticipated discoveries.
- Provide direction and guidance to Project personnel on the proper procedures to be followed should an unanticipated discovery occur.
- Provide guidance when an Archaeological Monitor is on site and when they are not on site the IDP must be on site at all times.

ARCHAEOLOGICAL MONITORING PLAN

As part of the construction team, a professional archaeologist will ensure proper documentation and assessment of any discovered cultural resources. Archaeological monitoring may involve visually examining excavated soils and sidewalls of excavated areas and backdirt piles for specific indicators of cultural resources. The monitor may need to stand close to machines and be able to examine the sediments on the ground, in the bucket, or in the backdirt pile. The monitor may also need to request a closer look at some *in situ* sediments or profiles and will require the ability to talk directly to the machine operator and the on-site superintendent. In some situations, the archaeologist may need a small area to use a hand screen to improve the visibility of the soil constituents.

For safety reasons the archaeologist will not enter any excavations deeper than 4 feet, so for that reason the archaeologist may ask to get inside the trench at 4 feet for a closer examination. The archaeological monitor/s will fill out detailed monitoring forms with descriptions of the Project activities and take a series of before, during and after photographs. A combination of hand sketch-mapping and GPS data will be used to document locational information. The notes, locational data and photographs will be used to create a report.

The monitoring area is provided in 2.3 *Monitoring Map*.

The project archaeologist can, with concurrence from DAHP and the tribes exclude certain areas from monitoring if they can show that they have seen enough of the sediment/landform/location to state that the probability of encountering cultural resources has lowered to very low. This can be verbal with a written follow up of this decision point. This is not intended to remove the responsibility of protection or oversight of cultural resources in any way. This is intended provide some flexibility on projects that have areas that are very low probability to function with an unanticipated or inadvertent discovery plan when the archaeological monitor is not on site. This allows us to focus resources where they are most needed while still protecting unique and nonrenewable archaeological resources.

Expected Deposits:

Based on archival research the following deposits may be encountered during Project implementation:

1. Fill Deposits Imported
2. Fill Deposits Local
3. Historical disturbed culture-rich deposits, feature, or objects
4. Historical Intact culture-rich deposits, feature, or objects
5. Precontact disturbed or intact culture-rich deposits, feature, or objects
6. Human remains.

Fill deposits and disturbed historical and precontact deposits are most common in this area. Due to the long land-use history of the area, it is possible that intact historical or precontact deposits could be in the area. The protocols provided below are listed according to the type of deposits that may be encountered during Project implementation.

Fill Deposits Imported

Fill deposits and imported fills are characterized by uniform particle size and morphology as they have been screened in a commercial quarry. **There is no management of the imported fill or any objects in them.**

Fill Deposits Local

Local fills are characterized by unsorted, mixed sediments that match the local natural sediments, but lack any internal structure or soil development, or other indicators of being undisturbed. They are clumped and have varying soil densities and colors. In this area, historic and precontact artifacts have been discovered in local fill sediment. Fill deposits will not be avoided or protected in any way during this Project. It is very difficult for an isolated object or even a group of objects to rise to the level of significance in deposits without clear stratigraphic integrity. **There would be no management of objects in these deposits beyond recording and discarding.**

Historical Disturbed Culture-Rich Deposits, Features or Objects

Historical disturbed culture-rich deposits, objects or features type represent evidence of a historic activity older than 50 years, and could include burned sediments, metal, glass, ceramic or wood debris that is not in its original position. This includes deposits that may have been displaced by hand or machine during the historic period. Examples might include a buried pile of bricks that has been

pushed into its current position sometime in the past or discarded equipment that has been pushed into position and buried purposefully. These deposits lack integrity but can sometimes provide information based on the objects themselves. **There would be no management of objects in these deposits beyond recording and discarding.**

If historical objects (such as a bottle with a maker's mark) are encountered in disturbed deposits, the archaeological monitor may choose record and discard it. This could include mapping the location, photographing the object, writing a description that includes the measurements and details about the way the object was manufactured. The objective in documenting these items is to record any information that could provide some part of the story of these disturbed deposits. Examples of this would be a single bottle or can, car parts or other roadside trash. Following documentation, such historical objects from disturbed deposits will be reburied in the trench from which they came or discarded in a waste disposal receptacle.

If a historical object is encountered in a disturbed deposit that the archaeologist believes provides significant information about the historical use of the area, the monitor may carry out more in-depth documentation of the item. For example, if a complete, labeled, glass or ceramic object is encountered, the monitor would photograph it, and record its attributes such as size, morphology and markings. If the monitor is very busy they may collect temporarily any historic object to be recorded back in the ERCI lab prior to disposal.

Objects from disturbed deposits that are significant, unique or previously unknown in that locality (e.g., Hudson's Bay trade beads, complete bone toothbrushes, complete clay tobacco pipes with logos) will be bagged and temporarily stored at ERCI's secured-access laboratory until a suitable long-term management strategy can be developed. This process would be managed by Ecology, Skagit County and DAHP.

Historical Intact Culture-Rich Deposits, Feature or Objects

Historical intact culture-rich deposits, objects or features are defined as either a matrix with cultural material in them or objects in association with each other or a feature which is a cultural object that cannot easily be removed from its location and taken back to a lab for analysis. These include but are not limited to burn layers, rail lines, brick water culverts, brick roads, bottle caches, building foundations, buried infrastructure vaults, brick culverts, agricultural ditches, trails, or features associated with a road.

If two or more artifacts older than 50 years (i.e., historical) are found in clear archaeological association, in the same, intact matrix, this will be considered a feature. Intact historical deposits/features will be identified by the following characteristics: A clear/distinct, mostly continuous, interface between the feature and the surrounding matrix. With the contents to include but not be limited to any combination of the following:

- Low-fired and bisque ceramics with subdued colors, or blue/pink willow-like design; thick-bodied pieces indicating crockery.
- Non-tempered glass; violet-colored glass; stopper-topped glass jars or bottles; press-capped (cork gasket liner) heavy-walled soda or liquor bottles (not twist-top, thin-walled); zinc and vitreous glass-lidded glass canning jars with colored body.
- Miscellaneous fragments of metal (or plated) clothing closures (hooks and eyes, and suspender fittings, but not zippers), shell buttons, fragments of Bakelite houseware, and celluloid.
- Sawn animal bone or fruit pits.

- Punch-opened and solder-sealed beverage cans; and solder-sealed food tins (not thin-walled aluminum and welded steel cans).
- Knob-and-tube electrical insulators especially with other electrical infrastructure or supplies.
- The internal structure of the feature would be easily identified and characterized. Examples of this would be a buried cellar, privy, or boardwalk, Electric trolley rail line, building foundation or buried vault.
- Old infrastructure that retains its spatial connections to a larger system, such as intact buried brick wastewater vault or wood stave pipes that are still connected and part of a larger still- intact system.

There would be no management of objects in these deposits beyond recording and discarding.

Precontact Disturbed Culture-Rich Deposits, Objects or Features

Precontact disturbed culture-rich deposits are characterized by fill, alluvial or glacial deposits mixed with carbon concentrations or pockets of oxidized sediment, shell deposits, animal bone fragments, stone tools or the stone debris created by their manufacture, or fire cracked rock. **If the Archaeological Monitor identifies such deposits, objects or features they will stop the excavation, move the equipment to a safe distance and follow the procedure outlined in Section 2.2 of this document.**

Precontact Intact Culture-Rich Deposits, Objects or Features

Precontact intact culture rich deposits, objects or features are characterized by carbon concentrations or layers of oxidized sediment, shell deposits, animal bone fragments, stone tools or the stone debris created by their manufacture, or fire cracked rock or other rock alignments. **If the Archaeological Monitor identifies such deposits, objects or features they will stop the excavation, move the equipment to a safe distance and follow the procedure outlined in Section 2.2 of this document.**

Human Remains

Follow procedures in the Inadvertent Discovery Protocol (IDP) document approved in 2021.

Treatment of Archaeological Resources

Construction and/or field activities related to the Project may cause disturbance to underground archaeological resources. The following provisions are intended to ensure the professional archaeological treatment of cultural materials inadvertently discovered during construction activities. Implementing the plan is the responsibility of Skagit County.

If an inadvertent discovery occurs, the Archaeological monitor will immediately contact the Project Archaeologist, with enough information that they will be able to provide a detailed description of the resource to the Skagit County Project Managers. Skagit County will then provide this information to DAHP. Construction equipment will immediately be moved to a safe distance away from the find until a plan for avoidance or minimizing disturbance is made, while the Archaeological Monitor determines the nature, character and integrity of the site as previously discussed.

All prehistoric and historic cultural material discovered during Project construction will at a minimum, be recorded by the Professional Archaeologist on State of Washington cultural resource site forms or on isolate forms using standard techniques. Site overviews, features, and artifacts will be photographed; and stratigraphic profiles and soil/sediment descriptions will be prepared for

subsurface exposure. Discovery locations will be documented on scaled site plans and site location maps and a GPS point or points will be taken.

Where complex or extensive cultural remains are encountered, DAHP and Skagit County will jointly determine the appropriate level of documentation and treatment of the resources after consultation with the concerned Tribal representatives.

DAHP and Skagit County will jointly decide when construction may continue at the discovery location. Where cultural resources are encountered during construction, but additional Project affects to the resources are not anticipated, Project construction may continue while documentation and assessment of the cultural resources proceed. If continued construction is likely to cause additional impacts to such resources, Project activities within a radius of 30 feet (or at a distance that is safe for the resource and the archaeologist) of the discovery will cease until the site has been documented, evaluated its significance, and assessed potential effects to the site.

Cultural features, horizons, and artifacts detected in buried sediments may require further evaluation using hand-dug test units to clarify aspects of integrity, stratigraphic context, or feature function. Units may be dug in controlled fashion to expose features, collect radiocarbon or animal/plant macrofossil samples from undisturbed contexts, or interpret complex stratification. A test excavation unit or small trench might also be used to cross-section a feature to determine if an intact occupation surface is present. Test units will be used only when necessary, to gather information on the nature, extent, and integrity of subsurface cultural deposits to evaluate the site's potential to address significant research domains. Excavations will be conducted using standard techniques for controlling provenience of recovered materials.

Sediments excavated for purposes of cultural resources investigations will be screened through 1/4-inch mesh (or whichever mesh size is appropriate for the sediment type and target object size). Where appropriate, nested screens or other screen sizes can be used depending on the matrix and the conditions. Spatial information, depth of excavation levels, natural and cultural stratification, presence or absence of cultural material, and depth of sterile soil, regolith, or bedrock will be recorded for each probe on a standard form. Test excavation units will be recorded on unit-level forms, which include plan maps for each excavated level, and material type, number and vertical provenience (depth below surface and stratum association where applicable) for all artifacts recovered from the level. Radiocarbon and macrofossil samples will be taken from intact subsurface features exposed by shovel/auger probes or test units. A stratigraphic profile will be drawn for at least one sidewall of each test excavation unit.

All prehistoric and historic artifacts collected from surface and subsurface locations will be analyzed, catalogued, and temporarily stored at the ERCI secure lab facility in Mount Vernon Washington. Permanent disposition of cultural materials will be determined in consultation with the DAHP and affected Tribes.

Within 90 days of conclusion of fieldwork, a monitoring report describing all monitoring activities and resultant archaeological excavations will be provided to Skagit County. Then Skagit County will forward the report to DAHP and consulting Tribes.

If construction activity exposes potential human remains (burials, or isolated teeth or bones), construction in the immediate vicinity of the find will be halted. Skagit County will follow procedures outlined in the IDP. Treatment of all human remains will be careful and respectful and will be managed either by law enforcement or the State Physical Anthropologist.

Curation: Skagit County will ensure that the treatment plan developed in consultation with tribes is carried out. Including but not limited to having eligible artifacts curated appropriately. Collected artifacts and samples that are determined historically significant would be curated for future use for research, interpretation, preservation, and cultural resource management activities using where appropriate Department of the Interior federal guidelines for curation (36 CFR 79). Artifacts and associated documents resulting from data recovery, including maps, photographs, field notes, stone, bone, shell, soil samples, wood and other botanical samples, and fire-modified rock, would be curated following analysis. Artifacts, samples, and records would be prepared for curation. A sample of some artifact categories and sediments may be selected for curation. For cultural resources that are determined “significant” Skagit County will, in consultation with DAHP and Tribes, identify appropriate treatment including facilities, provide and pay for permanent curation where needed of prehistoric, ethnohistoric, and historic artifacts, data samples, and records resulting from the Project investigations. Skagit County will consult with Tribes to reach agreement about permanent storage of some of the materials.

As the Lead Agency for the Project is the Washington State Department of Ecology, it requires the application of newly signed Governor’s Executive Order 21-02 (EO 21-02) which replaces EO 05-05 which requires state funding of capital projects to undergo a thorough review and consultation.

Contracting: Skagit County will include provisions in any contracts for construction or field-disturbing work that provide for the ability of Skagit County and federal, state, and local government agencies to implement the requirements of this Plan.

Monitoring Map

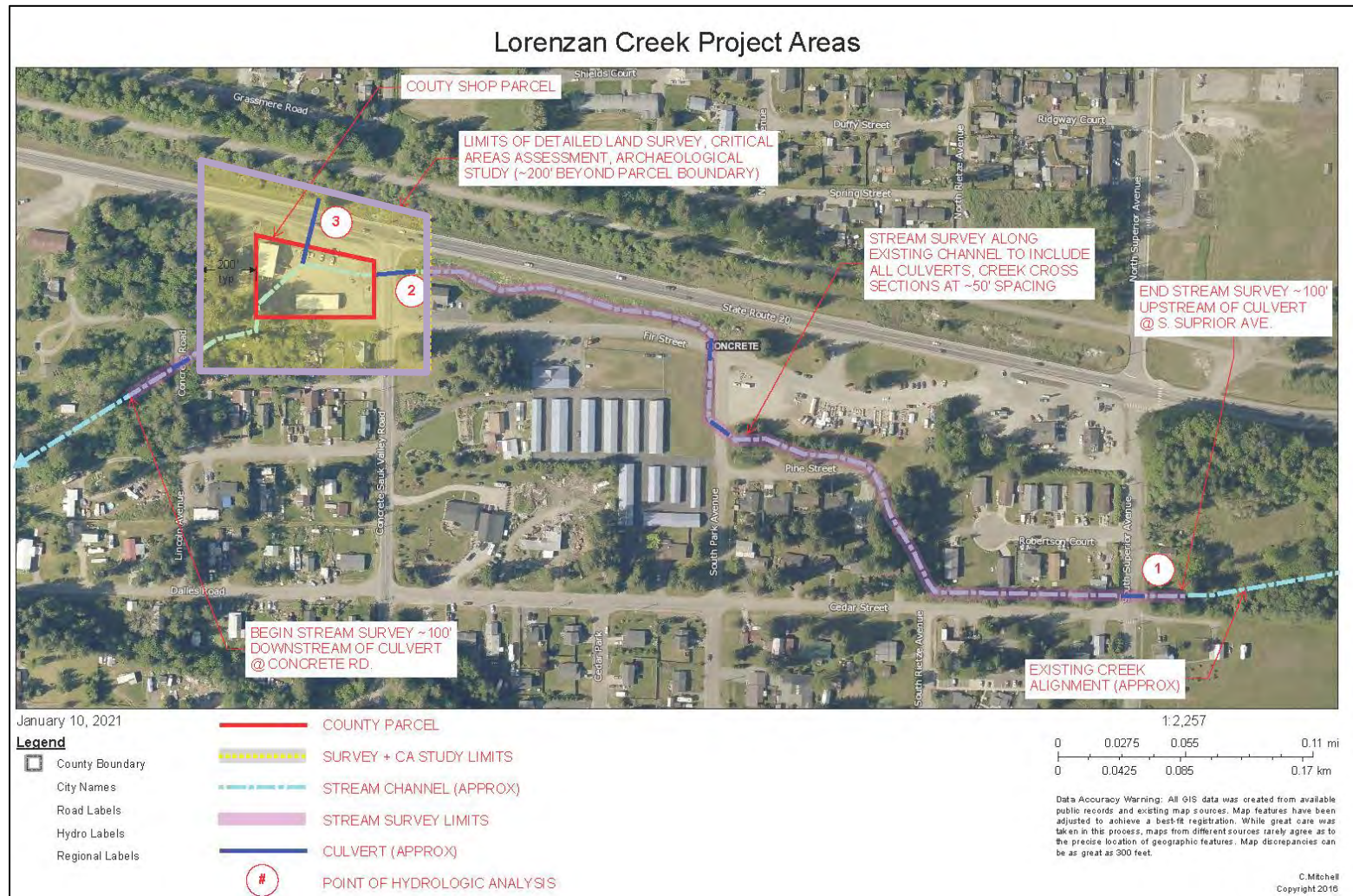


Figure 3: Map of Project activities with monitoring areas indicated in purple

CONTACT INFORMATION

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Kelly Bush	Project Archaeologist (ERCI)	360-661-0356	kelrbush@gmail.com

APPENDIX D

Survey

KEY

BURL, BURLINGTON BASIN
CB, CATCH BASIN
SSMH, SANITARY SEWER MANHOLE
SDMH, STORM DRAIN MANHOLE
GM, GAS METER
YH, YARD HYDRANT
FH, FIRE HYDRANT
BOL, BOLLARD
GP, GATE POST
GA, GUY ANCHOR
MW, MONITORING WELL
UP, UTILITY POLE
WV, WATER VALVE
WM, WATER METER
CO, CLEANOUT SEWER
AC, AIR CONDITIONER
NOP, NO OVERNIGHT PARKING
SAT, SATELLITE DISH
FTV, FUEL TANK VENT
PD, POWER DROP
PT, PROPANE TANK
POST
FL, FLOW LINE
EP, EDGE PAVEMENT
CONC, CONCRETE PIPE
CMP, CORRUGATED METAL PIPE
CPE, CORRUGATED POLYURETHANE PIPE
PVC, POLYVINYL CHLORIDE PIPE
OVERHEAD POWER
OVERHEAD TELEPHONE
BURIED SANITARY SEWER
BURIED STORM DRAIN
FENCE

NOTES:

1. BASIS OF BEARING: WASHINGTON STATE PLANE COORDINATE NORTH ZONE NO. 4601, NAD 83/2009.
2. DATUM: NAVD88 FROM RTK GPS
3. SURVEY PROCEDURE: STANDARD FIELD TRAVERSE AND RTK GPS.
4. INSTRUMENTATION USED: LEICA MS50 THEODOLITE DISTANCE METER, LEICA VIVA 14 GPS/GNSS RECEIVERS.
5. BENCH MARK FOR THIS SURVEY IS TOP OF WSDOT MONUMENT IN CASE AT INTERSECTION OF SR20A CONCRETE SAUK VALLEY ROAD. ELEVATION = 000.00 NAVD88.
6. CONTOUR ARE LOCATED AND SHOWN FROM VISIBLE EVIDENCE.

IE 18" CONC=176.25
IE 12" CONC=176.96
IE 18" CONC=176.75
IE 12" CONC=177.05

0' 20' 40'
SCALE

BLOCK 3

811
Know what's below.
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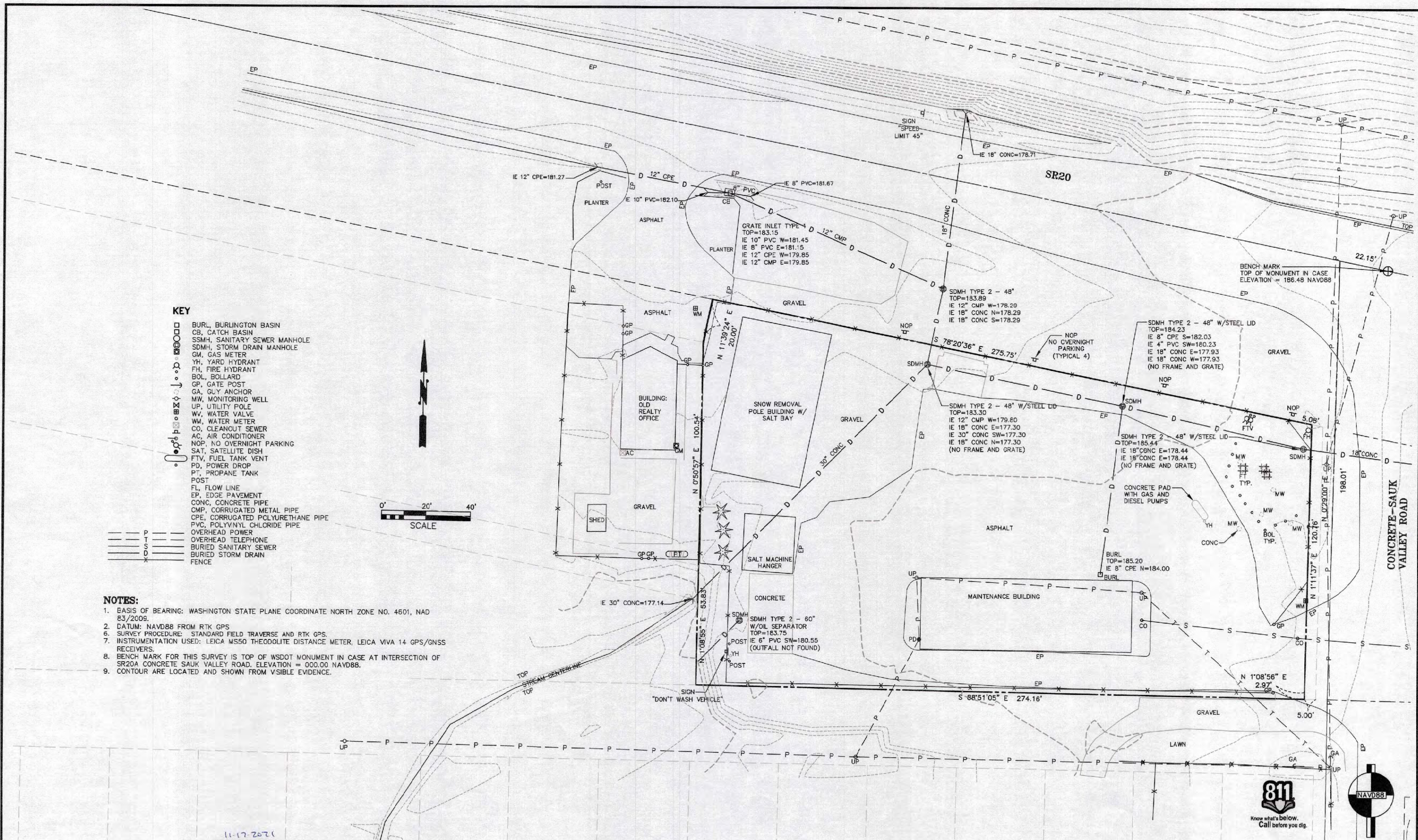
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DATE: 11/17/2021
DRAWING: 6101.DWG
JOB NO.: 6101
SHEET: 1 OF 6

KEY

- BURL, BURLINGTON BASIN
- CB, CATCH BASIN
- SSMH, SANITARY SEWER MANHOLE
- SDMH, STORM DRAIN MANHOLE
- GM, GAS METER
- YH, YARD HYDRANT
- FH, FIRE HYDRANT
- BOL, BOLLARD
- GP, GATE POST
- GA, GUY ANCHOR
- MW, MONITORING WELL
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- PVC, POLYVINYL CHLORIDE PIPE
- OVERHEAD POWER
- OVERHEAD TELEPHONE
- BURIED SANITARY SEWER
- BURIED STORM DRAIN
- FENCE

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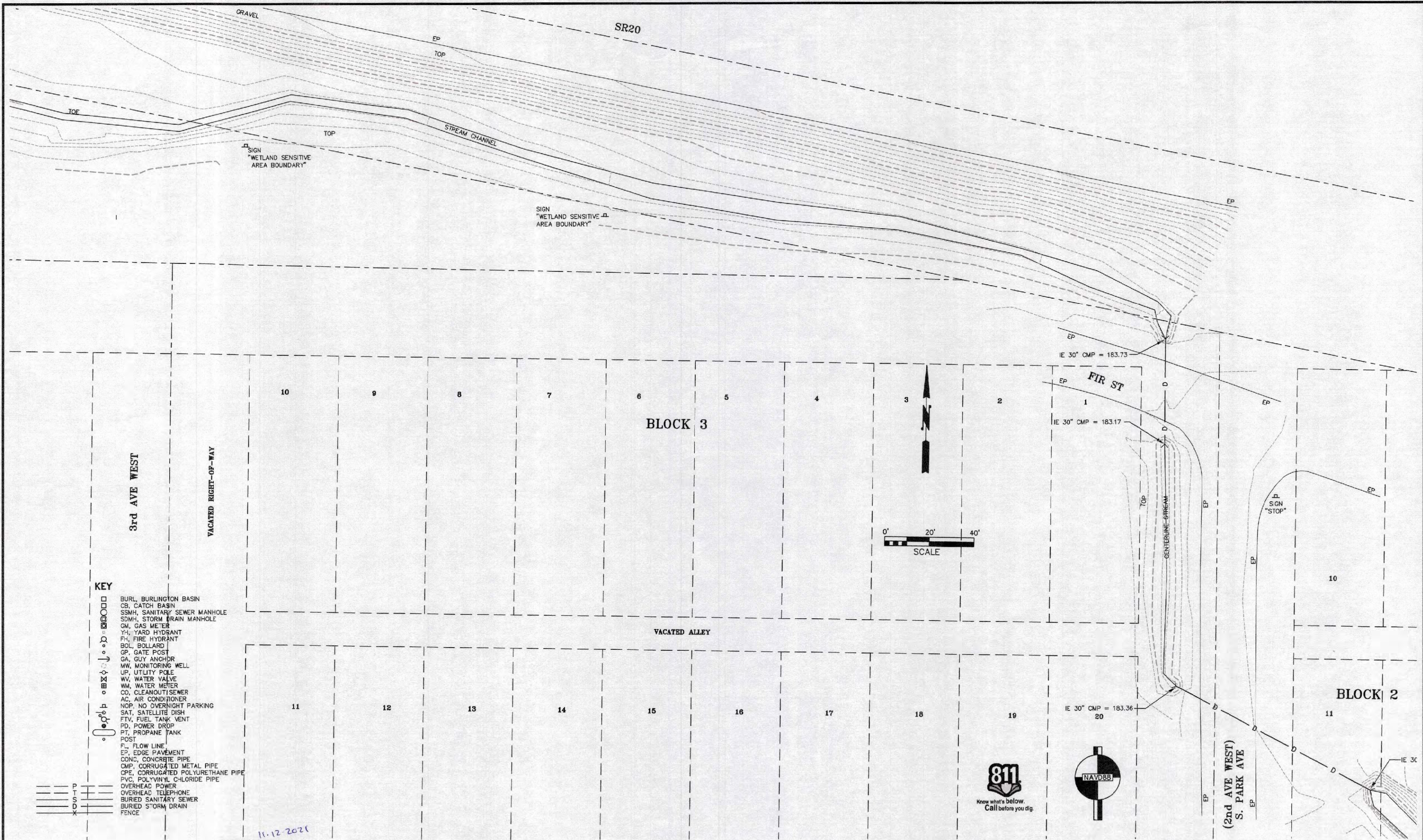
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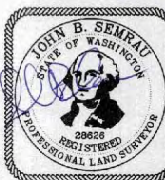
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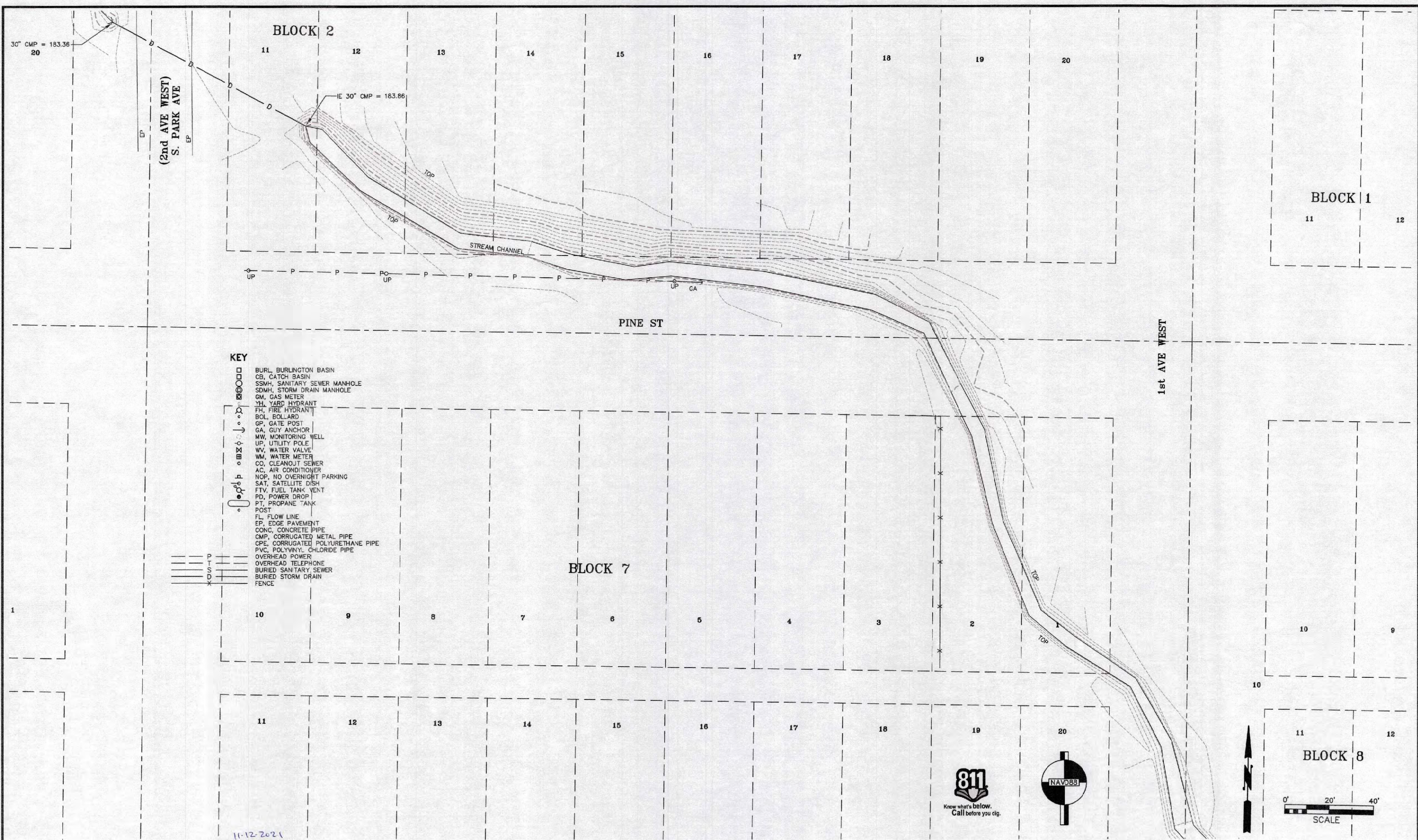
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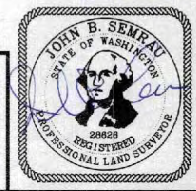
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SHEET: 4 OF 6



KEY

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- CB, CATCH BASIN
- SSMH, SANITARY SEWER MANHOLE
- SDMH, STORM DRAIN MANHOLE
- GM, GAS METER
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- FTV, FUEL TANK VENT
- PD, POWER DROP
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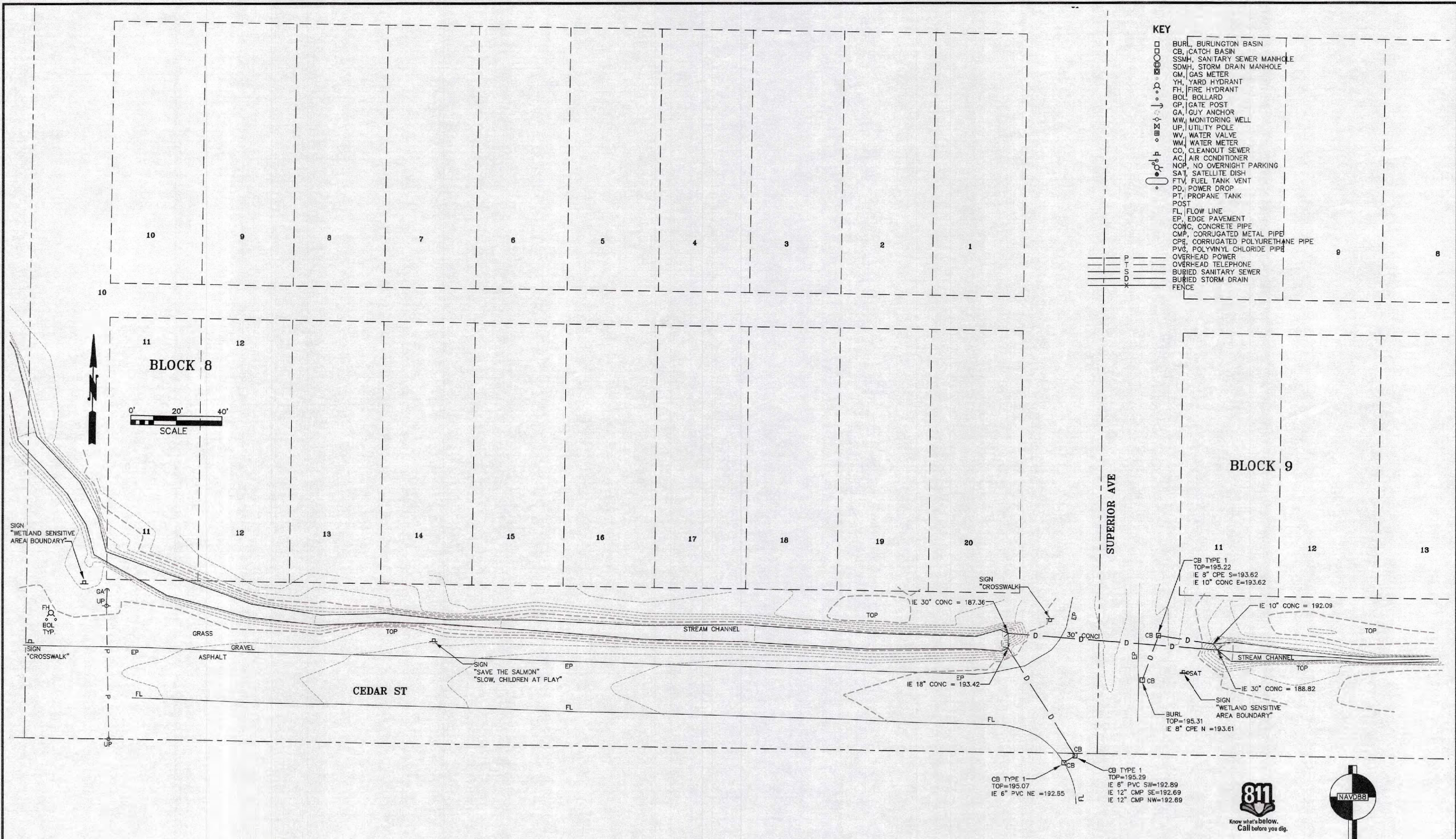
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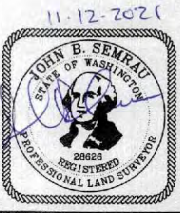
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- KEY**
- BURL, BURLINGTON BASIN
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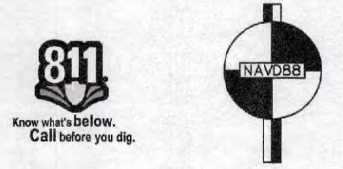


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APPENDIX E

Wetland and Stream Delineation Methods

WETLAND AND STREAM DELINEATION METHODS

WETLAND DELINEATION METHODS

The wetland delineation for the Lorenzan Creek Stormwater Improvement Project was performed in accordance with the *Regional Supplement to the US Army Corps of Engineers Wetlands Delineation Manual: Western Mountains, Valleys, and Coast Region* (Environmental Laboratory 2010)), which is consistent with the *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987). These methods use a three-parameter approach for identifying and delineating wetlands: the presence of field indicators for hydrophytic vegetation, hydric soils, and hydrology. This wetland delineation was performed according to procedures specified for the routine wetland determination method (Environmental Laboratory 1987).

To identify potential wetlands, wetland biologists evaluated field conditions by traversing the study area and noting wetlands, streams, and other aquatic features. The biologists also walked through and documented conditions within 200 feet of the study area.

A test plot was established for each area that appeared to have potential wetland characteristics. For each test plot, data on dominant plant species, soil conditions in test plots, and evidence of hydrologic conditions were recorded on wetland determination data forms. Plants, soils, and hydrologic conditions were also analyzed and documented in adjacent uplands. Based on collected data, a determination of wetland or upland was made for each area examined.

Following confirmation of wetland conditions in a given area, the wetland boundary was delineated by placing sequentially numbered, fluorescent pink flagging along the wetland perimeter. Test plot locations were marked with pink and black striped flagging. The locations of wetland boundaries and test plots were subsequently surveyed by Semrau Engineering & Surveying, PLLC.

Hydrophytic Vegetation

Hydrophytic vegetation is characterized by the ability to grow, effectively compete, reproduce, and persist in anaerobic soil conditions resulting from periodic or long-term saturation (Environmental Laboratory 1987). Vegetation must meet at least one of the four indicators (described below) that are used to determine the presence of hydrophytic vegetation in wetlands. Problematic and atypical situations for hydrophytic vegetation are also described in the US Army Corps of Engineers (USACE) delineation manual and supplement (Environmental Laboratory 1987, 2010).

Plant Species Identification

Plant species were identified using *Flora of the Pacific Northwest* (Hitchcock and Cronquist 1987) and *A Field Guide to the Common Wetland Plants of Western Washington and Northwestern Oregon* (Cooke 1997). The indicator status of each plant species is based on the *National Wetland Plant List* (Lichvar 2016) for the Western Mountains, Valleys, and Coast Region.

Dominant Species Determination

Dominant species are those that contribute more than other species to the character of a plant community. To determine dominance, a vegetation sampling area is determined by the field biologist to accurately characterize the plant community that occurs in the area to be evaluated. These are commonly circular sampling areas, centered on the location of the test plot (where soil and hydrologic data is also collected). The radius of the circle is determined in the field, based on site conditions. In large wetlands, a typical sampling radius would be 2 to 5 meters for tree and sapling/shrub species, and 1 meter for herbaceous species. In a small or narrow wetland (or upland), the radius might be reduced to accurately sample wetland (upland) areas, thereby avoiding an overlap into an adjacent community having different vegetation, soils, or hydrologic conditions (Environmental Laboratory 2010).

Within the vegetation sampling area, a complete list of plant species that occur in the sampling area is compiled and the species divided into four strata: tree, shrub (including saplings, see criteria below), herb, and woody vines. A plant is included in the tree stratum if it is a woody plant 3 inches in diameter at breast height (dbh) or greater; in the shrub stratum if it is a woody plant less than 3 inches dbh (including tree saplings under 3 inches dbh); in the herb stratum if it is an herbaceous (non-woody) plant; and in the woody vine stratum if it is a woody vine of any height (Environmental Laboratory 2010). To be included in the sampling, 50 percent or more of the plant base must be within the radius of the sampling area. For trees specifically, more than 50 percent of the trunk (diameter) must be within the sampling radius to be included.

A rapid test, dominance test (e.g., the 50/20 rule), or prevalence index are commonly used to determine which species are considered dominant and to assess whether the criteria for hydrophytic vegetation are met at each test plot (Environmental Laboratory 2010). Additional hydrophytic vegetation indicators are discussed in the following section.

To conduct a rapid test (Indicator 1 on the wetland determination data form), the dominant species are evaluated visually and if all are FACW or OBL, the vegetation data passes the rapid test. To conduct a dominance test (Indicator 2 on the wetland determination data form), the absolute areal coverage of the plant species within a stratum are totaled, starting with the most abundant species and including other species in descending order of coverage, until the cumulative coverage exceeds 50 percent of the total coverage for the stratum. The plant species that constitute this first 50 percent of areal coverage are considered the dominant species in the stratum. In addition, any other any single plant species that constitutes at least 20 percent of the total percent cover in the stratum is also considered a dominant species (Environmental

Laboratory 2010). The indicator status category for each plant (shown in Table A-1) is also listed on the wetland determination form. If more than 50 percent of the dominant species across all strata are rated OBL, FACW, or FAC, the hydrophytic vegetation dominance test (Indicator 2) is met.

The prevalence index (Indicator 3 on the wetland determination data form) is a weighted-average wetland indicator status of all plant species in the sampling plot, where weighting is by abundance (Environmental Laboratory 2010). This method is used where indicators of hydric soil and wetland hydrology are present, but the vegetation initially fails the rapid and dominance tests (Indicators 1 and 2). To determine the prevalence index, the absolute cover of each species in each stratum is determined. All species (across all strata) are organized into wetland indicator status groups (i.e., OBL, FACW, FAC, FACU, or UPL) and their cover values are summed within the groups. The formula for the prevalence index is applied. If the prevalence index (which ranges from 1.0 to 5.0) equals 3.0 or less, this hydrophytic vegetation indicator is met.

Table A-1. Plant Indicator Status Categories.		
Indicator Status	Indicator Symbol	Definition
Obligate wetland plants	OBL	Plants that occur almost always (estimated probability >99%) in wetlands under natural conditions but also occur rarely (estimated probability <1%) in upland areas
Facultative wetland plants	FACW	Plants that usually occur (estimated probability >67%) in wetlands under natural conditions but also occur (estimated probability 1% to 33%) in upland areas
Facultative plants	FAC	Plants with a similar likelihood (estimated probability 33% to 67%) of occurring in both wetlands and upland areas
Facultative upland plants	FACU	Plants that sometimes occur (estimated probability 1% to 33%) in wetlands but occur more often (estimated probability >67% to 99%) in upland areas
Obligate upland plants	UPL	Plants that rarely occur (estimated probability <1%) in wetlands under natural conditions
WET ← $OBL - FACW - FAC - FACU - UPL$ → DRY		

Source: Environmental Laboratory (1987).

Additional Hydrophytic Vegetation Indicators

The presence of morphological adaptations to wetland conditions in plants that lack a published hydrophytic vegetation indicator status or with an indicator status of FACU or drier is also a hydrophytic vegetation indicator (Indicator 4). Evidence of physiological, morphological, or reproductive adaptations indicating growth in hydrophytic conditions can include, but are not limited to, buttressed roots, adventitious roots, multi-stemmed trunks, or tussocks. To determine whether Indicator 4 is met, the morphological features must be observed on more than 50 percent of the individuals of a FACU species (or species without a published indicator status) living in an area where hydric soil and wetland hydrology are present. On the wetland

determination data form, the indicator status of the species with morphological adaptations would be changed to FAC (with supporting notes), and the dominance test (Indicator 2) and/or prevalence index (Indicator 3) would then be recalculated.

Wetland non-vascular plants, referred to as bryophytes and consisting of mosses, liverworts, and hornworts, may also meet the hydric vegetation criteria, under Indicator 5 (Environmental Laboratory 2010). These plants must be present in areas containing hydric soils and wetland hydrology. The percent cover of wetland specialist bryophytes is determined in 10-inch-by-10-inch square plots placed at the base of hummocks, if present. The summed cover of wetland specialist bryophytes must be more than 50 percent of the total bryophyte cover in the vegetation sampling area.

The problematic hydrophytic vegetation indicator section in the USACE regional supplement further explains how to interpret situations in which hydric soils and wetland hydrology are present but hydrophytic vegetation Indicators 1 through 5 are lacking (Environmental Laboratory 2010). Procedures for looking at settings such as areas with active vegetation management (e.g., farms), areas dominated by aggressive invasive species, active floodplains, and low terraces are described, as well as explanations for specific situations, such as seasonal shifts in plant communities, extended drought conditions, and riparian areas.

Hydric Soils

A hydric soil is a soil that is saturated, flooded, or inundated long enough during the growing season to develop anaerobic conditions that favor the growth and regeneration of hydrophytic vegetation (Environmental Laboratory 1987, 2010). The evaluation of existing soil maps (developed by the US Department of Agriculture [USDA] Natural Resources Conservation Service [NRCS] and other sources) is used to understand hydric soil distribution and to identify the likely locations of hydric soils (by verifying their inclusion on the hydric soils list). Comparison of these mapped soils to conditions found on site help verify the presence of hydric soils.

For onsite soils characterization, hydric soils data were obtained generally by digging test pits at least 20 inches deep and 4 inches wide. Hydric soil conditions were evaluated using indicators outlined in *Field Indicators of Hydric Soils in the United States* (NRCS 2017) and adopted by the *Regional Supplement to the US Army Corps of Engineers Wetlands Delineation Manual: Western Mountains, Valleys, and Coast Region* (Environmental Laboratory 2010).

Hydric soil indicators applicable to the Western Mountains, Valleys, and Coast region include, but are not limited to, the presence of organic soils (i.e., histosols or histic epipedons); sulfidic material (i.e., hydrogen sulfide); depleted, gleyed, or reduced soil matrices; and/or the presence of iron or manganese concretions (Environmental Laboratory 2010). Soil color characterization (i.e., hue, value, and chroma) is a critical tool in determining depleted, gleyed, and reduced soil conditions. Soil color was evaluated by comparing soil colors at test plots to standardized color samples in *Munsell Soil Color Charts* (Munsell Color 2000).

Wetland Hydrology

Wetland hydrology is indicated by site conditions that demonstrate the periodic inundation or saturation to the soil surface for a sufficient duration during the total growing season. A *sufficient duration* during the growing season is defined as 14 or more consecutive days of flooding, ponding, or presence of a water table at 12 inches or less from the soil surface (Environmental Laboratory 2010). The growing season is the period of consecutive frost-free days, or the longest period during which the soil temperature stays above biological zero (41°F), when measured at 12 inches below the soil surface.

Two indicators of biological activity can be used to determine whether the growing season has begun and is ongoing (Environmental Laboratory 2010):

- Occurrence of aboveground growth and development of at least two non-evergreen vascular plant species growing within the wetland. Examples of this growth include the emergence or elongation of leaves on woody plants and the emergence or opening of flowers.
- Soil temperature, which can be measured once during a single site visit, should be at least 41°F or higher at a depth of 12 inches.

For this assessment, onsite hydrologic indicators were examined at the test plots. Hydrologic indicators may include the presence of surface water, standing water in the test pit at a depth of 12 inches or less, saturation in the root zone, watermarks, drift lines, sediment deposits, drainage patterns within wetlands, oxidized rhizospheres surrounding living roots, and water-stained leaves.

Antecedent Precipitation Analysis

Analyzing climatic conditions and local weather patterns are important in the assessment of vegetation, soil conditions, and hydrology for wetland delineations (Environmental Laboratory 1987, 2010), and information on precipitation that precedes a site visit is valuable in helping determine whether conditions observed at a site are reflective of normal rainfall. The NRCS (1997) provides methodology for the analysis of normal environmental conditions using antecedent rainfall measurements. For this method, “normal precipitation” is defined as ranges of normal precipitation or values falling within defined thresholds, in this case, the 30th and 70th percentile thresholds (Sprecher and Warne 2000). These ranges for a particular site are provided by WETS tables, which can be accessed through the NRCS National Water and Climate Center (NRCS 2018) and are calculated using long-term data (30 years) recorded at National Weather Service meteorological stations. USDA WETS tables display monthly average rainfall data (50th percentile) in addition to the upper and lower limits at which there is a 30 percent chance that rainfall will be more or less than the average (30th and 70 percentiles) (NRCS 2017). USDA WETS tables use climatological probabilities and are calculated on the basis of the most recent three decades of data, as factors such as climate change and different recording

technologies may alter probabilities (Sprecher and Warne 2000). Currently, the 30-year range from 1981 to 2010 is used. This method makes the assumptions that rainfall is evenly distributed within a month, that antecedent precipitation can be properly evaluated for a 3-month period (i.e., assumes that evapotranspiration is the same in each season), that antecedent precipitation affects different systems similarly, and that snowmelt has the same contribution to hydrology as rainfall (Sprecher and Warne 2000).

To determine whether recent precipitation is reflective of normal precipitation, a representative weather station near the site is selected; as other conditions may affect precipitation (e.g., elevation, aspect, and proximity to mountains), the nearest station may not be the most representative of the site (Environmental Laboratory 2010). The procedure for determining normal precipitation uses measured rainfall data from the 3 months prior to the month of the site visit. For example, if the site visit occurs in September, precipitation data from June, July, and August would be analyzed. The recorded rainfall of each month is first compared to the long term range of normal precipitation (30th and 70th percentiles) and is determined to have a "normal" condition if it falls within this range; if the recorded data is higher or lower than the range, then it is determined to have a "wet" or "dry" condition, respectively. The condition is then given a value, "1" for "dry", "2" for "normal", and "3" for "wet", and this value is multiplied by the weighted monthly value, where the most recent month (one month prior) is weighted heavier (3) than 3 months prior (1). The sum of this product is then used to determine whether the entire 3-month period is "drier than normal" (6-9), "normal" (10-14) or "wetter than normal" (15-18). While this method is useful for comparing a short-term time period to normal, this method is limited in that it discounts analysis of daily precipitation patterns within a given month (Sprecher and Warne 2000, Sumner et al. 2009).

STREAM DELINEATION METHODS

The OHWMs of streams within the study area were delineated using the definition provided in the WAC, Section 173-22-030(11). According to this definition, the OHWM of streams is "that mark that will be found by examining the bed and banks and ascertaining where the presence and action of waters are so common and usual, and so long continued in all ordinary years, as to mark upon the soil a character distinct from that of the abutting upland, in respect to vegetation." In addition, methods in the publication *Determining the Ordinary High Water Mark for Shoreline Management Act Compliance in Washington State* (Anderson et al. 2016) were applied.

To delineate the OHWM, the bed and adjacent banks of streams in the study area were examined for indications of regular high water events. Factors considered when assessing changes in vegetation include:

- Scour (removal of vegetation and exposure of gravel, sand, or other soil substrate)
- Drainage patterns

- Elevation of floodplain benches
- Changes in sediment texture across the floodplain
- Sediment layering
- Sediment or vegetation deposition
- Changes in vegetation communities across the floodplain

Herrera placed orange flags on the site, indicating the horizontal location of the OHWM along the stream(s). The locations of wetland boundaries and test plots were subsequently surveyed by Semrau Engineering & Surveying, PLLC.

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APPENDIX F

Photographic Log - Wetlands and Streams

EXISTING CONDITIONS REPORT— LORENZAN CREEK STORMWATER IMPROVEMENT PROJECT: PHOTOGRAPHIC LOG

Photo Number	Photo Description
1a	Reach 1 – Downstream
1b	Reach 1 – Upstream
1c	Reach 1 – Downstream toward culvert inlet (upstream of Superior Avenue)
2a	Reach 2 – Upstream toward submerged culvert (downstream of Superior Avenue)
2b	Reach 2 – Downstream
2c	Reach 2 – Upstream
2d	Reach 2 – Downstream
2e	Reach 2 – Upstream
2f	Reach 2 – Downstream toward culvert inlet (upstream of South Park Avenue)
2g	Reach 2 – Upstream toward culvert outlet (downstream of South Park Avenue)
3a	Reach 3 – Downstream
3b	Reach 3 – Upstream
3c	Reach 3 – Downstream
3d	Reach 3 – Wetland A representative vegetation
4a	Reach 4 – Skagit County maintenance facility
5a	Reach 5 – Upstream toward culvert outlet (downstream of County facility)
5b	Reach 5 – Upstream
5c	Reach 5 – Downstream
5d	Reach 5 – Upstream
5e	Reach 5 – Wetland B representative vegetation
5f	Reach 5 – Downstream
5g	Reach 5 – Downstream
5h	Reach 5 – Upstream
5i	Reach 5 – Upstream
5j	Reach 5 – Downstream
5k	Reach 5 – Downstream toward culvert inlets (upstream of Concrete road)
6	Downstream of Reach 5 and Concrete Road – Looking upstream toward obscure culvert outlet











2f



2g



3a



3b





4a



5a



5b



5c





5f



5g



5h



5i





APPENDIX G

Geotechnical Memo and NRCS Soils Data



November 23, 2021
Project No. 20210020E001

Herrera Environmental Consultants
2200 Sixth Avenue, Suite 1100
Seattle, Washington 98121

Attention: Colleen Mitchell

Subject: Subsurface Exploration and Geotechnical Recommendations
Lorenzan Creek Stormwater
44510 Concrete Sauk Valley Road
Concrete, Washington

Dear Ms. Mitchell:

Associated Earth Sciences, Inc. (AESI) is pleased to submit this letter-report presenting the results of our subsurface exploration and preliminary geotechnical evaluation for the proposed Lorenzan Creek Stormwater Improvement project in Concrete, Washington (Figure 1). We are familiar with the project through several prior cursory site visits and a series of client conversations. Our services were completed in general accordance with Task 3.4 of the project's Washington State Department of Ecology (Ecology) Agreement (Ecology Agreement # WQC-2021-SkCoPW-00083) and our professional services agreement dated June 14, 2021. At this time, final plans for the site are still in development.

PROJECT AND SITE DESCRIPTION

The project site is located within an existing Skagit County Public Works maintenance facility located at 44510 Concrete Sauk Valley Road, as shown on the attached "Vicinity Map" (Figure 1). Currently, Lorenzan Creek flows through the project site and is contained in a metal culvert. The culvert enters the site near the northeast corner and extends generally to the southwest corner where it opens up. A maintenance shop and associated outbuilding are located on the south and west portions of the site, respectively, and a large underground storage tank is located near the northeast corner. The majority of the project site is covered in asphalt pavement with some areas of crushed rock along the north margins. Site grades across the property are generally flat. We understand that the project proposes to remove the existing culvert structure and daylight the stream in an effort to improve water quality, fish passage and

habitat, and reduce upstream flooding in Lorenzan Creek. Additionally, we anticipate some amount of regrading and utility installation will be necessary in conjunction with the project.

PURPOSE AND SCOPE

The purpose of this study was to provide geotechnical engineering recommendations to be utilized in the design of the project. This study included reviewing selected available geologic literature and performing geologic studies to assess the type, thickness, distribution, and physical properties of the subsurface sediments and shallow groundwater. Geotechnical engineering studies were completed to establish recommendations for earthwork and site preparation including placement and compaction of structural fill and trench backfill, support and backfill of manholes, preparation of pavement subgrade soils, and mitigation of unsuitable/compressible soil conditions. Additionally, the letter-report will include an evaluation of the effects of weather and/or construction equipment on site soils and a preliminary assessment of the potential for infiltration. This letter-report offers recommendations based on our present understanding of the project. We recommend that we be allowed to review the recommendations presented in this letter-report and revise them, if needed, once a project design has been finalized.

FIELD EXPLORATION PROCEDURES

AESI was onsite October 7, 2021 with several personnel from Skagit County Public Works and a third-party archeologist to observe the excavation of six exploration pits located within the project site. The approximate locations of the exploration pits are shown on the "Site and Exploration Plan," Figure 2. The various types of sediments, as well as the depths where characteristics of the sediments changed, are shown on the exploration logs contained in Appendix A. Soil contact depths shown on the logs should be regarded as only an approximation; the actual changes between sediment types are often gradational and/or undulating.

The conclusions and recommendations presented in this letter-report are based, in part, on conditions encountered by our explorations. Due to the nature of subsurface exploratory work, it is necessary to interpolate and extrapolate soil conditions between and beyond the field explorations. Differing subsurface conditions could be present outside the area of the explorations due to the random nature of deposition and the alteration of topography by past grading and/or filling. The nature and extent of any variations between the field explorations might not become fully evident until construction begins. If variations are observed at that time, it could be necessary to modify specific conclusions or recommendations in this letter-report.

Exploration Pits

The exploration pits were excavated by a Skagit County Public Works operator with a medium-sized excavator. The pits permitted direct, visual observation of subsurface conditions. Materials encountered in the excavations were studied and classified in the field by an AESI geologist. The exploration pits were backfilled after examination and logging. Disturbed soil samples were selected from the pits, placed in moisture-tight containers, and then transported to our laboratory for further visual classification and testing, as necessary. The exploration logs attached to this letter-report are based on the field observations, review of the samples, and laboratory grain-size analyses.

Published Geologic Map

We reviewed the *Geologic Map of the Mount Baker 30- by 60-Minute Quadrangle, Washington* by R.W. Tabor, R.A. Haugerud, Wes Hildreth, and E.H. Brown, 2003. The referenced map indicates that the site is expected to be underlain at shallow depths by Holocene-age alluvium. Our on-site explorations and interpretations are in general agreement with the referenced map.

Published Soils Map

The United States Department of Agriculture [USDA], Soils Conservation Service [SCS] now referred to as Natural Resources Conservation Service [NRCS] indicates that the site is underlain by Indianola loamy sand. The Indianola loamy sand soils generally consist of coarse-grained sediments that are formed from the weathering of glacial outwash soils.

Stratigraphy

As shown on the exploration logs included in Appendix A, sediments encountered at the site consisted generally of a variable thickness of fill soils underlain by alluvial sediments. The explorations completed for this current study were excavated to a maximum depth of 10 feet. The following sections present more detailed subsurface information for sediments encountered, organized from the youngest to the oldest sediment types.

Asphalt Paving and Crushed Rock

Existing asphalt paving and a surficial layer of crushed rock were observed in exploration pits EP-2, EP-3, and EP-5. Observed thickness for each ranged from 3 to 4 inches (asphalt) and 3 inches (crushed rock), respectively.

Sod and Topsoil

Sod and topsoil sediments were observed in EP-1 and EP-6, with associated grass growth ranging from 6 to 12 inches. Additionally, a remnant layer of buried topsoil was encountered in EP-3 at a depth of 3 feet below the surface with an observed thickness of 6 inches. Rootlets and a weakly- to moderately-developed organic horizon were observed in each of the above-noted pits.

Fill

Fill soils consisting primarily of unsorted, loose to dense, moist, brown to grayish brown, silty SAND to very gravelly SAND with trace to some cobbles, trace to some woody and deleterious debris, and trace sub-round boulders were encountered in all pits with the exception of EP-6. The fill soils ranged in thickness from 3 feet below grade in EP-3 to the maximum extent accomplished by the excavator in EP-2 and EP-5, approximately 10 feet. Additionally, an approximately 6-inch thickness of pea gravel and “buried waterline” utility locating tape were encountered at a depth of 3.5 feet below grade in EP-1, which was thereafter abandoned due to the potential utility conflict. Existing fill soils may be suitable for support of new paving sections when prepared properly. Excavated existing fill is suitable for reuse in structural fill applications if specifically allowed by project specifications, and if any organic or other deleterious materials are removed. Due to their variable nature, excavated existing fill material may require moisture-conditioning (drying or wetting) during dry site and weather conditions prior to use in compacted fills. Due to their variable composition and observed amount of deleterious debris observed in several of the pits, these materials are not considered suitable for stormwater infiltration.

Quaternary Alluvial Sediments

Alluvial soils generally consisting of unsorted to lightly stratified, medium dense to dense, moist, orangish brown to brownish gray, gravelly to very gravelly SAND with trace to some sub-round to round cobbles and trace sub-round to round boulders (1- to 2-foot-diameter) were encountered in EP-3, EP-4, and EP-6. Alluvial soils consist of any material deposited by the running water of streams and rivers. As rates of flow for streams and rivers can vary dramatically, alluvial soils can be highly variable in composition and may contain silt, sand, and clay and often contains portions of organic matter. The alluvial soils encountered in our exploration pits were deposited by the Skagit River during the most recent non-glacial period (Holocene) and to some extent from previous flows on Lorenzan Creek. Alluvial soils may be suitable for support of new paving sections if prepared properly. Excavated alluvium is suitable for reuse in structural fill applications if specifically allowed by project specifications, and if any organic or other deleterious materials are removed. Due to their granular nature, excavated existing fill materials are expected to be slightly drier than optimum moisture content for compaction purposes and may require wetting prior to use in compacted fills.

Groundwater Conditions

Groundwater seepage was not encountered in any of the exploration pits.

It should be noted that the depth or occurrence of groundwater seepage beneath the site may vary in response to such factors as topography, time of year, changes in on- and off-site land use, and variations in the amount of rainfall.

LABORATORY TESTING

AESI collected soil samples in support of a preliminary infiltration assessment. These samples were analyzed for sieve, cation exchange capacity (CEC), and organic matter.

Grain-Size Analysis

We performed one grain-size analysis in accordance with *ASTM International* (ASTM) procedures on a sample collected from EP-3 at an interval depth of 3 to 9 feet. The grain-size analysis test result is presented in Appendix B. Based on ASTM D-2487 Unified Soil Classification System (USCS), the tested alluvial sediments correlate to a “gravelly SAND” with a fines content of 2.9 percent.

Cation Exchange Capacity

AESI submitted a soil sample to a third party lab to complete a CEC test in accordance with methodology SW-846 9081. The results of the test revealed a CEC of 7.5 milliequivalents per 100 grams of soil (meq/100g).

Organic Content

In conjunction with the above CEC testing, an organic burn test was conducted by a third party lab to ascertain the percentage of organic matter in the submitted soil sample. The results of the test revealed an organic matter of 2.1 percent.

INFILTRATION ASSESSMENT

Our explorations encountered native coarse-grained alluvial sediments near the surface or underlying existing fill soils with no groundwater encountered during our time of exploration. The on-site existing fill soils are not recommended for use as an infiltration receptor due to their variability and hence potential for unforeseen flood damage to neighboring infrastructure. The native sediments encountered in our explorations likely have a moderate to high permeability due to their relatively small content of fines (silt and clay). These native sediments

can potentially act as a receptor soil for surface stormwater runoff and allow the introduced groundwater to move vertically.

If infiltration facilities are planned for the project, we recommend conducting an infiltration test of the native receptor soils to establish a field infiltration rate and monitoring groundwater conditions to establish a seasonal high water table elevation. The infiltration test should be conducted using the general methodology for a “Small-Scale Pilot Infiltration Test” as described in the Ecology 2019 *Stormwater Management Manual for Western Washington* (2019 SWMMWW).

GEOTECHNICAL CONCLUSIONS AND RECOMMENDATIONS

Our explorations indicate that, from a geotechnical standpoint, the subject site is suitable for the proposed development provided the risks discussed are accepted and the recommendations contained herein are properly followed.

Site Preparation

Existing debris, vegetation, topsoil, and any other deleterious materials should be removed when they are located below planned site improvements. All excavations below final grade made for demolition activities should be backfilled, as needed, with structural fill. Erosion and surface water control should be established around the clearing limits to satisfy local requirements.

Site Drainage and Surface Water Control

The site should be graded to prevent water from ponding in construction areas and/or flowing into excavations. Exposed grades should be crowned, sloped, and smooth drum-rolled at the end of each day to facilitate drainage. Accumulated water must be removed from subgrades and work areas immediately prior to performing further work in the area. Equipment access may be limited, and the amount of soil rendered unfit for use as structural fill may be greatly increased if drainage efforts are not accomplished in a timely sequence. If an effective drainage system is not utilized, project delays and increased costs could be incurred due to the greater quantities of wet and unsuitable fill, or poor access and unstable conditions.

Subgrade Protection

If construction will proceed during the winter, we recommend the use of a working surface of sand and gravel, crushed rock, or quarry spalls to protect exposed soils, particularly in areas supporting concentrated equipment traffic. In winter construction staging areas and areas that will be subjected to repeated heavy loads, a minimum thickness of 12 inches of quarry spalls or 18 inches of pit run sand and gravel is recommended. If subgrade conditions are soft and silty, a geotextile separation fabric, such as Mirafi® 500X or approved equivalent, should be used

between the subgrade and the new fill. Construction of working surfaces from advancing fill pads could be used to avoid directly exposing the subgrade soils to construction traffic.

Overexcavation of Unsuitable/Compressible Soils and Stabilization

Construction during extended wet weather periods could create the need to overexcavate exposed soils if they become disturbed and cannot be recompacted due to elevated moisture content and/or weather conditions. Even during dry weather periods, soft compressible/wet soils, which may need to be overexcavated, may be encountered in some portions of the site. If overexcavation is necessary, it should be confirmed through observation and testing by AESI. Soils that have become unstable may require remedial measures in the form of one or more of the following:

1. Drying and recompaction. Selective drying may be accomplished by scarifying or windrowing surficial material during extended periods of dry and warm weather.
2. Removal of affected soils to expose a suitable bearing subgrade and replacement with compacted structural fill.
3. Mechanical stabilization with a coarse crushed aggregate compacted into the subgrade, possibly in conjunction with a geotextile.

Wet Weather Conditions

If construction proceeds during an extended wet weather construction period and the moisture-sensitive site soils become wet, they will become unstable. Therefore, the bids for site grading operations should be based upon the time of year that construction will proceed. It is expected that in wet conditions additional soils may need to be removed and/or other stabilization methods used, such as a coarse crushed rock working mat, to develop a stable condition if silty subgrade soils are disturbed in the presence of excess moisture. The severity of construction disturbance will be dependent, in part, on the precautions that are taken by the contractor to protect the moisture- and disturbance-sensitive site soils. If overexcavation is necessary, it should be confirmed through continuous observation and testing by a representative of our firm.

Temporary and Permanent Cut Slopes

In our opinion, stable construction slopes should be the responsibility of the contractor and should be determined during construction. For estimating purposes, however, we anticipate that temporary, unsupported cut slopes in the native alluvial sediments or existing fill can be made at a maximum slope of 1.5H:1V (Horizontal:Vertical) or flatter. As is typical with earthwork operations, some sloughing and raveling may occur, and cut slopes may have to be adjusted in the field. If groundwater seepage is encountered in cut slopes, or if surface water is

not routed away from temporary cut slope faces, flatter slopes will be required. In addition, WISHA/OSHA regulations should be followed at all times. Permanent cut and structural fill slopes that are not intended to be exposed to surface water should be designed at inclinations of 2H:1V or flatter.

Frozen Subgrades

If earthwork takes place during freezing conditions, all exposed subgrades should be allowed to thaw and then be recompacted prior to placing subsequent lifts of structural fill. Alternatively, the frozen material could be stripped from the subgrade to reveal unfrozen soil prior to placing subsequent lifts of fill or foundation components. The frozen soil should not be reused as structural fill until allowed to thaw and adjusted to the proper moisture content, which may not be possible during winter months.

Structural Fill

All references to structural fill in this letter-report refer to subgrade preparation, fill type and placement, and compaction of materials, as discussed in this section. If a percentage of compaction is specified under another section of this letter-report, the value given in that section should be used.

After stripping, planned excavation, and any required overexcavation have been performed, the surface should be recompacted to a firm and unyielding condition. If the subgrade contains silty soils and too much moisture, adequate recompaction may be difficult or impossible to obtain and should probably not be attempted. In lieu of recompaction, the area to receive fill should be blanketed with washed rock or quarry spalls to act as a capillary break between the new fill and the wet subgrade. Where the exposed ground remains soft and further overexcavation is impractical, placement of an engineering stabilization fabric may be necessary to prevent contamination of the free-draining layer by silt migration from below.

After recompaction of the exposed ground is approved, or a free-draining rock course is laid, structural fill may be placed to attain desired grades. Structural fill is defined as non-organic soil, acceptable to the geotechnical engineer, placed in maximum 8-inch loose lifts, with each lift being compacted to 95 percent of the modified Proctor maximum density using ASTM D-1557 as the standard. Use of soils from the site in structural fill applications is acceptable if the material meets the project specifications for the intended use, and if specifically allowed by project specifications.

Soils in which the amount of fine-grained material (smaller than the No. 200 sieve) is greater than approximately 5 percent (measured on the minus No. 4 sieve size) should be considered moisture-sensitive. Use of moisture-sensitive soil in structural fills should be limited to favorable dry weather conditions and is only permitted if specifically allowed by project plans and specifications. The native and existing fill soils present onsite contained trace to some

amounts of silt and are considered mildly moisture-sensitive. Existing fill also contained trace organic and deleterious materials in some areas, which are not suitable for reuse in structural fill applications and should be removed prior to reuse. If fill is placed during wet weather or if proper compaction cannot be obtained, a select import material consisting of a clean, free-draining gravel and/or sand should be used. Free-draining fill consists of non-organic soil with the amount of fine-grained material limited to 5 percent by weight when measured on the minus No. 4 sieve fraction with at least 25 percent retained on the No. 4 sieve.

A representative from our firm should observe the stripped subgrade and be present during placement of structural fill to observe the work and perform a representative number of in-place density tests. In this way, the adequacy of the earthwork may be evaluated as filling progresses, and any problem areas may be corrected at that time. It is important to understand that taking random compaction tests on a part-time basis will not assure uniformity or acceptable performance of a fill. As such, we are available to aid the client in developing a suitable monitoring and testing program.

Utility Support

Newly installed utilities and structures should be placed atop firm and unyielding soils acceptable to the geotechnical engineer. If such conditions do not exist at the planned elevation, the exposed soils may need to be recompact and/or removed and replaced with suitable structural fill prior to continuing installation processes. The removal of soft or compressible soils and/or any remedial preparation of the underlying subgrade should be completed on a case-by-case basis and to the satisfaction of the geotechnical engineer.

Utility Backfill

Private utility trench backfill should be placed in accordance with the above-referenced "Structural Fill" section and adhere to a minimum compaction standard of 95 percent ASTM D-1557 in areas below planned paving and hardscape areas and 90 percent ASTM D-1557 in all other areas. Trenches backfilled within the Skagit County Right-of-Way (ROW) should conform to County standards. As such and per the Skagit County Utility Policy (update dated July 5, 2000), backfill shall consist of County-approved granular material conforming to Washington State Department of Transportation (WSDOT) Standard Specification 9-03.10 for gravel base placed in lifts no thicker than 8 inches (loose thickness). Each lift should be uniformly compacted by mechanical tamping. Backfill within the roadway prism and within 2 feet of the bottom of the pavement section shall be compacted to at least 95 percent of maximum dry density as determined by AASHTO Method T 180-96. Backfill more than 2 feet below the bottom of the pavement section shall be compacted to at least 90 percent.

CLOSURE

AESI has prepared this letter-report for the exclusive use of Herrera Environmental Consultants and their agents, for specific application to this project. Within the limitations of scope and schedule, our services have been performed in accordance with generally accepted local geotechnical engineering practices in effect at the time our letter-report was prepared. No other warranty, express or implied, is made.

We appreciate the opportunity to be of service to you on this project. Should you have any questions regarding this letter-report or other geotechnical aspects of the project, please call us at your earliest convenience.

Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Kirkland, Washington

DRAFT

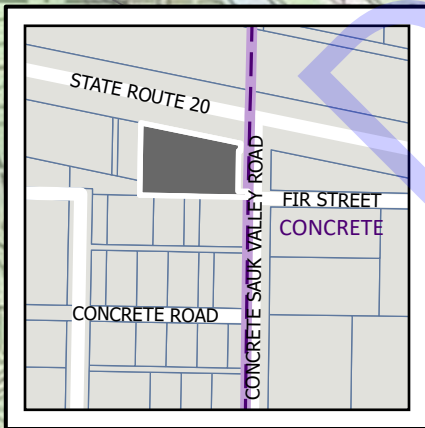
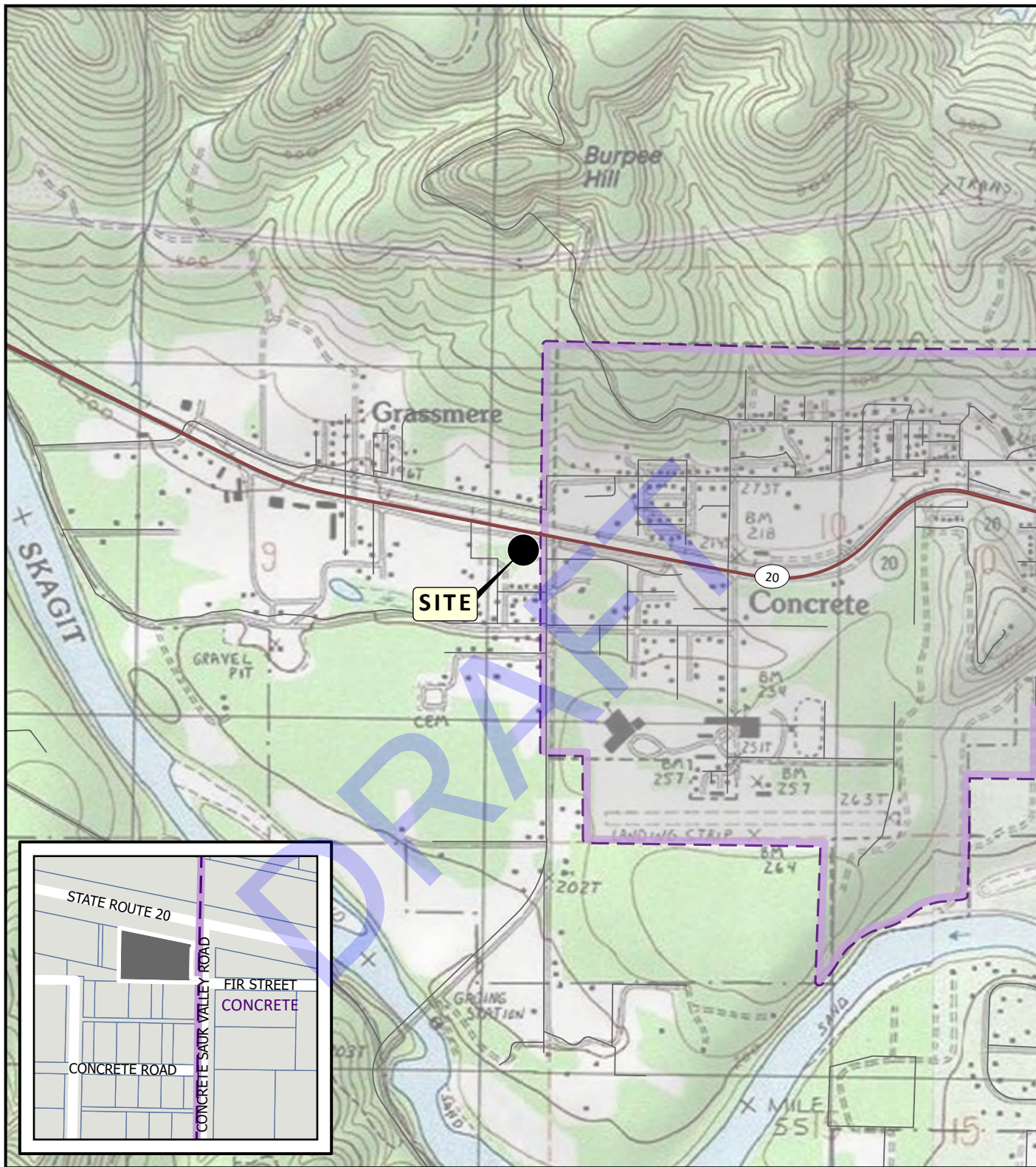
DRAFT

Jon D. Hansen
Senior Staff Geologist

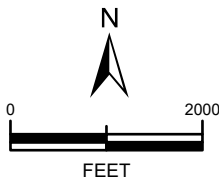
Matthew A. Miller, P.E.
Principal Geotechnical Engineer

Attachments: Figure 1: Vicinity Map
 Figure 2: Site and Exploration Plan
 Appendix A: Exploration Logs
 Appendix B: Laboratory Test Result

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DATA SOURCES / REFERENCES:
USGS: 7.5' SERIES TOPOGRAPHIC MAPS, ESRI/I-CUBED/NATIONAL GEOGRAPHIC SOCIETY 2013
SKAGIT CO: STREETS, CITY LIMITS, PARCELS, 7/20
LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE



NOTE: BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION



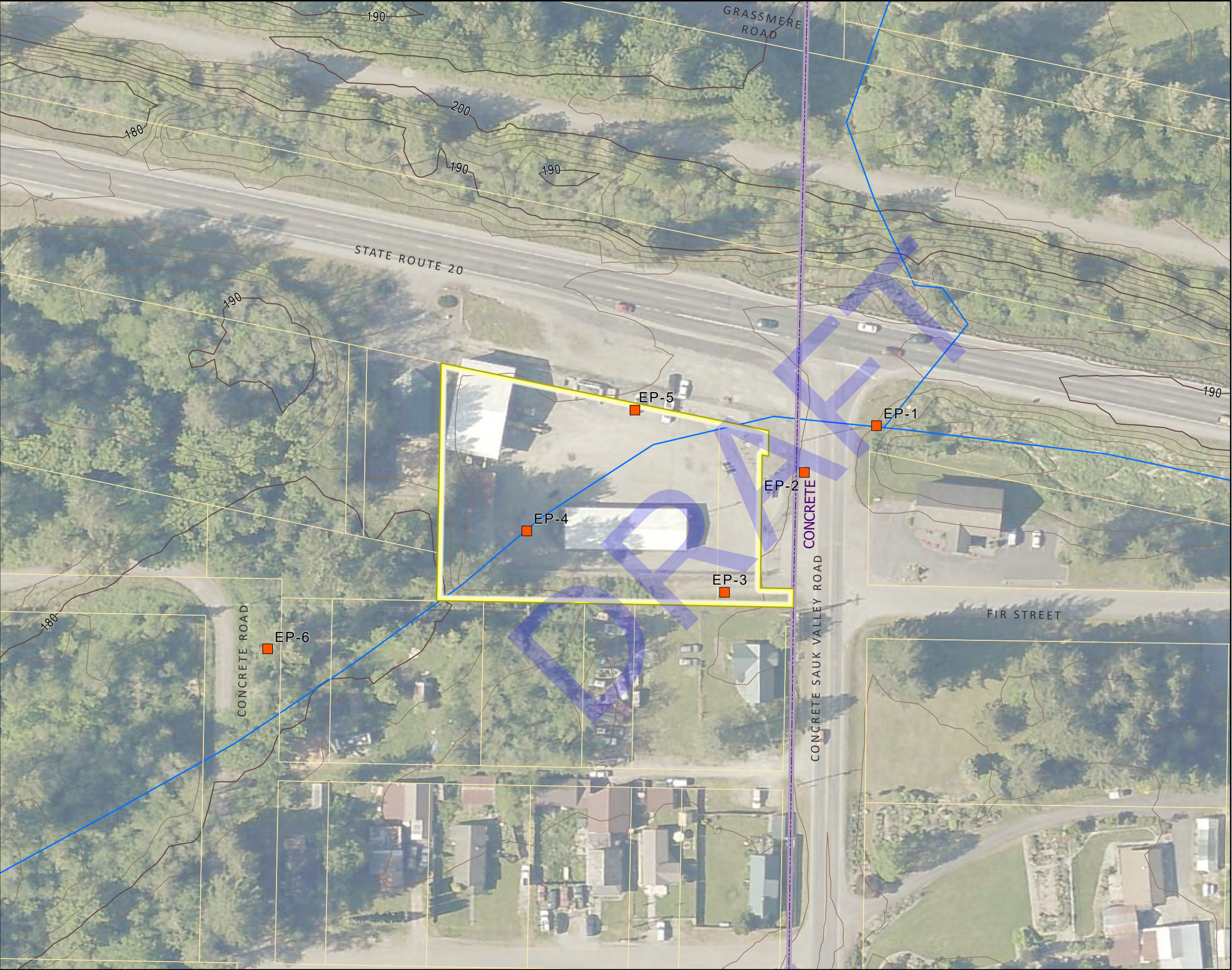
associated
earth sciences
incorporated

VICINITY MAP

LORENZAN CREEK STORMWATER
SKAGIT COUNTY, WASHINGTON

PROJ NO.	20210020E001	DATE:	11/21	FIGURE:	1
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LEGEND

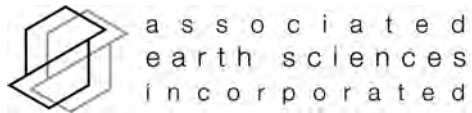
- SITE
- EXPLORATION PIT
- CITY LIMITS
- STREAM
- PARCEL
- CONTOUR 10 FT
- CONTOUR 2 FT

DATA SOURCES / REFERENCES:
WA STATE LIDAR PORTAL: NORTH PUGET SOUND 2016
ACQUIRED MARCH - SEPT 2016, GRID CELL SIZE IS 3'
CONTOURS FROM LIDAR
SKAGIT CO.: PARCELS, ROADS, CITY 7/20
WA DNR: STREAMS 10/21
AERIAL PICTOMETRY INT. 2019

LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE



BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION



EXISTING SITE AND
EXPLORATION PLAN

LORENZAN CREEK STORMWATER
SKAGIT COUNTY, WASHINGTON

PROJ NO. 20210020E001	DATE: 11/21	FIGURE: 2
--------------------------	----------------	--------------

APPENDIX A

Exploration Logs

DRAFT

EXPLORATION PIT NO. EP-1

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.	
	DESCRIPTION	<u>Elevation (ft): ~200</u>
	Sod - 6 inches	
	Fill	
1	Medium dense, moist, grayish brown, gravelly, SAND, some cobbles, trace silt; unsorted (SP).	
2		
3		
4	Pea gravel with "buried waterline" tape exposed.	
5	Bottom of exploration pit at depth 4 feet due to potential conflicting utility. No seepage. No caving.	
6		
7		
8		
9		
10		
11		
12		

Lorenzan Creek Stormwater Concrete, WA

Logged by: JH
Approved by: ???



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10/7/21

EXPLORATION PIT NO. EP-2

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.	
	DESCRIPTION	<u>Elevation (ft): ~200</u>
	Crushed Rock - 3 inches	
	Fill	
1	Medium dense, moist, gray, very gravelly, SAND, some cobbles, trace silt; unsorted (SP).	
2		
3		
4		
5		
6	Loose to medium dense, moist to very moist, brown, silty, SAND, some gravel, trace to some deleterious debris (concrete, bottles, metal pieces), trace fine organics; unsorted (SM).	
7		
8	Bottom of exploration pit at depth 7.5 feet No seepage. Moderate to heavy caving at 6 feet.	
9		
10		
11		
12		

Lorenzan Creek Stormwater Concrete, WA

Logged by: JH
Approved by: ???



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Project No. 20210020E001

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EXPLORATION PIT NO. EP-3

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.	
	DESCRIPTION	<u>Elevation (ft): ~200</u>
	Asphalt - 4 inches	
	Fill	
1	Medium dense to dense, moist, brown to grayish brown, gravelly, SAND, some cobbles, trace silt; unsorted (SP).	
2		
3	Quaternary Alluvium	
4	Topsoil ??? consisting of loose, moist, dark brown, silty, SAND, some fine organics; unsorted (SM). Medium dense to dense, moist, orangish brown, very gravelly, SAND, some sub-round to round cobbles; lightly stratified (SP).	
5	Medium dense to dense, moist, gray, gravelly, SAND, some sub-round to round cobbles, trace sub-round to round boulders; lightly stratified (SP).	
6		
7		
8		
9		
10	Bottom of exploration pit at depth 9 feet No seepage. Slight caving at 8 feet.	
11		
12		

Lorenzan Creek Stormwater Concrete, WA

Logged by: JH
Approved by: ???



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Project No. 20210020E001

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EXPLORATION PIT NO. EP-4

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered. DESCRIPTION <u>Elevation (ft): ~200</u>
1	Fill Medium dense, moist, brownish gray, gravelly, SAND, some cobbles, trace silt; unsorted (SP).
2	
3	
4	Subrounded granitic boulder (3 feet in diameter) encountered at 3.5 feet
5	
6	Turns loose, moist, dark brown, silt, SAND, some gravel, trace deleterious debris (bottles, brick pieces); unsorted (SM).
7	Quaternary Alluvium Medium dense to dense, moist, orangish brown to grayish brown, very gravelly, SAND, some sub-round to round cobbles, trace subround boulders (1 to 2 feet in diameter); unsorted (SP).
8	
9	
10	
11	Bottom of exploration pit at depth 10 feet No seepage. Slight caving at 7 feet.
12	

Lorenzan Creek Stormwater Concrete, WA

Logged by: JH
Approved by: ???



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Project No. 20210020E001

10/7/21

EXPLORATION PIT NO. EP-5

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.
	DESCRIPTION Elevation (ft): ~200
	Asphalt - 3 inches
	Fill
1	Medium dense, moist, grayish brown, gravelly, SAND, trace to some cobbles, trace silt; unsorted (SP).
2	
3	
4	
5	
6	Loose to medium dense, moist, brown to dark brown, silty, SAND, some fine organics and woody debris, trace cobbles; unsorted (SM). Two sub-round boulders and deleterious debris (plastic pieces) encountered at 6 feet.
7	
8	
9	
	Quaternary Alluvium ?
10	Medium dense, moist to very moist, orangish brown, gravelly, SAND, some sub-round to round cobbles; unsorted (SP).
11	Bottom of exploration pit at depth 10 feet No seepage. Slight to moderate caving at 8 feet.
12	

Lorenzan Creek Stormwater Concrete, WA

Logged by: JH
Approved by: ???



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EXPLORATION PIT NO. EP-6

Depth (ft)	DESCRIPTION	<u>Elevation (ft): ~200</u>
	Quaternary Alluvium	
	Topsoil ??? consisting of loose, moist, dark brown, silty, SAND, trace to some gravel, trace surficial debris (bottles and wood pieces) (___).	
1	Medium dense, moist, brownish gray, very gravelly, SAND, some sub-round to round cobbles, trace to some sub-round to round boulders (one to two feet in diameter); lightly stratified (SP).	
2		
3		
4		
5	Medium dense to dense, moist, light brown, very gravelly, SAND, trace to some small cobbles; lightly stratified (SP).	
6		
7	Bottom of exploration pit at depth 6 feet No seepage. No caving.	
8		
9		
10		
11		
12		

Lorenzan Creek Stormwater Concrete, WA

Logged by: JH
Approved by: ???



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Project No. 20210020E001

10/7/21

EXPLORATION PIT NO. EP-1

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.	
	DESCRIPTION Elevation (ft): ~200	
	Sod - 6 inches	
	Fill	
1	Medium dense, moist, grayish brown, gravelly, SAND, some cobbles, trace silt; unsorted (SP).	
2		
3		
4	Pea gravel with "buried waterline" tape exposed.	
5	Bottom of exploration pit at depth 4 feet due to potential conflicting utility. No seepage. No caving.	
6		
7		
8		
9		
10		
11		
12		

Lorenzan Creek Stormwater Concrete, WA

Logged by: JH
Approved by: JC



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Project No. 20210020E001

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EXPLORATION PIT NO. EP-2

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.	
	DESCRIPTION	<u>Elevation (ft): ~200</u>
	Crushed Rock - 3 inches	
	Fill	
1	Medium dense, moist, gray, very gravelly, SAND, some cobbles, trace silt; unsorted (SP).	
2		
3		
4		
5		
6	Loose to medium dense, moist to very moist, brown, silty, SAND, some gravel, trace to some deleterious debris (concrete, bottles, metal pieces), trace fine organics; unsorted (SM).	
7		
8	Bottom of exploration pit at depth 7.5 feet No seepage. Moderate to heavy caving at 6 feet.	
9		
10		
11		
12		

Lorenzan Creek Stormwater Concrete, WA

Logged by: JH
Approved by: JC



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Project No. 20210020E001

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EXPLORATION PIT NO. EP-3

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.	
	DESCRIPTION	<u>Elevation (ft): ~200</u>
	Asphalt - 4 inches	
	Fill	
1	Medium dense to dense, moist, brown to grayish brown, gravelly, SAND, some cobbles, trace silt; unsorted (SP).	
2		
3	Quaternary Alluvium	
	Remnant topsoil layer (6 inches thick).	
4	Medium dense to dense, moist, orangish brown, very gravelly, SAND, some sub-round to round cobbles; lightly stratified (SP).	
5	Medium dense to dense, moist, brownish gray, gravelly, SAND, some sub-round to round cobbles, trace sub-round to round boulders; lightly stratified (SP).	
6		
7		
8		
9		
10	Bottom of exploration pit at depth 9 feet No seepage. Slight caving at 8 feet.	
11		
12		

Lorenzan Creek Stormwater Concrete, WA

Logged by: JH
Approved by: JC



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EXPLORATION PIT NO. EP-4

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered. DESCRIPTION <u>Elevation (ft): ~200</u>
1	Fill Medium dense, moist, brownish gray, gravelly, SAND, some cobbles, trace silt; unsorted (SP).
2	
3	
4	Subrounded granitic boulder (3 feet in diameter) encountered at 3.5 feet
5	
6	Turns loose, moist, dark brown, silt, SAND, some gravel, trace deleterious debris (bottles, brick pieces); unsorted (SM). Rootlets 0 to 7 feet.
7	Quaternary Alluvium Medium dense to dense, moist, orangish brown to grayish brown, very gravelly, SAND, some sub-round to round cobbles, trace subround boulders (1 to 2 feet in diameter); unsorted (SP).
8	
9	
10	
11	Bottom of exploration pit at depth 10 feet No seepage. Slight caving at 7 feet.
12	

Lorenzan Creek Stormwater Concrete, WA

Logged by: JH
Approved by: JC



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Project No. 20210020E001

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EXPLORATION PIT NO. EP-5

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.	
	DESCRIPTION	<u>Elevation (ft): ~200</u>
	Asphalt - 3 inches	
	Fill	
1	Medium dense, moist, grayish brown, gravelly, SAND, trace to some cobbles, trace silt; unsorted (SP).	
2		
3		
4		
5		
6	Loose to medium dense, moist, brown to dark brown, silty, SAND, some fine organics and woody debris, trace cobbles; unsorted (SM). Two sub-round boulders and deleterious debris (plastic pieces) encountered at 6 feet.	
7		
8		
9		
10	Medium dense, moist to very moist, orangish brown, gravelly, SAND, some sub-round to round cobbles; unsorted (SP).	
11	Bottom of exploration pit at depth 10 feet No seepage. Slight to moderate caving at 8 feet.	
12		

Lorenzan Creek Stormwater Concrete, WA

Logged by: JH
Approved by: JC



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Project No. 20210020E001

10/7/21

EXPLORATION PIT NO. EP-6

Depth (ft)	DESCRIPTION	<u>Elevation (ft): ~200</u>
1	Topsoil Loose, moist, dark brown, silty, SAND, trace to some gravel, trace surficial debris (bottles and wood pieces) (___).	
2	Quaternary Alluvium Medium dense, moist, brownish gray, very gravelly, SAND, some sub-round to round cobbles, trace to some sub-round to round boulders (one to two feet in diameter), trace to some silt; lightly stratified (SP).	
3		
4		
5	Medium dense to dense, moist, light brown to grayish brown, very gravelly, SAND, trace to some small cobbles; lightly stratified (SP).	
6		
7	Bottom of exploration pit at depth 6 feet No seepage. No caving.	
8		
9		
10		
11		
12		

Lorenzan Creek Stormwater Concrete, WA

Logged by: JH
Approved by: JC



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EXPLORATION PIT NO. EP-1

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.	
	DESCRIPTION Elevation (ft): ~200	
	Sod - 6 inches	
	Fill	
1	Medium dense, moist, grayish brown, gravelly, SAND, some cobbles, trace silt; unsorted (SP).	
2		
3		
4	Pea gravel with "buried waterline" tape exposed.	
5	Bottom of exploration pit at depth 4 feet due to potential conflicting utility. No seepage. No caving.	
6		
7		
8		
9		
10		
11		
12		

Lorenzan Creek Stormwater Concrete, WA

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Approved by: JC



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EXPLORATION PIT NO. EP-2

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.	
	DESCRIPTION	<u>Elevation (ft): ~200</u>
	Crushed Rock - 3 inches	
	Fill	
1	Medium dense, moist, gray, very gravelly, SAND, some cobbles, trace silt; unsorted (SP).	
2		
3		
4		
5		
6	Loose to medium dense, moist to very moist, brown, silty, SAND, some gravel, trace to some deleterious debris (concrete, bottles, metal pieces), trace fine organics; unsorted (SM).	
7		
8	Bottom of exploration pit at depth 7.5 feet No seepage. Moderate to heavy caving at 6 feet.	
9		
10		
11		
12		

Lorenzan Creek Stormwater Concrete, WA

Logged by: JH
Approved by: JC



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EXPLORATION PIT NO. EP-3

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered. DESCRIPTION <u>Elevation (ft): ~200</u>
1	Asphalt - 4 inches Fill Medium dense to dense, moist, brown to grayish brown, gravelly, SAND, some cobbles, trace silt; unsorted (SP).
2	
3	Quaternary Alluvium Remnant topsoil layer (6 inches thick).
4	Medium dense to dense, moist, orangish brown, very gravelly, SAND, some sub-round to round cobbles; lightly stratified (SP).
5	Medium dense to dense, moist, brownish gray, gravelly, SAND, some sub-round to round cobbles, trace sub-round to round boulders; lightly stratified (SP).
6	
7	
8	
9	
10	Bottom of exploration pit at depth 9 feet No seepage. Slight caving at 8 feet.
11	
12	

Lorenzan Creek Stormwater Concrete, WA

Logged by: JH
Approved by: JC



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Project No. 20210020E001

10/7/21

EXPLORATION PIT NO. EP-4

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.	
	DESCRIPTION <u>Elevation (ft): ~200</u>	
	Fill Medium dense, moist, brownish gray, gravelly, SAND, some cobbles, trace silt; unsorted (SP).	
1		
2		
3		
4	Subrounded granitic boulder (3 feet in diameter) encountered at 3.5 feet	
5		
6	Turns loose, moist, dark brown, silt, SAND, some gravel, trace deleterious debris (bottles, brick pieces); unsorted (SM). Rootlets 0 to 7 feet.	
7	Quaternary Alluvium Medium dense to dense, moist, orangish brown to grayish brown, very gravelly, SAND, some sub-round to round cobbles, trace subround boulders (1 to 2 feet in diameter); unsorted (SP).	
8		
9		
10		
11	Bottom of exploration pit at depth 10 feet No seepage. Slight caving at 7 feet.	
12		

Lorenzan Creek Stormwater Concrete, WA

Logged by: JH
Approved by: JC



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Project No. 20210020E001

10/7/21

EXPLORATION PIT NO. EP-5

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.	
	DESCRIPTION	<u>Elevation (ft): ~200</u>
	Asphalt - 3 inches	
	Fill	
1	Medium dense, moist, grayish brown, gravelly, SAND, trace to some cobbles, trace silt; unsorted (SP).	
2		
3		
4		
5		
6	Loose to medium dense, moist, brown to dark brown, silty, SAND, some fine organics and woody debris, trace cobbles; unsorted (SM). Two sub-round boulders and deleterious debris (plastic pieces) encountered at 6 feet.	
7		
8		
9		
10	Medium dense, moist to very moist, orangish brown, gravelly, SAND, some sub-round to round cobbles; unsorted (SP).	
11	Bottom of exploration pit at depth 10 feet No seepage. Slight to moderate caving at 8 feet.	
12		

Lorenzan Creek Stormwater Concrete, WA

Logged by: JH
Approved by: JC



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EXPLORATION PIT NO. EP-6

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.	
	DESCRIPTION <u>Elevation (ft): ~200</u>	
	Topsoil	
1	Quaternary Alluvium	
	Medium dense, moist, brownish gray, very gravelly, SAND, some sub-round to round cobbles, trace to some silt, trace to some sub-round to round boulders (one to two feet in diameter), trace to some silt; lightly stratified (SP).	
2		
3		
4	Medium dense to dense, moist, light brown to grayish brown, very gravelly, SAND, trace to some small cobbles; lightly stratified (SP).	
5		
6	Bottom of exploration pit at depth 6 feet No seepage. No caving.	
7		
8		
9		
10		
11		
12		

Lorenzan Creek Stormwater Concrete, WA

Logged by: JH
Approved by: JC



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i n c o r p o r a t e d

Project No. 20210020E001

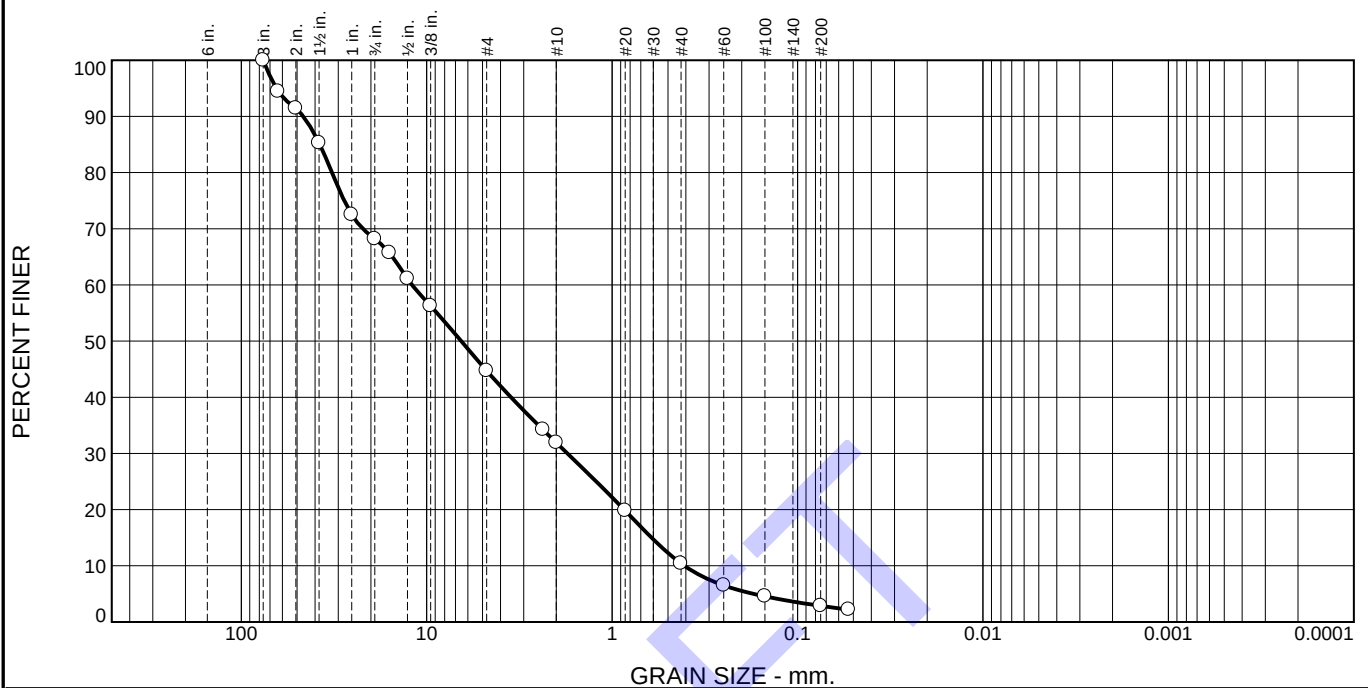
10/7/21

APPENDIX B

Laboratory Test Result

DRAFT

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	31.8	23.5	12.8	21.5	7.5	2.9	

TEST RESULTS			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3"	100.0		
2.5"	94.5		
2"	91.5		
1.5"	85.3		
1"	72.5		
3/4"	68.2		
5/8"	65.7		
1/2"	61.1		
3/8"	56.3		
#4	44.7		
#8	34.2		
#10	31.9		
#20	19.8		
#40	10.4		
#60	6.5		
#100	4.6		
#200	2.9		
#270	2.2		

* (no specification provided)

Material Description

very sandy GRAVEL, trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= GP AASHTO (M 145)= A-1-a

Coefficients

D₉₀= 46.2875 D₈₅= 37.7248 D₆₀= 11.9873
D₅₀= 6.5172 D₃₀= 1.7420 D₁₅= 0.6124
D₁₀= 0.4079 C_u= 29.38 C_c= 0.62

Remarks

Date Received: 10/26/2021 Date Tested: 11/1/2021

Tested By: CI

Checked By: JOH/MM

Title:

Location: Onsite - Alluvium

Sample Number: EP-3

Depth: 3'-9'

Date Sampled: 10/26/2021



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Client: Herrera Environmental Consultants

Project: Lorenzan Creek Stormwater

Project No: 20210020 E001

Figure

Am Test Inc.
13600 NE 126TH PL
Suite C
Kirkland, WA 98034
(425) 885-1664
www.amtestlab.com



Professional
Analytical
Services

ANALYSIS REPORT

Associated Earth Sciences
911 - 5th Avenue
Kirkland, WA 98033
Attention: CATHERIN IKEDA
Project Name: LORENZAN CREEK
Project #: 20210020 E001
All results reported on an as received basis.

Date Received: 11/02/21
Date Reported: 11/17/21

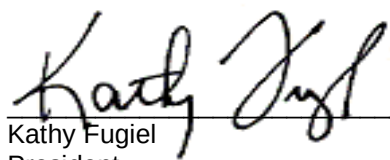
AMTEST Identification Number 21-A016808
Client Identification 20210020EP-3
Sampling Date 10/27/21

Conventionals

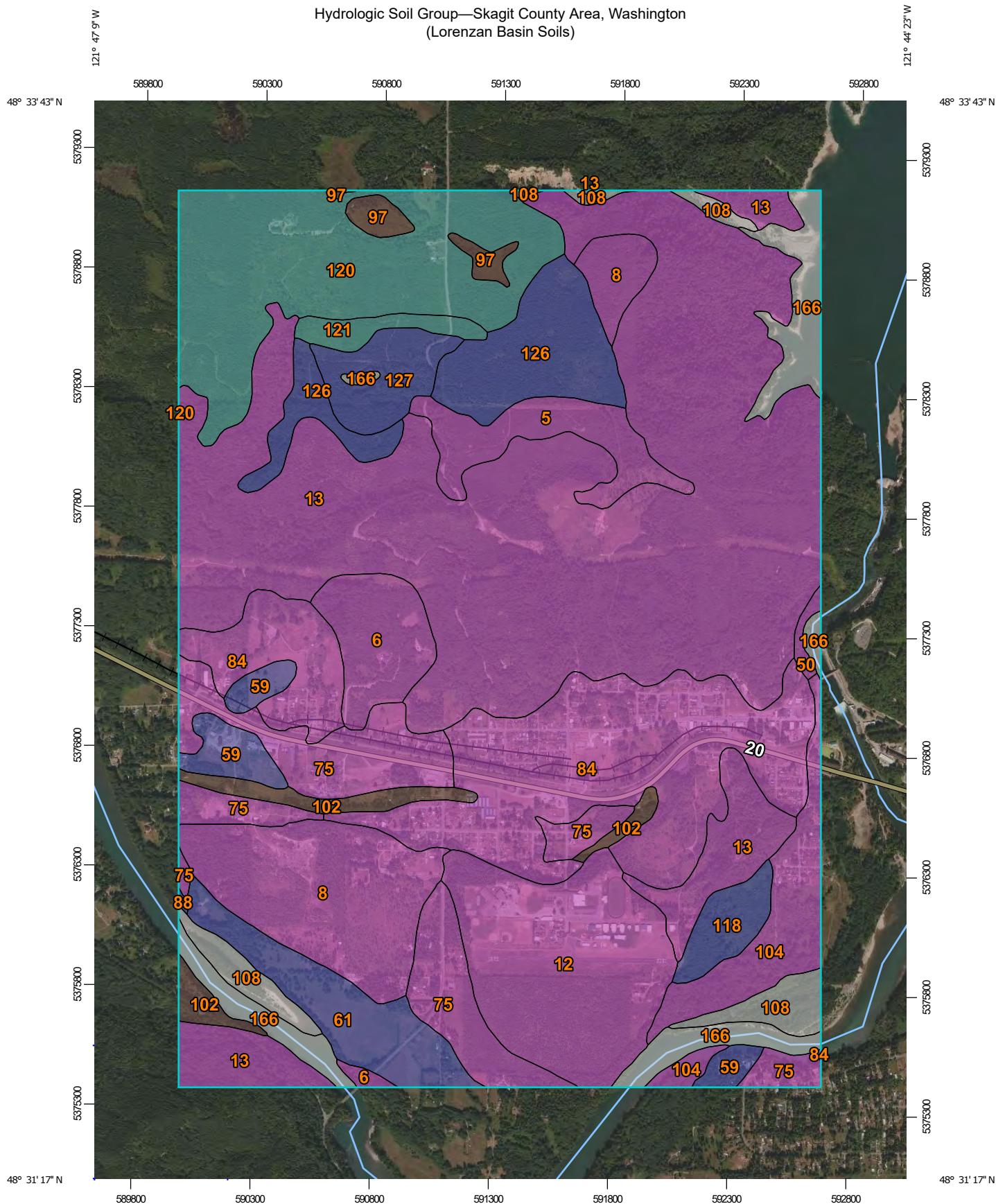
PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Cation Exchange Capacity	7.5	meq/100g		0.5	SW-846 9081	JDR	11/08/21

Miscellaneous

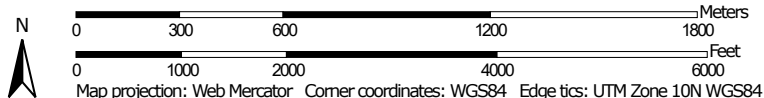
PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANLST	DATE
Organic Matter	2.1	%			SM 2540G	MD	11/08/21


Kathy Fugiel
President

Hydrologic Soil Group—Skagit County Area, Washington (Lorenzan Basin Soils)



Map Scale: 1:21,900 if printed on A portrait (8.5" x 11") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84



**Natural Resources
Conservation Service**

Web Soil Survey
National Cooperative Soil Survey

12/15/2021
Page 1 of 4

Hydrologic Soil Group—Skagit County Area, Washington
(Lorenzan Basin Soils)

MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

Soil Rating Polygons

 A
 A/D
 B
 B/D
 C
 C/D
 D
 Not rated or not available

Soil Rating Lines

 A
 A/D
 B
 B/D
 C
 C/D
 D
 Not rated or not available

Soil Rating Points

 A
 A/D
 B
 B/D

 C
 C/D
 D
 Not rated or not available

Water Features

 Streams and Canals

Transportation

 Rails
 Interstate Highways
 US Routes
 Major Roads
 Local Roads

Background

 Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service

Web Soil Survey URL:

Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Skagit County Area, Washington

Survey Area Data: Version 21, Aug 31, 2021

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jul 25, 2010—Sep 29, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
5	Barneston gravelly ashy loam, 0 to 8 percent slopes	A	55.5	2.2%
6	Barneston gravelly ashy loam, 8 to 30 percent slopes	A	56.5	2.3%
8	Barneston very cobbly sandy loam, 0 to 8 percent slopes	A	151.9	6.1%
12	Birdsview loamy sand, 0 to 8 percent slopes	A	165.2	6.6%
13	Birdsview loamy sand, 50 to 80 percent slopes	A	855.2	34.1%
50	Dystic Xerorthents, 50 to 80 percent slopes	A	4.3	0.2%
59	Giles silt loam	B	36.8	1.5%
61	Gilligan silt loam	B	69.4	2.8%
75	Indianola loamy sand, 0 to 5 percent slopes	A	156.5	6.2%
84	Kline very gravelly sandy loam, 0 to 8 percent slopes	A	300.7	12.0%
88	Larush silt loam	B	0.6	0.0%
97	Mukilteo muck	B/D	15.5	0.6%
102	Norma silt loam	B/D	35.6	1.4%
104	Pilchuck loamy sand	A	68.7	2.7%
108	Riverwash		44.9	1.8%
118	Sedrowoolley silt loam	B	25.5	1.0%
120	Sehome loam, 8 to 15 percent slopes	C	217.8	8.7%
121	Sehome gravelly loam, 15 to 30 percent slopes	C	17.4	0.7%
126	Skiyou gravelly silt loam, 3 to 15 percent slopes	B	102.1	4.1%
127	Skiyou gravelly silt loam, 15 to 30 percent slopes	B	40.5	1.6%
166	Water		85.4	3.4%
Totals for Area of Interest			2,506.1	100.0%

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

APPENDIX H

Hydrologic and Hydraulic Modeling Results



Figure 1.
Lorenzan Creek
Hydraulic Model Results
Existing Conditions

Legend

 Model Boundary

2-yr Flood Depth
(feet)

 < 0.5

 0.5 - 1.0

 1 - 2

 2 - 3

 3 - 4

 4 - 5

 5 - 6

 6 - 7

Background: 2019 NAIP Imagery



0 50 100 200 300 400 500
Feet



Coordinates:
NAD 1983 StatePlane Washington North FIPS 4601 Feet



Figure 2.
Lorenzan Creek
Hydraulic Model Results
Existing Conditions

Legend

 Model Boundary

10-yr Flood Depth
(feet)

 < 0.5

 0.5 - 1.0

 1 - 2

 2 - 3

 3 - 4

 4 - 5

 5 - 6

 6 - 7

Background: 2019 NAIP Imagery



0 50 100 200 300 400 500
Feet



Coordinates:
NAD 1983 StatePlane Washington North FIPS 4601 Feet

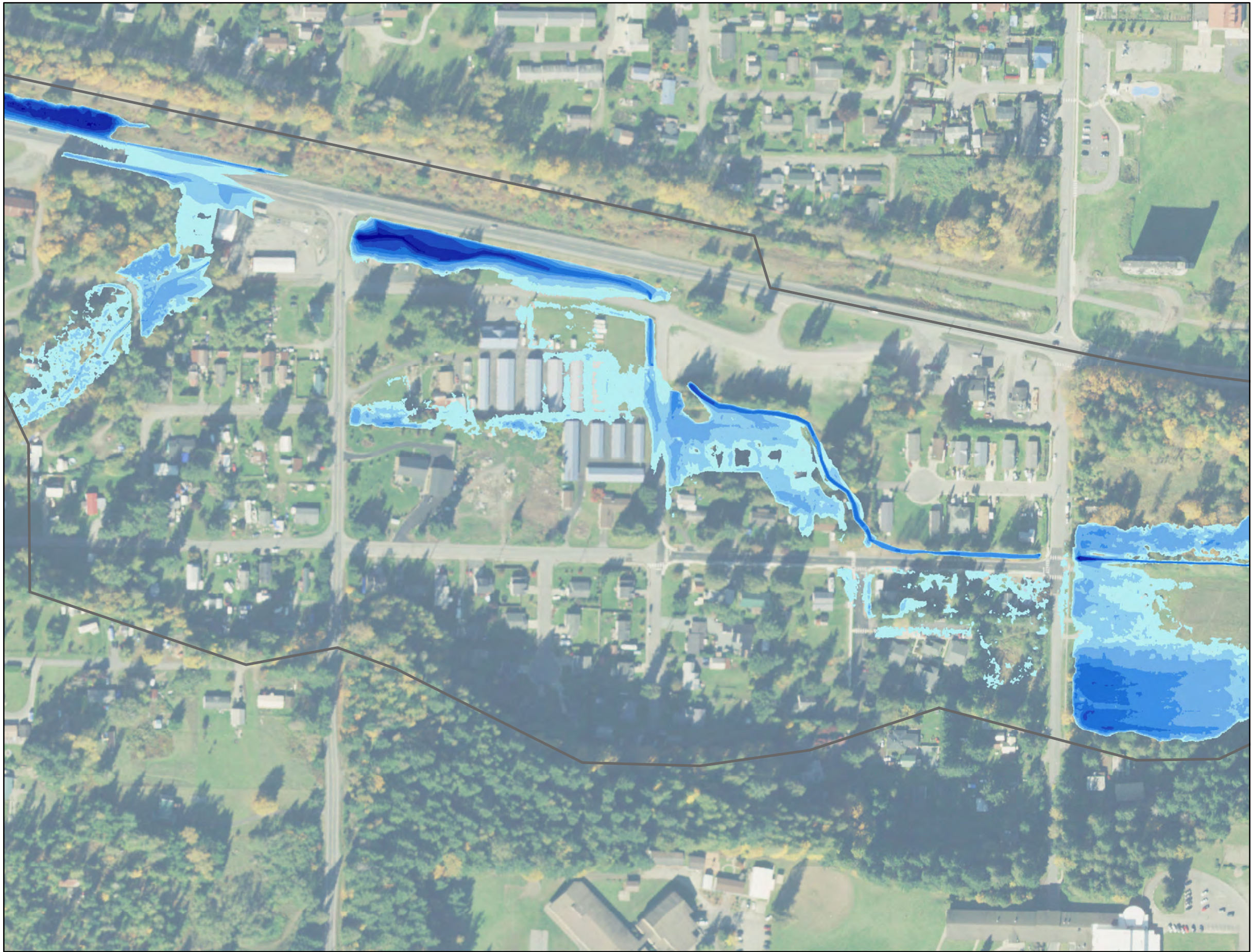


Figure 3.
Lorenzan Creek
Hydraulic Model Results
Existing Conditions

Legend

 Model Boundary

**100-yr Flood Depth
(feet)**

 < 0.5

 0.5 - 1.0

 1 - 2

 2 - 3

 3 - 4

 4 - 5

 5 - 6

 6 - 7

Background: 2019 NAIP Imagery



0 50 100 200 300 400 500
Feet



Coordinates:
NAD 1983 StatePlane Washington North FIPS 4601 Feet

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Figure 4.
Lorenzan Creek
Hydraulic Model Results
Existing Conditions

Legend

 Model Boundary

2-yr Flood Velocity
(feet/second)

 < 0.5

 0.5 - 1.0

 1 - 2

 2 - 3

 3 - 4

 4 - 5

Background: 2019 NAIP Imagery



0 50 100 200 300 400 500
Feet



Coordinates:
NAD 1983 StatePlane Washington North FIPS 4601 Feet



Figure 5.
Lorenzan Creek
Hydraulic Model Results
Existing Conditions

Legend

 Model Boundary

10-yr Flood Velocity
(feet/second)

 < 0.5

 0.5 - 1.0

 1 - 2

 2 - 3

 3 - 4

 4 - 5

Background: 2019 NAIP Imagery



0 50 100 200 300 400 500
Feet



Coordinates:
NAD 1983 StatePlane Washington North FIPS 4601 Feet



Figure 6.
Lorenzan Creek
Hydraulic Model Results
Existing Conditions

Legend

 Model Boundary

100-yr Flood Velocity
(feet/second)

 < 0.5

 0.5 - 1.0

 1 - 2

 2 - 3

 3 - 4

 4 - 5

Background: 2019 NAIP Imagery



0 50 100 200 300 400 500
Feet



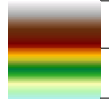
Coordinates:
NAD 1983 StatePlane Washington North FIPS 4601 Feet

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Figure 7.
Lorenzan Creek
Hydraulic Model Results
Existing Conditions

Legend

-  Model Boundary
-  2-yr WSEL 1ft Contours
- 2-yr Water Surface Elevation**
(feet - NAVD88)
 -  High : 220.1
 -  Low : 174.7

Background: 2019 NAIP Imagery



0 50 100 200 300 400 500
Feet



Coordinates:
NAD 1983 StatePlane Washington North FIPS 4601 Feet



Figure 8.
Lorenzan Creek
Hydraulic Model Results
Existing Conditions

Legend

-  Model Boundary
-  10-yr WSEL 1ft Contours
- 10-yr Water Surface Elevation**
(feet - NAVD88)
 -  High : 220.1
 -  Low : 174.7

Background: 2019 NAIP Imagery



0 50 100 200 300 400 500
Feet



Coordinates:
NAD 1983 StatePlane Washington North FIPS 4601 Feet



Figure 9.
Lorenzan Creek
Hydraulic Model Results
Existing Conditions

Legend

-  Model Boundary
-  100-yr WSEL 1ft Contours
- 100-yr Water Surface Elevation**
(feet - NAVD88)
 -  High : 220.1
 -  Low : 174.7

Background: 2019 NAIP Imagery



0 50 100 200 300 400 500
Feet



Coordinates:
NAD 1983 StatePlane Washington North FIPS 4601 Feet

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WWHM2012
PROJECT REPORT

General Model Information

Project Name: 21-1220_LorenzanCreek
Site Name: Skagit County Shop
Site Address:
City:
Report Date: 1/14/2022
Gage: Burlington
Data Start: 1948/10/01
Data End: 2009/09/30
Timestep: 15 Minute
Precip Scale: 1.333
Version Date: 2021/08/18
Version: 4.2.18

POC Thresholds

Low Flow Threshold for POC1:	50 Percent of the 2 Year
High Flow Threshold for POC1:	50 Year

Low Flow Threshold for POC2:	50 Percent of the 2 Year
High Flow Threshold for POC2:	50 Year

Low Flow Threshold for POC3:	50 Percent of the 2 Year
High Flow Threshold for POC3:	50 Year

Low Flow Threshold for POC4:	50 Percent of the 2 Year
High Flow Threshold for POC4:	50 Year

Landuse Basin Data

Predeveloped Land Use

Analysis Point #3

Bypass: No

GroundWater: No

Pervious Land Use acre
A B, Forest, Steep 349

Pervious Total 349

Impervious Land Use acre

Impervious Total 0

Basin Total 349

Element Flows To:		
Surface	Interflow	Groundwater

Analysis Point #2

Bypass: No

GroundWater: No

Pervious Land Use acre
A B, Forest, Flat 107.7

Pervious Total 107.7

Impervious Land Use acre

Impervious Total 0

Basin Total 107.7

Element Flows To:		
Surface	Interflow	Groundwater

Analysis Point #1

Bypass: No

GroundWater: No

Pervious Land Use acre
A B, Forest, Mod 127.3

Pervious Total 127.3

Impervious Land Use acre

Impervious Total 0

Basin Total 127.3

Element Flows To:		
Surface	Interflow	Groundwater

Basin 2+3

Bypass: No

GroundWater: No

Pervious Land Use	acre
A B, Forest, Steep	349
A B, Forest, Flat	107.7

Pervious Total 456.7

Impervious Land Use acre

Impervious Total 0

Basin Total 456.7

Element Flows To:		
Surface	Interflow	Groundwater

Mitigated Land Use

Analysis Point #1

Bypass: No

GroundWater: No

Pervious Land Use acre

A B, Forest, Mod 68.8

A B, Lawn, Mod 40

Pervious Total 108.8

Impervious Land Use acre

ROADS FLAT 18.5

Impervious Total 18.5

Basin Total 127.3

Element Flows To:

Surface

Interflow

Groundwater

Analysis Point #2

Bypass: No

GroundWater: No

Pervious Land Use acre

A B, Forest, Flat 62.7

A B, Lawn, Flat 32.3

Pervious Total 95

Impervious Land Use acre

ROADS FLAT 12.7

Impervious Total 12.7

Basin Total 107.7

Element Flows To:
Surface

Interflow

Groundwater

Basin 3

Bypass: No

GroundWater: No

Pervious Land Use acre

A B, Forest, Steep 278

A B, Lawn, Steep 50.6

Pervious Total 328.6

Impervious Land Use acre

ROADS FLAT 20.4

Impervious Total 20.4

Basin Total 349

Element Flows To:
Surface

Interflow

Groundwater

Basin 4

Bypass: No

GroundWater: No

Pervious Land Use	acre
A B, Forest, Flat	62.7
A B, Forest, Steep	278
A B, Lawn, Flat	32.3
A B, Lawn, Steep	50.6

Pervious Total 423.6

Impervious Land Use	acre
ROADS FLAT	33.1

Impervious Total 33.1

Basin Total 456.7

Element Flows To:		
Surface	Interflow	Groundwater

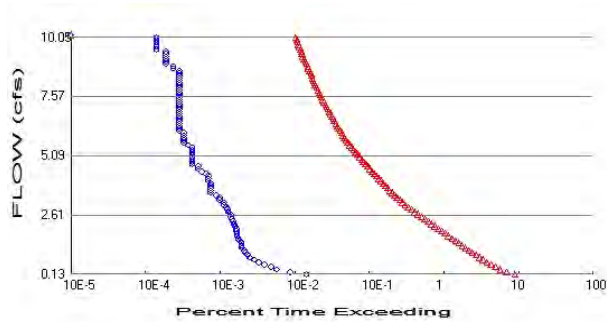
Routing Elements

Predeveloped Routing

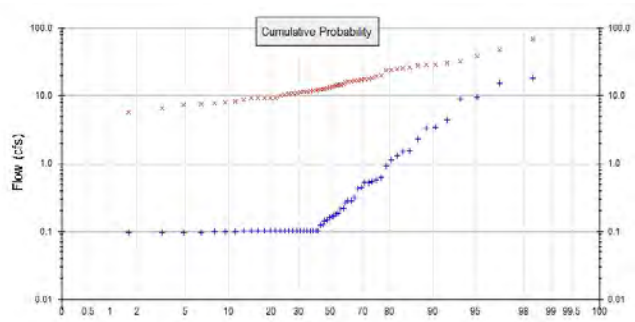
Mitigated Routing

Analysis Results

POC 1



+ Predeveloped x Mitigated



Predeveloped Landuse Totals for POC #1

Total Pervious Area: 127.3
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1

Total Pervious Area: 108.8
Total Impervious Area: 18.5

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	0.25472
5 year	0.953112
10 year	2.102026
25 year	5.291048
50 year	10.045783
100 year	18.439173

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	13.900535
5 year	21.924874
10 year	28.526126
25 year	38.513108
50 year	47.267413
100 year	57.253208

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	Predeveloped	Mitigated
1949	9.483	31.910
1950	0.102	9.254
1951	0.439	29.228
1952	0.633	17.395
1953	0.103	20.153
1954	3.470	16.854
1955	0.102	7.957
1956	0.102	5.737
1957	0.217	26.190
1958	0.094	12.240

1959	1.128	10.485
1960	1.509	19.570
1961	0.103	10.991
1962	0.098	12.536
1963	0.101	13.276
1964	0.168	11.038
1965	0.144	24.016
1966	0.102	9.236
1967	0.102	17.839
1968	0.126	14.739
1969	0.102	9.267
1970	0.100	17.639
1971	8.907	25.408
1972	0.526	8.893
1973	0.282	11.761
1974	0.447	13.855
1975	15.422	47.864
1976	0.102	28.473
1977	0.096	11.573
1978	0.536	16.342
1979	0.186	11.940
1980	0.129	18.449
1981	0.098	12.518
1982	0.940	12.094
1983	0.101	14.551
1984	2.290	17.080
1985	0.161	14.064
1986	0.314	9.208
1987	0.102	8.373
1988	0.102	28.385
1989	0.281	10.847
1990	0.573	15.906
1991	1.544	23.739
1992	0.148	13.032
1993	0.215	7.734
1994	0.100	7.556
1995	0.095	6.650
1996	3.357	30.202
1997	18.161	69.004
1998	1.325	11.360
1999	0.103	5.785
2000	0.097	15.039
2001	0.101	10.038
2002	0.181	7.446
2003	0.101	9.228
2004	0.101	38.665
2005	0.102	11.934
2006	4.477	25.916
2007	0.268	16.158
2008	0.524	13.873
2009	0.166	12.544

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	18.1611	69.0039
2	15.4222	47.8637
3	9.4828	38.6653

4	8.9067	31.9102
5	4.4769	30.2017
6	3.4700	29.2279
7	3.3568	28.4729
8	2.2895	28.3850
9	1.5444	26.1896
10	1.5093	25.9161
11	1.3253	25.4080
12	1.1276	24.0162
13	0.9401	23.7393
14	0.6327	20.1533
15	0.5730	19.5699
16	0.5358	18.4490
17	0.5260	17.8388
18	0.5239	17.6388
19	0.4469	17.3948
20	0.4393	17.0799
21	0.3143	16.8542
22	0.2820	16.3423
23	0.2805	16.1577
24	0.2679	15.9057
25	0.2168	15.0394
26	0.2151	14.7390
27	0.1856	14.5508
28	0.1806	14.0640
29	0.1684	13.8732
30	0.1657	13.8553
31	0.1612	13.2762
32	0.1476	13.0322
33	0.1437	12.5444
34	0.1287	12.5360
35	0.1257	12.5184
36	0.1027	12.2403
37	0.1026	12.0936
38	0.1026	11.9395
39	0.1024	11.9339
40	0.1024	11.7607
41	0.1024	11.5733
42	0.1024	11.3604
43	0.1021	11.0378
44	0.1021	10.9907
45	0.1021	10.8473
46	0.1019	10.4845
47	0.1019	10.0376
48	0.1017	9.2667
49	0.1013	9.2545
50	0.1012	9.2357
51	0.1011	9.2279
52	0.1011	9.2078
53	0.1006	8.8934
54	0.1002	8.3732
55	0.0997	7.9567
56	0.0979	7.7336
57	0.0977	7.5563
58	0.0965	7.4456
59	0.0956	6.6502
60	0.0953	5.7855
61	0.0938	5.7366

Duration Flows

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.1274	307	190596	62083	Fail
0.2275	185	147198	79566	Fail
0.3277	123	122002	99188	Fail
0.4279	104	104570	100548	Fail
0.5281	83	91074	109727	Fail
0.6283	71	80336	113149	Fail
0.7285	62	71503	115327	Fail
0.8287	54	63867	118272	Fail
0.9288	50	57279	114557	Fail
1.0290	47	51461	109491	Fail
1.1292	45	46328	102951	Fail
1.2294	42	41772	99457	Fail
1.3296	41	37644	91814	Fail
1.4298	41	33816	82478	Fail
1.5300	39	30458	78097	Fail
1.6302	37	27420	74108	Fail
1.7303	36	24619	68386	Fail
1.8305	36	22159	61552	Fail
1.9307	35	19990	57114	Fail
2.0309	35	17969	51340	Fail
2.1311	34	16164	47541	Fail
2.2313	33	14634	44345	Fail
2.3315	32	13139	41059	Fail
2.4316	31	11873	38300	Fail
2.5318	30	10688	35626	Fail
2.6320	30	9595	31983	Fail
2.7322	28	8675	30982	Fail
2.8324	27	7858	29103	Fail
2.9326	26	7116	27369	Fail
3.0328	24	6494	27058	Fail
3.1329	24	5938	24741	Fail
3.2331	21	5473	26061	Fail
3.3333	21	5033	23966	Fail
3.4335	19	4658	24515	Fail
3.5337	16	4325	27031	Fail
3.6339	16	3987	24918	Fail
3.7341	16	3741	23381	Fail
3.8342	16	3506	21912	Fail
3.9344	16	3277	20481	Fail
4.0346	15	3059	20393	Fail
4.1348	15	2866	19106	Fail
4.2350	15	2654	17693	Fail
4.3352	14	2479	17707	Fail
4.4354	12	2329	19408	Fail
4.5355	11	2180	19818	Fail
4.6357	11	2037	18518	Fail
4.7359	9	1909	21211	Fail
4.8361	9	1789	19877	Fail
4.9363	9	1691	18788	Fail
5.0365	9	1589	17655	Fail
5.1367	9	1489	16544	Fail
5.2369	9	1391	15455	Fail
5.3370	9	1316	14622	Fail
5.4372	9	1238	13755	Fail

5.5374	8	1173	14662	Fail
5.6376	7	1098	15685	Fail
5.7378	7	1035	14785	Fail
5.8380	7	994	14200	Fail
5.9382	7	948	13542	Fail
6.0383	7	912	13028	Fail
6.1385	6	874	14566	Fail
6.2387	6	827	13783	Fail
6.3389	6	793	13216	Fail
6.4391	6	763	12716	Fail
6.5393	6	728	12133	Fail
6.6395	6	705	11750	Fail
6.7396	6	672	11200	Fail
6.8398	6	646	10766	Fail
6.9400	6	616	10266	Fail
7.0402	6	597	9950	Fail
7.1404	6	576	9600	Fail
7.2406	6	556	9266	Fail
7.3408	6	533	8883	Fail
7.4409	6	516	8600	Fail
7.5411	6	489	8150	Fail
7.6413	6	475	7916	Fail
7.7415	6	456	7600	Fail
7.8417	6	438	7300	Fail
7.9419	6	421	7016	Fail
8.0421	6	405	6750	Fail
8.1422	6	393	6550	Fail
8.2424	6	381	6350	Fail
8.3426	6	366	6100	Fail
8.4428	6	358	5966	Fail
8.5430	6	353	5883	Fail
8.6432	6	337	5616	Fail
8.7434	5	327	6540	Fail
8.8435	5	321	6419	Fail
8.9437	4	309	7725	Fail
9.0439	4	298	7450	Fail
9.1441	4	284	7100	Fail
9.2443	4	272	6800	Fail
9.3445	4	265	6625	Fail
9.4447	4	262	6550	Fail
9.5449	3	254	8466	Fail
9.6450	3	247	8233	Fail
9.7452	3	239	7966	Fail
9.8454	3	234	7800	Fail
9.9456	3	228	7600	Fail
10.0458	3	220	7333	Fail

The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.

The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

Water Quality

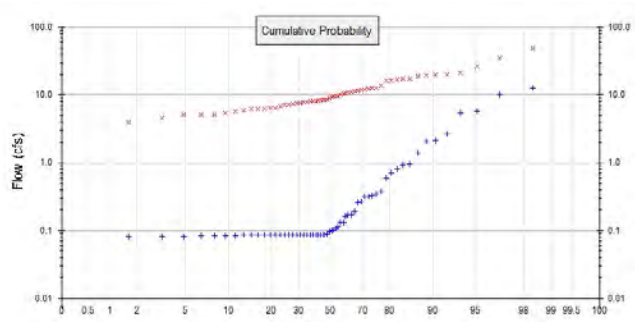
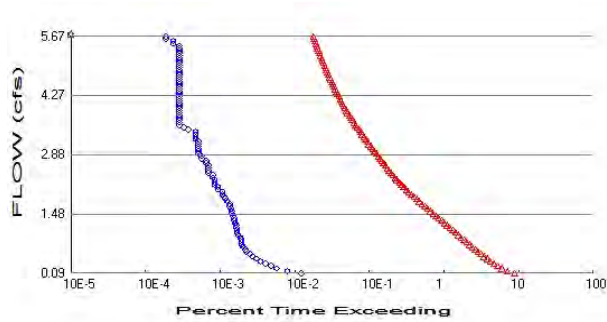
Water Quality BMP Flow and Volume for POC #1

On-line facility volume: 0 acre-feet
On-line facility target flow: 0 cfs.
Adjusted for 15 min: 0 cfs.
Off-line facility target flow: 0 cfs.
Adjusted for 15 min: 0 cfs.

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
Total Volume Infiltrated		0.00	0.00	0.00		0.00	0.00	0%	No Treat Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Failed

POC 2



+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #2

Total Pervious Area: 107.7
Total Impervious Area: 0

Mitigated Landuse Totals for POC #2

Total Pervious Area: 95
Total Impervious Area: 12.7

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #2

Return Period	Flow(cfs)
2 year	0.181517
5 year	0.624509
10 year	1.309723
25 year	3.108687
50 year	5.666362
100 year	10.006481

Flow Frequency Return Periods for Mitigated. POC #2

Return Period	Flow(cfs)
2 year	9.421846
5 year	14.907002
10 year	19.430098
25 year	26.286283
50 year	32.306407
100 year	39.182658

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #2

Year	Predeveloped	Mitigated
1949	5.724	20.999
1950	0.086	6.196
1951	0.259	19.270
1952	0.381	11.777
1953	0.087	13.622
1954	2.128	10.999
1955	0.087	5.449
1956	0.086	3.922
1957	0.131	17.168
1958	0.079	7.986
1959	0.711	7.193

1960	0.956	12.862
1961	0.087	7.192
1962	0.083	8.605
1963	0.085	8.614
1964	0.102	7.576
1965	0.087	16.476
1966	0.087	6.340
1967	0.087	12.254
1968	0.087	10.113
1969	0.086	6.305
1970	0.085	12.107
1971	5.476	16.560
1972	0.319	5.904
1973	0.171	8.068
1974	0.271	9.601
1975	10.116	35.346
1976	0.086	18.943
1977	0.081	7.645
1978	0.326	11.216
1979	0.114	8.072
1980	0.087	12.775
1981	0.083	8.591
1982	0.586	7.913
1983	0.086	9.527
1984	1.401	12.031
1985	0.097	9.657
1986	0.190	6.164
1987	0.086	5.747
1988	0.087	20.052
1989	0.169	7.457
1990	0.347	10.957
1991	0.941	16.757
1992	0.088	8.944
1993	0.130	5.051
1994	0.084	5.187
1995	0.081	4.570
1996	2.050	19.761
1997	12.792	48.805
1998	0.809	7.791
1999	0.087	3.905
2000	0.082	10.331
2001	0.086	6.890
2002	0.109	5.120
2003	0.086	6.335
2004	0.086	26.397
2005	0.086	8.190
2006	2.630	17.320
2007	0.162	10.670
2008	0.318	9.188
2009	0.100	8.572

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #2

Rank	Predeveloped	Mitigated
1	12.7923	48.8049
2	10.1159	35.3462
3	5.7239	26.3965
4	5.4759	20.9990

5	2.6299	20.0518
6	2.1284	19.7606
7	2.0497	19.2700
8	1.4009	18.9433
9	0.9557	17.3202
10	0.9411	17.1677
11	0.8089	16.7565
12	0.7112	16.5597
13	0.5855	16.4755
14	0.3806	13.6216
15	0.3473	12.8616
16	0.3255	12.7745
17	0.3195	12.2540
18	0.3182	12.1074
19	0.2713	12.0309
20	0.2592	11.7773
21	0.1905	11.2155
22	0.1709	10.9991
23	0.1694	10.9565
24	0.1621	10.6701
25	0.1312	10.3313
26	0.1300	10.1134
27	0.1138	9.6574
28	0.1092	9.6010
29	0.1024	9.5271
30	0.1002	9.1877
31	0.0974	8.9440
32	0.0879	8.6137
33	0.0870	8.6045
34	0.0869	8.5910
35	0.0869	8.5723
36	0.0868	8.1898
37	0.0868	8.0722
38	0.0868	8.0684
39	0.0866	7.9865
40	0.0866	7.9134
41	0.0866	7.7914
42	0.0866	7.6446
43	0.0864	7.5756
44	0.0864	7.4566
45	0.0864	7.1931
46	0.0862	7.1923
47	0.0862	6.8901
48	0.0861	6.3397
49	0.0857	6.3348
50	0.0856	6.3051
51	0.0856	6.1964
52	0.0855	6.1638
53	0.0851	5.9040
54	0.0848	5.7473
55	0.0843	5.4492
56	0.0828	5.1869
57	0.0827	5.1196
58	0.0816	5.0514
59	0.0809	4.5697
60	0.0806	3.9218
61	0.0793	3.9051

Duration Flows

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0908	264	188286	71320	Fail
0.1471	170	151561	89153	Fail
0.2034	122	128889	105646	Fail
0.2597	103	112698	109415	Fail
0.3160	86	99928	116195	Fail
0.3724	74	89512	120962	Fail
0.4287	66	80871	122531	Fail
0.4850	58	73492	126710	Fail
0.5413	53	66754	125950	Fail
0.5976	48	61044	127175	Fail
0.6540	46	56017	121776	Fail
0.7103	43	51248	119181	Fail
0.7666	42	47055	112035	Fail
0.8229	41	43184	105326	Fail
0.8792	41	39612	96614	Fail
0.9355	40	36382	90955	Fail
0.9919	37	33388	90237	Fail
1.0482	36	30565	84902	Fail
1.1045	36	28083	78008	Fail
1.1608	35	25709	73454	Fail
1.2171	35	23528	67222	Fail
1.2735	34	21645	63661	Fail
1.3298	33	19881	60245	Fail
1.3861	33	18225	55227	Fail
1.4424	32	16690	52156	Fail
1.4987	31	15389	49641	Fail
1.5551	31	14138	45606	Fail
1.6114	30	12940	43133	Fail
1.6677	29	11903	41044	Fail
1.7240	29	10900	37586	Fail
1.7803	27	10025	37129	Fail
1.8367	25	9195	36780	Fail
1.8930	24	8483	35345	Fail
1.9493	23	7781	33830	Fail
2.0056	23	7187	31247	Fail
2.0619	20	6667	33335	Fail
2.1183	20	6190	30950	Fail
2.1746	18	5756	31977	Fail
2.2309	18	5405	30027	Fail
2.2872	18	5029	27938	Fail
2.3435	17	4714	27729	Fail
2.3998	17	4436	26094	Fail
2.4562	15	4158	27720	Fail
2.5125	15	3910	26066	Fail
2.5688	15	3715	24766	Fail
2.6251	15	3518	23453	Fail
2.6814	14	3322	23728	Fail
2.7378	14	3140	22428	Fail
2.7941	12	2977	24808	Fail
2.8504	12	2815	23458	Fail
2.9067	11	2650	24090	Fail
2.9630	11	2498	22709	Fail
3.0194	11	2376	21600	Fail
3.0757	11	2250	20454	Fail

3.1320	11	2126	19327	Fail
3.1883	11	2014	18309	Fail
3.2446	10	1909	19090	Fail
3.3010	10	1807	18070	Fail
3.3573	10	1727	17270	Fail
3.4136	10	1652	16520	Fail
3.4699	8	1563	19537	Fail
3.5262	7	1471	21014	Fail
3.5826	6	1400	23333	Fail
3.6389	6	1334	22233	Fail
3.6952	6	1264	21066	Fail
3.7515	6	1210	20166	Fail
3.8078	6	1160	19333	Fail
3.8641	6	1090	18166	Fail
3.9205	6	1045	17416	Fail
3.9768	6	1005	16750	Fail
4.0331	6	964	16066	Fail
4.0894	6	931	15516	Fail
4.1457	6	900	15000	Fail
4.2021	6	870	14500	Fail
4.2584	6	842	14033	Fail
4.3147	6	808	13466	Fail
4.3710	6	781	13016	Fail
4.4273	6	749	12483	Fail
4.4837	6	718	11966	Fail
4.5400	6	693	11550	Fail
4.5963	6	674	11233	Fail
4.6526	6	655	10916	Fail
4.7089	6	634	10566	Fail
4.7653	6	604	10066	Fail
4.8216	6	583	9716	Fail
4.8779	6	568	9466	Fail
4.9342	6	553	9216	Fail
4.9905	6	539	8983	Fail
5.0469	6	520	8666	Fail
5.1032	6	501	8350	Fail
5.1595	6	490	8166	Fail
5.2158	6	476	7933	Fail
5.2721	6	458	7633	Fail
5.3284	6	446	7433	Fail
5.3848	6	433	7216	Fail
5.4411	6	425	7083	Fail
5.4974	5	412	8240	Fail
5.5537	5	397	7940	Fail
5.6100	4	387	9675	Fail
5.6664	4	379	9475	Fail

The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.

The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

Water Quality

Water Quality BMP Flow and Volume for POC #2

On-line facility volume: 0 acre-feet

On-line facility target flow: 0 cfs.

Adjusted for 15 min: 0 cfs.

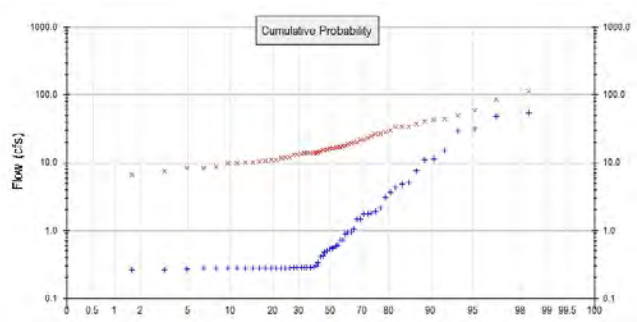
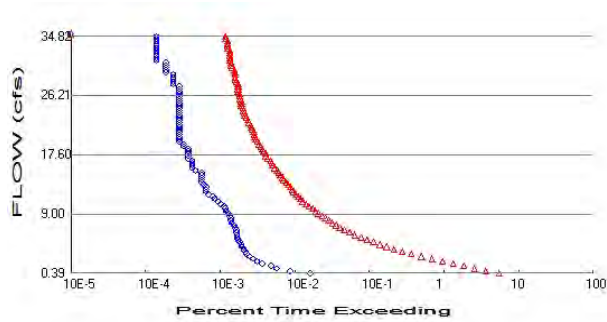
Off-line facility target flow: 0 cfs.

Adjusted for 15 min: 0 cfs.

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
Total Volume Infiltrated		0.00	0.00	0.00		0.00	0.00	0%	No Treat Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Failed

POC 3



+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #3

Total Pervious Area: 349
Total Impervious Area: 0

Mitigated Landuse Totals for POC #3

Total Pervious Area: 328.6
Total Impervious Area: 20.4

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #3

Return Period	Flow(cfs)
2 year	0.777844
5 year	3.045941
10 year	6.903229
25 year	17.937859
50 year	34.818306
100 year	65.261065

Flow Frequency Return Periods for Mitigated. POC #3

Return Period	Flow(cfs)
2 year	16.846313
5 year	28.890485
10 year	39.682824
25 year	57.237058
50 year	73.656799
100 year	93.402589

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #3

Year	Predeveloped	Mitigated
1949	31.321	58.248
1950	0.280	10.781
1951	1.493	37.858
1952	2.119	22.147
1953	0.281	23.173
1954	11.451	28.021
1955	0.281	8.844
1956	0.280	6.537
1957	0.722	33.024
1958	0.257	15.378
1959	3.643	14.195

1960	4.863	24.692
1961	0.281	13.643
1962	0.268	13.829
1963	0.276	16.828
1964	0.559	12.182
1965	0.479	26.536
1966	0.281	10.189
1967	0.338	19.793
1968	0.415	16.285
1969	0.279	10.508
1970	0.275	19.457
1971	29.299	49.764
1972	1.747	11.547
1973	0.938	12.992
1974	1.486	16.672
1975	47.839	85.984
1976	0.280	34.411
1977	0.262	13.894
1978	1.780	18.036
1979	0.612	13.940
1980	0.429	22.114
1981	0.293	13.831
1982	3.116	16.760
1983	0.277	18.107
1984	7.568	26.658
1985	0.537	15.559
1986	1.046	11.010
1987	0.279	9.800
1988	0.281	34.165
1989	0.936	12.100
1990	1.907	19.033
1991	5.121	29.865
1992	0.499	15.643
1993	0.717	9.857
1994	0.273	8.335
1995	0.261	7.394
1996	11.114	44.968
1997	54.430	114.307
1998	4.388	14.599
1999	0.281	6.637
2000	0.299	16.689
2001	0.277	11.071
2002	0.602	8.321
2003	0.278	10.177
2004	0.277	43.304
2005	0.279	13.172
2006	15.065	41.314
2007	0.892	20.017
2008	1.741	16.735
2009	0.552	14.042

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #3

Rank	Predeveloped	Mitigated
1	54.4298	114.3070
2	47.8390	85.9835
3	31.3210	58.2476
4	29.2987	49.7636

5	15.0645	44.9684
6	11.4507	43.3038
7	11.1140	41.3137
8	7.5684	37.8583
9	5.1207	34.4105
10	4.8626	34.1647
11	4.3884	33.0242
12	3.6427	29.8648
13	3.1164	28.0205
14	2.1189	26.6575
15	1.9073	26.5362
16	1.7798	24.6923
17	1.7474	23.1725
18	1.7405	22.1472
19	1.4934	22.1139
20	1.4856	20.0172
21	1.0456	19.7929
22	0.9385	19.4566
23	0.9364	19.0332
24	0.8924	18.1068
25	0.7220	18.0355
26	0.7173	16.8280
27	0.6120	16.7596
28	0.6016	16.7352
29	0.5591	16.6889
30	0.5521	16.6719
31	0.5370	16.2845
32	0.4986	15.6430
33	0.4788	15.5591
34	0.4291	15.3776
35	0.4152	14.5985
36	0.3376	14.1952
37	0.2995	14.0415
38	0.2934	13.9402
39	0.2815	13.8939
40	0.2814	13.8308
41	0.2811	13.8293
42	0.2807	13.6432
43	0.2806	13.1722
44	0.2806	12.9918
45	0.2800	12.1819
46	0.2799	12.0997
47	0.2798	11.5466
48	0.2794	11.0710
49	0.2793	11.0101
50	0.2789	10.7814
51	0.2778	10.5075
52	0.2773	10.1890
53	0.2772	10.1765
54	0.2772	9.8573
55	0.2757	9.8001
56	0.2748	8.8441
57	0.2732	8.3346
58	0.2679	8.3206
59	0.2621	7.3941
60	0.2613	6.6366
61	0.2570	6.5369

Duration Flows

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.3889	344	117959	34290	Fail
0.7367	187	77385	41382	Fail
1.0845	123	54734	44499	Fail
1.4322	104	39505	37985	Fail
1.7800	79	28447	36008	Fail
2.1278	67	20531	30643	Fail
2.4756	59	14876	25213	Fail
2.8233	54	10748	19903	Fail
3.1711	48	7809	16268	Fail
3.5189	47	5882	12514	Fail
3.8666	44	4592	10436	Fail
4.2144	42	3679	8759	Fail
4.5622	41	2994	7302	Fail
4.9100	39	2432	6235	Fail
5.2577	37	1989	5375	Fail
5.6055	36	1669	4636	Fail
5.9533	36	1373	3813	Fail
6.3010	35	1162	3320	Fail
6.6488	35	984	2811	Fail
6.9966	34	863	2538	Fail
7.3444	33	767	2324	Fail
7.6921	31	684	2206	Fail
8.0399	30	611	2036	Fail
8.3877	30	549	1829	Fail
8.7354	29	500	1724	Fail
9.0832	28	444	1585	Fail
9.4310	26	409	1573	Fail
9.7788	25	370	1480	Fail
10.1265	24	330	1375	Fail
10.4743	22	302	1372	Fail
10.8221	20	272	1360	Fail
11.1698	18	253	1405	Fail
11.5176	17	238	1400	Fail
11.8654	15	222	1480	Fail
12.2132	14	207	1478	Fail
12.5609	14	197	1407	Fail
12.9087	14	187	1335	Fail
13.2565	13	174	1338	Fail
13.6042	12	166	1383	Fail
13.9520	12	152	1266	Fail
14.2998	12	146	1216	Fail
14.6476	12	136	1133	Fail
14.9953	12	130	1083	Fail
15.3431	10	125	1250	Fail
15.6909	9	115	1277	Fail
16.0386	9	108	1200	Fail
16.3864	9	106	1177	Fail
16.7342	9	102	1133	Fail
17.0820	8	92	1150	Fail
17.4297	8	87	1087	Fail
17.7775	8	87	1087	Fail
18.1253	8	81	1012	Fail
18.4730	8	79	987	Fail
18.8208	7	75	1071	Fail

19.1686	7	71	1014	Fail
19.5164	6	68	1133	Fail
19.8641	6	64	1066	Fail
20.2119	6	62	1033	Fail
20.5597	6	62	1033	Fail
20.9074	6	60	1000	Fail
21.2552	6	57	950	Fail
21.6030	6	56	933	Fail
21.9508	6	55	916	Fail
22.2985	6	52	866	Fail
22.6463	6	50	833	Fail
22.9941	6	48	800	Fail
23.3418	6	45	750	Fail
23.6896	6	45	750	Fail
24.0374	6	44	733	Fail
24.3852	6	43	716	Fail
24.7329	6	41	683	Fail
25.0807	6	41	683	Fail
25.4285	6	41	683	Fail
25.7762	6	40	666	Fail
26.1240	6	39	650	Fail
26.4718	6	39	650	Fail
26.8196	6	37	616	Fail
27.1673	6	37	616	Fail
27.5151	6	37	616	Fail
27.8629	5	37	740	Fail
28.2106	5	35	700	Fail
28.5584	5	34	680	Fail
28.9062	5	34	680	Fail
29.2540	5	34	680	Fail
29.6017	4	34	850	Fail
29.9495	4	33	825	Fail
30.2973	4	31	775	Fail
30.6450	4	30	750	Fail
30.9928	4	30	750	Fail
31.3406	3	29	966	Fail
31.6884	3	29	966	Fail
32.0361	3	29	966	Fail
32.3839	3	29	966	Fail
32.7317	3	29	966	Fail
33.0794	3	27	900	Fail
33.4272	3	27	900	Fail
33.7750	3	27	900	Fail
34.1228	3	27	900	Fail
34.4705	3	25	833	Fail
34.8183	3	25	833	Fail

The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.

The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

Water Quality

Water Quality BMP Flow and Volume for POC #3

On-line facility volume: 0 acre-feet

On-line facility target flow: 0 cfs.

Adjusted for 15 min: 0 cfs.

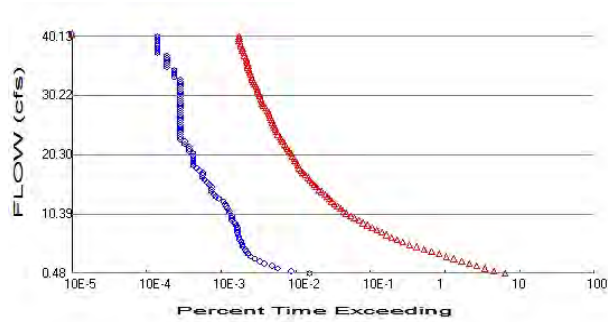
Off-line facility target flow: 0 cfs.

Adjusted for 15 min: 0 cfs.

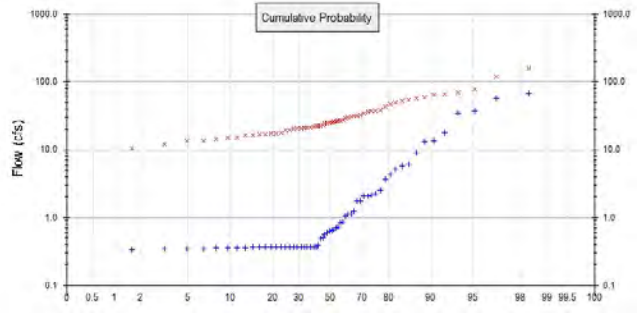
LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
Total Volume Infiltrated		0.00	0.00	0.00		0.00	0.00	0%	No Treat Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Failed

POC 4



+ Predeveloped x Mitigated



Predeveloped Landuse Totals for POC #4

Total Pervious Area: 456.7
Total Impervious Area: 0

Mitigated Landuse Totals for POC #4

Total Pervious Area: 423.6
Total Impervious Area: 33.1

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #4

Return Period	Flow(cfs)
2 year	0.959733
5 year	3.667283
10 year	8.190317
25 year	20.920847
50 year	40.128145
100 year	74.370535

Flow Frequency Return Periods for Mitigated. POC #4

Return Period	Flow(cfs)
2 year	26.162356
5 year	43.632635
10 year	58.956232
25 year	83.440546
50 year	105.985758
100 year	132.757445

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #4

Year	Predeveloped	Mitigated
1949	37.045	79.247
1950	0.366	16.978
1951	1.753	57.128
1952	2.499	32.850
1953	0.368	36.794
1954	13.579	39.020
1955	0.367	14.293
1956	0.366	10.459
1957	0.853	50.192
1958	0.336	23.364
1959	4.354	20.659

1960	5.818	37.554
1961	0.368	20.836
1962	0.351	22.434
1963	0.361	25.442
1964	0.661	19.758
1965	0.566	43.012
1966	0.367	16.529
1967	0.391	32.047
1968	0.492	26.398
1969	0.365	16.813
1970	0.360	31.564
1971	34.775	66.323
1972	2.067	17.451
1973	1.109	21.060
1974	1.757	26.273
1975	57.955	121.330
1976	0.366	53.354
1977	0.343	21.539
1978	2.105	29.251
1979	0.726	22.012
1980	0.507	34.888
1981	0.351	22.422
1982	3.689	24.673
1983	0.363	27.634
1984	8.969	37.700
1985	0.634	25.217
1986	1.236	17.174
1987	0.365	15.241
1988	0.367	54.217
1989	1.106	19.556
1990	2.255	29.990
1991	6.062	46.621
1992	0.586	24.305
1993	0.847	14.909
1994	0.358	13.522
1995	0.342	11.964
1996	13.164	64.729
1997	67.222	160.256
1998	5.197	20.934
1999	0.368	10.542
2000	0.354	27.020
2001	0.363	17.961
2002	0.711	13.440
2003	0.364	16.511
2004	0.363	69.700
2005	0.366	21.362
2006	17.694	58.634
2007	1.054	30.687
2008	2.059	25.923
2009	0.652	22.614

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #4

Rank	Predeveloped	Mitigated
1	67.2221	160.2560
2	57.9549	121.3300
3	37.0449	79.2467
4	34.7746	69.7003

5	17.6944	66.3232
6	13.5791	64.7291
7	13.1637	58.6339
8	8.9693	57.1283
9	6.0618	54.2165
10	5.8184	53.3538
11	5.1974	50.1919
12	4.3539	46.6213
13	3.6893	43.0117
14	2.4995	39.0196
15	2.2546	37.7001
16	2.1054	37.5539
17	2.0669	36.7941
18	2.0588	34.8884
19	1.7569	32.8498
20	1.7527	32.0470
21	1.2361	31.5640
22	1.1093	30.6872
23	1.1058	29.9897
24	1.0545	29.2511
25	0.8532	27.6340
26	0.8473	27.0202
27	0.7258	26.3979
28	0.7108	26.2729
29	0.6614	25.9229
30	0.6523	25.4417
31	0.6344	25.2165
32	0.5865	24.6730
33	0.5657	24.3046
34	0.5069	23.3640
35	0.4921	22.6138
36	0.3915	22.4338
37	0.3684	22.4218
38	0.3682	22.0124
39	0.3678	21.5385
40	0.3673	21.3620
41	0.3672	21.0603
42	0.3672	20.9341
43	0.3664	20.8355
44	0.3663	20.6594
45	0.3661	19.7575
46	0.3656	19.5563
47	0.3655	17.9611
48	0.3650	17.4506
49	0.3636	17.1739
50	0.3629	16.9777
51	0.3628	16.8126
52	0.3627	16.5287
53	0.3609	16.5114
54	0.3595	15.2413
55	0.3575	14.9087
56	0.3536	14.2934
57	0.3512	13.5215
58	0.3505	13.4402
59	0.3430	11.9638
60	0.3419	10.5417
61	0.3363	10.4587

Duration Flows

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.4799	326	135969	41708	Fail
0.8804	186	96100	51666	Fail
1.2808	123	73043	59384	Fail
1.6813	104	57001	54808	Fail
2.0818	81	45088	55664	Fail
2.4823	70	35741	51058	Fail
2.8828	60	28340	47233	Fail
3.2833	54	22373	41431	Fail
3.6838	49	17721	36165	Fail
4.0843	47	14151	30108	Fail
4.4847	45	11174	24831	Fail
4.8852	42	8906	21204	Fail
5.2857	41	7135	17402	Fail
5.6862	40	5854	14635	Fail
6.0867	38	4875	12828	Fail
6.4872	37	4143	11197	Fail
6.8877	36	3555	9875	Fail
7.2882	35	3065	8757	Fail
7.6886	35	2624	7497	Fail
8.0891	35	2278	6508	Fail
8.4896	34	1971	5797	Fail
8.8901	33	1721	5215	Fail
9.2906	30	1511	5036	Fail
9.6911	30	1309	4363	Fail
10.0916	30	1157	3856	Fail
10.4921	28	1027	3667	Fail
10.8925	28	930	3321	Fail
11.2930	26	852	3276	Fail
11.6935	25	780	3120	Fail
12.0940	24	709	2954	Fail
12.4945	23	654	2843	Fail
12.8950	20	602	3010	Fail
13.2955	18	564	3133	Fail
13.6960	17	523	3076	Fail
14.0964	16	475	2968	Fail
14.4969	16	435	2718	Fail
14.8974	16	402	2512	Fail
15.2979	15	380	2533	Fail
15.6984	14	353	2521	Fail
16.0989	13	330	2538	Fail
16.4994	12	311	2591	Fail
16.8999	12	289	2408	Fail
17.3003	12	266	2216	Fail
17.7008	11	251	2281	Fail
18.1013	10	238	2380	Fail
18.5018	9	229	2544	Fail
18.9023	9	222	2466	Fail
19.3028	9	210	2333	Fail
19.7033	9	204	2266	Fail
20.1038	9	194	2155	Fail
20.5042	9	187	2077	Fail
20.9047	8	174	2175	Fail
21.3052	8	166	2075	Fail
21.7057	8	160	2000	Fail

22.1062	7	154	2200	Fail
22.5067	7	143	2042	Fail
22.9072	6	136	2266	Fail
23.3077	6	132	2200	Fail
23.7082	6	125	2083	Fail
24.1086	6	119	1983	Fail
24.5091	6	114	1900	Fail
24.9096	6	112	1866	Fail
25.3101	6	108	1800	Fail
25.7106	6	104	1733	Fail
26.1111	6	101	1683	Fail
26.5116	6	98	1633	Fail
26.9121	6	95	1583	Fail
27.3125	6	93	1550	Fail
27.7130	6	89	1483	Fail
28.1135	6	84	1400	Fail
28.5140	6	78	1300	Fail
28.9145	6	77	1283	Fail
29.3150	6	75	1250	Fail
29.7155	6	73	1216	Fail
30.1160	6	70	1166	Fail
30.5164	6	69	1150	Fail
30.9169	6	65	1083	Fail
31.3174	6	65	1083	Fail
31.7179	6	63	1050	Fail
32.1184	6	60	1000	Fail
32.5189	6	58	966	Fail
32.9194	6	56	933	Fail
33.3199	5	55	1100	Fail
33.7203	5	53	1060	Fail
34.1208	5	52	1040	Fail
34.5213	5	50	1000	Fail
34.9218	4	49	1225	Fail
35.3223	4	49	1225	Fail
35.7228	4	48	1200	Fail
36.1233	4	47	1175	Fail
36.5238	4	46	1150	Fail
36.9242	4	44	1100	Fail
37.3247	3	43	1433	Fail
37.7252	3	41	1366	Fail
38.1257	3	41	1366	Fail
38.5262	3	40	1333	Fail
38.9267	3	39	1300	Fail
39.3272	3	37	1233	Fail
39.7277	3	37	1233	Fail
40.1281	3	37	1233	Fail

The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.

The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

Water Quality

Water Quality BMP Flow and Volume for POC #4

On-line facility volume: 0 acre-feet

On-line facility target flow: 0 cfs.

Adjusted for 15 min: 0 cfs.

Off-line facility target flow: 0 cfs.

Adjusted for 15 min: 0 cfs.

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
Total Volume Infiltrated		0.00	0.00	0.00		0.00	0.00	0%	No Treat Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Failed

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

No PERLND changes have been made.

IMPLND Changes

No IMPLND changes have been made.

Appendix

Predeveloped Schematic



Analysis
Point #1
127.30ac



Analysis
Point #2
107.70ac

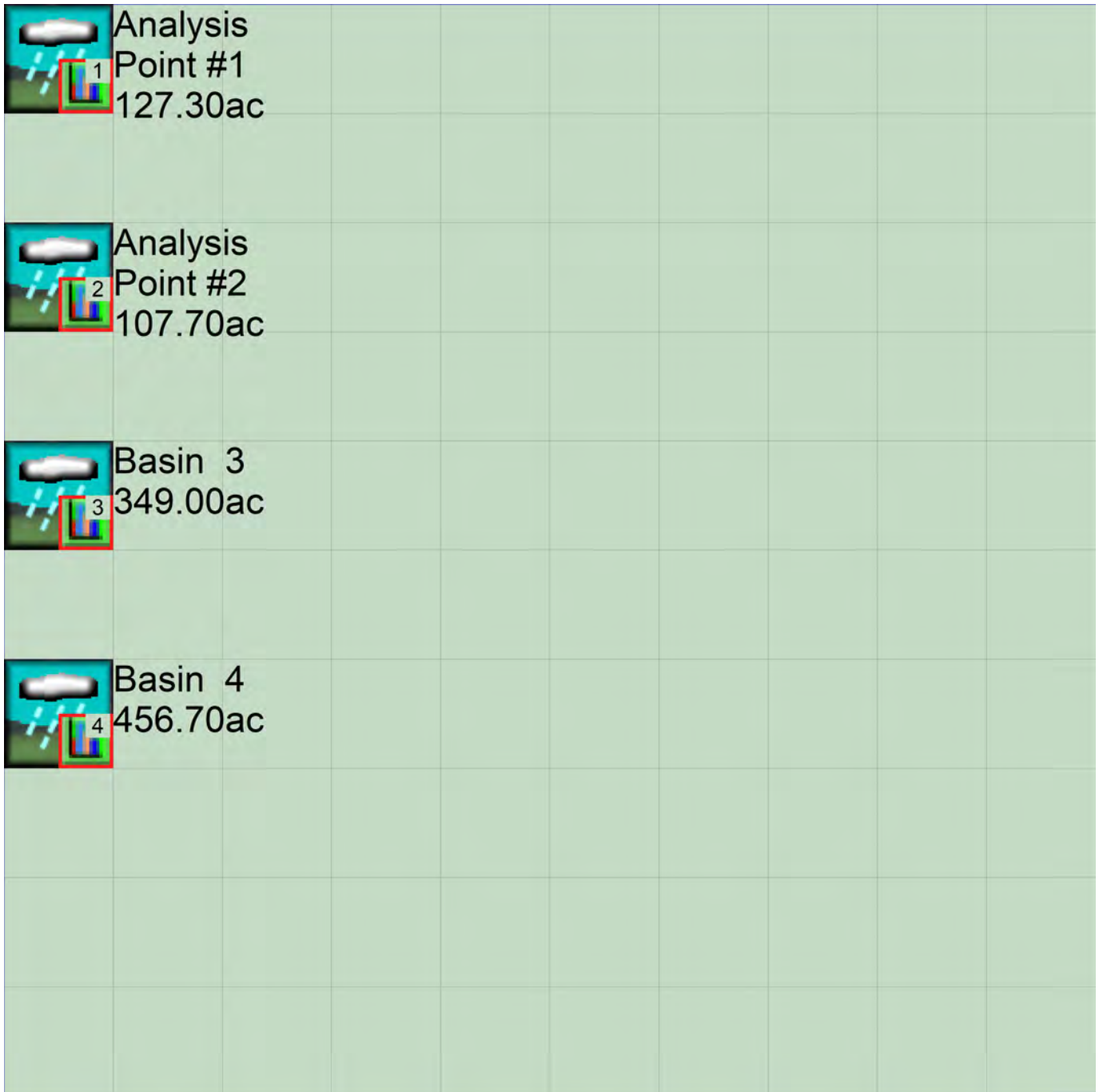


Analysis
Point #3
349.00ac



Basin 2+3
456.70ac

Mitigated Schematic



Predeveloped UCI File

RUN

GLOBAL

```
WWM4 model simulation
START      1948 10 01      END      2009 09 30
RUN INTERP OUTPUT LEVEL    3      0
RESUME     0 RUN      1
UNIT SYSTEM      1
END GLOBAL
```

FILES

```
<File>  <Un#>  <-----File Name----->***
<-ID->                                     ***
WDM      26     21-1220_LorenzanCreek.wdm
MESSU    25     Pre21-1220_LorenzanCreek.MES
          27     Pre21-1220_LorenzanCreek.L61
          28     Pre21-1220_LorenzanCreek.L62
          32     POC21-1220_LorenzanCreek3.dat
          31     POC21-1220_LorenzanCreek2.dat
          30     POC21-1220_LorenzanCreek1.dat
          33     POC21-1220_LorenzanCreek4.dat
```

END FILES

OPN SEQUENCE

INGRP INDELT 00:15

```
PERLND    3
PERLND    1
PERLND    2
COPY      503
COPY      502
COPY      501
COPY      504
DISPLY    3
DISPLY    2
DISPLY    1
DISPLY    4
```

END INGRP

END OPN SEQUENCE

DISPLY

DISPLY-INF01

#	-	#	<-----Title----->***	TRAN	PIVL	DIG1	FIL1	PYR	DIG2	FIL2	YRND
3			Analysis Point #3	MAX				1	2	32	9
2			Analysis Point #2	MAX				1	2	31	9
1			Analysis Point #1	MAX				1	2	30	9
4			Basin 2+3	MAX				1	2	33	9

END DISPLY-INF01

END DISPLY

COPY

TIMESERIES

#	-	#	NPT	NMN	***
1			1	1	
503			1	1	
502			1	1	
501			1	1	
504			1	1	

END TIMESERIES

END COPY

GENER

OPCODE

OPCD ***

END OPCODE

PARM

K ***

END PARM

END GENER

PERLND

GEN-INFO

```
<PLS ><-----Name----->NBLKS  Unit-systems  Printer ***
# - #                               User  t-series  Engl Metr ***
```

				in	out		***
3	A/B, Forest, Steep	1	1	1	1	27	0
1	A/B, Forest, Flat	1	1	1	1	27	0
2	A/B, Forest, Mod	1	1	1	1	27	0

END GEN-INFO
*** Section PWATER***

ACTIVITY

<PLS > ***** Active Sections *****															
#	-	#	ATMP	SNOW	PWAT	SED	PST	PWG	PQAL	MSTL	PEST	NITR	PHOS	TRAC	***
3			0	0	1	0	0	0	0	0	0	0	0	0	
1			0	0	1	0	0	0	0	0	0	0	0	0	
2			0	0	1	0	0	0	0	0	0	0	0	0	

END ACTIVITY

PRINT-INFO

<PLS > ***** Print-flags *****														PIVL	PYR	
#	-	#	ATMP	SNOW	PWAT	SED	PST	PWG	PQAL	MSTL	PEST	NITR	PHOS	TRAC	*****	
3			0	0	4	0	0	0	0	0	0	0	0	0	1	9
1			0	0	4	0	0	0	0	0	0	0	0	0	1	9
2			0	0	4	0	0	0	0	0	0	0	0	0	1	9

END PRINT-INFO

PWAT-PARM1

<PLS > PWATER variable monthly parameter value flags ***														
#	-	#	CSNO	RTOP	UZFG	VCS	VUZ	VNN	VIFW	VIRC	VLE	INFC	HWT	***
3			0	0	0	0	0	0	0	0	0	0	0	
1			0	0	0	0	0	0	0	0	0	0	0	
2			0	0	0	0	0	0	0	0	0	0	0	

END PWAT-PARM1

PWAT-PARM2

<PLS > PWATER input info: Part 2 ***									
#	-	#	***FOREST	LZSN	INFILT	LSUR	SLSUR	KVARY	AGWRC
3			0	5	2	400	0.15	0.3	0.996
1			0	5	2	400	0.05	0.3	0.996
2			0	5	2	400	0.1	0.3	0.996

END PWAT-PARM2

PWAT-PARM3

<PLS > PWATER input info: Part 3 ***									
#	-	#	***PETMAX	PETMIN	INFEXP	INFILD	DEEPFR	BASETP	AGWETP
3			0	0	2	2	0	0	0
1			0	0	2	2	0	0	0
2			0	0	2	2	0	0	0

END PWAT-PARM3

PWAT-PARM4

<PLS > PWATER input info: Part 4 ***									
#	-	#	CEPSC	UZSN	NSUR	INTFW	IRC	LZETP	***
3			0.2	0.5	0.35	0	0.7	0.7	
1			0.2	0.5	0.35	0	0.7	0.7	
2			0.2	0.5	0.35	0	0.7	0.7	

END PWAT-PARM4

PWAT-STATE1

<PLS > *** Initial conditions at start of simulation										
ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***										
#	-	#	***	CEPS	SURS	UZS	IFWS	LZS	AGWS	GWVS
3				0	0	0	0	3	1	0
1				0	0	0	0	3	1	0
2				0	0	0	0	3	1	0

END PWAT-STATE1

END PERLND

IMPLND

GEN-INFO

<PLS ><-----Name----->				Unit-systems	Printer	***	
#	-	#		User	t-series	Engl Metr	***
					in	out	***


```

END GEN-INFO
*** Section IWATER***

ACTIVITY
<PLS > ***** Active Sections *****
# - # ATMP SNOW IWAT SLD IWG IQAL ***
END ACTIVITY

PRINT-INFO
<ILS > ***** Print-flags ***** PIVL PYR
# - # ATMP SNOW IWAT SLD IWG IQAL *****
END PRINT-INFO

IWAT-PARM1
<PLS > IWATER variable monthly parameter value flags ***
# - # CSNO RTOP VRS VNN RTLI ***
END IWAT-PARM1

IWAT-PARM2
<PLS > IWATER input info: Part 2 ***
# - # *** LSUR SLSUR NSUR RETSC
END IWAT-PARM2

IWAT-PARM3
<PLS > IWATER input info: Part 3 ***
# - # ***PETMAX PETMIN
END IWAT-PARM3

IWAT-STATE1
<PLS > *** Initial conditions at start of simulation
# - # *** RETS SURS
END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->          <--Area-->    <-Target->    MBLK    ***
<Name>   #          <-factor->    <Name>   #    Tbl#    ***
Analysis Point #3***
PERLND   3          349      COPY    503      12
PERLND   3          349      COPY    503      13
Analysis Point #2***
PERLND   1          107.7    COPY    502      12
PERLND   1          107.7    COPY    502      13
Analysis Point #1***
PERLND   2          127.3    COPY    501      12
PERLND   2          127.3    COPY    501      13
Basin 2+3***
PERLND   3          349      COPY    504      12
PERLND   3          349      COPY    504      13
PERLND   1          107.7    COPY    504      12
PERLND   1          107.7    COPY    504      13

*****Routing*****
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member-> ***
<Name>   #      <Name> # #<-factor->strg <Name>   #   #      <Name> # #   ***
COPY    503 OUTPUT MEAN   1 1  48.4      DISPLY   3     INPUT TIMSER 1
COPY    502 OUTPUT MEAN   1 1  48.4      DISPLY   2     INPUT TIMSER 1
COPY    501 OUTPUT MEAN   1 1  48.4      DISPLY   1     INPUT TIMSER 1
COPY    504 OUTPUT MEAN   1 1  48.4      DISPLY   4     INPUT TIMSER 1

<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member-> ***
<Name>   #      <Name> # #<-factor->strg <Name>   #   #      <Name> # #   ***
END NETWORK

```

```

RCHRES
GEN-INFO
  RCHRES      Name      Nexits  Unit Systems  Printer      ***
  # - #<-----><----> User T-series Engl Metr LKFG      ***
                                in out      ***
END GEN-INFO
*** Section RCHRES***

ACTIVITY
<PLS > ***** Active Sections *****
# - # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
END ACTIVITY

PRINT-INFO
<PLS > ***** Print-flags ***** PIVL  PYR
# - # HYDR ADCA CONS HEAT  SED  GQL  OXRX NUTR PLNK PHCB PIVL  PYR  *****
END PRINT-INFO

HYDR-PARM1
RCHRES  Flags for each HYDR Section      ***
# - #   VC A1 A2 A3  ODFVFG for each ***  ODGTFG for each  FUNCT for each
      FG FG FG FG  possible exit ***  possible exit  possible exit
      * * * * *      * * * * *      * * * * *
END HYDR-PARM1

HYDR-PARM2
# - #   FTABNO      LEN      DELTH      STCOR      KS      DB50      ***
<-----><-----><-----><-----><-----><-----><----->      ***
END HYDR-PARM2

HYDR-INIT
RCHRES  Initial conditions for each HYDR section      ***
# - # *** VOL      Initial value of COLIND      Initial value of OUTDGT
      *** ac-ft      for each possible exit      for each possible exit
<-----><----->      <---><---><---><---><---> *** <---><---><---><---><--->
END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member-> ***
<Name> # <Name> # tem strg<-factor->strg <Name> # # <Name> # # ***
WDM 2 PREC ENGL 1.333 PERLND 1 999 EXTNL PREC
WDM 2 PREC ENGL 1.333 IMPLND 1 999 EXTNL PREC
WDM 1 EVAP ENGL 0.76 PERLND 1 999 EXTNL PETINP
WDM 1 EVAP ENGL 0.76 IMPLND 1 999 EXTNL PETINP
END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name> # <Name> # #<-factor->strg <Name> # <Name> tem strg strg***
COPY 503 OUTPUT MEAN 1 1 48.4 WDM 503 FLOW ENGL REPL
COPY 502 OUTPUT MEAN 1 1 48.4 WDM 502 FLOW ENGL REPL
COPY 501 OUTPUT MEAN 1 1 48.4 WDM 501 FLOW ENGL REPL
COPY 504 OUTPUT MEAN 1 1 48.4 WDM 504 FLOW ENGL REPL
END EXT TARGETS

MASS-LINK
<Volume> <-Grp> <-Member-><--Mult--> <Target> <-Grp> <-Member->***
<Name> <Name> # #<-factor-> <Name> <Name> # #***
MASS-LINK 12
PERLND PWATER SURO 0.083333 COPY INPUT MEAN
END MASS-LINK 12

MASS-LINK 13
PERLND PWATER IFWO 0.083333 COPY INPUT MEAN

```

END MASS-LINK 13

END MASS-LINK

END RUN

Mitigated UCI File

RUN

GLOBAL

WWM4 model simulation
START 1948 10 01 END 2009 09 30
RUN INTERP OUTPUT LEVEL 3 0
RESUME 0 RUN 1 UNIT SYSTEM 1
END GLOBAL

FILES

<File>	<Un#>	<-----File Name----->	***
<-ID->			***
WDM	26	21-1220_LorenzanCreek.wdm	
MESSU	25	Mit21-1220_LorenzanCreek.MES	
	27	Mit21-1220_LorenzanCreek.L61	
	28	Mit21-1220_LorenzanCreek.L62	
	30	POC21-1220_LorenzanCreek1.dat	
	31	POC21-1220_LorenzanCreek2.dat	
	32	POC21-1220_LorenzanCreek3.dat	
	33	POC21-1220_LorenzanCreek4.dat	

END FILES

OPN SEQUENCE

INGRP INDELT 00:15

PERLND	2
PERLND	8
IMPLND	1
PERLND	1
PERLND	7
PERLND	3
PERLND	9
COPY	501
COPY	502
COPY	503
COPY	504
DISPLY	1
DISPLY	2
DISPLY	3
DISPLY	4

END INGRP

END OPN SEQUENCE

DISPLY

DISPLY-INF01

#	-	#	<-----Title----->	***	TRAN	PIVL	DIG1	FIL1	PYR	DIG2	FIL2	YRND
1			Analysis Point #1		MAX				1	2	30	9
2			Analysis Point #2		MAX				1	2	31	9
3			Basin 3		MAX				1	2	32	9
4			Basin 4		MAX				1	2	33	9

END DISPLY-INF01

END DISPLY

COPY

TIMESERIES

#	-	#	NPT	NMN	***
1			1	1	
501			1	1	
502			1	1	
503			1	1	
504			1	1	

END TIMESERIES

END COPY

GENER

OPCODE

#	#	OPCD	***
---	---	------	-----

END OPCODE

PARM

#	#	K	***
---	---	---	-----

END PARM

END GENER

PERLND

GEN-INFO

<PLS ><-----Name----->		NBLKS	Unit-systems		Printer		***
#	-	#	User	t-series	Engl	Metr	***
				in	out		***
2	A/B, Forest, Mod	1	1	1	1	27	0
8	A/B, Lawn, Mod	1	1	1	1	27	0
1	A/B, Forest, Flat	1	1	1	1	27	0
7	A/B, Lawn, Flat	1	1	1	1	27	0
3	A/B, Forest, Steep	1	1	1	1	27	0
9	A/B, Lawn, Steep	1	1	1	1	27	0

END GEN-INFO

*** Section PWATER***

ACTIVITY

<PLS >		***** Active Sections *****												***	
#	-	#	ATMP	SNOW	PWAT	SED	PST	PWG	PQAL	MSTL	PEST	NITR	PHOS	TRAC	***
2			0	0	1	0	0	0	0	0	0	0	0	0	
8			0	0	1	0	0	0	0	0	0	0	0	0	
1			0	0	1	0	0	0	0	0	0	0	0	0	
7			0	0	1	0	0	0	0	0	0	0	0	0	
3			0	0	1	0	0	0	0	0	0	0	0	0	
9			0	0	1	0	0	0	0	0	0	0	0	0	

END ACTIVITY

PRINT-INFO

<PLS >		***** Print-flags *****												PIVL	PYR	
#	-	#	ATMP	SNOW	PWAT	SED	PST	PWG	PQAL	MSTL	PEST	NITR	PHOS	TRAC	*****	*****
2			0	0	4	0	0	0	0	0	0	0	0	0	1	9
8			0	0	4	0	0	0	0	0	0	0	0	0	1	9
1			0	0	4	0	0	0	0	0	0	0	0	0	1	9
7			0	0	4	0	0	0	0	0	0	0	0	0	1	9
3			0	0	4	0	0	0	0	0	0	0	0	0	1	9
9			0	0	4	0	0	0	0	0	0	0	0	0	1	9

END PRINT-INFO

PWAT-PARM1

<PLS >		PWATER variable monthly parameter value flags											***	
#	-	#	CSNO	RTOP	UZFG	VCS	VUZ	VNN	VIFW	VIRC	VLE	INFC	HWT	***
2			0	0	0	0	0	0	0	0	0	0	0	
8			0	0	0	0	0	0	0	0	0	0	0	
1			0	0	0	0	0	0	0	0	0	0	0	
7			0	0	0	0	0	0	0	0	0	0	0	
3			0	0	0	0	0	0	0	0	0	0	0	
9			0	0	0	0	0	0	0	0	0	0	0	

END PWAT-PARM1

PWAT-PARM2

<PLS >		PWATER input info: Part 2							***
#	-	#	***FOREST	LZSN	INFILT	LSUR	SLSUR	KVARY	AGWRC
2			0	5	2	400	0.1	0.3	0.996
8			0	5	0.8	400	0.1	0.3	0.996
1			0	5	2	400	0.05	0.3	0.996
7			0	5	0.8	400	0.05	0.3	0.996
3			0	5	2	400	0.15	0.3	0.996
9			0	5	0.8	400	0.15	0.3	0.996

END PWAT-PARM2

PWAT-PARM3

<PLS >		PWATER input info: Part 3							***
#	-	#	***PETMAX	PETMIN	INFEXP	INFILD	DEEPPFR	BASETP	AGWETP
2			0	0	2	2	0	0	0
8			0	0	2	2	0	0	0
1			0	0	2	2	0	0	0
7			0	0	2	2	0	0	0
3			0	0	2	2	0	0	0
9			0	0	2	2	0	0	0

END PWAT-PARM3

PWAT-PARM4

<PLS >		PWATER input info: Part 4							***
--------	--	---------------------------	--	--	--	--	--	--	-----

```

# - #      CEPSC      UZSN      NSUR      INTFW      IRC      LZETP ***
2          0.2        0.5        0.35        0          0.7        0.7
8          0.1        0.5        0.25        0          0.7        0.25
1          0.2        0.5        0.35        0          0.7        0.7
7          0.1        0.5        0.25        0          0.7        0.25
3          0.2        0.5        0.35        0          0.7        0.7
9          0.1        0.5        0.25        0          0.7        0.25
END PWAT-PARM4

PWAT-STATE1
<PLS > *** Initial conditions at start of simulation
          ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
# - # ***  CEPS      SURS      UZS      IFWS      LZS      AGWS      GWVS
2          0          0          0          0          3          1          0
8          0          0          0          0          3          1          0
1          0          0          0          0          3          1          0
7          0          0          0          0          3          1          0
3          0          0          0          0          3          1          0
9          0          0          0          0          3          1          0
END PWAT-STATE1

END PERLND

IMPLND
GEN-INFO
<PLS ><-----Name----->      Unit-systems      Printer ***
# - #      User      t-series      Engr Metr ***
          in      out      ***
1      ROADS/FLAT      1      1      1      27      0
END GEN-INFO
*** Section IWATER***

ACTIVITY
<PLS > ***** Active Sections *****
# - # ATMP SNOW IWAT SLD IWG IQAL ***
1          0          0          1          0          0          0
END ACTIVITY

PRINT-INFO
<ILS > ***** Print-flags ***** PIVL PYR
# - # ATMP SNOW IWAT SLD IWG IQAL *****
1          0          0          4          0          0          0          1          9
END PRINT-INFO

IWAT-PARM1
<PLS > IWATER variable monthly parameter value flags ***
# - # CSNO RTOP VRS VNN RTLI ***
1          0          0          0          0          0
END IWAT-PARM1

IWAT-PARM2
<PLS > IWATER input info: Part 2 ***
# - # *** LSUR      SLSUR      NSUR      RETSC
1          400          0.01          0.1          0.1
END IWAT-PARM2

IWAT-PARM3
<PLS > IWATER input info: Part 3 ***
# - # ***PETMAX      PETMIN
1          0          0
END IWAT-PARM3

IWAT-STATE1
<PLS > *** Initial conditions at start of simulation
# - # *** RETS      SURS
1          0          0
END IWAT-STATE1

END IMPLND

```

```

SCHEMATIC
<-Source->          <--Area-->      <-Target->      MBLK      ***
<Name>   #          <-factor->      <Name>   #      Tbl#      ***
Analysis Point #1***
PERLND    2          68.8      COPY    501      12
PERLND    2          68.8      COPY    501      13
PERLND    8          40       COPY    501      12
PERLND    8          40       COPY    501      13
IMPLND    1          18.5      COPY    501      15
Analysis Point #2***
PERLND    1          62.7      COPY    502      12
PERLND    1          62.7      COPY    502      13
PERLND    7          32.3      COPY    502      12
PERLND    7          32.3      COPY    502      13
IMPLND    1          12.7      COPY    502      15
Basin     3***
PERLND    3          278       COPY    503      12
PERLND    3          278       COPY    503      13
PERLND    9          50.6      COPY    503      12
PERLND    9          50.6      COPY    503      13
IMPLND    1          20.4      COPY    503      15
Basin     4***
PERLND    1          62.7      COPY    504      12
PERLND    1          62.7      COPY    504      13
PERLND    3          278       COPY    504      12
PERLND    3          278       COPY    504      13
PERLND    7          32.3      COPY    504      12
PERLND    7          32.3      COPY    504      13
PERLND    9          50.6      COPY    504      12
PERLND    9          50.6      COPY    504      13
IMPLND    1          33.1      COPY    504      15

```

```

*****Routing*****
END SCHEMATIC

```

```

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member-> ***
<Name>   #      <Name> # #<-factor->strg <Name>   #  #      <Name> # #      ***
COPY    501 OUTPUT MEAN   1 1  48.4      DISPLY    1      INPUT TIMSER 1
COPY    502 OUTPUT MEAN   1 1  48.4      DISPLY    2      INPUT TIMSER 1
COPY    503 OUTPUT MEAN   1 1  48.4      DISPLY    3      INPUT TIMSER 1
COPY    504 OUTPUT MEAN   1 1  48.4      DISPLY    4      INPUT TIMSER 1

```

```

<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member-> ***
<Name>   #      <Name> # #<-factor->strg <Name>   #  #      <Name> # #      ***
END NETWORK

```

```

RCHRES
GEN-INFO
RCHRES      Name      Nexits      Unit Systems      Printer      ***
# - #<-----><----> User T-series Engl Metr LKFG      ***
in out      ***
END GEN-INFO
*** Section RCHRES***

```

```

ACTIVITY
<PLS > ***** Active Sections *****
# - # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
END ACTIVITY

```

```

PRINT-INFO
<PLS > ***** Print-flags ***** PIVL PYR
# - # HYDR ADCA CONS HEAT SED GQL OXRX NUTR PLNK PHCB PIVL PYR *****
END PRINT-INFO

```

```

HYDR-PARM1
RCHRES      Flags for each HYDR Section      ***
# - # VC A1 A2 A3 ODFVFG for each *** ODGTFG for each      FUNCT for each

```

```

      FG FG FG FG possible exit *** possible exit possible exit
      * * * * * * * * * * * * * * * * * * * * * *
END HYDR-PARM1

HYDR-PARM2
# - # FTABNO LEN DELTH STCOR KS DB50 ***
<-----><-----><-----><-----><-----><----->
END HYDR-PARM2
HYDR-INIT
RCHRES Initial conditions for each HYDR section ***
# - # *** VOL Initial value of COLIND Initial value of OUTDGT
      *** ac-ft for each possible exit for each possible exit
<-----><-----><-----><-----><-----><-----> *** <-----><-----><-----><-----><----->
END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member-> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member-> ***
<Name> # <Name> # tem strg<-factor->strg <Name> # # <Name> # # ***
WDM 2 PREC ENGL 1.333 PERLND 1 999 EXTNL PREC
WDM 2 PREC ENGL 1.333 IMPLND 1 999 EXTNL PREC
WDM 1 EVAP ENGL 0.76 PERLND 1 999 EXTNL PETINP
WDM 1 EVAP ENGL 0.76 IMPLND 1 999 EXTNL PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name> # <Name> # #<-factor->strg <Name> # <Name> tem strg strg***
COPY 1 OUTPUT MEAN 1 1 48.4 WDM 701 FLOW ENGL REPL
COPY 501 OUTPUT MEAN 1 1 48.4 WDM 801 FLOW ENGL REPL
COPY 2 OUTPUT MEAN 1 1 48.4 WDM 702 FLOW ENGL REPL
COPY 502 OUTPUT MEAN 1 1 48.4 WDM 802 FLOW ENGL REPL
COPY 3 OUTPUT MEAN 1 1 48.4 WDM 703 FLOW ENGL REPL
COPY 503 OUTPUT MEAN 1 1 48.4 WDM 803 FLOW ENGL REPL
COPY 4 OUTPUT MEAN 1 1 48.4 WDM 704 FLOW ENGL REPL
COPY 504 OUTPUT MEAN 1 1 48.4 WDM 804 FLOW ENGL REPL
END EXT TARGETS

MASS-LINK
<Volume> <-Grp> <-Member-><--Mult--> <Target> <-Grp> <-Member->***
<Name> <Name> # #<-factor-> <Name> <Name> # #***
MASS-LINK 12
PERLND PWATER SURO 0.083333 COPY INPUT MEAN
END MASS-LINK 12

MASS-LINK 13
PERLND PWATER IFW0 0.083333 COPY INPUT MEAN
END MASS-LINK 13

MASS-LINK 15
IMPLND IWATER SURO 0.083333 COPY INPUT MEAN
END MASS-LINK 15

END MASS-LINK

END RUN

```


Predeveloped HSPF Message File

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