Appendix D

Master Drainage Plan

AT THE HEART OF GREAT LIVING

TEHALEH DEVELOPMENT

Tehaleh E.B.P.C
Phase II Draft Supplemental EIS

Pierce County, Washington

Master Drainage Plan and Assessment of Hydrologic Impacts

June 21, 2017

Owner: Newland Communities
Civil Engineer: MacKay Sposito

Master Drainage Plan and Assessment of Hydrologic Impacts

·EHALEH EMPLOYMENT BASED PLANNED COMMUNITY
PHASE II MAJOR AMENDMENT

Pierce County, WA

June 21, 2017

DRAFT

PREPARED FOR:
Newland Communities
Contact: Tom Uren

CLIENT:
Newland Communities
505 South 336th St, Ste. 430
Federal Way, WA 98003

MacKay Sposito
Project Number: 16076

Prepared by:
D. Riely-Gibbons

MacKay Sposito

Federal Way Office
33400 8th Avenue South, Suite 130• Federal Way, WA 98003
253.205.8700 • info@mackaysposito.com

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Project Engineer's Certification:

"I hereby state that this Master Drainage Plan and Assessment of Hydrologic Impacts Report for Tehaleh Employment Based Plan Community has been prepared by me or under my supervision and meets the standard of care and expertise which is usual and customary in this community for professional engineers. I understand that Pierce County does not and will not assume liability for the sufficiency, suitability, or performance of drainage facilities prepared by me."

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1.0 PROPOSED PROJECT DESCRIPTION

The purpose of this technical report is to support the *Tehaleh Employment Based Planned Community (EBPC) Planned Unit Development (PUD) Phase II Major Amendment Project Supplemental Draft Environmental Impact Statement* (Tehaleh Phase II SDEIS) and amend the existing approved "*Cascadia Master Drainage and Assessment of Hydrologic Impacts*" prepared by Hugh G. Goldsmith and Associates, Inc. dated May 1997 and revised in November 1997 and January 1998 (Goldsmith 1998 Report). This report describes existing hydrologic conditions and constraints on the proposed development at the time of the 1998 Environmental Impact Statement (1998 EIS). The report was prepared for the Cascadia Development Company as part of the Cascadia Development 1998 EIS. Since the 1998 EIS and the approval of this report, the Cascadia Development has been sold to Nash Cascadia Verde, LLC and renamed Tehaleh. The following report also amends a subsequent EIS amendment, *2014 Amended Tehaleh Phase I Proposal EIS Addendum* (2014 EIS Addendum). This report amends the information, description and computer modeling presented in the original drainage report to reflect the current proposed land use action for the Tehaleh Phase II SDEIS.

The observations and conclusions provided herein are based on a review of resource data available through a variety of sources. This includes numerous field visits by MacKay Sposito, Inc. as well as other consultants and all complete construction and historical information from previous report and construction documents for the site.

This report is not a design level drainage analysis, although hydrologic modeling was completed to verify the proposed plan and assess the environmental impacts of development of the site. It is assumed that this report will be supplemented by additional detailed study and hydrologic analysis as specific applications for development are submitted for review and approval.

2.0 PROJECT LOCATION

The 4,756-acre Tehaleh Employment Based Planned Community development is located on a plateau northeast of the City of Orting and south of the City Bonney Lake in Pierce County, Washington (portions of Sections 8, 9, 16 through 23, 27 through 30 and 33, all in Township 19 North, Range 5 East, W.M.). Tehaleh is bounded to the south and west by the Carbon River, to the east by South Prairie Creek, and to the northwest by Canyonfalls Creek. See Figure 1 for a vicinity map showing the location of the site.

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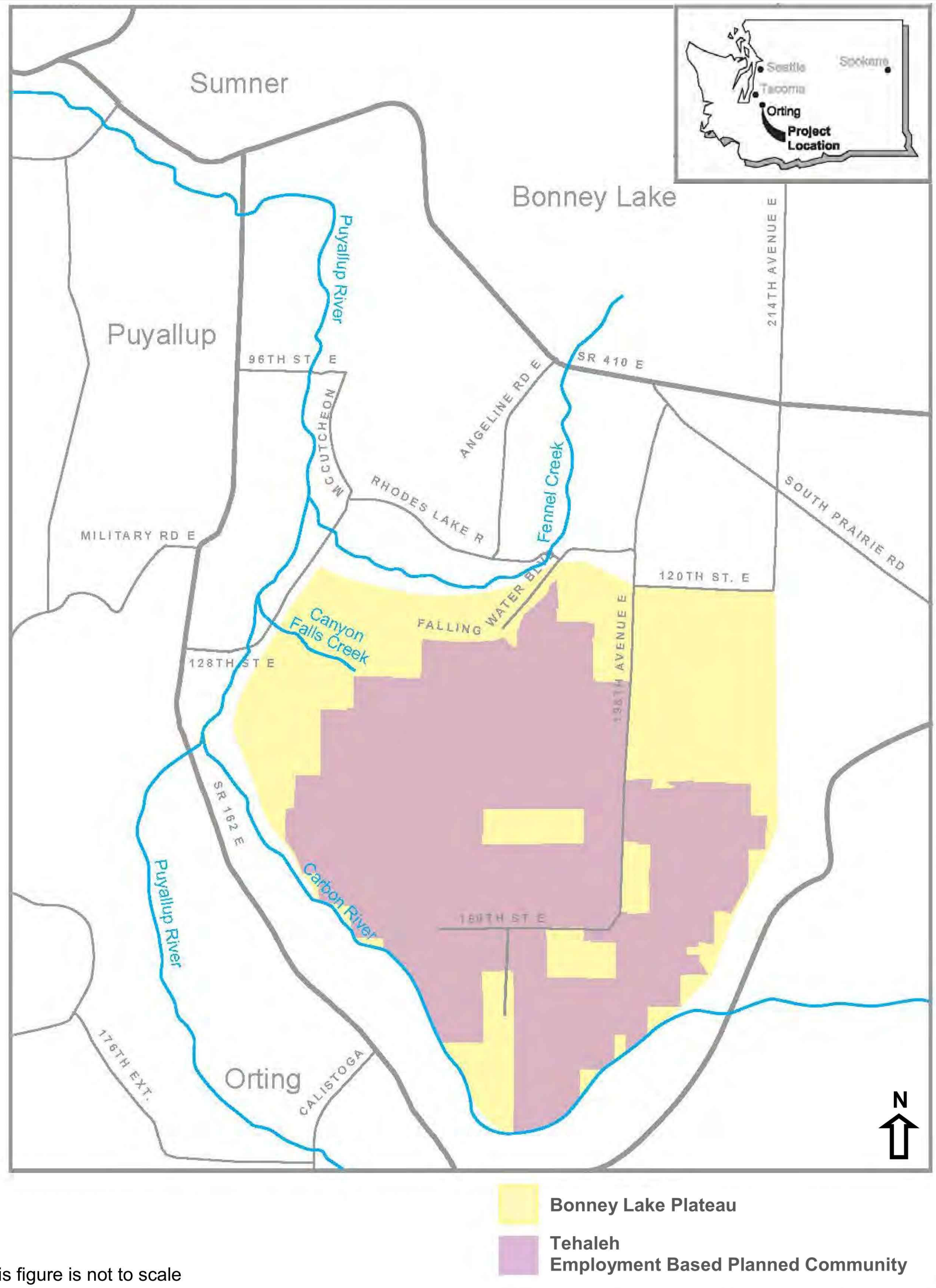
FILE: J:\CASCADIA\16076 - TEHALEH PHASE 2 EIS\CIVIL\EXHIBITS\FIGURE 1 - VICINITY MAP.DWG



Note: This figure is not to scale

MAP/IMAGE PROVIDED BY ENGINEERING, SCIENCE, AND TECHNOLOGY, INC., PBC

MacKay Sposito

1325 SE TECH CENTER DRIVE, SUITE 140
VANCOUVER, WA 98683
PHONE (360) 695-3411
www.mackaysposito.com

TEHALEH E.B.P.C.

FIGURE 1 - VICINITY MAP

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3.0 EXECUTIVE SUMMARY

The following report provides a preliminary analysis of the proposed Stormwater Master Plan for Tehaleh. The analysis presents a description of the existing and proposed infrastructure requirements to meet estimated developed stormwater runoff and proposed detention and retention facilities sizing. The existing Tehaleh conveyance system and stormwater facilities within Tehaleh consist of one water quality/retention facility (R4), two water quality/detention facilities (D3 and D4), and approximately 12,000 linear feet of backbone conveyance system. This infrastructure is operational and no stormwater-related issues have been identified.

The existing condition of the Tehaleh site is forested with mainly till and some outwash soils. The Tehaleh area is located on a plateau with somewhat unique drainage characteristics. The site is approximately 4,756 acres but does not have significant drainage courses that run off the property. The existing hydrology of the site consists of a series of closed depressions and wetlands that receive excess precipitation and infiltrate it into the soil, recharging groundwater aquifers. The site is surrounded by the Carbon River, Puyallup River, Canyonfalls Creek, Fennel Creek, and South Prairie Creek. From Associated Earth Sciences, Inc. (AESI) Earth and Groundwater report dated June 30, 2017 (AESI 2017 Report) and previous AESI reports (1996, 2013), the existing groundwater system captures almost all excess precipitation. The groundwater has been recorded seeping out of the western and eastern bluff with the main seepage point in Canyonfalls Valley and is the source of the Canyonfalls Creek headwaters. The headwater of Canyonfalls Creek is Tehaleh's only significant discharge location of excess precipitation in existing conditions.

The proposed Stormwater Master Plan follows guidelines of infiltrating all stormwater onsite due to the unique existing conditions described above. A major stormwater-related impact will be the volume of water infiltrated into the subsurface aquifers and the corresponding effect on slope stability and water quality and quantity at the seepage point to Canyonfalls Creek. These volumes infiltrated by proposed stormwater facilities and by the proposed rapid infiltration facility for the effluent from the proposed Wastewater Treatment Plant have been analyzed by AESI and it was determined that the proposed quality and quantity of volume infiltrated into the aquifers will not have a significant impact the Canyonfalls Creek headwaters.

Twenty (20) stormwater facilities are proposed through the site, 6 water quality/ detention facilities and 14 water quality/ retention facilities. Each of these facilities will have an emergency overflow spillway and will have a conveyance route or be sized with increased factors of safety to reduce the risk of overflowing in catastrophic storm events. All the retention facilities will have water quality facilities upstream from their inlets and all water quality and flow control parameters will be designed in accordance with applicable stormwater regulations and the provisions of the Phase II Development Agreement.

There are multiple closed depressions and wetlands throughout the site. Some closed depressions have been identified as having flooding problems (CC2B and CC2A). These depressions are partially located within exception parcels, as well as their tributary areas, and will be mitigated with overflow systems to ensure that existing flooding problems are improved or remain the same as under existing conditions. Wetlands throughout the site will also be mitigated when their tributary areas are affected by development. Based on the size of the wetlands, either roof drains or water quality/detention facilities will be used to mitigate the affected wetlands. Wetlands will be mitigated to meet or exceed applicable stormwater regulations.

Each wetland within the site will be assessed by Raedeke Associates during the preliminary plat process and a Pierce County-approved mitigation plan will be established based on that wetland's unique attributes. At this date, Raedeke Associates has identified six wetlands that may potentially require mitigation using a water quality/detention facility. These wetlands are Wetland 1, 4, 6, 14, 63 and Orting Lake. Wetland 4 is already being mitigated by existing water quality/detention facility D4 with no identified concerns or issues to date.

Environmental Impacts and Mitigation Measures

Below are the identified potential stormwater-related impacts and respective mitigation measures:

Impacts of Canyonfalls Creek and Bonney Lake Springs will be mitigated by mimicking pre-developed conditions and maintaining infiltration volumes to the local groundwater and regional aquifers. Groundwater and continuous simulation surface hydrology models were used to analyze pre- and post-development conditions to determine if the quality and quantity of water will cause any significant impacts on slope stability, and/or flow rates and volumes to the Canyonfalls Creek headwater. From the AESI model results, significant impacts to groundwater quality or quantity and slope stability shall not occur (AESI 2017 Report). Using the mitigation measures presented and the proposed stormwater drainage system, the groundwater models show that at the main groundwater discharge point on the site, the flows are projected to only increase by 5 percent. This equates to approximately 0.5 cfs, which from AESI's analysis will not cause any adverse impacts to the downstream system. AESI also modeled the volume coming from any facility located near a slope, specifically proposed retention facilities R5 and R10. These facilities were analyzed to determine the extent of groundwater mounding that could occur; AESI determined that with proposed volumes infiltrating from these facilities, there shall be no adverse impacts to slope stability or erosion.

Additional detailed geotechnical and hydrologic studies will be conducted at each facility site at the time of final design (prior to any development) to verify the suitability of each specific site. The final design studies will include extensive field exploration at each site. Facility locations could shift based on the results of the field exploration and final design studies. Of particular concern is the effect of retention facilities on the stability of steep slopes along the perimeter of the Tehaleh site. Slope stability will be specifically addressed in the final design of retention facilities and facilities will be specifically relocated – or facility configuration modified – as necessary to avoid slope stability concerns. This analysis will also ensure that impacts to Major Rivers are not significant. Since Canyonfalls Creek is the main discharge location for Tehaleh stormwater (via infiltration and groundwater seepage) and there are no water courses leaving the plateau, no significant impact shall occur to any surrounding major rivers.

The water quality of receiving water bodies will not be impacted from the proposed development and Stormwater Master Plan. All retention facilities will have water quality facilities upstream of the infiltration cells per applicable stormwater regulations. Stormwater released from developed areas to wetlands will either come directly from non-pollutant generating surfaces or will be treated in a water quality facility prior to discharge to a wetland. With these mitigation measures, no significant adverse impacts shall occur.

The Tehaleh site has many closed depressions, some with wetlands and some without. Impacts to closed depressions and wetlands can cause flooding impacts if unmitigated flow is released to them. Closed depressions and wetlands will be mitigated by modeling their existing conditions and maintaining their hydrology (if left in existing conditions). Closed depressions that are filled by development activities will be analyzed and the existing drainage conditions will be mimicked, replaced with a retention facility, or provided with an overflow and monitored.

The Tehaleh proposed stormwater management system will be designed to recharge all runoff to the regional aquifer since there are no water courses on the plateau. Downstream impacts such as erosion, siltation, etc. do not normally occur since no water courses are present. In catastrophic storm events, emergency overflows will route stormwater to the Puyallup River and in one case, to Canyonfalls Creek. These overflows will use closed conveyance with energy dissipaters or dispersion methods to ensure erosion is not caused in the unlikely event of an emergency overflow. Facilities without overflow paths will be designed with significant safety factors and emergency spillways to reduce erosion of the facilities.

The Tehaleh Stormwater Master Plan proposed an access road that cuts across a moderately steep slope southwest of proposed parcel 2F.3. This proposed alignment and profile was provided to AESI for impact analysis and no significant impacts were identified. Interim gravel mining will be conducted on-site in Parcel 2C.2 and 2C.3, and these clearing and grading activities will be mitigated by Stormwater Pollution Prevention Plans and onsite infiltration facilities for stormwater runoff. With these mitigations, no significant impacts from clearing, grading and/or slope stability issues shall occur.

Along with the above impacts and mitigation measures presented within this report, refer to the Tehaleh Conditions of Approval from the 2015 Development Agreement. For a full description of environmental impacts and mitigation measures see Section 7 on page 52 of this report.

Significant Unavoidable Adverse Impacts

Development under the Phase II will result in potential stormwater-related impacts associated with construction (site clearing and grading, installation of utilities/infrastructure), infiltration to groundwater, and surface water runoff. With the implementation of the mitigation measures related to these hazards, as discussed in detail in this report, no significant unavoidable adverse stormwater-related impacts would be anticipated.

4.0 AFFECTED ENVIRONMENT (EXISTING CONDITIONS)

4.1 GENERAL

A map of the site, and surrounding region, is shown in Exhibit 1. The site is accessible from the north via 198th Avenue East, a public road. Future secondary access will be constructed on the west side of the project from the Orting valley. This access is proposed to be the main entrance for the project and will be at minimum a 4-lane roadway and will loop through the project to the current project entrance (intersection of Cascadia Blvd E and 198th Ave E). SEPA review for the roadway, known as “New Rhodes Lake Road East”, is provided in a separate Supplemental EIS.

198th Ave E has undergone and will undergo further improvements and realignment from the existing intersection of 107th St Ct E and 199th Ave Ct E to approximately 1,600 feet south of the intersection of 198th Ave E and Cascadia Blvd E. Improvements have been completed from 137th St E to approximately 1,600 feet south of Cascadia Blvd E and 198th Ave E. The remaining improvements are in progress and

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should be completed by summer of 2017. Based on traffic volumes and construction progress of New Rhodes Lake Road E, 198th Ave E can potentially be expanded from 2 lanes to 4 lanes. Internal major roadways that are currently constructed are Canyon View Blvd E and portions of Cascadia Blvd E with the final segment of Cascadia Blvd E in the process of construction. Several feeder roads and secondary collectors have been constructed on a plat-by-plat basis. Proposed Tehaleh Blvd from the intersection of Cascadia Blvd E to the proposed WWTP access road has been cleared and a 20' access road has been constructed.

There are 6 completed neighborhoods in Tehaleh (Columbia Vista, Liberty Ridge, Winthrop, Whitman, Inspiration Ridge and Trilogy East), as well as other completed developments such as the Donald Eismann Elementary School, the Visitor Center/The Post and the Seven Summits Lodge, the Retention Facility R4 and Detention Facilities D3 and D4. There are 5 neighborhoods currently under construction (Trilogy West, Cathedral Ridge, Berkeley Park, Panorama Point and Pinnacle Ridge). As of March 1, 2016, there are 1,022 single family lots platted, 727 single family building permits issued, 514 single family homes occupied, approximately 3,000 sq. ft. of employment, and 888 additional single family lots under development (preliminary platted). Approximately 4,000-acres are still undeveloped and have been managed for forest resource production over most of this century. The majority of the site currently consists of vacant land with plant communities at varying stages of maturity. Notable natural features on the site include Orting Lake, approximately 56 acres of wetlands and additional 208 acres of buffer area within Tehaleh, a portion of Canyonfalls Creek, and the plateau bluffs. Three parcels termed "exception parcels" are not part of the Tehaleh ownership, but are on the plateau and surrounded by the site. These parcels are largely wooded and contain scattered low-density single-family residences.

4.2 EXISTING INFRASTRUCTURE

The existing stormwater system consists of Retention/Water Quality Facility R4, Detention/Water Quality Facilities D3 and D4 and approximately 12,000 linear feet of major backbone conveyance infrastructure. The system was designed for the capacity of 917.2 developed acres - 202 developed acres directly tributary and an additional 715.2 developed acres tributary via detention facilities D1-D4. This area covers a large percentage of the residential, roads, parks, commercial, and public facilities in the Phase I boundary from the 2014 EIS Addendum (For detailed analysis of R4, D3, and D4 sizing specification, land use and sub-basin information, see 2006 Whitman at Cascadia Onsite Roadway and Stormwater Plan prepared by Goldsmith and Associates, Inc.).

The existing backbone conveyance system begins on the eastern side of the project site with Detention Facility D3 located directly west of the intersection of Cascadia Boulevard and 198th Avenue East. Currently detention facility D3 receives runoff through a 36" conveyance pipe from Sub-basin A, which consists of existing Columbia Vista (Parcels K1 and K2), south portion of proposed Panorama Point (Parcel N), proposed Pinnacle Ridge (Parcel J), and existing and future 198th Ave E. The stormwater is detained in D3 and through a control release is conveyed into a 30" conveyance system that runs west along Cascadia Boulevard to the location of the existing Detention Facility D4. This conveyance pipe will incorporate junctions to collect and convey runoff from adjacent parcels along its route.

Facility D4 currently is designed to receive runoff from Sub-basins D and G which contain the Trilogy Plats (M parcels) and will also collect flow from a 48" conveyance system routing flows from future Water Quality/Detention Facilities D3B and D2. Sub-basin CC1B drains to future Detention Facility D3B, located south of Panorama Point (Parcel N), and will also mitigate Wetland 6's hydrology. Sub-basins

CC2A, CC2B, CC7A, CC7B, and CC7C drain developed runoff to future Detention Facility D2, located south of Wetland 14 and north of Parcel 2E.7, and will also mitigate Wetland 14's hydrology.

The backbone conveyance system continues from the intersection of Cascadia Blvd E and Canyon View Blvd E through a 60" pipe. The conveyance system runs along Canyon View Blvd E to the north and collects runoff from adjacent parcels along its route, then drains to an open channel that runs west along the north boundary of the Liberty Ridge plat (Parcel L). The backbone conveyance system is transferred from an open channel into a 60" pipe that runs between Berkeley Park (Parcel G) and the Liberty Ridge plat (see Exhibit 3). The system then drains into an open channel which crosses through Berkeley Park (Parcels G, P2.1, and P2.2) to the existing retention facility R4. Facility R4 is designed to provide stormwater flow control for Sub-basins A, B, C, D, E, F, G, H, CC1B, CC2A, CC2B, CC7A, CC7B, and CC7C (From 2006 Whitman at Cascadia Onsite Roadway and Stormwater Plan). Retention Facility R4 has an emergency overflow spillway that will convey emergency overflows to a proposed flow path to the proposed Facility R4A (see Exhibit 4).

4.3 SURFICIAL SOILS

A Soils Map is provided in the *Soils, Geology, Groundwater and Geologic Hazards Report* by Associated Earth Sciences, Inc. (AESI) dated June 30, 2017 (AESI 2017 Report). Per AESI 2017 Report, site soils formed over relatively young glacial deposits on the upland or post-glacially deposited alluvial sediments in the bordering valleys and consist of Alderwood Series, Everett Series, Indianola Series, Kitsap Series, Xerochrepts, Dupont Muck, Semiahmoo Muck, and Assorted Alluvium Soils. For a detailed description of these soils series see the AESI 2017 Report.

The Everett and Indianola Series soils are considered extremely well-drained. Everett Series soil types were typically found across portions of the upper plateau and the terraces bordering the plateau. Indianola Series soils types were typically found on the southern portion of the site, and along the southern and eastern bank to Canyonfalls Creek valley. The Alderwood and Kitsap Series soils are considered moderately well-drained. The Alderwood series were typically found on portions of the upper plateau were they form on flat to steep slopes. The Kitsap Series soils were typically found along the western border of the site. These soil series are identified because they exhibit qualities which are conducive to infiltration facilities. These types of soils will be referred to as "outwash" soils compared to less well-drained soils, referred to as "till" soils. The site is predominately "till" soils. The site is covered by second-growth mixed forest with dense native understory, except where recent and historic logging has occurred.

4.4 TOPOGRAPHY

The Tehaleh site is located at the southern end of the Bonney Lake Plateau with topographic features formed by various glacial processes during the Vashon Stade of the Fraser Glaciation. Most of the site surface soils are covered by a layer of Vashon-age sediment deposits. The site is covered by roughly circular depressions, called kettles, which were formed by blocks of melting ice, and terraces were formed by meltwater channels.

Elevations within Phase I (upland area) of the site range from 600 feet to just over 900 feet. Orting Lake, a notable feature in the center of the site, is at an elevation of 738 feet with surrounding areas in Phase II ranging to just under 900 feet. Terrace elevations along the eastern and southeastern margins of the upland typically range from 600 to 680 feet. Elevations along the western and southwestern dissected and kettled terrace surface range from about 540 to 600 feet.

Elevations in the surrounding river valleys range from elevation 100 to 200 feet in the Puyallup/Carbon River valley to elevation 200 to 300 feet in the South Prairie Creek Valley. Bluffs bordering the major river valleys adjacent to the site generally range from 200 to more than 400 feet in height. Steep slopes bordering Canyonfalls Creek are approximately 200 to 220 feet high.

The slopes within Tehaleh will be categorized by 3 ranges of slope: areas with slopes at 0 to 15 percent gradient, 15 to 30 percent gradient, and steeper than 30 percent gradient. Most of the site falls into the category of 0 to 15 percent gradients with small areas within the site having slopes of 15 to 30 percent. Areas with slope in excess of 30 percent typically correspond with the steep bluffs adjacent to the major river valleys, steep slopes south of Canyonfalls Creek, slopes north of 131st Ave E and parallel with 198th Ave E and also border terrace areas.

4.5 REGIONAL HYDROGEOLOGY

Regional Hydrogeology is described in detail in the Technical Report *Soils, Geology, Groundwater and Geologic Hazards Report* by AESI (AESI 2017 Report). The following is a summary of the information provided by AESI that is pertinent to surficial drainage features throughout the site.

AESI identified four zones of groundwater flow; three of the zones are considered aquifers, while the other is considered an interflow zone which is not an aquifer due to its seasonal occurrence. The three aquifers determined are: a shallow Alluvial Aquifer that occurs within Holocene Carbon/Puyallup River valley sediments; a Plateau Aquifer formed primarily in Vashon advance outwash, pre-Vashon-age coarse-grained deposits and in upper portions of the Puyallup Formation; and a deeper upland aquifer in older predominately glacial deposits termed Orting Aquifer, see 2014 EIS Addendum and referenced reports for further details on the aquifers and interflow zones. These aquifers are partially recharged from the Tehaleh project area through infiltration of excess precipitation.

Previous reports and the June 30, 2017 report by AESI confirm that due to the unique hydrology of the Tehaleh site the vast majority of excess precipitation on the upland plateau is captured in the site system of closed depression and is infiltrated into the groundwater. Per AESI 2 Report, Groundwater from the upland plateau flows west towards the Carbon/Puyallup River valley and northwest towards Canyonfalls Creek and Fennel Creek through a major aquifer system, referred to as the Plateau Aquifer. From groundwater analysis/models, slope stability analysis/models, field data, and field observations performed by AESI and described in detail in the AESI 2017 Report, most of the groundwater flowing in the Plateau Aquifer under the project area discharges to Canyonfalls Creek, which is the source of the spring and headwaters of Canyonfalls Creek. This occurs due to the large bluffs surrounding the plateau; as the aquifer approaches the bluffs, some groundwater daylights onto the slope as springs and seeps. Areas were this phenomenon occurs are described in more detail in the Surface Drainage Courses below.

A smaller portion of the flows from the Plateau Aquifer also discharges to a series of springs located north of the project site and south of Fennel Creek. Some of this groundwater also remains in the subsurface and flows past Fennel Creek to the Carbon/Puyallup River valley within the permeable Fennel Creek Delta.

From AESI's analysis, the estimated groundwater capture zone of Canyonfalls Creek encompasses areas north and east of the Tehaleh project area. These springs and well locations are shown in Figure 4 of the

AESI 2017 Report. From the observations and analysis performed by AESI, they conclude that "*The primary implication is the understanding that both water quantity and water quality in the headwaters of Canyonfalls Creek can be strongly influenced by off-site land use activities.*" (AESI 2017 Report) Modeling of the existing and proposed groundwater systems and monitoring Canyonfalls Creek discharge for both quality and quantity will assist in determining and avoiding potential impacts from development.

4.6 SURFICIAL HYDROLOGY

The entire Tehaleh site is located within the Puyallup River tributary drainage basin area, which can be broken down into 5 basins: Carbon River basin (49.9% of project area), Canyonfalls Creek basin (32.2% of project area), South Prairie Creek basin (16.1% of project area), direct Puyallup River basin (1.5% of project area), and Rhodes Lake/Fennel Creek basin (0.3% of project area). Exhibit 1: Regional Pre-Developed Basins shows these surficial drainage basins, existing topography, and project boundary.

From field exploration, field data, previous reports and studies compiled since initial development processes began in the mid 1990's, it is evident that the regional basins shown on Exhibit 1 are not necessarily representative of stormwater surface runoff patterns on the Tehaleh site. As discussed in the Regional Hydrology section above, the majority of the excess precipitation that falls on the project area is tributary to the Canyonfalls headwaters and Carbon/Puyallup river basin through subsurface flow paths and not through direct surface runoff or significant drainage courses. Although the surface topography may indicate that portions of the site drain to certain drainage basins, field data and observations indicate that this is not the case. Virtually all excess precipitation on the upland portion of the Tehaleh site eventually reaches the outwash aquifer beneath the site and flows north to Canyonfalls Creek or to the Bonney Lake Springs. This fact is a key element in understanding the unique hydrology of the Tehaleh site.

Puyallup River

The Puyallup River is the largest surficial drainage feature located near the site. At its closest point, the river is located about ⅔ miles west of the site. The entire site is contained within the Puyallup River drainage basin. As mentioned above, three major tributaries of the Puyallup River are located in close proximity to the site: Carbon River, South Prairie Creek and Canyonfalls Creek.

A small area of the site (71 ac.) drains directly to the Puyallup River. This area was reviewed by wetland specialists for the 1998 EIS, the 2014 EIS Addendum, and in their Surface Drainage No.1 (SD 1, see Exhibit 3). However, most of the site drains to the Puyallup River indirectly, via the major tributaries described above, particularly Canyonfalls Creek. The various tributaries of the Puyallup River are described in separate sections below.

The Puyallup River has a total tributary area (including all of its tributaries) of approximately 996 square miles. Above the confluence of the Puyallup and Carbon Rivers, the Puyallup River has a tributary area of approximately 416 square miles. The site is about 4,700 acres in size and comprises about 0.7% of the total area of the Puyallup River Drainage Basin and about 1.8% of the area of the Puyallup Basin above the confluence of the Puyallup and Carbon Rivers.

The Puyallup River has its headwaters on Mt. Rainier and its flow characteristics are influenced greatly by snowmelt and precipitation conditions in its upper watershed and those of its major tributaries. At the confluence of the Puyallup and Carbon Rivers the average annual flow and average summer low flow in the Puyallup River are 696 cfs and 160 cfs respectively. The Tehaleh site contributes significant flow to the Puyallup River only via groundwater discharge to Canyonfalls Creek.

Carbon River

The Carbon River is a major tributary of the Puyallup River. It is located in close proximity to the south and west boundaries of the site. Small portions of the site boundaries extend into the Carbon River, although none of the developable portion of the site is in close proximity to the river or the river valley. The Federal Emergency Management Agency (FEMA) maps floodplains for most significant waterways. None of the proposed development is within the Carbon River floodplain.

The Carbon River has its confluence with the Puyallup River about ⅔ miles west of the Tehaleh site. The Carbon River has a total tributary area of approximately 145 square miles. About 2,400 acres of the site is located within the surficial topographic boundaries of the Carbon River Basin and, therefore, the site theoretically comprises about 2.6% of the Carbon River Drainage Basin. However, as a result of site hydrogeology (described above) the actual area of the site which drains to the Carbon River is significantly less than the area defined by topographic drainage boundaries.

There are four known tributaries which convey surface runoff from the Tehaleh site to the Carbon River (SD's 2,3,4 and 5). These surface drainage courses appear to begin at, or near, the southwestern project boundary. Theses drainage courses, per AESI’s report, are fed by groundwater through seepage and continue down the valley slope to the Carbon River. The locations of SD's 2,3,4 and 5 are shown on Exhibit 3 and the surface drainage courses are described in more detail in a following section. The surficial tributary area of these surface drainage courses is relatively small and they do not appear to carry significant amounts of water flow from Tehaleh to the Carbon River. The Tehaleh site is not believed to be a significant contributor of flow directly to the Carbon River.

South Prairie Creek

South Prairie Creek is a major tributary of the Carbon River. It is located adjacent to the south and east boundaries of the site. Small portions of the site extend into the South Prairie Creek Valley although none of the developable portion of the site is in close proximity to the creek or its valley. All of the area of the Tehaleh site that is proposed for development is located on the Orting Plateau, separated from the creek by the steep slopes that form the valley walls. A FEMA map shows that the proposed development is not within any South Prairie Creek Floodplain area.

South Prairie Creek has its confluence with the Carbon River approximately 1,000 feet southeast of the Tehaleh site. South Prairie Creek has a total tributary area of approximately 95 square miles. About 860 acres of the site is located within the surficial topographic boundaries of the South Prairie Creek Basin and, therefore, the site theoretically comprises about 1.4% of the South Prairie Creek Drainage Basin. However, as a result of site hydrogeology (described above) the actual area of the site which drains to South Prairie Creek is significantly less than the area defined by topographic drainage boundaries.

There are three known tributaries which convey surface runoff from the Tehaleh site to South Prairie Creek (SD's 6,7 and 8). These surface drainage courses appear to begin at, or near, the edge of the Orting Plateau and continue down the valley slope to South Prairie Creek. The locations of SD's 6,7 and 8 are shown on Exhibit 3. The surficial tributary area of these surface drainage courses is relatively small and they do not appear to carry significant amounts of water flow from Tehaleh to South Prairie Creek. The Tehaleh site is not believed to be a significant contributor of flow directly to South Prairie Creek.

Canyonfalls Creek

Canyonfalls Creek is a tributary of the Puyallup River. The Canyonfalls Creek valley is located within the north boundary of the Tehaleh site. It continues west, off of the site, to the Puyallup River valley. As previously noted, the creek has its headwaters in a series of wetlands located in the bottom of the Canyonfalls Creek valley at the northwest corner of the Tehaleh site. Upstream of these wetlands there is no stream flow and the valley contains no drainage course. Downstream of the wetlands the creek flows perennially. The source of Canyonfalls Creek is groundwater discharge from the aquifer beneath Tehaleh.

Significant surface water flow is present in the Canyonfalls Creek ravine at the north end of the site. The headwaters of Canyonfalls Creek begin at a spring zone that represents discharge from the Plateau Aquifer. The Plateau Aquifer’s capture zone encompasses approximately 50 percent of the Tehaleh property and stormwater infiltrated on the Tehaleh site can influence the quantity and quality of water of Canyonfalls Creek (see Regional Hydrology section above). Canyonfalls Creek flows generally westward from its headwater springs to the Carbon/Puyallup River valley. The Canyonfalls Creek ravine is interpreted to be a Vashon-age recessional meltwater channel and does not appear to have been modified by post-glacial stream activity. Rainfall is interpreted to infiltrate downward into the coarse-grained recessional outwash deposits in the swale up gradient of the Canyonfalls Creek spring zone.

Raedeke Associates, Inc. preformed site investigation and analysis of the Canyonfalls Creek are in the 1997 Wetland Assessment Report and in their updated March 31, 2016 Wetland Assessment Report for the Tehaleh Phase II SEIS (Raedeke 2016 Report). This report describes the Canyonfalls Creek headwaters as Wetland 11 (see Raedeke 2016 Report for detailed descriptions). Wetland 11 is within the project area and is connected to an offsite wetland, Wetland 10. Wetland 10 is where the Canyonfalls creek becomes a perennial stream. According to the Raedeke 2016 Report, there is no surface water connection between the two wetlands.

AESI has been monitoring Canyonfalls Creek flow for approximately 15 years. The monitoring location is directly downstream from the headwater of Canyonfalls Creek. AESI interpreters the flows from the headwater as spring flow from the Plateau Aquifer. Monitoring data shows that Canyonfalls Creek ranges from about 8 to 26 cfs with an annual low flow of approximately 10 to 11 cfs (see AESI 2017 Report for complete monitoring details and analysis).

An important note for Canyonfalls Creek is that the Troutlodge Fish Hatchery is located along the Canyonfalls Creek to the northwest of the Tehaleh site. The fish hatchery has surface water rights to withdraw 15 cfs from Canyonfalls Creek. The water withdrawn by the hatchery is released downstream of the hatchery and is considered a non-consumptive use.

The floodplain of Canyonfalls Creek has not been mapped. However, because the creek is primarily influenced by groundwater discharge it is not subjected to high flood flows. Therefore, the limits of the Canyonfalls Creek floodplain are likely to be within the banks of the creek and nearly the same as the limits of the ordinary high water line of the Creek. In any event, the area of the Tehaleh site that is proposed for development is separated from the creek by the steep slopes that form the Canyonfalls Creek valley. Canyonfalls Creek has a total surficial topographic tributary area of approximately 3.8

square miles. About 1,465 acres of the site is located within the surficial topographic boundaries of the Canyon falls Creek Basin and, therefore, the site theoretically comprises about 60% of the surficial drainage basin. However, as a result of site hydrogeology, the Canyonfalls Creek capture zone is actually significantly larger than the surficial drainage boundaries indicate. The Tehaleh site appears to be almost totally located within the Canyonfalls Creek capture zone and the site probably comprises well over 75% of the Canyonfalls Creek capture zone. There are no known tributaries or drainage courses which convey surface runoff from the Tehaleh site into Canyonfalls Creek.

Surface Drainage Courses (SD's)

There are eight small tributaries (SD's) that are scattered around the edge of the site and convey surface water from the Tehaleh site to the Puyallup/Carbon/South Prairie Valleys (Goldsmith 1998 Report). The locations of these tributaries are shown on Exhibit 3. The locations of these SD's are based on field reconnaissance by Raedeke Associates, Associated Earth Sciences, Inc and previous exhibit and reports from the 1998 EIS. Descriptions of the Drainage Courses are described in Raedeke 2016 Report and AESI 2017 Report. Identified streams from the Raedeke 2016 Report are described to be coming from Wetland 56 (SD 2), Wetland J/K/M (SD 3), Wetland E (SD 4), and Wetland A (SD 5). Drainage courses SD 1, SD 6, SD 7 and SD 8 are not as well defined. Goldsmith 1998 Report identified eight drainage courses throughout the site and showed them on their respective exhibits. As described above, drainage courses SD 2 through SD 5 have been identified as coming from particular delineated Wetlands within the Tehaleh Project Area and have active seasonal waters visually identified during field reconnaissance. SD 1 is described in the Goldsmith 1998 Report as being the sole drainage course from the direct Puyallup River Tributary Area (see above) but there is no discussion of active water or visual confirmation of water within this drainage course. The drainage course is a historical drainage course assumed to be created by glacial melt-water, however it appears to be a dry drainage course in current climate. The drainage course has not been visually identified by Raedeke Associates, Inc. but is shown on exhibit due to records of previous report and exhibits in the 1998 EIS, therefore is shown on our exhibits and discussed in this report. Drainage Courses SD 6 through SD 8 were also identified in the 1998 EIS and discussed in reports and shown on exhibits. These drainage courses are very similar to SD 1 in that no active water has been identified within these areas. It is also assumed that these are historical drainage courses from glacial melt-water and appear to be dry drainage courses in current climate. AESI and conducted reconnaissance in these areas and has not identified any flowing or active water.

It is believed that the sources of the SD's 2 through 5 are springs emanating from the bluffs of the Orting Plateau and it is not believed that the SD's convey significant amounts of surface runoff from the plateau to the valley (AESI 2017 Report). This conclusion is based on two factors: 1. The tributary areas of the various SD's is underlain by permeable soils and geologic strata, and 2. The SD's do not appear to be significantly incised or eroded. The SD's traverse the extremely steep slopes of the bluff as they flow to the valley bottom and significant surface flows would be expected to create severe incisions in the valley walls (AESI 2017 Report). It appears that SD 1 and SD 6 through SD 8 are topographically and historically drainage courses but during reconnaissance conducted by AESI, no water has been observed in these drainage courses. It is assumed that these are dry drainage courses created by historical glacial melt-waters.

Closed Depressions

A closed depression is defined as a topographic low area which has no apparent surface outlet. Water that drains to a closed depression, either via surface runoff or interflow, is infiltrated into the ground. If the rate of runoff or interflow into the closed depression exceeds the infiltrative capacity of the soil, ponding (storage) of excess runoff will occur. Infiltration of stored water will occur over extended time periods, after the rainfall event has ended. The level of ponding (if any) that occurs in each closed depression is dependent upon numerous factors such as the size of the tributary area, the volume and rate of runoff/interflow, available storage (size of the depression) and the infiltrative capacity of the soil. The site contains numerous closed depressions scattered relatively evenly about the Tehaleh site. Some of these larger depressions and wetlands are shown on Exhibit 2.

Most of the closed depressions are located on the till cap which overlies the center of the Tehaleh site. Since the till cap has a relatively low permeability, this should result in relatively favorable conditions for the formation of wetlands. However, only some of the major closed depressions on the site contain wetlands. The lack of wetland vegetation in most of the closed depressions on the site indicates that saturated soil conditions do not exist in the closed depressions for sufficient lengths of time to support wetland species. This appears to be the result of the relative permeability of the till cap beneath the Tehaleh site. The permeability of the till cap limits the amount of water which can reach the depressions and it allows the water which does reach the depressions to drain away relatively rapidly.

EXISTING FLOODING PROBLEMS IN CLOSED DEPRESSIONS

Closed Depression CC2B

Closed Depression CC2B is located east from the most northern NE corner of Exception Parcel 3 and west of the most SW corner of Exception Parcel 2 and just south of existing 160th St. E. within Phase II of Tehaleh. The depression covers approximately 2.5 acres and has a tributary area of approximately 107 acres. Approximately 63 acres were directly tributary (sub-basin CC2B) to the depression during existing conditions and the additional 44 acres come from sub-basin CC7C, a smaller closed depression within Exception Parcel 3 (see Exhibit 2). The sub-basin drains to a smaller closed depression within Exception Parcel 3 and eventually overflows into closed depression CC2B based on topography.

This closed depression was analyzed by Goldsmith & Associates for the 1998 EIS and below is a direct excerpt from their report, *"Cascadia Master Drainage and Assessment of Hydrologic Impacts"* dated January 1998.

> *The bottom of the depression is at about EI. 758. Its theoretical overflow elevation is located on the Cascadia Phase 1 site at about EI. 777. This would theoretically allow for up to 19 feet of storage depth before overflow. 160'h Street E. is located adjacent to the depression at an elevation of about 760. It is below the theoretical overflow elevation for the depression and, therefore, subject to potential flooding during major storm events. If the depression were to fill and overflow, overflow would flow to the north and into Wetland 14.*
>
> *Depression CC2B normally contains no water. It has been examined by the project biologist and it does not contain a wetland. This indicates that the soils in the bottom of depression CC2B are not saturated for sufficient lengths of time to support wetland species. Depression CC2B has been field checked at various times during the study period. In particular it was visited in February*

1996 and January 1997, after extremely large storm events. During, and immediately after these storm events, CC2B contained over four feet of standing water, with water ponding over the roadway of 160'h Street E. During the January 1997 event 160th Street E. was temporarily closed due to the excessive depth of water over the roadway.

A hydrologic model of the depression was constructed using HSPF modeling technology (See Appendix C for modeling details). The model was roughly calibrated using data from the field observations. The modeling shows that the depression infiltrates most storm events without significant ponding. However, the depression will pond to significant levels during major storm events. The model uses approximately a 50 year record of actual rainfall (10-1-48 to 1-15- 97). According to the model the highest ponding depth reached by CC2B during the 50 year period of record was about EI. 762.9, in December, 1973.

Flooding of the adjacent roadway related to high water levels in CC2B is a known existing problem. Therefore, it is important to avoid development related impacts that could increase the frequency and/or magnitude of flooding associated with CC2B.

MacKay Sposito, Inc. performed site visits of the area of closed depression CC2B and did not witness any flooding during the site visits. Standing water was visible, approximately 3 to 6 inches deep in some spots. Based on the existing elevations of 160th St E, water would need to reach depths of 3 to 4 feet to overflow across the roadway.

This closed depression will be modeled using WWHM12 during the preliminary plat process of future development that could potentially impact the closed depressions tributary area. As mentioned above, this closed depression is identified by Pierce County PublicGIS as a potential flood hazard area; therefore, this closed depression will potentially require a Flood Plain Analysis. The Flood Plain analysis, if required by the County, will be conducted per Pierce County Standards.

Closed Depression CC2A

Closed Depression CC2A is located on the on the west border of Exception Parcel 2. The depression is adjacent to existing 198th Ave E just before the roadway curves and becomes 160th St E. The majority of the depression is located outside of the Tehaleh property. The depression covers approximately 1.5 acres and has a tributary area of approximately 43 acres, about half of which is located on the Tehaleh property.

This closed depression was analyzed by Goldsmith & Associates for the 1998 EIS and below is a direct excerpt from their report, *"Cascadia Master Drainage and Assessment of Hydrologic Impacts"* dated January 1998.

The bottom of the depression is at about EI. 768. Its theoretical overflow elevation is located at about EI. 773. This would theoretically allow for up to five feet of storage depth before overflow. 198th Avenue E. is located adjacent to the depression at an elevation of about 770. It is below the theoretical overflow elevation for the depression and, therefore, subject to potential flooding during major storm events. If the depression were to fill and overflow, overflow would flow to the east.

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> *Depression CC2A normally contains no water. Depression CC2A has been field checked at various times during the study period. In particular it was visited in February 1996 and January 1997, after extremely large storm events. During, and immediately after these storm events, CC2A contained over four feet of standing water, with water ponding over a portion of the roadway of 198th Avenue E. The high water level in the depression also flooded and blocked driveway access to an adjacent property.*
>
> *A hydrologic model of the depression was constructed using HSPF modeling technology (see Appendix C for modeling details). The model was roughly calibrated using data from the field observations. The modeling shows that the depression infiltrates most storm events without significant ponding. However, the depression will pond to significant levels during major storm events. According to the model the highest ponding depth reached by CC2A during the 50 year period of record was EI. 772, in December 1973.*
>
> *Flooding related to high water levels in CC2A is a known existing problem. Therefore, it is important to avoid development related impacts that could increase the frequency and/or magnitude of flooding associated with CC2A.*

MacKay Sposito, Inc. performed site visits of the area of closed depression CC2A and did not witness any flooding during the site visits. There also did not appear to be any standing water on the Tehaleh property. No standing water in Exception Parcel 2 was visible from the Tehaleh property.

This closed depression will be modeled using WWHM12 during the preliminary plat process of future development that could potentially impact the closed depressions tributary area.

Other Closed Depressions

Since the 1998 EIS, no other major closed depressions have been identified as needing modeling or have drainage issues. Below is a direct excerpt from their report, *"Cascadia Master Drainage and Assessment of Hydrologic Impacts"* by Hugh G Goldsmith & Associates dated January 1998.

> *All of the other closed depressions behave in a manner similar to CC2A and CC2B. The depressions appear able to infiltrate small and moderate storm events with little or no ponding. During major storm events significant ponding may occur and last for the period of time necessary to infiltrate the ponded water (up to several weeks). However, unlike CC2A and CC2B, the remaining depressions on the site are located in undeveloped forest land, and occasional ponded water or localized minor flooding has not been considered a problem. Only closed depressions CC2A and CC2B have been modeled as part of this study.*

Potential Flood Hazard Areas

Some wetlands or closed depressions within the Tehaleh site could potentially require a floodplain analysis prior to development within tributary area or in areas potentially flooded by the respective wetland or closed depression. The above mentioned closed depressions are currently the only areas with recorded flooding issues. Based on Pierce County PublicGIS, Orting Lake, Wetland 14, Wetland 6, Wetland 63 and closed depression CC2B are identified as potential flood hazards. Information put into Pierce County PublicGIS potential flood hazards is based on aerial inspection and not from official studies or recommendation from hydrologists, hydrogeologists or wetland specialists. These areas can potentially have flooding issues, but have not been recorded to-date except in closed depression CC2B.

These areas identified by Pierce County PublicGIS will be recognized in this report and will be reviewed during the preliminary plat process of any development that could potentially affect or is in close proximity to these below listed features to determine if official flood plain analysis will be required by Pierce County.

Official Flood Plain Analysis will be completed per Pierce County Standards at the preliminary plat stage of developments identified by Pierce County as being within potential flood plains. The below list of Wetlands and Closed Depressions will potentially require Flood Plain Analysis conducted:

- Orting Lake
- Wetland 6
- Wetland 11 (Canyonfalls Creek Ravine)
- Wetland 14
- Wetland 60
- Closed Depression CC2B

A potential flooding area has also been identified on the far east side of the project, immediately east of the existing TPU Prairie Ridge Water Reservoir and Pump Station. This area was a previously graded stormwater facility that was created during development by the previous developer. The area is not a wetland under existing conditions and was not identified as having flooding issue in the 1998 EIS or any pre or post studies conducted or reports. This is a closed depression due to the previous grading work done but will be replaced by proposed stormwater facility O-2R in proposed conditions, which will be designed per Pierce County Standards.

Wetlands

Through coordination with Raedeke Associates, Inc. (Raedeke), the project's Wetland Specialists, 55 wetlands have been identified in Phases I and II of the Tehaleh Project area. These 55 wetlands encompass approximately 56.3 acres with an additional 208.4 acres of buffer area within Phases I and II. Buffer widths and wetland categories were identified by Raedeke Associates, Inc. Wetland identification and classification in Phase I was performed per the 1996 DOE wetland identification standards. Phase II wetlands were identified and classified per DOE's 2004 wetland identification process.

Wetlands within the site vary in size from approximately 0.01 acres (Wetland 5) to 20.5 acres (Orting Lake), buffer widths also vary from wetlands without buffers (Wetland 80) to 300' buffers (Orting Lake). Almost all of the site's wetlands are located at the bottom of closed depressions. The exceptions are Wetland 10 and 11 which are located at the bottom of Canyonfalls Valley and they are the headwaters of Canyonfalls Creek. These two wetlands are formed by the saturated soil conditions resulting from the discharge of groundwater from the regional aquifer. Wetlands A-E are also noted as potentially receiving groundwater seepage from shallow aquifers as identified by Associated Earth Sciences, Inc.(AESI). Wetlands Q, J, M, S and R were identified by AESI as seepage wetlands. These wetlands are much smaller than Wetlands 10 and 11 and are not monitored.

Modeling of wetlands will be performed during the preliminary plat design stage for any future development that impacts the existing hydrology of the wetland. The modeling will vary depending on the type of wetland, the area affected by development, and recommendations by wetland specialists (Raedeke Associates) and hydrogeologists (AESI). Through coordination with wetland specialists and hydrogeologists, each wetland will be analyzed and mitigated with best management practices which best fit the particular wetland's hydrology. Mitigation measures will range from none to simple roof drain connection to potential water quality/detention facilities.

AESI 2017 Report explains that the wetlands within Tehaleh can be generally categorized into two distinct types, Basin Wetlands and Seepage Wetlands.

- A basin wetland is a type of wetland that receives runoff from within its topographic basin through surface runoff or interflow (see AESI report for detail description of interflow). Basin wetlands are usually located on glacial till with low permeability. Examples of these types of wetlands onsite are Orting Lake and surrounding wetlands in the central area of site. These wetlands can typically be dry during summer months.

- A seepage wetland is a type of wetland that receives runoff from groundwater seepage (see AESI report for detailed description of groundwater). Excess precipitation received from groundwater seepage does not entirely come from the wetland's topographic tributary area. On the Tehaleh site, this category of wetland can be broken down into three types depending on the source aquifer. The three types are Recessional outwash over glacial till, Deeper Aquifers, and Valley Aquifers (see aquifers and associated examples of wetlands are described in detail in AESI's report).

Orting Lake

Orting Lake is the largest body of water/wetland on the Tehaleh site. The wetland portion of Orting Lake is about 20.6 acres in size with a tributary area of approximately 88 acres. Orting Lake water surface is being monitored currently and for the 1998 EIS. Below is a direct excerpt from the report *"Cascadia Master Drainage and Assessment of Hydrologic Impacts"* by Hugh G Goldsmith & Associates dated January 1998.

> *Orting Lake is the largest wetland/water body on the site. The wetland portion of Orting Lake is about 20.5 acres in size and it has a tributary area of about 64 acres. The average water surface of Orting Lake is at about El. 733.5. Its theoretical overflow elevation is located at about El. 740. This would theoretically allow for up to about 6.5 feet of storage depth prior to overflow. If Orting Lake were to overflow, overflow would discharge to the northeast, into Wetland 6.*

MacKay Sposito, Inc. has reviewed LiDAR topography surrounding Orting Lake. From the elevations shown from LIDAR, it appears that Orting Lake can flow northeast to Wetland 6 as Goldsmith describes above but that there is an equally likely location at similar elevation to the southeast of Orting Lake. Planning parcels have been developed to leave an allee/natural buffer within the valley through which Orting Lake overflow would travel. Proposed Retention Facility R7 is preliminarily located within this ravine/overflow path and will receive overflow flows from Orting Lake. If Orting Lake overflows to the northeast to Wetland 6, Wetland 6 has an overflow storm structure at the southeast corner of Trilogy Phase 5 (Parcel M2). The overflow structure will convey flow to existing Detention Facility D4, which ultimately is conveyed to Retention Facility R4.

Orting Lake appears to be fed by runoff/interflow from its tributary area. It is at the top of a topographic divide and it has no significant surficial drainage courses which flow into it. Geotechnical data indicates that the wetland is underlain by glacial till and is not spring fed. The drainage basin for Orting Lake is relatively small in relation to the size of the wetland. Therefore, relatively minor hydrologic changes within its tributary area could result in significant impacts to wetland hydrology.

Orting Lake has been visited regularly since April 1996 as part of the wetland water level monitoring program. Based on the water level data its wetland water level appears to fluctuate on average about 2 feet, reaching a low in the fall of the year. However, its maximum level each year varies depending on the magnitude of individual winter storm events. Orting Lake was visited in January 1997, after an extremely large storm event. The water level was noted to be extremely high but it was not possible to secure a water level elevation because the staff gage was inundated. However, it was noted that Orting Lake did not overflow. Because of extremely high water levels in January of 1997, total yearly water surface fluctuation in 1997 will likely be significantly more than 2 feet.

A hydrologic model of Orting Lake was constructed using HSPF modeling technology (See Appendix C for modeling details). The model was roughly calibrated using data from the field observations and the recorded wetland water levels. The modeling shows that Orting Lake fluctuates significantly in relation to major storm events but that it has never overflowed. The highest calculated water level achieved by Orting Lake during the 50 year period of record was 736.0, in February 1996.

Orting Lake has been monitored by Associated Earth Science, Inc. (AESI) during March 2015 through January 2016. The Orting lake water surface elevation fluctuated by approximately 3.78 feet during this time period. There remains no account of any historic overflow of Orting Lake.

As mentioned above, Orting Lake is identified by Pierce County PublicGIS as a potential flood hazard. This could potentially result in a Flood Plain Analysis being required prior to any development that may encroach on tributary area or be in the area of potentially flooding from Orting Lake. This analysis will be done per Pierce County standards during the preliminary plat process of any development that could impact or be potentially impacted from flooding issues due to Orting Lake.

Wetlands 4 and 6

Wetland 4 is about 3.7 acres in size with an approximate tributary area of 227 acres. The wetland is located at the bottom of a closed depression. The wetland currently has a detention facility (D4) mitigating its influent flow rates and volumes and no reported issues have been identified. See the "*Cascadia Phase 1A Onsite Arterial Roadways and Stormwater Infrastructure Improvements Plan"* prepared by Hugh G. Goldsmith & Associates, Inc. last revised July 2005 for detailed analysis and description of Wetland 4 and D4 mitigation of the wetland.

Wetland 6 is about 6.2 acres in size. Wetland 6 is only partially located on the Tehaleh site. The tributary areas of this wetland is about 248 acres. The wetland exists at the bottom of a closed depression. Below is a direct excerpt describing wetlands 4 and 6 from the report *"Cascadia Master Drainage and Assessment of Hydrologic Impacts"* by Hugh G Goldsmith & Associates dated January 1998.

> *These wetlands appear to be fed by runoff/interflow from their tributary areas, and in the case of Wetland 6, flow from Wetland 14 and its tributary area. Wetlands 4 and 6 are lower than Orting Lake and the topographic mapping shows that these wetlands are downstream of Orting Lake and could be potentially fed by it. However, based on field visits at various times of the year, no surficial drainage courses connect Orting Lake, Wetland 6 and Wetland 4. A field visit was made in January 1997, after an extremely large storm event, with the specific purpose of verifying the presence or absence of a surface connection between the various wetlands. No surface flow was noted. The available geotechnical data shows no indication of a subsurface connection between the wetlands. Therefore, based on the available data it is concluded that these wetlands are hydrologically isolated from each other.*

MacKay Sposito designed an overflow structure for Wetland 6 located in the southeast corner of Trilogy at Tehaleh Phase 5 (Parcel M2). This overflow structure was constructed as part of the existing Private Storm Line running adjacent to Trilogy at Tehaleh Phase 5 and discharges to existing Detention/Water Quality facility D4. Facility D4 is ultimately conveyed to Retention Facility R4. This private storm line (Site Development Permit No. 780581) was constructed to complete a connection for an existing 48" conveyance stormwater trunk line running along the south border of Whitman at Tehaleh (Parcel M1). This 48" trunk line was constructed for the purpose of routing flow from proposed Detention/Water Quality facility D3B, proposed to be located on the east side of Wetland 6 (see Exhibit 3). Facility D3B is proposed to provide water quality and detention for the developed area within sub-basin CC1B (approximately 155 acres) and mitigate Wetland 6's hydrology post-development.

To determine location and elevation of the overflow structure for Wetland 6, a preliminary analysis was performed. A memorandum was submitted to Pierce County on June 14, 2014 (Permit No. 780581) and determined that the historic high water elevation of Wetland 6 was 714.15' and in order to maintain this high water elevation the overflow structure will be set at a rim of 713.82'. For further detail please refer to the above mentioned construction documents and memorandums.

Wetland 14

Below is a direct excerpt from the report, *"Cascadia Master Drainage and Assessment of Hydrologic Impacts"* by Hugh G Goldsmith & Associates dated January 1998.

> *Wetland 14 is about 5 acres in size its tributary area is about 60 acres. Wetland 14 is hydrologically connected to Wetland 6 by a small wetland/drainage course. Therefore, it appears to be a source of inflow to Wetland 6 during the wet season. Because Wetland 14 has an outlet it will overflow during the wet season and its water surface will fluctuate to a lesser degree than the other wetlands onsite. Wetland 14 is, therefore, less sensitive to hydrologic changes in its tributary area.*

The proposed stormwater master plan includes proposed Water Quality/Detention Facility D2 located south of the southern lobe of Wetland 14. The proposed D2 facility will collect stormwater from Sub-basin CC7A as well as developed flows from CC2B and overflow volumes from existing closed depressions CC2B and CC2A. In the case that the CC2B closed depression is removed in the development process, all developed flows and overflow from CC7C will be directed to Facility D2 and ultimately conveyed through various conveyance systems to existing Retention Facility R4.

4.7 HYDROLOGIC MODELING

A hydrologic model was developed for the site in the existing condition to aid in the assessment of the impacts of development. In previous modeling efforts performed by Hugh G. Goldsmith & Associates, a HSPF modeling methodology was used (see 1998 Cascadia Master Drainage Plan and Assessment of Hydrologic Impacts report). The HSPF model was chosen as the best model at the time for the site's unique hydrology. Single event models would not accurately model the stormwater-related issues present on the site. Specific details on the Tehaleh hydrologic modeling and the model results are provided in Appendix C.

For the proposed Tehaleh Drainage System, the pre-developed and post-developed conditions were modeled using the Washington State Department of Ecology's Western Washington Hydrology Model version 2012 (WWHM). WWHM uses HSPF as a backbone for stormwater runoff analysis. The model is a Pierce County-approved continuous simulation model and is promoted in the Pierce County Stormwater Management and Site Development Manual as a preferred modeling program along with MGSFlood. WWHM was developed by Clear Creek Solutions, Inc. specifically for the Department of Ecology and was designed specifically for the purpose of sizing stormwater control facilities for development in Western Washington. The program uses HSPF to do all of the rainfall, runoff and other routing computations; the model is limited by not being capable of backwater or tailwater conditions. Single event models using SBUH will be used to model conveyance systems at the design stage. Pierce County has also developed an extended 158-year precipitation time series, which is specific to the county. This time series is required when using WWHM in Pierce County.

Precipitation, soil data, vegetation data, pan evaporation data, and development land use data is provided within the model. As mentioned above, precipitation data is specific to Pierce County, pan evaporation data is also specific to the selected location and county. The model allows the user to select a specific location within the county where the proposed stormwater facility will be located. Area, land use, vegetation data, and soil data are entered by the user. The default setting for time of concentration, infiltration rates, saturation zones, etc. are available to modify in order to calibrate the model to a specific location and hydrology. Modification must be justified and approved by the county. The modeling analysis for the proposed facilities and existing conditions was left at the default settings.

Precipitation used in the original HSPF model was from observed data over a 50-year period (see 1998 Cascadia Master Drainage Plan and Assessment of Hydrologic Impacts report for rainfall data).

The Tehaleh model constructed for this study is not a design-level model. In particular, it uses aerial topographic data for determination of closed depression storage and generalized infiltration data for closed depression recharge. However, the model is sufficiently accurate for the assessment of environmental impacts and the adequacy of mitigating measures. As each specific development area within the Tehaleh EBPC is engineered it is expected that the Tehaleh model will be updated with more accurate field data and that the specific engineering designs will be based on the most current, accurate results.

MacKay Sposito, Inc. created WWHM12 models of each proposed retention facility within the project area. The models were developed using conservative land use, impervious percentages and infiltration rates. The proposed retention ponds were not done to a design level but were created to meet applicable stormwater regulations. The models results were used for general sizing during planning stages. The volume and flow rate data from WWHM12 was used for this analysis and to send to

Associated Earth Sciences, Inc. (AESI) to determine impacts to erosion, slope stability and local and regional aquifers. From the 158-year data created by WWHM12, MacKay Sposito, Inc. determined the largest 30-day cumulative volume and the 15 days before and after the largest average daily flow rate from the facilities. These hydrographs for each retention facility can be found in Appendix C.

4.8 POTENTIAL DRAINAGE ISSUES

Below is a list of potential drainage issues based on the assessment of existing site hydrology. The list of issues was used to design the preliminary Tehaleh drainage system so that significant impacts could be mitigated.

Canyonfalls Creek and Bonney Lake Springs

Uncontrolled or unmitigated development of the Tehaleh site could change recharge patterns on the Tehaleh portion of the Bonney Lake Plateau. This could affect the volume and distribution of recharge to the aquifer below the site. Of particular concern is the potential reduction in flow in Canyonfalls Creek and the Bonney Lake Springs. The flow of Canyonfalls Creek is used to operate a fish hatchery just downstream of the Tehaleh site. The Bonney Lake Springs are a source of municipal potable water supply.

Major Rivers

A reduction in the flow of Canyonfalls Creek could affect the flow of the Puyallup River, its receiving water body. Reductions in low flows in the Puyallup River are a major concern, particularly as it relates to water quality. Due to its unique hydrogeology, the proposed developed area of Tehaleh does not include significant area which drains to the Carbon River or to South Prairie Creek. Therefore, the theoretical impact of the Tehaleh project on flows in these watercourses would be limited so long as existing drainage patterns are maintained.

Closed Depressions

Changes in the hydrology of the closed depressions may have an effect on recharge patterns with subsequent impacts to the regional aquifer. Any changes to the hydrologic patterns of the existing system of closed depressions should be analyzed to determine the possible impact on recharge to the regional aquifer.

Uncontrolled or unmitigated development of the tributary area of the closed depressions could result in increased rates and volumes of runoff into the depressions. This could result in higher (and more frequently high) water levels, creating new or exacerbating existing flooding problems.

Uncontrolled or unmitigated development of the tributary area of the closed depressions could also result in increased siltation within the depressions. This could reduce infiltration rates which could result in higher (and more frequently high) water levels creating new or exacerbating existing flooding problems.

Uncontrolled or unmitigated filling or draining of the closed depressions could result in the elimination of existing closed depression storage, which could result in a reduction, or elimination, of the level of flood protection that is currently available to downstream properties.

Wetlands

Uncontrolled or unmitigated development of the tributary area of wetlands could result in increases in runoff rate and volume to the wetlands. This could result in changes to wetland hydrology, and in particular, to the water level fluctuation pattern of the wetlands. Wetlands in closed depressions are especially sensitive to changes in watershed hydrology. Development could result in higher (and more frequently high) and lower (and more frequently low) water levels.

Uncontrolled or unmitigated development of the tributary area of the wetlands could result in increased siltation within the wetlands. This could affect wetland habitat and it could reduce infiltration rates which could result in higher (and more frequently high) water levels creating new or exacerbating existing flooding problems.

Downstream Issues

In its existing condition the Tehaleh site does not discharge significant surface runoff to downstream drainage courses. Downstream drainage courses are fed by groundwater from the regional aquifer. If Tehaleh discharges surface runoff to downstream drainage courses after development, significant changes to the geomorphology of downstream drainage courses could result.

Water Quality Issues

Runoff from developed areas typically contains pollutants not present in existing conditions. Therefore, the uncontrolled or unmitigated discharge of urban runoff into the receiving waters (wetlands and aquifers) could raise pollutant concentrations in receiving waters.

5.0 MASTER DRAINAGE PLAN

5.1 TEHALEH PROJECT DESCRIPTION – PROPOSED ACTION

The proposed Tehaleh development (previously named Cascadia) is an Employment Based Planned Community. Land uses on the site will consist of single family and multi-family residential developments; employment centers consisting of business, retail, and light industrial developments; institutional uses consisting primarily of schools; and open space, parks and recreational areas.

Five (5) land use alternatives are analyzed in the Supplemental EIS for the Tehaleh Phase II Major Amendment. These alternatives are summarized in Section 8.0 of this report. The hydrologic analysis presented in this report will focus on the Applicant's Preferred Alternative (without Golf Course, Figure 3) because the proposed land-use densities for this alternative are the highest of the alternatives. Land uses with higher percentages of impervious area result in higher flows and volumes to stormwater management facilities. Therefore, proposed sizes for water quality, detention retention, and conveyance based on the Applicant's Preferred Alterative 3 would be considered conservative.

The Tehaleh EBPC will be developed in two major phases. In this report both Phases I and II are examined in detail. The boundaries of each phase are shown on the Tehaleh Master Land Use Plans, Figure 2 and Figure 3. Figure 3 is the land use plan for the Applicant's Preferred Alternative and Figure 4 is the land use plan for Alternative 3. The following Tables 1 and 2, show the contemplated land use for the entire Tehaleh site for the Applicant's Preferred Alternatives 3 and 4, respectively, on a type of land uses basis. The tables show the parcel areas, proposed land use and densities as well as the number of units and employment square footage where applicable. The locations for each of these parcels along with the boundaries for each phase are shown on Figure 2 and Figure 3, for the Applicant's Preferred Alternatives 3 and 4, respectively.

The proposed Master Drainage Plan for the Applicant's Preferred Alternative is shown in Exhibit 3. Detailed environmental assessment and hydrologic analysis has been completed for this alternative based on the Master Drainage Plan depicted on Exhibit 3.

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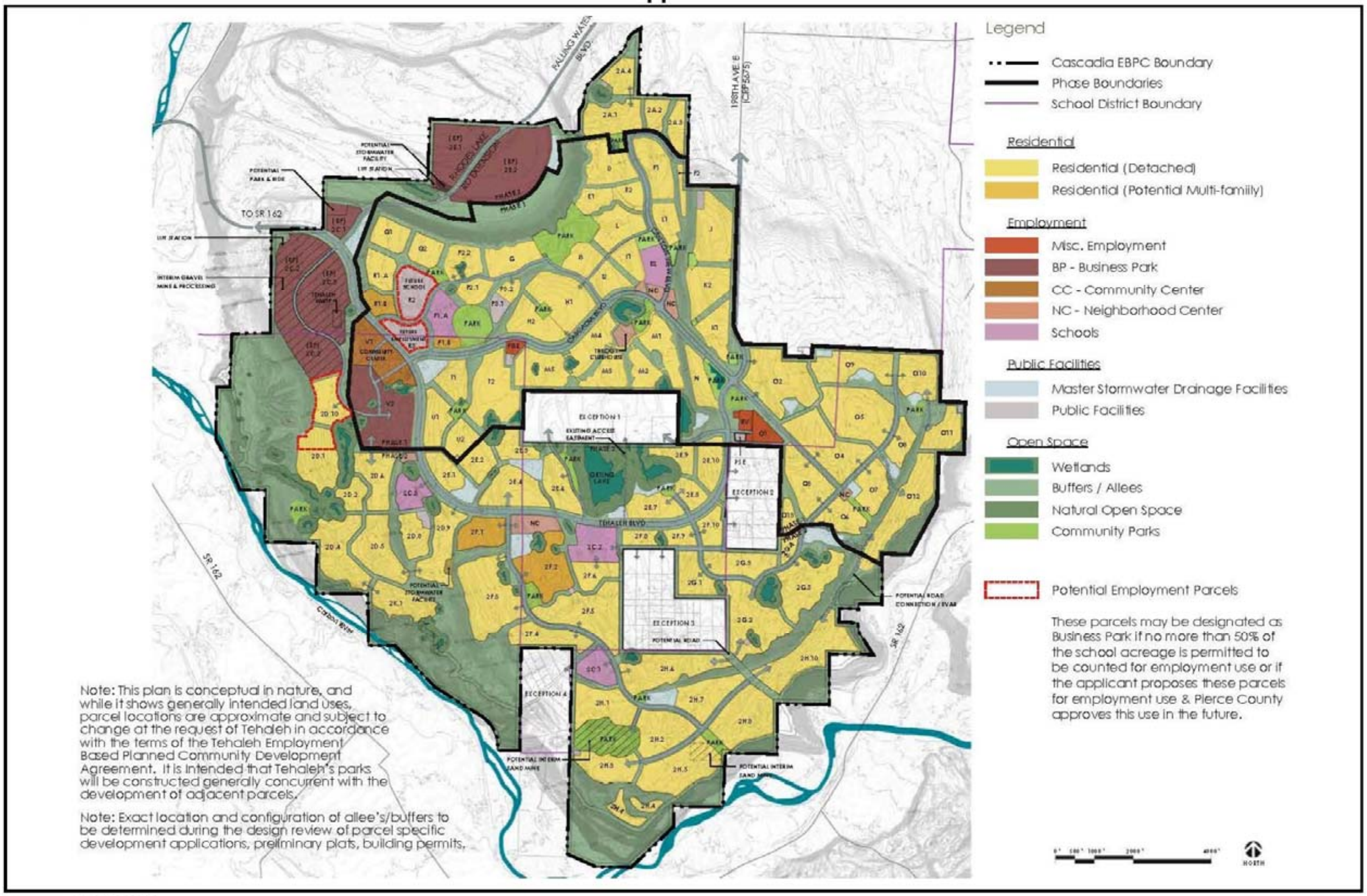
Figure 2: Proposed Land Use for SEIS Applicant's Preferred Alternative

Tehaleh EBPC PUD Phase II Project
Draft Supplemental EIS



Source: GCH, 2017.

EA Engineering, Science, and Technology, Inc., PBC

Figure 2-5

Applicant's Preferred Alternative Site Plan

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Table 1: Proposed Land Use for SEIS Applicant's Preferred Alternative

GCH
Tehaleh Land Use Summary COUNTY
Preferred Summary - 100% School Acreage

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PHASE 1 SUMMARY

	Parcels	Land Use	FAR	Gross Acreage	Quantity Estimated	% of Phase I
RESIDENTIAL	D, E1-2, F1, G, H1-2, I2-3, J, K1-2, L, M1-5, N, P2, Q1-2, R1, T1-2, U1-2	**Residential (Detached 1-10 D.U./ac.)**		589.8		
	P1B, R1B	**Multi Family (Attached 10-25 D.U./ac)**		15.8		
	O2-O12	**Parcel O Residential Area**		340.0		
		TOTAL RESIDENTIAL USES		**945.6**	**4,400 d.u.**	**48.5%**
* EMPLOYMENT	NC	**Neighborhood Center**		7.3	62,783 sf	
	Post	**The Post / Visitor Center**		1.4	3,217 sf	
	V1	**Community Center (west)**	0.19	35.0	290,000 sf	
	V2	**Business Park** *(General Light Industrial, Business/Office, Support Services)*	0.18	58.2	453,782 sf	
	ES	**Elementary School**		14.1	60,000 sf	
	P1.A	**School (Future)**		14.0	60,000 sf	
		Fire Station		3.3	25,000 sf	
		Trilogy Clubhouse		6.0	18,000 sf	
		Parcel O		15.3	77,000 sf	
	RV	RV & Construction Trailer		5.0	2,000	
	NC	Neighborhood Center		2.0	5,000	
	O1	Storage Garage		8.3	70,000	
		TOTAL EMPLOYMENT USES		**154.6**	**1,049,782 sf**	**7.9%**
PUBLIC FACILITIES		**Waste Water Treatment / LOSS**		41.9		
	R2	LOSS / Effluent Disposal		22.5		
	R3	Pump Station / Treatment		13.4		
	P3.1	Future Effluent Disposal		6.0		
		Arterials / Feeders		70.0		
		Master Stormwater Drainage Facility		10.0		
		Water Storage Reservoirs (potable)		4.1		
	O	**Parcel O**		43.8		
		Puget Sound Energy Sub-station		1.3		
		Master Stormwater Facilities		14.0		
		Sewer Lift Stations		0.5		
		Arterials / Feeders		28.0		
		TOTAL PUBLIC FACILITIES USES		**169.8**		**8.7%**
OPEN SPACE / REC.		**Community Parks (Existing)**		73.2		
		Sprouts Holler Park		*4.6*		
		Ponder Park		*3.3*		
		Sticks & Stones		*1.4*		
		Overlook Park		*0.5*		
		Yonder Park		*4.2*		
		Knoll Park		*1.7*		
		Center Park		*2.0*		
		The Edge		*2.5*		
		North Forest Park		*29.7*		
		Meadow Park		*19.8*		
		Post Park		*1.0*		
		Big Sky Park		2.5		
		Additional Community Parks		7.6		
		Evergreen Park		2.6		
		Rainier Vista Park		5.0		
		Open Space (Allee's, Critical Areas, Buffers)		445.4		
	O	**Parcel O**		148.2		
		Parks		13.0		
		Open Space (Allee's, Critical Areas, Buffers)		135.2		
		TOTAL OPEN SPACE USES		**674.4**		**34.6%**
		PHASE 1 TOTALS W/O PARCEL O		1,397.1		
		PARCEL O TOTALS		550.5		
		PHASE 1 TOTALS		**1,947.6**		**100.0%**

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GCH
Tehaleh Land Use Summary COUNTY
Preferred Summary - 100% School Acreage

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PHASE 2 SUMMARY

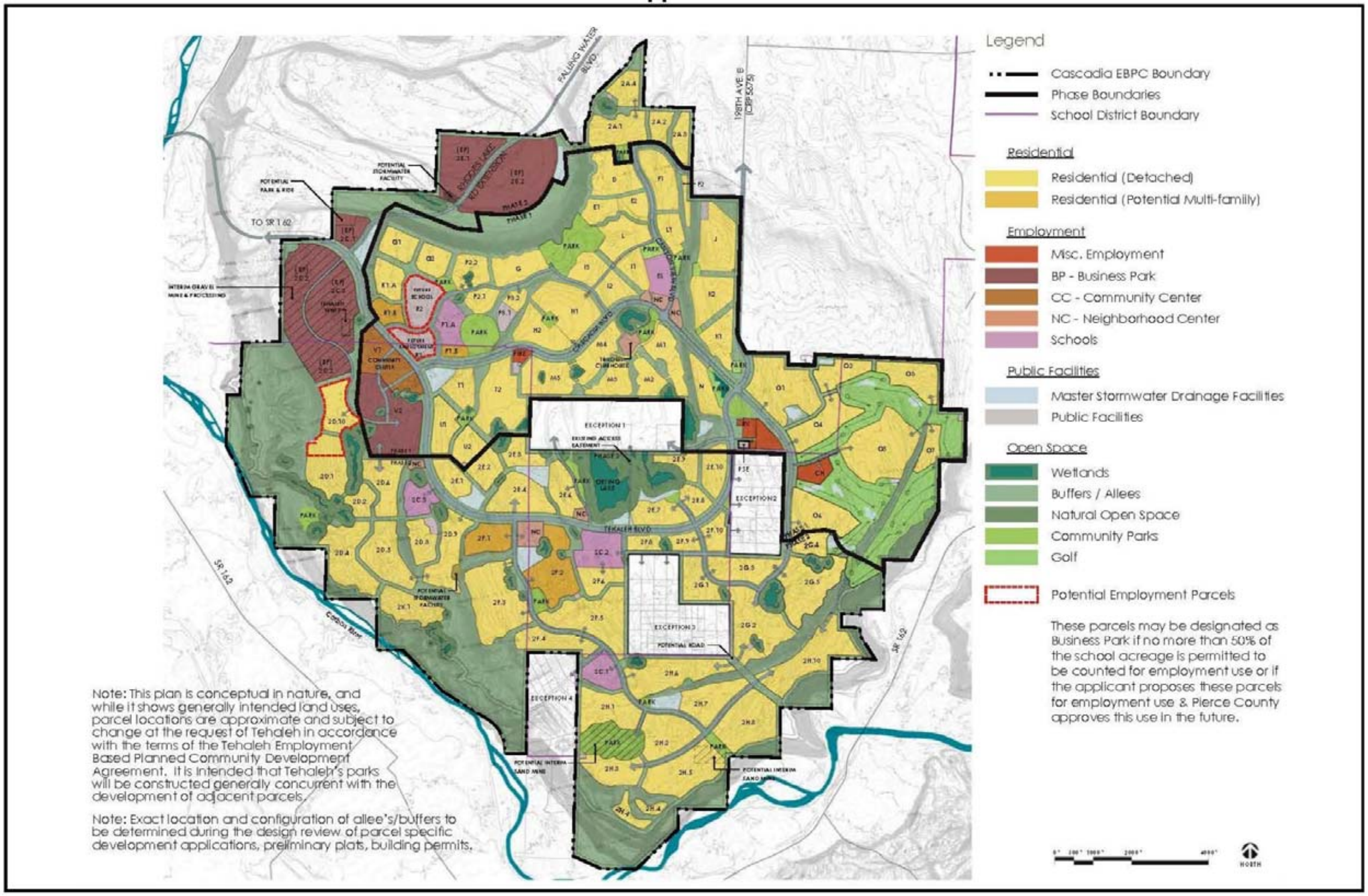
	Parcels	Land Use	FAR	Gross Acreage	Quantity Estimated		% of Phase 2
RESIDENTIAL	2A.1-4, 2D.1-10, 2E.1-8, 2F.3-11, 2G.1-5, 2H.1-10, 2K.1	Residential (Detached 1-10 du/ac)		1,026.8			
	2F.1, 2F.2	Multi-Family (Attached 10-25 du/ac)		51.9			
		TOTAL RESIDENTIAL USES		1,078.7	5,300	d.u.	38.4%
* EMPLOYMENT	2B.1-2, 2C.1-3	Business Park	0.18	248.5	1,948,439	sf	
		BP - Gravel Mine		124.0			
		BP - General Development Area		124.5			
	NC	Neighborhood Center (South)	0.18	12.5	98,010	sf	
	NC	Neighborhood Center (West)	0.18	2.0	15,682	sf	
	SC 1-3	Schools		54.5	240,000	sf	
		Park & Ride		3.5			
		TOTAL EMPLOYMENT USES		321.0	2,302,130	s.f.	11.4%
PUBLIC FACILITIES		Master Stormwater Drainage Facilities		53.0			
		Water Storage Reservoirs		2.5			
		Cell Towers		1.0			
		Lift Stations		1.5			
		Arterials / Feeders		170.0			
		TOTAL PUBLIC FACILITIES USES		228.0			8.1%
OPEN SPACE / REC.		Parks		60.0			
		Open Space (Allee's, Critical Areas, Buffers)		1,120.5			
		TOTAL OPEN SPACE USES		1,180.5			42.0%
		PHASE 2 TOTALS		2,808.2			100.0%

TOTALS

Land Use	FAR	Gross Acreage	Quantity Proposed		% of Total
TOTAL RESIDENTIAL USES		2,024.3	9,700	d.u.	42.6%
TOTAL EMPLOYMENT USES		475.6	3,351,912	sf	10.0%
TOTAL PUBLIC FACILITIES USES		397.8			8.4%
TOTAL OPEN SPACE USES		1,854.9			39.0%
PHASE 1 TOTALS		1,947.6	4,400		
PHASE 2 TOTALS		2,808.2	5,300		
TOTALS		4,755.8	9,700	d.u.	100.0%

Figure 3: Proposed Land Use for SEIS Alternative 3

Tehaleh EBPC PUD Phase II Project
Draft Supplemental EIS



Source: GCH, 2017.

EA Engineering, Science, and Technology, Inc., PBC

Figure 2-14
Alternative 3—Site Plan

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Table 2: Proposed Land Use for SEIS Alternative 3

GCH
Tehaleh Land Use Summary COUNTY
Alternative 3 - 100% School Acreage

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PHASE 1 SUMMARY

	Parcels	Land Use	FAR	Gross Acreage	Quantity Estimated	% of Phase I
RESIDENTIAL	D, E1-2, F1, G, H1-2, I2-3, J, K1-2, L, M1-5, N, P2, Q1-2, R1, T1-2, U1-2, S1	**Residential (Detached 1-10 D.U./ac.)**		589.8		
	P1B, R1B	**Multi Family (Attached 10-25 D.U./ac)**		15.8		
	O	**Parcel O Residential Area**		225.0		
		TOTAL RESIDENTIAL USES		**830.6**	**4,150 d.u.**	**42.6%**
* EMPLOYMENT	NC	**Neighborhood Center**		7.3	62,783 sf	
	Post	**The Post / Visitor Center**		1.4	3,217 sf	
	V1	**Community Center (west)**	0.19	35.0	290,000 sf	
	V2	**Business Park** *(General Light Industrial, Business/Office, Support Services)*	0.18	58.2	456,335 sf	
	ES	**Elementary School**		14.1	60,000 sf	
	P1.A	**School**		14.0	60,000 sf	
		Fire Station		3.3	25,000 sf	
		Trilogy Clubhouse		6.0	18,000 sf	
	O	**Parcel O**		18.8	87,000 sf	
		RV & Construction Trailer		4.0	2,000	
		Golf Clubhouse		6.5	15,000	
		Storage Garage		8.3	70,000	
		TOTAL EMPLOYMENT USES		**158.1**	**1,062,335 sf**	**8.1%**
PUBLIC FACILITIES		**Waste Water Treatment / LOSS**		41.9		
	R2	LOSS / Effluent Disposal		22.5		
	R3	Pump Station / Treatment		13.4		
	P3.1	Future Effluent Disposal		6.0		
		Arterials / Feeders		70.0		
		Master Stormwater Drainage Facility		10.0		
		Water Storage Reservoirs (potable)		4.1		
	O	**Parcel O**		40.8		
		Puget Sound Energy Sub-station		1.3		
		Master Stormwater Facilities		14.0		
		Sewer Lift Stations		0.5		
		Arterials / Feeders		25.0		
		TOTAL PUBLIC FACILITIES USES		**166.8**		**8.6%**
OPEN SPACE / REC.		**Community Parks (Existing)**		73.2		
		Sprouts Holler Park		*4.6*		
		Ponder Park		*3.3*		
		Sticks & Stones		*1.4*		
		Overlook Park		*0.5*		
		Yonder Park		*4.2*		
		Knoll Park		*1.7*		
		Center Park		*2.0*		
		The Edge		*2.5*		
		North Forest Park		*29.7*		
		Meadow Park		*19.8*		
		Post Park		*1.0*		
		Big Sky Park		2.5		
		Additional Community Parks		7.6		
		Evergreen Park		2.6		
		Rainier Vista Park		5.0		
		Open Space (Allee's, Critical Areas, Buffers)		445.4		
	O	**Parcel O**		265.9		
		Parks		6.0		
		Open Space (Allee's, Critical Areas, Buffers)		104.9		
		Golf Course		155.0		
		TOTAL OPEN SPACE USES		**792.1**		**40.7%**
		PHASE 1 TOTALS W/O PARCEL O		1,397.1		
		PARCEL O TOTALS		550.5		
		PHASE 1 TOTALS		**1,947.6**		**100.0%**

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GCH
Tehaleh Land Use Summary COUNTY
Alternative 3 - 100% School Acreage

DRAFT

PHASE 2 SUMMARY

	Parcels	Land Use	FAR	Gross Acreage	Quantity Estimated	% of Phase 2
RESIDENTIAL	2A.1-4, 2D.1-10, 2E.1-8, 2F.3-11, 2G.1-5, 2H.1-10, 2K.1	Residential (Detached 1-10 du/ac)		1,027.1		
	2F.1, 2F.2	Multi-Family (Attached 10-25 du/ac)		54.5		
		TOTAL RESIDENTIAL USES		1,081.6	5,550 d.u.	38.5%
* EMPLOYMENT	2B.1-2, 2C.1-3	Business Park	0.18	245.3	1,923,348 sf	
		BP - Gravel Mine		124.0		
		BP - General Development Area		121.3		
	NC	Neighborhood Center (South)	0.18	10.0	78,408 sf	
	NC	Neighborhood Center (Orting Lake)	0.18	2.5	19,602 sf	
	NC	Neighborhood Center (West)	0.18	2.0	15,682 sf	
	SC 1-3	Schools		54.5	240,000 sf	
		Park & Ride		3.5		
		TOTAL EMPLOYMENT USES		317.8	2,277,040 s.f.	11.3%
PUBLIC FACILITIES		Master Stormwater Drainage Facilities		58.0		
		Water Storage Reservoir		2.5		
		Cell Towers		1.0		
		Lift Stations		1.5		
		Arterials / Feeders		170.0		
		TOTAL PUBLIC FACILITIES USES		233.0		8.3%
OPEN SPACE / REC.		Parks		60.0		
		Open Space (Allee's, Critical Areas, Buffers)		1,115.8		
		TOTAL OPEN SPACE USES		1,175.8		41.9%
		PHASE 2 TOTALS		2,808.2		100.0%

TOTALS

Land Use	FAR	Gross Acreage	Quantity Proposed	% of Total
TOTAL RESIDENTIAL USES		1,912.2	9,700 d.u.	40.2%
TOTAL EMPLOYMENT USES		475.9	3,339,374 sf	10.0%
TOTAL PUBLIC FACILITIES USES		399.8		8.4%
TOTAL OPEN SPACE USES		1,967.9		41.4%
PHASE 1 TOTALS		1,947.6	4,150	
PHASE 2 TOTALS		2,808.2	5,550	
TOTALS		4,755.8	9,700 d.u.	100.0%

5.2 PHASE I AND II

5.2.1 GENERAL

A map showing the conceptual Master Drainage Plan for the site development under SEIS Applicant's Preferred Alternative is shown on Exhibit 3. A number of key hydrologic issues were identified during the assessment of existing conditions:

1. Potential reduction of flows to Canyonfalls Creek, wetlands and streams along western the bluff and the Bonney Lake Springs due to changes in recharge patterns.
2. Potential increases in closed depression flooding.
3. Potential impacts to wetland hydrology.
4. Potential impacts to the water quality of receiving waters
5. Potential impacts to downstream properties as a result of changes to the existing closed depressions on the site.

The Master Drainage Plan has been specifically designed to prevent, or mitigate, these potential impacts. The proposed Master Drainage Plan is designed with two ultimate design goals:

1. Infiltrate all stormwater onsite, overflow for catastrophic events only, water quality ponds design per applicable stormwater regulations.
2. Maintain flows to existing subsurface capture zones so as to not change the pattern or volume of the water recharge to underlying aquifers.

In general, the Tehaleh Master Drainage Plan will consist of a system of stormwater facilities for retention, water quality, detention, low impact development and a master system of overflow/bypass pipes and channels. Detention facilities within the Tehaleh project area will be used for stormwater quality and quantity management. Where needed, detention facilities will be located upstream from major wetlands requiring hydrologic mitigation that cannot be achieved by open space and roof drains. Retention/recharge facilities will be located in areas that have been identified through close coordination with hydrogeologists at Associated Earth Sciences, Inc. (AESI) as appropriate locations for stormwater recharge based on site topography, soil conditions, regional aquifer capture zones, and groundwater mounding analysis. The retention facilities are designed to infiltrate runoff from developed areas of the site into the regional aquifer.

The master conveyance system will consist of a series large pipes and channels designed to convey runoff from developed areas to their respective retention facilities. The system will also include overflows for the major wetlands and closed depressions to prevent flooding problems during major storm events, bypasses to convey excess runoff around major wetland, and overflows to the Puyallup River and Canyonfalls Creek Valley to safely convey flows that greatly exceed the 100-year design capacity of the constructed system.

The site contains numerous small internal sub-basins in the existing condition. This network of internal sub-basins will change after development. AESI has completed hydrologic models of sub-surface conditions based on the existing conditions at the Tehaleh site using a MODFLOW computer model (see AESI 2017 Report for detailed description of model). Retention facilities recharge rate and volumes have been shared with AESI to determine the potential impacts from the proposed location and volumes determined from the proposed Master Drainage Plan. From AESI's analysis, the proposed location of the retention facilities and their respective recharge rates and volumes showed an insignificant change from existing conditions analysis. AESI also used MODFLOW to perform groundwater mounding analysis and the computer model showed only a 5 percent increase to the projected flow rate from Canyonfalls Creek. From AESI's analysis this will cause no adverse impacts to the downstream systems for Tehaleh's regional or local aquifers.

Slope stability, erosion and groundwater mounding analysis were also performed by AESI for specific facilities near steep slopes (facilities R5 and R10) using computer models. Per the AESI 2017 report, no significant impacts will occur based on current flow, volume and location of proposed retention facilities. This analysis determined that their given location with their provided flow rates and volumes will not adversely impact the erosion or slope stability from groundwater mounding. Continued coordination with hydrogeologists will occur throughout the final design of all proposed retention facilities. Groundwater monitoring and continued monitoring of Canyonfalls Creek will be performed on a facility-by-facility basis, as required per Pierce County Standards.

Some areas of the site will be required to use temporary stormwater management in areas where the proposed downstream management facility is not operational during the beginning of construction. This scenario will be avoided whenever feasible. Currently, the areas known to require temporary stormwater management will be the interim R4A retention facility and the gravel mining activities proposed within Phase II.

The Interim R4A facility is located within the footprint of the proposed permanent R4A retention facility. The interim R4A facility will treat and infiltrate stormwater from a small portion of Cascadia Blvd E Segment 3 and 175th Ave and portions of Berkeley Parkway E. Specific design procedures and construction can be found in the Construction Documents and associated Drainage Report for Cascadia Blvd E Segment 3.

Interim mining activities on proposed Parcels 2C.2 and 2C.3 (previously named Parcel KK) include the clearing and grading of approximately 140 acres to obtain suitable gravel material to meet the needs of future on-, and off- site construction activities. Mining activities will be required to infiltrate stormwater onsite and provide all erosion and sediment controls per Pierce County requirements.

5.2.2 EXISTING FACILITIES USED FOR PROPOSED DEVELOPMENT

The existing stormwater system consists of Retention/Water Quality Facility R4, Detention/Water Quality Facilities D3 and D4 and approximately 12,000 linear feet of major backbone conveyance infrastructure. The system was designed for the capacity of 917.2 developed acres: 202 developed acres directly tributary and an additional 715.2 developed acres tributary via detention facilities D1-D4. This area covers a large percentage of the residential, roads, parks, commercial, and public facilities in the Phase I boundary from the 2014 EIS Addendum (for detailed analysis of R4, D3, and D4 sizing specification, land use and sub-basin information see 2006 Whitman at Cascadia Onsite Roadway and Stormwater Plan prepared by Goldsmith and Associates, Inc.).

Facility R4 was originally designed and approved by Pierce County under the 2005 Revised Phase 1A and 2006 Whitman construction documents and drainage report for a total tributary area of 1,156.1 acres at 48 percent impervious. The current Stormwater Master Plan proposes a total area tributary (developed and undeveloped areas) to the R4 facility of 1,147.1 acres at 40% impervious. This has been increased slightly from the 2006 Whitman Drainage Report due to new changes in proposed plat layouts; however, the developed area of 917.2 acres will not increase nor will the existing design impervious area of 560 acres. Maintaining or reducing the developed area will be a key component of maintaining the original design assumptions for Facility R4. Additionally, the overall percent impervious has decreased based on updated land use plans. The proposed Applicant's Preferred Alternative has land use within R4 tributary area that has lower assumed percent impervious.

Facility R4 has capacity for a majority of the Phase I and a portion of Phase II (under the 2014 EIS Addendum). The original design of retention facility R4 assumed multi-family residential in the M parcels and Business Park land uses for the T parcels which correspond to approximately 75 and 80 percent impervious, respectively. For the proposed Stormwater Master Plan, the M and T parcels were developed as single family residential development corresponding to 55 percent impervious for modeling, and typically less than 40% impervious as reported in their respective Drainage Reports. Therefore, retention facility R4 is anticipated to receive the equal or less runoff volumes than was originally intended in the 2006 Whitman at Cascadia Onsite Roadway and Stormwater Plan.

5.2.3 INFILTRATION AND RECHARGE MITIGATIONS

The primary goal of the Tehaleh Master Drainage Plan is to replicate existing conditions to the maximum extent feasible by infiltrating all stormwater runoff generated on the site and prevent surface runoff from flowing into the downstream drainage system. In the existing conditions no significant runoff is generated on the site and the existing drainage characteristics of closed depressions and wetlands is generally adequate to control site drainage. After development, the addition of large areas of impervious surfaces will significantly increase the volume and rate of runoff generated on the site. Geotechnical and hydrologic analysis has determined that the existing site drainage system of closed depressions and wetlands will not have sufficient infiltrative or storage capacity to recharge all of the runoff that will be generated after the site is developed. Therefore, constructed retention facilities will be required to infiltrate runoff from developed areas.

A primary design criteria of the Tehaleh Master Drainage Plan is that all constructed infiltration facilities should have a high factor of safety to avoid malfunctions, overflows and long term maintenance problems. Field geotechnical studies and hydrologic analysis has determined that new retention facilities sited on the glacial till cap will lack the infiltrative capacity to provide reliable recharge of stormwater after development. Therefore, all retention facilities will be sited, where possible, within the outwash formation, where it is exposed around the edges of the site. Retention facilities located on the glacial till cap will utilize Underground Injection Control (UIC) wells, which will be designed per Pierce County requirements. The infiltration capacity of the outwash formation has been determined to be extremely high. Design infiltration rates of 15 inches per hour can be expected in facilities located on the outwash formation. Actual measured infiltration rates range up to 2800 inches per hour. Design infiltration rates on the glacial till cap are much lower than the outwash formation. Therefore, for facilities designed in areas where the sub-surface conditions have less explorative information, infiltration rates of 1 or 2 inches per hour were assumed. These rates are based on conservative assumptions from AESI based on current sub-surface information.

At least sixteen retention facilities are planned to be constructed to serve Phases 1 and 2 of Tehaleh. Preliminary locations of the retention facilities are shown on Exhibit 3. These facilities will be large open areas excavated below grade into the porous outwash strata. Facilities located on glacial till and other less desirable infiltrative soils will have deeper excavation, known as UIC wells, to facilitate and increase infiltration rates. UIC wells will be designed and constructed per Pierce County requirements. The facilities will be designed to be sufficiently large and contain sufficient storage to store and infiltrate peak flows without overflow. All runoff will be treated per Pierce County water quality standards prior to discharging into the proposed retention facilities. The retention facilities will be designed assuming that the infiltration and storage functions of all existing closed depressions in proposed development zones will be eliminated after development. This is a conservative, but realistic assumption which will be used for design purposes. It is likely that closed depressions which are not eliminated by filling and grading will ultimately lose their infiltrative capacity sometime during the design life of the drainage system due to long term siltation. The exact extent to which existing closed depressions will be filled and/or eliminated will not be known until detailed grading plans are developed as part of the preliminary plat and engineering design process. Pierce County requires that compensating storage and/or replacement of functions be provided for all filled closed depressions. Typically, the compensatory storage will be provided with retention and detention facilities.

The sixteen retention facilities were preliminarily designed using standard design methods, applicable stormwater regulations, and a Pierce County-approved continuous simulation hydrologic model. The approved continuous simulation model used was the Washington State Department of Ecology's Western Washington Hydrology Model (WWHM) developed by Clear Creek Solutions, Inc., which uses HSPF as its backbone software. The various preliminary retention facility size parameters are provided in Table 3. Table 3 shows the facility sub-basin area, percent effective impervious area, required facility area, assumed infiltration rate, maximum 30-day cumulative volume, and maximum average daily flow rate.

The proposed locations of most infiltration facilities are preliminarily located but may vary during the engineering stage. There is one retention facility, Facility R11, which currently has a proposed alternative to the design shown on Exhibit 3. Currently R11 is located on the eastern end of Canyonfalls Creek Ravine. This facility is preliminarily designed to receive and infiltrate stormwater from Sub-basin CC-01 (see Exhibit 3). The Sub-basin CC-01 area is known as the North Corridor. In the current design, stormwater runoff will be treated in Detention Facility D6 and then tightlined down the slopes to the west of the sub-basin. An alternate design proposes an infiltration facility within the northern corridor in between planning parcel 2A.1 and 2A.4. This infiltration facility would be in addition to the Detention Facility D6 and would infiltrate runoff from either the entire CC-01 sub-basin or will infiltrate stormwater from planning parcels 2A.1 though 2A.4. If the latter option is chosen, the remainder of Sub-basin CC-01 will be tightlined to the Canyonfalls Creek Ravine and infiltrated in the proposed location of R11.

From the AESI 2017 Report, the very north tip of the Tehaleh Project area (planning parcel 2A.4) is within the Victor Falls Springs Capture Zone. The Victor Falls Spring is used by the City of Bonney Lake for municipal water supply and is part of the Bonney Lake Comprehensive Water System Plan. Per the 1996 Final EIS, mitigation requirements were established for this capture zone.

Due to the size of the Tehaleh site, some areas proposed for retention facilities have more information than others. Infiltration rates vary for each proposed facility. Preliminary infiltration rates assumed are based on coordination with AESI and are also considered conservative based on the information that is available. The actual infiltration rates for each facility will change as more sub-surface information is determined. The actual size of the facilities could vary based on detailed geotechnical testing and siting requirements which will be examined in detail as part of the design associated with the specific development application and review process.

The retention facilities were sized based on applicable stormwater regulations using the following procedure:

1. Conduct general site reconnaissance, and review survey and other information to identify existing drinking water wells or aquifers, existing and proposed buildings, steep slopes, and septic systems in the vicinity of the proposed facility.
2. Evaluate the minimum requirements for infiltration facilities per Pierce County requirements to determine whether infiltration is feasible.
3. Determine facility tributary area based on topography and preliminary conveyance system design.
4. Determine conservative infiltration rates based on recommendation by Hydrogeologists.
5. Determine preliminary location based on coordination with Hydrogeologists and review of topography.
6. Preliminarily size facility using WWHM continuous simulation model based on 158-year Pierce County specific rainfall data.
7. Produce hydrographs of each facility of average daily flow rate vs. time over a 30-day period to Hydrogeologists. Two hydrographs, one for the 30-day period of the largest cumulative volume and the second for the 15 days before and after the maximum average daily flow rate. This analysis is used to determine impact to surrounding slopes due to groundwater mounding.
8. Complete detailed analysis with close coordination with Pierce County to ensure proper function and to obtain approval of design assumption and location.

Infiltration rates are conservative and safety factors will be applied to all infiltration rates after initial infiltration tests are conducted. Additionally, infiltration facilities without emergency overflow systems or located in areas with low infiltration rates will increase storage volume by 30% for an added factor of safety. The final factors of safety used for design and construction of the retention facilities will be reevaluated at the engineering design stage. The exact factor of safety which will be applied to each retention facility will be determined based on the following factors: tributary area, density of development, need to provide compensatory storage for filled closed depressions, potential for downstream damage resulting from overflow, and risk of overflow relation to potential damage. Factors of safety will, at a minimum, comply with Washington State Department of Ecology and Pierce County Standards.

This preliminary sizing analysis demonstrates that the proposed retention facilities are feasible and reasonable. Appendix C contains the details of the Western Washington Hydrology modeling effort.

Runoff from the various developed areas will be conveyed to the retention facilities in constructed conveyance systems. Major conveyance systems will consist of underground pipes, and/or constructed open channels. Conveyance systems will be analyzed using Santa Barbra Urban Hydrograph (SBUH) methodology and backwater analysis for each conveyance system within Tehaleh. Plat-scale conveyance systems are analyzed initially during the preliminary plat stage and finalized in the construction documents and drainage report for the respective development.

Some runoff from developed areas will be directed to site wetlands to maintain wetland hydrology (see Section 5.2.7 below). However, most site runoff will be diverted to retention facilities for infiltration into the regional aquifer. This diversion could alter existing site recharge patterns and discharge rates from the aquifer to Canyonfalls Creek and the Bonney Lake Springs. To assess this potential impact, the project geotechnical/ hydrologic engineer has analyzed the proposed drainage system and facility siting using a MODFLOW computer model of the groundwater system beneath the site. They have verified that there will be no significant impacts to the regional aquifer or its discharge rate into Canyonfalls Creek or the Bonney Lake Springs. The analysis of impacts to the regional aquifer is discussed in detail in the 2016 Earth and Groundwater report for Tehaleh Phase II prepared by Associated Earth Science on April 15, 2016.

As designed, the Tehaleh Drainage System will replicate existing site hydrogeology and prevent surface runoff to downstream receiving waters to the maximum extent feasible.

Overflow of the Tehaleh retention and detention system could occur as a result of rainfall in excess of the 100-year design storm. This overflow could adversely affect downstream drainage systems. The design of the Tehaleh Drainage System to mitigate this impact is discussed in the Emergency Overflow section below.

Diversion of site runoff to the regional retention facilities could affect wetland hydrology. The design of the drainage system to mitigate this impact is discussed in the Wetland Mitigations section below.

Tehaleh existing drainage system does not leave the project area through any main water course or stream, but rather infiltrates into the groundwater system. To ensure that the post-development drainage system does not adversely impact the quantity or quality of the regional aquifer or receiving waterways or cause any adverse impacts to bank stability or erosion, the groundwater system requires modeling. Associated Earth Science, Inc. (AESI) are the hydrologist for the project and have created a pre- and post- development groundwater model using MODFLOW. The AESI 2017 Earth and Groundwater report for Tehaleh Phase II explains in more detail the aquifer system below Tehaleh and how the MODFLOW computer model was created. To ensure that the aquafer systems would not be adversely impacted by the proposed retention facilities and volumes of water estimated to infiltrate, AESI used output data from Mackay Sposito's WWHM models of all the proposed retention facilities as well as previously modeled existing facilities' volumes and compared them to the existing conditions model. The models showed that at the main groundwater discharge point on the site, the flow are projected to only increase by 5 percent. This equates to approximately 0.5 cfs, which from AESI's analysis will not cause any adverse impacts to the downstream system.

AESI also modeled the volume coming from any facility located near a slope, specifically proposed Retention Facilities R5 and R10. These facilities were analyzed to determine the extent of groundwater mounding that could occur. AESI determined that with proposed volumes infiltrating from these facilities, there shall be no adverse impacts to slope stability or erosion.

For AESI to complete their models, MacKay Sposito, Inc. modeled all the proposed retention facilities within Tehaleh using WWHM12. WWHM12 analyzes 158 years of Pierce County tailored simulated precipitation data. From this data, MacKay Sposito, Inc. sent AESI the largest 30-day cumulative volume infiltrated from each pond as well as the 15 days before and after the largest average daily inflow into each proposed retention facility (see Appendix C for hydrographs of each proposed facility). From this data, AESI was able to determine that no adverse impacts will occur from the volume of water infiltrated. In addition, there shall be no adverse impacts from the location of the facilities due to bank stability or erosion. With the location of the proposed retention facilities and proposed stormwater volumes, the post-developed regional hydrology of the Tehaleh site will have an insignificant change and cause no adverse impacts to the quantity and quality water.

Additional detailed geotechnical and hydrologic studies will be conducted at each facility site at the time of final design (prior to any development) to verify the suitability of each specific site. The final design studies will include extensive field exploration at each site. Facility locations could shift based on the results of the field exploration and final design studies. Of particular concern is the effect of retention facilities on the stability of steep slopes along the of the Tehaleh site. Slope stability will be specifically addressed in the final design of retention facilities and facilities will be specifically relocated, or facility configuration modified, as necessary to avoid slope stability problems.

Table 3: Preliminary Retention Facility Sizing

Retention Facilities	Sub-Basin Area (ac)	Percent Impervious Area (%)	Required Facility Area (ac.)	Designed or Assumed Infiltration Rate (in/hr)	Max 30 day Cumulative Volume (ac-ft)	Maximum Average Daily Flow Rate (cfs)
R4A	123.2	40%	3.29	5	79.0	9.4
R5*	524.9	37%	7.37	10	136.7	14.3
R5A*				15	136.7	14.3
R6	103.3	50%	5.09	2	89.2	8.8
R7	152.0	35%	4.89	2	83.9	8.5
R8	69.4	62%	3.83	2	62.2	6.3
R9	205.5	41%	6.08	2	127.7	12.4
R10	219.8	44%	8.25	1	162.6	13.4
R11	177.6	39%	4.22	5	114.3	10.8
O-1R	36.0	53%	2.32	1	28.7	2.8
O-2R	31.5	42%	1.63	1	19.6	1.9
O-3R	62.8	50%	3.65	1	51.6	4.6
O-4R	56.0	28%	1.95	1	24.3	2.6
O-5R	31.2	40%	2.07	1	27.4	2.6
O-6R	42.9	51%	2.96	1	39.9	3.8

*Proposed Retention Facilities R5 and R5A are proposed to share a tributary area and water quality facilities. Flows are split evenly between facilities via a flow splitter installed downstream from proposed water quality facilities.

5.2.4 LOW IMPACT DEVELOPMENT

Introduction to Low Impact Development:

Low Impact Development (LID) is an approach to managing stormwater runoff from land development/improvement projects. LID Best Management Practices (BMPs) work with natural features to manage stormwater as close to its source as possible using principles such as preserving and recreating natural landscape features, minimizing effective impervious areas, disconnecting non-pollutant generating surfaces from pollutant generating surfaces, and reducing total developed footprint to greatest extent feasible. LID BMPs are most affective when implemented into the design of the development.

Traditional stormwater conveyance and management systems deal with stormwater as a waste product - similar to sewer, the management issue is dealt with at the discharge location of the service basin. With this traditional approach, large conveyance systems and stormwater water quality and management facilities are required. Traditional BMPs mitigate the increased peak flow and time of concentration, as well as providing water quality to current standards but they do not mimic the drainage conditions prior to development to the level that LID BMPs accomplish.

Typical Types of LID:

Typical LID BMPs include but are not limited to: bio-retention facilities, rain gardens, vegetated rooftops, and permeable pavement/pavers. These BMPs use vegetation and/or soils to treat and control stormwater and are used when dealing with pollutant-generating surfaces. Runoff from non-pollutant-generating surfaces can be directed to LID BMPs including but not limited to: rain barrels/cisterns, infiltration trenches, and open spaces. All BMPs typically mitigate smaller tributary areas than conventional stormwater techniques, which is part of the LID approach of treating and managing stormwater runoff as close to its source as possible.

LID Implementation:

There are four areas within the Tehaleh E.B.P.C. where the stormwater infrastructure is proposed to be managed by Low Impact Development (LID). The first area is located in the northern portion of the site where proposed Phase II Parcels 2B.1 and 2B.2 are located. This proposed area is anticipated to be a business park and due to the soils within the area and its close proximity to Canyonfalls Creek, this area is ideal for LID implementation.

The second area is located on the northwest corner of the Tehaleh project area where proposed Parcels 2C.2 and 2C.3 are located. This proposed area is anticipated to be a business park and due to its soils and proximity to the steep slopes to the west, it is an ideal location to implement LID BMPs.

The third area proposed for LID stormwater management is located along the southeast bluff of the Tehaleh project site. This area encompasses proposed residential parcels 2H.1, 2H.2, 2H.3, 2H.4, 2H.5, 2H.7, 2H.8, 2H.9, and 2H.10, as well as proposed developments located on this southeastern bluff (planning parcels O11 and O12 per the Applicant's Preferred Alternative). This area is ideal for LID BMPs due to the soils along this bluff, and the proximity to steep slopes along the southeast corner of this area.

The fourth area proposed for LID stormwater management is located along the western bluff of the project site. This includes proposed residential parcels 2D.1, 2D.2, 2D.4, 2D.5, 2D.10 and 2K.1. These parcels will also be considered to be managed using distributed flow techniques or localized Underground Injection Control (UIC) techniques to mitigate stormwater impacts. These parcels proposed much lower densities to accommodate the LID, UIC, or Distributed management methods.

All facilities and techniques will meet or exceed applicable stormwater regulations and provisions of the Phase II Development Agreement. The use of LID will be reviewed on a project-by-project basis for feasibility and applicability.

UIC wells are a DOE-approved method of stormwater management. Pierce County will approve UIC wells based on registering the UIC wells with the DOE. These facilities will require treated stormwater to protect the groundwater from potential pollutants. Water quality will be assessed per applicable stormwater regulations.

All four of these areas are preliminarily identified as areas that will accommodate LID BMPs well based on preliminary soil tests and topography. As the project moves forward, these areas will be closely analyzed to determine the feasibility of LID implementation as the main method of stormwater management.

If the soil conditions are accommodating to LID infiltration techniques and it is feasible, the proposed development will treat and control its stormwater purely using LID. LID BMPs will be analyzed during the design process and close coordination with geotechnical engineers and hydrogeologists will be continued throughout the process. This will allow for the proposed development to have a complete stormwater management plan that is per Pierce County Code and is aesthetically pleasing. The aesthetic of the LID development will be most realized in the increased number of individual small green areas that will be required to accommodate the LID facility and no large single facility. Surface drainage for this basin flows down the slopes to Prairie Creek. Prairies Creek is a tributary of the Carbon River and is a part of the Carbon River Basin groundwater capture zone.

5.2.5 WWTP EFFLUENT & IRRIGATION IMPACTS ON RECHARGE VOLUMES

AESI MODFLOW model, as discussed above, showed no adverse impacts to the regional aquifer from discharge due to the proposed stormwater infiltration facilities. AESI not only modeled the infiltrated volumes from the proposed and existing retention facilities, but also inputted the proposed volumes of reclaimed water infiltrated from the proposed Wastewater Treatment Plant (WWTP) based on the proposed various stages of the WWTP effluent (See AESI 2017 Report).

Three locations will potentially receive reclaimed water for infiltration into the groundwater system. The first location is the current drainfield located west of existing retention facility R4. This area is currently being used as a large onsite septic system with a discharge permit of 0.5 million gallons per day (MGD) of grade “A” effluent. The second location will be utilized when the drainfield reaches capacity or when it is feasible to relocate the drainfield so the drainfield land can be developed. The second option for a drainfield site is located directly east (Parcel P3.1) from the retention facility R4 for a proposed rapid infiltration facility. The third option is located along the proposed new Rhodes Lake Road East within two recently purchased by Nash Cascadia, LLC parcel numbers 0519182005 and 051982025. Both of these parcels are not within the Canyonfalls Creek Capture Zone but within the Puyallup River Capture Zone. Using the current design flows for the WWTP, AESI analyzed the impact from infiltrating all the effluent into the groundwater. The analysis shows that there will be a significant increase in flow but that this will not cause any adverse impacts. Monitoring will continue to occur to ensure the models projections stay true. There are two monitoring stations currently in use for Canyonfalls Creek. The first monitoring station is operated and maintained by AESI and the second is operated and maintained by Pierce County. These monitoring stations will monitor the quality and quantity of flows from Canyonfalls Creek. Water quality and flows will be monitored to ensure Canyonfalls Creek stays within projected volume and quality predicted from modeling. If groundwater monitoring shows that quality and quantity levels that could potentially impact Canyonfalls Creek, the new Rhodes Lake Road East Infiltration area will be used which will recharge effluent outside of the Canyonfalls Capture Zone and into the Puyallup River Capture zone.

The effluent from the proposed WWTP will also potentially be used for irrigation. The effluent will be routed to a reservoir where chlorine will be added to create reclaimed water. This reclaimed water will be used to irrigate landscaping along major arterials as well as local parks and landscaped tracks. The distribution of reclaimed water throughout the site will not cause any adverse impacts from infiltration into groundwater as analyzed by AESI. This can be concluded due to no adverse impacts occurring from the concentrated infiltration at the drainfield or rapid infiltration facility, which both infiltrate the effluent at a much higher rate and much closer to the discharge location of Canyonfalls Creek (see AESI 2017 Report for further details on analysis).

5.2.6 EMERGENCY OVERFLOWS TO DOWNSTREAM SYSTEMS

The primary goal of the Tehaleh Drainage System is to mimic the natural system and avoid downstream impacts. The Tehaleh system, as proposed, meets or exceeds applicable stormwater regulations in regards to design storm and facility sizing.

The proposed Tehaleh system is sized to recharge storm events significantly larger than the 100-year design event based on a 158-year continuous simulation model (WWHM12). However, catastrophic storm events, or failure of facilities, could cause downstream impacts. Therefore, the majority of the Tehaleh drainage system will be connected to emergency overflows which will discharge to receiving points in the downstream drainage system. The locations of emergency overflows are shown on Exhibit 3 and the site area tributary to each overflow is shown on Exhibit 4.

1. Puyallup River Overflow

The primary overflow from the Tehaleh Drainage System will be from Retention Facility R5 and directed to the Puyallup River. The overflow will be constructed as an enclosed pipe which will be located within the New Rhodes Lake Road East to be built to serve existing and expected development on the Bonney Lake Plateau. The conveyance sizing will be completed at the time of R5 design process. The overflow will discharge into the Puyallup River near the 128th Street Puyallup River Bridge. The emergency outfall will be constructed at the terminus of the overflow. The outfall will be designed per applicable stormwater standards. Final details of the design of the overflow, and outfall, will be developed during design of the New Rhodes Lake Road East.

The overflow outfall will be located downstream of the confluence of the Carbon and Puyallup Rivers. Below the Carbon/Puyallup confluence, the Puyallup River is considered a Major Water Body which can accept the overflows from the Tehaleh site per Pierce County Standards.

Six of the retention facilities (R4, R4A, R5, R6, R7, and R8) proposed to be constructed on the Tehaleh site will connect into the Puyallup River overflow. The tributary areas of these eight facilities total approximately 2,362 acres (52% of the Tehaleh drainage area). The area which will connect to the Puyallup River overflow will include the majority of the high density development which is proposed on the Tehaleh site (multi-family, business parks, schools, etc.).

Prior to the start of Phase II, and construction of the overflow to the Puyallup River, overflow protection for downstream properties will be provided on an interim basis by one or more of the following methods:

1. Routing overflows from the Phase I facilities to existing large potholes in Phase II,
2. Constructing Phase II retention facilities as part of Phase I and routing overflows from the Phase I facilities to the Phase II facilities, or
3. Enlarging the size of Phase II retention facilities to provide a larger factor of safety.

These proposed methods of treating overflows will essentially allow storms larger than the 100-year reoccurrence interval, based on an approved continuous simulation model, to be accommodated prior to overflow.

All these methods will be closely reviewed during the design process and specific factors of safety will be established during the design process. The design process will include coordinating with Pierce County

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and hydrogeologists to ensure no adverse impacts are anticipated from the proposed retention facilities. All facilities will be designed per applicable stormwater regulations.

2. **Canyonfalls Creek Valley Overflow**

A secondary overflow from the Tehaleh Drainage System will be directed from Retention Facility R11 to the Canyonfalls Creek valley. This overflow is to be located about 3,600 feet upstream of the source of Canyonfalls Creek. The facility is proposed to be located just outside of Phase I at the northeast end of the valley. The facility will have an appropriately-sized overflow spillway and outfall that will discharge to the valley and meet all applicable stormwater regulations. Final details of the design of the overflow, and outfall, will be developed during the design of Retention Facility R11.

The Canyonfalls Creek overflow will be constructed as part of Retention Facility R11. Facility R11 serves proposed Parcels D, E2, F1, 2A.1, 2A.2, 2A.3, and 2A.4. It is anticipated that Facility R11, together with the emergency overflow, will be constructed along with these proposed developments.

The project geotechnical engineer has indicated that the Canyonfalls Creek valley, between the facility/overflow and the Canyonfalls Creek wetlands, is underlain by sand and gravel which is highly porous. It is anticipated that overflows will infiltrate long before reaching the Canyonfalls wetlands, the source of Canyonfalls Creek. Therefore, it is expected that there will be no wetland or stream impacts due to drainage system overflows.

3. **Facilities with no Emergency Overflow**

Nine facilities in Phase I and II will not be able to connect to the proposed Puyallup River or Canyonfalls Creek overflow systems due to topographic constraints (O-1R, O-2R, O-3R, O-4R, O-5R, O-6R, R5A, R9, and R10). These nine facilities combined tributary area totals approximately 723 acres (16% of the Tehaleh drainage area). The areas which will not connect to an emergency overflow contain less high density and commercial uses than the Puyallup River and Canyonfalls Creek overflow systems.

The retention facilities which will not connect to an emergency overflow system will be increased in size to provide a larger factor of safety, thereby allowing the facilities to accept larger storm events than the 100-year reoccurrence interval analyzed by WWHM12 continuous simulation software. The exact factor of safety which will be applied to retention facilities serving these areas will be determined in future, at the design phase, based on the following factors: tributary area, the need to provide compensatory storage for filled potholes, density of development, potential for downstream damage resulting from overflow, and risk of overflow in relation to potential damage. Field visits and coordination with geotechnical and hydrologic engineers will be performed to determine potential flow paths and associated impacts. See Exhibit 4 for overflow basins and proposed flow paths.

Specific factors of safety that will be applied to those facilities without emergency overflow routes will be determined during the design phase of the individual facilities. The facilities will be designed per applicable stormwater regulations and the overflows and factors of safety will be developed through coordination with the project hydrogeologists and Pierce County to ensure no adverse impacts are anticipated.

Facility R5A will be unique from the other facilities without emergency overflows. Retention R5A shares a water quality facility and tributary area with proposed Retention Facility R5. As discussed above, R5 will have a direct conveyance system to the Puyallup River for emergency overflow situations. The flow splitter that will divide flow between the R5 and R5A facilities will be designed so that the conveyance line feeding R5A will be limited to conveying the 100-year inflow rate for R5A. Therefore, any flows over the 100-year design storm will be routed to the Puyallup River overflow conveyance system. R5A will not, to the maximum extent feasible, receive flows larger than its designed 100-year inflow rate. The facility will also be sized with increased factors of safety similar to the facilities described above.

Another section of facilities which will not have an overflow system are all parcels proposed for stormwater management through Low Impact Development (LID) techniques. These areas will use LID techniques to infiltrate stormwater as close to its source as feasible. LID techniques will be designed to meet or exceed applicable stormwater regulations and provisions of the Phase II development agreement. Common LID facilities will be constructed with overflow risers, per Pierce County requirements; however, the facilities' overflow risers will not be connected to a conveyance system, but rather they will sheet flow to open space. Since the LID approach will distribute/infiltrate stormwater close to its source, impacts should not be significantly different then in the pre-development condition. Design of LID facilities will require close coordination with geotechnical engineers and hydrologists to reduce potential impacts. Based on the distribution of wetlands in areas proposed for LID, LID may prevent concentrated flows more than pre-development conditions in catastrophic storm events.

5.2.7 CLOSED DEPRESSION MITIGATIONS

Hydrologic and geotechnical studies of the site indicate that the existing system of closed depressions on the site will not have sufficient infiltrative or storage capacity to recharge the increased volumes of runoff that will be generated after the site is developed. Discharge of developed runoff into existing closed depressions will likely result in exacerbation of existing, or creation of new, flooding problems, particularly during major storm events, even if detention is provided in accordance with applicable stormwater regulations. This will be largely due to most of the existing closed depressions within the Tehaleh property being filled during development and replaced with detention or retention facilities. To eliminate this potential impact from development, Tehaleh will create a new system to closed depressions (retention facilities) that are specifically designed and sized to accept the large volumes of runoff that will be generated after development. These facilities will be located in areas of the site with high infiltration potential. The existing closed depression system will be functionally replaced and essentially relocated to areas of the site which have better infiltration characteristics. The new system of retention facilities will be "compensating storage" for the existing closed depression system.

For the purposes of sizing the proposed Tehaleh drainage system it is conservatively assumed that all closed depressions will be essentially eliminated by filling, grading, or by providing a positive outlet for drainage. This is a worst-case scenario used for impacts assessment in the EIS. Since the existing closed depression system will be functionally replaced and "compensated" for, Pierce County Code will permit the filling and/or elimination of existing closed depressions. The extent to which existing closed depressions will be filled will not be known until detailed grading plans are developed as part of the preliminary plat and engineering design process.

The elimination of closed depressions on the site will have a substantial effect on the existing site recharge patterns. This impact was analyzed by the project geotechnical engineers and hydrologists using MODFLOW groundwater modeling. A pre- and post- development model was created by AESI which shows the increase in flows from pre- to post- development. Existing flows from Canyonfalls Creek range from 8 to 15 cfs and based on the post-development model, flows will increase by approximately 0.5 cfs. This is an increase of only 5% and is considered insignificant by the AESI 2017 Report. Therefore, no significant impact on downstream groundwater discharge rates is expected. Of the many closed depressions onsite, only two have reports of historic flooding; these two closed depressions are discussed below.

Some closed depressions on the site may remain (in some form) after development. To prevent flooding in these depressions, overflows will be provided to effectively control maximum water surfaces. Closed depressions CC2A and CC2B (sub-basins of CC-04 (R4 Basin)) are located within Phase II with portions of their tributary area outside of Tehaleh Phase I and II boundary. These depressions have been identified as having existing flooding problems. Specific drainage features proposed to prevent impacts to these depressions are discussed below.

CC2B:

CC2B is located within Tehaleh Phase II between Exception Parcels 2 and 3. Portions of the closed depression tributary area extend into Exception Parcel 3. The depression has been known to flood 160th St E during major storm events. In the existing conditions about 107 acres of the Tehaleh site drains to CC2B. The addition of developed state runoff from Tehaleh into closed depression CC2B would likely exacerbate existing flooding problems, even if detention were provided. To avoid this impact, all area in Tehaleh that is proposed for development will be diverted away from CC2B and into the master conveyance system. In the case of depression CC2B, flows from developed areas will be conveyed to proposed detention facility D2.

A positive overflow will also be constructed to CC2B. The overflow will be placed at an elevation so that major flooding of 160th St E will not occur. The overflow from CC2B will be directed to the master conveyance system, as shown in Exhibit 3. These features would significantly reduce, or prevent, the reoccurrence of significant flooding problems associated with depression CC2B.

CC2A:

CC2A is located within Tehaleh Phase II and Exception Parcel 2. The depression has been known to flood 198th Ave E during major storm events. In existing conditions about 44 acres drains to CC2A. The addition of developed-state runoff from Tehaleh into closed depression CC2A would likely exacerbate existing flooding problems, even if detention were provided. To avoid this impact, all area in Tehaleh that is proposed for development will be diverted away from CC2A and into the master conveyance system. This will reduce the tributary area to the closed depression and would significantly reduce the existing flooding problem.

The diversion of developed-state runoff away from CC2A would help reduce the existing flooding problem and assure that the development of Tehaleh will not worsen the situation. The impact of the diversion of runoff from closed depressions into the downstream wetlands is discussed in the Wetland section below.

5.2.8 WETLAND DEPRESSION MITIGATIONS

After development, the addition of significant areas of impervious surfaces within wetland tributary areas and increases in total tributary area (for some of the major wetlands) could increase the volume and rate of runoff into the wetlands. This could result in significant increases in wetland water level fluctuations. In general, impacts to major wetlands resulting from increased rate and volume of runoff will be mitigated in three ways:

1. Detention facilities will be constructed upstream of wetlands,

2. The master conveyance system will bypass excess runoff from developed areas around the major wetlands, and
3. Wetland overflows will be installed to limit maximum water surface elevations in the wetlands. Overflow discharges from the various wetlands will be routed into the master conveyance system for eventual discharge into the proposed retention facilities.

Each of these mitigations is described in more detail below.

Wetlands that have been preliminarily identified as requiring more extensive mitigation methods than alterations in tributary area or disconnected roof drains include Wetlands 1, 4, 6, 14, 63 and Orting Lake. Wetland 4 is currently being mitigated by Water Quality/Detention Facility D4. Orting Lake and Wetlands 1, 6, 14 and 63 are preliminarily proposed to have Water Quality/Detention Facilities D1, D6, D3B, D2, and D7, respectively. These facilities have been preliminarily sized and located upstream from their respective wetlands (see Exhibit 3). The preliminary sizing was not performed at a design level; facilities were roughly sized using WWHM12 to allow adequate room during the parcel planning process. These facilities will be designed during the preliminary plat stage of any development that could potentially impact the tributary area of the above mentioned wetlands. See Detention Facilities section below for more details.

Wetlands with affected tributary area will be mitigated per applicable stormwater regulations. These standards will require necessary mitigation measures that will ensure no significant adverse impacts will occur from the proposed development.

For smaller wetlands on the site, wetland hydrology will be maintained by adjusting the developed-state tributary areas so that wetland hydrology is maintained at the proper level. In many cases, this will be accomplished through disconnected roof drains. In addition, wetland overflows will also be installed in each of the smaller wetlands on the site to limit the maximum wetland water surfaces to acceptable levels. The assessment of wetland hydrology and the determination of the appropriate applications are reviewed for areas tributary to each wetland. Determining the appropriate hydrology of each wetland and how to best maintain its hydrology will be closely coordinated with wetland specialists during design process. Each wetland and its proposed mitigation will be closely reviewed and approved by Pierce County.

1. <u>Detention Facilities</u>

Approximately 8 detention facilities are planned to be constructed, 6 of these facilities will be located upstream of major wetlands in Phases I and II of Tehaleh to control the increased runoff generated after development, and the remaining 2 facilities will be used as flow control. Preliminary locations of the detention facilities are shown of Exhibit 3.

All detention facilities on the site will be located outside of wetlands. However, detention facilities may encroach into wetland buffers at specific locations depending on site-specific topographic requirements. The extent of encroachment, if any, will be determined during the preliminary design stage, which will occur during the preliminary plat process. Detention facility outlets will be located outside of wetlands, but may be located inside wetland buffers. Detention facility outlets will be equipped with level spreaders, where soil conditions are appropriate. Mitigation for encroachment of facilities, or outlets, into buffers may include restoration, enhancement or enlargement of buffers at other locations, as described in the Wetland Report (2016) prepared by Raedeke Associates.

At a minimum, the detention facilities will be designed to discharge runoff from the wetlands so that wetland water fluctuations are kept nearly the same as in the pre-developed conditions. Excess runoff volumes and rates will be discharged to the master conveyance system and will bypass the individual wetlands. Changes in wetland fluctuations for Orting Lake, Wetland 1 and Wetland 4 are discussed in more detail in the following sections.

Six (6) of the 8 detention facilities are proposed and were preliminarily designed using a Pierce County-approved continuous simulation model, WWHM. Detention Facilities D3 and D4 are existing and are currently in operation. All detention facilities within the Tehaleh Drainage System will be on-line facilities, either discharging to wetlands or to conveyance systems which ultimately discharge to a retention facility. Detention facilities will provide two important roles in the Tehaleh Drainage System: maintaining existing hydrology and maximum high water elevations of large wetlands, and providing flow control for downstream retention facilities.

The outlet structure for detention facilities mitigating wetlands will be designed in closed coordination with project wetland consultants and will use monitoring data from the specific wetland in question. Preliminary sizes are given in Table 4 below. The facility will be designed to ensure no overflows discharge into the wetlands and large flows will be routed through bypasses to the downstream conveyance system. Discharge rates into wetlands will be modeled based on predevelopment model results. The facility will be designed applicable stormwater regulations and will limit the facilities discharge duration to pre-developed durations for the range of discharge from 50 percent of the 2-year recurrence interval flow up to the full 50-year flow and discharge rates will match the pre-developed rates of the 2-, 10-, and 100-year recurrence interval flows. Final factors of safety will be evaluated in accordance with Pierce County requirements and coordination with wetland consultants and hydrogeologists.

Table 4: Preliminary Detention Facility Sizing

Detention Facility	Sub-Basin	Sub-Basin Area (ac.)	% Impervious	Pond Area (ac.)	50-yr Peak Storage Volume
D1	CC-08	87.3	15%	1.6	11.5
D2	CC7A &CC7B	108.0	44%	1.8	14.4
D3*	R4-A	95.9	44%	4.8	31.6
D3B	CC1B	70.2	25%	2.0	11.5
D4*	R4-G	173.3	43%	2.8	2.3
D5	CC-03A	115.4	40%	1.0	4.6
D6	CC-01A	50.8	55%	0.4	3.0
D7	CR-05A	62.6	39%	2.6	20.2

*Detention Facilities D3 and D4 were previously constructed and are currently in operation. The values for these facilities were taken from the 2005 Cascadia Phase IA Onsite Arterial Roadways and Stormwater Infrastructure Improvements Plan by Hugh G. Goldsmith and Associates for facility D3 and 2007 Whitman at Cascadia Onsite Roadways and Stormwater Plan by Hugh G. Goldsmith and Associates for facility D4. These facilities will be audited and updated as required prior to construction of downstream tributary facilities (D2 and D3B).

The six proposed detention facilities were preliminarily sized using standard design methods and the hydrologic model, and the various pond sizes requirements

2. Bypass of Excess Runoff

Since most major wetlands on the site exist at the bottom of closed depressions (with no outlet), they are very sensitive to increases in the volume of runoff discharged to them. Even if the rate of discharge into the wetlands is limited to "natural" rates, the extended duration of discharge would likely cause higher water levels in the wetlands after development. To mitigate this impact of development, bypasses will be constructed to route excess runoff volume away from the wetlands and into the retention facility system. The locations of the bypasses are shown on the Exhibits 3 and 4.

The bypasses will be located upstream of each wetland to intercept runoff prior to discharge into the wetland. The exact design of each bypass, and the percentages of runoff volume which is bypassed, will be determined on a case-by-case basis for each wetland during the preliminary design stage, which will occur during the preliminary plat process. The bypass will be designed so that changes in the runoff volume allowed to flow into each wetland can be made after the system is in place.

3. Wetland Overflows

Wetland overflows will be installed to limit the maximum water surface elevations in the wetlands. It is anticipated that wetland overflows will consist of a culvert extended into the buffer of the wetland. It is not anticipated that direct impacts to the wetlands will occur, although impacts to the wetland buffer or enlargement of adjacent buffer/buffer averaging could be used to mitigate impacts.
The wetland overflows will be placed at an elevation above the normal high water surface of the wetland and, therefore, the overflows will have no effect on the normal water surface fluctuation pattern of the various wetlands during extreme storm events or in the event of a failure of a detention facility.

6.0 GOVERNMENTAL APPROVALS

The following governmental approvals are required for implementation of Master Drainage Plan:

1. **Washington State**
   a. Department of Ecology
      i. NPDES Permit
      ii. Shoreline Permit (Outfall to Puyallup River)
   b. Department of Fish and Wildlife
      i. HPA (Outfall to Puyallup River)
   c. Department of National Resources
      i. Surface Mining Permit
2. **Pierce County**
   a. Grading permits for individual facilities and development application
   b. Stormwater Pollution Prevention Plan (SWPPP) for individual grading/clearing plans.
   c. Approval of stormwater drainage construction plans and analysis for individual facilities and development applications.
   d. Shoreline Permit (Outfall to Puyallup River)
   e. Substantial Development Permit

7.0 ENVIRONMENTAL IMPACTS & MITIGATION MEASURES

Below is a list of potential hydrologic impacts that were previously identified. The impacts are assessed in relation to the proposed Tehaleh Master Drainage Plan.

Impacts of Canyonfalls Creek and Bonney Lake Springs

Development of the Tehaleh site will change recharge patterns on the Bonney Lake Plateau. This will be mitigated by the installation of at least sixteen retention facilities located throughout the site to mimic pre-developed recharge zones to the maximum extent possible. Computer modeling of the recharge system and its impacts on the groundwater system below the site indicates that there will be no significant impacts on flowrates to Canyonfalls Creek and the Bonney Lake Springs.

Associated Earth Sciences, Inc. has performed groundwater modeling of the existing and proposed conditions for the site. The model inputs the existing groundwater recharge volumes and rates compared to the volumes and rates from the proposed retention facilities throughout the site. MODFLOW results show an increase of 5% in the flow rate of Canyonfalls Creek corresponding to approximately 0.5 cfs, which is an insignificant change and will not cause any adverse impacts on Canyonfalls Creek (AESI 2017 Report). Monitoring systems will remain in place to insure MODFLOW results remain accurate. From the results of this groundwater model, no significant impacts will occur from the volume and rate of water infiltrated during developed conditions. The model also analyzes the impact of groundwater mounding and slope stability. Special attention was given to retention facilities located near the edge of the property for slope stability impacts. The model once again showed that the groundwater mounding from the proposed retention facilities will not cause any significant impact during developed conditions

Impacts to Major Rivers

There will be no significant impacts to the Carbon River or South Prairie Creek because there is no significant drainage to these watercourses from the site either before or after development.

There will be no significant impacts to flows in the Puyallup River because there is no significant impact on flowrates in Canyonfalls Creek or the Bonney Lake Springs. These watercourses are the only significant means by which site drainage contributes to the Puyallup River.

Impacts to Closed Depressions

Existing flooding problems in closed depressions CC2A and CC2B will be mitigated by diverting stormwater from developed areas away from these features. Therefore, the development of Tehaleh will not worsen existing flooding conditions and will likely reduce the magnitude of existing flooding problems. An emergency overflow will be extended to closed depression CC2B. This will prevent high water levels from flooding 160th Street E.

Existing closed depressions in the interior of the Tehaleh site will be treated in one or more of the following ways:

1. Filled/graded to have positive drainage and no longer store water,
2. Provided with an outlet drain into the Tehaleh storm conveyance system so that they no longer store water, or
3. Maintained in their existing configuration but provided with an emergency overflow so that flooding is precluded.

The exact method of treating each depression onsite will be determined at the design stage as part of specific development applications. Potential flooding impacts in the closed depressions will be eliminated by these measures.

Existing closed depression storage on the site provides a significant level of protection to downstream properties, particularly during very large storm events. The elimination of closed depression storage by uncontrolled or unmitigated filling/draining could result in a significant increase in the rate and/or volume of drainage leaving the site. Without mitigation, this could cause significant impacts to the natural and constructed systems downstream of the site. These potential impacts of development will be mitigated primarily in three ways:

1. Depression storage which is eliminated will be “compensated for” within the recharge system which will be constructed as part of the Tehaleh drainage system. The existing closed depression system will be functionally replaced and essentially relocated to areas of the site which have better infiltration characteristics.
2. The majority of the Tehaleh drainage system will be connected to emergency overflows which will discharge to acceptable receiving points in the downstream drainage system. The locations of emergency overflows are shown in Figure 4.
3. The retention facilities, which will functionally replace many closed depressions, will be increased in size to provide a factor of safety, thereby allowing the facilities to accept storm events much larger than the 100-year design storm without overflow. The exact factor of safety which will be applied will be determined at the design phase based on the following factors: tributary area, the need to provide compensatory storage for filled closed depressions, density of development within the tributary area, potential for downstream damage resulting from overflow, and risk of overflow in relation to potential damage.

Computer modeling of the site drainage system after development, assuming the above described mitigation and assuming the elimination of all existing closed depression storage on the site, indicates that there will be no significant impacts on downstream drainage systems after development.

Impacts to Wetlands

Impacts to site wetlands from increases in runoff rates and volumes will be mitigated by limiting the rate and volume of runoff that is discharged to the wetlands so that wetland hydrology is maintained in a condition similar to the existing state. For the major wetlands this will be accomplished by network of water quality/detention facilities and high flow bypasses. These facilities will be designed during the preliminary plat process of any development that impacts tributary area of existing wetlands. For the smaller wetlands it will be accomplished by adjusting the area tributary to the wetlands so that runoff to the wetland is limited to maintain wetland hydrology in a condition similar to existing state. Mitigation methods will be adjusted on a wetland-by-wetland basis based on coordination with wetland specialists and hydrologists to ensure the proper methodology is used mitigating potential impacts to the wetlands. Potential hydrologic impacts to wetlands should be insignificant.

Downstream Impacts (erosion, siltation, etc.)

Tehaleh will recharge its runoff into the regional aquifer. Discharge from the site into downstream drainage courses, and subsequent impacts to those courses, will not normally occur. Potential catastrophic storm events may cause the proposed facilities to overflow in emergency conditions. Emergency overflow paths, tributary area and outfalls have been preliminarily determined (see Exhibit

4). The majority of retention facilities will have closed conveyance systems routed form their respective emergency spillways to the Puyallup River. Energy dissipaters will be installed at the outlet of these overflow discharge location to prevent erosion. Facilities without overflow paths will be designed with significant safety factors and emergency spillways to reduce erosion of the facilities.

Impacts to Clearing, Grading and Slope Stability

A conveyance system, denoted as Segment B on Exhibit 3, will cut along a moderately steep slope southwest of proposed planning parcel 2F.3. This conveyance system will share an access road with a proposed sanitary sewer trunk line. The proposed alignment and profile for the access road was sent to AESI on February 12, 2016 so that AESI could provide potential impacts from the proposed access road. AESI reviewed the proposed profiles and alignment and determined that on the above described slope, the soils area was comprised of glacial tills and there should not be any anticipated adverse impacts to the erosion or slope stability from the proposed access road.

Interim Gravel Mining Impacts

Interim gravel mining is proposed within Phase II of the Tehaleh project site. Mining activities on proposed Parcels 2C.2 and 2C.3 (previously named Parcel KK) include the clearing and grading of approximately 130 acres to obtain suitable gravel material to meet the needs of future on- and off- site construction activities. The excavation for the mining will range from about 20 to 60 feet deep and 6 million cubic yards of material. Potential impacts from the proposed mining activities will include the clearing of forest and exposing soils to direct precipitation resulting in potential erosion and sediment problems. The mining activities will employ erosion and sediment control and will be mitigated by the required Stormwater Pollution Prevention Plan (SWPPP) for all projects proposing clearing and grading. The SWPPP will ensure that stormwater is managed onsite during interim construction activities. During the lifespan of the mining activities, all stormwater runoff will be contained onsite within the excavated grading sites and infiltrated. No runoff will be discharged offsite. No offsite properties or sensitive areas are anticipated to be affected or disturbed.

Water Quality Impacts to Receiving Waters

Runoff from developed areas will be treated to remove pollutants prior to discharge into receiving waters (wetlands and aquifers). All stormwater recharge facilities within the Tehaleh drainage system will be designed per applicable stormwater regulations. Water quality facilities will be incorporated into the drainage system prior to runoff reaching any infiltration facility or wetland. Runoff from non-pollutant-generating surfaces (e.g., rooftops) will be used to mitigate wetland hydrology where no water quality facility is needed or feasible.

Groundwater Recharge Impacts

Associated Earth Science, Inc. (AESI) developed a MODFLOW computer model which models the existing and proposed conditions of the groundwater system below Tehaleh, particularly the aquifer which feeds the Canyonfalls Creek. This aquifer's capture zone encompasses the majority of the Tehaleh site (See Exhibit 3). AESI MODFLOW model, as discussed above, showed no adverse impacts the regional aquifer for discharge due to the proposed stormwater infiltration facilities. AESI not only modeled the infiltrated volumes from the proposed and existing retention facilities, but also inputted the proposed volumes of reclaimed water infiltrated from the proposed Wastewater Treatment Plant (WWTP).

Three locations will potentially receive reclaimed water for infiltration into the groundwater system. The first location is the current drainfield located west of existing retention facility R4. This area is currently being used as a Large Onsite Septic System with a discharge permit of 0.5 million gallons per day (MGD) of grade "A" effluent. The second location will be utilized when the drainfield reaches capacity and will be located directly east from the retention facility R4 to a proposed rapid infiltration facility. The third location would potentially be located in the southern Phase II portion of the site at the far end or outside the Canyonfalls Creek capture zone. Using the current design flows for the WWTP, AESI analyzed the impact from infiltrating all the effluent into the groundwater. The analysis shows that there will be a significant increase in flow but that this will not cause any adverse impacts. Monitoring will continue to occur to ensure the model's projections stay true. The third location, outside of the Canyonfalls Creek capture zone will be determined if flows or water quality from monitoring does not match modeling projections.

The effluent from the proposed WWTP will also potentially be used for irrigation. The effluent will be routed to a reservoir where chlorine will be added to create reclaimed water. This reclaimed water will be used to irrigate landscaping along major arterials as well as local parks and landscaped tracts. The distribution of reclaimed water throughout the site will not cause any adverse impacts from infiltration into groundwater. It can be concluded that no adverse impacts will occur from the concentrated infiltration at the drainfield or rapid infiltration facility, which both infiltrate the effluent at a much higher rate and much closer to the discharge location of Canyonfalls Creek.

Along with the above impacts and mitigation measures presented within this report, refer to the Tehaleh Conditions of Approval from the 1999 Development Agreement, as amended.

Mitigation Measures for Water

The following list presents the conditions/mitigation measures that have been identified for the SEIS Alternatives and any significant unavoidable adverse impacts that could potentially result from the alternatives. This list is not intended to be a substitute for the complete discussion of mitigation measures in the technical appendices to this SDEIS**.**

Mitigation measures were identified in the 1998 EIS and in conditions to the subsequent approvals. The "Current Conditions of Approval" would apply to the *Tehaleh EBPC PUD Phase II Major Amendment Project* unless noted by strikethrough text in the list of conditions below.

- **Current Conditions of Approval** are the conditions contained in Exhibits H and I to the updated *Tehaleh EBPC Development Agreement* (2015). These conditions would pertain to the Amended Phase II Proposal, and are intended to reduce impacts of the proposal to non-significant levels.

As appropriate, additional "Required/Proposed" and "Other Possible Mitigation Measures" have been identified. "Significant Unavoidable Adverse Impacts" are noted where significant impacts from construction and operation of the proposal cannot be mitigated by known mitigation measures.

- **Additional Required/Proposed Mitigation Measures** are measures which the Applicant has proposed at this point in time that are above and beyond the Current Conditions of Approval, and/or that are required by code; laws; or local, state and federal regulations. These measures are intended to reduce the impacts of the proposal to non-significant levels.
- **Other Possible Mitigation Measures** are additional measures that could be implemented, but are not necessary to mitigate significant impacts, and are above and beyond those proposed by the Applicant.

Water Mitigation Measures

1. The Cascadia Employment Based Planned Community (EBPC) shall meet the requirements of the Pierce County Stormwater Management and Site Development Manual, Ordinance No. 96-46S2 for Phase I development, except as revised in the development agreement. The Pierce County Stormwater Management and Site Development Manual may be revised over the course of development of the Cascadia EBPC. However, if requested by the County and approved by the Hearing Examiner, or if requested by the applicant, the Cascadia EBPC shall upgrade to meet or exceed the current stormwater manual.

2. A Master Drainage Plan has been developed for the Phase I and II areas of the site. The permanent drainage system shall consist of a system of regional recharge (infiltration) facilities, detention ponds, a master system of overflow/bypass pipes and channels and an emergency overflow system. The system shall be designed to replicate existing conditions by infiltrating all stormwater runoff generated on the site and prevent surface runoff from flowing to the downstream drainage system. The proposed drainage system will be designed to cause no adverse impacts to wetlands within the site and wetland hydrology affected by development will be mitigated per applicable stormwater regulations. The recharge facilities shall be designed and sized to functionally replace and provide compensatory storage for filling of the existing closed depression system.

3. The design of the project's stormwater quantity, quality, and conveyance facilities shall be consistent with the Storm Drainage Master Plan contained in the EIS, except as modified in the development agreement.

4. The development agreement shall include criteria for determining the appropriate factor of safety for sizing the retention and detention facilities. The Pierce County Development Engineering Section and the Pierce County Water Programs Division shall approve the criteria.

5. Permanent stormwater detention ponds and infiltration facilities shall be sized using the Washington State Department of Ecology Western Washington Continuous Simulation Hydrology Model (WWHM) 2012 version 4.2.12 modeling as part of the detailed design process. Specifics of the sizing criteria shall be contained in the development agreement.

6. Detailed analysis (including slope stability analysis) shall be conducted at each detention or infiltration facility site at the time of analysis of final design to verify the suitability of each specific facility if requested by the County.

7. As necessary, the area interflow network shall be maintained in roadway construction areas by placing a minimum two feet of free-draining base material beneath roadways in both cut and fill areas. The applicant's designer and the County reviewer of future road construction shall decide, based on area-specific factors, where the excess (two feet) free-draining material shall be utilized.

8. Site-specific geotechnical investigations shall be performed during engineering design for facilities R5, R10, and O-6. The site-specific investigations shall be used to place infiltration facilities within the Canyonfalls Creek groundwater capture zone and to avoid the potential for infiltration discharge that could daylight on the west or east slopes. Geotechnical investigations

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shall consist of drilling exploration borings to confirm geologic suitability for infiltration at specific locations and aquifer conditions.

9. A minimum of two groundwater wells shall be established between the proposed infiltration facilities and the top of both the westerly and easterly slopes to monitor static water levels. To establish existing conditions, the monitoring wells shall be installed before infiltration facility construction and, at a minimum, shall be monitored through one winter recharge cycle. The monitoring program shall continue for three years following 75 percent buildout within each applicable drainage basin. If monitoring indicates that slopes are being recharged from infiltration, infiltration facilities shall be relocated to avoid the potential for slope failure.

10. Oil/water separators shall be installed and maintained for runoff from heavily used roadways and large parking lots.

11. Native or adapted species shall be included in landscaped common areas (i.e. road corridor and business park landscaping) to reduce the need for irrigation and chemical application.

12. Restoration, enhancement, or enlargement of wetland buffers and/or buffer averaging to compensate for any encroachment of conveyance systems, detention facility outlets or wetland overflow pipes into the buffers shall meet the requirements of the Pierce County Wetland Management Regulations.

13. The exact design of the wetland bypasses and the percentage of runoff that is bypassed shall be determined on a case-by-case basis for each wetland during the preliminary design stage of the preliminary plat process. The bypasses shall be designed so that changes can be made in the runoff volume to each wetland after the system is in place.

14. A post-development monitoring program shall be formulated in conjunction with Pierce County, as part of the project's Development Agreement, to monitor water quality and quantity conditions. Monitoring would be expected to occur at selected inflow points to representative infiltration ponds, at the headwaters of Canyonfalls Creek, and at well TW-2. The program shall include data from the gauging of Canyonfalls Creek, data from wells TW-2 and TW-3 and use of the MODFLOW model. Groundwater elevation monitoring shall also be part of an overall monitoring program to check the project's effects on groundwater recharge.

15. The development agreement shall include a post-construction water quality and quantity monitoring program for Canyon Falls Creek, Victor Falls Springs, the on-site wetlands, wells TW-2 and TW-3 and the inflows of proposed stormwater infiltration ponds. The details of said water quality monitoring program shall be approved by the County.

16. If the interim community drainfield system is utilized, any such drainfield system shall be subject to review and approval by Washington State. The applicant shall limit the use of or connections to the drainfield systems consistent with Washington State standards or permit requirements.

17. Prior to site development permit approval for construction of the golf course, a Final Golf Course Management Plan (a.k.a. Pollution Source Control Plan) shall be prepared by the applicant and approved by the County. This plan shall comply with Section 4.8.3.3 of the Stormwater Management and Site Development Ordinance and shall, at a minimum, include: instructions on the use of herbicides, pesticides and fertilizers, stipulating that slow release fertilizers low in

phosphorus be used on the golf course and that any herbicide or pesticide usage be minimal and on an as-needed basis, selected on the basis of minimal transport and persistence potential.

18. If a golf course is constructed on the site it shall be designed so that as many of the existing closed depressions within the golf course boundaries are retained and new storage areas added (in addition to planned recharge facilities), as feasible given topographic conditions and specific golf course design requirements. Golf course design shall reduce the amount of runoff reaching proposed facilities O-1, O-2, O-3, O-4, O-5, O-6, and R10, and shall take every reasonable precaution to reduce the risk of recharge facility failure and overflow.

19. A program shall be implemented to monitor infiltration facility performance, beginning with construction of the first infiltration facility in Phase I. The purpose of the monitoring program shall be to verify the adequacy of system design assumptions, determine the specific long-term infiltration capacity of each facility and determine long-term maintenance needs. The details of the monitoring program shall be approved by the Pierce County Development Engineering Section and the Pierce County Water Programs Division. The details of the monitoring program shall be included in the development agreement.

20. Educational materials for water quality and habitat/resource protection shall be provided to businesses, schools, residences, and parks maintenance personnel to minimize the use of pesticide and lawn and landscape fertilizers.

21. Trails shall be routed away from the most sensitive wetlands to reduce the potential for fecal coliform and sediment introduction from horses.

22. The Development Agreement shall establish sizing criteria for the proposed stormwater overflows. The sizing criteria shall be approved by the Pierce County Development Engineering Section and the Pierce County Water Programs Division and shall be included in the development agreement.

23. The Storm Drainage Master Plan elements (i.e. recharge facilities, detention facilities) that are necessary for each development application shall be determined prior to preliminary plat approval.

24. A pollution prevention plan shall be submitted to the Department of Ecology as part of an NPDES permit application for construction on the site.

25. Emergency overflow facilities to the Puyallup River and to the Canyonfalls Creek valley shall allow discharge to acceptable locations during extreme storm events in order to preclude any downstream impacts. Areas of the site not connected to the overflow facilities shall discharge to recharge facilities designed to a larger factor of safety (beyond 30 percent). The specific design of the emergency overflow and outfall facilities shall be reviewed and approved by the County as part of specific construction applications.

26. Construction runoff (e.g. concrete wastes, equipment oils) shall be collected in sumps and disposed of in approved off-site facilities.

27. A Stormwater Pollution Prevention Plan (SWPPP) shall be prepared and submitted to the County with associated Fill & Grade Construction Documents per applicable stormwater regulations.

28. Accidental spill response cleanup and notification procedures shall be included in construction contractor agreements.

29. A minimum setback distance of 500 feet shall be maintained between proposed stormwater infiltration facilities and the top of Landslide Hazard 1 areas to reduce the risk of recharging the on-site slopes and initiating slope failures below the ponds. Groundwater mounding potential and slope stability shall be evaluated on a case-by-case basis for any infiltration facilities located within 1,000 feet of a Landslide Hazard Zone 1 boundary. Facility setback distances shall be increased or decreased depending on the results of site-specific studies conducted as part of the review of specific development applications.

30. Wetland fringe vegetation shall be planted within stormwater detention facilities which discharge developed stormwater runoff to wetlands in order to further reduce nitrogen and metals potential effects on Canyon Falls Creek, Bonney Lake Springs and Orting Lake. These facilities can potentially include D1, D2, D3B, D6 and D7.

31. Open channel conveyances to infiltration areas R4-E, R4-F, R4-H and all other open channel conveyances shall be constructed as open channel wetland swales as feasible to reduce nitrate-nitrogen, ammonia and metals potential effects on Canyon Falls Creek.

Significant Unavoidable Adverse Impacts

Development under the Phase II will result in potential stormwater-related impacts associated with construction (site clearing and grading, installation of utilities/infrastructure), infiltration to groundwater, and surface water runoff. With the implementation of the mitigation measures related to these hazards, as discussed in detail in this report, no significant unavoidable adverse stormwater-related impacts would be anticipated.

All proposed storm facilities will be designed per Pierce County standards for both water quality and quantity. The proposed storm drainage facilities are designed to replicate existing conditions and meter treated runoff to major wetlands and infiltrate all treated runoff into the existing aquifer recharge zones. All stormwater runoff will be treated per DOE and Pierce County standards prior to release to any wetlands or being infiltrated. Therefore, the increase of 3,263 dwelling units as proposed in the Applicant's Preferred Alternative will not have any additionally impacts as compared with the 6,437 dwelling units proposed in the original EIS.

8.0 DEVELOPMENT ALTERNATIVES

As shown below, three of the five alternatives proposed the same maximum residential units of 9,700 units. These alternatives have very similar land uses for commercial, public facilities, recreation and open space. Alternatives 2 and 4 have a much lower residential unit count and with similar ratio of land uses for commercial, public facilities, recreation and open space as alternatives 1, 2, and 3. Additionally, all proposed alternatives will have similar plans for energy infrastructure. The biggest difference in infrastructure location will occur in alternative 4, which will not include any infrastructure proposed in phase II but will have the same infrastructure proposed in the remaining alternatives for phase I.

Applicant's Preferred Alternative *– No Golf Course or Hotel - 9,700 dwelling units*

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The Applicant's Preferred Alternative proposes to modify the Current Approval to allow project-level development in Phase II and more residential development on the entire site (up to 9,700 dwelling units). The site would be developed as an EBPC PUD with the same general types of land uses as the Current Approval; however, the areas and in some cases locations of the various uses would differ. The percentage of unrestricted single-family/two-family housing would increase and the percentage of Age Qualified housing would decrease at similar modest rates over that approved in the Phase I Major Amendment. The percentage of multifamily housing is proposed to develop at a rate similar to that approved in the Phase I Major Amendment. These changes are intended to reduce impacts on the environment, particularly on traffic. No golf course and associated uses are proposed. The EBPC would include:

- *Employment Center Areas – 476 acres* (10 percent of the site, including no golf course, hotel or conference center; 1 existing school and additional school sites; and up to 3.4 million sq. ft. of employment-related building space);*
- *Residential Areas – 2,024 acres (43 percent of the site, including 9,700 units – 6,397 detached units, 1,101 attached multifamily units and 2,202 Age Qualified units);*
- *Public Facility Areas – 398 acres (8 percent of the site); and*
- *Open Space/Parks/Critical Areas – 1,855 acres (39 percent of the site).*

**Assumes 100% of the school acreage counts toward employment center area, consistent with the Phase II proposal and as allowed by the current Tehaleh zoning (Exhibit I to the 2015 Development Agreement).*

***SEIS Alternative 1** – Golf Course and Hotel - 9,700 dwelling units*

Alternative 1 is the 2014 Phase II Major Amendment Application and proposes to modify the Current Approval to allow project-level development in Phase II and more residential development on the overall site (up to 9,700 dwelling units). The site would be developed as an EBPC PUD with the same general types of land uses as the Current Approval; however, the areas and in some cases locations of the various uses would differ. A golf resort with hotel is proposed. The EBPC would include:

- *Employment Center Areas – 484 acres* (10 percent of the site, including 16 acres of golf uses** and up to 3.5 million sq. ft. of employment-related uses);*
- *Residential Areas – 1,865 acres (39 percent of the site, including 9,700 units – 7,514 detached units, 1,486 attached multifamily units and 700 designated Age Qualified units);*
- *Public Facility Areas – 367 acres (10 percent of the site, including 1 existing school and additional school sites); and*
- *Open Space/Parks/Critical Areas –2,040 acres (43 percent of the site, including 219 acres in a golf course***).*

**Assumes 100% of the school acreage counts toward employment center area, consistent with the Phase II proposal and as allowed by the current Tehaleh zoning (Exhibit I to the 2015 Development Agreement).*

***As under the Current Approval, golf uses (e.g., hotel, conference center and golf academy) would be included as employment area.*

****As in the 1998 EIS, the golf course would be included as open space area.*

***SEIS Alternative 2** – Golf Course and Hotel - 6,437 dwelling units*

Under Alternative 2, the site would be developed as an EBPC PUD conceptually consistent with the 1998 EIS and PUD approval. The general types and layout of land uses would be the same as the Applicant's Preferred Alternative, except that fewer dwelling units would be included (up to 6,437 dwelling units). A golf resort with hotel is proposed. (This alternative does not meet the Applicant's *objectives for the project because the magnitude of the infrastructure costs would not be offset by the revenue from building fewer housing units.) The EBPC would include:*

- *Employment Center Areas – 484 acres* (10 percent of the site, including 16 acres of golf uses** and up to 3.5 million sq. ft. of employment-related building space);*
- *Residential Areas – 1,865 acres (39 percent of the site, 6,437 units – 4,980 detached units, 757 attached multifamily units and 700 designated Age Qualified units);*
- *Public Facility Areas – 367 acres (10 percent of the sites, including 1 existing school and additional school sites); and*
- *Open Space/Parks/Critical Areas – 2,040 acres (43 percent of the site, including 219 acres in a golf course***).*

** Assumes 100% of the school acreage counts toward employment center area, consistent with the Phase II proposal and as allowed by the current Tehaleh zoning (Exhibit I to the 2015 Development Agreement).*
***As under the Current Approval, golf uses (e.g., hotel, conference center and golf academy) would be included as employment area.*
****As in the 1998 EIS, the golf course would be included as open space area.*

***SEIS Alternative 3** – Golf Course - 9,700 dwelling units*

Alternative 3 proposes to modify the Current Approval to allow project-level development in Phase II and more residential development on the overall site (up to 9,700 dwelling units). The site would be developed as an EBPC PUD with the same general types of land uses as the Current Approval; however, the areas and in some cases locations of the various uses would differ. The perentage of Age Qualified housing would decrease at similar modest rates over that approved in the Phase I Major Amendment, and the percentage of multifamily housing is proposed to develop at a rate similar to approved in the Phase I Major Amendment. These changes are intended to reduce impacts on the environment, particularly on traffic. A golf course is proposed, but in a different configuration than under the Current Approval. No hotel, resort of conference center would be included. The EBPC would include:

- *Employment Center Areas – 476 acres* (10 percent of the site, including no golf uses, 1 existing school and additional school sites and up to 3.3 million sq. ft. of employment-related building space);*
- *Residential Areas – 1,912 acres (40 percent of the site, including 9,700 units – 6,333 detached units, 1,148 attached multifamily units and 2,219 designated Age Qualified units);*
- *Public Facility Areas – 400 acres (8 percent of the site); and*
- *Open Space/Parks/Critical Areas – 1,968 acres, (41 percent of the site, including 155 acres in a golf course**).*

** Assumes 100% of the school acreage counts toward employment center area, consistent with the Phase II proposal and as allowed by the current Tehaleh zoning (Exhibit I to the 2015 Development Agreement).*
***As in the 1998 EIS, the golf course would be included as open space area.*

***SEIS Alternative 4** – Phase I Build-out/No Phase II Development - 2,586 dwelling units (No Action Alternative)*

Under Alternative 4, the No Action Alternative, Phase I would continue to build out as approved through the 2014 Phase I Major Amendment (including up to 2,586 dwelling units). A golf resort with hotel is proposed in Phase I. Phase II would remain largely undeveloped at this time except for infrastructure needed to serve Phase I and resources uses in Phase II. However, it is likely that *development would occur in the future, in accordance with the site's EBPC zoning. Site development would include:*

- *Employment Center Areas – 159 acres* (3 percent of the site, including 16 acres of golf uses** and up to 1.0 million sq. ft. of employment-related building space);*
- *Residential Areas – 821 acres (17 percent of the site, including 2,586 units – 1,600 detached units, 286 attached multifamily units and 700 designated Age Qualified units);*
- *Public Facility Areas – 127 acres (3 percent of the site, including 1 existing school and an additional school site(s)); and*
- *Open Space/Parks/Critical Areas – 3,648 acres (77 percent of the site, including 219 acres in a golf course***).*

** Assumes 100% of the school acreage counts toward employment center area, consistent with the Phase II proposal and as allowed by the current Tehaleh zoning (Exhibit I to the 2015 Development Agreement).*
***As under the Current Approval, golf uses (e.g., hotel, conference center and golf academy) would be included as employment uses.*
****As in the 1998 EIS, the golf course would be included as open space area.*

Under all of the SEIS Alternatives, resource uses (e.g., gravel mining, timber harvesting and topsoil production) would be included as allowed uses in the EBPC. Material harvested, mined or manufactured onsite may be produced commercially for profit and used for residential and employment development onsite or may be transported offsite.

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Appendix A Canyonfalls Creek Flow Data

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Appendix B Wetland Monitoring

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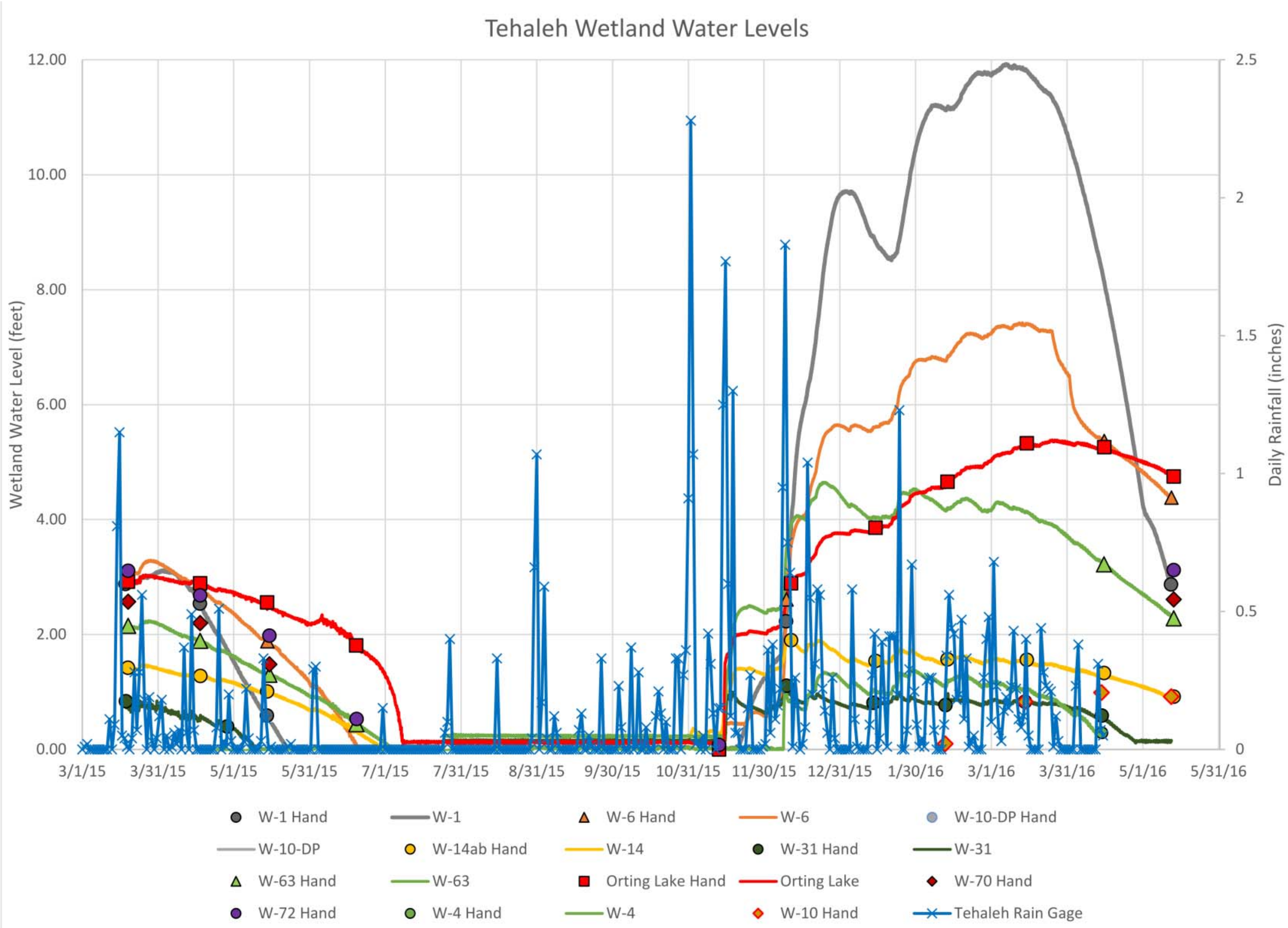

Associated Earth Sciences, Inc.

Tehaleh EBPC
Pierce County, Washington

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Appendix C Hydrologic Modeling Report and Exhibits

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1.0 INTRODUCTION

The proposed post-development Tehaleh Drainage System and the pre-developed conditions of the Tehaleh site have been modeled using the Washington State Department of Ecology's Western Washington Hydrology Model version 2012 (WWHM). This simulation of the pre- and post- development conditions was conducted to assess the existing hydrology of Tehaleh and to assess the effectiveness and suitability of the proposed Tehaleh Drainage System at mitigating potential stormwater related impacts from the development.

The pre- and post- development conditions were analyzed from 1996 to 1998 in the 1998 Cascadia Master Drainage Plan and Assessment of Hydrologic Impacts report by Hugh G Goldsmith & Associates. Their analysis of the development used the Environmental Protection Agency's (EPA) Hydrologic Simulation Program – FORTRAN (HSPF). HSPF is a deterministic model that is capable of simulating a large variety of hydrologic processes and conditions. The HSPF model was used because it could represent surface runoff, interflow and groundwater discharge and recharge. The HSPF program completes a continuous water balance by accounting for precipitation volumes as they move through the hydrologic process. HSPF was the best model to use at the time the analysis was performed. MacKay Sposito did not use the same model as Goldsmith, because newer models have been developed that have the capabilities of older HSPF models with a more user-friendly interface and WWHM has a specifically-tailored precipitation and evaporation data specific for Pierce County. These two elements are important because it allows for the same level of analysis without the extensive process of calibrating the model. Flow monitoring is in progress to determine how conservative the previous HSPF and current WWHM model is and also to verify design assumption for existing facilities.

2.0 GENERAL MODELING APPROACH

The general stormwater facility sizing for infiltration and detention facilities follows guidelines presented in the 2012 update to the 2008 Pierce County Stormwater Management and Site Development Manual (see 1998 Cascadia Master Drainage Plan and Assessment of Hydrologic Impacts report for details on the previous model design approach). Flow control and water quality treatment standards are followed though the preliminary design process for all proposed facilities.

In general, each basin that drains to a stormwater management system or has proposed development within it or a tributary basin is delineated using LiDAR topography and surveyed topography (where available). Soil characteristics are then identified within each basin. WWHM has three soil types, A/B, C, and SAT (saturated soils), and there are two general categories of soils onsite, till and outwash. For areas in outwash soils, soil group A/B is used. For areas in till soils, soils group C is used. In areas where the soil is unknown or not verified, till soils area assumed. The basin is then broken into vegetation and development land uses; in the case of Tehaleh, all pre-developed areas are modeled as forested area. In post-development conditions, conservative impervious percentages are applied to the gross development area and any area proposed to disturb the existing conditions. Facilities are preliminarily sized using conservative infiltration rates through coordination with geotechnical engineers and hydrologists. The facility is then sized based on the post-development conditions. Closed depressions which will be left in pre-developed conditions, will be modeled to determine if any tributary area is affected or flooding is identified as a potential impact. This will ensure that no flooding or stormwater related impacts are anticipated. The storage and infiltration rate of the closed depression left within the post-development conditions will be determined in the pre-development conditions model.

The continuous simulation model will analyze the 2-year through 100-year recurrence interval flow values for pre- and post- development scenarios. There are three criteria by which flow duration values are computed:

1. If the post-development flow duration values exceed any of the pre-development flow levels between 50 percent and 100 percent of the 2-year recurrence interval pre-development peak flow values (100 percent threshold) then the flow duration requirement has not been met.
2. If the post-development flow duration values exceed any of the pre-development flows levels between 100 percent of the 2-year and 100 percent of the 50-year recurrence interval pre-development peak flow values more than 10 percent of the time (110 percent threshold) then the flow duration requirement has not been met.
3. If more than 50 percent of the flow duration levels exceed the 100 percent threshold, then the flow duration requirement has not been met.

The goal of the modeling process is to input all of these elements and ensure that the post-development facilities have the capability to infiltrate 100 percent of runoff produced in the model. This goal meets the pre-development flow rates from the site which also infiltrate all stormwater onsite. The goal was achieved for each proposed retention facility.

Tehaleh's existing drainage system does not leave the project area through any main water course or stream, but rather infiltrates into groundwater system (see existing conditions section in main report). Therefore, to ensure that the post-development drainage system does not increase or decrease groundwater flow rates and quality and that erosion and bank stability is not impacted by the post-development system, Associated Earth Science, Inc. (AESI), the hydrogeologists for the project, have created a pre- and post- development groundwater model using MODFLOW. The AESI 2017 Earth and Groundwater Report for Tehaleh Phase II explains in more detail the aquifer system below Tehaleh and how the MODFLOW model is created. To ensure that the aquafer systems would not be adversely impacted by the proposed retention facilities and volumes of water estimated to infiltrate, AESI used output data from Mackay Sposito's WWHM models of all the proposed retention facilities as well as previously modeled existing facilities volumes and compared them to the existing conditions model. The models showed that at the main groundwater discharge point on the site, the flows are projected to only increase by 5 percent. This equates to approximately 0.5 cfs, which from AESI's analysis will not cause any adverse impacts to the downstream system.

AESI also modeled the volume coming from any facility located near a slope, specifically proposed retention facilities R5 and R10. These facilities were analyzed to determine the extent of groundwater mounding that could occur and AESI determined that with proposed volumes infiltrating from these facilities, there shall be no adverse impacts to slope stability or erosion.

For AESI to complete their models, MacKay Sposito, Inc. modeled all the proposed retention facilities within Tehaleh using WWHM12. WWHM12 analyzes 158 years of Pierce County-tailored simulated precipitation data. From this data, MacKay Sposito, Inc. sent AESI the largest 30-day cumulative volume infiltrated from each pond as well as the 15 days before and after the largest average daily inflow into each proposed retention facility. From this data, AESI was able to determine that no adverse impacts will occur from the volume of water infiltrated. In addition, there shall be no adverse impacts from the location of the facilities due to bank stability or erosion. With the location of the proposed retention facilities and proposed stormwater volumes, the post-developed regional hydrology of the Tehaleh site will have an insignificant change and cause no adverse impacts to the quantity and quality water.

3.0 CLIMATIC DATA

The previous HSPF model used in the 1998 Cascadia Master Drainage Plan and Assessment of Hydrologic Impacts report used 50-years of observed rainfall data provided by Pierce County. For the WWHM used in this analysis a Pierce County precipitation time series was used. This Pierce County precipitation data consists of 158-years of simulated data that was designed specifically for sizing stormwater management facilities within Pierce County. Using this simulated precipitation time series from Pierce County is required when using continuous simulation models for designing stormwater management facilities in Pierce County.

See 1998 Cascadia Master Drainage Plan and Assessment of Hydrologic Impacts Report Appendix C for a detailed account of the precipitation data used for the original HSPF model.

4.0 LAND SEGMENT CHARACTERISTICS

The Western Washington Hydrology Model version 2012 (WWHM) method for hydrologic modeling of the site requires that the land use be subdivided into segments based on soil types, topography, and ground cover. The following sections give a detailed description of these classifications and how they are implemented in the modeling of the proposed Tehaleh Drainage System.

4.1 SOIL CHARACTERISTICS

The surficial soil types found on the Tehaleh site include predominately Alderwood, Kitsap, Everett and Indianola soils series. The locations and descriptions of these soil series are presented in the Project Geotechnical Report Soils, Geology, Groundwater and Geologic Hazards Report by Associated Earth Science Inc. For the purpose of the tables presented in this report, we will simplify these soil groups into outwash and till. In WWHM, outwash soil is modeled as A/B soil group and till soil is modeled as C soil group.

The areas with Alderwood and Kitsap soils can be assigned the characteristics of the till soil group. Till soil segments can represent areas with a predominate interflow component. Till soil segments can also represent both areas comprised predominately of till-derived soils and areas with shallow soils underlain by material with low permeability.

The remaining areas within the Tehaleh site can be assigned the outwash soils segment properties. These areas consist of both Everett and Indianola soil series. Outwash soils represent areas with a predominate groundwater component of runoff. The regional aquifer in the Tehaleh site is very deep and was not modeled in WWHM. Stormwater infiltrated past the interflow level is assumed to leave the site’s hydrology.

4.2 TOPOGRAPHY

The site can be separated into sub-areas based on slope. WWHM looks at three ranges of slopes; flat slopes are defined as slope of 0 to 5 percent, moderate slopes are defined as slopes of 6 to 15 percent,

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and steep slopes are defined as slopes steeper than 15 percent. Most residential, commercial, and public facilities will assume that areas disturbed will be considered flat, special circumstances may require developed areas to be modeled at a steep slope. Forest and pre-development areas will be broken down based on these ranges of slopes with each basin. WWHM has internal parameters that can be changed to affect how each ground cover is modeled in the program. For this analysis, the WWHM parameters are kept on their default settings.

4.3 GROUND COVER

Pre-development conditions will be modeled with a forested ground cover. Post-development ground cover will range in ground cover such as impervious area, lawns/landscaped area, and forest area. This is the most critical aspect of analyzing the basin. Impervious area and lawns/landscape area (especially in areas of till) produce much more runoff than forested areas. Impervious ground cover has significant impacts on peak runoff rates and total amount of surface runoff.

5.0 WWHM MODEL PARAMETERS

The Western Washington Hydrology Model version 2012 (WWHM) has default settings for their pre- and post- development ground cover, topography (slope), and soil group. Since the model is an approved continuous simulation model by Pierce County, in order to modify the parameters of WWHM, extensive testing and calibration would be required to justify changes made to the default settings. Therefore, the default settings were not changed and the parameters used for design of all the proposed facilities were based on these default settings.

The HSPF modeling done previously in the 1998 Cascadia Master Drainage Plan and Assessment of Hydrologic Impacts report does have modifications to the HSPF parameters (same as WWHM parameters). Please see 1998 Cascadia Master Drainage Plan and Assessment of Hydrologic Impacts report for more details on parameter modification on the original HSPF model.

6.0 PRE-DEVELOPMENT CONDITIONS MODEL

Using the modeling approach and parameters discussed in the preceding sections, a WWHM12 model was constructed to simulate the drainage system under existing conditions. The areas modeled in the existing conditions are those that have surface runoff to closed depressions, since there is no significant runoff from the site during pre-developed conditions. Closed depressions that will remain fully or partially in their natural state during post-development will be modeled to ensure that flooding in closed depressions is the same or better than in existing conditions. Most closed depressions will be assumed to be filled during development and runoff will be infiltrated into the regional aquifer in a designed retention facility rather than a natural closed depression. Hydrogeologists from AESI have developed a MODFLOW program to model the groundwater recharge to the regional aquifer pre- and post-development.

The entire Tehaleh site has no significant surface runoff from the site. Small, very insignificant storm drainage courses are found around the edges of the site, as discussed in the main section of this report. Since these drainage courses are insignificant, the post-development drainage system for Tehaleh will release no stormwater to any offsite water courses - all stormwater will be infiltrated. Emergency overflows during catastrophic events are the only time where stormwater can potentially be directly routed off the Tehaleh site. Therefore, in most sub-basins, where there are no closed depressions or wetlands requiring mitigated hydrology, the pre-development flow rates determined by WWHM will not be used. The pre-developed conditions will only be used to determine required flow rates and volumes to remain in closed depression and wetlands.

7.0 POST-DEVELOPMENT CONDITIONS MODEL

The post-development model was developed using the proposed land use plans for the entire Tehaleh site. The proposed land use plans have five alternatives, all but one alternative proposed a total of 9,700 residential units. By summing the proposed percent impervious based on the conservative assumption detailed below, of the 5 alternatives, SEIS Applicant's Preferred Alternative (Parcel O without Golf Course) would require the most significant mitigation measures for stormwater. This is because this alternative has the highest amount of proposed impervious area and therefore would need the largest facilities. The facility locations, infiltration rates, and conveyance systems for all five alternatives will not change except for Alternative 4, which would not have a Phase II and therefore will not have facilities in proposed Phase II. The stormwater management system for Alternative 4 would be the same as assumed in the current approval for Phase I.

Percent impervious assumptions will be based on the land use proposed. There are approximately seven different types of proposed land use that correspond to different percent impervious. Theses land types and percent impervious are as follows:

- Single Family Residential (0 to 3.9 DU/ac.): 25% EIA
- Single Family Residential (4.0 to 6.0 DU/ac.): 55% EIA
- Single Family Residential (6.1 to 13.9 DU/ac): 75% EIA
- Multi-Family Residential (14.0 to 20.0 DU/ac): 85% EIA
- Commercial/Retail/Employment/Schools/Public Facilities: 90% EIA
- Major Roadways (outside developments): 90% EIA
- Stormwater Ponds/Water Body: 100% EIA

From these assumptions for percent impervious surfaces a post-development basin can be created for each stormwater facility based on SEIS Applicant's Preferred Alternative. From this layout the basin parameters have been entered into WWHM and the facilities' water quality cells, detention cells, and infiltration cells were preliminarily sized so that all stormwater runoff infiltrates and meets Pierce County quality treatment prior to infiltration.

The depth for each facility was assumed to be between 5 to 10 feet deep, including freeboard requirements. The side slope for all facilities was assumed to be 3:1 (horizontal: vertical). Infiltration rates assumed were based on coordination with the project's geotechnical engineers and hydrologists to determine conservative infiltrations for preliminary design. The infiltration rates assumed ranged from 1 to 15 inches per hour. Facilities located in areas with uncertain sub-surface conditions were modeled at 1 inch per hour. Infiltration testing, exploration borings, and test pits will be conducted during the design stage of retention facilities.

Since the Tehaleh site is on a plateau, groundwater recharge has the potential to impact slope stability due to groundwater mounding. Geotechnical engineers and hydrologists at Associated Earth Science, Inc. (AESI) conducted groundwater mounding analysis for each pond. Special attention was given to any pond near steep slopes. For the analysis of the groundwater mounding and the pre- and post-development recharge of the regional aquifer, MacKay Sposito provided AESI with hydrographs for the maximum cumulative 30-day period volume and corresponding average daily flow rate and hydrographs of the 15 day period before and after the maximum average daily flow rate and corresponding daily volumes. Peak 15-min flow rates are also provided for each time period. The time period of the maximum cumulative 30-day period and the 15 days before and after the maximum average daily flowrate do not occur during the same time period. This type of analysis can only be provided by a continuous model. These time periods are found in the output of 158 years of simulated data. Pierce County minimum requirement for analysis of stormwater facilities is 20 years.

AESI conducted their model of the recharge of the regional aquifer and groundwater mounding and determined there will be no significant impacts from the proposed flow rates, volumes and locations of the proposed retention facilities in the Tehaleh Drainage System.

All proposed facilities infiltrate 100 percent of the runoff from the 158-year Pierce County extended simulated precipitation time series. All facilities maintain 1 foot of freeboard during the 100-year recurrence interval and all inflow to retention facilities meeting Pierce County water quality requirements. The analysis of the proposed retention facilities shows that with the 158-year simulation and tributary areas shown on Exhibit 3, no significant stormwater related impacts are anticipated from the proposed Tehaleh Drainage System.

STORMWATER MASTER PLAN EXHIBITS

- **Exhibit 1: Regional Pre-Development Basins**
- **Exhibit 2: Pre-Development Condition**
- **Exhibit 3: Developed Drainage Conditions**
- **Exhibit 4: Emergency Overflow Tributary Areas**

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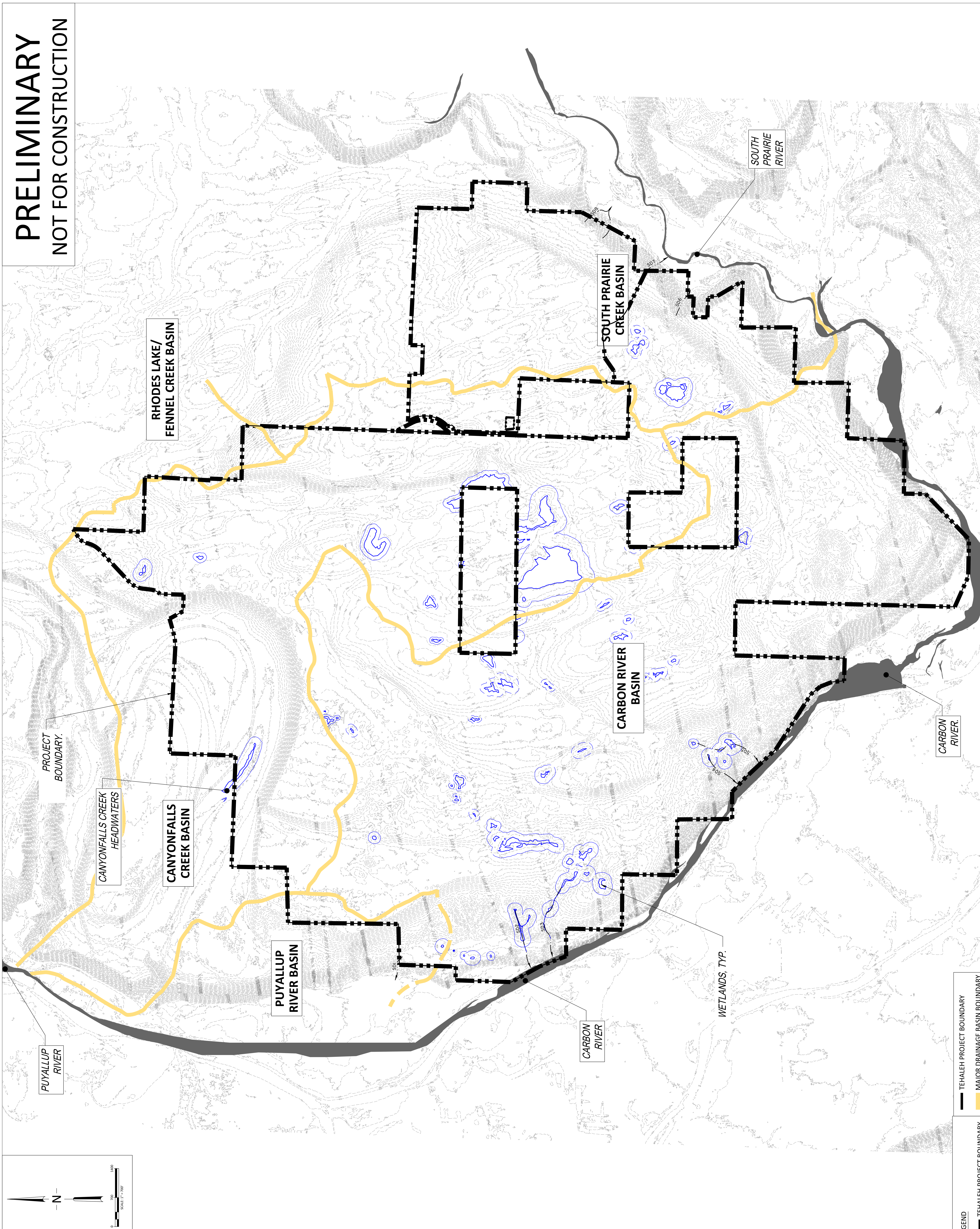

TEHALEH E.B.P.C.
PIERCE COUNTY, WA

STORMWATER MASTER PLAN
REGIONAL PRE-DEVELOPED SURFICAL DRAINAGE BASINS

EXHIBIT 1

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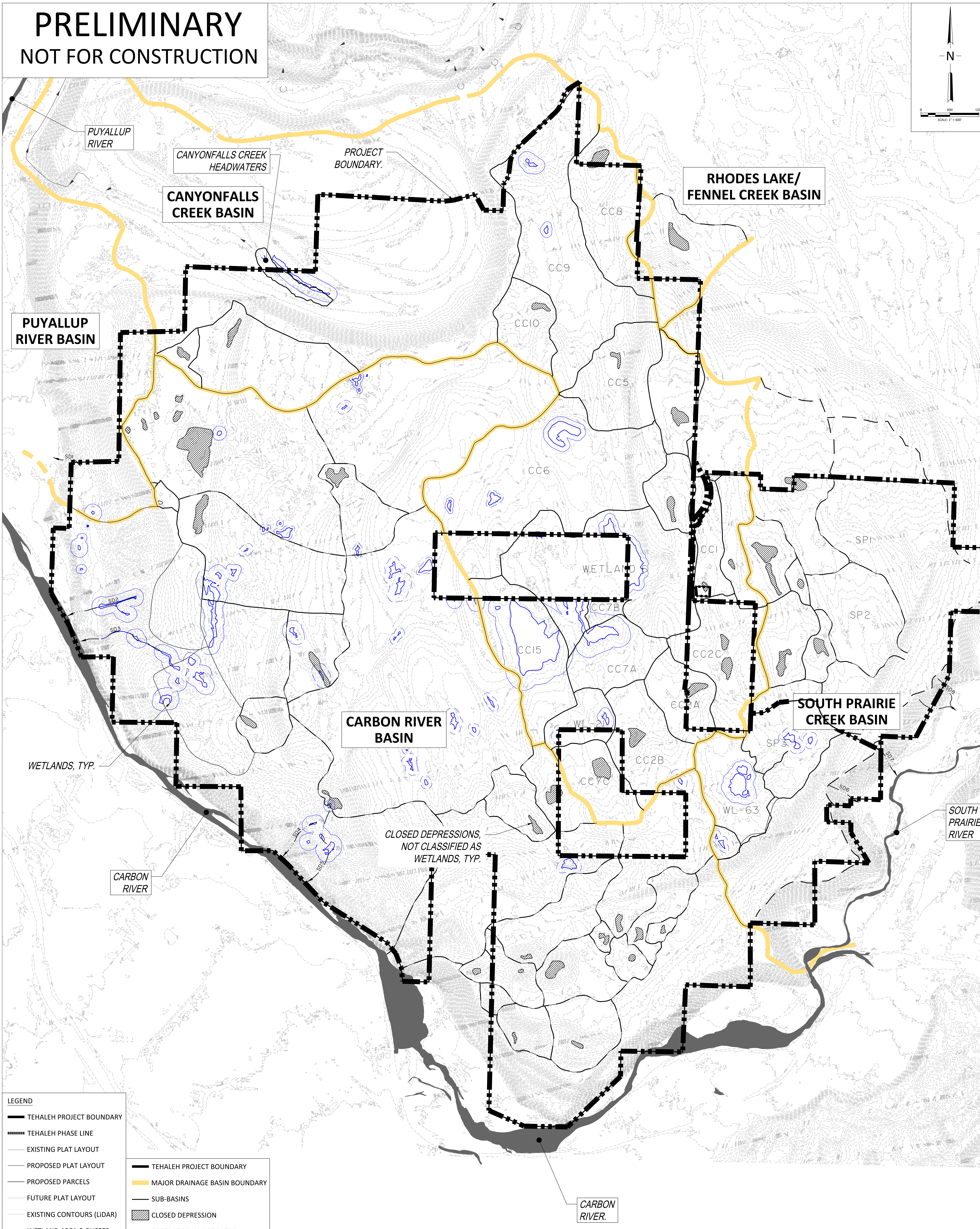

TEHALEH E.B.P.C.
PIERCE COUNTY, WA

STORMWATER MASTER PLAN
PRE-DEVELOPMENT SURFICAL DRAINAGE CONDITIONS

EXHIBIT 2

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PRELIMINARY
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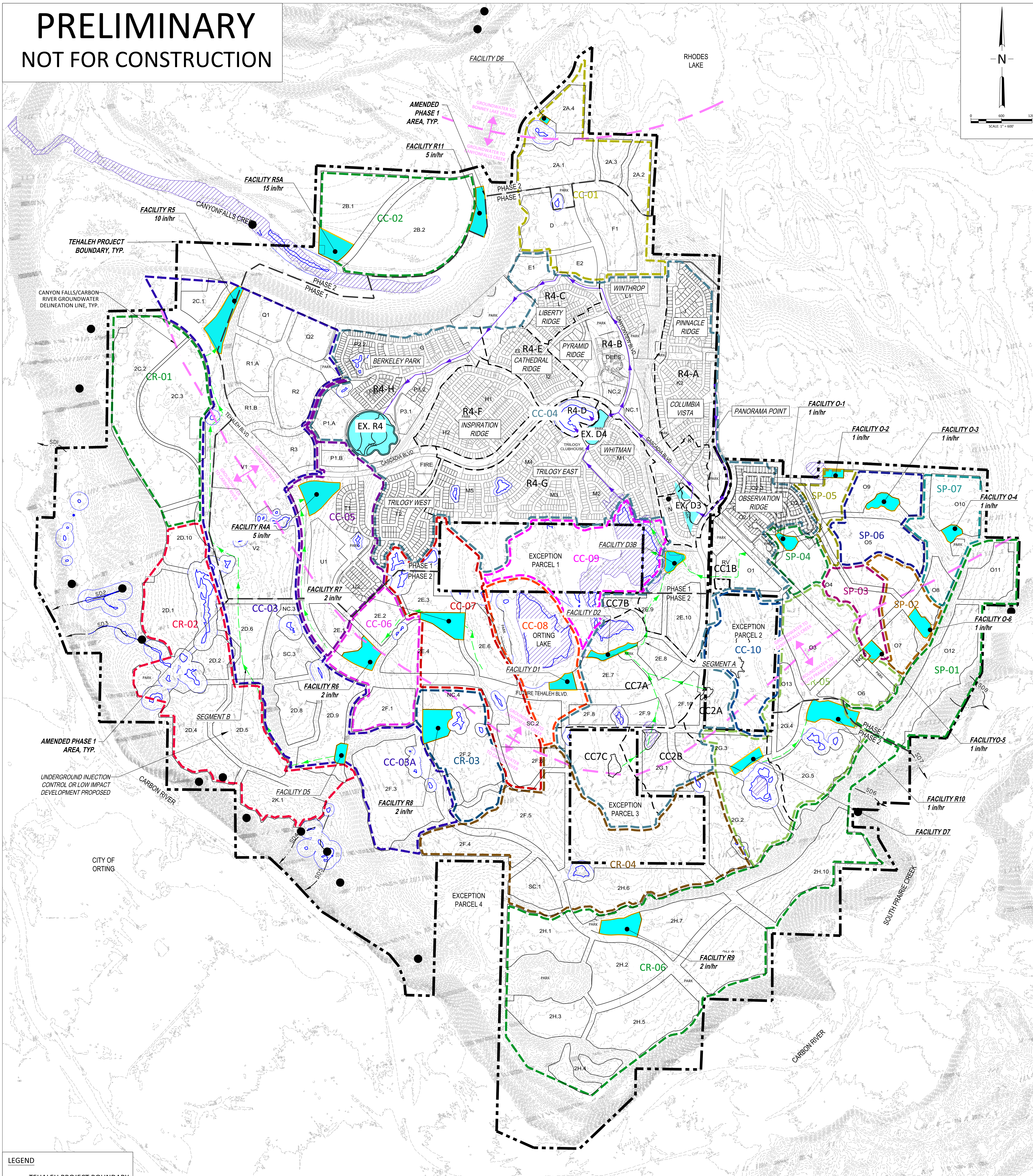

LEGEND

- TEHALEH PROJECT BOUNDARY
- TEHALEH PHASE LINE
- EXISTING PLAT LAYOUT
- PROPOSED PLAT LAYOUT
- PROPOSED PARCELS
- FUTURE PLAT LAYOUT
- EXISTING CONTOURS (LiDAR)
- WETLAND AREA & BUFFER
- *PROPOSED STORMWATER FACILITY*
- *EXISTING STORMWATER FACILITY*
- *CC-04/ R4 DEVELOPED BASIN*
- *R4 SUB-BASINS*
- *EXISTING CONVEYANCE SYSTEMS*
- *PROPOSED CONVEYANCE SYSTEMS*
- *CLOSED DEPRESSION*
- *PIERCE COUNTY FLOOD HAZARDS*
- *GROUNDWATER DELINEATION LINE*
- *CC-08 / ORTING LAKE BASIN*
- *CC-09/ WETLAND 6 BASIN*
- *CC-01/ R11 DEVELOPED BASIN*
- *CC-03/ R5 & R5A DEVELOPED BASIN*
- *CC-06/ R6 PROPOSED DEVELOPED BASIN*
- *CC-07/ R7 PROPOSED DEVELOPED BASIN*
- *CR-03/ R8 PROPOSED DEVELOPED BASIN*
- *CR-04/ R9 PROPOSED DEVELOPED BASIN*
- *CR-05/ R10 PROPOSED DEVELOPED BASIN*
- *SP-02/ O-6 PROPOSED DEVELOPED BASIN*
- *SP-03/ O-5 PROPOSED DEVELOPED BASIN*
- *SP-04/ O-1 PROPOSED DEVELOPED BASIN*
- *SP-05/ O-2 PROPOSED DEVELOPED BASIN*
- *SP-06/ O-4 PROPOSED DEVELOPED BASIN*
- *CC-10/ CLOSED DEPRESSION*
- *CC-02/ CR-01/ CR-02/ CR-06/ SP-01 PROPOSED LID/DISTRUBUTED*

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STORMWATER MASTER PLAN
DEVELOPED DRAINAGE CONDITIONS

EXHIBIT 3

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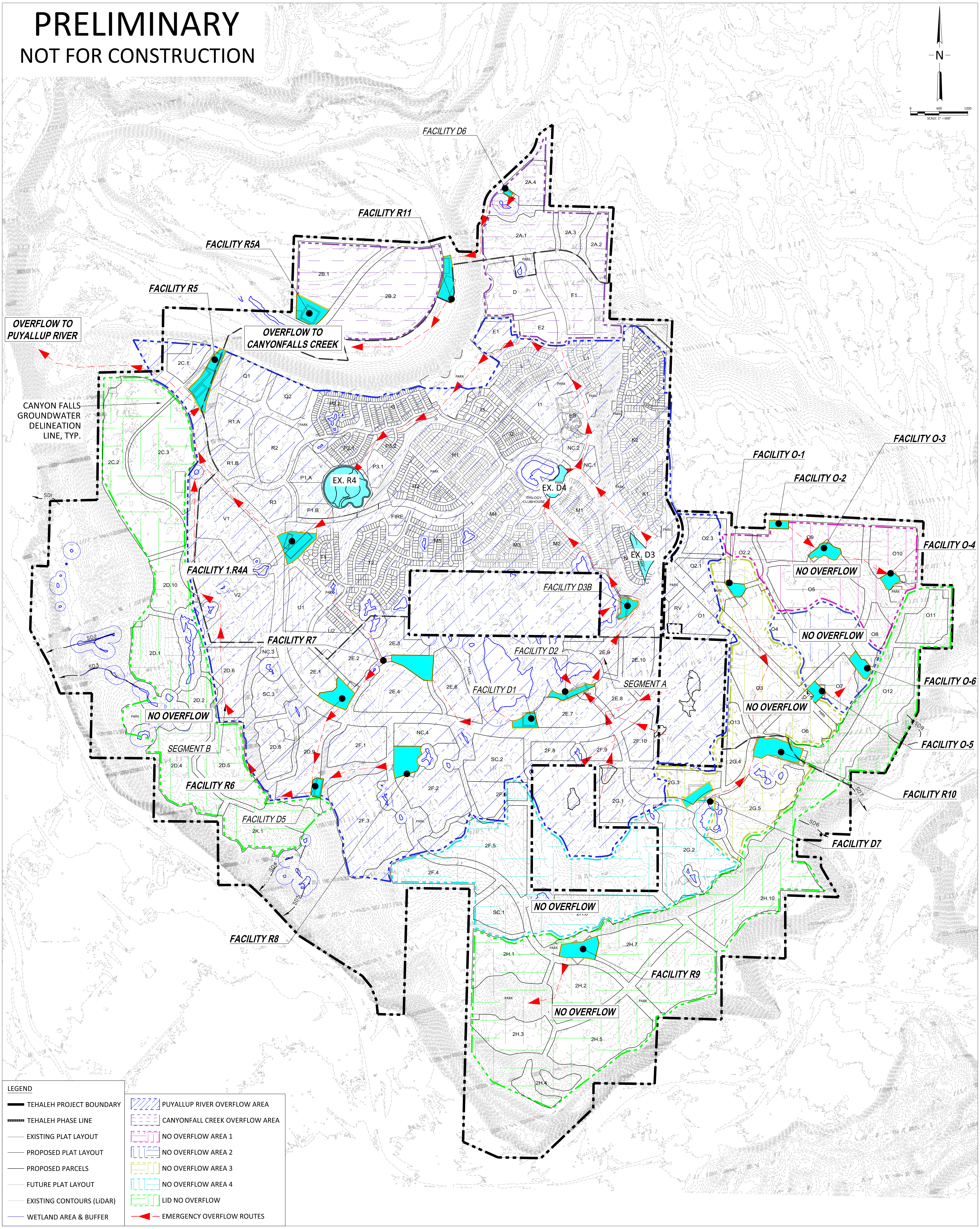

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STORMWATER MASTER PLAN
EMERGENCY OVERFLOW TRIBUTARY AREA

EXHIBIT 4

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STORMWATER RETENTION FACILITY HYDROGRAPHS

- **Hydrographs with data of largest 30-day cumulative volume through proposed facilities**
  - Facilities: R4A, R5, R5A, R6, R7, R8, R9, R10, R11, O-1R, O-2R, O-3R, O-4R, O-5R, and O-6R.

- **Hydrographs with data of 15-days before and after the largest average daily flow rate into the facility**
  - Facilities: R4A, R5, R5A, R6, R7, R8, R9, R10, R11, O-1R, O-2R, O-3R, O-4R, O-5R, and O-6R.

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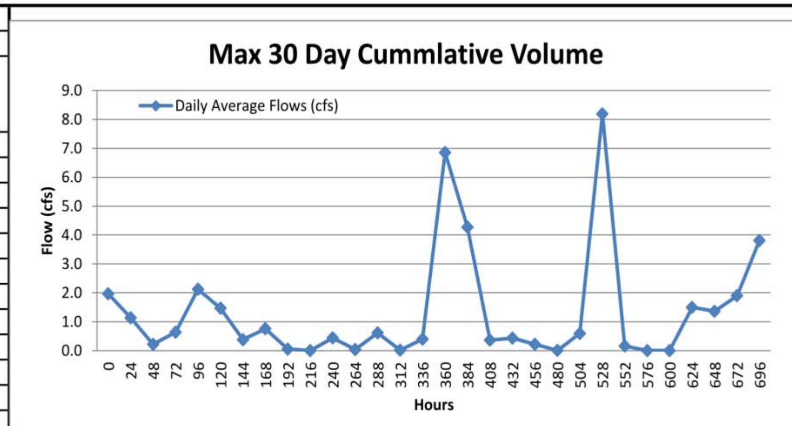
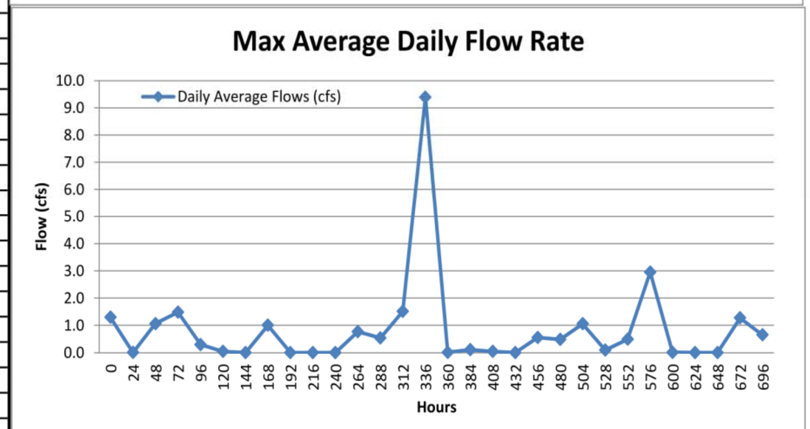
PROPOSED STORMWATER RETENTION FACILITY R4A

30 Day Cummlative Maximum Volume*				
Peak 30-day Period (ac-	79.01	8.19	24.68	
Date	Hours	Daily Volume (ac-ft)	Daily Average Flows (cfs)	Daily Peak Flows (cfs)
2/13/1934	0	3.9	2.0	6.5
2/14/1934	24	2.2	1.1	6.0
2/15/1934	48	0.4	0.2	1.4
2/16/1934	72	1.3	0.6	2.5
2/17/1934	96	4.2	2.1	11.6
2/18/1934	120	2.9	1.5	4.0
2/19/1934	144	0.7	0.4	2.5
2/20/1934	168	1.5	0.8	4.3
2/21/1934	192	0.1	0.0	0.5
2/22/1934	216	0.0	0.0	0.0
2/23/1934	240	0.9	0.4	1.7
2/24/1934	264	0.1	0.0	0.5
2/25/1934	288	1.2	0.6	2.5
2/26/1934	312	0.0	0.0	0.0
2/27/1934	336	0.8	0.4	3.2
2/28/1934	360	13.6	6.8	24.7
3/1/1934	384	8.5	4.3	13.2
3/2/1934	408	0.7	0.4	1.9
3/3/1934	432	0.8	0.4	3.0
3/4/1934	456	0.4	0.2	1.1
3/5/1934	480	0.0	0.0	0.0
3/6/1934	504	1.2	0.6	3.9
3/7/1934	528	16.2	8.2	11.2
3/8/1934	552	0.3	0.2	3.0
3/9/1934	576	0.0	0.0	0.0
3/10/1934	600	0.0	0.0	0.0
3/11/1934	624	3.0	1.5	4.5
3/12/1934	648	2.7	1.4	4.9
3/13/1934	672	3.8	1.9	7.7
3/14/1934	696	7.5	3.8	6.5

Maximum Average Daily Flow Rate*				
Peak 30-day Period (ac-	49.86	9.39	34.44	
Date	Hours	Daily Volume (ac-ft)	Daily Average Flows (cfs)	Daily Peak Flows (cfs)
11/10/1952	0	2.6	1.3	8.0
11/11/1952	24	0.0	0.0	0.0
11/12/1952	48	2.1	1.1	8.6
11/13/1952	72	2.9	1.5	4.1
11/14/1952	96	0.6	0.3	1.7
11/15/1952	120	0.1	0.0	0.3
11/16/1952	144	0.0	0.0	0.0
11/17/1952	168	2.0	1.0	5.3
11/18/1952	192	0.0	0.0	0.0
11/19/1952	216	0.0	0.0	0.0
11/20/1952	240	0.0	0.0	0.0
11/21/1952	264	1.5	0.8	4.5
11/22/1952	288	1.1	0.5	2.3
11/23/1952	312	3.0	1.5	5.8
11/24/1952	336	18.6	9.4	34.4
11/25/1952	360	0.0	0.0	0.1
11/26/1952	384	0.2	0.1	1.0
11/27/1952	408	0.1	0.0	0.4
11/28/1952	432	0.0	0.0	0.0
11/29/1952	456	1.1	0.6	3.1
11/30/1952	480	1.0	0.5	3.3
12/1/1952	504	2.1	1.1	3.4
12/2/1952	528	0.2	0.1	0.6
12/3/1952	552	1.0	0.5	2.2
12/4/1952	576	5.9	3.0	9.4
12/5/1952	600	0.0	0.0	0.0
12/6/1952	624	0.0	0.0	0.0
12/7/1952	648	0.0	0.0	0.0
12/8/1952	672	2.5	1.3	3.4
12/9/1952	696	1.3	0.7	1.9





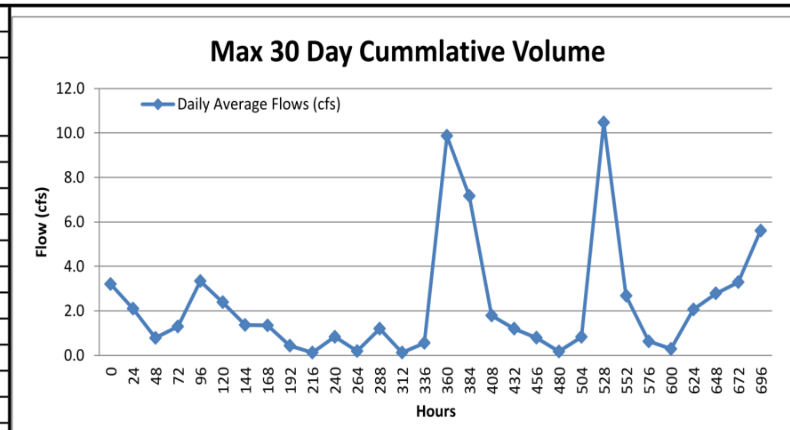
*FLOWS ARE BASED ON 15-MINUTE TIME STEP

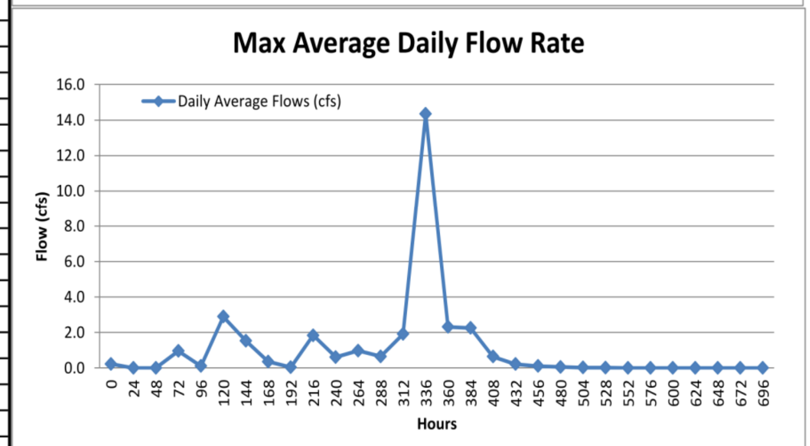
DRAFT

PROPOSED STORMWATER RETENTION FACILITY R5

30 Day Cummlative Maximum Volume*				
Peak 30-day Period (ac-		136.66	10.47	27.57
Date	Hours	Daily Volume (ac-ft)	Daily Average Flows (cfs)	Daily Peak Flows (cfs)
2/12/1934	0	6.4	3.2	7.0
2/13/1934	24	4.2	2.1	5.9
2/14/1934	48	1.5	0.8	2.5
2/15/1934	72	2.6	1.3	3.1
2/16/1934	96	6.6	3.3	10.4
2/17/1934	120	4.7	2.4	4.6
2/18/1934	144	2.7	1.4	4.4
2/19/1934	168	2.7	1.3	4.6
2/20/1934	192	0.9	0.4	1.6
2/21/1934	216	0.2	0.1	0.2
2/22/1934	240	1.7	0.8	2.6
2/23/1934	264	0.4	0.2	0.8
2/24/1934	288	2.4	1.2	3.0
2/25/1934	312	0.2	0.1	0.3
2/26/1934	336	1.1	0.6	4.0
2/27/1934	360	19.6	9.9	27.6
2/28/1934	384	14.2	7.2	12.1
3/1/1934	408	3.5	1.8	3.6
3/2/1934	432	2.4	1.2	3.6
3/3/1934	456	1.6	0.8	2.3
3/4/1934	480	0.3	0.2	0.2
3/5/1934	504	1.6	0.8	4.6
3/6/1934	528	20.8	10.5	12.5
3/7/1934	552	5.3	2.7	10.0
3/8/1934	576	1.2	0.6	0.9
3/9/1934	600	0.6	0.3	0.4
3/10/1934	624	4.1	2.1	5.8
3/11/1934	648	5.5	2.8	6.2
3/12/1934	672	6.5	3.3	7.6
3/13/1934	696	11.1	5.6	7.2

Maximum Average Daily Flow Rate*				
Peak 30-day Period (ac-		63.68	14.34	38.18
Date	Hours	Daily Volume (ac-ft)	Daily Average Flows (cfs)	Daily Peak Flows (cfs)
9/23/1943	0	0.4	0.2	1.5
9/24/1943	24	0.0	0.0	0.0
9/25/1943	48	0.0	0.0	0.0
9/26/1943	72	1.9	1.0	4.0
9/27/1943	96	0.2	0.1	0.9
9/28/1943	120	5.7	2.9	8.2
9/29/1943	144	3.0	1.5	6.0
9/30/1943	168	0.7	0.4	1.5
10/1/1943	192	0.1	0.0	0.1
10/2/1943	216	3.6	1.8	5.6
10/3/1943	240	1.2	0.6	3.8
10/4/1943	264	1.9	1.0	5.8
10/5/1943	288	1.3	0.6	2.9
10/6/1943	312	3.8	1.9	8.9
10/7/1943	336	28.4	14.3	38.2
10/8/1943	360	4.6	2.3	6.8
10/9/1943	384	4.5	2.3	6.1
10/10/1943	408	1.3	0.6	1.9
10/11/1943	432	0.4	0.2	0.3
10/12/1943	456	0.2	0.1	0.2
10/13/1943	480	0.1	0.1	0.1
10/14/1943	504	0.1	0.0	0.0
10/15/1943	528	0.0	0.0	0.0
10/16/1943	552	0.0	0.0	0.0
10/17/1943	576	0.0	0.0	0.0
10/18/1943	600	0.0	0.0	0.0
10/19/1943	624	0.0	0.0	0.0
10/20/1943	648	0.0	0.0	0.0
10/21/1943	672	0.0	0.0	0.0
10/22/1943	696	0.0	0.0	0.0





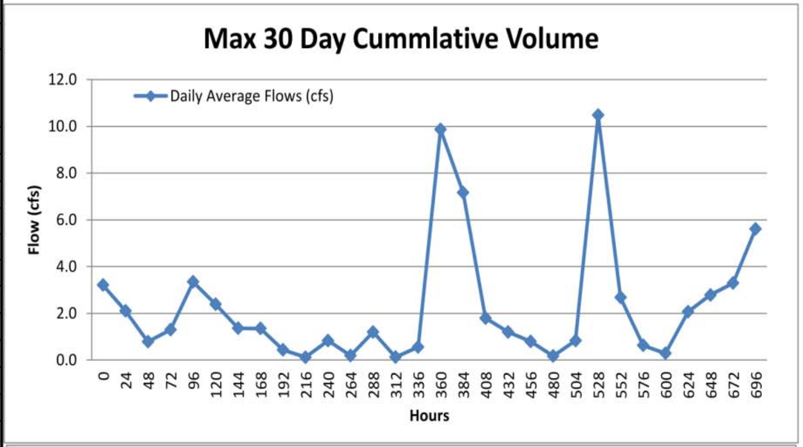
*FLOWS ARE BASED ON 15-MINUTE TIME STEP

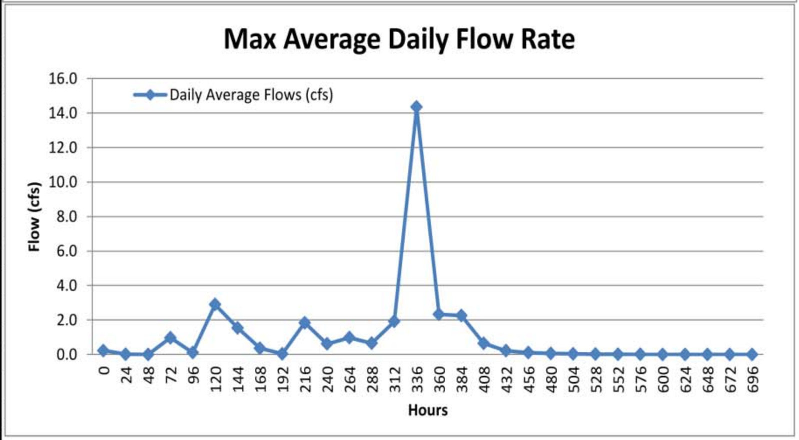
DRAFT

PROPOSED STORMWATER RETENTION FACILITY R5A

30 Day Cummlative Maximum Volume*				
Peak 30-day Period (ac-		136.66	10.47	27.57
Date	Hours	Daily Volume (ac-ft)	Daily Average Flows (cfs)	Daily Peak Flows (cfs)
2/12/1934	0	6.4	3.2	7.0
2/13/1934	24	4.2	2.1	5.9
2/14/1934	48	1.5	0.8	2.5
2/15/1934	72	2.6	1.3	3.1
2/16/1934	96	6.6	3.3	10.4
2/17/1934	120	4.7	2.4	4.6
2/18/1934	144	2.7	1.4	4.4
2/19/1934	168	2.7	1.3	4.6
2/20/1934	192	0.9	0.4	1.6
2/21/1934	216	0.2	0.1	0.2
2/22/1934	240	1.7	0.8	2.6
2/23/1934	264	0.4	0.2	0.8
2/24/1934	288	2.4	1.2	3.0
2/25/1934	312	0.2	0.1	0.3
2/26/1934	336	1.1	0.6	4.0
2/27/1934	360	19.6	9.9	27.6
2/28/1934	384	14.2	7.2	12.1
3/1/1934	408	3.5	1.8	3.6
3/2/1934	432	2.4	1.2	3.6
3/3/1934	456	1.6	0.8	2.3
3/4/1934	480	0.3	0.2	0.2
3/5/1934	504	1.6	0.8	4.6
3/6/1934	528	20.8	10.5	12.5
3/7/1934	552	5.3	2.7	10.0
3/8/1934	576	1.2	0.6	0.9
3/9/1934	600	0.6	0.3	0.4
3/10/1934	624	4.1	2.1	5.8
3/11/1934	648	5.5	2.8	6.2
3/12/1934	672	6.5	3.3	7.6
3/13/1934	696	11.1	5.6	7.2

Maximum Average Daily Flow Rate*				
Peak 30-day Period (ac-		63.68	14.34	38.18
Date	Hours	Daily Volume (ac-ft)	Daily Average Flows (cfs)	Daily Peak Flows (cfs)
9/23/1943	0	0.4	0.2	1.5
9/24/1943	24	0.0	0.0	0.0
9/25/1943	48	0.0	0.0	0.0
9/26/1943	72	1.9	1.0	4.0
9/27/1943	96	0.2	0.1	0.9
9/28/1943	120	5.7	2.9	8.2
9/29/1943	144	3.0	1.5	6.0
9/30/1943	168	0.7	0.4	1.5
10/1/1943	192	0.1	0.0	0.1
10/2/1943	216	3.6	1.8	5.6
10/3/1943	240	1.2	0.6	3.8
10/4/1943	264	1.9	1.0	5.8
10/5/1943	288	1.3	0.6	2.9
10/6/1943	312	3.8	1.9	8.9
10/7/1943	336	28.4	14.3	38.2
10/8/1943	360	4.6	2.3	6.8
10/9/1943	384	4.5	2.3	6.1
10/10/1943	408	1.3	0.6	1.9
10/11/1943	432	0.4	0.2	0.3
10/12/1943	456	0.2	0.1	0.2
10/13/1943	480	0.1	0.1	0.1
10/14/1943	504	0.1	0.0	0.0
10/15/1943	528	0.0	0.0	0.0
10/16/1943	552	0.0	0.0	0.0
10/17/1943	576	0.0	0.0	0.0
10/18/1943	600	0.0	0.0	0.0
10/19/1943	624	0.0	0.0	0.0
10/20/1943	648	0.0	0.0	0.0
10/21/1943	672	0.0	0.0	0.0
10/22/1943	696	0.0	0.0	0.0





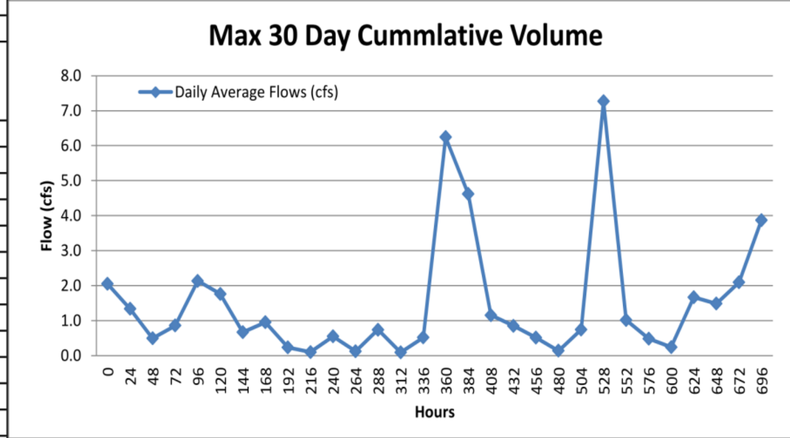
*FLOWS ARE BASED ON 15-MINUTE TIME STEP

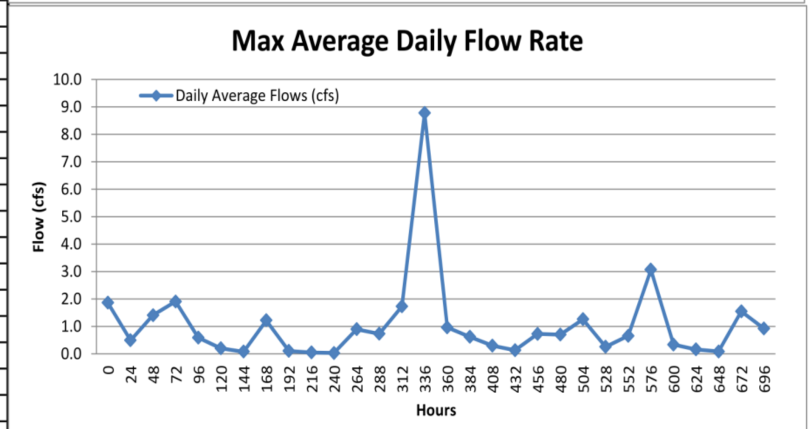
DRAFT

PROPOSED STORMWATER RETENTION FACILITY R6

30 Day Cummlative Maximum Volume*				
Peak 30-day Period (ac-		89.19	7.27	22.93
Date	Hours	Daily Volume (ac-ft)	Daily Average Flows (cfs)	Daily Peak Flows (cfs)
2/12/1934	0	4.1	2.0	8.1
2/13/1934	24	2.7	1.3	7.7
2/14/1934	48	1.0	0.5	2.1
2/15/1934	72	1.7	0.9	3.2
2/16/1934	96	4.2	2.1	20.4
2/17/1934	120	3.5	1.8	4.9
2/18/1934	144	1.3	0.7	2.3
2/19/1934	168	1.9	1.0	5.9
2/20/1934	192	0.5	0.2	0.6
2/21/1934	216	0.2	0.1	0.1
2/22/1934	240	1.1	0.6	2.1
2/23/1934	264	0.2	0.1	1.1
2/24/1934	288	1.5	0.7	3.4
2/25/1934	312	0.2	0.1	0.2
2/26/1934	336	1.0	0.5	3.4
2/27/1934	360	12.4	6.2	22.9
2/28/1934	384	9.2	4.6	21.3
3/1/1934	408	2.3	1.2	3.4
3/2/1934	432	1.7	0.9	3.7
3/3/1934	456	1.0	0.5	1.7
3/4/1934	480	0.3	0.1	0.2
3/5/1934	504	1.5	0.7	4.5
3/6/1934	528	14.4	7.3	14.8
3/7/1934	552	2.0	1.0	1.9
3/8/1934	576	0.9	0.5	0.7
3/9/1934	600	0.5	0.2	0.3
3/10/1934	624	3.3	1.7	6.0
3/11/1934	648	3.0	1.5	5.5
3/12/1934	672	4.2	2.1	10.9
3/13/1934	696	7.7	3.9	9.8

Maximum Average Daily Flow Rate*				
Peak 30-day Period (ac-		62.76	8.77	31.03
Date	Hours	Daily Volume (ac-ft)	Daily Average Flows (cfs)	Daily Peak Flows (cfs)
11/10/1952	0	3.7	1.9	6.0
11/11/1952	24	1.0	0.5	0.7
11/12/1952	48	2.8	1.4	19.0
11/13/1952	72	3.8	1.9	5.4
11/14/1952	96	1.2	0.6	2.7
11/15/1952	120	0.4	0.2	0.6
11/16/1952	144	0.1	0.1	0.1
11/17/1952	168	2.4	1.2	6.7
11/18/1952	192	0.2	0.1	0.1
11/19/1952	216	0.1	0.0	0.1
11/20/1952	240	0.0	0.0	0.0
11/21/1952	264	1.8	0.9	6.4
11/22/1952	288	1.4	0.7	3.1
11/23/1952	312	3.4	1.7	6.9
11/24/1952	336	17.4	8.8	31.0
11/25/1952	360	1.9	1.0	1.4
11/26/1952	384	1.2	0.6	1.7
11/27/1952	408	0.6	0.3	0.7
11/28/1952	432	0.3	0.1	0.2
11/29/1952	456	1.4	0.7	3.8
11/30/1952	480	1.4	0.7	4.1
12/1/1952	504	2.5	1.3	4.0
12/2/1952	528	0.5	0.3	0.8
12/3/1952	552	1.3	0.6	3.5
12/4/1952	576	6.1	3.1	11.3
12/5/1952	600	0.6	0.3	0.5
12/6/1952	624	0.3	0.2	0.2
12/7/1952	648	0.2	0.1	0.1
12/8/1952	672	3.1	1.5	4.4
12/9/1952	696	1.8	0.9	2.7





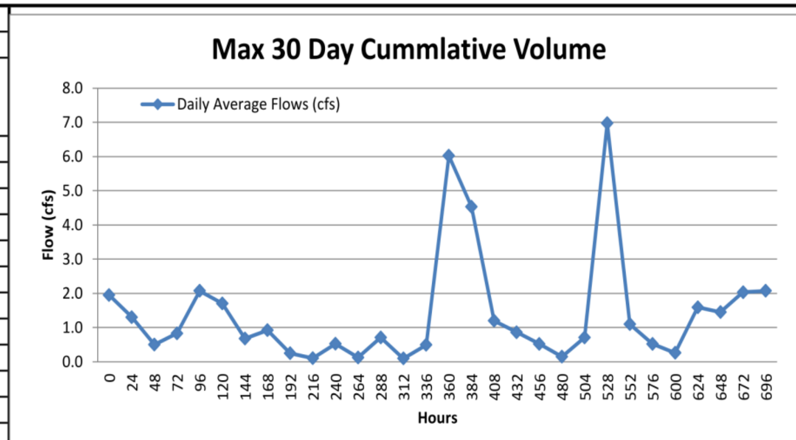
*FLOWS ARE BASED ON 15-MINUTE TIME STEP

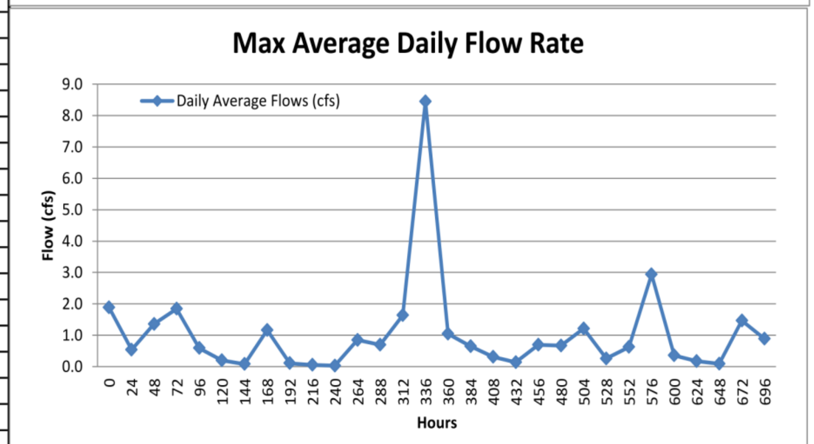
DRAFT

PROPOSED STORMWATER RETENTION FACILITY R7

30 Day Cummlative Maximum Volume*				
Peak 30-day Period (ac-		83.90	6.97	22.33
Date	Hours	Daily Volume (ac-ft)	Daily Average Flows (cfs)	Daily Peak Flows (cfs)
2/12/1934	0	3.9	1.9	7.6
2/13/1934	24	2.6	1.3	7.3
2/14/1934	48	1.0	0.5	2.0
2/15/1934	72	1.7	0.8	3.1
2/16/1934	96	4.1	2.1	19.5
2/17/1934	120	3.4	1.7	4.7
2/18/1934	144	1.3	0.7	2.2
2/19/1934	168	1.8	0.9	5.6
2/20/1934	192	0.5	0.2	0.6
2/21/1934	216	0.2	0.1	0.1
2/22/1934	240	1.0	0.5	2.0
2/23/1934	264	0.3	0.1	1.1
2/24/1934	288	1.4	0.7	3.2
2/25/1934	312	0.2	0.1	0.2
2/26/1934	336	1.0	0.5	3.2
2/27/1934	360	11.9	6.0	22.3
2/28/1934	384	9.0	4.5	20.8
3/1/1934	408	2.4	1.2	3.3
3/2/1934	432	1.7	0.9	3.6
3/3/1934	456	1.0	0.5	1.7
3/4/1934	480	0.3	0.2	0.2
3/5/1934	504	1.4	0.7	4.3
3/6/1934	528	13.8	7.0	14.3
3/7/1934	552	2.2	1.1	1.9
3/8/1934	576	1.0	0.5	0.7
3/9/1934	600	0.5	0.3	0.4
3/10/1934	624	3.2	1.6	5.6
3/11/1934	648	2.9	1.5	5.2
3/12/1934	672	4.0	2.0	10.3
3/13/1934	696	4.1	2.1	5.1

Maximum Average Daily Flow Rate*				
Peak 30-day Period (ac-		61.46	8.45	29.91
Date	Hours	Daily Volume (ac-ft)	Daily Average Flows (cfs)	Daily Peak Flows (cfs)
11/10/1952	0	3.7	1.9	5.8
11/11/1952	24	1.1	0.5	0.8
11/12/1952	48	2.7	1.4	18.0
11/13/1952	72	3.7	1.8	5.1
11/14/1952	96	1.2	0.6	2.6
11/15/1952	120	0.4	0.2	0.6
11/16/1952	144	0.2	0.1	0.1
11/17/1952	168	2.3	1.2	6.3
11/18/1952	192	0.2	0.1	0.2
11/19/1952	216	0.1	0.1	0.1
11/20/1952	240	0.1	0.0	0.0
11/21/1952	264	1.7	0.8	6.0
11/22/1952	288	1.4	0.7	2.9
11/23/1952	312	3.2	1.6	6.5
11/24/1952	336	16.8	8.5	29.9
11/25/1952	360	2.1	1.0	1.5
11/26/1952	384	1.3	0.7	1.6
11/27/1952	408	0.6	0.3	0.7
11/28/1952	432	0.3	0.1	0.2
11/29/1952	456	1.4	0.7	3.6
11/30/1952	480	1.3	0.7	3.9
12/1/1952	504	2.4	1.2	3.8
12/2/1952	528	0.5	0.3	0.8
12/3/1952	552	1.2	0.6	3.3
12/4/1952	576	5.8	2.9	10.6
12/5/1952	600	0.7	0.4	0.5
12/6/1952	624	0.3	0.2	0.2
12/7/1952	648	0.2	0.1	0.1
12/8/1952	672	2.9	1.5	4.2
12/9/1952	696	1.8	0.9	2.6





*FLOWS ARE BASED ON 15-MINUTE TIME STEP

DRAFT

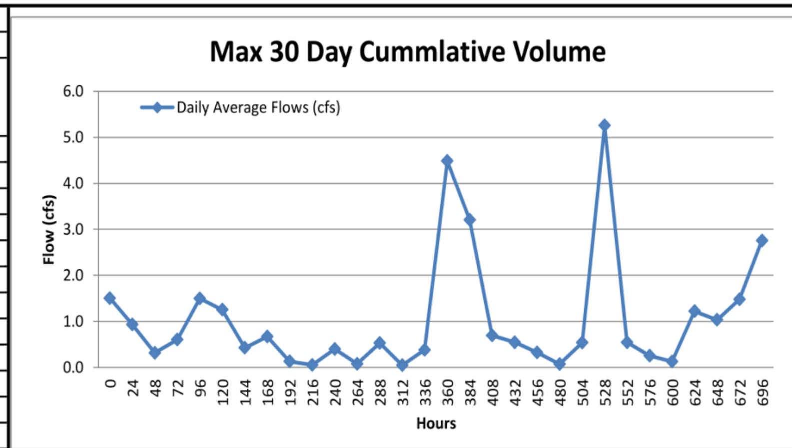
PROPOSED STORMWATER RETENTION FACILITY R8

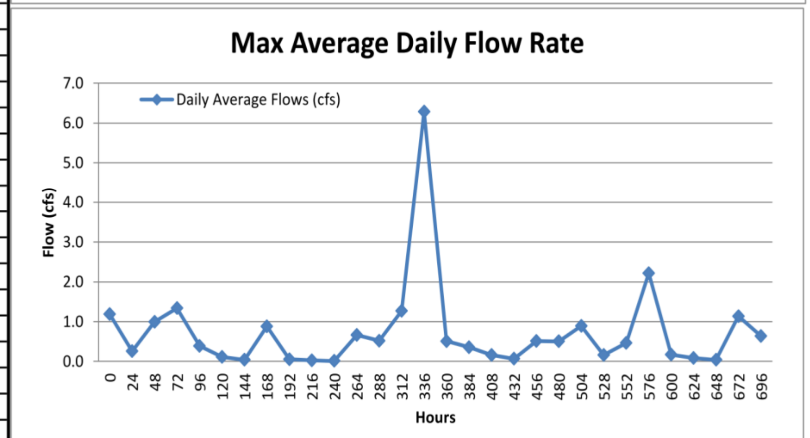
30 Day Cummlative Maximum Volume*

Date	Hours	Daily Volume (ac-ft)	Daily Average Flows (cfs)	Daily Peak Flows (cfs)
Peak 30-day Period (ac-		62.23	5.26	16.56
2/12/1934	0	3.0	1.5	6.1
2/13/1934	24	1.9	0.9	5.7
2/14/1934	48	0.6	0.3	1.5
2/15/1934	72	1.2	0.6	2.4
2/16/1934	96	3.0	1.5	15.0
2/17/1934	120	2.5	1.3	3.7
2/18/1934	144	0.8	0.4	1.7
2/19/1934	168	1.3	0.7	4.5
2/20/1934	192	0.3	0.1	0.4
2/21/1934	216	0.1	0.1	0.1
2/22/1934	240	0.8	0.4	1.5
2/23/1934	264	0.2	0.1	0.9
2/24/1934	288	1.1	0.5	2.6
2/25/1934	312	0.1	0.1	0.1
2/26/1934	336	0.8	0.4	2.6
2/27/1934	360	8.9	4.5	16.6
2/28/1934	384	6.4	3.2	15.5
3/1/1934	408	1.4	0.7	2.4
3/2/1934	432	1.1	0.5	2.8
3/3/1934	456	0.6	0.3	1.2
3/4/1934	480	0.1	0.1	0.1
3/5/1934	504	1.1	0.5	3.4
3/6/1934	528	10.4	5.3	10.9
3/7/1934	552	1.1	0.5	1.1
3/8/1934	576	0.5	0.3	0.3
3/9/1934	600	0.3	0.1	0.2
3/10/1934	624	2.4	1.2	4.4
3/11/1934	648	2.1	1.0	4.0
3/12/1934	672	2.9	1.5	8.1
3/13/1934	696	5.5	2.8	7.2

Maximum Average Daily Flow Rate*

Date	Hours	Daily Volume (ac-ft)	Daily Average Flows (cfs)	Daily Peak Flows (cfs)
Peak 30-day Period (ac-		43.51	6.28	22.52
11/10/1952	0	2.4	1.2	4.3
11/11/1952	24	0.5	0.3	0.4
11/12/1952	48	2.0	1.0	14.4
11/13/1952	72	2.7	1.3	4.0
11/14/1952	96	0.8	0.4	2.0
11/15/1952	120	0.2	0.1	0.4
11/16/1952	144	0.1	0.0	0.1
11/17/1952	168	1.7	0.9	5.1
11/18/1952	192	0.1	0.1	0.1
11/19/1952	216	0.1	0.0	0.0
11/20/1952	240	0.0	0.0	0.0
11/21/1952	264	1.3	0.7	4.8
11/22/1952	288	1.0	0.5	2.3
11/23/1952	312	2.5	1.3	5.2
11/24/1952	336	12.5	6.3	22.5
11/25/1952	360	1.0	0.5	0.7
11/26/1952	384	0.7	0.4	1.2
11/27/1952	408	0.3	0.2	0.4
11/28/1952	432	0.1	0.1	0.1
11/29/1952	456	1.0	0.5	2.9
11/30/1952	480	1.0	0.5	3.1
12/1/1952	504	1.8	0.9	3.0
12/2/1952	528	0.3	0.2	0.6
12/3/1952	552	0.9	0.5	2.7
12/4/1952	576	4.4	2.2	8.4
12/5/1952	600	0.3	0.2	0.3
12/6/1952	624	0.2	0.1	0.1
12/7/1952	648	0.1	0.0	0.1
12/8/1952	672	2.2	1.1	3.3
12/9/1952	696	1.3	0.6	2.0





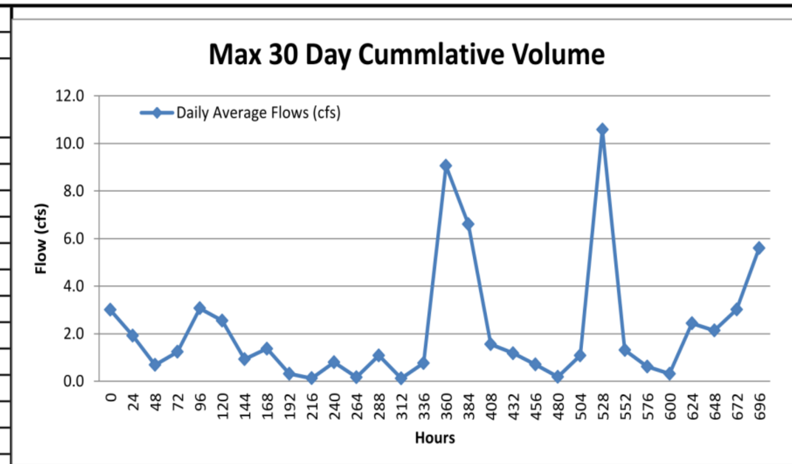
*FLOWS ARE BASED ON 15-MINUTE TIME STEP

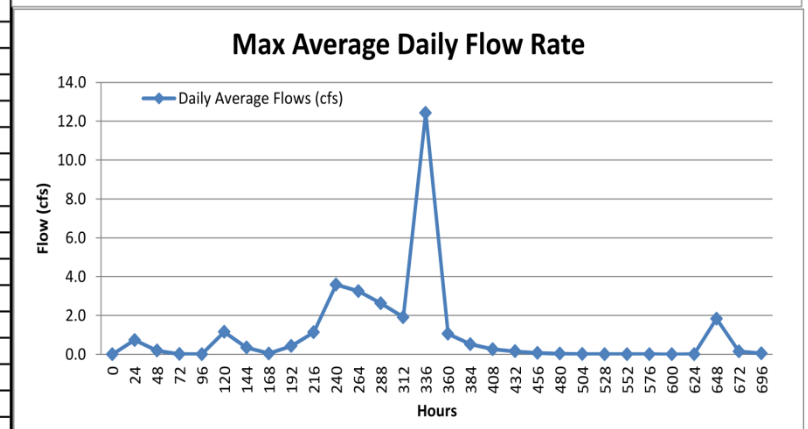
DRAFT

PROPOSED STORMWATER RETENTION FACILITY R9

30 Day Cummlative Maximum Volume*				
Peak 30-day Period (ac-		127.74	10.58	33.32
Date	Hours	Daily Volume (ac-ft)	Daily Average Flows (cfs)	Daily Peak Flows (cfs)
2/12/1934	0	6.0	3.0	12.0
2/13/1934	24	3.8	1.9	11.3
2/14/1934	48	1.4	0.7	3.1
2/15/1934	72	2.4	1.2	4.7
2/16/1934	96	6.1	3.1	29.7
2/17/1934	120	5.0	2.5	7.2
2/18/1934	144	1.8	0.9	3.3
2/19/1934	168	2.7	1.4	8.7
2/20/1934	192	0.6	0.3	0.9
2/21/1934	216	0.2	0.1	0.2
2/22/1934	240	1.6	0.8	3.1
2/23/1934	264	0.3	0.2	1.6
2/24/1934	288	2.1	1.1	4.9
2/25/1934	312	0.2	0.1	0.2
2/26/1934	336	1.5	0.8	5.0
2/27/1934	360	18.0	9.1	33.3
2/28/1934	384	13.1	6.6	31.0
3/1/1934	408	3.1	1.6	4.8
3/2/1934	432	2.3	1.2	5.5
3/3/1934	456	1.4	0.7	2.5
3/4/1934	480	0.4	0.2	0.3
3/5/1934	504	2.1	1.1	6.7
3/6/1934	528	21.0	10.6	21.6
3/7/1934	552	2.6	1.3	2.5
3/8/1934	576	1.2	0.6	0.8
3/9/1934	600	0.6	0.3	0.4
3/10/1934	624	4.8	2.4	8.7
3/11/1934	648	4.2	2.1	8.1
3/12/1934	672	6.0	3.0	15.9
3/13/1934	696	11.1	5.6	14.4

Maximum Average Daily Flow Rate*				
Peak 30-day Period (ac-		63.47	12.42	53.51
Date	Hours	Daily Volume (ac-ft)	Daily Average Flows (cfs)	Daily Peak Flows (cfs)
12/27/1951	0	0.0	0.0	0.0
12/28/1951	24	1.5	0.7	6.5
12/29/1951	48	0.4	0.2	1.2
12/30/1951	72	0.0	0.0	0.0
12/31/1951	96	0.0	0.0	0.0
1/1/1952	120	2.3	1.2	6.5
1/2/1952	144	0.7	0.3	2.1
1/3/1952	168	0.1	0.0	0.1
1/4/1952	192	0.8	0.4	2.9
1/5/1952	216	2.2	1.1	7.2
1/6/1952	240	7.1	3.6	15.6
1/7/1952	264	6.4	3.2	13.7
1/8/1952	288	5.2	2.6	11.5
1/9/1952	312	3.8	1.9	9.3
1/10/1952	336	24.6	12.4	53.5
1/11/1952	360	2.1	1.1	1.5
1/12/1952	384	1.0	0.5	0.7
1/13/1952	408	0.5	0.3	0.4
1/14/1952	432	0.3	0.2	0.3
1/15/1952	456	0.1	0.1	0.1
1/16/1952	480	0.1	0.0	0.0
1/17/1952	504	0.0	0.0	0.0
1/18/1952	528	0.0	0.0	0.0
1/19/1952	552	0.0	0.0	0.0
1/20/1952	576	0.0	0.0	0.0
1/21/1952	600	0.0	0.0	0.0
1/22/1952	624	0.0	0.0	0.3
1/23/1952	648	3.6	1.8	9.8
1/24/1952	672	0.3	0.2	0.5
1/25/1952	696	0.1	0.1	0.1





*FLOWS ARE BASED ON 15-MINUTE TIME STEP

DRAFT

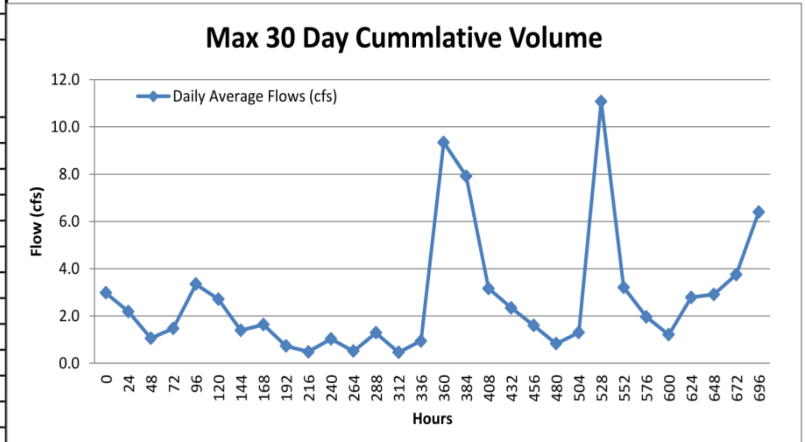
PROPOSED STORMWATER RETENTION FACILITY R10

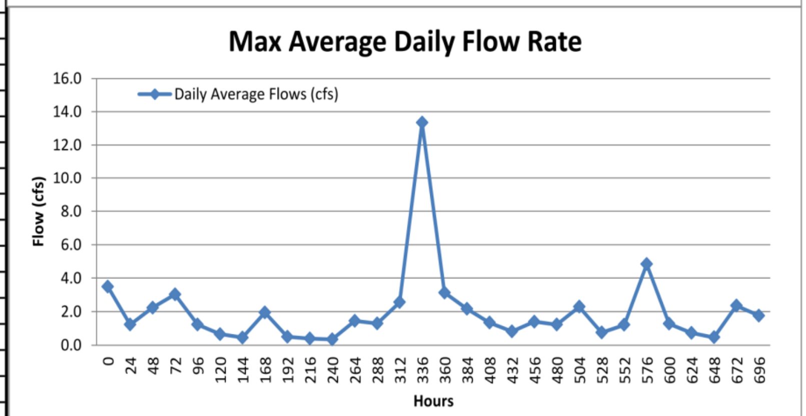
30 Day Cummlative Maximum Volume*

Peak 30-day Period (ac-	162.60	11.07	22.28	
Date	Hours	Daily Volume (ac-ft)	Daily Average Flows (cfs)	Daily Peak Flows (cfs)
11/5/1952	0	5.9	3.0	8.3
11/6/1952	24	4.3	2.2	7.8
11/7/1952	48	2.1	1.1	2.5
11/8/1952	72	2.9	1.5	3.3
11/9/1952	96	6.6	3.3	16.3
11/10/1952	120	5.4	2.7	5.6
11/11/1952	144	2.8	1.4	3.2
11/12/1952	168	3.2	1.6	5.9
11/13/1952	192	1.4	0.7	1.2
11/14/1952	216	1.0	0.5	0.6
11/15/1952	240	2.0	1.0	2.5
11/16/1952	264	1.0	0.5	1.2
11/17/1952	288	2.6	1.3	3.5
11/18/1952	312	0.9	0.5	0.6
11/19/1952	336	1.9	0.9	4.2
11/20/1952	360	18.5	9.3	22.3
11/21/1952	384	15.7	7.9	17.8
11/22/1952	408	6.3	3.2	5.4
11/23/1952	432	4.6	2.3	5.1
11/24/1952	456	3.2	1.6	3.0
11/25/1952	480	1.6	0.8	1.0
11/26/1952	504	2.6	1.3	5.4
11/27/1952	528	22.0	11.1	15.8
11/28/1952	552	6.4	3.2	5.2
11/29/1952	576	3.9	2.0	2.4
11/30/1952	600	2.4	1.2	1.5
12/1/1952	624	5.5	2.8	6.2
12/2/1952	648	5.8	2.9	6.4
12/3/1952	672	7.4	3.7	10.4
12/4/1952	696	12.7	6.4	10.0

Maximum Average Daily Flow Rate*

Peak 30-day Period (ac-	118.65	13.35	38.51	
Date	Hours	Daily Volume (ac-ft)	Daily Average Flows (cfs)	Daily Peak Flows (cfs)
9/23/1943	0	6.9	3.5	8.8
9/24/1943	24	2.4	1.2	1.6
9/25/1943	48	4.4	2.2	13.5
9/26/1943	72	6.0	3.0	6.0
9/27/1943	96	2.4	1.2	3.2
9/28/1943	120	1.3	0.6	1.1
9/29/1943	144	0.9	0.4	0.5
9/30/1943	168	3.9	1.9	7.5
10/1/1943	192	1.0	0.5	0.6
10/2/1943	216	0.8	0.4	0.4
10/3/1943	240	0.7	0.3	0.4
10/4/1943	264	2.9	1.4	6.2
10/5/1943	288	2.6	1.3	3.7
10/6/1943	312	5.1	2.6	8.0
10/7/1943	336	26.5	13.3	38.5
10/8/1943	360	6.2	3.1	3.9
10/9/1943	384	4.3	2.2	3.1
10/10/1943	408	2.7	1.3	2.0
10/11/1943	432	1.6	0.8	1.0
10/12/1943	456	2.8	1.4	4.7
10/13/1943	480	2.4	1.2	4.8
10/14/1943	504	4.5	2.3	5.1
10/15/1943	528	1.5	0.7	1.3
10/16/1943	552	2.4	1.2	3.5
10/17/1943	576	9.6	4.8	12.6
10/18/1943	600	2.5	1.3	1.6
10/19/1943	624	1.4	0.7	1.0
10/20/1943	648	0.9	0.5	0.5
10/21/1943	672	4.7	2.4	4.6
10/22/1943	696	3.5	1.8	3.3





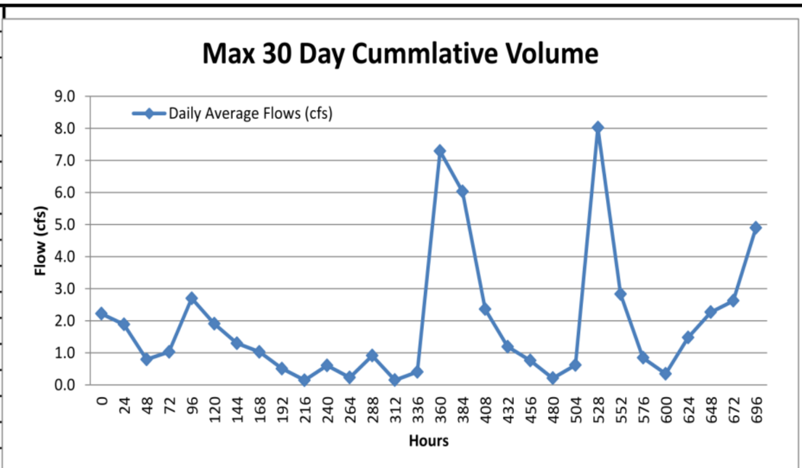
*FLOWS ARE BASED ON 15-MINUTE TIME STEP

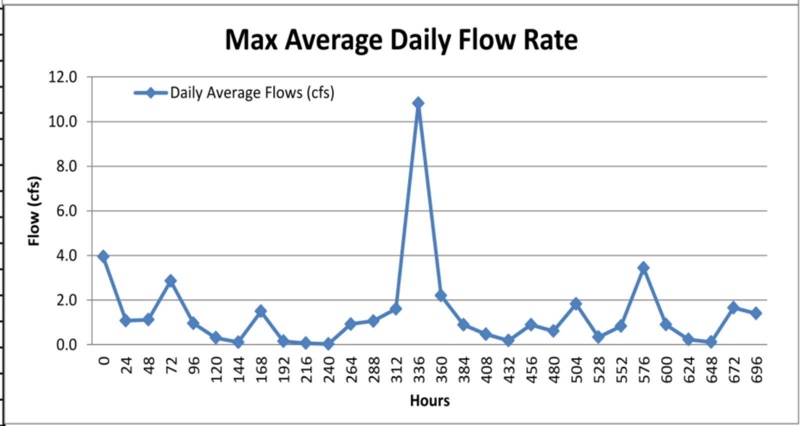
DRAFT

PROPOSED STORMWATER RETENTION FACILITY R11

30 Day Cummlative Maximum Volume*				
Peak 30-day Period (ac-		114.30	8.03	22.60
Date	Hours	Daily Volume (ac-ft)	Daily Average Flows (cfs)	Daily Peak Flows (cfs)
11/5/1952	0	4.4	2.2	4.6
11/6/1952	24	3.8	1.9	4.0
11/7/1952	48	1.6	0.8	1.6
11/8/1952	72	2.0	1.0	2.0
11/9/1952	96	5.4	2.7	7.3
11/10/1952	120	3.8	1.9	3.2
11/11/1952	144	2.6	1.3	3.0
11/12/1952	168	2.0	1.0	3.0
11/13/1952	192	1.0	0.5	1.3
11/14/1952	216	0.3	0.1	0.2
11/15/1952	240	1.2	0.6	1.7
11/16/1952	264	0.5	0.2	0.7
11/17/1952	288	1.8	0.9	1.9
11/18/1952	312	0.3	0.2	0.4
11/19/1952	336	0.8	0.4	2.6
11/20/1952	360	14.5	7.3	22.6
11/21/1952	384	12.0	6.0	14.5
11/22/1952	408	4.7	2.4	3.5
11/23/1952	432	2.4	1.2	2.4
11/24/1952	456	1.5	0.8	1.6
11/25/1952	480	0.4	0.2	0.3
11/26/1952	504	1.2	0.6	3.0
11/27/1952	528	15.9	8.0	13.8
11/28/1952	552	5.6	2.8	6.4
11/29/1952	576	1.7	0.8	1.4
11/30/1952	600	0.7	0.3	0.5
12/1/1952	624	2.9	1.5	3.9
12/2/1952	648	4.5	2.3	4.1
12/3/1952	672	5.2	2.6	5.2
12/4/1952	696	9.7	4.9	12.2

Maximum Average Daily Flow Rate*				
Peak 30-day Period (ac-		84.36	10.82	33.95
Date	Hours	Daily Volume (ac-ft)	Daily Average Flows (cfs)	Daily Peak Flows (cfs)
9/23/1943	0	7.8	3.9	7.5
9/24/1943	24	2.1	1.1	1.8
9/25/1943	48	2.2	1.1	5.6
9/26/1943	72	5.7	2.9	4.4
9/27/1943	96	1.9	1.0	1.8
9/28/1943	120	0.6	0.3	0.8
9/29/1943	144	0.2	0.1	0.2
9/30/1943	168	3.0	1.5	4.0
10/1/1943	192	0.3	0.2	0.3
10/2/1943	216	0.1	0.1	0.1
10/3/1943	240	0.1	0.0	0.0
10/4/1943	264	1.8	0.9	3.5
10/5/1943	288	2.1	1.1	2.3
10/6/1943	312	3.2	1.6	4.6
10/7/1943	336	21.5	10.8	33.9
10/8/1943	360	4.4	2.2	3.5
10/9/1943	384	1.8	0.9	1.5
10/10/1943	408	0.9	0.5	1.0
10/11/1943	432	0.4	0.2	0.3
10/12/1943	456	1.8	0.9	2.7
10/13/1943	480	1.2	0.6	2.8
10/14/1943	504	3.6	1.8	3.4
10/15/1943	528	0.7	0.3	0.8
10/16/1943	552	1.7	0.8	1.9
10/17/1943	576	6.8	3.4	6.5
10/18/1943	600	1.8	0.9	1.7
10/19/1943	624	0.5	0.2	0.3
10/20/1943	648	0.2	0.1	0.2
10/21/1943	672	3.3	1.7	2.7
10/22/1943	696	2.8	1.4	2.3





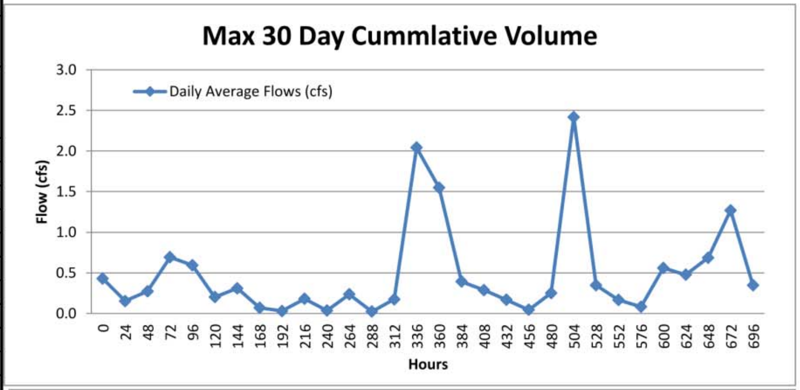
*FLOWS ARE BASED ON 15-MINUTE TIME STEP

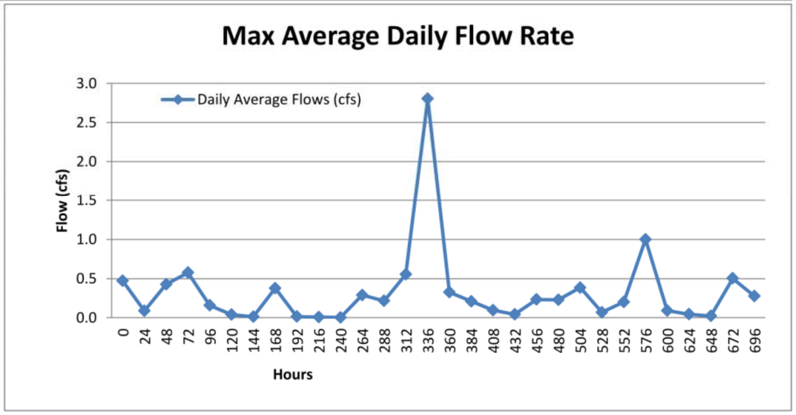
DRAFT

PROPOSED STORMWATER RETENTION FACILITY 0-1R

30 Day Cummlative Maximum Volume*				
Peak 30-day Period (ac-ft)		28.74	2.42	6.88
Date	Hours	Daily Volume (ac-ft)	Daily Average Flows (cfs)	Daily Peak Flows (cfs)
2/13/1934	0	0.9	0.4	2.6
2/14/1934	24	0.3	0.2	0.7
2/15/1934	48	0.5	0.3	1.1
2/16/1934	72	1.4	0.7	6.3
2/17/1934	96	1.2	0.6	1.7
2/18/1934	120	0.4	0.2	0.7
2/19/1934	144	0.6	0.3	2.1
2/20/1934	168	0.1	0.1	0.2
2/21/1934	192	0.1	0.0	0.0
2/22/1934	216	0.4	0.2	0.7
2/23/1934	240	0.1	0.0	0.5
2/24/1934	264	0.5	0.2	1.2
2/25/1934	288	0.0	0.0	0.0
2/26/1934	312	0.3	0.2	1.1
2/27/1934	336	4.1	2.0	6.9
2/28/1934	360	3.1	1.5	6.6
3/1/1934	384	0.8	0.4	1.2
3/2/1934	408	0.6	0.3	1.3
3/3/1934	432	0.3	0.2	0.6
3/4/1934	456	0.1	0.0	0.1
3/5/1934	480	0.5	0.2	1.5
3/6/1934	504	4.8	2.4	4.9
3/7/1934	528	0.7	0.3	0.6
3/8/1934	552	0.3	0.2	0.2
3/9/1934	576	0.2	0.1	0.1
3/10/1934	600	1.1	0.6	2.0
3/11/1934	624	0.9	0.5	1.8
3/12/1934	648	1.4	0.7	3.6
3/13/1934	672	2.5	1.3	3.4
3/14/1934	696	0.7	0.3	1.8

Maximum Average Daily Flow Rate*				
Peak 30-day Period (ac-ft)		19.34	2.80	9.42
Date	Hours	Daily Volume (ac-ft)	Daily Average Flows (cfs)	Daily Peak Flows (cfs)
11/10/1952	0	0.9	0.5	1.9
11/11/1952	24	0.2	0.1	0.1
11/12/1952	48	0.8	0.4	6.4
11/13/1952	72	1.1	0.6	1.8
11/14/1952	96	0.3	0.2	0.9
11/15/1952	120	0.1	0.0	0.2
11/16/1952	144	0.0	0.0	0.0
11/17/1952	168	0.7	0.4	2.2
11/18/1952	192	0.0	0.0	0.0
11/19/1952	216	0.0	0.0	0.0
11/20/1952	240	0.0	0.0	0.0
11/21/1952	264	0.6	0.3	2.2
11/22/1952	288	0.4	0.2	1.0
11/23/1952	312	1.1	0.6	2.3
11/24/1952	336	5.6	2.8	9.4
11/25/1952	360	0.6	0.3	0.5
11/26/1952	384	0.4	0.2	0.6
11/27/1952	408	0.2	0.1	0.2
11/28/1952	432	0.1	0.0	0.1
11/29/1952	456	0.5	0.2	1.3
11/30/1952	480	0.5	0.2	1.4
12/1/1952	504	0.8	0.4	1.3
12/2/1952	528	0.1	0.1	0.3
12/3/1952	552	0.4	0.2	1.2
12/4/1952	576	2.0	1.0	3.7
12/5/1952	600	0.2	0.1	0.1
12/6/1952	624	0.1	0.0	0.1
12/7/1952	648	0.0	0.0	0.0
12/8/1952	672	1.0	0.5	1.5
12/9/1952	696	0.5	0.3	0.9





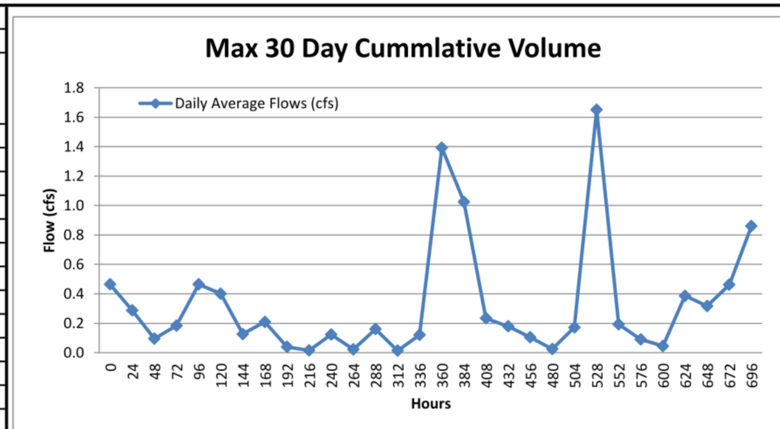
*FLOWS ARE BASED ON 15-MINUTE TIME STEP

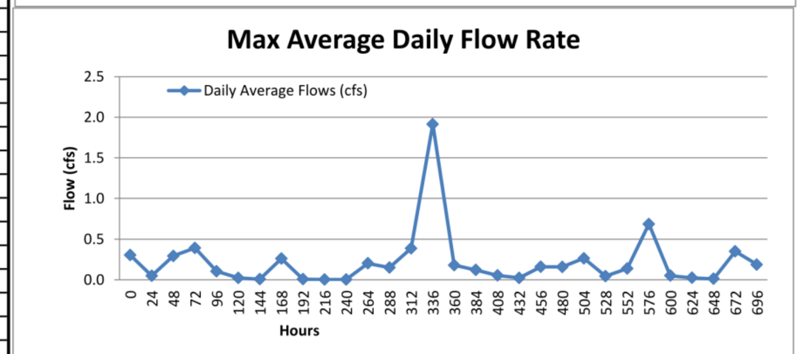
DRAFT

PROPOSED STORMWATER RETENTION FACILITY 0-2R

30 Day Cummlative Maximum Volume*				
Peak 30-day Period (ac-		19.57	1.65	4.79
Date	Hours	Daily Volume (ac-ft)	Daily Average Flows (cfs)	Daily Peak Flows (cfs)
2/12/1934	0	0.9	0.5	1.9
2/13/1934	24	0.6	0.3	1.8
2/14/1934	48	0.2	0.1	0.5
2/15/1934	72	0.4	0.2	0.7
2/16/1934	96	0.9	0.5	4.4
2/17/1934	120	0.8	0.4	1.2
2/18/1934	144	0.3	0.1	0.5
2/19/1934	168	0.4	0.2	1.4
2/20/1934	192	0.1	0.0	0.1
2/21/1934	216	0.0	0.0	0.0
2/22/1934	240	0.2	0.1	0.5
2/23/1934	264	0.0	0.0	0.4
2/24/1934	288	0.3	0.2	0.8
2/25/1934	312	0.0	0.0	0.0
2/26/1934	336	0.2	0.1	0.8
2/27/1934	360	2.8	1.4	4.8
2/28/1934	384	2.0	1.0	4.5
3/1/1934	408	0.5	0.2	0.8
3/2/1934	432	0.4	0.2	0.9
3/3/1934	456	0.2	0.1	0.4
3/4/1934	480	0.0	0.0	0.0
3/5/1934	504	0.3	0.2	1.1
3/6/1934	528	3.3	1.7	3.3
3/7/1934	552	0.4	0.2	0.4
3/8/1934	576	0.2	0.1	0.1
3/9/1934	600	0.1	0.0	0.1
3/10/1934	624	0.8	0.4	1.4
3/11/1934	648	0.6	0.3	1.2
3/12/1934	672	0.9	0.5	2.6
3/13/1934	696	1.7	0.9	2.3

Maximum Average Daily Flow Rate*				
Peak 30-day Period (ac-		12.98	1.91	6.61
Date	Hours	Daily Volume (ac-ft)	Daily Average Flows (cfs)	Daily Peak Flows (cfs)
11/10/1952	0	0.6	0.3	1.3
11/11/1952	24	0.1	0.0	0.1
11/12/1952	48	0.6	0.3	4.5
11/13/1952	72	0.8	0.4	1.2
11/14/1952	96	0.2	0.1	0.6
11/15/1952	120	0.0	0.0	0.1
11/16/1952	144	0.0	0.0	0.0
11/17/1952	168	0.5	0.3	1.6
11/18/1952	192	0.0	0.0	0.0
11/19/1952	216	0.0	0.0	0.0
11/20/1952	240	0.0	0.0	0.0
11/21/1952	264	0.4	0.2	1.5
11/22/1952	288	0.3	0.2	0.7
11/23/1952	312	0.8	0.4	1.6
11/24/1952	336	3.8	1.9	6.6
11/25/1952	360	0.4	0.2	0.3
11/26/1952	384	0.2	0.1	0.4
11/27/1952	408	0.1	0.1	0.1
11/28/1952	432	0.0	0.0	0.0
11/29/1952	456	0.3	0.2	0.9
11/30/1952	480	0.3	0.2	1.0
12/1/1952	504	0.5	0.3	0.9
12/2/1952	528	0.1	0.0	0.2
12/3/1952	552	0.3	0.1	0.8
12/4/1952	576	1.4	0.7	2.6
12/5/1952	600	0.1	0.1	0.1
12/6/1952	624	0.0	0.0	0.0
12/7/1952	648	0.0	0.0	0.0
12/8/1952	672	0.7	0.3	1.0
12/9/1952	696	0.4	0.2	0.6





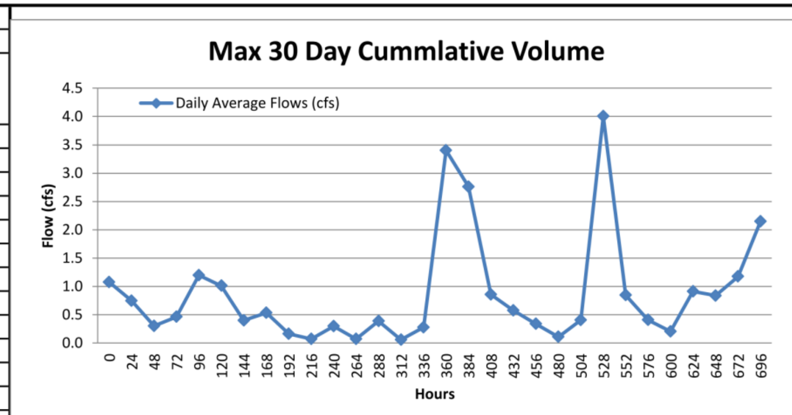
*FLOWS ARE BASED ON 15-MINUTE TIME STEP

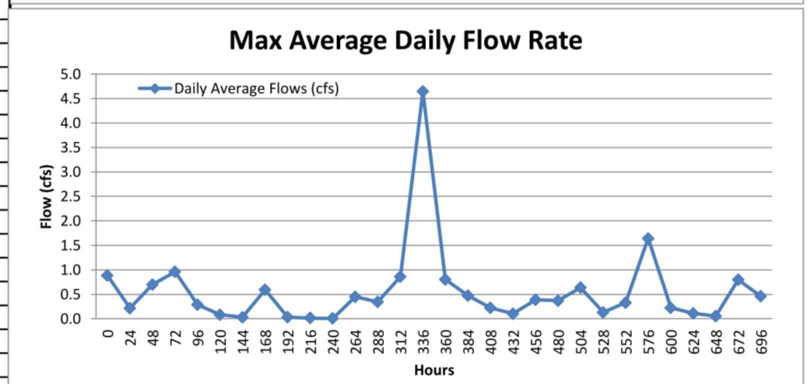
DRAFT

PROPOSED STORMWATER RETENTION FACILITY 0-3R

30 Day Cummlative Maximum Volume*				
Peak 30-day Period (ac-		51.64	4.01	10.87
Date	Hours	Daily Volume (ac-ft)	Daily Average Flows (cfs)	Daily Peak Flows (cfs)
2/12/1934	0	2.1	1.1	4.2
2/13/1934	24	1.5	0.7	4.0
2/14/1934	48	0.6	0.3	1.2
2/15/1934	72	0.9	0.5	1.7
2/16/1934	96	2.4	1.2	9.8
2/17/1934	120	2.0	1.0	2.7
2/18/1934	144	0.8	0.4	1.3
2/19/1934	168	1.1	0.5	3.2
2/20/1934	192	0.3	0.2	0.3
2/21/1934	216	0.1	0.1	0.1
2/22/1934	240	0.6	0.3	1.1
2/23/1934	264	0.1	0.1	0.7
2/24/1934	288	0.8	0.4	1.8
2/25/1934	312	0.1	0.1	0.1
2/26/1934	336	0.5	0.3	1.8
2/27/1934	360	6.8	3.4	10.9
2/28/1934	384	5.5	2.8	10.5
3/1/1934	408	1.7	0.9	2.1
3/2/1934	432	1.1	0.6	2.1
3/3/1934	456	0.7	0.3	1.0
3/4/1934	480	0.2	0.1	0.2
3/5/1934	504	0.8	0.4	2.4
3/6/1934	528	7.9	4.0	7.8
3/7/1934	552	1.7	0.8	1.4
3/8/1934	576	0.8	0.4	0.6
3/9/1934	600	0.4	0.2	0.3
3/10/1934	624	1.8	0.9	3.2
3/11/1934	648	1.7	0.8	2.9
3/12/1934	672	2.3	1.2	5.7
3/13/1934	696	4.3	2.1	5.2

Maximum Average Daily Flow Rate*				
Peak 30-day Period (ac-		33.45	4.65	14.69
Date	Hours	Daily Volume (ac-ft)	Daily Average Flows (cfs)	Daily Peak Flows (cfs)
11/10/1952	0	1.8	0.9	3.0
11/11/1952	24	0.4	0.2	0.3
11/12/1952	48	1.4	0.7	9.7
11/13/1952	72	1.9	1.0	2.8
11/14/1952	96	0.6	0.3	1.4
11/15/1952	120	0.2	0.1	0.3
11/16/1952	144	0.1	0.0	0.0
11/17/1952	168	1.2	0.6	3.4
11/18/1952	192	0.1	0.0	0.1
11/19/1952	216	0.0	0.0	0.0
11/20/1952	240	0.0	0.0	0.0
11/21/1952	264	0.9	0.4	3.3
11/22/1952	288	0.7	0.3	1.6
11/23/1952	312	1.7	0.9	3.5
11/24/1952	336	9.2	4.6	14.7
11/25/1952	360	1.6	0.8	1.1
11/26/1952	384	0.9	0.5	1.0
11/27/1952	408	0.4	0.2	0.4
11/28/1952	432	0.2	0.1	0.1
11/29/1952	456	0.8	0.4	2.0
11/30/1952	480	0.7	0.4	2.2
12/1/1952	504	1.3	0.6	2.1
12/2/1952	528	0.3	0.1	0.4
12/3/1952	552	0.7	0.3	1.8
12/4/1952	576	3.3	1.6	5.8
12/5/1952	600	0.4	0.2	0.3
12/6/1952	624	0.2	0.1	0.2
12/7/1952	648	0.1	0.1	0.1
12/8/1952	672	1.6	0.8	2.3
12/9/1952	696	0.9	0.5	1.4





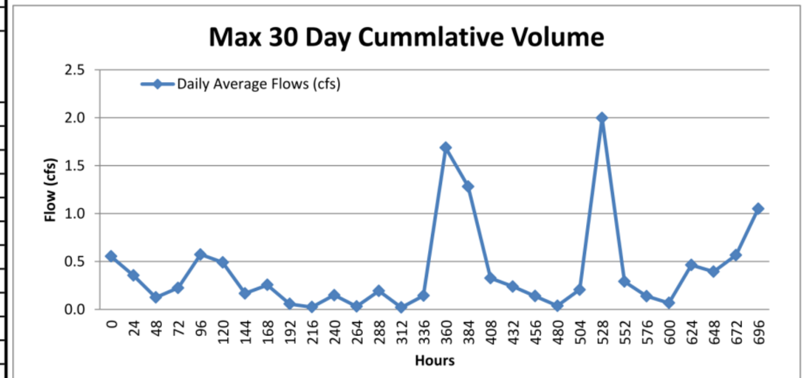
*FLOWS ARE BASED ON 15-MINUTE TIME STEP

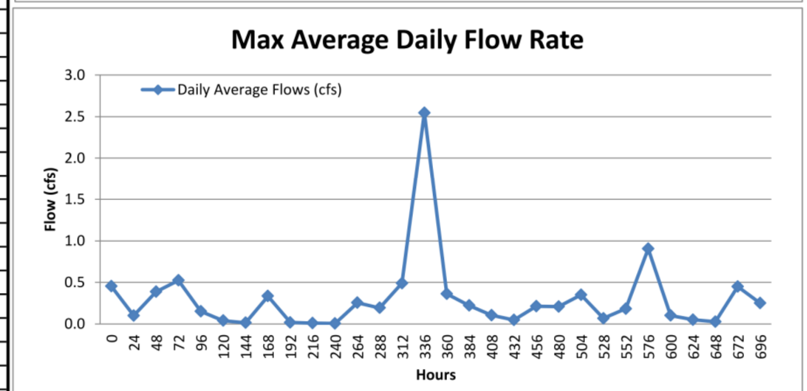
DRAFT

PROPOSED STORMWATER RETENTION FACILITY 0-4R

30 Day Cummlative Maximum Volume*				
Peak 30-day Period (ac-		24.32	2.00	5.69
Date	Hours	Daily Volume (ac-ft)	Daily Average Flows (cfs)	Daily Peak Flows (cfs)
2/12/1934	0	1.1	0.6	2.2
2/13/1934	24	0.7	0.4	2.1
2/14/1934	48	0.3	0.1	0.6
2/15/1934	72	0.4	0.2	0.9
2/16/1934	96	1.1	0.6	5.2
2/17/1934	120	1.0	0.5	1.4
2/18/1934	144	0.3	0.2	0.6
2/19/1934	168	0.5	0.3	1.7
2/20/1934	192	0.1	0.1	0.1
2/21/1934	216	0.0	0.0	0.0
2/22/1934	240	0.3	0.1	0.6
2/23/1934	264	0.1	0.0	0.4
2/24/1934	288	0.4	0.2	1.0
2/25/1934	312	0.0	0.0	0.0
2/26/1934	336	0.3	0.1	0.9
2/27/1934	360	3.3	1.7	5.7
2/28/1934	384	2.5	1.3	5.4
3/1/1934	408	0.6	0.3	1.0
3/2/1934	432	0.5	0.2	1.0
3/3/1934	456	0.3	0.1	0.5
3/4/1934	480	0.1	0.0	0.1
3/5/1934	504	0.4	0.2	1.3
3/6/1934	528	4.0	2.0	4.0
3/7/1934	552	0.6	0.3	0.5
3/8/1934	576	0.3	0.1	0.2
3/9/1934	600	0.1	0.1	0.1
3/10/1934	624	0.9	0.5	1.7
3/11/1934	648	0.8	0.4	1.5
3/12/1934	672	1.1	0.6	3.0
3/13/1934	696	2.1	1.0	2.8

Maximum Average Daily Flow Rate*				
Peak 30-day Period (ac-		16.00	2.55	7.81
Date	Hours	Daily Volume (ac-ft)	Daily Average Flows (cfs)	Daily Peak Flows (cfs)
11/10/1952	0	0.8	0.5	1.5
11/11/1952	24	0.1	0.1	0.1
11/12/1952	48	0.7	0.4	5.3
11/13/1952	72	0.9	0.5	1.5
11/14/1952	96	0.3	0.2	0.7
11/15/1952	120	0.1	0.0	0.1
11/16/1952	144	0.0	0.0	0.0
11/17/1952	168	0.6	0.3	1.8
11/18/1952	192	0.0	0.0	0.0
11/19/1952	216	0.0	0.0	0.0
11/20/1952	240	0.0	0.0	0.0
11/21/1952	264	0.5	0.3	1.8
11/22/1952	288	0.4	0.2	0.9
11/23/1952	312	0.9	0.5	1.9
11/24/1952	336	4.6	2.5	7.8
11/25/1952	360	0.5	0.4	0.4
11/26/1952	384	0.3	0.2	0.5
11/27/1952	408	0.2	0.1	0.2
11/28/1952	432	0.1	0.0	0.0
11/29/1952	456	0.4	0.2	1.1
11/30/1952	480	0.4	0.2	1.1
12/1/1952	504	0.6	0.3	1.1
12/2/1952	528	0.1	0.1	0.2
12/3/1952	552	0.3	0.2	1.0
12/4/1952	576	1.6	0.9	3.1
12/5/1952	600	0.2	0.1	0.1
12/6/1952	624	0.1	0.0	0.1
12/7/1952	648	0.0	0.0	0.0
12/8/1952	672	0.8	0.4	1.2
12/9/1952	696	0.4	0.3	0.7





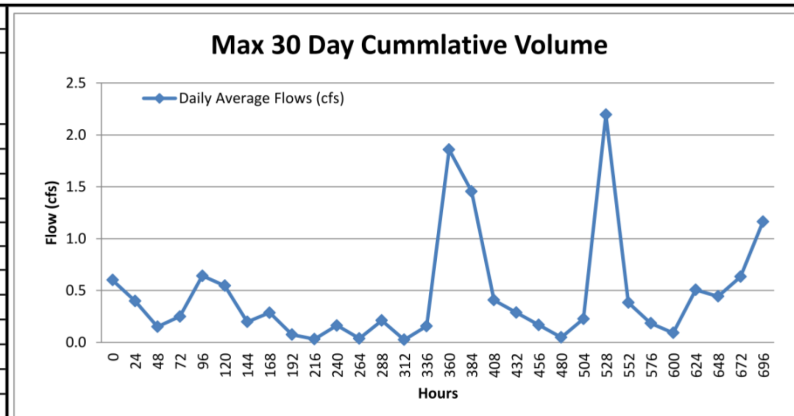
*FLOWS ARE BASED ON 15-MINUTE TIME STEP

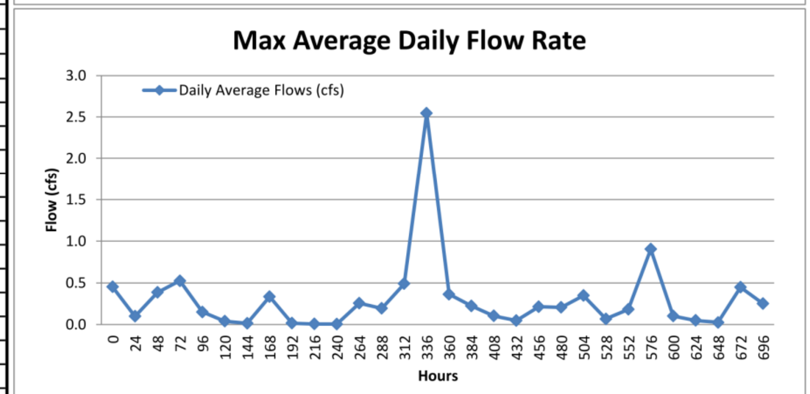
DRAFT

PROPOSED STORMWATER RETENTION FACILITY 0-5R

30 Day Cummlative Maximum Volume*				
Peak 30-day Period (ac-		27.43	2.20	6.12
Date	Hours	Daily Volume (ac-ft)	Daily Average Flows (cfs)	Daily Peak Flows (cfs)
2/12/1934	0	1.2	0.6	2.4
2/13/1934	24	0.8	0.4	2.3
2/14/1934	48	0.3	0.2	0.7
2/15/1934	72	0.5	0.3	1.0
2/16/1934	96	1.3	0.6	5.6
2/17/1934	120	1.1	0.5	1.5
2/18/1934	144	0.4	0.2	0.7
2/19/1934	168	0.6	0.3	1.8
2/20/1934	192	0.1	0.1	0.2
2/21/1934	216	0.1	0.0	0.0
2/22/1934	240	0.3	0.2	0.6
2/23/1934	264	0.1	0.0	0.4
2/24/1934	288	0.4	0.2	1.0
2/25/1934	312	0.1	0.0	0.0
2/26/1934	336	0.3	0.2	1.0
2/27/1934	360	3.7	1.9	6.1
2/28/1934	384	2.9	1.5	5.9
3/1/1934	408	0.8	0.4	1.1
3/2/1934	432	0.6	0.3	1.1
3/3/1934	456	0.3	0.2	0.5
3/4/1934	480	0.1	0.0	0.1
3/5/1934	504	0.4	0.2	1.4
3/6/1934	528	4.4	2.2	4.4
3/7/1934	552	0.8	0.4	0.7
3/8/1934	576	0.4	0.2	0.3
3/9/1934	600	0.2	0.1	0.1
3/10/1934	624	1.0	0.5	1.8
3/11/1934	648	0.9	0.4	1.6
3/12/1934	672	1.3	0.6	3.2
3/13/1934	696	2.3	1.2	3.0

Maximum Average Daily Flow Rate*				
Peak 30-day Period (ac-		17.92	2.55	8.38
Date	Hours	Daily Volume (ac-ft)	Daily Average Flows (cfs)	Daily Peak Flows (cfs)
11/10/1952	0	0.9	0.5	1.7
11/11/1952	24	0.2	0.1	0.1
11/12/1952	48	0.8	0.4	5.6
11/13/1952	72	1.0	0.5	1.6
11/14/1952	96	0.3	0.2	0.8
11/15/1952	120	0.1	0.0	0.1
11/16/1952	144	0.0	0.0	0.0
11/17/1952	168	0.7	0.3	2.0
11/18/1952	192	0.0	0.0	0.0
11/19/1952	216	0.0	0.0	0.0
11/20/1952	240	0.0	0.0	0.0
11/21/1952	264	0.5	0.3	1.9
11/22/1952	288	0.4	0.2	0.9
11/23/1952	312	1.0	0.5	2.0
11/24/1952	336	5.0	2.5	8.4
11/25/1952	360	0.7	0.4	0.5
11/26/1952	384	0.4	0.2	0.5
11/27/1952	408	0.2	0.1	0.2
11/28/1952	432	0.1	0.0	0.1
11/29/1952	456	0.4	0.2	1.1
11/30/1952	480	0.4	0.2	1.2
12/1/1952	504	0.7	0.3	1.2
12/2/1952	528	0.1	0.1	0.2
12/3/1952	552	0.4	0.2	1.0
12/4/1952	576	1.8	0.9	3.3
12/5/1952	600	0.2	0.1	0.1
12/6/1952	624	0.1	0.0	0.1
12/7/1952	648	0.0	0.0	0.0
12/8/1952	672	0.9	0.4	1.3
12/9/1952	696	0.5	0.3	0.8





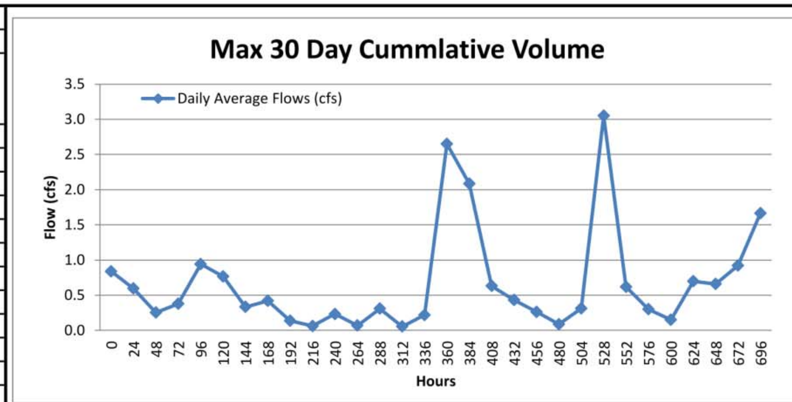
*FLOWS ARE BASED ON 15-MINUTE TIME STEP

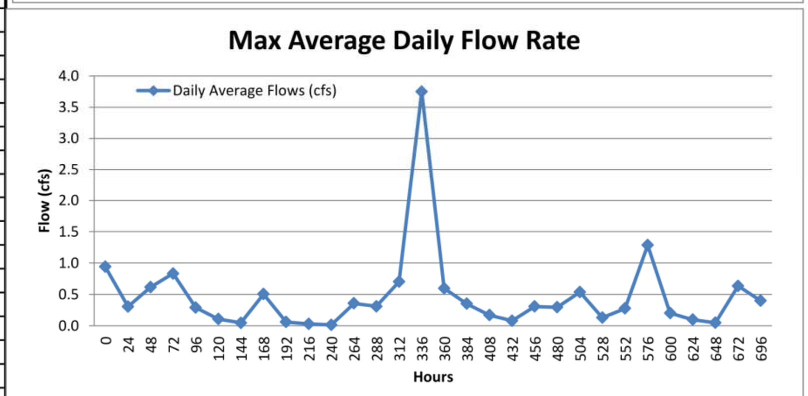
DRAFT

PROPOSED STORMWATER RETENTION FACILITY 0-6R

30 Day Cummlative Maximum Volume*				
Peak 30-day Period (ac-		39.92	3.05	9.68
Date	Hours	Daily Volume (ac-ft)	Daily Average Flows (cfs)	Daily Peak Flows (cfs)
2/12/1934	0	1.7	0.8	3.2
2/13/1934	24	1.2	0.6	3.1
2/14/1934	48	0.5	0.3	0.9
2/15/1934	72	0.7	0.4	1.3
2/16/1934	96	1.9	0.9	8.6
2/17/1934	120	1.5	0.8	2.0
2/18/1934	144	0.7	0.3	1.0
2/19/1934	168	0.8	0.4	2.5
2/20/1934	192	0.3	0.1	0.3
2/21/1934	216	0.1	0.1	0.1
2/22/1934	240	0.5	0.2	0.8
2/23/1934	264	0.1	0.1	0.6
2/24/1934	288	0.6	0.3	1.4
2/25/1934	312	0.1	0.1	0.1
2/26/1934	336	0.4	0.2	1.4
2/27/1934	360	5.3	2.6	9.7
2/28/1934	384	4.1	2.1	9.1
3/1/1934	408	1.3	0.6	1.5
3/2/1934	432	0.9	0.4	1.6
3/3/1934	456	0.5	0.3	0.7
3/4/1934	480	0.2	0.1	0.1
3/5/1934	504	0.6	0.3	1.8
3/6/1934	528	6.0	3.0	6.2
3/7/1934	552	1.2	0.6	1.0
3/8/1934	576	0.6	0.3	0.4
3/9/1934	600	0.3	0.1	0.2
3/10/1934	624	1.4	0.7	2.5
3/11/1934	648	1.3	0.7	2.2
3/12/1934	672	1.8	0.9	4.4
3/13/1934	696	3.3	1.7	4.1

Maximum Average Daily Flow Rate*				
Peak 30-day Period (ac-		28.35	3.75	13.54
Date	Hours	Daily Volume (ac-ft)	Daily Average Flows (cfs)	Daily Peak Flows (cfs)
11/10/1952	0	1.9	0.9	2.6
11/11/1952	24	0.6	0.3	0.4
11/12/1952	48	1.2	0.6	7.9
11/13/1952	72	1.7	0.8	2.3
11/14/1952	96	0.6	0.3	1.1
11/15/1952	120	0.2	0.1	0.3
11/16/1952	144	0.1	0.0	0.1
11/17/1952	168	1.0	0.5	2.7
11/18/1952	192	0.1	0.1	0.1
11/19/1952	216	0.1	0.0	0.0
11/20/1952	240	0.0	0.0	0.0
11/21/1952	264	0.7	0.4	2.5
11/22/1952	288	0.6	0.3	1.2
11/23/1952	312	1.4	0.7	2.8
11/24/1952	336	7.4	3.7	13.5
11/25/1952	360	1.2	0.6	0.8
11/26/1952	384	0.7	0.4	0.8
11/27/1952	408	0.3	0.2	0.3
11/28/1952	432	0.2	0.1	0.1
11/29/1952	456	0.6	0.3	1.5
11/30/1952	480	0.6	0.3	1.6
12/1/1952	504	1.1	0.5	1.6
12/2/1952	528	0.3	0.1	0.3
12/3/1952	552	0.5	0.3	1.4
12/4/1952	576	2.6	1.3	4.5
12/5/1952	600	0.4	0.2	0.3
12/6/1952	624	0.2	0.1	0.1
12/7/1952	648	0.1	0.0	0.1
12/8/1952	672	1.3	0.6	1.8
12/9/1952	696	0.8	0.4	1.1





*FLOWS ARE BASED ON 15-MINUTE TIME STEP

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Appendix D Reference Materials

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Summary of Base Data and Reference Materials

Topographic Mapping

- The topographic mapping used in this report was prepared by two sources.
    - Light Detection and Ranging (LiDAR) topography prepared by Puget Sound LiDAR Consortium.
    - Surveyed topography gathered and prepared by MacKay Sposito, Inc.

- Wetlands shown were delineated by Raedeke and Associates and surveyed by MacKay Sposito, Inc., ESM Consulting Engineers, LLC, and KPFF Consulting Engineers.

Reference Documents

- **Soils, Geology, Groundwater and Geologic Hazards Report for the Supplemental Draft Environmental Impact Statement EARTH AND GROUNDWATER,** prepared by Associated Earth Science, Inc, (AESI), dated 6-30-2017, and Reference Meetings, Phone calls, and Emails with AESI. (AESI 2017 Report)

- **Wetland Assessment Draft Supplemental EIS Report for Tehaleh Phase II** prepared by Raedeke Associates, Inc. dated 3-31-2016. In combination with General Coordination, Meetings, Phone calls, and Emails with Raedeke, Inc. (Raedeke 2016 Report)

- **Pierce County 2008 Stormwater Management and Site Development Manual as Amended in 2012 by Ordinance 2012-2s.** Prepared by Pierce County Public Works & Utilities, Effective Date: July 16, 2012. (2012 Pierce County Manual)

- **Cascadia Phase 1A Onsite Arterial Roadways and Stormwater Infrastructure Improvements Plan.** Prepared by Hugh G. Goldsmith & Associates, Inc. Last Revised July 2005.

- **Whitman at Cascadia Onsite Roadways and Stormwater Plan.** Prepared by Hugh G. Goldsmith & Associates, Inc. Last Revised April 2007.

- **Master Drainage Plan and Assessment of Hydrologic Impacts.** Prepared by Hugh G. Goldsmith & Associates, Inc. Last Revised January 1998. (Goldsmith 1998 Report)

- **Major Amendment to Cascadia (Tehaleh) Employment Based Planned Community, Major Amendment Application No. 760298, Environmental Application No. 760302.** (2014 EIS Addendum)

- **Washington State Department of Ecology Western Washington Continuous Simulation Model (WWHM) 2012 version 4.2.12** developed by Clear Creek Solutions, Inc. (WWHM12)

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