Washington State Department of Transportation

Memorandum

November 4, 2024

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SUBJECT: I-405 MP 21.94 Juanita Creek Fish Passage Project – Flood Risk Assessment

## 1 Purpose

The Flood Risk Assessment (FRA) is a communication tool to identify if there are potential risks of meeting Federal Emergency Management Agency (FEMA), local jurisdiction, and public health and safety requirements in the preliminary stages of design. The FRA also identifies subsequent deliverables (e.g., floodplain analysis, no-rise, zero-rise, conditional letter of map revision [CLOMR], etc.) that may be needed for the permitting process. This preliminary assessment should allow the Project Engineer's Office (PEO) and other disciplines to know if the project may need a CLOMR, easement, right-of-way (ROW), temporary construction easement, etc., allowing the project schedule and budget to be modified, if needed, early in the project delivery process.

## 2 Introduction

The Washington State Department of Transportation (WSDOT) requires all proposed projects to be documented in an FRA during the preliminary stage of design. The FRA identifies if there are potential risks 1) of meeting FEMA Code of Federal Regulations requirements; 2) of meeting local jurisdiction code floodplain development requirements; and 3) to public health and safety in order for a project to be considered for permitting as a fish habitat enhancement project, as required per RCW 77.55.181.

AECOM assessed the potential effects from replacing the existing infrastructure at the Interstate Route 405 (I-405) Mile Post (MP) 21.94 crossing of Juanita Creek. The two-dimensional (2D) model developed for the Final Hydraulic Design (FHD), which assessed the existing and proposed preliminary project conditions during the 1-percent annual exceedance probability (AEP) (100-year) flood, was utilized. Peak flows corresponding with the 1-percent AEP (100-year) flood were referenced from a technical memorandum that documents the hydrology to be used for final design and the finding for potential downstream effects that result from the removal of the flow control structure (City of Kirkland 2022). The existing and proposed conditions results from the 2D

hydraulic models were compared to 1) determine how the project may affect floodplain water surface elevations (WSEs) and extents and 2) assess how these differences may pose potential risks to public health and safety.

### *2.1 Project Description*

WSDOT is proposing a replacement structure for the I-405 crossing of Juanita Creek at MP 21.94, in Kirkland, Washington, in Water Resource Inventory Area (WRIA) 8 (**Figure 1).** The existing 4.0-foot-diameter, 358.6-foot-long corrugated metal pipe (CMP) at I-405 was identified as a fish barrier by the Washington Department of Fish and Wildlife (WDFW) and the WSDOT Environmental Services Office (Site ID 998602.; WDFW 2019a), due to the excessive slope and length required for fish passage (WDFW 2019b). The proposed project will replace the existing CMP with a structure having a minimum hydraulic width of 23 feet and a structure free zone width of 30 feet. The WSDOT proposed project also includes associated channel grading and habitat features, including large woody material (LWM), mobile woody material, meander bars, and deformable grade control structures (AECOM 2024).

### *2.2 FEMA Special Flood Hazard Area Minimum Requirements*

This project is not within a FEMA Special Flood Hazard Area (SFHA); however, there is still potential for flood risk, which is evaluated for local jurisdiction code requirements in **Section 2.3** and public health and safety in **Section 3.3.1.4**.

### *2.3 Local Community Code Requirements*

The I-405 Juanita Creek project is **not** located in a FEMA SFHA Zone. Kirkland Municipal Code Chapter 15.52 outlines the Surface Water utility requirements for development activities, water quality and flood protection, inspection, and enforcement and states that drainage review is required when any proposed project is subject to a City of Kirkland development permit or approval (City of Kirkland 2024a). The City of Kirkland design and construction standards and requirements would follow the *King County Surface Water Design Manual* (King County 2021), along with the City of Kirkland addendum to that manual (City of Kirkland 2024b). The manual guidelines state that any new project must include a Level 1 downstream analysis to identify potential flooding problems, erosion problems, and impacts to wetland hydrology. Upon review of the Level 1 analysis, the City may require a Level 2 or Level 3 analysis. This FRA may meet the qualifications to be considered a Level 2 or Level 3 analysis.

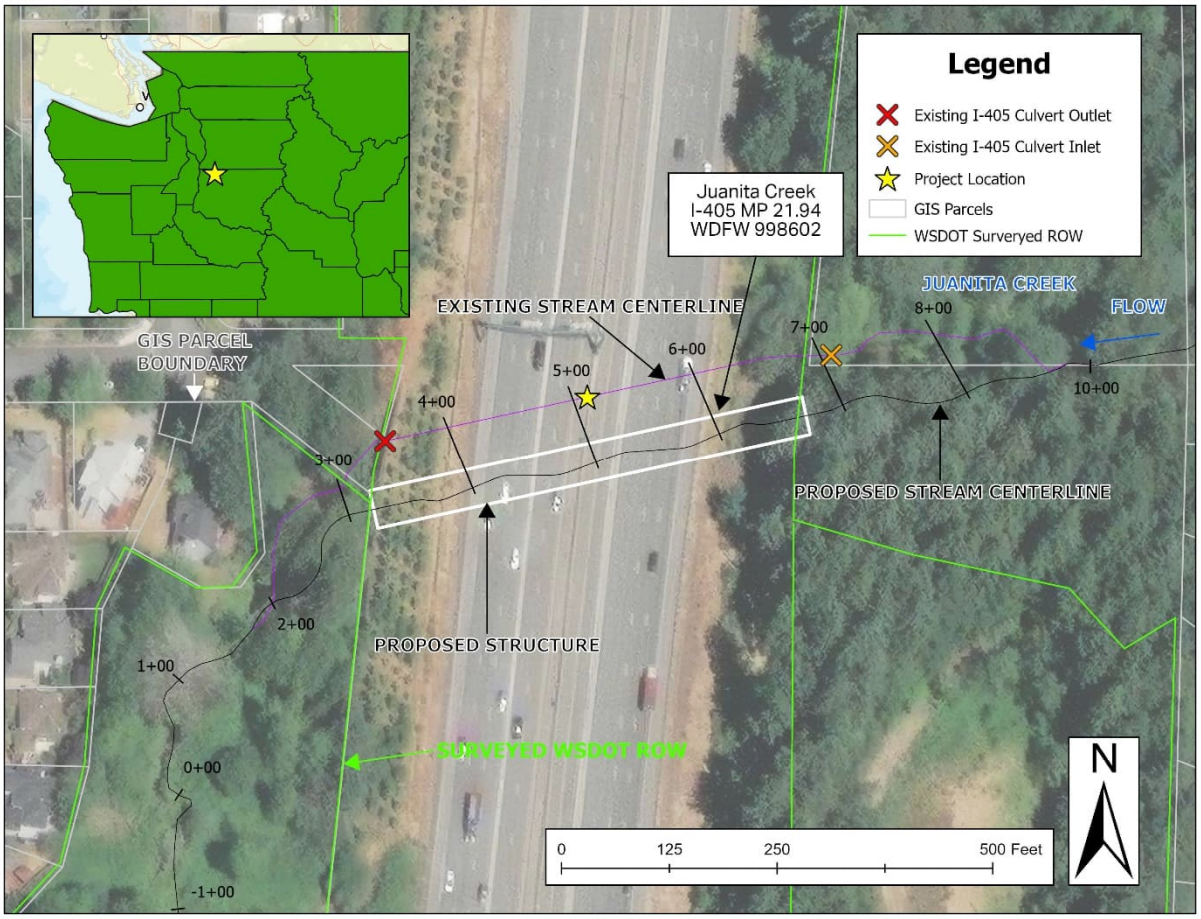


**Figure 1 I-405 Juanita Creek Fish Passage Project Site.**

## 3 Flood Risk Assessment

AECOM completed the following technical tasks for the proposed I-405 Juanita Creek crossing: 1) performed an assessment of the project site; 2) compiled topographic, hydrologic, FEMA SFHA, and local jurisdiction data; 3) developed an existing (i.e., pre-project) conditions 2D floodplain model; 4) developed a proposed (i.e., post-project) conditions 2D floodplain model; 5) compared the proposed to existing conditions WSEs for the 1-percent AEP (100-year) peak flows; and 6) assessed potential risks and project effects to public health and safety. These tasks are discussed in detail in the following sections.

All elevations specified in this memo are referenced to the NAVD88 vertical datum.

### *3.1 Site Assessment*

Juanita Creek originates in an area 3,800 feet northeast of the I-405 crossing and generally flows southwest through commercial development before entering forested areas. The stream feature riffle-pool habitat and is bordered by red alder (*Alnus rubra*), bigleaf maple (*Acer macrophyllum*), western red cedar (*Thuja plicata*), and Douglas fir (*Pseudotsuga menziesii*). There is an inline

detention facility located just upstream of I-405 known as the "High Woodlands Regional Detention Pond Project #047007" that influences channel shape and riparian and floodplain conditions. In this area, the stream channel is 5 to 7 feet wide and 1 foot deep. This detention facility area has a poorly defined channel where water spreads out and is very shallow. On the upstream side of the culvert, backwatering was observed, and the inlet was completely submerged. No spawning or rearing habit was present within the first 170 feet of open channel upstream of the crossing. The upstream portion of the stream was poorly defined with a shallow channel, and the stream has incised down through accumulated sediments that were deposited due to the detention facility (**Figure 2**). Due to this incision, this section of the stream is straight and offers minimal habitat for fish. Sediment substrate is dominated by fines and provides no benefit to fish in its current state. Juanita Creek crosses I-405 through an existing 48-inch-diameter CMP (**Figure 3**).

AECOM conducted a site assessment on December 3, 2023. The site assessment extended upstream approximately 300 feet to an existing pedestrian bridge of Juanita Creek and extended downstream approximately 700 feet. AECOM confirmed that site conditions generally agreed with a previous site assessment completed in 2019 (WSDOT 2019a). AECOM confirmed culvert sizes, condition of vegetation habitat features, and evidence of erosion.

At the outlet, there is a water surface drop of 2.62 feet with no plunge pool present. In addition, the culvert downstream daylights onto rocks, which creates white water conditions and dissipates the energy (**Figure 4**). Downstream of the I-405 crossing, Juanita Creek is dominated by angular riprap that provides no immediate fish habitat benefits. The riprap extends to the next downstream barrier, two property access CMP culverts (36 and 24 inches in diameter) that are located approximately 70 feet southwest of the I-405 crossing (**Figure 5**). Downstream of the property access culverts, the stream flows through a vegetated area in the middle of a housing development dominated by Himalayan blackberry (*Rubus armeniacus*) with some trees. An active beaver dam was present approximately 400 feet downstream from I-405 (**Figure 6**). The creek flows through a series of open channels and culverts passing through residential areas, Edith Moulton Park, and commercial areas, until it finally reaches the northeast end of Lake Washington at Juanita Beach Park.

No nearby parcels were identified containing structures within the modeled 100-year WSE. As previously mentioned, the reach is not in a FEMA SFHA and there is no mapped 100-year WSE.

**Figure 2 Juanita Creek I-405 MP 21.94 Upstream Reach Conditions**

**Figure 3 Juanita Creek I-405 MP 21.94 Existing Culvert Inlet**

**Figure 4 Juanita Creek I-405 MP 21.94 Existing Culvert Outlet**

**Figure 5 Property Access Culverts Downstream of Juanita Creek I-405 MP 21.94**

**Figure 6 Juanita Creek I-405 MP 21.94 Downstream Reach Conditions**

## *3.2 Data Compilation*

### *3.2.1 Topographic Data*

Topographic survey of Juanita Creek was conducted by 1-Alliance Geomatics in February 2024 from the I-405 crossing 400 feet downstream and 500 feet upstream. Cross sections were taken every 50 feet and identified tops of bank, water's edge, thalweg, and water depth at thalweg. Additionally, culvert diameter, length, and inlet and outlet elevations were measured for both the existing crossings at the I-405 and property access downstream. The topographic survey included the WSDOT ROW, both upstream and downstream of the crossing.

### *3.2.2 Hydrologic Data*

The hydrologic data in this FRA is used to assess: 1) whether the proposed project will meet FEMA requirements 2) whether the proposed project will meet local jurisdiction code requirements, using flows developed by WSDOT and AECOM, and 3) potential risks to public health and safety based on best available flow information developed as part of the Preliminary Hydraulic Design (PHD) report.

In May 2021, WSDOT completed the PHD report, which details the design elements necessary to comply with the federal injunction as coordinated with the permitting agencies and affected tribe. Following the completion of the PHD report, WSDOT coordinated with the City of Kirkland and its consultant, Northwest Hydraulic Consultants, to better understand the basin hydrology and floodplain impacts for existing and proposed conditions. A technical memorandum documents the hydrology to be used for final design (City of Kirkland 2022). This memorandum recommends a 1-percent AEP (100-year) discharge of 129 cubic feet per second (cfs).

### *3.2.3 FEMA and Local Jurisdiction SFHA Data*

This project is not in a FEMA SFHA. There is no FEMA effective model or associated flood profile for Juanita Creek

## *3.3 2D Floodplain Model Development*

The hydraulic analyses for the existing I-405 Juanita Creek crossing were performed by AECOM using SRH-2D (USBR 2017), a 2D, depth-averaged hydraulic and sediment transport numerical model that is included in the Surface-water Modeling System (SMS) Version 13.3.10 (Aquaveo 2024).

The hydraulic roughness (Manning's n) values assigned to the existing and proposed conditions were based on standard values from the WSDOT *Hydraulics Manual* (WSDOT 2022) and Arcement and Schneider (1989) calculations for the land cover types observed at the site.

The mesh development selected hydraulic roughness values, and boundary conditions for the existing and proposed conditions models are described in detail in the FHD (AECOM 2024). The downstream boundary condition was set to a constant WSE placed approximately 1,300 feet downstream of the I-405 crossing, defined by a normal depth calculator tool in SMS.

The existing and proposed models assume a steady-state condition and a fixed bed. Due to the fixed bed assumption, the existing condition mesh reflects the topography at the time of LiDAR collection and 2023 survey. The proposed conditions mesh represents post-construction grading merged with existing LiDAR and survey outside of the regrade area. These mesh elevations do not deform in response to sediment transport or movement of large wood (AECOM 2024).

### *3.3.1 2D Floodplain Model Development – Utilizing FHD Information*

The existing and proposed conditions 2D floodplain model described in **Section 3.3.1.1** and **3.3.1.2** of this memorandum, along with the corresponding results comparisons (**Section 3.3.1.3**) and assessment of flood risk (**Section 3.3.1.4**), all use the 1-percent AEP (100-year) flow based on best available information developed as part of the FHD (AECOM 2024).

#### *3.3.1.1 Existing Conditions 2D Floodplain Model*

An existing conditions 2D mesh was developed by discretizing the existing conditions topographic surface (see **Section 3.2.1**) with appropriate resolution to resolve the ground topography and hydraulic variables required for design. Hydraulic conditions through the three existing culverts, 48-inch CMP at I-405, and 36-inch and 48-inch CMP at the property access crossing, were computed by the HY-8 culvert analysis software (FHWA 2021) integrated within SMS and SRH-2D. The HY-8 computations used the culvert geometry, type, and site data from the 2024 survey and field observations.

Manning's n values in the channel with mobile woody material were 0.075 for existing while 0.15 was used to represent roughness on the floodplain. The three existing culverts were modeled with no blockage and Manning's n values of 0.024. Manning's n values were established from additive increases from a base value following the *Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains* (Arcement and Schneider 1989) and standard values from the WSDOT *Hydraulics Manual* (WSDOT 2022). See the FHD for further information regarding the selection of Manning's roughness values for the existing conditions model (AECOM 2024).

#### *3.3.1.2 Proposed Conditions 2D Floodplain Model*

The proposed conditions mesh was developed based on the post-project geometry of the Juanita Creek channel, floodplain, I-405 roadway embankments, and proposed 30-foot span structure geometry. The model also includes associated channel and overbank grading that is incorporated into the model surface to represent the proposed conditions. Other habitat features including LWM and meander bars are included in the hydraulic model to account for the influence of these features on hydraulics and WSEs.

Manning's n values, in areas where no grading is expected to occur, matched the existing conditions model. In regrade areas, the Manning's n value for the proposed channel was 0.086, and values ranged from 0.087 to 0.15 for proposed planting areas. LWM was assigned a Manning's roughness of 0.098. A Manning's n value of 0.15 was used for the overbank areas of the floodplain. Manning's n values were established from additive increases from a base value following the *Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains* (Arcement and Schneider 1989) and standard values from the WSDOT *Hydraulics Manual*

(WSDOT 2022). See the FHD for further information regarding the selection of Manning's roughness values for the proposed conditions model (AECOM 2024).

#### *3.3.1.3 Comparison of Existing and Proposed 1-percent AEP (100-Year) Water Surface Elevations*

The difference of the 1-percent AEP (100-year) existing conditions WSE from the proposed conditions WSE (proposed minus existing), upstream and downstream of the project site, is depicted in **Figure 7.** The negative values, shown with blue shades, indicate a WSE reduction from existing to proposed conditions. The positive values, shown with red shades, indicate a WSE rise.

Based on the recommendations of FHWA (2019), the comparison of the proposed to the existing 1-percent AEP (100-year) WSE is performed along the 1.0-foot WSE contours calculated from the existing conditions model, which are depicted between stations -3+98 and 14+36 in **Figure 7**.

Dark green shades in **Figure 7** designate existing dry areas that become inundated under proposed conditions, as seen immediately downstream of the proposed I-405 crossing where WSEs rise in response to the proposed grading and new channel alignment. Conversely, inundated areas under existing conditions that are dry under proposed conditions are represented with a pink shade, as seen up and downstream of the proposed grading where WSEs reduce from existing to proposed conditions.

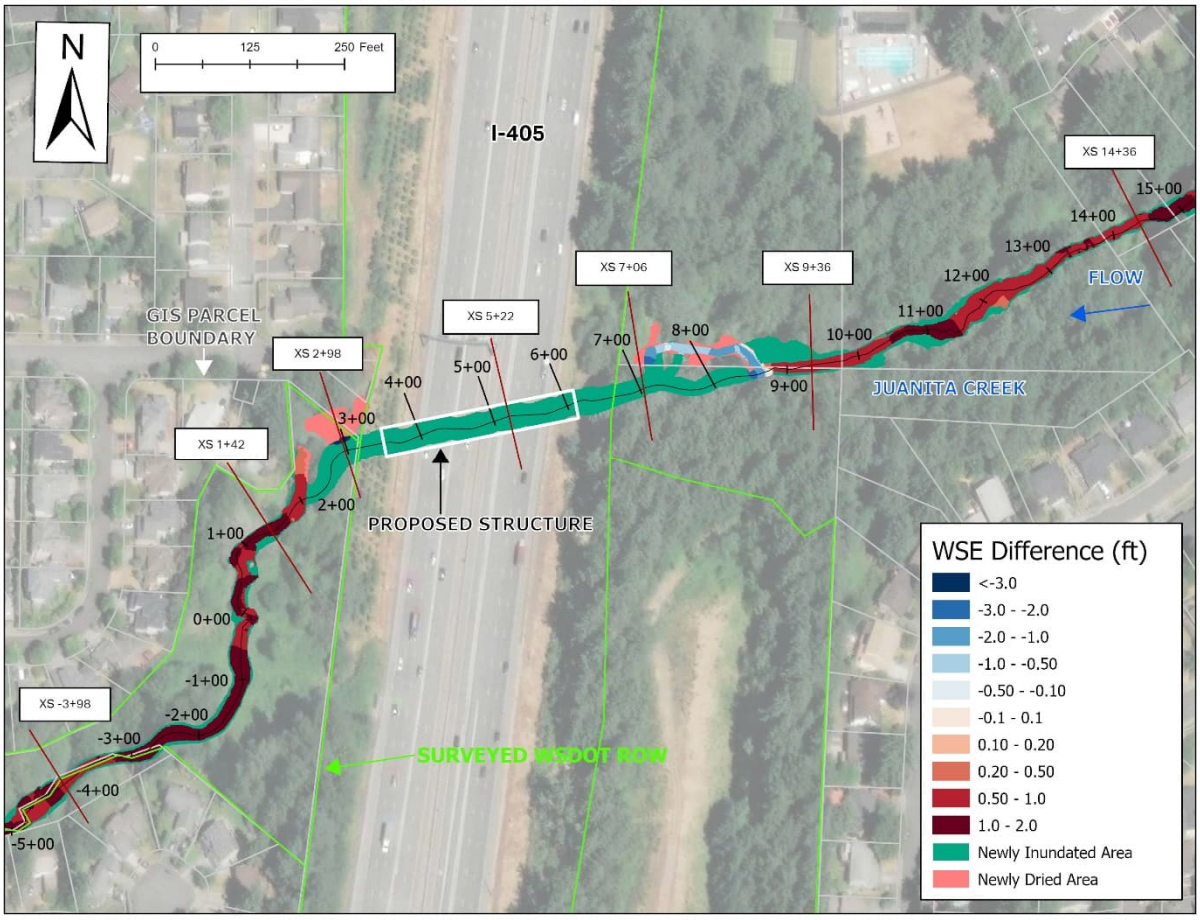


**Figure 7 Difference of the Existing and Proposed 1-Percent AEP (100-Year) WSE Upstream and Downstream of the I-405 Crossing**

The model results downstream of I-405 indicate a rise in the 1-percent AEP (100-year) WSE, as depicted by the red color in **Figure 7**. This rise is attributed to the replacement of the existing 48-inch CMP culvert with the proposed 30-foot-wide channel and attributed to the detention area being removed, which increases 1-percent AEP peak flows from 41 cfs to 111 cfs (City of Kirkland 2022). While the wider proposed channel increases the conveyance capacity of flow through the crossing and would typically establish a slower and deeper flow through the water crossing, the loss of the detention area actually increases WSEs (WSDOT 2022). The proposed conditions 100-year WSE upstream of the I-405 crossing is reduced by more than 1 foot from the existing conditions 100-year WSE (**Figure 8**) because the terrain of the proposed channel is lower than the terrain of the existing channel, while downstream WSEs increase by approximately 1 foot (**Figure 9**).

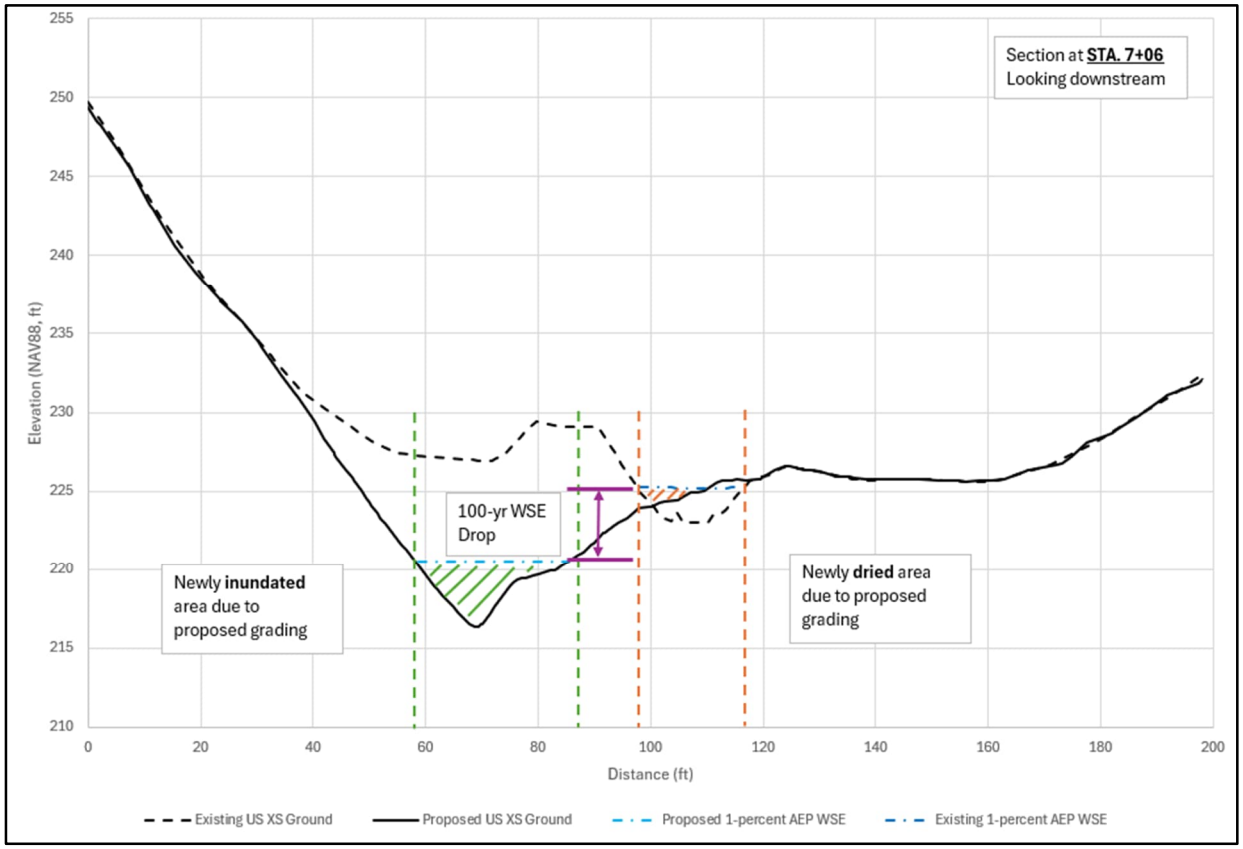


**Figure 8 Comparison of the Existing and Proposed Conditions 1-Percent AEP (100-Year) WSE at Observation Line Station 7+06 Upstream of the I-405 Crossing**

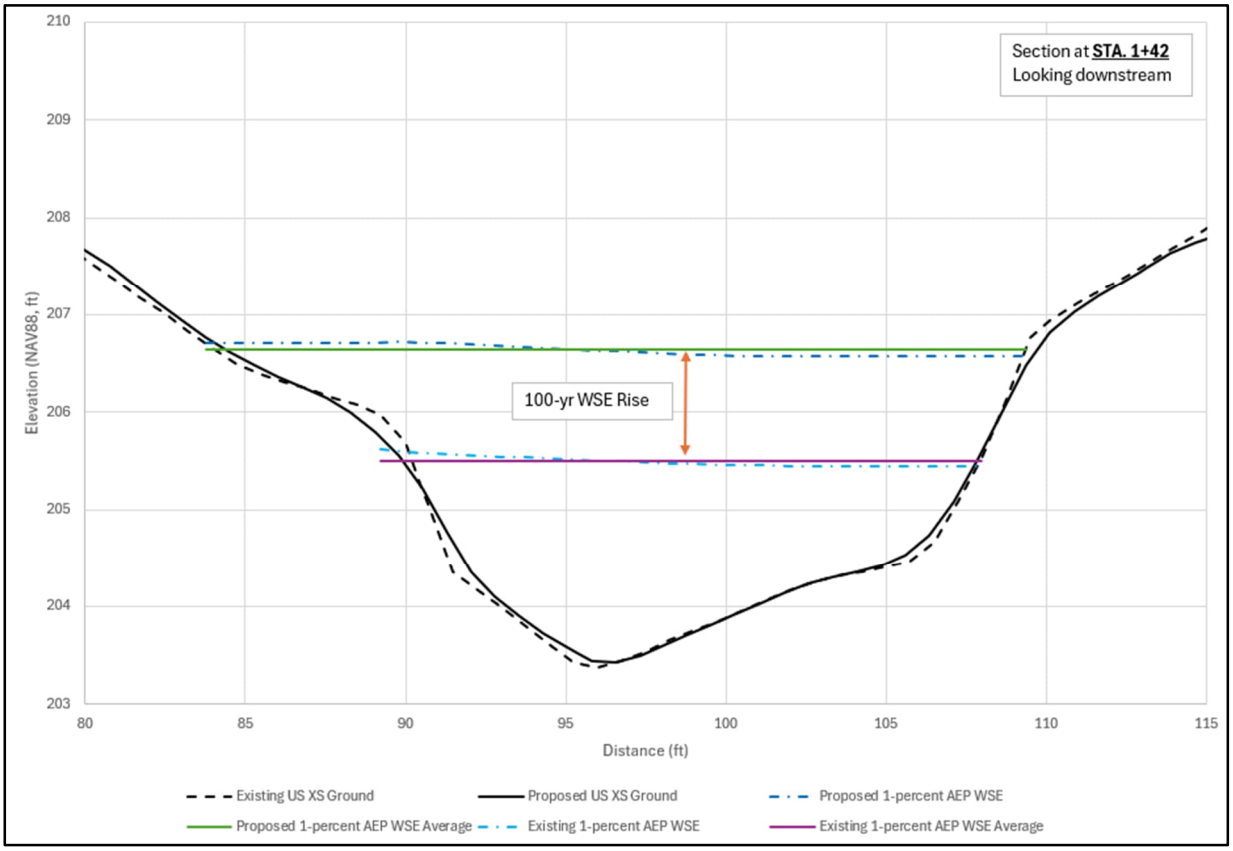


**Figure 9 Comparison of the Existing and Proposed Conditions 1-Percent AEP (100-Year) WSE at Station 1+42 (measured on the proposed creek centerline) Downstream of the Juanita I-405 Creek Crossing**

Juanita Creek does not cross any parcel boundaries in the vicinity of the I-405 crossing; however, it does traverse a survey ROW line immediately upstream of the crossing. The 1-percent AEP (100-year) WSEs predicted by the existing and proposed models along the WSDOT ROW line at Station 7+06 are seen in **Figure 10.** The WSE comparisons use the discharge-weighted average of existing and proposed 1-percent AEP (100-year) WSEs at these observation lines, in accordance with the recommendations of FHWA (2019). As depicted in **Figure 10**, the average 1-percent AEP (100-year) WSE is reduced by 4.68 feet at the upstream ROW (Station 7+06). All locations downstream of the I-405 crossing, as shown in **Figure 7,** are within WSDOT ROW.

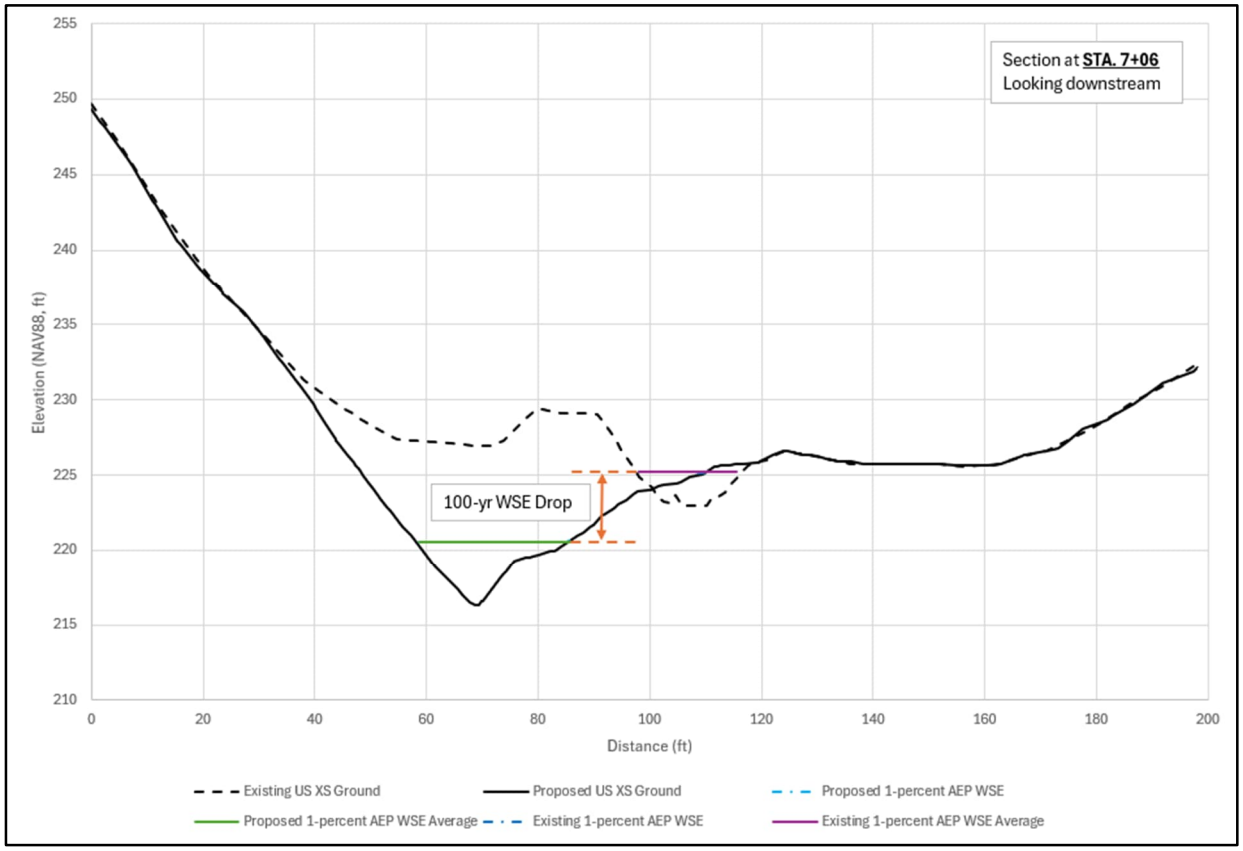


**Figure 10 Comparison of the Existing and Proposed Conditions 1-Percent AEP (100-Year) WSE at Station 7+06 (measured on the proposed creek centerline) Along the Upstream Surveyed WSDOT ROW Line**

The 1-percent AEP (100-year) discharge WSEs for both existing and proposed conditions, measured at 1-foot contours from the current 100-year WSE, are summarized in **Table 1**. The results indicate a **reduction** in WSE between 0 and 4.68 feet upstream of the crossing; it is important to note that proposed grading lowers the thalweg elevation along the entire grading limit. For example, at Station 7+06, the ground is lowered by about 6.65 feet, and the net WSE **reduction** is thus approximately 4.68 feet at this location. More generally, upstream of the I-405 crossing (between Stations 7+00 to 10+00), the WSDOT proposed project creates up to a 1.9-foot drop in the average 1-percent AEP (100-year) WSE, because the grading of the proposed channel is lower than the existing channel. The resulting 1-percent AEP (100-year) WSE drop reduces the inundation extents of the creek floodplain, as seen with the pink color in **Figure 7.**

Downstream of the crossing, there is a WSE **rise** of 0 to 1.15 feet when comparing existing and proposed conditions. The largest 100-year WSE **rise** of 1.15 feet at the station evaluated herein is observed at Station 1+42.

**Table 1 Summary of Existing and Proposed Discharge Weighted WSEs for the 1-Percent AEP (100-Year) Peak Flow**

| Observation Line Number | Station Measured Along Existing Centerline (Feet) | Existing (Feet, NAVD88) | Proposed (Feet, NAVD88) | Difference (Proposed Minus Existing) (Feet) |
|---|---|---|---|---|
| 1 | -3+98 | 191.27 | 192.18 | 0.91 |
| 2 | 1+42 | 205.49 | 206.64 | 1.15 |
| 3 | 2+98 | 212.16 | 208.62 | -3.54 |
| 4 | 5+22/ Structure | NA | 215.11 | NA |
| 5 | 7+06/ ROW Crossing | 225.86 | 220.52 | -4.68 |
| 6 | 9+36 | 229.86 | 230.69 | 0.83 |
| 7 | 14+36 | 238.53 | 239.49 | 0.96 |

*3.3.1.4 Assessment of Flood Risk*

The purpose of this section is to describe the potential risk(s) the preliminary design may have to public health and safety in order for a project to be considered for permitting as a fish habitat enhancement project, as required per RCW 77.55.181.

As shown in Table 1, the average WSE is reduced both directly upstream and downstream of the crossing, because these will be newly graded areas. There are areas where the WSE increases downstream of the crossing; however, they do not extend into adjacent parcels or impact adjacent infrastructure.

The 2022 Juanita downstream hydrology and hydraulics analysis (City of Kirkland 2022) also determined there was a potential increase in flood risk. The report states, "Outside of the Design-Build contract, WSDOT and the City of Kirkland will continue to coordinate to further investigate solutions to the area around NE 141st Street." It is out of the scope of the Design-Build contract to extend the model as far downstream as the 2022 study.

The proposed conditions 1-percent AEP (100-year) inundation extents for Juanita Creek are superimposed on the proposed conditions ground and provided in **Figure 11**.

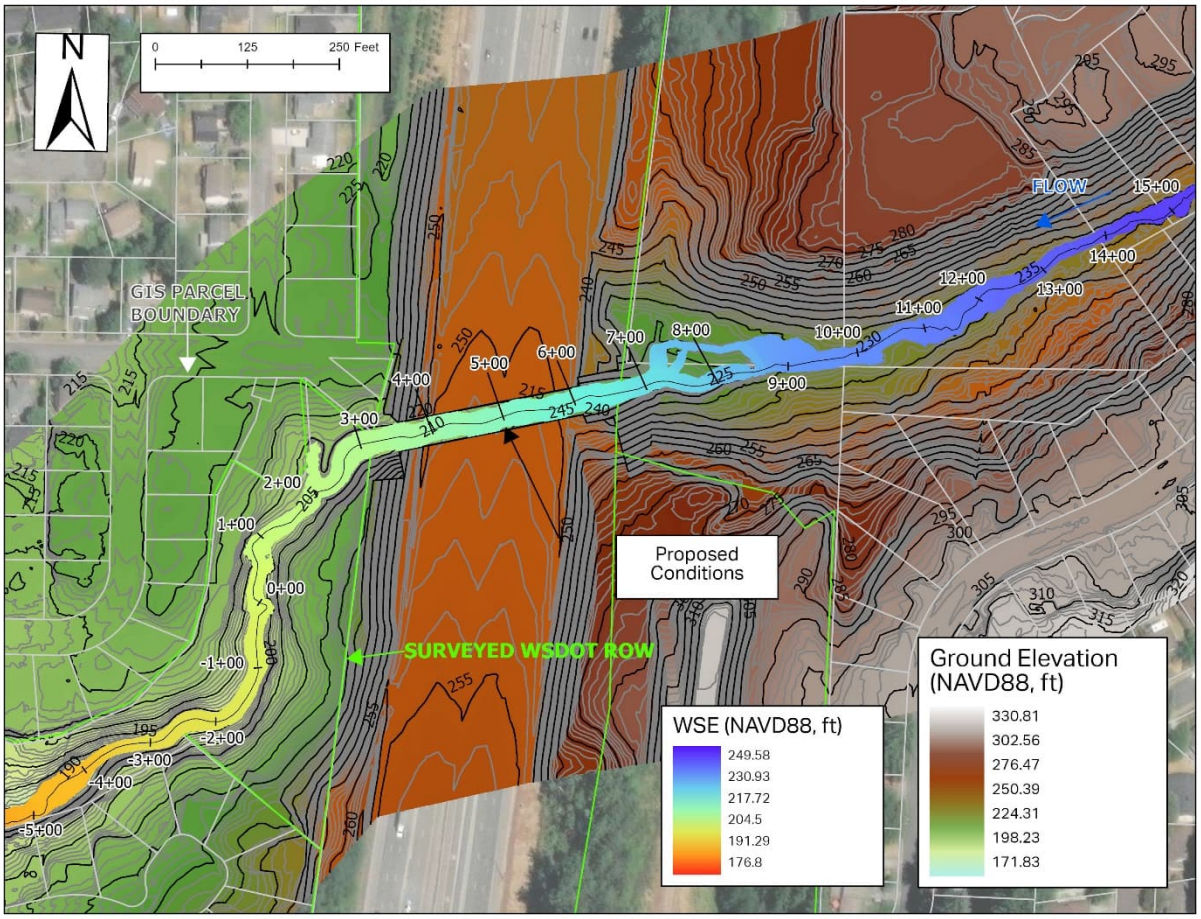


**Figure 11 Proposed Conditions 1-percent AEP (100-Year) WSE, 1-Percent AEP (100-Year) Inundation Extents, and Ground Elevations**

## 4 Summary

In summary, the WSDOT proposed I-405 replacement structure, with associated channel grading and habitat features, does not cause an average rise in the 1-percent AEP (100-year) WSE larger than 1.0 foot (**Section 3.3.1**). Because the inline detention facility will be removed, 1-percent AEP flows will increase from 41 cfs to 111 cfs (City of Kirkland 2022), which will cause an increase in downstream WSEs. Approximately 750 feet downstream of the structure at Station -3+98, the hydraulic model indicates there will be a 0.9-foot increase in 1-percent AEP (100-year) WSE from existing to proposed conditions, however this does not appear to impact any adjacent parcels or infrastructure within the model extents. There are no FEMA SFHA or local jurisdictional requirements regarding change in the 1-percent AEP (100-year) WSE. Outside of the Design-Build contract, WSDOT will lead ongoing and future communication related to potential downstream flood impacts and/or improvements.

## 5 References

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