CITY COUNCIL WORK SESSION
MEETING AGENDA

Online via Zoom and In Person at
Tumwater Fire Department
Headquarters, EOC, 311 Israel Rd. SW,
Tumwater, WA 98501

Tuesday, September 26, 2023
6:00 PM

1. Call to Order
2. Roll Call
3. Deschutes River Flood Reduction Study Report (Dan Smith)
4. Mayor/City Administrator's Report
5. Adjourn

Meeting Information
All Councilmembers will be attending remotely. The public are welcome to attend in person, by telephone or online via Zoom.

Watch Online
https://us02web.zoom.us/j/88525159183?pwd=aWtqWFNXSHhFUDdIQlByNS80UUJLUT09

Listen by Telephone
Call (253) 215-8782, listen for the prompts and enter the Webinar ID 885 2515 9183 and Passcode 845221.

Public Comment
The public may submit comments by sending an email to council@ci.tumwater.wa.us, no later than 4:00 p.m. the day of the meeting. Comments are submitted directly to the Councilmembers and will not be read individually into the record of the meeting.

Post Meeting
Video recording of this meeting will be available within 24 hours of the meeting.
https://tcmedia.org/stream.php

Accommodations
The City of Tumwater takes pride in ensuring that people with disabilities are able to take part in, and benefit from, the range of public programs, services, and activities offered by the City. To request an accommodation or alternate format of communication, please contact the City Clerk by calling (360) 252-5488 or email CityClerk@ci.tumwater.wa.us. For vision or hearing impaired services, please contact the Washington State Relay Services at 7-1-1 or 1-(800)-833-6384. To contact the City's ADA Coordinator directly, call (360) 754-4128 or email ADACoordinator@ci.tumwater.wa.us

TO: City Council

FROM: Dan Smith, Water Resources and Sustainability Director

DATE: September 26, 2023

SUBJECT: Deschutes River Flood Reduction Study Report

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1) Recommended Action:

None. Item is for discussion only.

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2) Background:

The City of Tumwater received a one-time grant from the Washington State Department of Ecology to conduct a study and hydraulic model of the Deschutes River Valley within Tumwater to develop a detailed understanding of the potential flood risk between Henderson Boulevard and the lower Tumwater Falls at Brewery Park, with a primary focus on the properties experiencing the most historic flooding associated with the former Olympia Brewery. Greer Environmental Consulting will present the study completed by Stantec Engineering, which describes existing conditions and factors contributing to flooding and erosion, identifies alternatives to reduce/eliminate flooding and erosion, necessary permit actions, development feasibility, and conceptual costs for mitigation.

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3) Policy Support:

Strategic Priority A – Pursue Targeted Community Development Opportunities, specifically
- Facilitate brewery redevelopment

Strategic Priority F – Be a Leader in Environmental Sustainability, specifically
- Enhance salmon runs

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4) Alternatives:

❑ None. Item is for information only.

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5) Fiscal Notes:

Tumwater received a $250,000 Washington State Department of Ecology grant, with $75,000 reserved for the project from the Storm Drain Fund. The project was completed on time and under budget, for a total cost of ~$270,000. 100% of grant funds were expended, covering both study and external management costs for the project.

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6) Attachments:

A. Deschutes River Flood Reduction Study

A

Deschutes River Flood Reduction Study

Hydraulic and Erosion Analysis and Alternative Report

June 30, 2023

Prepared for:

Washington State Department of Ecology
300 Desmond Dr
Lacey, WA 98503

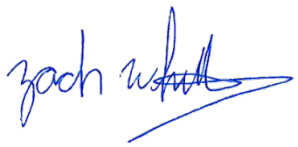
City of Tumwater, Washington
555 Israel Rd
Tumwater, WA 98501

Prepared by:

Stantec Consulting Ltd
601 SW 2nd Ave
Suite 1400
Portland, OR 97204

This document entitled Deschutes River Flood Reduction Study was prepared by Stantec Consulting Ltd. (“Stantec”) for the account of Washington State Department of Ecology (the “Client”). Any reliance on this document by any third party is strictly prohibited. The material in it reflects Stantec’s professional judgment in light of the scope, schedule and other limitations stated in the document and in the contract between Stantec and the Client. The opinions in the document are based on conditions and information existing at the time the document was published and do not take into account any subsequent changes. In preparing the document, Stantec did not verify information supplied to it by others. Any use which a third party makes of this document is the responsibility of such third party. Such third party agrees that Stantec shall not be responsible for costs or damages of any kind, if any, suffered by it or any other third party as a result of decisions made or actions taken based on this document.

Prepared by



Zach Whitten, P.E.

Reviewed by

Blair Greimann, P.E.

Approved by

Joe Richards, P.E.

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EXECUTIVE SUMMARY

The Tumwater community has experienced repetitive flooding by the Deschutes River and desires to understand flood mitigation alternatives to support urban redevelopment of key parcels within the community. The purpose of this study is to develop a detailed understanding of the potential flood risk from the Deschutes River between Pioneer Park and Henderson Blvd and then utilize the understanding to development flood mitigation alternatives to facilitate redevelopment of the key parcels. For this study, the most significant key parcel is the historic Olympia Brewery Site. Hydraulic modeling is used to develop a calibrated existing conditions model which is later modified to incorporate specific interventions within the study area that may engender flood reduction at the brewery site and facilitate redevelopment. While flood reduction and redevelopment are the purpose of this effort the alternatives have been developed to support inclusion of multiple benefits and nature-based features like native vegetation, large woody material (LWM), and reconnected floodplains that support a naturalized riparian ecosystem. For this study the United States Army Corps (USACE) hydraulic modeling software HEC-RAS is utilized. This Study is intended to support planning level decision making. The first step in this process is developing a calibrated base model that accurately simulates historical flooding conditions at the site. For a visual of locations discussed in this section and throughout the report, please refer to **Figure 1** and **Figure 2** at the end of **Section 1.0** of this report below.

The base model was calibrated to a 6,900 cfs peak flow storm event that occurred in the study area in 2022 to provide confidence that the model is accurately depicting existing conditions and to provide a basis for developing flood reduction alternatives that build on the base model configuration. The City of Tumwater provided Stantec with aerial photography of the 2022 event with timestamps provided for each photo. The photos were utilized to compare the model's simulated flood event vs the actual flood conditions of 2022 based on the aerial photos. Base model flood inundation extents match aerial data demonstrating that the model is doing an exceptional job simulating the 2022 flood event.

Historical evidence indicates that the Olympia Brewery site is susceptible to flooding during events less than a 10-year event (7,500 cfs). The 2022 calibration event (6,900 cfs) resulted in site flooding and the 8,500 cfs event that occurred in 2009 resulted in sustained flooding at the site with an average recurrence interval of less than 25-years (25-year storm on the Deschutes River at this location is 9,100 cfs). With a calibrated base model reliably simulating historical flooding at the site, the specific causes of and mitigations for flooding can be investigated.

Flooding at the site is exacerbated by channel and floodplain conveyance restrictions upstream of the brewery site near the Tumwater Valley Golf Club driving range and downstream of the brewery site within the vicinity of the Capital Blvd Bridge. During the low flow or initial stages of a flood the topography near the golf course driving range forces water onto the floodplain to the east and north paralleling the railroad alignment towards the brewery site. At higher flow stages the power substation and the ground elevation directly below the Capitol Blvd overpass restricts flow conveyance from a floodplain width of more than 2,000 feet to 190 feet resulting in retention of flood waters at the Brewery Site. These two conditions exacerbate flooding at the site and form the basis for flood reduction alternatives.

The primary goal of this study is to determine and evaluate alternatives for the purpose of flood mitigation at the Olympia Brewery Site to support redevelopment. For this effort flood reduction strategies or components are considered and the components that engender flood reduction at the Brewery Site are

used to form the basis of flood reduction alternatives. An alternative is a combination of up to 3 components.

For the alternative analysis, 7 components (flood channel, benching, power substation relocation in conjunction with lowering the elevation directly below the Capitol Blvd Bridge overpass, upstream flood storage, lowering of Tumwater Falls Dam, removal of the walking path near Valley Athletic Club, and the watershed floodplain reconnection near Pioneer Park), were combined to form 17 different screening-level alternatives. These alternatives are considered “screening-level” due to the relatively low level of detail applied for each alternative in the HEC-RAS model. The intent of the modeling of the screening-level alternatives was to obtain a basic understanding of the flood reduction potential of each alternative. The results and understanding would be utilized to determine which screening level alternative should be considered further in the alternatives stage of the study.

All 17 screening-level alternatives were simulated for the 2-year (4,400 cfs), 2022-based (6,900 cfs since it is similar to a 10-year event) and 100-year (10,100 cfs) storm events to determine the level of flood reduction effectiveness at the Olympia Brewery site for each alternative. Modeling results showed little flood benefit at the Olympia Brewery Site for dam lowering, upstream flood storage, removal of the walking path near Valley Athletic Club, and the watershed floodplain reconnection near Pioneer Park, so these components were removed from further consideration.

Flood mitigation components that form the basis for alternatives development include a flood channel, benching, and relocation of the power substation in conjunction with lowering of the ground elevation directly below the Capitol Blvd overpass. Each component was able to demonstrate independent flood reduction potential and when combined with other components the potential for flood reduction is increased.

To reduce flooding extents for the 2022 storm (close to a 10-year event) an alternative that combines a flood channel with benching protects the portion of the Olympia Brewery Site east of the railroad from flood inundation. While alternatives do provide reductions in flood depth for the 100-year event none of the alternatives remove flooding from the eastern portion of Olympia Brewery Site altogether. This is attributed to two factors: lack of conveyance capacity near the driving range and the remaining contraction of flow width at the Capitol Blvd Bridge. All modelled alternatives can reduce the potential for flooding on the Olympia Brewery Site east of the existing railroad but cannot completely remove the potential during a 100-year flood event. Additional flood protection measures could be considered to further improve redevelopment potential at the Brewery Site.

Additional measures may include a flood wall near the railroad and/or fill placement in conjunction with a proposed redevelopment at the Brewery Site to achieve a finished floor elevation above the 100-year base flood elevation in accordance with development standards. In addition, modifying the grading around the Tumwater Golf Course Driving Range may also improve 100-year flooding conditions at the Brewery Site. It should be noted that if the channel or benching alternative were to be implemented, there would be an abundance of fill available from the excavation (approximately 125,000 cubic yards from the Alternative 10B estimate). This fill could be utilized to increase the elevations of the brewery property, raising it out of the 100-year floodplain elevation. Implementing a balanced cut and fill strategy at the site would require further modeling of the specific redevelopment alternative and the strategy would require regulatory support for cut and fill operations within the floodplain of the Deschutes River. This next step that considers specific redevelopment approaches should be coupled with other efforts like the E Street Bridge Project to develop an inclusive and feasible redevelopment strategy for the Olympia Brewery Site.

1.0 INTRODUCTION AND BACKGROUND

This report summarizes the Deschutes River Flood Reduction Study (Study) performed by Stantec, Inc. for the City of Tumwater (City), Washington. The Tumwater community desires to understand flood mitigation alternatives to support urban redevelopment of key parcels such as the Olympia Brewery Site within the community. This Study leverages hydrologic modeling from previous studies on the Deschutes River to develop a two-dimensional hydraulic model of the river. Hydrographs are developed from USGS Gaging Stations to quantify the effects of storage on storm volumes over time. The detailed hydraulic model is calibrated to known flooding events to confirm that the extents and depth of existing flooding are consistent with past flooding evidence and to test redevelopment concepts. This Study was completed with the City of Tumwater and other key partners. This Study shared all drafts with Squaxin Island Tribe and received their input. This Study is funded through a grant administered by the State of Washington Department of Ecology in support of flood reduction alternatives identification and redevelopment of the Historic Olympia Brewery Site (see **Section 1.2**). The Olympia Brewery Site was part of the larger Olympia Beer company that operated on the banks of the Deschutes River from 1896 until 2003. In the twenty years since the brewery closed, the bottling and shipping warehouses on the southeastern portion of the site have sat empty and unused. Efforts to transform the area have been in the works for several years, including the 2016 Deschutes Valley Property Master Plan (a precursor study to this effort) and the City of Tumwater's 2014 Brewery District Plan. One of the largest projects identified in the Brewery District Plan is the E Street Connection project.

The E Street Project is intended to reduce congestion and includes construction of a bridge over the project area replacing the current E Street Bridge with one that connects Capitol Boulevard to Cleveland Avenue. The scope of this Study is limited (see **Section 1.1**), and additional analysis and design will need to be completed to ensure that the flood reduction goals align with other projects and efforts in the study area. Investigation of legacy contamination at the site will be supported by a $500,000 Brownfields grant that the City of Tumwater received in spring 2023 from the U.S. Environmental Protection Agency.

This funding will support assessments to identify site contamination in buildings and the environment and to propose management options for cleanup. The alternatives considered in this study do not address site contamination and it should be anticipated that cleanup operations at the Olympia Brewery Site, if necessary, will be completed before or during implementation of flood reduction alternatives. Site modifications that remove asphalt or concrete paving should not be completed until the nature and extent of subsurface contamination is understood and mitigated to the satisfaction of state and local agencies. This is critical since the nature of flood reduction strategies would increase the potential for infiltration of surface water from the Deschutes River into existing site soils which has the potential to adversely affect legacy contamination.

1.1 STUDY PURPOSE AND SCOPE

The purpose of this study is to develop a detailed understanding of the potential flood risk of the Deschutes River between Pioneer Park and Henderson Blvd and then utilize the understanding to development flood mitigation alternatives to facilitate redevelopment of key parcel. For this study, the most significant key parcel is the historic Olympia Brewery Site. The purpose of this study is to identify flood reduction alternatives that allow for redevelopment of the historic Olympia Brewery Site. Flood reduction alternatives are developed through hydraulic modeling to understand and calibrate existing flooding patterns within the study area. Once existing conditions are understood the existing conditions model is modified to incorporate specific interventions within the study area that may engender flood reduction at the brewery site and facilitate redevelopment. Flood reduction alternatives may represent single or multiple flood reduction components intended to result in varying degrees of flood reduction potential at the brewery site to support different levels of redevelopment. This Study is intended to support planning level decision making. Flood reduction alternatives are presented along with a consideration of regulatory pathways to gain approval for each alternative. Additional analysis and design will be required to establish feasibility of a flood reduction alternative to support a specific redevelopment approach at the Olympia Brewery Site.

The alternatives contained within this report were developed with the intention that multiple benefits (ecological, recreational, social, etc...) could be incorporated into the alternatives in the next phase of the project. For example, the geometry of proposed flood channels or terracing could be altered to have more diverse hydraulic conditions as long as the conveyance is approximately equal. We have also assumed high roughness in the flood channels assuming that native riparian and wetland species could be planted within the channels. Finally, public access trails and river access could be incorporated into these features while still maintaining flood benefit.

Also, as part of this study, the information obtained from the detailed two-dimensional model is utilized to estimate potential erosion risk areas. A qualitative risk assessment associated with bank erosion within the project site is presented utilizing velocity and shear stress information from the hydraulic model.

1.2 STUDY AREA AND DESCHUTES RIVER WATERSHED

The Study Area for this effort extends from 1,700 feet downstream of Tumwater Falls at River Mile 0 to River Mile 5 which is approximately 12,000 feet upstream of the Henderson Blvd Bridge. The redevelopment focus of this effort is the southern portion of the Historic Olympia Brewery Site. Due to the presence of the railroad and proximity of the river on the west side of the Site, flood reduction alternatives are focused on the west side of the Site and redevelopment is envisioned on the eastern portion of the property. **Figure 1** provides a visualization of the Historical Olympia Brewery Site and surround area, and **Figure 2** provides a visualization of the entire study with locations discussed in throughout this report called out. The purpose of these figures are to aid in the reader's understanding of references in this report.

DESCHUTES RIVER FLOOD REDUCTION STUDY

Introduction and Background

The Deschutes River watershed is made up of 143 streams totaling 256 linear miles. The basin begins at an elevation of 3,870 feet on Cougar Mountain and encompasses approximately 170 square miles of the Cascade foothills, draining to the north and west and ending at sea level at Capitol Lake in Olympia, Thurston County, Washington. The main stem of the Deschutes River flows 52 miles before reaching Capitol Lake and eventually the Budd Inlet of the Puget Sound.

The climate in the basin is characterized by cool, dry summers and mild, wet winters. Due to the varied relief within the watershed, temperature and precipitation vary with elevation, but overall temperatures average 60 to 70 degrees Fahrenheit in the summer and 30 to 40 degrees Fahrenheit in the winter. Precipitation within the basin falls primarily as rainfall with some snow at high elevations, resulting in peak flows during the winter months when heavier precipitation occurs. According to the U.S. Geological Survey (USGS), the average annual precipitation within the Deschutes River watershed is approximately 60.5 inches. As part of this Study climate change scenarios are considered for 2040 and 2080 based on the Washington Department of Fish and Wildlife web application “Culverts and Climate Change”. It anticipated that this region will experience increased heavy rain events via climate change which will result in a higher potential peak discharge within the Deschutes River.

As part of the 2016 Deschutes Valley Property Master Plan Cardno (now part of Stantec) completed a rapid geomorphic assessment to examine the processes shaping the environment in the study area. Geomorphic conditions in the study reach were examined using existing reports, topographic data, historical maps, and aerial photographs. Data sources included 2002 light detection and ranging (LiDAR) data from the Puget Sound LiDAR Consortium (PSLC), a General Land Office (GLO) survey plat map from 1854, and aerial photographs from 1968, 1956, and 1941 obtained through the USGS. The latter was georectified in ArcGIS with 2011 aerial photos from the U.S. Department of Agriculture National Agricultural Inventory Program (NAIP) with an error of 3 feet. The unvegetated channels from the 1854 plat map and 1941 and 2011 aerial photographs were digitized at a scale of 1:3,000 using ArcGIS. The average unvegetated channel width (the area frequently disturbed by river flows) in the project site is approximately 60 feet, and the average valley width is about 1,400 feet. The valley was defined as the land surface no more than 10 feet above the channel elevation, which coincides with the clear slope break at the glacial terrace as seen in the LiDAR. The channel confinement (ratio of valley width to channel width) is low; there is little natural topographic restriction to channel movement other than the western valley bedrock.

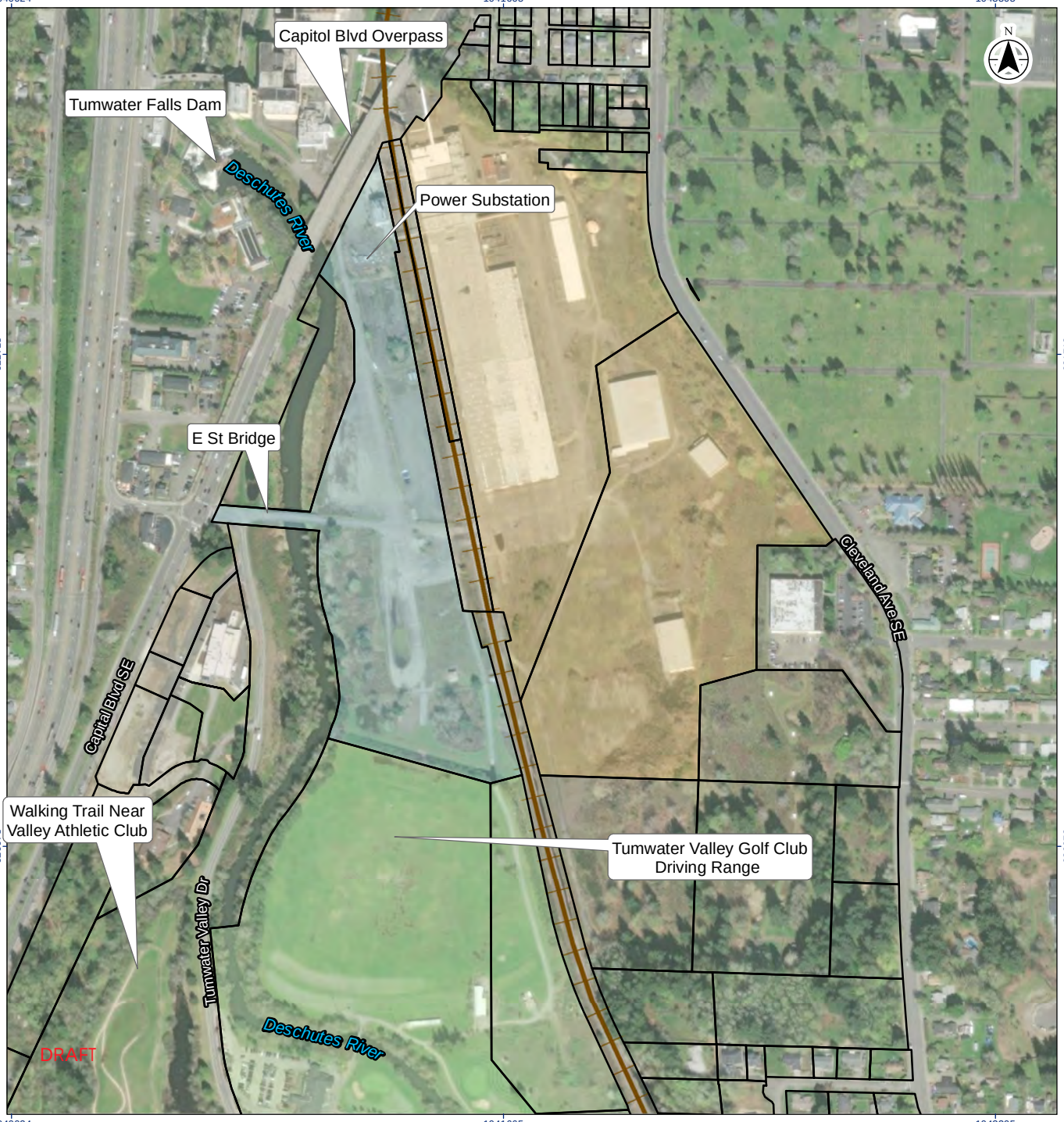
1.3 STATE AND LOCAL STAKEHOLDERS

The success of developing this document is attributed to many individuals who contributed their professional expertise and shared belief that with appropriate planning, the public's safety, quality of life, and environmental health can be maintained for the citizens of the City of Tumwater and Thurston County. Our sincere appreciation is extended to the following governmental bodies, agencies and individuals for their help and perspective while developing the Deschutes Flood Reduction Study.

Table 1 – Project Stakeholders

Name(s)	Organization
Meridith Greer	Greer Environmental Consulting
Dan Smith	City of Tumwater
Grant Gilmore	City of Tumwater
Stan Osborn	City of Tumwater

Name(s)	Organization
Alex Rosen	Department of Ecology
Erica Marbet	Squaxin Island Tribe
Kyle Cronk	South Sound YMCA



Legend

- Railroad
- Parcel Boundary
- City of Tumwater Parks
- Olympia Brewery Site - Floodplain Area
- Olympia Brewery Site - Redevelopment Area

0 200 400 Feet

CITY OF TUMWATER

Project Location
City of Tumwater
Thurston County, Wa

Prepared by JZ on 2023 - 06 - 22
Technical Review by ZW on 2023 - 06 - 26
Independent Review by JR on 2023 - 06 -26

Client/Project
City of Tumwater
Deschutes River Flood and Erosion Reduction Study

Figure No.
1

Title
Historic Olympia Brewery Site Map

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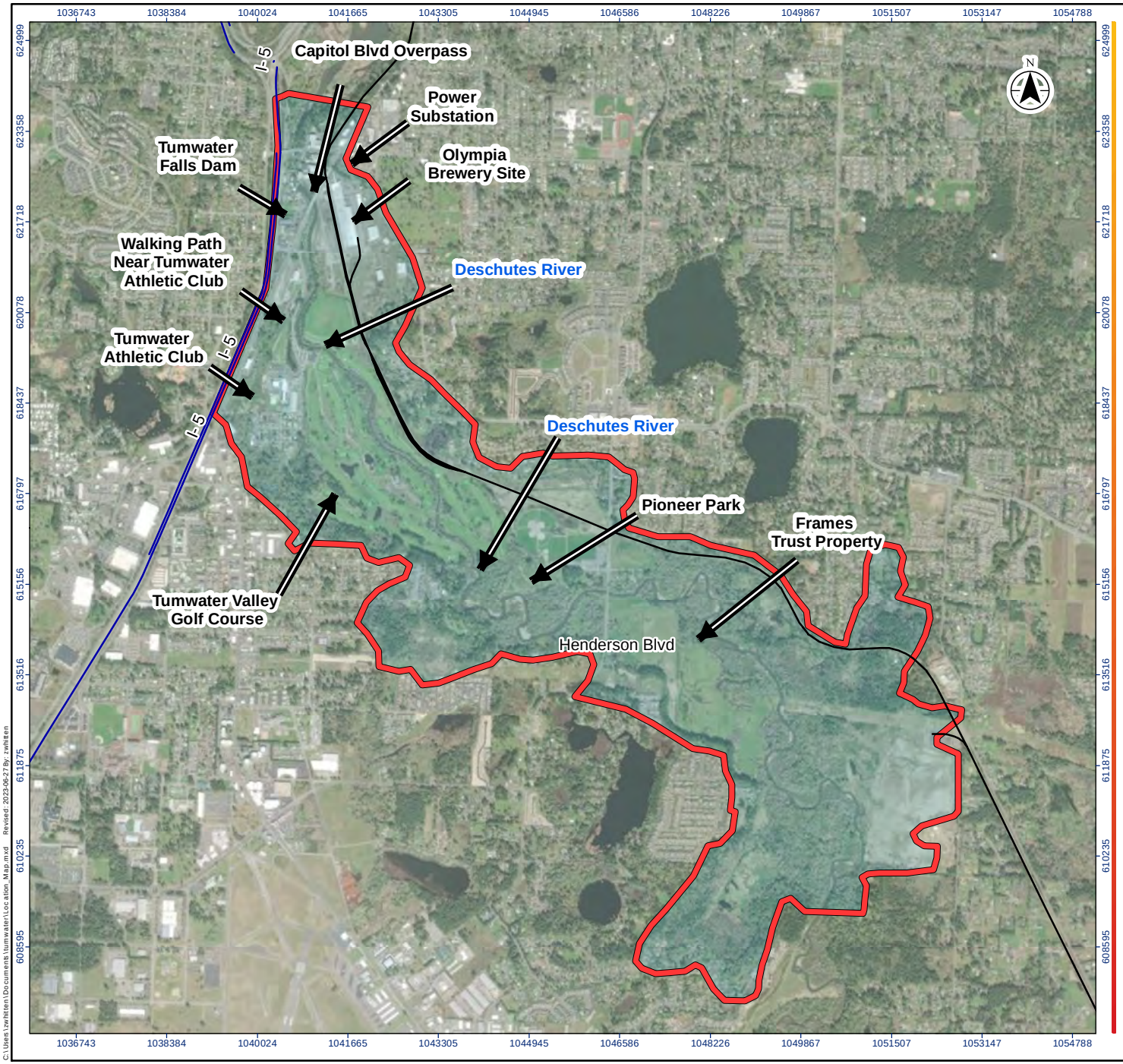

Figure No.
2

Title

Vicinity Map

Client/Project
City of Tumwater
Deschutes River Flood and Erosion Reduction Study

Project Location:
City of Tumwater
Thurston County, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 -26

0 0.25 0.5 Miles

1:31,680 (At Original document size of 8.5x11)

Legend

- Railroad
- Interstate
- HEC-RAS Domain

CITY OF TUMWATER

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2.0 LITERATURE REVIEW AND PROJECT CONCEPTUALIZATION

2.1 PREVIOUS STUDIES

Prior to the commencement of this study, two studies had been completed in and around this area that had some significant information that would be utilized for this study. Below provides a brief summary of the previous work:

1. Effective FEMA Study – FEMA developed a detailed hydrologic and hydraulic analysis of the Deschutes River that was completed in 2014. The study utilized gage analysis to determine flood flow frequencies and a one-dimensional HEC-RAS model to determine base flood elevations (BFE's). The study also completed detailed bathymetric survey of the Deschutes River and structures such as bridges along the study reach.

   For Stantec's analysis for this study, the bathymetric survey, structures survey and part of the gage analysis will be utilized.

2. Brown and Caldwell completed the "Deschutes Valley Property Master Plan" in 2016. The intent of the Master Plan was to create a River2D Hydraulic model to investigate concepts for flood mitigation. As part of this study, Brown and Caldwell utilized hydrology and hydraulic modeling completed by Cardno (now part of Stantec) to develop the alternatives for the Master Plan. Cardno created the "Deschutes Valley Master Plan Geomorphic and Hydrologic Analyses" technical memorandum to summarize the findings of the geomorphology and hydrology of the study area.

   For this Deschutes Flood Reduction Study, Stantec will utilize the updated hydrology developed in the Cardno study. In addition, the results of the analysis will be reviewed to determine which alternative did and did not work according to the modeling and will dive deeper into those that illustrated benefit.

2.2 CURRENT ZONING, LAND USE AND DEVELOPMENT STANDARDS REVIEW

Land use, zoning, and development standards within the Study Area are investigated and reported on in **Appendix B**. The Land Use and Zoning Summary Report is a stand-alone document that identifies regulatory requirements that would affect implementation of flood reduction alternatives and redevelopment activities. The report is structured to support planning level decision making by summarizing the local regulatory framework within the Study Area using maps and land use and zoning descriptions to facilitate an understanding of what would be required for implementation of both flood reduction alternatives and redevelopment actions. Please refer to Appendix B for more information.

3.0 DATA SOURCES

To the extent practicable Stantec leveraged existing data sources and available studies to inform this effort. Data sources that were utilized as part of this Study are described below.

3.1 HYDROLOGIC DATA

Cardno (now part of Stantec) created the "Deschutes Valley Master Plan Geomorphic and Hydrologic Analyses" Technical Memo in June of 2015. As part of the Cardno analysis, previous studies were examined in conjunction with a new Log-Pearson Type III statistical analysis of the annual peak flows of the gaging station on the Olympia Brewery Site (USGS 12080010) through 2013. The results of the analysis generated estimates for the 1.5, 2, 10, 25,100 and 500-year recurrence interval (RI). **Table 2** summarizes the flood flows and the source of the estimated flow at the project site according to the 2015 memo. It should be noted that even through the 2015 memo states that the 10- and 25- year storm recurrence interval was computed by Cardno as part of the study, the final summary table states that the effective FEMA flows were utilized for these events. This study will use the flows as stated in the final summary of the memo without change. **Appendix A** Contains the Deschutes Valley Master Plan Geomorphic and Hydrologic Analyses" Technical Memo.

Table 2 – Flood Flows at Project Site

Recurrence Interval (years)	Peak Flow (cfs)	Source
1.5	3,566	2015 Cardno Study
2	4,418	2015 Cardno Study
10	7,476	Effective FEMA 2014 FIS
25	9,116	Effective FEMA 2014 FIS
100	10,144	2015 Study STARR II
500	14,752	Effective FEMA 2014 FIS

3.2 FLOW AND STAGE HYDROGRAPH DATA

The United States Geological Survey (USGS) established a stream gage on the Deschutes River at the E Street Bridge located within the study area in October of 1990. The gage is USGS No.12080010. Since the establishment of the gage, the gage has been recording the discharge of the Deschutes River at the site in 15-minute time intervals. Since 2007, the gage has also been recording the stage of the Deschutes River in 15-minute time intervals. The available information for stage and flow hydrographs was downloaded from the USGS National Water Information System (NWIS) Web Interface for the December 2007, January 2009 and January 2022 storm events. This information will be utilized to calibrate the base conditions modeling for this study. **Appendix A C**ontains the raw data download from the NWIS Web Interface.

3.3 CLIMATE CHANGE DATA

The Washington Department of Fish and Wildlife created a web application called “Culverts and Climate Change” to help identify the anticipated increase in peak discharge within various watercourses due to climate change. Stantec utilized the web application to determine what the anticipated increase in peak discharge would be for the Deschutes River for year 2040 and 2080. According to the web application results, the peak discharge for the estimated 100-year flood event Deschutes River within the study area is anticipated to increase by 28.7% and 35.5% for the years 2040 and 2080, respectively. As such, the 100-year peak discharge for the Deschutes River will increase from the current 10,144 cfs to 13,055 cfs and 13,745 cfs by years 2040 and 2080, respectively. It should be noted that the web application does not take into account storage and regulation such as dams in the in the watershed. Storage and regulation may limit the increase in the estimated peak discharge.

The results of the web application can be found in **Appendix A.**

3.4 TOPOGRAPHIC DATA

The USGS published Quantity Level 1 lidar point cloud data for the Western Portion of Washington that was flown in 2016 in 2017. This data has a Vertical Accuracy RMSEz of 10 cm. The lidar point cloud data was downloaded and utilized to create a 3-ft Digital Elevation Map (DEM) raster for the study area. The lidar-based data was provided to Stantec by the City of Tumwater. The raw lidar-based DEM can be found in **Appendix A.**

3.5 AERIAL IMAGERY

The Washington Geospatial Open Data Portal has a collection of aerial imagery that has been collected since the 1980’s available online. For this study, Stantec downloaded the “2020 Statewide Imagery” data that was published in December of 2020. This data will be utilized to determine the existing conditions landuse for the hydraulic modeling of this study. This aerial imagery will be utilized for this study and can be found in **Appendix A.**

Also, as part of this study, Stantec reviewed the aerial imagery of the study area since 1980 to determine the history of erosion of the Deschutes River in this area. Using the Washington Geospatial Open Data Portal, Stantec downloaded aerial imagery from 1980, 1990, 1999, 2000, 2003, 2006, 2008, 2009, 2011, 2013, 2015 and 2017 for this analysis. These aerial imagery files can be found in **Appendix A.**

3.6 FIELD RECONNAISSANCE

Stantec personnel performed a field reconnaissance for the study area on Monday, September 26, 2022 and Tuesday, September 27, 2022.The purpose of the visit was to obtain a better understanding of stream characteristics by observing and photographing the surrounding streambed characteristics and overbank characteristics for use in Manning's n-value determination, observe potential erosion hazard locations, perform field survey for transects within Deschutes River and take measurements of structures.

Appendix A provides the site photos detailing the locations visited and observations recorded during the field reconnaissance.

During the site visit, Stantec's team was able to take 8 transects within the Deschutes River. The intent of the transects was to understand the channel geometry of the Deschutes River and its conveyance capacity. Lidar does not have the ability to accurately penetrate water and therefore the lidar cannot accurately represent the Deschutes River channel geometry below the surface of the water. Therefore, the 8 transects were utilized to provide that understanding.

It should be noted that the Stantec has initially planned to take 10 transects within the study area. However, there multiple locations in which access to the Deschutes River was not obtainable due to the private property or unsafe conditions. Therefore, Stantec performed the survey at only the locations that were accessible. **Appendix A** contains the survey data performed for this study.

4.0 EXISTING CONDITIONS ASSESSMENT

The following sections provide a summary of the assumptions, methodologies, procedures, data sources and computations that were completed to identify the current flood risk conditions of the Deschutes River within the study area. For this study, the existing flood risk potential and erosion potential were investigated.

4.1 BASE MODEL DEVELOPMENT

A base hydraulics model was constructed to represent the existing conditions to adequately assess the current flood risk of the Deschutes River within the study area during various flood frequencies. For this study the United States Army Corps (USACE) hydraulic modeling software HEC-RAS was utilized. The model was calibrated to known storm events that have occurred in the study area to provide confidence that the model is accurately depicting the existing conditions. The following sections will discuss the development of the base model along with the calibration process.

4.1.1 Approach and Methodology

The hydraulic modeling methodology was developed in accordance with the US Army Corps of Engineers' (USACE) "HEC-RAS River Analysis System: Hydraulic Reference Manual" (USACE 2016), "HEC-RAS River Analysis System: User's Manual" (USACE 2016) and "HEC-RAS River Analysis System: 2D Modeling User's Manual" (USACE 2016).

Flow within the main channel of the Deschutes River within the study area acts in a typical, uniform manner during low flow events. However, when flood water exceeds the banks of the Deschutes River, the floodplain is wide and relatively flat and no longer acts in a uniform manner. As such a one-dimensional model is not adequate for accurately representing the potential flood patterns of the Deschutes River. Therefore, HEC-RAS v6.3.1's two-dimensional flow capabilities were utilized for the base model for this study.

No additional hydrologic analysis will be conducted as part of this study. The hydrologic data discussed in **Section 3.1** was used without change to assess the current potential flood flows of the Deschutes River within the study area. Climate Change potential was assessed using information from the State of Washington Discussed in **Section 3.2.** To develop inflow hydrographs for the HEC-RAS models from the hydrology in **Section 3.1,** historical gage records were utilized**.** Discussion on how this was accomplished can be found in **Section 0** below.

4.1.2 Parameter Development

The following sections provide details about the setup of the HEC-RAS two-dimensional model geometries and associated parameters.

4.1.2.1 Model Extents/Domain

The domain for this study was set to be 1,700 ft downstream of the Tumwater Falls Dam to approximately 12,000 ft upstream of Henderson Blvd for a total study reach of 5.2 miles. The Tumwater Falls Dam is assumed to have a significant impact to the hydraulics of the Deschutes River and potentially has an impact to the water surface elevation of the river at the Olympia Brewery Property during large flooding events. As such, the Tumwater Falls Dam needed to be within the hydraulic computation domain. However, the hydraulics of the stretch of the Deschutes River immediately downstream of the of the dam is extremely complex and is difficult to simulate with a boundary condition within HEC-RAS. As such, the model domain was extended 1,700 feet downstream of the dam to allow the model to simulate the complex hydraulics and thus a modeler estimated boundary condition would not have a potential impact to the results at the Tumwater Falls dam or the Olympia Brewery property.

Before the model domain was established, it was known that a potential alternative for this study would be flood storage in the floodplain upstream of the Olympia Brewery Property. As such, the upstream boundary condition needed to be in a location in which the Deschutes River is acting uniformly and one-dimensionally across the floodplain upstream of any potential flood storage locations. This would allow for an accurate representation of how much flood depth was within the main channel of the river and how much was in the overbanks upstream of the potential flood storage location. Prior to the commencement of the modelling, Stantec was made aware that the Frame Trustee Property upstream of Henderson Blvd may be a location where flood storage was feasible. Given this knowledge, the location 12,000 ft upstream of Henderson Blvd was selected as the upstream boundary of the study. At this location, the Deschutes River floodplain narrows to a confined canyon and thus uniform flow is expected.

Figure 3 below illustrates the model domain extents.

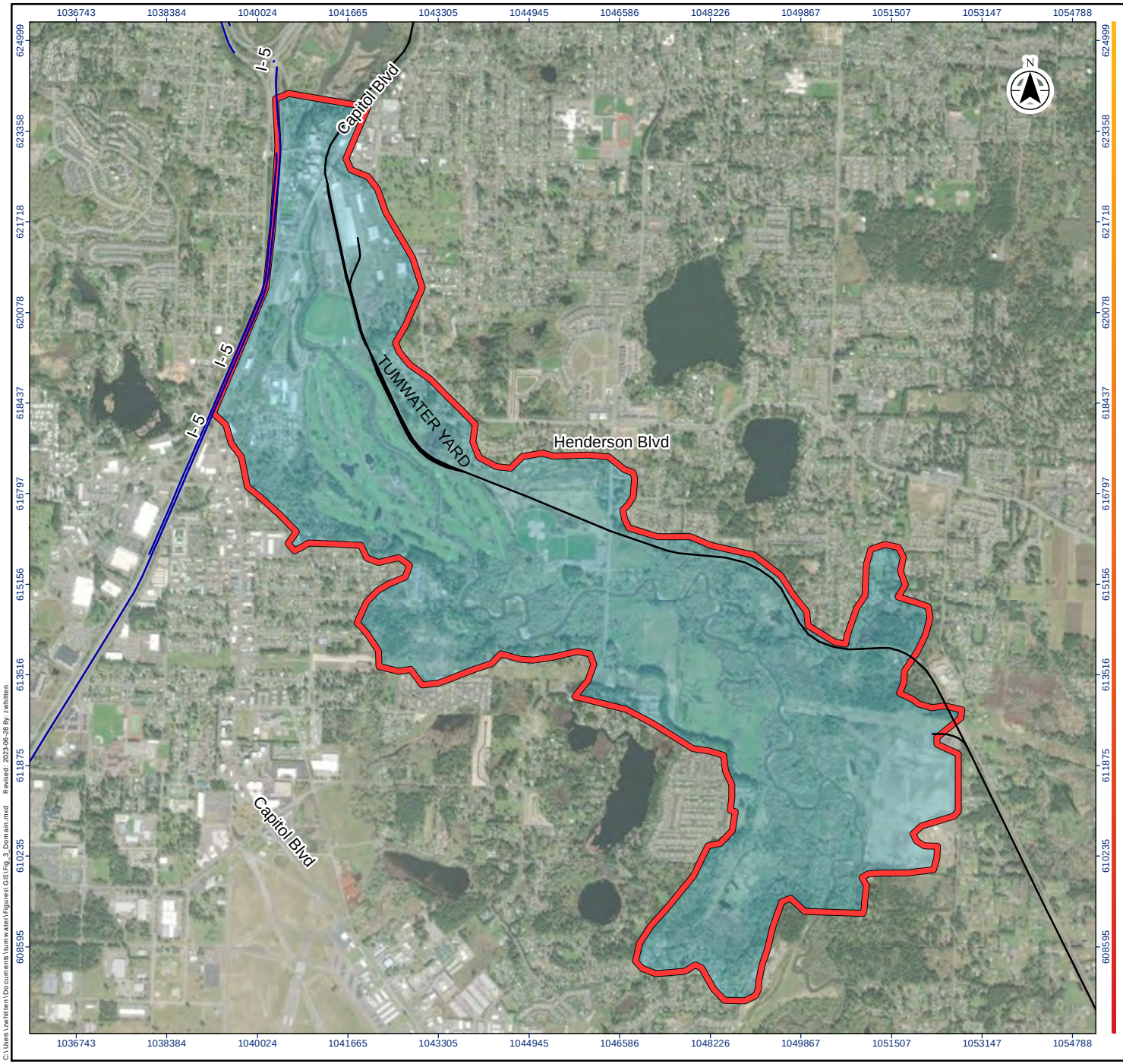

Figure No.
3

Title

HEC-RAS Model Domain

Client/Project
City of Tumwater
Deschutes River Flood and
Erosion Reduction Study

Project Location:
City of Tumwater
Thurston County, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 -26

0 0.25 0.5 Miles

1:31,680 (At Original document size of 8.5x11)

Legend

- Railroad
- Interstate
- HEC-RAS Domain

CITY OF TUMWATER

Page 01 of 01

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4.1.2.2 Terrain and Terrain Modifications

To perform the two-dimensional flow analysis in HEC-RAS, the user must provide the simulation with a terrain data source in the form of a raster. Stantec utilized the lidar-based terrain dataset discussed in **Section 3.2** to create a 3-foot geotif to be utilized as the base terrain for this study. The terrain data used in the HEC-RAS model analysis is a 1-meter USGS Quality Level 1 (QL1) LiDAR dataset provided by City of Tumwater. The QL1 LiDAR data has a stated vertical accuracy of +/- 10 cm.

In the overbanks of the floodplain and surrounding area, no changes or modifications to the model were completed. However, lidar does not have the ability to accurately penetrate water and therefore the lidar cannot accurately represent the Deschutes River channel geometry below the surface of the water. To simulate the channel capacity of the Deschutes River more accurately, the channel geometry below the water surface must be added to the terrain.

The FEMA Floodplain Delineation model described in **Section 2.1** performed bathymetry survey of the Deschutes River at various locations within the study area. However, the study was completed in 2014 so it is assumed that the survey was completed around 2010 or 2011. Therefore, it is possible the channel inverts have changed due to scour and sedimentation within the channel. To determine if the FEMA study's bathymetric survey was still accurately representing the Deschutes River channel geometry and inverts, Stantec performed a field survey in September of 2022 as described in **Section 3.6**. The results of the field survey indicated that the bathymetric data from the 2014 FEMA model was still accurately representing the channel inverts and thus could be utilized to supplement the lidar-based terrain for the channel. As such, all survey from the 2014 FEMA model was incorporated in the terrain.

Stantec utilized HEC-RAS RASMapper-based tools to add the channel geometry from the 2014 bathymetric survey into the terrain. **Figure 4** below illustrates an example of the terrain modification in plan view and **Figure 5** illustrates and example of the terrain medication in profile view.

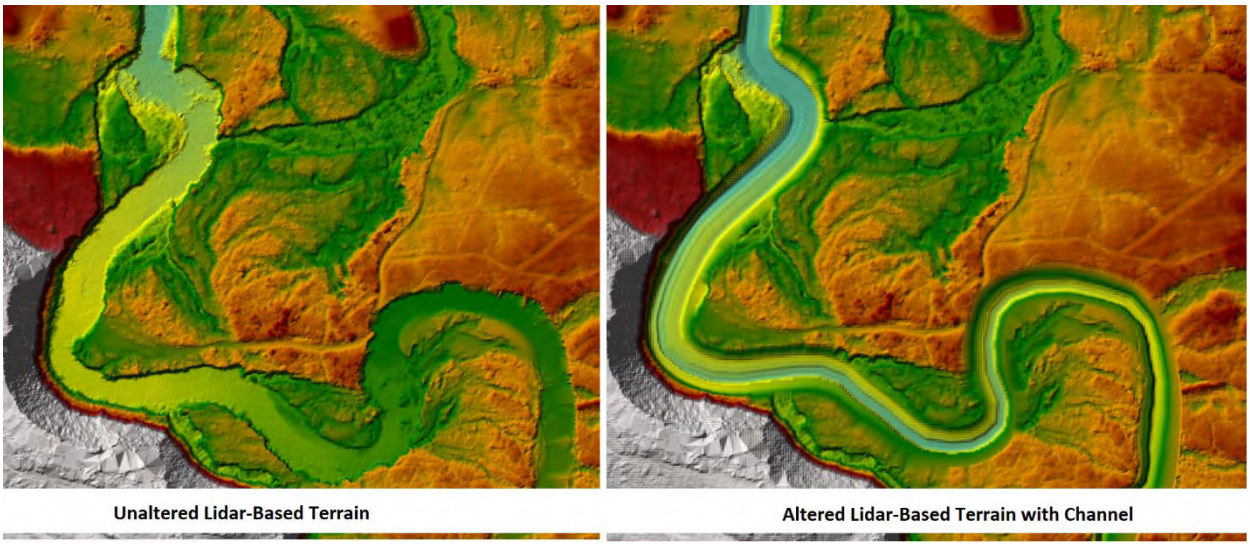

Figure 4 – Plan View Example of Terrain Modifications

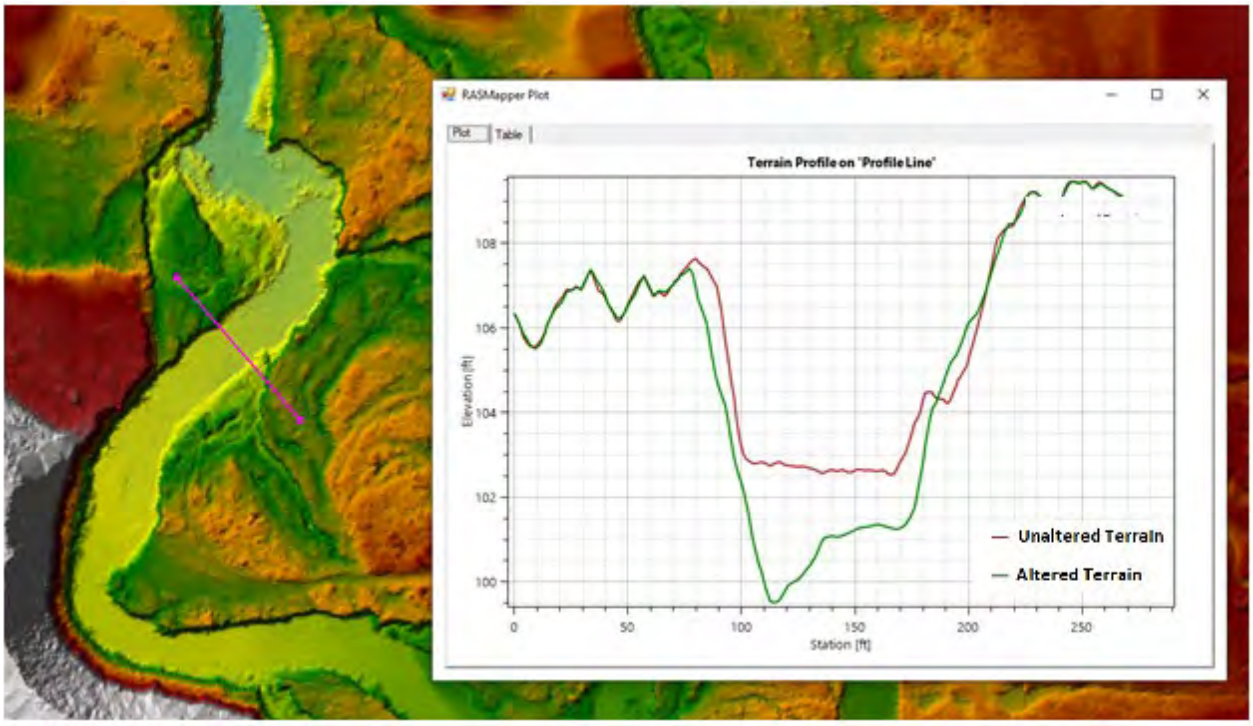

Figure 5 – Profile View Example of Terrain Modifications

4.1.2.3 2D Mesh and Breakline

Selection of the grid cell size is a function of the base mapping resolution, numerical stability, the need to capture man-made infrastructure and perceived accuracy of the model and model run time. The selection of a larger grid element size will allow for faster model simulation times, but it may not provide sufficient detail to provide an accurate estimate of the flood risk for critical areas in the watershed. Selection of a smaller grid element will increase the model run time and may provide a more detailed estimate of the flood risk conditions. If a model uses a grid size that is too small, it can introduce model stability issues.

To capture the fine detail needed to accurately simulate the potential flood hazard of the Deschutes River Floodplain, a 50ft-by-50ft base grid resolution was selected. The domain meshes are further refined by using the breakline feature in HEC-RAS. The purpose of the breaklines were to provide a better refinement to the mesh alignment and to create areas of smaller grid sizes to capture more detail where necessary such as channel banks and embankments. For mesh refinement, the breaklines were setup to realign the mesh faces in such a way that the high ground is captured by the mesh and flow cannot go from one side of the high ground to the other without exceeding a certain height. This prevents flow from "leaking" across cell faces. For the channel and ditches, the breaklines were aligned on the banks of the channel/ditch and a reduced grid size was set such that there were, at a minimum, two cells representing the channel. **Figure 6** below provides an example of the mesh alignment adjusted due to breaklines for this study.

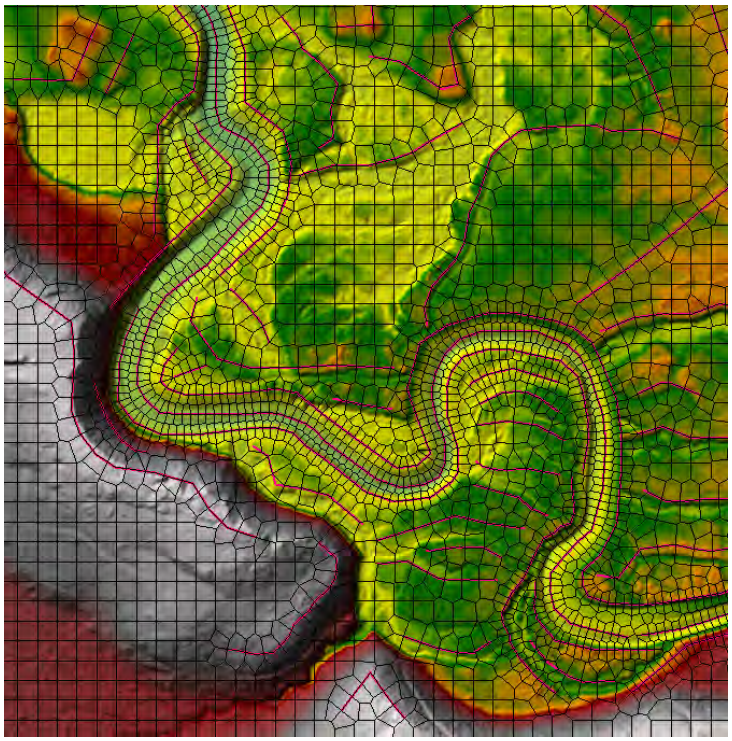

Figure 6 – Example of Mesh Refinement in HEC-RAS Domain

4.1.2.4 Manning's N-values

To represent the roughness coefficients or Manning's n-values for the studied streams and domains, a polygon shapefile was created which separated the project area into land use categories based upon the aerial imagery described in **Section 3.5** and the site reconnaissance described in **Section 3.6**. The values that were selected to represent the land use categories were taken from a combination of the United States Geological Survey (USGS) Water-Supply Paper (WSP) 2339 and the HEC-RAS user's manual which utilizes research conducted by Chow in 1959.

All Manning's n-values were based upon general observations of the project area but were adjusted utilizing survey photos and field reconnaissance observations, initially. However, the Manning's n-values were adjusted and validated based upon a calibration process utilizing a USGS gage at the E Street Bridge. **Section 4.1.3** describes the calibration process in more detail. The study Manning's n-values summarized in **Table 3** below are reflective of calibrated values. The shapefile digitized to represent the landuse for each study area can be found in **Appendix C**. **Figure 7** below provides an illustration of the Manning's n-values for the study area. It should be noted that buildings were represented in the HEC-RAS model using a Manning's n-value of 10. This value essentially creates a situation in the simulation in which flow is "blocked" once it reaches this grid and has the same effect as raised terrain.

Table 3 – Land Use and Corresponding Manning's "n"

Description	Manning's n
Channels	0.02 – 0.065
Brush	0.04 – 0.06
Building	10
Tree Cover	0.055 – 0.12
Grassland	0.035 – 0.045
Open Water	0.02
Pavement	0.02
Railroad	0.045
Residential	0.065

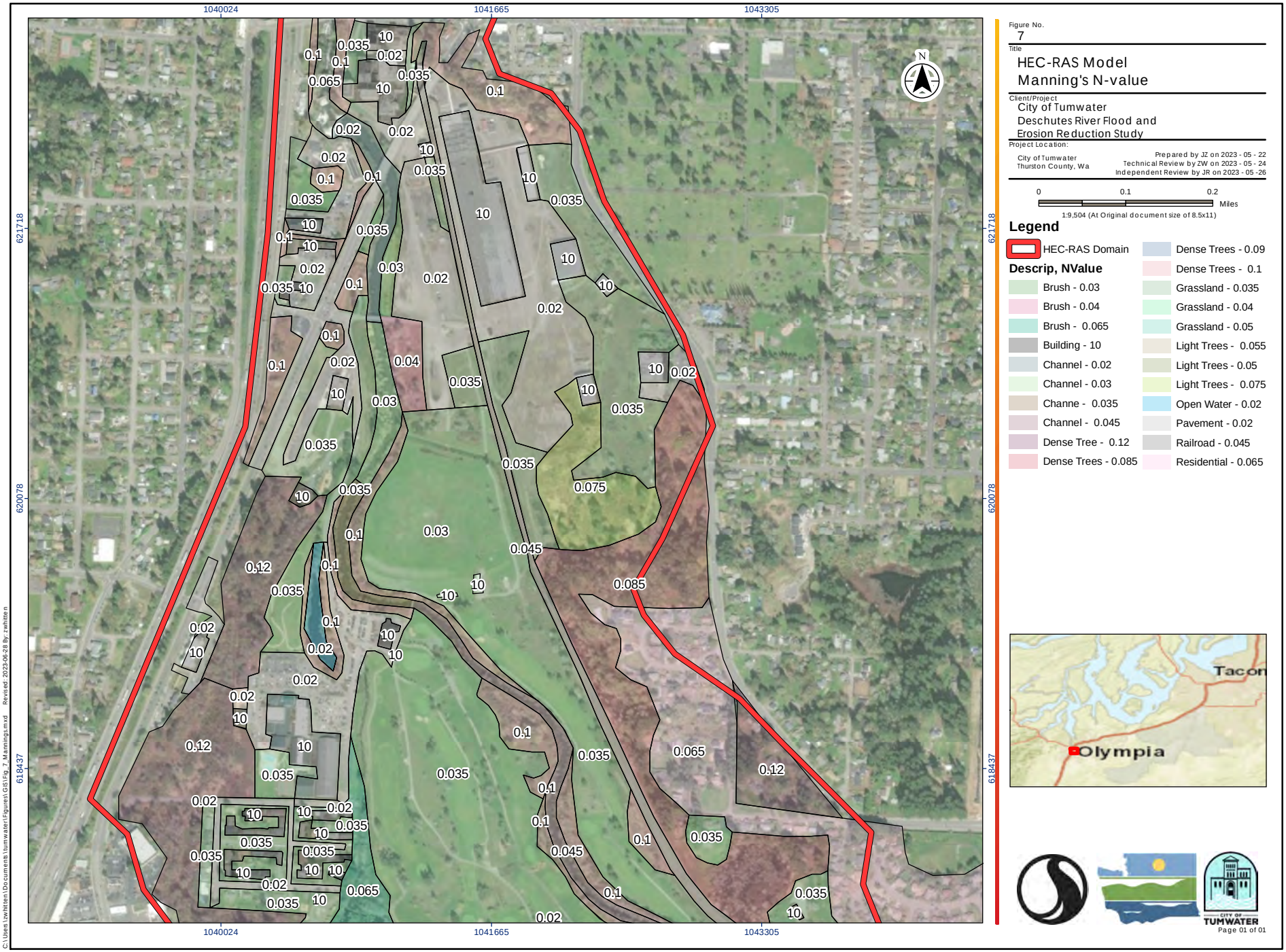

Figure No.
7

Title
HEC-RAS Model
Manning's N-value

Client/Project
City of Tumwater
Deschutes River Flood and
Erosion Reduction Study

Project Location:
City of Tumwater
Thurston County, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 - 26

0 0.1 0.2
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Legend

- HEC-RAS Domain

Descrip, NValue

- Brush - 0.03
- Brush - 0.04
- Brush - 0.065
- Building - 10
- Channel - 0.02
- Channel - 0.03
- Channe - 0.035
- Channel - 0.045
- Dense Tree - 0.12
- Dense Trees - 0.085
- Dense Trees - 0.09
- Dense Trees - 0.1
- Grassland - 0.035
- Grassland - 0.04
- Grassland - 0.05
- Light Trees - 0.055
- Light Trees - 0.05
- Light Trees - 0.075
- Open Water - 0.02
- Pavement - 0.02
- Railroad - 0.045
- Residential - 0.065

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4.1.2.5 Structures

FEMA funded a hydraulic model of the Deschutes River in 2014. For this study, FEMA performed detailed survey for the bridges over Henderson Blvd, Capitol Blvd, E Street Tumwater Falls dam, and the three golf cart bridges within the Tumwater Valley Golf Club golf course. The dimensions of the surveyed structures were reviewed and compared during the Field Reconnaissance described in **Section 3.6**. All structures, with the exception of the Capitol Blvd Bridge, compared very well and thus were leveraged into the two-dimensional model for this study without modification.

The effective FEMA model simulated the Capitol Blvd Bridge with a 230 ft opening and the entire right overbank as blocked by an abutment. During the Field Reconnaissance, it was discovered that the right overbank is not blocked and flow would be able to flow through the abutment unimpeded if the flood stage exceeded 104ft. Therefore, the Capitol Blvd Bridge was modified in the HEC-RAS model for this study to be reflective of the existing conditions. The pier size and shape and the spacing between piers was assumed to be consistent throughout the opening of the bridge and therefore 7 additional 4-ft circular piers were placed 90 ft apart within the new bridge. **Figure 8** provides an image of the effective FEMA model geometry of Capitol Blvd Bridge. **Figure 9** provides an illustration of the modified bridge geometry used for this study and **Figure 10** provides an image of the Capitol Blvd right overbank taken during the field reconnaissance visit.

Lastly, the effective FEMA model did not contain the 36” culvert that is present underneath Tumwater Valley Drive, just south of the Serendipity Academy. For this modeling effort, the 36” RCP culvert was added to the model using invert elevations estimated using the lidar-based terrain discussed in **Section 3.4.**

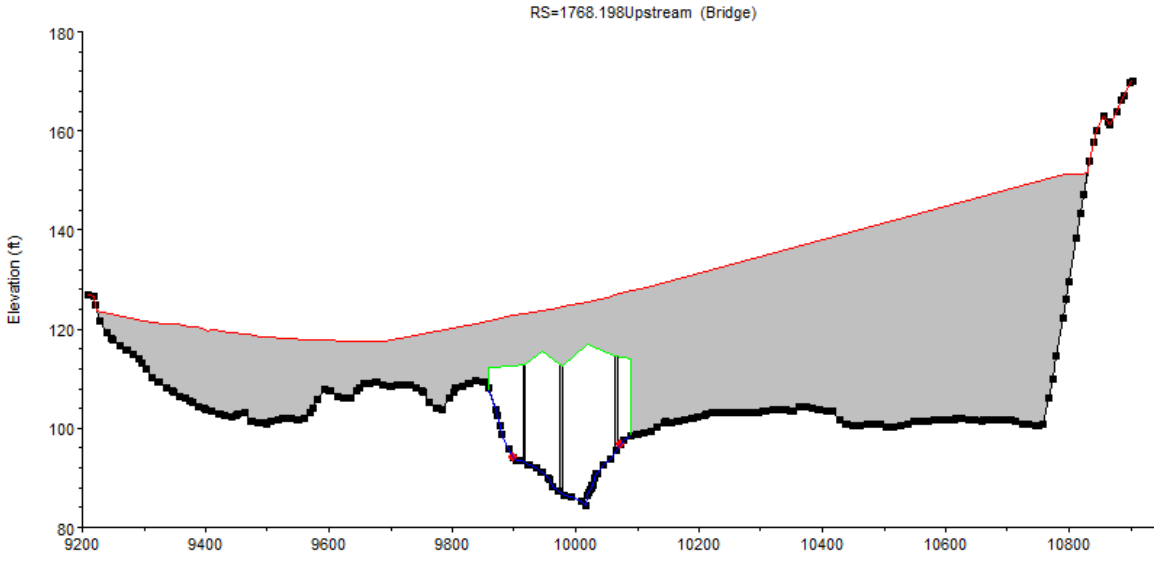

Figure 8 – Effective FEMA Model Geometry of Capitol Blvd Bridge

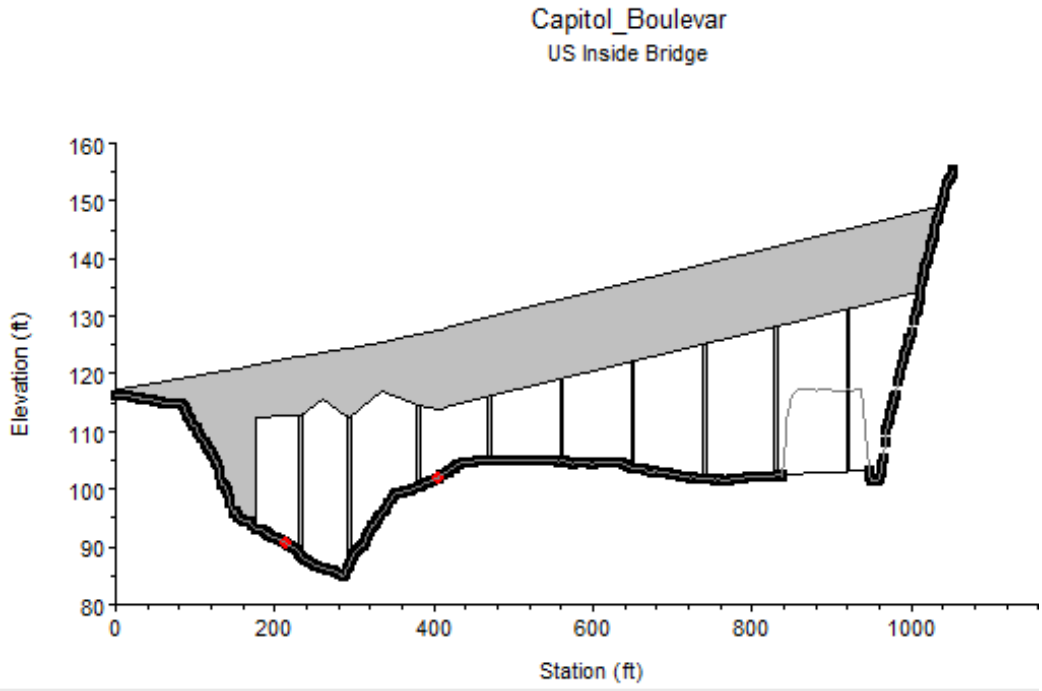

Figure 9 – Modified Bridge Geometry for Capitol Blvd Bridge Used for This Study

Figure 10 – Image of Capitol Blvd Right Overbank

4.1.2.6 Boundary Conditions

Flows are added (inflow) and removed (outflow) from the model domain through the use of boundary condition lines. For the outflow, a normal-depth assumption was applied to the downstream end of the model. As stated in the model domain portion of this report, the Tumwater Falls Dam has the potential to have a significant impact to the hydraulics of the Deschutes River therefore the extents of the model were moved 1,700 ft downstream of the falls. Though it cannot be confirmed that Deschutes River is acting in a "free-flow" condition at the location in which the downstream boundary condition was placed (free-flowing conditions is a requirement for the normal-depth assumption), the boundary condition is far enough downstream of the dam that the selection of normal depth will not impact the results of the model in the study area. The slope applied to the normal depth assumption utilized the LiDAR-based DEM to estimate the energy slope.

Upstream, an inflow hydrograph was utilized to simulate the flow entering the system. Details about the development of the hydrographs is discussed in **Section 0** below.

4.1.2.7 Hydrologic Data

No hydrologic analysis to determine the flood flows at the study site was conducted as part of this study. The flood flows from the 2015 Cardno (now part of Stantec) study discussed in **Section 3.1,** was utilized without change. However, the 2015 study did not develop inflow hydrographs that can be utilized for the HEC-RAS model. Since the two-dimensional capabilities of HEC-RAS was utilized as part of this study, an unsteady inflow hydrograph is required for the model to be simulated.

For this study, two different types of unsteady flow hydrographs were created: one synthetic flow hydrograph representative of an actual storm event and another that is considered to be a “steady-state” unsteady hydrograph. Performing a two-dimensional model in “steady-state” has multiple advantages, if applicable. It allows the simulation to estimate a peak stage and discharge throughout the entire system at one timestep. This allows the modeler to check the model for potential errors and numerical instabilities more efficiently. Typically, this approach also has the ability to allow the model to run for a shorter time duration and thereby shortening the model runtime. As such, the “steady-state” modeling approach is preferred if the overbank flooding is not volume driven. To accomplish a steady state hydrograph, the flow hydrograph is slowly and linearly increased from a base flow condition (around 500 cfs for this study) to the peak discharge of the flood event for the first 4 hours of the simulation (the slow increase was to minimize model instabilities in the beginning of the model. Once at the peak, the hydrograph remained at the peak discharge for over 4 hours. This allows the model to reach a “steady state condition” within the two-dimensional domain. The “steady-state” unsteady modeling was simulated for the 2-, 10-, 25-, 100-, and year events as well as the peak discharge for the 2022 event (details of the 2022 event are described in **Section 4.1.4.).**

To verify that the overbank flooding of Deschutes River in this study is not significantly affected by flood storage in the project area and thus a “steady-state” model would potentially overestimate flood depths, Stantec performed a test simulation using a synthetic flow hydrograph. The results indicated that the maximum difference in flow depth between “steady-state” and synthetic modeling was 0.1 ft and almost the entire area experienced less than 0.1 ft of difference. Given this result, it was concluded that the difference between steady-state and unsteady was nominal and thus steady-state could be utilized for this system.

Though the current system is not currently affected by flood storage in the project area as described above, it was known prior to the commencement of this study that a flood storage-based alternative may be a consideration for this project. Because a flood-storage based solution is volume-driven, the “steady-state” flow hydrograph methodology would not be applicable to determine the effectiveness of a flood-storage-based alternative. As such, a synthetic flow hydrograph was required for this study. To accomplish this, the most severe flooding event that was recorded by the USGS gage on E Street Gage (the 2009 event) was utilized. The 15-minute increments of the rising and receding limbs of the flood event was downloaded from the USGS NWIS Web Interface and then scaled to the 2-, 10-, 25-, 100- and 500-year events. **Figure 11** below provides an illustration of the synthetic hydrographs generated for this study. **Appendix C** contains the excel spreadsheet that was utilized to create the synthetic hydrographs.

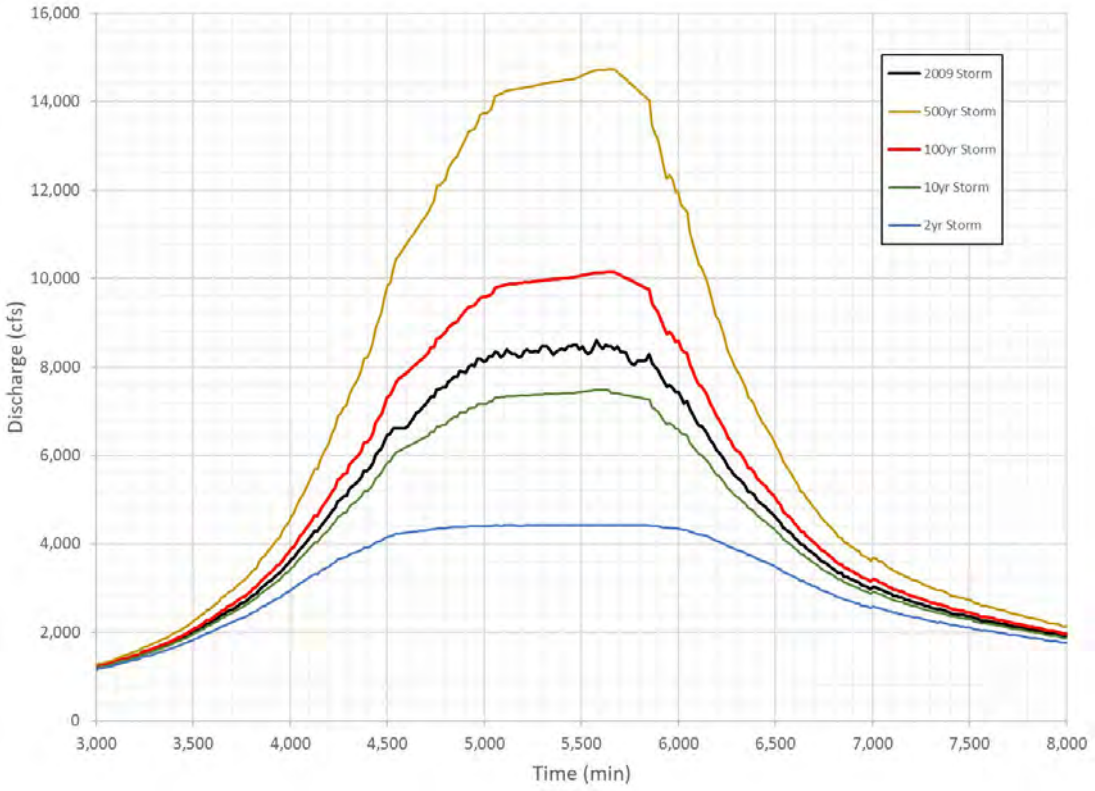

Figure 11 – Synthetic Flow Hydrograph for the Deschutes River

4.1.2.8 Model Computational Options and Tolerances

The modeling utilized unsteady modeling approaches. In the HEC-RAS program, the model user has the option to have a constant timestep in the simulation, or to have the timestep vary based upon the courant condition of the simulation. In Stantec's recent modeling experience, it has been observed that turning on the "adjust time step based on Courant" option creates potential numerical stability issues. These issues arise because just a single isolated cell located anywhere within the grid that experiences a high courant value is enough to trigger a timestep adjustment. This creates a situation where the timestep oscillates back and forth unnecessarily rather than a steady transition. As such, the team determined that modeling with a single time step and then reviewing the courant output in RASMapper to determine if the timestep needs to be lowered universally is the most efficient modeling approach. Ultimately, a fixed time step of 2 seconds was used to minimize instability while also considering runtime efficiency.

The Full Momentum (SWE-ELM) equation was used for calculations. This equation was set because it utilizes the most elements when computing the flood depths and is assumed to provide more accurate results compared to diffusive wave. Given the accuracy needs of this project, SWE-ELM was selected as the most appropriate equation set for this study.

4.1.3 Base Model Calibration

A base hydraulics model was constructed to represent the existing conditions to adequately assess the current flood risk conditions of the Deschutes River within the study area during various flood frequencies. To provide confidence that the model is providing an accurate representation of the existing conditions, the model was calibrated to known storm events that have occurred in the study area. The following sections will discuss the assumptions, methodologies, procedures, data sources and computations that were utilized to in the calibration process.

In the past 15 years, the Olympia Brewery has experienced significant flooding in 2007, 2009 and 2022. The original intent for the model calibration process was to utilize the stage and flow hydrograph information form the USGS E Street Bridge (no. 12080010) to calibrate the model to all three events. However, while reviewing the data from the USGS NWIS website, it was discovered that the 2007, 2009 and 2022 events had very similar peak stage recordings though the peak discharges were different. See **Table 4** below for a summary of the peak discharge and peak stages.

Table 4 – Peak Stage and Flow Recording at USGS E Street Gage (no. 12080010)

Date Recorded	Peak Flow (cfs)	Peak Stage (ft)
Jan 8, 2009	8,600	33.11
Jan 7, 2022	6,900	32.99
December 4, 2007	6,790	32.76

As shown in **Table 4**, though the peak discharge for the 2009 event is more than 20% (1,700 cfs) greater than 2022 event, the peak stage is only 0.12 ft different. The small difference in stage (0.12 ft) is significantly less than what would be expected from a 1,700cfs difference. Plus, it was observed that in 2009 there was significantly more flooding observed on the Olympia Brewery Property than the 2022 event. This provides more evidence that the gage height readings may be inaccurate for this gage.

Given the significant discrepancy in discharge and peak stage, it was determined that trying to calibrate the model to both events using the gage would not be possible. The changes to the model that would be required to make the model simulate the 2022 event accurately would lead to an overestimate of flooding for the 2009 event and vice versa. As such, calibration for multiple events was not carried forward.

Alternatively, the City of Tumwater provided Stantec with aerial photography of the 2022 event with timestamps provided for each photo. Given that the USGS gage provided stage and hydrograph information at real-world 15-min intervals, it is possible to correlate the flooding that is occurring in the provided photo to a peak discharge that is occurring with the Deschutes River. Therefore, the calibration process for base conditions model was centered around the 2022 event.

The 15-minute incremental data of the flow hydrograph of the 2022 event was downloaded from the USGS NWIS Web Interface and input into the HEC-RAS model as an inflow hydrograph. The model was then run with multiple iterations for various n-values for channel and overbank Manning's n-values. With each iteration, the Manning's n-values were refined to better match the known flooding conditions of the 2022 event. The number of iterations and changes is too great to state in this report. Instead, please refer to **Figure 7** and **Table 3** in **Section 4.1.2.4** for the final n-values in the area. **Figure 12 and Figure 13** provide illustrations of the final calibrated model results in comparison to the known flood photos from 2022. It should be noted that model results are taken at the same time as the photo timestamp. For instance, for **Figure 12,** the photo time stamp is 1/7/2022 at 11:19 AM and the model screenshot is for simulation time 1/7/2022 at 11:30 AM.

As shown in **Figure 12** and **Figure 13**, the results of the calibration illustrate that the model is doing an exceptional job simulating and reproducing the 2022 flood event. The simulated flood has a nearly identical flood extent as the actual 2022 event. This creates confidence that the modelling is an accurate representation of the current flooding potential of the Deschutes River at this location.

Flood Depth

feet

High : 5 ft +

Low : 0 ft

Project Location
City of Tumwater
Thurston County, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 -26

Client/Project
City of Tumwater
Deschutes River Flood and
Erosion Reduction Study

Figure No.
12

Title
Model Calibration
Location 1 Comparison

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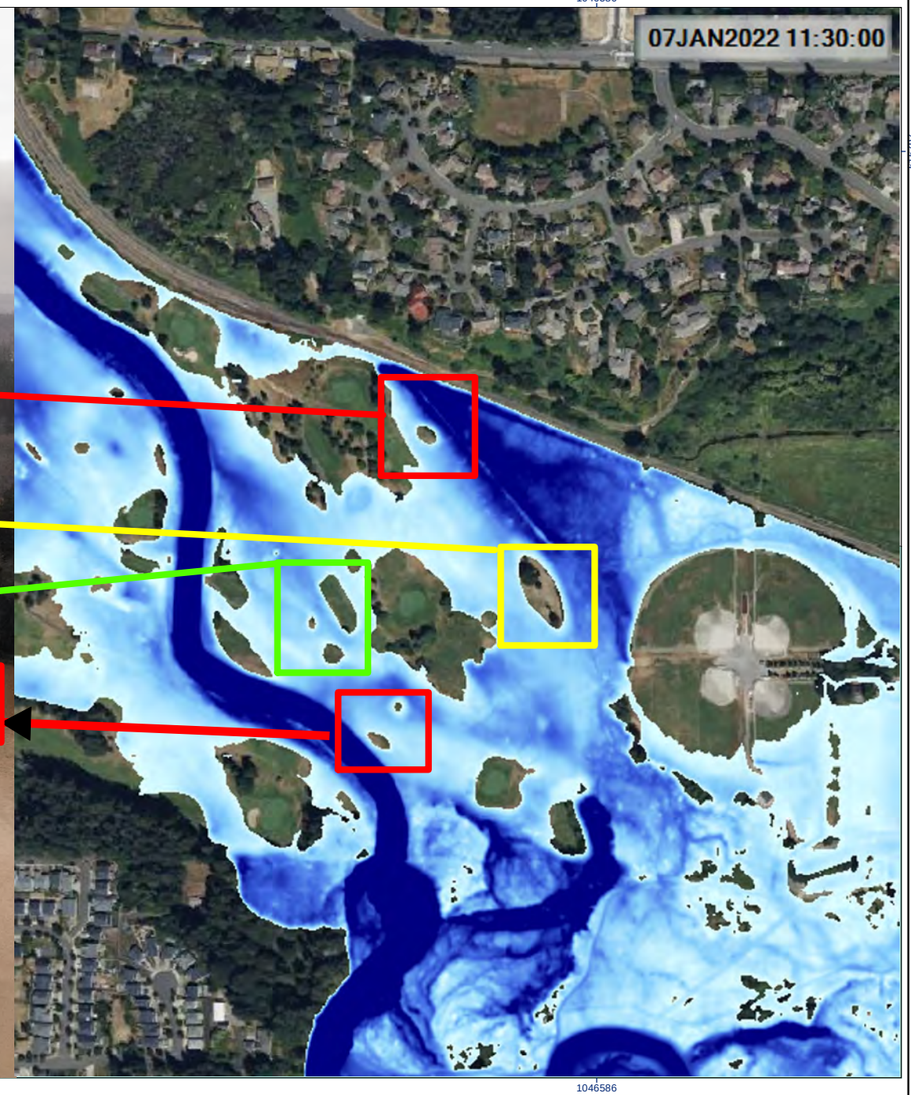

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1046586

Flood Depth

feet

High : 5 ft +

Low : 0 ft

Project Location
City of Tumwater
Thurston County, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 -26

Client/Project
City of Tumwater
Deschutes River Flood and
Erosion Reduction Study

Figure No.
12B

Title
Model Calibration
Location 2 Comparison

Page 01 of 01

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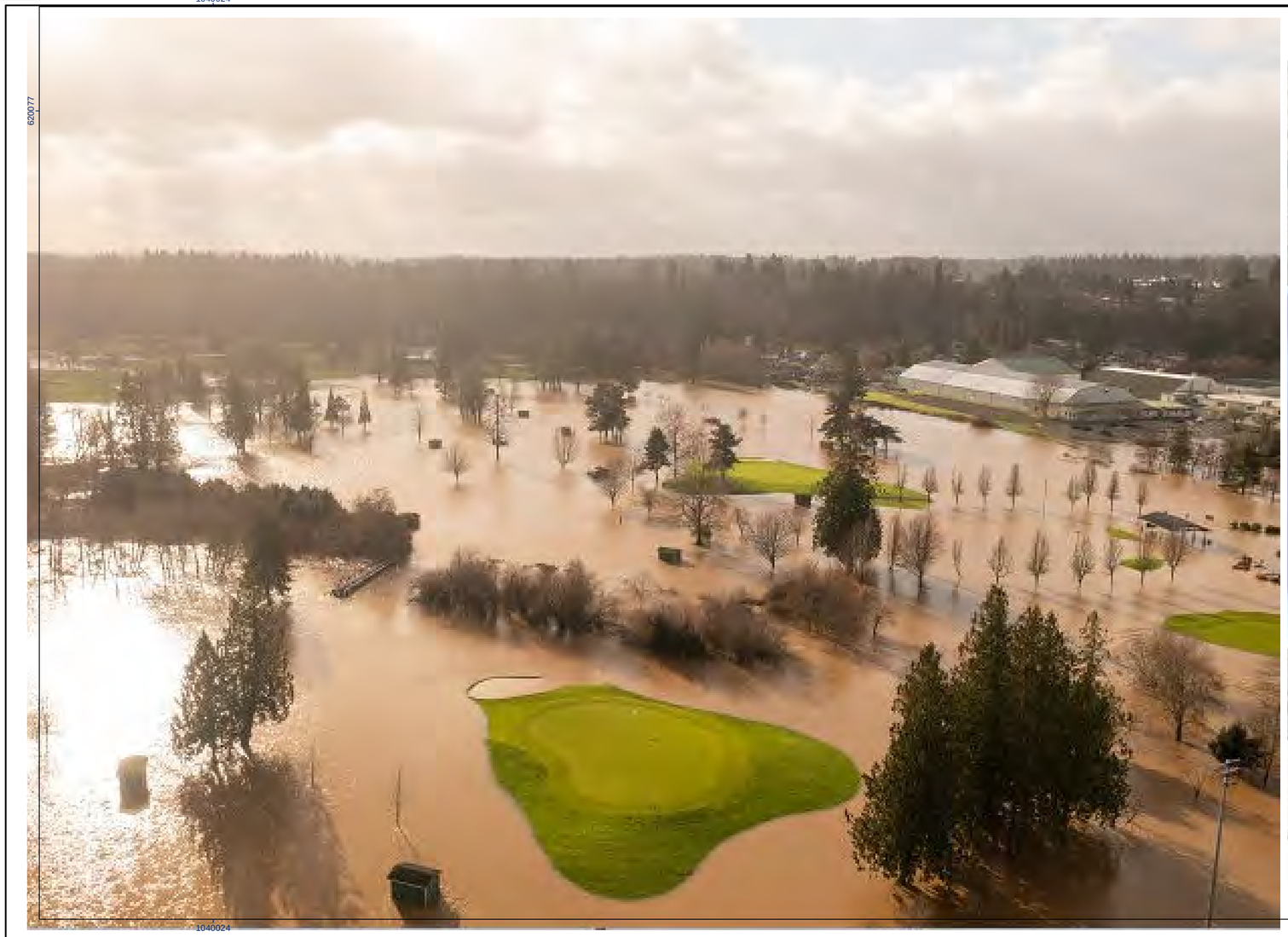

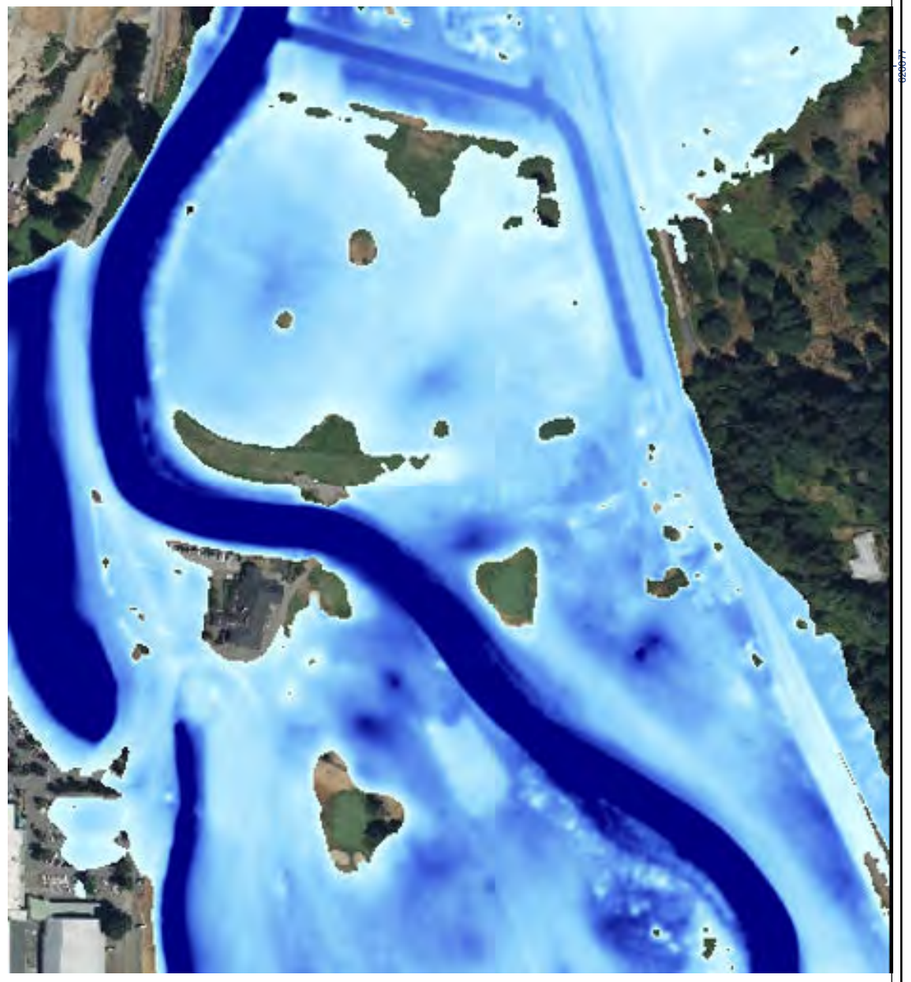

1040024 1043305

Flood Depth

feet

High : 5 ft +

Low : 0 ft

Project Location
City of Tumwater
Thurston County, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 -26

Client/Project
City of Tumwater
Deschutes River Flood and
Erosion Reduction Study

Figure No.
13

Title
Model Calibration
Location 2 Comparison

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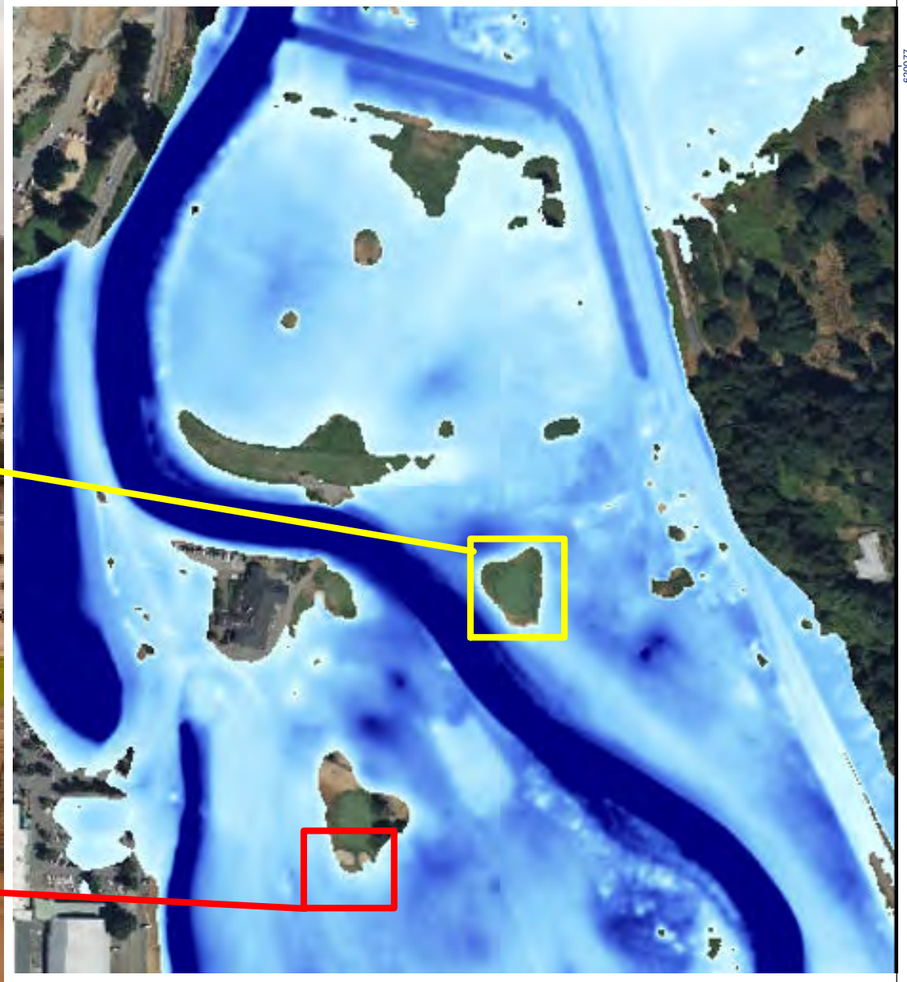

Flood Depth

feet

High : 5 ft +

Low : 0 ft

Project Location
City of Tumwater
Thurston County, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 -26

Client/Project
City of Tumwater
Deschutes River Flood and
Erosion Reduction Study

Figure No.
13B

Title
Model Calibration
Location 2 Comparison

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4.1.4 Base Model Results

The HEC-RAS model for the Base Conditions was simulated for the 2-, 10-, 25-, 100- (current and climate-change-based for 2040 and 2080) and 500-year events as well as a simulation of the actual 2022 and 2009 flooding events. The following sections provide details about the results of the HEC-RAS model.

4.1.4.1 Model Stability Outputs

The HEC-RAS model was simulated using two-dimensional flow domains. The use of unsteady, two-dimensional analysis has the potential to produce unstable results that may have a negative impact on the validity of the model. HEC-RAS produces multiple numerical statistics that help the user determine if a model is stable and producing reasonable results. The three most common numerical statistics that are studied by a modeler are the total volume conservation, water surface elevation errors at specific grids, and the stage and flow hydrographs at structures, connections and throughout the model. The following sections will discuss the three parameters in more detail and illustrate why it is known that the model is running stable and producing reasonable results.

Volume Conservation

The volume conservation is observed for each model via the “Computational Log File…” in HEC-RAS. The total volume conservation error and percent conservation error for each domain was examined. For the 2022 Calibration Model, the total error is 5.9 ac-ft which equates to 0.138% volume error. The error for all the simulated events are minor and indicate that volume is being conserved throughout the model simulation. Only the 2022 Calibration Model is shown in this report for simplicity. Each frequency had a separate model simulation completed with a unique volume conservation, but the 2022 Calibration Model volume is representative of all other runs as all other models are very similar results and no volume error was greater than 8 ac-ft or 0.02%

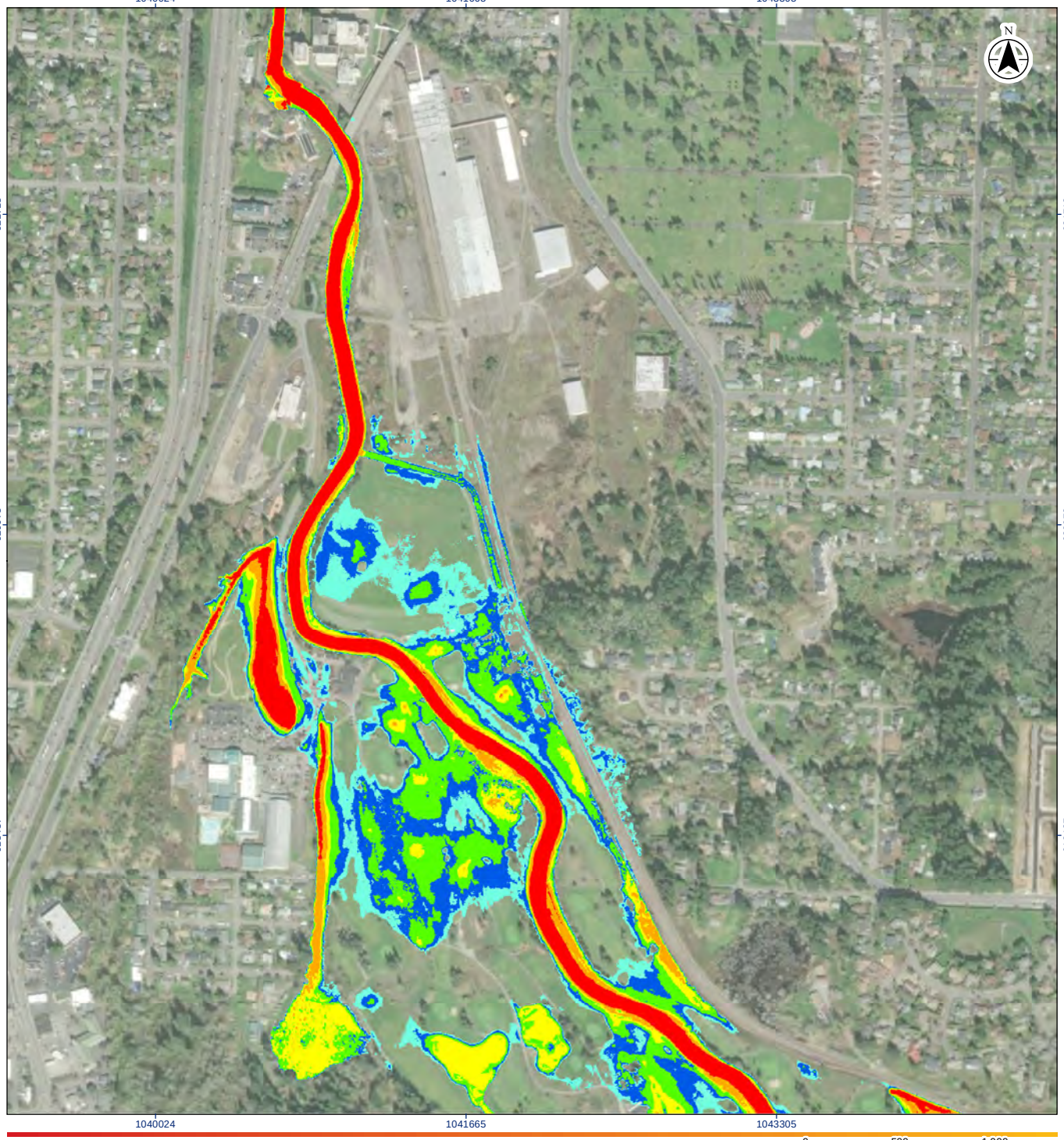
Water Surface Elevation Errors

The observed water surface elevation errors are summarized in the “Compute Messages” window of HEC-RAS. The highest observed error is 0.38 feet at grid 36967. The error is occurring downstream of the Tumwater Falls dam where the model is having trouble balancing the water surface elevation across the steep drops and complex hydraulics of this area. The error location, amount and time of error was investigated, and it was determined that the error is not within or directly contributing to a floodplain and is therefore acceptable for the purpose of this study. There were no other significant errors observed which indicates that the models are stable and producing reasonable results.

4.1.4.2 Summary of Results of Existing Conditions

Figure 14 through **Figure 22** provide illustrations of the maximum flood depths for the 2-, 10-, 25-, 100- and 500-year and the 2022 and 2009 flooding events simulations, respectively. GIS raster files resenting these results of maximum depth, maximum water surface elevation and maximum velocities can be found in **Appendix C.**

C:\Users\zwhitten\Documents\tumwater\Figures\GIS\Fig_14_Base_2yr_Depth.mxd Revised: 2023-06-28 By: zwhitten



Legend

Maximum Flood Depth

(ft)

- > 5+ ft
- 3.0 - 5.0 ft
- 2.0 - 3.0 ft
- 1.0 - 2.0 ft
- 0.5 - 1.0 ft
- 0.1 ft - 0.5 ft
- < 0.1 ft

0 500 1,000 Feet

CITY OF TUMWATER

Page 01 of 01

Project Location
City of Tumwater
Thurston County, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 -26

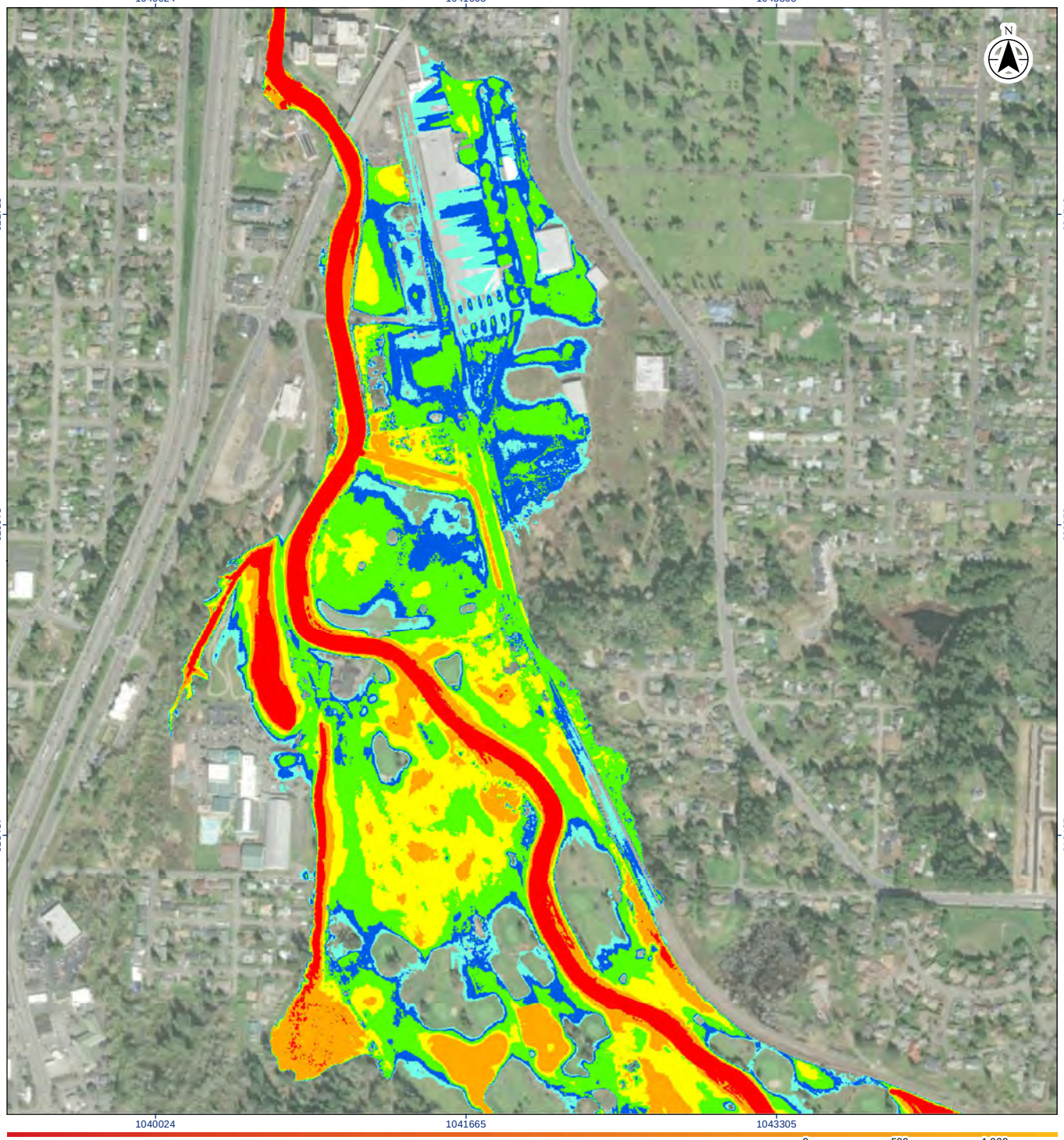
Client/Project
City of Tumwater
Deschutes River Flood and Erosion Reduction Study

Figure No.
14

Title
Maximum Flood Depth
Base Conditions 2-year Event

Page 01 of 01

C:\Users\zwhitten\Documents\tumwater\Figures\GIS\Fig_15_Base_10yr_Depth.mxd Revised: 2023-06-28 By: zwhitten



Legend

Maximum Flood Depth (ft)

- > 5+ ft
- 3.0 - 5.0 ft
- 2.0 - 3.0 ft
- 1.0 - 2.0 ft
- 0.5 - 1.0 ft
- 0.1 ft - 0.5 ft
- < 0.1 ft

0 500 1,000 Feet

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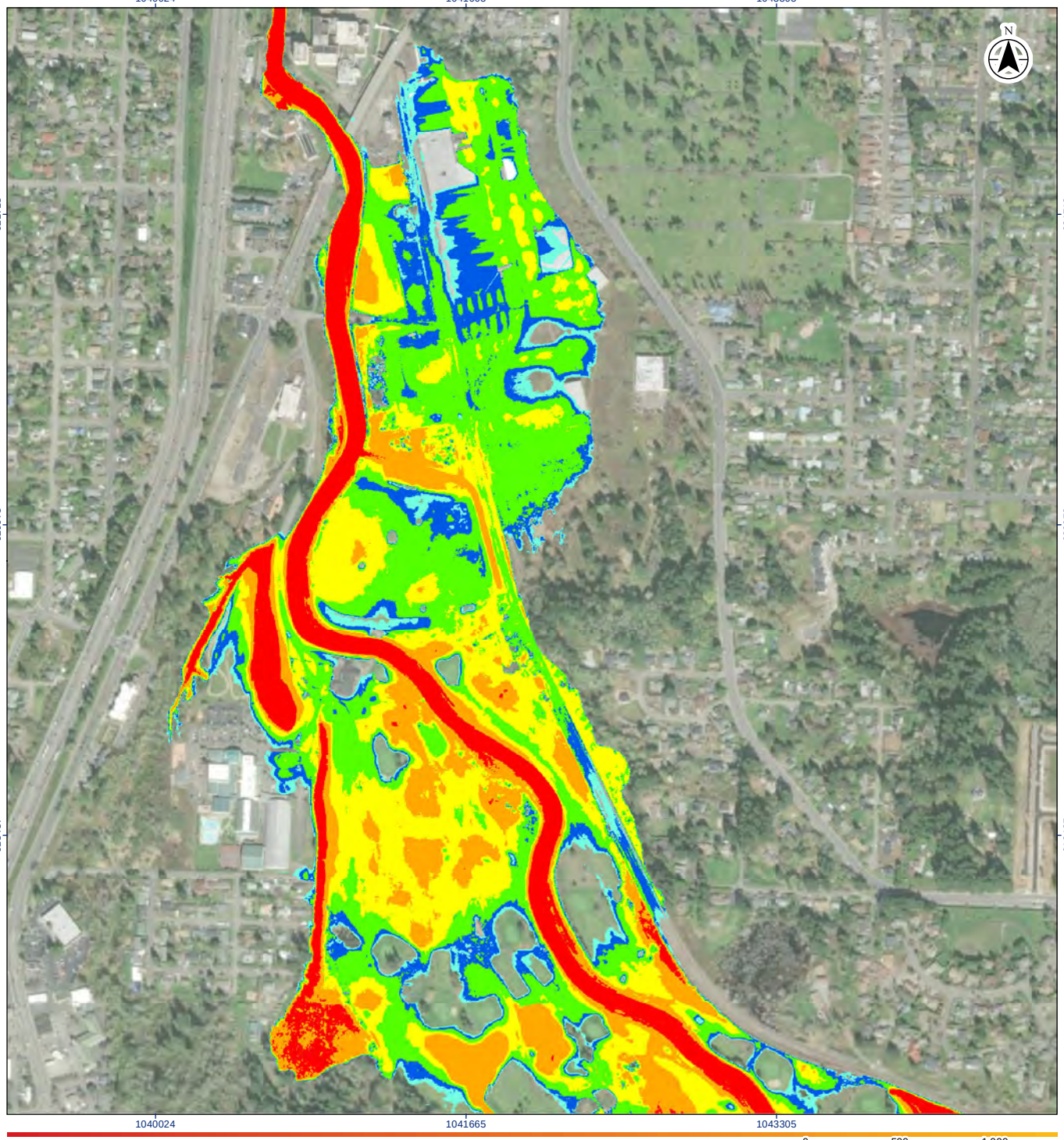
Figure No.
15

Title
Maximum Flood Depth
Base Conditions 10-year Event

Page 01 of 01

C:\Users\zwhitten\Documents\tumwater\Figures\GIS\Fig_16_Base_25yr_Depth.mxd Revised: 2023-06-28 By: zwhitten



Legend

Maximum Flood Depth (ft)

- > 5+ ft
- 3.0 - 5.0 ft
- 2.0 - 3.0 ft
- 1.0 - 2.0 ft
- 0.5 - 1.0 ft
- 0.1 ft - 0.5 ft
- < 0.1 ft

0 500 1,000 Feet

CITY OF TUMWATER

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Client/Project
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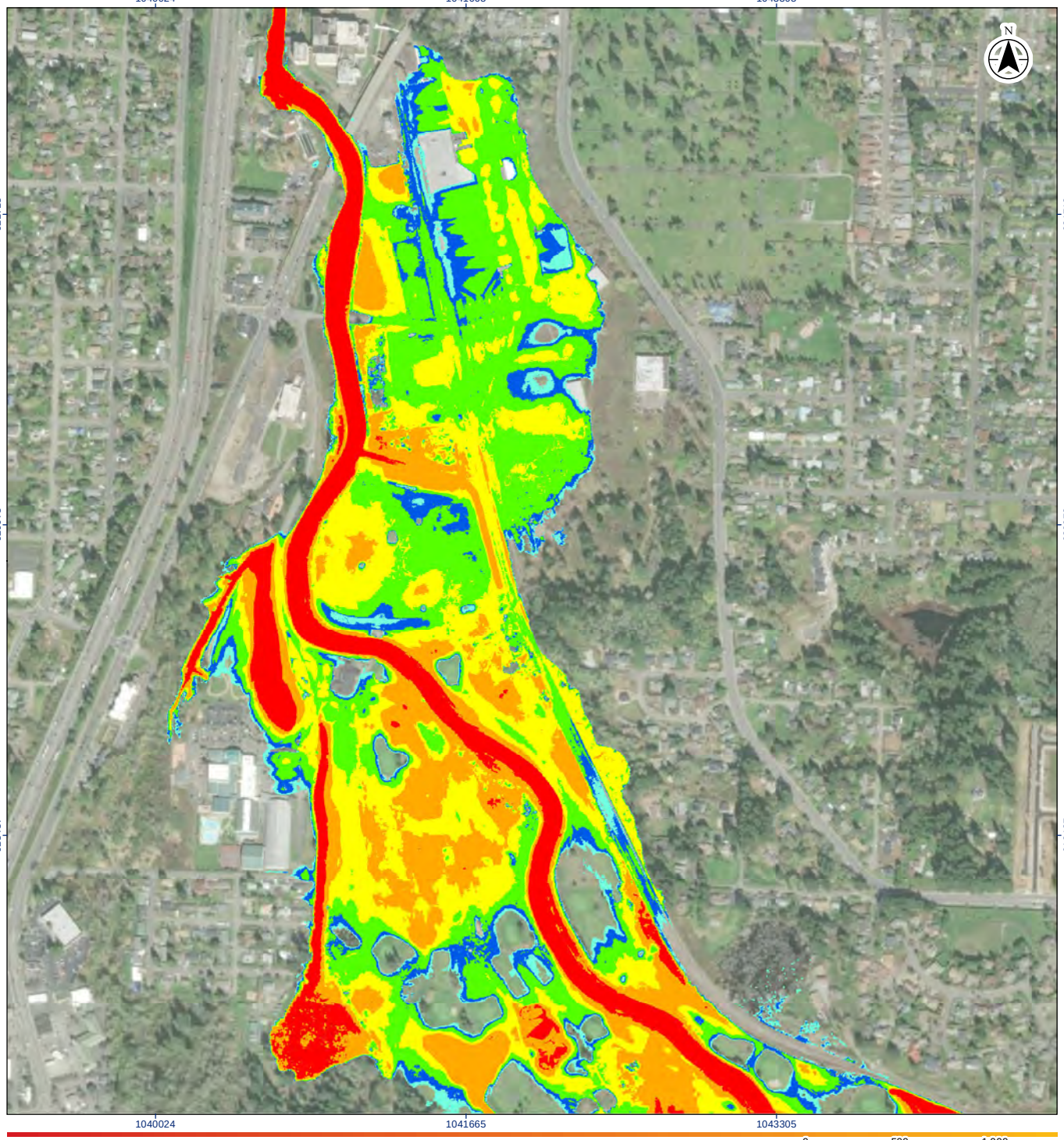
Figure No.
16

Title
Maximum Flood Depth
Base Conditions 25-year Event

Page 01 of 01

C:\Users\zwhitten\Documents\tumwater\Figures\GIS\Fig_17_Base_100yr_Depth.mxd Revised: 2023-06-28 By: zwhitten



Legend

Maximum Flood Depth (ft)

- > 5+ ft
- 3.0 - 5.0 ft
- 2.0 - 3.0 ft
- 1.0 - 2.0 ft
- 0.5 - 1.0 ft
- 0.1 ft - 0.5 ft
- < 0.1 ft

0 500 1,000 Feet

CITY OF TUMWATER

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Project Location
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Client/Project
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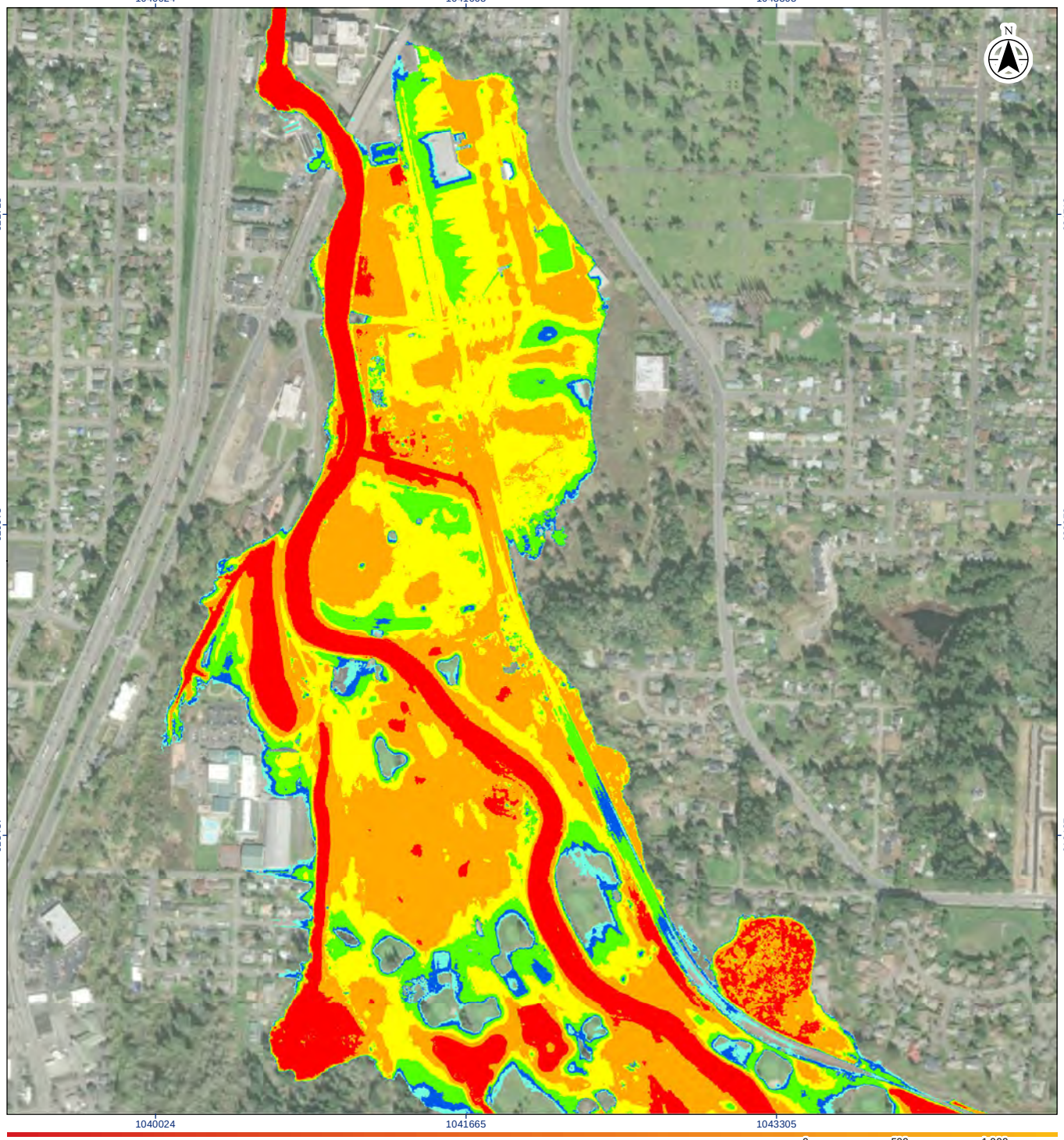
Figure No.
17

Title
Maximum Flood Depth
Base Conditions Current 100-yr Event

Page 01 of 01

C:\Users\zwhitten\Documents\tumwater\Figures\GIS\Fig_19_CC_2080_100yr_Depth.mxd Revised: 2023-06-28 By: zwhitten



Legend

Maximum Flood Depth

(ft)

- > 5+ ft
- 3.0 - 5.0 ft
- 2.0 - 3.0 ft
- 1.0 - 2.0 ft
- 0.5 - 1.0 ft
- 0.1 ft - 0.5 ft
- < 0.1 ft

0 500 1,000 Feet

Project Location
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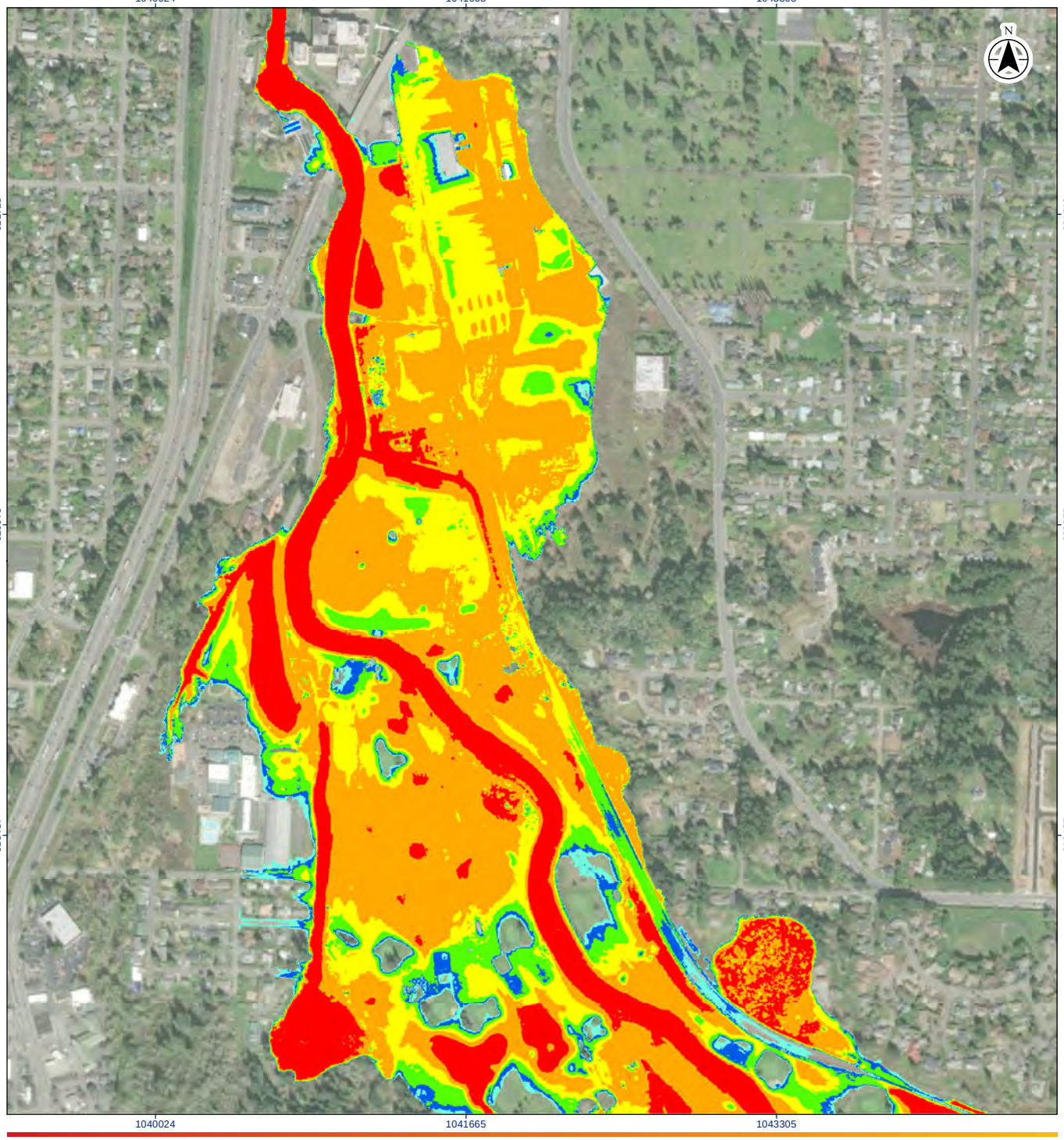
Figure No.
19

Title
Maximum Flood Depth
Base Conditions Climate Change
2080 100-yr Event

Page 01 of 01

C:\Users\zwhitten\Documents\tumwater\Figures\GIS\Fig_20_Base_500yr_Depth.mxd Revised: 2023-06-28 By: zwhitten



Legend

Maximum Flood Depth

(ft)

- > 5+ ft
- 3.0 - 5.0 ft
- 2.0 - 3.0 ft
- 1.0 - 2.0 ft
- 0.5 - 1.0 ft
- 0.1 ft - 0.5 ft
- < 0.1 ft

0 500 1,000 Feet

Project Location
City of Tumwater
Thurston County, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
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Figure No.
20

Title
Maximum Flood Depth
Base Conditions 500-Year Event

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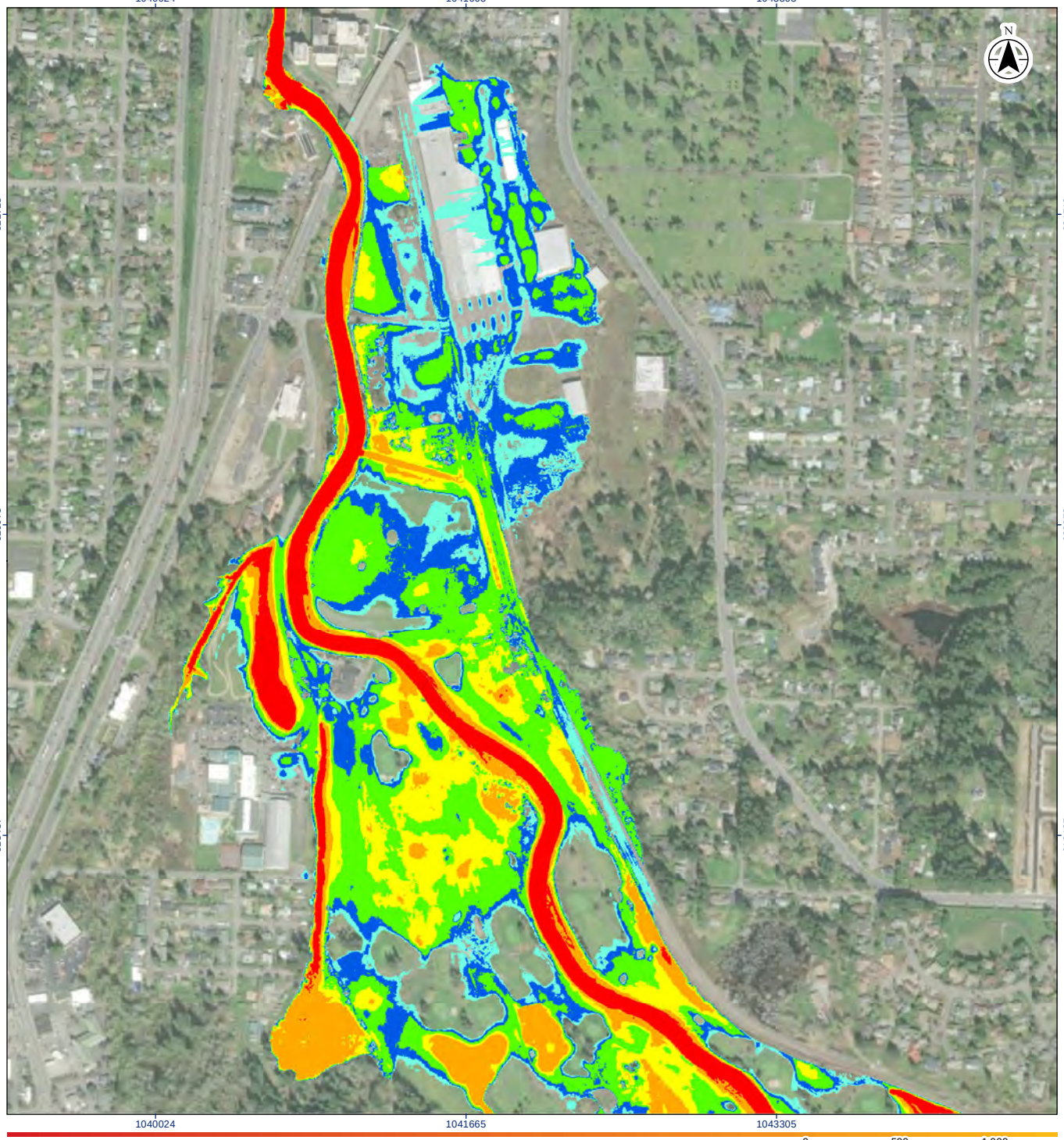
C:\Users\zwhitten\Documents\tumwater\Figures\GIS\Fig_21_Base_2022_Depth.mxd Revised: 2023-06-28 By: zwhitten



Legend

Maximum Flood Depth

(ft)

- > 5+ ft
- 3.0 - 5.0 ft
- 2.0 - 3.0 ft
- 1.0 - 2.0 ft
- 0.5 - 1.0 ft
- 0.1 ft - 0.5 ft
- < 0.1 ft

0 500 1,000 Feet

CITY OF TUMWATER

Page 01 of 01

Project Location
City of Tumwater
Thurston County, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
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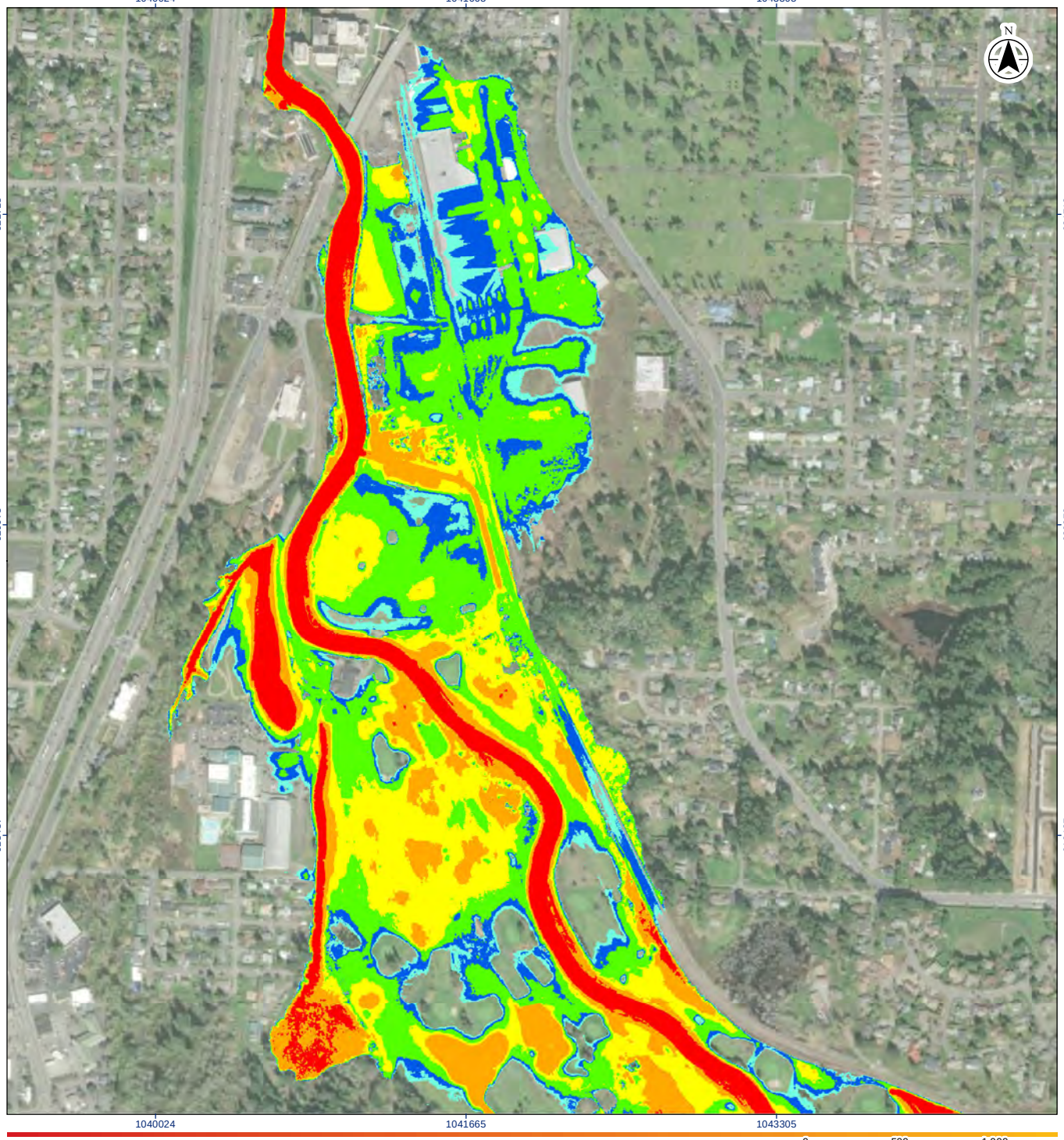
Client/Project
City of Tumwater
Deschutes River Flood and Erosion Reduction Study

Figure No.
21

Title
Maximum Flood Depth
Base Conditions 2022 Flood Event

Page 01 of 01

C:\Users\zwhitten\Documents\tumwater\Figures\GIS\Fig_22_Base_2009_Depth.mxd Revised: 2023-06-28 By: zwhitten



Legend

Maximum Flood Depth (ft)

- > 5+ ft
- 3.0 - 5.0 ft
- 2.0 - 3.0 ft
- 1.0 - 2.0 ft
- 0.5 - 1.0 ft
- 0.1 ft - 0.5 ft
- < 0.1 ft

0 500 1,000 Feet

CITY OF TUMWATER

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Project Location
City of Tumwater
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Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
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Client/Project
City of Tumwater
Deschutes River Flood and Erosion Reduction Study

Figure No.
22

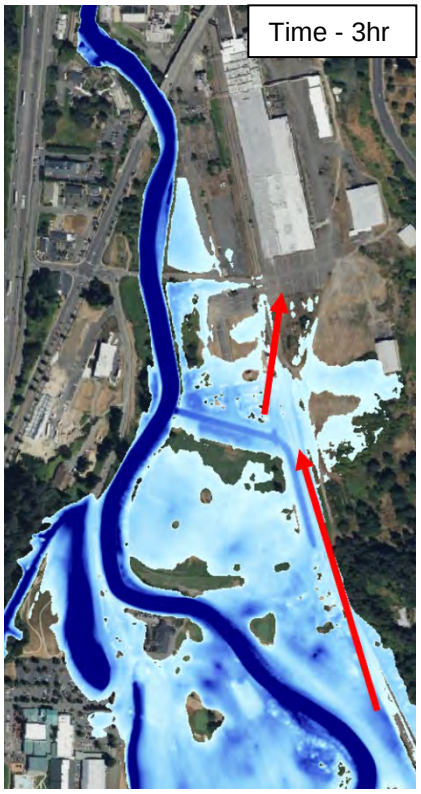
Title
Maximum Flood Depth
Base Conditions 2009 Flood Event

Page 01 of 01

4.1.5 Base Model Conclusions

Figure 14 through **Figure 22** illustrate that the Olympia Brewery Site is susceptible to potential flooding during flood events as low as the 10-year event. However, this result was expected given the knowledge that the brewery site experienced flooding during the 2022 event and the 2009 event. The 2022 event had a recorded peak discharge of 6,900 cfs according to the USGS gage at E Street, and the 10-year event is estimated at 7,500 cfs. The 2009 event (which observed sustainable flooding on the site), had a recorded peak discharge of 8,500 cfs which is less than the 25-year event of 9,100 cfs. Therefore, the results illustrating that the brewery site is susceptible to potential flooding was an expected outcome.

The main goal of the base conditions modeling, however, was to develop a better understanding of the potential reasons that the site is prone to flooding. A benefit of using two-dimensional, unsteady flow analysis with HEC-RAS is that the modeler/user has the ability to see the results over time; not just the peak of the event. As such, the modeler can visualize the progression of the flood that will lead to the user being able to better comprehend how the flooding develops and how it originates. The modeling for this study was able to accomplish this goal. **Figure 23** below provides an illustration of flood water entering the Olympia Brewery site over time with red arrows indicating the direction of flow. Please note a timestamp starting at zero is added to the top right of the image to indicate the amount of time elapsing between each image.



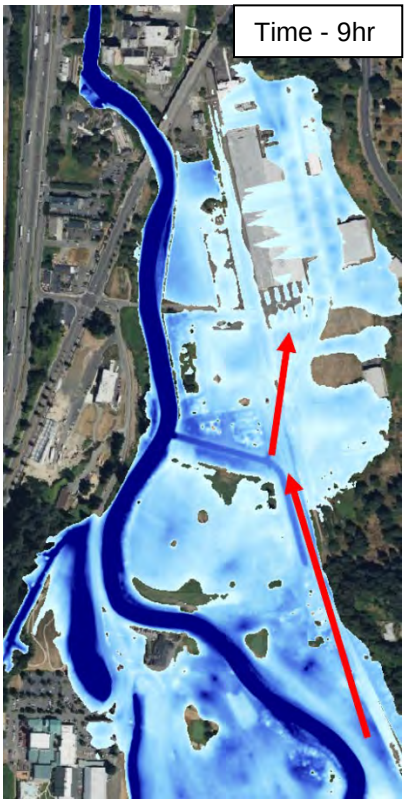


Figure 23 – Progression of Flooding during 2022 Olympia Brewery Flood Over Time

As **Figure 23** illustrates, before flow enters the brewery site, flood waters are already in the overbanks over 1,500 ft upstream of the site; before the Deschutes River has flooded its overbanks at the actual brewery site. As the flooding progresses, the flood waters do not have the ability to get back into the Deschutes River. Instead, flood waters continue to flow northeast, away from the Deschutes River and onto the brewery site. Once flow is on the brewery site east of the railroad, flood waters continue to expand laterally since there is no path for the water to get back to the river, eventually leading to flooding on the site. This result illustrates that the lack of conveyance capacity in the river upstream of the brewery is causing the site to flood. **Figure 24** below provides an illustration of the lack of conveyance and the lack of a path back to the Deschutes River from the Brewery Site. The image is from the end of the flood simulation (2 days after the peak of the storm) and there is still 2ft of flood depth on some locations within the brewery site. It should be noted that localized site drainage which would drain nuisance flooding on the site ove time is not simulated as part of this study.

Figure 24 – Flooding on Brewery Site Two Days After Peak of Simulation

As the flooding progresses and flows increase, the power substation in conjunction with the ground elevation directly below the Capitol Blvd Bridge create two issues: a contraction point in the floodplain and cutting off flow from reentering the Deschutes River. At the power substation, the floodplain width in which the Deschutes River can flow is restricted down to 190ft; significantly less than over 2,000 feet seen in other locations of the Deschutes River upstream of the power substation. This creates a location along the Deschutes River where flood waters build up behind the power station, increasing the flood potential upstream.

The modeling also illustrates that the power station and the ground elevation directly below the Capitol Blvd overpass impede from leaving the brewery property and reentering the system. Therefore, this exacerbates the flooding potential from the flows that have already entered the brewery property from the southern end of the property. **Figure 25** below illustrates the power substation and the location of the ground elevation directly below the Capitol Blvd overpass impeding flow from reentering the Deschutes River and the 190 ft contraction created by the power station. This result is further exemplified by the water surface elevation profile of the 100-year flood event seen in **Figure 26**.

Therefore, the conclusion of the base conditions modeling is that the potential flood risk of the Olympia Brewery Site is most likely created by lack of conveyance in the overbanks at south side (upstream side) of the site during the low flow stages of a flood, and the power substation and elevation of the Capitol Blvd Bridge impeding flow, creating a contraction of flow at the downstream end of the property during higher flow stages of the flood. This type of flooding that is occurring on Olympia Brewery property could not have been simulated accurately with a one-dimensional model. This proves the need for a two-dimensional model to understand the flooding in this location. It is recommended at all future modeling of this site and its alternatives be completed using two-dimensional analysis.

Figure 25 – Illustration of Power Substation and Ground Under Capitol Blvd Impeding Flow

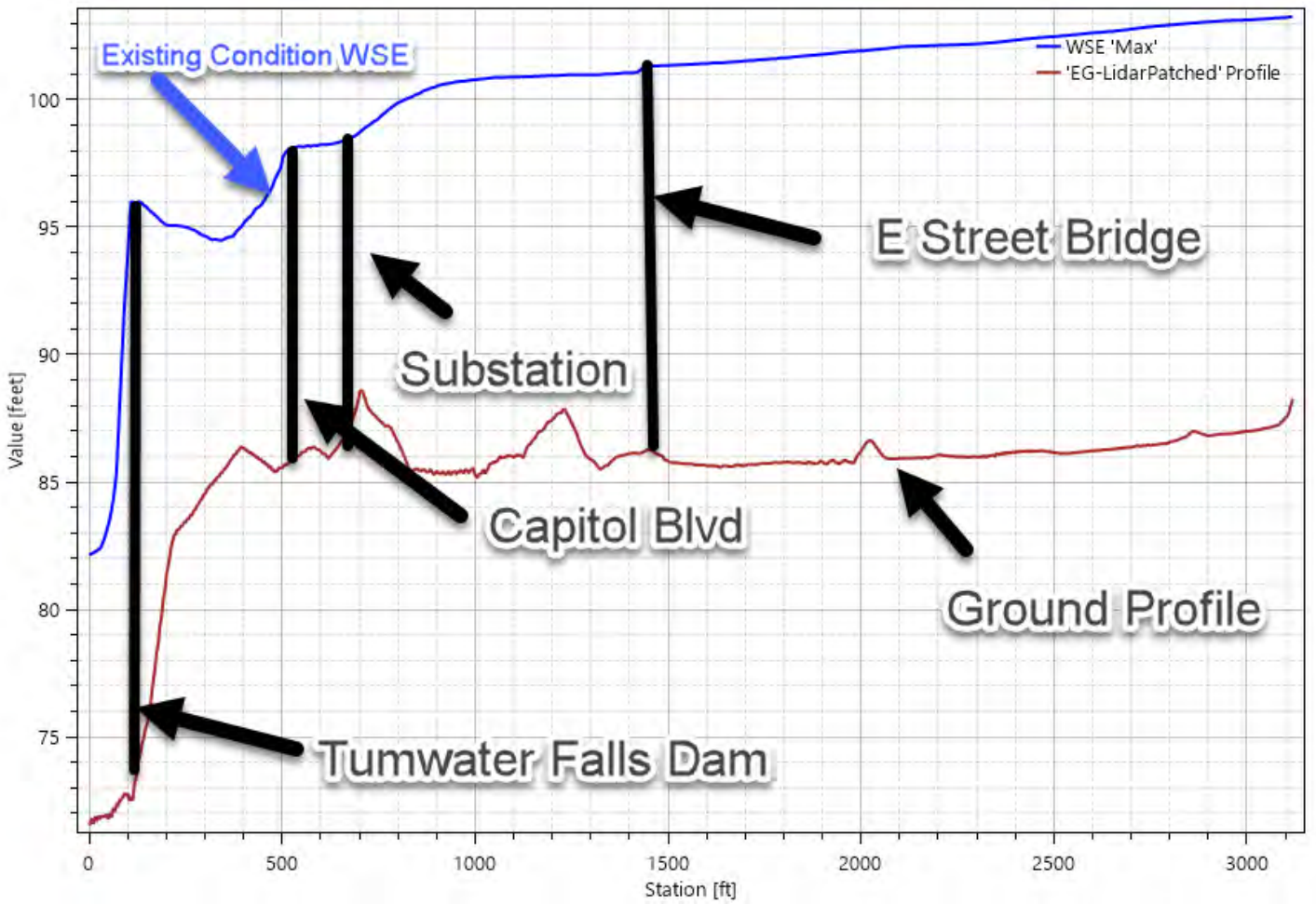


Figure 26 – Water Surface Elevation Profile during 100-year Flood Event

4.2 EROSION RISK AREAS

The planform of the Deschutes River can be classified as a single threaded meandering channel. The meanders are formed by erosion and sedimentation processes that make the channel migrate across the floodplain. Bank erosion usually occurs on the outer part of the bank while sedimentation occurs on the inner portion of the bend, forming a point bar. Eroding outer banks and point bars are present throughout the Deschutes River, except for areas where the river has been channelized or the banks hardened. In undisturbed portions of the river, the rate of bank erosion of the outer bend is limited by the presence of vegetation along the banks and large woody debris withing the channel. The vegetation acts to increase the bank's resistance to erosion, while large woody debris acts to reduce the channel velocities near the bank. In these undisturbed areas, bank erosion still continues to occur, but the rates of erosion will be less than in areas where vegetation has been removed. The woody vegetation also has benefits of providing hydraulic complexity and more diverse habitat. Bank erosion and the river meandering creates a diverse self-sustaining ecosystem. As bank erosion occurs, large woody debris is supplied to the main channel, creating habitat for several aquatic species. The point bars deposited on the inner bend create bare substrate that can be colonized by woody riparian species that will eventually be eroded by another meander in the future.

We performed an analysis of bank channels from 1989 to 2022 using NRCS aerial photography. We digitized the main channel in 1989, 2003, 2013, 2017, and 2022 for the Deschutes River at two locations show in **Figure 27.** The first location was within the project area from Henderson Bridge to where the river enters the golf course (**Figure 28**). From the golf course to Tumwater Falls, the river has been straightened and the banks armored. Practically no channel movement has occurred in the reach during the period of analysis, so this area is excluded from the analysis. The process of river meandering is evident in the figure, showing the process of elongation of the river bends as bank erosion occurs. The highest rates of erosion are at Pioneer Park, where woody vegetation has been removed from the bank. In the meander bend upstream of Pioneer Park, the meander elongated but then the bank erosion ceased as a cutoff occurred across the point bar. The erosion of the upstream bank also likely ceased because of large woody debris that protected the bank.

To elucidate the process of meandering elongation and cutoff, we also studied a portion of the Deschutes River upstream of the project area. The digitized channel location is shown in **Figure 29**. The meander bend is shown in 1989 as highly sinuous. In 2003, a cutoff occurred. This cutoff then began the process of meander formation downstream of the cutoff. A similar cutoff will likely occur at the Pioneer Park meander bend, however, it is difficult to predict exactly when this will occur, and more bank erosion will occur before such a cutoff.

The computed depth average river velocities for the 2-yr flood were compared against areas of erosion **Figure 30**. The velocity within the channel near Pioneer Park are actually lower than in some other parts of the river and the bank erosion does not appear to be well correlated to velocity of flow within the channel. The composition of the bank and the protection offered by vegetation are likely more important in determining the erosion rates than the velocity within the channel.

Figure No.
26

Title
Deschutes River Historical Main Channel Location

Client/Project
City of Tumwater
Deschutes River Flood and Erosion Reduction Study

Project Location:
City of Tumwater
Thurston, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 -26

0 0.15 0.3 Miles

1:20,000 (At Original document size of 8.5x11)

Legend

Channel Location

Year

- 1989
- 2003
- 2013
- 2017
- 2021

Figure No.
27

Title
Deschutes River
Velocity

Client/Project
City of Tumwater
Deschutes River Flood and
Erosion Reduction Study

Project Location:
City of Tumwater
Thurston, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 -26

0 0.04 0.08
Miles

1:5,249 (At Original document size of 8.5x11)

Legend

Channel Location

Year

- 1989
- 2003
- 2013
- 2017
- 2021

CITY OF TUMWATER

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Figure No.
28

Title
Deschutes River Historical Main Channel Location

Client/Project
City of Tumwater
Deschutes River Flood and Erosion Reduction Study

Project Location:
City of Tumwater
Thurston, Wa

Prepared by JZ on 2023 - 05 - 22
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0 0.025 0.05 Miles

1:3,143 (At Original document size of 8.5x11)

Legend

Channel Location

Year

- 1989
- 2003
- 2013
- 2017
- 2021

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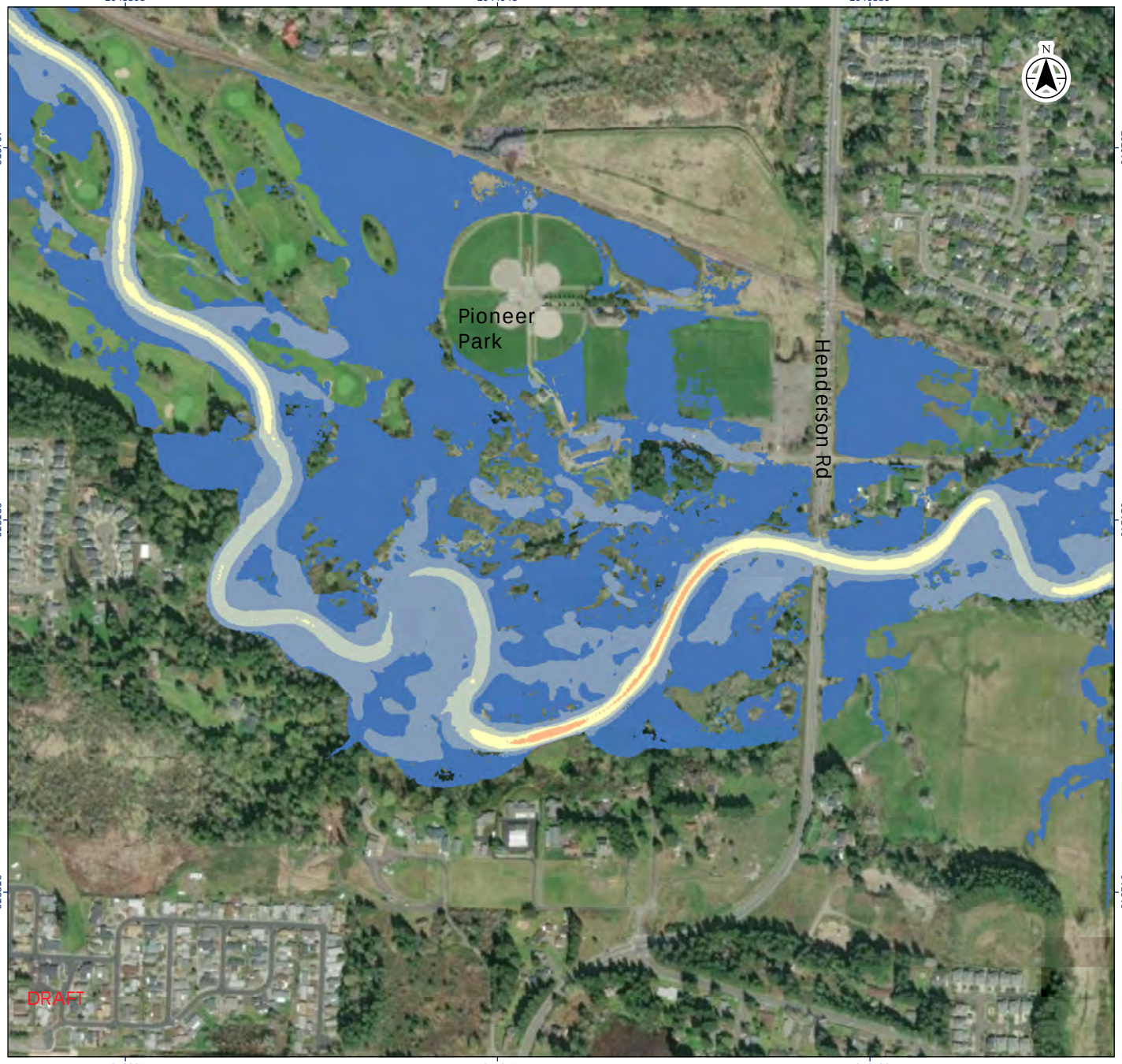

Figure No.
29

Title
Deschutes River Velocity

Client/Project
City of Tumwater
Deschutes River Flood and Erosion Reduction Study

Project Location:
City of Tumwater
Thurston, Wa

Prepared by JZ on 2023 - 05 - 22
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0 0.065 0.13
Miles

1:8,000 (At Original document size of 8.5x11)

Legend

Velocity 2-yr

ft/s

- 0 - 1
- 1 - 3
- 3 - 5
- 5 - 7
- 7 - 9
- 9 - 11
- 11 - 21

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5.0 ALTERNATIVE ANALYSIS

5.1 APPROACH AND METHODOLOGY

The primary goal of this flood reduction study was to determine and evaluate alternatives for the purpose of flood mitigation within the Olympia Brewery Site. For this analysis an alternative will be combination of 1, 2 or 3 “components”. For example, one alternative (alternative 9A) is utilizing a flood channel (component 1) through the brewery property and benching the flood property close to the river (component 2). In this alternative, there are two, separate “components” (a flood channel and benching) being combined into one alternative (alternative 9A). As such, this section will discuss the various “components” that were investigated as part of this study and the alternatives that were a combination of 1, 2 or 3 different components. The goal of the alternative analysis is to quantify the flood reduction benefit of various alternative for the Olympia Brewery Site. While the primary goal of the alternative design was to provide flood benefits, the alternatives were designed with the intention of incorporating ecological, recreational and other benefits in the future.

5.2 SUMMARY OF COMPONENTS

The following section will discuss the development of the components for this alternatives analysis. As stated above, alternatives will be a combination of 1, 2 or 3 different components. On January 10, 2022, Stantec held a meeting with stakeholders to discuss the potential alternatives and components that could be investigated as part of this study. The following summarized the components that were carried forward as part of the meeting. There is also a brief description of what the component is, but note that more details about the sizing and location of the component will be discussed in the description of the modelled alternatives in **Section 5.3.2.**

1. **Flood Channel** - create a flood channel through the Olympia Brewery Property to convey excess flow in overbanks back to the main channel near Capitol Blvd. The channel would start downstream of the current driving range would tie into the Deschutes River just upstream of the power substation. The channel would also be west of the current railroad. **Figure 31** below provides an illustration of the general location of the channel.

   For this study, a conceptual-level channel was simulated. The intent of the conceptual-level channel is to determine if a flood channel will reduce the potential flooding, only; not to provide a detailed design for the channel. It is anticipated that if development is planned for this property and a flood channel is part of the development, more detail about the channel’s path/location and material within the channel will be known and can be simulated. For the modelling in this study, it was assumed that the channel was an engineered natural channel and contained vegetation in and around the channel. As such, a high Manning’s n-value for the channel was applied. A high Manning’s n-value representing a natural channel will provide less channel conveyance compared to low Manning’s n-value that represents a concrete-lined channel but provides more eco-restoration capacity.

Figure 31 – Location of Proposed Flood Channel

2. **Benching** – lower the ground elevation of the Olympia Brewery west of the railroad and north of the driving range to create one or more series of floodplain terraces. The benched area could become a wetland area where trails could be placed and the ecosystem could be restored. This would increase flooding of this area during higher frequencies events such as the 2yr but potentially reduce flooding at and around the brewery property. The elevation of the benching was set to allow for the 2year event to pass without inundating the benching area. The 2yr event has an estimated maximum water surface elevation of 95' in this area according to the base-conditions modeling. Given this elevation, the benching elevation was set to 96'. **Figure 32** below provides an illustration of the area that would be including in the benching.

   Similar to the flood channel, please note that for this study, a conceptual-level benching will be simulated. The intent of the conceptual-level benching is to determine if benching will reduce the potential for flooding, only; not provide a detailed design for what the benching may be transformed into. It is anticipated that if development is planned for this property and benching is part of the development, more detail about the purpose and features of the area being benched will be known and can be simulated. For the modelling in this study, it was assumed that the benched area was a natural wetland with high concentrations of vegetation in the area. As such, a high Manning's n-value for the area was applied. A high Manning's n-value representing a natural, vegetated area will provide less channel conveyance compared to low Manning's n-value that represents a grass-lined area but provides more eco-restoration capacity.

It should also be noted that the benching component is in the same general area as the proposed E Street Extension (see Appendix A for copy of E Street Extension Alternative Analysis). In a meeting with stakeholders held on June 21st, 2023, it was discussed that Alternative 2A was the preferred alternative at the time, but no immediate plans to move the alternative forward to construction had been made. Review of Alternative 2A indicates that the plan would remove the existing E Street bridge and abutment and replace it with a new bridge that goes over the Deschutes River and the railroad before going back down to the natural ground as it connects with Cleveland Ave. Given that the new bridge would go over the area that is being benched at an elevation of 125 ft and the maximum water surface elevation during the climate-change-based year 2080 100-year storm is 103 ft, it is assumed for this study that the proposed E Street Extension will not interfere with the benching alternative. As such, the E Street Extension was not modelled as part of this study. Future considerations of the E Street Extension should be evaluated in more detail to confirm this assumption.

Lastly, for screening-level purposes, only, the existing E Street Bridge and abutment was simulated as both in the model and not in the model to determine if the existing bridge and abutment will have an effect on the benching concept's effectiveness.

Figure 32 – Area to be part of Benching

3. **Power Substation Relocation and Lowering of Ground Elevation below Capitol Blvd Overpass** – this concept will relocate the Power Substation away from its current position adjacent to the Deschutes River as well as lower the ground elevation directly below the Capitol Blvd overpass. This intent of this concept is to remove the current high ground that is impeding flood waters from being able to reenter the Deschutes River. **Figure 33** provides an illustration of the location of the power substation and ground elevation to be lowered.

Figure 33 – Power Substation and Ground under Capitol Blvd Overpass to be Lowered

4. **Upstream Flood Storage** - A property upstream of Henderson Blvd Bridge (Frame Trustee Property) potentially could be utilized for flood storage. The intent for this component would be to create a location where flood waters could be stored offline of the main Deschutes River during peak flow conditions, reducing the peak discharge downstream. **Figure 34** below provides an illustration of the location of the property where flood storage may be applicable.

Figure 34 – Location of Property for Potential Flood Storage

5. **Dam Lowering** – lower the height of the current Tumwater Falls Dam. The intent of this component would be to reduce the water impoundment downstream of the brewery in an attempt to decrease the water surface elevation at the brewery site. The analysis did not include the potential erosion of sediment that would occur following dam removal and this would increase the benefit of this alternative.

6. **Removal of Walking Path near Valley Athletic Club** – Stantec would review removal of manmade features such as the walking path north of the Valley Athletic club and replacing it with a wetland/riparian area. This alternative will also include the removal the roadway embankment for Tumwater Valley Dr near the walking path and replace it with a bridge deck on piers. The change from an embankment to bridge with pier will allow for a reconnection of the floodplain west of Tumwater Valley Dr during low flow events.

7. **Watershed Floodplain Reconnection Near Pioneer Park –** in and around Pioneer Park are multiple historic channels (channels that were once part of the main watercourse of the Deschutes River that have since been cutoff due to natural stream mitigation). The model terrain was modified to reconnect these historical channels to the main channel and add conveyance for the Deschutes River near Pioneer Park. It is be assumed that the grading elevations of the side channels will match the current slopes and elevations of the existing main channel and that any stabilization measures will use materials that naturally occur within the Deschutes River, such as large wood and gravel sized sediment.

5.3 ALTERNATIVE MODELING

5.3.1 Modelled Screening-Level Alternatives

Utilizing the components for mitigating flood risk that were agreed upon to move forward with, a total of 17 screening-level alternatives were derived by combining up to 3 of the components to be simulated within the HEC-RAS model. These alternatives are considered “screening-level” due to the relatively low level of detail applied for each alternative in the HEC-RAS model. The intent of the modeling of the screening-level alternatives was to obtain a basic understanding of the flood reduction potential of each alternative. After the screening-level modeling has been completed, the modelling team would be able to review the results and determine which alternatives have the potential to reduce flooding at the key parcels within the study area and more detail would be applied to those models moving forward. For this study six (6) screening-level alternatives were selected to be moved forward into detailed analysis. **Section 5.3.4** discussed the detailed alternatives in more detail below.

All 17 screening-level alternatives were simulated with a 2-year flood (4,400 cfs), 2022 flood (6,900 cfs) and a 100-year flood (10,100 cfs) event to determine the level of effectiveness during those events. **Table 5** below provides a summary of the 17 screening-level alternatives derived for this analysis. Please note that a detailed visual of the 6 alternatives carried forward to detailed analysis will be provided in **Section 5.3.4** of this report.

Table 5 – Alternatives Modelled in HEC-RAS Hydraulic Model

Alternative	Components in the model	Detail of the Component
1	Flood Channel	A flood channel with a 20-ft bottom width, 3:1 side slopes and 0.001 ft/ft channel slope. Channel depth varies
2	Flood Channel	A flood channel with a 50-ft bottom width, 3:1 side slopes and 0.001 ft/ft channel slope. Channel depth varies
3	Flood Channel	A multi-thread, 20-ft bottom width channel, 3:1 side slopes and 0.001 ft/ft channel slope. Channel depth varies
4	Benching	Lower entire property west of railroad from average of 100' to 96'
		E Street Bridge Abutment is removed from terrain
5	Benching	Lower entire property west of railroad from average of 100' to 96'
		E Street Bridge Abutment is removed from terrain
	Power Substation Relocated	Power Substation Relocated and ground elevation under Capitol Blvd Overpass lowered
6	Benching	Lower entire property west of railroad from average of 100' to a tiered approach of 98' and 96'
		E Street Bridge Abutment is removed from terrain
7	Benching	Lower portion of property west of railroad from average of 100' to 96'
		E Street Bridge Abutment is still in place
8	Benching	Lower portion of property west of railroad from average of 100' to 96'
		E Street Bridge Abutment is removed from terrain
	Power Substation Relocated	Power Substation Relocated and ground elevation under Capitol Blvd Overpass lowered
9A	Benching	Lower entire property west of railroad from average of 100' to 96'
		E Street Bridge Abutment is removed from terrain
	Flood Channel	A flood channel with a 20-ft bottom width, 3:1 side slopes and 0.001 ft/ft channel slope. Channel depth varies

DESCHUTES RIVER FLOOD REDUCTION STUDY

Alternative Analysis

Alternative	Components in the model	Detail of the Component
9B	Benching	Lower entire property west of railroad from average of 100' to 96'
		E Street Bridge Abutment is removed from terrain
	Power Substation Relocated	Power Substation Relocated and ground elevation under Capitol Blvd Overpass lowered
	Flood Channel	A flood channel with a 20-ft bottom width, 3:1 side slopes and 0.001 ft/ft channel slope. Channel depth varies
10A	Benching	Lower entire property west of railroad from average of 100' to 96'
		E Street Bridge Abutment is removed from terrain
	Flood Channel	A flood channel with a 50-ft bottom width, 3:1 side slopes and 0.001 ft/ft channel slope. Channel depth varies
10B	Benching	Lower entire property west of railroad from average of 100' to 96'
		E Street Bridge Abutment is removed from the terrain
	Power Substation Relocated	Power Substation Relocated and ground elevation under Capitol Blvd Overpass lowered
	Flood Channel	A flood channel with a 50-ft bottom width, 3:1 side slopes and 0.001 ft/ft channel slope. Channel depth varies
11	Upstream Storage	Excavating approximately 250,000 cubic yards from the Frame Trustee Property for Flood Storage
12	Removal of Walking Path near Valley Athletic Club	Replaced Tumwater Valley Dr embankment road and 36" culvert with raised bridge to connect floodplain on west side of road
		Lower the ground elevation of the walking trail area north of the Valley Athletic Club and replace with riparian area
13	Watershed Floodplain Reconnection Near Pioneer Park	Utilize natural channels near the Pioneer Park area to increase conveyance of Deschutes River
14	Dam Lowering	Lower Dam from a top crest elevation of 88ft to 85ft
15	Dam Lowering	Lower Dam from a top crest elevation of 88ft to 80ft

5.3.2 Screening-Level Alternative Modelling Results and Discussion

All 17 screening-level alternative model scenarios were simulated for three events for comparison to the existing conditions: a 2-year (4,400 cfs), 2022-flood (6,900 cfs) and a 100-year (10,000 cfs). this section will first discuss the screening-level alternatives that did not provide benefit for reducing flooding at the Olympia Brewery site and why. Depth figures for these screening-level alternatives can be accessed in **Appendix C** of this report. This report will provide detailed depth and depth difference figures and discussion for the 6 alternatives carried forward for detailed analysis in subsequent sections.

5.3.3 Screening-Level Alternative Models that Illustrated Low Flood Reduction Potential

The first screening-level alternative that did not illustrate flood reduction at the brewery site was the lowering of the Tumwater Falls Dam (screening-level alternative number 14 and 15). Though the dam crest elevation was reduced by up to 8 feet (from 88 feet to 80 feet) in the simulation, the change in water surface elevation at the brewery site was nominal. Inspection of the results indicated that the main reason lowering the dam was not effective was because of the contraction in the floodplain that is caused by the existing power substation and the ground elevation directly below the Capitol Blvd overpass. As Figure 35 below illustrated, the water surface elevation profile of the Deschutes River drops significantly just upstream of the dam when lowered, but the benefit is no longer seen when it reaches Capitol Blvd. This illustrates that the power substation and ground elevation below the overpass are acting as a flood water impediment and have a much greater impact to the Olympia Brewery site than the dam. Therefore, changes to the dam alone do not have a significant impact on upstream flooding without the relocation of the power station and lowering of the ground under the overpass. It is anticipated, however, that once the dam is removed, the sediment behind the dam will erode and increase the conveyance of the river. The analysis of sediment erosion could be conducted if this option is pursued further to assess the decrease in water surfaces due to the dam removal and of the erosion of sediment stored behind the dam.

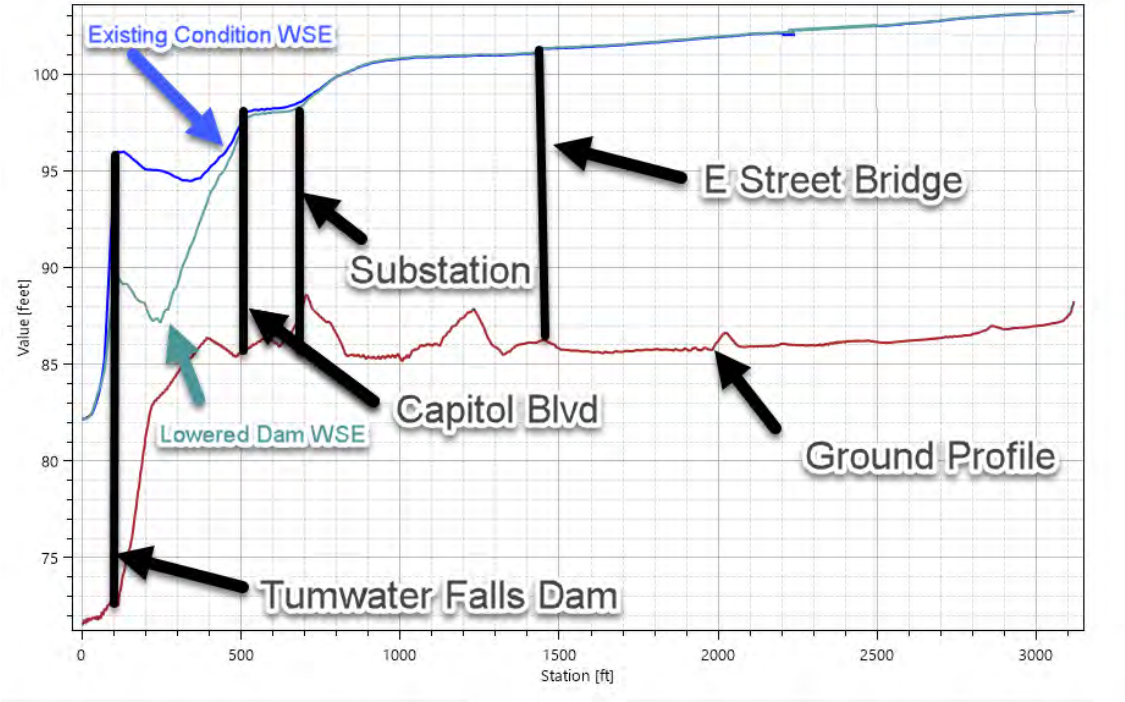

Figure 35 – Water Surface Elevation Profile with Existing and Lowered Dam

The flood storage screening-level alternative (alternative number 11) also had no impact to the water surface elevations downstream. This result is due to the volume needed to detain flow to significantly reduce flood elevations. In short, from historical observations of flooding on the Deschutes River, the river remains in a flood stage for a significant amount of time. During the 2009 event, the Deschutes River was above its baseflow condition from January 7th until January 12th. This sustained flooding causes the storage area to be completely filled by the time the peak of the flooding occurs Therefore, there is no storage available to retain incoming flood waters and no reduction to the peak downstream. The amount of storage that would be required is far greater than what is available in the immediate area upstream of the Olympia Brewery site.

Similar to the flood storage alternatives, the removal of walking path near Valley Athletic Club (screening-level alternative number 12) and watershed floodplain reconnection near Pioneer Park (screening-level alternative number 13) screening-level alternatives illustrated no flood reduction at the Olympia Brewery site due to the lack of volume storage the alternatives provide and the lack of additional conveyance at the brewery site. The additional flood storage that the floodplain connection created through the Tumwater Valley Dr embankment removal is quickly consumed during the early stages of the flood and no longer exists during the peak of the event. However, it should be noted that both alternatives did illustrate significant velocity reductions in the immediate area of alternatives. This would provide significant potential erosion reduction at these sites including at Pioneer Park where the erosion has been a significant concern. The HEC-RAS model generated for both scenarios are available for use and can be modified to provide more detail about potential designs for erosion reduction.

5.3.4 Alternative Models that Illustrated Significant Flood Reduction Potential

The flood mitigation components flood channel, benching and relocation of the power substation in conjunction with the lowering of the ground elevation directly below the Capitol Blvd overpass demonstrate a potential for significant flood reduction if implemented. Each component was able to demonstrate some potential in flood mitigation on its own and when combined with other components, the potential for flood reduction was increased. As such, the following alternatives were selected to be moved forward to detailed modeling and conceptual phase. The flood reduction for each alternative selected allow for the flood reduction of each individual component to be visualized as well as what the flood reduction would be for the combination of components:

1. **Alternative 2 –** A flood channel with a 50-ft bottom width and 3:1 side slopes
2. **Alternative 4 –** Benching of the Olympia Brewery Property west of the railroad from an average elevation of 100’ to 96’
3. **Alternative 5 –** Benching of the Olympia Brewery Property west of the railroad from an average elevation of 100’ to 96’ and relocation of the power substation in conjunction with the lowering of the ground elevation directly below the Capitol Blvd overpass
4. **Alternative 9B –** A flood channel with a 20-ft bottom width and 3:1 side slopes with benching of the Olympia Brewery Property west of the railroad from an average elevation of 100’ to 96’ and relocation of the power substation in conjunction with the lowering of the ground elevation directly below the Capitol Blvd overpass
5. **Alternative 10A –** A flood channel with a 50-ft bottom width and 3:1 side slopes with benching of the Olympia Brewery Property west of the railroad from an average elevation of 100’ to 96’.
6. **Alternative 10B -** A flood channel with a 50-ft bottom width and 3:1 side slopes with benching of the Olympia Brewery Property west of the railroad from an average elevation of 100’ to 96’ and relocation of the power substation in conjunction with the lowering of the ground elevation directly below the Capitol Blvd overpass.

Alternative Analysis

We developed figures to show a plan view of each alternative and illustrate the flood reduction of each alternative. For each alternative the following figures are given:

1. Conceptual drawing of the alternative
2. Comparison of the topographic terrain of the alternative to the existing conditions terrain
3. Maximum flood depth figure for the 2022 event (6,900 cfs) compared to existing conditions for 2022 event.
4. Maximum flood depth figure for the 25yr event (9,100 cfs) compared to existing conditions for the 25yr event
5. Maximum flood depth figure for the current 100yr event (10,100 cfs) compared to existing conditions for current 100yr event
6. Maximum flood depth figure for the climate-change-based year 2080 100yr event (13,700 cfs) compared to existing conditions for year 2080 100yr event

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Legend

Components

- 20ft Bottom Width Channel
- 50ft Bottom Width Channel
- Benching
- Substation Relocation and Abutment Lowering

0 250 500 Feet

Page 01 of 01

Project Location
City of Tumwater
Thurston County, Wa

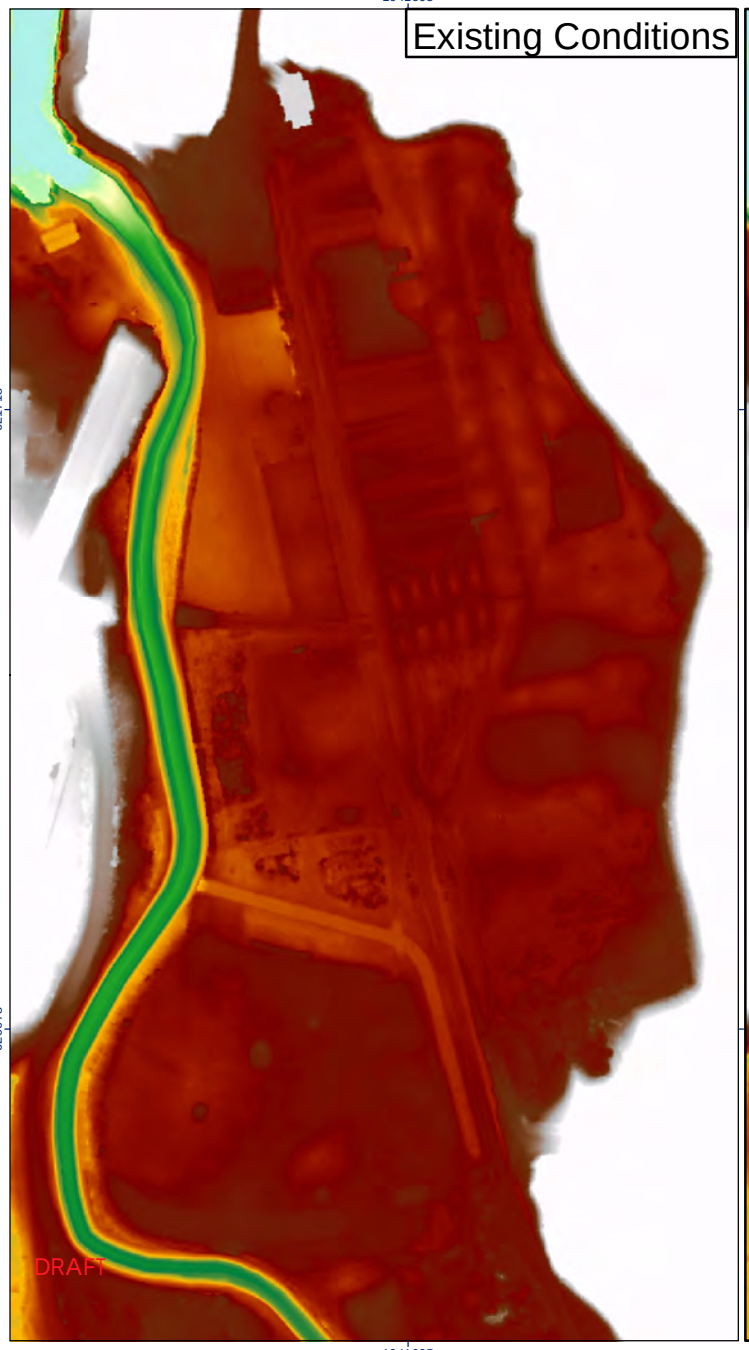
Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 -26

Client/Project
City of Tumwater
Deschutes River Flood and Erosion Reduction Study

Figure No.
35

Title
Conceptual Drawing
Alternative 2

Page 01 of 01



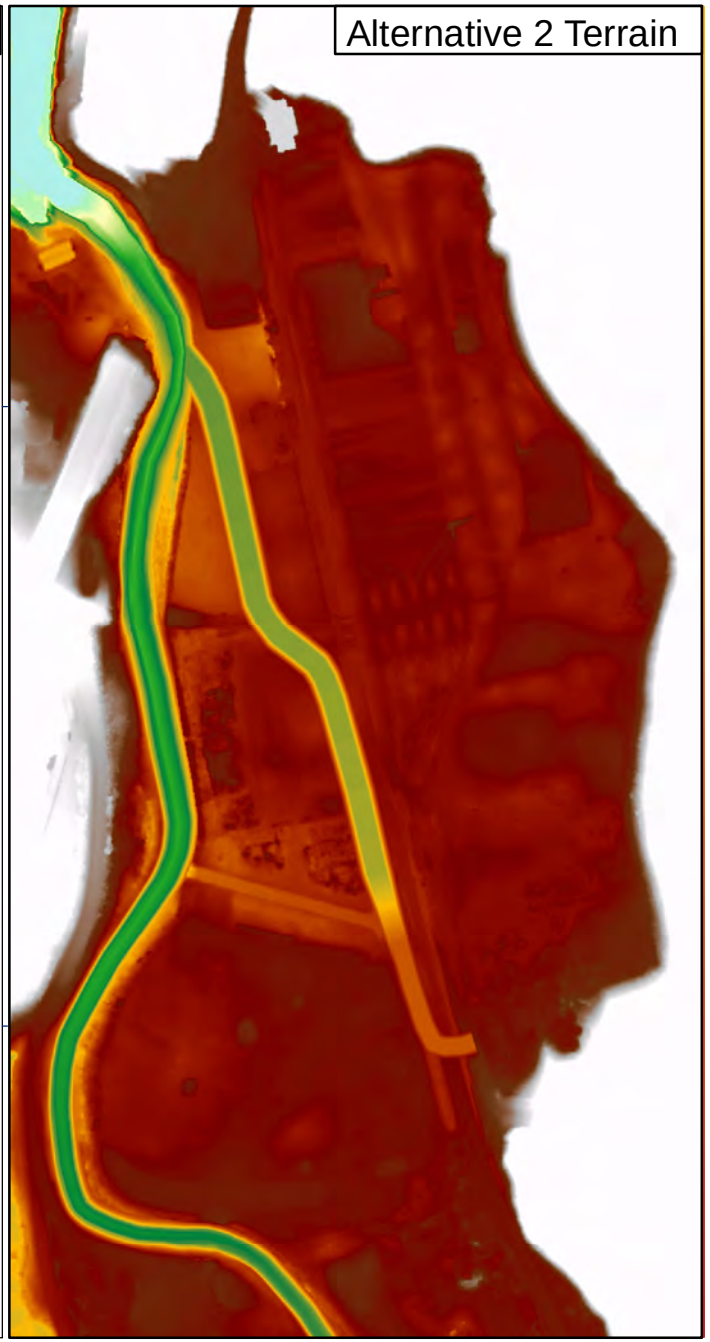


Figure No.
36

Title
Alternative Model - Alternative 2 Terrain Modification

Client/Project
City of Tumwater
Deschutes River Flood and Erosion Reduction Study

Project Location:
City of Tumwater
Thurston, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 -26

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Miles

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Legend

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Low : 75

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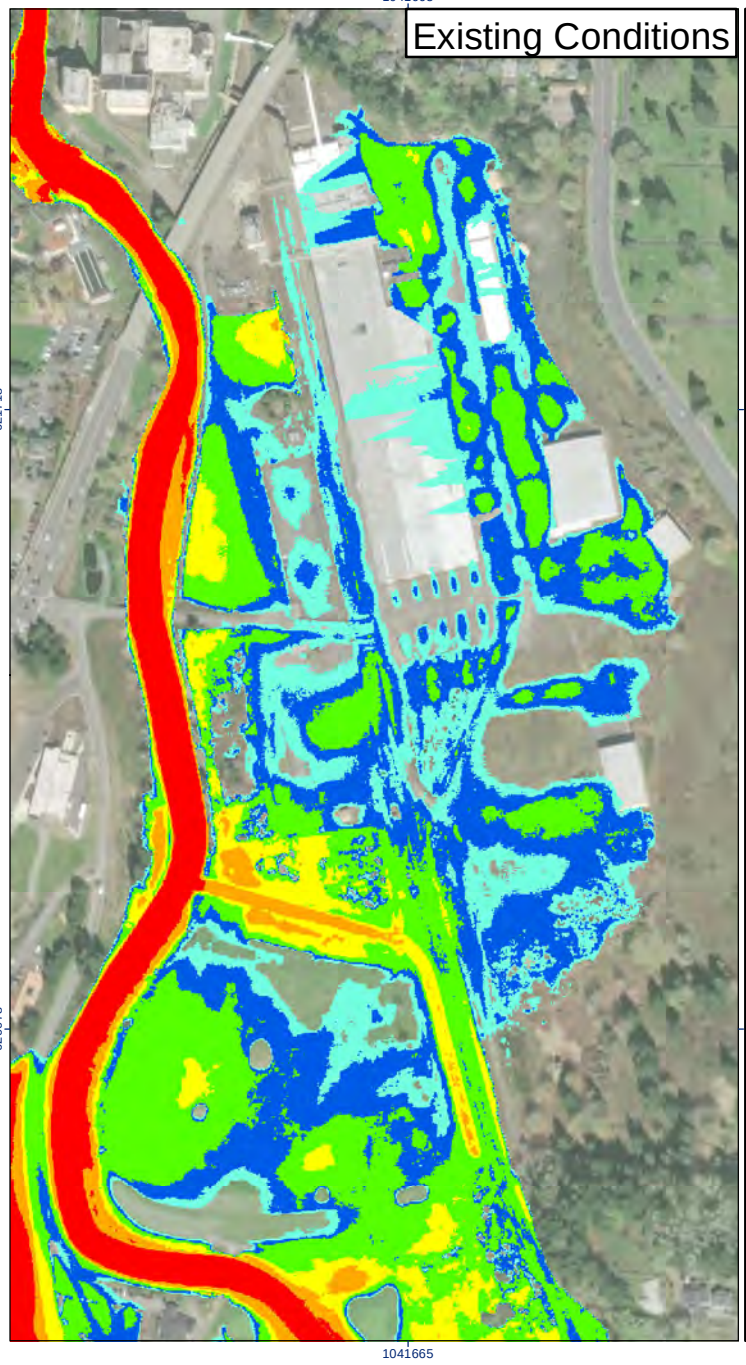

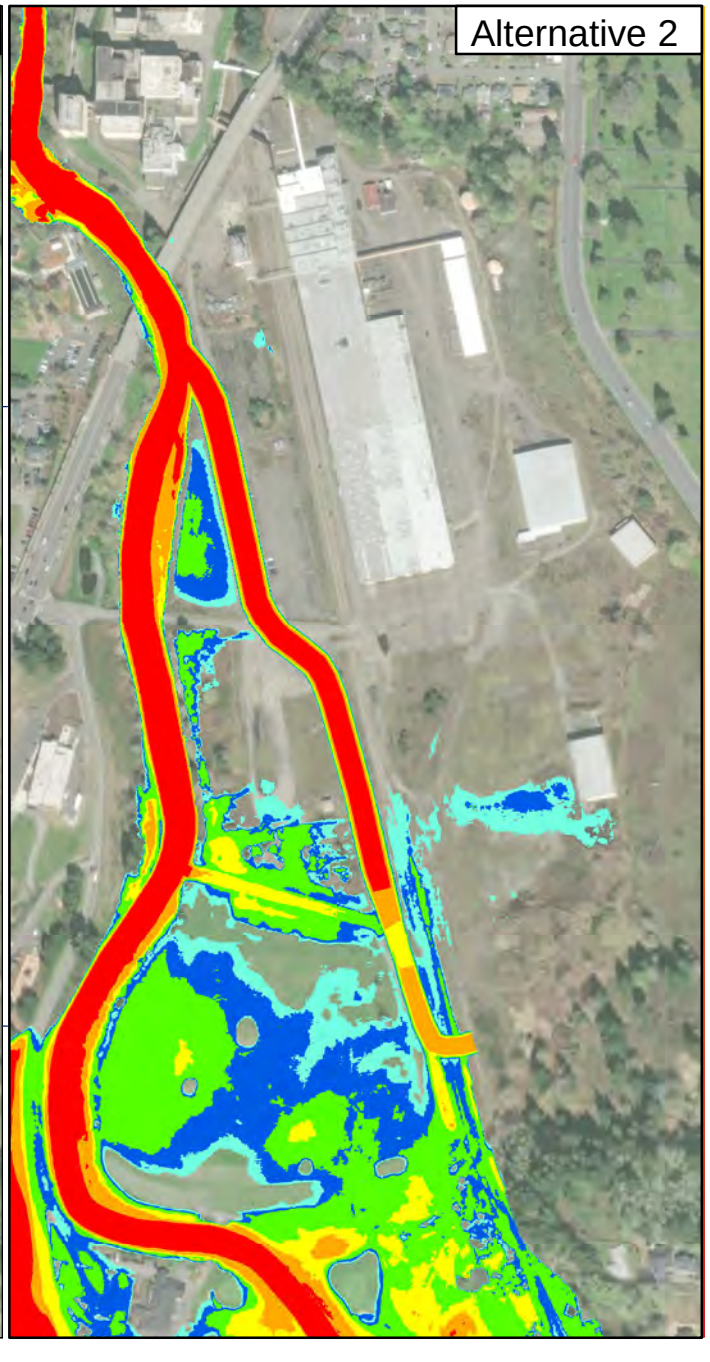

Figure No.
37

Title
Alternative Model
Maximum Flood Depth 2022 Flood

Client/Project
City of Tumwater
Deschutes River Flood and
Erosion Reduction Study

Project Location:
City of Tumwater
Thurston, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 - 26

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Miles

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Legend

Depth

- > 5+ ft
- 3.0 - 5.0 ft
- 2.0 - 3.0 ft
- 1.0 - 2.0 ft
- 0.5 - 1.0 ft
- 0.1 ft - 0.5 ft
- < 0.1 ft

CITY OF TUMWATER

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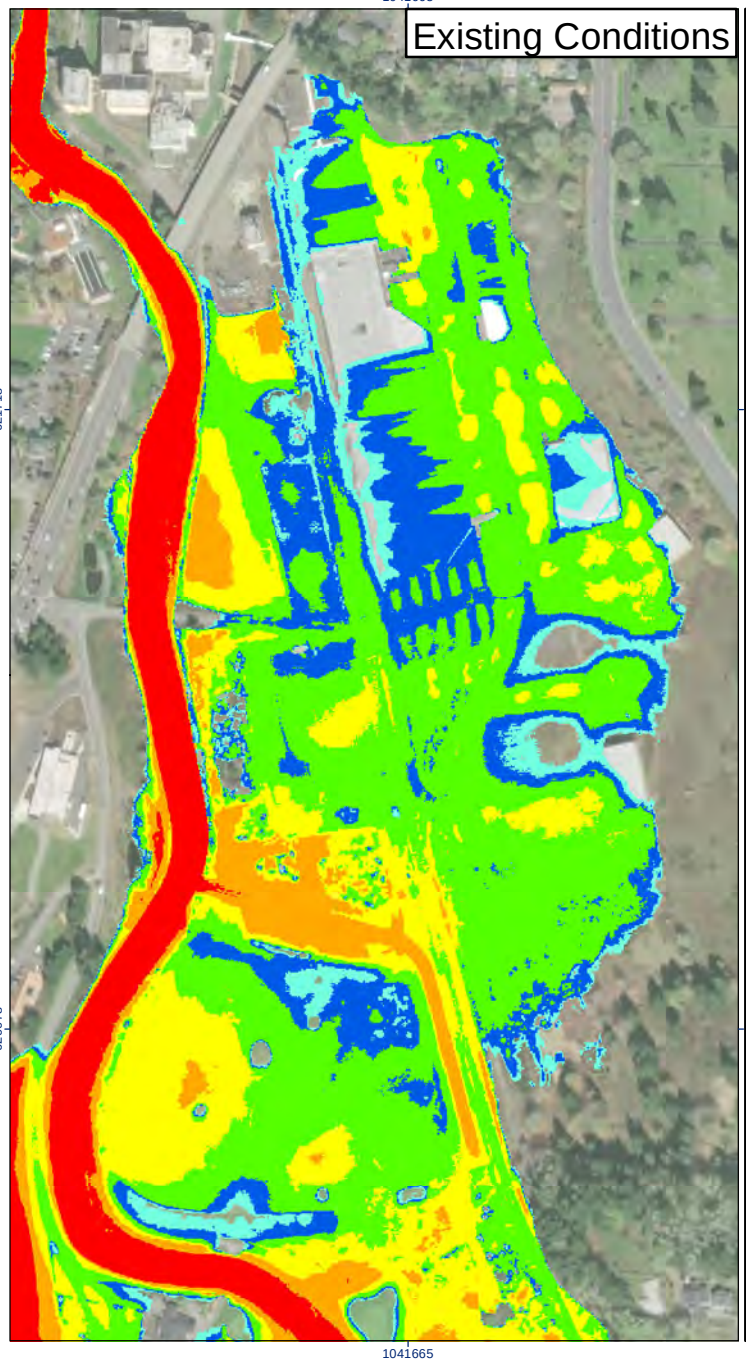

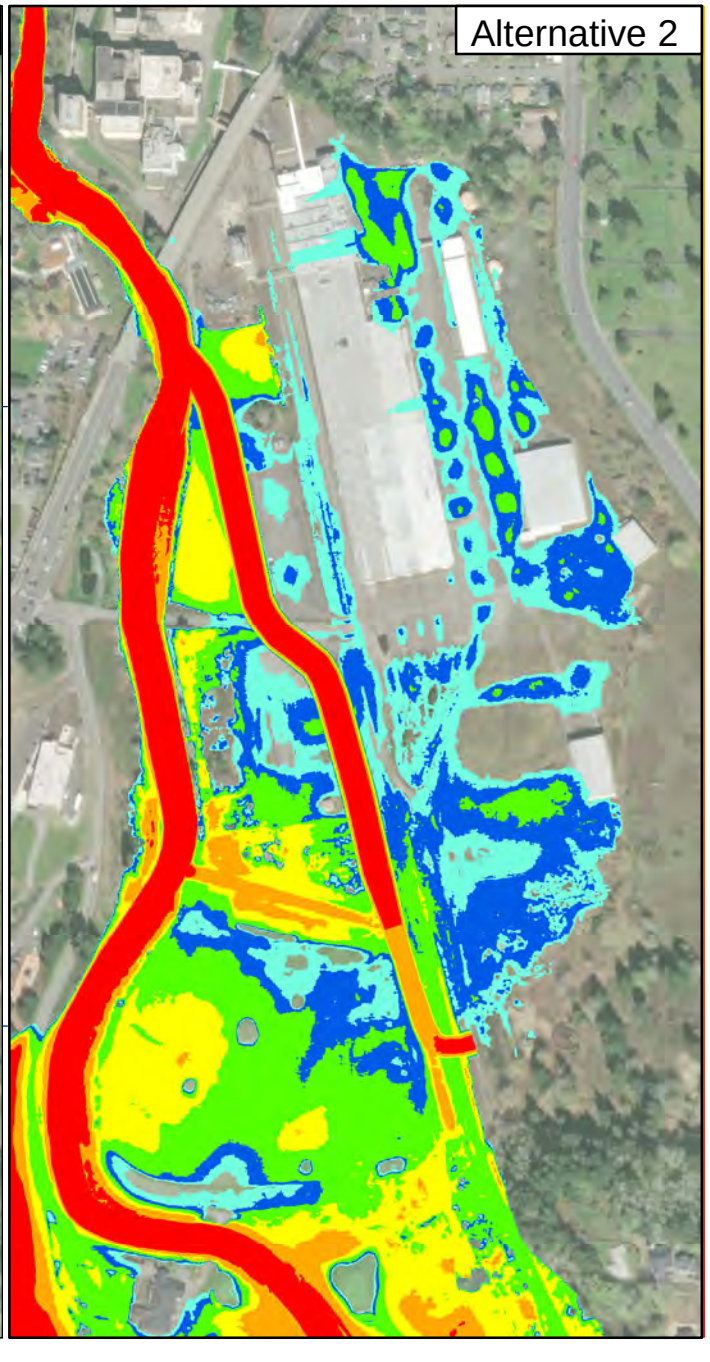

Figure No.
38

Title
Alternative Model - Alternative 2
Maximum Flood Depth 25yr Flood

Client/Project
City of Tumwater
Deschutes River Flood and
Erosion Reduction Study

Project Location:
City of Tumwater
Thurston, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
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Miles

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Legend

Depth

- > 5+ ft
- 3.0 - 5.0 ft
- 2.0 - 3.0 ft
- 1.0 - 2.0 ft
- 0.5 - 1.0 ft
- 0.1 ft - 0.5 ft
- < 0.1 ft

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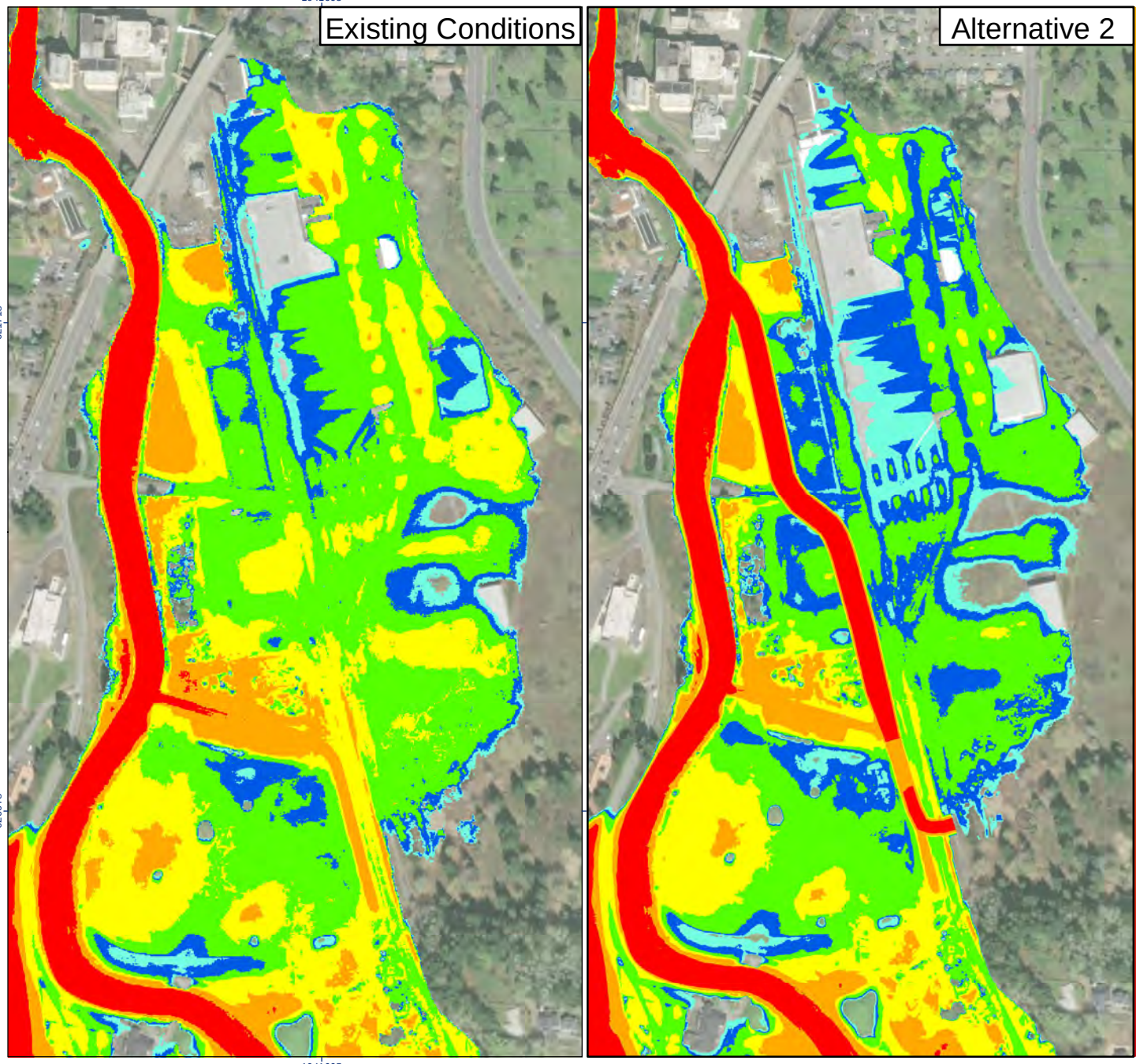

Figure No.
39

Title
Alternative Model - Alternative 2
Max Flood Depth Current 100yr Event

Client/Project
City of Tumwater
Deschutes River Flood and
Erosion Reduction Study

Project Location:
City of Tumwater
Thurston, Wa

Prepared by JZ on 2023 - 05 - 22
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Miles

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Legend

Depth

- > 5+ ft
- 3.0 - 5.0 ft
- 2.0 - 3.0 ft
- 1.0 - 2.0 ft
- 0.5 - 1.0 ft
- 0.1 ft - 0.5 ft
- < 0.1 ft

CITY OF TUMWATER

Page 01 of 01

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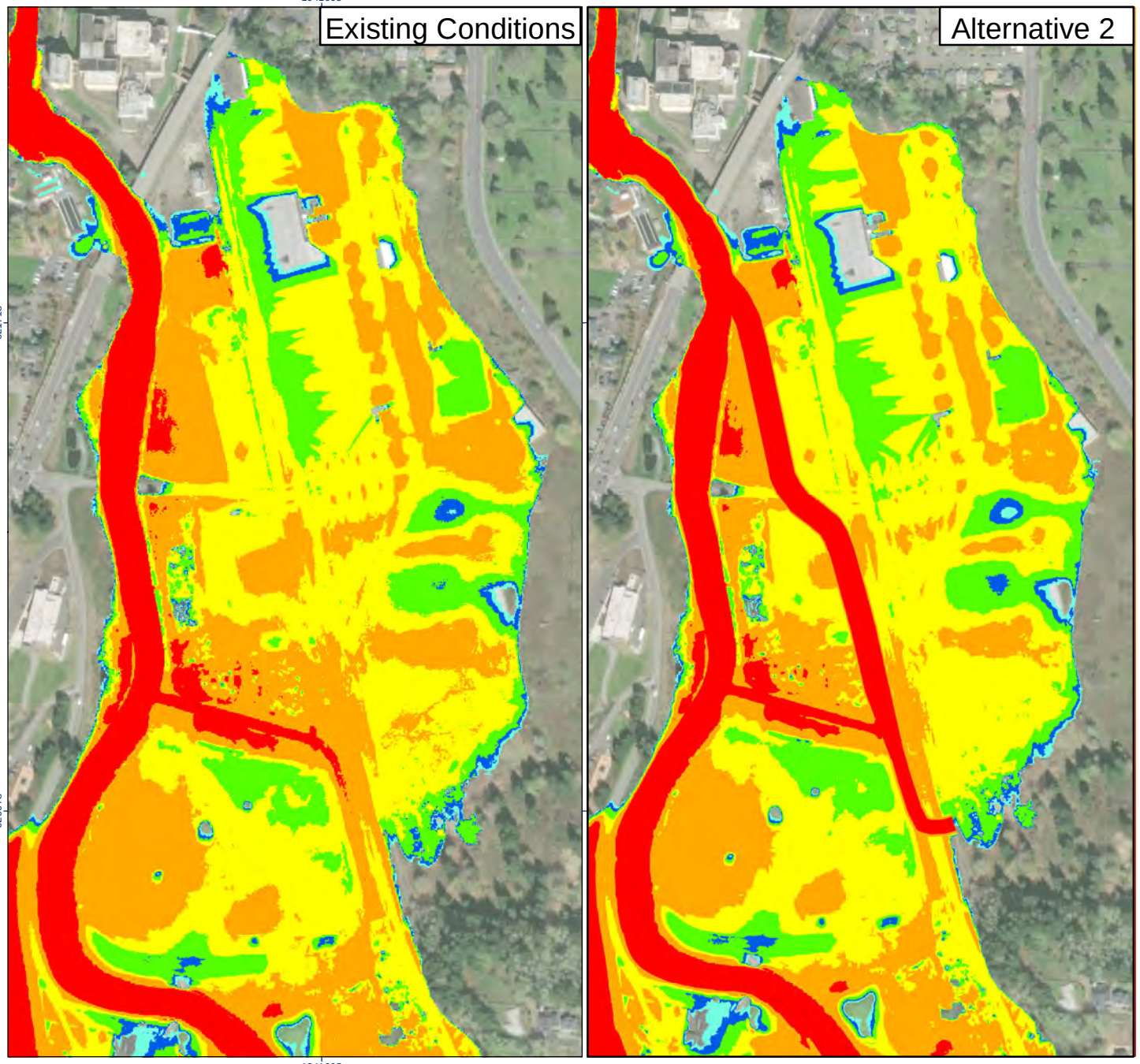

Figure No.
40

Title
Alternative Model - Alternative 2
Max Flood Depth 2080 - 100yr Event

Client/Project
City of Tumwater
Deschutes River Flood and
Erosion Reduction Study

Project Location:
City of Tumwater
Thurston, Wa

Prepared by JZ on 2023 - 05 - 22
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0 0.05 0.1 Miles

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Legend

Depth

- > 5+ ft
- 3.0 - 5.0 ft
- 2.0 - 3.0 ft
- 1.0 - 2.0 ft
- 0.5 - 1.0 ft
- 0.1 ft - 0.5 ft
- < 0.1 ft

CITY OF TUMWATER

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Legend

Components

- 20ft Bottom Width Channel
- 50ft Bottom Width Channel
- Benching
- Substation Relocation and Abutment Lowering

0 250 500 Feet

Page 01 of 01

Project Location
City of Tumwater
Thurston County, Wa

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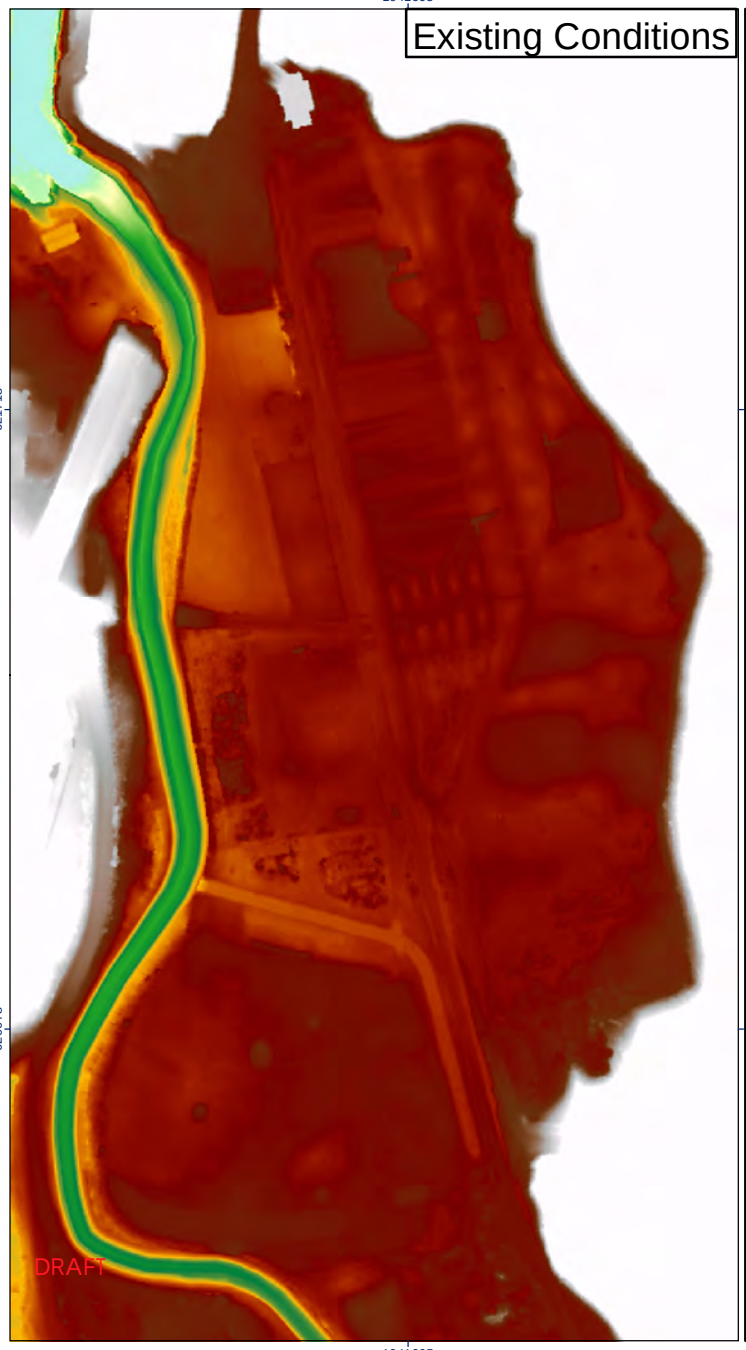
Client/Project
City of Tumwater
Deschutes River Flood and Erosion Reduction Study

Figure No.
41

Title
Conceptual Drawing
Alternative 4

Page 01 of 01



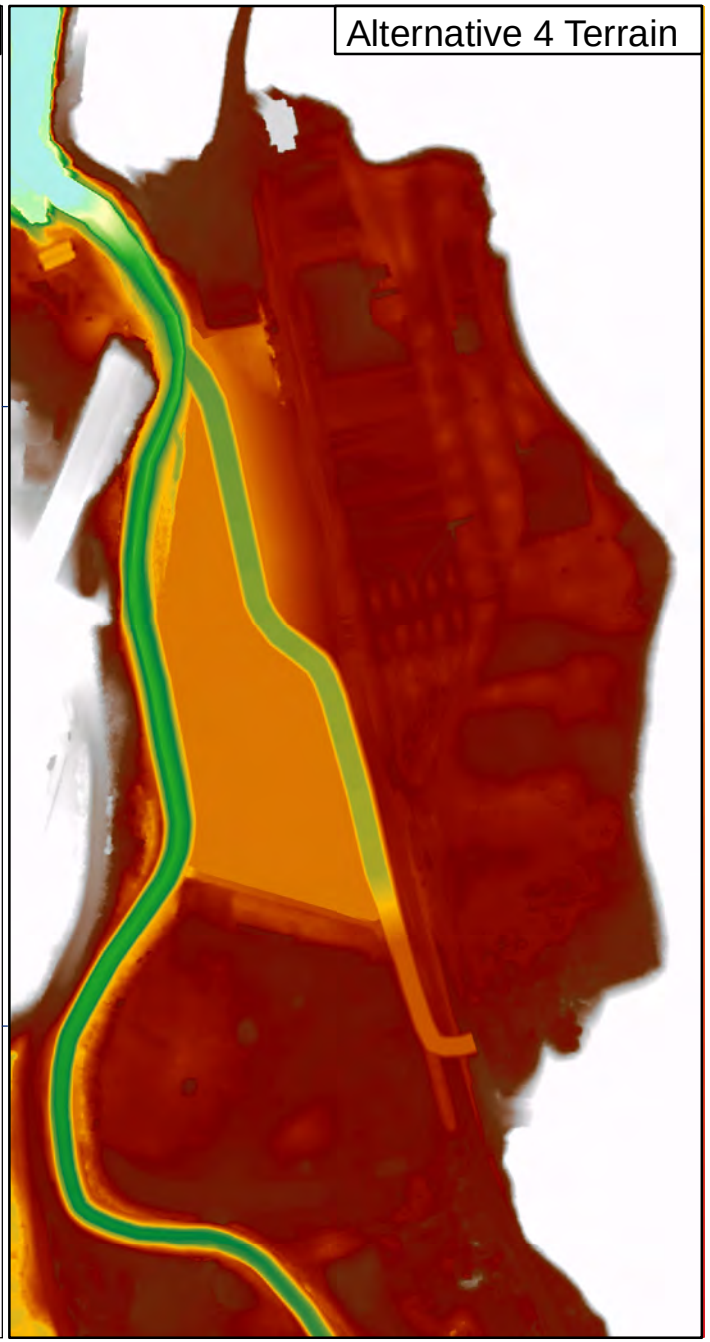


Figure No.
42

Title
Alternative Model - Alternative 4 Terrain Modification

Client/Project
City of Tumwater
Deschutes River Flood and Erosion Reduction Study

Project Location:
City of Tumwater
Thurston, Wa

Prepared by JZ on 2023 - 05 - 22
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Independent Review by JR on 2023 - 05 -26

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Miles

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Legend

High : 120

Low : 75

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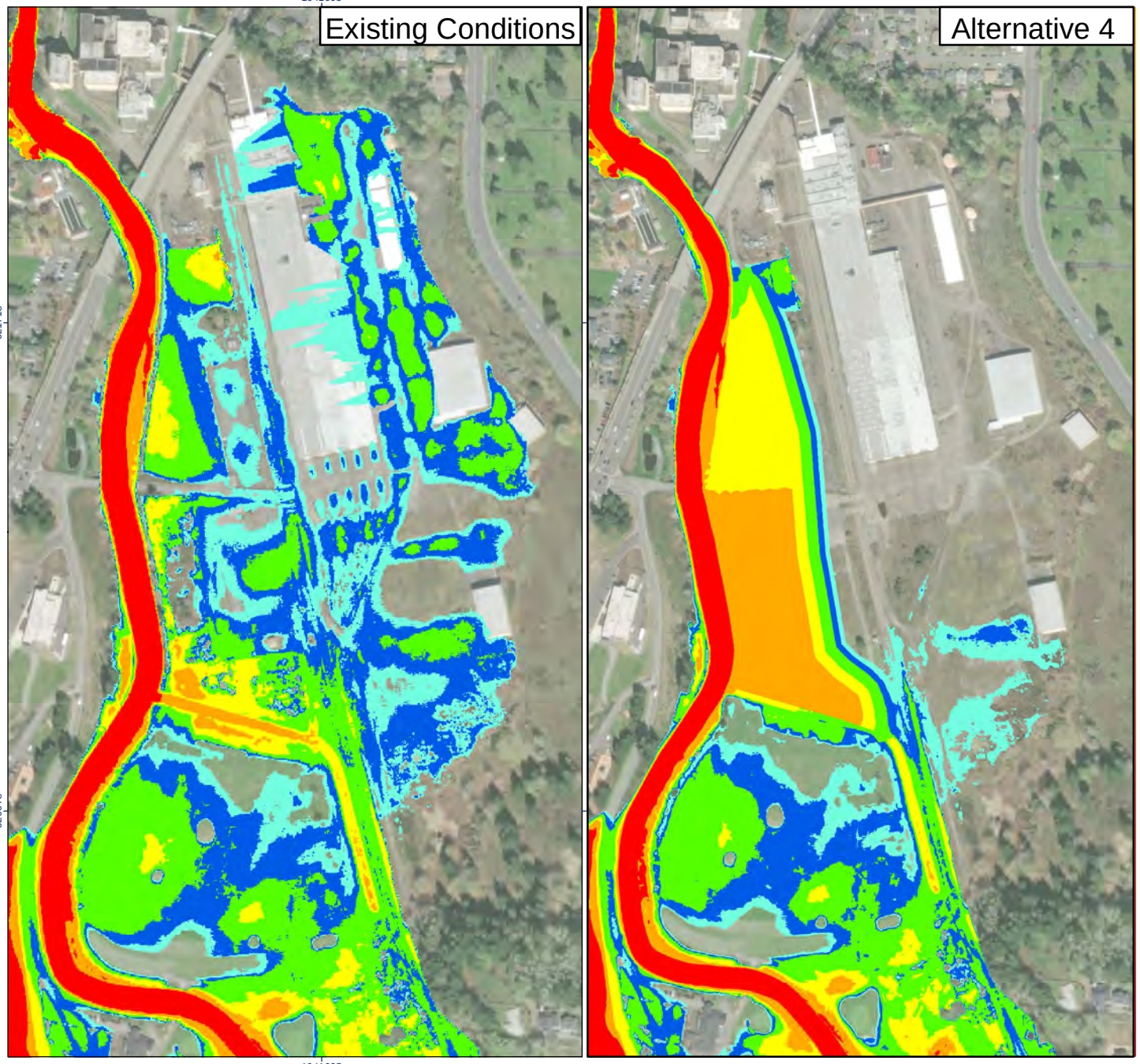

Figure No.
43

Title
Alternative Model - Alternative 4
Maximum Flood Depth 2022 Flood

Client/Project
City of Tumwater
Deschutes River Flood and
Erosion Reduction Study

Project Location:
City of Tumwater
Thurston, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 -26

0 0.05 0.1
Miles
1:6,103 (At Original document size of 8.5x11)

Legend

Depth

- > 5+ ft
- 3.0 - 5.0 ft
- 2.0 - 3.0 ft
- 1.0 - 2.0 ft
- 0.5 - 1.0 ft
- 0.1 ft - 0.5 ft
- < 0.1 ft

CITY OF TUMWATER

Page 01 of 01

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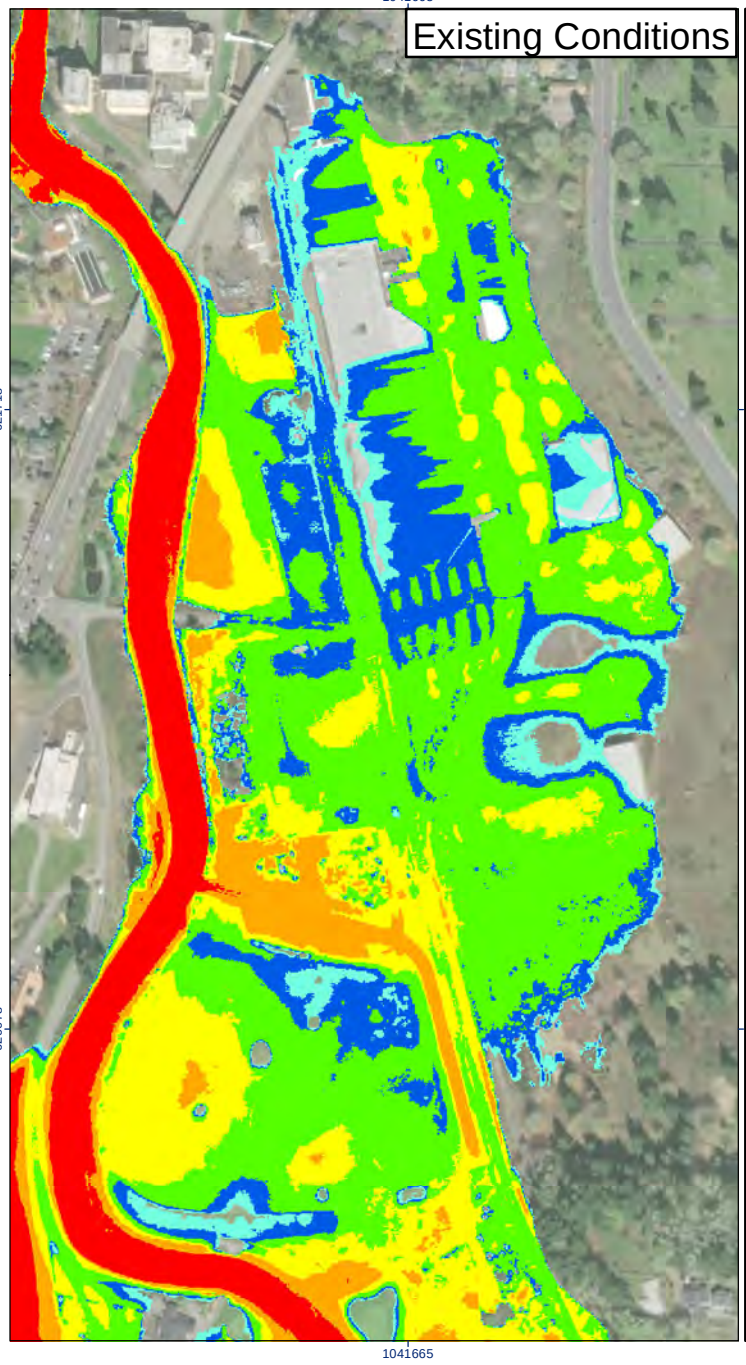

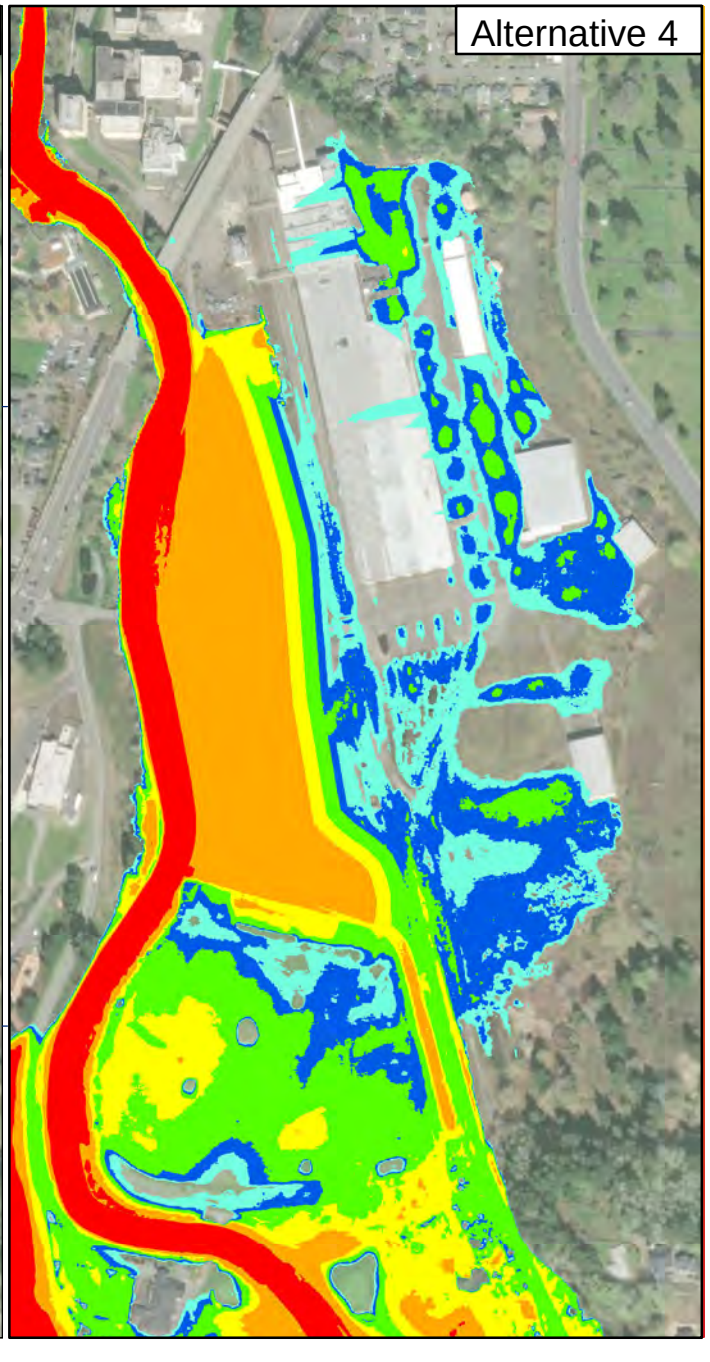

Figure No.
44

Title
Alternative Model - Alternative 4
Maximum Flood Depth 25yr Flood

Client/Project
City of Tumwater
Deschutes River Flood and
Erosion Reduction Study

Project Location:
City of Tumwater
Thurston, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 - 26

0 0.05 0.1
Miles

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Legend

Depth

- > 5+ ft
- 3.0 - 5.0 ft
- 2.0 - 3.0 ft
- 1.0 - 2.0 ft
- 0.5 - 1.0 ft
- 0.1 ft - 0.5 ft
- < 0.1 ft

CITY OF TUMWATER

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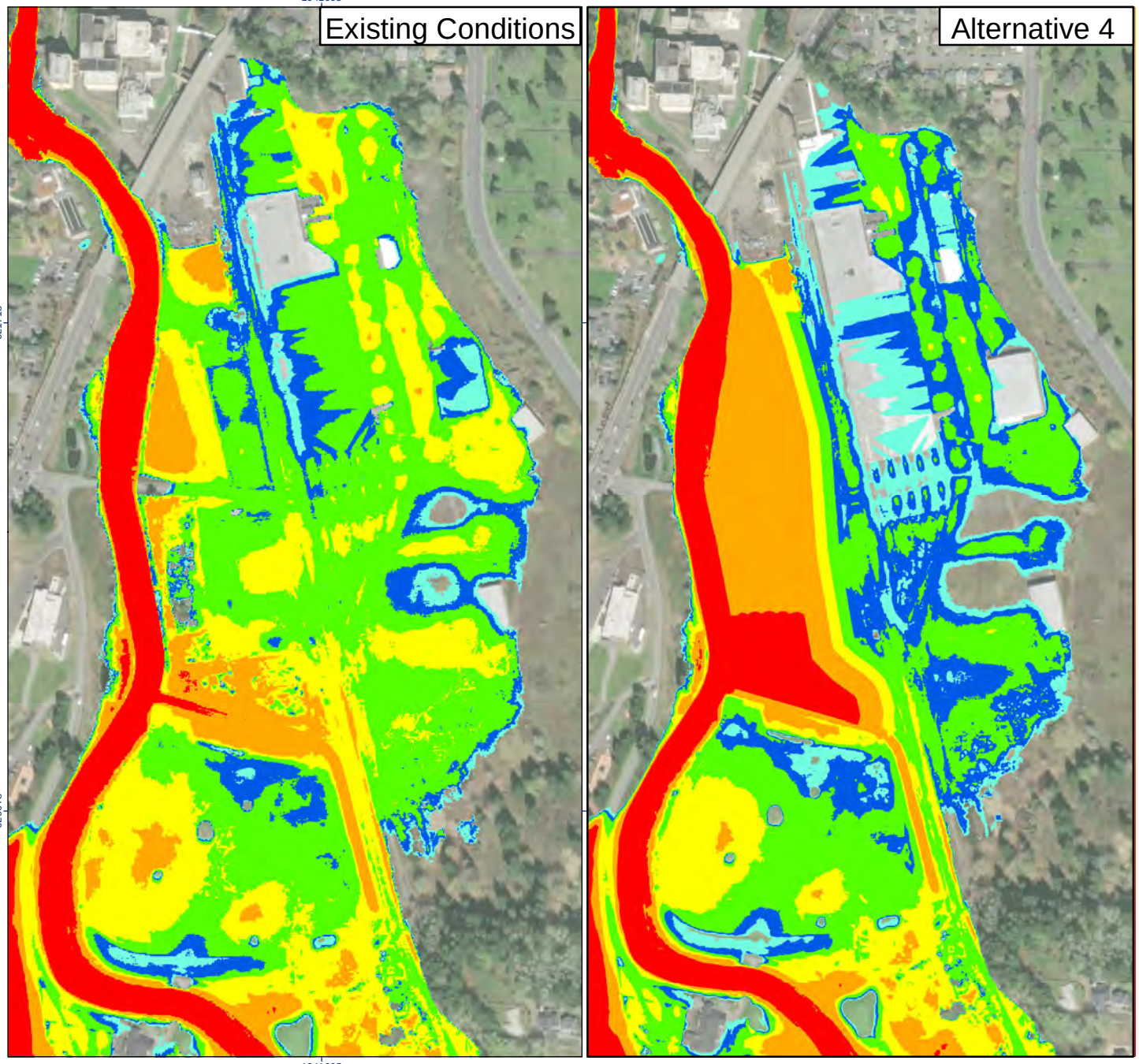

Figure No.
45

Title
Alternative Model - Alternative 4
Max Flood Depth Current 100yr Event

Client/Project
City of Tumwater
Deschutes River Flood and
Erosion Reduction Study

Project Location:
City of Tumwater
Thurston, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 -26

0 0.05 0.1
Miles

1:6,103 (At Original document size of 8.5x11)

Legend

Depth

- > 5+ ft
- 3.0 - 5.0 ft
- 2.0 - 3.0 ft
- 1.0 - 2.0 ft
- 0.5 - 1.0 ft
- 0.1 ft - 0.5 ft
- < 0.1 ft

CITY OF TUMWATER

Page 01 of 01

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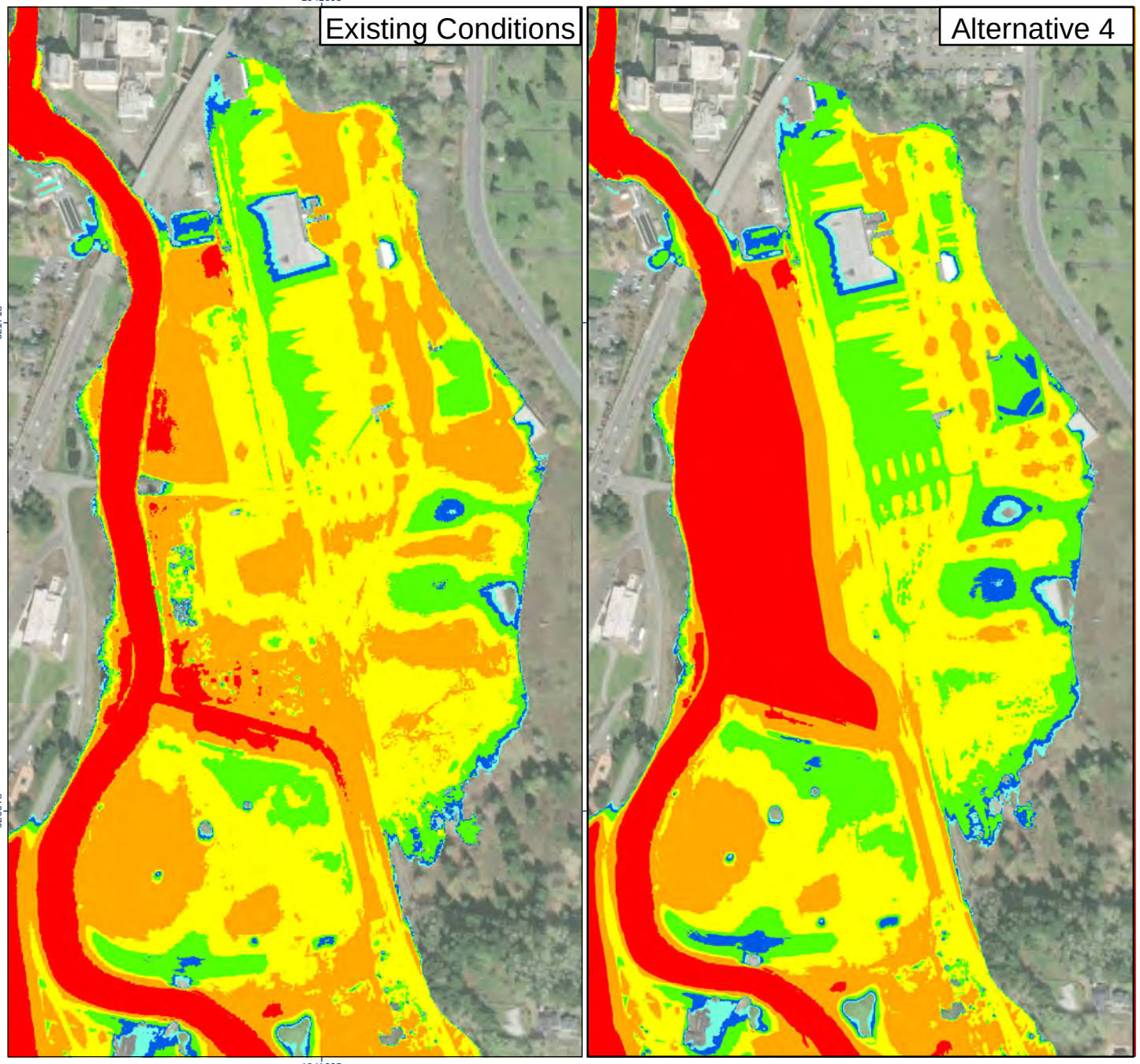


Figure No.
46

Title
Alternative Model - Alternative 4
Max Flood Depth 2080 - 100yr Event

Client/Project
City of Tumwater
Deschutes River Flood and
Erosion Reduction Study

Project Location:
City of Tumwater
Thurston, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 - 26

0 0.05 0.1 Miles

1:6,103 (At Original document size of 8.5x11)

Legend

Depth

- > 5+ ft
- 3.0 - 5.0 ft
- 2.0 - 3.0 ft
- 1.0 - 2.0 ft
- 0.5 - 1.0 ft
- 0.1 ft - 0.5 ft
- < 0.1 ft

CITY OF TUMWATER

C:\Users\zwhitten\Documents\tumwater\Figures\GIS\Fig_46_Model4_2080_100yr.mxd Revised: 2023-06-29 By: zwhitten

C:\Users\zwhitten\Documents\Tumwater\Figures\GIS\Fig_47_Conceptual_Alt5.mxd Revised: 2023-06-28 By: zwhitten

Legend

Components

- 20ft Bottom Width Channel
- 50ft Bottom Width Channel
- Benching
- Substation Relocation and Abutment Lowering

0 250 500 Feet

Page 01 of 01

Project Location
City of Tumwater
Thurston County, Wa

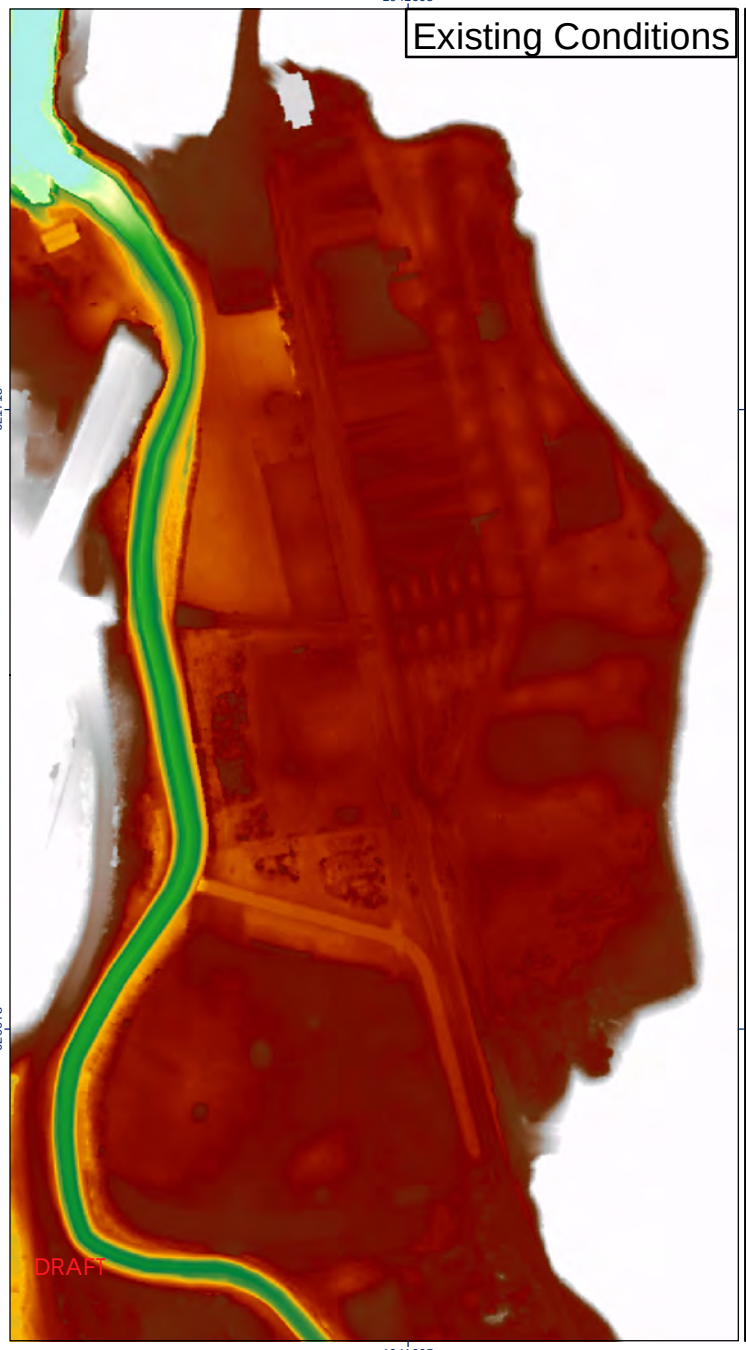
Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 -26

Client/Project
City of Tumwater
Deschutes River Flood and Erosion Reduction Study

Figure No.
47

Title
Conceptual Drawing
Alternative 5

Page 01 of 01



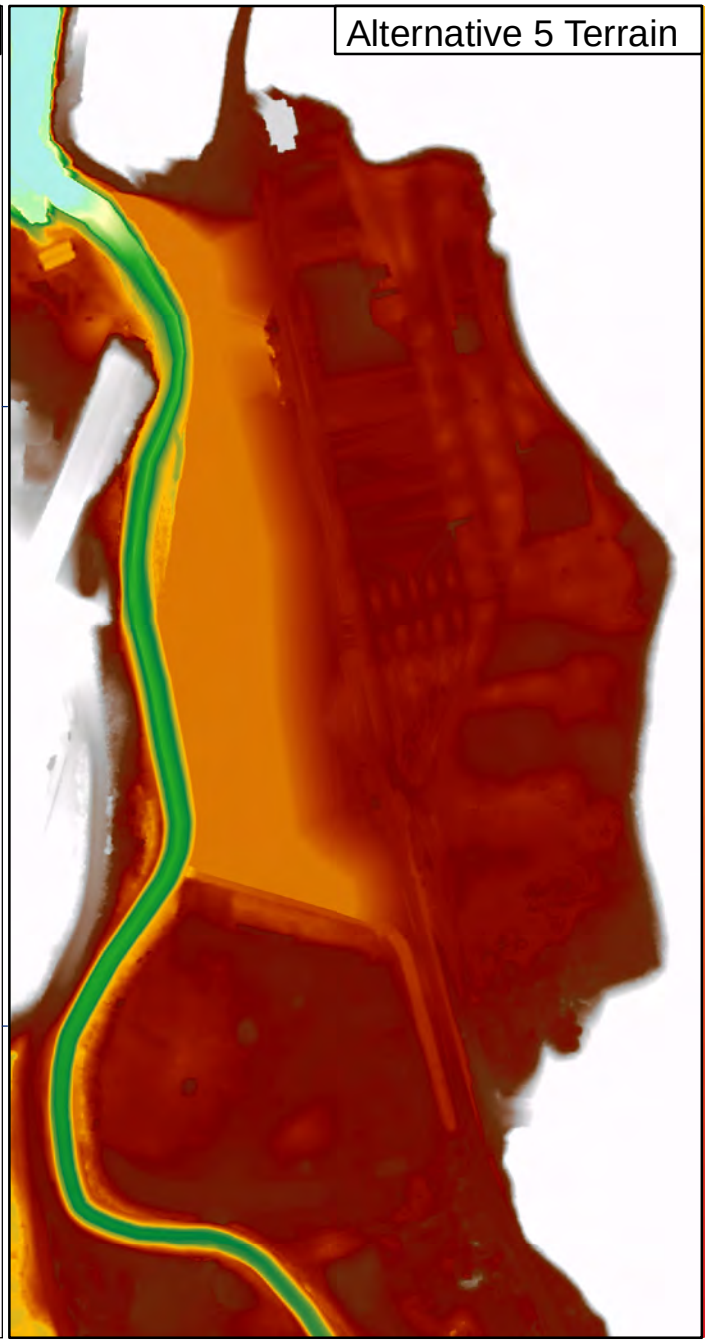


Figure No.
48

Title
Alternative Model - Alternative 5 Terrain Modification

Client/Project
City of Tumwater
Deschutes River Flood and Erosion Reduction Study

Project Location:
City of Tumwater
Thurston, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 -26

0 0.05 0.1
Miles

1:6,103 (At Original document size of 8.5x11)

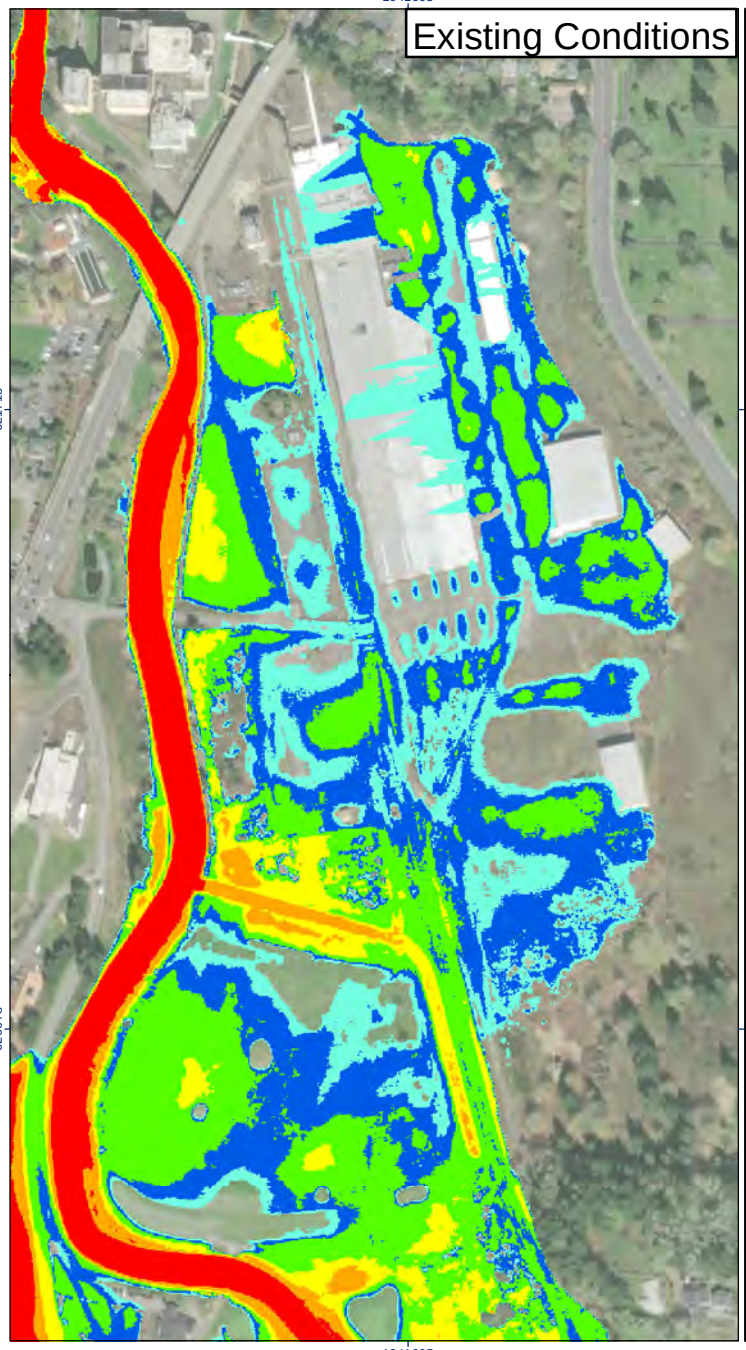
Legend

Value

High : 120

Low : 75

C:\Users\zwhitten\Documents\tumwater\Figures\GIS\Fig_48_Model5_Topo_Compare.mxd Revised: 2023-06-28 By: zwhitten



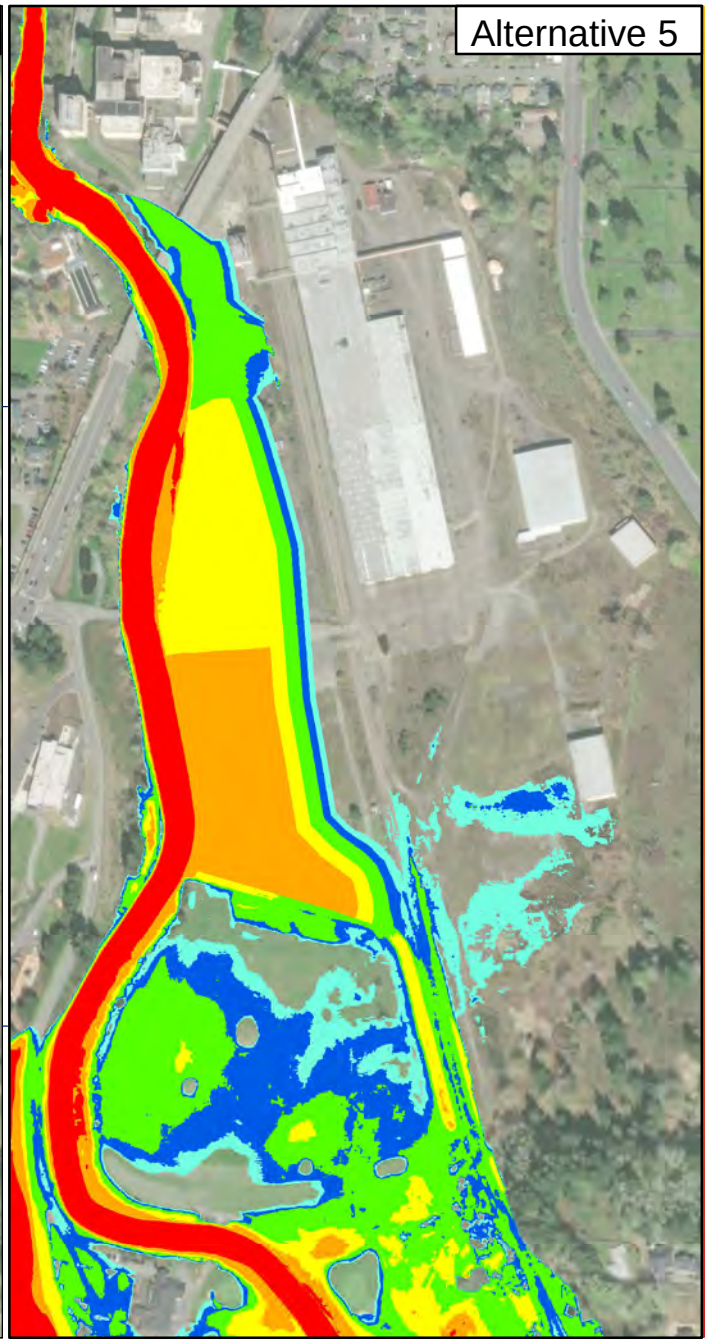


Figure No.
49

Title
Alternative Model - Alternative 5
Maximum Flood Depth 2022 Flood

Client/Project
City of Tumwater
Deschutes River Flood and
Erosion Reduction Study

Project Location:
City of Tumwater
Thurston, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 -26

0 0.05 0.1
Miles

1:6,103 (At Original document size of 8.5x11)

Legend

Depth

- > 5+ ft
- 3.0 - 5.0 ft
- 2.0 - 3.0 ft
- 1.0 - 2.0 ft
- 0.5 - 1.0 ft
- 0.1 ft - 0.5 ft
- < 0.1 ft

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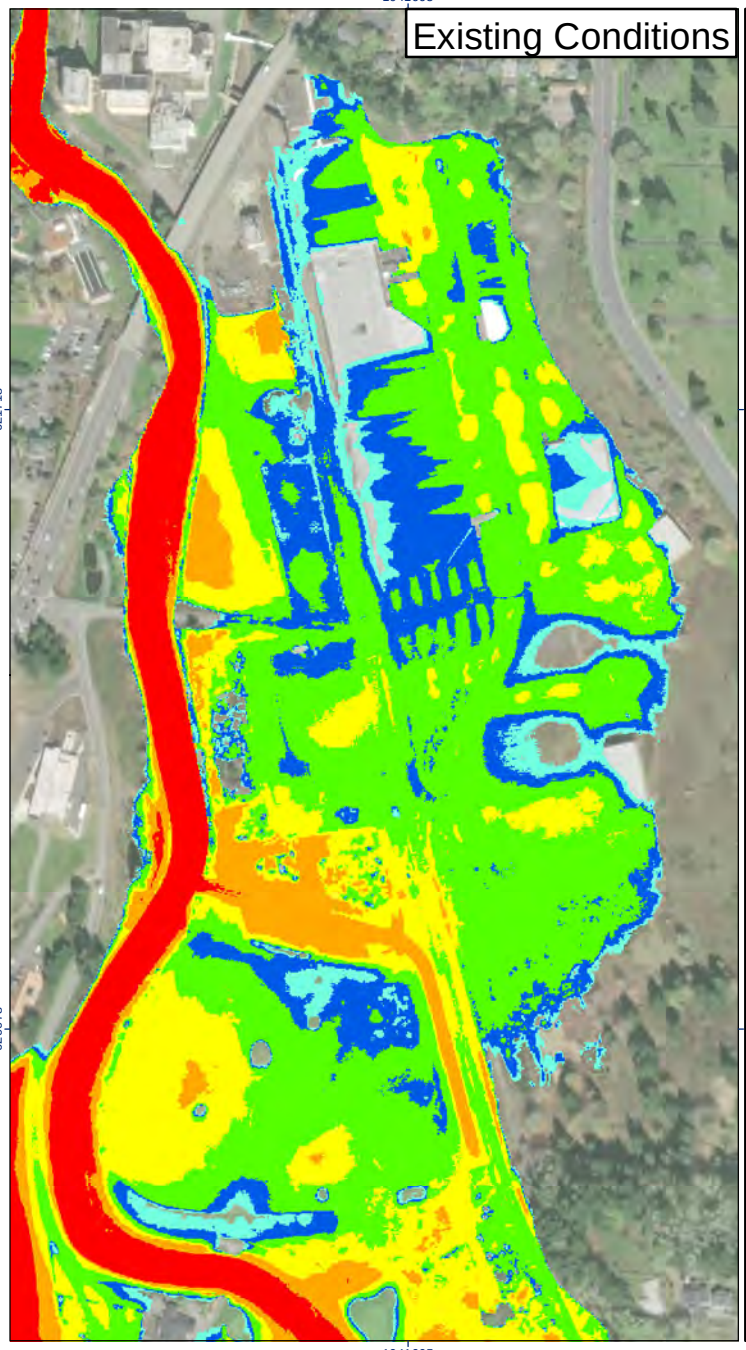

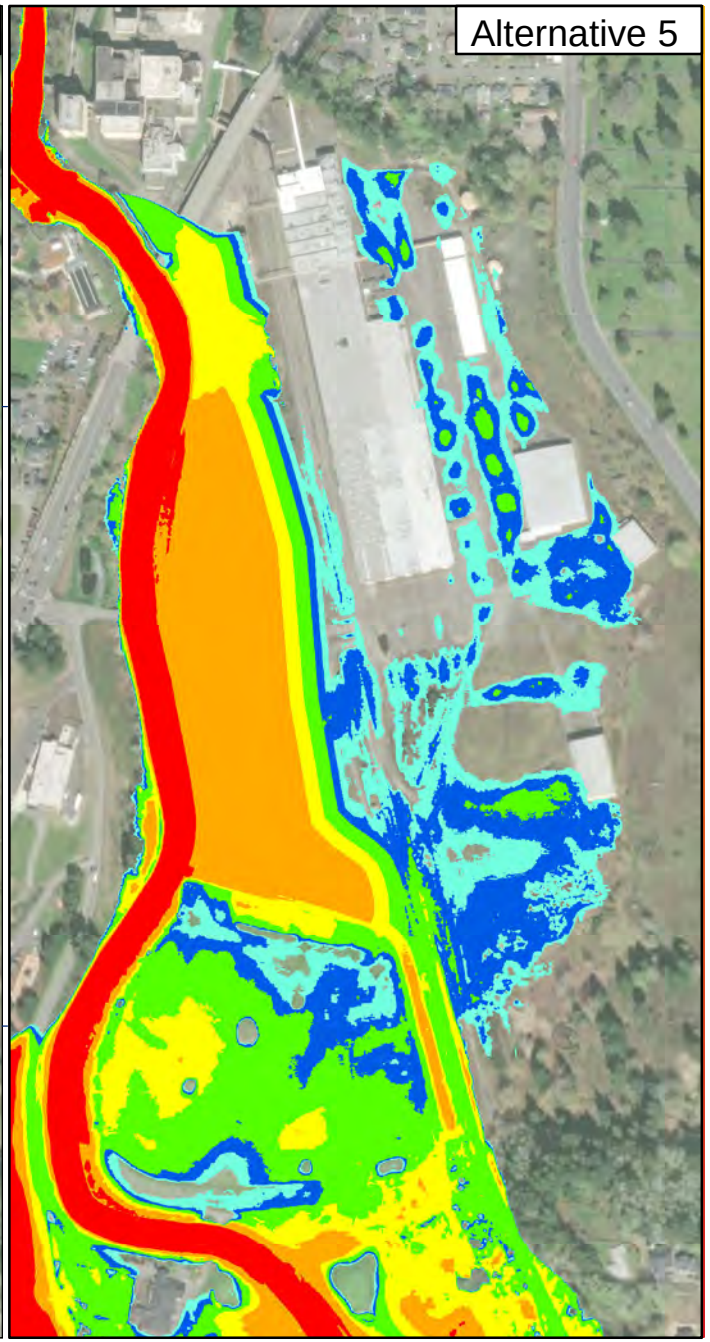

Figure No.
69

Title
Alternative Model - Alternative 5
Maximum Flood Depth 25yr Flood

Client/Project
City of Tumwater
Deschutes River Flood and
Erosion Reduction Study

Project Location:
City of Tumwater
Thurston, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 - 26

0 0.05 0.1
Miles

1:6,103 (At Original document size of 8.5x11)

Legend

Depth

- > 5+ ft
- 3.0 - 5.0 ft
- 2.0 - 3.0 ft
- 1.0 - 2.0 ft
- 0.5 - 1.0 ft
- 0.1 ft - 0.5 ft
- < 0.1 ft

CITY OF TUMWATER

Page 01 of 01

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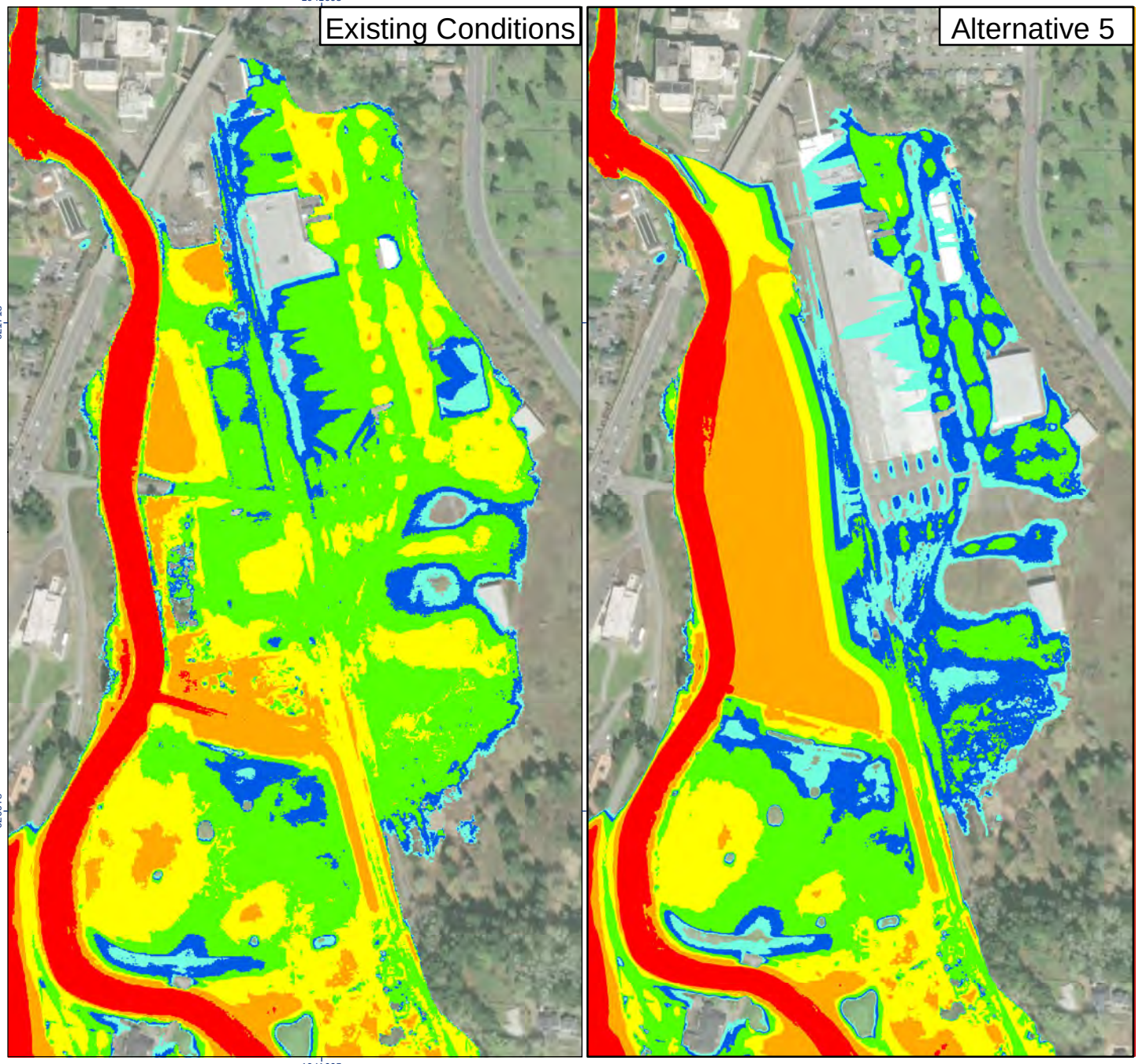


Figure No.
51

Title
Alternative Model - Alternative 5
Max Flood Depth Current 100yr Event

Client/Project
City of Tumwater
Deschutes River Flood and
Erosion Reduction Study

Project Location:
City of Tumwater
Thurston, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 -26

0 0.05 0.1
Miles

1:6,103 (At Original document size of 8.5x11)

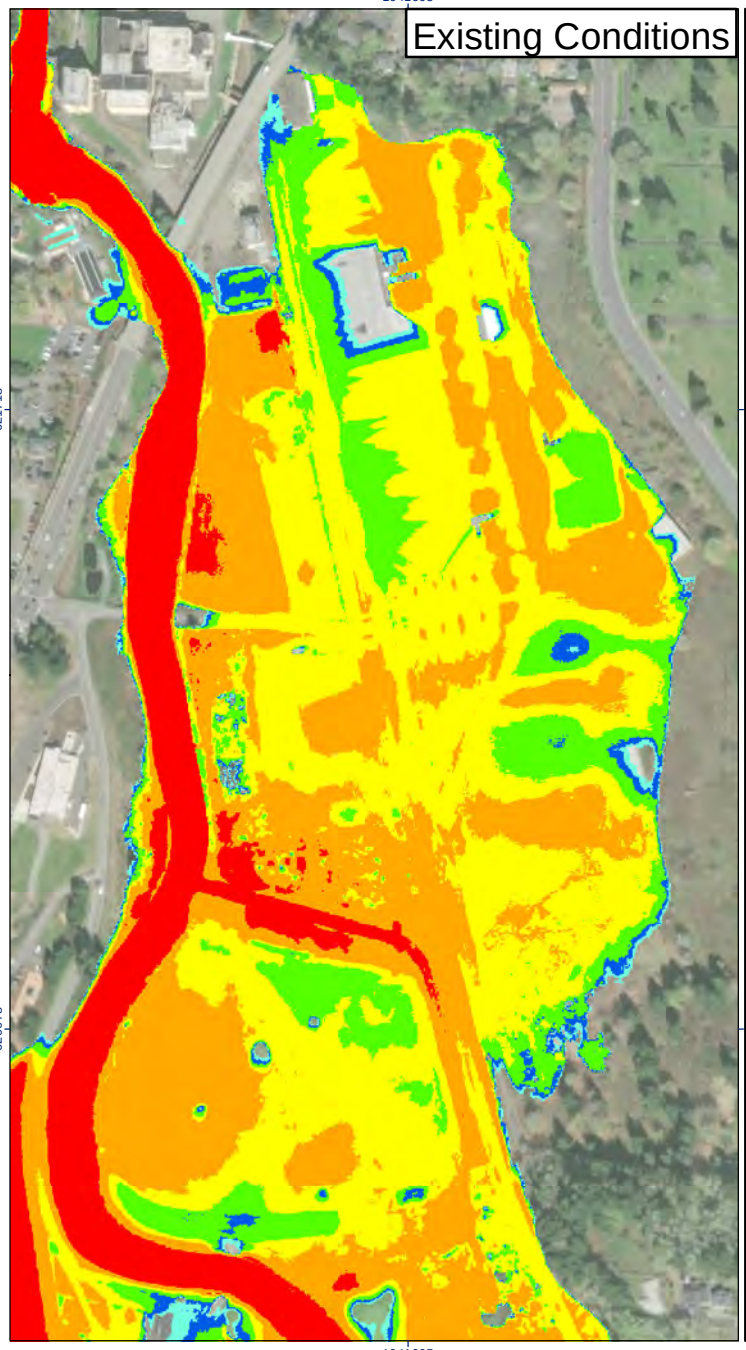
Legend

Depth

- > 5+ ft
- 3.0 - 5.0 ft
- 2.0 - 3.0 ft
- 1.0 - 2.0 ft
- 0.5 - 1.0 ft
- 0.1 ft - 0.5 ft
- < 0.1 ft

CITY OF TUMWATER

C:\Users\zwhitten\Documents\tumwater\Figures\GIS\Fig_51_Model5_100yr.mxd Revised: 2023-06-28 By: zwhitten



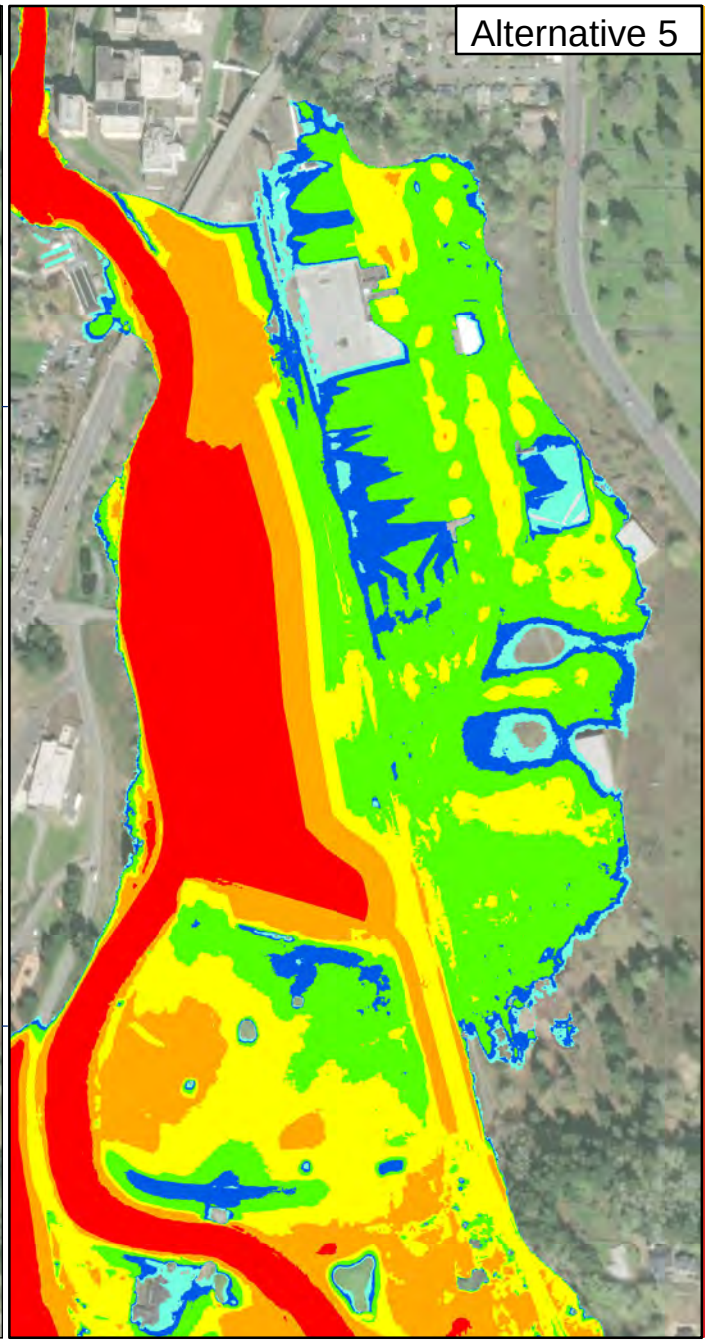


Figure No.
52

Title
Alternative Model - Alternative 5
Max Flood Depth 2080 - 100yr Event

Client/Project
City of Tumwater
Deschutes River Flood and
Erosion Reduction Study

Project Location:
City of Tumwater
Thurston, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 - 26

0 0.05 0.1
Miles

1:6,103 (At Original document size of 8.5x11)

Legend

Depth

- > 5+ ft
- 3.0 - 5.0 ft
- 2.0 - 3.0 ft
- 1.0 - 2.0 ft
- 0.5 - 1.0 ft
- 0.1 ft - 0.5 ft
- < 0.1 ft

CITY OF TUMWATER

Page 01 of 01

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Legend

Components

- 20ft Bottom Width Channel
- 50ft Bottom Width Channel
- Benching
- Substation Relocation and Abutment Lowering

0 250 500 Feet

Page 01 of 01

Project Location
City of Tumwater
Thurston County, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 -26

Client/Project
City of Tumwater
Deschutes River Flood and Erosion Reduction Study

Figure No.
53

Title
Conceptual Drawing
Alternative 9B

Page 01 of 01

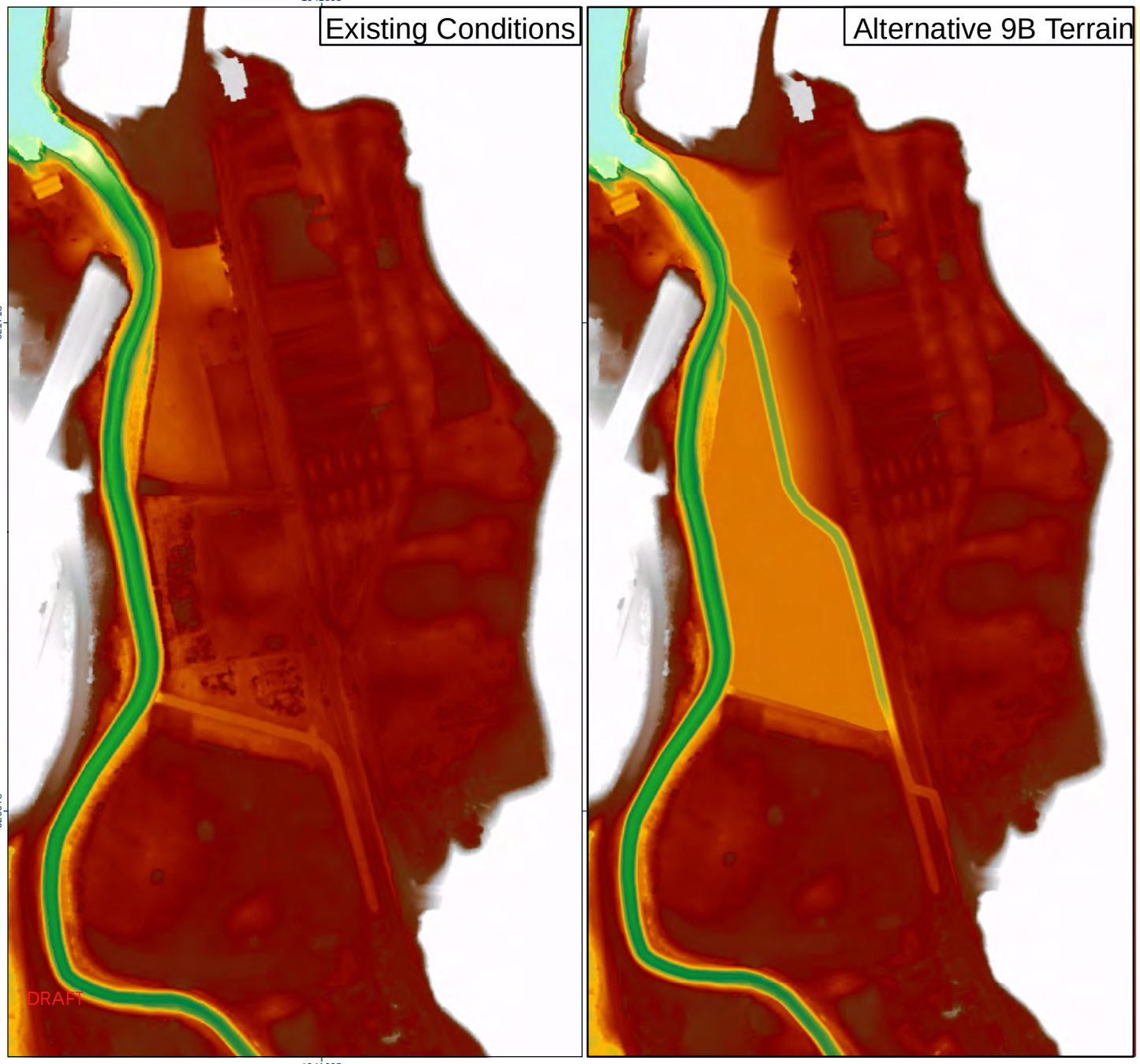

Figure No.
54

Title
Alternative Model - Alternative 9B Terrain Modification

Client/Project
City of Tumwater
Deschutes River Flood and Erosion Reduction Study

Project Location:
City of Tumwater
Thurston, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 -26

0 0.05 0.1
Miles
1:6,103 (At Original document size of 8.5x11)

Legend

Value

High : 120

Low : 75

CITY OF TUMWATER

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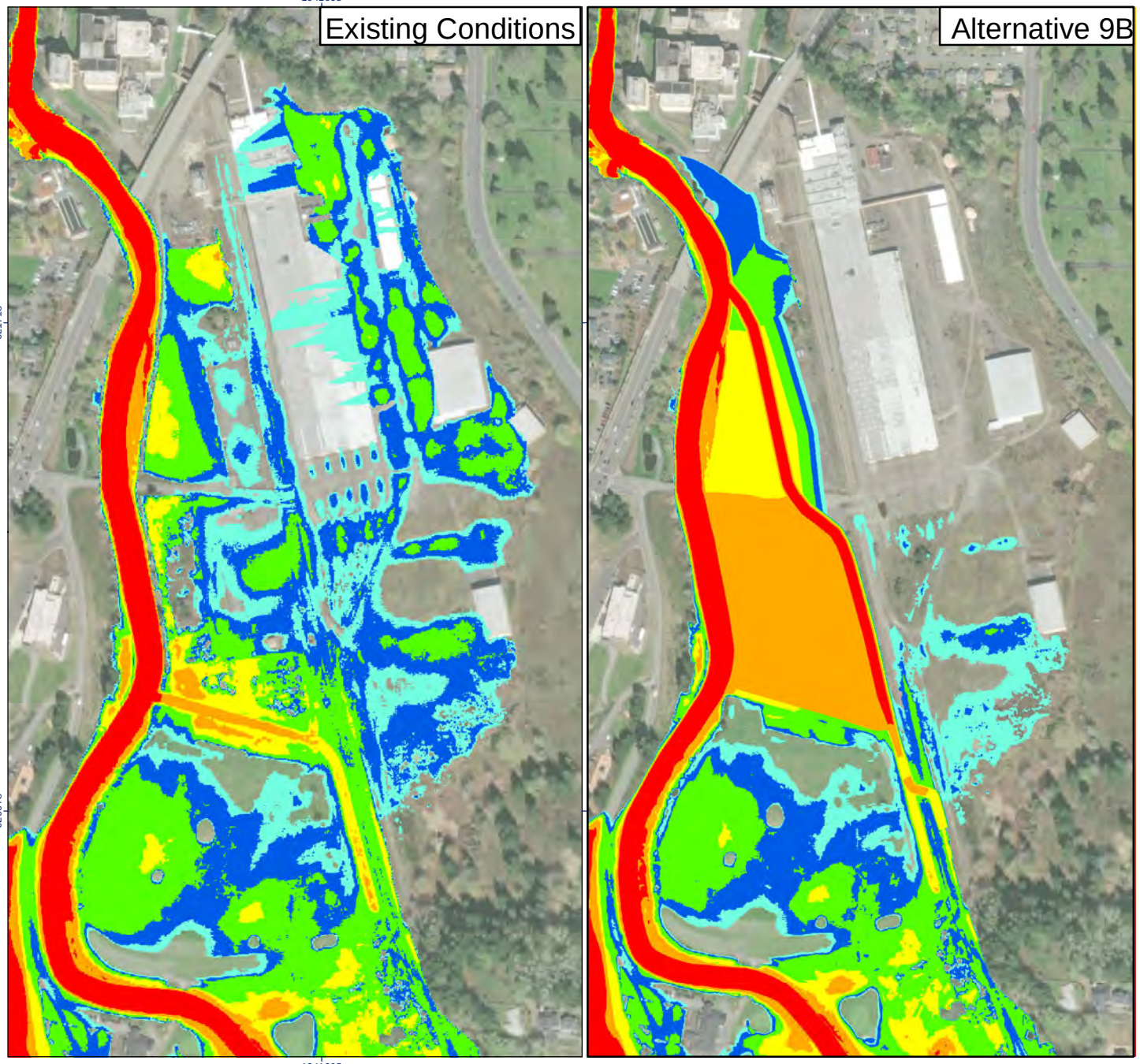

Figure No.
55

Title
Alternative Model - Alternative 9B
Maximum Flood Depth 2022 Flood

Client/Project
City of Tumwater
Deschutes River Flood and
Erosion Reduction Study

Project Location:
City of Tumwater
Thurston, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 -26

0 0.05 0.1
Miles

1:6,103 (At Original document size of 8.5x11)

Legend

Depth

- > 5+ ft
- 3.0 - 5.0 ft
- 2.0 - 3.0 ft
- 1.0 - 2.0 ft
- 0.5 - 1.0 ft
- 0.1 ft - 0.5 ft
- < 0.1 ft

CITY OF TUMWATER

Page 01 of 01

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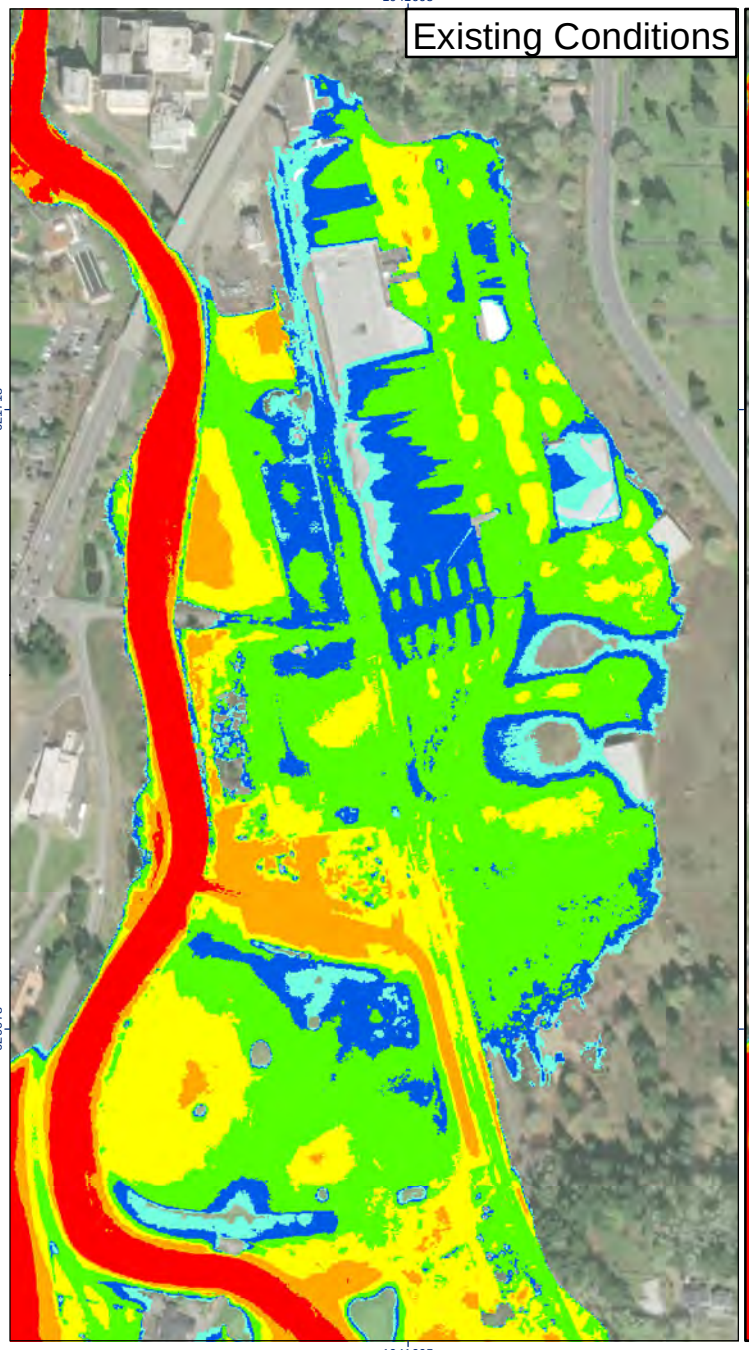

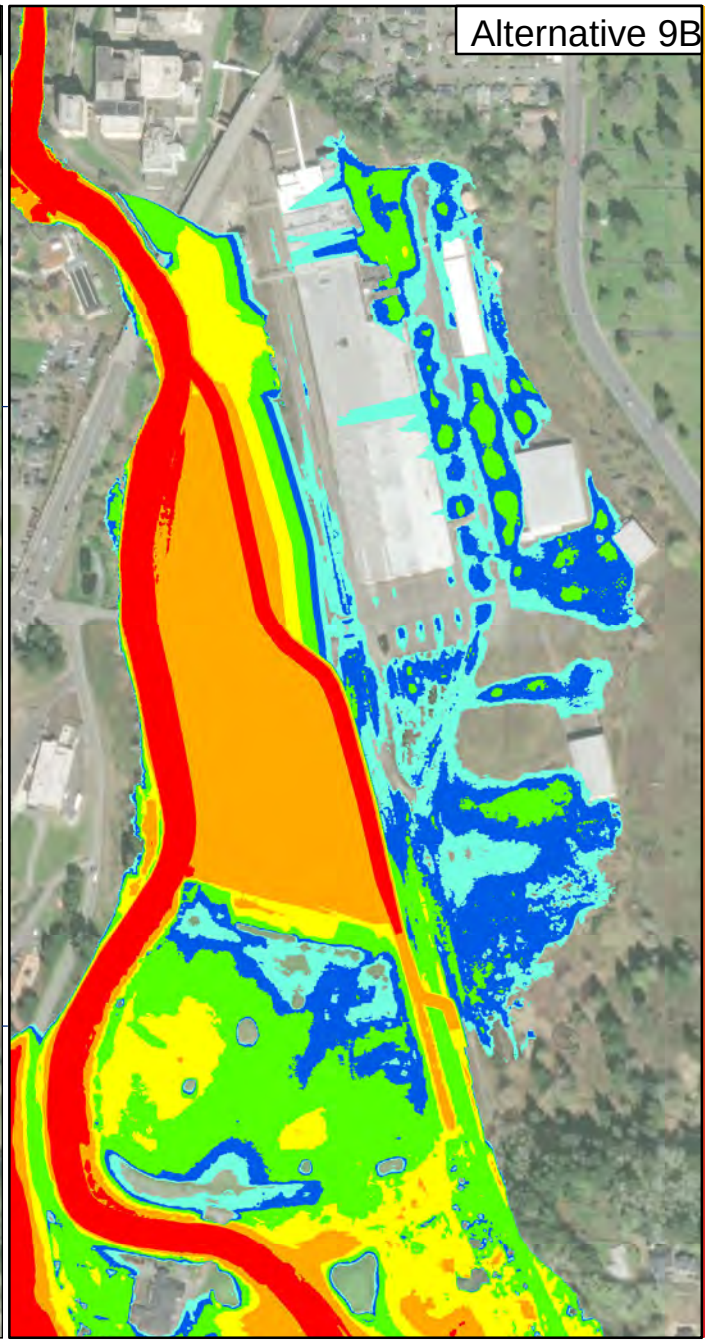

Figure No.
56

Title
Alternative Model - Alternative 9B
Maximum Flood Depth 25yr Flood

Client/Project
City of Tumwater
Deschutes River Flood and
Erosion Reduction Study

Project Location:
City of Tumwater
Thurston, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 -26

0 0.05 0.1
Miles

1:6,103 (At Original document size of 8.5x11)

Legend

Depth

- > 5+ ft
- 3.0 - 5.0 ft
- 2.0 - 3.0 ft
- 1.0 - 2.0 ft
- 0.5 - 1.0 ft
- 0.1 ft - 0.5 ft
- < 0.1 ft

CITY OF TUMWATER

Page 01 of 01

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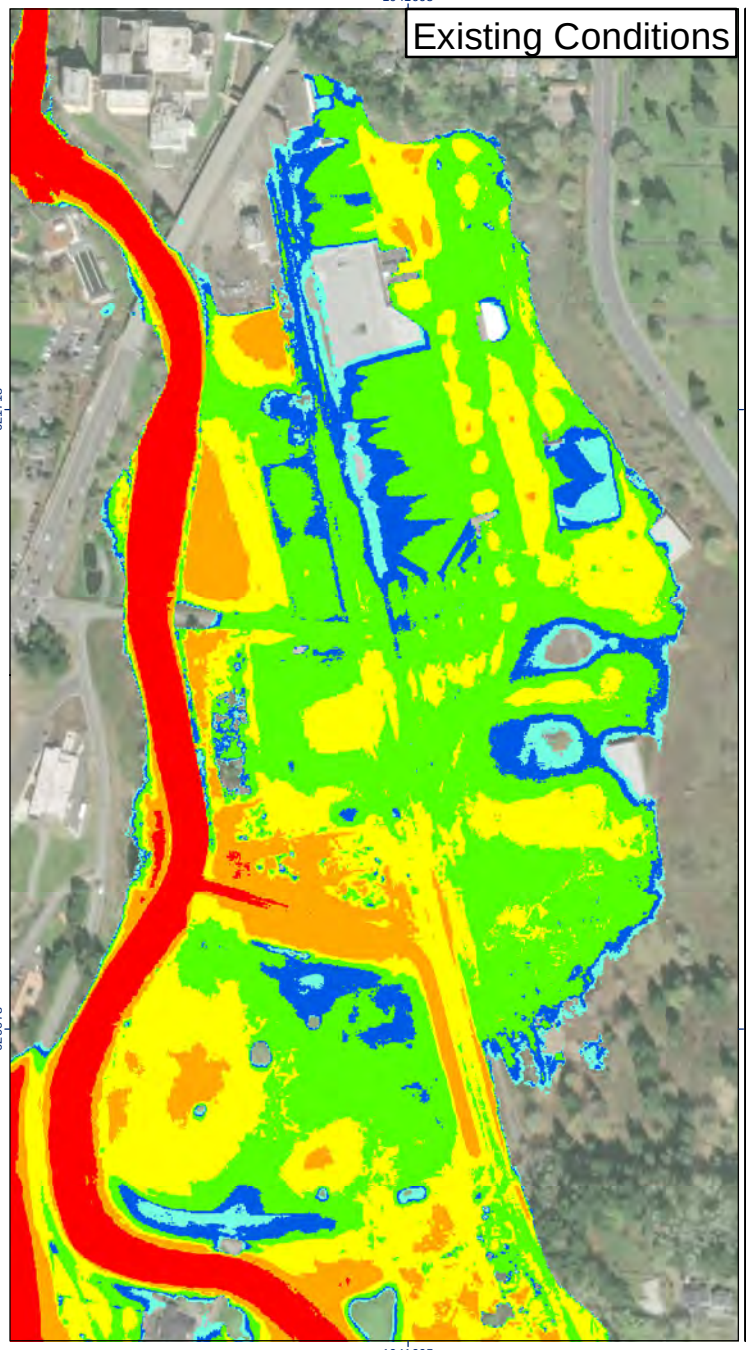

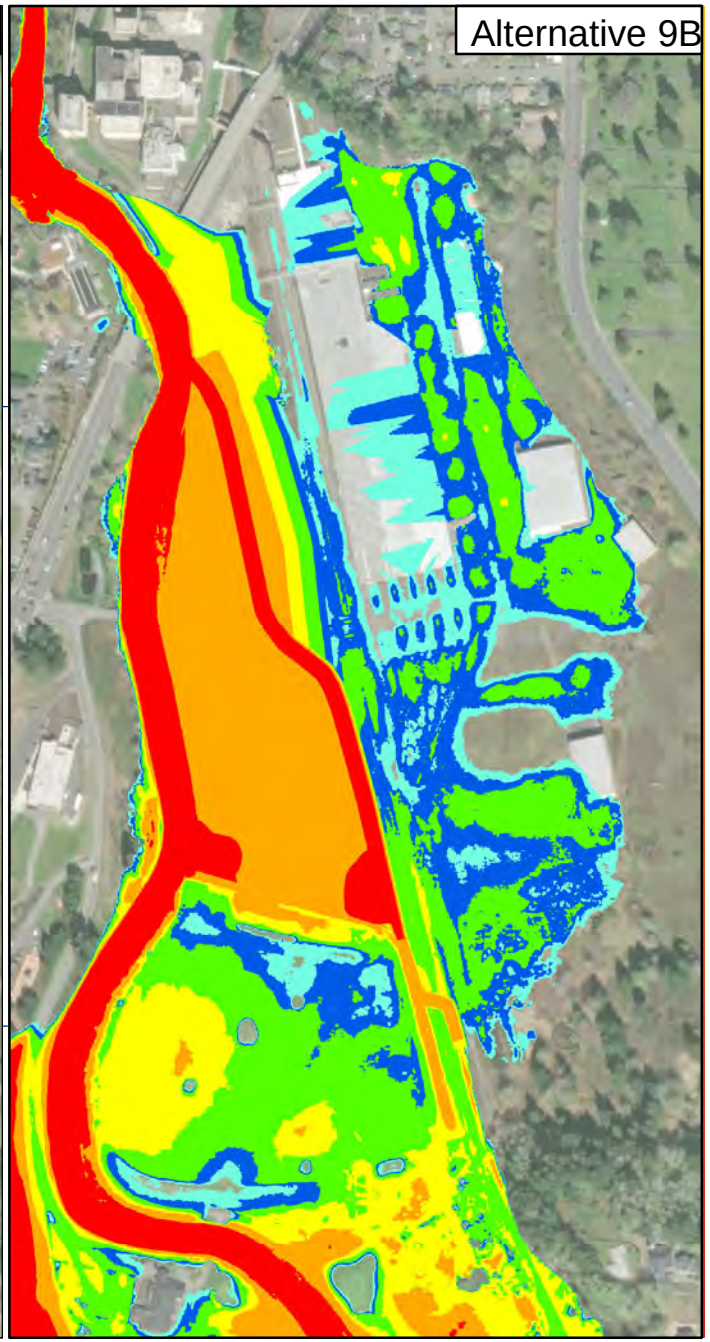

Figure No.
57

Title
Alternative Model - Alternative 9B
Max Flood Depth Current 100yr Event

Client/Project
City of Tumwater
Deschutes River Flood and
Erosion Reduction Study

Project Location:
City of Tumwater
Thurston, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 -26

0 0.05 0.1
Miles

1:6,103 (At Original document size of 8.5x11)

Legend

Depth

- > 5+ ft
- 3.0 - 5.0 ft
- 2.0 - 3.0 ft
- 1.0 - 2.0 ft
- 0.5 - 1.0 ft
- 0.1 ft - 0.5 ft
- < 0.1 ft

C:\Users\zwhitten\Documents\Tumwater\Figures\GIS\Fig_57_Model98_100yr.mxd Revised: 2023-06-28 By: zwhitten

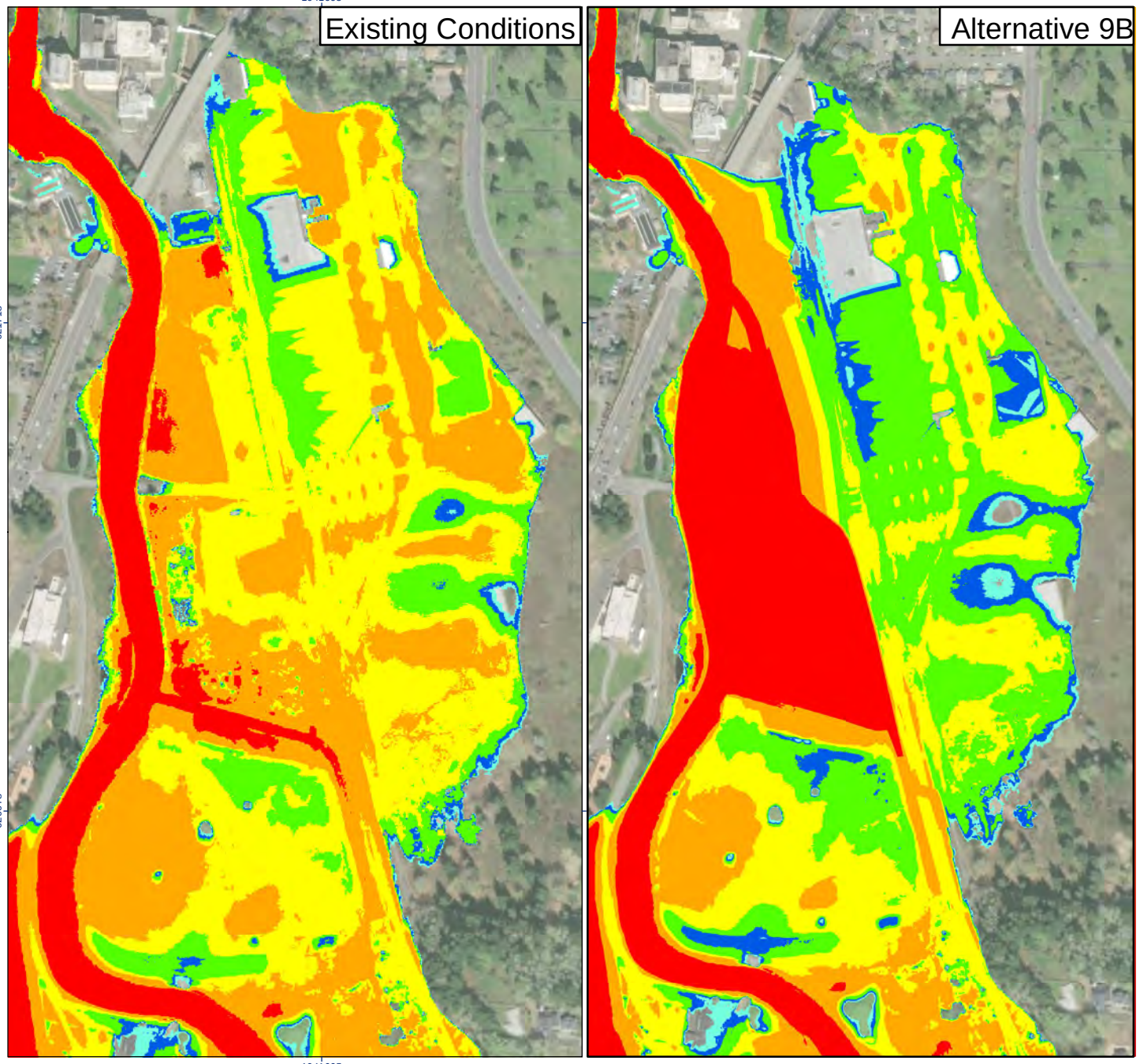

Figure No.
58

Title
Alternative Model - Alternative 9B
Max Flood Depth 2080 - 100yr Event

Client/Project
City of Tumwater
Deschutes River Flood and
Erosion Reduction Study

Project Location:
City of Tumwater
Thurston, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 -26

0 0.05 0.1
Miles

1:6,103 (At Original document size of 8.5x11)

Legend

Depth

- > 5+ ft
- 3.0 - 5.0 ft
- 2.0 - 3.0 ft
- 1.0 - 2.0 ft
- 0.5 - 1.0 ft
- 0.1 ft - 0.5 ft
- < 0.1 ft

C:\Users\zwhitten\Documents\tumwater\Figures\GIS\Fig_58_Model98_2080_100yr.mxd Revised: 2023-06-30 By: zwhitten

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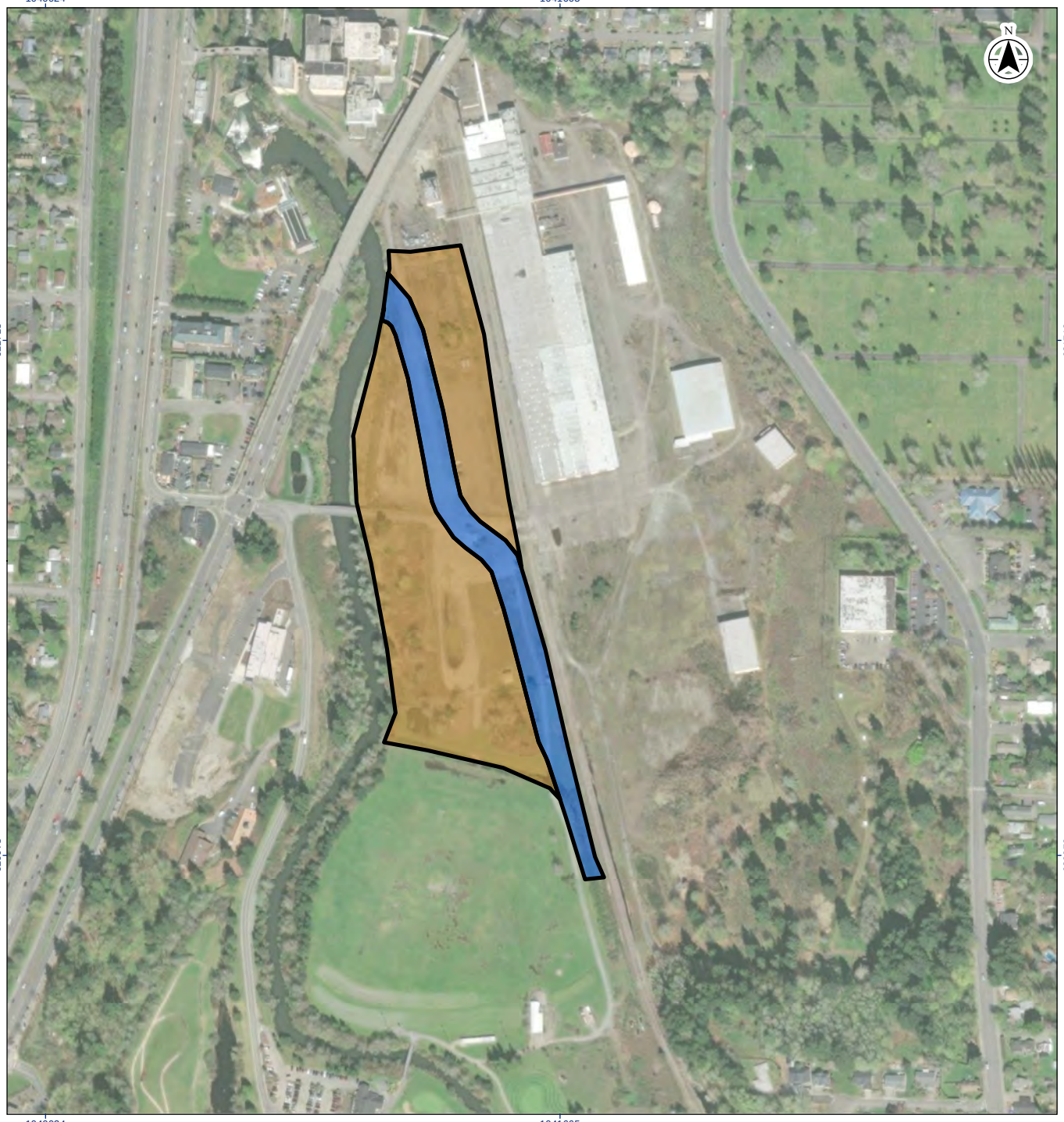


Legend

Components

- 20ft Bottom Width Channel
- 50ft Bottom Width Channel
- Benching
- Substation Relocation and Abutment Lowering

0 250 500 Feet

Page 01 of 01

Project Location
City of Tumwater
Thurston County, Wa

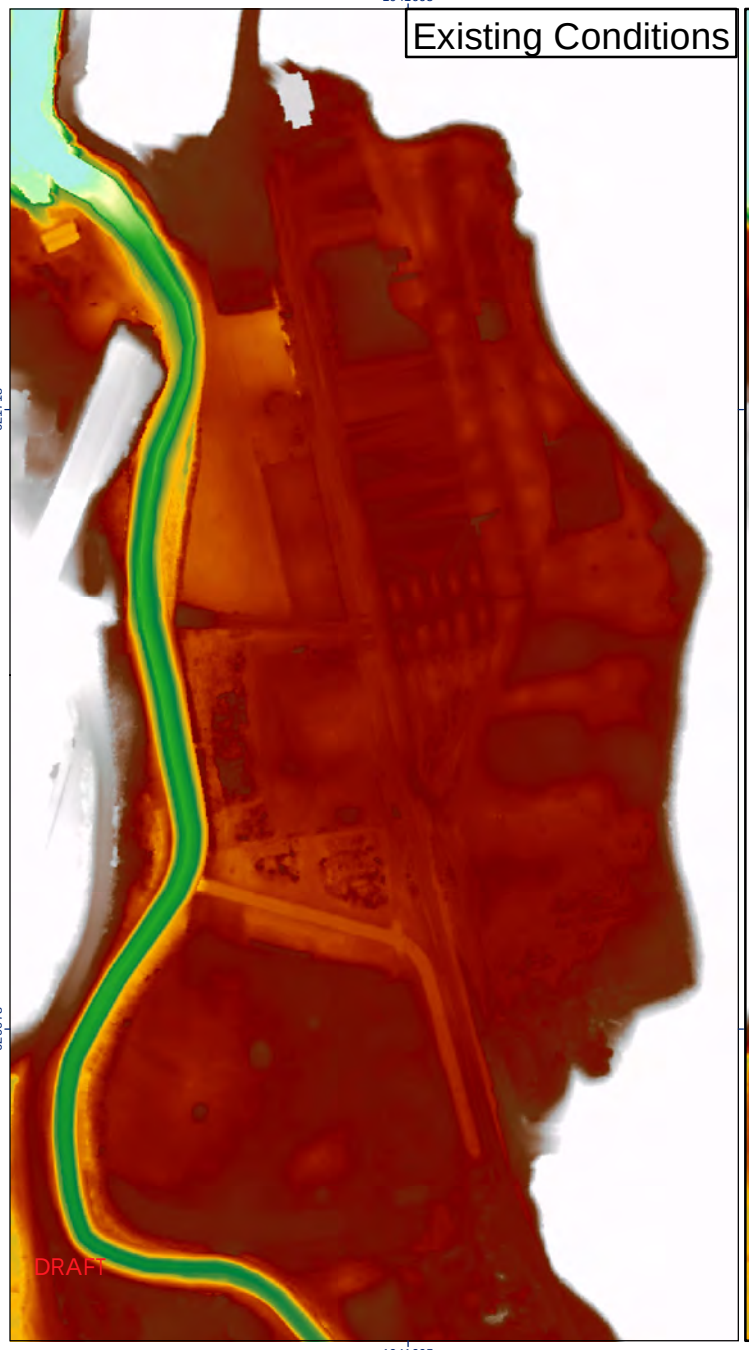
Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 -26

Client/Project
City of Tumwater
Deschutes River Flood and Erosion Reduction Study

Figure No.
59

Title
Conceptual Drawing
Alternative 10A

Page 01 of 01



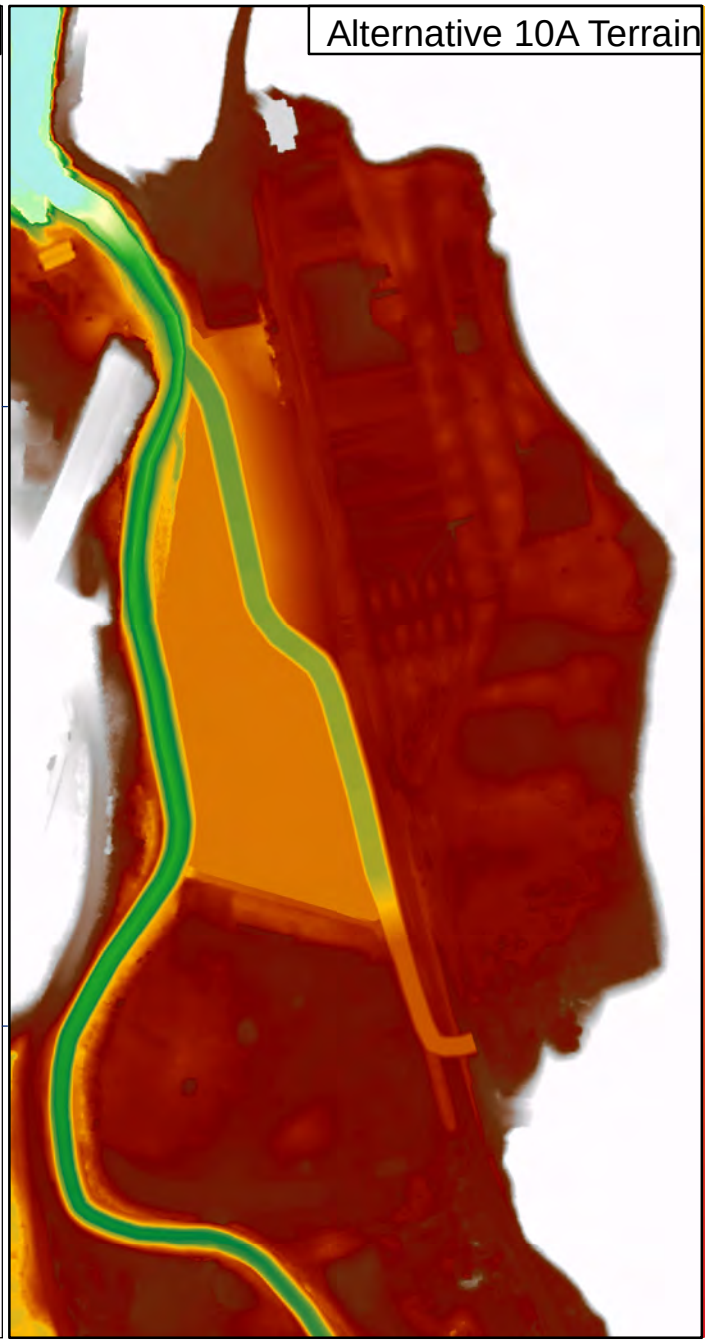


Figure No.
60

Title
Alternative Model - Alternative 10A Terrain Modification

Client/Project
City of Tumwater
Deschutes River Flood and Erosion Reduction Study

Project Location:
City of Tumwater
Thurston, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 -26

0 0.05 0.1
Miles

1:6,103 (At Original document size of 8.5x11)

Legend

High : 120

Low : 75

CITY OF TUMWATER

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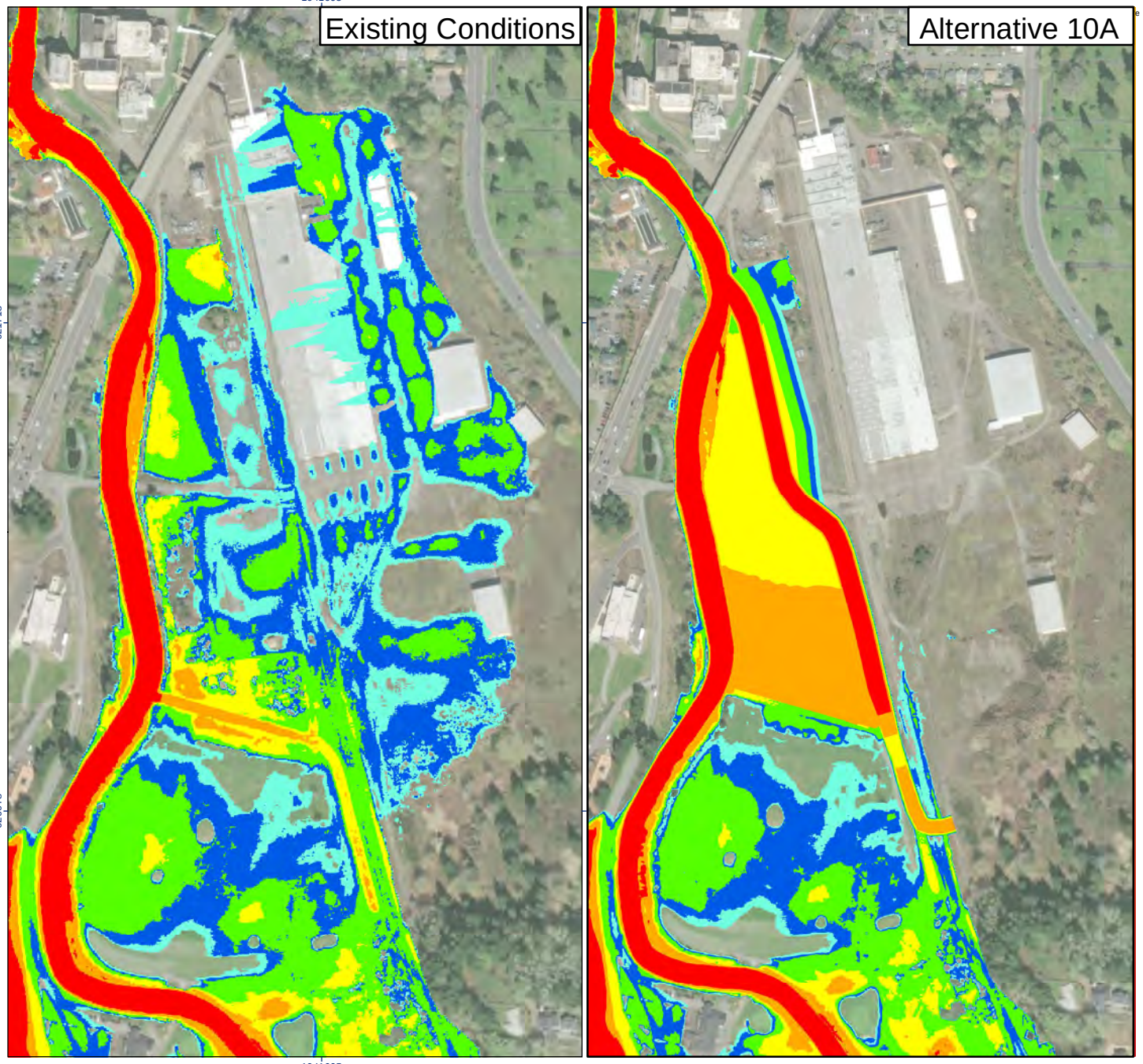

Figure No.
61

Title
Alternative Model - Alternative 10A
Maximum Flood Depth 2022 Flood

Client/Project
City of Tumwater
Deschutes River Flood and
Erosion Reduction Study

Project Location:
City of Tumwater
Thurston, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 -26

0 0.05 0.1
Miles
1:6,103 (At Original document size of 8.5x11)

Legend

Depth

- > 5+ ft
- 3.0 - 5.0 ft
- 2.0 - 3.0 ft
- 1.0 - 2.0 ft
- 0.5 - 1.0 ft
- 0.1 ft - 0.5 ft
- < 0.1 ft

CITY OF TUMWATER

Page 01 of 01

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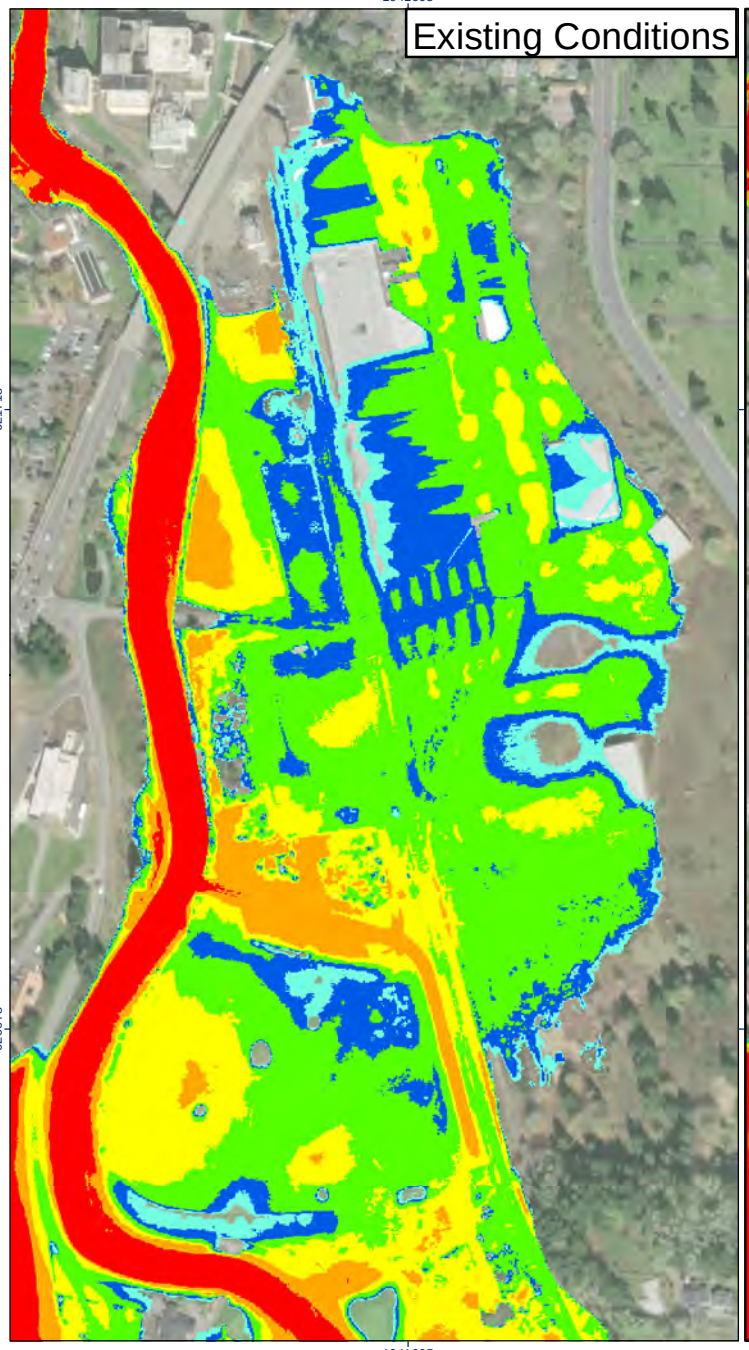

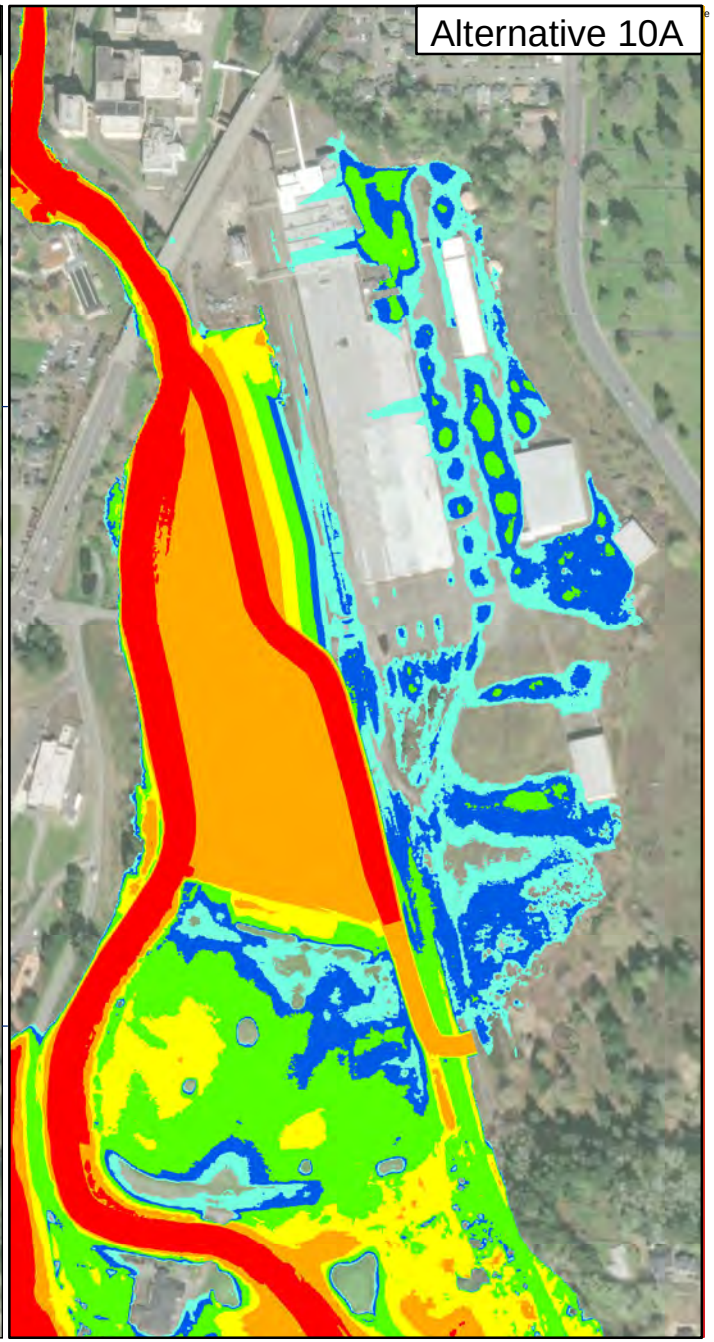

Figure No.
62

Alternative Model - Alternative 10A
Maximum Flood Depth 25yr Flood

Client/Project
City of Tumwater
Deschutes River Flood and
Erosion Reduction Study

Project Location:
City of Tumwater
Thurston, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 - 26

0 0.05 0.1
Miles

1:6,103 (At Original document size of 8.5x11)

Legend

Depth

- > 5+ ft
- 3.0 - 5.0 ft
- 2.0 - 3.0 ft
- 1.0 - 2.0 ft
- 0.5 - 1.0 ft
- 0.1 ft - 0.5 ft
- < 0.1 ft

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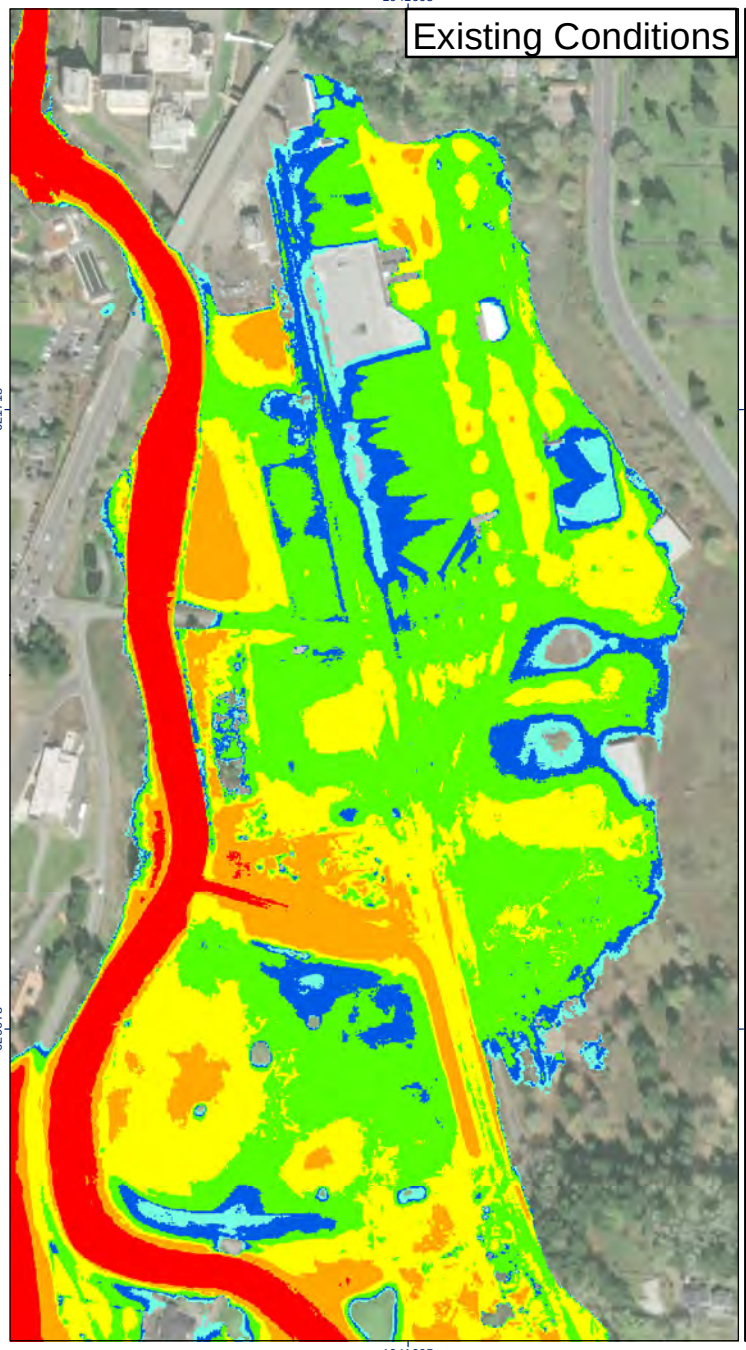

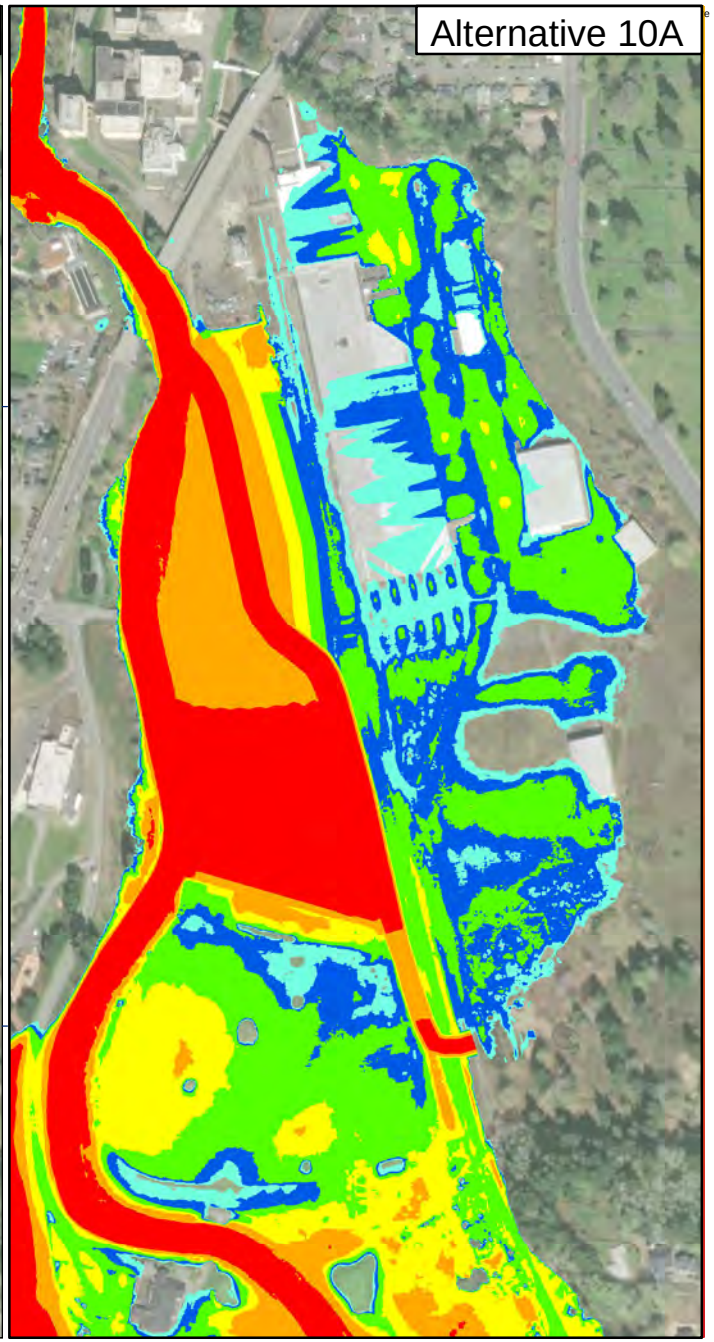

Figure No.
63

Title
Alternative Model - Alternative 10A
Max Flood Depth Current 100yr Event

Client/Project
City of Tumwater
Deschutes River Flood and
Erosion Reduction Study

Project Location:
City of Tumwater
Thurston, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 -26

0 0.05 0.1
Miles
1:6,103 (At Original document size of 8.5x11)

Legend

Depth

- > 5+ ft
- 3.0 - 5.0 ft
- 2.0 - 3.0 ft
- 1.0 - 2.0 ft
- 0.5 - 1.0 ft
- 0.1 ft - 0.5 ft
- < 0.1 ft

CITY OF TUMWATER

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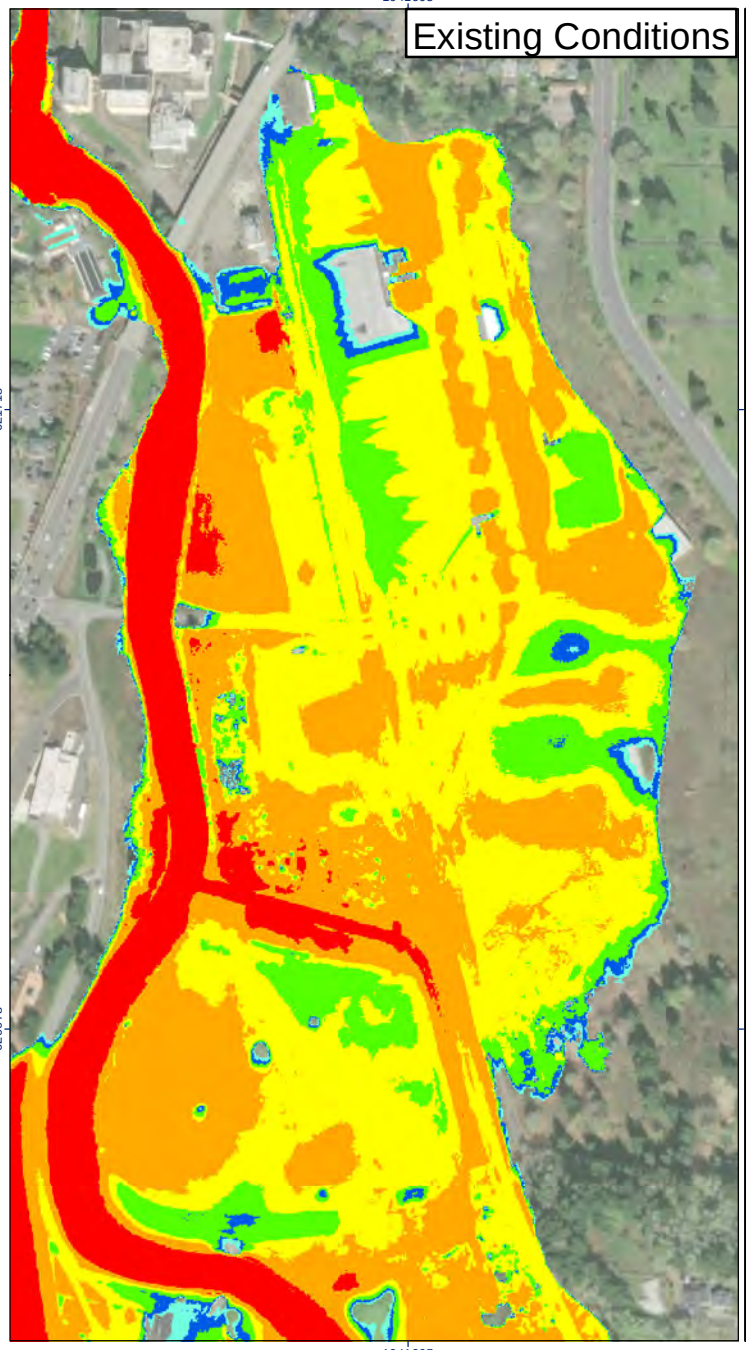
C:\Users\zwhitten\Documents\Tumwater\Figures\GIS\Fig_63_Model10A_100yr.mxd Revised: 2023-06-28 By: zwhitten



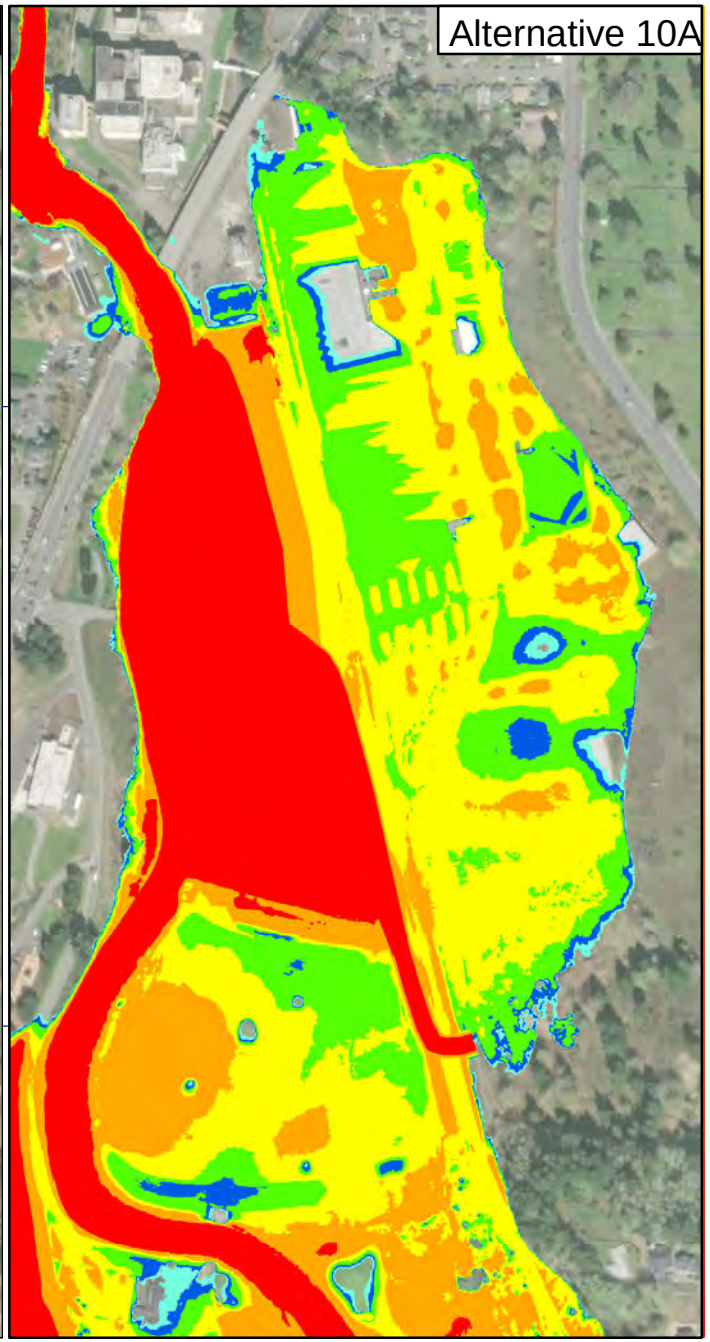


Figure No.
64

Title
Alternative Model - Alternative 10A
Max Flood Depth 2080 - 100yr Event

Client/Project
City of Tumwater
Deschutes River Flood and
Erosion Reduction Study

Project Location:
City of Tumwater
Thurston, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 - 26

0 0.05 0.1
Miles

1:6,103 (At Original document size of 8.5x11)

Legend

Depth

- > 5+ ft
- 3.0 - 5.0 ft
- 2.0 - 3.0 ft
- 1.0 - 2.0 ft
- 0.5 - 1.0 ft
- 0.1 ft - 0.5 ft
- < 0.1 ft

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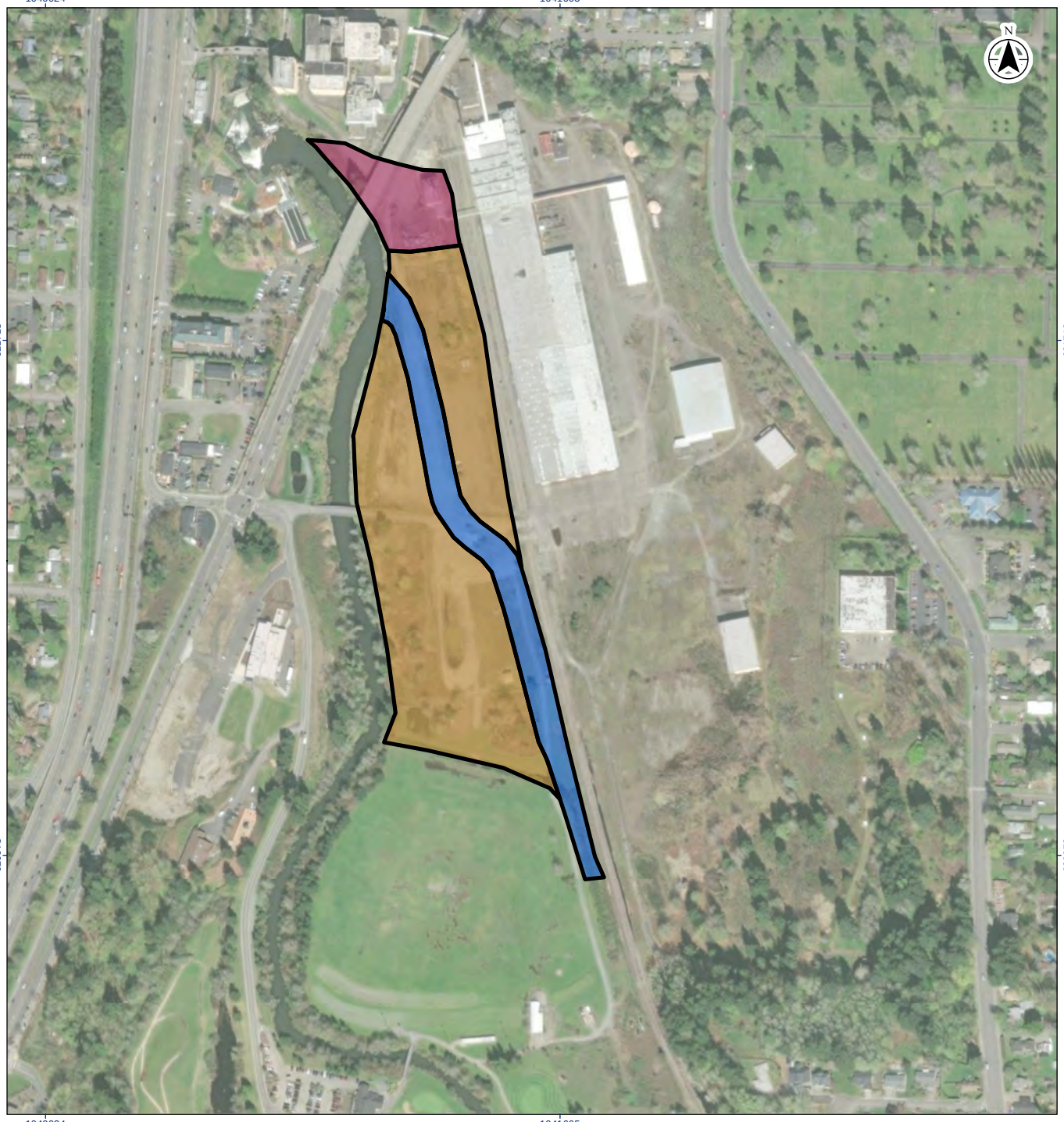
C:\Users\zwhitten\Documents\tumwater\Figures\GIS\Fig_65_Conceptual_Alt10B.mxd Revised: 2023-06-28 By: zwhitten



Legend

Components

- 20ft Bottom Width Channel
- 50ft Bottom Width Channel
- Benching
- Substation Relocation and Abutment Lowering

0 250 500 Feet

Page 01 of 01

Project Location
City of Tumwater
Thurston County, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 -26

Client/Project
City of Tumwater
Deschutes River Flood and Erosion Reduction Study

Figure No.
65

Title
Conceptual Drawing
Alternative 10B

Page 01 of 01

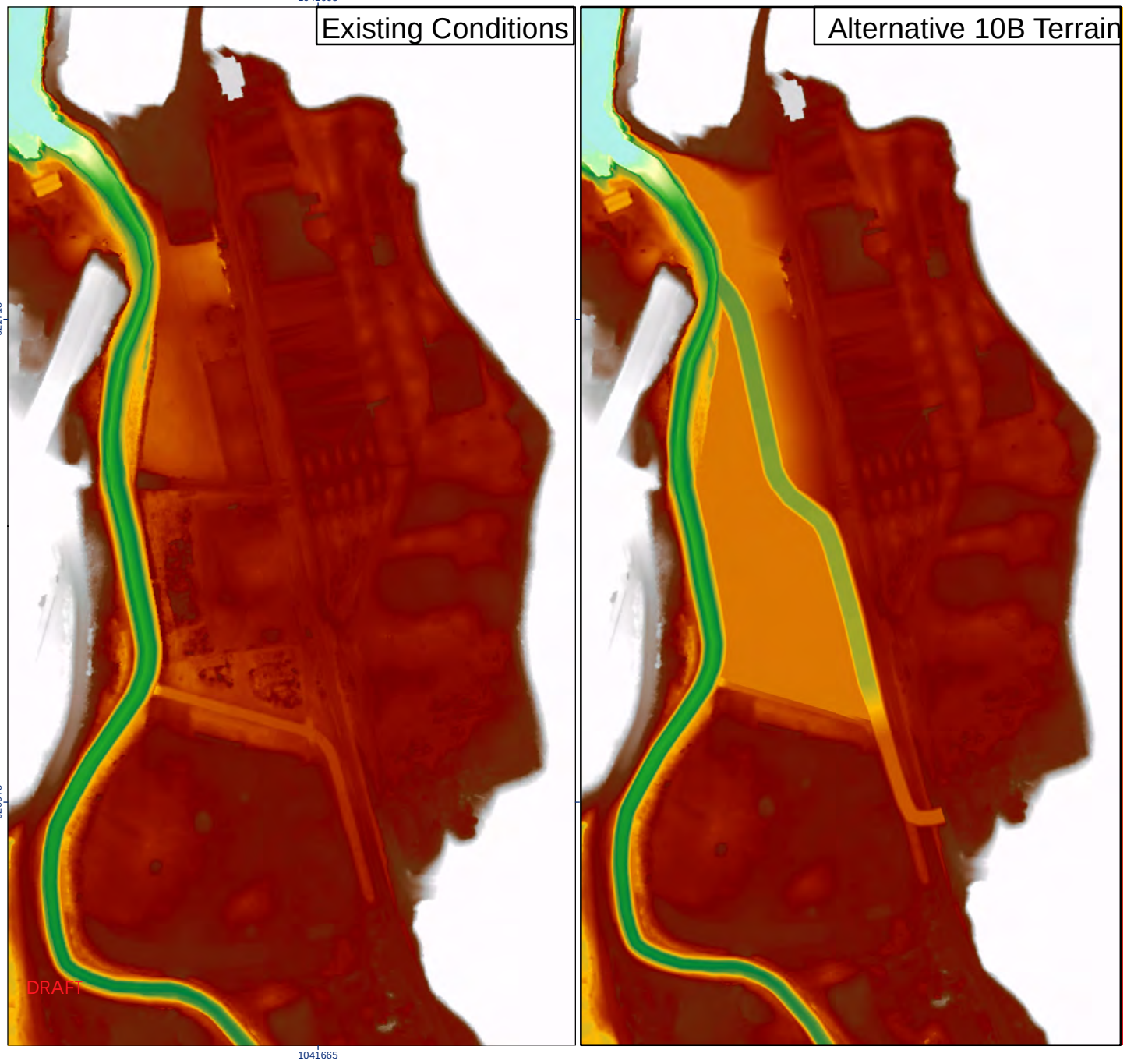


Figure No.
66

Title
Alternative Model - Alternative 10B Terrain Modification

Client/Project
City of Tumwater
Deschutes River Flood and Erosion Reduction Study

Project Location:
City of Tumwater
Thurston, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 -26

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Miles
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Legend

Value

High : 120

Low : 75

CITY OF TUMWATER

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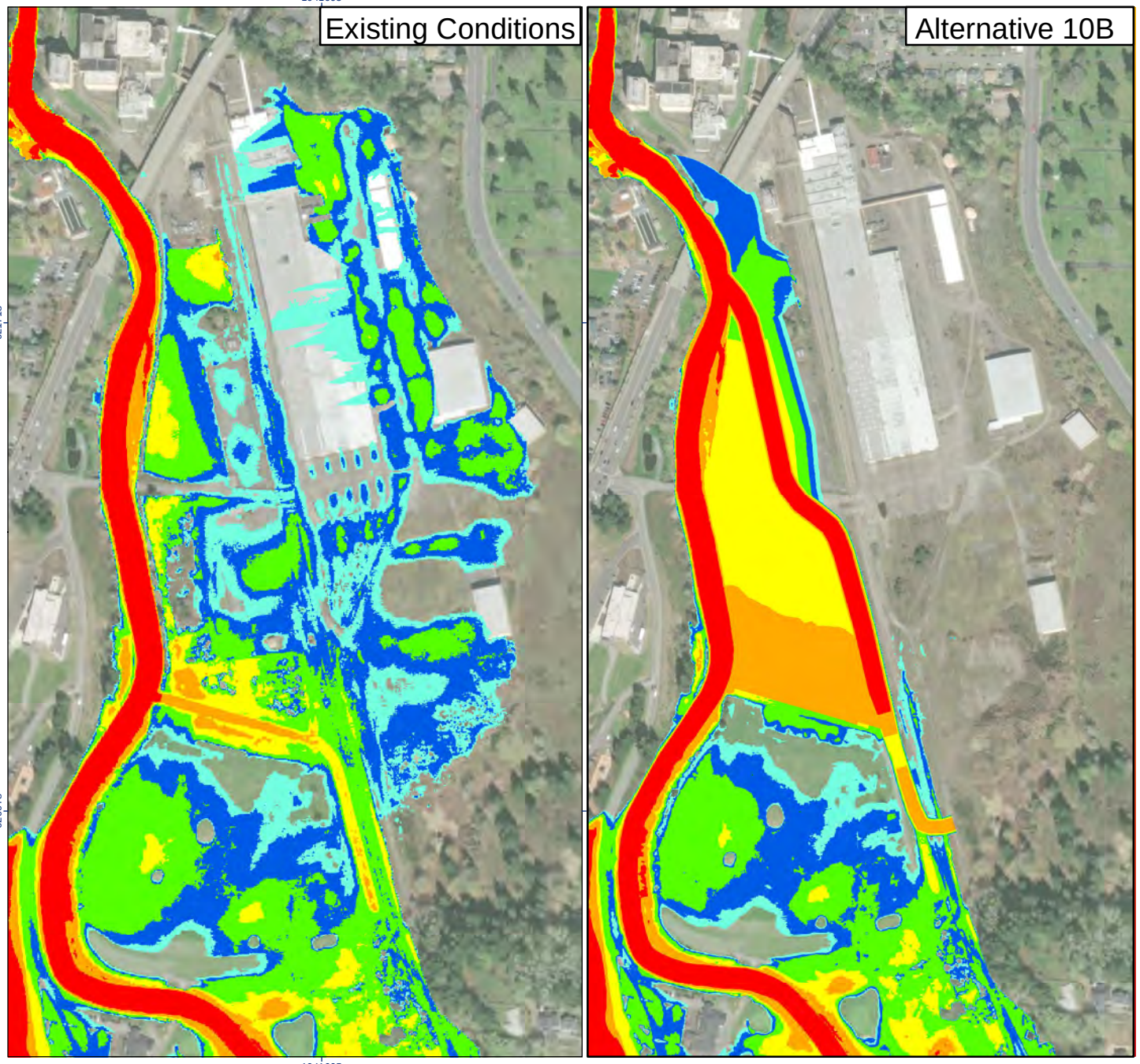

Figure No.
67

Title
Alternative Model - Alternative 10B
Maximum Flood Depth 2022 Flood

Client/Project
City of Tumwater
Deschutes River Flood and
Erosion Reduction Study

Project Location:
City of Tumwater
Thurston, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 - 26

0 0.05 0.1
Miles

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Legend

Depth

- > 5+ ft
- 3.0 - 5.0 ft
- 2.0 - 3.0 ft
- 1.0 - 2.0 ft
- 0.5 - 1.0 ft
- 0.1 ft - 0.5 ft
- < 0.1 ft

CITY OF TUMWATER

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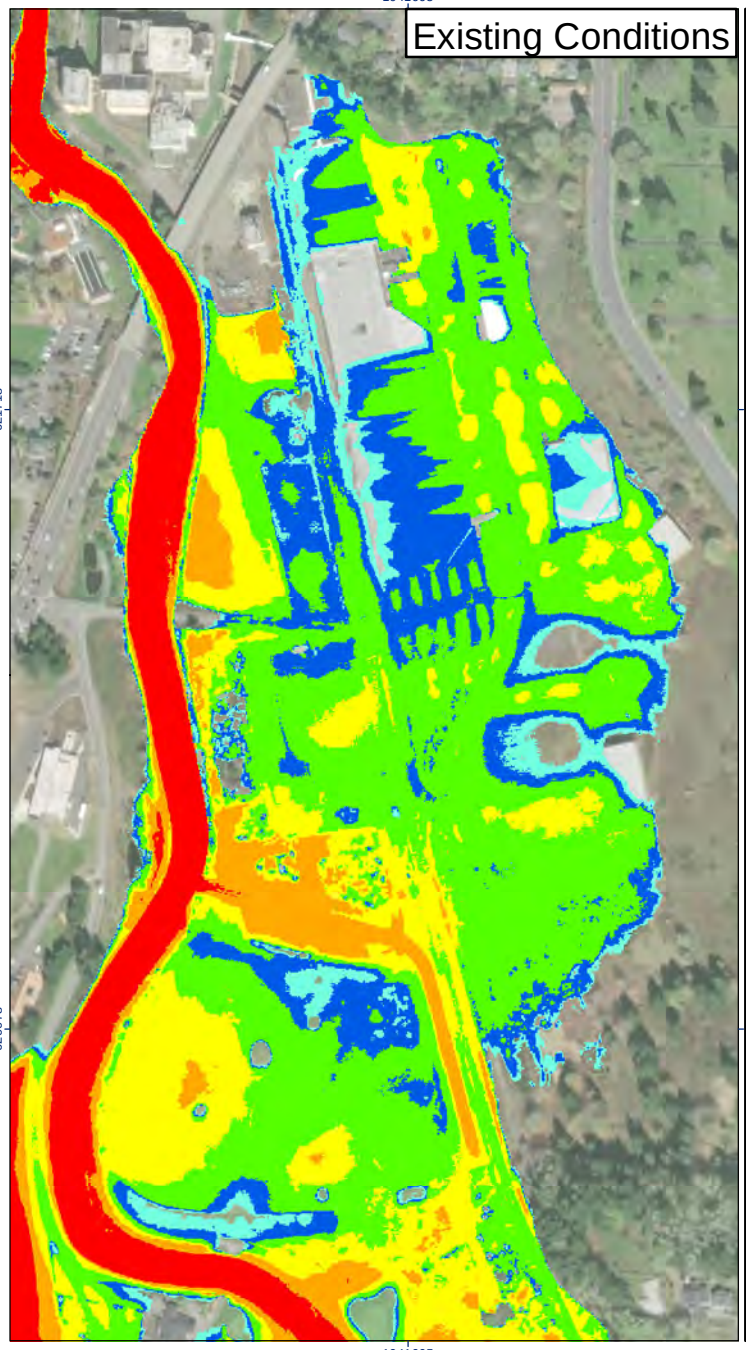

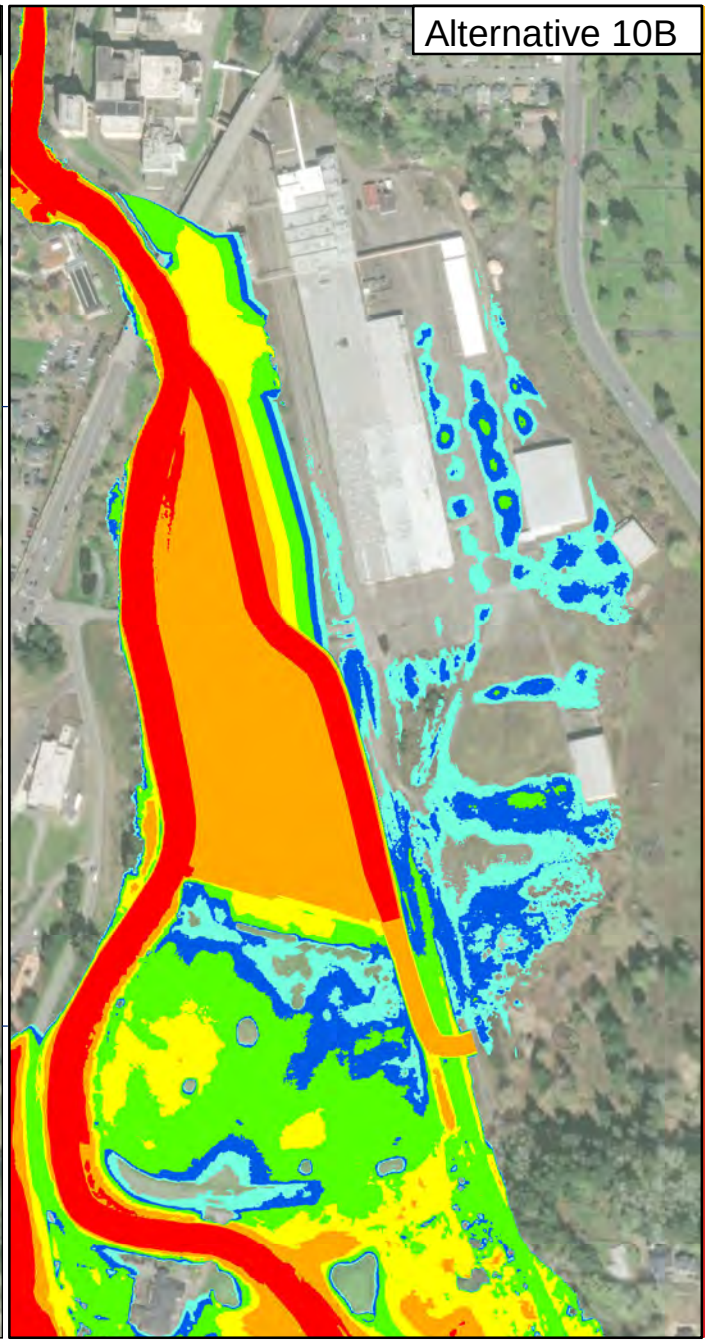

Figure No.
68

Title
Alternative Model - Alternative 10B
Maximum Flood Depth 25yr Flood

Client/Project
City of Tumwater
Deschutes River Flood and
Erosion Reduction Study

Project Location:
City of Tumwater
Thurston, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 - 26

0 0.05 0.1
Miles

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Legend

Depth

- > 5+ ft
- 3.0 - 5.0 ft
- 2.0 - 3.0 ft
- 1.0 - 2.0 ft
- 0.5 - 1.0 ft
- 0.1 ft - 0.5 ft
- < 0.1 ft

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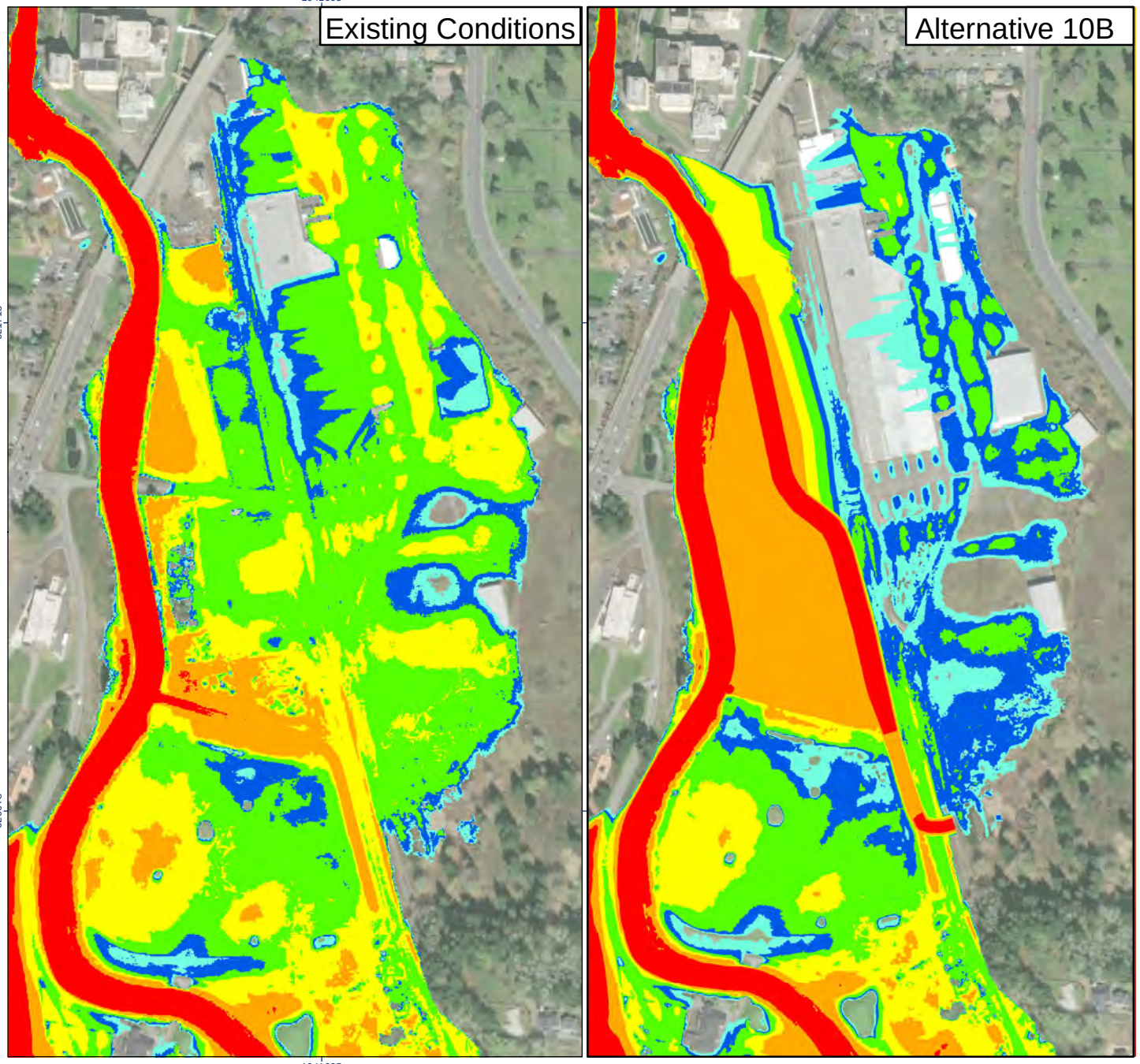

Figure No.
69

Title
Alternative Model - Alternative 10B
Max Flood Depth Current 100yr Event

Client/Project
City of Tumwater
Deschutes River Flood and
Erosion Reduction Study

Project Location:
City of Tumwater
Thurston, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 - 26

0 0.05 0.1
Miles

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Legend

Depth

- > 5+ ft
- 3.0 - 5.0 ft
- 2.0 - 3.0 ft
- 1.0 - 2.0 ft
- 0.5 - 1.0 ft
- 0.1 ft - 0.5 ft
- < 0.1 ft

CITY OF TUMWATER

Page 01 of 01

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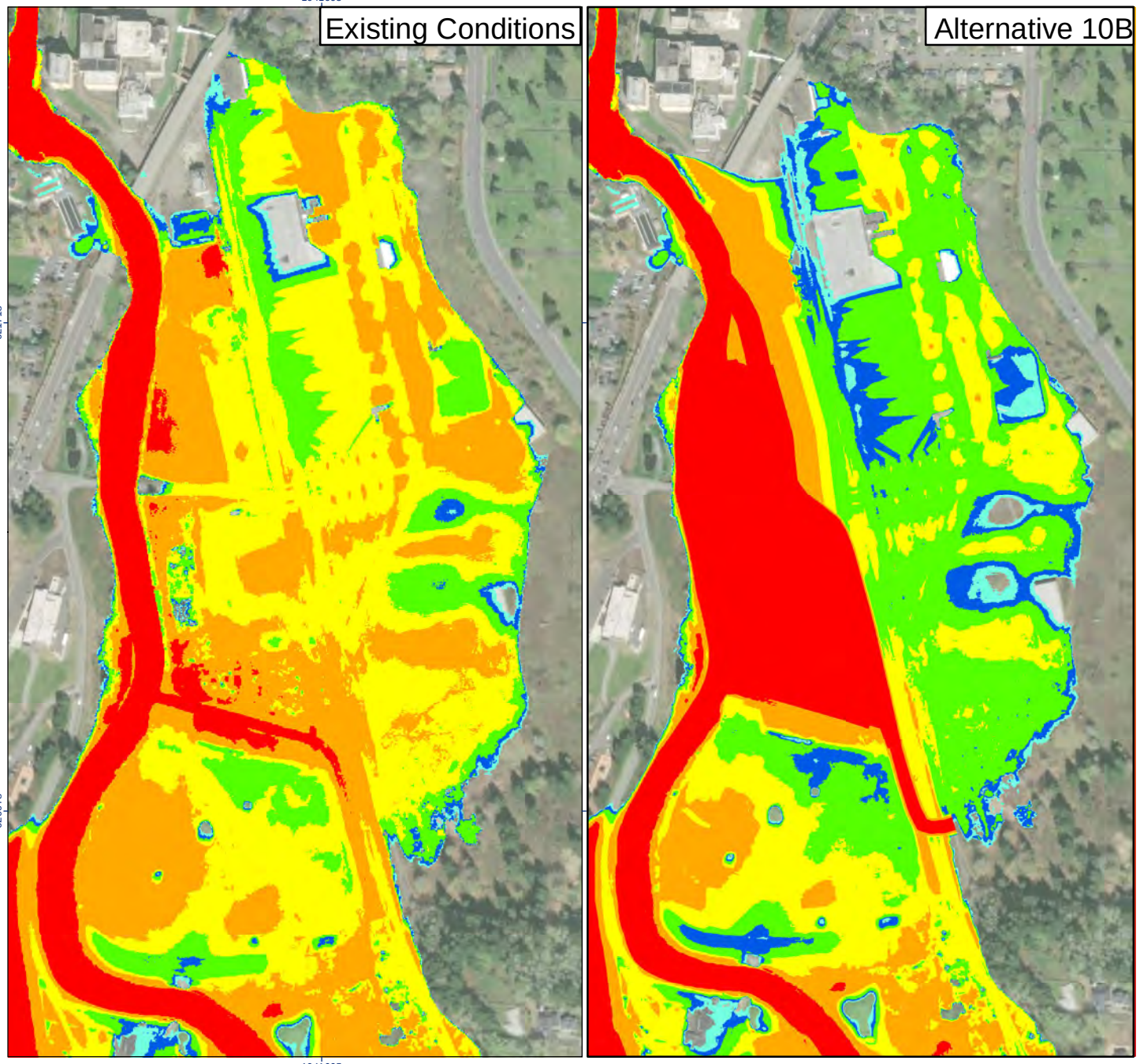

Figure No.
64

Title
Alternative Model - Alternative 10B
Max Flood Depth 2080 - 100yr Event

Client/Project
City of Tumwater
Deschutes River Flood and
Erosion Reduction Study

Project Location:
City of Tumwater
Thurston, Wa

Prepared by JZ on 2023 - 05 - 22
Technical Review by ZW on 2023 - 05 - 24
Independent Review by JR on 2023 - 05 - 26

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1:6,103 (At Original document size of 8.5x11)

Legend

Depth

- > 5+ ft
- 3.0 - 5.0 ft
- 2.0 - 3.0 ft
- 1.0 - 2.0 ft
- 0.5 - 1.0 ft
- 0.1 ft - 0.5 ft
- < 0.1 ft

CITY OF TUMWATER

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5.4 ALTERNATIVE MODELING CONCLUSIONS

The result of the alternative analysis illustrates that all 6 alternatives (2, 4, 5, 9B, 10A, 10B) have the capability to reduce the potential flood risk from the Olympia Brewery property east of the existing railroad; no alternative was able to eliminate flooding at the 100-year level for the entire Olympia Brewery site. If the 2022 event (which has a similar peak discharge as the 10-year event) were to occur with either of the alternatives, the brewery site would not have been flooded according to the simulations. For the 2022 event, the flood channel and the benching alternatives convey enough flood flow through the system that the flood elevations do not reach the Olympia Brewery property. Therefore, the relocation of the power substation and the lowering of the ground elevation directly below the Capitol Blvd overpass would not be required to prevent flooding during a 10-year event; the flood channel and/or benching would create enough flood reduction on their own.

It should be noted that the simulations of the alternatives during the 2022 event show some minor flooding on the southern end of the property east of the railroad for all flood alternatives, but this would most likely be removed with minor refinements to the alternative and the associated modeling; it is expected that this flooding would not occur with these alternatives in place.

For the 100-year simulations, though all the 6 alternatives illustrate a benefit in reducing the flood potential, they did not fully remove the flood potential. Though the water surface elevations are reduced by over a foot for some of the alternatives, flood waters are still able to enter the property. Review of the results indicate the reason flow still enters the property is two-fold: the lack of conveyance capacity near the driving range and the contraction at the Capitol Blvd, though reduced, is still present.

Review of the peak discharges through the west side of the brewery property indicate that all alternatives have adequate conveyance capacity to pass the 100-year event (10,100 cfs) on the downstream side of the property (north side), but on the south end, the system does not. Near the driving range, flood water is exceeding the railroad elevation and flowing into the brewery property east of the railroad and continuing onto the brewery site. The flow that overtops the railroad is relatively low but given the sustained time in which the flood water is flowing, significant volume enters the brewery site, behind the main building (this is illustrated in **Figure 72** below – please note the time stamp added to the top right of each image to help illustrate the time elapsed between each image). The site grading of the brewery is not designed to pass flood flows and as such has multiple locations in which water can “pool” or pond within the site. This is evident in the number of areas of high flood depths (more than 1 ft) in between areas of low depth (less than 0.5 ft). Therefore, though the conveyance of the downstream side of the property is significantly increased for each alternative compared to the existing conditions, the upstream side of the property is still suspectable to creating flooding on the brewery site due to the lack of conveyance near the driving range.

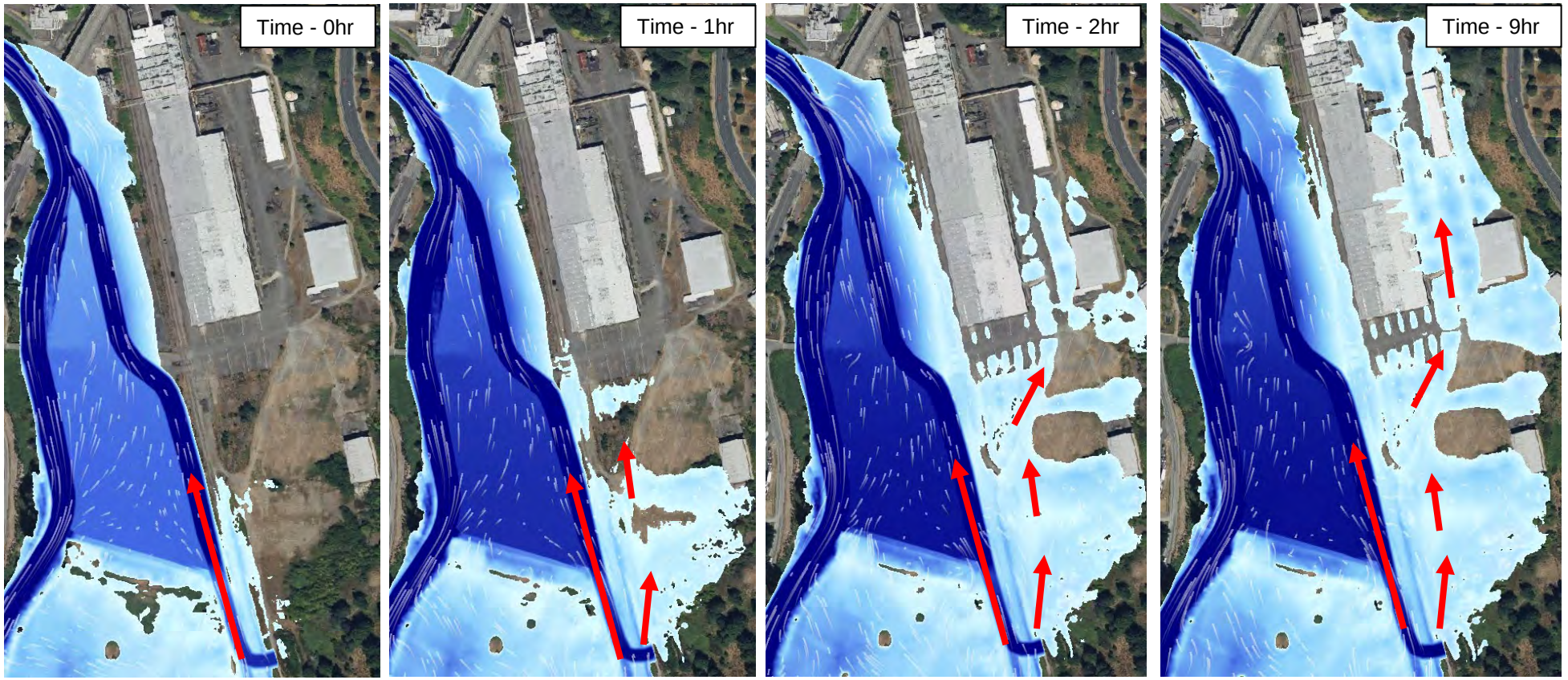


Figure 72 – Progression of Flooding during 100-year Event with Alternative 10B Proposed Conditions

The second factor that increases flooding at the Olympia Brewery site during the 100-year event is the contraction that occurs at the Capitol Blvd. The modeling results indicate that the power station and ground elevation directly below the Capitol Blvd overpass have an impact on the flooding on the site, but the benefit is limited to the downstream (northern) portion of the property. Though the relocation of the substation and lowering the ground elevation lowers the water surface elevation under the bridge, there is still a noticeable increase in the water surface elevation profile upstream of the overpass. The increase due to the impediment created by this location reduces the effectiveness of any alternative upstream. **Figure 73** illustrates the contraction after the substation relocation and ground elevation lowering. The water surface profile in **Figure 74** illustrates the effect of the contraction.

Figure 73 – Contraction at Capitol Blvd

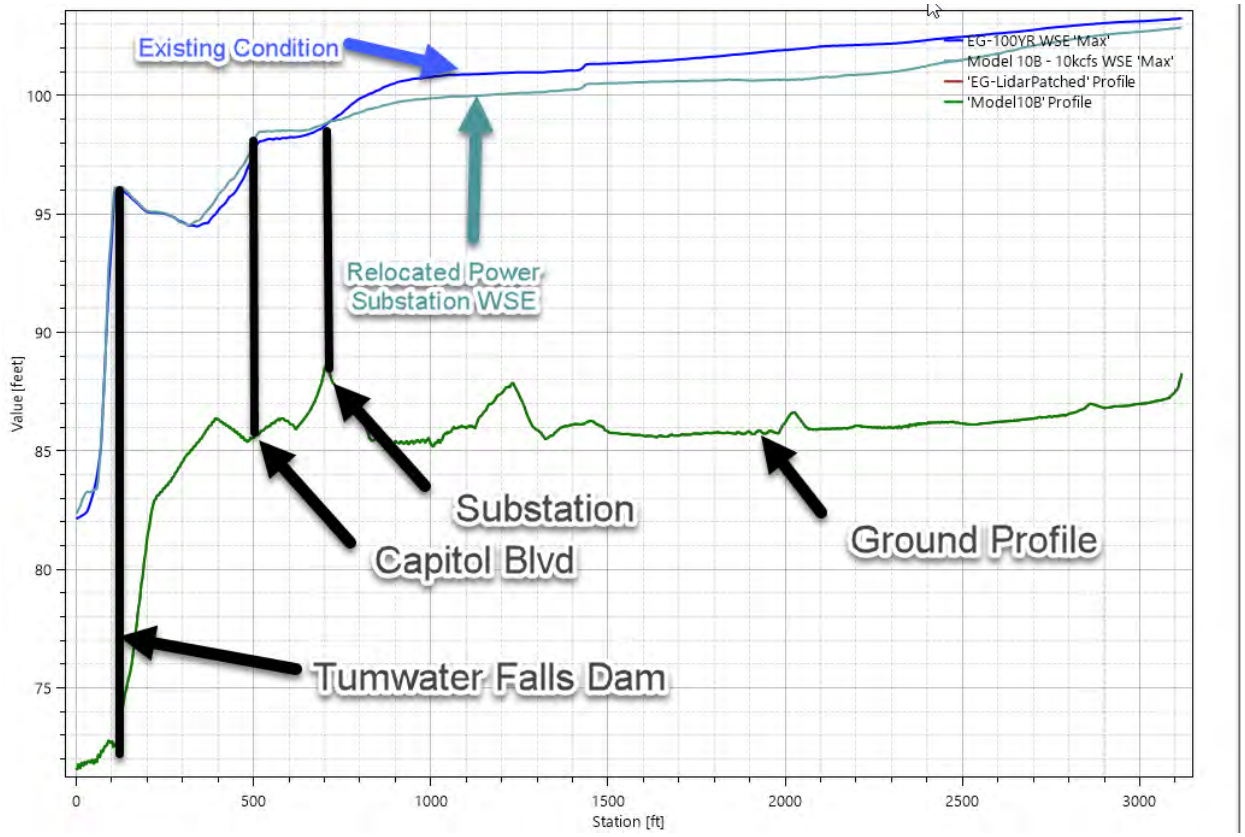


Figure 74 – Water Surface Elevation Profile Upstream of Capitol Blvd

To illustrate the effect the alternatives have on reducing the flow on the brewery property, a water surface elevation profile was developed just east of the railroad. The location of the profile is illustrated in **Figure 75** and the profile is illustrated in **Figure 76**. As shown in the profile, all profiles show reduction to the WSE compared to the current 100yr existing condition, with a greater reduction on the downstream compared to the upstream side. This profile illustrates what elevation a potential wall might need to be to reduce flows getting onto the property.

It should be noted that for the benching alternatives, removal of the existing E Street Bridge does provide additional flood reduction impacts. However, the change is minimal for events such as the 2022 event and therefore the E Street Bridge removal is not required for these alternatives to provide a benefit.

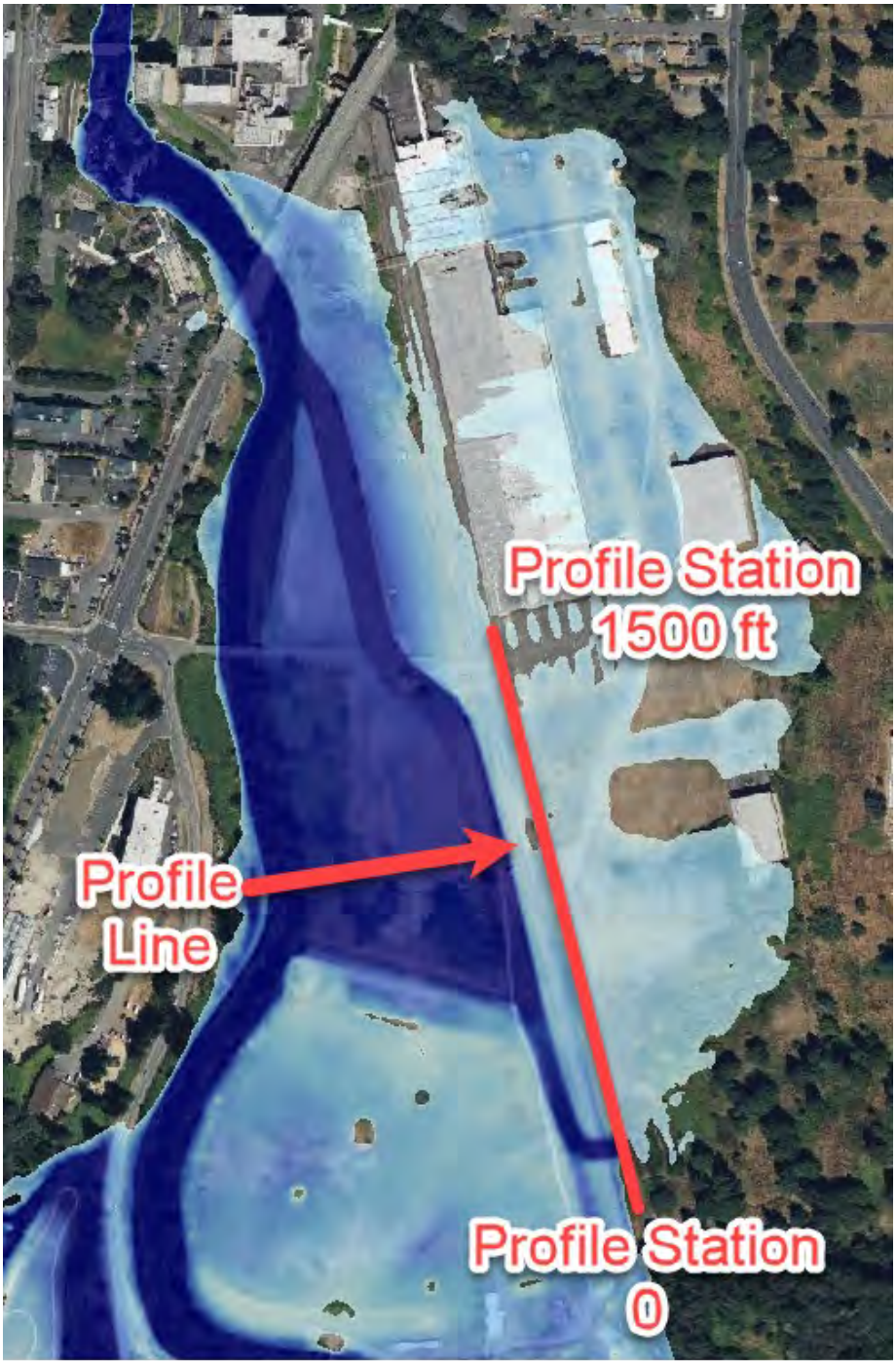


Figure 75 – Location of Profile Taken along Brewery Property

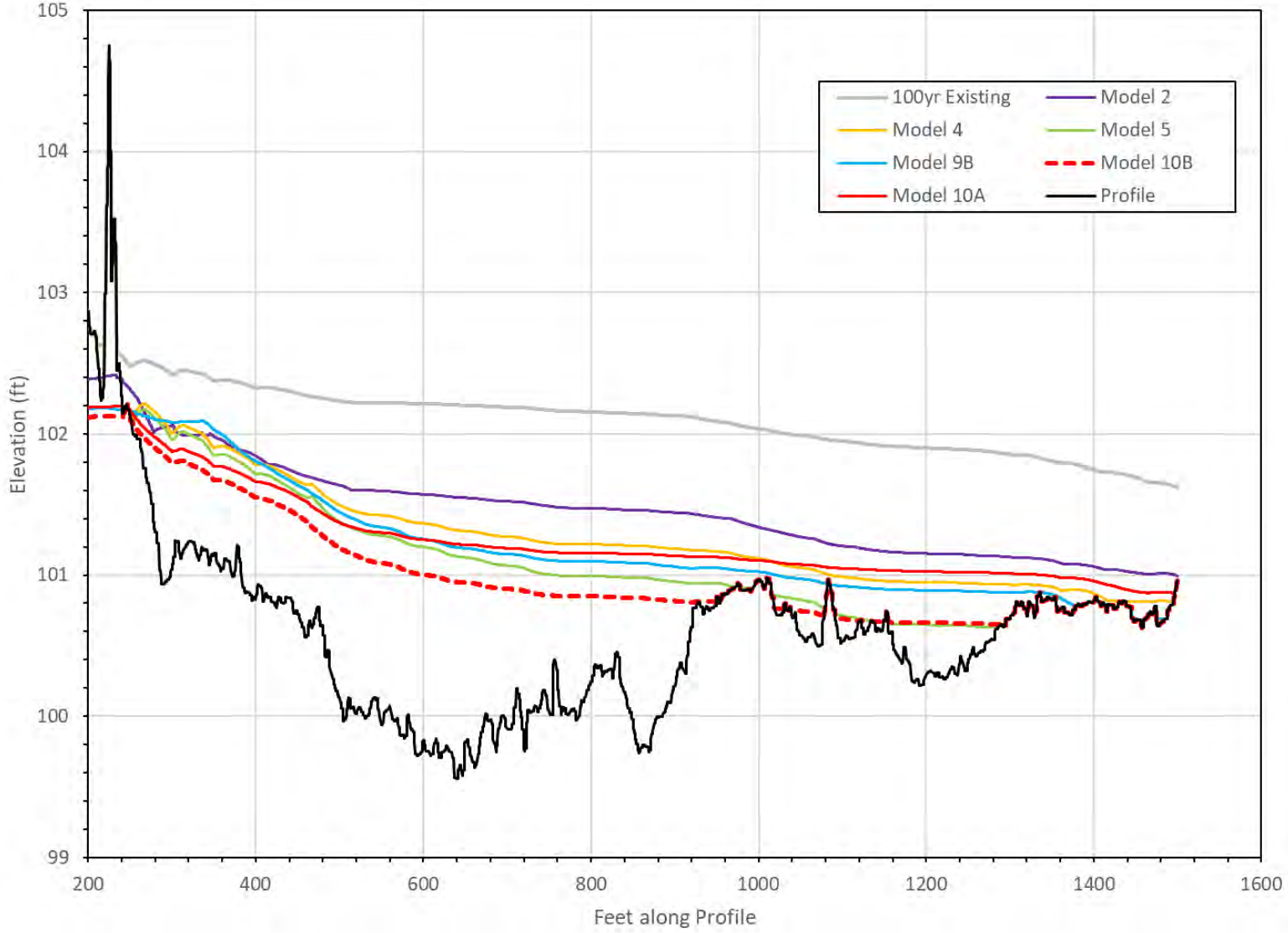


Figure 76 – Water Surface Elevation Profile Along Olympia Brewery Site during the 100-year Flood

Alternative Analysis

In summary, all modelled alternatives have the ability to reduce the potential for flooding on the Olympia Brewery Site but cannot completely remove the potential during a 100-year flood event (current or climate-change-based future 100yr). Additional measures of flood reduction such as a flood wall near the railroad, importing fill to raise ground elevations, or modifying the grading around the driving range may be required to fully remove the 100-year flood event. It should be noted that if the channel or benching alternative were to be implemented, there would be an abundance of fill available from the excavation (approximately 125,000 cubic yards from the Alternative 10B estimate). This fill could be utilized to increase the elevations of the brewery property, raising it out of the 100-year floodplain elevation.

To estimate how high the ground may need to be raised to elevate development above the current 100yr and the climate-change-based 100year flood elevation, Alternative 10B was simulated with the ground artificially raised. **Figure 78** Illustrates the ground elevation requirements that were generated from this simulation. The location of where the profile was taken is illustrated in **Figure 77.** As shown in the profile, all profiles shown reduction to the water surface elevation compared to the existing conditions, but the ground would need to be raised by an average of 2 ft and a maximum of 3.4 ft for the climate-changed-based 100yr storm event and average of 0.8ft and a maximum of 2 ft for the current 100yr to raise the development above the expected flood depths.

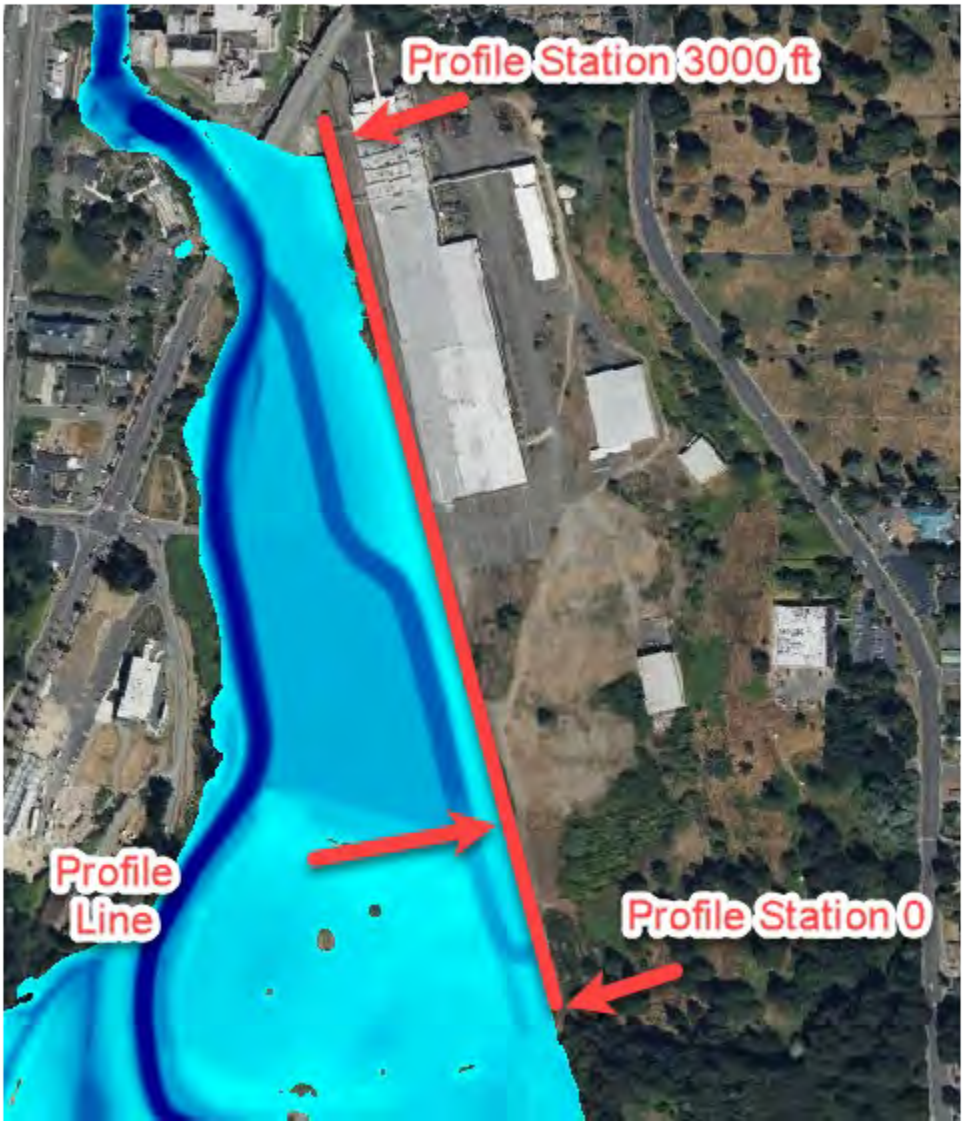


Figure 77 – Location of Profile Taken along Brewery Property for Flood Profile with Elevated Ground at Brewery Site

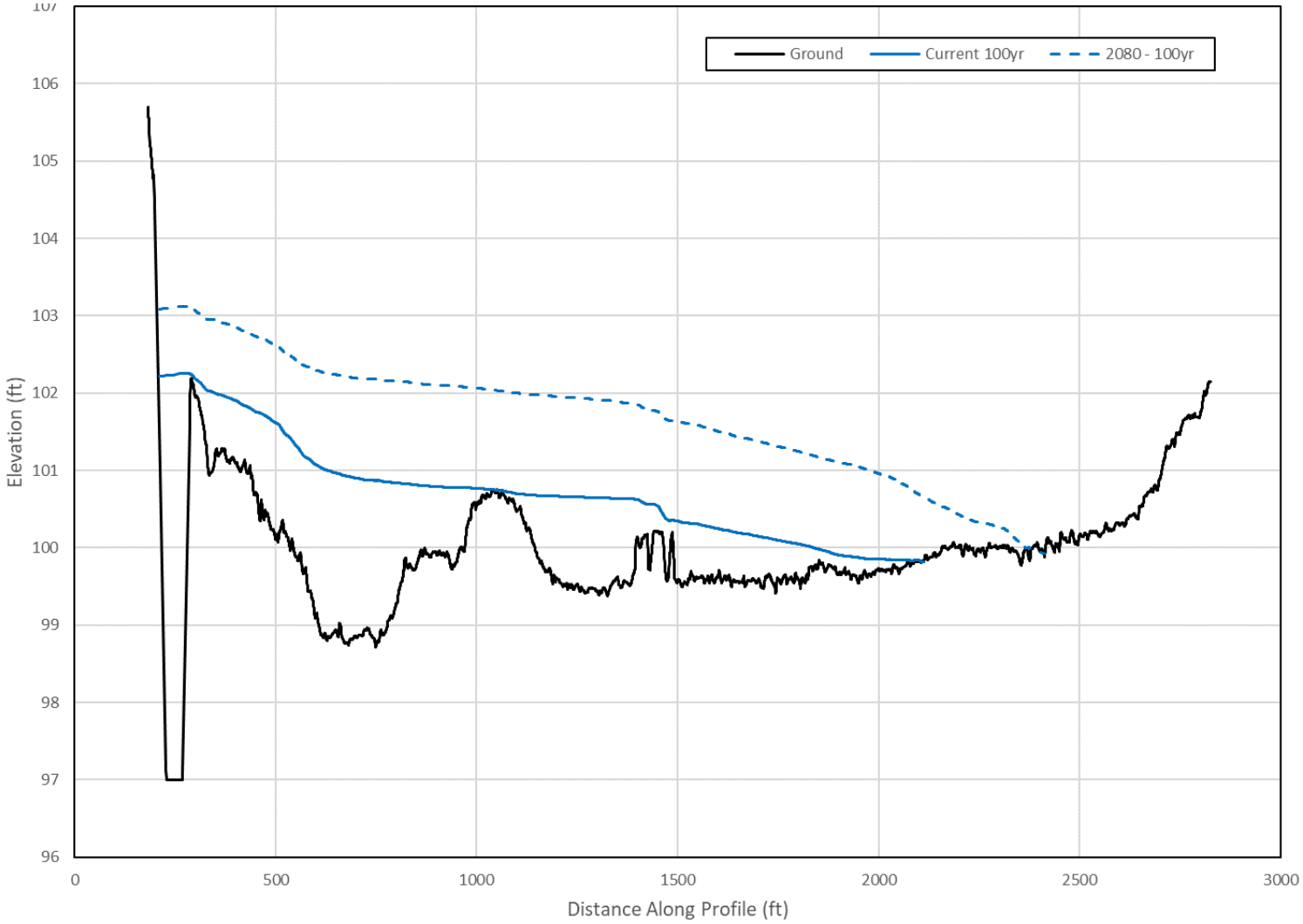


Figure 78 – Water Surface Elevation Profile Along Olympia Brewery Site with Elevated Ground during 100-year Flood Events

6.0 CONCEPTUAL PLANS DETAILS

To aid in the decision of selection of an alternative, the following sections will provide details about the development of a Rough Order of Magnitude (ROM) cost estimate, the expected permits that would be required for each concept and the Conceptual Plan Scoring Matrix that was developed for this study.

6.1 COST ESTIMATE

To develop a ROM for each concept, each alternative was broken down into the components that would be required for the alternative to be implemented. Stantec then utilized a combination of Washington State Department of Transportation's (WSDOT) Unit Bid Analysis Standard (UBA) Item Inquiry system where applicable, engineering judgement and past experience to determine a unit cost for each construction component. If the construction component could be found within WSDOT's UBA system, a unit price for the components was estimated using previously bid items within WSDOT's database. If the item could not be found, such as the relocation of the Power Substation, Stantec utilized past experience of similar projects to estimate the cost. These costs are intended to be a ROM and therefore conservativism and contingency was added to each alternative's ROM.

It was discussed during a stakeholder meeting held on May 31st, 2023, that the power substation may not need to be relocated as it is possible that power can be supplied to this area without the need for this substation. More investigation into the power supply needs will need to occur to confirm this, but if it is discovered to be true, then the substation would just need to be demolished, not relocated. Demolition in lieu of relocation would lead to significant cost savings. For this study, two cost estimates were assumed: one assumed power substation relocation, the second with power substation demolition.

Table 6 provides a summary of the estimated ROM for each alternative. **Appendix D** provides a detailed breakdown for each alternative.

Table 6 – ROM Cost Estimate for Each Alternative

Alternative	ROM Cost Estimate ($)
2	$1,859,000
4	$2,264,000
5 – Substation Relocation	$6,124,000
5 – Substation Demolition	$3,043,000
9B – Substation Relocation	$6,698,000

Alternative	ROM Cost Estimate ($)
9B – Substation Demolition	$3,618,000
10A	$3,319,000
10B – Substation Relocation	$7,179,000
10B – Substation Demolition	$4,098,000

6.2 PERMITTING REQUIREMENTS

Permitting for alternative implementation would include local, state, and federal permits associated with in-water projects where cut and fill would be undertaken within water of the state where sensitive, threatened, and endangered species are present. These may include:

- Archeological and Cultural Resources Report (GEO 21-02)
- Hydraulic Project Approval (HPA)
- Shoreline Permit
- Habitat Conservation Plan (HCP)
- State Environmental Policy Act (SEPA)
- Water Quality Certification (Section 401)
- JARPA (Section 404)
- Critical Areas Ordinance Certificate of Compliance
- No-Rise Certification Statement
- FEMA Conditional Letter of Map Revision (CLOMR) and Letter of Map Revision (LOMR)

Alternative implementation would also need to consider local land use requirements as described in Appendix B. In addition, a No Further Action (NFA) from the Washington State Department of Ecology regarding legacy Site contamination will be needed prior to implementation of flood reduction alternatives.

6.3 CONCEPTUAL PLAN SCORING MATRIX

A sample preferred alternative scoring matrix is provided in **Table 7**. The scoring matrix is a point-based approach that will score an alternative out of 100 possible points based upon 6 weighted factors. The sample scoring matrix is intended to be used as guide for future development moving forward; not for selection of a preferred alternative for this study. Sample alternative selection factors and corresponding weights are described below:

1. **Flood Risk Reduction** – **30 points** – the alternatives ability to reduce the potential flood risk. A score of 25 points equates to the property east of the railroad to have no flood potential during the 100year event.

2. **Study Area Resiliency** – **20 points** – a qualitative measure of the longer-term resiliency of the alternative. A high score of 15-20 equates an alternative that will have a low cost to maintain over time and is expected to have long sustainability. Medium scores are 10-15 and anything less than 10 is considered low in resiliency.

3. **Construction Cost** – **15 Points** – the cost of the alternative..

4. **Ecological Benefits** – **15 points** – a qualitative measure of the benefit that the alternative will have on the ecosystem in the immediate area and the surrounding area if applicable.

5. **Community Benefit** – **10 points** – a qualitative measure of how the alternative will benefit the community. An example of this is the benching alternative's ability to provide the community with a park with walking trails

6. **Permitting/Zoning Applicability/Land Ownership** – **10 points** – a qualitative measure of the alternatives ability to be permitted and constructed to due to the current zoning laws

Table 7 – Conceptual Plan Scoring Matrix

Alternative	Flood Risk Reduction	Study Area Resiliency	Construction Cost	Ecological Benefits	Community Benefit	Permitting/Zoning Applicability	Total Score
	30	20	15	15	10	10	100
2							0
4							0
5							0
9A							0
10A							0
10B							0

7.0 NEXT STEPS

This report summarizes the base-conditions hydraulic modeling and alternative analysis that was completed to determine a base-level understanding of potential flood mitigation features that may reduce flood risk on the Olympia Brewery Site (Site) This study is not intended to be part of any construction package or design proposal. As noted in the report, certain mitigation features may reduce the flood risk at the Olympia Brewery Site, but more analysis is required to fully understand the potential reduction that would coincide with future development concepts. Next steps to consider are listed below:

1. Model specific Site redevelopment approaches with a preferred flood reduction alternative to meet finish floor elevation standards for proposed buildings (see Appendix B).
2. Add proposed features of other projects under consideration by the City within the Study Area such as the E Street Project.
3. Include multiple benefits in a site redevelopment plan and proposed conditions model to locate features such as trails, river access, and parking if desired.
4. Modify the preferred alternative to explicitly include a diversity of habitats, native revegetation, LWM, stream substrate etc. to achieve ecosystem benefits such as habitat restoration, water quality, hyporheic recharge, and refuge.
5. Where feasible, consider relocation and/or removal of existing development within the Deschutes River Floodplain that drives flooding at the Site and restricts flood reduction and redevelopment approaches.
6. Complete Site investigations to identify legacy contamination and approaches for cleanup.
7. Based on the results of the contamination site investigation, include any necessary measures to prevent the spread of contaminants into a flood reduction and redevelopment plan.
8. Complete cleanup of legacy contamination at the Site and receive a NFA from Ecology.
9. Progress design document preparation of the preferred alternative to 30% including a reliable cost estimate.
10. Collaborate with regulatory stakeholders to formalize a permitting pathway.
11. Apply for implementation funding.
12. Complete Site Design and advertise the project for construction.
13. Construct the project and enjoy the benefits.

Appendix A – BACKGROUND DATA

APPENDIX A.1 – AERIAL IMAGERY

Provided Digitally Only

APPENDIX A.2 – CLIMATE CHANGE HYDROLOGY

Project Name:

Stream Name:

Drainage Area: 56,212 ac

Projected mean percent change in bankfull flow:

2040s: 13.3%

2080s: 18.1%

Projected mean percent change in bankfull width:

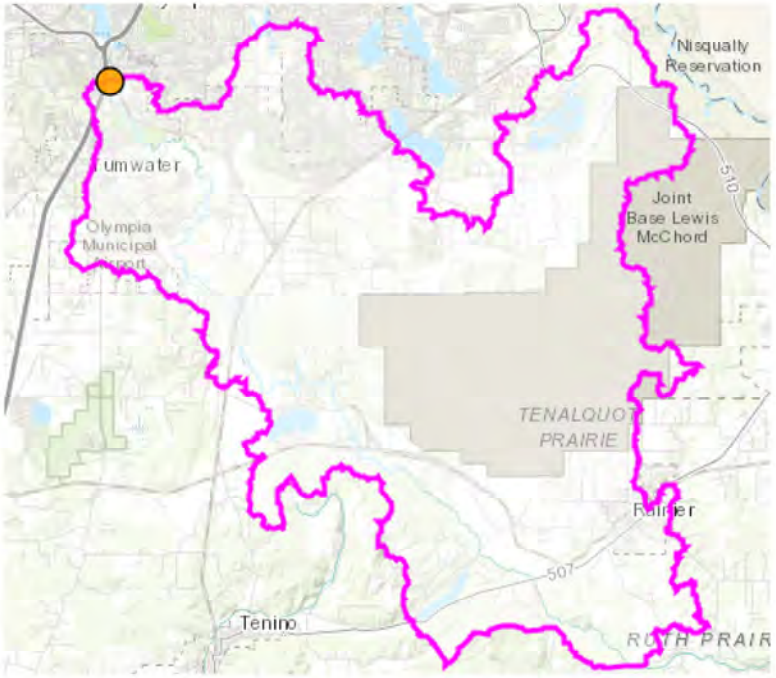
2040s: 6.5%

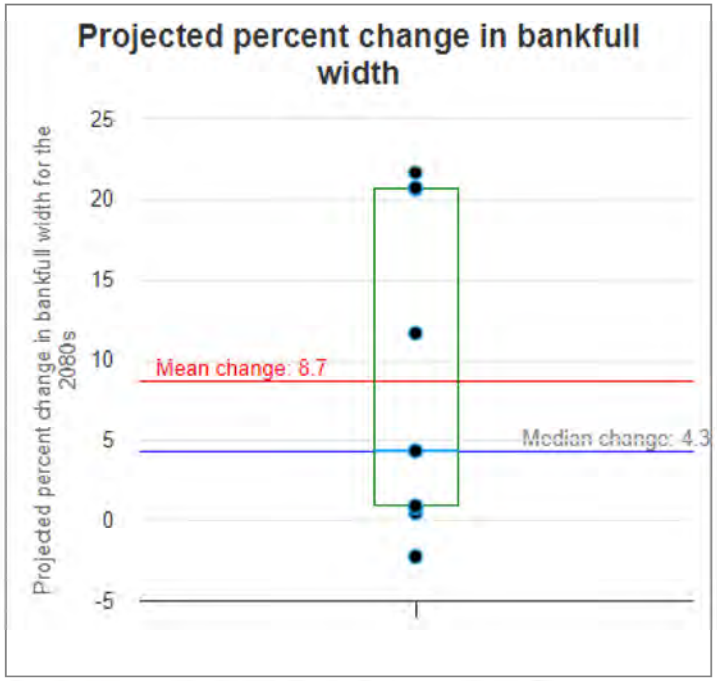
2080s: 8.7%

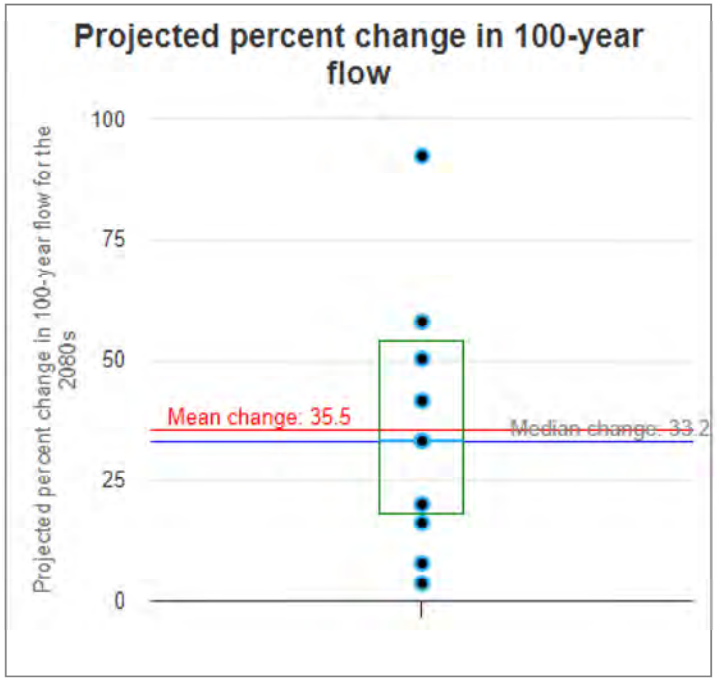
Projected mean percent change in 100-year flood:

2040s: 28.7%

2080s: 35.5%







Black dots are projections from 10 separate models

APPENDIX A.3 – E STREET EXTENSION – ALTERNATIVES ANALYSIS FOR E STREET ALIGNMENT ACROSS

TECHNICAL MEMORANDUM

TO:	Jay Eaton, PE
FROM:	Scott Sawyer, PE Patrick Holm, PE
DATE:	September 28, 2015
PROJECT #:	0625.13
SUBJECT:	E Street Extension – Alternatives Analysis for E Street Alignment Across Deschutes Valley

BACKGROUND

The proposed project connects E Street across the Deschutes Valley between Capitol Boulevard and Cleveland Avenue to alleviate congestion in the Custer Way Corridor. We are coordinating the design of the E Street extension project with the LOTT Clean Water Alliance Deschutes Valley Property Master Plan (LOTT Master Plan), which includes a Water Reuse Facility to the east of the railroad tracks. A previous technical memorandum analyzed the pros and cons of three different valley crossing locations: E Street, Linwood Avenue and Trosper Road. In that technical memorandum, we recommended the crossing at E Street because it provides the best traffic operations with the least impact to surrounding properties.

PURPOSE

The purpose of this Alternatives Analysis is to outline the three alternatives proposed for the E Street connection. Each alternative is rated based on performance and cost. We present multiple options for weighing performance criteria to show how emphasizing different criteria affects the value of each alternative.

CONCEPTUAL ASSUMPTIONS/DESIGN CRITERIA

E Street is a Minor Arterial based upon the classification of the City of Tumwater Development Guide (Development Guide). We assumed a four-lane roadway (11-foot outside lanes and 10-foot inside lanes), with 5-foot bike lanes, and 6.5-foot sidewalks with curb and gutter, for a total cross section width of 65 feet. We assumed the access road to the LOTT facility from Cleveland Avenue will be an Industrial/Commercial Collector with two lanes (12-foot lanes), with 6-foot bikes lanes and 6.5-foot sidewalks with curb and gutter, for a total cross section width of 49 feet. In an effort to minimize cost, both street cross sections do not include the landscape planters prescribed in the Development Guide. The Development Guide proposes a design speed of 40 mph for Minor Arterials; however, we used a design speed of 35 mph due to topographic constraints.

LOTT WATER REUSE FACILITY/BREWERY PROPERTY ACCESS

The LOTT Master Plan proposes a Water Reuse Facility on the Deschutes Valley floor to the east of the railroad tracks. In addition to the Water Reuse Facility, there are Brewery parcels on the east side of the tracks, which will likely be developed in the future. Union Pacific railroad indicated that future uses to the east of the tracks will not be allowed to cross the tracks at grade for access. In order for the LOTT Master Plan and future Brewery development to be possible, access to the east side of the valley needs to be addressed. Each alternative accounts for access to the east side of the valley with the main challenge being the grade differential across the valley floor. Access to the east side of the valley will require significant cut to the hillside.

RAILROAD CROSSING

Union Pacific owns the railroad right-of-way and tracks that run through the Deschutes Valley. Union Pacific requires 23.5 feet of vertical clearance for structures crossing over railroad tracks. The bridge deck that crosses over the tracks in each alternative has an approximate depth of 10 feet. The bridge deck and the Union Pacific vertical clearance height combine for a total of 33.5 feet. We used a conservative clearance of 35 feet for all bridge spans over the Union Pacific right-of-way and private railroad spurs.

PERFORMANCE RANKING

Criteria and Weighting

We based the following criteria (performance attributes) on the goals and the purpose of the project. Criteria were kept basic due to the conceptual stage of the project. The criteria follow:

- Roadway Geometry
- LOTT Master Plan Compatibility
- Aesthetics

PERFORMANCE ATTRIBUTE MATRIX

E Street Extension - LOTT Compatibility Target

Rate the relative importance of the attributes relative to the project's Need and Purpose.

Performance Attributes	Roadway Geometry	LOTT Master Plan Compatibility	Aesthetics	TOTAL COUNT	PRIORITIES
Roadway Geometry	A	B	A	2	0.333
LOTT Master Plan Compatibility		B	B	3	0.500
Aesthetics			C	1	0.167
SUB-TOTALS				6	1.00

Performance Attribute Matrix (Pair Wise Comparison)
Weighted toward LOTT Facility

Each criterion was weighted using pair-wise comparisons. The criteria were weighted two different ways to demonstrate how different project goals will affect the values of the alternatives. The first weighting scheme focused on LOTT Master Plan Compatibility; the second weighting scheme focused on roadway geometry. See Appendix A for both criteria matrices.

Scoring

Each of the three alternatives was scored against the criteria above. A rating of 0 to 10 was applied to each performance attribute. The rating was then multiplied by the weighting to determine the performance attribute score. The alternative score was determined by the sum of the performance attribute scores. See Appendix A for complete scoring data for each performance attribute.

Cost

We generated conceptual cost estimates for each alternative using industry standard cost breakdowns and unit cost values derived from WSDOT unit bid tabs. Each estimate was given a 20% contingency factor due to the conceptual nature. The calculated costs are based on 2015 dollars. We included the following cost-reducing ideas in the conceptual designs shown in Appendix C:

- Per discussion with the City, minimizing the roadway section with more narrow lanes and sidewalks decreases pavement and bridge footprint.
- Using mechanically stabilized earth walls as much as possible minimizes bridge costs.

In addition, the following opportunities may provide cost savings as design details progress:

- Coordinating improvements with the LOTT facility has the potential to save costs because certain parts of the construction process will overlap and benefit both projects.
- Integrating the stormwater mitigation of both projects has the potential to minimize footprint for stormwater facilities and prevent reconstruction.

See Appendix B for conceptual level cost estimates.

Value Ranking

We ranked each alternative by its value. The value of each alternative is a function of the cost index and alternative score, where the cost index is the ratio of individual alternative cost divided by the sum of all alternative costs. The alternative value is determined by dividing the alternative score by the cost index. The alternative with the best value will be the recommended alternative.

$$Criteria\ Score = weight * rating$$

$$Alternative\ Score = \sum criteria\ scores$$

$$Cost\ Index = \frac{Alternative\ Cost}{\sum Alternative\ Cost}$$

$$Alternative\ Value = \frac{Alternative\ Score}{Cost\ Index}$$

Formulae for developing Value Index

ALTERNATIVES

Alternative 1

Alternative 1 is a bridge that uses the existing alignment of E Street and extends across the Deschutes Valley with a slight curve sweeping to the north. The bridge extends the full width of the valley and has piers that are located within the LOTT facility footprint. This option requires a separate road from Cleveland Avenue to access the LOTT facility due to the difference in grades between the bridge and the valley floor. This alternative connects to Cleveland Avenue to the south where the City of Tumwater owns a parcel, Tax ID# 09470029000. This access road requires a large earthwork cut into the hillside. See Appendix C for an exhibit showing Alternative 1.

Performance Scores

Roadway Geometry	*7*
LOTT Master Plan Compatibility	*3*
Aesthetics	*3*

***Alternative 1 Cost**:* *$45,750,000*

Alternative 1 Value Index

LOTT Compatibility Emphasis	*1.704*
Geometry Emphasis	*1.966*

Alternative 2

Alternative 2 realigns the E Street and Capitol Boulevard intersection to provide a 90° intersection for the east leg. The alignment heads southeast curving to the south as it crosses the railroad right-of-way. From there it parallels the railroad tracks until it curves to the east to connect with Cleveland Avenue through the previously mentioned City of Tumwater-owned parcel. This alternative uses a bridge for the entire valley crossing. The grade challenges for LOTT access are also present in this alternative. This access road connects to E Street instead of Cleveland Avenue, but it still requires a large earthwork cut into the hillside. See Appendix C for exhibits showing Alternative 2.

Performance Scores:

Roadway Geometry	*5*
LOTT Master Plan Compatibility	*5*
Aesthetics	*5*

Alternative 2 Cost: *$59,090,000*

Alternative 2 Value Index

LOTT Compatibility Emphasis	*1.522*
Geometry Emphasis	*1.522*

Alternative 2a

Alternative 2a follows the same alignment as Alternative 2, but it uses a different vertical profile to minimize bridge span length and to provide an opportunity for access to the LOTT facility closer to the valley floor. Alternative 2a descends to the valley floor after the bridge clears the railroad tracks. At the low point of this descent, an intersection provides access to the LOTT facility. After the low point, the road ascends and curves up to Cleveland Avenue through the previously mentioned City of Tumwater parcel. The roadway increases to five lanes proximate to the intersection to allow for a left turn lane. The vertical ascent to Cleveland Avenue requires a large earthwork cut. See Appendix C for exhibits showing Alternative 2a.

Performance Scores:

Roadway Geometry	*3*
LOTT Master Plan Compatibility	*7*
Aesthetics	*7*

Alternative 2 Cost: *$37,240,000*

Alternative 2 Value Index

LOTT Compatibility Emphasis	*2.737*
Geometry Emphasis	*2.415*

Alternative 2b

Alternative 2b is the same layout as Alternative 2a but with flatter profile grades to make it easier for trucks, pedestrians and cyclists (6% vs. 8% in Alternative 2a). The flatter grades increase the height and length of retaining wall on the valley floor; however, the cost of the larger wall is offset by less earthwork cut required in the hillside. See Appendix C for exhibits showing Alternative 2b.

Performance Scores:

Roadway Geometry	*5*
LOTT Master Plan Compatibility	*7*
Aesthetics	*7*

Alternative 2 Cost: *$37,790,000*

Alternative 2 Value Index

LOTT Compatibility Emphasis	*3.014*
Geometry Emphasis	*2.856*

CONCLUSION

Alternative 2b provides the best value under both criteria weighting schemes. It provides the opportunity to access the LOTT facility as a part of the E Street extension, which eliminates the extra cost associated with separate access from Cleveland Avenue. Alternative 2b offers relatively smooth geometry, which only differs slightly in grade from the best performing alternative (Alternative 1). Alternative 2b has the shortest bridge span of the alternatives, which substantially reduces cost.

We recommend Alternative 2b as the preferred alternative.

Appendix A

Performance Ranking/Criteria/Value

PERFORMANCE ATTRIBUTE SCALES

E Street Extension

Performance Attribute	Definition	
Roadway Geometry		
Scales		
Rating	**Rating Rationale**	**Rating**
Unacceptable	Roadway Geometry does not meet minimums stated in City of Tumwater Development Guide and AASHTO Green Book.	0
	Roadway Geometry mainly meets minimum requirements stated in City of Tumwater Development Guide and AASHTO Green Book, but variances may be required. Complex road geometry.	3
	Roadway Geometry mainly above minimum requirements stated in City of Tumwater Development Guide and AASHTO Green Book, but variances may be required. Complex road geometry.	5
	Roadway Geometry mainly above minimum requirements stated in City of Tumwater Development Guide and AASHTO Green Book, but variances may be required. Simple road geometry.	7
Ideal	Roadway Geometry above and beyond minimums stated in City of Tumwater Development Guide and AASHTO Green Book	10

Performance Attribute	Definition	
LOTT Master Plan Compatibility		
Scales		
Rating	**Rating Rationale**	**Rating**
Unacceptable	Roadway alignment and geometry in direct conflict with LOTT Master Plan.	0
	Roadway alignment and geometry provide complex access to LOTT Facility. Flood plain berm not part of roadway geometry. LOTT Facility will be impacted by roadway alignment.	3
	Roadway alignment and geometry provide complex access to LOTT Facility.	5
	Roadway alignment and geometry provides integrated access to LOTT Facility. Flood plain berm a part of roadway geometry. LOTT Facility will not be impacted negatively by roadway alignment	7
Ideal	Roadway alignment and geometry completely compatible with LOTT Master Plan	10

Performance Attribute	Definition	
Aesthetics		
Scales		
Rating	**Rating Rationale**	**Rating**
Unacceptable	Roadway design makes the Deschutes Valley visually displeasing. Obstructs valley views from all angles.	0
	Roadway design affects valley views from all viewpoints.	3
	Roadway design affects valley views from some viewpoints	5
	Roadway design affects valley views from some viewpoints but are relatively minimal.	7
Ideal	Roadway design enhances Deschutes Valley visual appeal.	10

PERFORMANCE ATTRIBUTE WEIGHTING

E Street Extension - LOTT Compatibility Emphasis

Rate the relative importance of the attributes relative to the project's Need and Purpose.

Performance Attributes	Roadway Geometry	LOTT Master Plan Compatibility	Aesthetics	TOTAL COUNT	PRIORITIES
Roadway Geometry	A	B	A	2	**0.333**
LOTT Master Plan Compatibility		B	B	3	**0.500**
Aesthetics			C	1	**0.167**
SUB-TOTALS				6	**1.00**

Compare each pair of criteria and input the letter designating the more important criteria:

For instance, comparing A vs. B
Input A if you think A is more important.
Input B is you think B is more important.
Input A/B if you think they are equally important.

Count the total number of letters counting 1.0 for single letters and 0.5 for shared letters.

The "Priority" percentage is the total letter count divided by the total available count (6).

PERFORMANCE ATTRIBUTE WEIGHTING

E Street Extension - Roadway Geometry Emphasis

Rate the relative importance of the attributes relative to the project's Need and Purpose.

Performance Attributes	Roadway Geometry	LOTT Master Plan Compatibility	Aesthetics	TOTAL COUNT	PRIORITIES
Roadway Geometry	A	A	A	3	**0.500**
LOTT Master Plan Compatibility		B	C	1	**0.167**
Aesthetics			C	2	**0.333**
SUB-TOTALS				6	**1.00**

Compare each pair of criteria and input the letter designating the more important criteria:

For instance, comparing A vs. B
Input A if you think A is more important.
Input B is you think B is more important.
Input A/B if you think they are equally important.

Count the total number of letters counting 1.0 for single letters and 0.5 for shared letters.

The "Priority" percentage is the total letter count divided by the total available count (6).

PERFORMANCE ASSESSMENT SCORING

E Street Extension

Alternative 1

Performance Attributes	Rationale	Rating
Roadway Geometry	Direct roadway alignment; above and below minimum/maximum requirements respectively.	7
LOTT Master Plan Compatibility	Complex LOTT Facility access. Not conducive to floodplain mitigation. Bridge will impact LOTT Facility layout.	3
Aesthetics	Bridge can be seen from most valley viewponts	3

Alternative 2 Name

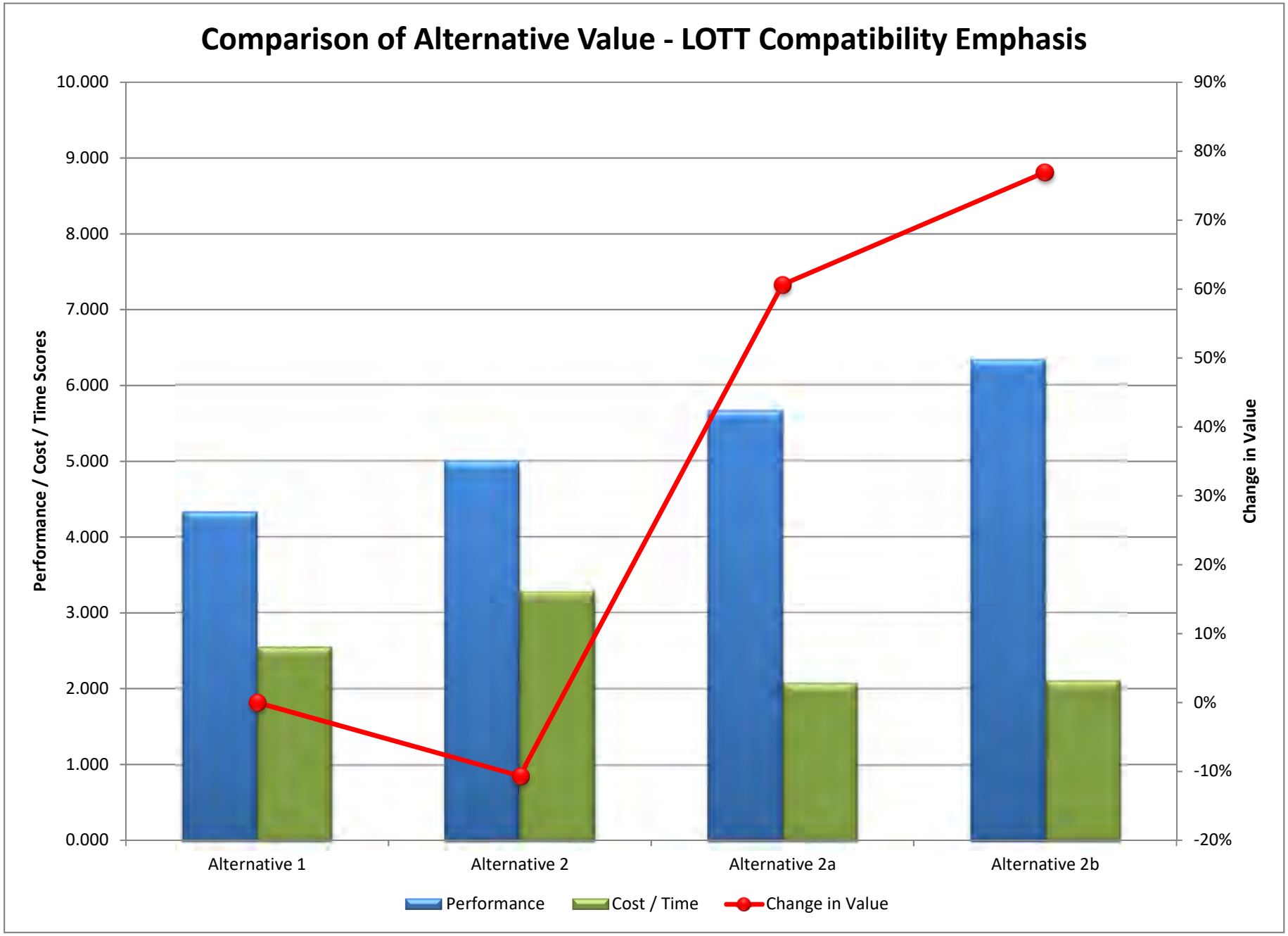
Performance Attributes	Rationale	Rating
Roadway Geometry	More complex roadway alignment; above and below minimum/maximum requirements respectively.	5
LOTT Master Plan Compatibility	Roadway alignment and geometry provide complex LOTT facility access	5
Aesthetics	Bridge can be seen from some viewpoints.	5

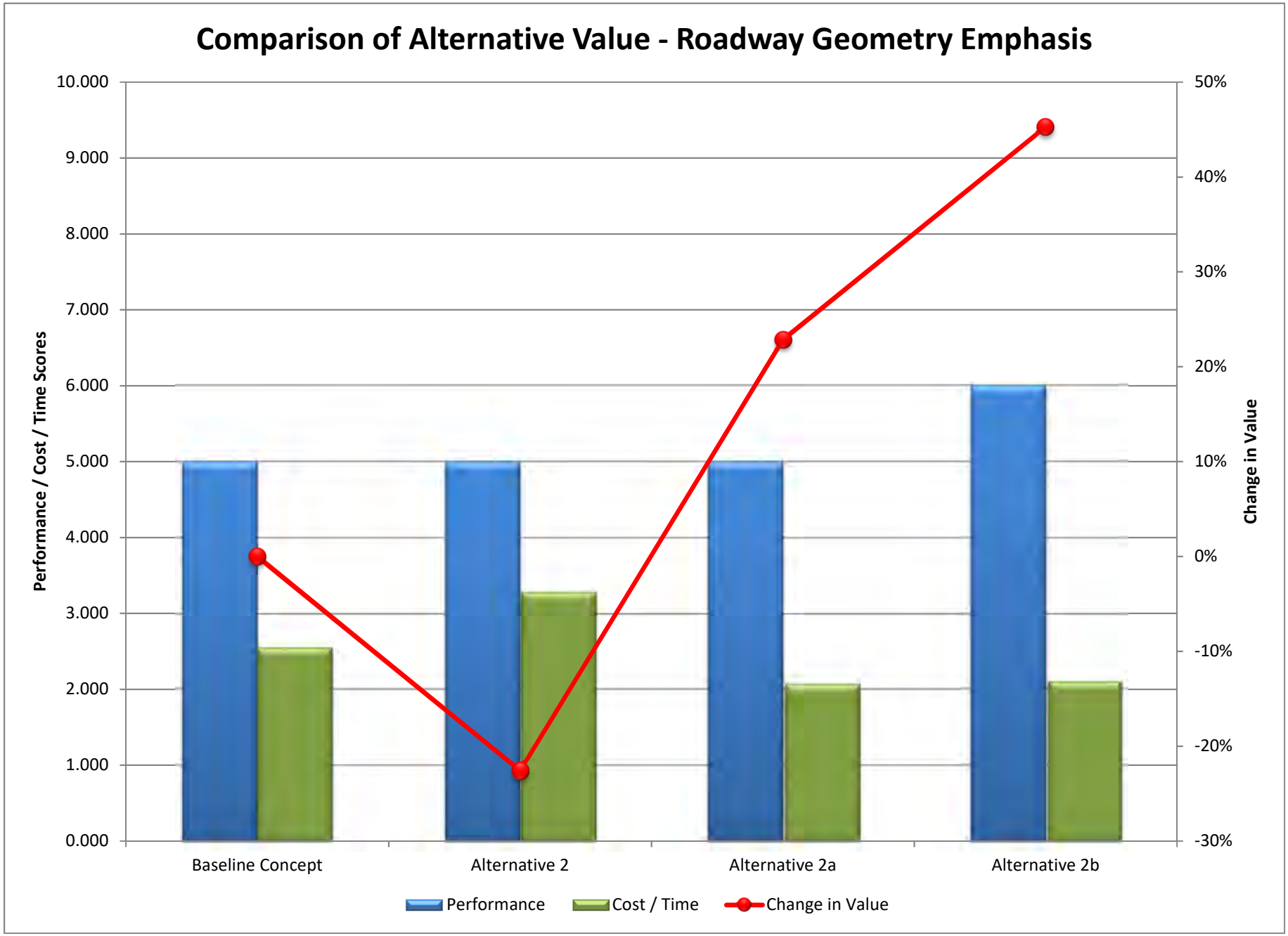
Alternative 2a Name

Performance Attributes	Rationale	Rating
Roadway Geometry	More complex roadway alignment; Roadway slopes at maximum value near hillside and bridge	3
LOTT Master Plan Compatibility	Roadway alignment offers integrated LOTT Facility access. Floodplain mitigation will be part of roadway design.	7
Aesthetics	Bridge and Retaining wall can be seen from some viewpoints, but relatively minimal.	7

Alternative 2b Name

Performance Attributes	Rationale	Rating
Roadway Geometry	More complex roadway alignment; Roadway slopes at maximum value near hillside and bridge	5
LOTT Master Plan Compatibility	Roadway alignment offers integrated LOTT Facility access. Floodplain mitigation will be part of roadway design.	7
Aesthetics	Bridge and Retaining wall can be seen from some viewpoints, but relatively minimal.	7


Comparison of Alternative Value - LOTT Compatibility Emphasis
Performance / Cost / Time Scores
Change in Value
10.000
9.000
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
-10%
-20%
Alternative 1
Alternative 2
Alternative 2a
Alternative 2b
Performance
Cost / Time
Change in Value


Comparison of Alternative Value - Roadway Geometry Emphasis
Performance / Cost / Time Scores
Change in Value
10.000
9.000
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
50%
40%
30%
20%
10%
0%
-10%
-20%
-30%
Baseline Concept
Alternative 2
Alternative 2a
Alternative 2b
Performance
Cost / Time
Change in Value

Appendix B

Conceptual Cost Estimates

SCJ ALLIANCE
CONSULTING SERVICES

City of Tumwater
E Street Extension
CONCEPTUAL LEVEL ESTIMATE SUMMARY

	Strategy Description	E Street Extension	LOTT Access	E Street + LOTT Access
A1	Alternative 1 - Bridge to East, Separate LOTT Facility Access	$41,840,000	$3,910,000	$45,750,000
A2	Alternative 2 - Bridge to Southeast, LOTT Facility access from top of hill	$55,280,000	$3,810,000	$59,090,000
A2a	Alternative 2a - Bridge east across railroad ROW, integrated LOTT access on valley floor	$36,610,000	$630,000	$37,240,000
A2b	Alternative 2b - Bridge east across railroad ROW, integrated LOTT access on valley floor with 6% grades	$37,060,000	$730,000	$37,790,000

SCJ ALLIANCE
CONSULTING SERVICES

			ALT 1 - E STREET	
Element	**Element Based Upon**		**Estimate Measurement**	
Roadwork	**Estimated Quantities**			**$ 29,502,801**
	Mobilization	6%	1	$ 2,001,681
	Clearing and Grubbing	SF	15,000	$ 3,444
	Roadway Excavation Incl Haul	CY		$ -
	Roadway Section	SF	100,100	$ 633,633
	Ditchline	LF		$ -
	Conveyance	LF	1,925	$ 117,233
	Water Quality/Flow Control	SF	129,000	$ 293,475
	Bridge	SF	115,910	$ 26,079,750
	Sidewalk	LF	1,925	$ 133,403
	Curb and Gutter	LF	1,925	$ 97,559
	Erosion Control	LF	400	$ 6,720
	Signal	EACH		$ -
	Illumination	LF	1,925	$ 128,205
	Undergrounding Power	LF		$ -
	Permanent Signing	LF	1,925	$ 7,700
	Wall	SF		$ -
	Landscaping	LF		$ -
Traffic Control				**$ 300,000**
	Traffic Control	LS	1	$ 300,000
Right-of-Way				**$ 706,400**
	UP Property	SF	8,000	$ 160,000
	LOTT Property	SF	119,200	$ 238,400
	Private Property	SF	30,800	$ 308,000
	Parcels	Value		$ -
Engineering	**18%**			**$ 5,364,504**
	PE	10%	1	$ 2,980,280
	CN	8%	1	$ 2,384,224
		Subtotal		$ 35,873,705
		Conceptual Contingency (20%)		$ 5,960,560
		Total		**$ 41,840,000**

SCJ ALLIANCE
CONSULTING SERVICES

			ALT 1 - LOTT Access	
Element	**Element Based Upon**		**Estimate Measurement**	
Roadwork	**Estimated Quantities**			**$ 2,832,396**
	Mobilization	6%	1	$ 190,236
	Clearing and Grubbing	SF	253,209	$ 58,129
	Roadway Excavation Incl Haul	CY	59,750	$ 1,493,750
	Roadway Section	SF	57,600	$ 364,608
	Embankment Compaction	CY	5,500	$ 33,000
	Conveyance	LF	1,600	$ 97,440
	Water Quality/Flow Control	SF	78,500	$ 178,588
	Sidewalk	LF	1,600	$ 110,880
	Curb and Gutter	LF	1,600	$ 81,088
	Erosion Control	LF	1,600	$ 26,880
	Signal	EACH		$ -
	Illumination	LF	1,600	$ 106,560
	Undergrounding Power	LF	1,600	$ 84,838
	Permanent Signing	LF	1,600	$ 6,400
	Landscaping	LF		$ -
Right-of-Way				**$ -**
	UP Property	SF		$ -
	LOTT Property	SF		$ -
	Private Property	SF		$ -
	Parcels	Value		$ -
Engineering	**18%**			**$ 509,831**
	Design	10%	1	$ 283,240
	Construction	8%	1	$ 226,592
	Subtotal			$ 3,342,228
	Conceptual Contingency (20%)			$ 566,479
	Total			**$ 3,910,000**

SCJ ALLIANCE
CONSULTING SERVICES

Element	Element Based Upon		ALT 2 - E Street Estimate Measurement	
Roadwork	**Estimated Quantities**			**$ 37,605,096**
	Mobilization	6%	1	$ 2,545,865
	Clearing and Grubbing	SF	85,500	$ 19,628
	Roadway Excavation Incl Haul	CY	23,100	$ 577,500
	Roadway Section	SF	191,400	$ 1,211,562
	Embankment Compaction	CY	1600	$ 9,600
	Conveyance	LF	3,300	$ 200,970
	Water Quality/Flow Control	SF	221,500	$ 503,913
	Bridge	SF	141,705	$ 31,883,625
	Sidewalk	LF	3,300	$ 228,690
	Curb and Gutter	LF	3,300	$ 167,244
	Erosion Control	LF	1,400	$ 23,520
	Signal	EACH		$ -
	Illumination	LF	3,300	$ 219,780
	Undergrounding Power	LF		$ -
	Permanent Signing	LF	3,300	$ 13,200
	Landscaping	LF		$ -
Traffic Control				**$ 300,000**
	Traffic Control	LS	1	$ 300,000
Right-of-Way				**$ 2,964,100**
	UP Property	SF	10,720	$ 214,400
	LOTT Property	SF	79,280	$ 1,585,600
	Private Property	SF	30,800	$ 61,600
	Parcels	Value	110,250	$ 1,102,500
Engineering	**18%**			**$ 6,822,917**
	Design	10%	1	$ 3,790,510
	Construction	8%	1	$ 3,032,408
		Subtotal		$ 47,692,114
		Conceptual Contingency (20%)		$ 7,581,019
		Total		**$ 55,280,000**

SCJ ALLIANCE
CONSULTING SERVICES

Element	Element Based Upon		ALT 2 - LOTT Access Estimate Measurement	
Roadwork	**Estimated Quantities**			**$ 2,753,703**
	Mobilization	6%	1	$ 184,950
	Clearing and Grubbing	SF	176,014	$ 40,407
	Roadway Excavation Incl Haul	CY	67,100	$ 1,677,500
	Roadway Section	SF	43,200	$ 273,456
	Embankment Compaction	CY	9,600	$ 57,600
	Conveyance	LF	1,200	$ 73,080
	Water Quality/Flow Control	SF	59,000	$ 134,225
	Sidewalk	LF	1,200	$ 83,160
	Curb and Gutter	LF	1,200	$ 60,816
	Erosion Control	LF	1,200	$ 20,160
	Signal	EACH		$ -
	Illumination	LF	1,200	$ 79,920
	Undergrounding Power	LF	1,200	$ 63,629
	Permanent Signing	LF	1,200	$ 4,800
	Landscaping	LF		$ -
Right-of-Way				**$ -**
	UP Property	SF		$ -
	LOTT Property	SF		$ -
	Private Property	SF		$ -
	Parcels	Value		$ -
Engineering	**18%**			**$ 495,667**
	Design	10%	1	$ 275,370
	Construction	8%	1	$ 220,296
	Subtotal			$ 3,249,370
	Conceptual Contingency (20%)			$ 550,741
	Total			**$ 3,810,000**

SCJ ALLIANCE
CONSULTING SERVICES

Element	Element Based Upon		ALT 2a - E Street Estimate Measurement	
Roadwork	**Estimated Quantities**			**$ 25,612,065**
	Mobilization	6%	1	$ 1,740,363
	Clearing and Grubbing	SF	342,209	$ 78,560
	Roadway Excavation Incl Haul	CY	125,100	$ 3,127,500
	Roadway Section	SF	166,500	$ 1,053,945
	Embankment Compaction	CY	20,100	$ 120,600
	Conveyance	LF	3,200	$ 194,880
	Water Quality/Flow Control	SF	214,500	$ 487,988
	Bridge	SF	77,500	$ 17,437,500
	Sidewalk	LF	3,200	$ 221,760
	Curb and Gutter	LF	3,200	$ 162,176
	Erosion Control	LF	2,300	$ 38,640
	Signal	EACH		$ -
	Illumination	LF	3,200	$ 213,120
	Undergrounding Power	LF	1400	$ 74,234
	Permanent Signing	LF	3,200	$ 12,800
	Wall	SF	10,800	$ 648,000
	Landscaping	LF		$ -
Traffic Control				**$ 300,000**
	Traffic Control	LS	1	$ 300,000
Right-of-Way				**$ 846,335**
	UP Property	SF	10,720	$ 214,400
	LOTT Property	SF	79,280	$ 158,560
	Private Property	SF	30,800	$ 308,000
	Parcels	Value	110,250	$ 165,375
Engineering	**18%**			**$ 4,664,172**
	Design	10%	1	$ 2,591,207
	Construction	8%	1	$ 2,072,965
		Subtotal		$ 31,422,572
		Conceptual Contingency (20%)		$ 5,182,413
		Total		**$ 36,610,000**

SCJ ALLIANCE
CONSULTING SERVICES

Element	Element Based Upon		ALT 2a - LOTT Access Estimate Measurement	
Roadwork	**Estimated Quantities**			**$ 404,365**
	Mobilization	6%	1	$ 27,159
	Clearing and Grubbing	SF	38,500	$ 8,838
	Fill	TON		$ -
	Roadway Section	SF	19,800	$ 125,334
	Ditchline	LF		$ -
	Conveyance	LF	550	$ 33,495
	Water Quality/Flow Control	SF	29,150	$ 66,316
	Sidewalk	LF	550	$ 38,115
	Curb and Gutter	LF	550	$ 27,874
	Erosion Control	LF	550	$ 9,240
	Signal	EACH		$ -
	Illumination	LF	550	$ 36,630
	Undergrounding Power	LF	550	$ 29,163
	Permanent Signing	LF	550	$ 2,200
	Landscaping	LF		$ -
Right-of-Way				**$ 62,280**
	UP Property	SF		$ -
	LOTT Property	SF	31,140	$ 62,280
	Private Property	SF		$ -
	Parcels	Value		$ -
Engineering	**18%**			**$ 72,786**
	Design	10%	1	$ 40,436
	Construction	8%	1	$ 32,349
		Subtotal		$ 539,430
		Conceptual Contingency (20%)		$ 80,873
		Total		**$ 630,000**

SCJ ALLIANCE
CONSULTING SERVICES

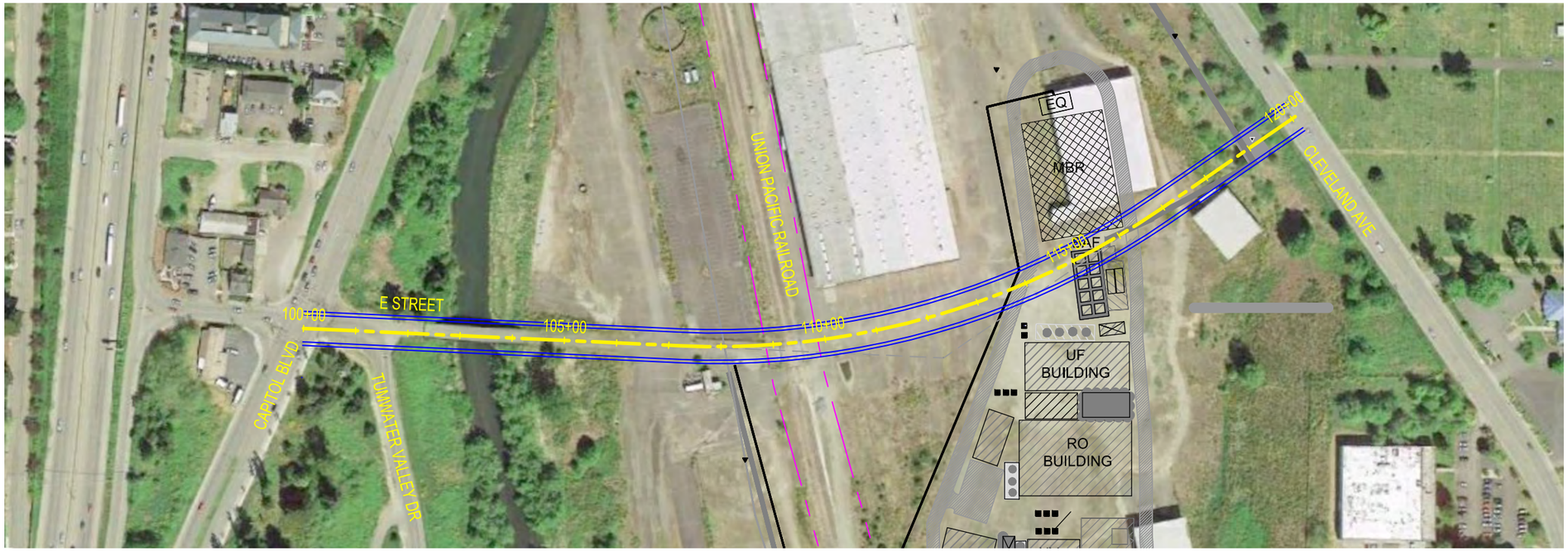
Element	Element Based Upon		ALT 2b - E Street Estimate Measurement	
Roadwork	**Estimated Quantities**			**$ 25,934,951**
	Mobilization	6%	1	$ 1,762,049
	Clearing and Grubbing	SF	342,209	$ 78,560
	Roadway Excavation Incl Haul	CY	74,700	$ 1,867,500
	Roadway Section	SF	166,500	$ 1,053,945
	Embankment Compaction	CY	43,900	$ 263,400
	Conveyance	LF	3,200	$ 194,880
	Water Quality/Flow Control	SF	214,500	$ 487,988
	Bridge	SF	77,500	$ 17,437,500
	Sidewalk	LF	3,200	$ 221,760
	Curb and Gutter	LF	3,200	$ 162,176
	Erosion Control	LF	2,300	$ 38,640
	Signal	EACH		$ -
	Illumination	LF	3,200	$ 213,120
	Undergrounding Power	LF	1400	$ 74,234
	Permanent Signing	LF	3,200	$ 12,800
	Wall	SF	34,440	$ 2,066,400
	Landscaping	LF		$ -
Traffic Control				**$ 300,000**
	Traffic Control	LS	1	$ 300,000
Right-of-Way				**$ 846,335**
	UP Property	SF	10,720	$ 214,400
	LOTT Property	SF	79,280	$ 158,560
	Private Property	SF	30,800	$ 308,000
	Parcels	Value	110,250	$ 165,375
Engineering	**18%**			**$ 4,722,291**
	Design	10%	1	$ 2,623,495
	Construction	8%	1	$ 2,098,796
		Subtotal		$ 31,803,578
		Conceptual Contingency (20%)		$ 5,246,990
		Total		**$ 37,060,000**

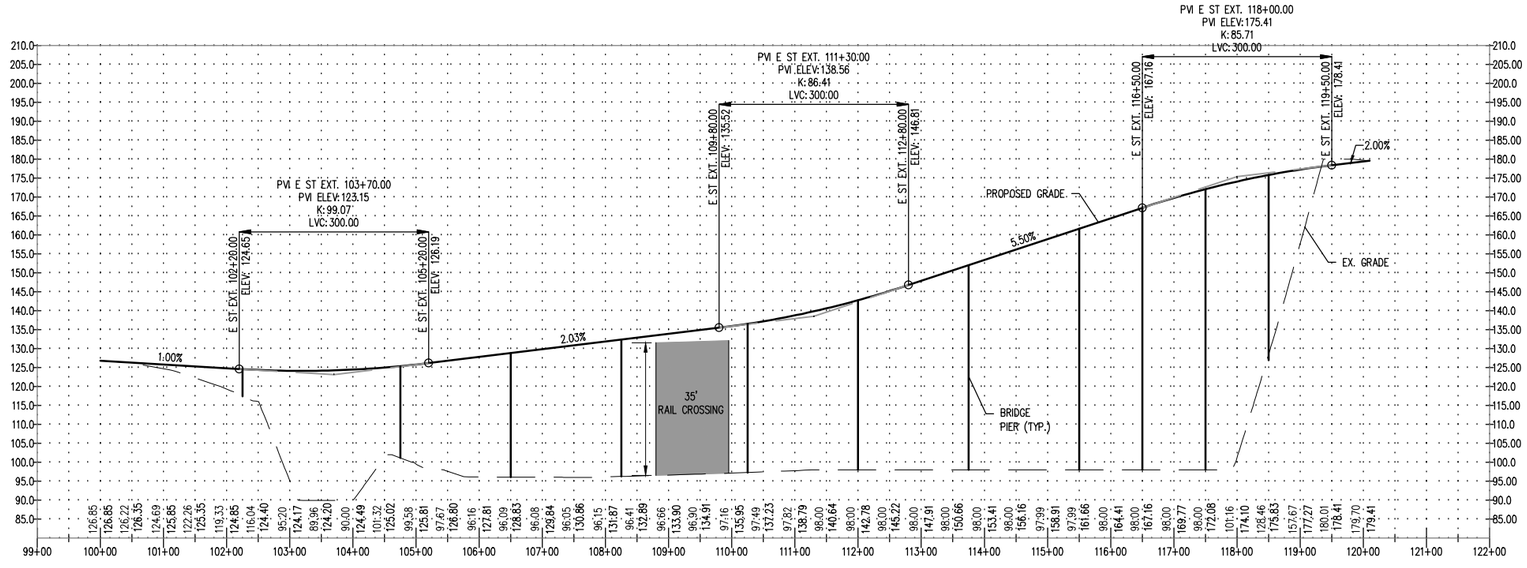
SCJ ALLIANCE
CONSULTING SERVICES

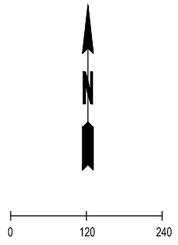
			ALT 2b - LOTT Access	
Element	**Element Based Upon**		**Estimate Measurement**	
Roadwork	**Estimated Quantities**			**$ 482,192**
	Mobilization	6%	1	$ 32,386
	Clearing and Grubbing	SF	38,500	$ 8,838
	Embankment Compaction	CY	12,100	$ 72,600
	Roadway Section	SF	19,800	$ 125,334
	Ditchline	LF		$ -
	Conveyance	LF	550	$ 33,495
	Water Quality/Flow Control	SF	29,150	$ 66,316
	Sidewalk	LF	550	$ 38,115
	Curb and Gutter	LF	550	$ 27,874
	Erosion Control	LF	550	$ 9,240
	Signal	EACH		$ -
	Illumination	LF	550	$ 36,630
	Undergrounding Power	LF	550	$ 29,163
	Permanent Signing	LF	550	$ 2,200
	Landscaping	LF		$ -
Right-of-Way				**$ 62,280**
	UP Property	SF		$ -
	LOTT Property	SF	31,140	$ 62,280
	Private Property	SF		$ -
	Parcels	Value		$ -
Engineering	**18%**			**$ 86,795**
	Design	10%	1	$ 48,219
	Construction	8%	1	$ 38,575
		Subtotal		$ 631,266
		Conceptual Contingency (20%)		$ 96,438
		Total		**$ 730,000**

Appendix C

Alternative Exhibits







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JOB No.:	0625.13
DRAWING FILE No.:	E-STREET EX-1.dwg

CITY OF TUMWATER - E STREET EXTENSION

E STREET CONCEPTUAL PLAN AND PROFILE - ALTERNATIVE 1

EXHIBIT No: **EX1**

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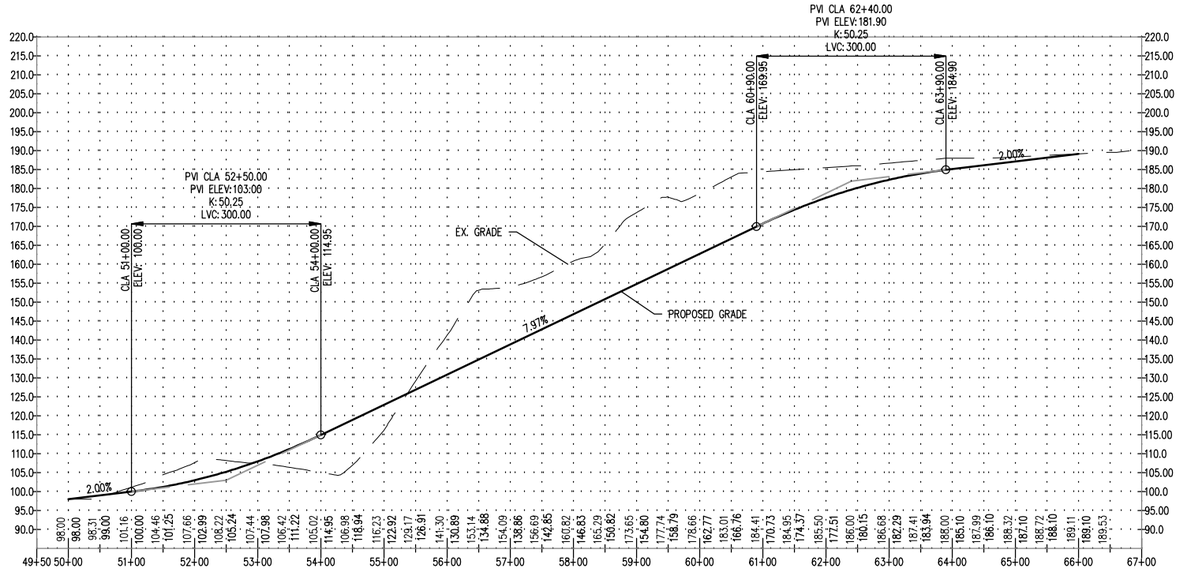

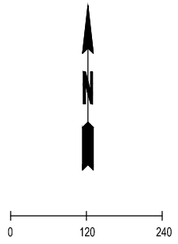

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LOTT ACCESS CONCEPTUAL PLAN AND PROFILE - ALTERNATIVE 1

EXHIBIT No: **EX2**

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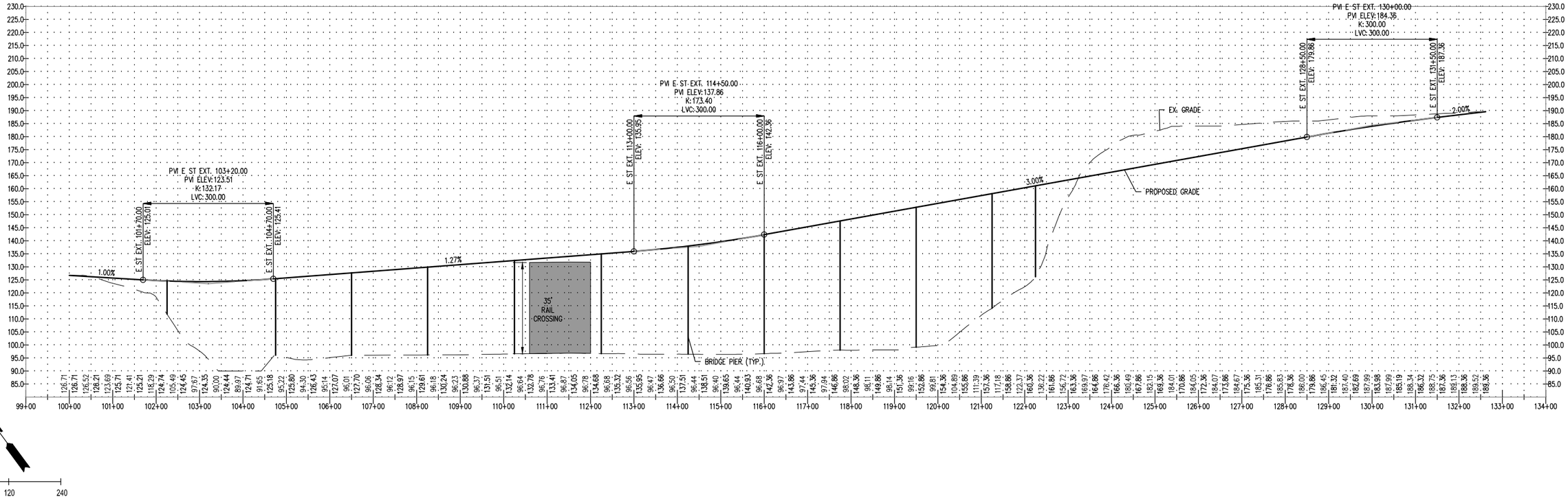

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CITY OF TUMWATER - E STREET EXTENSION

E STREET CONCEPTUAL PLAN AND PROFILE - ALTERNATIVE 2

EXHIBIT No: **EX2**

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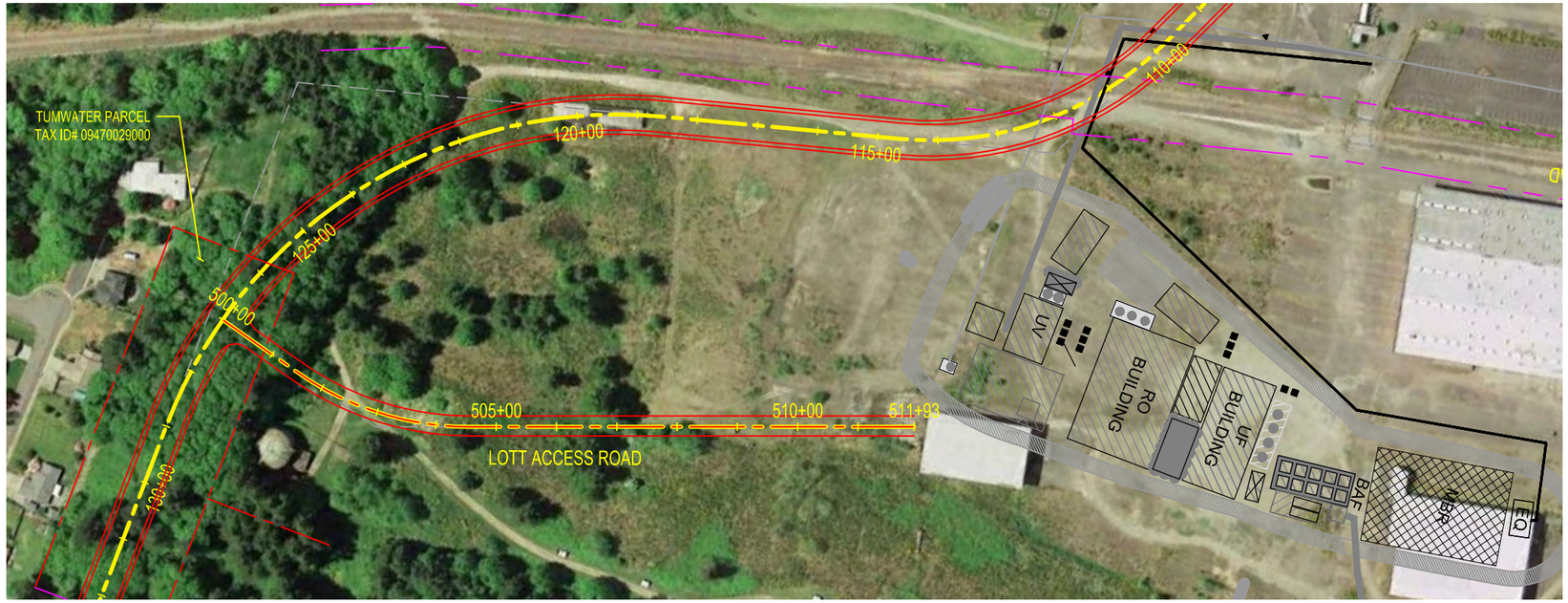

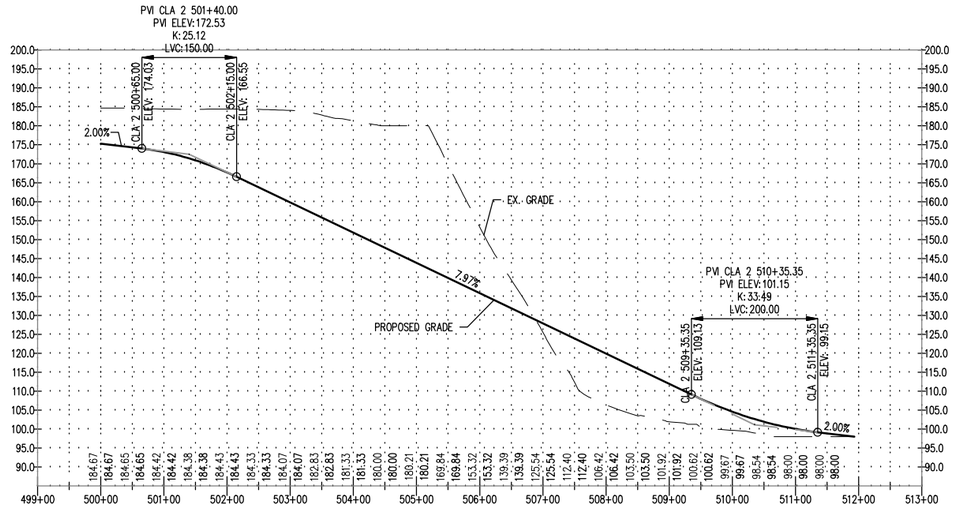

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DATE:	JUNE 2015
JOB No.:	0625.13
DRAWING FILE No.:	E STREET EX-2.dwg

CITY OF TUMWATER - E STREET EXTENSION

LOTT ACCESS ROAD CONCEPTUAL PLAN AND PROFILE - ALTERNATIVE 2

EXHIBIT No: EX4

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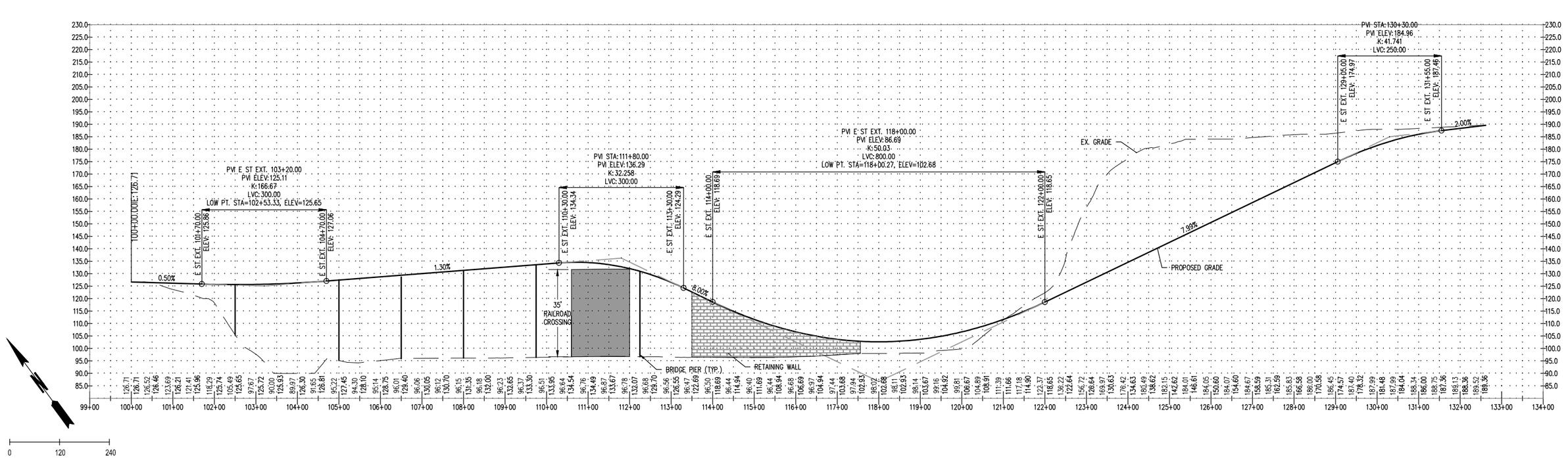

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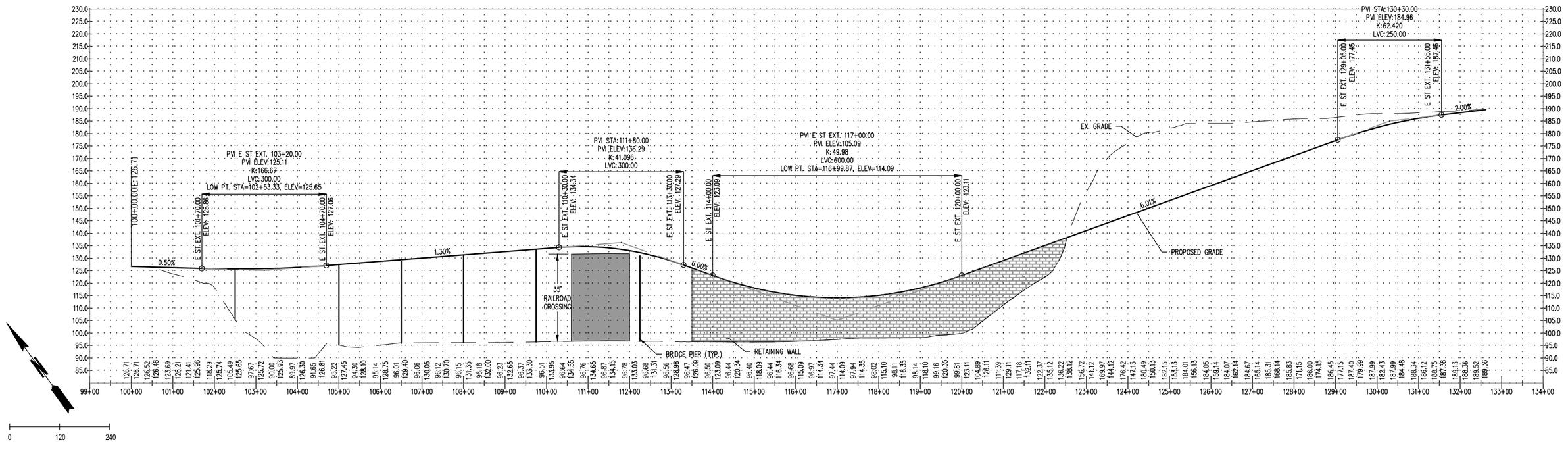
CITY OF TUMWATER - E STREET EXTENSION

E STREET CONCEPTUAL PLAN AND PROFILE - ALTERNATIVE 2a

EXHIBIT No: **EX2A**

SHEET No: **5**



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HORIZONTAL SCALE:	AS SHOWN
DATE:	SEPTEMBER 2015
JOB No.:	0625.13
DRAWING FILE No.:	E STREET EX-2a.dwg

CITY OF TUMWATER - E STREET EXTENSION

E STREET CONCEPTUAL PLAN AND PROFILE - ALTERNATIVE 2b

EXHIBIT No: EX2B

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APPENDIX A.4 – FIELD RECON PHOTOS

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APPENDIX A.5 – FIELD SURVEY

Provided Digitally Only

APPENDIX A.6 – HYDROLOGY DATA

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Technical Memorandum

Date	June 18, 2014 Revision
To:	Jon Turk Brown and Caldwell
From:	Jack Bjork, P.E.
RE:	**Deschutes Valley Master Plan** **Geomorphic and Hydrologic Analyses**

1.0 Introduction and Purpose

The Lacey, Olympia, Tumwater, and Thurston County (LOTT) Clean Water Alliance and Brown and Caldwell have engaged Cardno for geomorphic and engineering services in support of the Deschutes Valley Master Plan (project). The project site includes several thousand feet of river channel and 17 acres of riverfront property located on the Deschutes River in Tumwater, Washington. The project site is located within property owned by the LOTT Clean Water Alliance on part of the former Olympia Brewery site (Figure 1-1).

The purpose of this memorandum is to provide a basic description of the river and known salmonid habitat concerns within the project site and describe the basic geomorphic processes and conditions as well as flow rates in the river.

Figure 1-1. Deschutes Valley and the project area.

2.0 Site Description

2.1 Hydrology

The Deschutes River watershed is made up of 143 streams totaling 256 linear miles. The basin begins at an elevation of 3,870 feet on Cougar Mountain and encompasses approximately 170 square miles of the Cascade foothills, draining to the north and west and ending at sea level at Capitol Lake in Olympia, Thurston County, Washington. The main stem of the Deschutes River flows 52 miles before reaching Capitol Lake and eventually the Budd Inlet of the Puget Sound.

The climate in the basin is characterized by cool, dry summers and mild, wet winters. Due to the varied relief within the watershed, temperature and precipitation vary with elevation, but overall temperatures average 60 to 70 degrees Fahrenheit in the summer and 30 to 40 degrees Fahrenheit in the winter. Precipitation within the basin falls primarily as rainfall with some snow at high elevations, resulting in peak flows during the winter months when heavier precipitation occurs. According to the U.S. Geological Survey (USGS), the average annual precipitation within the Deschutes River watershed is approximately 60.5 inches.

River flows have been measured at USGS gage No. 12080010 located on the E Street Bridge (1965-2013) and No. 12080000 located downstream of Tumwater Falls (1946-1964). The estimates and methodology for the for the 10-year recurrence interval (RI), 25-year RI, and 100-year RI peak flows are discussed in *Hydrology Report* (STARR 2013) and presented in the Federal Emergency Management Agency (FEMA) *Preliminary Flood Insurance Study* (2014). An error was discovered in December 2014 in the USGS estimate of the February 9, 1996 flood, the maximum of record. Therefore, the peak flow estimates presented in these reports needed to be reevaluated. Several peak flows after 1996 were then revised downward as a result. The resulting revisions of peak flow estimates are discussed in the Appendix C of this memo (STARR 2015). The conclusion was that the 100-year peak needed to be revised but smaller peaks did not.

Peak flow estimates for the smaller floods of 1.5- and 2-year peaks were determined by Cardno using a Log Pearson Type III statistical analysis computed by the software PeakFQ using annual peak flows from 1946 through 2013 for the E Street gage alone (Table 2-1). Results of this analysis are presented in Appendix D. The 1.5- year peak flow was used to determine the elevation of the proposed excavated floodplain bench on the site.

During the period of record, peak flows of 8,600 cubic feet per second (cfs) and 7,220 cfs were recorded on February 9, 1996, and January 8, 2009, respectively.

Table 2-1. Flood Flows at the Project Site

Recurrence Interval (years)	Peak Flow (cfs)	Source
1.5	3,566	This study
2	4,418	This study
10	7,475	STARR 2013/FEMA 2014
25	9,116	STARR 2013/FEMA 2014
100	10,144	STARR 2015

Typical flows are high during the winter and low in the late summer and early fall, as shown in Table 2-2. The minimum recorded flow was 76 cfs in 2003.

Table 2-2. Monthly Mean Flow (1945–2013) (cfs)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
788	745	611	483	312	203	132	106	105	159	506	720

2.2 Geology

The Deschutes River is separated into several geological and geomorphic domains. Tumwater Falls at river mile (RM) 2 and Deschutes Falls at RM 41 form natural geological breaks. Above Deschutes Falls, the river incises through weathered bedrock in steep valleys comprised of Tertiary volcanics: andesite, basalt, flow breccias, siltstones, and sandstones (Schuster 2005). Between the two falls (RM 2 to RM 41), the river flows through a glacial drift plain (Raines 2005). In the lower 15 RMs, the river flows through a post-glacial channel in unconsolidated sands and silts (known as the Tumwater Sands) that were deposited after glacial recession (Raines 2005). The alluvial valley is about 1,400 feet wide in the project site, which is directly upstream of Tumwater Falls. The bedrock of basalt and breccias of the Crescent Formation that constitute the narrow gorge at the falls also occur on the western side of the valley in the project area. The river flows through modern river alluvium and glacial outwash sands in the project area (Figure 2-1).

According to Chuck Denny, Tumwater Parks Director, the portion of the hillside east of the railroad tracks was excavated during the period 1968 to 1970 to be used as fill for the golf course to the south, which was a wetland. The excavated area can be seen in Figures 2-1 and 2-2.

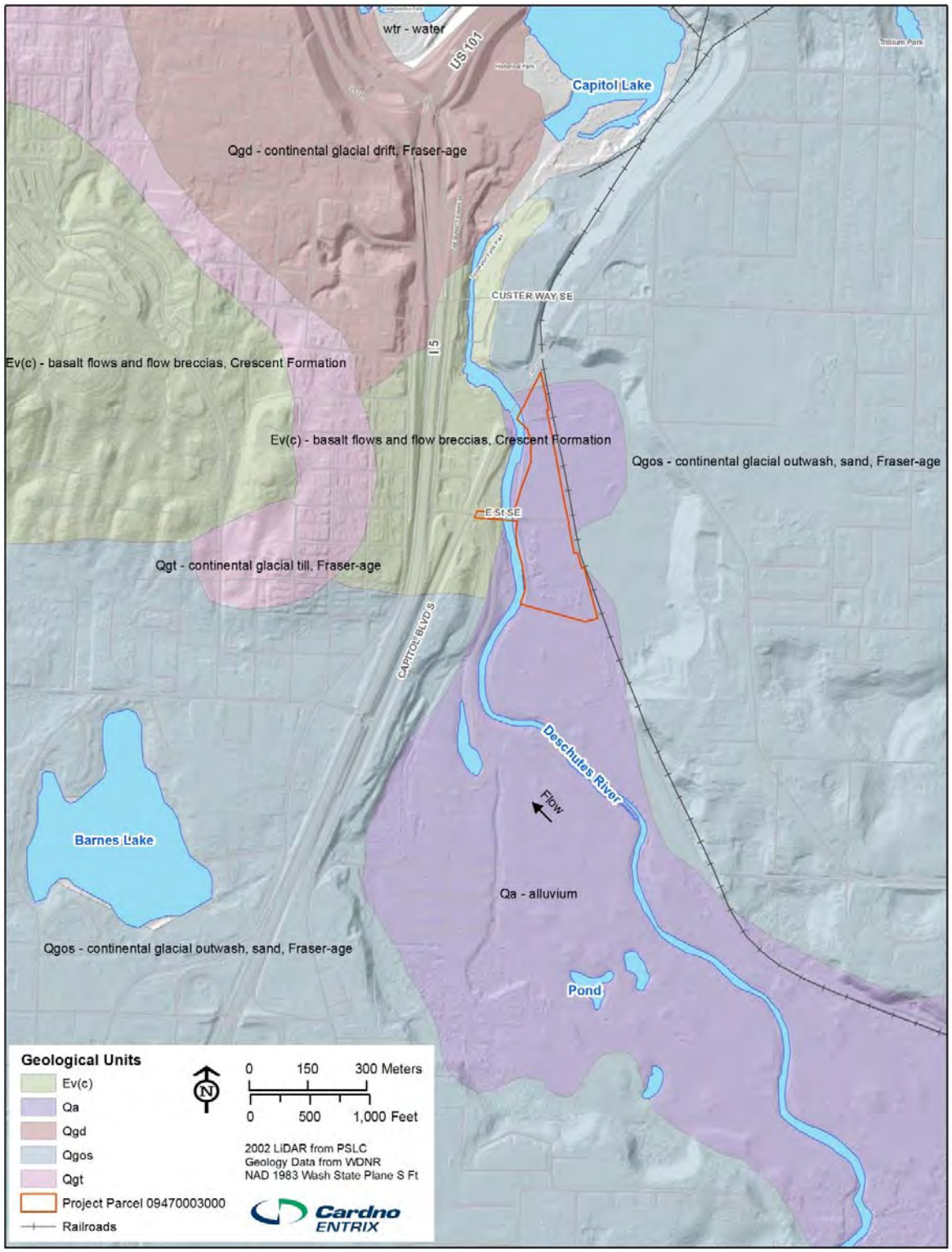

Figure 2-1. Geology of the project reach (Washington Department of Natural Resources 1:100,000 geological map).

2.3 Geomorphology and Soils

A rapid geomorphic assessment was completed to examine the processes shaping the environment in the project site. Geomorphic conditions in the study reach were examined using existing reports, topographic data, historical maps, and aerial photographs. Data sources included 2002 light detection and ranging (LiDAR) data from the Puget Sound LiDAR Consortium (PSLC), a General Land Office (GLO) survey plat map from 1854, and aerial photographs from 1968, 1956, and 1941 obtained through the USGS. The latter was georectified in ArcGIS with 2011 aerial photos from the U.S. Department of Agriculture National Agricultural Inventory Program (NAIP) with an error of 3 feet. The unvegetated channels from the 1854 plat map and 1941 and 2011 aerial photographs were digitized at a scale of 1:3,000 using ArcGIS.

The average unvegetated channel width (the area frequently disturbed by river flows) in the project site is approximately 60 feet, and the average valley width is about 1,400 feet. The valley was defined as the land surface no more than 10 feet above the channel elevation, which coincides with the clear slope break at the glacial terrace as seen in the LiDAR. The channel confinement (ratio of valley width to channel width) is low; there is little natural topographic restriction to channel movement other than the western valley bedrock. The channel gradient in the project site is 0.004 feet/feet and the river planform is single-thread meandering.

The project site is located in the former location of the Olympia Brewery. The brewery was established in 1896 at a site downstream of Tumwater Falls. The brewery operation began expansion into the upstream properties following the repeal of Prohibition in 1933 until about 1976 (Lorig Associates 2011). The operating brewery was closed in 2003.

The locations of the channel in 1854, 1941, and 2011 are shown in Figure 2-2, and this historical imagery is presented in Appendix A. The 1941 aerial was taken before development of the project site, and the Deschutes River can be seen to occupy more of the valley at that time. In the 1956 aerial, parts of the valley had been developed, and by 1968, the channel had been fixed into its current location (Figure 2-3). By the time of the 2002 LiDAR flight, the west margin of the alluvial valley had been altered by construction of Capitol Boulevard and Tumwater Valley Road SE (Figure 2-2). In a site reconnaissance on May 8, 2012, 1- to 2-foot riprap was observed on the banks along the project site. Site photographs are included in Appendix B.

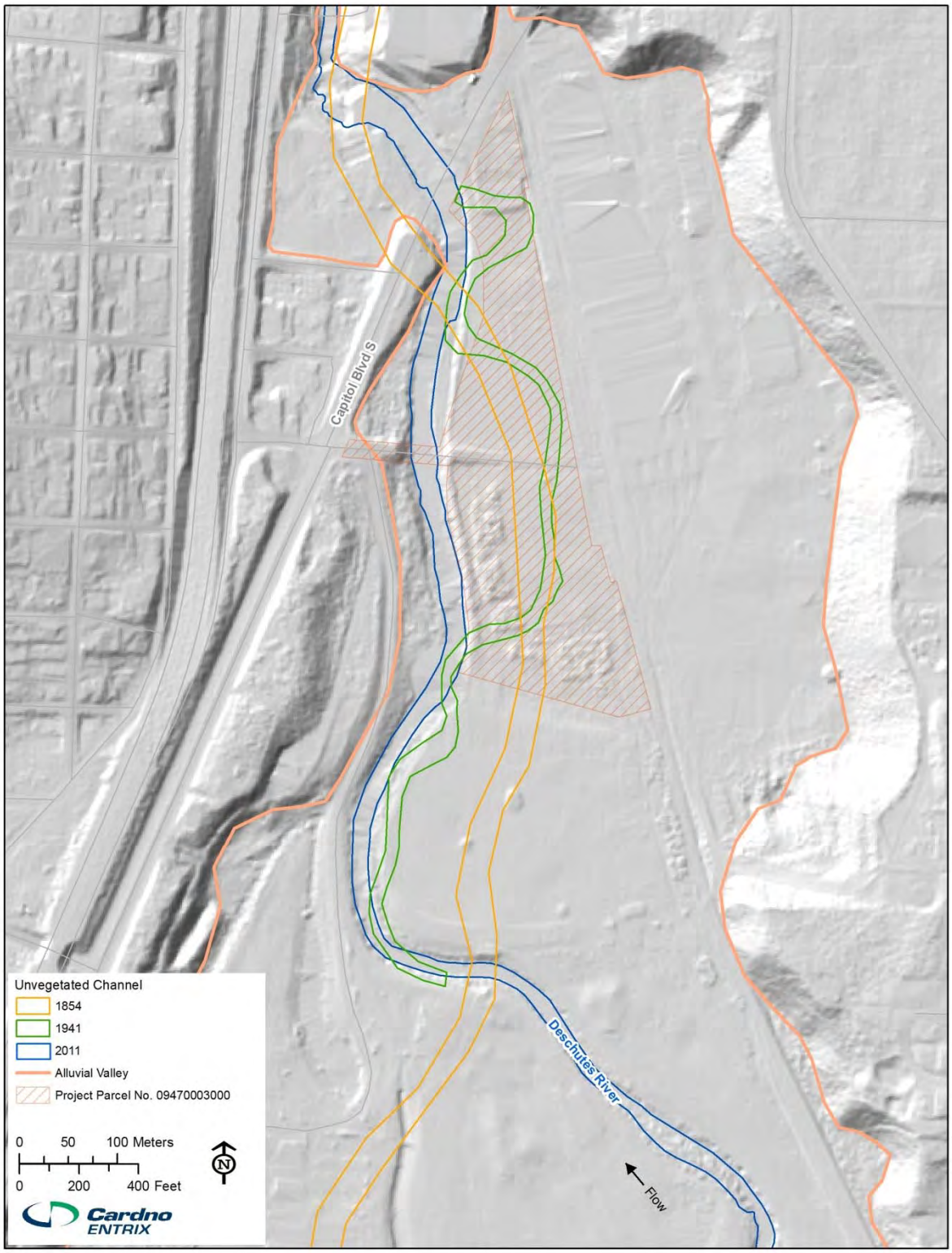

Figure 2-2. Unvegetated channel in the project site from 1854 to 2011.

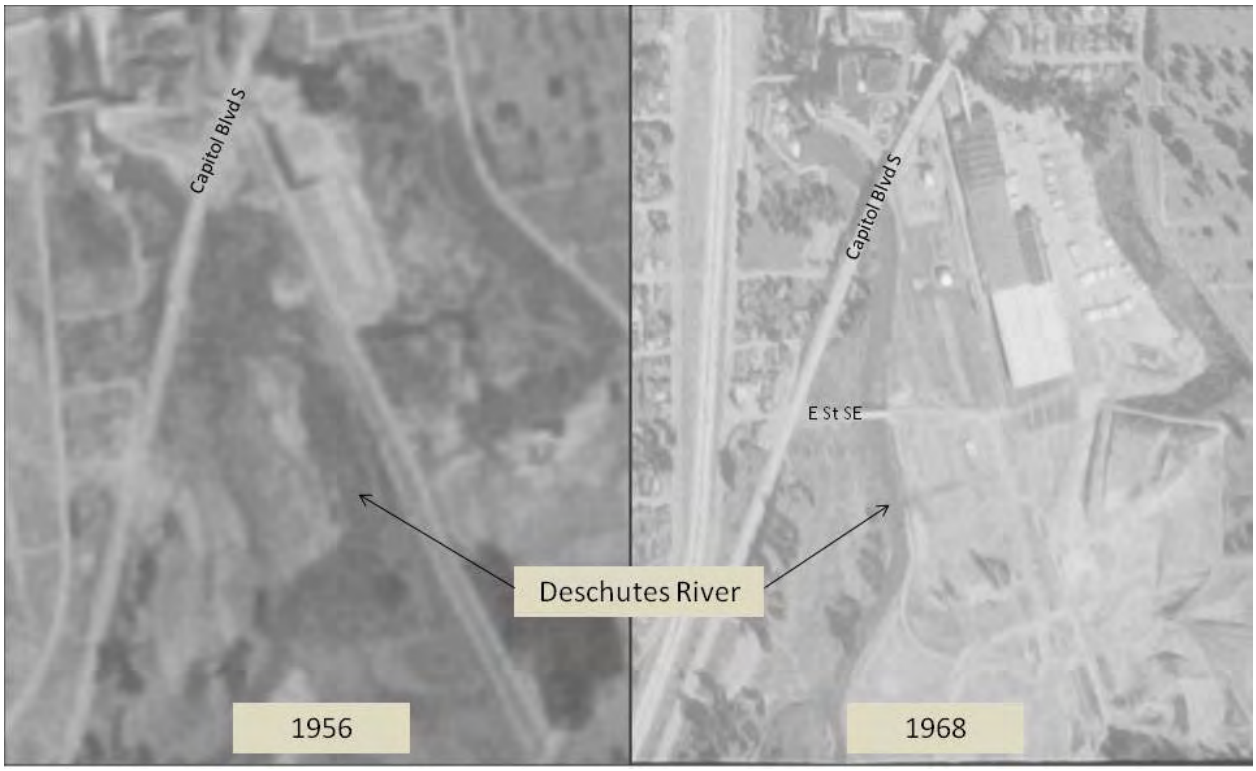

Figure 2-3. The project site in 1956 and 1968.

The soils of the project site are mapped as Puyallup silt loam with Indianola loamy sand at the alluvial valley walls beyond the project boundaries (Natural Resources Conservation Service [NRCS] 2012). The typical profile for Puyallup silt loam is silt loam underlain by layers of fine sandy loam and sand. It is generally well drained, but contains a minor Semiahmoo component that is considered a hydric soil that frequently ponds for long or very long durations (NRCS 2012). Contamination levels of the soils on the project site are not known.

2.4 Land Use

The primary land use in the upper basin is commercial forestry with residential properties and agricultural land located in the middle potion and urban development in the lower portion and within the project site. These activities have all resulted in clearing of riparian forests (Haring and Konovsky 1999). In addition, channelization of the river, armoring of the banks, and development in the floodplain have altered river conditions and reduced salmonid habitats (Haring and Konovsky 1999). The Thurston County survey of off-channel habitat (Taylor 1999) found that nearly the entire channel length had some form of bank modification, including armoring, clearing of vegetation, or trampling by grazing cattle. Juvenile salmonids, particularly coho (*Oncorhynchus kisutch*), use off-channel habitat for refugia from high flows, high temperatures, and predators (Taylor 1999).

Much of the Deschutes River floodplain forest has been cleared for timber harvest, agriculture, and urban development. The loss of floodplain forests has limited habitat-forming and sustaining processes in the Deschutes River system. Riparian vegetation serves a number of important ecological and geomorphic functions. Wood delivered by riparian forests can form snags and logjams that deflect flows and capture sediment. The large woody debris (LWD) introduced from riparian forests increases scour pool frequency, habitat complexity, shading of wetted areas, adult salmonid holding areas, spawning substrates, hyporheic flow connection, and floodplain connectivity (Abbe and Brooks 2011; Abbe and Montgomery 1996; Fetherston et al. 1995; Latterell 2005; Sedell and Froggatt 1984; Montgomery et al. 2003). Live vegetation increases bank strength through root cohesion and adds hydraulic

roughness to floodplains, while wood recruited to the river partitions shear stress (Abbe and Montgomery 1996; Abbe et al. 2003).

The estuary has also been highly modified by the creation of Capitol Lake in 1954. A dike and tide gate produced an artificial freshwater impoundment in the estuary, which historically had extended from the river outlet into Budd Inlet up to Tumwater Falls (Haring and Konovsky 1999). Because Capitol Lake was historically a narrow tidal basin, little natural flushing occurs and sediment drops out of river water as it fills the basin. Consequently, sedimentation of the lake requires continual management through dredging.

2.5 Limiting Factors for Salmonid Populations

Of the anadromous salmon that use the Deschutes River, two are listed under the Endangered Species Act (ESA)—the Puget Sound Chinook (*O. tshawytscha*) were listed as threatened in 1999 and steelhead (*O. mykiss*) were listed as threatened in 2007 (National Oceanic and Atmospheric Administration [NOAA] 2011). Coho salmon (*O. kisutch*) were listed as a species of concern in 2004. Anadromous salmonids did not have access to the river until 1954, when a fish ladder was installed at Tumwater Falls, a natural barrier at RM 2; today they utilize the river up to Deschutes Falls at RM 42 (Haring and Konovsky 1999). Although not native to this river, the reduction of salmonid habitat quality and quantity throughout the Puget Sound and the resulting decline in populations of Chinook, steelhead, and coho creates an imperative for enhancing all available habitat. Coastal cutthroat trout (*O. clarkii*) also occur in the Deschutes River watershed (Washington Department of Fish and Wildlife [WDFW] 2008).

The key limiting factors for salmon habitat in the Deschutes River above Capitol Lake as identified by Haring and Konovsky (1999) include the following:

- Fine sediment (grain size less than 0.85 millimeter, or silt), which is listed as an impairment under Section 303(d) of the Clean Water Act. Gravels in the Deschutes River regularly exceed the 12 percent limit of fine material for suitable spawning habitat. Fine sediments in streams interfere with salmonid spawning and respiration and can bury redds, fill in pools, and reduce penetration of light, this reducing productivity in the stream. The reach from RM 2.5 to 4.5, including the project site, was rated as poor for spawning suitability and success due to fine sediments in the substrate (Schuett-Hames and Child 1996 as quoted in Haring and Konovsky 1999).

- Lack of LWD, particularly the large key pieces that form stable logjams that are rare in the Deschutes River (Cramer 1997). Most of the project site lacked LWD on May 8, 2012.

- Significantly impaired riparian conditions due to loss of riparian vegetation. Riparian vegetation at the project site is currently displaced by asphalt and other infrastructure.

- Lack of off-channel habitat used by juvenile salmonids, particularly coho, for refugia from high flows, high temperatures, and predators (Taylor 1999). Only 11 percent of the 343 reaches surveyed by Cramer (1997) had high levels of off-channel rearing availability, while 17 percent had medium levels, and 72 percent had little or no off-channel rearing availability. Taylor identified no off-channel habitats in the project site (1999); however floodplain connection is not currently impeded geologically or from human modifications.

- Inadequate instream flows, for which the Deschutes River is listed as 303(d) impaired (Thurston County 2010).

- Elevated water temperatures in the summer due to loss of riparian cover and low flows, also resulting in a 303(d) listing (Thurston County 2010).

3.0 References

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APPENDIX A.7 – TERRAIN DATA

Provided Digitally Only

APPENDIX A.8 – USGS GAGE DATA

Provided Digitally Only

Appendix B – LANDUSE & ZONING SUMMARY

B.1 - DESCHUTES RIVER FLOOD REDUCTION STUDY - LITERATURE REVIEW AND PROJECT CONCEPTUALIZATION TASK

Stantec

LAND USE & ZONING SUMMARY

Deschutes River Flood Reduction Study

Literature Review and Project Conceptualization Task

TUMWATER, WASHINGTON

Prepared for:
City of Tumwater

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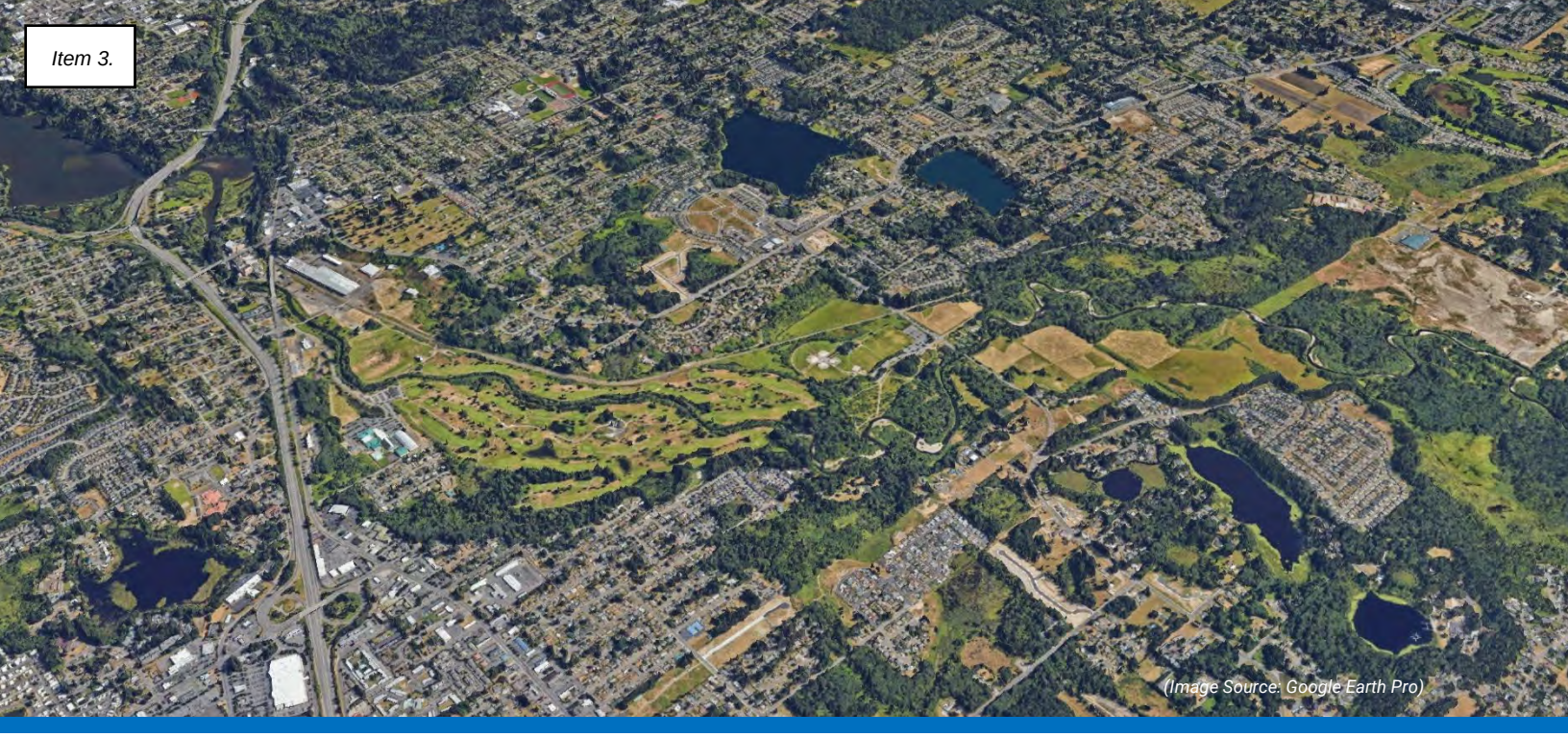


1.0 – Project Introduction

The purpose of this memorandum is to summarize the applicable zoning/land use standards and the long-range policy documents related to the Deschutes River Flood Reduction Study. Stantec Consulting Services, Inc. ("Stantec" herein) is conducting a drainage analysis for a segment of the Deschutes River to model flood conditions and to identify potential options (i.e., capital projects) that would reduce flooding impacts to the vicinity. The "Study Area" includes the Deschutes River and the properties along its shoreline between Custer Way and Rich Road in Tumwater and a small portion of unincorporated Thurston County (See Figure 1.0.1 for the Study Area Boundaries). Specifically, this information pertains to the *Literature Review and Project Conceptualization* task for the larger drainage study project.

This memorandum summarizes the land use/zoning standards and other local policies that guide how the properties within the Study Area can be used, developed, and/or modified. The City and other community stakeholders can use this information to guide decisions relating to potential flood mitigation strategies and/or redevelopment activities. Notably, this analysis reviewed the following regulatory/policy sources:

- City of Tumwater Comprehensive Plan
- Thurston County Comprehensive Plan
- City of Tumwater Municipal Code (Title 18 – Zoning) / Official Zoning Map
- Thurston County Code (Title 20: Zoning and Title 23: Olympia Urban Growth Area (UGA) / Official Zoning Map
- City of Tumwater Shoreline Master Program (SMP)
- City of Tumwater – Special plans and studies

Above: Aerial view of the Study Area and the surrounding context

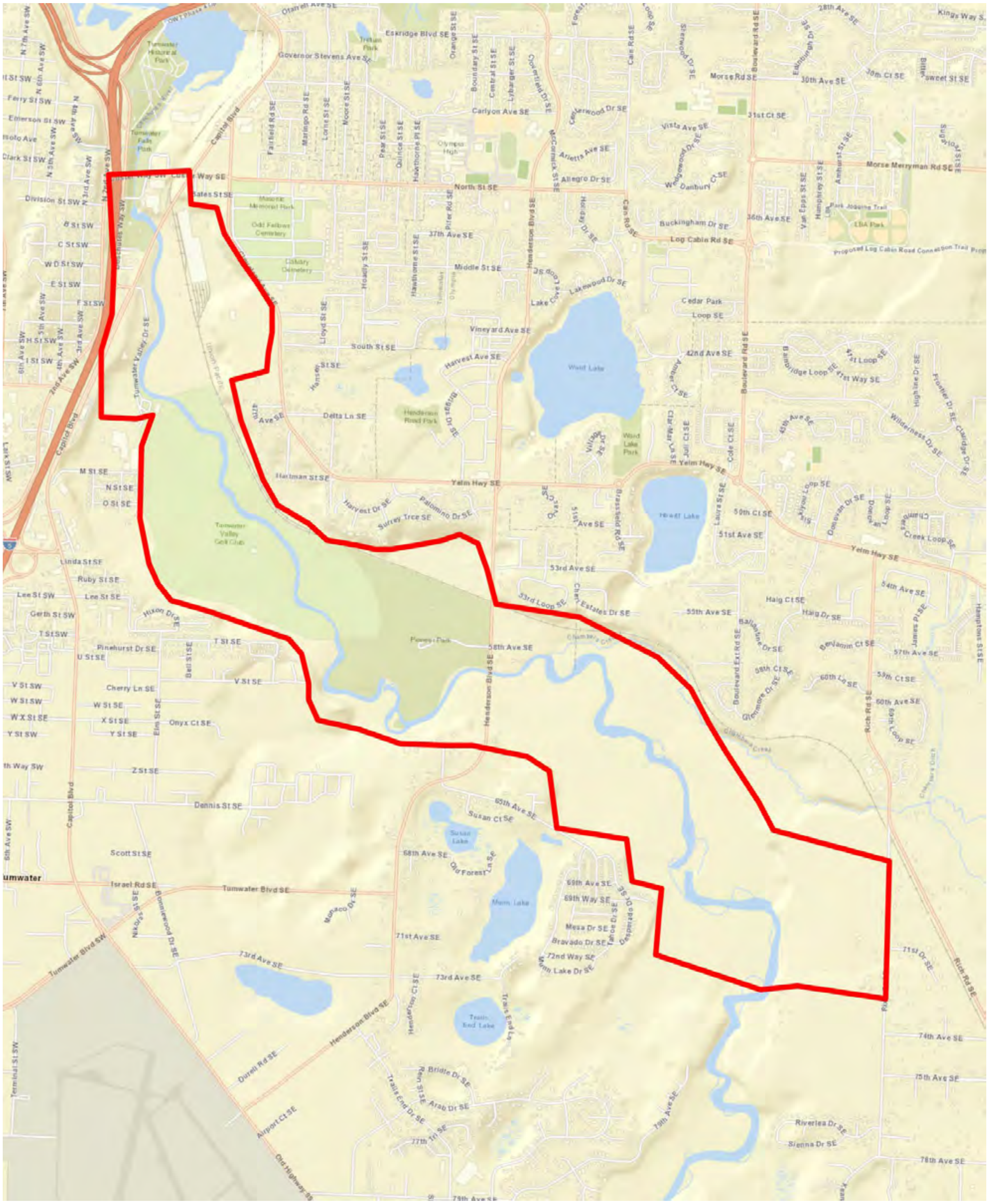


Figure 1.0.1 – Study Area

(Study Area delineated in red thick line – Source: ArcGIS)

2.0 – Comprehensive Plan

The City of Tumwater and Thurston County Comprehensive Plans are the primary policy documents that guide land use, transportation, conservation, economic development, public service, and utility-related decisions for the local jurisdictions. Specifically, each Comprehensive Plan includes a series of separate "elements" that focus on various topics. Each plan element includes analytical data for specific topics (e.g., land use, transportation, etc.) along with supportive goals and policies relating how the jurisdiction will address/manage those topics. Notably, each Comprehensive Plan includes a Land Use Element that describes the long-range needs to accommodate growth and land usage. These elements include a Land Use Map (or Future Land Use Map) that assign a land use designation to each property within the local jurisdiction. These land use designations identify (and regulate) which land use activities and development types can occur therein; these designations also guide which zoning designation can be assigned to those geographic areas. The Comprehensive Plans are implemented, in part, through the local jurisdictions' zoning and development codes (see Section 3.0 for more detail on the zoning requirements). The following subsections describe the land use designations for each jurisdiction and focused on the Study Area for the larger drainage study.

Above: Aerial view of the Study Area looking to the southeast (urbanized areas in foreground)

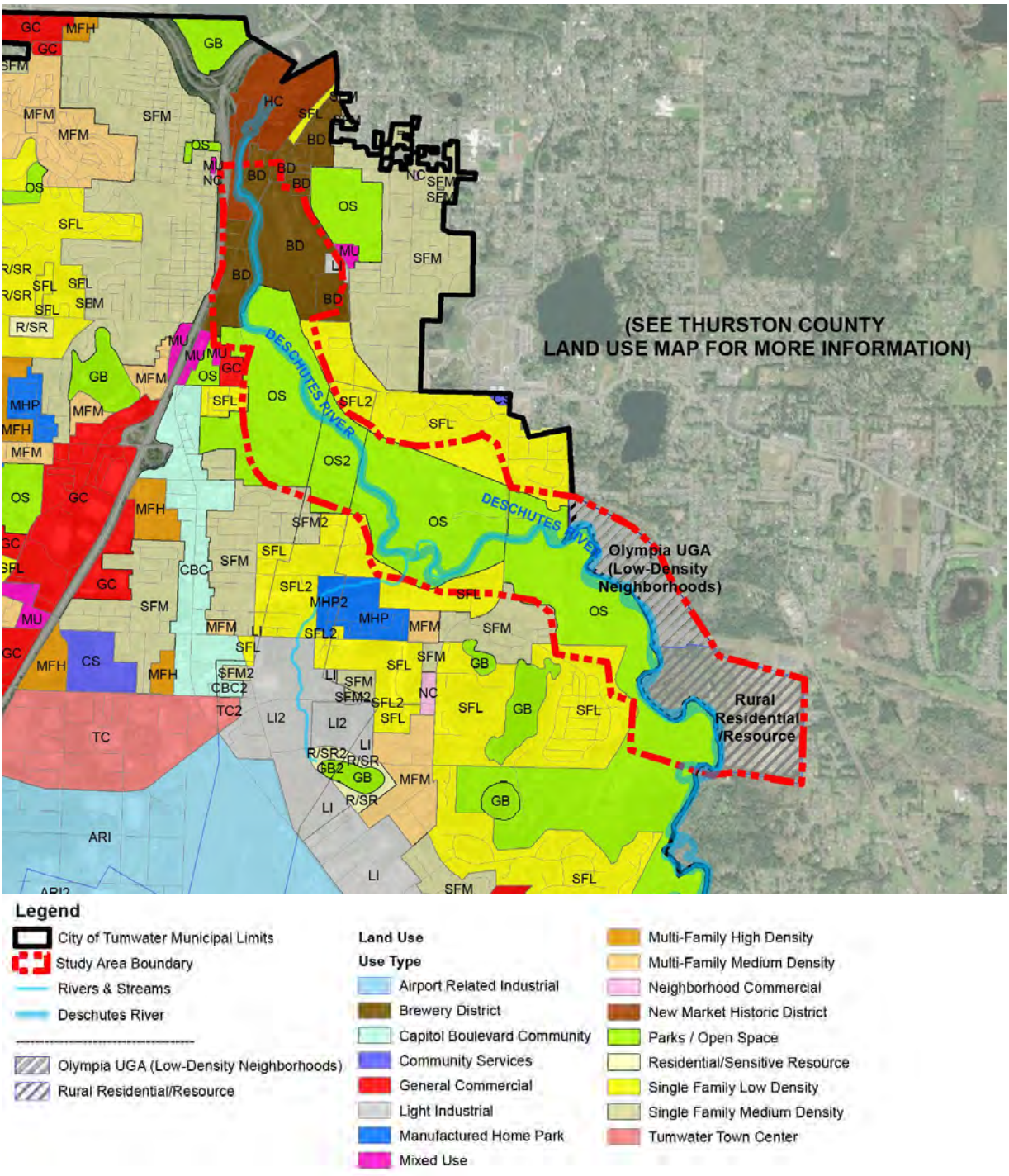


Figure 2.0.1 - Comprehensive Plan Map (combination of Tumwater, Thurston County & Olympia designations)

(Source: City of Tumwater and Thurston County GIS)

Tumwater City-Wide Land Use Map (Tumwater Municipal Limits)

The City-Wide Future Land Use Map represents the general future land use patterns that are desired for Tumwater within the 20-year planning period. The City-Wide Future Land Use Map (not to be confused with the Zoning Map) is meant to be used to evaluate individual land use proposals and is intended to be a guide for both public and private actions affecting the growth and development of Tumwater; the map indicates the type of future development that is desired for specific geographic areas, while allowing flexibility for previously approved development.

Tumwater land use designations that comprise the Study Area include: Parks/Open Space; Brewery District; Single Family Low Density; Single Family Medium Density; General Commercial; New Market Historic District; and Light Industrial. The following lists the Comprehensive Plan's descriptions for use land use designation

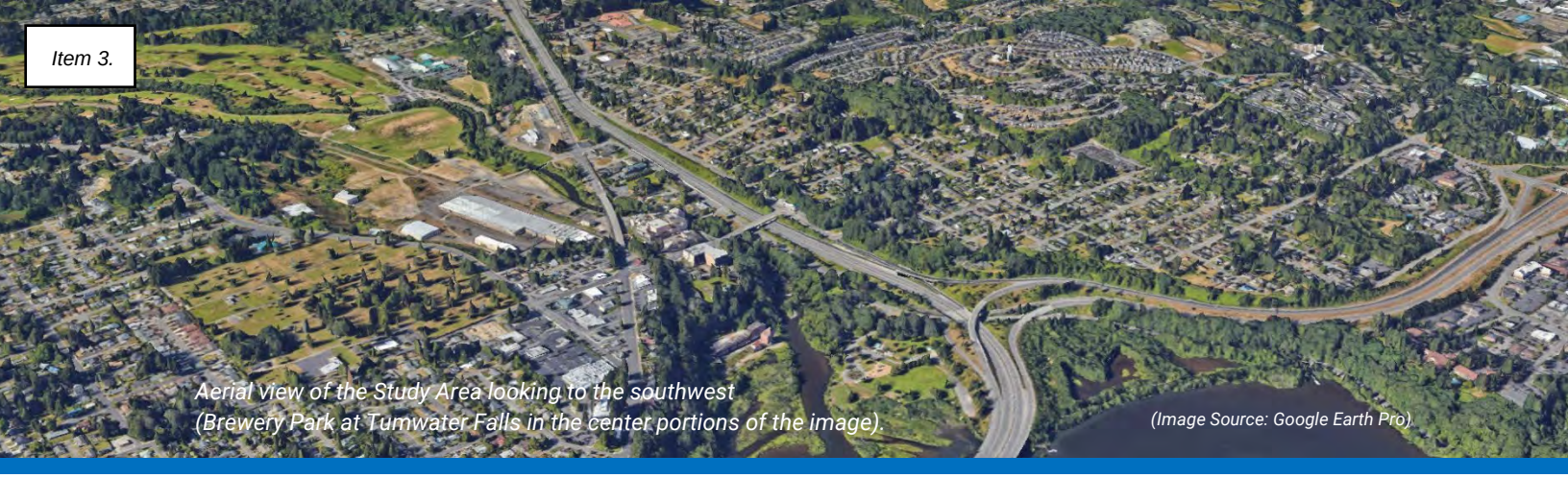
- **Parks and Open Space (OS)** - The Parks and Open Space designation accommodates public recreation, retains views and historical features, preserves land in a natural and open state, or provides for continuation of agricultural uses. Areas designated Parks and Open Space include developed active parks, privately operated parks, designated open space, flood plains, areas of steep slopes or other physical constraints, golf courses, delineated wetland areas and lakes not under shoreline jurisdiction, and watershed areas.
- **Brewery District (BD)** - The intent of the Brewery District land use designation is to create a lively, walkable, and economically vibrant multimodal neighborhood center with a mixture of housing and neighborhood-serving businesses The Brewery District designation is intended to foster development that creates a sense of place by establishing gathering places for residents and fostering a distinct District identity. This district is intended to expand economic opportunity and activity while improving the built environment through integration of the former brewery site. Matching zoning and special design guidelines must be referenced for new development or expansion in this area to support the above goals.
- **Single-Family Low Density (4-7 Dwelling Units/Acre) (SFM)** – Development density within this area designation should be averaged over the entire site in order to reach the maximum densities required to accommodate future population. Single-family dwellings and duplexes, clustering, and designated manufactured housing should be considered in this residential designation to protect sensitive areas yet still accommodate residential development - subject to Citywide Design Standards. Accessory units should be permitted in this designation within the permitted density on lots with sewer connections, except where the Health Department has approved septic systems.
- **Single-Family Medium Density (6-9 Dwelling Units/Acre) (SFM)** – Development density within this area designation should be averaged over the entire site to reach the maximum densities required to accommodate future population. These areas should permit innovative techniques such as small single-family housing with alleys and zero lot line or Z-lot developments, and alternate width lot housing. A mix of housing types such as duplexes and designated manufactured housing, clustering, and use of accessory units should be considered to accommodate stable residential development and provide affordable housing options.
- **General Commercial (GC)** – The aim of this area designation is to create a new commercial center for Tumwater while preserving space for commercial facilities near Interstate 5, and to minimize impacts on adjacent residential neighborhoods. Commercial development should be architecturally and functionally compatible with surrounding uses and the general character of the community. Mixed-use structures are encouraged here to provide affordable housing in a walkable area with access to public transit and community open space.

- **New Market Historic District (HC)** – This designation (also referred to in the Comprehensive Plan as Historic Commercial) includes the Tumwater Historical Park, the Tumwater Falls Park, and the site of the Old Tumwater Brewhouse on the east side of the Deschutes River. All development that occurs in the area designated Historic Commercial is subject to the standards and recommendations of the New Market Historic District Master Plan (adopted by City Council in 1993).
- **Light Industrial (LI)** –The purpose of the Light Industrial designation is to provide lands manufacturing, wholesale trade, and distribution activities that will attract new industries and expand existing ones while maintaining a high quality environment. Light industrial areas should have compatibility with surrounding non-industrial development and protect adjacent uses from noise, dust, odor, vibration, and air and water pollution. Light industrial areas need to be located within reasonable access to multiple transportation modes, as well as public sewer, water, and storm drainage.

Thurston County Future Land Use Map (Olympia UGA / Unincorporated Areas)

The eastern limits of the Study Area fall within unincorporated Thurston County and the City of Olympia Urban Growth Area (UGA); the UGA parcels are subject to the County's land use designations (in anticipation for future incorporation into the municipal limits). Those eastern most areas of the Study Area are designated as "Rural Residential/Resource" or "Olympia UGA – Low Density Neighborhoods". The following lists the descriptions of these land use designations.

- **Rural Residential/Resource (RRR 1/5)** – This purpose of this the RRR destinations is to maintain the rural character of the county, buffer environmentally sensitive areas and resource management areas from incompatible activities, and to maintain a balance between human uses and the natural environment. Primary land uses in the one unit per five-acre areas are resource-oriented (farming, forestry, mineral extraction), open space, and low density residential. Residential use may be limited due to physical land capability constraints, including the presence of critical areas. Innovative techniques are used by the County to provide a variety of rural densities within this designation.
- **Olympia Urban Growth Area (UGA)** – This designation is applied to certain properties that are within a designated UGA for an adjacent municipality (for the Study Area, there are parcels are designated as Olympia Urban Growth Area). Pursuant to the Comprehensive Plan, those areas within designated this UGA location are further regulated under the Olympia/Thurston County Joint Plan; for the Study Area, the draft Joint Plan future designates those lands as Low Density Neighborhoods (and subject to the City of Olympia Comprehensive Plan policies); the following lists the description for this designation.
    - **Low Density Neighborhoods** - This designation provides for low-density residential development, primarily single-family detached housing and low-rise multi-family housing, in densities ranging from twelve units per acre to one unit per five acres depending on environmental sensitivity of the area. Where environmental constraints are significant, to achieve minimum densities extraordinary clustering may be allowed when combined with environmental protection. Barring environmental constraints, densities of at least four units per acre should be achieved. Supportive land uses and other types of housing, including accessory dwelling units, townhomes and small apartment buildings, may be permitted. Specific zoning and densities are to be based on the unique characteristics of each area with special attention to stormwater drainage and aquatic habitat. Medium Density Neighborhood Centers are allowed in this designation.



Aerial view of the Study Area looking to the southwest (Brewery Park at Tumwater Falls in the center portions of the image).

(Image Source: Google Earth Pro)

3.0 – Zoning and Development Standards

The properties within the Study Area are subject to the zoning requirements of the jurisdictions in which they are located; notably, the majority of the Study Area is within the City of Tumwater while the far eastern limits are in unincorporated Thurston County. A property is subject to its zoning district's land use allowances/restrictions and development standards (e.g., minimum building setbacks, maximum building height, etc.). Additionally, each jurisdiction has additional development standards that apply to certain site components regardless of a property's zoning designation (e.g., parking areas, landscaping/buffering etc.). This section summarizes the applicable zoning and development standards for the properties within the Study Area.

Tumwater – The properties within the municipal limits are subject to the requirements and standards outlined in *Title 18 – Zoning Code* of the larger *Tumwater Municipal Code* (the "Code" or "TMC"). The code lists the land use allowances (whether permitted, allowed under a conditional use permit, or prohibited), and the associated development standards.

Unincorporated Thurston County – Properties within the unincorporated area are subject to the Thurston County Code and specifically *Title 20: Zoning* and *Title 23: Olympia Urban Growth Area (UGA)*. Notably, a few properties in the easternmost limits of the Study Area are within Olympia's UGA and the County's zoning regulations acknowledge and plan for this designation (long-term it is anticipated that these properties will eventually annex into the Olympia municipal limits).

Zoning Districts

The Study Area includes nine zoning districts and three overlay zones; most are City of Tumwater zones whereas others are associated with Thurston County. Each zoning district has a list of allowable land uses and includes development standards for projects therein. Notably, the BD (Brewery District Zone) includes several "subdistricts" with unique land use and development standards.

Overlay zones represent additional land designations aimed to protect critical natural resources, achieve land use compatibility, and/or achieve a specific local goal/policy – thus they impose additional allowances, restrictions, and standards. In some situations, a property has a zoning district and an overlay zoning designation – in those situations, land use/development activities are subject to both standards (the zoning district and the overlay zone).

The following subsections herein provide more detail on the associated land use and development standards for each zoning district and overlay zones. Figure 3.0.1 depicts the zoning designation for the Study Area and the surrounding vicinity (based on readily available public information). Figure 3.0.2 depicts the subdistricts comprising the larger BD zone (located on the western edges of the Study Area). The following tables (3.0.a and 3.0.b) list/describe the zoning districts and overlay zones comprising the Study Area.

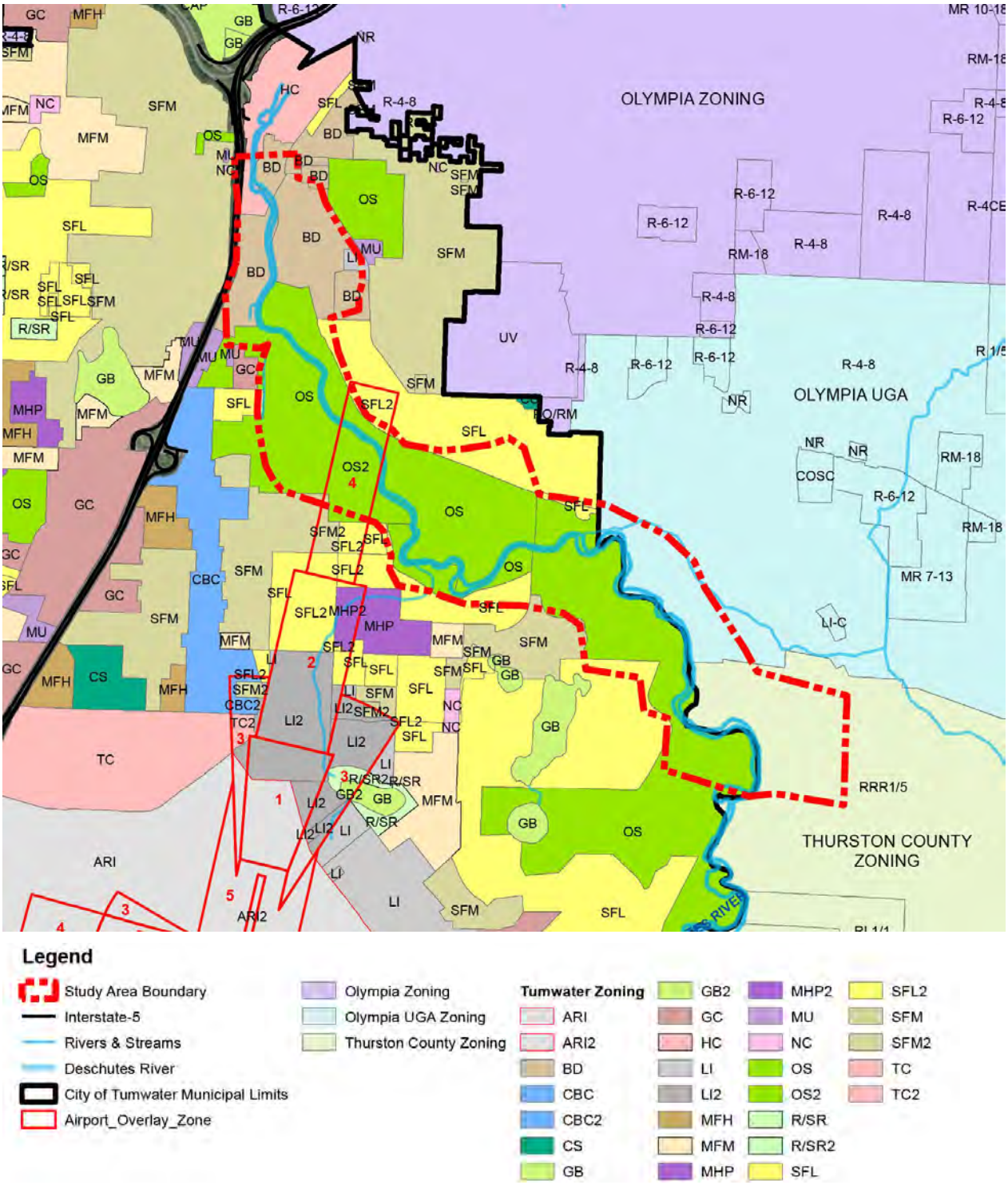


Figure 3.0.1 – Zoning Map

(Source: City of Tumwater, Thurston County, and City of Olympia GIS)

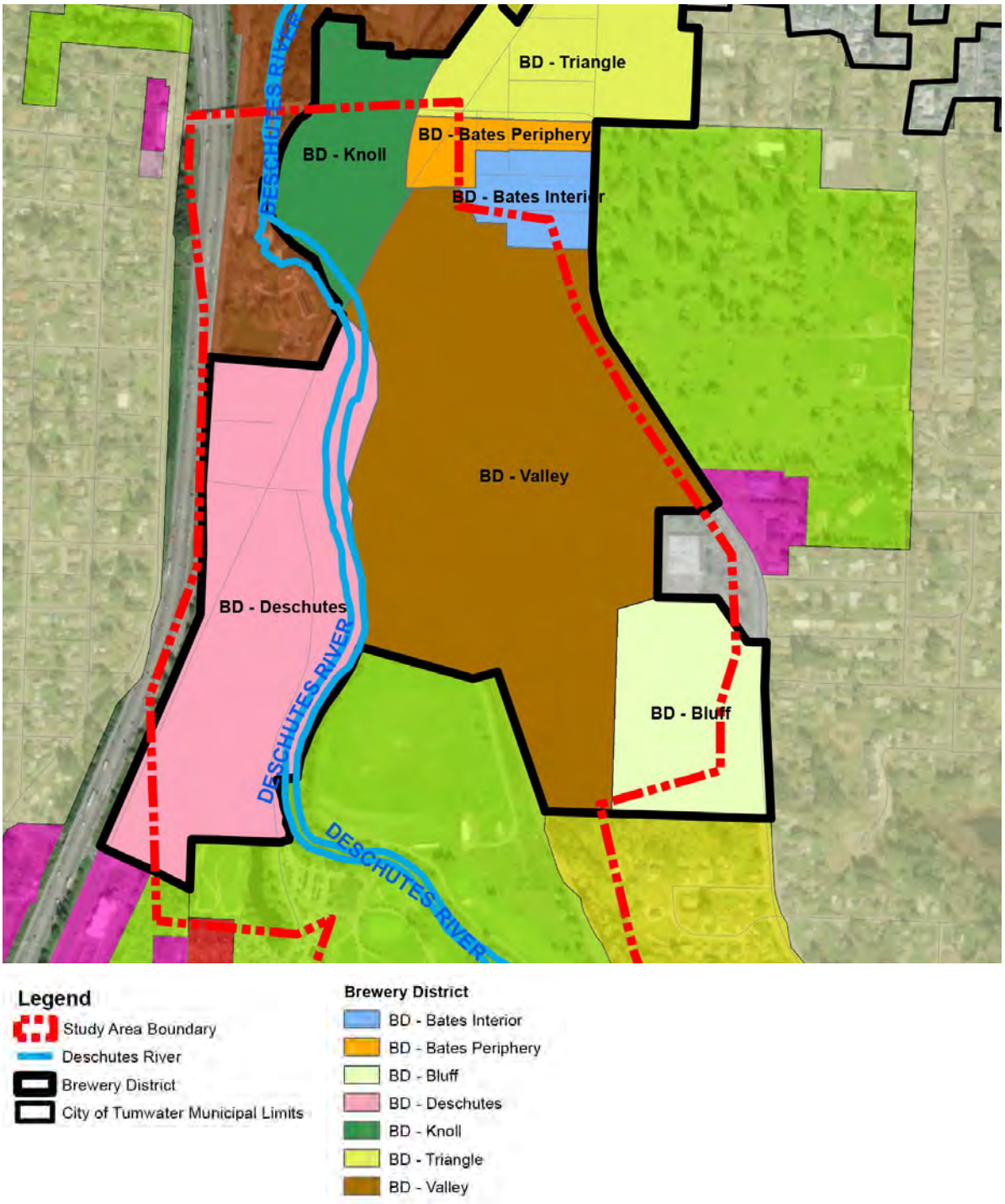


Figure 3.0.2 – Brewery District Zone (BD) Subdistricts Map

(Study Area covers portions of the BD zones as delineated in red dashed line; map shows the northern limits of the Study Area– Source: City of Tumwater Municipal Code)

Table 3.0.a – Zoning Districts in the Study Area	
Zone / Jurisdiction	***Description / Purpose***
BD – Brewery District (including subdistricts) City of Tumwater	The purpose of the brewery district zone (BD) is to provide design and development standards to transform the brewery district from a largely auto-oriented commercial node into a lively, walkable, and economically vibrant neighborhood center with a mixture of housing and neighborhood-serving businesses in accordance with the goals and objectives of the brewery district plan. Additionally, the BD zone is intended to provide for a mix of uses within the former brewery properties consistent with the city's economic development and strategic plans and the final report for the Community Visioning Project for the former Olympia Brewery. The BD zone consists of the following subdistricts: • **BD-Knoll**. The location overlooking the Deschutes River, with high visibility from the freeway and close proximity to the historic district, makes this a unique economic and community development opportunity. A mixture of uses is desirable to create a vibrant sense of place that appeals to pedestrians and creates a community focal point for Tumwater and the surrounding area. A broad mix of uses is allowed in this subdistrict, including but not limited to retail, personal and professional services, restaurants, educational, entertainment, lodging, and residential. • **BD-Valley**. Existing industrial buildings located adjacent to rail access make this area ideal for light industrial uses that do not create compatibility issues with other land uses, and for certain kinds of commercial uses that are most appropriately located as neighbors of industrial uses. • **BD-Bluff**. Vacant land overlooking the valley and near residential development to the south and east makes multifamily residential a possibility. A minimum net density of ten units per acre will apply to promote the efficient use of land and to provide a density pattern that will support public transit in the long term. • **BD-Triangle**. Given its proximity to surrounding residential neighborhoods and the former brewery properties, excellent transit service, and its visibility and access from I-5 and major urban corridors, the Triangle has the potential to transform into a highly pedestrianized neighborhood center with a broad mixture of uses, including medium-density housing and community-serving commercial uses. New development in the Triangle may be a mixture of single-use and mixed-use buildings up to five stories in height, and will provide active ground floors that engage the sidewalk (particularly along Cleveland Avenue "Main Street"). • **BD-Deschutes**. The Deschutes subdistrict benefits from excellent freeway access as well as high volumes of pass-by traffic (which may increase upon completion of the E Street Connection), and consequently this area may experience increased development pressure in the future. Given its relative isolation from surrounding residential areas and the remainder of the brewery district, new development in the Deschutes subdistrict will likely remain dependent upon automobile access for its success. Such new development may include a mixture of office and retail uses, as well as housing (which may be desirable adjacent to the park). Design and development standards for the Deschutes are intended to improve the character of development in this area and improve the appearance of this important gateway into the brewery district, with a focus on decreasing the visibility of surface parking areas and improving building frontage conditions along key rights-of-way. • **BD-Bates Neighborhood North.** Development located in the Bates Neighborhood North subdistrict will create a transition between the small-scale, residential character of development in the Bates Neighborhood South and the higher intensity

Table 3.0.a – Zoning Districts in the Study Area	
Zone / Jurisdiction	***Description / Purpose***
	commercial area in the Triangle and along Capitol Boulevard. Within the Bates Neighborhood North, buildings may provide commercial-style elements and site development patterns, including large ground floor windows, articulated architectural bays, and masonry facades, and may reach up to four stories in height. • **BD-Bates Neighborhood South**. New development in the Bates Neighborhood South will reflect and be compatible with the detached, single-family structures currently seen in this area. While uses within these structures may be commercial or residential, buildings in this area should continue to be residential in character, mirroring not only surrounding building heights, but also providing site development and building design elements (including setbacks, landscaping, building materials, and architectural elements) that are consistent with the surrounding residential character. New development in the Bates Neighborhood South will be limited to a maximum height of three stories.
GC – General Commercial City of Tumwater	The intent of the general commercial (GC) zone is to: • Provide for those commercial uses and activities which are dependent on convenient vehicular access. • Discourage extension of "strip" development by filling in available space in areas where substantial auto-oriented commercial development already exists. • Provide development standards which enhance efficient operation of these districts, and lead to more pedestrian and transit-oriented development. • Provide for a type, configuration, and density of development that will entice pedestrian shoppers to frequent the area, encourage pedestrian traffic between businesses, facilitate efficient mass transit, and require less reliance on automobiles within a business area. • Balance the needs of motorists and businesses serving a regional or community-wide market with the needs of pedestrians and neighborhood residents. • Integrate new development with existing uses to achieve a better environment for pedestrians and to maintain or enhance the livability of adjacent residential neighborhoods. • Encourage the provision of urban plazas and convenient access to transit stops.
HC – Historic Commercial City of Tumwater	The intent of the historic commercial zone is to recognize that Tumwater was the first American settlement on Puget Sound, and one of the industrial and commercial centers of Washington Territory, the historic commercial (HC) zone district is created to help preserve the character of the built environment of the Tumwater historic district as it once existed. Development in this district should be consistent with the goals and general land use plan set forth in the 1993 City of Tumwater New Market Historic District Master Plan (and as amended), thereby promoting the general welfare of the citizens of Tumwater and the economy of Tumwater by developing and maintaining the city's commerce and vacation/travel industry.
LI – Light Industrial City of Tumwater	The intent of the light industrial (LI) zone district is to establish and preserve areas for industrial and other uses of such a nature that they do not create serious problems of compatibility with other kinds of land uses; to make provisions for certain kinds of commercial uses which are most appropriately located as neighbors of industrial uses, or which are necessary to service immediate needs of people in these areas; to ensure that retail commercial areas are encouraged within one quarter mile of the 93rd Avenue/Interstate 5 intersection; to provide pedestrian and transit orientation in these

Table 3.0.a – Zoning Districts in the Study Area	
Zone / Jurisdiction	***Description / Purpose***
	commercial areas to provide an alternative to driving a private automobile; and to encourage the preservation and provision of open space in industrial areas to ensure a desirable quality of life.
OS – Open City of Tumwater	It is the intent of the open space (OS) zone district to: • Provide open space in Tumwater that is of an institutional nature such as parks for active and passive recreation, cemeteries and golf courses. • Provide opportunities for joint usage of facilities such as stormwater retention/detention ponds and conveyance facilities and wellfields. • Provide for the needs of the Tumwater community as those needs relate to open space and recreational facilities, whether publicly or privately sponsored. • Provide and protect parks, open space and other natural, physical assets of Tumwater in order to improve the aesthetic and functional features of the community. • Ensure the care, preservation and stewardship of open spaces in the city and urban growth area for future generations to enjoy. • Identify and preserve areas of historic significance.
SFL – Single-Family Low-Density Residential City of Tumwater	The intent of the single-family low density residential (SFL) zone district is to: • Preserve and establish peaceful low density neighborhoods in which owner-occupied single- family structures are the dominant form of dwelling unit; • Provide designated areas in which a minimum net density of four units per acre and a maximum net density of seven units per acre apply to promote the efficient use of land; • Guide residential development in such a manner as to encourage and plan for the availability of public services and community facilities such as utilities, police and fire protection, streets, schools, parks and recreation; • Encourage development of attractive residential areas that provide a sense of community, establish a pedestrian-friendly atmosphere and contain a variety of housing types; • Ensure that development without municipal utilities is at a density and in a configuration that enables cost effective urban density in-fill development when municipal utilities become available.
SFM – Single-Family Medium-Density Residential City of Tumwater	The intent of the single-family medium density residential (SFM) zone district is to: • Provide for a high standard of development for residential areas of moderate density in which single-family housing is the primary form of development; • Provide designated areas in which a minimum net density of six units per acre and a maximum net density of nine units per acre apply to promote the efficient use of land; • Guide residential development in such a manner as to encourage and plan for the availability of public services and community facilities such as utilities, police and fire protection, streets, schools, parks and recreation; • Encourage development of attractive residential areas that provide a sense of community, establish a pedestrian-friendly atmosphere and contain a variety of housing types;

Table 3.0.a – Zoning Districts in the Study Area	
Zone / Jurisdiction	***Description / Purpose***
	• Ensure that development without municipal utilities is at a density and in a configuration that enables cost effective urban density in-fill development when municipal utilities become available.
R-4-8 – Residential 4-8 Units Per Acre (Olympia UGA) Thurston County	The purpose of the R-4-8 zone is to accommodate single-family houses and townhouses at densities ranging from a minimum of four units per acre to a maximum of eight units per acre; to allow sufficient residential density to facilitate effective mass transit service; and to help maintain the character of established neighborhoods;
RRR1/5 – Rural Residential Resource 1 Unit Per 5 Acres Thurston County	The purpose of the RRR1/5 zone is to encourage residential development that maintains the county's rural character; provides opportunities for compatible agricultural, forestry and other rural land uses; is sensitive to the site's physical characteristics; provides greater opportunities for protecting sensitive environmental areas and creating open space corridors; enables efficient road and utility systems; and does not create demands for urban level services.

Table 3.0.b –Overlay Zones in the Study Area	
Zone / Jurisdiction	***Description / Purpose***
AP – Airport Overlay (Zone 4) City of Tumwater	The intent of the AP overlay zone district is to protect the viability of Olympia Regional Airport as a significant resource to the community by encouraging compatible land uses and densities, and reducing hazards that may endanger the lives and property of the public and aviation users. The airport (AP) overlay zone district identifies a series of compatible use zones designed to minimize such hazards. Zone 4 is the Outer Approach/Departure Zone.
FP – Floodplain Overlay Zone City of Tumwater	It is the purpose of FP overlay zone is to promote the public health, safety, and general welfare by managing development in order to: • Protect human life, health and property from the dangers of flooding; • Minimize the need for publicly funded and hazardous rescue efforts to save those who are isolated by flood waters; • Minimize expenditure of public money for costly flood damage repair and flood control projects; • Minimize disruption of commerce and governmental services; • Minimize damage to public facilities and utilities such as water and gas mains, electric, telephone and sewer lines, streets, and bridges located in the floodplain; • Maintain a stable tax base by providing for the sound use of flood prone areas so as to minimize future flood blight areas; • Encourage those who occupy areas subject to flooding and channel migration to assume responsibility for their actions; • Qualify the city of Tumwater for participation in the National Flood Insurance Program, thereby giving citizens and businesses the opportunity to purchase flood insurance;

Table 3.0.b –Overlay Zones in the Study Area	
Zone / Jurisdiction	***Description / Purpose***
	• Maintain the quality of water in rivers, streams, lakes, estuaries, and marine areas and their floodplains so as to protect public water supplies, areas of the public trust, and wildlife habitat protected by the Endangered Species Act; • Retain the natural channel, shoreline, and floodplain creation processes and other natural floodplain functions that protect, create, and maintain habitat for threatened and endangered species; • Prevent or minimize loss of hydraulic, geomorphic, and ecological functions of floodplains and stream channels.
AQP – Aquifer Protection Overlay Zone City of Tumwater	The intent of the aquifer protection (AQP) overlay zone district is to identify, classify, and protect vulnerable and/or critical aquifer recharge areas within the city and urban growth area. Protection is to be accomplished by controlling the use and handling of hazardous substances and uses of land that pose a threat to groundwater. This district imposes additional restrictions on development in order to protect public health and safety by preserving the existing and future groundwater supply for the city and urban growth area.

Development Standards

The following tables summarize the development standards for each zoning district in the Study Area; separate tables are provided for each zoning classification group (e.g., Nonresidential, residential, and the Brewery District). The tables describe the development standards in terms of lot configurations, density, setbacks, and building height (as applicable). Notably, the Open Space/OS zone covers most of the Study Area. The Brewery District /BD zone (at the far northwest edge of the Study Area) includes several subdistricts (those are listed on an independent table) and include additional design/architectural requirements (listed at the end of this subsection).

Table 3.0.c. – Zoning District Development Standards Summary (Mixed-use, Commercial, and Other Nonresidential Zones)				
Study Area Zoning Districts (City Tumwater)				
Standard	***OS (Open Space)***	***GC (General Commercial)***	***HC (Historic Commercial)***	***LI (Light Industrial)***
Site area minimum	*Unspecified*	None, except lot must provide for required parking, yards, and landscaping	None, except lot must provide for required parking, yards, and landscaping	None, except lot must provide for required parking, yards, and landscaping
Maximum impervious surface	Unspecified	85% of total area of the lot	None, except lot must provide for required parking, yards, and landscaping	85% of total area of the lot
Structure height maximum	Unspecified	65-feet (*provided structure does not penetrate imaginary airspace defined by 14 CFR Part 77)	Subject to approval by historic preservation commission	65-feet (*provided structure does not penetrate imaginary airspace defined by 14 CFR Part 77)

Table 3.0.c. – Zoning District Development Standards Summary (Mixed-use, Commercial, and Other Nonresidential Zones)

Study Area Zoning Districts (City Tumwater)				
Standard	***OS (Open Space)***	***GC (General Commercial)***	***HC (Historic Commercial)***	***LI (Light Industrial)***
Front yard setback minimum	Unspecified	None	None	20-feet minimum on all street frontages unless otherwise specified by the Tumwater Design Guidelines.
Side yard setback minimum	Unspecified	None	None	10-feet minimum (*In cases where sites share drive aisles and/or truck maneuvering areas, no side setback is required on the side where an aisle is shared)
Rear yard setback minimum	Unspecified	None	None	10-feet from property line (*In cases where sites share drive aisles and/or truck maneuvering areas, no rear setback is required on the side where an aisle is shared)
Setback requirement where adjacent to residential zoning district (single story structures)	Unspecified	20-feet minimum structural setback	None	20-feet minimum structural setback
Setback requirement where adjacent to residential zoning district (multi-story structures)	Unspecified	20-feet minimum structural setback for first story; setback of structure from adjacent property line(s) increases 10-feet for each story above ground level story and must be screened from view	None	20-feet minimum structural setback for first story (*For structures over 25-feet in height, setback of structure increases one foot for each additional foot in height above 25-feet and must be screened from view)

Table 3.0.d. – Zoning District Development Standards Summary (Residential Zones)				
Study Area Zoning Districts				
	City of Tumwater		***Thurston County***	
Standard	***SFL (Single Family Low Density)***	***SFM (Single Family Medium Density)***	***R-4-8 (Residential 4-8 Units Per Acre, Olympia Urban Growth Area)***	***RRR1/5 (Rural Residential/Resource 1 Unit Per 5 Acres)***
Minimum density	4 dwelling units per acre	6 dwelling units per acre	4 units per acre	Unspecified
Maximum density	7 dwelling units per acre	9 dwelling units per acre	8 units per acre	1 dwelling unit per 5 acres*
Minimum lot size	3,200 square feet	3,200 square feet	2,500 SF (cottage) 3,000 SF (townhouse) 4,000 SF (other)	5 acres
Maximum lot size	None	None	2,500 SF = cottage 3,000 SF average = townhouse 4,000 SF = other	Large lot—five acres or one-one hundred twenty-eighth of a section
Lot width minimum	50-feet (*except if alley is located adjacent to a side property line, then min. lot width 40-feet)	50-feet minimum (*except if alley is located adjacent to a side property line, then min. lot width 40-feet)	45' except: 35'= cottage 22' = 1-story townhouse 18' = 2-story townhouse	Unspecified
Maximum impervious surface	60% of total lot area	70% of total lot area	45% = 0.25 acre or less 40% = 0.26 acre or more 60% = townhouses	Unspecified
Maximum hard surface	Unspecified	Unspecified	55% = 0.25 acre or less 50% = 0.26 acre or more 70% = Townhouses	Green Cove Creek Drainage Basin: 45% or 10,000-sf (lots <4 acres); 6% (lots >4 acres)
Maximum building coverage	Unspecified	Unspecified	45% = 0.25 acre or less 40% = 0.26 acre or more	6,000 square feet (for parcels <10 acres); 20,000 square feet (for parcels >10 acres)
Structure height maximum	35-feet (*provided structure does not penetrate imaginary airspace defined by 14 CFR Part 77)	35-feet (*provided structure does not penetrate imaginary airspace defined by 14 CFR Part 77)	2 stories or 35', whichever is less, except: 16' for accessory buildings; 25' for cottage 35' on sites 1acre or more, if setbacks equal or exceed building height	35-feet (*except exempt structures)

Table 3.0.d. – Zoning District Development Standards Summary (Residential Zones)				
Study Area Zoning Districts				
	City of Tumwater		***Thurston County***	
Standard	***SFL (Single Family Low Density)***	***SFM (Single Family Medium Density)***	***R-4-8 (Residential 4-8 Units Per Acre, Olympia Urban Growth Area)***	***RRR1/5 (Rural Residential/Resource 1 Unit Per 5 Acres)***
Front setback minimum	10-feet minimum from frontage property line	10-feet minimum from frontage property line	20' except: 10' with side or rear parking; 10'for flag lots; 50' for agricultural buildings with farm animals	25'; 10' from right-of-way of a flanking street (for lots facing arterial/major roads); 20'; 10' from right-of-way of a flanking street (for lots facing collector/local roads)
Side setback minimum	5-feet from property line minimum (*may be reduced to zero if not abutting public or private street; reduced yard area must then be added to required setback on opposite side of site)	5-feet from property line minimum (*may be reduced to zero if not abutting public or private street; reduced yard area must then be added to required setback on opposite side of site)	5' except: 10' along flanking streets except garages shall be set back 20'; 6' on one side of zero lot; 3' for cottages; 50' for agricultural buildings with farm animals	Most Buildings: 5-feet Buildings housing animals: 35-feet
Rear setback minimum	20-feet from property line (*ADU's can be located 5-feet from property line) (*may be reduced to zero if not abutting public or private street; reduced yard area must then be added to required setback on opposite side of site)	20-feet from property line (*ADU's can be located 5-feet from property line) (*may be reduced to zero if not abutting public or private street; reduced yard area must then be added to required setback on opposite side of site)	20' except: 50' for agricultural buildings with farm animals; 10' for cottages and wedge-shaped lots	Most Buildings: 5-feet Buildings housing animals: 35-feet
Table Footnotes **(asterisk) indicates that specific exceptions exist for the development standard; the respective municipality's municipal code or code of ordinances should be reviewed for the full extent of these exceptions.*				

Table 3.0.e. – Zoning District Development Standards Summary (Brewery District Subdistrict)

	BD Subdistricts (City of Tumwater)						
Standard	***Knoll***	***Valley***	***Bluff***	***Triangle***	***Deschutes***	***Bates N***	***Bates S***
Maximum building height	75 feet (8)	50 feet (5) (9)	40 feet (10)	55 feet (11)	55 feet (12)	45 feet (13)	35 feet
Maximum lot coverage	None (1)	None (1)	None (1)	None (1)	None (1)	85%	75%
Minimum street-facing setback	None	20 feet	10 feet	5 feet along Cleveland Ave., otherwise no minimum (2)	5 feet facing Capitol Blvd.; no minimum for other streets	None	5 feet
Maximum street-facing setback	10 feet (2)	None	None	10 feet (2) (6)	No maximum facing Capitol Blvd.; 15 feet maximum for other streets (2)	10 feet (2)	10 feet (2)
Minimum side setback	None	10 feet	10 feet	None	None	5 feet	5 feet
Minimum rear setback	None	10 feet	10 feet	None	None	5 feet	5 feet
Minimum street-facing building frontage (3)	*Unspecified*	*Unspecified*	*Unspecified*	75% along Cleveland Ave., 50% along all other streets	50%	50%	50%
Minimum residential net density (4)	*Unspecified*	*Unspecified*	10 du/acre	20 du/acre	20 du/acre	20 du/acre	8 du/acre

Table Footnotes (figure references are on the TMC)

1. *Maximum attainable lot coverage subject to on-site parking requirements in TMC Chapter 18.50, minimum landscaping requirements in TMC Chapter 18.47 and in this chapter, minimum setback requirements, and on-site stormwater management requirements as described in the city of Tumwater drainage design and erosion control manual.*
2. *When maximum setbacks are provided, the setback area must be hardscaped and/or landscaped, in accordance with TMC 18.27.080(A)(2)(b) or 18.27.090(A)(3), whichever applies. Exceptions to the maximum street-facing setback may be granted to allow setbacks of existing buildings to be maintained including expansions of those buildings; to preserve mature tree stands; and to integrate publicly accessible site design elements that encourage pedestrian use and activity along the street. Such site design elements include but are not limited to building modulation, forecourts/plazas, covered or recessed building entryways, public art, seating areas and*

pedestrian-oriented signs. When maximum street-facing setbacks are increased for site design elements, the setback areas must be landscaped and/or paved pursuant to TMC 18.27.080(A)(2)(b) or 18.27.090(A)(3).

3. *See Figure 18.27.080.A.5 for illustration of street-facing building frontage requirement.*
4. *When residential uses are provided, either as a single development or as a component of a mixed use development. "du/acre" means dwelling units per acre.*
5. *Maximum height may be increased by ten feet for every fifty thousand square feet of the existing warehouse building that is removed, up to a maximum building height of eighty feet.*
6. *For the Sunset Campus, the maximum street-facing setback shall apply only to Capitol Boulevard.*
7. *Setbacks must meet minimum IBC setback requirements.*
8. *New mixed use or multifamily projects with a total of thirty or more dwelling units that provide thirty percent of those units as permanently affordable housing units in the Knoll subdistrict would be allowed an additional maximum building height increase of ten feet, subject to imaginary airspace surface limitations. This would create a new maximum height limit of eight-five feet in the Knoll subdistrict. Projects providing permanently affordable housing units by this method would have to meet the requirements of TMC 18.42.140.*
9. *New mixed use or multifamily projects with a total of thirty or more dwelling units that provide thirty percent of those units as permanently affordable housing units in the Valley subdistrict would be allowed an additional maximum building height increase of ten feet, subject to imaginary airspace surface limitations. This would create a new maximum height limit of sixty feet in the Valley subdistrict. Projects providing permanently affordable housing units by this method would have to meet the requirements of TMC 18.42.140.*
10. *New mixed use or multifamily projects with a total of thirty or more dwelling units that provide thirty percent of those units as permanently affordable housing units in the Bluff subdistrict would be allowed an additional maximum building height increase of ten feet, subject to imaginary airspace surface limitations. This would create a new maximum height limit of fifty feet in the Bluff subdistrict. Projects providing permanently affordable housing units by this method would have to meet the requirements of TMC 18.42.140.*
11. *New mixed use or multifamily projects with a total of thirty or more dwelling units that provide thirty percent of those units as permanently affordable housing units in the Triangle subdistrict would be allowed an additional maximum building height increase of ten feet, subject to imaginary airspace surface limitations. This would create a new maximum height limit of sixty-five feet in the Triangle subdistrict. Projects providing permanently affordable housing units by this method would have to meet the requirements of TMC 18.42.140.*
12. *New mixed use or multifamily projects with a total of thirty or more dwelling units that provide thirty percent of those units as permanently affordable housing units in the Deschutes subdistrict would be allowed an additional maximum building height increase of ten feet, subject to imaginary airspace surface limitations. This would create a new maximum height limit of sixty-five feet in the Deschutes subdistrict. Projects providing permanently affordable housing units by this method would have to meet the requirements of TMC 18.42.140.*
13. *New mixed use or multifamily projects with a total of thirty or more dwelling units that provide thirty percent of those units as permanently affordable housing units in the Bates Neighborhood North subdistrict would be allowed an additional maximum building height increase of ten feet, subject to imaginary airspace surface limitations. This would create a new maximum height limit of fifty-five feet in the Bates Neighborhood North subdistrict. Projects providing permanently affordable housing units by this method would have to meet the requirements of TMC 18.42.140.*

Overlay Zones

In addition to the development standards for each zone, properties that are within an overlay zone are applicable to additional requirements as summarized below (the land use allowances/restrictions for each overlay zone are summarized in the next subsection). The additional standards associated with each overlay zone are complex and exhaustive, see the Tumwater Municipal Code for a detailed list.

- **AP – Airport Overlay (Zone 4)** – Residential development in the AP is required to be clustered so that most residential lots are located as far away from the runway centerline as possible. The AP requires residential projects to be clustered in a manner that results in large open space areas. For nonresidential development, the AP places limits on occupancy as to reduce the number of individuals within the airport flight path; for the Study Area the AP (zone 4) limits occupancy to a maximum of one hundred thirty-five people per acre. The AP overlay boundaries are displayed on the zoning map – See Figure 3.0.1 near the beginning of this Section.
- **FP – Floodplain Overlay Zone** – Development within the FP overlay is subject to a long list of flood hazard and habitat protection standards. The list of requirements are site-specific and should be applied at the time of project design. In general, the FP overlay zone boundaries are defined by floodplain maps – See Figure 3.0.3. for the Floodway Overlay Map. See the Tumwater Municipal Code for specific requirements in the FP overlay zone.
- **AQP – Aquifer Protection Overlay Zone** – The AQP overlay restricts/prohibits certain high intensity land uses that could pose a threat to the community's drinking water. In summary, the AQP requires that projects demonstrate protective measures to guard against groundwater contamination – technical studies and engineering design are warranted. See Figure 3.0.4. for the AQP Overlay Map and the Tumwater Municipal Code for specific requirement in the AQP overlay zone.

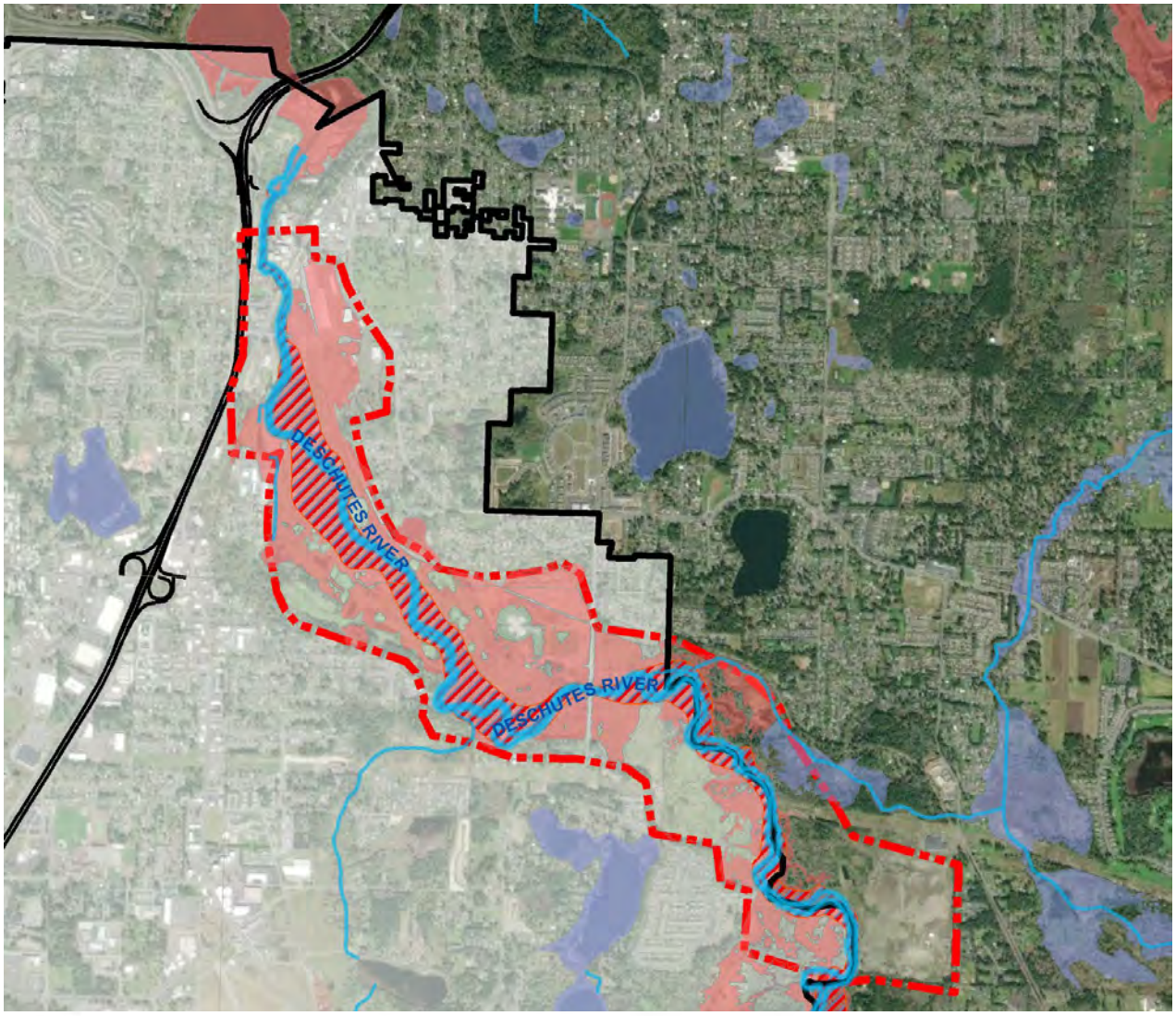
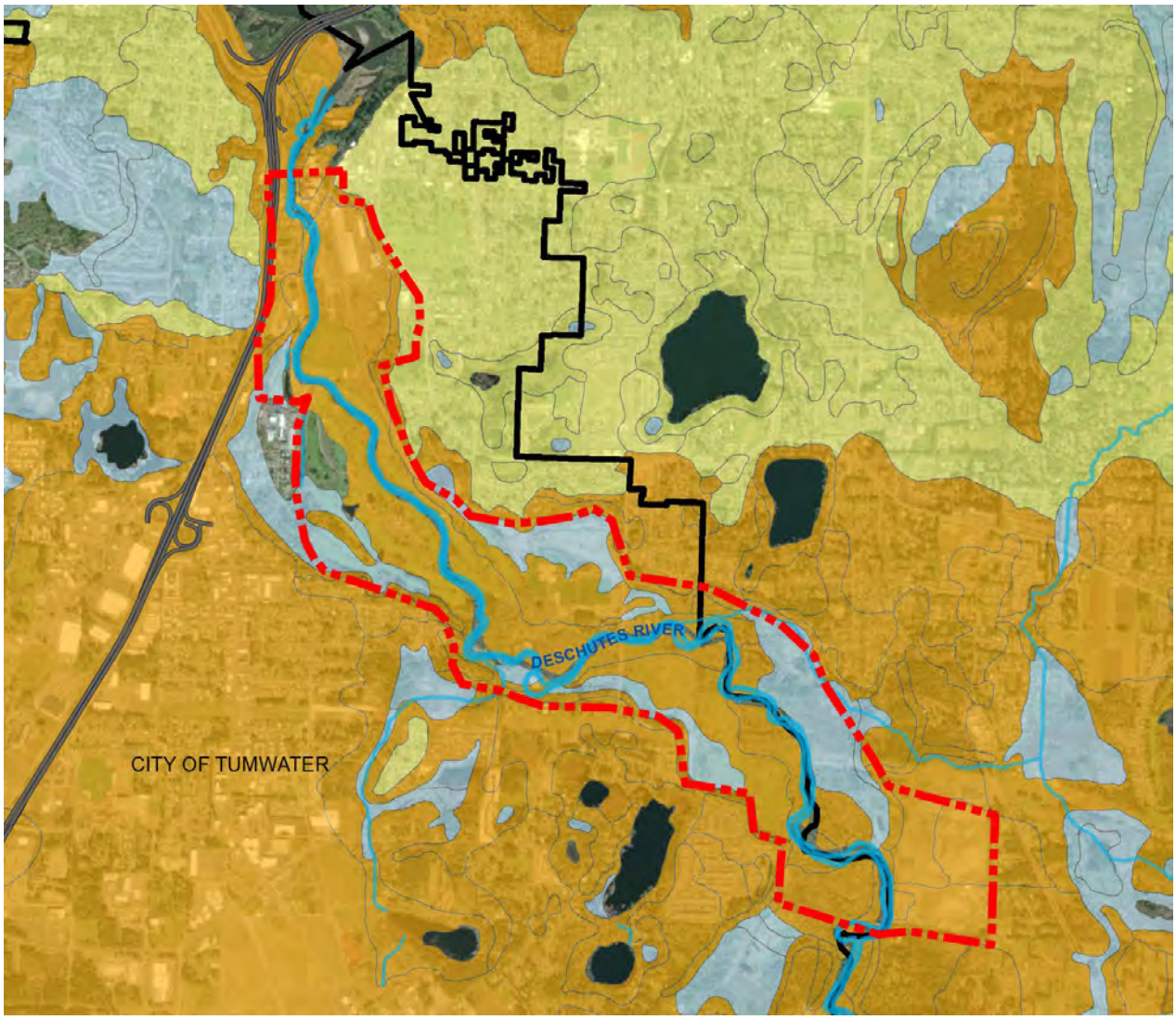


Figure 3.0.3 – Floodplain Overlay (FP) Map

Notes:

1. AE, A, and X are designated flood zones pursuant to the FEMA floodplain maps – specific elevation requirements are site specific and determined as the time of site design/feasibility analysis for individual properties
2. Properties in the Floodway, AE, and A flood zones are within Floodplain Overlay (FP) Zone.



Legend

- City of Tumwater Municipal Limits
- Study Area Boundary
- Interstate-5
- Rivers & Streams
- Deschutes River

Critical Aquifer Recharge Areas

Level

- Extreme
- High
- Moderate

DATA SOURCE: USDA Critical Aquifer Recharge Areas, Thurston County, accessed May of 2023

Figure 3.0.4 – Aquifer Protection Overlay Map

Brewery District Design and Architectural Standards

The BD zone includes a long list of design and architectural standards that are unique and specific to each of the subdistricts therein. In summary, these BD design/architectural standards aim to achieve a distinct walkable urban community with quality buildings and site layout; the BD zone (and its subdistricts) aim to guide reuse plans for the legacy brewery operations into new community-serving uses. These requirements are detailed and related to specific locations/land uses. For brevity, the following highlights the various design-related topics - see the Tumwater Municipal Code for specific requirements:

- Pedestrian Access
- Parks, Open Space, and Semi-public Outdoor Spaces
- Setbacks
- Building Design and Orientation
- Street Design / Site Access

Land Use Allowances

The following tables summarize the allowable land uses for each zoning district in the Study Area. The first table lists most of the zones in the Study Area, whereas the BD zone and its subdistricts are listed in the second table. For brevity, these tables represent a consolidated list to include only those uses that are generally applicable to the Study Area (See the City/County Codes for a full list of allowable land uses). The land use standards for the overlay zones are summarized at the end of this subsection. (Note: specific land use allowances/restrictions may apply in addition to the standard zoning district).

Uses listed as "P" are permitted (or allowed) in the zone/district subject to the City/County permitting requirements. In the City of Tumwater, uses listed as "C" may be allowed as a Conditional Use Permit subject to a public hearing before a Hearing Examiner. In the County, uses listed as "S" may be allowed as a Special Use Permit subject to a public hearing before the County's Hearing Examiner. The Examiner (in both jurisdictions) may choose to approve, approve with conditions, or deny these land use requests.

In most situations, applicants for a conditional use or special use permit must demonstrate compatibility with other properties/uses in the neighborhood. Blank boxes in the table indicate that the use is not allowed in the zone.

Table 3.0.f. – Land Use Allowances (not including the BD Zones)

P = Permitted Use; C = Conditional Use (Tumwater); S = Special Use Permit (Thurston County); A = Accessory Use; If the box is blank, the use is not allowed in that zone district.

	City of Tumwater Zones						***Thurston County Zones***	
Land Use / Activity	***GC***	***HC***	***LI***	***OS***	***SFL***	***SFM***	***R-4-8***	***RRR 1/5***
Adult family homes, residential care facilities	P	P		P*	P	P	S	S
Agriculture			P	P*	P	P	P	P
Animals (the housing, care and keeping of)					P	P	P	P
Attached wireless communication facilities	P	P	P		P	P	S	S
Bed and breakfasts					C*	C*	P	S
Camp facilities				P				S
Cemeteries			C	P*	C	C	S	S

Table 3.0.f. – Land Use Allowances (not including the BD Zones)

P = Permitted Use; C = Conditional Use (Tumwater); S = Special Use Permit (Thurston County); A = Accessory Use; If the box is blank, the use is not allowed in that zone district.

	City of Tumwater Zones						***Thurston County Zones***	
Land Use / Activity	***GC***	***HC***	***LI***	***OS***	***SFL***	***SFM***	***R-4-8***	***RRR 1/5***
Child day care center	P	P	P		C	C	S	S
Churches	P				C	C	S	S
Community garden	P	P	P	P	P	P	S	S
Cottage housing					P	P	P	P
Designated manufactured home parks								
Designated manufactured homes					P	P	P	
Duplexes					P*	P*		P
Emergency communication towers or antennas			C		C	C	S	S
Family child care home, child mini-day care center	P	P	P		P	P	P	P
Fourplexes								
Group foster homes	P				C	C	P/S*	S
Inpatient facilities	C							
Medical clinics or hospitals								
Mental health facilities	C						S	
Multifamily dwellings	P						P	
Multifamily dwellings (three or four stories)	P							
Manufactured home parks in accordance with the provisions of TMC Chapter 18.48								S
Mobile home parks which were legally established prior to July 1, 2008								S
Neighborhood community center					C	C	P	S
Neighborhood-oriented commercial center					C	C	P/S	S
Parks, trails, open space areas and recreational facilities	P	P	P	P	P	P	P/S	S
Permanent supportive housing	P	P		C*	P	P		S
Planned unit developments	P				P	P		
Private clubs and lodges	P					C	S	S
Recreational vehicle parks	P						S	
Schools	C*	P			C	C	S	S
Senior housing facilities, assisted	P							S
Senior housing facilities, independent	P							S
Single-family detached dwellings					P	P	P	P
Single-family detached dwellings existing prior to April 15, 2021							P	P

Table 3.0.f. – Land Use Allowances (not including the BD Zones)

P = Permitted Use; C = Conditional Use (Tumwater); S = Special Use Permit (Thurston County); A = Accessory Use; If the box is blank, the use is not allowed in that zone district.

	City of Tumwater Zones						***Thurston County Zones***	
Land Use / Activity	***GC***	***HC***	***LI***	***OS***	***SFL***	***SFM***	***R-4-8***	***RRR 1/5***
Support facilities	P	P		P	P	P	S	S
Temporary expansions of schools, such as portable classrooms	P	P	P		C	C	S	S
Townhouses and rowhouses						P*	P	
Transitional housing	P	P		C*	P	P		S
Triplexes								
Wildlife refuges and forest preserves		P	P	P	P	P	P/S	S
Wireless communication towers			P		C	C	S	S
Animal clinics or hospitals	P		P				P	S
Appliance equipment repair/sales	P							S
Auto repair facility	P		P					
Automobile service stations	P		P					
Breweries, wineries, distilleries	P	P	P					S
Centers for senior citizens, youth, general community and similar groups	P	P					P	S
Civic center complex	P						P	S
Community center							P	S
Convalescent centers, rest homes, nursing homes	P						S	
Crematories			P					
Dance clubs								
Electric vehicle infrastructure	P	P	P					S
Emergency housing	P	P					P	S
Emergency shelter	P	P					P	S
Entertainment facility	P							
Equipment rental and sales facility	P		P					S
Existing uses, legally established prior to adoption		P					P	
Farmers markets	P	P	P	P			P/S	S
Fish hatcheries, associated appurtenances, and related interpretive centers		P		P				S
Food truck or trailer courts	P	P	P					S
Food trucks or trailers	P	P	P	P				S
Freestanding wireless communication facilities	C						S	S
Golf courses				P			S	S
High-rise residential (five stories or more)	C							

Table 3.0.f. – Land Use Allowances (not including the BD Zones)

P = Permitted Use; C = Conditional Use (Tumwater); S = Special Use Permit (Thurston County); A = Accessory Use; If the box is blank, the use is not allowed in that zone district.

	City of Tumwater Zones						***Thurston County Zones***	
Land Use / Activity	***GC***	***HC***	***LI***	***OS***	***SFL***	***SFM***	***R-4-8***	***RRR 1/5***
Hotel/motel and conference facilities								S
Kennels	C		P				S	S
Library, museum, art gallery	P	P					S	
Manufacturing, assembly, processing and/or fabrication activities entirely within a building and ancillary to primary office use (less than 25 percent of building)								S
Marijuana retailer	P		P					
Mini-storage	C		P					
Mixed use structures	P							
Motels, hotels	P	P						S
Motor vehicle sales facilities	P		P					
Nurseries, retail	P		P				S	S
Offices	P	P	P					
Optometry clinics	P	P	P					
Parcel delivery facility							S	
Park and ride lots	P		P					
Parking lots, parking structures	P	P						
Personal services	P	P						S
Post office	P	P					S	S
Prisons, jails and other correctional facilities	C						S	S
Private post-secondary educational facilities	C							S
Professional services	P	P						
Residential uses				P/C *	P	P	P	P
Restaurants	P	P						S
Retail sales	P	P						S
Riding academies	P						S	S
Sewage treatment facilities								S
State educational facilities	C						S	S
Taverns, cocktail lounges	P	P						
Transit facilities			P				S	S
Transportation facilities, large scale state or regional	C		C				S	S
Transportation terminals	C		P				S	S
Used motor oil recycling collection point	P							S

Table 3.0.f. – Land Use Allowances (not including the BD Zones)

P = Permitted Use; C = Conditional Use (Tumwater); S = Special Use Permit (Thurston County); A = Accessory Use; If the box is blank, the use is not allowed in that zone district.

	City of Tumwater Zones						***Thurston County Zones***	
Land Use / Activity	***GC***	***HC***	***LI***	***OS***	***SFL***	***SFM***	***R-4-8***	***RRR 1/5***
Wholesaling, manufacturing, assembling, repairing, fabricating, or other handling of products and equipment entirely within a building		P	P					
Warehouse distribution centers		P						
Warehouses, nondistribution		P						S

Table Footnotes:

*(asterisk) indicates specific conditions exist for the allowance designation of a land use/activity such as the latest date a development had to have been constructed in order to occupy the zoning district; the respective municipality's municipal code or code of ordinances should be reviewed for the specific details of the condition(s).

Table 3.0.e Brewery District (BD) Zoning District Uses

P = Permitted Use; C = Conditional Use; A = Accessory Use; If the box is shaded, the use is not allowed in that zone district.

	City of Tumwater Brewery District Subdistricts						
Land Use / Activity	***Triangle (1)***	***Deschutes***	***Bates N***	***Bates S***	***Knoll (7)***	***Valley***	***Bluff***
Accessory dwelling units	A	A	A	A	A	A	A
Accessory wireless communication antenna (2)	A	A	A	A	A		A
Adult family homes, residential care facilities (13)	P	P	P	P	P	P	P
Agriculture, indoor						P	
All existing uses legally established prior to September 1, 2014, except where there is a cessation of the use for two or more years	P	P	P	P	P	P	P
Animal clinics or hospitals (6)	P	P	P	P	P	P	
Attached wireless communications facilities (3)	P	P	P	P	P	P	P
Bed and breakfasts	P	P	P	P	P		P
Breweries, wineries, distilleries	P	P			P	P	
Child day care centers; child mini-day care centers	P	P	P	P	P	P	P
Churches	C	C	C		C	P	C
Community Gardens	P	P	P	P	P	P	P

Table 3.0.e Brewery District (BD) Zoning District Uses

P = Permitted Use; C = Conditional Use; A = Accessory Use; If the box is shaded, the use is not allowed in that zone district.

	City of Tumwater Brewery District Subdistricts						
Land Use / Activity	***Triangle (1)***	***Deschutes***	***Bates N***	***Bates S***	***Knoll (7)***	***Valley***	***Bluff***
Convalescent center, rest home, nursing home	P	P	P	P	P		
Cottage housing	P	P		P			P
Electric vehicle infrastructure	P	P	P	P	P	P	P
Emergency housing (11) (12)	P/A	P/A			P/A		
Emergency shelter (11) (12)	P/A	P/A			P/A		
Energy systems	A	A	A	A	A	A	A
Entertainment facilities	P	P	P	P	P	P	
Family child care homes	P	P	P	P	P		P
Farmers markers	P	P	P	P	P	P	
Fish hatcheries, associated appurtenances and related interpretive centers						P	
Food truck or trailer courts (9)	P	P	P		P	P	
Food trucks or trailers (10)	P	P	P		P	P	
General offices	P	P	P	P	P	P	P
Group foster homes	P	P	P	P			
Home occupancies	P	P	P	P	P	P	P
Large scale state or regional transportation facilities (essential public facility)						C	
Medical clinics	P	P	P	P	P		
Motels, hotels	P	P			P		
Movie production; movie studio					P	P	
Museums, libraries, art galleries	P	P	P	P	P		
Noncommercial recreational structures associated with a residential use which include but are not limited to swimming pools and recreational ball courts	A	A	A	A	A	A	A
Off-street parking and loading	A	A	A	A	A	A	A
Optometry clinics	P	P	P	P	P	P	
Parking structures	P	P	P	P	P	P	P
Parks, open space areas and recreational facilities	P	P	P	P	P	P	P
Permanent supportive housing (11) (12)	P/A	P/A	P/A	P	P/A	P/A	P/A

Table 3.0.e Brewery District (BD) Zoning District Uses

P = Permitted Use; C = Conditional Use; A = Accessory Use; If the box is shaded, the use is not allowed in that zone district.

	City of Tumwater Brewery District Subdistricts						
Land Use / Activity	***Triangle (1)***	***Deschutes***	***Bates N***	***Bates S***	***Knoll (7)***	***Valley***	***Bluff***
Personal services	P	P	P	P	P	P	
Planned unit developments (PUD)	P	P	P	P	P	P	P
Post offices	P	P			P		
Private clubs and lodges	P	P	P		P	P	
Private garages and carports	A	A	A	A	A	A	A
Professional services	P	P	P	P	P	P	
Public parking lot as a primary use	P	P	P	P	P	P	
Residential	P	P	P	P	P	P	P
Restaurants, taverns, cocktail lounges, brew pubs and similar dining and drinking establishments	P	P	P	P	P	P	
Retail sales	P	P	P	P	P	P	
Schools	P	P			P	P	
Senior housing facilities, independent and assisted	P	P	P	P	P		
State education facilities (essential public facility)					C	C	
Storage sheds, toolsheds, greenhouses (8)	A	A	A	A	A	A	A
Support facilities	P	P	P	P	P	P	P
Temporary expansions of schools, such as portable classrooms	P	P			P	P	
Transitional housing (11) (12)	P/A	P/A	P/A	P	P/A	P/A	P/A
Transportation terminals	C						
Wholesaling, manufacturing, assembling, repairing, fabricating, nondistribution warehousing (4)						P	

Table Footnotes:

1. *Along the Cleveland Avenue Main Street, active ground floor uses are required in accordance with TMC 18.27.080(B)(1)(e).*
2. *Emergency communication antennas and wireless communication facilities are subject to Federal Aviation Administration (FAA) standards and approval, and furthermore both uses are subject to provisions for wireless communication facilities in TMC Chapter 11.20, Wireless Communication Facilities.*
3. *Antennas must be affixed to or erected upon existing buildings, water tanks or other existing structures. Antennas shall not be affixed to a wireless communication support structure. Emergency communication towers are not permitted.*
4. *Warehousing must be for product for use in or production resulting from on-site manufacturing, assembly, repair or fabrication.*

Table 3.0.e Brewery District (BD) Zoning District Uses

P = Permitted Use; C = Conditional Use; A = Accessory Use; If the box is shaded, the use is not allowed in that zone district.

	City of Tumwater Brewery District Subdistricts						
Land Use / Activity	**Triangle (1)**	**Deschutes**	**Bates N**	**Bates S**	**Knoll (7)**	**Valley**	**Bluff**

5. *Drive-through uses are prohibited in the Bates North and Bates South subdistricts. For all other subdistricts, drive-through uses are limited to espresso stands less than five hundred square feet in floor area, pharmacies, banks, credit unions, and the reuse of permitted drive-through facilities in existence as of the effective date of O2014-007 (September 1, 2014) for restaurant uses.*
6. *All animals must be kept at all times within a fully enclosed building with adequate controls so that animal noise and odor cannot be detected on adjoining property or in adjoining units with shared walls.*
7. *South of Custer Way, development must consist of two or more of the listed uses; provided, that each use shall occupy a minimum of twenty percent of the gross floor area of the project.*
8. *Buildings or structures for storage, a greenhouse, detached garage, or carport in the Bates South subdistrict accessory to a permitted use are subject to the provisions in TMC 18.42.015.*
9. *Food truck or trailer courts in accordance with TMC 18.42.120.*
10. *Food trucks or trailers in accordance with TMC 18.42.120.*
11. *Supportive housing facilities such as emergency housing, emergency shelters, permanent supportive housing, and transitional housing are subject to the requirements of TMC 18.42.150.*
12. *Supportive housing facilities such as emergency housing, emergency shelters, permanent supportive housing, and transitional housing are permitted as an accessory use only as part of a permitted church use. Such supportive housing facilities shall not exceed twenty percent of the total building square footage of a church use and are subject to the requirements of TMC 18.42.150.*
13. *Adult family homes and residential care facilities in accordance with TMC Chapter 18.53.*

Overlay Zones

In addition to the land use standards for each zone, properties that are within an overlay zone are applicable to additional allowances/restrictions as summarized below. The additional land use standards associated with each overlay zone may be complex based on the property and its physical characteristics, see the Tumwater Municipal Code for a detailed list.

- **AP – Airport Overlay (Zone 4)** – The following land uses are prohibited in the AP Zone 4 overlay: multifamily dwellings, schools, preschool/child care facilities, child day care centers; churches, hospitals, independent and assisted senior housing facilities, rest homes and group foster homes. Land uses that create excessive light, noise, dust, and electrical interference are also prohibited. Additionally, nonresidential uses are limited in capacity to one hundred thirty-five people per acre (see previous subsection related to development standards).
- **FP – Floodplain Overlay Zone** –FP overlay includes a long list of use-related standards/restrictions based on specific land uses/development activity. While most of the uses allowed in the underlying zoning district apply, the FP imposes additional restrictions. See the Tumwater Municipal Code.
- **AQP – Aquifer Protection Overlay Zone** – The AQP overlay prohibits certain high intensity land uses that could pose a threat to the community's drinking water. The following land uses/operational activities are prohibited in the AQP: (i) Chemical or hazardous material manufacture, processing, reprocessing, transfer, storage, and disposal; (ii) Creosote/asphalt manufacture or treatment; (iii) Electroplating activities; (iv) Manufacture of flammable or combustible liquids as defined in the current edition of the fire code; (v) Petroleum products refinery, including reprocessing; (vi) Wood products preserving; (vii) On- and off-site hazardous waste treatment and storage facilities (as defined by Chapter 173-303 WAC); and (viii) Landfills (municipal sanitary solid waste, hazardous waste, and wood waste as defined by WAC 173-304-100).

Parking Standards

New development projects and properties that are subject to a change of use, must provide for both motor vehicle parking and bicycle parking pursuant to the Tumwater Municipal Code or the Thurston County Code (based on the property's jurisdiction location). In most situations, the Codes require a minimum parking ratio (i.e., number of stalls) by land use. For brevity, the tables herein summarize the parking-related requirement and focus on the typical land uses that would be most conducive to the Study Area – see the City/County Codes for a complete list.

Table 3.0.f. – Motor Vehicle Parking Design Standards Summary

Subject	*City of Tumwater Standard*	*Thurston County Standard*
Off-Street Space (standard dimensions)	Standard Stall: 9-ft X 18-ft Compact Stall: 8-ft X 17-ft	Standard Stall: 9-ft X 18-ft
Aisle/Driveway width	22-feet minimum unobstructed width	21-feet (single-tier 90-degree parking)
On-Street Parking Credit Option	Properties not exclusively residential and located adjacent to a public right-of-way where on-street parking is permitted may receive credit for one off-street parking stall for each twenty linear feet of abutting right-of-way available for parallel parking, and 13.3 linear feet of abutting right-of-way available for diagonal parking.	A modification to reduce the number of required parking spaces within the range of ten percent to forty percent shall be considered by the approval authority when on-street parking is available and approved.

Table 3.0.g. – Motor Vehicle Parking Ratios

Subject	*City of Tumwater Standard (min.)*	*Thurston County Standard (min.)*
Residential – single family (includes duplex, townhouse and manufactured homes)	Minimum of 2.0 spaces per dwelling unit.	Minimum of 2.0 spaces per dwelling unit.
Residential - multifamily	1.5 spaces per 1 – 2 bedroom dwelling unit, 2.0 spaces per 3+ bedroom dwelling units, plus 1.0 guest space for every 10 units.1	1.5 spaces per 1 – 2 bedroom dwelling unit, 2.0 spaces per 3+ bedroom dwelling units
Banks with drive-through windows/ATM units	3.0 per 1,000 square feet.	1 per 250 square feet
Hotel and motel	1.0 space for each room or suite and 1.0 space per manager's unit. Banquet and meeting rooms shall provide 6.0 spaces for 1,000 square feet of seating area. Restaurants are figured separately.	1.0 space for each room or suite
Market, shopping center, and large retail/wholesale outlet	Less than 20,000 square feet = 3.5 spaces per 1,000 square feet of gross floor area.	Shopping: 1 per 250 square feet, up to 200,000 square feet; and 1 per 300

Table 3.0.g. – Motor Vehicle Parking Ratios		
Subject	***City of Tumwater Standard (min.)***	***Thurston County Standard (min.)***
	Greater than 20,000 square feet = 3.25 spaces per 1,000 square feet of gross floor area.	square feet, for additional area above 200,000 square feet Wholesale: 1 per 2,000 square feet
Mixed use	Shared or combined parking standards shall be used to calculate needed parking. This calculation is based upon the gross leasable area for each shop or business and does not include atriums, foyers, hallways, courts, maintenance areas, etc.	Joint parking standards shall be used to calculate needed parking. This calculation is based upon the gross leasable area (GLA)for each shop or business and does not include atriums, foyers, hallways, courts, maintenance areas, etc.
Offices, general	Gross floor area up to 2,000 square feet (SF) = 4.0 spaces per 1,000 square feet. GFA 2,001 to 7,500 sf = 3.3 spaces per 1,000 square feet. GFA 7,501 to 40,000 sf = 2.8 spaces per 1,000 square feet. GFA greater than 40,000 sf = 2.5 spaces per 1,000 sf.	1 per 300 square feet for offices with on-site customer service: or 1 per 500 square feet for offices without on-site customer service
Retail use	3.5 spaces per 1,000 square feet.	1 per 300 square feet
Cafe, bar and other drinking establishments	10.0 spaces per 1,000 square feet.	1 per 200 square feet
Restaurant with seats	1.0 space per 100 square feet of dining area.	1 per 200 square feet
Manufacturing use	1.0 space for each employee on the largest shift, with a minimum of 5.0 spaces.	1 per 1,500 square feet

Table 3.0.h. – Bicycle Parking Ratios

Subject	*City of Tumwater Standard (min.)*	*Thurston County Standard (min.)*
Short-term (class 2) bicycle facilities[1]:		
Parking areas or buildings with less than 150 vehicular parking spaces	2 spaces or 5% of vehicular spaces, whichever is greater	All commercial, industrial, institutional, and recreational uses which require 25 or more parking spaces, shall provide a designated bicycle parking area to accommodate a minimum of five bicycle spaces. Such bicycle parking areas shall provide a secure facility (e.g., rack, posts) to which to lock bicycles. Bicycle racks shall be covered in such a manner as to protect the entire bicycle from rain and installed to provide adequate maneuvering space and ensure that the requisite bicycle parking spaces remain accessible.
Parking areas or buildings with 150 or more vehicular parking spaces	8 spaces or 3% of vehicular spaces, whichever is greater	
Residential uses	2 spaces or 1 space per 4 units, whichever is greater	N/A
Long-term (class 1) bicycle facilities[2]:		
Commercial, industrial, and institutional uses or parking areas providing 50 or more vehicular parking spaces	1 space per 50 vehicular spaces, plus 1 space per 100 additional vehicular spaces	N/A
Residential uses	1 space per 4 units	N/A

Notes:

1 - Short-term (class 2) bicycle facilities shall provide a secure and quickly accessible space to lock a bicycle to a bicycle rack.

2 - Long-term (class 1) bicycle facilities shall protect bicycles and their components from theft, unauthorized access, and weather. Examples include a lockable bike cage or class 1 bicycle lockers.

Aerial view of the south segments of the Study Area in the vicinity of the Deschutes River and Pioneer Park

(Image Source: Google Earth Pro)

4.0 – Shoreline Master Program

The City of Tumwater Shoreline Master Program (SMP) is intended to regulate (and restrict) certain land uses and development activities along the shorelines of the state; the SMP standards apply to the shoreline and upland areas along the Deschutes River. Specifically, the SMP (or shoreline jurisdiction) applies to streams where the mean annual flow is twenty (20) cubic feet per second or greater. The following areas are subject to the SMP:

- Those lands which extend landward two (200) hundred feet as measured on a horizontal plane from the ordinary high water mark;
- Floodways and all of the contiguous one hundred (100) year floodplain within 200 feet of the floodway;
- Those wetlands which are in proximity to and either influence or area influenced by the stream. This influence includes but is not limited to one or more of the following: Periodic inundation; location within a floodplain; or hydraulic continuity; and
- Those lands within a river delta.

The SMP is intended to guide the future use and development of the City of Tumwater's shoreline areas consistent with the Washington State Shoreline Management Act of 1971 (Revised Code of Washington (RCW) 90.58) as amended; and adhere to the policies contained in RCW 90.58.020. The City of Tumwater shall have authority over those shoreline areas within its municipal boundaries.

Shoreline Environmental Designations

Properties along the public shorelines are subject to the SMP. The SMP establishes requirements/land use restrictions in addition to the underlying zoning. The SMP assigns Shoreline Environmental Designations to the various segments along the Deschutes River as depicted on the Shoreline Environmental Designation Map; Figure 4.0.1. depicts this map. The boundaries of shoreline jurisdiction on the map are approximate, whereas the extent of shoreline jurisdiction shall be based upon an on-site inspection. Each Environmental Designation lists the allowed activities (and restrictions) therein. Areas within shoreline jurisdiction that are not mapped and/or designated are automatically assigned an urban conservancy designation until the shoreline area can be re-designated through a master program amendment.

In addition to other permits and zoning requirements, applicants shall secure a Shoreline Permit for land use and development activities in Environmental Designations. Table 4.0.a lists each shoreline environmental designation along with their purpose statement, designation criteria, and the management policies. For the Deschutes River Flood Reduction Study, the shoreline areas fall within one of the following Shoreline Environmental Designations: Aquatic, Natural, Urban Conservancy, and Urban Intensity (there are no areas designated as Shoreline Residential).

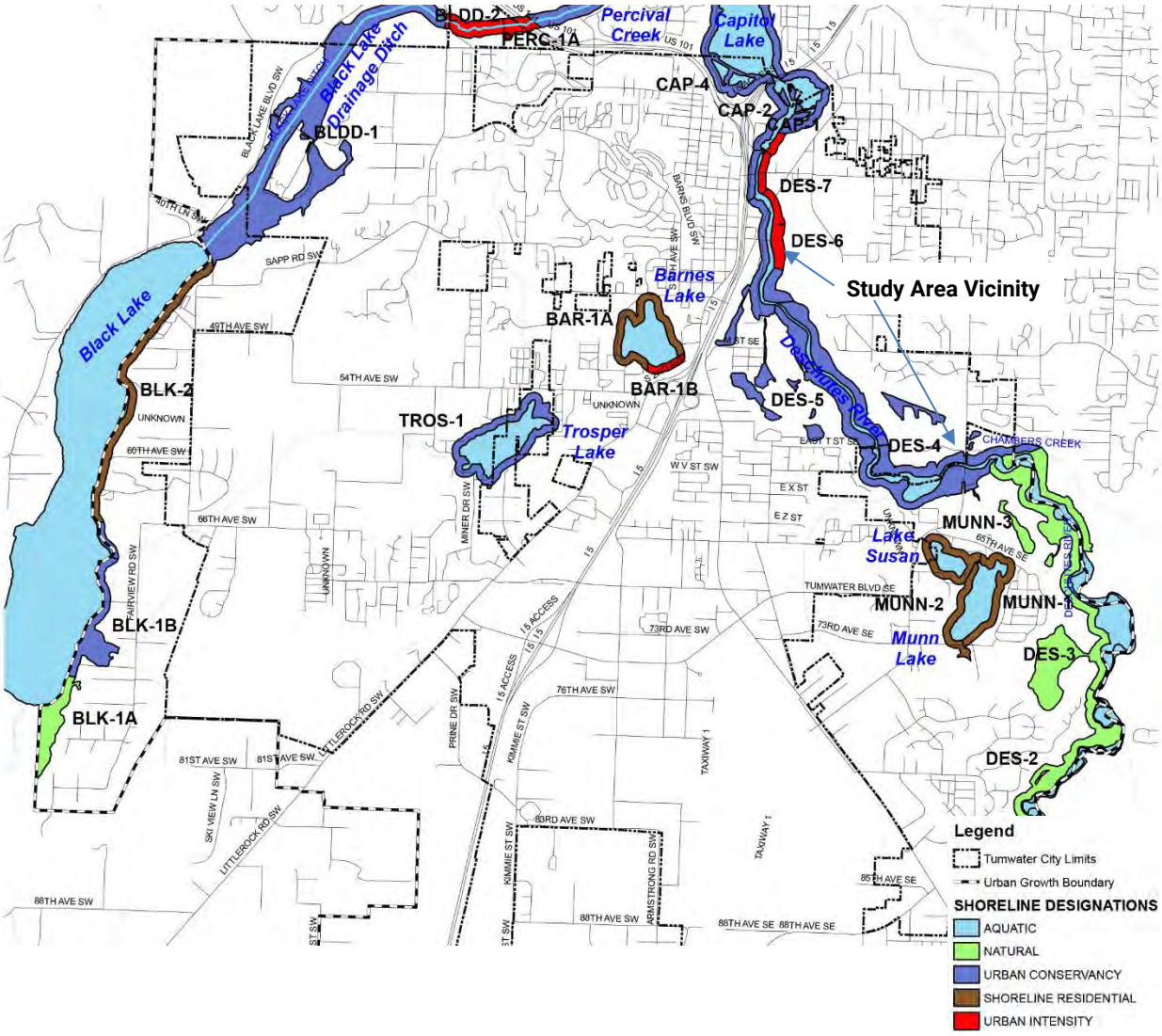


Figure 4.0.1 - Shoreline Environmental Designations Map - Tumwater SMP

(Source: City of Tumwater Shoreline Master Program - SMP)

Table 4.0.a – Shoreline Environmental Designations		
Designation	***Purpose / Designation Criteria***	***Management Policies***
Aquatic	Purpose: To protect, restore, and manage the unique characteristics and resources of the areas waterward of the ordinary high-water mark. Designation Criteria: The "aquatic" environment designation shall be applied to lands waterward of the ordinary high-water mark.	1. Allow new over-water structures only for water-dependent uses, public access, or ecological restoration. 2. The size of new over-water structures should be limited to the minimum necessary to support the structure's intended use. 3. In order to reduce the impacts of shoreline area development and increase effective use of water resources, multiple uses of over-water facilities should be encouraged. 4. All developments and uses on navigable waters or their beds should be located and designed to minimize interference with surface navigation, to consider impacts to public views, and to allow for the safe, unobstructed passage of fish and wildlife, particularly those species dependent on migration. 5. Uses that adversely impact the ecological functions of critical freshwater habitats should not be allowed except where necessary to achieve the objectives of RCW 90.58.020, and then only when their impacts are mitigated according to the sequence described in WAC 173-26-201(2)(e) as necessary to assure no net loss of ecological functions.
Natural	Purpose: To protect those shoreline areas that are relatively free of human influence or that include intact or minimally degraded shoreline functions intolerant of human use. These systems require that only very low intensity uses be allowed to maintain the ecological functions and ecosystem-wide processes. Consistent with the policies of the designation, planning for restoration of degraded shoreline areas should be included within this environment designation Designation Criteria: The "natural" environment designation shall be applied to shoreline areas if any of the following characteristics apply: 1. The shoreline area is ecologically intact and therefore currently performing an	1. Any use that would substantially degrade the ecological functions or natural character of the shoreline area should not be allowed. 2. The following uses should not be allowed: a. Commercial uses; b. Industrial uses; c. Non water-oriented recreation; and d. Roads, utility corridors and parking areas that can be located outside of "natural"– designated shoreline areas. 3. Single family residential development should be allowed as a conditional use if the density and intensity of such use is limited as necessary to protect ecological functions and be consistent with the purpose of the environment. 4. Scientific, historical, cultural, educational research uses and low intensity water-oriented

Table 4.0.a – Shoreline Environmental Designations		
Designation	***Purpose / Designation Criteria***	***Management Policies***
	important, irreplaceable function or ecosystem-wide process that would be damaged by human activity. Ecologically intact shorelines, as used here, means those shoreline areas that retain the majority of their natural shoreline functions, as evidenced by the shoreline configuration and the presence of native vegetation. Generally, but not necessarily, ecologically intact shorelines are free of structural shoreline modifications, structures, and intensive human uses. In forested areas, they generally include native vegetation with diverse plant communities, multiple canopy layers, and the presence of large woody debris. Whether or not a shoreline is ecologically intact is determined on a case-by-case basis (consolidated). The term "ecologically intact shorelines" applies to all shoreline areas meeting the below criteria ranging from larger reaches that may include multiple properties to small areas located within a single property. 2. The shoreline area is considered to represent ecosystems and geologic types that are of particular scientific and educational interest; or 3. The shoreline area is unable to support new development or uses without significant adverse impacts to ecological functions or risk to human safety. 4. The shoreline area includes largely undisturbed portions of shoreline areas such as wetlands, estuaries, unstable bluffs, coastal dunes, spits, and ecologically intact shoreline habitats. Shoreline areas inside or outside urban growth areas may be designated as "natural." 5. Areas with significant existing agriculture lands should not be included in the "natural" designation, except	recreational uses should be allowed provided that no significant ecological impact on the area will result 5. New development or significant vegetation removal that would reduce the capability of vegetation to perform normal ecological functions should not be allowed. Do not allow the subdivision of property in a configuration that, to achieve its intended purpose, will require significant vegetation removal or shoreline modification that adversely impacts ecological functions.

Table 4.0.a – Shoreline Environmental Designations		
Designation	***Purpose / Designation Criteria***	***Management Policies***
	where the existing agricultural operations involve very low intensity uses where there is no significant impact on natural ecological functions, and where the intensity or impacts associated with such agriculture activities is unlikely to expand in a manner inconsistent with the “natural” designation.	
Urban Conservancy	Purpose: To protect and restore ecological functions of open space, floodplain, and other sensitive lands where they exist in urban and developed settings, while allowing a variety of compatible uses. Designation Criteria: The "urban conservancy" environment designation shall be applied to shoreline areas appropriate and planned for development that is compatible with maintaining or restoring of the ecological functions of the area, that are not generally suitable for water-dependent uses and that lie in incorporated municipalities and urban growth areas if any of the following characteristics apply: 1. Shoreline areas that are suitable for water-related or water-enjoyment uses; 2. Shoreline areas that are open space, floodplain or other sensitive areas that should not be more intensively developed; 3. Shoreline areas that have potential for ecological restoration or the potential for development that is compatible with ecological restoration (consolidated); or 4. Shoreline areas that retain important ecological functions, even though partially developed. 5. Lands that may otherwise qualify for designation as urban conservancy and which are designated as "mineral resource lands" pursuant to RCW 36.70A.170 and WAC 365-190-070 may be assigned a designation within the "urban conservancy" environment that allows mining and associated uses in	1. Uses that preserve the natural character of the area or promote preservation of open space, floodplain or sensitive lands either directly or over the long term should be the primary uses allowed. Uses that result in restoration of ecological functions should be allowed if the use is otherwise compatible with the purpose of the environment and the setting. 2. The City will have standards that are designed to promote no net loss of shoreline ecological functions or values. 3. Public access and public recreation objectives should be implemented whenever feasible and significant ecological impacts can be mitigated. 4. Water-oriented uses should be given priority over non water-oriented uses.

Table 4.0.a – Shoreline Environmental Designations		
Designation	***Purpose / Designation Criteria***	***Management Policies***
	addition to other uses consistent with the urban conservancy environment designation	
Shoreline Residential	Purpose: To accommodate residential development and appurtenant structures that are consistent with this Program, and to provide appropriate public access and recreational uses. Designation Criteria: The "shoreline residential" environment designation shall be applied to shoreline areas inside urban growth areas, as defined in RCW 36.70A.110, and incorporated municipalities in areas that are predominantly developed with single-family or multi-family residential development or are planned and platted for residential development.	1. The City will have standards that are designed to promote no net loss of shoreline ecological functions or values. 2. Multifamily and multi-lot residential and recreational developments should provide public access and joint use for community recreational facilities. 3. Access, utilities and public services should be available and adequate to serve existing needs and/or planned future development. 4. Commercial development should be prohibited.
Urban Intensity	Purpose: To provide for high-intensity water-oriented commercial, transportation and industrial uses while protecting existing ecological functions and restoring ecological functions in areas that have been previously degraded. Designation Criteria: The "urban intensity" environment designation shall be assigned to shoreline areas within incorporated municipalities and urban growth areas if they currently support high-intensity uses related to commerce, transportation, or navigation; or are suitable and planned for high-intensity water-oriented uses.	1. New uses and activities should result in no net loss of shoreline ecological functions 2. Where feasible, visual, and physical public access should be required as provided for in this Program. 3. The City will establish sign control regulations, appropriate development siting, screening, and architectural standards, and vegetation conservation areas to promote visually attractive uses. 4. The City will encourage a variety of urban uses in accordance with City plans and regulations to create a vibrant shoreline area consistent with Tumwater's character and quality of life. Three distinct areas shall comprise the Urban Intensity Shoreline Environment: a. Barnes Lake: A State government facility is located on the south end of the lake. Future development should include restoration and/or enhancement of degraded shoreline areas. b. Black Lake Drainage Ditch/Percival Creek north of Mottman Road: Industrial uses are located on the north and south sides of the canyon in which the Black Lake Drainage Ditch and Percival Creek are located. Future development should be set back

Table 4.0.a – Shoreline Environmental Designations		
Designation	***Purpose / Designation Criteria***	***Management Policies***
		from the canyon in accordance with the City's critical areas regulations. c. Deschutes River: The former Olympia Brewery is located on the east side of the Deschutes River. Consistent with the City's vision for these properties, a wide variety and mixture of uses are envisioned including residential, commercial, industrial, educational, and cultural as well as public and recreational places. Future development should include restoration and/or enhancement of degraded shoreline areas.

Permits (Permitted / Conditional / Variances)

Most land use and development activities within the shoreline jurisdiction are subject to a shoreline permit either as a (i) Substantial Development Permit, or a (ii) Shoreline Conditional Use Permit. Where hardships or special site conditions exist, applicants may seek a Shoreline Variance permit to request regulatory relief from certain SMP requirements (subject to Washington State Department of Ecology review and approval). Table 4.0.b summarizes these various permits and variance options.

Table 4.0.b – Shoreline Permits		
Permit Type and Approval Authority	***Purpose***	***Standards / Review Criteria***
Substantial Development Permit Administrator	Purpose: A shoreline substantial development permit shall be required for all proposed use and development of shoreline areas unless the proposal is specifically exempted by the SMP.	In order to be approved, the Administrator shall find that the proposal is consistent with the following criteria: • All applicable regulations of this Program appropriate to the shoreline environment designation and the type of use or development proposed shall be met, except those bulk and dimensional standards that have been modified by approval of a shoreline variance under the SMP. • All policies of this Program appropriate to the shoreline environment designation and the type of use or development activity proposed shall be considered and substantial compliance demonstrated. The City is the final authority for a Shoreline Substantial Development Permit, unless there is an appeal filed with the State Shorelines Hearings Board.
Shoreline Conditional Use Permit	The purpose of a shoreline conditional use permit is to provide a system within the Program which allows flexibility in the application of	A. Uses which are classified or set forth in this Program as conditional uses may be authorized provided that the applicant demonstrates all of the following: • The proposed use is consistent with the policies of RCW 90.58.020 and this Program;

Table 4.0.b – Shoreline Permits		
Permit Type and Approval Authority	***Purpose***	***Standards / Review Criteria***
Washington Department of Ecology	use regulations in a manner that is consistent with the policies of RCW 90.58.020 and this Program. In authorizing a shoreline conditional use, the City or Department may attach special conditions to the permit to prevent undesirable effects of the proposed use and/or to assure consistency of the project with the Act and this Program.	• The proposed use will not interfere with the normal public use of shoreline areas; • The proposed use of the site and the design of the project are compatible with other authorized uses within the area and with uses planned for the area under the Comprehensive Plan and this Program; • That the proposed use will cause no significant adverse effects to the shoreline environment in which it is to be located; and • The public interest suffers no substantial detrimental effect. B. Other uses which are not classified or set forth in this Program may be authorized as conditional uses provided the applicant can demonstrate consistency with the requirements of this section and the requirements for conditional uses contained in this Program. C. Uses which are specifically prohibited by this Program may not be authorized. D. A development or use, that is an unlisted use, must obtain a shoreline conditional use permit, even if the development or use does not require a shoreline substantial development permit. E. The Washington State Department of Ecology is the final authority for a conditional use permit, unless there is an appeal filed with the State Shorelines Hearings Board. The Department of Ecology shall render and transmit its final decision to the City and the applicant approving, approving with conditions, or disapproving the permit within thirty days of the date of submittal by the City.
Shoreline Variance Permit Washington Department of Ecology	Purpose: Strictly limited to granting relief from specific bulk, dimensional or performance standards set forth in this Program where there are extraordinary circumstances relating to the physical character or configuration of property such that the strict implementation of this Program will impose unnecessary hardships on the applicant or thwart the policies set forth in RCW 90.58.020.	A. Variance permits should be granted in circumstances where denial of the permit would result in a thwarting of the policy enumerated in RCW 90.58.020. In all instances, the applicant must demonstrate that extraordinary circumstances exist and that the public interest shall suffer no substantial detrimental effect. B. Variance permits for development and/or uses that will be located landward of the ordinary high water mark (OHWM), as defined in RCW 90.58.030(2)(c), and/or landward of any wetland as defined in RCW 90.58.030(2)(h), may be authorized provided that the applicant can demonstrate all of the following: 1. The strict application of the bulk, dimensional or performance standards set forth in this Program precludes, or significantly interferes with, reasonable use of the property.

Table 4.0.b – Shoreline Permits		
Permit Type and Approval Authority	***Purpose***	***Standards / Review Criteria***
		2. The hardship is specifically related to the property, and is the result of unique conditions such as irregular lot shape, size, or natural features and the application of this Program, and not, for example, from deed restrictions or the applicant's own actions 3. The design of the project is compatible with other authorized uses within the area and with uses planned for the area under the City's comprehensive plan and this Program and will not cause adverse impacts to the shoreline environment; 4. The variance will not constitute a grant of special privilege not enjoyed by the other properties in the area; 5. The variance requested is the minimum necessary to afford relief; and 6. The public interest will suffer no substantial detrimental effect. C. Variance permits for development and/or uses that will be located waterward of the ordinary high water mark (OHWM), as defined in RCW 90.58.030(2)(b), or within any wetland as defined in RCW 90.58.030(2)(h), may be authorized provided that the applicant can demonstrate all of the following: 1. The strict application of the bulk, dimensional or performance standards set forth in this Program precludes all reasonable use of the property; 2. The proposal is consistent with the criteria established under Section 2.4(B); and 3. The public rights of navigation and use of the shoreline areas will not be adversely affected. D. Variances from the use regulations of this Program are prohibited. E. When a development or use does not comply with the bulk, dimensional, and/or performance standards of this Program, such development or use shall only be authorized by approval of a shoreline variance, even if the development or use does not require a substantial development permit. F. The Washington State Department of Ecology is the final authority for a variance, unless there is an appeal filed with the State Shorelines Hearings Board. The Department of Ecology shall render and transmit its final decision to the City and the applicant approving, approving with conditions, or disapproving the permit within thirty days of the date of submittal by the City.

Shoreline Exemptions

Applicants may seek exemptions from certain standards associated with the SMP. In those situations, the applicant shall request a letter of exemption from the City. Letters of exemption shall include written findings such as documentation of compliance and, if applicable, conditions for the approval of the development and/or use prepared by the Administrator. If any part of the proposed development is not eligible for exemption, then a substantial development permit is required for the entire development. The burden of proof is on the applicant or proponent. The list of eligible exemptions is long, refer to the City of Tumwater SMP for more detail).

Land Use Allowances / Table of Uses

Table 4.0.c lists the land use allowances for each of the five Shoreline Environmental Designations as defined in the SMP. The purpose of these allowances is to ensure that the nature of the land use properly aligns with the objectives of the specific Shoreline Environmental Designation. Each land use category is assigned an allowance designation of either permitted, conditional, prohibited, or not applicable. In some cases, superscripts are utilized to provide greater detail of the allowance designation for a land use category; please see the footnote below Table 4.0.c for a description of what each character and superscript represent. Permitted uses within a Shoreline Environmental Designation will still require a substantial development permit or letter of exemption.

Table 4.0.c – SMP Table of Uses and Activities by Shoreline Environmental Designation

	Shoreline Environmental Designations				
Uses and Activities	***Urban Intensity***	***Shoreline Residential***	***Urban Conservancy***	***Natural***	***Aquatic***
Agriculture	P	P	P	P[3]	NA
Aquaculture	P	P	P	P[4]	P[4]
Boating Facilities: Launch Ramps	P	P	P	C[5]	P*
Boating Facilities: Marinas	P	P	X	X	P*
Boating Facilities: Aquatic Management Access	P[7]	P[7]	X	X	P*
Commercial: Water-Dependent	P	X	C	X	X
Commercial: Water-related	P	X	C	X	X
Commercial: Water-enjoyment	P	X	C	X	X
Commercial: Nonwater-oriented	P	X	X[8]	X	X
Forest Practices	X	X	X	X	X
Industrial: Water-Dependent	P	X	C	X	C*
Industrial: Water-related	P	X	C[6]	X	X
Industrial: Nonwater-oriented	C	X	X[8]	X	X
Mining	X	X	X	X	NA

Table 4.0.c – SMP Table of Uses and Activities by Shoreline Environmental Designation

	Shoreline Environmental Designations				
Uses and Activities	***Urban Intensity***	***Shoreline Residential***	***Urban Conservancy***	***Natural***	***Aquatic***
Recreation: Water-Dependent	P	P	P	P	P
Recreation: Water-related	P	P	P	P	P
Recreation: Water-enjoyment	P	P	P	P	C
Recreation: Non water-oriented	P	C[1]/P[2]	C[1]/P[2]	X[1]/P[2]	X
Residential: Single-Family	P	P	P	C	X
Residential: Attached Single-Family & Multi-Family	P	P	P	X	X
Solid Waste Disposal	X	X	X	X	X
Roads and Railroads	P	C[1]/P[2]	C[1]/P[2]	C[3]	C*
Utilities: Primary and accessory	P	C[1]/P[2]	C[1]/P[2]	C	C*

P = Permitted Use; Use may require substantial development permit or statement of exemption approval

C = Requires a Shoreline Conditional Use Permit

X = Prohibited; not eligible for a Substantial Development or Shoreline Conditional Use Permit

NA = Not applicable, refer to the appropriate Master Program section for additional standards

1 = Within one hundred (100) feet from the ordinary high water mark (OHWM)

2 = Greater than one hundred (100) feet from the OHWM to the edge of the shoreline jurisdiction

3 = Low-intensity agriculture is allowed provided the activities are consistent with the applicable policies, intent and the regulations of this program, and provided it does not cause significant ecological impacts

4 = Aquaculture allowed in Aquatic Environment designation subject to applicable policies, intent and the regulations of the abutting upland shoreline environment designation. Aquaculture is allowed in the Natural Environment designation provided the activities are consistent with the applicable policies, intent, and the regulations of this program, it does not require structures, facilities or mechanized harvest practices and it will not result in the alteration of natural systems or features.

5 = Launch ramps allowed in Natural Environment designation to facilitate hand launching of non-motorized watercraft provided activities are consistent with applicable policies, intent and the regulations of this Program, and provided the size and design are compatible with the site.

6 = Use permitted if significant public benefit is provided with respect to the objectives of the Act such as providing public access and ecological restoration, and provided further that the use is either part of a mixed use project that includes a water-oriented use or is proposed on a site where navigability is severely limited.

7 = Temporary use only with intent of implementing the adopted management plan for Barnes Lake

8 = See Section 5.2(B)(14)(c) for exception, which will require a Shoreline Conditional Use Permit

** = Use may be allowed in the Aquatic Environment designation if it is allowed in the adjacent upland shoreline environment*

Development Regulations/ Table of Regulations

Critical area buffers apply to all shoreline areas regulated by this Program; refer to Section 5.2 of the SMP for more detail. Critical areas regulations impose buffer requirements that are established on a case-by-case basis and will require a plan prepared by a qualified professional. The Ordinary High Water Mark (OHWM) setbacks prescribed below apply to water-oriented uses (i.e. water-dependent, water-related and water-enjoyment uses) that may be allowed within the critical area buffer per Section 5.2(B)(14) of the SMP. The purpose of the setback is to ensure that a separation exists between water-oriented uses and the shoreline area. Applicants for new or expanded buildings or structures exceeding 35 feet in height above average grade level may be required to conduct a view analysis if the Administrator determines that such building could obstruct the view of a substantial number of residences.

Table 4.0.d – SMP Table of Regulations by Shoreline Environmental Designation

	Shoreline Environmental Designations				
Regulations	***Urban Intensity***	***Shoreline Residential***	***Urban Conservancy***	***Natural***	***Aquatic***
Agriculture					
OHWM Setback	*	*	*	*	NA
Building Height	35-ft	35-ft	35-ft	35-ft	NA
Aquaculture					
OHWM Setback	15-ft	15-ft	25-ft	50-ft	NA
Building Height	35-ft	35-ft	35-ft	35-ft	10-ft
Boating Facilities: Water-dependent					
OHWM Setback	0-ft	0-ft	0-ft	0-ft	NA
Building Height	35-ft	30-ft	30-ft	25-ft	20-ft
Boating Facilities: Water-related					
OHWM Setback	15-ft	15-ft	15-ft	25-ft	NA
Building Height	35-ft	30-ft	30-ft	25-ft	NA
Commercial & Industrial Development: Water-dependent					
OHWM Setback	0-ft	NA	25-ft	NA	NA
Building Height	75-ft	NA	35-ft	NA	35-ft
Commercial & Industrial Development: Water-related & enjoyment					
OHWM Setback	15-ft	NA	50-ft	NA	NA
Building Height	75-ft	NA	35-ft	NA	35-ft
Commercial & Industrial Development: Nonwater-oriented					
OHWM Setback	*	NA	*	NA	NA
Building Height	75-ft	NA	50-ft	NA	NA
Recreation Development: Water-dependent					
OHWM Setback	25-ft	25-ft	25-ft	25-ft	NA
Building Height	35-ft	25-ft	25-ft	25-ft	10-ft

Table 4.0.d – SMP Table of Regulations by Shoreline Environmental Designation

	Shoreline Environmental Designations				
Regulations	***Urban Intensity***	***Shoreline Residential***	***Urban Conservancy***	***Natural***	***Aquatic***
Recreation Development: Water-related & enjoyment					
OHWM Setback	50-ft[4]	50-ft[4]	50-ft[4]	50-ft[4]	NA
Building Height	35-ft	25-ft	25-ft	25-ft	10-ft
Recreation Development: Nonwater-oriented					
OHWM Setback	*	*	*	*	NA
Building Height	35-ft	25-ft	25-ft	25-ft	NA
Single-Family Dwellings					
Maximum Net Density[3]	NA	8 du/ac	1 du/ac	1 du/10 ac	NA
OHWM Setback	*	*	*	*	NA
Building Height	35-ft	35-ft	35-ft	35-ft	NA
Maximum Impervious Surfaces	NA	50%	30%	10%	NA
Attached Single-Family & Multi-Family Dwellings					
Maximum Net Density[3]	NA	8 du/ac	1 du/ac	NA	NA
OHWM Setback	*	*	*	NA	NA
Building Height	40-ft[1]/75-ft[2]	35-ft	35-ft	NA	NA
Maximum Impervious Surfaces	NA[5]	50%	30%	NA	NA
Roads and Railroads					
OHWM Setback	*	*	*	*	*
Utilities	*	*	*	*	NA
OHWM Setback	25-ft[1]/35-ft[2]	25-ft[1]/35-ft[2]	25-ft[1]/35-ft[2]	25-ft[1]/35-ft[2]	NA
Building Height	Refer to primary use	Refer to primary use	Refer to primary use	Refer to primary use	Refer to primary use
Accessory to primary use					

OHWM = Ordinary high-water mark

NA = Not applicable, refer to the appropriate Master Program section for additional standards

1 = Within one hundred (100) feet from the ordinary high-water mark (OHWM)

2 = Greater than one hundred (100) feet from the OHWM to the edge of the shoreline jurisdiction

** = Use must be located outside of the Critical area buffer. See Section 5.2(B)(14). Certain exceptions apply*

SMP Public Access Goals – Deschutes River

In accordance with RCW 90.58.100(2)(b), the SMP includes a provision for public access and has developed goals that address the ability of the public to reach, touch and travel on the shorelines of the state and to view the water and the shoreline from adjacent locations. Additional public access goals are to:

1. Ensure the prevention of environmental and human health impacts, the prevention of adverse impacts on adjacent private shoreline area properties, and compatibility with water-dependent uses for public access areas (consolidated); and
2. Increase public access to shorelines through acquisition as opportunities arise and require public access to shorelines as a condition for shoreline development as appropriate (consolidated).

Existing, Planned and Opportunities for Public Access (Deschutes River) - These goals have been applied to the Deschutes River. The SMP lists existing, planned, and identified areas for public access along its shoreline. The following are public access considerations specific to the Deschutes River identified within *Table 5.3: Existing, Planned, and Opportunities for Public Access for Tumwater and UGA* in the SMP:

- **Existing Public Access** - Pioneer Park (City of Tumwater) includes unofficial hand carry boat launch and trails; Brewery Park at Tumwater Falls (Olympia Tumwater Foundation) includes trails and a fishery operated by the Washington Department of Fish and Wildlife (WDFW).
- **Planned Public Access** – Plans for a Deschutes Watershed Center and hatchery are underway (City of Tumwater and WDFW), but no location has been determined. Deschutes Valley Trail will provide additional points of public access and interpretative areas (City of Tumwater). The Tumwater Park, Recreation, and Open Space Plan recommends incorporating and extending the freshwater trail network for hand-carry or car-top craft on the Deschutes River from Deschutes Ridge through Pioneer Park to Brewery Park at Tumwater Falls, and from the Old Tumwater Brewery into Capital Lake.
- **Other Opportunities** - A portion of the former Brewery Property may be considered for acquisition by the City of Tumwater for a park.

Shoreline Modification Policies and Regulations

Shoreline modifications are generally related to construction of a physical element such as a dike, breakwater, dredged basin, or fill and excavation, but modifications can include other actions such as clearing, grading, application of chemicals or significant vegetation removal. Shoreline modification policies and regulations are guided by the governing principles in Chapter 1 of the SMP, help implement the Master Program goals in Chapter 4 of the SMP, are consistent with the other policies and regulations contained in the Program and are based on the state shoreline guidelines listed in WAC 173-26.

The following shoreline modification activities are subject to specific development regulations – see Chapter 6 of City's SMP for specific requirements.

- Shoreline Stabilization
- Bioengineering
- Breakwaters, Jetties, Groins and Weirs
- Bulkheads
- Buoys
- Dikes, Levees, and Instream Structures
- Dredging
- Fill and Excavation
- Piers and Docks
- Recreational Floats
- Restoration and Enhancement
- Revetments and Gabions
- Stair Towers

Shoreline Uses and Activities Policies and Regulations

Policies and regulations that apply to specific uses and activities in shoreline areas are intended to be consistent with all other policies and regulations contained in this Program. Pursuant to the SMP rule, certain uses and activities are subject to the policies and regulations for that specific use or activity. When there are no regulations for a specific use or activity, the proposed use shall assure no net loss of shoreline ecological functions.

The following shoreline modification activities are subject to specific development regulations – see Chapter 7 of City's SMP for specific requirements.

- Agriculture
- Aquaculture
- Boating Facilities (Boat Launches and Marinas)
- Commercial
- Forest Practices
- Industrial
- Mining
- Recreation
- Residential
- Solid Waste
- Transportation
- Utilities

5.0 – Special Land Use Studies/Plans

Two recent land use studies and resulting planning documents provide additional information relevant to potential redevelopment considerations within the Deschutes River Study Area. The Tumwater Brewery District Plan (2020) should be referenced for any development proposals occurring within the north end of the Study Area where it overlaps one or more Brewery District (BD) subdistricts; this plan provides detailed information on right-of-way improvements and future development within the BD zone. By contrast the Bush Prairie Habitat Conservation Plan (2023 Draft) may impact the entirety of the Study Area; this plan will serve as the basis for an application for an incidental take permit from the U.S. Fish and Wildlife Service for proposed development of any kind, as well as operations and maintenance of new and existing facilities alike – including airport facilities and air space.

Tumwater Brewery District Plan

The Tumwater Brewery District Plan ("the Plan") is the result of the Brewery District Planning Project. The Plan provides existing conditions information as well as suggested land use, transportation, zoning code, and building code improvements for all subdistrict areas located within the new Tumwater Brewery District (BD, or "the District"). The District covers commercial area surrounding the former Olympia Brewery which, prior to the 1956 construction of the I-5 freeway, was the site of Tumwater's historic downtown business district; this area remains a key commercial center for the city but is now heavily vehicle-oriented. BD geographic coverage includes the area stretching east-west from the Cleveland Ave cemeteries (east) to I-5 (west); north-south boundaries run from Tumwater Historical Park (north) to E Street and the Tumwater Valley Golf Course (south). Subdistricts have been identified within the Plan based on circulation boundaries and use considerations.

Plan goals and selected design alternatives were developed from the findings of a 2011 community visioning exercise, which identified two overarching goals for the District: redevelopment of low density properties to high-profile mixed-use and multi-family project, and to shift the auto-oriented commercial district into a multimodal town center. The Plan document functions as a guide for phased land use and ROW improvements in the District, centered around the following key concerns/goals:

- Create a stronger sense of place by facilitating pedestrian access, establishing gathering places for residents and fostering a distinct District identity
- Improve transportation options, safety and access within and across the District
- Expand economic opportunity and activity
- Improve the function and appearance of the built environment

Bush Prairie Habitat Conservation Plan

The Bush Prairie Habitat Conservation Plan is the integral component of the joint application to be submitted by the City of Tumwater and Port of Olympia to receive an Incidental Take Permit (ITP) from the US Fish and Wildlife Service (USFWS). Incidental take is defined as any process that may result in the unintentional loss of species listed under the Endangered Species Act (ESA) through habitat disruption and/or reduction. As required by Section 10(a)(2)(A) of the ESA, the Bush Prairie Habitat Conservation Plan (HCP) contains the following elements:

- The impact that will likely result in the taking of covered species.
- The steps the Permittees will take to monitor, avoid, minimize, and mitigate such impacts to the maximum extent practicable.
- The funding that will be available to implement such steps.

- The procedures to be used to deal with unforeseen circumstances.
- The alternative actions to such taking the Permittees considered and the reasons why such alternatives are not proposed.
- Such other measures that the Director [of the Department of Interior or Commerce] may require as being necessary or appropriate for purposes of the Plan (50 CFR 17.22(b))

As of the start of this analysis, the HCP is in draft form. If approved, the City of Tumwater and Port of Olympia will receive a 30-year ITP for the HCP Plan Area, defined as the 31,136 acres where covered species may occur within the City's Urban Growth Area (UGA). Within the Deschutes River Flood Reduction Study Area, all land along the west bank of the river falls within the Permit Area for the HCP Plan Area. The covered species in the HCP are the Olympia Pocket Gopher, Oregon Spotted Frog, Streaked Horned Lark, and the Oregon Vesper Sparrow. Once the ITP is issued, the City of Tumwater will adopt the HCP by ordinance or other binding legal mechanism and update its permitting process and regulations to properly implement the HCP. Proposed developments consisting of covered activities in the Plan Area may apply for coverage under the Plan by submitting an HCP application package to the City containing (1) the project application form, (2) the project description and site plan, and (3) the determination of covered species habitat (see Section 7.3.1 for more detail). Covered activities in the HCP are defined as ones occurring within the following categories (see Chapters 3.3 through 3.7 for more detail):

- City
  - Urban development projects
  - Recurring activities
  - Public facility operations and maintenance
- Port
  - Aeronautical-related
    - Capital infrastructure support facilities and utilities
    - Facility operations (see Sections 1.3.1.2, Endangered Species Act 4(d) Rule for the Olympia Pocket Gopher, and 1.3.1.4, Endangered Species Act 4(d) Rule for Streaked Horned Lark).
    - Recurring activities
  - Non-aeronautical activities (urban commercial development)
    - Development on Port Owned Land
    - Facility operations and maintenance
- Conservation strategy implementation

Once the HCP application package is approved by the City, applicants will submit a habitat conversion fee of $58,816 per acre, subject to periodic adjustments, at the first step in the project approval process that authorizes ground disturbance. Alternatives, exemptions, and adjustments to the habitat conversion fee exist and are outlined in Section 8.3.1 of the HCP. Once approved and granted coverage, projects are required to comply with all of the relevant terms and conditions of the plan:

- Compliance with all relevant avoidance, minimization, survey, monitoring, and mitigation measures.
- Allowances for the City to monitor the project proponent's compliance with all applicable conditions of the Plan.
- Allowances for USFWS to monitor the project proponent's compliance with all applicable conditions of the Plan, if USFWS chooses to do so.

Appendix C – HYDRAULIC DATA

Provided Digitally Only

Appendix D – COST ESTIMATE

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CONSTRUCTION COST ESTIMATE
DESCHUTES RIVER FLOOD MITIGATION
MODEL 2 - FLOOD CHANNEL IMPROVEMENT

Item No.	Item Description	Unit	Quantity	Unit Cost ($)	Cost ($)
0025	CLEARING AND GRUBBING	AC	9	$ 5,000.00	$ 45,000.00
0050	REMOVAL OF STRUCTURES AND OBSTRUCTIONS	LS	1	$ 42,000.00	$ 42,000.00
0120	REMOVING ASPHALT CONC. PAVEMENT	SY	38,720	$ 5.00	$ 193,600.00
1040	CHANNEL EXCAVATION INCL. HAUL	CY	40,000	$ 15.00	$ 600,000.00
6414	SEEDING, FERTILIZING AND MULCHING	AC	17	$ 8,000.00	$ 136,000.00
7008	SHORING OR EXTRA EXCAVATION CLASS B	SF	140,000	$ 0.50	$ 70,000.00
7552	CONSTRUCTION GEOTEXTILE FOR SOIL STABILIZATION	SY	15,556	$ 3.00	$ 46,666.67
N/A	Wetland Study	AC	17	$ 1,000.00	$ 17,000.00
N/A	Utility Locating	HR	72	$ 160.00	$ 11,520.00
N/A	Power Station Relocation/Removal	LS	0	$ 2,000,000.00	$ -
	Construction Subtotal, Before Contingencies and Other				$ 1,161,786.67
	Mobilization (10%)				$ 116,178.67
	Contingency (25%; 20% unidentified items + 5% construction)				$ 290,446.67
	Design (15% of Construction)				$ 174,268.00
	ICAP (10%)				$ 116,178.67
	Total Cost				$ 1,858,859.00

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CONSTRUCTION COST ESTIMATE
DESCHUTES RIVER FLOOD MITIGATION
MODEL 4 - FLOOD BENCHING (1)

Item No.	Item Description	Unit	Quantity	Unit Cost ($)	Cost ($)
0025	CLEARING AND GRUBBING	AC	9	$ 5,000.00	$ 45,000.00
0050	REMOVAL OF STRUCTURES AND OBSTRUCTIONS	LS	1	$ 42,000.00	$ 42,000.00
0120	REMOVING ASPHALT CONC. PAVEMENT	SY	38,720	$ 5.00	$ 193,600.00
1040	CHANNEL EXCAVATION INCL. HAUL	CY	60,000	$ 15.00	$ 900,000.00
6414	SEEDING, FERTILIZING AND MULCHING	AC	17	$ 8,000.00	$ 136,000.00
7008	SHORING OR EXTRA EXCAVATION CLASS B	SF	0	$ 0.50	$ -
7552	CONSTRUCTION GEOTEXTILE FOR SOIL STABILIZATION	SY	23,333	$ 3.00	$ 70,000.00
N/A	Wetland Study	AC	17	$ 1,000.00	$ 17,000.00
N/A	Utility Locating	HR	72	$ 160.00	$ 11,520.00
	Construction Subtotal, Before Contingencies and Other				$ 1,415,120.00
	Mobilization (10%)				$ 141,512.00
	Contingency (25%; 20% unidentified items + 5% construction)				$ 353,780.00
	Design (15% of Construction)				$ 212,268.00
	ICAP (10%)				$ 141,512.00
	Total Cost				$ 2,264,192.00

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CONSTRUCTION COST ESTIMATE
DESCHUTES RIVER FLOOD MITIGATION
MODEL 5 - FLOOD BENCHING (2)

Item No.	Item Description	Unit	Quantity	Unit Cost ($)	Cost ($)
0025	CLEARING AND GRUBBING	AC	9	$ 5,000.00	$ 45,000.00
0050	REMOVAL OF STRUCTURES AND OBSTRUCTIONS	LS	1	$ 42,000.00	$ 42,000.00
0120	REMOVING ASPHALT CONC. PAVEMENT	SY	38,720	$ 5.00	$ 193,600.00
1040	CHANNEL EXCAVATION INCL. HAUL	CY	85,000	$ 15.00	$ 1,275,000.00
6414	SEEDING, FERTILIZING AND MULCHING	AC	17	$ 8,000.00	$ 136,000.00
7008	SHORING OR EXTRA EXCAVATION CLASS B	SF	0	$ 0.50	$ -
7552	CONSTRUCTION GEOTEXTILE FOR SOIL STABILIZATION	SY	35,778	$ 3.00	$ 107,333.33
N/A	Wetland Study	AC	17	$ 1,000.00	$ 17,000.00
N/A	Utility Locating	HR	72	$ 160.00	$ 11,520.00
N/A	Power Station Relocation/Removal	LS	1	$ 2,000,000.00	$ 2,000,000.00
	Construction Subtotal, Before Contingencies and Other				$ 3,827,453.33
	Mobilization (10%)				$ 382,745.33
	Contingency (25%; 20% unidentified items + 5% construction)				$ 956,863.33
	Design (15% of Construction)				$ 574,118.00
	ICAP (10%)				$ 382,745.33
	Total Cost				$ 6,123,925.00

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CONSTRUCTION COST ESTIMATE
DESCHUTES RIVER FLOOD MITIGATION
MODEL 5 - FLOOD BENCHING (2)

Item No.	Item Description	Unit	Quantity	Unit Cost ($)	Cost ($)
0025	CLEARING AND GRUBBING	AC	9	$ 5,000.00	$ 45,000.00
0050	REMOVAL OF STRUCTURES AND OBSTRUCTIONS	LS	1	$ 42,000.00	$ 42,000.00
0120	REMOVING ASPHALT CONC. PAVEMENT	SY	38,720	$ 5.00	$ 193,600.00
1040	CHANNEL EXCAVATION INCL. HAUL	CY	85,000	$ 15.00	$ 1,275,000.00
6414	SEEDING, FERTILIZING AND MULCHING	AC	17	$ 8,000.00	$ 136,000.00
7008	SHORING OR EXTRA EXCAVATION CLASS B	SF	0	$ 0.50	$ -
7552	CONSTRUCTION GEOTEXTILE FOR SOIL STABILIZATION	SY	35,778	$ 3.00	$ 107,333.33
N/A	Wetland Study	AC	17	$ 1,000.00	$ 17,000.00
N/A	Utility Locating	HR	72	$ 160.00	$ 11,520.00
N/A	Power Station Demolition	LS	1	$ 75,000.00	$ 75,000.00
	Construction Subtotal, Before Contingencies and Other				$ 1,902,453.33
	Mobilization (10%)				$ 190,245.33
	Contingency (25%; 20% unidentified items + 5% construction)				$ 475,613.33
	Design (15% of Construction)				$ 285,368.00
	ICAP (10%)				$ 190,245.33
	Total Cost				$ 3,043,925.00

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CONSTRUCTION COST ESTIMATE

DESCHUTES RIVER FLOOD MITIGATION

MODEL 9A - FLOOD BENCHING WITH CHANNEL (1)

Item No.	Item Description	Unit	Quantity	Unit Cost ($)	Cost ($)
0025	CLEARING AND GRUBBING	AC	9	$ 5,000.00	$ 45,000.00
0050	REMOVAL OF STRUCTURES AND OBSTRUCTIONS	LS	1	$ 42,000.00	$ 42,000.00
0120	REMOVING ASPHALT CONC. PAVEMENT	SY	38,720	$ 5.00	$ 193,600.00
1040	CHANNEL EXCAVATION INCL. HAUL	CY	80,000	$ 15.00	$ 1,200,000.00
6414	SEEDING, FERTILIZING AND MULCHING	AC	17	$ 8,000.00	$ 136,000.00
7008	SHORING OR EXTRA EXCAVATION CLASS B	SF	110,000	$ 0.50	$ 55,000.00
7552	CONSTRUCTION GEOTEXTILE FOR SOIL STABILIZATION	SY	24,667	$ 3.00	$ 74,000.00
N/A	Wetland Study	AC	17	$ 1,000.00	$ 17,000.00
N/A	Utility Locating	HR	72	$ 160.00	$ 11,520.00
	Construction Subtotal, Before Contingencies and Other				$ 1,774,120.00
	Mobilization (10%)				$ 177,412.00
	Contingency (25%; 20% unidentified items + 5% construction)				$ 443,530.00
	Design (15% of Construction)				$ 266,118.00
	ICAP (10%)				$ 177,412.00
	Total Cost				$ 2,838,592.00

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CONSTRUCTION COST ESTIMATE
DESCHUTES RIVER FLOOD MITIGATION
MODEL 9B - FLOOD BENCHING WITH CHANNEL (2)

Item No.	Item Description	Unit	Quantity	Unit Cost ($)	Cost ($)
0025	CLEARING AND GRUBBING	AC	9	$ 5,000.00	$ 45,000.00
0050	REMOVAL OF STRUCTURES AND OBSTRUCTIONS	LS	1	$ 42,000.00	$ 42,000.00
0120	REMOVING ASPHALT CONC. PAVEMENT	SY	38,720	$ 5.00	$ 193,600.00
1040	CHANNEL EXCAVATION INCL. HAUL	CY	105,000	$ 15.00	$ 1,575,000.00
6414	SEEDING, FERTILIZING AND MULCHING	AC	17	$ 8,000.00	$ 136,000.00
7008	SHORING OR EXTRA EXCAVATION CLASS B	SF	110,000	$ 0.50	$ 55,000.00
7552	CONSTRUCTION GEOTEXTILE FOR SOIL STABILIZATION	SY	37,111	$ 3.00	$ 111,333.33
N/A	Wetland Study	AC	17	$ 1,000.00	$ 17,000.00
N/A	Utility Locating	HR	72	$ 160.00	$ 11,520.00
N/A	Power Station Relocation/Removal	LS	1	$ 2,000,000.00	$ 2,000,000.00
	Construction Subtotal, Before Contingencies and Other				$ 4,186,453.33
	Mobilization (10%)				$ 418,645.33
	Contingency (25%; 20% unidentified items + 5% construction)				$ 1,046,613.33
	Design (15% of Construction)				$ 627,968.00
	ICAP (10%)				$ 418,645.33
	Total Cost				$ 6,698,325.00

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CONSTRUCTION COST ESTIMATE

DESCHUTES RIVER FLOOD MITIGATION

MODEL 9B - FLOOD BENCHING WITH CHANNEL (2)

Item No.	Item Description	Unit	Quantity	Unit Cost ($)	Cost ($)
0025	CLEARING AND GRUBBING	AC	9	$ 5,000.00	$ 45,000.00
0050	REMOVAL OF STRUCTURES AND OBSTRUCTIONS	LS	1	$ 42,000.00	$ 42,000.00
0120	REMOVING ASPHALT CONC. PAVEMENT	SY	38,720	$ 5.00	$ 193,600.00
1040	CHANNEL EXCAVATION INCL. HAUL	CY	105,000	$ 15.00	$ 1,575,000.00
6414	SEEDING, FERTILIZING AND MULCHING	AC	17	$ 8,000.00	$ 136,000.00
7008	SHORING OR EXTRA EXCAVATION CLASS B	SF	110,000	$ 0.50	$ 55,000.00
7552	CONSTRUCTION GEOTEXTILE FOR SOIL STABILIZATION	SY	37,111	$ 3.00	$ 111,333.33
N/A	Wetland Study	AC	17	$ 1,000.00	$ 17,000.00
N/A	Utility Locating	HR	72	$ 160.00	$ 11,520.00
N/A	Power Station Demolition	LS	1	$ 75,000.00	$ 75,000.00
	Construction Subtotal, Before Contingencies and Other				$ 2,261,453.33
	Mobilization (10%)				$ 226,145.33
	Contingency (25%; 20% unidentified items + 5% construction)				$ 565,363.33
	Design (15% of Construction)				$ 339,218.00
	ICAP (10%)				$ 226,145.33
	Total Cost				$ 3,618,325.00

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CONSTRUCTION COST ESTIMATE
DESCHUTES RIVER FLOOD MITIGATION
MODEL 10A - FLOOD BENCHING WITH CHANNEL (3)

Item No.	Item Description	Unit	Quantity	Unit Cost ($)	Cost ($)
0025	CLEARING AND GRUBBING	AC	9	$ 5,000.00	$ 45,000.00
0050	REMOVAL OF STRUCTURES AND OBSTRUCTIONS	LS	1	$ 42,000.00	$ 42,000.00
0120	REMOVING ASPHALT CONC. PAVEMENT	SY	38,720	$ 5.00	$ 193,600.00
1040	CHANNEL EXCAVATION INCL. HAUL	CY	100,000	$ 15.00	$ 1,500,000.00
6414	SEEDING, FERTILIZING AND MULCHING	AC	17	$ 8,000.00	$ 136,000.00
7008	SHORING OR EXTRA EXCAVATION CLASS B	SF	110,000	$ 0.50	$ 55,000.00
7552	CONSTRUCTION GEOTEXTILE FOR SOIL STABILIZATION	SY	24,667	$ 3.00	$ 74,000.00
N/A	Wetland Study	AC	17	$ 1,000.00	$ 17,000.00
N/A	Utility Locating	HR	72	$ 160.00	$ 11,520.00
	Construction Subtotal, Before Contingencies and Other				$ 2,074,120.00
	Mobilization (10%)				$ 207,412.00
	Contingency (25%; 20% unidentified items + 5% construction)				$ 518,530.00
	Design (15% of Construction)				$ 311,118.00
	ICAP (10%)				$ 207,412.00
	Total Cost				$ 3,318,592.00

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CONSTRUCTION COST ESTIMATE
DESCHUTES RIVER FLOOD MITIGATION
MODEL 10B - FLOOD BENCHING WITH CHANNEL (4)

Item No.	Item Description	Unit	Quantity	Unit Cost ($)	Cost ($)
0025	CLEARING AND GRUBBING	AC	9	$ 5,000.00	$ 45,000.00
0050	REMOVAL OF STRUCTURES AND OBSTRUCTIONS	LS	1	$ 42,000.00	$ 42,000.00
0120	REMOVING ASPHALT CONC. PAVEMENT	SY	38,720	$ 5.00	$ 193,600.00
1040	CHANNEL EXCAVATION INCL. HAUL	CY	125,000	$ 15.00	$ 1,875,000.00
6414	SEEDING, FERTILIZING AND MULCHING	AC	17	$ 8,000.00	$ 136,000.00
7008	SHORING OR EXTRA EXCAVATION CLASS B	SF	110,000	$ 0.50	$ 55,000.00
7552	CONSTRUCTION GEOTEXTILE FOR SOIL STABILIZATION	SY	37,111	$ 3.00	$ 111,333.33
N/A	Wetland Study	AC	17	$ 1,000.00	$ 17,000.00
N/A	Utility Locating	HR	72	$ 160.00	$ 11,520.00
N/A	Power Station Relocation/Removal	LS	1	$ 2,000,000.00	$ 2,000,000.00
	Construction Subtotal, Before Contingencies and Other				$ 4,486,453.33
	Mobilization (10%)				$ 448,645.33
	Contingency (25%; 20% unidentified items + 5% construction)				$ 1,121,613.33
	Design (15% of Construction)				$ 672,968.00
	ICAP (10%)				$ 448,645.33
	Total Cost				$ 7,178,325.00

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CONSTRUCTION COST ESTIMATE
DESCHUTES RIVER FLOOD MITIGATION
MODEL 10B - FLOOD BENCHING WITH CHANNEL (4)

Item No.	Item Description	Unit	Quantity	Unit Cost ($)	Cost ($)
0025	CLEARING AND GRUBBING	AC	9	$ 5,000.00	$ 45,000.00
0050	REMOVAL OF STRUCTURES AND OBSTRUCTIONS	LS	1	$ 42,000.00	$ 42,000.00
0120	REMOVING ASPHALT CONC. PAVEMENT	SY	38,720	$ 5.00	$ 193,600.00
1040	CHANNEL EXCAVATION INCL. HAUL	CY	125,000	$ 15.00	$ 1,875,000.00
6414	SEEDING, FERTILIZING AND MULCHING	AC	17	$ 8,000.00	$ 136,000.00
7008	SHORING OR EXTRA EXCAVATION CLASS B	SF	110,000	$ 0.50	$ 55,000.00
7552	CONSTRUCTION GEOTEXTILE FOR SOIL STABILIZATION	SY	37,111	$ 3.00	$ 111,333.33
N/A	Wetland Study	AC	17	$ 1,000.00	$ 17,000.00
N/A	Utility Locating	HR	72	$ 160.00	$ 11,520.00
N/A	Power Station Demolition	LS	1	$ 75,000.00	$ 75,000.00
	Construction Subtotal, Before Contingencies and Other				$ 2,561,453.33
	Mobilization (10%)				$ 256,145.33
	Contingency (25%; 20% unidentified items + 5% construction)				$ 640,363.33
	Design (15% of Construction)				$ 384,218.00
	ICAP (10%)				$ 256,145.33
	Total Cost				$ 4,098,325.00