UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
1201 NE Lloyd Boulevard, Suite 1100
PORTLAND, OR 97232-1274

Refer to NMFS No:
WCRO-2020-01652

September 3, 2021

William Abadie
Portland District Regulatory Branch Chief
U.S. Army Corps of Engineers
Attention: CENWP-OD-G
P.O. Box 2946
Portland, Oregon 97208-2946

Re: Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Washington County Department of Land Use & Transportation and Clean Water Service’s SW 198th Avenue Road Improvements and Butternut Creek Stream Enhancements Project (NWP-2018-535), Aloha, Oregon (HUC# 1709001004 Rock Creek – Tualatin River).

Dear Mr. Abadie:

Thank you for your letter of June 23, 2020, requesting initiation of consultation with NOAA’s National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) for the Washington County Department of Land Use & Transportation and Clean Water Service’s SW 198th Avenue Road Improvements and Butternut Creek Stream Enhancements Project. This consultation was conducted in accordance with the 2019 revised regulations that implement section 7 of the ESA (50 CFR 402, 84 FR 45016).

Thank you, also, for your request for consultation pursuant to the essential fish habitat (EFH) provisions in Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1855(b)) for this action.

The enclosed document contains a biological opinion (opinion) prepared by the National Marine Fisheries Service (NMFS) pursuant to section 7(a) (2) of the Endangered Species Act (ESA or “the Act”) on the effects of the U.S. Army Corps of Engineers’ (Corps) proposed issuance of a Clean Water Act (CWA), Section 404 authorization to construct the SW 198th Avenue Road Improvements Project and in-stream habitat improvement activities in Oregon State.

This action is in accordance with the Corps’ regulatory and civil works authorities under section 10 of the Rivers and Harbors Act of 1899, section 404 of the Clean Water Act of 1972, and sections 1135, 206, and 536 of the Water Resources Development Acts of 1986, 1996, and 2000, respectively.

NMFS concluded the proposed programs are not likely to jeopardize the continued existence of the following 15 species, or result in the destruction or adverse modification of their designated critical habitats:

1. Lower Columbia River (LCR) Chinook salmon (*Oncorhynchus tshawytscha*)
2. Upper Willamette River (UWR) Chinook salmon
3. Upper Columbia River (UCR) spring-run Chinook salmon
4. Snake River (SR) spring/summer run Chinook salmon
5. SR fall-run Chinook salmon
6. Columbia River (CR) chum salmon (*O. keta*)
7. LCR coho salmon (*O. kisutch*)
8. SR sockeye salmon (*O. nerka*)
9. LCR steelhead (*O. mykiss*)
10. UWR steelhead
11. MCR steelhead
12. UCR steelhead
13. Snake River Basin (SRB) steelhead
14. Southern distinct population segment (DPS) green sturgeon *(Acipenser medirostris)*
15. Southern DPS eulachon (*Thaleichthys pacificus*)

As required by section 7 of the ESA, NMFS is providing an incidental take statement (ITS) with the opinion. The ITS describes reasonable and prudent measures NMFS considers necessary or appropriate to minimize the impact of incidental take associated with this program. The ITS also sets forth nondiscretionary terms and conditions, including reporting requirements, that the applicant must comply with upon implementation of the proposed action of the Federal action agency. Incidental take from actions that meet these terms and conditions will be exempt from the ESA's prohibition against the take of the listed species considered in this opinion.

Thank you also for your request for consultation pursuant to the essential fish habitat (EFH) provisions in Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA)(16 U.S.C. 1855(b)) for this action. This document includes the results of our analysis of the action's likely effects on EFH pursuant to section 305(b) of the MSA, and includes two conservation recommendations to avoid, minimize, or otherwise offset potential adverse effects on EFH. Section 305(b) (4) (B) of the MSA requires Federal agencies to provide a detailed written response to NMFS within 30 days after receiving these recommendations.

If the response is inconsistent with the EFH conservation recommendations, the Corps must explain why it will not follow the recommendations, including the scientific justification for any disagreements over the effects of the action and the recommendations. In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations NMFS provide as part of each EFH consultation and how many are adopted by the action agency. Therefore, we request that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

Please contact Kate Wells, Oregon Washington Coastal Office (503-230-5437; Kathleen.wells@noaa.gov) if you have any questions concerning this consultation, or if you require additional information.

Sincerely,

Kim W. Kratz. Ph.D
Assistant Regional Administrator
Oregon Washington Coastal Office

cc: Danielle Erb, USACE Project Manager
Matthew Costigan, Washington County Sr. Project Manager
Brian Cook, Clean Water Services Water Resource Project Manager
Anne MacDonald, Clean Water Services Sr. Water Resource Project Manager

Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the

Washington County Department of Land Use & Transportation and Clean Water Service's
SW 198th Avenue Road Improvements and Butternut Creek Stream Enhancements Project
(NWP-2018-535)

NMFS Consultation Number: WCRO-2020-01652

Action Agency: U.S. Army Corps of Engineers

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely To Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Lower Columbia River Chinook salmon (*Oncorhynchus tshawytscha*)	Threatened 6/28/05	Yes	No	Yes	No
Upper Columbia River spring-run Chinook salmon (*O. tshawytscha*)	Endangered 6/28/05	Yes	No	Yes	No
Snake River spring/summer-run Chinook salmon (*O. tshawytscha*)	Threatened 6/28/05	Yes	No	Yes	No
Upper Willamette River Chinook salmon (*O. tshawytscha*)	Threatened 6/28/05	Yes	No	Yes	No
Snake River fall-run Chinook salmon (*O. tshawytscha*)	Threatened 6/28/05	Yes	No	Yes	No
Columbia River chum salmon (*O. keta*)	Threatened 6/28/05	Yes	No	Yes	No
Lower Columbia River coho salmon (*O. kisutch*)	Threatened 6/28/05	Yes	No	Yes	No
Snake River sockeye salmon (*O. nerka)*	Endangered 6/28/05	Yes	No	Yes	No
Upper Columbia River steelhead (*O. mykiss*)	Threatened 1/5/06	Yes	No	Yes	No

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely To Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Lower Columbia River steelhead (*O. mykiss*)	Threatened 1/5/06	Yes	No	Yes	No
Upper Willamette River steelhead (*O. mykiss*)	Threatened 1/5/06	Yes	No	Yes	No
Middle Columbia River steelhead (*O. mykiss*)	Threatened 1/5/06	Yes	No	Yes	No
Snake River basin steelhead (*O. mykiss*)	Threatened 1/5/06	Yes	No	Yes	No
Southern DPS of green sturgeon (*Acipenser medirostris*)	Threatened 4/7/06	Yes	No	Yes	No
Southern DPS of eulachon (*Thaleichthys pacificus*)	Threatened 3/18/10	Yes	No	Yes	No

Fishery Management Plan That Identifies EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Salmon	Yes	Yes

Consultation Conducted By: National Marine Fisheries Service,
West Coast Region

Issued By: ____________________
Kim W. Kratz, Ph.D
Assistant Regional Administrator
Oregon Washington Coastal Office

Date: September 3, 2021

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ACRONYMS & TERMS

ac	Acre
BA	Biological Assessment
BO	Biological Opinion
cfs	cubic feet per second
CHARTs	critical habitat analytical review teams
CIA	Contributing Impervious Area
Corps	United States Army Corps of Engineers
CWA	Clean Water Act
CWS	Clean Water Services
Cy	cubic yard
DLUT	[Washington County] Department of Land Use & Transportation
DPS	Distinct Population Segment
DQA	Data Quality Act
EFH	Essential Fish Habitat
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FAIM	Flood Attenuation Impact Mitigation [Tool]
FR	Federal Register
ft^2	Square feet
HEC-RAS	[Corps] Hydrologic Engineering Center's River Analysis System
HUC	Hydrologic Unit Code
ITS	Incidental Take Statement
LAA	[May Affect] Likely to Adversely Affect
LIDA / LID	Low Impact Design Approaches / Low Impact Design
MSA	Magnuson-Stevens Fisheries Conservation & Management Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic & Atmospheric Administration
NWFSC	Northwest Fisheries Science Center
ODFW	Oregon Department of Fish & Wildlife
OHWM	Ordinary High-Water Mark
Opinion	Biological Opinion for the SW 189th Avenue Road Improvements Project
PBF	Physical or Biological Features
PCE	Primary Constituent Elements
PDC / PDCs	Project Design Criteria
Project	SW 189th Avenue Road Improvements Project
RPM	Reasonable & Prudent Measure
SLOPES Restoration	SLOPES V – Restoration Programmatic Biological Opinion [NWR-2013-9717]
SLOPES STU	SLOPES V – Stormwater, Transportation, and Utilities Programmatic Biological Opinion [NWR-2013-10411]
SLOPES	Standard Local Operating Procedures for Endangered Species
TA	Technical Assistance
TMDL	Total Maximum Daily Load
TRT	Technical Recovery Team
WCRO	[NMFS] West Coast Regional Office

1. INTRODUCTION

This Introduction section provides information relevant to the other sections of this document and is incorporated by reference into Sections 2 and 3, below.

1.1. Background

The National Marine Fisheries Service (NMFS) prepared the biological opinion (opinion) and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 U.S.C. 1531 et seq.), and implementing regulations at 50 CFR 402, as amended.

We also completed an essential fish habitat (EFH) consultation on the proposed action, in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 et seq.) and implementing regulations at 50 CFR 600.

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available within two weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. A complete record of this consultation is on file at Oregon Washington Coastal Office, Portland Oregon.

1.2. Consultation History

On June 23, 2020, the United States (U.S.) Army Corps of Engineers (Corps) submitted for ESA Section 7 review, the SW 198th Avenue Road Improvements and Butternut Creek Stream Habitat Improvements Project; (NWP-2018-535). The action is proposed jointly by Washington County Department of Land Use and Transportation (DLUT) and Clean Water Services (CWS). The Corps evaluated the proposal under Section 404 of the Clean Water Act (CWA) and determined that the project met the conditions for review under Nationwide Permit 14 (Linear Transportation). The issuance of a CWA Section 404 permit is the federal nexus triggering ESA inter-agency review.

The Corps originally submitted the proposed action to NMFS in October 2018 for ESA review through the Standard Local Operating Procedures for Endangered Species V – Stormwater, Transportation and Utilities Programmatic Biological Opinion (SLOPES STU (2014); BO). However, modifications by the applicants to the Project's stormwater detention (flow control) approach, necessitated an individual ESA consultation. The Project modifications entail the implementation of stream corridor enhancements that achieve equivalent protection to the SLOPES STU criteria for flow control. This opinion reviews the modified Project, including the analysis provided by the applicants' consultants of the stream corridor enhancements (beneficial hydromodification) to achieve sufficient stormwater flow control.

The concepts underlying beneficial hydromodification for stormwater flow control have been a technical assistance (TA) topic discussed between CWS and NMFS since mid-2019. TA meetings and pre-consultation (PC) meetings occurred between CWS and NMFS as follows:

April 14, 2017	Technical Assistance (TA)	SLOPES STU criteria for bridge spans above ESA-listed species range and distribution	Email correspondence between Ethan Rosenthal (DEA) and Marc Liverman (NMFS)
June 14, 2018	TA	Preliminary discussion on road project and beneficial hydromodification concepts	Meeting between USACE, CWS Team, and NMFS
May 14, 2019	TA	Presentation on beneficial hydromodification approach	Meeting between Anne MacDonald (CWS) and Marc Liverman and Brad Rawls (NMFS)
June 14, 2019	Pre-Consultation (PC)	Confirmation of permitting approach for SW 198th Ave Project	Email correspondence between Danielle Erb (USACE) and Marc Liverman (NMFS)
July 25, 2019	PC	Discussion on permitting approach	Meeting between Danielle Erb (USACE) and Brad Rawls (NMFS)
July 29, 2019	PC	Discussion on beneficial hydromodification approach	Meeting between Anne MacDonald (CWS) and Brad Rawls (NMFS)
August 8, 2019	PC	Discussion on permitting approach for beneficial hydromodification and information required in BA	Meeting between CWS team and Brad Rawls (NMFS)
September 23, 2019	PC	Butternut Creek site visit with ODFW	Tom Murtagh (ODFW and Brad Rawls (NMFS)
December 20, 2019	PC	Discussion on beneficial hydromodification materials submitted	Call between Anne MacDonald (CWS) and Brad Rawls (NMFS)
January 7, 2020	PC	Discussion on beneficial hydromodification materials submitted	Call between Anne MacDonald (CWS) and Brad Rawls (NMFS)
April 23, 2020	PC	Presentation on beneficial hydromodification approach	Webex meeting between CWS team and Brad Rawls (NMFS)
June 23, 2020	--	Request for formal consultation received	--

The project is located within the upper watershed of Butternut Creek, a tributary to the Tualatin River. All Project activities will occur above the known range and distribution for ESA-listed species; however, the water quality impacts from stormwater runoff from the Project's new impervious surface area extend into habitat occupied by listed species, designated critical habitat, and EFH. Consequently, the Project may affect, and is likely to adversely affect listed species, designated critical habitat and EFH that is downstream of Project activities. Listed species and critical habitat potentially affected are identified in Table 1, below.

Table 1. Project-related Effects to ESA-listed Species, Critical Habitat, and Essential Fish Habitat

ESA-Listed Species	Determination of Effect to Listed Species	Determination of Effect to Critical Habitat	Pathway for Potential Effects
LCR Chinook salmon[1,2]	LAA	LAA	Water quality degradation from stormwater runoff
UCR spring-run Chinook salmon[1,2]	LAA	LAA	Water quality degradation from stormwater runoff
UWR Chinook salmon[1,2]	LAA	LAA	Water quality degradation from stormwater runoff
SR spring/summer-run Chinook salmon[1,3]	LAA	LAA	Water quality degradation from stormwater runoff
SR fall-run Chinook salmon[1,4]	LAA	LAA	Water quality degradation from stormwater runoff
CR chum salmon[1,2]	LAA	LAA	Water quality degradation from stormwater runoff
LCR coho salmon[1,5]	LAA	LAA	Water quality degradation from stormwater runoff
SR sockeye salmon[1,4]	LAA	LAA	Water quality degradation from stormwater runoff
UCR steelhead[6,2]	LAA	LAA	Water quality degradation from stormwater runoff
LCR steelhead[6,2]	LAA	LAA	Water quality degradation from stormwater runoff
UWR steelhead[6,2]	LAA	LAA	Water quality degradation from stormwater runoff;
MCR steelhead[6,2]	LAA	LAA	Water quality degradation from stormwater runoff
SRB steelhead[6,2]	LAA	LAA	Water quality degradation from stormwater runoff
Southern DPS green sturgeon[7,8]	LAA	LAA	Water quality degradation from stormwater runoff
Southern DPS eulachon[9,10]	LAA	LAA	Water quality degradation from stormwater runoff
EFH – Pacific Salmonids[11]	LAA	--	Water quality degradation from stormwater runoff

[1] 70 FR 37160; [2] 70 FR 25630; [3] 64 FR 57399; [4] 58 FR 68543 [5] 81 FR 9252; [6] 71 FR 834; [7] 71 FR 17757; [8] 74 FR 30714; [9] 75 FR 13012; [10] 74 FR 65324; [11] PFMC 2014

1.3. Proposed Federal Action

Under the ESA, “action” means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.02). Under MSA, Federal action means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a Federal Agency (50 CFR 600.910).

The SW 198th Avenue Road Improvement and Butternut Stream Habitat Improvements Project is a priority project identified on Washington County’s Major Streets Transportation Improvement Program list of multimodal road projects approved by the Board of County Commissioners. The Project is situated in the unincorporated community of Aloha, between the cities of Hillsboro and Beaverton (Figure 1). SW 198th Avenue is classified as a collector roadway with houses immediately adjacent to the public right-of-way and driveways accessing directly onto SW 198th Avenue.

The Project will widen SW 198th Avenue, between Farmington Road and the Tualatin Valley Highway and is proposed to improve traffic flow while improving bicycle and pedestrian facilities. The Project has four major components, as follows:

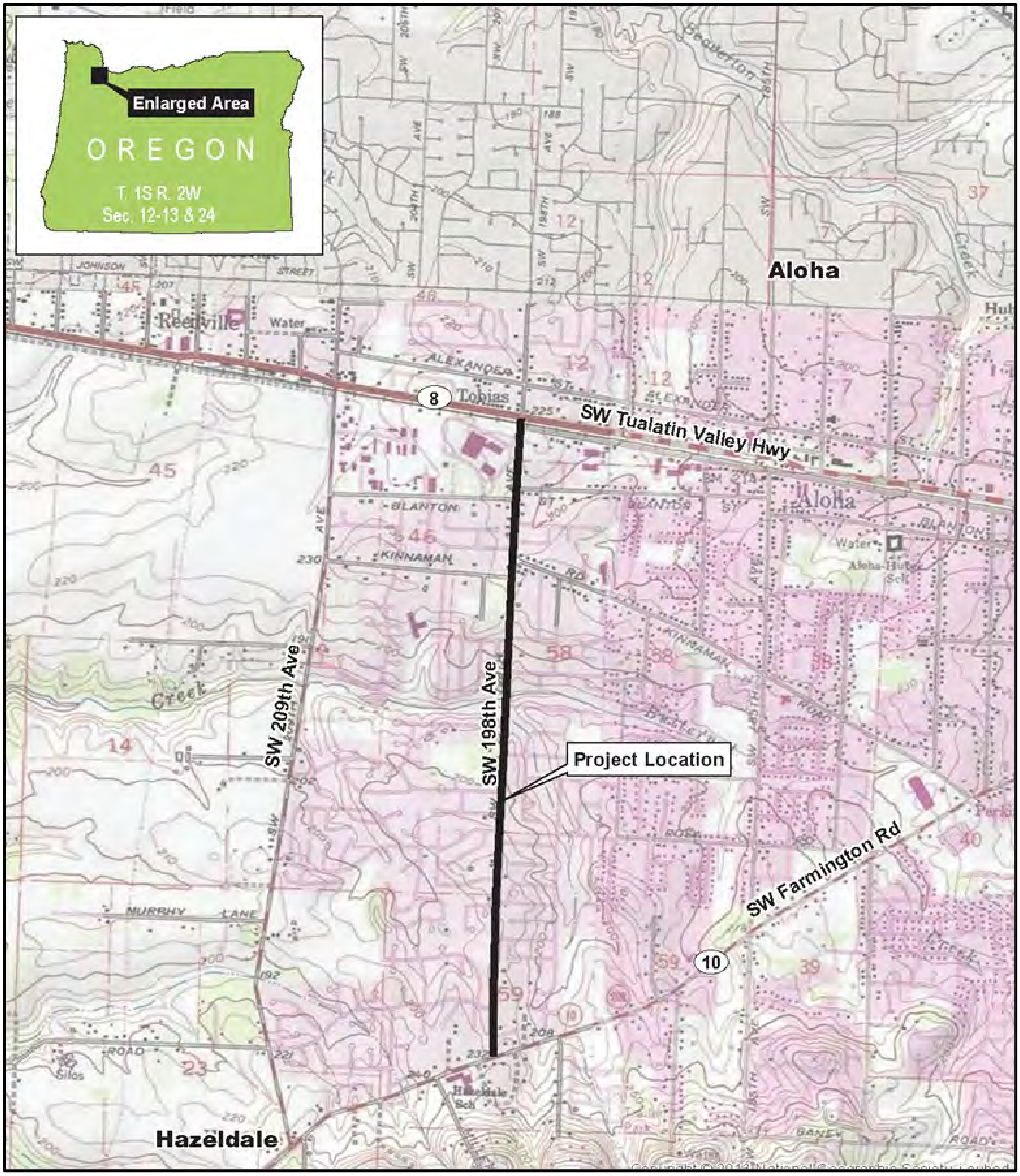


Figure 1. Vicinity Map. Source: Stormwater Management Plan SW 198th Avenue Improvements. David Evans & Associates, Inc. February 2019

Roadway improvements

- Upgrade existing 2-lane roadway to a 3-lane roadway section (1 travel lane in each direction, 1 center turn lane)
- Add 6.5-foot curb tight sidewalks (sidewalks currently absent along most of the road alignment)
- Add 6.0-foot buffered bike lanes (currently no bike lanes present)
- Proposed cross-section dimensions: 11-foot travel lanes, 13-foot center turn lane, and a 2.5-foot street lighting/utility corridor behind the walk on the west side and a 1-foot grading bench on the east side. This equates to a 63.5-foot right-of-way width for a modified 3-lane County Collector.
- Add turn lanes at intersections to include:
    - 1 eastbound left turn lane on SW Carlin Blvd
    - 1 eastbound left turn lane on SW Rosa Road
    - 1 eastbound left turn lane on SW Deline Street
- Enhanced Pedestrian Crossings at SW Southview Street (marked crosswalk) and SW Rosa Road (Rectangular rapid flashing beacon installations)

The Project will create 7.2 acres (ac) of new impervious surface area and collect a total of 20.18 acres (ac) of contributing impervious area (CIA), of which 12.98 ac is existing impervious surface area that is untreated. The project includes the permanent discharge of 2,049 cubic yards (cy) of fill over 0.29 ac of wetlands for road improvements. Temporary fill totaling 247 cy will also occur over 0.02 ac below the ordinary high-water mark (OHWM) of Butternut and Celebrity Creeks for temporary water management and sewer work.

Replacement of existing stream crossings at Celebrity and Butternut creeks

- The existing Butternut Creek Bridge (Washington County Bridge 1214) has an approximate low chord elevation of 172.2 feet with a 23-foot-wide hydraulic opening. The proposed replacement bridge/roadway will have a proposed low chord elevation of 173.8 feet with a 35-foot bridge length (31-foot-wide hydraulic opening). The recommended superstructure will consist of sixteen 21-inch-deep precast pre-stressed slabs with an 8-inch cast-in-place concrete deck. The bridge will be placed at a 15-degree skew to the roadway centerline (rotated counterclockwise) with wing walls along the length of the end panels. There will be twenty 16-inch-diameter metal piles driven in with an impact hammer. Retaining walls will be constructed along the west side in order to reduce impacts to the wetlands. Bridge mounted railings will also be provided at the back of the sidewalks. A natural stream cross-section will be graded under the bridge, allowing for improved fish passage and will include floodplain benches that will provide passage for small wildlife.
- The existing roadway crosses over Celebrity Creek with four 36-inch diameter culverts. The invert elevation varies between each culvert but they have an average invert elevation of approximately 170.4 feet. The proposed crossing will be a 36-foot long, single span bridge with a low chord elevation of 174.9 feet. The proposed bridge will replace the existing culverts and will be placed at a 30-degree skew angle from the roadway centerline (rotated clockwise). The recommended superstructure will consist of sixteen 21-inch-deep precast pre-stressed slabs with an 8-inch cast-in-place deck. There will be twenty 16-inchdiameter metal piles driven in with an impact hammer. The

Celebrity Creek bridge will similarly have wing walls along the length of the end panels, use a retaining wall to minimize impacts to the wetland, and will have bridge mounted railing at the back of sidewalk. A natural stream cross-section will be graded under the bridge, allowing for improved fish passage and will include floodplain benches that will provide passage for small wildlife. A temporary flow bypass will be implemented for each crossing for a period of up to 8 weeks during the in-water work window to allow construction "in the dry" and to avoid discharging sediment into the streamflow. Sandbag cofferdams for flow bypass will comprise a temporary in-water fill while the stream is pumped around the work area. Fish will be removed from the isolated creek sections between the cofferdams as the water within the work area is drawn down.

- Unavoidable impacts to floodplain wetlands associated with Butternut Creek and its tributary Celebrity Creek will be mitigated through the purchase of wetland mitigation bank credits.

Sanitary sewer relocation

- A single 18-inch sanitary sewer main will be relocated 4 to 5 feet to the east of the right-of-way off the west side of SW 198th Avenue through the Butternut and Celebrity Creek floodplain. The majority of the impacts associated with the sewer relocation will be temporary excavation and backfill associated with trenching for the sewer pipe. The relocated sewer alignment will include seven new manholes with watertight lids that will result in minor permanent wetland impacts. The proposed manholes are configured to use the minimum number required to allow for proper maintenance access in accordance CWS design standards. Trench width and depth will range from 3.5 to 4 feet and 7 to 12 feet, respectively.
- The sanitary sewer will cross both Butternut and Celebrity Creeks. To protect this infrastructure from future scour, grade control structures will be placed immediately downstream of the sewer line. These structures will be log cross vanes, a standard structure in stream restoration. The cross vanes will prevent a headcut from proceeding upstream and threatening the sewer line as well as simulating large woody debris. They also are designed to center the thalweg of the stream during normal flow and storm events.

Stream channel habitat enhancement to achieve stormwater flow control and beneficial hydromodification

- Establish an 880 linear foot (lf) treatment reach in Butternut Creek, downstream of the SW 198th Avenue stream crossing in which the following activities will be implemented:
- Regrading along the eroding banks of Butternut Creek to reduce channelization and reconnect the stream channel to the floodplain;
- Install large wood into the stream bed and banks to increase channel roughness, prevent further incision, and provide improved habitat complexity;
- Removal of invasive vegetation species on the floodplain – within publicly-owned lands – and revegetate with native woody and herbaceous species; and
- Install wood habitat structures on the floodplain of Butternut Creek to provide floodplain roughness and habitat.

The vast majority of the proposed action is routine road and culvert improvement activities. Most project elements are consistent with the design criteria and conservation measures from the SLOPES STU opinion. Effects from the proposed action are expected to be mostly consistent with the effects described in the SLOPES STU opinion. However, the applicants are proposing a novel stormwater flow control approach, which has not been analyzed in prior consultations.

The underlying intent of stormwater flow control (detention/retention) facilities or methods is to prevent adverse hydromodification (downcutting, erosion, increased sediment transport, etc.) resulting from stormwater-caused increases to stream power. To date, most hydromodification strategies consist of site-based flow control (detention/retention) measures with site-specific objectives (e.g., detention ponds, infiltration swales, constructed wetlands, underground detention vaults). These site-based approaches provide little to no opportunity for coordination between projects within a watershed. Long-term reversal of reach and stream-level adverse hydromodification effects requires movement away from reliance on localized, site-based approaches to flow control and toward more integrated watershed-scale strategies.

In keeping with this concept, CWS and DLUT propose to meet flow control requirements through implementation of stream corridor enhancements to achieve beneficial hydromodification effects. The applicants assert that such beneficial hydromodification approaches will offset the adverse hydromodification effects of stormwater generated from the SW 198th Project and begin to reverse adverse hydromodification in Butternut Creek that has occurred from prior development in the watershed. By implementing the proposed stream corridor enhancements, higher quality stream corridor habitat located in downstream reaches of Butternut Creek will be extended upstream in the basin as far as is practicable given the constraints of topography, channel alteration, and urban development.

We considered the proposed action for potential short-term, long-term, and cumulative effects from Project activities to listed species and critical habitat. The Project requires construction activities to take place within and adjacent to Butternut and Celebrity Creeks. The short term and long-term construction-related impacts associated with the road improvement project elements are consistent with the design criteria and conservation measures from the SLOPES STU opinion. Effects from the proposed action are expected to be largely consistent with the effects described in the SLOPES STU opinion.

In addition to construction-related impacts, we considered the proposed stream channel enhancements for short and long-term impacts on stream hydrology and stream habitat forming processes, as well as whether such enhancements will provide a comparable level of flow control as more traditional stormwater low impact development (LID) detention/retention approaches approved by NMFS. We considered, under the ESA, whether or not the proposed action would cause any other activities or impacts and determined that the Project would also cause the following activities:

- Short and long-term beneficial hydromodification to the treatment reach as a result of improved channel forming processes;

- Long-term habitat improvements to the in-stream/near-stream environment as a result of increased habitat complexity, removal of invasive species, and re-establishment of native riparian and floodplain vegetation.

2. ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, each Federal agency must ensure that its actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, Federal action agencies consult with NMFS and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provide an opinion stating how the agency's actions would affect listed species and their critical habitats. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

2.1. Analytical Approach

This biological opinion includes both a jeopardy analysis and an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "jeopardize the continued existence of" a listed species, which is "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

This biological opinion relies on the definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species" (50 CFR 402.02).

The designation of critical habitat for species uses the term primary constituent element (PCE) or essential features. The 2016 critical habitat regulations (50 CFR 424.12) replaced this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a "destruction or adverse modification" analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

The 2019 regulations define effects of the action using the term "consequences" (50 CFR 402.02). As explained in the preamble to the regulations (84 FR 44977), that definition does not change the scope of our analysis and in this Opinion we use the terms "effects" and "consequences" interchangeably.

We use the following approach to determine whether a proposed action is likely to jeopardize listed species or destroy or adversely modify critical habitat:

- Evaluate the range-wide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Evaluate the environmental baseline of the species and critical habitat.
- Evaluate the effects of the proposed action on species and their habitat using an exposure-response approach.
- Evaluate cumulative effects.
- In the integration and synthesis, add the effects of the action and cumulative effects to the environmental baseline, and, in light of the status of the species and critical habitat, analyze whether the proposed action is likely to: (1) directly or indirectly reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species, or (2) directly or indirectly result in an alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species.
- If necessary, suggest a reasonable and prudent alternative to the proposed action.

The proposed project was designed to conform to two existing programmatic biological opinions: SLOPES STU (NWR-2013-10411; NMFS 2014a) and SLOPES Restoration (NWR-2013-9717; NMFS 2013b). As previously discussed, the original project was evaluated under the SLOPES STU opinion and found to be consistent with the PDCs established for road widening and utility improvement projects, including those with culvert replacement and increased stormwater generating elements. Table 2 identifies the SLOPES STU PDCs that were found to be applicable and with which the project was found consistent.

Table 2. SLOPES V – STU PDCs Applicable for the SW 198th Avenue Improvement Project

PDC 5: Full Implementation Required	PDC 23: Temporary Access Roads and Paths
PDC 6: Site Access	PDC 25: Equipment, Vehicles and Power Tools
PDC 7: Project Completion Report	PDC 26: Site Layout and Flagging
PDC 9: Site Restoration Report	PDC 27: Staging, Storage, and Stockpile Areas
PDC 13: Project Design	PDC 30: Erosion Control
PDC 14: In-Water Work Timing	PDC 34: Work Area Isolation
PDC 15: Pile Installation	PDC 36: Actions Requiring Stormwater Management
PDC 18: Fish Capture and Release	PDC 42: Road Maintenance, Rehabilitation and Replacement (a, b, e)
PDC 19: Fish Passage	PDC 43: Utility Line Stream Crossings (a, e)
PDC 20: Fish Screens	

As previously mentioned, SLOPES STU PDC 36 c. iii. requires water quantity treatment (retention or detention facilities) for projects discharging to water bodies not considered to be "major water bodies." The proposed action, prior to modification, included an off-line stormwater detention pond to comply with PDC 36 c. iii. The proposed modification – replacing the stormwater detention pond with stream corridor enhancements – requires construction practices more commonly associated with stream restoration activities. As such, the BA identifies the construction-related effects of the stream enhancement elements, which were designed to comply with the PDCs found in the SLOPES Restoration opinion (NMFS 2013b) as listed in Table 3, below.

Table 3. SLOPES V – Restoration PDCs Applicable for the SW 198th Avenue Improvement Project's Stream Corridor Enhancements

PDC 3: Full Implementation Required	PDC 19: Temporary Stream Crossings
PDC 6: Site Access	PDC 21: Fish Passage
PDC 7: Monitoring & Reporting	PDC 22: In-Water Work Timing
PDC 10: Project Design	PDC 23: Work Area Isolation
PDC 12: Site Layout and Flagging	PDC 24: Fish Capture
PDC 13: Staging, Storage, and Stockpile Areas	PDC 25: Site Restoration
PDC 14: Erosion Control	PDC 26: Revegetation
PDC 16: Equipment, Vehicles and Power Tools	PDC 27: Invasive and Non-native Plant Control
PDC 17: Temporary Access Roads and Paths	PDC 30: Large Wood Placement
	PDC 35 Streambank Restoration

This analysis evaluates the proposed stream corridor enhancement activities relative to the SLOPES V – Restoration PDCs for consistency. This method of analysis – assessing project activities for consistency to PDCs found in the two SLOPES opinions – ensures that the proposed activities maintain the protection and conservation intent of those opinions. Further, consistency analysis reduces repetition of assessments of commonplace and well understood construction activities and project actions that underpin the programmatic opinion framework. Consequently, this Opinion focuses primarily on the proposed project elements that fall outside the analyses conducted for the SLOPES opinions; specifically, the use of stream corridor enhancements as a mechanism for achieving stormwater runoff flow control.

The BA proposes a novel approach to assessing stream corridor enhancements to achieve stormwater flow control. The first element in this approach is development of a tool to determine "how much" corridor enhancement is required to achieve the desired flow control; this Opinion uses the terminology "Treatment Reach Length Assessment Tool" (or "Assessment Tool") to refer to this approach. The second element is a hydraulic model of the proposed stream corridor enhancements to validate their flow control capabilities and the adequacy of the assessment tool. Flow control is assessed both for the creation of sufficient peak runoff storage in the treatment reach and the decrease in stream power comparable to the SLOPES STU flow control criteria. The stated goal of this approach is to allow CWS and Washington County DLUT to identify treatment reaches in other watersheds and estimate the treatment length necessary to offset anticipated stormwater runoff impacts associated with future capital improvement projects that include substantial stormwater elements.

From the BA (W^2W 2020), [edited for clarity and consistency of terminology]:

> The intention of water quantity treatment regulations using flow detention is to account for the cumulative effects of impervious areas in watersheds. For purposes of determining the amount of stream corridor enhancement that would offset impacts of runoff from new impervious surface [associated with the SW] 198th Avenue [P]roject . . . direct impacts are those resulting from the energy (measured

as stream power) of the runoff volume increase. Where such increases are negligible, these direct effects can be managed as energy dissipation at the location of stormwater discharge to the channel corridor. Whereas, the effects of increased discharge on streams from an individual development are often not discernable, while watershed-wide changes in runoff volume from the cumulative impervious area can still have observable effects. Such effects are most commonly demonstrated by increased incision, bank erosion, and channel simplification. To provide a measure of an individual project's contribution to these cumulative effects, [CWS] used the total length of stream channel and total impervious area within the Butternut Creek basin to develop a cumulative impacts index. The expectation is that the entire corridor width at all locations within the enhanced length of the stream will benefit, that functional lift will extend over an area rather than a length of stream corridor. This was used to determine the stream corridor reach length necessary to address the effects of the addition of impervious area from the [SW] 198th Project, as shown below.

$$\text{Cumulative Impacts Index} = \frac{\text{(length of stream channel in basin)}}{\text{(impervious area in basin)}}$$

The [SW] 198th Project will add 7.2 acres of new impervious area and have a total contributing impervious area (CIA) of 20.18 acres. As measured at the downstream limit of Reach 1 [Figure 2], there is 30,754 linear feet of stream channel in the basin, and there will be 754 acres of impervious area in the basin after the [SW] 198th Project is constructed. [CWS] estimates that at full build-out of the basin, associated with future development projects, under current zoning, there will be approximately 850 acres of impervious surface.

Figure 2. Project Reach Map. Source: Technical Memorandum. Butternut Creek at Witzig Reservoir – Hydraulic Changes Associated with Changed Hydrology and Channel Restoration. Otak, September 27, 2019 [included as appendix to BA (W2R 2020)].

Based on the above method, the calculated treatment reach length for stream corridor enhancements in Butternut Creek to offset the stormwater inputs from the new impervious surface area and CIA associated with the SW 198th Avenue Project are:

$$\frac{\underline{20.18 \text{ ac} \times (30{,}754 \text{ lf})}}{(754 \text{ ac})} = 821 \text{ lf of treatment reach length}$$

CWS is proposing to perform stream corridor enhancements on the entire 880 linear feet of Reach 1 along Butternut Creek, as this constitutes an appropriate scale for an enhancement project and exceeds the minimum reach length as calculated above. Habitat enhancement is proposed across the full width of the undeveloped stream corridor within the floodplain on City of Hillsboro property (W^2R 2020).

The stream corridor enhancements proposed within Butternut Creek Reach 1 (the Treatment Reach) will include the following elements:

- Minor regrading along the eroding banks of the Treatment Reach to reduce stream velocities;
- Large wood placements incorporated into the stream bed and banks to increase channel roughness, prevent any further incision, and provide improved habitat complexity;

- Extensive removal of invasive vegetation species on the floodplain and revegetation with native woody and herbaceous species; and
- Wood habitat structures incorporated into the floodplain of the Treatment Reach to provide floodplain roughness and habitat.

Proposed enhancement elements are depicted in Figure 3.

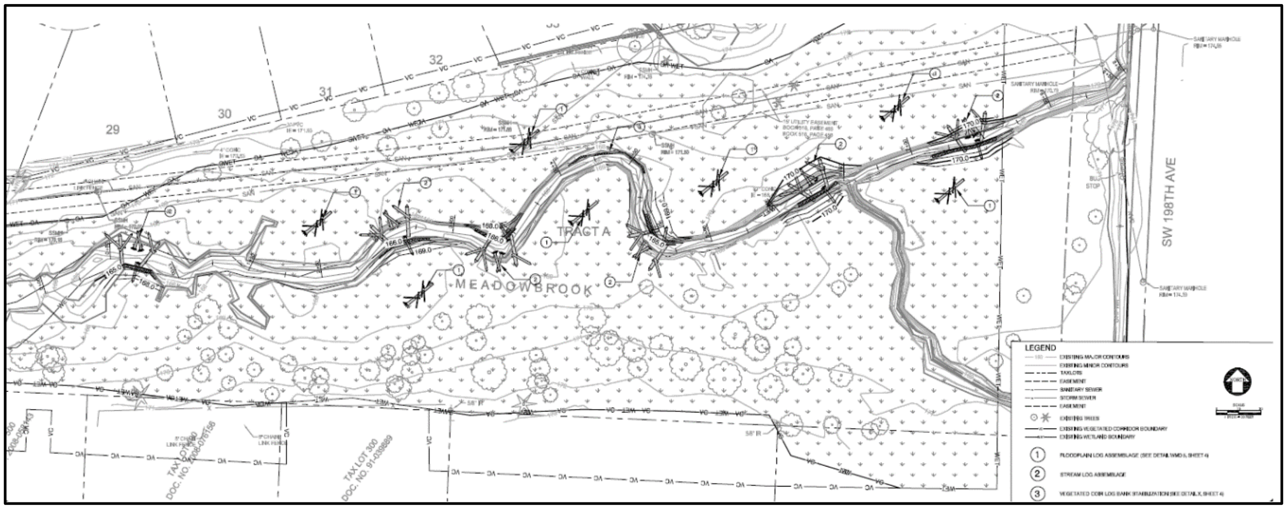


Figure 3. Proposed Stream Corridor Enhancements for Butternut Creek Treatment Reach. Source: Technical Memorandum. Butternut Creek at Witzig Reservoir – Hydraulic Changes Associated with Changed Hydrology and Channel Restoration. Otak, September 27, 2019 [included as appendix to BA (W2R 2020)].

The full engineering sheet for Figure 4 is included in Appendix A of this Opinion, along with typical drawings for floodplain-placed wood habitat structures, stream log assemblies, and channel grading stabilization/erosion control details.

Hydraulic conditions along the Treatment Reach, where the stream corridor enhancements are proposed, were analyzed using a one-dimensional (1-D) hydraulic model (Appendix A). The modeling was carried out using version 5.07 of the Corps' Hydrologic Engineering Center's River Analysis System (HEC-RAS) software (ACOE 2016). The HEC-RAS model was run over a range of flows to evaluate changes in hydraulic conditions, along a series of cross-sections within Butternut Creek Reach 1 that estimated the geometry of the proposed structural modifications to the corridor included in the Project. This included an evaluation of changes in main-channel velocities, which is an important metric in determining susceptibility to erosion. The development and calibration of the estimating tool is intended to obviate the need to conduct a hydraulic model for future stream corridor enhancement applications/locations.
Due to the technical nature of the hydraulic model supporting the BA, NMFS has adopted the information and analyses included in *Technical Memorandum: Butternut Creek at Witzig Reservoir – Hydraulic Changes Associated with Changed Hydrology and Channel Restoration.* (Otak 2019) and included the document, in full, as Appendix A of this Opinion. The technical

memorandum was provided as an attachment to the submitted BA. NMFS has evaluated this document and after our independent, science-based evaluation, determined it meets our regulatory and scientific standards. A summary of the technical memo's findings appears in Section 2.5 Effects of the Action, in this Opinion.

2.2. Rangewide Status of the Species and Critical Habitat

This opinion examines the status of each species that would be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' "reproduction, numbers, or distribution" as described in 50 CFR 402.02. The opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the function of the PBFs that are essential for the conservation of the species.

One factor affecting the status of ESA-listed species considered in this opinion, and aquatic habitat at large, is climate change. Climate change is likely to play an increasingly important role in determining the abundance and distribution of ESA-listed species, and the conservation value of designated critical habitats, in the Pacific Northwest. These changes will not be spatially homogeneous across the Pacific Northwest. The largest hydrologic responses are expected to occur in basins with significant snow accumulation, where warming decreases snow pack, increases winter flows, and advances the timing of spring melt (Mote et al. 2014, Mote et al 2016). Rain-dominated watersheds and those with significant contributions from groundwater may be less sensitive to predicted changes in climate (Tague et al. 2013, Mote et al. 2014).

During the last century, average regional air temperatures in the Pacific Northwest increased by 1-1.4°F as an annual average, and up to 2°F in some seasons (based on average linear increase per decade; Abatzoglou et al. 2014; Kunkel et al. 2013). Warming is likely to continue during the next century as average temperatures are projected to increase another 3 to 10°F, with the largest increases predicted to occur in the summer (Mote et al. 2014).

Decreases in summer precipitation of as much as 30% by the end of the century are consistently predicted across climate models (Mote et al. 2014). Precipitation is more likely to occur during October through March, less during summer months, and more winter precipitation will be rain than snow (ISAB 2007; Mote et al. 2013). Earlier snowmelt will cause lower stream flows in late spring, summer, and fall, and water temperatures will be warmer (ISAB 2007; Mote et al. 2013). Models consistently predict increases in the frequency of severe winter precipitation events (i.e., 20-year and 50-year events), in the western United States (Dominguez et al. 2012). The largest increases in winter flood frequency and magnitude are predicted in mixed rain-snow watersheds (Mote et al. 2014).

Overall, about one-third of the current cold-water salmonid habitat in the Pacific Northwest is likely to exceed key water temperature thresholds by the end of this century (Mantua et al. 2009).

Higher temperatures will reduce the quality of available salmonid habitat for most freshwater life stages (ISAB 2007). Reduced flows will make it more difficult for migrating fish to pass physical and thermal obstructions, limiting their access to available habitat (Mantua et al. 2010; Isaak et al. 2012). Temperature increases shift timing of key life cycle events for salmonids and species forming the base of their aquatic food web (Crozier et al. 2011; Tillmann and Siemann 2011; Winder and Schindler 2004). Higher stream temperatures will also cause decreases in dissolved oxygen and may also cause earlier onset of stratification and reduced mixing between layers in lakes and reservoirs, which can also result in reduced oxygen (Meyer et al. 1999; Winder and Schindler 2004, Raymondi et al. 2013). Higher temperatures are likely to cause several species to become more susceptible to parasites, disease, and higher predation rates (Crozier et al. 2008; Wainwright and Weitkamp 2013; Raymondi et al. 2013).

As more basins become rain-dominated and prone to more severe winter storms, higher winter stream flows may increase the risk that winter or spring floods in sensitive watersheds will damage spawning redds and wash away incubating eggs (Goode et al. 2013). Earlier peak stream flows will also alter migration timing for salmon smolts, and may flush some young salmon and steelhead from rivers to estuaries before they are physically mature, increasing stress and reducing smolt survival (McMahon and Hartman 1989; Lawson et al. 2004).

In addition to changes in freshwater conditions, predicted changes for coastal waters in the Pacific Northwest as a result of climate change include increasing surface water temperature, increasing but highly variable acidity, and increasing storm frequency and magnitude (Mote et al. 2014). Elevated ocean temperatures already documented for the Pacific Northwest are highly likely to continue during the next century, with sea surface temperature projected to increase by 1.0-3.7° C by the end of the century (IPCC 2014). Habitat loss, shifts in species' ranges and abundances, and altered marine food webs could have substantial consequences to anadromous, coastal, and marine species in the Pacific Northwest (Tillmann and Siemann 2011, Reeder et al. 2013).

Moreover, as atmospheric carbon emissions increase, increasing levels of carbon are absorbed by the oceans, changing the pH of the water. Acidification also impacts sensitive estuary habitats, where organic matter and nutrient inputs further reduce pH and produce conditions more corrosive than those in offshore waters (Feely et al. 2012, Sunda and Cai 2012).

Global sea levels are expected to continue rising throughout this century, reaching likely predicted increases of 10-32 inches by 2081-2100 (IPCC 2014). These changes will likely result in increased erosion and more frequent and severe coastal flooding, and shifts in the composition of nearshore habitats (Tillmann and Siemann 2011, Reeder et al. 2013). Estuarine-dependent salmonids such as chum and Chinook salmon are predicted to be impacted by significant reductions in rearing habitat in some Pacific Northwest coastal areas (Glick et al. 2007).

Historically, warm periods in the coastal Pacific Ocean have coincided with relatively low abundances of salmon and steelhead, while cooler ocean periods have coincided with relatively high abundances, and therefore these species are predicted to fare poorly in warming ocean conditions (Scheuerell and Williams 2005; Zabel et al. 2006). This is supported by the recent observation that anomalously warm sea surface temperatures off the coast of Washington from

2013 to 2016 resulted in poor coho and Chinook salmon body condition for juveniles caught in those waters (NWFSC 2015). Changes to estuarine and coastal conditions, as well as the timing of seasonal shifts in these habitats, have the potential to impact a wide range of listed aquatic species (Tillmann and Siemann 2011, Reeder et al. 2013).

The adaptive ability of these threatened and endangered species is depressed due to reductions in population size, habitat quantity and diversity, and loss of behavioral and genetic variation. Without these natural sources of resilience, systematic changes in local and regional climatic conditions due to anthropogenic global climate change will likely reduce long-term viability and sustainability of populations in many of these ESUs (NWFSC 2015). New stressors generated by climate change, or existing stressors with effects that have been amplified by climate change, may also have synergistic impacts on species and ecosystems (Doney et al. 2012). These conditions will possibly intensify the climate change stressors inhibiting recovery of ESA-listed species in the future

2.2.1 Status of the Species

Table 4, below provides a summary of listing and recovery plan information, status summaries and limiting factors for the species addressed in this opinion. More information can be found in recovery plans and status reviews for these species. Acronyms appearing in the table include DPS (Distinct Population Segment), ESU (Evolutionarily Significant Unit), ICTRT (Interior Columbia Technical Recovery Team), MPG (Multiple Population Grouping), NWFSC (Northwest Fisheries Science Center), TRT (Technical Recovery Team), and VSP (Viable Salmonid Population).

Table 4. Listing classification and date, recovery plan reference, most recent status review, status summary, and limiting factors for each species considered in this opinion.

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Lower Columbia River Chinook salmon	Threatened 6/28/05	NMFS 2013a	NWFSC 2015	This ESU comprises 32 independent populations. Twenty-seven populations are at very high risk, 2 populations are at high risk, one population is at moderate risk, and 2 populations are at very low risk Overall, there was little change since the last status review in the biological status of this ESU, although there are some positive trends. Increases in abundance were noted in about 70% of the fall-run populations and decreases in hatchery contribution were noted for several populations. Relative to baseline VSP levels identified in the recovery plan, there has been an overall improvement in the status of a number of fall-run populations, although most are still far from the recovery plan goals.	• Reduced access to spawning and rearing habitat • Hatchery-related effects • Harvest-related effects on fall Chinook salmon • An altered flow regime and Columbia River plume • Reduced access to off-channel rearing habitat • Reduced productivity resulting from sediment and nutrient-related changes in the estuary • Contaminant
Upper Columbia River spring-run Chinook salmon	Endangered 6/28/05	Upper Columbia Salmon Recovery Board 2007	NWFSC 2015	This ESU comprises four independent populations. Three are at high risk and one is functionally extirpated. Current estimates of natural origin spawner abundance increased relative to the levels observed in the prior review for all three extant populations, and productivities were higher for the Wenatchee and Entiat populations and unchanged for the Methow population. However, abundance and productivity remained well below the viable thresholds called for in the Upper Columbia Recovery Plan for all three populations.	• Effects related to hydropower system in the mainstem Columbia River • Degraded freshwater habitat • Degraded estuarine and nearshore marine habitat • Hatchery-related effects • Persistence of non-native (exotic) fish species • Harvest in Columbia River fisheries

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Snake River spring/summer-run Chinook salmon	Threatened 6/28/05	NMFS 2017c	NWFSC 2015	This ESU comprises 28 extant and four extirpated populations. All expect one extant population (Chamberlin Creek) are at high risk. Natural origin abundance has increased over the levels reported in the prior review for most populations in this ESU, although the increases were not substantial enough to change viability ratings. Relatively high ocean survivals in recent years were a major factor in recent abundance patterns. While there have been improvements in abundance and productivity in several populations relative to prior reviews, those changes have not been sufficient to warrant a change in ESU status.	• Degraded freshwater habitat • Effects related to the hydropower system in the mainstem Columbia River, • Altered flows and degraded water quality • Harvest-related effects • Predation

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Upper Willamette River Chinook salmon	Threatened 6/28/05	ODFW & NMFS 2011	NWFSC 2015	This ESU comprises seven populations. Five populations are at very high risk, one population is at moderate risk (Clackamas River) and one population is at low risk (McKenzie River). Consideration of data collected since the last status review in 2010 indicates the fraction of hatchery origin fish in all populations remains high (even in Clackamas and McKenzie populations). The proportion of natural origin spawners improved in the North and South Santiam basins, but is still well below identified recovery goals. Abundance levels for five of the seven populations remain well below their recovery goals. Of these, the Calapooia River may be functionally extinct and the Molalla River remains critically low. Abundances in the North and South Santiam rivers have risen since the 2010 review, but still range only in the high hundreds of fish. The Clackamas and McKenzie populations have previously been viewed as natural population strongholds, but have both experienced declines in abundance despite having access to much of their historical spawning habitat. Overall, populations appear to be at either moderate or high risk, there has been likely little net change in the VSP score for the ESU since the last review, so the ESU remains at moderate risk.	• Degraded freshwater habitat • Degraded water quality • Increased disease incidence • Altered stream flows • Reduced access to spawning and rearing habitats • Altered food web due to reduced inputs of microdetritus • Predation by native and non-native species, including hatchery fish • Competition related to introduced salmon and steelhead • Altered population traits due to fisheries and bycatch

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Snake River fall-run Chinook salmon	Threatened 6/28/05	NMFS 2017a	NWFSC 2015	This ESU has one extant population. Historically, large populations of fall Chinook salmon spawned in the Snake River upstream of the Hells Canyon Dam complex. The extant population is at moderate risk for both diversity and spatial structure and abundance and productivity. The overall viability rating for this population is 'viable.' Overall, the status of Snake River fall Chinook salmon has clearly improved compared to the time of listing and compared to prior status reviews. The single extant population in the ESU is currently meeting the criteria for a rating of 'viable' developed by the ICTRT, but the ESU as a whole is not meeting the recovery goals described in the recovery plan for the species, which require the single population to be "highly viable with high certainty" and/or will require reintroduction of a viable population above the Hells Canyon Dam complex.	• Degraded floodplain connectivity and function • Harvest-related effects • Loss of access to historical habitat above Hells Canyon and other Snake River dams • Impacts from mainstem Columbia River and Snake River hydropower systems • Hatchery-related effects • Degraded estuarine and nearshore habitat.
Columbia River chum salmon	Threatened 6/28/05	NMFS 2013a	NWFSC 2015	Overall, the status of most chum salmon populations is unchanged from the baseline VSP scores estimated in the recovery plan. A total of 3 of 17 populations are at or near their recovery viability goals, although under the recovery plan scenario these populations have very low recovery goals of 0. The remaining populations generally require a higher level of viability and most require substantial improvements to reach their viability goals. Even with the improvements observed during the last five years, the majority of populations in this ESU remain at a high or very high risk category and considerable progress remains to be made to achieve the recovery goals.	• Degraded estuarine and nearshore marine habitat • Degraded freshwater habitat • Degraded stream flow as a result of hydropower and water supply operations • Reduced water quality • Current or potential predation • An altered flow regime and Columbia River plume • Reduced access to off-channel rearing habitat in the lower Columbia River • Reduced productivity resulting from sediment and nutrient-related changes in the estuary • Juvenile fish wake strandings • Contaminants

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Lower Columbia River coho salmon	Threatened 6/28/05	NMFS 2013a	NWFSC 2015	Of the 24 populations that make up this ESU, 21 populations are at very high risk, 1 population is at high risk, and 2 populations are at moderate risk. Recent recovery efforts may have contributed to the observed natural production, but in the absence of longer term data sets it is not possible to parse out these effects. Populations with longer term data sets exhibit stable or slightly positive abundance trends. Some trap and haul programs appear to be operating at or near replacement, although other programs still are far from that threshold and require supplementation with additional hatchery-origin spawners .Initiation of or improvement in the downstream juvenile facilities at Cowlitz Falls, Merwin, and North Fork Dam are likely to further improve the status of the associated upstream populations. While these and other recovery efforts have likely improved the status of a number of coho salmon populations, abundances are still at low levels and the majority of the populations remain at moderate or high risk. For the Lower Columbia River region land development and increasing human population pressures will likely continue to degrade habitat, especially in lowland areas. Although populations in this ESU have generally improved, especially in the 2013/14 and 2014/15 return years, recent poor ocean conditions suggest that population declines might occur in the upcoming return years	• Degraded estuarine and near-shore marine habitat • Fish passage barriers • Degraded freshwater habitat: Hatchery-related effects • Harvest-related effects • An altered flow regime and Columbia River plume • Reduced access to off-channel rearing habitat in the lower Columbia River • Reduced productivity resulting from sediment and nutrient-related changes in the estuary • Juvenile fish wake strandings • Contaminants

Species	**Listing Classification and Date**	**Recovery Plan Reference**	**Most Recent Status Review**	**Status Summary**	**Limiting Factors**
Snake River sockeye salmon	Endangered 6/28/05	NMFS 2015b	NWFSC 2015	This single population ESU is at very high risk dues to small population size. There is high risk across all four basic risk measures. Although the captive brood program has been successful in providing substantial numbers of hatchery produced fish for use in supplementation efforts, substantial increases in survival rates across all life history stages must occur to re-establish sustainable natural production In terms of natural production, the Snake River Sockeye ESU remains at extremely high risk although there has been substantial progress on the first phase of the proposed recovery approach – developing a hatchery based program to amplify and conserve the stock to facilitate reintroductions.	• Effects related to the hydropower system in the mainstem Columbia River • Reduced water quality and elevated temperatures in the Salmon River • Water quantity • Predation
Upper Columbia River steelhead	Threatened 1/5/06	Upper Columbia Salmon Recovery Board 2007	NWFSC 2015	This DPS comprises four independent populations. Three populations are at high risk of extinction while 1 population is at moderate risk. Upper Columbia River steelhead populations have increased relative to the low levels observed in the 1990s, but natural origin abundance and productivity remain well below viability thresholds for three out of the four populations. The status of the Wenatchee River steelhead population continued to improve based on the additional year's information available for the most recent review. The abundance and productivity viability rating for the Wenatchee River exceeds the minimum threshold for 5% extinction risk. However, the overall DPS status remains unchanged from the prior review, remaining at high risk driven by low abundance and productivity relative to viability objectives and diversity concerns.	• Adverse effects related to the mainstem Columbia River hydropower system • Impaired tributary fish passage • Degraded floodplain connectivity and function, channel structure and complexity, riparian areas, large woody debris recruitment, stream flow, and water quality • Hatchery-related effects • Predation and competition • Harvest-related effects

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Lower Columbia River steelhead	Threatened 1/5/06	NMFS 2013a	NWFSC 2015	This DPS comprises 23 historical populations, 17 winter-run populations and six summer-run populations. Nine populations are at very high risk, 7 populations are at high risk, 6 populations are at moderate risk, and 1 population is at low risk. The majority of winter-run steelhead populations in this DPS continue to persist at low abundances. Hatchery interactions remain a concern in select basins, but the overall situation is somewhat improved compared to prior reviews. Summer-run steelhead populations were similarly stable, but at low abundance levels. The decline in the Wind River summer-run population is a source of concern, given that this population has been considered one of the healthiest of the summer-runs; however, the most recent abundance estimates suggest that the decline was a single year aberration. Passage programs in the Cowlitz and Lewis basins have the potential to provide considerable improvements in abundance and spatial structure, but have not produced self-sustaining populations to date. Even with modest improvements in the status of several winter-run DIPs, none of the populations appear to be at fully viable status, and similarly none of the MPGs meet the criteria for viability.	• Degraded estuarine and nearshore marine habitat • Degraded freshwater habitat • Reduced access to spawning and rearing habitat • Avian and marine mammal predation • Hatchery-related effects • An altered flow regime and Columbia River plume • Reduced access to off-channel rearing habitat in the lower Columbia River • Reduced productivity resulting from sediment and nutrient-related changes in the estuary • Juvenile fish wake strandings • Contaminants

Species	**Listing Classification and Date**	**Recovery Plan Reference**	**Most Recent Status Review**	**Status Summary**	**Limiting Factors**
Upper Willamette River steelhead	Threatened 1/5/06	ODFW & NMFS 2011	NWFSC 2015	This DPS has four demographically independent populations. Three populations are at low risk and one population is at moderate risk. Declines in abundance noted in the last status review continued through the period from 2010-2015. While rates of decline appear moderate, the DPS continues to demonstrate the overall low abundance pattern that was of concern during the last status review. The causes of these declines are not well understood, although much accessible habitat is degraded and under continued development pressure. The elimination of winter-run hatchery release in the basin reduces hatchery threats, but non-native summer steelhead hatchery releases are still a concern for species diversity and a source of competition for the DPS. While the collective risk to the persistence of the DPS has not changed significantly in recent years, continued declines and potential negative impacts from climate change may cause increased risk in the near future.	• Degraded freshwater habitat • Degraded water quality • Increased disease incidence • Altered stream flows • Reduced access to spawning and rearing habitats due to impaired passage at dams • Altered food web due to changes in inputs of microdetritus • Predation by native and non-native species, including hatchery fish and pinnipeds • Competition related to introduced salmon and steelhead • Altered population traits due to interbreeding with hatchery origin fish
Middle Columbia River steelhead	Threatened 1/5/06	NMFS 2009b	NWFSC 2015	This DPS comprises 17 extant populations. The DPS does not currently include steelhead that are designated as part of an experimental population above the Pelton Round Butte Hydroelectric Project. Returns to the Yakima River basin and to the Umatilla and Walla Walla Rivers have been higher over the most recent brood cycle, while natural origin returns to the John Day River have decreased. There have been improvements in the viability ratings for some of the component populations, but the DPS is not currently meeting the viability criteria in the MCR steelhead recovery plan. In general, the majority of population level viability ratings remained unchanged from prior reviews for each major population group within the DPS.	• Degraded freshwater habitat • Mainstem Columbia River hydropower-related impacts • Degraded estuarine and nearshore marine habitat • Hatchery-related effects • Harvest-related effects • Effects of predation, competition, and disease

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Snake River basin steelhead	Threatened 1/5/06	NMFS 2017a	NWFSC 2015	This DPS comprises 24 populations. Two populations are at high risk, 15 populations are rated as maintained, 3 populations are rated between high risk and maintained, 2 populations are at moderate risk, 1 population is viable, and 1 population is highly viable. Four out of the five MPGs are not meeting the specific objectives in the draft recovery plan based on the updated status information available for this review, and the status of many individual populations remains uncertain A great deal of uncertainty still remains regarding the relative proportion of hatchery fish in natural spawning areas near major hatchery release sites within individual populations.	• Adverse effects related to the mainstem Columbia River hydropower system • Impaired tributary fish passage • Degraded freshwater habitat • Increased water temperature • Harvest-related effects, particularly for B-run steelhead • Predation • Genetic diversity effects from out-of-population hatchery releases
Southern DPS of green sturgeon	Threatened 4/7/06	NMFS 2018	NMFS 2015a	The Sacramento River contains the only known green sturgeon spawning population in this DPS. The current estimate of spawning adult abundance is between 824-1,872 individuals. Telemetry data and genetic analyses suggest that Southern DPS green sturgeon generally occur from Graves Harbor, Alaska to Monterey Bay, California and, within this range, most frequently occur in coastal waters of Washington, Oregon, and Vancouver Island and near San Francisco and Monterey bays. Within the nearshore marine environment, tagging and fisheries data indicate that Northern and Southern DPS green sturgeon prefer marine waters of less than a depth of 110 meters.	• Reduction of its spawning area to a single known population • Lack of water quantity • Poor water quality • Poaching

Species	**Listing Classification and Date**	**Recovery Plan Reference**	**Most Recent Status Review**	**Status Summary**	**Limiting Factors**
Southern DPS of eulachon	Threatened 3/18/10	NMFS 2017b	Gustafson et al. 2016	The Southern DPS of eulachon includes all naturally-spawned populations that occur in rivers south of the Nass River in British Columbia to the Mad River in California. Sub populations for this species include the Fraser River, Columbia River, British Columbia and the Klamath River. In the early 1990s, there was an abrupt decline in the abundance of eulachon returning to the Columbia River. Despite a brief period of improved returns in 2001-2003, the returns and associated commercial landings eventually declined to the low levels observed in the mid-1990s. Although eulachon abundance in monitored rivers has generally improved, especially in the 2013-2015 return years, recent poor ocean conditions and the likelihood that these conditions will persist into the near future suggest that population declines may be widespread in the upcoming return years	• Changes in ocean conditions due to climate change, particularly in the southern portion of the species' range where ocean warming trends may be the most pronounced and may alter prey, spawning, and rearing success. • Climate-induced change to freshwater habitats • Bycatch of eulachon in commercial fisheries • Adverse effects related to dams and water diversions • Water quality, • Shoreline construction • Over harvest • Predation

2.2.2 Status of the Critical Habitat

This section describes the status of designated critical habitat affected by the proposed action by examining the condition and trends of the essential physical and biological features of that habitat throughout the designated areas. These features are essential to the conservation of the ESA-listed species because they support one or more of the species' life stages (e.g., sites with conditions that support spawning, rearing, migration and foraging).

For most salmon and steelhead, NMFS' critical habitat analytical review teams (CHARTs) ranked watersheds within designated critical habitat at the scale of the fifth-field hydrologic unit code (HUC5) in terms of the conservation value they provide to each ESA-listed species that they support (NMFS 2005). The conservation rankings were high, medium, or low. To determine the conservation value of each watershed to species viability, the CHARTs evaluated the quantity and quality of habitat features, the relationship of the area compared to other areas within the species' range, and the significance to the species of the population occupying that area. Even if a location had poor habitat quality, it could be ranked with a high conservation value if it were essential due to factors such as limited availability, a unique contribution of the population it served, or is serving another important role.

For southern DPS green sturgeon, a team similar to the CHARTs — a critical habitat review team (CHRT) — identified and analyzed the conservation value of particular areas occupied by southern green sturgeon, and unoccupied areas necessary to ensure the conservation of the species (USDC 2009). The CHRT did not identify those particular areas using HUC nomenclature, but did provide geographic place names for those areas, including the names of freshwater rivers, the bypasses, the Sacramento-San Joaquin Delta, coastal bays and estuaries, and coastal marine areas (within 110 m depth) extending from the California/Mexico border north to Monterey Bay, California, and from the Alaska/Canada border northwest to the Bering Strait; and certain coastal bays and estuaries in California, Oregon, and Washington.

For southern DPS eulachon, critical habitat includes portions of 16 rivers and streams in California, Oregon, and Washington (USDC 2011). We designated all of these areas as migration and spawning habitat for this species.

A summary of the status of critical habitats, considered in this opinion, is provided in Table 5, below.

Table 5. Critical habitat, designation date, federal register citation, and status summary for critical habitat considered in this opinion

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
Lower Columbia River Chinook salmon	9/02/05 70 FR 52630	Critical habitat encompasses 10 subbasins in Oregon and Washington containing 47 occupied watersheds, as well as the lower Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some, or high potential for improvement. We rated conservation value of HUC5 watersheds as high for 30 watersheds, medium for 13 watersheds, and low for four watersheds.
Upper Columbia River spring-run Chinook salmon	9/02/05 70 FR 52630	Critical habitat encompasses four subbasins in Washington containing 15 occupied watersheds, as well as the Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some, or high, potential for improvement. We rated conservation value of HUC5 watersheds as high for 10 watersheds, and medium for five watersheds. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Snake River spring/summer-run Chinook salmon	10/25/99 64 FR 57399	Critical habitat consists of river reaches of the Columbia, Snake, and Salmon rivers, and all tributaries of the Snake and Salmon rivers (except the Clearwater River) presently or historically accessible to this ESU (except reaches above impassable natural falls and Hells Canyon Dam). Habitat quality in tributary streams varies from excellent in wilderness and roadless areas, to poor in areas subject to heavy agricultural and urban development (Wissmar et al. 1994). Reduced summer stream flows, impaired water quality, and reduced habitat complexity are common problems. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Upper Willamette River Chinook salmon	9/02/05 70 FR 52630	Critical habitat encompasses 10 subbasins in Oregon containing 56 occupied watersheds, as well as the lower Willamette/Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some, or high, potential for improvement. Watersheds are in good to excellent condition with no potential for improvement only in the upper McKenzie River and its tributaries (NMFS 2005). We rated conservation value of HUC5 watersheds as high for 22 watersheds, medium for 16 watersheds, and low for 18 watersheds.
Snake River fall-run Chinook salmon	10/25/99 64 FR 57399	Critical habitat consists of river reaches of the Columbia, Snake, and Salmon rivers, and all tributaries of the Snake and Salmon rivers presently or historically accessible to this ESU (except reaches above impassable natural falls, and Dworshak and Hells Canyon dams). Habitat quality in tributary streams varies from excellent in wilderness and roadless areas, to poor in areas subject to heavy agricultural and urban development (Wissmar et al. 1994). Reduced summer stream flows, impaired water quality, and reduced habitat complexity are common problems. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.

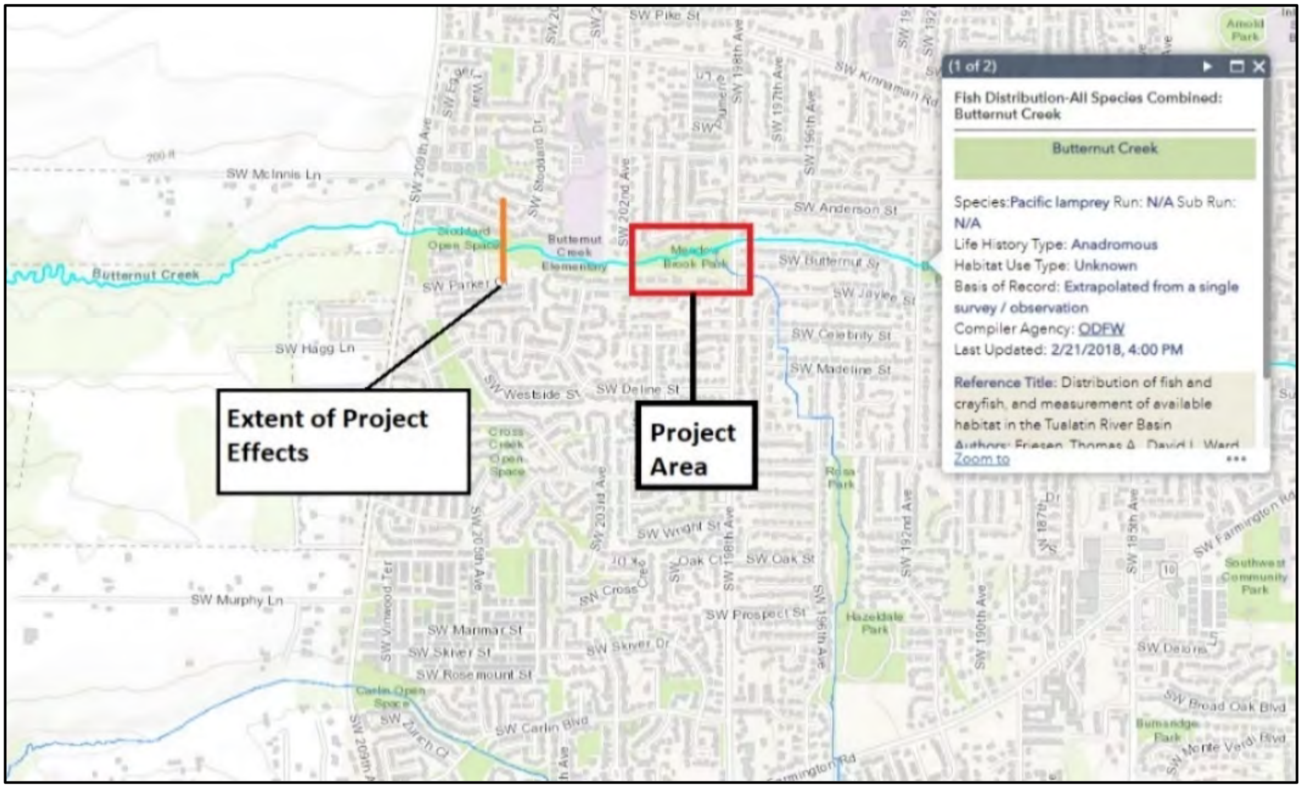
Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
Columbia River chum salmon	9/02/05 70 FR 52630	Critical habitat encompasses six subbasins in Oregon and Washington containing 19 occupied watersheds, as well as the lower Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 16 watersheds, and medium for three watersheds.
Lower Columbia River coho salmon	2/24/16 81 FR 9252	Critical habitat encompasses 10 subbasins in Oregon and Washington containing 55 occupied watersheds, as well as the lower Columbia River and estuary rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 34 watersheds, medium for 18 watersheds, and low for three watersheds.
Snake River sockeye salmon	10/25/99 64 FR 57399	Critical habitat consists of river reaches of the Columbia, Snake, and Salmon rivers; Alturas Lake Creek; Valley Creek; and Stanley, Redfish, Yellow Belly, Pettit and Alturas lakes (including their inlet and outlet creeks). Water quality in all five lakes generally is adequate for juvenile sockeye salmon, although zooplankton numbers vary considerably. Some reaches of the Salmon River and tributaries exhibit temporary elevated water temperatures and sediment loads that could restrict sockeye salmon production and survival (NMFS 2015b). Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Upper Columbia River steelhead	9/02/05 70 FR 52630	Critical habitat encompasses 10 subbasins in Washington containing 31 occupied watersheds, as well as the Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 20 watersheds, medium for eight watersheds, and low for three watersheds.
Lower Columbia River steelhead	9/02/05 70 FR 52630	Critical habitat encompasses nine subbasins in Oregon and Washington containing 41 occupied watersheds, as well as the lower Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 28 watersheds, medium for 11 watersheds, and low for two watersheds.
Upper Willamette River steelhead	9/02/05 70 FR 52630	Critical habitat encompasses seven subbasins in Oregon containing 34 occupied watersheds, as well as the lower Willamette/Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. Watersheds are in good to excellent condition with no potential for improvement only in the upper McKenzie River and its tributaries (NMFS 2005). We rated conservation value of HUC5 watersheds as high for 25 watersheds, medium for 6 watersheds, and low for 3 watersheds.
Middle Columbia River steelhead	9/02/05 70 FR 52630	Critical habitat encompasses 15 subbasins in Oregon and Washington containing 111 occupied watersheds, as well as the Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of occupied HUC5 watersheds as high for 80 watersheds, medium for 24 watersheds, and low for 9 watersheds.

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
Snake River basin steelhead	9/02/05 70 FR 52630	Critical habitat encompasses 25 subbasins in Oregon, Washington, and Idaho. Habitat quality in tributary streams varies from excellent in wilderness and roadless areas, to poor in areas subject to heavy agricultural and urban development (Wissmar et al. 1994). Reduced summer stream flows, impaired water quality, and reduced habitat complexity are common problems. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Southern DPS of green sturgeon	10/09/09 74 FR 52300	Critical habitat has been designated in coastal U.S. marine waters within 60 fathoms depth from Monterey Bay, California (including Monterey Bay), north to Cape Flattery, Washington, including the Strait of Juan de Fuca, Washington, to its United States boundary; the Sacramento River, lower Feather River, and lower Yuba River in California; the Sacramento-San Joaquin Delta and Suisun, San Pablo, and San Francisco bays in California; tidally influenced areas of the Columbia River estuary from the mouth upstream to river mile 46; and certain coastal bays and estuaries in California (Humboldt Bay), Oregon (Coos Bay, Winchester Bay, Yaquina Bay, and Nehalem Bay), and Washington (Willapa Bay and Grays Harbor), including, but not limited to, areas upstream to the head of tide in various streams that drain into the bays. Several activities threaten the PBFs in coastal bays and estuaries and need special management considerations or protection. The application of pesticides, activities that disturb bottom substrates/ adversely affect prey resources/ degrade water quality through re-suspension of contaminated sediments, commercial shipping and activities that discharge contaminants and result in bioaccumulation of contaminants in green sturgeon; disposal of dredged materials that bury prey resources; and bottom trawl fisheries that disturb the bottom/prey resources for green sturgeon.
Southern DPS of eulachon	10/20/11 76 FR 65324	Critical habitat for eulachon includes portions of 16 rivers and streams in California, Oregon, and Washington. All of these areas are designated as migration and spawning habitat for this species. In Oregon, we designated 24.2 miles of the lower Umpqua River, 12.4 miles of the lower Sandy River, and 0.2 miles of Tenmile Creek. We also designated the mainstem Columbia River from the mouth to the base of Bonneville Dam, a distance of 143.2 miles. Dams and water diversions are moderate threats to eulachon in the Columbia and Klamath rivers where hydropower generation and flood control are major activities. Degraded water quality is common in some areas occupied by southern DPS eulachon. In the Columbia and Klamath river basins, large-scale impoundment of water has increased winter water temperatures, potentially altering the water temperature during eulachon spawning periods. Numerous chemical contaminants are also present in spawning rivers, but the exact effect these compounds have on spawning and egg development is unknown. Dredging is a low to moderate threat to eulachon in the Columbia River. Dredging during eulachon spawning would be particularly detrimental.

2.3. Action Area

“Action area” means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). The action area for the proposed action is defined by its direct and indirect effects, particularly, the downstream extent to which water quality contamination, derived from stormwater runoff, may affect listed species or impair critical habitat. The fate and transport of contaminants found in stormwater runoff, particularly dissolved metals, have the potential to be carried great distances by contiguous waters. Stormwater pollutants may be carried from inland freshwaters all the way to the mouth of the Columbia River for eventual dispersion into the Pacific Ocean. These pollutants are known to be absorbed into downstream aquatic life, including ESA-listed salmonids (Baldwin et al. 2011; Carls and Meador 2009; Hicken et al. 2011; Johnson et al. 2013).

The action area for the proposed action is delimited by the water quality effects from project stormwater runoff from the road improvement/widening aspects of the Project and extend downstream from areas of project activity to the mouth of the Columbia River. The direct and indirect effects of instream construction to implement the road improvements and stream corridor enhancements for stormwater flow control have a much more limited spatial scale. It is anticipated that with the proper application of PDCs the effects of in-stream and near-stream construction, revegetation, and future monitoring and maintenance activities will only extend downstream to Witzig Reservoir, a downstream distance of less than 1,000 linear feet (Figure 4).



Fish Distribution-All Species Combined: Butternut Creek

Butternut Creek

Species: Pacific lamprey Run: N/A Sub Run: N/A
Life History Type: Anadromous
Habitat Use Type: Unknown
Basis of Record: Extrapolated from a single survey / observation
Compiler Agency: ODFW
Last Updated: 2/21/2018, 4:00 PM

Reference Title: Distribution of fish and crayfish, and measurement of available habitat in the Tualatin River Basin

Figure 4. Anticipated Downstream Extent of Stream Corridor Enhancement Water Quality Effects. Source: StreamNet Mapper 2020

2.4. Environmental Baseline

The "environmental baseline" refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultations, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR 402.02).

Much of the environmental baseline information that follows is taken from the BA submitted with the consultation initiation package. All references within the block text, except those noted in brackets, are from the source document. NMFS has adopted the Environmental Baseline information documented in *SW 198th Avenue Improvement Project – Stormwater management Design Biological Assessment.* June 2020 (BA; W^{2}R 2020). NMFS has evaluated this section of the BA and after our independent, science-based evaluation, determined it meets our regulatory and scientific standards.

> Butternut Creek is a tributary to the Tualatin River. It is the primary receiving water from the proposed project and is where stream corridor enhancements for flow control are proposed. Celebrity Creek is a small creek that flows into Butternut Creek approximately 200 feet west of the SW 198th Project crossing and is assumed to have similar baseline conditions. In the project area, Butternut Creek flows from east to west under a bridge that carries SW 198th Avenue over the creek. Upstream of the crossing, the drainage is confined to a deeply incised channel bordered by a narrow palustrine emergent wetland, riparian corridor, and several residences. Downstream of the crossing, the Butternut Creek channel is less confined and is bordered by palustrine emergent and forested wetlands (Otak 2019).

Approximately 1,000 feet downstream of the SW 198th Avenue bridge crossing, a small water control structure and reservoir (< 1 ac) have been constructed within Butternut Creek. The water control structure has been identified as a passage barrier to UWR steelhead within the Butternut Creek watershed (Murtagh 2019).

2.4.1 Listed Species

> Butternut Creek provides suitable habitat for native fish such as: western brook lamprey, reticulate sculpin, and resident coastal cutthroat trout and may provide suitable habitat for Pacific lamprey. UWR steelhead are mapped by ODFW as spawning and rearing more than a mile downstream of the project area (ODFW 2019). Substrates in this reach would not usually be considered suitable for spawning, based on Tualatin River Basin Rapid Stream Assessment Technique

> data collected by the CWS. UWR steelhead are not present within the immediate project vicinity due to downstream barriers that prevent access (W^2R 2020; [Murtagh 2019]). Butternut Creek is not designated as critical habitat for UWR steelhead. The closest designated UWR steelhead critical habitat is located more than five miles upstream of the confluence of Butternut Creek with the Tualatin River. Designated UWR steelhead critical habitat is also located downstream, at the confluence of the Tualatin River with the Willamette River (ODFW 2019).

As part of the recovery plan for UWR steelhead, NMFS concluded that the Tualatin River likely does not constitute an independent population. Rather, several west-side tributaries may have functioned and continue to function as a population sink with the DPS meta-population structure (Myers et al. 2006; ODFW & NMFS 2011).

UWR Chinook salmon are known to be present in the Tualatin River; however, ODFW notes that the population is of unknown origin (spring run, fall run, hatchery or wild) (ODFW 2020; Murtagh 2019). UWR Chinook distribution and prevalence is not well known, nor has spawning habitat been identified within the basin. NMFS has not designated critical habitat for UWR Chinook in the Tualatin Basin and excludes the basin from the core populations comprising the ESU (NMFS 2005).

The Tualatin River basin also supports a population of coho salmon, though there is no documented presence of the species in Butternut Creek (W^2R 2020; Murtagh 2019). ODFW has determined that the coho population is likely non-native to the basin, accessing the basin following construction of the locks at Willamette Falls or the fish ladders associated with Portland General Electric’s generation facility (ODFW 2020; Murtagh 2019). NMFS similarly does not identify the coho above Willamette Falls as an ESU, nor are coho in the Tualatin Basin included in the LCR coho ESU (NMFS 2016b). NMFS has not designated any part of the Tualatin Basin as critical habitat for coho salmon (NMFS 2016b).

2.4.2 Water Quality

> The Tualatin River basin, including Butternut Creek, is subject to TMDLs for dissolved oxygen, bacteria, phosphorus, and temperature; these were issued August 7, 2001 (ODEQ 2001). Mercury was an added parameter as of 2006 through the Willamette River TMDL (ODEQ 2006). The phosphorus TMDL on the Tualatin was amended in 2012 (ODEQ 2012). The major source of phosphorus in surface waters of the Tualatin River basin is groundwater (W^2R 2020). The Tualatin River is also listed on Oregon’s 303(d) list as an impaired water for biological criteria. Water quality related to other parameters either cannot be assessed due to insufficient data or does not represent complete impairment of beneficial uses. Based on the low levels of dissolved oxygen, excess nutrients, and excessive temperatures, it can be assumed that Butternut Creek is not properly functioning in terms of supporting aquatic life and ESA-listed salmonids that require cooler temperatures and clear water.

2.4.3 Hydrology

The hydrology of Butternut Creek is described in the Technical Memorandum: *Butternut Creek at Witzig Reservoir – Hydraulic Changes Associated with Changed Hydrology and Channel Restoration* (Otak 2019; Appendix A) as follows: streamflow in the Tualatin River Basin is associated with the seasonal precipitation patterns (winter rains) and flows are typically higher from December through March and lowest July through October. Flows in the treatment reach are perennial; below the treatment reach (downstream of 209th Avenue) the stream also flows perennially, with frequent large wetland complexes formed or enhanced by beaver activity. During periods of low streamflow, these wetland complexes may provide sufficient groundwater and surface water recharge to the channel downstream so that stream flows are maintained.

Historically, the Tualatin Valley was characterized by the meandering Tualatin River surrounded by wet prairie, wetlands, and upland prairie-oak habitat. Water flowed from the surrounding hillslopes into the valley where lakes, wet prairies, wetlands, and streams arose and formed multiple channels and drainages down to the Tualatin River. Most drainages exist but have been ditched and/or channelized and active floodplain areas have been dramatically reduced. Over time this area has evolved from natural to agricultural and then residential land uses.

The lower Butternut Creek floodplain west of Jacktown Road is broad (average of 200 feet wide) and the valley is very flat. The valley gradually steepens and becomes more confined upstream to SW 209th Avenue before becoming flatter and less confined in the project area. Upstream of SW 198th Avenue, the valley goes back into a steeper and more confined configuration. Any wetlands in the upper basin have been lost to urbanization. The lower Butternut Creek continues to maintain broad wetland complexes. Several large high-quality wetland complexes form a mosaic of persistent wetland complexes along the corridor. These wetland patches are often hydrologically-augmented and maintained by beaver activity. Erosion tends to be slow and marked channel changes are infrequent.

The catchment-scale transition to urbanization, more specifically the increase in impervious surfaces, has lowered soil infiltration rates and increased overland flow. The consequences of this transition from subsurface to overland flow processes means that the basin is more efficient at transmitting water into channels and downstream. For any given intensity and duration of rainfall, the peak flows are greater, and the frequency with which sediment-transporting and habitat-disturbing flows move downstream through the channel network is increased (Otak 2019).

The 2-year peak flow event in Butternut Creek downstream of the confluence with Celebrity Creek and downstream of the Butternut Creek Elementary School is estimated to be approximately 180 cubic feet per second (cfs) and the 10-year

> peak flow event is estimated to be approximately 250 cfs, based on Hydrological Simulation Program - FORTRAN (HSPF) hydrologic modeling by. Furthermore, Butternut Creek is a sub-basin that is located in an urban area, where impervious surfaces are likely to continue to expand. The proportion of basin that is impervious is estimated as being in the range of 44%, rising to about 50% at full build out of the developable area. As impervious areas increase, infiltration of water through the soil decrease and runoff volumes, measured by peak flow magnitude and duration, will continue to increase. Higher peak flows lead to increased erosion and downstream sedimentation, which may have adverse effects to downstream ESA-listed fish and critical habitat.
>
> Therefore, any further increase in impervious area and peak flows in the Butternut Creek basin, can be assumed to be detrimental the hydrology and proper functioning conditions (PFC) of Butternut Creek. Stream corridor enhancements focused on channel and floodplain complexity and connectivity are anticipated to increase the resilience of streams in the Butternut Creek sub-basin, recreating and maintaining habitat over time even as flows change in response to changes in land use and/or shifting climate.

2.5. Effects of the Action

Under the ESA, "effects of the action" are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see 50 CFR 402.17). In our analysis, which describes the effects of the proposed action, we considered 50 CFR 402.17(a) and (b).

2.5.1 Effects from the SW 198th Avenue Road Improvements Project Elements

As previously stated, the road improvement and stream crossing project elements were evaluated under the SLOPES STU opinion and found to be consistent with the opinion's project design criteria (PDCs). PDCs are stipulated in the opinion as measures to minimize and avoid effects to listed species, prevent impairment or degradation of critical habitat, and promote recovery and conservation. Because the proposed project is consistent with the SLOPES PDC, and the analysis in SLOPES for the effects from these routine construction-related impacts and stormwater treatment requirements, NMFS incorporates by reference, the effects analysis found in the SLOPES V – Stormwater, Transportation, and Utilities Programmatic Opinion (NWR-2013-10411; NMFS 2014a). Table 6 summarizes the anticipated effects associated with the Project, lists the applicable SLOPES STU PDCs, and summarizes the anticipated effects to listed species and critical habitat. Specific discussion related to treatment of stormwater pollutants, which is the principal mechanism for the Project's adverse effects, follows Table 6.

Table 6. Anticipated Effects of the SW 198th Avenue Road Improvement Project Elements

Anticipated Effect	**PDCs Applied to Minimize & Avoid Effects**	**Effect to Listed Species**	**Effect to Designated Critical Habitat**
Turbidity and Sedimentation	PDC #14 In-Water Work Timing PDC #18 Fish Capture and Release PDC #19 Fish Passage PDC #30 Erosion Control PDC #34 Work Area Isolation PDC #36 Actions Requiring Stormwater Management	No construction-related, short-term effects to UWR steelhead. The species is not present in the project area. Implementation of PDCs and the presence of Witzig Reservoir will limit the generation and prevent the transport of sediment and associated turbidity into habitat used by species.	Construction-related effects will not destroy or impair UWR steelhead critical habitat. Nearest mapped critical habitat is more than 5 miles from project area.
Chemical Contamination	PDC #14 In-Water Work Timing PDC #27 Staging, Storage, and Stockpile Areas PDC #34 Work Area Isolation PDC #36 Actions Requiring Stormwater Management	Potential short-term effects to UWR steelhead from accidental release of contaminants will be limited due to PDCs 14, 27, and 34. Long-term increase in impervious surface area will increase pollutants transported in stormwater runoff. Proposed stormwater treatment facilities/methods constructed per PDC 36 will minimize effects, but all species identified in Table 1 may be adversely affected to increased contaminant contribution to the downstream aquatic environment.	Accidental release of contaminants during construction unlikely to impair or destroy UWR critical habitat due to distance and PDCs. Increase in stormwater transport of pollutants may impair, but not destroy critical habitat identified in Table 1.
Temperature Increases	PDC #36 Actions Requiring Stormwater Management	Potential minor, long-term, water temperature increases as a result of increased stormwater runoff and decreased groundwater recharge. While difficult to quantify, possible adverse effects to UWR steelhead use of Butternut Creek.	Minor, long-term, water temperature increases unlikely to affect critical habitat of UWR steelhead due to distance.
Peak Flow Increases	PDC #36 Actions Requiring Stormwater Management	Long-term peak flow increases as a result of impervious surface increases, and consequently increased stream power. Unlikely to adversely affect UWR steelhead due to distance from project and detention pond proposed to comply with PDC 36.	No effect on UWR steelhead critical habitat due to attenuation of stream power over the 5+ mile distance between project area and nearest mapped critical habitat.

Stormwater runoff from the roadways, bridges, and other impervious surfaces deliver a wide variety of pollutants to aquatic ecosystems, such as nutrients, metals, petroleum-related compounds, sediment washed off the road surface, and agricultural chemicals used in road maintenance (Buckler and Granato 1999; Colman *et al.* 2001; Driscoll *et al.* 1990; Kayhanian *et al.* 2003; Tian *et al.* 2020). These ubiquitous pollutants are a source of potent adverse effects to salmon and steelhead, even at ambient levels (Hecht *et al.* 2007; Johnson *et al.* 2007; Loge *et al.*

2006; Sandahl *et al.* 2007; Spromberg and Meador 2006; Tian *et al.* 2020), and are among the identified threats to sturgeon.

Aquatic contaminants often travel long distances in solution or attached to suspended sediments, or gather in sediments until they are mobilized and transported by next high flow (Alpers *et al.* 2000b; Alpers *et al.* 2000a; Anderson *et al.* 1996). These contaminants also accumulate in the prey and tissues of juvenile salmon where, depending on the level of exposure, they cause a variety of lethal and sublethal effects on salmon and steelhead, including disrupted behavior, reduced olfactory function, immune suppression, reduced growth, disrupted smoltification, hormone disruption, disrupted reproduction, cellular damage, and physical and developmental abnormalities (Fresh *et al.* 2005; Hecht *et al.* 2007; Lower Columbia River Estuary Partnership 2007; Tian *et al.* 2020). The proposed project will likely add a small amount of impervious surface to the existing infrastructure, thereby increasing the potential for stormwater runoff.

Pollutants included in stormwater travel long distances in rivers either in solution, adsorbed to suspended particles, or retained in sediments until mobilized and transported by future sediment moving flows (Alpers *et al.* 2000b; Alpers *et al.* 2000a; Anderson *et al.* 1996). The toxicity of these pollutants varies in other water quality speciation and concentration. Regarding dissolved heavy metals, Santore *et al.* (2001) indicates that the presence of natural organic matter and changes in pH and hardness affect the potential for toxicity (increase and decrease).

Additionally, organics (living and dead) can adsorb and absorb other pollutants such as PAHs. The variables of organic decay further complicate the path and cycle of pollutants. The persistence and speciation of these pollutants also cause effects and, consequently, the action area, to extend from the point where runoff discharges into a receiving water and eventually discharges into the Columbia River, its estuary, and then into coastal waters. Once in these waters, these pollutants have been linked to a wide variety of ecological stressors affecting the water column, sediments, and the diversity and abundance of aquatic life (EPA 2009; U.S. Commission on Ocean Policy 2004).

As discussed above, stormwater runoff delivers a wide variety of pollutants to aquatic ecosystems, and many of the pollutants are unregulated and unevaluated. Fish exposure to these ubiquitous pollutants in the freshwater, estuarine, and nearshore marine habitats is likely to cause multiple adverse effects to salmon and steelhead, sturgeon, and eulachon, even at pre-project, ambient levels (Hecht *et al.* 2007; Macneale *et al.* 2010; Sandahl *et al.* 2007; Spromberg and Meador 2006; Tian *et al.* 2020), and are among the identified threats to sturgeon. Contaminants also accumulate in both the prey of and tissues of juvenile salmon. Depending on the level of concentration, those contaminants can cause a variety of lethal and sublethal effects on salmon and steelhead, including disrupted behavior, reduced olfactory function, immune suppression, reduced growth, disrupted smoltification, hormone disruption, disrupted reproduction, cellular damage, and physical and developmental abnormalities (Fresh *et al.* 2005; Hecht *et al.* 2007; Lower Columbia River Estuary Partnership 2007; Tian *et al.* 2020). Even at very low levels, chronic exposures to those contaminants have a wide range of adverse effects on the ESA-listed species considered in this opinion (Carls *et al.* 2008; Comeleo *et al.* 1996; Feist *et al.* 2011; Hecht *et al.* 2007; Sandahl *et al.* 2007; Spromberg and Meador 2006; Tian *et al.* 2020), including:

- Early development – gastrulation, organogenesis, hatching success
- Juvenile growth – foraging behavior, growth rate, condition index
- Smoltification (only in salmonids) – anion exchange, thyroxin blood hormone, salinity tolerance
- Disease induced mortality – immunocompetence, pathogens, histopathology
- Predation-induced mortality – predator detection, shelter use, schooling behavior
- Migration/distribution – use of rearing habitats, adult homing, spawning site selection
- Reproduction – courtship behavior, number of eggs produced, fertilization success

Using the best available science, NMFS cannot show the adverse effects of stormwater runoff from this specific project on individual fish. However, the types of contaminants in runoff throughout the action area have been shown to injure or kill individual exposed fish. Injury or death from exposure to contaminants in stormwater occur through a variety of behavioral, endocrine disrupting, and immunotoxic disease effects, either by themselves or through additive, interactive, and synergistic interactions with other contaminants (Baldwin *et al.* 2009; Feist *et al.* 2011; Hicken *et al.* 2011; Spromberg and Meador 2006; Spromberg and Scholz 2011; Tian *et al.* 2020) at ambient levels already present in Oregon's rivers and its estuaries (Fuhrer *et al.* 1996; Johnson *et al.* 2013; Morace 2006; Morace 2012; ODEQ 2012).

Furthermore, multiple facts influence the effects of contaminants on individual fish. These factors include life history stage at time of exposure, and the particular species exposed, geographic distribution of the species, the duration of exposure, and land use patterns where the projects occur, which influences the composition of chemicals to which the individual fish are exposed (Feist *et al.* 2011; Johnson *et al.* 2013; Scholz *et al.* 2011; Spromberg and Scholz 2011; Stehr *et al.* 2009; Tian *et al.* 2020). Repeated and chronic exposures, even of very low levels, are still likely to injure or kill individual fish, by themselves and through synergistic interactions with other contaminants already present in the water (Baldwin *et al.* 2009; Feist *et al.* 2011; Hicken *et al.* 2011; Spromberg and Meador 2006; Spromberg and Scholz 2011; Tian *et al.* 2020).

Stormwater treatment proposed by the CWS and DLUT is based on a design storm (50% of the 2-year, 24-hour storm) that will generally result in more than 95% of the runoff from all impervious surfaces within the action area being infiltrated at or near the point at which rainfall occurs (Igloira 2007; Igloira 2008a; Igloria 2008b). The treatment will consist primarily of biofiltration through a low impact development (LID) water quality swale. The highway runoff literature identifies this practice as excellent treatment to reduce or eliminate contaminants from roadway runoff (Barrett *et al.* 1993; Center for Watershed Protection and Maryland Department of the Environment 2000; Herrera Environmental Consultants 2006; Hirschman *et al.* 2008; National Cooperative Highway Research Program 2006; McIntyre *et al.* 2014; McIntyre *et al.* 2014).

Although CWS and DLUT propose to capture and treat stormwater runoff, in compliance with SLOPES STU design criteria, including CIA and areas that are not currently treated or are under-treated, the proposed treatment will not eliminate all pollutants in the runoff produced by the SW 198th Avenue Project. Thus, adverse effects are likely for all species in contiguous waters downstream from the SW 198th Avenue Project area. Species affected are listed in Table 7.

Furthermore, adverse effects from stormwater contaminants will persist in the Project's Action Area for the design life of the proposed project.

Table 7. Effects of the Proposed Action on ESA-listed Species

ESA-Listed Species	Life History Stage Affected	Life Stage Affected
CR Chum	Freshwater Spawning	Adult, Egg, Alevin
LCR Chinook, UCR spring-run Chinook, UWR Chinook, SR spring/summer-run Chinook, SR fall-run Chinook, CR chum, LCR coho, SR sockeye, UCR steelhead, LCR steelhead, UWR steelhead, MCR steelhead, SRB steelhead	Freshwater Rearing	Fry, Parr
	Freshwater Migration	Adult, Kelt, Fry, Parr
	Estuary Rearing & Smoltification	Fry Parr, Smolt
	Nearshore Marine Growth & Migration	Juvenile
	Offshore Marine Growth & Migration	Does not occur in action area
Southern DPS green sturgeon	Freshwater Migration & Rearing	Sub-adult, Adult
	Nearshore Migration	Sub-adult, Adult
Southern DPS Eulachon	Freshwater Spawning	Does not occur in action area
	Freshwater Rearing & Migration	Larval, Juvenile
	Estuary Rearing	Larval, Juvenile
	Nearshore Marine Growth	Juvenal, Adult

2.5.2 Effects from the Butternut Creek Stream Corridor Enhancement Project Elements

The proposed Project –including the stream corridor enhancements to achieve flow control – would require in-stream and near-stream construction practices. The proposed enhancements are designed to comply with SLOPES Restoration PDCs to ensure protection of listed species and conservation of critical habitat. The likely effects from these routine restoration-related impacts have been assessed in SLOPES Restoration opinion; therefore, NMFS incorporates by reference, the effects analysis found in the SLOPES Restoration Programmatic Opinion (NMFS 2013b). Table 8 summarizes the anticipated effects associated with the Butternut Creek stream corridor enhancement effects and lists the applicable SLOPES V – Restoration PDCs, and summarizes the anticipated effects to listed species and critical habitat.

Table 8. Anticipated Effects of the Butternut Creek Stream Corridor Enhancements Project Elements

Anticipated Effect	PDCs Applied to Minimize & Avoid Effects	Effect to Listed Species	Effect to Designated Critical Habitat
Turbidity and Sedimentation	PDC #13 Staging, Storage, and Stockpile Areas PDC #14 Erosion Control PDC #16 Equipment, Vehicles and Power Tools PDC #19 Temporary Stream Crossings PDC #22 In-Water Work Timing PDC #23 Work Area Isolation PDC #25 Site Restoration PDC #26 Revegetation PDC #35 Streambank Restoration	No construction-related, short-term effects to UWR steelhead. The species is not present in the project area. PDCs will limit the generation and transport of sediment and associated turbidity into habitat used by species. The presence of Witzig Reservoir will prevent sediment transport into habitat accessible to UWR steelhead	Construction-related effects will not destroy or impair UWR steelhead critical habitat. Nearest mapped critical habitat is more than 5 miles from project area.
Chemical Contamination	PDC #13 Staging, Storage, and Stockpile Areas PDC #16 Equipment, Vehicles and Power Tools PDC #22 In-Water Work Timing PDC #23 Work Area Isolation PDC #25 Site Restoration PDC #26 Revegetation PDC #27 Invasive & Non-native Plant Control PDC #35 Streambank Restoration	Potential short-term effects to UWR steelhead from accidental release of contaminants will be limited due to PDCs 13, 16, 22, and 23.	Accidental release of contaminants during construction unlikely to impair or destroy UWR critical habitat due to distance and PDCs. Long-term, minor water quality improvements from restored and enhanced stream corridor morphology, vegetation, and biota. More frequent activation of floodplain during storm event peak flows will sequester some pollutants in the stream floodplain that would otherwise be transported to downstream critical habitat.
Temperature Increases	PDC #25 Site Restoration PDC #26 Revegetation PDC #35 Streambank Restoration	Short-term, minor water temperature increase resulting from removal of invasive vegetation and time lag before restoration planting provides comparable cover and shade. Effects are not anticipated to last more than 2 years. Long-term, water temperature improvement as native, restoration vegetation matures and provides shade for treatment reach. Potential long-term, water temperature improvement as a result of increased surface water – groundwater exchange.	Minor, short-term, water temperature increases unlikely to affect critical habitat of UWR steelhead due to distance. Long-term, minor, water temperature improvement from restoration plantings and groundwater exchange. Will contribute to larger, basin-wide temperature TMDL response, which will have increasing, cumulative effect as stream/ riverside vegetation matures to provide shade.

Anticipated Effect	PDCs Applied to Minimize & Avoid Effects	Effect to Listed Species	Effect to Designated Critical Habitat
Peak Flow Increases	PDC #22 In-Water Work Timing PDC #25 Site Restoration PDC #26 Revegetation PDC #30 Large Wood Placement PDC #35 Streambank Restoration	No short-term, construction-related effects to peak flows are anticipated due to construction timing. Long-term, the Butternut Creek enhancement actions will mitigate the peak flow increases associated with stormwater runoff from the SW 198th Avenue Project. Reductions in peak storm flows are anticipated as more of the floodplain is re-engaged with stream flows on a regular basis, thereby attenuating flood flows. Potential minor, beneficial effects to UWR steelhead are possible, depending on habitat use and timing in Butternut Creek downstream of the treatment reach.	No measurable, short- or long-term effect on UWR steelhead critical habitat due to attenuation of stream power over the 5+ mile distance between project area and nearest mapped critical habitat.

2.5.3 Stormwater Runoff Flow Control (Peak Discharge Attenuation)

As stated in Section 2.1 of this Opinion, NMFS has evaluated the hydraulic modeling carried out in support of the BA and determined that it provides a comprehensive assessment of the effects of the proposed action. The assessment is based on the best available scientific and commercial information. After our independent, science-based evaluation, the *Technical Memorandum: Butternut Creek at Witzig Reservoir – Hydraulic Changes Associated with Changed Hydrology and Channel Restoration* (Otak 2019) was determined to meets our regulatory and scientific standards; as such, this document is adopted here (50 CFR 402.14(h)(3)). The memo, submitted as an Attachment to the BA, is included in full, as Appendix A of this Opinion. A summary of findings, taken from both the memo and the BA (Section 2.5.2 Hydromodification) follows.

If stormwater flow controls were not implemented to offset the increased stormwater runoff from the SW 198th Avenue Project, the change in a key channel-forming discharge (50% of the 2-year flow event) resulting from constructing the Project would be an increase of approximately 1 cfs, which is less than 1% change in stream discharge. The impacts of such a small addition to flow in Butternut Creek do not show up in a hydraulic model and would not be measurable in the field. Table 9 compares the expected changes in stormwater peak flows resulting from no stormwater flow controls, installing a biofiltration facility (e.g., detention pond), and modeled response to construction of the proposed stream corridor enhancements.

Table 9. Comparison of Butternut Creek Peak Flows with and without Flow Control

	Peak Discharge (cfs) from Stormwater Management Plan[1]						
Flow Event	**Pre-Developed Conditions**	**SW 198th Ave. Project without Biofiltration Pond**		**SW 198th Ave. Project with Biofiltration Pond**		**SW 198th Ave. Project with Stream Corridor Enhancements**	
		Computed	**Change from Pre-developed**	**Computed**	**Change from Pre-developed**	**Computed**	**Change from Pre-developed**
50% of 2-year	92.9	93.7	+0.8	92.1	-0.8	*	*
2-year	203.9	205.0	+1.1	201.3	-2.6	205.6	-4.9
5-year	250.8	252.0	+1.2	246.9	-3.9	255.8	-5.1
10-year	292.8	293.9	+1.1	288.0	-4.8	287.5	-5.1

[1] Stormwater Management Plan SW 198th Avenue Improvements. David Evans and Associates, Inc. February 2019. Submitted as Attachment 4 to the BA (W^2R 2020).

* Data not provided.

SLOPES STU provides LID flow control guidance that NMFS considers protective of stream function and sufficient to prevent adverse hydromodification under most scenarios. The SLOPES STU guidance is for post-construction runoff be equal to, or less than, the pre-developed conditions, for the range of storm events from the 50% of the 2-year, 24-hour storm, through the 10-year storm event. The proposed stream corridor enhancements provide better or comparable peak discharge attenuation, compared with industry standard LID methods. As storm events exceed the 10-year event, the amount of peak flow attenuation remains fairly consistent, at approximately 5 cfs. This is likely due to the geophysical and anthropogenic constraints that delimit the Treatment Reach.

Based on the analysis presented, we do not anticipate any substantive difference between the proposed stream corridor enhancement approach to stormwater discharge flow control and commonly accepted LID methods (e.g., detention pond, infiltration swale). Since UWR steelhead do not occur in the Treatment Reach, there is little evidence that the use of stream corridor enhancement to achieve stormwater runoff flow control will affect the species when and where they utilize Butternut Creek. This is primarily because Witzig Reservoir, immediately downstream of the Treatment Reach, would have an attenuating influence on stormwater-induced increases in stream discharge. Further, given the considerable distance to the nearest designated critical habitat (at the confluence of the Tualatin River and the Willamette River), any changes in peak discharge from stormwater runoff would be attenuated at the downstream end of the Treatment Reach. Therefore, the use of stream corridor enhancement methods to meet flow control criteria will not destroy or adversely modify UWR steelhead critical habitat or that of any other species listed in Table 1.

2.5.4 Stormwater Runoff Flow Control (Floodplain Storage)

To assess floodplain storage capacity, CWS also analyzed the project using metrics in the Flood Attenuation Impact Mitigation (FAIM) tool (USDA 2018). From the BA (W^2R 2020):

> [The FAIM] tool was designed to assign values to changes in floodplain storage and attenuation associated with both development and enhancement actions implemented within floodplain areas. This allows project designers to provide verification that floodplain enhancement actions can effectively offset the impacts of development. The primary difference between FAIM and other assessment methods is that the FAIM tool equates the negative impacts of floodplain development directly to the positive uplift of floodplain enhancement actions, rather than measuring change (either negative or positive) against a baseline condition. This feature makes it sensitive to small changes that are not measurable with standard hydrology and hydraulic analysis - similar to the intent of flow control requirements to manage hydromodification impacts.
>
> Using FAIM, enhancement actions are evaluated based on how these add in-channel or floodplain complexity and increase connectivity between the channel and its floodplain. The value of an enhancement action is assessed primarily on the basis of its proximity to the active stream channel, vertically and horizontally.
>
> Because a biofiltration/detention pond provides no improvement to habitat structure within the Butternut Creek stream corridor, there is zero uplift associated with using a detention system to manage the Project stormwater, according to the FAIM tool.

The FAIM analysis results in a projected uplift of functional floodplain storage of approximately 66,100 square feet (ft^2; W^{2}R 2020). Under the FAIM analysis, a traditional bioretention pond would provide no flood storage, due to its lack of habitat value. This appears to be a limitation of the analysis tool, as the detention pond originally proposed as a project component does provide storage volume for stormwater runoff; indeed, it is the facilities primary purpose. Storage volume ranges from 36,453 cf for the 50% of the 2-year storm event, up to 84,544 cf of storage for the 10-year storm event (DEA 2019). The analysis provided is not an effective comparison, as the FAIM model does not output storage volume, but storage area (or such output is not reported). Consequently, it is difficult to assess the storage volume that would be created by the stream corridor enhancements. There will clearly be an increase in flood storage volume, though easy quantification of the volume for comparison with traditional LID retention/detention facilities or engineered storage facilities is unclear.

Based on the analysis presented, we are not clear on whether the proposed stream corridor enhancements would create floodplain storage comparable to the original stormwater detention approach (e.g., bioretention pond). As it relates to the proposed Project, this is a moot point, since; 1) stream corridor enhancements have been demonstrated to attenuate peak flows comparable to traditional LID methods; and 2) UWR steelhead do not occur in or upstream of the Treatment Reach. There is little evidence that the use of stream corridor enhancement to achieve floodplain storage will affect the species when and where they are present in Butternut Creek downstream of the Treatment Reach, primarily because Witzig Reservoir, immediately downstream of the Treatment Reach, would have an attenuating influence on stormwater-caused increases in stream discharge. Further, given the considerable distance to the nearest designated critical habitat for any of the species identified in Table 1, any changes in floodplain storage of stormwater runoff would be attenuated within Butternut Creek prior to its confluence with the Tualatin River. Therefore, the use of stream corridor enhancement methods will not destroy or adversely modified UWR steelhead critical habitat or that of any listed species in Table 1.

2.5.5 Treatment Reach Length Estimating Tool

CWS and DLUT have proposed a method to quickly determine the length of a needed treatment reach to offset stormwater contributions from new or existing impervious surface area that does not require hydraulic modeling of a candidate stream reach. NMFS recognizes the applicant's desire for such an efficient and cost effective mechanism. However, NMFS is concerned the estimating tool proposed for use in the BA has significant limitations that could undermine the beneficial hydromodification approach if widely implemented. Primarily, our concerns focus on the fact that the estimating tool includes no mechanism for determining how many or what kind of enhancements should be added within an identified treatment reach. A treatment reach that is twice as long, but has half as many enhancement elements as the SW 198th Avenue Project may not be comparable.

At this time, the estimating tool seems superfluous. We expect that divining candidate treatment reaches based on the quantity of anticipated new and existing (untreated) impervious area is a more appropriate metric than the estimating tool. Further, we suspect that the scale and scope of enhancement elements (e.g., in-stream large wood, floodplain roughness, streambank grading) will be more accurately determined by available floodplain area and the estimation of a design team experienced in site assessment, stream restoration, and hydraulic engineering. Therefore, use of the proposed Cumulative Impacts Index and Treatment Reach Estimating Tool do not aid in assessment of stream corridor enhancement approaches without further modification.

2.5.6 Beneficial Hydromodification

One of the more compelling rationales supporting the use of stream channel enhancements as a flow control mechanism for managing stormwater runoff is the stream restoration elements that are intrinsic to the approach. The BA provides a robust assessment of the anticipated ecological uplift that would accompany the flow control functions. After our independent, science-based evaluation, Section 2.5.2 Hydromodification of the project BA (W^2R 2020) was determined to meet our regulatory and scientific standards; as such, this section is adopted here and excerpted, as follows (50 CFR 402.14(h)(3)). [edited for clarity and consistency of terminology]

> As it relates to adverse stormwater effects, hydromodification refers to how runoff volumes and peak flows increase as more and more of the land surface in a watershed is converted from pervious to impervious. These increased runoff volumes and peak flows produce commensurate increases in stream power (as well as velocities and shear stresses) resulting in increased rates of streambed and/or streambank erosion in headwater streams, and increased rates of downstream sediment delivery to receiving waters. Commonly, in the Tualatin River basin, where there is little bedrock to hinder the process, increased erosion rates have resulted in channel incision. Some of this incision likely began in response to the trapping of beaver in the 1820s and 1830s, and the subsequent

removal of wood from streams between the 1850s and 1970s. Riparian and instream wood removal was typically precipitated by the local need for lumber, or to facilitate lumber transport, navigation, land drainage, or (ostensibly) fish passage (CWS 2019).

Floodplains that once featured a complex network of channels and wetlands, have been replaced by systems featuring a single-thread channel that is to some degree incised. Even in the absence of strong incision, instream habitat complexity has decreased. Native, migratory fish species, including ESA-listed salmonids, depend on a diversity of stream velocities within the water column and use floodplain refugia during high flow events. For example, at different times during the salmon lifecycle, fish may use strands of fast flowing water for efficient out-migration, but they may seek out areas of slow-moving water for resting during upstream migration. In addition, when bed and/or bank erosion rates increase, this supplies more sediment into the stream system, which increases turbidity, with the potential to adversely affect any downstream ESA-listed fish and associated critical habitat.

As the [SW] 198th Project proposes to replace and expand impervious areas, NMFS requires flow control to offset potential hydromodification impacts to Butternut Creek and minimize adverse effects to the extent possible. The [SW] 198th Project design team originally proposed that flow control requirements be met through the construction of detention ponds. To date, most hydromodification strategies consist of similar, site-based flow control measures with local objectives. These site-based approaches provide little to no opportunity for coordination between projects within a watershed. Long-term reversal of hydromodification effects will require movement away from reliance on such localized, site-based approaches and toward more integrated watershed-scale strategies (Stein et al. 2012).

In keeping with this new direction, the [SW] 198th Project is now proposing to meet the intent of the flow control requirements through implementation of [stream corridor enhancements], which will offset the adverse hydromodification effects of the [SW] 198th Project, while also adding more sustainable functional benefits and contributing to resiliency in the Butternut Creek sub-basin, and offsetting the adverse historic hydromodification effects to Butternut Creek from other actions upstream of the [SW] 198th Project. By implementing the proposed [stream corridor enhancements], high quality stream corridor habitat in downstream reaches of Butternut Creek [are] being extended upstream in the basin as far as is practicable given the constraints of topography, channel alteration, and urban development.

The enhancements authorized within Butternut Creek Reach 1 [the Treatment Reach] just upstream of Witzig Reservoir will include the following elements:

- Minor regrading along the eroding banks of Butternut Creek Reach 1 to reduce stream velocities;
- Large wood placements incorporated into the stream bed and banks to increase channel roughness, prevent any further incision, and provide improved habitat complexity;
- Extensive removal of invasive vegetation species on the floodplain and revegetation with native woody and herbaceous species; and
- Wood habitat structures incorporated into the floodplain of Butternut Creek Reach 1 to provide floodplain roughness and habitat.

As described previously, the pre-development hydrology and morphology of the Butternut Creek corridor likely featured a series of floodplain surfaces and wetlands, connected by multiple flow paths. Such hydro-morphic systems are typical of streams with healthy aquatic, riparian, wetland and floodplain ecosystems, and often include robust populations of beaver. This corresponds to the fully connected and complex riparian corridor condition (Stage 0) [in the Stream Evolution Model (SEM); Figure 5] in contrast to the current, slightly incised, single-threaded condition (Stages 1 or 2) that has resulted from the impacts of past human activities in the sub-basin (Cluer and Thorne 2013).

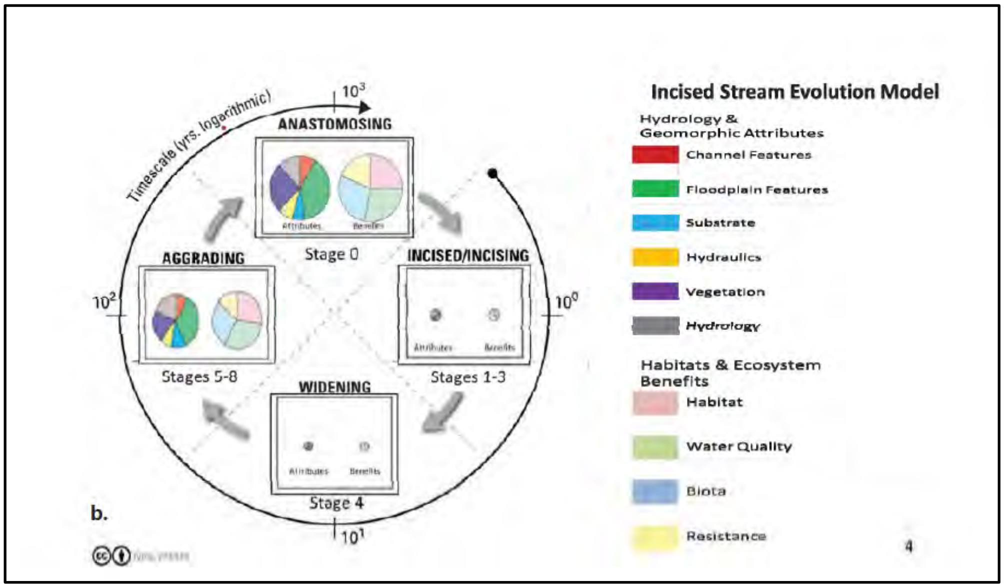


Figure 5. Stream Evolution Model and Related Morphologic Attributes and Ecological Function Source: Cluer and Thorne 2013. Taken from SW 198th Avenue Improvement Project – Stormwater Management Design Biological Assessment. W2R. June 2020.

Whether the current channel condition corresponds to Stage 1 or 2 in the Stream Evolution Model (SEM) depends on how simplification of the channel of Butternut Creek occurred. If it was formed by increased erosion and flushing out of large wood due to past hydromodification, the channel is in Stage 1. If it was formed through channelization that was achieved by ditch digging and/or channel straightening and clearance, it is in Stage 2. Due to local grade control provided by Witzig Reservoir and/or beaver activity, it is likely that further incision and progression through the SEM is unlikely. In that case, the current channel is in Stage 3s – arrested degradation. Regardless of how the stream arrived at its current state, the quantity and diversity of ecological function in the current stream channel is inherently limited by the channel morphology (Stages 1 – 3).

Experience in river restoration best practice indicates that recreation of a complex and fully functional riparian corridor condition requires action to reinstate full connectivity between the stream and its floodplain (Pollock et al. 2014). The type of restorative action necessary depends on the evolutionary Stage of the current channel. As Butternut Creek is only slightly incised (Stages 1 – 3), floodplain reconnection may be achieved using wood placement, with recovery being hastened if and when beaver re-occupy the restored reach (Pollock et al. 2014). The resulting stream-wetland-floodplain complex represents a naturally sustainable and resilient stream corridor condition, and one that has considerable erosion resistance and flow attenuation capacity. This is the case because, after enhancement, stream power that was concentrated within the channel is distributed across the reconnected floodplain, so that stream power per unit width, velocities and shear stresses are dramatically decreased by the roughness elements of large wood and dense native vegetation.

The functional benefits of multi-channel streams are numerous. In particular, fully reconnecting a stream with its floodplain spreads out the water, re-wets small distributaries and lowers the stream power per unit width of the flow. In a single-channel stream corridor the river has a tendency to enlarge through time because the flow is concentrated, driving either incision, widening or both (Walter and Merritts 2008). While the existing channel in Reach 1 of Butternut Creek does not appear to be unstable (due to being in Stage 3s), this could change in future if flows increase due to climate change and/or further hydromodification. Even if incision is limited by a natural or artificial downstream grade control, concentration of stream power may drive channel instability through lateral erosion (widening, lateral migration or sudden planform change).

Conversely, in a multi-channel, fully-connected floodplain corridor, the water is spread out across the corridor and therefore, channel erosion and instability is less likely to occur. Increased connectivity to the floodplain leads to floodplain inundation by smaller, more frequent flow events, which is beneficial to ecological productivity and stream function (Opperman et al. 2010). This attenuates flooding downstream because water is stored on the floodplain between the anastomosed channels. Also, floodplain ecology and low summer flows are enhanced because the fluvial (hyporheic) aquifer within the floodplain is recharged frequently during overbank flows. Sediment pulses are also attenuated where multiple channels interact with the floodplain, because excess sediment deposited during floods is stored on the floodplain and then released gradually through time and space (Cluer and Thorne 2013).

[CWS] has demonstrated the benefits of stream corridor vegetation on channel and floodplain connectivity and complexity by comparing stream reaches that were revegetated over a decade ago with those that were not (Wolf Water Resources 2016). For example, in one such reach on Bronson Creek, the floodplain converted from a reed canary grass field drained by a straightened, incised channel, to a fully connected wetland-floodplain complex.

The [stream corridor enhancements] will apply experience gained from SEM-based enhancements across Oregon and efforts to improve channel and floodplain complexity in the Tualatin drainage system. The stream corridor in Reach 1 will be enhanced from its current condition (Stage 3s – arrested degradation) to Stage 6 (quasi-equilibrium), with the expectation that this will evolve toward Stage 7 (laterally active). This is possible because, as riparian and floodplain vegetation matures, localized, lateral activity can be allowed at locations where bank adjustments can be accommodated with the sediment eroded being stored in point and lateral bars. Once riparian vegetation matures, limited lateral activity can take place within the existing channel migration zone and without any risk to adjacent properties. That said, full reconnection of the channel with the inset floodplain (Stage 8) is not feasible, due to the proximity of private properties that could be at somewhat higher risk of flooding.

Immediate uplift will be achieved through increases in instream, riparian, and floodplain complexity. Complexity will be increased immediately through placement of large wood within the channel and the riparian corridor and floodplain. Current bank instability will immediately be addressed by bank grading where appropriate. In the near-term and subsequently, much higher complexity and dynamic channel-stability will be achieved through extensive revegetation across
the stream corridor. These actions will re-engage the vegetation-dominated stream processes that will enhance the stream to a dynamically-stable Stage 6/7 condition. Both the SEM and experience gained from past enhancement projects in the basin show that, compared to Stages 1-3, enhancement to Stage 6/7 will deliver substantial uplift in hydrology and geomorphic attributes, and habitat and ecosystem benefits.

In contrast, detention provides neither immediate benefits nor any prospect of near-term improvements in stream attributes or benefits, because the only outcome is to avoid a very slight (practically unmeasurable) increase peak flows that would otherwise be expected due to expansion of impervious following implementation of the [SW] 198th Project.

Any potential benefit to the stream from detention strategies would only be realized many decades from now, assuming that the impervious area of the basin is redeveloped over that time to meet flow control standards. In the meantime, the existing single-thread, simplified channel with its invasive vegetation dominated floodplain would remain vulnerable to erosion (probably through bank retreat as there is grade control downstream that may prevent further incision) and sub-optimal ecologically. Also, bank instability would continue to contribute excess fine sediment and increase turbidity in the fluvial system downstream. In addition, temperature effects would continue due to the chronic lack of existing shade.

Beneficial hydromodification, resulting from the proposed stream corridor enhancements, will improve ecological conditions within the Treatment Reach of Butternut Creek. Ecological uplift, downstream of the Treatment Reach, is less clear. There would likely be benefits to water temperature, sediment transport, and peak flow regulation. Beneficial hydromodification will contribute to the larger, basin-wide temperature TMDL response, which will have an increasing, incremental effect as stream/ riverside vegetation matures to provide shade. However, since UWR steelhead do not occur in the Treatment Reach of Butternut Creek, the principal beneficiaries of ecological uplift will be for non-listed native fish and lotic-associated biota. While muted due to distance, ecological uplift downstream of the Treatment Reach will improve habitat quality and may benefit UWR steelhead when and where they utilize Butternut Creek.

Given the considerable distance to the nearest designated critical habitat (at the confluence of the Tualatin River and the Willamette River), any ecological uplift resulting from beneficial hydromodification will be minor and incremental.

Because UWR steelhead do not occur in the project area where construction activities will occur, the effects of the proposed action on listed species include:

- Long-term improvement to water quality to Butternut Creek and all downstream receiving waters due to implementation of stormwater treatment for new and existing (untreated) impervious surface area; and
- Long-term improvement in water temperature in Butternut Creek, within and downstream of the stream enhancement treatment reach, due to maturing riparian and floodplain vegetation;

While the effects to UWR steelhead that utilize Butternut Creek are largely beneficial, this population is not believed to contribute directly to the recovery of UWR steelhead. It should also be noted that the project does increase the amount of stormwater-generating surface area that will incrementally increase adverse effects associated with stormwater contaminants transported downstream from the project area to the species in the Tualatin, Willamette, and Columbia rivers (i.e., the species identified in Table 1). However, such minor, incremental impairment of water quality is not likely to result in population level impacts.

With proper implementation of construction PDCs, identified project activities are too far removed from designated critical habitat to have any measurable impact, with the exception of stormwater-related pollutants. As with listed species, the increase in impervious surface area will result in more stormwater-related pollutants discharged to receiving waters. Because many of these pollutants are persistent in the environment and transport over varying time scales, critical habitat identified in the Willamette and Columbia rivers are likely to receive minor, incremental, long-term impairments to the water column and sediments.

2.6. Cumulative Effects

"Cumulative effects" are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02 and 402.17(a)). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline *vs*. cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the environmental baseline (Section 2.4).

The contribution of non-Federal activities to the current condition of ESA-listed species and designated critical habitats within the action area was described in the Status of the Species and Critical Habitat and Environmental Baseline sections, above. Among those activities were road construction, urbanization, and river restoration. Those actions were driven by a combination of economic conditions characterized by general resource demands associated with settlement of local and regional population centers, and the efforts of social groups dedicated to the river restoration and use of natural amenities, such as cultural inspiration and recreational experiences.

General resource demands are increasing with growth in the size and standard of living of the local and regional human population (Metro 2010; Metro 2011). The percentage increase in population growth may provide the best estimate of general resource demands because as local human populations grow, so does the overall consumption of local and regional natural resources. Between 2000 and 2010, the population of Oregon grew from approximately 3.4 to 3.8 million, primarily due to migration from other states (U.S. Census Bureau 2011). Most of that growth occurred before the economic slowdown that began in 2007. Half of the population increase occurred in Oregon's three most populated counties around the City of Portland area, including Washington County, where the Project is located. The State population is expected to continue to grow in the future, although the rate of growth has slowed and is unlikely to change soon.

The adverse effects of non-Federal actions stimulated by general resource demands are likely to continue in the future driven by changes in human population density and standards of living. Counties that are gaining population around the City of Portland, like Washington County, are likely to experience greater resource demands, and therefore more adverse environmental effects. Oregon's land use laws and progressive policies related to long-range planning will help to limit those impacts by ensuring that concern for a healthy economy that generates jobs and business opportunities is balanced by concern for protection of farms, forests, rivers, streams and natural areas (Metro 2000; Metro 2008; Metro 2011). In addition to careful land use planning to minimize adverse environmental impacts, larger population centers may also partly offset the adverse effects of their growing resource demands with more river restoration projects designed to provides ecosystem-based cultural amenities, although the geographic distribution of those actions, and therefore any benefits to ESA-listed species or critical habitats, may occur far from the centers of human populations.

Similarly, demand for cultural and aesthetic amenities continues to grow with human population, and is reflected in decades of concentrated effort by Tribes, states, and local communities to restore an environment that supports flourishing wildlife populations, including populations of species that are now ESA-listed (CRITFC 1995; ODFW & NMFS 2011; NWPCC 2012; OWEB 2011). Reduced economic dependence on traditional resource-based industries has been associated with growing public appreciation for the economic benefits of river restoration, and growing demand for the cultural amenities that river restoration provides. Thus, many non-Federal actions have become responsive to the recovery needs of ESA-listed species. Those actions included efforts to ensure that resource-based industries adopt improved practices to avoid, minimize, or offset their adverse impacts. Similarly, many actions focused on completion of river restoration projects specifically designed to broadly reverse the major factors now limiting the survival of ESA-listed species at all stages of their life cycle. Those actions have improved the availability and quality of estuarine and nearshore habitats, floodplain connectivity, channel structure and complexity, riparian areas and large wood recruitment, stream substrates, stream flow, water quality, and fish passage. In this way, the goal of ESA-species recovery has become institutionalized as a common and accepted part of the State's economic and environmental culture. We expect this trend to continue into the future as awareness of environmental and at-risk species issues increases among the general public.

CWS is one of the local natural resource management agencies for the Tualatin Basin. CWS and DLUT are required, through a NPDES permit, to manage stormwater from new and redeveloped impervious areas across the watershed in such a way that minimizes these cumulative effects. Addressing hydromodification effects within the receiving waterbody itself through enhancement actions is anticipated to be the most successful approach for maintaining or creating stream corridors that will be resilient in the face of future land use and climate change. In addition, stream corridor enhancements provide a range of other functional improvement opportunities that will have a net benefit to ESA-listed species and critical habitat.

The future effects of river restoration are also unpredictable due to uncertainties about the economy, funding levels for restoration actions, and individual investment decisions. But their net beneficial effects may grow with the increased sophistication and size of projects completed and the additive effects of completing multiple projects in some watersheds.

In summary, the population of Oregon is expected to increase in the next several decades with a corresponding increase in natural resource consumption. Additional residential and commercial development and a general increase in human activities are expected to cause localized degradation of freshwater and estuarine habitat. Interest in restoration activities is also increasing as is environmental awareness among the public. This will lead to localized improvements to freshwater and estuarine habitat. When these influences are considered collectively, we expect trends in habitat quality to remain flat or improve gradually over time. This will, at best, have positive influence on population abundance and productivity for the species affected by this consultation. In a worst cases scenario, we expect cumulative effects would have a relatively neutral effect on population abundance trends. Similarly, we expect the quality and function of critical habitat PCEs or physical and biological features to express a slightly positive to neutral trend over time as a result of the cumulative effects.

2.7. Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action (Section 2.5) to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), taking into account the status of the species and critical habitat (Section 2.2), to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) Reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated or proposed critical habitat as a whole for the conservation of the species.

2.7.1 Species at the Population Scale

The adverse effects of the action will occur in the Tualatin River, the lower Willamette River, the lower Columbia River, and the nearshore environment of the Pacific west coast. Pollutants in stormwater runoff from the proposed project will combine with pollutants from other sources in mixtures and concentrations that exceed thresholds for sublethal and lethal effects on the growth and survival of individual fish. The effect of the action on populations would be the integrated responses of individual fish to the predicted environmental changes. Instantaneous measures of population characteristics, such as population size, growth rate, spatial structure, and diversity, are the sums of individual characteristics within a particular area, while measures of population change, such as a population growth rate, are measured as the productivity of individuals over the entire life cycle (McElhany et al. 2000). A persistent change in the environmental conditions affecting a population, for better or worse, can lead to changes in each of these population characteristics.

NMFS identified many factors as limiting the recovery of the salmon species analyzed in this opinion, but only three that will be affected by the proposed action: substrate, water quality, and estuarine and nearshore marine conditions. The identification of substrate and water quality as limiting factors refers to both tributary and mainstem conditions. Within the WLC recovery domain, estuarine and nearshore marine conditions are limiting for CR chum salmon and LCR Chinook salmon; stream substrate is limiting for LCR Chinook salmon, CR chum salmon, LCR coho salmon, and LCR steelhead; and water quality is limiting for LCR Chinook salmon, UWR Chinook salmon, CR chum salmon, and LCR coho salmon. Similarly, for species within the IC recovery domain, estuarine and nearshore marine conditions are limiting for UCR spring-run Chinook salmon; stream substrate is limiting for UCR spring-run Chinook salmon, SR spring/summer-run Chinook salmon, UCR steelhead, MCR steelhead, and SRB steelhead; and water quality is a factor limiting recovery of SR spring/summer-run Chinook salmon, MCR steelhead, and SRB steelhead. SR sockeye are not limited by any of these three factors.

For Southern DPS green sturgeon, NMFS identified the primary limiting factor as reduction of its spawning area to a single known population limited to a small portion of the Sacramento River, although poaching, the effects of nonnative species, and effects of contaminants were identified as other potentially serious threats. Of those, this action affects contaminants. Limiting factors for Southern DPS eulachon include water pollution and sediment balances, which are also affected by this action, although the primary threats appear to be changes in ocean and freshwater conditions due to climate change, by-catch of eulachon in commercial fisheries, adverse effects related to dams and water diversions, artificial fish passage barriers, over-harvest, and predation.

The effects of the proposed action are likely to cause a small addition to the limiting factors related to estuarine and nearshore marine conditions, substrate and water quality, contaminant exposure, and water pollution when runoff from the proposed project area is sufficient to reach Butternut Creek, and hence the Tualatin, Willamette, and Columbia rivers. Those effects will be due to the additive effect of contributing persistent pollutants to areas with impaired water quality and contaminated substrate, and making them available for accumulation in the prey base. These impacts are likely to impair essential fish rearing and feeding behavior patterns for some individuals of each species considered. However, the number of individual Pacific salmon, southern green sturgeon, or eulachon injured or killed annually from this incremental increase in stormwater pollutants will be small, commensurate with its contribution to the total pollutant load that now enters the Columbia River from all sources, and therefore, is not likely to cause a new risk of harm or deterioration in the pre-action condition of any species or appreciably reduce the likelihood of survival or recovery.

Of the 15 species that are likely to be adversely affected by this proposed action, none meet the NMFS guidelines for a viable salmonid population (McElhany et al. 2000). It may seem that populations in such weak condition could not sustain additional habitat degradation. However, habitat is only one of many factors associated with population abundance and productivity, and its impacts must be evaluated over a long time scale of decades or longer to account for the effects of habitat recovery actions, the influence of genetic factors, and role the environmental cycles and processes (McElhany et al. 2000).

Toxic pollutant loading in the receiving waters downstream of the Project has decreased and is likely to continue to decrease due to abatement of anthropogenic sources and natural flushing process of river discharge. The listed species considered in this opinion are likely to benefit from decreasing pollutant loads in the future due to abatement of anthropogenic sources and the natural flushing process of river discharge.

Recovery plans that address the needs of Pacific salmon affected by the action (IC-TRT 2011; NMFS 2009; NMFS 2013a; ODFW and NMFS 2011; Upper Columbia Salmon Recovery Board 2007), as well as those prepared for green sturgeon and eulachon (NMFS 20118; NMFS2017b), all call for measures to improve water quality and reduce the impact of residential and municipal development, including improved stormwater management in particular, as among the most potent and high priority recovery actions. Thus, the proposed new development, which includes stormwater treatment to reduce impacts, is consistent with actions identified in recovery plans as necessary to recover species in the within the Columbia Basin.

Climate change presents several unknowns for UWR steelhead and UWR Chinook salmon that utilize the Tualatin Basin. The basin is rainfall and groundwater dependent. Summer river/stream flows are not reliant on snow pack, so a projected regional shift from snowfall to rainfall are unlikely to have pronounced effects on water quantity in the basin. Within the Butternut Creek watershed, no large-scale alteration in stream discharge is anticipated. Water temperatures, however, are likely to increase in the mainstem Tualatin and its tributaries. Increased water temperatures, especially from summer into fall, has the potential to be a significant stressor to UWR steelhead and UWR Chinook salmon. The possibility of modified run timing and diminished individual fitness is possibility, potentially leading to a decrease in species numbers within the basin. Within the Butternut Creek watershed, increased shade from riparian plantings and increased activation of storm flows onto the floodplain are likely to have positive water temperature effects within the lower reaches of the watershed, but such improvements are not likely to alter broader warming signals associated with climate change.

In summary, pollutants by stormwater runoff from the proposed action that would be added to the Butternut Creek, the Tualatin, Willamette, and Columbia rivers, are likely to injure or kill a small number of individual listed Pacific salmon, steelhead, green sturgeon, and eulachon each year. The load of contaminants and the volume of stormwater runoff that the project would add are small in comparison to the contaminant load and total discharge of the Columbia Basin, and the additional runoff would not expose listed species to a new risk, but those contaminants would still have a significant impact when taken together with existing contaminant load from other actions. However, even with the new additional load of pollutants from this project, the total load of pollutants within the action area is declining and is expected to decline further. Thus, the effects of the proposed action, when added to the environmental baseline, status of the 15 species, and cumulative effects, are not reasonably likely to reduce appreciably the abundance, productivity, spatial structure, or genetic diversity of the populations of the 15 species considered in this Opinion.

2.7.2 Critical Habitat at the Watershed Scale

The NMFS designated critical habitat for all of the species considered in this opinion. PCEs designated for the 15 listed species include physical and biological features that support the following site types:

- Pacific salmon – freshwater spawning (CR chum only), freshwater rearing, freshwater migration, estuarine areas, nearshore areas
- Southern DPS green sturgeon – adult and juvenile migration corridors
- Southern DPS Eulachon – freshwater riverine system, estuarine area, coastal marine area

The conservation value of critical habitats within the action area remains high although the complexity and productivity of aquatic habitat in the Columbia River has been significantly diminished by the effects of dam and reservoir development, channelization, and the introduction of pollutants from land use. Contaminants delivered to the Columbia River by stormwater runoff from the proposed project will adversely affect PCEs for all species related to substrate and water quality, and prey, as described above. Similarly, cumulative effects in the action area will include additional pollution as a result of continuing and new land uses, although most new and redeveloped residential, commercial, and industrial areas will all be subject to strengthened, modern standards and methods for treating and managing stormwater that did not apply until very recently and the natural flushing of river discharge that removes old pollutants from the Basin over a period of decades.

Climate change has the potential to impair the condition and function of critical habitat in the Tualatin Basin, reducing its suitability, accessibility, and extent, as a result of increased water temperatures. Critical habitat is designated in the upper portions of the basin, primarily tributaries originating in the coastal mountains. The benefits of localized habitat improvement activities in Butternut Creek will be largely irrelevant, as there is no critical habitat in the Butternut Creek watershed and any improvements in stream temperature would be largely attenuated by the mainstem Tualatin River.

Overall, the effects of the proposed action, when added to the environmental baseline, cumulative effects, and status of critical habitat, will not appreciably reduce the condition and function of PCEs in the action area. PCEs will suffer some localized degradation of critical habitat PCE quality and function, but these minor effects will not impair the ability of any of the affected critical habitat units to play their intended conservation roles. Thus, the proposed action will not reduce the conservation value of designated critical habitat and the affected critical habitat units will retain their ability to serve their intended conservation roles for the 15 species considered in this opinion.

2.8. Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, the effects of other activities caused by the proposed action, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of, or to destroy or adversely modify designated critical habitat for:

LCR Chinook salmon
UWR Chinook salmon
UCR Chinook salmon
SR spring/summer run Chinook salmon
SR fall-run Chinook salmon
CR chum salmon
LCR coho salmon
SR sockeye salmon
LCR steelhead
UWR steelhead
MCR steelhead
UCR steelhead
SRB steelhead
Southern green sturgeon
Southern eulachon

2.9. Incidental Take Statement

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by regulation to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. For purposes of this consultation, we interpret "harass" to mean an intentional or negligent action that has the potential to injure an animal or disrupt its normal behaviors to a point where such behaviors are abandoned or significantly altered.[1] Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA, if that action is performed in compliance with the terms and conditions of this incidental take statement.

The measures described below are non-discretionary, and must be undertaken by the Corps so that they become binding conditions of any grant or permits issued to others conducting the work, as appropriate, for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by the incidental take statement. If the Corps (1) fails to assume and implement the terms and conditions or (2) fails to require their grantees to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the grant document, the protective coverage of section 7(o)(2) may lapse. To monitor the impact of incidental take, the Corps must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR 402.14(i)(3)].

2.9.1 Amount or Extent of Take

Actions necessary to complete construction components of the proposed action will occur at an upland site and within/adjacent to the stream channel of Butternut Creek. However, ESA-listed do not occur in the project area and are prevented from access to the project area by established passage barriers. Critical habitat is sufficiently removed from the project area. Consequently, the construction-related aspects of the proposed action will not cause any incidental take. However, the proposed project will result in the production of stormwater runoff that will deliver a wide variety of pollutants into aquatic habitats at times when those habitats are occupied by LCR Chinook salmon, UWR Chinook salmon, UCR spring-run Chinook salmon, SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, CR chum salmon, LCR coho salmon, SR sockeye salmon, LCR steelhead, UWR steelhead, MCR steelhead, UCR steelhead, SRB steelhead, southern green sturgeon, or southern eulachon.

Stormwater runoff from the proposed project will contain dissolved and particulate metals (*e.g.*, copper, lead, zinc), PAHs, pesticides, sediment, and other pollutants of concern that are reasonably certain to result in the harm of juveniles and adults of each of those species due to impaired juvenile rearing and migration and impaired adult migration for all species, and impaired reproduction in CR chum salmon. This take cannot be accurately quantified as a number of ESA-listed fish because the distribution and abundance of species that occur within an action area is affected by habitat quality, interactions with other species, and other influences that cannot be precisely determined by observation or modeling. Therefore, NMFS will not identify

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[1] NMFS recognizes the benefit of providing guidance on the interpretation of the term "harass" to ensure nationwide consistency. As a first step, for use on an interim basis, NMFS will interpret harass in a manner similar to the USFWS regulatory definition for non-captive wildlife:
"Create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering."

the amount of take, but will identify an incidental take surrogate that will serve as an extent of take.

Here, the best available indicators for the extent of take are the following combination of stormwater facility inspection, maintenance, and recording actions, because those variables will determine whether the stormwater treatment system continues to reduce the concentration of pollutants in stormwater runoff as designed, and thus reflect the amount of incidental take analyzed in the opinion (Claytor and Brown 1996; Santa Clara Valley Urban Runoff Pollution Prevention Program 1999; Santa Clara Valley Urban Runoff Pollution Prevention Program 2001):

1. Each part of the stormwater system, catch basins, conveyance system, and bioswales must be inspected and maintained at least twice a year, and within 48-hours of a major storm event, *i.e.*, a storm event with greater than or equal to 1.0 inch of rain during a 24-hour period (City of Portland 2020; CWS 2016).
2. Stream corridor enhancement elements must be inspected and assessed in accordance with the Butternut Creek Enhancement and Adaptive Management Plan [submitted as Attachment 7 to the SW 198th Avenue Improvement Project – Stormwater Management Design Biological Assessment. June 2020].
3. All stormwater must drain out of the flow-through swale within 48-hours after rainfall ends.
4. All structural components, including inlets and outlets, must freely convey stormwater.
5. Desirable vegetation in the flow-through planter must cover at least 90% of the facility – excluding dead or stressed vegetation, dry grass or other plants, and weeds.
6. An annual report documenting inspection and maintenance actions must be submitted by March 1 of each year, for a period of five years. Corrective actions deemed necessary, per the Adaptive Management Plan, must be described in detail, including any engineering design elements.
7. A stream enhancements completion report must be submitted to NMFS describing the stream enhancement actions and features as they were actually constructed, and note any deviations from the design plan. Deviations from the design must be coordinated through NMFS.

If the stormwater system is not inspected and maintained (as described in #1); if stream corridor enhancements within the treatment reach are not inspected and assessed (#2); if water ponds in the flow-through swale for longer than 48 hours after rainfall ends (#3); structural components are blocked (#4); or if desirable vegetation does not cover 90% of the swale and corrective action is not taken within seven days (#5); or if corrective action is not taken with respect to #3-4 within seven days of a required inspection; or if an annual report is not produced and provided to NMFS (#6) the extent of take surrogate for stormwater will be exceeded and the Corps shall reinitiate this consultation.

2.9.2 Effect of the Take

In Section 2.7, NMFS determined that the level of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

2.9.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" are nondiscretionary measures to minimize the amount or extent of incidental take (50 CFR 402.02). HUD shall minimize take by:

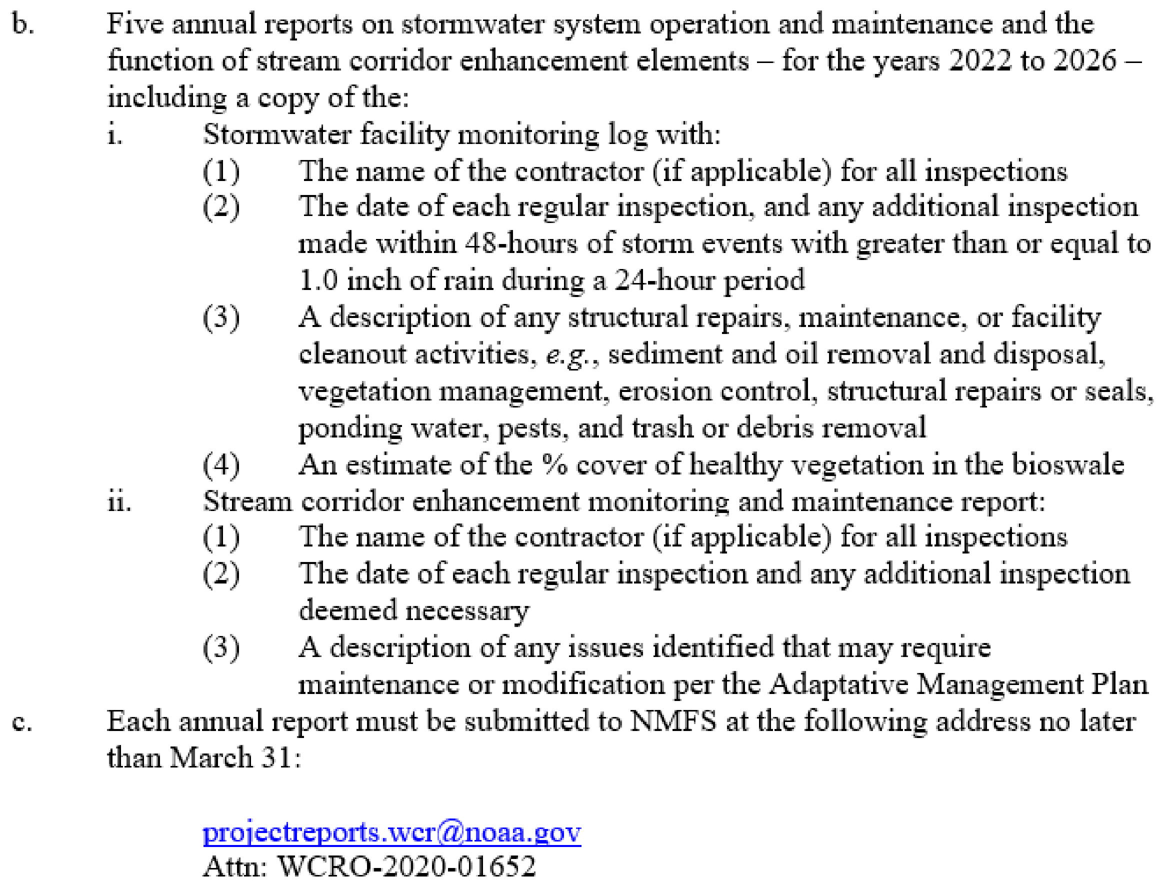
1. Ensuring that stormwater runoff produced by the SW 198th Avenue Road Improvements Project is treated with stormwater facilities that are designed, constructed, operated, and maintained using the best available information on LID and BMPs for stormwater treatment and discharge; and
2. Ensuring completion of a monitoring and reporting program to confirm that the take exemption for the proposed action is not exceeded, and that the terms and conditions in this incidental take statement are effective in minimizing incidental take.

2.9.4 Terms and Conditions

The terms and conditions described below are non-discretionary, and the Corps or any applicant must comply with them in order to implement the RPMs (50 CFR 402.14). The Corps or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this ITS (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.

1. The following terms and conditions implement reasonable and prudent measure 1: (design, construction, operation and maintenance of stormwater BMPs), the applicants shall ensure that the stream corridor enhancement elements will be constructed, operated, and maintained, as described in the Project BA (W^2R 2020) and the Butternut Creek Enhancement Adaptive Management Plan (CWS 2020). :

2. The following terms and conditions implement reasonable and prudent measure 2: (monitoring and reporting), the Corps shall submit the following reports to NMFS:
   a. A project completion report within 60-days of completing construction, including:
      i. Project name
      ii. Corps contact person
      iii. Construction completion date
      iv. An explanation of the stormwater system as built or installed by the construction contractor, including any on-site changes from the original design plans
      v. A photograph of the stormwater outfall with a map showing its location



b. Five annual reports on stormwater system operation and maintenance and the function of stream corridor enhancement elements – for the years 2022 to 2026 – including a copy of the:
    i. Stormwater facility monitoring log with:
        (1) The name of the contractor (if applicable) for all inspections
        (2) The date of each regular inspection, and any additional inspection made within 48-hours of storm events with greater than or equal to 1.0 inch of rain during a 24-hour period
        (3) A description of any structural repairs, maintenance, or facility cleanout activities, *e.g.*, sediment and oil removal and disposal, vegetation management, erosion control, structural repairs or seals, ponding water, pests, and trash or debris removal
        (4) An estimate of the % cover of healthy vegetation in the bioswale
    ii. Stream corridor enhancement monitoring and maintenance report:
        (1) The name of the contractor (if applicable) for all inspections
        (2) The date of each regular inspection and any additional inspection deemed necessary
        (3) A description of any issues identified that may require maintenance or modification per the Adaptative Management Plan

c. Each annual report must be submitted to NMFS at the following address no later than March 31:

projectreports.wcr@noaa.gov
Attn: WCRO-2020-01652

2.10. Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02).

- No conservation recommendations are included with this Opinion.

2.11. Reinitiation of Consultation

This concludes formal consultation for SW 198th Avenue Road Improvements Project.

As 50 CFR 402.16 states, reinitiation of consultation is required and shall be requested by the Federal agency or by the Service where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) The amount or extent of incidental taking specified in the ITS is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

3. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT RESPONSE

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. Under the MSA, this consultation is intended to promote the conservation of EFH as necessary to support sustainable fisheries and the managed species' contribution to a healthy ecosystem. For the purposes of the MSA, EFH means "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity", and includes the physical, biological, and chemical properties that are used by fish (50 CFR 600.10). Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) of the MSA also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH. Such recommendations may include measures to avoid, minimize, mitigate, or otherwise offset the adverse effects of the action on EFH [CFR 600.905(b)]

This analysis is based, in part, on the EFH assessment provided by the Corps and descriptions of EFH for Pacific Coast salmon (Pacific Fishery Management Council [PFMC] 2014); contained in the fishery management plans developed by the PFMC and approved by the Secretary of Commerce.

3.1. Essential Fish Habitat Affected by the Project

The PFMC described and identified EFH for Chinook salmon, coho salmon, and Puget Sound pink salmon (PFMC 1999). The proposed action and action area for this consultation are described in the Introduction to this document. The action area includes areas designated as EFH for various life-history stages of Chinook and coho. Based on information provided by the action agency and the analysis of effects presented in the ESA portion of this document, NMFS concludes that proposed action will have the following adverse effects on EFH designated for Pacific Coast salmon.

3.2. Adverse Effects on Essential Fish Habitat

For purposes of MSA, "adverse effect" means any impact which reduces quality or quantity of EFH. Adverse effects may include direct (*e.g.*, contamination, physical disruption), indirect (*e.g.*, loss of prey, reduction in species' fecundity), site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions [50 CFR 600.910(a)].

As part of the information developed during this consultation, NMFS determined that the action, as proposed, will adversely affect EFH designated for Chinook and coho salmon. The project will discharge stormwater runoff that contains PAHs, dissolved and suspended metals, and other persistent contaminants of concern into waters of Butternut Creek, and the Tualatin, Willamette, and Columbia rivers. From there, the contaminants will move toward the Columbia River estuary, a Habitat Area of Particular Concern (HAPC) and the Pacific Ocean. Contaminants that are dissolved or in suspension will reach the ocean within days or weeks while others deposited in sediments will require years or decades to complete the trip. During that time, some of those contaminants will be absorbed or ingested by Chinook and coho salmon, sometimes in prey that will increase the concentration of contaminants through a process of bioaccumulation. Some individuals will be exposed to these contaminants in quantities sufficient to cause injury or death by modifying their behavior, disrupting endocrine functions, or causing immunotoxic disease effects, either by themselves or through additive, interactive, and synergistic interactions with other contaminants in the river.

3.3. Essential Fish Habitat Conservation Recommendations

NMFS expects that full implementation of these EFH conservation recommendations would protect by avoiding or minimizing the adverse effects described in Section 3.2 above in the Columbia Basin that provide habitat for Pacific salmon.

Because the properties of EFH that are necessary for the spawning, breeding, feeding or growth to maturity of managed species in the action area are the same or similar to the biological requirements of ESA-listed species as analyzed above, and because the best management practices and conservation measures that the applicant included as part of the proposed action are adequate to avoid, minimize, or otherwise offset those adverse effects to designated EFH, NMFS has provided the following two conservation recommendations.

The following conservation recommendation is necessary to avoid, mitigate, or offset the impact of the proposed action on EFH. This conservation recommendation is a subset of the ESA reasonable and prudent measures, terms and conditions:

- Follow reasonable and prudent measures #1 (ensure that stormwater runoff produced by the SW 198th Avenue Road Improvement Project is treated with stormwater facilities that are designed, constructed, operated, and maintained using the best available information on LID and BMPs for stormwater treatment and discharge), and
- #2 (ensure completion of a monitoring and reporting program to confirm that the stormwater facilities were completed as described).

3.4. Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, the ACOE must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH Conservation Recommendations unless NMFS and the Federal agency have agreed to use alternative time frames for the Federal agency response. The response must include a description of the measures proposed by the agency for avoiding, minimizing, mitigating, or otherwise offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with the Conservation Recommendations, the Federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(k)(1)).

In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, we ask that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

3.5. Supplemental Consultation

The Corps must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH Conservation Recommendations (50 CFR 600.920(l)).

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these DQA components, documents compliance with the DQA, and certifies that this opinion has undergone pre-dissemination review.

Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are the U.S. Army Corps of Engineers (Corps). Other interested users could include Clean Water Services (CWS) and Washington County Department of Land Use and Transportation (DLUT). The document will be available within two weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. The format and naming adheres to conventional standards for style.

Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this opinion and EFH consultation contain more background on information sources and quality.

Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA and EFH implementation, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

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6. APPENDICES

Appendix A:

Technical Memorandum, Butternut Creek Enhancement at Witzig Reservoir – Hydraulic Changes with Channel Hydrology and Channel Restoration. Gary Wolf. Otak. September 27, 2019. [submitted as Attachment 5 to W2R. 2020. SW 198th Avenue Improvement Project – Stormwater management Design Biological Assessment. June 2020.]

Technical Memorandum

To:	Richard Boyle, Clean Water Services
From:	Gary Wolff, PE, D.WRE, CFM
Copies:	Project Files
Date:	September 27, 2019
Subject:	Butternut Creek Enhancement at Witzig Reservoir Hydraulic Changes Associated with Changed Hydrology and Channel Restoration
Project No.:	18505.C00

1. Introduction

This Technical Memorandum documents hydrologic and hydraulic modeling carried out to evaluate changes in hydraulic conditions along Butternut Creek associated with the proposed Butternut Creek Enhancement at Witzig Reservoir Project (restoration project). Butternut Creek from SW 198th Avenue to SW 209th Avenue (project reach) is a single-thread channel that is incised and disconnected from the adjacent floodplain. Centered in the middle of the reach is an artificial impoundment known as Witzig Reservoir. Clean Water Services (District) in partnership with Washington County (County) is evaluating restoration opportunities along the stream corridor within the project reach to help mitigate impacts from increased runoff associated with the widening of SW 198th Avenue. The project area is shown in Figure 1.

Figure 1. Project Reach Map

The SW 198th Avenue road widening project will increase the amount of impervious area in the Butternut Creek watershed, and if not detained, the increased runoff from the road could result in hydromodification impacts (increased velocities and erosion) to Butternut Creek downstream of the road. To address projected increases in runoff associated with the project, a stormwater management flow control facility has been designed for an offsite location at Butternut Creek Elementary School (see Figure 1).

The point of compliance for the road project is located below the outfall from this facility, or roughly half way between SW 198th Avenue and SW 209th Avenue (middle of the project reach). The restoration project being designed by the District is being proposed as a way to mitigate the hydromodification impacts from the road project in lieu of constructing the flow control facility at Butternut Creek Elementary School.

The proposed restoration along the project reach of Butternut Creek will include the following elements:

- Minor grading along the eroding banks of Reach 1 to stabilize the banks using bio-engineering techniques
- Large woody debris (LWD) assemblages incorporated into the bank stabilization to increase stability and provide improved habitat conditions
- Extensive removal of invasive species and revegetation with native species along the entire project reach between SW 198th Avenue and SW 209th Avenue
- Wood habitat structures incorporated into the floodplain of Reach 1 (upstream of Witzig Reservoir)

The analyses presented in this technical memorandum include 1) hydrologic modeling carried out to quantify changes in streamflows associated with the road widening project and 2) hydraulic modeling of the project reach of Butternut Creek to evaluate hydraulic changes associated with the proposed restoration project. Results of the hydraulic modeling are also used to quantify potential changes in reach storage associated with the restoration project that might translate to reductions in downstream discharges.

Note that all elevations in this Technical Memorandum are in the National Geodetic Vertical Datum of 1929 (NGVD29).

2. Hydrologic Modeling

Hydrologic modeling was carried out using the Tualatin River Urban Stormwater Tool (TRUST) to quantify changes in flow in the project reach of Butternut Creek associated with the SW 198th Avenue road widening project. The following three scenarios were evaluated:

- Scenario 1: Existing Conditions = Current hydrologic conditions in Butternut Creek before the 198th Avenue Road Widening project to act as a baseline hydrology for comparison.
- Scenario 2: Road Widening without Detention= predicts changes in the hydrology of Butternut Creek after road widening if no detention pond is constructed
- Scenario 3: Road Widening with Detention = predicts changes in the hydrology of Butternut Creek after road widening that includes a flow control facility constructed at Butternut Creek Elementary School.

Model results were also used as the flow input to the hydraulic modeling discussed in Section 3. This includes an evaluation of potential changes in hydrology downstream of SW 209th Avenue due to changes in reach storage associated with the restoration project.

Model Development

TRUST is software developed to perform continuous simulation hydrologic modeling using the Hydrologic Simulation Program – Fortran (HSPF) for areas within the Tualatin River watershed. The TRUST software includes local precipitation data, local evaporation data, and HSPF hydrologic parameters calibrated to local streamflow data. Inputs into TRUST include precipitation, land cover, storage-discharge curves for streams and reservoirs, and hydrologic parameters. The model computes a continuous time series of flow in each of the stream or reservoir segments over the simulation period (currently 64 years). The resulting time series is then statistically analyzed by the TRUST software to determine annual flood peaks (flood frequency). For this study, the resulting time series was output and analyzed to determine the frequency and duration of the flows (flow duration) for the full range of flows, not just those in the range reported by the TRUST software.

Basin delineations provided were reviewed and adjusted according to LiDAR topography and GIS data of the stormwater infrastructure. Sub-basin areas were further refined in the vicinity of the project reach to achieve a higher resolution for the evaluation of project effects and for inputs into the HEC-RAS model (Section 3).

Figure 2 shows the sub-basin delineation of the entire Butternut Creek basin with specific sub-basins that were changed highlighted in the figure.

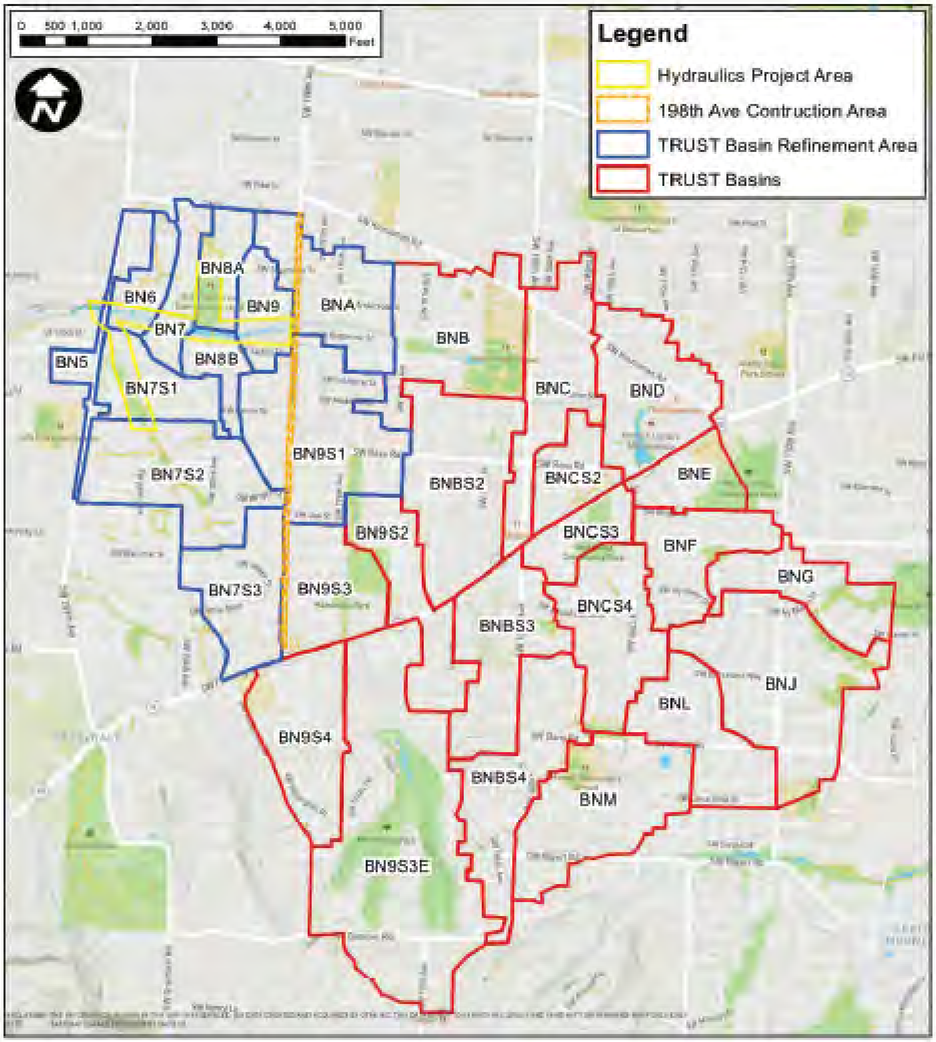

Figure 2. Butternut Creek TRUST model sub-basin delineation

TRUST includes a predefined set of 39 land segments used to describe the land cover of a watershed. Each land segment is coded as a different PERLND or IMPERLND in the HSPF model and is defined by the combination of slope (flat, moderate, steep), vegetative cover (lawn, pasture, forest), and hydrologic soil group (A,B,C,D). Data sources described in Table 1 for slope, soil, land use, and impervious area were processed on a GIS platform using spatial analyst extension to intersect the data sets and calculate total acres of each land segment present in each of the Butternut Creek basins. Hydrologic parameters in the TRUST software were updated for this study based concurrent calibration efforts being conducted by Otak for the District under a separate contract.

Table 1— Data sources for the TRUST model inputs

Precipitation Gage	Butternut pump station (1950-2014)
Slope	City of Hillsboro LiDar (2013)
Soil Type	Natural Resources Conservation Service Web Soil Survey (Downloaded 2018)
Land Use	National Land Cover Data Set (2011)
Impervious Area	National Land Cover Data Set (2011)

Hydrologic routing in HSPF is accounted for using FTABLES which are simply stage-storage-discharge relationships for the routing reaches (streams and reservoirs). The FTABLES for the routing reaches covered by the HEC-RAS model (Section 3) were updated for this study. This was done by running the HEC-RAS model over a range of flows (very low to high) and extracting the stage-storage-discharge relationships from the model output. FTABLES not covered by the HEC-RAS model were not changed. Figure 3 shows the routing reaches in the vicinity of the project reach.

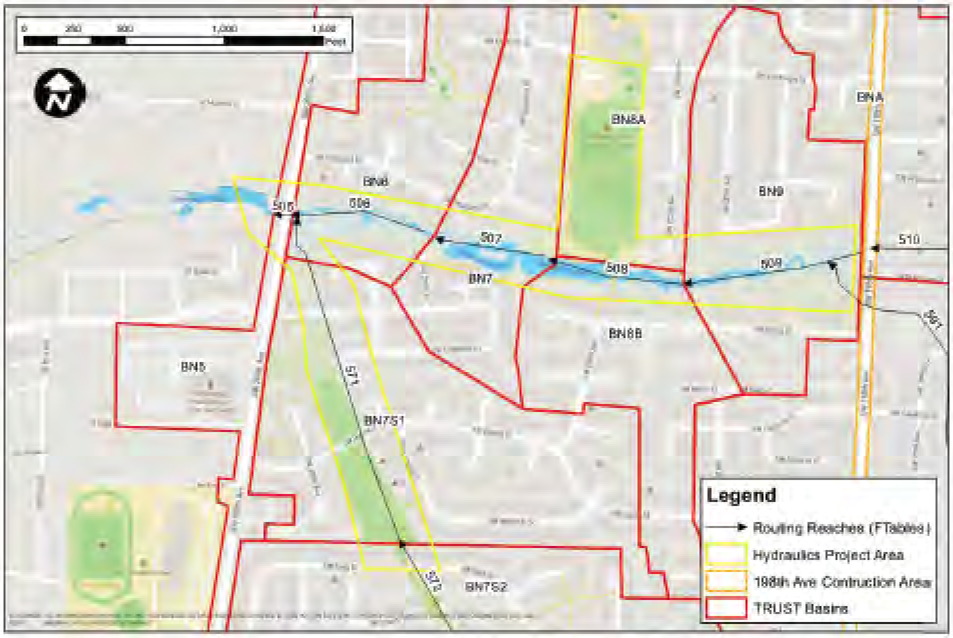

Figure 3. TRUST model sub-basins and routing reaches in the vicinity of the project reach

The road widening project changes the quantity of impervious area in the effected sub-basins, so pervious area is converted to impervious area in the model. Table 2 shows the impervious areas of the effected sub-basins before and after road construction. An FTABLE was developed to model the storage provided by the detention pond at Butternut Creek Elementary School. Review of the SW 198th Road Widening Project Drainage Report (DEA, 2018) provided design information needed to define the stage-storage-discharge relationship for the detention pond.

Table 2— Summary of changes in impervious areas for sub-basins affected by the road widening project

Sub-Basin	Drainage Area (acres)	Impervious Area (acres)		
		Existing Conditions	Project Conditions	Change
BN9S1	118.4	39.8	42.0	2.2
BN9S3	62.5	20.0	21.4	1.5
BNA	71.0	25.3	26.5	1.3
Total	251.9	85.1	90.0	4.9

Results

Table 3 summaries the computed peak flows for reaches along Butternut Creek between SW 198th Avenue and SW 209th Avenue. The peak flows for the different return periods are based on a flood frequency analysis of the simulated annual peak flows with the computations performed by the TRUST software. The changes in impervious area are confined to the basin upstream of SW 198th Avenue, so all flows below this are influenced by the road widening project. The results show very small flow changes as a result of the road widening project, with a maximum increase over Existing Conditions equal to only 1.0 cfs for the scenario with the road project and no detention. Adding the proposed detention pond at the Butternut Creek Elementary School reduces the flows below the outfall (routing reaches 508 and 509) slightly, but again the changes are very small; less than 0.5% of total flow in the creek. These very small changes are consistent with the very small change in impervious area as summarized in Table 2. The total increase in impervious area of 4.9 acres is only 0.03 percent of the total drainage area of 1,566 acres at SW 198th Avenue.

Flow duration curves show the percent of time a specific flow is equaled or exceeded and provide a quantification of the frequency and duration of the more commonly occurring flows that is not captured by only looking at the flood peaks. This is important for sediment transport and channel stability, aquatic habitat, and other environmental considerations. Figures 4 through 7 compare the computed flow-duration curves for the different hydrologic model scenarios for the routing reaches along the project reach of Butternut Creek. There are no visible differences in the curves between the different model scenarios, again demonstrating that the very small change in impervious area associated with the road widening project will have an insignificant effect on the flows in the project reach of Butternut Creek.

Table 3— Comparison of peak discharges along the project reach of Butternut

Peak Discharge (cfs)					
Return Period (Years)	Existing Conditions	Project Conditions without Detention		Project Conditions with Detention	
		Computed	Change from Existing	Computed	Change from Existing
At 198th - Reach 510					
2	127.3	127.5	0.2	127.5	0.2
5	156.5	156.8	0.3	156.8	0.3
10	174.7	175.0	0.3	175.0	0.3
25	196.8	197.1	0.3	197.1	0.3
50	212.7	213.1	0.4	213.1	0.4
100	228.3	228.7	0.4	228.7	0.4

(Table 3 continued)

Return Period (Years)	Existing Conditions	Peak Discharge (cfs)			
		Project Conditions without Detention		Project Conditions with Detention	
		Computed	Change from Existing	Computed	Change from Existing
Downstream of Celebrity Creek - Reach 509					
2	177.3	178.2	0.9	178.2	0.9
5	219.2	220.2	0.9	220.2	0.9
10	245.5	246.5	1.0	246.5	1.0
25	277.6	278.5	1.0	278.5	1.0
50	300.7	301.7	1.0	301.7	1.0
100	323.5	324.4	1.0	324.4	1.0
Downstream of Butternut Creek Elementary School - Reach 508					
2	180.3	181.2	0.9	181.0	0.7
5	223.1	224.0	0.9	223.4	0.3
10	250.0	250.9	0.9	250.0	0.0
25	282.7	283.6	0.9	282.3	-0.4
50	306.3	307.2	0.9	305.7	-0.7
100	329.6	330.4	0.8	328.5	-1.0
At SW 209th Avenue Bridge - Reach 505					
2	205.6	206.6	1.0	205.5	-0.2
5	255.8	256.8	1.0	255.2	-0.6
10	287.5	288.4	0.9	286.5	-1.0
25	326.2	327.1	0.9	324.8	-1.4
50	354.3	355.1	0.8	352.5	-1.8
100	381.8	382.6	0.8	379.7	-2.1

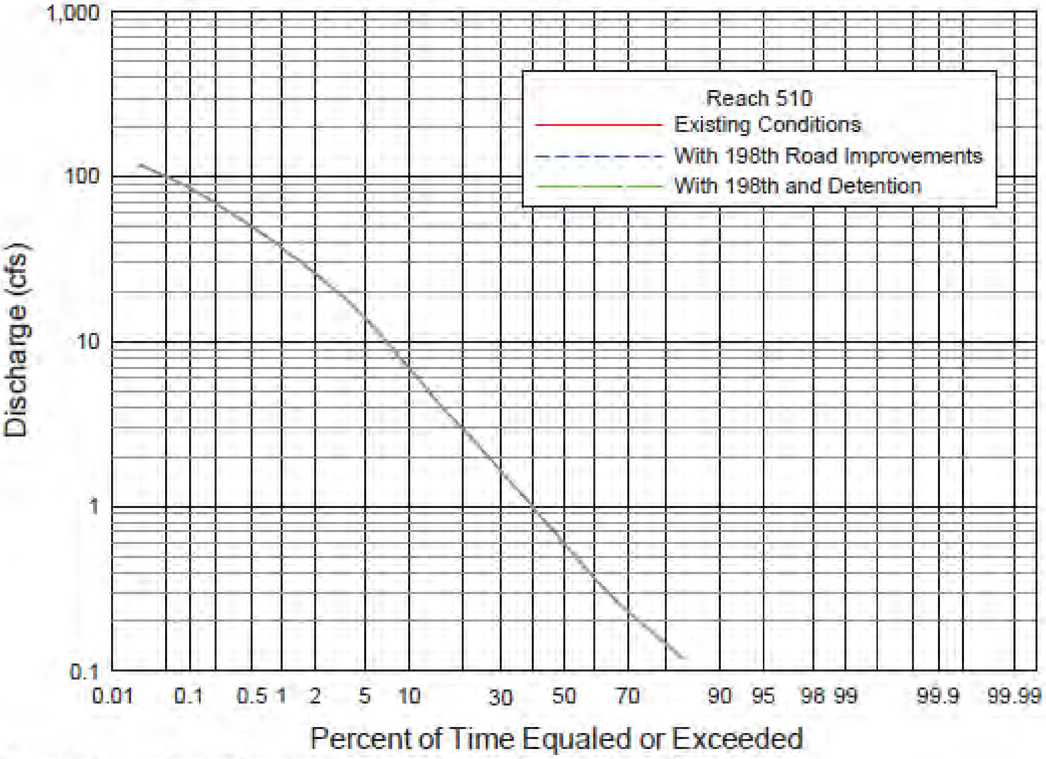

Figure 4. Comparison of flow duration curves for Reach 510, at SW 198th Avenue

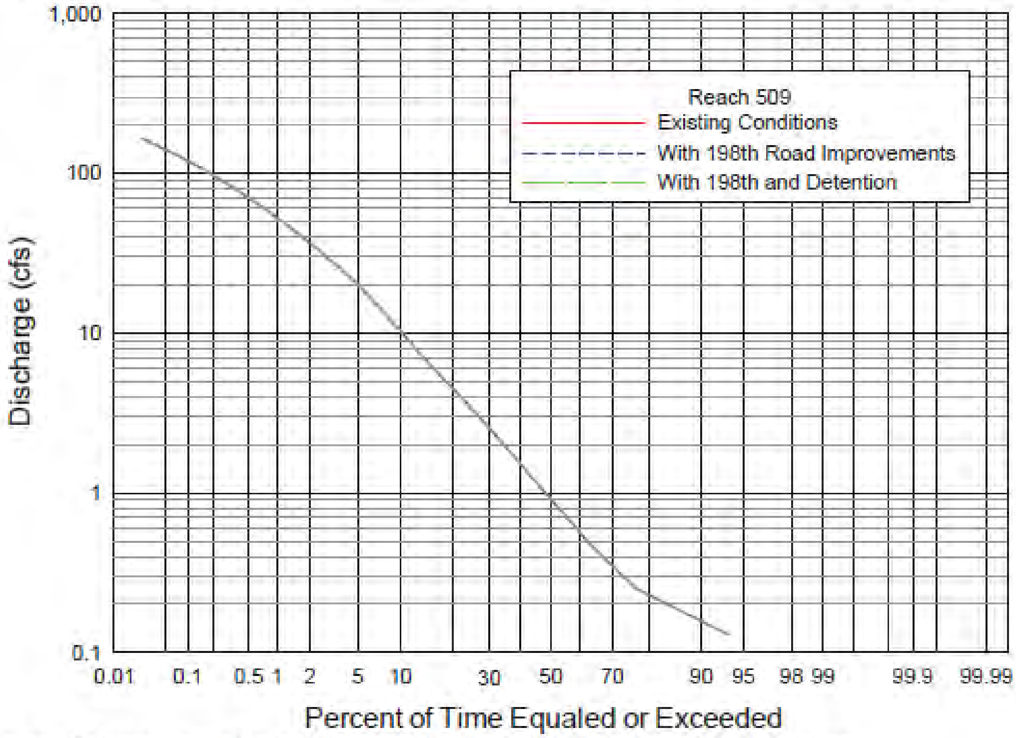

Figure 5. Comparison of flow duration curves for Reach 509, downstream of Celebrity Creek.

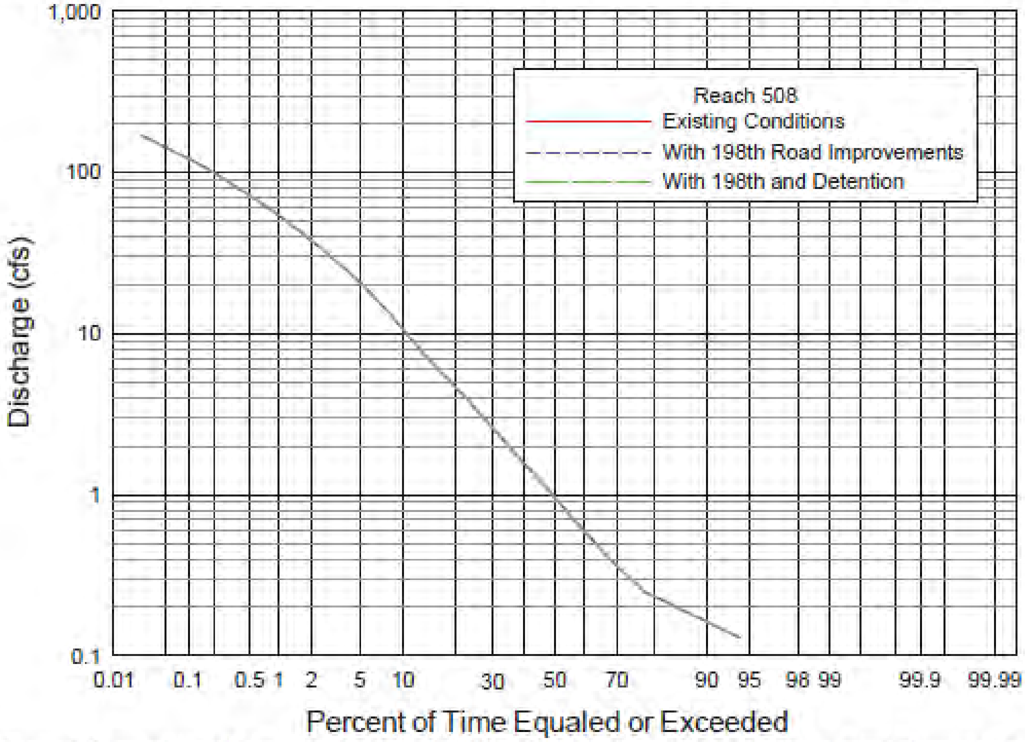

Figure 6. Comparison of flow duration curves for Reach 508, downstream of the butternut creek elementary school stormwater outfall

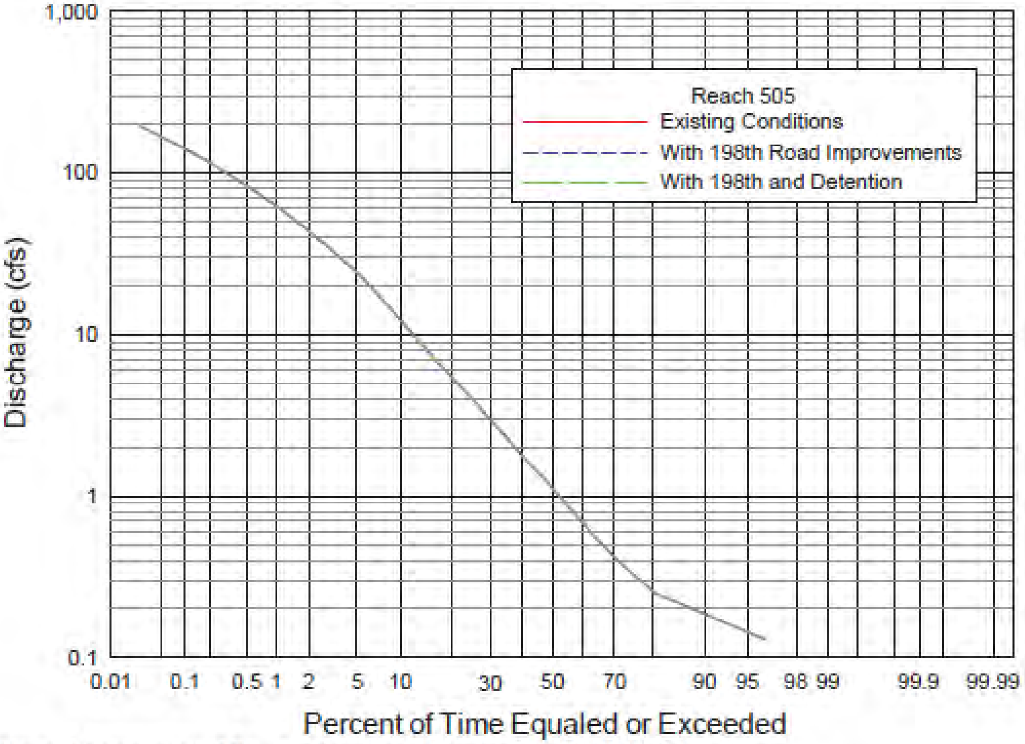

Figure 7. Comparison of flow duration curves for reach 505, at SW 209th Avenue

The very small predicted changes in Butternut Creek flows associated with the SW 198th Avenue Road project suggest that the road project by itself will not cause significant hydromodification impacts to the downstream creek. It should be noted that while the changes associated with the road project by itself are expected to be insignificant, the changes are not zero. Cumulative effects from continued development, if not mitigated, would result in further impacts to the creek that is already in a degraded state from past development. In the next section the results of analyses of the proposed restoration project are discussed.

3. Hydraulic Modeling

As shown in Section 2 changes in Butternut Creek flows associated with the SW 198th Avenue road widening project are insignificant and therefore would not result in significant hydromodification impacts to the stream. Therefore, the focus of the hydraulic modeling discussed in this section are changes associated with the proposed restoration project. This includes both changes in hydraulic conditions within the reach and potential changes in storage that would have effects on downstream flows.

Approach

Hydraulic conditions along the project reach of Butternut Creek were analyzed using a one-dimensional (1-D) hydraulic model. The modeling was carried out using version 5.07 of the United States Army Corps of Engineers (USACE) HEC-RAS software (USACE, 2016). The HEC-RAS model was run over a range of flows to evaluate changes in hydraulic conditions along the project reach (water-surface elevations and velocities) that could be attributed to the proposed restoration. This included an evaluation of changes in the magnitude and frequency of main-channel velocities at select locations, with main-channel velocity being an important metric for channel stability. Finally, changes in reach storage were quantified and used in conjunction with the hydrologic model discussed in Section 2 to evaluate potential project effects on downstream discharges.

Note that in this section (discussion of hydraulic modeling) Pre-Project Conditions refers to the existing condition of the Butternut Creek channel and floodplain and Post-Project Conditions refers to conditions of the channel and floodplain based on the proposed restoration. This distinction is made to avoid confusion with Existing Conditions and Project Conditions presented in Section 2 that references hydrologic changes associated with the road widening project. Hydrologic input (flows) in the hydraulic model is based on results from the Existing Conditions hydrologic model. The same hydrologic input was used for all hydraulic modeling scenarios, so the results are comparing just the changes to hydraulics due to the proposed restoration actions. Since there are very small differences in flow rates predicted for the other hydrologic modeling scenarios, changes in hydraulic conditions due to the very small changes in flow rates are negligible.

Model Development

The modeled reach is about 3,500 feet long and extends from just downstream of SW 209th Avenue to just upstream of SW 198th Avenue. Figure 8 shows the model layout and cross section locations. To account for the flow split at Witzig Reservoir the model includes two separate reaches: one that models the flow path through the reservoir and the second that follows along the adjacent main channel. The HEC-RAS software determines the flow in each branch by performing an energy balance at the upstream end. A lateral weir is included to account for overtopping of the berm that separates the reservoir from the channel.

Figure 8. Map of the project reach showing HEC-RAS cross sections

Pre-Project Conditions cross sections were developed from a detailed topographic survey of the site carried out by Otak during the winter months in early 2019. The survey resulted in a detailed digital terrain model (DTM) of the project area that could be used to cut the cross sections. Note that the survey was in the NGVD29 vertical datum which was used for all the modeling presented in this Technical Memorandum. The model is tied to the hydraulic model of the Effective Flood Insurance Study (Effective FIS) immediately downstream of SW 209th Avenue (Cross Section 0 is FIS Cross Section W, or FIS Model Cross Section 2317104). This cross section formed the downstream boundary condition for the model with starting water-surface elevations taken from the Effective model run over a wide range of discharges.

Post-Project Conditions were modeled by updating the Pre-Project Conditions cross sections to reflect proposed grading and modifying Manning's n values to reflect roughness changes associated with the introduction of LWD and proposed revegetation. The proposed grading was incorporated into the Pre-Project Conditions DTM allowing the cross sections to easily be recut to represent Post-Project Conditions. The proposed LWD was modeled through changes in Manning's n value as these features cannot easily be represented by geometric (cross-section) changes. The scale of these structures (small, without significantly blocking the flow) is on the same order of other natural features such as trees, etc. that are not explicitly included in the model geometry but rather captured though the selected roughness coefficients (Manning's n values). The estimation of Manning's n values is discussed below.

The models of Pre-Project Conditions and Post-Project Conditions were run over a wide range of flows to evaluate changes associated with the restoration project. Flows for specific flood events (peak flows) were taken from the TRUST model output for Existing Conditions (pre-road widening project construction). Discharges for smaller flows were prorated based on the flow distribution for the 2-year event. Flows from the hydrologic scenarios that include the road widening project were not modeled as they are nearly identical to Existing Conditions. Table 4 summarizes the discharges used in the model for select profiles.

Table 4— Summary of HEC-RAS discharges for select profiles

Location	Discharge (cfs)					
	10 cfs	20 cfs	Half 2-yr	2-Year	10-Year	100-Year
SW 198th Avenue	10	20	64	127	175	228
Downstream of Celebrity Creek	14	28	89	177	246	323
Downstream of Butternut Creek Elementary Stormwater Outflow	14.5	29	90	180	250	330
Downstream of Cross Creek	15	30	103	206	287	382

Estimation of Manning's n Values

Hydraulic roughness in a hydraulic model such as HEC-RAS is accounted for using Manning's n roughness coefficients. In a one-dimensional model Manning's n values account for the energy losses associated with a variety of physical processes that are not explicitly accounted for in the model formulation. These included things such as bed material, bed forms, vegetation, channel sinuosity, sediment transport, and obstructions not included in the channel geometry. In the absence of calibration data Manning's n values must be estimated and are a principal source of uncertainty in the model results. Methods of estimation include handbook tables, photos of calibrated streams, and empirical equations. In all cases visual observation and engineering judgement is a key factor in the estimated values and different engineering practitioners are likely to come up with different results.

Calibration data are not available for this project and the Manning's n values had to be estimated. For Pre-Project Conditions this was done through detailed field observations with spatial fine-tuning by overlaying the cross sections on aerial imagery. Manning's n values were assigned using standard references (e.g. Chow, 1959, Barnes, 1967) and engineering judgement. The estimated values for Pre-Project Conditions are presented in Table 5.

Table 5— Manning's roughness coefficients for Pre-Project Conditions

Description	Manning's n
Main Channel	
Under bridges	0.025
Open water	0.03
Channel transition to open water	0.05
Meandering channel, heavy vegetation on banks, little debris.	0.06
Meandering channel, heavy vegetation on banks, occaisional beaver dams and debris.	0.07
Small tributary with dense vegetation	0.08

(Table 5 continued)

Description	Manning's n
Overbanks	
Reed canary grass, scattered trees, etc.	0.06
Moderately dense vegetation, willows, etc.	0.07-0.08
Forested areas	0.08
Dense willows, blackberries	0.10

For Post-Project Conditions changes in Manning's n value were made to reflect the in-channel LWD structures and proposed floodplain revegetation. The roughness of the scattered wood habitat structures incorporated into the floodplain is incorporated into the estimated overbank n values. Design and revegetation plans (see Appendices A and B) and GIS shape files showing the proposed revegetation zones provided by the District were used to determine the areas of roughness changes in the model. The estimated Post-Project Conditions Manning's n values are provided in Table 6.

Table 6— Manning's roughness coefficients for Post-Project restoration features

Description	Manning's n
Main Channel	
Large woody debris	0.08
Overbanks	
Emergent marsh	0.045
Riparian forest, low density	0.06
Riparian forest	0.08
Scrub schrub	0.08
Forested wetland	0.08

Project Reach Hydraulic Results

To evaluate hydraulic changes in the project reach associated with the proposed restoration project, the HEC-RAS model was run over a range of flows for both Pre-Project and Post-Project conditions. Figures 9 through 12 compare the computed water-surface profiles for select discharges ranging from one-half the 2-year peak to the 100-year peak. The low end represents a discharge that is within the channel banks for a high percentage of the cross sections and the upper end a large flood with significant overbank flooding. For the lower discharges (one-half the 2-year, 2-year) there are no significant differences in the lower section of the project reach (Reaches 2 and 3), with a noticeable decrease in the computed water-surface elevations in Reach 1 where proposed grading lays back eroding banks at specific locations (see Appendix A). The increased conveyance from the larger cross-section area appears to have a greater effect than the assumed roughness for the LWD. At the higher discharges (10-year, 100-year) the differences in the water-surface profiles are more subtle and not easily visible at the scale of the plots. Table 7 summarizes the largest computed changes for each profile. The table shows that the largest reduction in water-surface elevation ranges from 0.19 feet at the one-half the 2-year flow to 0.07 feet at the 100-year peak. The increases are generally very small, but generally increase with increasing discharge. This is the result of more floodplain inundation where the assumed roughness is generally higher with the proposed revegetation. The maximum increase is 0.06 feet for the 100-year flood peak. Note that the results for the 100-year flood presented here (and elsewhere in this report) are based on flows from the TRUST modeling carried out for this project. These flows are different than the 100-year flows used to define the 100-year floodplain in the Effective Flood Insurance Study (Effective FIS) and used to evaluate floodplain impacts presented in a separate Technical Memorandum (Otak, Inc., 2019a).

Table 7— Maximum changes in computed water-surface elevations associated with the proposed restoration project

Event	**Maximum change in water-surface elevation (feet)**	
	Reduction	**Increase**
One-Half 2-Year	0.19	0.03
2-Year	0.16	0.02
10-Year	0.10	0.04
100-Year	0.07	0.06

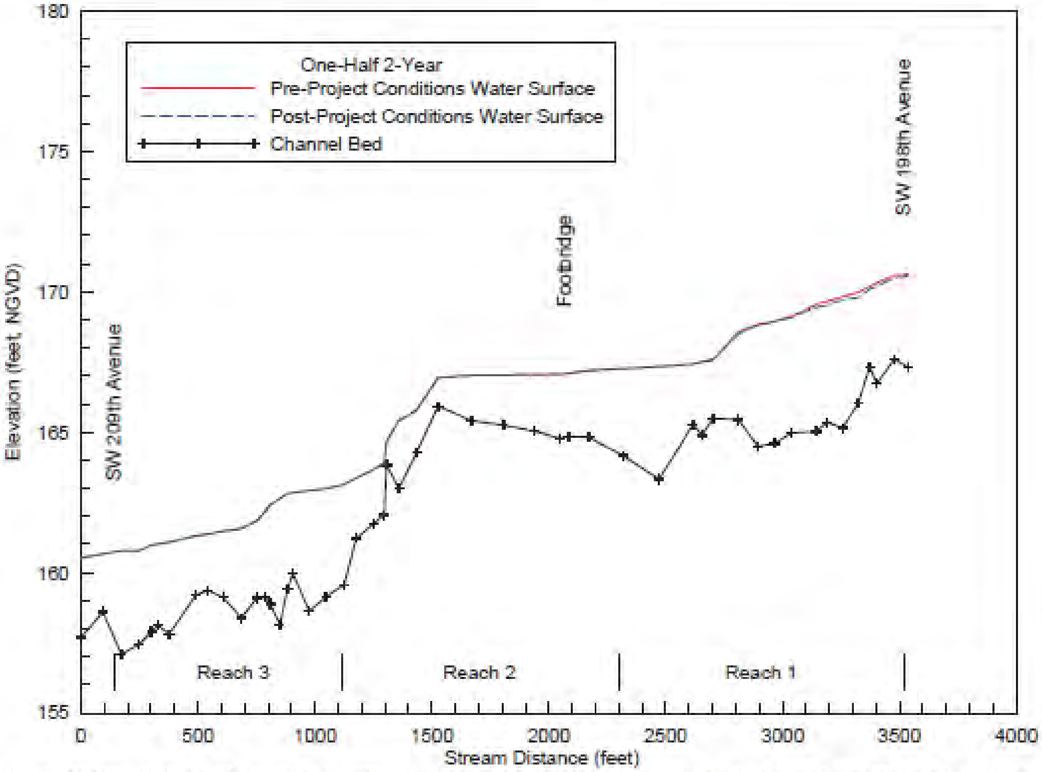

Figure 9. Comparison of computed water-surface profiles along the project reach for one-half the 2-year peak

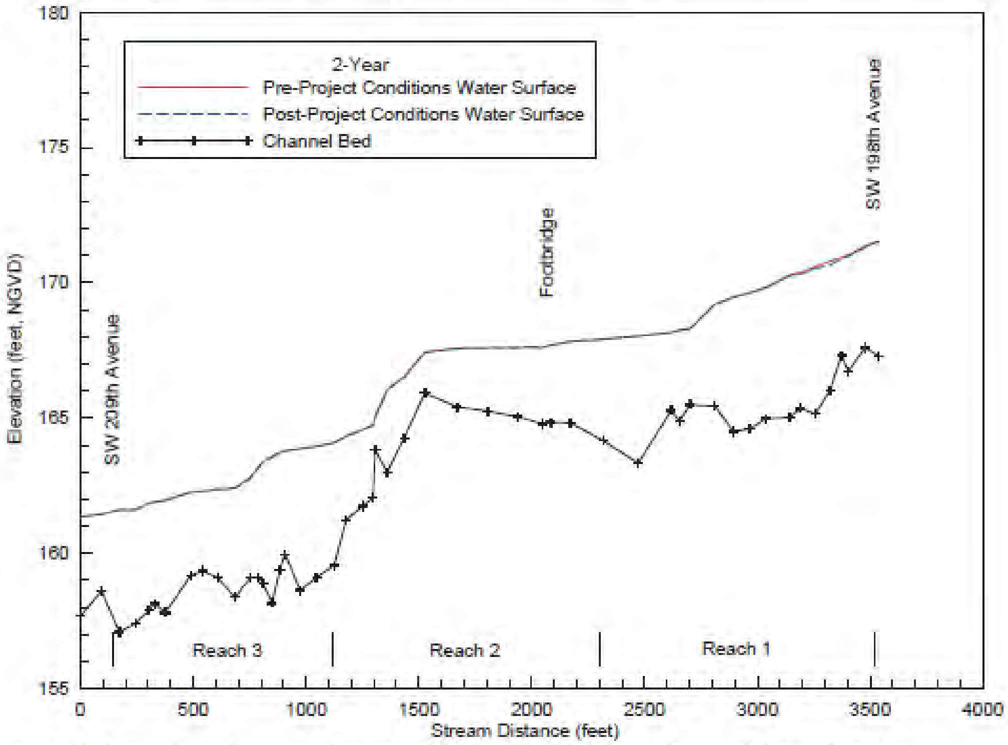

Figure 10. Comparison of computed water-surface profiles along the project reach for the 2-year peak

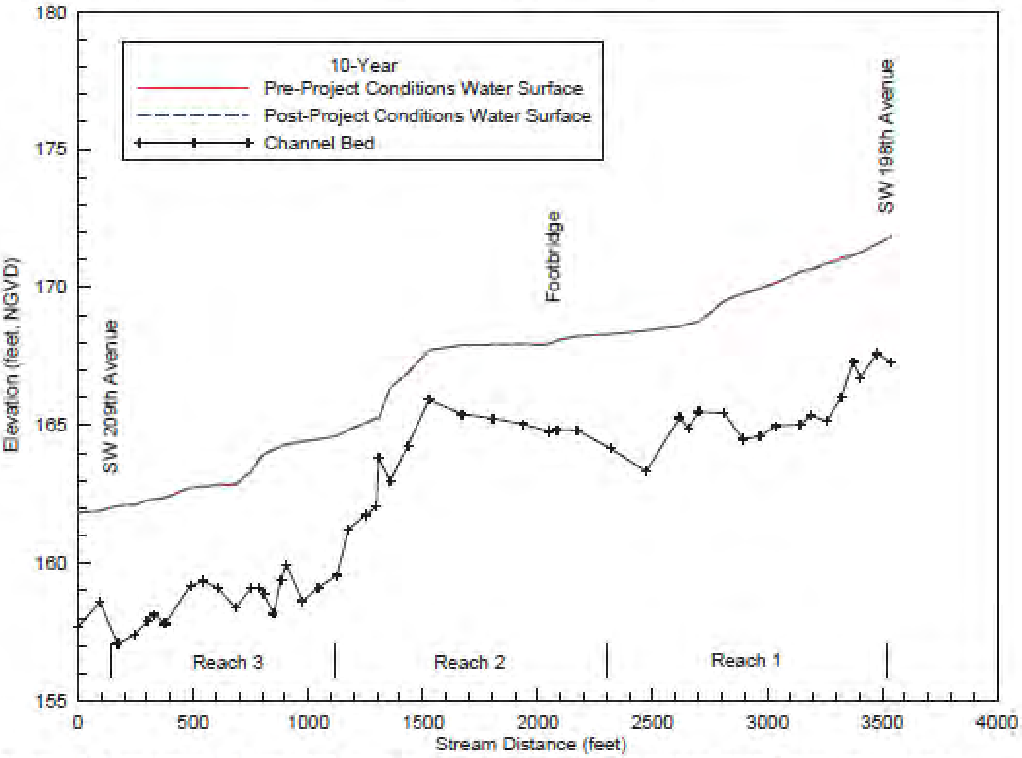

Figure 11. Comparison of computed water-surface profiles along the project reach for the 10-year peak

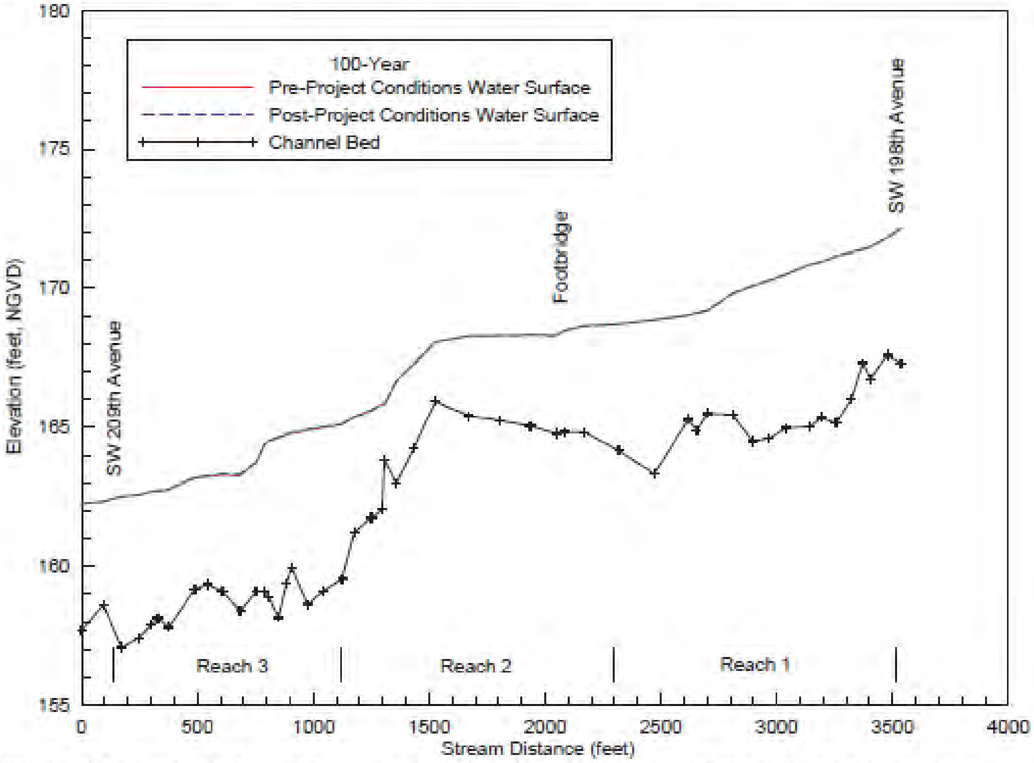

Figure 12. Comparison of computed water-surface profiles along the project reach for the 100-year peak

Figures 13 through 16 compare computed main-channel velocities for select discharges ranging from one-half the 2-year peak to the 100-year peak. A summary of the largest changes in velocity magnitude is provided in Table 8. At all the modeled discharges the largest changes occur in Reach 1 where the proposed project includes local grading and the addition of LWD to repair eroding banks and improve in-channel habitat. While the range of velocities are similar, the Post-Project results show more local variation from cross section to cross section. There also appears to be a net reduction in Reach 1 velocities where more cross sections show a velocity decrease than a velocity increase. For the lower discharges (one-half the 2-year, 2-year) there is very little change in Reaches 2 and 3 where there is little overbank flow and no proposed in-channel work. At higher discharges where there is more significant overbank flow there are small changes in Reaches 2 and 3, but the magnitude of the changes is much less than Reach 1. For the project reach as a whole Table 8 shows local velocity reductions as large as about 1.1 ft/s and local velocity increases as large as about 0.7 ft/s.

Table 8— Maximum changes in computed main-channel velocities associated with the proposed restoration project

Event	Maximum change in main-channel velocity (ft/s)	
	Reduction	Increase
One-Half 2-Year	0.90	0.19
2-Year	1.11	0.68
10-Year	1.02	0.47
100-Year	0.90	0.38

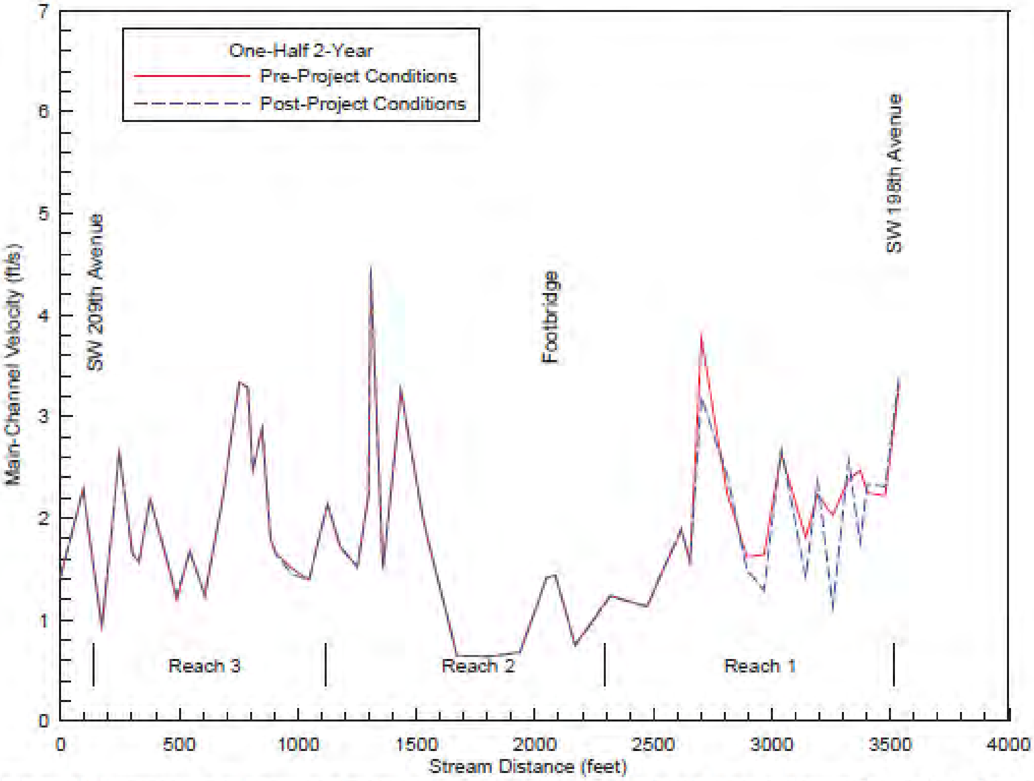

Figure 13. Comparison of computed main channel velocity profiles along the project reach for one-half the 2-year peak

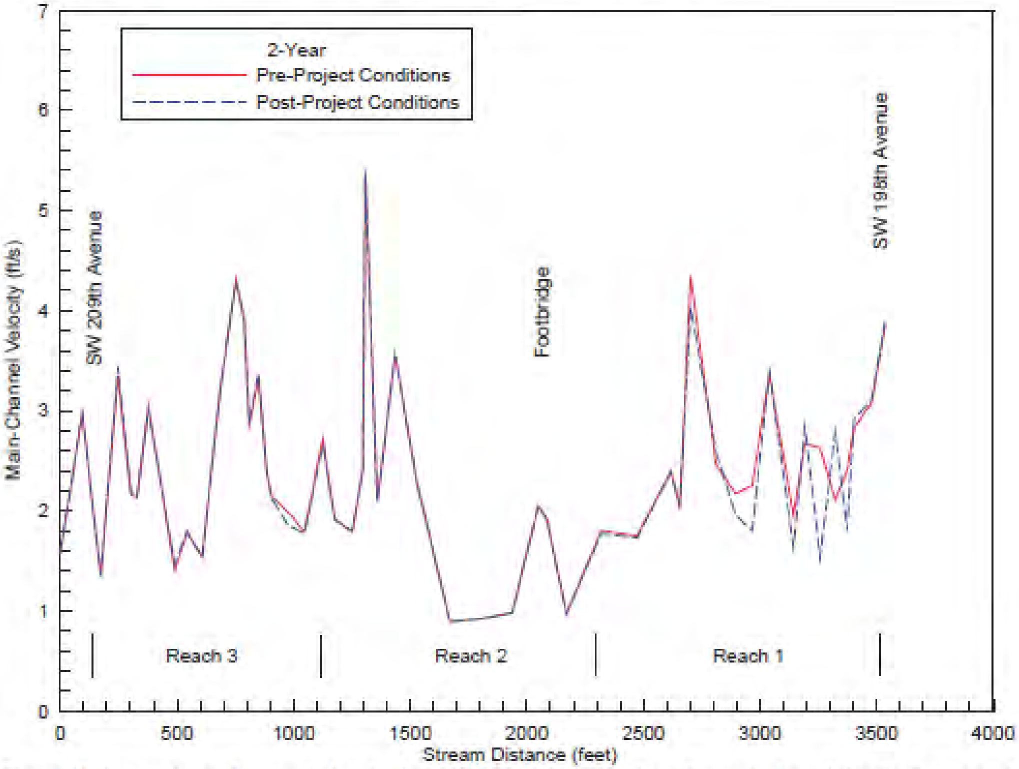

Figure 14. Comparison of computed main channel velocity profiles along the project reach for the 2-year peak

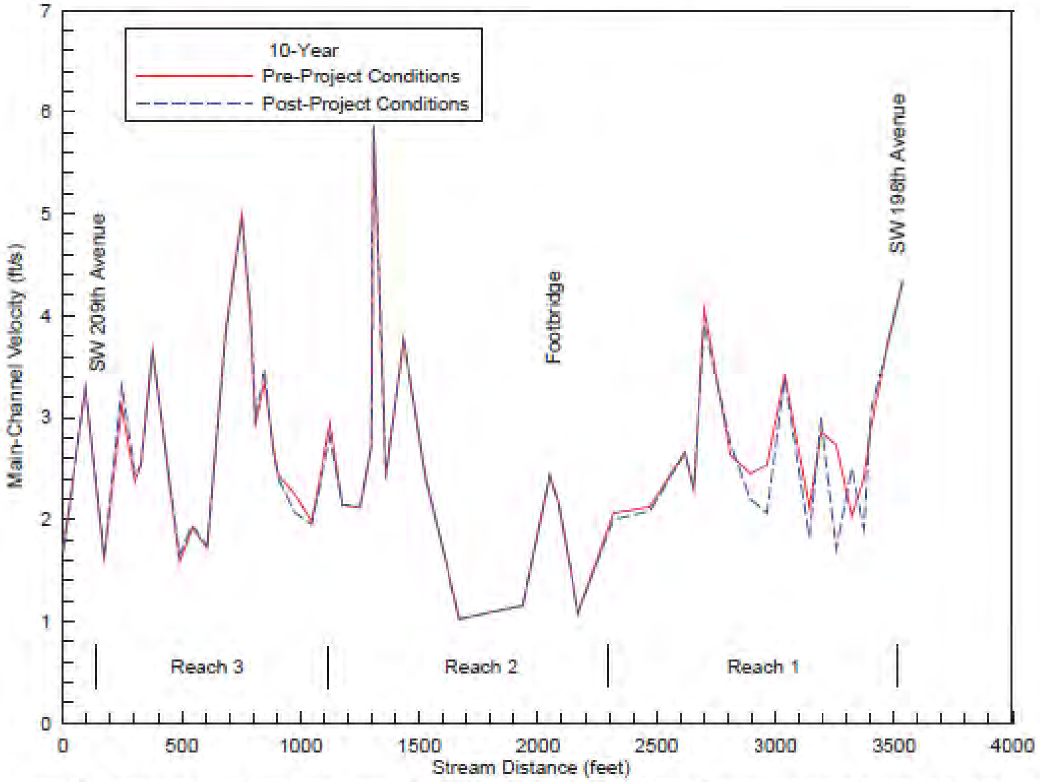

Figure 15. Comparison of computed main channel velocity profiles along the project reach for the 10-year peak

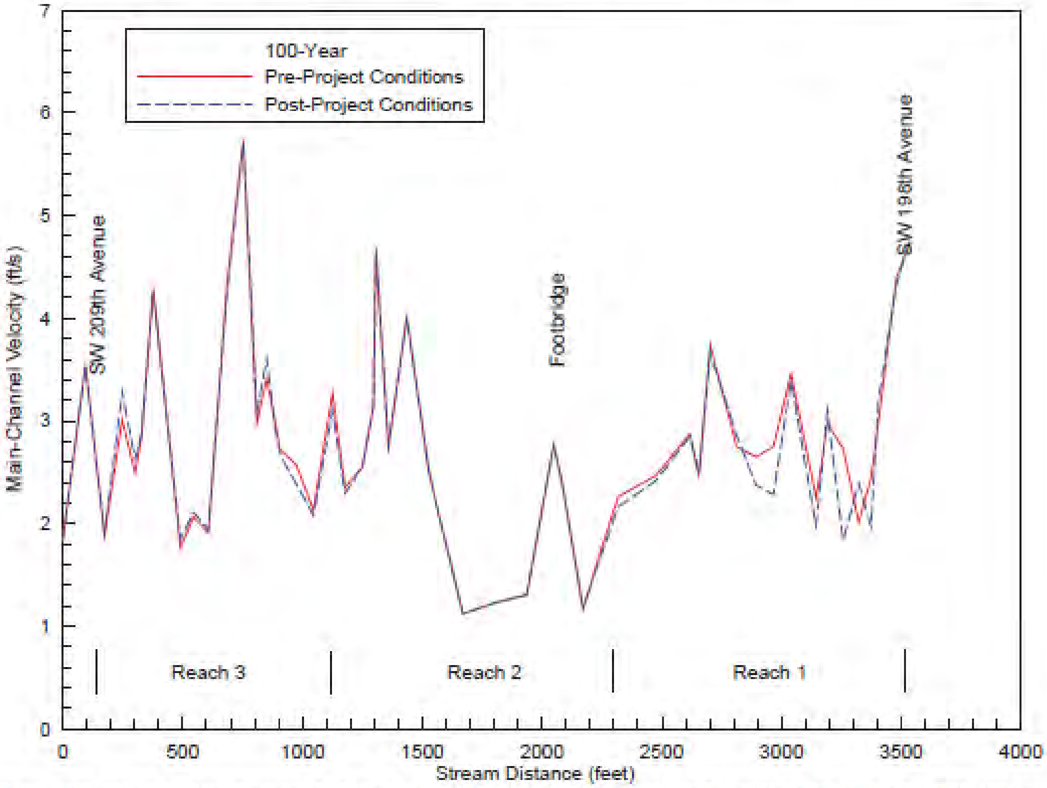

Figure 16. Comparison of computed main channel velocity profiles along the project reach for the 100-year peak

As shown in Figures 13 through 16 there are both increases and increases in main-channel velocities associated with the proposed restoration project, with the greatest changes in Reach 1. Again, there appears to be more cross sections with velocity reductions than increases. These changes suggest potential changes to channel stability associated with erosion and sedimentation. As documented in the geomorphic assessment of the project reach of Butternut Creek (Otak, Inc., 2019b), Reach 1 consists of a single-thread channel that is incised and currently lacks significant LWD or beaver activity. The condition of the channel and easily erodible fine-grained soils make it vulnerable to increased erosion from changed hydraulic conditions. Because the bed of the channel is made of very fine material with limited upstream input of bed material that could easily deposit in the channel during higher channel forming discharges, the stability is mainly dependent on the erosion resistance of the material (threshold channel). Since the erosion resistance of the channel bed has not been quantified in the project reach, the analysis was focused on changes in the erosive forces. This was done by examining the change in the frequency and duration of main-channel velocities.

Figures 17 and 18 show velocity-frequency curves for two representative cross sections in Reach 1 that show significant velocity changes under Post-Project conditions (see Figures 13 through 16). The curves were developed by computing velocity rating curves from the HEC-RAS model run over a wide range of flows and then computing a time series of velocities using the rating curves in conjunction with the simulated flow time series output from the TRUST model. The resulting velocity time series were statistically analyzed to generate the frequency curves. It is important to evaluate the velocity changes in terms of both magnitude and frequency (duration) as this provides an indication of total potential for change that cannot be evaluated by looking only at the results for the flood peaks. Figure 17 shows that velocities are consistently lower over the entire range of flows at Cross Section 3143, indicating a potential for reduced erosion. Figure 18 shows higher velocities at Cross

Section 3192, with the larger changes at the higher velocities where significant erosion is likely to occur. This indicates a potential for increased erosion at this location.

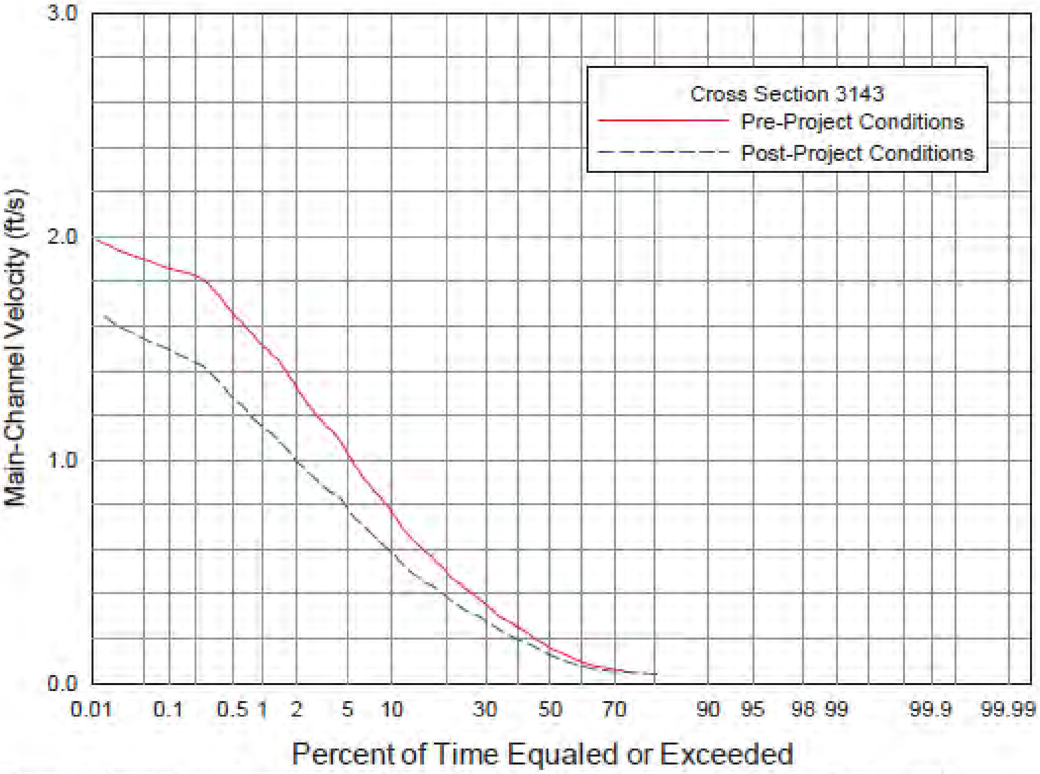

Figure 17. Comparison of computed main-channel velocity-frequency curves for Cross Section 3143

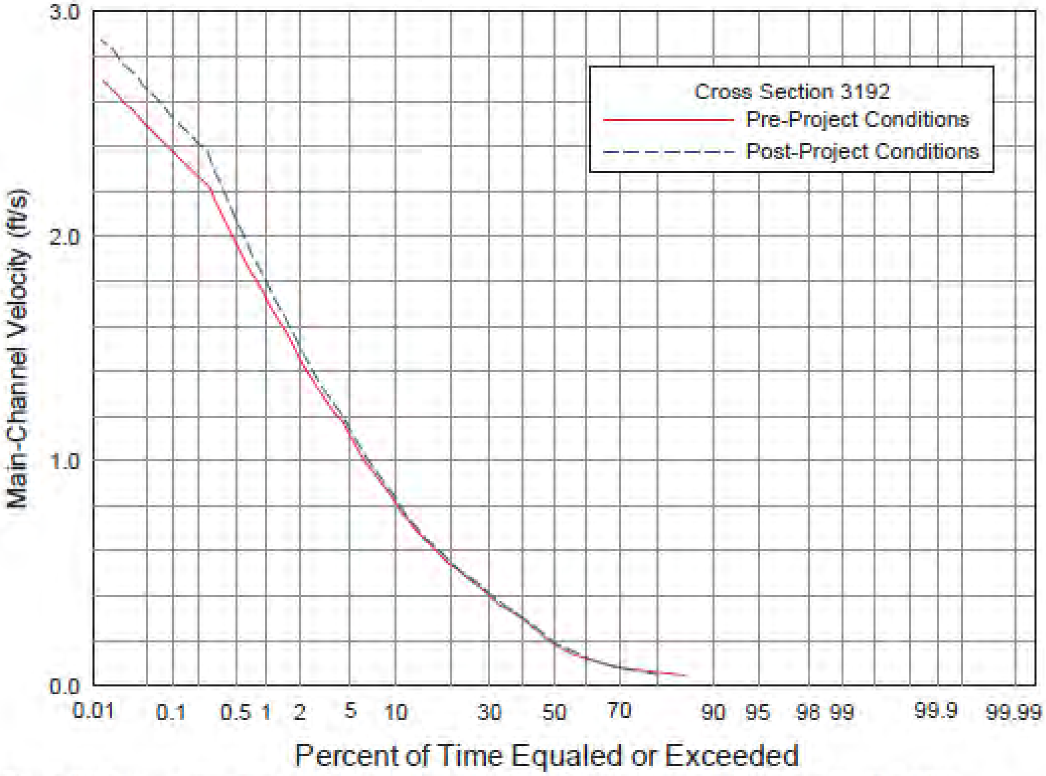

Figure 18. Comparison of computed main-channel velocity-frequency curves for Cross Section 3192

While specific statements cannot be made about the actual magnitude of channel changes, the analysis of velocity changes indicates some potential for both increased and decreased erosion along the reach. Given the generally low velocities in the reach, and the fact that the range of Post-Project velocity magnitudes is well within the range for Pre-Project conditions, changes are not expected to be significant. While there could be some isolated areas of increased erosion, overall there appears to be a net reduction in channel velocities and hence overall less erosive energy. This in combination with the proposed bank stabilization, the restoration project should increase overall stability of Reach 1. Little change is expected in Reaches 2 and 3.

To summarize, the computed changes in hydraulics associated with the proposed restoration project are relatively small, and not likely to result in significant changes to the channel. The project will result in a net benefit to the reach for the following reasons:

- Increased channel stability from fixing and stabilizing eroding banks.
- Increased channel complexity through the introduction of LWD that cannot easily be quantified in a hydraulic model.
- Increased floodplain function with revegetation and introduction of LWD that improves habitat conditions that are not reflected in a hydraulic model.

Changes in Reach Storage

In addition to hydraulic changes within the project reach that could affect channel stability, the proposed restoration project could also affect reach flood storage that in turn would have the potential to change downstream flows. The storage changes could result from the grading and changed roughness associated with the LWD and revegetation. This was evaluated by developing new stage-storage-discharge relationships that reflect Post-Project hydraulic conditions. The new Stage-storage-discharge relationships were developed from the

Post-Project Conditions HEC-RAS model run over a wide range of discharges. The resulting relationships were then entered into the TRUST model as revised FTABLES and the model run to generate Post-Project discharges. The modeling and comparisons were based on Existing Conditions hydrology.

Table 9 compares Pre-Project and Post-Project peak flows at the downstream end of the proposed restoration project (Reach 205 at SW 209th Avenue). The results show a small decrease in the flood peaks equal to about 5 cfs for each of the flood events. A comparison of computed flow-duration curves at the same location is shown in Figure 19. While not easily visible at the scale of the plot, there is a very small reduction in the magnitude of the higher discharges. The reductions in flood flows is due to changes in the computed reach storage. Figures 20 through 23 compare the Pre-Project and Post-Project conditions storage-discharge curves for the routing reaches between SW 198th Avenue and SW 209th Avenue (project reach). The largest change in storage occurs in Reach 509. This appears to be due to increased flow area associated with the proposed excavation since computed water-surface elevations are actually slightly lower in this reach. This result may be an over-estimate of the storage change given the way the 1-D HEC-RAS model computes storage between cross sections (average of cross-section areas without seeing the terrain between cross sections) and because the LWD is not included in the cross-section geometry. There is little computed change in storage in Reaches 508 and 507, and a slight increase in Reach 506. The increase in Reach 506 appears to be the result of the increased floodplain roughness in this reach that results in slightly higher water-surface elevations.

Table 9— Comparison of peak discharges at SW 209th Avenue showing the effects of the estimated change in reach storage associated with the proposed restoration project. Results are for Existing Conditions land use (pre-road widening project)

Return Period (Years)	Peak Discharge (cfs)		
	Pre-Project Conditions	Post-Project Conditions	Difference
2	205.6	200.7	-4.9
5	255.8	250.8	-5.1
10	287.5	282.4	-5.1
25	326.2	321.2	-5.0
50	354.3	349.4	-4.9
100	381.8	377.1	-4.7

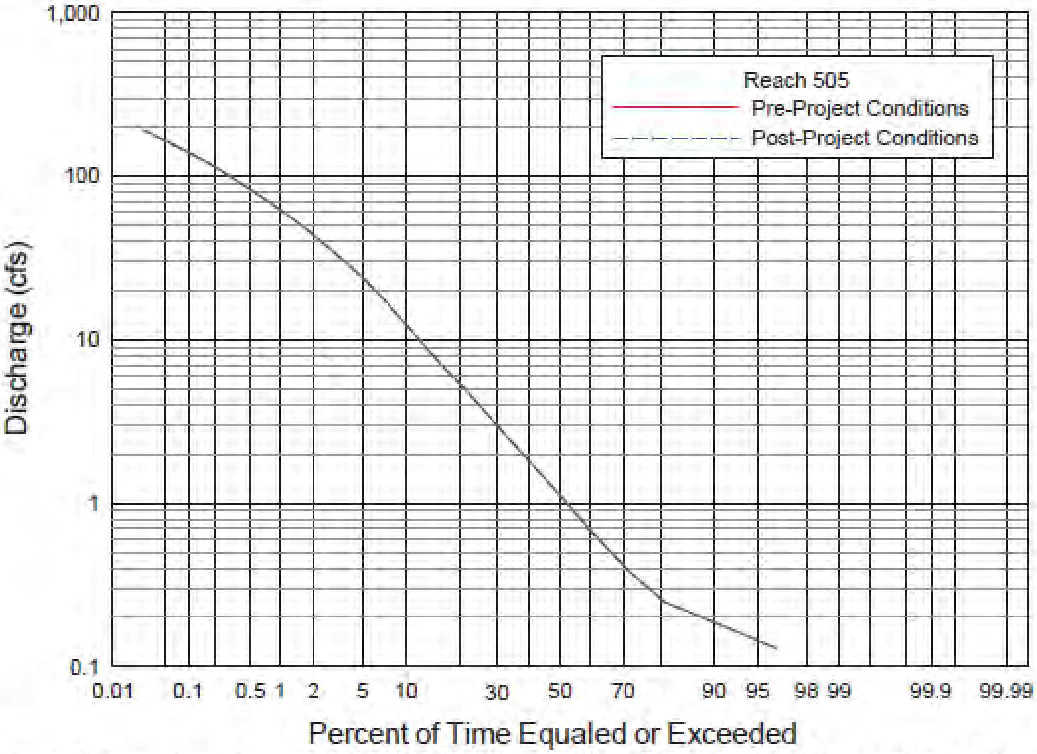

Figure 19. Comparison of computed flow-duration curves at SW 209th Avenue (Reach 505) showing the effects of changes in reach storage associated with the proposed restoration project. Both curves are based on Existing Conditions land use (pre-road widening project)

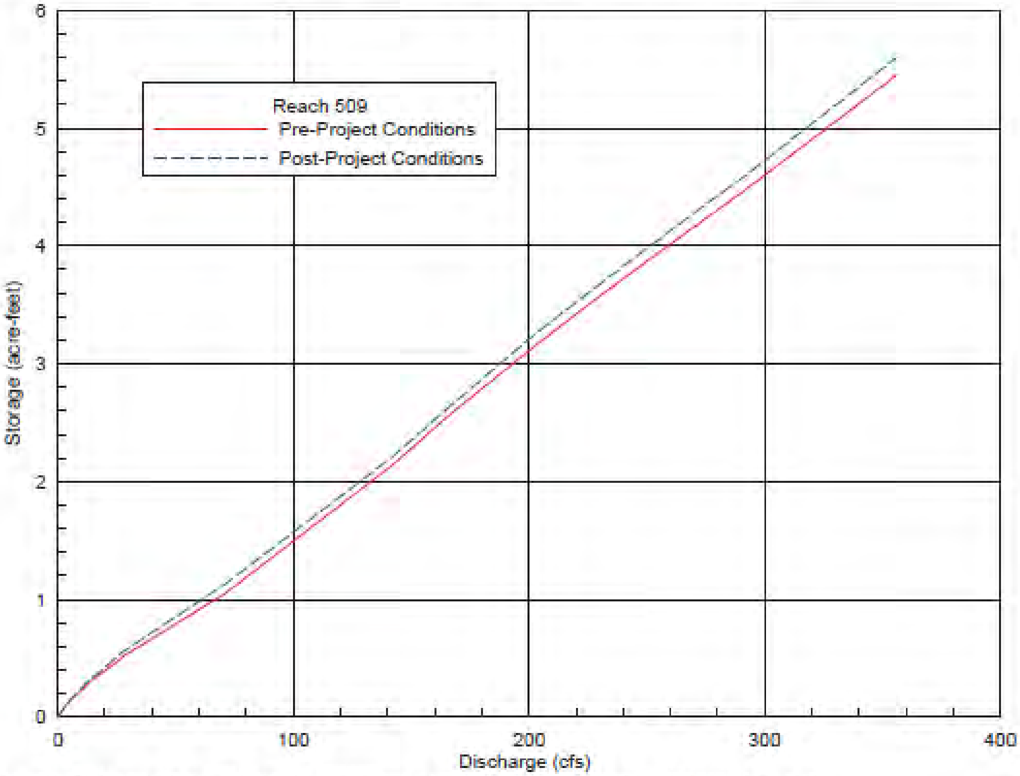

Figure 20. Comparison of storage-discharge curves for Routing Reach 509 (see Figure 3)

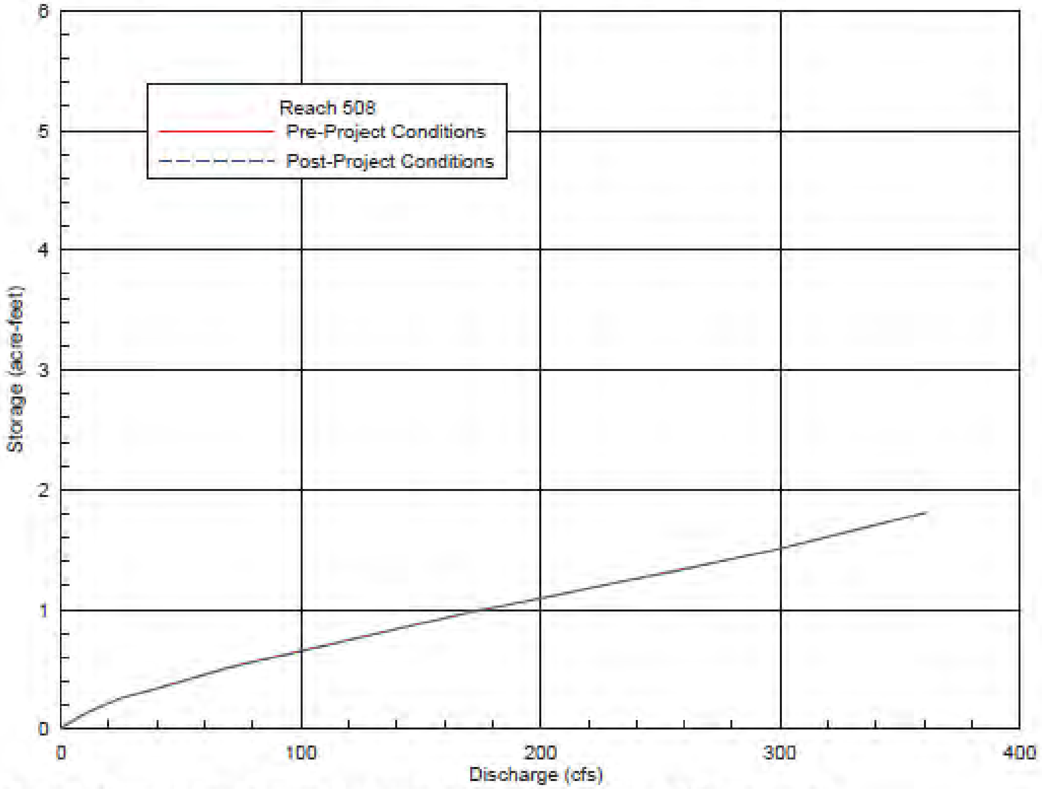

Figure 21. Comparison of storage-discharge curves for Routing Reach 508 (see Figure 3)

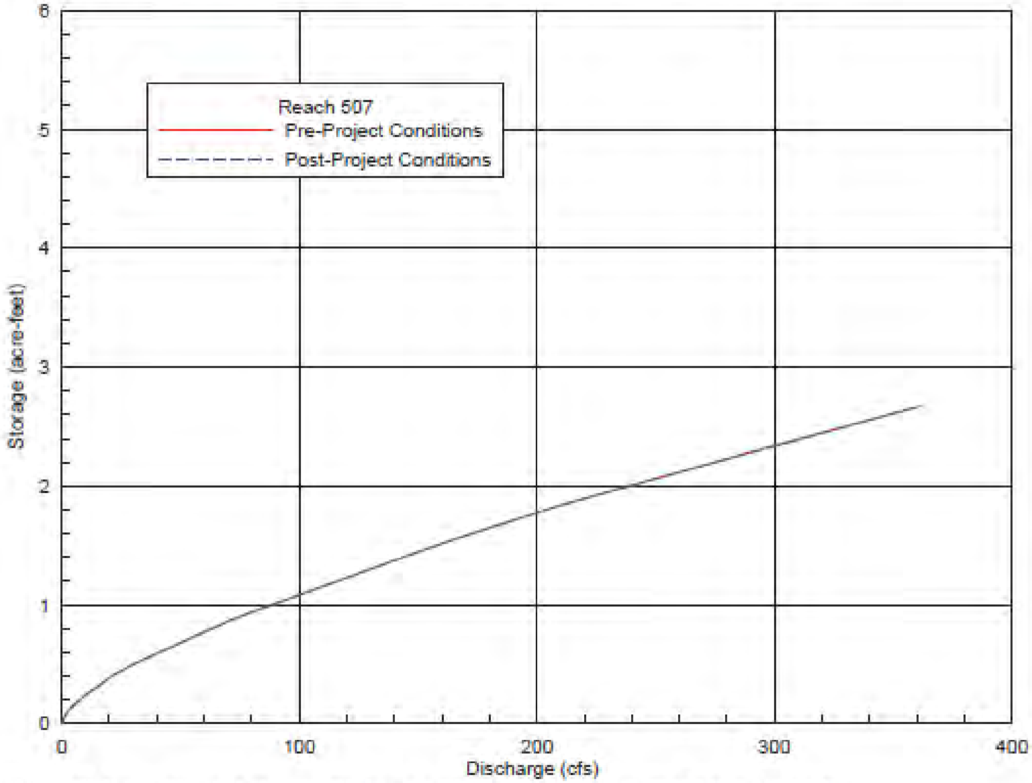

Figure 22. Comparison of storage-discharge curves for Routing Reach 507 (see Figure 3)

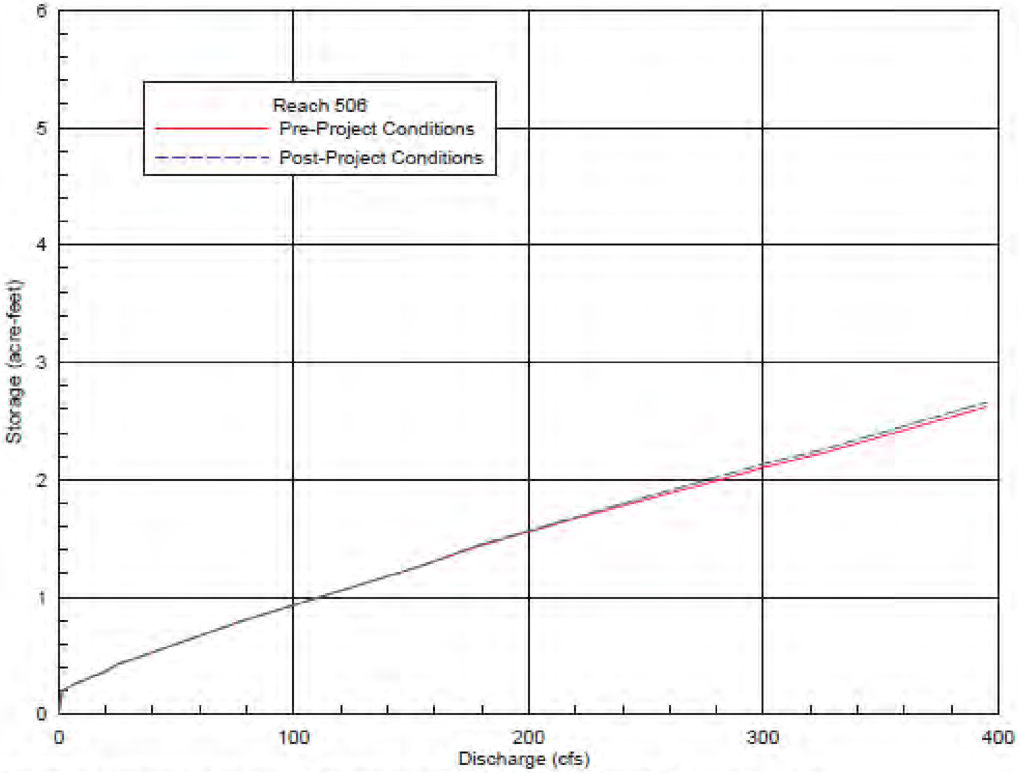

Figure 23. Comparison of storage-discharge curves for Routing Reach 506 (see Figure 3)

While the computed changes in reach storage and related changes in downstream flows are small, they do show a potential benefit of the restoration project that appears to be at least as big as the changes in flows associated with the road widening project. This shows that restoration has the potential to mitigate some of the hydromodification effects of development under certain circumstances.

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Otak, Inc., 2019b. Technical Memorandum, Geomorphic Assessment of Butternut Creek, prepared for Clean Water Services, September 16.

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David Evans and Associates, Inc, 2018. Draft Stormwater Management Plan, SW 198th Avenue Improvements.

Appendices

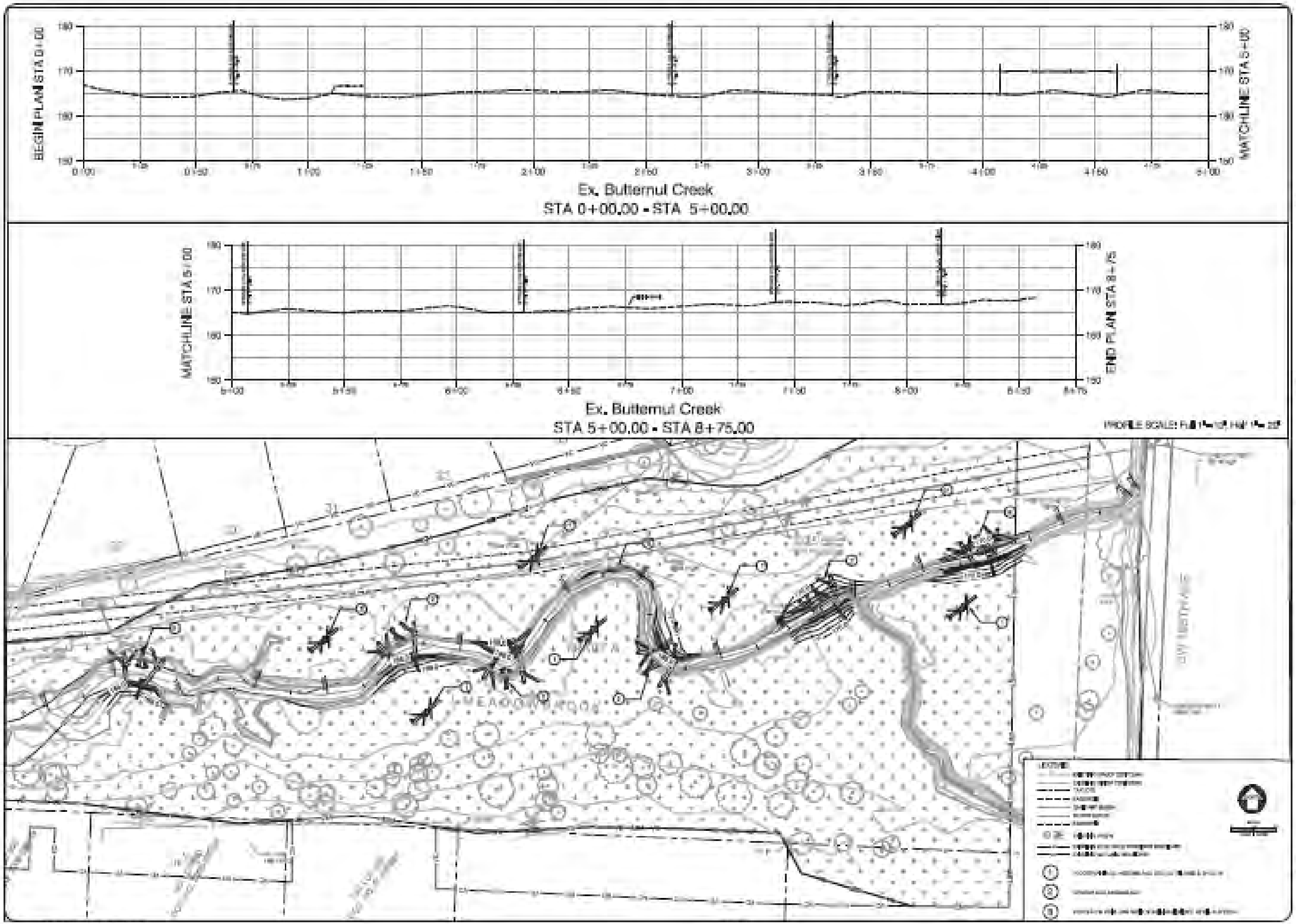
Appendix A: Preliminary Design Drawings, Butternut Creek Enhancement at Witzig Reservoir

Appendix B: Proposed planting plan

Appendix A

Preliminary Design Drawings, Butternut Creek Enhancement at Witzig Reservoir

Otak



BUTTERNUT CREEK ENHANCEMENT
@ WITZIG RESERVOIR

PROPOSED DEVELOPMENT-
REACH 1

NO.	REVISION	BY	DATE
1	?????	XXX	XX/XX/XX

Clean Water Services
2550 SW Hillsboro Hwy
Hillsboro, OR 97123
(503) 681-3600
www.cleanwaterservices.org

PROJECT: 6910
DRAFTER: MC
DESIGNER: XX
CHECKED BY: MB
APROVED: RB

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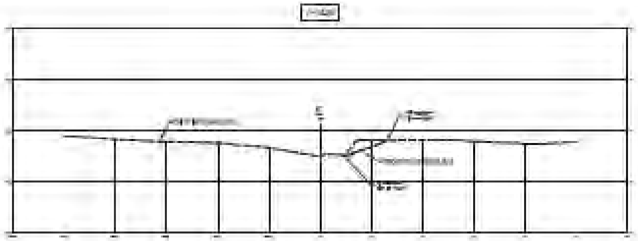

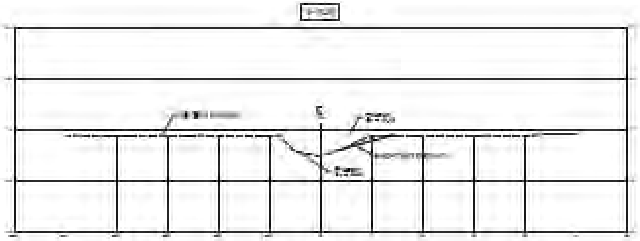

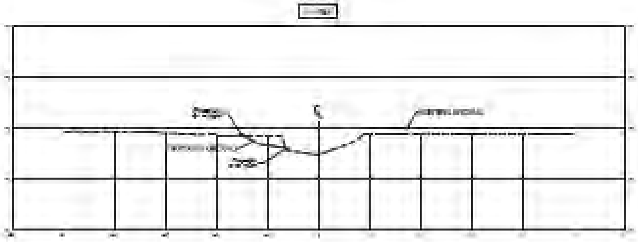

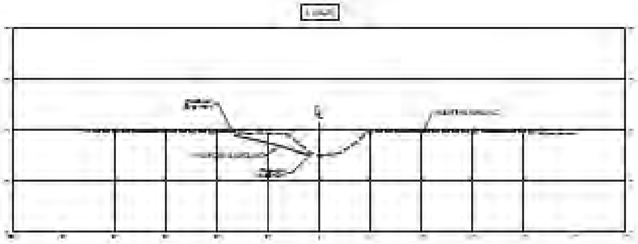

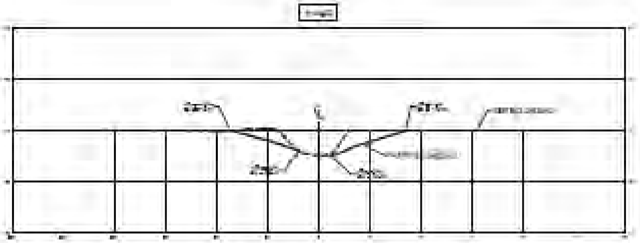

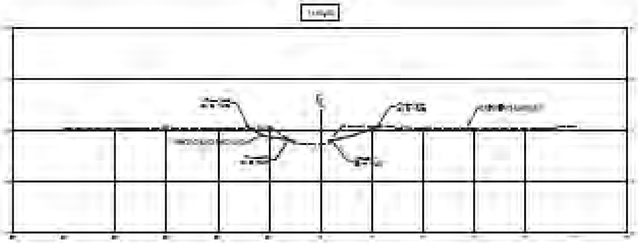

BUTTERNUT CREEK ENHANCEMENT
@ WITZIG RESERVOIR

CROSS SECTION DETAILS

Clean Water Services

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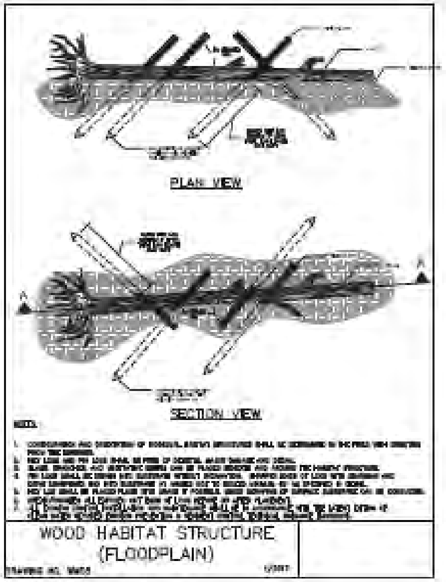
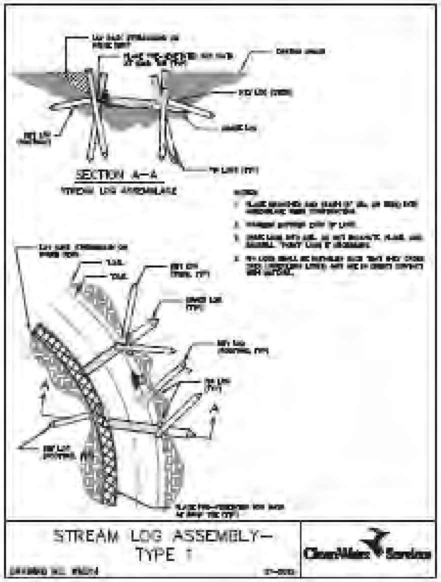
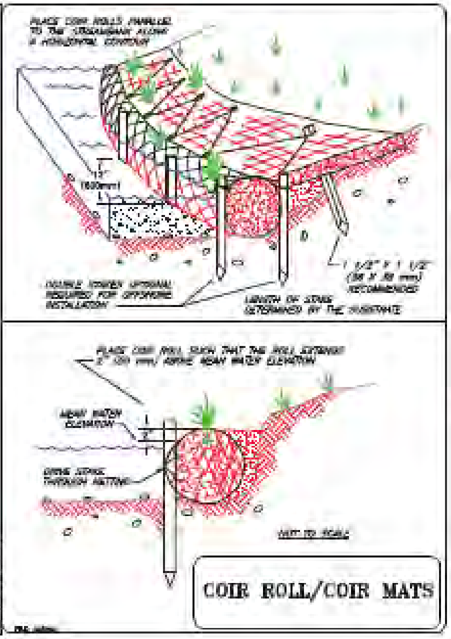


WOOD HABITAT STRUCTURE
(FLOODPLAIN)



STREAM LOG ASSEMBLY–
TYPE 1

Clean Water Services



COIR ROLL/COIR MATS

BUTTERNUT CREEK ENHANCEMENT
@ WITZIG RESERVOIR

CONSTRUCTION DETAILS

NO.	REVISION	BY	DATE
-	?????	XXX	XX/XX/XX

Clean Water Services
2550 SW Hillsboro Hwy
Hillsboro, OR 97123
(503) 681-3600
www.cleanwaterservices.org

PROJECT: 6819
DRAFTING: MC
DESIGNER: XX
CHECKED BY: MB
APPROVED: RB

SHEET
7 OF X

Appendix B:

Butternut Creek Enhancement Adaptive Management Plan. Clean Water Services. 2020 [submitted as Attachment 7 to W2R. 2020. SW 198th Avenue Improvement Project – Stormwater management Design Biological Assessment. June 2020.]

Attachment 7

Butterunt Creek Enhancement
Adaptive Management Plan

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Butternut Creek Enhancement Adaptive Management Plan

This Adaptive Management Plan is applicable to Reach 1 of the Butternut Creek Enhancement Project (Project) located immediately downstream of SW 198th Ave. The Project is associated with US Corps of Engineers (Corps) authorization to Clean Water Services under NWP-2019-385, and is part of the actions being used to offset runoff volume impacts from roadway improvements to SW 198th Avenue (Roadway Project; authorization to Washington County under Corps NWP-2019-0326).

Description

Reach 1 of Butternut Creek downstream of 198th Ave is 880 feet long and includes an additional 300 ft of Celebrity Creek. This along with the associated floodplain constitutes the Project Action Area (PAA).

The PAA is owned by the City of Hillsboro. Additional details of the Project are presented in the Biological Assessment (Wolf Water Resources 2020) and the Corps Joint Permit Application for the Project (NWP-2019-0385). Clean Water Services (the District) has a permanent easement with the City of Hillsboro, the landowner, to implement and maintain this project. The Project site is located in unincorporated Washington County; the proposed enhancement must meet the County's land use regulations, including those for floodplain management as required by the Federal Emergency Management Agency (FEMA) for participation in the National Flood Insurance Program.

The Project is intended to provide comprehensive ecological benefits, including diverse wildlife (aquatic and terrestrial) and improved water quality (e.g., temperature and fine sediment/turbidity). For the purposes of monitoring and adaptive management, three primary functional categories and associated enhancement goals have been identified. These are used to identify constraints and conditions of concern to be addressed by Project actions within the PAA.

1. **Stream Complexity**
   Enhancement Goal: Increase hydraulic variability over a range of flows. Establish complex structure (roughness) within streambed and stream banks; establish and maintain improved channel bed and bank morphological variability.
2. **Floodplain Complexity**
   Enhancement Goal: Provide complex vegetated community structure within floodplain wetlands and uplands adjacent to streams within the Project Action Area.
3. **Stream/Floodplain Connectivity**
   Enhancement Goal: Arrest bank destabilization and increase in-stream roughness to maintain or increase stream flow engagement with floodplain.

Project-Specific Conditions of Concern/Constraints

Vegetation Cover

Non-native invasive plants such as reed canarygrass and Armenian blackberries dominate the Project action area, suppressing existing native plants and reducing stream or floodplain functions. Because non-native invasive plants prevent or reduce native vegetation establishment, they are further limiting achievement the enhancement goals for all three functional categories.

Channel Complexity/Structure

Streambank erosion is occurring in the project area due to poor vegetative conditions. There is also a lack of morphological and associated hydraulic complexity (hydraulic roughness) in the stream. Reed canarygrass throughout the reach forms a shallow mat of dense roots near the floodplain surface that are easily undermined by erosion of the underlying floodplain sediments. The streambed elevation of Butternut Creek is relatively stable in the PAA due to grade control provided by an artificial embankment located approximately 1,000 feet downstream which impounds Witzig Reservoir. The high velocities of Butternut Creek at current peak flows combined with poor cohesion of the streambanks is leading to channel widening. Erosion of the banks results in increased delivery of fine sediment downstream.

Design Elements

Aggressive site preparation and intensive revegetation are the primary tools to create rich, diverse and resilient ecological function over time. In addition to these elements, the Project will include installation of large wood assemblages to immediately improve stream and floodplain complexity functions.

Invasive Species Removal and Native Plant Community Restoration

Diverse native plant communities will provide primary and long-lasting ecological functional improvement in the project reach by promoting channel complexity (in-channel and streambank structure), floodplain complexity, stream and floodplain connectivity, and food/habitat for wildlife communities. Functional improvements will occur first with the removal of invasive, non-native species followed by planting and establishment of emergent wetland, scrub-shrub wetland, and riparian forest communities. We use the Rapid Riparian Revegetation (R3) approach documented in Guillozet et al., 2014. This approach promotes rapid cover of woody and herbaceous plants in a composition designed to conform as closely as practicable to a riparian plant community typical of the pre-development Tualatin River valley (e.g., as described in Christy and Alverson, 2011).

Instream Large Wood Assemblages

Large wood assemblages will be constructed in the Butternut Creek stream channel to provide in-stream roughness and complexity. These assemblages are designed to increase roughness at the channel margins (channel bed and banks), and to maintain much of the stream's flow conveyance capacity within the channel and floodplain. This is due to the need to balance channel variability and habitat with maintaining floodwater elevations in the reach as required by Washington County's FEMA-required floodplain regulations. Some streambank grading will be necessary at these assemblages to achieve this balance. The instream large wood assemblages will help to achieve the enhancement goals of stream complexity and stream/floodplain connectivity.

Floodplain Large Wood Assemblages

Large wood assemblages consisting of habitat logs pinned to the floodplain surface with smaller logs will be constructed on the floodplain portion of the PAA. These assemblages will help to achieve the enhancement goal of floodplain complexity and provide physical habitat for native wildlife communities.

Bank Stabilization Treatment

A bioengineered streambank stabilization treatment will be constructed on the outside of a channel bend that is actively eroding such that it is migrating toward a shallow sanitary sewer line. This treatment involves placement of pre-vegetated coir logs along the toe of the eroding bank and densely vegetating the upper bank with fast-growing woody species to provide immediate and long-term stability.

Adaptive Management

The District has a long term (20 years+) commitment to stewardship of enhanced corridor areas, which allows us to take measures so that we meet our enhancement goals. Following construction, “as-built” conditions will be documented through site photographs, engineering scaled record drawings, and surveyed measurements to ensure that the intent of design was met with respect to the objectives of complexity and connectivity, and to provide a baseline for future measurements. Performance of the enhancement project will then be monitored using the following methods:

- Annual qualitative vegetation monitoring
- Annual qualitative site observations and documentation
- Biennial quantitative vegetation monitoring (per District Enhancement Monitoring Protocol and Performance Criteria)
- Periodic quantitative stream measurements (channel thalweg and cross-sections, allowing calculation of morphologic metrics such as bank height ratio, width to depth ratio, and residual pool depth).

Monitoring using quantitative stream measurements will be conducted at least once between 5 and 10 years post-construction, and after a flood equivalent to or larger than a 10-year event occurring within this time period. Monitoring will be focused on the physical structure that creates complexity and that forms habitat rather than direct measurement of hydraulic conditions. However, if it is determined that due to evolution of site conditions hydraulic conditions are in question, evaluation will be supplemented with revision of the existing hydraulic model to support adaptive management measures.

Performance Expectations

The enhanced project is expected to evolve over time, and our expectations for performance are not based on rigidly maintaining the design conditions. Rather, it is expected that the complexity and connectivity intents of the design persist or increase over time. The proposed actions are intended to provide structure needed to support instream connectivity and complexity in the absence of persistent beaver activity.

- Complexity – Structural complexity is designed into the project through the placement of large wood and planting of native woody and herbaceous species. This complexity is expected to maintain or increase with recruitment of woody material to the channel, densification and diversity of vegetation communities on the floodplain, and periodic beaver activity.
- Connectivity – Maintenance of connectivity between the stream and floodplain (as well as upstream – downstream) is intended to persist through maintaining dynamic stability of the channel bed. While channel incision is not seen as an acute risk, it is the primary long-term risk to loss of connectivity.

Monitoring

The table below summarizes the elements that will be the focus of performance monitoring, as well as applicable performance criteria. Annual qualitative vegetation monitoring and site observations will be conducted by qualified District staff and recorded on a mobile device for recordkeeping. Quantitative vegetation monitoring will be conducted per the District Vegetation Monitoring Protocol and Performance Criteria (Clean Water Services, 2013).

Quantitative stream measurements will consist of:

- Longitudinal profile survey of channel thalweg; and
- Survey of two representative channel and floodplain cross-sections and at least 3 additional channel cross sections.

The surveyed profile and cross-sections will be compared to baseline to document lateral and vertical changes in the stream channel as well as changes in channel geometry.

Element Monitored	Performance Criteria	Adaptive Management Actions Considered
Vegetation Monitoring		
Native Vegetation Density	≥1,600 stems per acre (woody plants)	Additional interplanting of native woody plants
Native Vegetation Diversity	≥5 woody native species	Additional interplanting of native woody plants
Native Vegetation Cover	≥80% herbaceous native cover	Additional interplanting of native herbaceous plants
Channel/Floodplain Monitoring		
In-stream Complexity – Large Wood Presence	>40 wood key pieces (12" + diameter) located in project reach	Supplement reach with additional wood
In-stream Complexity – Large Wood Distribution	>4 large wood key pieces (12" + diameter) in contact with stream in each of upper, middle, and lower 300-foot segments of the project reach	Redistribute existing key pieces and/or add additional wood as needed to support hydraulic variability
Streambank Erosion at Large Wood Assemblages	No extreme erosion that is substantially destabilizing large wood assemblage; Toe of stream bank no closer than 8 feet from sanitary sewer line	Additional vegetation, live brush material, prevegetated sod mats, coir logs
Channel Incision	No active headcuts/ progressive channel bed deougradation undermining large wood Reach-averaged Bank Height Ratio between large wood assemblages increases no more than 15% over post-construction measurements	Repair or supplement with additional large wood Consider use of additional vegetative treatments or wood placement to manage incision.

Actions

Vegetation

Long-term stewardship of the vegetative communities will include maintenance treatments to remove reoccurring invasives, and interplanting native species. This will push native recolonization along rapidly with the goal of achieving high density, diversity and cover early in the project timeline. These tasks are replicated for long-term maintenance as necessary to maintain performance standards.

Stream Channel/Floodplain

Results of the monitoring described above will be assessed with respect to the performance criteria and project functional objectives, and will determine whether adaptive management actions are necessary, and the nature of adaptive management actions to be implemented. If monitoring results suggest loss of function outside of expected variability or progressive degradation of ecological conditions, then actions will be considered ranging from supplementing the site with bioengineering materials (e.g., prevegetated sod mats, coir logs, vegetative cuttings and coconut fabric) and additional large wood, to repair or reconstruction of wood assemblages. Hydraulic modeling may be used to support the evaluation of potential additions of wood or modifications to channel geometry if the proposed changes are of a nature that allows sufficiently accurate representation in a hydraulic model.

Some important considerations to be made when deciding on these actions include:

- Impacting the site with construction equipment – it is important that the benefits of the action are greater than the disturbance or impact caused by heavy machinery (e.g., damage to mature floodplain forest).
- Beaver activity – The construction and maintenance of beaver dams can change a floodplain drastically and can make monitoring as outlined in this plan difficult. The ecological uplift associated with beaver activity in corridors such as Butternut Creek is substantial and represents some of the highest function with respect to complexity and connectivity. Inability to conduct monitoring exactly as described due to beaver inundation will not be considered a problem. Rather, it will be an indication of high function and good performance.

References

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