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-2021-01532

May 16, 2022

William D. Abadie
Chief, Regulatory Branch
U.S. Army Corps of Engineers, Portland District
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 Dyno Nobel Columbia River Outfall Discharge and Intake Screen Replacement Project (NWP-2020-119-1) HUC 170800030201 (Deer Island Slough-Frontal Columbia River) and 170800030700 (Cathlamet Channel-Columbia River)

Dear Mr. Abadie:

Thank you for your letter of June 25, 2021, 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 Columbia River Outfall Discharge and Intake Screen Replacement Project.

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.

NMFS determined that the proposed action is not likely to jeopardize the continued existence or recovery of Lower Columbia River (LCR) Chinook salmon, Upper Columbia River (UCR) spring-run Chinook salmon, Upper Willamette River (UWR) Chinook salmon, Snake River (SR) spring/summer-run Chinook salmon, SR fall-run Chinook salmon, LCR coho salmon, Columbia River (CR) chum salmon, SR sockeye salmon, LCR steelhead, Middle Columbia River (MCR) steelhead, UCR steelhead, Snake River Basin (SRB) steelhead, UWR steelhead, or eulachon or adversely modify their designated critical habitats. NMFS determined that the proposed action is not likely to adversely affect North American green sturgeon.

As required by section 7 of the ESA, NMFS is providing an incidental take statement with the biological opinion. The incidental take statement describes reasonable and prudent measures NMFS considers necessary or appropriate to minimize the impact of incidental take associated with this action. The take statement sets forth nondiscretionary terms and conditions, including reporting requirements, that the U.S. Army Corps of Engineers (USACE) or any applicant must comply with to carry out the reasonable and prudent measures. Incidental take from actions that meet these terms and conditions will be exempt from the ESA's prohibition against the take of listed species.

This document also includes the results of our analysis of the action's likely effects on essential fish habitat (EFH) pursuant to section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA).

Please contact Tom Hausmann, Oregon Washington Coastal Office in Lacey, Washington, 360-515-1478, Tom.Hausmann@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: Ms. Caila Heintz, USACE

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

Dyno Nobel Columbia River Outfall Discharge and Intake Screen Replacement Project

NMFS Consultation Number: WCRO-2021-01532

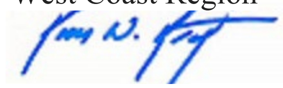
Action Agency: U.S. Army Corps of Engineers

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 (*Onchorhynchus tshawytscha*)	Threatened	Yes	No	Yes	No
Upper Willamette River Chinook	Threatened	Yes	No	Yes	No
Upper Columbia River Spring-run Chinook	Endangered	Yes	No	Yes	No
Snake River Spring-run Chinook	Threatened	Yes	No	Yes	No
Snake River Fall-run Chinook	Threatened	Yes	No	Yes	No
Columbia River Chum Salmon (*O. keta*)	Threatened	Yes	No	Yes	No
Lower Columbia River coho (*O. kisutch*)	Threatened	Yes	No	Yes	No
Snake River Sockeye (*O. nerka*)	Endangered	Yes	No	Yes	No
Lower Columbia River steelhead (*O. mykiss*)	Threatened	Yes	No	Yes	No
Upper Willamette River steelhead	Threatened	Yes	No	Yes	No
Middle Columbia River steelhead	Threatened	Yes	No	Yes	No
Upper Columbia River steelhead	Threatened	Yes	No	Yes	No
Snake River Basin steelhead	Threatened	Yes	No	Yes	No
Eulachon (*Thaleichthys pacificus)*	Threatened	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
Groundfish	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: May 16, 2022

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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.), as amended, and implementing regulations at 50 CFR part 402.

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 part 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 Lacey, Washington.

1.2. Consultation History

Dyno Nobel continuously withdraws and discharges up to 30 million gallons of water per day from the Columbia River to cool industrial processes at their St. Helens fertilizer manufacturing facility. On March 1, 2019 the Oregon Department of Environmental Quality (ODEQ) issued Dyno Nobel a National Pollutant Discharge Elimination System (NPDES) Permit under the Clean Water Act that requires Dyno Nobel to modify both the existing cooling water intake screen to meet NMFS requirements and to modify the cooling water effluent discharge outfall to comply with Clean Water Act Section 316(b) and the ODEQ NPDES Permit. The new intake screen and outfall modification require U.S. Corps of Engineer (USACE) permits under Section 10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act.

Excavation and dredging in the Deer Island slough and Columbia River and the new intake screen will affect 13 species of salmon and steelhead that migrate past or rear and forage in the action area of the project: Lower Columbia River (LCR) Chinook salmon, Upper Columbia River (UCR) spring-run Chinook salmon, Upper Willamette River (UWR) Chinook salmon, Snake River (SR) spring/summer-run Chinook salmon, SR fall-run Chinook salmon, LCR coho salmon, Columbia River (CR) chum salmon, SR sockeye salmon, LCR steelhead, Middle Columbia River (MCR) steelhead, UCR steelhead, Snake River Basin (SRB) steelhead, UWR steelhead), as well as eulachon.

There was no pre-consultation with NMFS for this project. Dyno Nobel's engineering consultant, Jacobs Engineering Group, Inc, prepared the Biological Assessment.

The USACE requested formal ESA consultation and EFH consultation on this project on June 25, 2021. NMFS did not request additional information and initiated consultation on June 25, 2021.

The project was assigned on July 27, 2021.

On August 30, 2021, NMFS assigned a fish passage engineer to assist with the intake screen part of the consultation.

On September 10, 2021, NMFS participated in a WebEx conference call with Dyno Nobel, Jacobs, and ODFW to discuss the effects of their intake screen maintenance requirement on fish, including ESA listed fish, in the Columbia River. Dyno Nobel explained that they would have to halt their manufacturing process to shut down cooling water withdrawal during planned or unplanned screen maintenance. In particular, Dyno Nobel informed ODFW and NMFS that during some scheduled and emergency intake screen maintenance when the screen is raised, the plant would continue to withdraw cooling water through the unscreened manifold to cool manufacturing processes. Both NMFS and ODFW found this to be an unacceptable entrainment risk to fish and requested that Dyno Nobel search for a way to deploy a temporary screen during maintenance.

On October 21, 2021, Dyno Nobel agreed that during times when Tee Screen maintenance require that the screen be raised, cooling water will be pumped through a ¼ inch mesh screen. NMFS and ODFW engineers agreed that the screen mesh size and water approach velocities are acceptable.

On February 1, 2022, the WCLC Branch Chief provided direction on how the outfall replacement project should be treated with respect to the Memorandum Between the Department of the Army (Civil Works) and the National Oceanic and Atmospheric Administration on existing structures.

On March 17, 2022, the NMFS fish passage engineer provided an email to the project administrative record stating: “I've reviewed the designs provided by Dyno Nobel for the replacement intake screen facility. The proposed designs are consistent with NMFS screening criteria and appropriate for the site conditions.”

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 (see 50 CFR 402.02).

The USACE proposes to issue a permit under Section 10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act to authorize Dyno Nobel to replace their cooling water intake screen and to excavate a trench across the Deer Island Slough and a trench into the Columbia River for the installation of a new wastewater effluent outfall pipeline and diffuser. The wastewater consists of 99 percent non-contact cooling water and treated boiler blowdown wastewater, treated pump bearing cooling water, and treated stormwater. The small amounts of boiler blowdown wastewater, pump bearing cooling water, and stormwater are treated through an oil/water separator before combining with the non-contact cooling water. The majority of pollutants in the final discharge, other than heat, are the pollutants in the raw Columbia River intake water.

The existing cooling water intake structure (CWIS) is located approximately 400 feet offshore and is accessible via a timber pile trestle. The intake structure includes a sheet pile intake plenum with a 35 foot by 27 foot (tremie) concrete bottom slab at an elevation of -7.0 feet and a 45 foot by 38 foot concrete deck slab on top of the sheet pile at an elevation of +27.0 feet. A sheet metal building enclosure is located on top of the slab and houses the pump motors and a bridge crane. Dyno Nobel will replace the existing CWIS traveling screen with a fine mesh (1.75 millimeter slot size per NMFS and ODFW criteria) cylindrical wedge wire tee screen during the November 1, 2022 to February 28, 2023 in water work window.

Dyno Nobel will use a crane on the existing intake pier or on a barge in the Columbia River to remove the existing screen and install the new screen system. They will temporarily remove the pump house roof, disconnect the electrical, control and spray wash systems and lift the existing screen out of the screen guides. They will lower a new bulkhead into the existing traveling screen guides, remove the existing trash rack at the face of the intake structure and install and anchor new structural supports into the existing concrete walls near the intake entrance. They will attach the new tee screen track and screen assembly to the new structural supports and attach the screen manifold to the opening in the new bulkhead. They will reconnect electrical and controls systems. They will connect the new sediment jetting system nozzles located at the base of the new screen structure.

The sediment jetting system works by spraying pressurized water from nozzles below the tee screen to move sediment away from the tee screen that is suspended into the water column and carried downstream. Dyno Nobel will test the new screen and resume normal water withdrawal through the new screening system (Figure 1). When the new tee screen is raised to the surface for maintenance, it will be replaced by a ¼ inch mesh screen across the plenum intake.

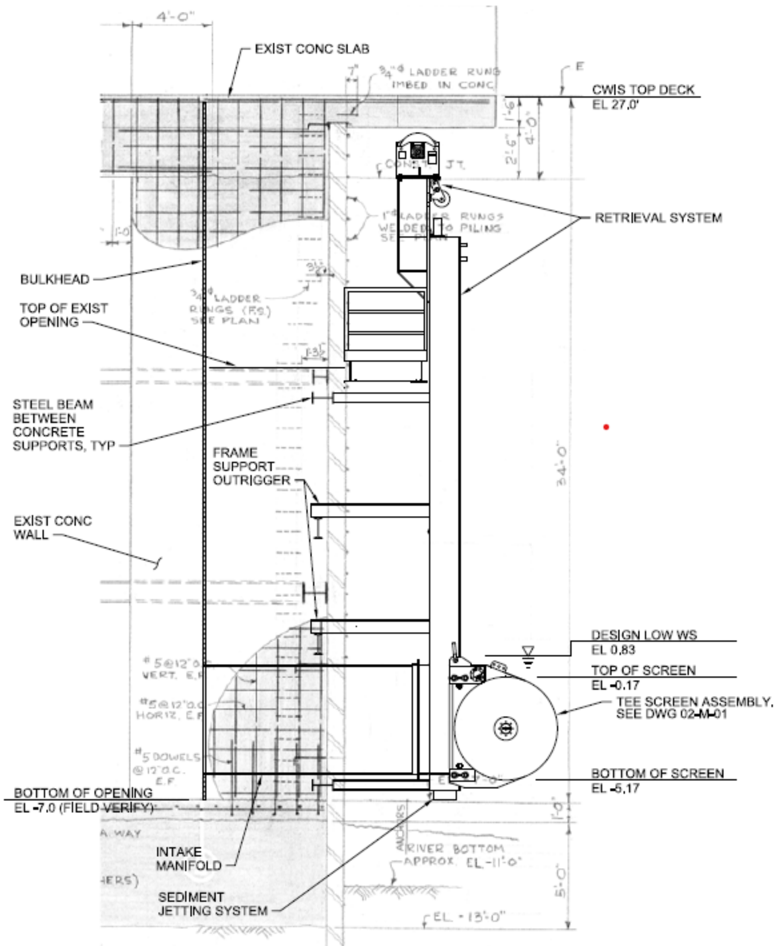

Figure 1. New intake schematic.

Wastewater effluent is currently discharged to the Columbia River with an open ditch across Deer Island that intersects the Columbia River shoreline at River Mile 82.1.

Dyno Nobel will replace the existing outfall pipeline and ditch with a 36-inch diameter, 4,600-foot long pipeline and outfall diffuser (Figure 2) that extends:

1. From the outfall collection vault to the Deer Island slough
2. Beneath the Deer Island slough
3. Across the Deer Island wetlands
4. Across the existing outfall ditch and across the Deer Island upland
5. Into the Columbia River.

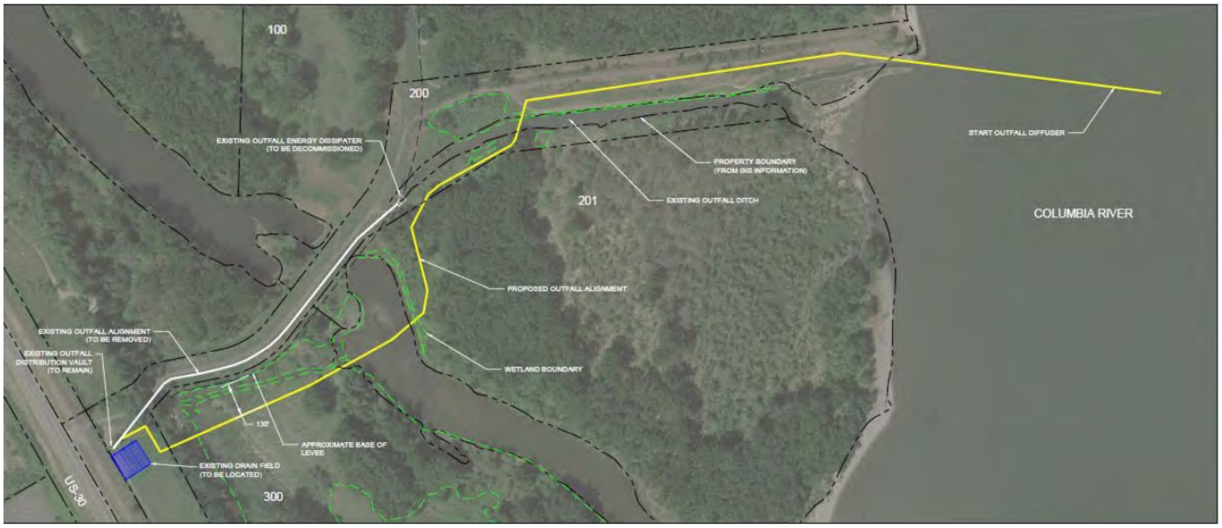

Figure 2. Yellow line showing the route of the new outfall pipeline and diffuser.

1. The construction contractor will take approximately 1 week to install the outfall pipe from the outfall collection vault to the Deer Island Slough. The contractor will construct a staging area and 18-foot wide temporary road to access the wetland portion of the project area at the base of the steep slope on the east side of the Deer Island Slough (Figure 3). The contractor will either place the temporary road bed material on top of a geotextile fabric over the soft soils to separate road bed materials from the underlying native surface or place temporary wood mats or wood lagging on top of the native surface to drive on. The contractor will remove the temporary road bed material and geotextile fabric or wood lagging after completing the wetland section of the outfall pipeline. The contractor will dig the 50-foot wide trench from the temporary road with a backhoe, side cast the excavated material adjacent to the trench, install the pipe bedding material and pipe, and backfill the trench with the side cast material. The contractor will remove any surplus material and restore the surface contours to their pre-construction elevations. The contractor will plant approved native grasses over disturbed areas which were previously vegetated and replace any riparian trees removed within 125 feet of water with native trees per the replacement ratios required by the permits. Within the wetland, the contractor will stockpile existing topsoil to backfill the upper portion of the trench.

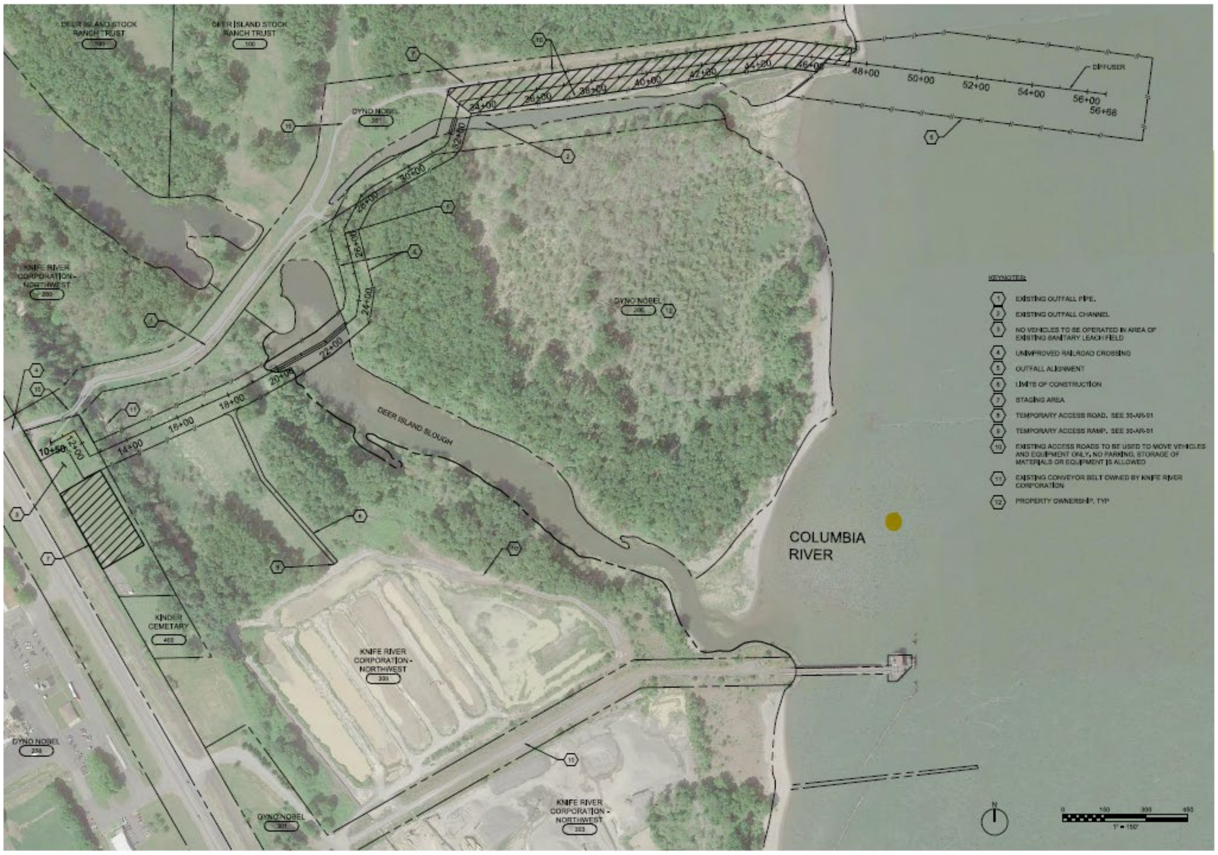

Figure 3. Staging area and temporary road construction.

2. The construction contractor will take approximately one week to install the pipe across the Deer Island slough during the dry season from July through September 2022 when there is almost no flow through the slough and wetland groundwater is at the lowest level of the year. The contractor will install two 70-foot long by 6-foot high cofferdams, remove fish from the coffer dammed work area, dewater the area with pumps, trench across the dewatered slough, install the pipe, backfill the trench, and restore the work area. Trained biologist will salvage fish with seine nets to push fish downstream after the upstream cofferdam is installed. After multiple sweeps, the contractor will install the downstream cofferdam with a small opening. Biologists will use additional seine net sweeps to drive any remaining fish through the opening before it is closed. The contractor will place excavated material on dry ground at either side of the slough, install pipe bedding material and the pipe and backfill the trench with the excavated material.

3. The construction contractor will take about 2 weeks to install the pipeline across the Deer Island wetland from July through September 2022 when the groundwater is at the lowest level of the year. The contractor will construct a temporary access road (Figure 3). If ground conditions are soft, the contractor will lay down a layer of geotextile that is wider than the temporary road to separate road materials from the underlying native surface without removing the wetland vegetation. The contractor will place and lightly compact roadbed materials on top of and within the geotextile footprint. From the access road the contractor will dig the trench with a backhoe, stockpile topsoil, side cast the excavated material adjacent to the trench, install the pipe bedding

material and pipe, backfill the trench with the side cast material and replace topsoil on top of the trench. The contractor will remove the temporary road bed and geotextile fabric and restore the temporary road and trench contours to their pre-construction elevations. The contractor will plant approved native grasses on disturbed areas that were previously vegetated and replace any riparian trees that were removed within 125 feet of water with native trees per the replacement ratios required by the permits.

4. The contractor will take about 2 weeks to install the pipeline across the existing outfall ditch and Deer Island upland. The contractor will repair an existing road and construct a new temporary staging area for equipment. The staging area will be surfaced with geotextile fabric and crushed gravel. The staging area will be at least 150 feet from the Columbia River. The contractor will dig the trench with a backhoe, side cast the excavated material adjacent to the trench, install the pipe bedding material and pipe and backfill the trench with the side cast material. The contractor will restore road and trench contours to their pre-construction elevations, plant approved native grasses in disturbed areas which were previously vegetated and replace any riparian trees removed within 125 feet of water per the replacement ratios required by the permits.

5. The contractor will install the outfall pipeline and diffuser into the Columbia River over 4 to 6 weeks during the November 1 to February 28 in water work window. The contractor will dredge a wide barge access channel in the nearshore to allow a clamshell dredge barge to get as close to the shoreline as possible. The clamshell dredge barge will excavate the outfall and diffuser trench. The contractor may limit the width of the trench by shoring the open trench with sheet pile installed and removed with a vibratory driver. The contractor will install the pipe and diffuser, backfill the trench and backfill the access channel with the side cast material. The contractor will place the majority of the material excavated from the trench back in the trench and spread excess material on the river bottom. The new pipeline will be buried in a trench in the riverbed with 3 to 4 feet of cover. The pipeline will terminate with a submerged diffuser pipe beneath 8 feet of cover to provide a minimum of 5 feet of cover if the river bottom drops. Effluent diffusion will be through fifteen 12-inch diameter steel pipe risers spaced at 12 feet apart and extending approximately 3 to 4 feet above the riverbed. The new outfall diffuser is designed to not cause the temperature of the Columbia River to increase more than 0.3 degrees C above a 7 day average maximum temperature of 20.0 degrees C after mixing with either 25 percent of the stream flow, or the temperature mixing zone, whichever is more restrictive (OAR-340-041-028 (Temperature) or more than 0.3 degrees C above the (colder) water ambient water temperature at the point of maximum impact where salmon and steelhead are present when the ambient temperature is lower than 20 degrees C (OAR-340-041-028 (Antidegradation)). The operational water quality mixing zone boundaries are 300 feet for the chronic mixing zone boundary and 30 feet for the acute mixing zone boundary, in all directions from the points of discharge. Dyno Nobel calculated the maximum river temperature increase at the edge of the mixing zone with an energy balance for effluent discharge temperatures from 34 to 38 degrees C under low river flow and peak summer river temperature. This calculation predicts that the new outfall/diffuser will meet both the ODEQ temperature and antidegradation standards.
Dyno Nobel will remove the existing effluent pipeline that runs on top of the Deer Island levee, cut and cap the wood pile supports 2 feet below surface and backfill the holes.

The contractor will minimize potential contamination, leaks and spills in the access roads and staging areas by:

a) Minimizing handling of fuel, oil and hazardous materials,
b) Not storing fuel,
c) Not refueling mobile equipment within 150 feet of the stream,
d) Refueling stationary equipment only within secondary containment,
e) Preventing leaks and spills from construction equipment and vehicles by daily inspecting and repairing those operated within 150 feet of stream and by cleaning equipment prior to operation within 150 feet of stream
f) Preventing sediment laden stormwater runoff from entering the stream by using mulch, matting, and netting, filter fabric fencing, quarry rock entrance mats, sediment traps and ponds or surface water interception swales and ditches
g) Reducing the risk of contaminants entering streams by developing and implementing a spill prevention and containment plan and having the necessary containment materials on site prior to and during construction.
h) Where staging areas will be within the FEMA 100-year floodplain, the contactor will minimize potential contamination, leaks, and spills in staging areas by: Surfacing the staging area with stable rock that will not move if flooded; Not leaving fuel, oil, hazardous materials, or equipment in the staging area if there is any risk of flooding.
i) Removing non-native materials prior to flooding or after construction is complete

Other best management practices (BMPs) to be carried out are:

1. Pollution and erosion control: Obtain and comply with the conditions of the NPDES Construction Stormwater General Permit from the ODEQ. Minimize damage to natural vegetation and permeable soils.
2. Equipment, vehicles and power tools: Clean equipment to prevent leaks or debris entering waterbodies.
3. Dust abatement: Use dust abatement measures commensurate to the site conditions.
4. Construction discharge water: Avoid or minimize pollutants discharged to waterbodies in dewatering return water. Detain and treat water from dewatering prior to discharge to surface water. In areas of high groundwater, the contractor may want to dewater the trench. If dewatering or partial dewatering is feasible, sediment-laden water pumped from the trench will be disposed of in accordance with best management practices and will be discharged to upland areas. Sediment-laden water pumped from the trench will not be discharged into streams or water courses.
5. Barge use: Any barge used as a work platform will be: large enough to remain stable under foreseeable loads and adverse conditions; inspected before arrival to ensure vessel and ballast are free of invasive species; secured, stabilized and maintained to ensure no loss of balance, stability, anchorage, or other condition that can result in the release of contaminants or construction debris.

We considered, under the ESA, whether or not the proposed action would cause any other activities. It is our responsibility to consider the intrinsic effects of structures in our jeopardy/adverse modification and incidental take analysis, which incorporate the presence and the operation of structures. Thus, the intrinsic effects of the outfall and intake structures are the effects of the thermal plume from the cooling water discharge and the effect of entrainment of eulachon larvae by the cooling water inlet pump. For this consultation we describe these effects in the environmental baseline instead of the effects of the proposed action. We summarize the thermal plume effects in the environmental baseline because the new outfall/diffuser is, in part, in response to our consultation (WCR 2015-01103) with the Environmental Protection Agency (EPA) on their approval of Oregon water quality standards. We analyze the entrainment of eulachon larvae in inlet pumps in the environmental baseline because the new inlet screen is required to protect fish from entrainment, was selected by Dyno Nobel to meet the latest NMFS and ODFW fish screen criteria, we can offer no technical solution to reduce the number of eulachon larvae entrained by the pumps and the proposed action does not change the timing, or the volume, or flow rate of cooling water, so that the effect of pump entrainment on the eulachon population does not change from the baseline into the future.

Under the MSA, "Federal action" means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a Federal agency (see 50 CFR 600.910).

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 to 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 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 also relies on the regulatory 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 designations of critical habitat for LCR Chinook salmon, UCR spring-run Chinook salmon, UWR Chinook salmon, SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, LCR coho salmon, CR chum salmon, SR sockeye salmon, LCR steelhead, MCR steelhead, UCR steelhead, SRB steelhead, and UWR steelhead use the term primary constituent element (PCE) or essential features. The 2016 final rule (81 FR 7414; February 11, 2016) that revised the 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 ESA Section 7 implementing regulations define effects of the action using the term "consequences" (50 CFR 402.02). As explained in the preamble to the final rule revising the definition and adding this term (84 FR 44976, 44977; August 27, 2019), that revision 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 rangewide 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 critical 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.

2.2. Rangewide Status of the Species and Critical Habitat

This opinion examines the status of each species that is likely to 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" for the jeopardy analysis. 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., 2016; Mote et al., 2014). Rain-dominated watersheds and those with significant contributions from groundwater may be less sensitive to predicted changes in climate (Mote et al., 2014; Tague et al., 2013).

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)). Recent temperatures in all but two years since 1998 ranked above the 20th century average (Mote et al., 2014). 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 percent 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; USGCRP, 2009). Earlier snowmelt will cause lower stream flows in late spring, summer, and fall, and water temperatures will be warmer (ISAB, 2007; USGCRP, 2009). 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).

The combined effects of increasing air temperatures and decreasing spring through fall flows are expected to cause increasing stream temperatures; in 2015 this resulted in 3.5-5.3^{o}C increases in Columbia Basin streams and a peak temperature of 26^{o} C in the Willamette (NWFSC, 2015). 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 (USGCRP, 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 (Isaak et al., 2012; Mantua et al., 2010). Temperature increases shift timing of key life cycle events for salmonids and species forming the base of their aquatic foodwebs (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; Raymondi et al., 2013; Winder and Schindler, 2004). Higher temperatures are likely to cause several species to become more susceptible to parasites, disease, and higher predation rates (Crozier et al., 2011; Raymondi et al., 2013; Wainwright and Weitkamp, 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 (Lawson et al., 2004; McMahon and Hartman, 1989).

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 (Reeder et al., 2013; Tillmann and Siemann, 2011).

Moreover, as atmospheric carbon emissions increase, increasing levels of carbon are absorbed by the oceans, changing the pH of the water. A 38 percent to 109 percent increase in acidity is projected by the end of this century in all but the most stringent CO_2 mitigation scenarios, and is essentially irreversible over a time scale of centuries (IPCC, 2014). Regional factors appear to be amplifying acidification in Northwest ocean waters, which is occurring earlier and more acutely than in other regions and is already impacting important local marine species (Barton et al., 2012; Feely et al., 2012). Acidification also affects 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 to 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 (Reeder et al., 2013; Tillmann and Siemann, 2011). 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; USGCRP, 2009; 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 (Reeder et al., 2013; Tillmann and Siemann, 2011). Siegel and Crozier (2019) observe that a newer study projects nearly complete loss of existing tidal wetlands along the U.S. West Coast, due to sea level rise (Thorne et al., 2018). California and

Oregon showed the greatest threat to tidal wetlands (100%), while 68% of Washington tidal wetlands are expected to be submerged. Coastal development and steep topography prevent horizontal migration of most wetlands, causing the net contraction of this crucial habitat.

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 evolutionarily significant units (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 ESA-Listed Fish Species

For Pacific salmon, steelhead, and certain other species, we commonly use the four "viable salmonid population" (VSP) criteria (McElhany et al., 2000) to assess the viability of the populations that, together, constitute the species. These four criteria (spatial structure, diversity, abundance, and productivity) encompass the species' "reproduction, numbers, or distribution" as described in 50 CFR 402.02. When these parameters are collectively at appropriate levels, they maintain a population's capacity to adapt to various environmental conditions and allow it to sustain itself in the natural environment.

"Spatial structure" refers both to the spatial distributions of individuals in the population and the processes that generate that distribution. A population's spatial structure depends on habitat quality and spatial configuration, and the dynamics and dispersal characteristics of individuals in the population.

"Diversity" refers to the distribution of traits within and among populations. These range in scale from DNA sequence variation in single genes to complex life history traits (McElhany et al., 2000).

"Abundance" generally refers to the number of naturally-produced adults (i.e., the progeny of naturally-spawning parents) in the natural environment (e.g., on spawning grounds).

"Productivity," as applied to viability factors, refers to the entire life cycle (i.e., the number of naturally-spawning adults produced per parent). When progeny replace or exceed the number of parents, a population is stable or increasing. When progeny fail to replace the number of parents, the population is declining. McElhany et al. (2000) use the terms "population growth rate" and "productivity" interchangeably when referring to production over the entire life cycle. They also refer to "trend in abundance," which is the manifestation of long-term population growth rate.

For species with multiple populations, once the biological status of a species' populations has been determined, we assess the status of the entire species using criteria for groups of populations, as described in recovery plans and guidance documents from technical recovery teams. Considerations for species viability include having multiple populations that are viable, ensuring that populations with unique life histories and phenotypes are viable, and that some viable populations are both widespread to avoid concurrent extinctions from mass catastrophes and spatially close to allow functioning as metapopulations (McElhany et al., 2000).

The summaries that follow describe the status of the ESA-listed species, and their designated critical habitats, that occur within the geographic area of this proposed action and are considered in this opinion. More detailed information on the status and trends of these listed resources, and their biology and ecology, are in the listing regulations and critical habitat designations published in the Federal Register. Additional information (e.g., abundance estimates) that has become available since the latest status reviews and technical support documents also comprises the best scientific and commercial data available and has also been summarized in the following sections.

Table 1. 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/ Viability Assessment	Status Summary	Limiting Factors
Lower Columbia River Chinook salmon	Threatened 6/28/05	NMFS 2013a	Ford 2022	This ESU comprises 32 independent populations seven are at or near the recovery viability goals. Ten independent populations either had no abundance information (presumed near zero) or exist at very low abundances. 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. Many of the populations in this ESU remain at "high risk," with low natural-origin abundance levels. Hatchery contributions remain high for a number of populations, and it is likely that many returning unmarked adults are the progeny of hatchery-origin parents, especially where large hatchery programs operate. Increases in abundance were noted in about half of the fall-run populations, and in 75% of the spring-run populations for which data were available. Overall, the viability of the ESU has increased somewhat since the last status review, although the ESU remains at "moderate" risk of extinction (Ford, 2022).	• 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 • Contaminants

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review/ Viability Assessment	Status Summary	Limiting Factors
Upper Columbia River spring-run Chinook salmon	Endangered 6/28/05	Upper Columbia Salmon Recovery Board 2007	Ford 2022	This ESU comprises four independent populations. Three are at high risk and one is functionally extirpated. Abundance and productivity remained well below the viable thresholds called for in the Upper Columbia Recovery Plan for all three populations. Based on the information available for the most recent viability assessment review (Ford, 2022), the Upper Columbia River spring-run Chinook salmon ESU remains at high risk, with viability largely unchanged from the 2015 status review (Ford, 2022).	• 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
Snake River spring/summer-run Chinook salmon	Threatened 6/28/05	NMFS 2017a	Ford 2022	This ESU comprises 28 extant and four extirpated populations. All except three populations are at high risk. The most recent five-year geometric mean abundance estimates for 26 of the 27 populations are lower than the corresponding estimates for the previous five-year period by varying degrees. The most recent ESU abundance data show consistent and marked pattern of declining population size, with the recent five-year abundance levels for the 27 populations declining by an average of 55%. The consistent and sharp declines for all populations in the ESU are concerning, as the abundances for some populations are approaching similar levels to those of the early 1990s when the ESU was listed. The Snake River spring/summer-run Chinook salmon ESU continues to be at moderate-to-high risk (Ford, 2022).	• 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/ Viability Assessment	Status Summary	Limiting Factors
Upper Willamette River Chinook salmon	Threatened 6/28/05	ODFW and NMFS 2011	NMFS 2016a/ Ford 2022	This ESU comprises seven populations. Abundance levels for all but one of the seven DIPs in this ESU remain well below their recovery goals. The Clackamas River DIP currently exceeds its abundance recovery goal, while the Calapooia River population may be functionally extinct, and the Molalla River population remains critically low (there is considerable uncertainty in the level of natural production in the Molalla River). Abundances in the North and South Santiam Rivers have declined since the last review, with natural-origin abundances in the low hundreds of fish. The Middle Fork Willamette River is at a very low abundance, even with the inclusion of natural-origin spring-run Chinook salmon spawning in Fall Creek. Overall, there has likely been a declining trend in the viability of the ESU since the last review (FORD 2015). The Upper Willamette River Chinook salmon ESU remains at "moderate" risk of extinction (Ford, 2022).	• 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 macrodetritus • 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/ Viability Assessment	Status Summary	Limiting Factors
Snake River fall-run Chinook salmon	Threatened 6/28/05	NMFS 2017b	Ford 2022	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. Overall, the status of Snake River fall-run Chinook salmon has improved compared to the time of listing. The single extant population in the ESU is currently meeting the criteria for a rating of "viable", 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 Complex (NMFS 2017b). The Snake River fall-run Chinook salmon ESU therefore is considered to be at a moderate-to-low risk of extinction, with viability largely unchanged from the prior review (Ford, 2022).	• 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.

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review/ Viability Assessment	Status Summary	Limiting Factors
Columbia River chum salmon	Threatened 6/28/05	NMFS 2013a	Ford2022	Presently, detectable numbers of chum salmon persist in only four of the 17 populations, a fraction of their historical range. A total of three of 17 populations exceed the recovery goals established in the recovery plan (NMFS, 2013). The remaining populations have unknown abundances, although it is reasonable to assume that the abundances are very low and unlikely to be more than 10% of the established recovery goals. With so many primary populations at near-zero abundance, none of the major population groups could be considered viable. It is notable that during this most recent review period, the three populations (Grays River, Washougal, and Lower Gorge) improved markedly in abundance. The ESU remains at "moderate" risk of extinction, and the viability is largely unchanged from the 2015 review (Ford, 2022).	• 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/ Viability Assessment	Status Summary	Limiting Factors
Lower Columbia River coho salmon	Threatened 6/28/05	NMFS 2013a	Ford 2022	In contrast to the previous status review update (NWFSC, 2015), which occurred at a time of near-record returns for several populations, the ESU's abundance has declined during the last five years. Only six of the 23 populations for which we have data appear to be above their recovery goals. This includes the Youngs Bay and Big Creek DIPs, which have very low recovery goals, and the Tilton River and Salmon Creek DIPs, which were not assigned goals but have relatively high abundances. Of the remaining DIPs in the ESU, three are at 50–99% of their recovery goals, seven are at 10–50% of their recovery goals, and seven are at <10% of their recovery goals (this includes the Lower Gorge DIP, for which there are no data, but it is assumed that the abundance is low). Overall, abundance trends for the ESU are generally negative and the status remains at "moderate" risk (Ford, 2022).	• 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/ Viability Assessment	Status Summary	Limiting Factors
Snake River sockeye salmon	Endangered 6/28/05	NMFS 2015b	NWFSC 2015/ Ford 2022	This single population ESU is 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. Current climate change modeling supports the "extremely high risk" rating with the potential for extirpation in the near future (Crozier et al., 2020). The viability of the Snake River sockeye salmon ESU has likely declined since the time of the 2015 review, and the extinction risk category remains "high" (Ford, 2022).	• Effects related to the hydropower system in the mainstem Columbia River • Reduced water quality and elevated temperatures in the Salmon River • Water quantity • Predation

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review/ Viability Assessment	Status Summary	Limiting Factors
Upper Columbia River steelhead	Threatened 1/5/06	Upper Columbia Salmon Recovery Board 2007	Ford 2022	This DPS comprises four independent populations. All four populations are at high risk of extinction. The proportions of hatchery-origin returns in natural spawning areas remain high across the DPS, especially in the Methow and Okanogan River populations. Tributary habitat actions called for in the Upper Columbia Salmon Recovery Plan are anticipated to be implemented over the next 25 years, and the benefits of some of those actions will require some time to be realized. The most recent estimates (five-year geometric mean) of total and natural-origin spawner abundance have declined since the 2015 report, largely erasing gains observed over the past two decades for all four populations. Recent declines are persistent and large enough to result in small, but negative 15-year trends in abundance for all four populations. The overall DPS viability remains largely unchanged from the 2015 review, and the DPS is at high risk driven by low abundance and productivity relative to viability objectives and diversity concerns (Ford, 2022).	• 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

Lower Columbia River steelhead	Threatened 1/5/06	NMFS 2013a	Ford2022	This DPS comprises 23 historical populations, 17 winter-run populations and six summer-run populations. The majority of winter-run steelhead DIPs in this DPS continue to persist at low abundance levels (hundreds of fish), with the exception of the Clackamas and Sandy River DIPs, which have abundances in the low 1,000s. Although the five-year geometric abundance means are near recovery plan goals for many populations, the recent trends are negative. Summer-run steelhead DIPs were similarly stable, but also at low abundance levels. Summer-run DIPs in the Kalama, East Fork Lewis, and Washougal River DIPs are near their recovery plan goals; however, it is unclear how hatchery-origin fish contribute to this abundance. The decline in the Wind River summer-run DIP is a source of concern, given that this population has been considered one of the healthiest of the summer runs. The juvenile collection facilities at North Fork Dam in the Clackamas River appear to be successful enough to support increases in abundance. Hatchery interactions remain a concern in select basins, but the overall situation is somewhat improved compared to prior reviews. Although a number of DIPs exhibited increases in their five-year geometric means, others still remain depressed, and neither the winter- nor summer-run MPGs are near viability in the Gorge. Overall, the Lower Columbia River steelhead DPS is therefore considered to be at “moderate” risk, and the viability is largely unchanged from the prior review (Ford, 2022).	• 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

Upper Willamette River steelhead	Threatened 1/5/06	NMFS 2011	NMFS 2016a/ Ford 2022	This DPS has four demographically independent populations. Populations in this DPS have experienced long-term declines in spawner abundance. The underlying cause(s) of these declines is not well understood. Returning adult winter steelhead do not experience the same deleterious water temperatures as the spring-run Chinook salmon, and prespawn mortalities are not likely to be significant. Although the recent magnitude of these declines is relatively moderate, continued declines would be a cause for concern. Improvements to Bennett Dam fish passage and operational temperature control at Detroit Dam may be providing some stability in abundance in the North Santiam River DIP. It is unclear if sufficient high-quality habitat is available below Detroit Dam to support the population reaching its VSP recovery goal, or if some form of access to the upper watershed is necessary to sustain a "recovered" population. Similarly, the South Santiam River basin may not be able to achieve its recovery goal status without access to historical spawning and rearing habitat above Green Peter Dam (Quartzville Creek and the Middle Santiam River) and/or improved juvenile downstream passage at Foster Dam. Overall, the Upper Willamette River steelhead DPS continued to decline in abundance, and introgression by non-native summer-run steelhead continues to be a concern. Although the most recent counts at Willamette Falls and the Bennett Dams in 2019 and 2020 suggest a rebound from the record 2017 lows, it should be noted that current "highs" are equivalent to past	• 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 macrodetritus • 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

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review/ Viability Assessment	Status Summary	Limiting Factors
				lows. In the absence of substantial changes in accessibility to high-quality habitat, the DPS will remain at "moderate-to-high" risk (Ford, 2022).	
Middle Columbia River steelhead	Threatened 1/5/06	NMFS 2009	Ford 2022	This DPS comprises 17 extant populations. The DPS does not currently meet the viability criteria described in the Middle Columbia River steelhead recovery plan. While recent (five-year) returns are declining across all populations, the declines are from relatively high returns in the previous five-to-ten year interval, so the longer-term risk metrics that are meant to buffer against short-period changes in abundance and productivity remain unchanged. Overall, the Middle Columbia River steelhead DPS remains at "moderate" risk of extinction, with viability unchanged from the prior review.	• 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/ Viability Assessment	Status Summary	Limiting Factors
Snake River basin steelhead	Threatened 1/5/06	NMFS 2017a	Ford 2022	This DPS comprises 24 populations. Snake River Basin steelhead are classified as summer-run based on their adult run timing patterns. Much of the freshwater habitat used by Snake River Basin steelhead for spawning and rearing is warmer and drier than that associated with other steelhead DPSes. Snake River Basin steelhead spawn and rear as juveniles across a wide range of freshwater temperature/precipitation regimes. Based on the updated viability information available for this review, all five MPGs are not meeting the specific objectives in the draft recovery plan, and the viability of many individual populations remains uncertain. Of particular note, the updated, population-level abundance estimates have made very clear the recent (last five years) sharp declines that are extremely worrisome, were they to continue. Overall, the Snake River Basin steelhead DPS remains at "moderate" risk of extinction, with viability largely unchanged from the 2015 review (Ford, 2022).	• 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

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review/ Viability Assessment	Status Summary	Limiting Factors
Southern DPS of eulachon	Threatened 3/18/10	NMFS 2017c	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's 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 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 the table below.

Table 2. Summary of the Status of Critical Habitats

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 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.
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.

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
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 the lower Snake River and Columbia River has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
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 the lower Snake River and Columbia River has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
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.

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
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 the lower Snake River and Columbia River has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
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.

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
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.
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.
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 the lower Snake River and Columbia River 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
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 project area is located east of the Dyno Nobel plant and Highway 30, 0.8 miles north of Columbia City and to the west of the Columbia River. The project is in two subwatersheds: Deer Island Slough (HUC 170800030201) and Cathlamet Channel – Columbia River (HUC 170800030700). The pipeline and outfall will terminate at latitude 45.920125°, longitude 122.810874°, which is near RM 82.1 of the Columbia River. The intake structure is located at latitude 45.913461°, longitude -122.814838°, which is near RM 82.5 of the Columbia River.

All of the effects of the proposed action are contained in an action area that has upland and aquatic components in the LCR estuary.

1. Deer Island Slough: The first part of the action area is the Deer Island Slough and its riparian buffer from the Columbia River entrance to the Deer Island Road Dike. This part of the action area encompasses effects from the construction of the cofferdam including fish salvage, the temporary passage obstruction created by the cofferdams, and the effects of the pipeline construction corridor through the riparian buffers on both sides of the slough. This part of the action area is about 2,500 feet long and about 400 feet wide with an area of about 1 million square feet. It includes roughly 625,000 square feet of riparian buffer.

2. Columbia River: The second part of the action area is the Columbia River from the mouth to the Dyno Nobel intake structure at river mile 82.5, and, because the proposed action is related to the addition of heat to the 303d listed Columbia River, the action area extends to the Pacific Ocean. Within this action area, the contractor may install sheet metal cofferdams in the Columbia River to excavate the outfall trench. We modeled the zone of hydroacoustic effects with our Optional Multi-Species Pile Driving Calculator (Version 1.0-Multi-Species: 2021) to estimate that vibratory pile driver noise exceeds 150 root mean square decibels (dB_{RMS}) (re: 1 microPascal) noise for all points within the ordinary high water elevation (OHWE) that are less than approximately 2.9 miles downstream and 6.1 miles upstream of the outfall diffuser construction site. Riparian effects extend the OHWE boundary to a point equal to one site potential tree height (125 feet) upland. Turbidity effects from dredging extend from the trench to a point where turbidity returns to background turbidity 300 feet downstream. The water quality temperature effects are bounded by a 300-foot radius mixing zone around the diffusers. Turbidity and temperature effects and effects of the new inlet are contained within the hydroacoustic effects action area

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).

2.4.1 ESA-Listed Salmon and Steelhead in the Action Area

The action area is in the Columbia River estuary which extends from the mouth of the Columbia River to Bonneville Dam. Unlike projects in a tributary that affect a few populations, projects in the Columbia River estuary affect every Columbia River and Snake River salmon and steelhead population in every ESU/DPS. The estuary provides the food-rich environment where all smolts grow and transition to saltwater. Ocean-type fall Chinook and chum salmon spend weeks to months in the estuary and make use of shallow, vegetated habitats such as marshes and tidal swamps. Stream-type coho salmon, spring Chinook salmon, and steelhead spend less time in the estuary and use mostly deeper, main channel estuarine habitats.

As summarized in Table 1, the baseline level of viability of all LCR Chinook salmon and CR chum salmon populations are limited by reduced productivity resulting from sediment and nutrient related changes in the estuary. SR fall run Chinook are limited by degraded estuarine and nearshore marine habitat. All LCR coho and LCR steelhead populations are limited by reduced productivity resulting from sediment and nutrient related changes in the estuary. All UCR Chinook and MCR steelhead populations are limited by degraded estuarine and nearshore marine habitat (NMFS, 2013).

Salmon and steelhead density-dependent mortality may be exacerbated by the introduction of large numbers of hatchery fish released over a relatively short time. Some scientists suspect that closely spaced releases of hatchery fish from Columbia Basin hatcheries may lead to increased competition with natural-origin fish for food and habitat space in the Columbia River estuary. Hatchery programs are currently managed as genetically integrated with or segregated from the natural populations they most directly influence. In integrated programs a composite population of fish spawns both in a hatchery and in the wild. In segregated programs, the intent is to maintain a hatchery population that is genetically isolated from and does not interact with the natural population. An important management consideration for both integrated and segregated programs is competition for food or space between hatchery-origin and natural-origin fish and hatchery releases are intended to reduce competition (NMFS, 2013).

2.4.2 Designated Salmon and Steelhead Critical Habitat in the Action Area

The action area contains designated critical habitat for all of the ESA-listed species considered in this opinion. More specifically, the action area provides migratory and rearing habitat for these listed species. The current baseline condition of the action area includes habitat impairments caused by human activities both within and upstream of the action area, and this is described in more detail below.

The quality of the habitat available to salmon and steelhead in the estuary has been compromised by agriculture, urbanization and industry and dams.

Agriculture, urbanization and industry reduced the amount of and access to in channel and off channel estuary habitat with flood control revetments, channelization dredging and higher bankfull elevations. Development eliminated 65 percent of historical tidal swamps and decreased the surface area of the estuary by approximately 20 percent. Irrigation and other water use withdrawals have reduced flows of the Columbia River by 7 percent (NMFS, 2013).

Scientists find a variety of toxic contaminants in estuary water, sediments, and in salmon tissue at concentrations above the estimated thresholds for health effects in juvenile salmon. These contaminants include polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), DDT, and copper (LCREP, 2007). They also detect currently used pesticides in the estuary, along with emerging contaminants such as pharmaceuticals, personal care products, and brominated fire retardants (LCREP, 2007). Although the effects of emerging contaminants on salmon and steelhead are not well understood, these compounds appear to pose risks to salmonid development, health, and fitness through endocrine disruption, bioaccumulative toxicity, or other means. Toxic contaminants are widespread in the estuary, both geographically and in the food chain (LCREP, 2007).

Juvenile salmon and steelhead in the estuary are exposed to mechanical hazards from dredging activities, ship ballast intake, and beach stranding as a result of ship wakes. Recovery planners estimate baseline anthropogenic mortality in the estuary, excluding mortality attributable to predation, at between 9 and 50 percent for most populations (NMFS, 2013).

Before development of the hydropower system, Columbia River flows in the estuary were characterized by regular winter and spring floods and by high spring runoff from snowmelt. Today, flow volumes to the estuary are more uniform throughout the year. The annual mean river flow through the estuary has declined by about 16 percent and peak spring flows have declined about 44 percent. The loss of regular overbank flooding disrupts estuary habitat-forming processes such as large wood recruitment. It also eliminated floodplain wetlands and juvenile salmonids access to large areas of off-channel habitat for refuge. The loss of wetlands and large wood changed the estuarine food web so that it is based on decaying phytoplankton delivered from upstream reservoirs, instead of wetland and riparian insect prey and benthic forage from macrodetrital inputs to the estuary. This switch from macrodetrital to microdetrital based food sources lowered the productivity of the estuary, provided different and possibly less favorable food sources to juvenile salmonids, concentrated food sources in the middle region of the estuary that is less accessible to ocean-type salmon and favors productivity of other fish species in the estuary, such as American shad. It is likely that estuarine food web dynamics are being further altered by the presence of native and exotic fish, introduced invertebrates, invasive plant species, and thousands of over-water and instream structures, which alter habitat in their immediate vicinity. Current habitat conditions in the estuary support increased predation on salmonids by northern pikeminnow, pinnipeds, Caspian terns, and cormorants. Adult spring Chinook salmon and steelhead and eulachon are subject to predation by seals and sea lions in the estuary (NMFS 2013).

Reservoirs behind dams trap up to 60 percent of upstream supplies of fine sediments that create estuary habitat for salmonids, increase populations of some juvenile salmon and steelhead predators including northern pikeminnow, walleye, smallmouth bass, and deliver water heated by solar radiation to the estuary. Estuary water temperatures above the upper thermal tolerance range for salmon and steelhead are occurring earlier and more often and are likely to continue to climb as a result of global climate change. Elevated temperatures cause adverse physiological and behavioral effects and may enhance conditions for warm-water fish that prey on juvenile salmonids (NMFS 2013).

Estuary habitat recovery strategies focus on providing adequate off-channel and intertidal habitats, such as tidal swamp and marsh; restoring habitat complexity in areas modified by agricultural or rural residential use; decreasing exposure to toxic contaminants; and lowering late summer and fall water temperatures. This will be accomplished over the long term by restoring hydrologic, sediment, and riparian processes that structure habitat in the estuary. Representative actions include protecting and restoring high-quality off-channel habitats and riparian areas; identifying and reducing current sources of pollutants; restoring contaminated sites; adjusting the timing, magnitude, and frequency of flows and breaching and lowering dikes and levees (NMFS, 2013).

2.4.3 ESA-Listed Eulachon in the Action Area

Eulachon spawn in the Columbia River and its tributaries in January, February, and March (Willson et al. 2006). Spawning stock biomass estimates of eulachon in the Columbia River for the years 2000 through 2017 ranged from a low of 783,400 adult fish in 2005 to a high of 185,965,200 adults in 2013. An estimated 18,307,100 fish spawned in 2017 (NMFS 2017). Eulachon eggs adhere to sand grains and begin move downstream with bedload (Willson et al. 2006), hatching in 20 to 40 days depending on temperature (Gustafson et al. 2010). Larvae can be in the water column from February through May (McCarter and Hay 1999, Willson et al. 2006). Newly hatched larvae are poor swimmers and are rapidly carried downstream to the ocean within hours or days of hatching (Smith and Saalfeld 1955, Howell 2001, Gustafson et al. 2010). Some larval eulachon remain in still, low-salinity surface waters of estuaries for weeks or months before entering the ocean (McCarter and Hay 1999, 2003).

The main threats to eulachon are the effects of climate change on ocean and freshwater conditions, dams and water diversions, eulachon bycatch in fisheries, and predation (NMFS, 2017).

NMFS (2017) describes the effect of dams and water diversion on adult eulachon access to spawning habitat and the larval eulachon food web in the estuary (see below) and the effects of larval entrainment in dredge equipment. However, it does not discuss the effect of larval entrainment in water diversion or identify this as a limiting factor to eulachon persistence or recovery. There are no fish screens that keep eulachon larvae from being entrained in water diversion. The proposed action fine mesh cylindrical wedge wire tee screen is specifically designed to meet all NMFS and ODFW fish passage screen criteria. The Dyno Nobel inlet pump has been in place since 1966. We do not have data on or estimates of how many larval eulachon have been killed or injured but the abundance of eulachon has varied by over two orders of magnitude while the Dyno Nobel pump has been in place so while it may have an influence, it is unlikely to be a major factor in this population-scale variability in the Columbia River subpopulation of eulachon.

2.4.4 Eulachon Critical Habitat in the Action Area

The Columbia River estuary is an upstream migration corridor for adult eulachon and rearing habitat and a downstream migration corridor for larval eulachon. Spawning also can occur in the Columbia River.

Estuary water and sediments are contaminated from human activity, agriculture and industrialization. The high lipid content of eulachon makes them susceptible to absorption of lipophilic organic contaminants such as hexachlorobenzene, DDTs, PCBs, PAHs, and dioxins. They are also affected by toxic metals such as mercury, arsenic, and lead, endocrine-disrupting compounds and new toxics like polybrominated diphenyl ether (PBDE).

Columbia River dams block or retard the downstream movement of organisms and nutrients and alter the downstream flux of water and sediment through estuary habitat that has been extensively modified by shoreline armoring, construction of over water structures, channel dredging, removal of large wood, and channelization by pile dikes and other structures. These modifications eliminated 65 percent of tidal marshes and swamps, 12 percent of deep water area and up to 20 percent of the estuary's tidal prism. The combination of altered flows and habitat modifications reduce the productive capacity of the estuary by changing its biogeochemical cycles and the match between eulachon larvae and their planktonic food supply, especially during the April through July period that coincides with eulachon larval freshwater-ocean transition (NMFS, 2017).

Adult eulachon are present in the Columbia River when water temperatures are between 2 degrees C and 10 degrees C and delay migration into spawning tributaries until temperatures are above about 4.4 degrees C. When river temperatures vary above or below normal, eulachon may fail to spawn in normal areas, delay spawning, or migrate into other tributaries. Eulachon have lower lethal temperature limits than salmonids. Eulachon have lower lethal temperature limits than salmonids. The eulachon recovery plan (NMFS, 2017) determined that the 7-day average of the daily maximum temperatures should not exceed 12–14°C prior to May 1 and no single daily maximum temperature should exceed 16°C . Fifty percent and 100 percent of adult eulachon removed from the Columbia River and exposed to water temperatures 2.8 degrees C and 5.6 degrees C above river temperature died within 8 days. Fifty percent of adults exposed to water temperature 9 degrees C above river temperature for a single hour died within 32 hours. Fifty percent of females exposed to water temperature 3.9 degrees C above river temperatures failed to deposit eggs. One hundred percent of eulachon acclimated to a water temperature of 5 degrees C died when placed in water warmed to 11°C within 8 days. Fifty percent of eulachon acclimated to 10 degrees C, exposed to 18 degrees C for one hour and returned to 10 degrees C died within 50 hours. All female fish exposed to elevated temperatures failed to deposit eggs within 50 hours, in contrast to female eulachon in control conditions that successfully deposited eggs (NMFS, 2017).

Columbia River water temperatures measured at tidal freshwater sites ranged from about 4°C to 10°C during January through April in 2003 to 2006 and do not exceed the range needed for the conservation of the species (NMFS, 2017). Climate change is likely to increase water temperatures and further decrease late spring and summer flows (NMFS, 2017). The specific effects of climate change on eulachon abundance, productivity, spatial distribution and diversity are poorly understood.

In WCR 2015-1103, NMFS analyzed the effects of EPA approval of provisions of the 2003 Oregon water quality standards (WQS) that the EPA determined are likely to adversely affect ESA listed species and designated critical habitat. The 7-day average daily maximum (7DADM) temperature for the migration corridor from the mouth of the Columbia River to the Oregon Washington border is 20.0°C.[1] NMFS determined that eulachon exposed to waters at the 20°C criterion are likely to suffer reproductive failure or death (adults), abnormal development or death (eggs) or death (larvae). The 7DADM temperature of the Columbia River is generally below the 10°C threshold for adverse effects to migrating adults during the peak spawning period of March to April but the criterion allows point source discharges to bring the river temperature to 20°C at the edge of their thermal mixing zones or to higher temperatures inside their mixing zones outside of the summer maximum period. NMFS requested that EPA analyze seven point-source discharges to the lower Columbia River in Oregon, including the Dyno Nobel discharge, with thermal plumes that affect eulachon[2]. Downstream distance to threshold, width of plume, and plume as percent of river width generally were related to discharge volume and temperature. Plumes from four discharges appeared to be rapidly dispersed and are unlikely to kill many eulachon or significantly interfere with migration. The plume from two discharges were large enough to kill or injure some eulachon or interfere with their migration, but thermal plumes affected only 6 percent of the river width and likely exposure in that limited subset of the migration pathway is too small to reduce the abundance of eulachon at such a scale that population productivity is diminished as most of the fish will be found in the larger unaffected portion of the river. The plume from the Dyno Nobel facility was significantly greater in all three

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[1] NMFS determined that for listed salmon and steelhead, the 20°C criterion migration corridor criterion is adequate to: (1) protect against lethal conditions for both juveniles and adults (21 to 22°C constant), and (2) prevent migration blockage conditions for migrating adults (21 to 22°C average) but that salmon and steelhead exposed to these temperatures are at risk of experiencing some adverse effects:

- Increased adult mortality and reduced gamete survival during pre-spawn holding
- Increased disease risk due to increased virulence and reduced resistance
- Reduced growth of juveniles
- Reduced competitive success of rearing juveniles relative to non-salmonid fishes
- Increased predation on juveniles due to increased abundance of non-native, warm-water species
- Delay, prevention, or reversal of smoltification
- Harmful interactions with other habitat stressors such as pH and certain toxic chemicals, the toxicity of which is affected by temperature
- Reduced swimming performance.

[2] The EPA estimated plume conditions and sizes with the ambient river temperature at 8°C (to address eulachon adults from February to April), 10°C (to address eulachon adults and eggs in April), and 14°C (to address eulachon larvae in late May). For the 14°C run, EPA estimated the upstream and downstream distances and river widths where the plume temperatures drop below the 18°C threshold that NMFS identified for eulachon larvae. For the 10°C run, EPA estimated the upstream and downstream distances and river widths where the plume temperatures drop below 12°C (a threshold EPA selected) and below the 14°C threshold NMFS identified for eulachon eggs. For the 8°C run, EPA estimated the upstream and downstream distances and river widths where the plume temperatures drop below the 10°C threshold that NMFS identified for eulachon adults.

dimensions than the plumes from the other six facilities because Dyno Nobel discharged to the Columbia River through a 6-meter wide surface canal, rather than through a multiport diffuser. The dilution-with-distance from the outfall was much lower than a submerged diffuser outfall would provide. Depending on ambient temperature and the temperature threshold of interest, the plume cools to the threshold at a distance of 221 to 333 meters downstream from the point of discharge, is 226 to 291 meters wide, and occupies 25 to 32% of the river's width. Even though this plume is above threshold temperatures for a quarter to almost a third of the river's width, and is large enough and warm enough to kill or injure some eulachon or interfere with their migration, it has been in place since 1966, and has been about as warm and as large as it is now for at least 20 years. We do not have data on exactly how many eulachon this discharge actually kills or injures. However, the available data shows abundance of eulachon has varied by over two orders of magnitude while this discharge has been in place so it is unlikely to be the driving cause of this population-scale variability in the Columbia River subpopulation of eulachon.

As a conservation measure, the EPA sent a letter to Oregon Department of Environmental Quality (ODEQ) regarding thermal discharges permitted under the National Pollutant Discharge Elimination System (NPDES) and the protection of eulachon that raised the importance of applying Oregon's mixing zone water quality standards in order to minimize adverse effects on eulachon, including reference to critical timeframes and temperature thresholds for eulachon identified in WCR-2015-1103. The EPA letter highlighted the importance of technologies to limit mixing zone sizes to the smallest extent practicable, including submerged ports and multi-port diffusers. In the letter, the EPA requested that the ODEQ issue an administrative order or re-issue the NPDES permit for Dyno-Nobel within two years from the issuance of WCR 2015-1103 to address the current adverse effects on eulachon from the thermal plume associated with this discharge.

We searched for and did not find any future proposed Federal projects in the action area that have undergone ESA consultation but have not been implemented.

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 (see 50 CFR 402.02). 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 the factors set forth in 50 CFR 402.17(a) and (b).

2.5.1 Effects on Salmon and Steelhead Critical Habitat

The action area is migration and foraging critical habitat for all salmon and steelhead listed in Table 2. Because these salmon and steelhead species have similar estuarine habitat requirements for migration and foraging, the following analysis is applicable to all of the salmon and steelhead critical habitat designations. The essential PBFs of migration corridors and forage habitat are freedom of obstruction and excessive predation, water quantity and quality, natural cover, side channels, and undercut banks that support foraging, mobility and survival. The proposed action will affect features of designated critical habitat as a result of construction activities and operations.

Water quality: Suspended sediment from intake sediment jets and from trench excavation

The intake sediment jetting system will transport sediment in the substrate beneath the traveling screen into the water column to be transported downstream. This system will be used periodically throughout the year to keep sediment out of the intake, overlapping the presence of juvenile salmon and steelhead from all 13 ESU/DSPs in the action area. The concentration of suspended sediment from this operation is likely to be very concentrated at the source and become rapidly dispersed. For example, if the jetting system is operated for a minute to remove 500 cubic feet of sediment from beneath the screen when the current is 0.3 meters per second, the concentration of suspended sediment would be less than 200 milligrams per liter[3] near the screen but would reduce to less than 10 milligrams per liter within an hour.

The contractor will dredge the barge access channel and outfall pipe trench, install the outfall pipe and diffuser and cover the outfall and diffuser with sidecast sediment over 4 to 6 weeks in the Columbia River. Clamshell dredging is likely to be a steady source of a suspended sediment plume that will be transported downstream as it becomes diluted by mixing into the water column. The Oregon Department of Environmental Quality (ODEQ) 401 certification requires the dredger to monitor turbidity and manage the source concentration such that turbidity returns to background within 300 feet downstream from the dredge and 200 feet laterally from the dredge. The proposed action includes best management practices during dredging to minimize the mass of suspended sediment in the mixing zone. The dredge operator will work in a controlled manner and will not stockpile dredged material on the river bottom surface. Here we use the empirical equation $\frac{C}{\rho x10^{-6}} = .0023\left(\frac{b}{v_s T}\right)^3$ to estimate the suspended sediment source concentration from clamshell dredging. In this equation, b is the size of the clamshell bucket, vs is the Stokes law settling velocity of the sediment particles and T is the dredge bucket cycle time (Collins, 1995). For example, to dredge sediment with an average particle size of .5 millimeters (Sherwood, 1990) for eight hours result in a continuous source suspended sediment concentration (C) of 180 milligrams per liter. Collins (1995) also demonstrates that the source concentration decreases exponentially in radial directions and would be less than 10 mg/L at the near shore edge of the dredge site mixing zone. As long as the dredger complies with the ODEQ 401 certification by controlling the dredge bucket cycle time, the suspended sediment will return to background concentration within 300 feet of the source. Water quality returns to its background condition when dredging stops at the end of the work day and clamshell dredging does not make any long term or permanent changes to the critical habitat water quality.

3 $\frac{50{,}000mg}{ft^3}(25ft x10ft x2ft)/(.3\frac{ft}{s}x250ft^2x60\text{s})$

According to the equal transport hypothesis (Southard, 2006) the sediment at the channel surface is coarser than the sediment beneath the surface forming a pavement that reduces exposure of the finer particles to the flow. Digging the outfall pipe trench disrupts the pavement and makes fine particles available to be entrained. Turbulence randomly transports fluid masses up and down the water column. The mean velocity is, by definition, zero so the net mass of fluid transferred up and down in this way must balance to zero on the average. The suspended sediment associated with the fluid is unevenly distributed so the balanced turbulent transfer across planes causes a diffusive transport (flux) from the boundary to the surface Southard (2006) summarizes the derivation of the equation describing the suspension of sediment particles by turbulent diffusion. The concentration of suspended sediment at a point y above a point at or very near the surface is given by $\frac{C(y)}{C_a} = \left(\frac{d-a}{y}\frac{a}{d-a}\right)^z$ where d is the depth of the water z is the Rouse number ($z = \frac{w}{\beta\kappa u_*}$) where w is the settling velocity of the sediment particle, u_* is the shear velocity, β is the coefficient to transform eddy viscosity to sediment diffusion (approximately 1), and κ is the von Karman's constant (approximately 0.4). $u_* = \sqrt{\frac{\tau_0}{\rho}}$ where $\tau_0 = \gamma \sin\alpha d$ is the boundary shear stress, γ is the specific weight of the water, α is the slope (Yeh et al., 2012) and d is the depth. For Reynolds number greater than 1, the settling velocity is determined experimentally as a function of particle diameter. For the shear velocity estimated here, sediment particles smaller than 0.25 mm will be transported as washload and the nominal particle size was selected to be 0.5 mm. The settling velocity for a 0.5 mm particle was taken from Figure 3-38 in Southard (2006). Using these parameters, the concentration of suspended sediment as a function of height above the surface is presented at 0 in Figure 8, below. Although the concentration of suspended sediment is predicted to be hundreds of milligrams per liter in the first few centimeters from the bottom, the plume disperses to background within a meter.

Water quality reductions from increased sediment are sufficiently limited in spatial and temporal extent that the disruption will not impair migration or rearing values for salmonids. Outmigrating juveniles will continue to move past the area with the water quality disruption – migration value being undiminished. Rearing salmon are expected to avoid areas with more intense turbidity. Turbidity "is particularly significant for visual feeders, such as salmonids, where suspended sediment can reduce the effectiveness of them obtaining food (Newcombe and Jensen, 1996). However, research also suggests the turbid-clear water interface may sometimes assist feeding, by offering concealment and protection within the turbid water (Wilber and Clarke, 2001) This suggests that there may be both positive and negative influence on the habitat's role for rearing value while turbid conditions persist.

Water quality: Noise from vibratory pile driving

The contractor will use a vibratory pile driver to install and remove a sheet pile cofferdam across the Deer Island Slough during late summer when the water level in the slough is lowest. The contractor may use a vibratory pile driver to install sheet pile to support the trench in the Columbia River during the November 1 to February 28 in water work window. Vibratory pile driver noise propagates through the water column until it reaches a solid boundary and suspended sediment remains in the water column until it resettles, generally within one hour of the time the vibratory pile driver stops for the day. Vibratory pile driver noise and suspended sediment degrade the water quality in the Slough while the noise and cofferdam presence obstruct fish passage in the slough and the noise obstructs passage in the Columbia River. Assuming the contractor uses 2-foot wide sheet pile and installs four sheets per hour, the vibratory pile driver will operate for up to 18 hours over up to three workdays and the cofferdam will be in place for up to 2 weeks while the contractor excavates the outfall pipe trench across the slough, installs the outfall pipe and covers the pipe with side cast sediment from the trench. The July 1 to September 31 work window overlaps the possible presence of individual juvenile salmon and steelhead from all 13 ESU/DPSs in the action area (Morrice et al., 2020). We used the NMFS Pile Driver Calculator to estimate that vibratory pile driving noise is greater than 150 dB_{RMS} threshold that affects fish behavior within 74 meters of the pile. The concentration of suspended sediment depends on the sediment size distribution around the pile but is generally less than 100 milligrams per liter within 40 feet of the pile (Weston Solutions, 2006). Therefore, water quality will be degraded for up to 7 hours per day over 3 work days and passage in the Deer Island Slough will be obstructed for up to two weeks while the cofferdam is present. The biological assessment does not quantify the amount of sheet pile that the contractor may use in the Columbia River to support the sides of the outfall pipe trench but the outfall is approximately 1000 feet long so installing 35 2 foot wide sheets per day would result in noise exceeding 150 dB_{RMS} within 74 meters of the pile (calculator) and suspended sediment up to 100 milligrams per liter within 40 feet of the pile for up to 30 days. Together these briefly reduce the value of the habitat for both rearing and migration, but conditions return to baseline levels when pile driving work ceases.

Forage: Wetland and riparian plants removed by road and staging area construction

The contractor will construct temporary access roads for excavation equipment to dig the trench for the outfall across wetlands and through riparian vegetation during late summer when the groundwater level in wetlands is lowest. The road may destroy and the ditch will destroy less than 10,000 square feet of wetland and riparian vegetation that is the basis of the forage for juvenile salmon and steelhead in the estuary. Road and ditch construction BMPs in the proposed action require replacement of any damaged vegetation as soon as construction is complete. Newly planted vegetation may then take up to one year to become fully established and functional. Individual salmon and steelhead from all 13 ESU/DSPs have access to and may enter the action area during this year. Salmonids complete the transition from fresh water to salt water in the lower estuary and undergo considerable physiological stress. The estuary is a key feeding location for juvenile salmonids, especially subyearling or fry life history types. They require abundant amphipods (*Corophium* spp), mysids (*Neomysis mercedis* and *A. grebnitzkii*) and dipteran insects to complete smoltification and to grow and maintain energy levels to avoid predators.

Macrodetritis is a complex of organic and inorganic matter from decaying wetland and riparian plant material mixed with sediment particles, bacteria, fungi, other microbes, and micrograzers such as protozoan ciliates and flagellates that is a key food source of benthic invertebrates, amphipods and mysids. The destruction of wetland and riparian plants slightly reduces the source material for this macrodetritis base of the salmonid food web in the action area. Since the roads and ditch will be constructed on a small area of wetland and riparian habitat, the contractor will use BMPs to minimize the destruction of wetland and riparian plants and BMPs to restore the habitat such that it becomes fully functional, the effect on the salmonid forage base in the action area is short term (about 1 year) and extremely small in scale. The reduction in prey at this site is unlikely to reduce the habitat's value for migration or rearing despite the duration because the amount of reduction is very small.

Forage: Macrodetritis removed by outfall trench excavation

The contractor will excavate a trench across the Deer Island slough in the late summer and dredge a barge access channel and trench in the Columbia River during the November 1 to February 28 in water work window. Excavation and dredging disrupts the benthic substrate, including macrodetritus and amphipods that feed on macrodetritus and that are important forage for salmonids. Since the contractor will cover the outfall pipe with side cast sediment, the recovery of benthic forage will not depend on replacement of macrodetritis and recolonization of amphipods and will take less than one year. During that year, the macrodetritus in the action area substrate that feeds amphipods and mysids that in turn provide the bulk of juvenile salmonid forage is slightly reduced.

The contractor will excavate the trench across Deer Island Slough inside the dry cofferdam so there are no other effects to critical habitat physical or biological features.

2.5.2 Effects on Salmon and Steelhead

Implementation of the proposed action will expose individuals of ESA-listed species that occur in the action area to effects from construction activities such as decreased forage, create noise (pile driving), and increase suspended sediment (pile driving and trench excavation) as described above. To reduce exposure to effects of work in Deer Island Slough, qualified biologists will use nets to sweep juvenile fish downstream but still in the slough. Electrofishing will not be used and fish will not be captured and transported away from the worksite in buckets. Since fish won't be handled, risk of injury or death from the netting and handling are avoided, and because fish are not stressed or stunned, risk of predation upon these fish at the new location is very low.

As described in the Effects to Critical Habitat section above, the intake screen sediment jets may be used anytime during the year to remove sediment from beneath the screen resulting in plumes of suspended sediment that are hundreds of milligrams per liter near the source and rapidly dispersed to background suspended sediment concentrations downstream. Individual fish from all 13 ESU/DPS may be exposed to suspended sediment from the operation of the intake sediment jetting system. Adults are likely to quickly swim around or through the plume and have extremely brief exposure but rearing juveniles may have longer exposure. Wilber and Clarke (2001) report that juvenile salmon exposed to 10-200 milligrams per liter of suspended sediment for less than 2 hours will result in behavioral effects such as reduced visual acuity and altered swimming either toward or away from suspended sediment. Since these plumes are relatively small and away from the shoreline, the consequences of these behavioral changes are likely negligible.

The small, temporary loss of wetland and riparian vegetation from road and trench construction slightly reduces the macrodetritis base of the salmonid food web. Juvenile salmon that search for and fail to find suitable estuarine rearing habitat and sufficient forage experience higher risk of mortality (ISAB, 2015). NMFS (2013) expresses concern that the carrying capacity of the estuary cannot always support the annual number of natural and hatchery fish dependent upon it for growth before they enter the ocean. However, there is insufficient information to determine whether available forage in the estuary limits the existence and recovery of ESA-listed salmon and steelhead (ISAB, 2015). Therefore the consequence of this small, temporary loss of macrodetritus from the salmonid food web and any subsequent decrease in salmonid forage is likely to be very negligible.

The effects of vibratory pile driving on critical habitat water quality are transient, that is water quality is degraded while the pile driver is operating and returns to normal when the pile driver is off. Therefore, pile driving effects to critical habitat only directly affect individual fish if the fish is within 74 meters of the pile driver while it is operating. The late summer work window overlaps the presence of juvenile coho and steelhead in the Deer Island Slough (StreamNet). The November 1 to February 28 in water work window overlaps the upstream migration of adult fall Chinook, chum and winter steelhead and the downstream migration of smolts from all 13 ESU/DPS past the action area. The density of smolts in the estuary drops dramatically in September, from 1,000s of fish per 1,000 square meters to 10s of fish per 1,000 square meters (Roegner et al., 2016). Vibratory pile driving creates noise greater than 150 dB_{RMS} (re: 1μPa) within 74 meters of the sheet pile. The Fisheries Hydroacoustic Working Group (FHWG, 2008) determined that SPLs in excess of 150 dB_{RMS} are likely to cause temporary behavioral changes, including a startle response or other behaviors indicative of stress. Popper et al. (2003) reports that behavioral response of fishes to sounds may include “freezing”, increasing the vulnerability of individual fish to predation. Proposed action vibratory pile driving BMPs (three sequences of operating the pile driver at reduced energy for 15 seconds and then turning the driver off for 30 seconds whenever the pile driver has been silent for more than 30 minutes) may increase the likelihood that any individual fish that have entered the action area will leave before they are exposed to noise greater than 150 dB_{RMS}. The BMPs and the low density of fish in the estuary during the work window are likely to minimize the number of individual fish exposed to the effects of vibratory pile driver noise.

Pile driving will also result in elevated concentrations of suspended sediment. Any individual fish within 40 feet of the pile-substrate interface will be exposed to up to 100 milligrams per liter of suspended sediment during and for a short time following vibratory pile driving. Wilber and Clarke (2001) report that adults exposed to 10-100 milligrams per liter of suspended sediment for less than 2 hours will result in behavioral effects such as reduced visual acuity and altered swimming either toward or away from suspended sediment and that juvenile fish exposed to 10 to 100 milligrams per liter for 8 hours would experience sublethal physiological effects such as reduced feeding and behavioral effects such as alarm followed by relocation. They note that these effects are somewhat offset by the ability of smolts to hide from predators in the turbidity associated with suspended sediment. Again, BMPs and the low density of fish in the estuary during the work window are likely to minimize the number of individual fish exposed to suspended sediment from vibratory pile driving.

Trench excavation and the disruption of the sediment size distribution in the Columbia River result in suspended sediment concentrations up to 100s of milligrams per liter for up to eight hours per day. Juvenile fish exposed to 10 to 100 milligrams per liter for 8 hours would experience sublethal physiological effects such as reduced feeding and behavioral effects such as alarm followed by relocation.

2.5.3 Effects on Eulachon Critical Habitat

Water quality - Suspended sediment from intake sediment jets

The intake sediment jetting system will transport sediment accumulated beneath the traveling screen into the water column to be transported downstream. This system will be used periodically throughout the year to keep sediment out of the intake, overlapping the presence of adult and larval eulachon in the action area. As shown above, the concentration of suspended sediment from this operation is likely to be up to 200 milligrams per liter at the source and less than 10 milligrams per liter within an hour.

Water quality: Noise and suspended sediment from vibratory pile driving

The contractor may use a vibratory pile driver to install sheet pile to support the trench in the Columbia River during the November 1 to February 28 in water work window. Vibratory pile driver noise propagates through the water column until it reaches a solid boundary and suspended sediment remains in the water column until it resettles, generally within one hour of the time the vibratory pile driver stops for the day. Vibratory pile driver noise obstructs passage in the Columbia River. As shown above noise exceeding 150 dB_{RMS} within 74 meters of the pile and suspended sediment up to 100 milligrams per liter will exist during the workday for up to 30 days of the November 1 to February 28 in water work window that overlaps upstream migration of eulachon adults.

Water quality: Suspended sediment from trench excavation

The contractor will dredge the barge access channel and outfall pipe trench, install the outfall pipe and diffuser and cover the outfall and diffuser with side cast sediment over 4 to 6 weeks in the Columbia River during the November 1 to February 28 in water work window. Clamshell dredging is likely to be a steady source of a suspended sediment plume that will be transported downstream as it becomes diluted by mixing into the water column. As shown above, dredging is likely to create a suspended sediment plume during the workday with a concentration less than 180 milligrams per liter at the source and equal to background 300 feet downstream and 200 feet laterally from the source. The presence of the plume overlaps adult eulachon upstream migration through the action area.

As described above, digging the outfall pipe makes fine particles in the trench, sidecast sediment pile and over the freshly covered pipe available to be entrained by turbulence flow in the boundary layer during construction in the in water work window and for some time after construction is complete until the source of fine sediment is exhausted. The suspended sediment concentration could be 100s of milligrams per liter in the first few centimeters from the surface and disperse to background within a meter. The presence of suspended sediment overlaps adult eulachon upstream migration through the action area. We have found no studies that indicate adult migration of eulachon is impaired by suspended sediment, so the value of the habitat for migration or spawning in the action area is unlikely to be reduced.

Water Quality: Heat from operation

After the new outfall/diffuser is constructed, Dyno Nobel will continuously discharge heat to the Columbia River. This heat will continue to increase the water temperature and decrease critical habitat water quality in the smaller and relocated mixing zone. Year round heat discharge could last for decades and overlaps the presence of migrating adult and larval eulachon in the action area. WCR 2015-1103 recommended moving the outfall/diffuser away from the shoreline and to the channel bottom to reduce the size of the mixing zone, add jet mixing from the diffusers and increase the buoyant mixing depth relative to the existing outfall because the baseline configuration has no jet mixing and the dimensionless ratio of buoyancy flux to shear velocity $\frac{B}{du^{*3}} = 1.7$ (Fischer et al., 1979) indicates that transverse mixing is essentially independent of the density difference between the effluent and the River. The shear boundary between the turbulent jets and the river causes the jets to entrain and rapidly mix with river water within the first 10 diffuser diameters and then gradually transition to buoyancy mixing. The temperature distribution across the cross section of the jet is Gaussian. Figure 4 (see Appendix 1) plots dilution and temperature for a total discharge of 24 million gallons per day from a single outfall diffuser as a function of downstream distance from the diffuser. Temperature decreases rapidly over the first 10 feet of dilution and reaches the water quality standard of 20 degrees within 30 feet of the diffuser and drops below 16 degrees within 40 feet of the diffuser.

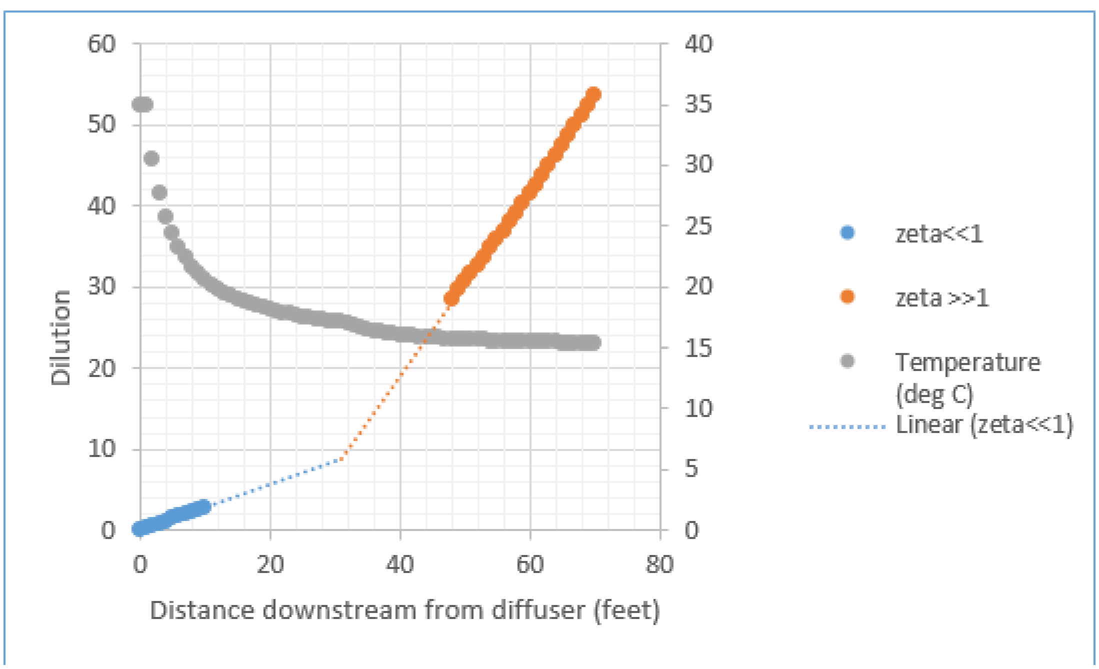

Figure 4. Dilution (left axis) and temperature (right axis, degrees Celsius) along the plume characteristic length zeta from a single diffuser buoyant jet.

2.5.4 Effects on Eulachon

As described in the Effects to Critical Habitat section above, the intake screen sediment jets may be used anytime during the year to remove sediment from beneath the screen resulting in plumes of suspended sediment that are hundreds of milligrams per liter near the source and rapidly dispersed to background suspended sediment concentrations downstream. Individual adult eulachon and eulachon larvae may be exposed to suspended sediment from the operation of the intake sediment jetting system. Adults are likely to quickly swim around or through the plume and have extremely brief exposure but larvae may have longer exposure up to an hour. Wilber and Clarke (2001) report inhibited feeding for Pacific herring larvae exposed to 2000 milligrams per liter of suspended sediment in one day so the consequence of eulachon larval exposure to less than 200 milligrams per liter for one hour is likely negligible. Larval eulachon rely for nutrition on their yolk sac until the sac is fully depleted, at which time they must consume prey. This also suggests that the sediment effects on eulachon prey consumption will be limited.

The effects of vibratory pile driving on critical habitat water quality are transient, that is water quality is degraded while the pile driver is operating and returns to normal when the pile driver is off. Therefore, pile driving effects to critical habitat only directly affect individual fish if the fish is sufficiently near the pile driver while it is operating. The November 1 to February 28 in water work window overlaps the upstream migration adult eulachon. Vibratory pile driving creates noise greater than 150 dB_{RMS} (re: 1μPa) within 74 meters of the sheet pile. The Fisheries Hydroacoustic Working Group (FHWG, 2008) determined that SPLs in excess of 150 dB_{RMS} are likely to cause temporary behavioral changes, including a startle response or other behaviors indicative of stress. Popper et al. (2003) reports that behavioral response of fishes to sounds may include "freezing", increasing the vulnerability of individual fish to predation. Proposed action vibratory pile driving BMPs (three sequences of operating the pile driver at reduced energy for 15 seconds and then turning the driver off for 30 seconds whenever the pile driver has been silent for more than 30 minutes) may increase the likelihood that any individual fish that have entered the action area will leave before they are exposed to noise greater than 150 dB_{RMS}. The BMPs are likely to minimize the number of individual fish exposed to the effects of vibratory pile driver noise.

Pile driving will also result in elevated concentrations of suspended sediment. Any individual fish near the pile-substrate interface will be exposed to up to 100 milligrams per liter of suspended sediment during and for a short time following vibratory pile driving. Wilber and Clarke (2001) report that adults exposed to 10-100 milligrams per liter of suspended sediment for less than 2 hours will result in behavioral effects such as reduced visual acuity and altered swimming either toward or away from suspended sediment and that juvenile fish exposed to 10 to 100 milligrams per liter for 8 hours would experience sublethal physiological effects such as reduced feeding and behavioral effects such as alarm followed by relocation. Again, BMPs are likely to minimize the number of individual fish exposed to suspended sediment from vibratory pile driving.

Trench excavation and the disruption of the sediment size distribution in the Columbia River result in suspended sediment concentrations up to 100s of milligrams per liter for up to eight hours per day during the November 1 to February 28 in water work window. Adult eulachon exposed to 10 to 100s milligrams per liter for 8 hours would experience sublethal physiological effects such as reduced feeding and behavioral effects such as alarm followed by relocation (Wilber and Clarke, 2001). BMPs are likely to effectively minimize the concentration of suspended sediment at the source and the volume of the dispersing plume.

Adult eulachon exposed to mixing zone temperature above 16 degrees C within approximately 40 feet downstream of the diffuser will likely experience the health and reproductive effects summarized in the Baseline. However, because the outfall is relocated to the bottom of the channel and dilution is greatly increased by diffusers, the likelihood that migrating adult eulachon will swim close to the diffuser and not be able to avoid or minimize exposure is greatly reduced. Eulachon larvae exposed to mixing zone temperature above 18 degrees C within approximately 20 feet downstream from the diffuser will likely experience lethal effects summarized in the Baseline. However, because dilution greatly decreases the mixing zone region where temperature exceeds 18 degrees C, the number of larvae killed is likely to be greatly reduced.

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. It is clear however that climate change presents an array of specific threats that can act synergistically with other threats, dramatically increasing the impacts of each. In particular, the loss of population spatial structures, as well as habitat heterogeneity and connectivity, removes the means by which salmon have historically persisted through frequent disturbances and climate extremes. Recent analyses in terrestrial environments found a correlation between habitat loss and climate stress and it is possible that, due to past adaptation or recent stressors, adaptive capacity may already be at its lowest levels precisely where salmon need it most (Crozier et al., 2019) , as warming temperatures, decreasing salinity, increasing acidity, rising sea level, and shifting food webs intensify over the period of years that this project will exist within the action area.

As with all projects in the estuary, the quality of the water that flows through the action area is affected by many city, county and private activities that are regulated by the states. For example, multiple upstream stormwater and wastewater sources deliver chemicals to the Columbia River that are be carried through the action area.

We searched for other relevant activities that may affect ESA species in the action area and found none. It is very likely however that upland uses will intensify over the next 75 years as human population growth continues in all areas adjacent to the Columbia River, increasing water withdrawals, storm and waste water inputs, and recreational and commercial boating, each of which incrementally adds to degrading habitat conditions necessary for viability and recovery in the action area.

2.7. Integration and Synthesis

The Integration and Synthesis section is the final step in assessing the risk that the proposed action poses to species and critical habitat. 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 ESA Listed Salmon and Steelhead

With the exception of UCR spring-run Chinook salmon and SR sockeye salmon, which are already considered endangered, each species of salmon and steelhead considered in this opinion is at risk of becoming endangered in the foreseeable future. These species are ESA-listed due to a combination of low abundance and productivity, reduced spatial structure, and decreased genetic (and in some cases, life history) diversity. Recent adult returns have been substantially below averages for many populations/MPGs. We expect that abundance could further decrease and extinction risk increase for many ESUs and DPSs due to factors associated with climate change.

The status of all designated critical habitats considered in this opinion varies, with habitat conditions ranging from excellent in wilderness and roadless areas to severely degraded habitat conditions in areas subject to intense human activities such as agricultural and urban development. There are a number of common limiting factors, including altered flow regimes, reduced access to off-channel rearing habitat in the lower Columbia River, impaired water quality and reduced habitat complexity.

The current baseline condition of the action area has been impacted by human activities both within and upstream of the action area. Under the environmental baseline, the fish from the component populations of each ESU and DPS that move through and use the action area will encounter habitat conditions degraded by a modified flow regime; reduced water quality (chemical contamination and elevated summer and fall temperatures); loss of functioning floodplains; and loss of vegetated riparian areas and associated shoreline cover; and high predation rates.

We translate the effects of the proposed action on individuals into their effects on the abundance, productivity, spatial structure and diversity (APSSD) parameters that summarize the survival and recovery of each species. In the Columbia River estuary action area, there are 13 species of salmon and steelhead that are exposed to the effects of the action. Salmon and steelhead smolts that migrate through the action area may be exposed to construction stressors including noise and suspended sediment from pile driving, suspended sediment from trench excavation and slightly reduced forage from wetland and riparian disturbance resulting in behavioral changes, injuries or death. Individual fish may: (1) expend more energy to reach the ocean due to the longer migration lengths; (2) experience greater predation pressures; and (3) have slightly reduced foraging opportunities.

Most of the individuals in the 13 species are not going to be affected by the construction activities because the vast majority of adults and smolts migrate past the action area outside of the proposed in water work window. Indeed, this is the intent of in water work windows, to dramatically reduce exposure to proposed action stressors. However, to be conservative, we've assumed that some individuals from each ESU population will migrate past the project during the proposed in water work window and be exposed to construction-related impacts.

Noise and suspended sediment from vibratory pile driving may affect the behavior of individual fish and may even cause them to swim into an area where they may more likely be killed by a predator. The number of individuals whose behavior may be altered or who may be harmed or killed as a result of implementation of the proposed action is expected to be too small to translate into a reduction in future population abundance or the growth rate of the population. For example, if one individual smolt from any population is killed by a predator, the reduction in future abundance would be much less than 0.02 adults because the smolt to adult return ratio for salmon and steelhead is greater than (and for subyearlings much greater than) 50. Given the relatively short duration of the construction, and implementation of BMPs to reduce impacts, the proposed action will affect far too few individual smolts to change future adult abundance or productivity of any population of any threatened or endangered species considered in this opinion. Spatial structure and diversity of populations will also be unaltered.

Because the proposed action will not reduce the abundance, productivity, spatial structure, or diversity of the affected populations, the action, when combined with a degraded environmental baseline and additional pressure from cumulative effects, will not appreciably reduce the survival or recovery any of the listed species considered in this opinion.

2.7.2 Salmon and Steelhead Critical Habitat

The status of all designated critical habitats considered in this opinion varies, with habitat conditions being excellent in wilderness and roadless areas to severely degraded habitat conditions in areas subject to intense human activities such as agricultural and urban development. There are a number of common limiting factors, including altered flow regimes, reduced access to off-channel rearing habitat in the lower Columbia River, impaired water quality and reduced habitat complexity.

The current baseline condition of the action area has been impacted by human activities both within and upstream of the action area. Under the environmental baseline, the fish from the component populations of each ESU and DPS that move through and use the action area will encounter habitat conditions degraded by a modified flow regime; reduced water quality (chemical contamination and elevated summer and fall temperatures); loss of functioning floodplains; and loss of vegetated riparian areas and associated shoreline cover; and high predation rates.

The action area is designated critical habitat for all 13 species of salmon and steelhead. Under the current environmental baseline, migration and rearing is functioning moderately. Proposed construction activities will add low-level, temporary effects on the migration and rearing PBFs. The addition of these temporary effects to baseline and cumulative effects is not likely to appreciably diminish the value of designated critical habitat for the conservation of salmon and steelhead species.

2.7.3 Southern DPS eulachon

The southern eulachon DPS is at risk of becoming endangered in the foreseeable future due to a combination of low abundance and productivity and reduced spatial structure. Recent adult returns have been substantially below average and we expect that abundance could further decrease and extinction risk increase for many ESUs and DPSs due to factors associated with climate change.

Eulachon designated critical habitat is degraded by intense human activities such as agricultural and urban development. Limiting factors, include poor ocean conditions, altered flow regimes and impaired water quality.

The current baseline condition of the action area has been impacted by human activities both within and upstream of the action area. Under the environmental baseline, adult and larval eulachon that move through and use the action area will encounter habitat conditions degraded by a modified flow regime; reduced water quality, chemical contamination, and elevated summer temperatures, elevated water temperature near the outfall diffusers and high predation rates. Larval eulachon will continue to be entrained in the flow through the intake screen and killed but this baseline condition is not a limiting factor to Southern eulachon DPS existence or recovery.

We translate the effects of the proposed action on individuals into their effects on the abundance, productivity, spatial structure and diversity (APSSD) parameters that summarize the survival and recovery of each species. Adult eulachon that migrate through the action area may be exposed to construction stressors including noise and suspended sediment from pile driving and suspended sediment from trench excavation, resulting in behavioral changes, injuries or death. Individual fish may expend more energy to reach spawning sites and may experience greater predation pressures.

At least half of adult eulachon individuals are not going to be affected by the construction activities because they migrate past the action area outside of the proposed in water work window and construction could be entirely completed before eulachon migration.

Noise and suspended sediment from vibratory pile driving may affect the behavior of individual adult eulachon and may even cause them to swim into an area where they may more likely be killed by a predator. The number of individuals whose behavior may be altered or who may be harmed or killed as a result of implementation of the proposed action is expected to be too small to translate into a reduction in future population abundance or the growth rate of the population. Given the relatively short duration of the construction, and implementation of BMPs to reduce impacts, the proposed action will affect far too few individual smolts to change future adult abundance or productivity. Spatial structure and diversity will remain unaltered

Because the proposed action will not reduce the abundance, productivity, spatial structure, or diversity of the DPS, the action, when combined with a degraded environmental baseline and additional pressure from cumulative effects, will not appreciably reduce the survival or recovery the Southern eulachon DPS.

2.7.4 Southern DPS Eulachon Critical Habitat

The action area is designated critical habitat for the Southern eulachon DPS. Under the current environmental baseline, migration and larval rearing is functioning moderately. Proposed construction activities will add low-level, temporary effects on the migration and rearing PBFs. The addition of these temporary effects to baseline and cumulative effects is not likely to appreciably diminish the value of designated critical habitat for the conservation of the Southern eulachon DPS.

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 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, or SR Basin steelhead, Southern DPS eulachon or destroy or adversely modify their designated critical habitat.

2.9. Incidental Take Statement

Section 9 of the ESA and Federal regulations 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 actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). "Harass" is further defined by interim guidance as to "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." "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). 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 ITS.

2.9.1 Amount or Extent of Take

In the biological opinion, NMFS determined that incidental take is reasonably certain to occur because the proposed construction and pile driving will take place when individual salmon, steelhead, and eulachon enter the action area.

Incidental take caused by the adverse effects of the proposed action will occur among individuals of the species identified above in the form of:

- harm or harassment as altered behavior increases the likelihood of injury or death from exposure to vibratory pile driver noise, and
- harm from exposure to suspended sediment.

A definitive number of ESA listed fish that will be killed, injured, or harmed cannot be estimated or measured because of the highly variable presence of species over time, and the inability to observe all injured or dead specimens. Instead, NMFS will use habitat–based surrogates that are causally related to harm to account for the take, which are called the "extent" of take.

For this proposed action, the extent of take from vibratory pile driving is causally related to the up to 7 weeks of outfall pipe and diffuser construction across the Deer Island Slough and into the Columbia River when vibratory pile driving may be necessary.

The extent of take from suspended sediment from dredging is also is also causally related to the up to 6 weeks of dredging in the Columbia River to install and cover the outfall pipe and diffuser.

These temporal limits of work that cause exposure to take are measurable and verifiable metrics by which the action agency or other observers can determine if the extent of take has been exceeded.

2.9.2 Effect of the Take

In the biological opinion, NMFS determined that the amount or extent 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 measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 CFR 402.02).

In order to be exempt from the prohibitions of section 9 of the ESA, the Federal action agency must comply (or must ensure that any applicant complies) with the following terms and conditions. The USACE 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. The proposed action includes several BMPs to minimize the effects of pile driving and dredging on ESA listed species and their critical habitat. Therefore, only monitoring to ensure that the incidental take surrogates are not exceeded is required.

1. Monitor to ensure the extent of take from pile driving is not exceeded and
2. Monitor to ensure the extent of take from dredging is not exceeded.

2.9.4 Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the Federal action agency must comply (or must ensure that any applicant complies) with the following terms and conditions. The Corps of Engineers 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 term and condition implements RPM 1 (monitor pile driving): Ensure that Dyno Nobel does all vibratory pile driving in 7 weeks or fewer during the ODFW recommended IWWW for the Columbia River estuary from November 1 to February 28 to confirm that the extent of take is not exceeded.

2. The following term and condition implements RPM 2 (monitor dredging): Ensure that Dyno Nobel does all dredging in 6 weeks or fewer during the ODFW recommended IWWW for the Columbia River estuary from November 1 to February 28 to confirm that the extent of take is not exceeded.

3. The following term and condition implements RPM 2: Prepare and provide NMFS with a plan before construction begins describing how impacts on listed species arising from turbidity in the action area would be monitored and documented, and a report within 90 days of the completion of construction documenting incidental take monitoring results.

4. The following term and condition implements both RPM 1 and 2 (monitoring pile driving and dredging): Provide turbidity monitoring plan and the reports to that indicates the extent of take has been documented to: projectreports.wcr@noaa.gov. Include the WCR tracking number for this consultation (WCRO-2021-01532) in the regarding line when the report is submitted.

2.10. Reinitiation of Consultation

This concludes formal consultation for the Columbia River Outfall Discharge and Intake Screen Replacement Project.

Under 50 CFR 402.16(a): “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: (1) If the amount or extent of taking specified in the incidental take statement is exceeded; (2) If new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) If 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 written concurrence; or (4) If a new species is listed or critical habitat designated that may be affected by the identified action."

2.11. "Not Likely to Adversely Affect" Determinations

The proposed action is summarized is described in Section 1.3 of this opinion. The proposed action may affect Southern DPS of green sturgeon (*Acipenser medirostris*), and their designated critical habitats.

Status of Species
The southern DPS of green sturgeon were listed as Threatened on April 7, 2006. 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. Limiting factors to recovery are: Reduction of its spawning area to a single known population; lack of water quantity; poor water quality; and poaching.

Baseline
Green sturgeon spawn and rear for up to three years in the Sacramento River in California but during the late summer and early fall, subadult and adult green sturgeon aggregate in estuaries along the Pacific coast including the Columbia River estuary. Tidal areas of rivers and streams draining into the lower Columbia River estuary from the mouth upstream to river mile 41, are occupied by green sturgeon (USDC 2009). The effect of Dyno Nobel cooling water heat to the Lower Columbia River 20 degrees C 7DADM criteria effect on green sturgeon during the summer was analyzed in WCR 2015-01103 which concluded "It is unlikely that approval of the migration corridor criterion of 20°C as a 7DADM and its application through beneficial use designations in the Columbia and Coos Rivers will reduce the numbers, reproduction or distribution of green sturgeon at any scale."

Effects
Based on tagging studies in Willapa Bay, Washington and the Columbia River estuary (Moser and Lindley 2007), green sturgeon likely are present in these estuarine areas from June through September. Since the project site is 35 miles upstream from river mile 41 and the Columbia River in water work window is after green sturgeon return to the ocean, their exposure to construction effects is discountable.

Conclusion
Therefore, the proposed action is not likely to adversely affect green sturgeon.

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 USACE and descriptions of EFH for Pacific Coast groundfish (Pacific Fishery Management Council (PFMC 2005) and Pacific Coast salmon (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 proposed action adversely affects salmon EFH and the salmon EFH estuary habitat of particular concern (HAPC) as identified in PFMC (2014), groundfish EFH and the groundfish EFH estuary HAPC as described in PFMC (2005).

3.2. Adverse Effects on Essential Fish Habitat

The project adverse effects on groundfish and salmon species' EFH and HAPCs are water quality disruption during pile removal and installation and dredging, and diminishment of prey communities.

1. Vibratory pile removal and pile driving will result in temporary increases in noise and turbidity disruptions to water quality. EFH habitat conditions for water quality will return to baseline level when pile driving ceases.

2. Dredging will result in temporary increase in suspended sediment, briefly diminishing water quality. EFH habitat conditions for water quality will return to baseline levels within hours after dredging is complete.

3. Dredging will result in temporary decreases of benthic prey communities. EFH habitat conditions for prey communities will return to baseline levels within weeks to months after dredging is complete.

3.3. Essential Fish Habitat Conservation Recommendations

NMFS determined that proposed action BMPs minimize the impact of the proposed action on Pacific Coast salmon, and Pacific Coast groundfish EFH such that additional conservation recommendations would be redundant.

3.4. Supplemental Consultation

The USACE 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.

4.1 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 is the USACE. Other interested users could include Dyno Nobel. Individual copies of this opinion were provided to the USACE. The document will be available within two weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. The format and naming adhere to conventional standards for style.

4.2 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.

4.3 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 part 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 MSA implementation, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

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6. APPENDIX 1

To estimate the temperature that a eulachon following the plume of a single diffuser to source would experience, we've followed the analysis for buoyant jets in (Fischer et al., 1979). The diameter (D) of each diffuser is 1 foot or 0.3 meters. For an effluent discharge of 24 million gallons per day at 35 degrees Fahrenheit with density $\rho = 994\,\frac{kilograms}{cubic\ meter}$ discharged to the river at 15 degrees Fahrenheit with density $\rho_0 = 999\,\frac{kilograms}{cubic\ meter}$, each of the 15 diffusers will discharge = 1.6 million gallons per day or .07 cubic meters per second. The average discharge velocity leaving the orifice is $B = g\left(\frac{\Delta\rho_0}{\rho}\right)Q = 0.0035\,\frac{meters^4}{second^3}$, .96 meters per second with momentum $M = \frac{\pi D^2 W^2}{4} = 0.67\,\frac{meters^4}{second^2}$ and the characteristic length of the jet is $l_Q = \frac{Q}{M^{\frac{1}{2}}}$. The initial buoyancy of the discharge $B = g\left(\frac{\Delta\rho_0}{\rho}\right)Q = 0.0035\,\frac{meters^4}{second^3}$ where the density deficiency$\Delta\rho_o = 5.07\,\frac{kilograms}{meter^3}$.

The time averaged vertical velocity (z) of a simple plume is $W_m = 4.7\left(\frac{B}{z}\right)^{\frac{1}{3}}$. The momentum flux $m = .35B^{\frac{2}{3}}z^{\frac{4}{3}}$ and the volume flux $\mu = .15B^{\frac{1}{3}}z^{\frac{5}{3}}$. The simple plume Richardson number $R_p = \frac{\mu B^{\frac{1}{2}}}{m^{\frac{5}{4}}} = .557$. The plume growth coefficient $c_p = .254$.

The characteristic length of a buoyant jet $l_M = \frac{M^{\frac{3}{4}}}{B^{\frac{1}{2}}} = 2.23$. The jet Richardson number $R_0 = \frac{l_Q}{l_M} = .121$. The dimensionless distance along the axis of a buoyant jet $\zeta = c_p\left(\frac{z}{l_Q}\right)\left(\frac{R_0}{R_p}\right)$.

The cross sectional mean velocity $\bar{\mu} = \zeta$ for $\zeta \ll 1$ and $\bar{\mu} = \zeta^{\frac{5}{3}}$ for $\zeta \gg 1$. The mean dilution as a function of ζ is $\frac{\mu}{Q} = \bar{\mu}(\frac{R_p}{R_0})$.

The temperature along ζ is given by $T_\zeta = \frac{T_e + \frac{\mu}{Q}T_a}{1+\frac{\mu}{Q}}$. Since $\bar{\mu}$ is only defined for $\zeta \ll 1$ and $\zeta \gg 1$ we've used excel linear trendlines from $x = 10\ feet$ to $x = 30\ feet$ and from $x = 48\ feet$ to $x = 70\ feet$.