



Grays Harbor Conservation District

Phase II - Grays Harbor and Willapa Bay Sedimentation Dynamics and Mitigation Measures

July 19th, 2019



Stantec Consulting Services, Inc.
11130 NE 33rd Place Suite 200 Bellevue WA 98004-1465

July 19, 2019

Brandon Carman,
330 Pioneer Ave West
Montesano, WA 98563

Reference: Grays Harbor Conservation District Phase II, Grays Harbor and Willapa Bay Sedimentation Dynamics and Mitigation Measures– Letter of Interest

Dear Mr. Carman,

Communities are fundamental. Whether around the corner or across the globe, they provide a foundation, a sense of place and of belonging. Communities also often share a common industry or vocation – much like the shellfish industry in Grays Harbor and Willapa Bay. These shellfish growers are unique and share common visions, objectives and lifestyles. That's why at Stantec, we always design with community in mind. We care about the communities we serve—because they're our communities too. This allows us to assess what's needed and connect our expertise, to appreciate nuances and envision what's never been considered.

We're designers, engineers, scientists, and project managers, innovating together at the intersection of community, creativity, and client relationships. Balancing these priorities results in projects that advance the quality of life in the communities we serve. When we say community, we don't just mean the neighborhoods that people call home. We mean everyone and everything with a stake in the work that we do—from our Stantec and industry colleagues to the clients we collaborate with and the people and places we impact. Whether creating, sustaining, or revitalizing a community, we help diverse cultures and perspectives work together toward shared successes.

We are excited to have the opportunity to employ these ideals with the Grays Harbor Conservation District by working with you on the Phase II, Grays Harbor and Willapa Bay Sedimentation Dynamics and Mitigation Measures project. Having had the experience of completing the Phase I Literature Review and developing mitigation options for this project in 2015, we are excited about this opportunity to continue working with you to solve this regionally significant and complex problem.

We hope that our ideals align well with yours, and that you provide us the opportunity to support your challenging and critically important project. Thank you for your consideration. Please call if you have any questions or wish to discuss this proposal in greater detail. Our contact information is below.

Sincerely,

A handwritten signature in blue ink, reading "Wayne S. Wright".

Wayne S. Wright, PWS, FP-C, CESCL
Principal
Mobile: 425.614.6594
wayne.wright@stantec.com

A handwritten signature in black ink, reading "Julia Sanders".

Julia Sanders
Deputy Director, Global Ocean Health
Phone: 253.951.3925
julia@globaloceanhealth.org

1. Qualifications and Relevant Experience

Firm Experience

Since our inception, Stantec has been providing coastal engineering analysis, numerical modeling, coastal structure design, environmental assessment and permitting, ecosystem and shoreline restoration, flood risk mapping, beach and inlet management, dredging services for both public and private clients. We know and understand the context of the key issues and concerns associated with coastal development, land planning, and environmental resources. Our team brings the most qualified engineers and design professionals with extensive experiences and local scientific knowledge to craft custom approaches to address regional and local concerns. Geographically, Stantec has been providing those services across the United States including Atlantic Ocean, Pacific Ocean, Gulf of Mexico, and the Great Lakes, and our client includes Federal Emergency Management Agency (FEMA), National Park Service (NPS), US Fish & Wildlife Service (USFWS), Environmental Defense Fund, the Nature Conservancy, ports and energy industry clients. More specifically, Stantec provides coastal engineering practices in environmental analysis and impact assessment; mitigation planning, and permitting; design of living shoreline; beach nourishment; and coastal structure.

Our team has strong expertise in numerical modeling using industry-leading commercial modeling platforms including Delft3D, MIKE, SWAN, FUNWAVE, SMS (STWAVE, CMS Flow/Waves, PTM, ADCIRC) for hindcasting and forecasting coastal hydrodynamics (currents and waves), sediment transport, and morphology at all physical scales. The modeling team is able to execute simulations on high performance computing with hundreds of processors to solve large-domain problems, resolve complex geometries with high resolution meshes, and deliver computationally demanding projects on schedule.

Stantec also provides services in development of beach and inlet management plans for both short-term (storm event) and long-term (five- to ten-year budgeting) and planning how segments or reaches of a shoreline could be enhanced with the expenditure of public funds for beach management projects. Stantec has been a prime contractor to FEMA for more than two decades in support of FEMA's National Flood Insurance Program (NFIP). Our experts have performed coastal flood hazard assessments and mapping on the Pacific, Alaska, Great Lakes, New England, Gulf of Mexico, and Atlantic coastlines. Stantec is also involved with the design, permitting, and development of contract documents for numerous dredging projects in Southwest Florida.

Team



Wayne Wright, *PWS, CF-P, CESCL*

Project Manager - Wayne is our choice to lead the Stantec team for your project. Wayne brings nearly 40 years of experience with aquatic sciences and habitat management throughout Washington State. Wayne's training and experience with shellfish science and shellfish aquaculture is particularly important to the demands of this project. In 2015, Wayne was the lead investigator with the National Fisheries Conservation Center (Julia Sanders) to complete the Phase I Literature Review for the Grays Harbor shellfish industry and he contributed heavily to the recommended mitigation options for the shellfish industry. His knowledge of the area, the industry, the science, the issues, and pathways forward are vital to coordinating and interpreting the modeling results this project will provide.

Wayne's project experience involves marine and estuary habitat investigations and management, eelgrass surveys, shellfish surveys and overall habitat health and productivity assessment. Recently, Wayne completed a 7-month assignment managing the marine protection program for a new terminal construction in Kitimat BC. Dredging and sediment controls were critical elements of that assignment as well as monitoring the estuary health in terms of sedimentation, contaminant resuspension, marine mammal protection and water quality maintenance.

Relevant Project Experience:

- Phase 1 Grays Harbor Shellfish Habitat Investigation, Grays, Harbor, WA
- Padilla Bay Estuary Reserve Habitat Inventory, Bellingham, WA
- Miller Bay Commercial Shellfish Population Assessment, Port Madison, WA
- Sequim Bay Shellfish Commercial Population Assessment, Sequim, WA
- Discovery Bay Commercial Shellfish Population Assessment, Discovery Bay, WA



Aaron Chen, PE

Coastal Engineering Specialist - Modeler -

Aaron is a highly motivated coastal and environmental engineer with solid background in estuarine and coastal dynamics, computational fluid dynamics, coastal processes, shoreline restoration, and coastal structure design. He is specialized in developing and/or using numerical models to study wave transformation, hydrodynamics (circulation, storm surge, flooding), and the associated coastal processes such as sediment transport, morphological changes, and pollutant migration. Aaron is also specialized in time series analysis and statistical analysis of extreme values. In addition, he has experience in hydrographic surveys and geographic mapping.

Relevant Project Experience:

- Tottenville Shoreline Protection Project, Tottenville, NY
- Jean Laffite Shoreline Protection Project, Los Angeles, CA
- Hastings on Hudson Mitigation Project, New York, NY
- Living Shoreline Design at West Pond, Jamaica Bay, NY



Patrick Kerr, PhD, PE

Senior Coastal Engineer - Modeler -

Dr. Kerr is a senior coastal engineer with 17 years of experience in environmental services. He has a PhD in civil engineering from the University of Notre Dame, where his dissertation was on the advancement of large-scale highly scalable and accurate computational hydrodynamic models used to simulate coastal inundation, storm surge, and waves. He played a key directional role in the U.S. IOOS SURA-led Coastal and Ocean Modeling Testbed, a highly successful multi-collaborative inter-agency/institution project, that facilitated cyber-based sharing of data and tools, synthesis of observation data, and the development of cross-platform tools to efficiently access, visualize, skill assess,

and evaluate model results. He has worked with public and private clients and partners including the U.S. Army Corps of Engineers (USACE), the Federal Management Agency (FEMA), the National Oceanic and Atmospheric Administration (NOAA), and local and state agencies across the United States. As part of his postdoctoral studies, Dr. Kerr researched the larval dispersal and population connectivity among a network of marine reserves in the Pamlico Sound of North Carolina using a high-resolution 3D Baroclinic model that captured the life cycle movement of oyster larvae through evolutionary algorithms built into a Lagrangian particle tracking model. Dr. Kerr has extensive experience in hydrodynamic and water quality modeling from the stream to the ocean, including stream restoration, storm water management, nutrient uptake, solute transport and particle tracking, sediment transport, real-time monitoring and remote sensing, oyster and other wildlife reserves, dams and levees, inundation mapping, emergency action plans, and permitting. He is a Professional Licensed Engineer in 9 states.

Relevant Project Experience:

- Tottenville Shoreline Protection Project, Tottenville, NY
- Hastings on Hudson Mitigation Project, New York, NY
- Electric Boat - South Yard, Groton, CT
- Storm Surge Impact Study, Cape Coral, FL



Jeff Tabar, PE, D.CE

Principal Engineer and QA/QC Lead -

Jeff is a principal engineer with 25 years of experience in coastal zone management planning, marine construction, flood risk assessment, shore protection design, waterfront development, ports, and sediment transport modeling. He holds a professional certificate as a Diplomat in Coastal Engineering (D.CE) from The Academy of Coastal, Ocean, Port & Navigation Engineers (ACOPNE). This certificate provides him with international recognition of specialized knowledge and skills in the field of coastal engineering. Jeff also holds professional licenses in multiple states including: Louisiana, Florida, New Jersey, Massachusetts, New York (pending) and Delaware. He has been heavily involved in the post-hurricane recovery effort throughout the impacted areas by providing consulting services to develop and implement recovery projects. Jeff's project experience is in managing projects related to marine

construction, dredging, coastal resiliency, shoreline erosion, coastal structures, marina design, ports and harbors, hydrodynamics, water quality, and mitigation programs. As principal coastal engineer and practice manager he has recently completed construction of the largest post-Hurricane Sandy recovery/restoration project (Prime Hook National Wildlife Refuge Project) costing \$40 mil that included the restoration of approximately 5,000 acres of salt marsh habitat and construction of a dune and beach. Jeff is responsible for conducting review and QA/QC of engineering design work including methodology and decision making throughout the entire work assignment. he has worked with public and private clients including the Federal Emergency Management Agency (FEMA), the U.S. Army Corps of Engineers (USACE), the United States Coast Guard (USCG), and local and state agencies across the United States.

Relevant Project Experience:

- Skipjack Windfarm Sediment Transport Modeling and Analysis, MD
- Vopak Marine Terminal Expansion, Deer Park, TX
- Navarre Beach Fishing Pier, Santa Rosa County, FL
- Hastings on Hudson Hydrodynamic Study, NY
- Prime Hook Circulation and Salinity Hydrodynamic Modeling Study, Smyrna, DE



Todd DeMunda, PE

Senior Coastal Engineer - Todd has 14 years of experience in research and applied coastal engineering, serving private and public clients across the United States and abroad, with a focus on hydrodynamic, wave, and morphological numerical modeling, as well as shoreline management and hydrodynamic data collection and analysis. He has extensive experience developing two- and three-dimensional hydrodynamic, wave, and sediment transport models, incorporating satellite-derived oceanographic and meteorological data and imagery, performing analyses of coastal hydrodynamics and developing management and infrastructure solutions to both short- and long-term climate events and changes. This specialized skill set has allowed Todd to support projects such as flood zone delineation, marshland restoration, beach management plans, and shore protection design and optimization.

Relevant Project Experience:

- Tiki Island Residential Channel Sedimentation Analysis, Village of Tiki Island, Galveston, TX
- Western Old Tampa Bay Water Quality Improvements, FDOT, St. Petersburg, FL
- Cooper's Bayou Circulation Enhancements, FDOT, Clearwater, FL
- Turbidity and Sediment Transport Modeling, Port Isabel, TX



National Fisheries Conservation Center

Founded in 1994, NFCC is a nonprofit 501(c)(3) think tank known for its work on complex problems in fisheries, habitat and climate policy. The NFCC team have experience in fisheries and marine environmental research, policy design and evaluation, convening and facilitation, and fostering collaborative solutions that engage multiple stakeholders and agencies to improve environmental performance in conflicted areas of marine resource management, conservation, and pollution control. Our Executive Director Brad Warren proposed, served on, and played a key role in designing Gov Gregoire's Blue Ribbon Panel on Ocean Acidification. That initiative defined avenues for state governments and their partners to tackle a problem many previously viewed as too big for mere states. The Blue Ribbon Panel initiative defined a strategy that has since spread to coastal states on both US coasts. NFCC's Global Ocean Health Program advises tribes, governments, communities and fishery stakeholders on options to combat and adapt to climate and other pollution threats to fisheries and marine ecosystems.

Designed for functionality and independence, the NFCC is a "virtual" organization, with a very small but agile staff. This approach allows it to engage some of the best and brightest researchers, experts, and problem solvers to work on individual projects as needed.



Brad Warren

Data Collection, Communications, and Reporting Support

- Brad is Executive Director of NFCC. Brad founded NFCC's Global Ocean Health program in 2007 after a 25+ year career in fisheries journalism and consulting, including 8 years as editor and publisher of Pacific Fishing magazine. In that role he delved deep into the science and culture of commercial fisheries and aquaculture, developing long-lasting relationships. Brad and the Global Ocean Health program were among the first on the scene when mass mortality events caused the oyster seed crisis around 2008, and raised over \$100k to sustain the Pacific Coast Shellfish Growers Association Monitoring program. Brad is an acknowledged expert on ocean acidification, carbon sequestration, fisheries, efficiency, and habitat management. He is also an advisor to Terry Williams, Natural Resources and Treaty Rights Director for Tulalip Tribes.

Relevant Project Experience:

- Port of San Diego copper sediment contamination project, 2017: pollution trading policy tools.
- Grays Harbor Conservation District sedimentation study Phase I, 2015
- Tulalip Tribes 2017: Sea level rise modeling and scenario planning for tribal resource management and land use
- Tulalip Tribes/EPA: Triple Value Simulation Pilot Study on Nutrient Management in Snohomish County.
- Increasing Social-Ecological Resilience in Puget Sound: lessons learned from marine protected areas and large-scale estuarine restoration



Julia Sanders

Data Collection, Communications, and Reporting Support

- Julia is Deputy Director of NFCC. Julia has worked with the seafood industry for 15 years. She has worked directly with stakeholders in Willapa Bay, Grays Harbor and other coastal communities. Deeply involved in NFCC's work on root-cause solutions to changing ocean conditions, Julia has delivered a dozen presentations on the topic, as well as writing articles and editorials, and helping waterfront champions develop their own op-eds and give testimony to policymakers. She is often an invited speaker on ocean acidification. Julia stays up to date on coastal resilience, blue carbon, and the variety of challenges facing shellfish growers. She is also editor and lead writer of the Ocean Acidification Report: a quarterly publication with over 7,000 subscribers, covering a range of fisheries and ocean news and research.

Relevant Project Experience:

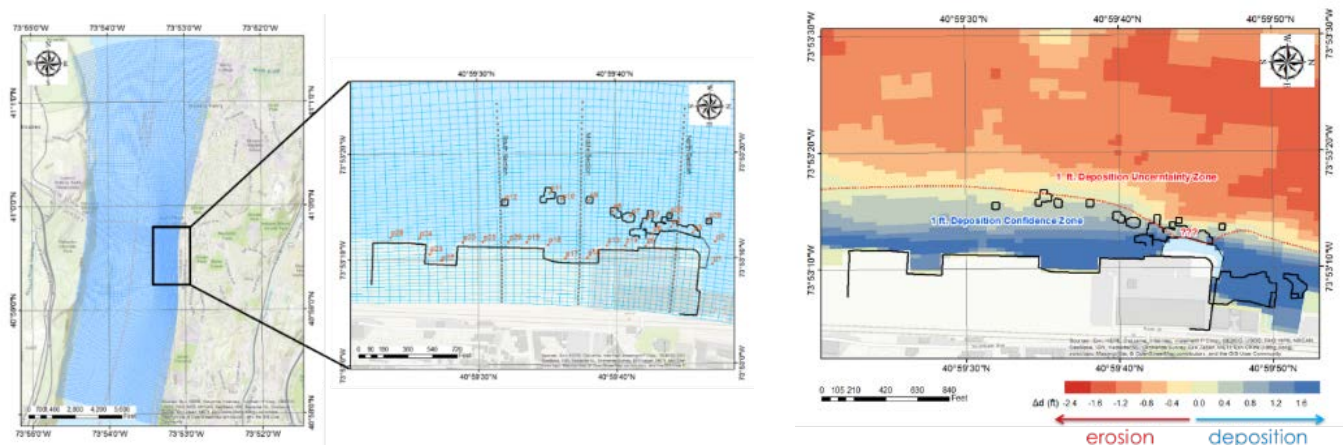
- High resolution sea level rise mapping of Grays Harbor and Pacific Counties
- Lead on Phase I of Grays Harbor Sedimentation Project
- Sea level rise and sea level affecting marshes (SLAMM) modeling and scenario planning for tribal resource management and land use, Tulalip, WA
- Board Member, advisor, and researcher for the Working Group on Seafood & Energy, a trade association for coastal communities, seafood businesses, and tribes whose livelihoods depend on healthy fisheries and aquaculture: provide background on emerging state and national climate legislation and initiatives, develop comment letters and op-eds, and assist in preparing testimony.
- Coastal Squeeze workshop and series of interviews for article in Journal of Ocean and Coastal Management

2. Description of Project Experience

Hydro- and Morpho-dynamic Study of a Remediation Project in NY

The project site is located in lower reach of Hudson river, which has a long history of industrial development. Our client initiated with a remediation effort for the project site including dredging of contaminated areas, design of a sloped shoreline, and extended bulkhead alignment. In support of this remediation efforts, Stantec's scope was to evaluate the performance of the remediation design using a numerical model. We developed and validated a hydrodynamic model for the entire Hudson River using Delft3D, and subsequently developed a refined hydro- and morpho-dynamic model specifically for the project site. Our team assessed hydrodynamic responses and the corresponding long-term morpho-dynamic responses to the remediation design with focus on the pollutant removal areas by comparing erosion and sedimentation patterns under the existing condition and the proposed design condition. Stantec also addressed one particular objective from the client that is to determine the time it takes for 1 foot of backfill to occur naturally at the dredging cells. **Reference:** Martha Gopal – Project Leader – Sovereign Consulting Inc, phone: 609-259-8200; email: MGopal@sovcon.com

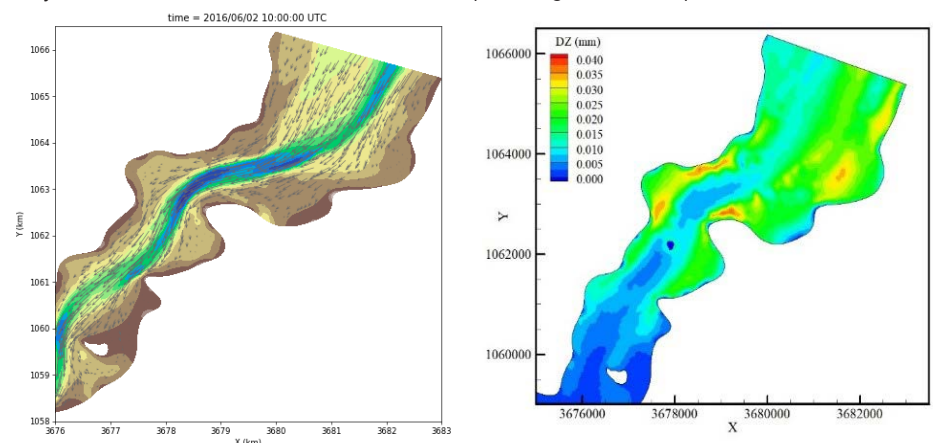
Figures: Delft3D model mesh (left) and erosion and deposition patterns after one-year simulation under the design conditions (right)



Impact of Tug Operation Induced Sediment Flume on Oyster Yields

Our client plans to replace five transmission towers across Nansemond River in Chesapeake Bay at an alignment that crosses four private oyster leases and is adjacent to several others. Although turbidity curtains will be installed to minimize sediment perturbation from the construction, sediment perturbation from tug boat is expected due to shallow water depth. Stantec's scope was to determine the sediment flume induced by tug operation during the proposed construction period and its impact on oyster yields. We analyzed the sediment perturbation due to tug operation and developed a hydro- and morpho-dynamic model using a proprietary model. Stantec simulated the corresponding sediment plume associated with the tug operation for the

construction of each transmission tower and determined the corresponding maximum suspended sediment concentration and the subsequent deposition rate at nearby oyster farms, which was used to assess the impact on the oyster yields. The analysis shows that the sedimentation due to the tug operation causes the environment to be inhabitable for the oysters. **Reference:** Confidential Client



Figures: An example of the maximum current during flood tide (left) and deposition from 3 hours of vessel activity at high tide during the proposed construction period of one transmission tower (right)

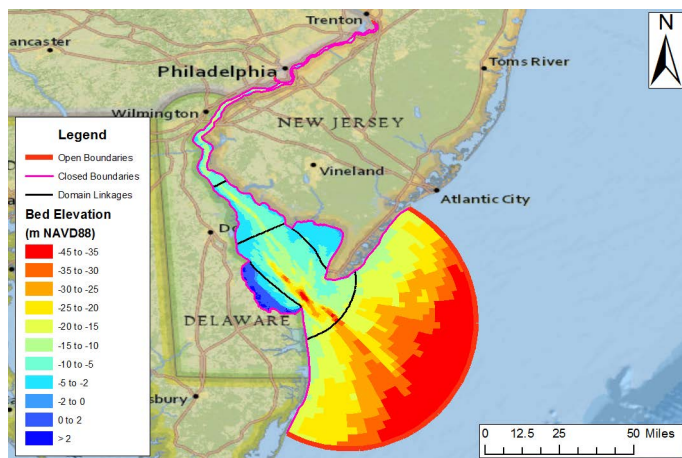
Prime Hook Project

On the Delaware Bay, Prime Hook National Wildlife Refuge (Refuge) provides critical stopover sites for migratory birds and habitat for many species of fish and wildlife. The Refuge wetlands have been hit hard over the past decade. Most recently, it underwent significant changes due to Hurricane Sandy. As a result, the United States Fish and Wildlife Service tasked us to complete a coastal engineering analysis. Stantec evaluated the physical impact of Hurricane Sandy and recommended an estimate of sand volume needed to build a protective beach barrier system that would protect the freshwater habitat from future storm events. The Stantec team determined the sand volume by conducting topographic and hydrographic survey of the Refuge including the marsh area, barrier beach, and breached dunes.

In addition, Stantec developed a hydrodynamic and salinity model of the Refuge and adjacent bay region using Delft3D. The Delft3D model was chosen for its ability to readily include morphology, salinity, and constituent transport within the hydrodynamic modeling framework. This model was used to determine the best marsh configuration. The results were used in conjunction with the coastal engineering analysis to recommend a preferred alternative for modifying and managing the Refuge under the new environmental regime post-Sandy. The resulting project includes placing approximately 1.1 million cubic yards of sand from an offshore borrow area along the shoreline and reconstructing a 40-foot wide dune, 150-foot wide beach berm and back-bay marsh platform. Through Stantec's work in the Refuge, the team has helped reestablish natural coastal systems to give the critical habitat strength to endure, adapt, and thrive in the face of future storms.

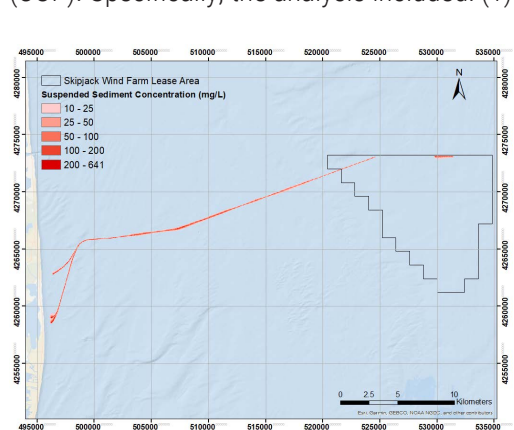
Reference: Al Rizzo, Project Leader - Coastal Delaware National Wildlife Refuge Complex, (302) 653-9345 ext. 102

Figures: Delft3D model domain (left) and breach fill activity for the beach and dune restoration (right)



Skipjack Wind Farm

Our client is developing the Skipjack Wind Farm, a wind farm project to be located between 17 and 21 nautical miles offshore from the Maryland and will connect to one of several possible landing sites in either Maryland or Delaware. The project includes construction of up to 16 Wind Turbine Generators (WTG) with inter-array cables and export cable system that connects onshore at the horizontal directional drill (HDD) exit pit to an upland sea-to-shore Transition Joint Bay. The project-related activities involve using hydraulic dredging for HDD exit pit and hydraulic trencher/mechanical plow for installation of inter-array and export cable. Stantec has performed a hydrodynamic and sediment transport modeling study to help assess potential environmental impacts of project-related activities in support of the project's Construction and Operations Plan (COP). Specifically, the analysis included: (1) development and calibration of a three-dimensional hydrodynamic model using



Delft3D Flow for the project area, including the Delaware Shelf of the Mid-Atlantic Bight southeast of the mouth of the Delaware Bay, and nearby waters of the Atlantic Ocean; (2) simulations of project-related sediment transport including sediment plumes and seabed deposition using the Delft3D sediment transport/morphology model. The maximum suspended sediment concentration and total sedimentation for each scenario were summarized and the maximum distance/areas that the suspended sediment concentration exceeds thresholds of concern and deposition exceeds thresholds of concern are identified and summarized in COP. **Reference:** Confidential Client - please contact Stantec Project Manager Amy Krebs. Email: amy.krebs@stantec.com Phone: 240-542-3081

Figure: Maximum footprint of SSC (> 10 mg/L) from all offshore construction simulations



Electric Boat

The existing Electric Boat (EB) shipyard facility in Groton, Connecticut is a large industrial complex encompassing approximately 4,500 feet (ft) of shoreline on the eastern bank of the Thames River. Current and historic activities at the facility include shipbuilding, overhaul, and repair work. As part of its Facilities Master Plan (FMP), dredging activities were required that would increase water depths near the facility up to 60ft within a relatively large areal footprint. Due to the significant changes in depth, there was the potential for impacts to water quality and benthic habitats due to changes in water circulation and vertical mixing. Stantec assessed changes in circulation and vertical mixing due to proposed bathymetry changes and investigated the influence of construction on turbidity with a sediment plume analysis. Additionally, Stantec provided an estimate of maintenance needs in order to maintain the proposed dredging conditions. **Reference:** Confidential Client - please contact Stantec Project Manager Brent Courchene. Email: brent.courchene@stantec.com Phone: 781-296-3643

Figure: Contours of Dredging-Induced Suspended Sediment Concentration

Flood Insurance Study for FEMA Region X

As a FEMA contractor, Stantec was tasked with county-wide coastal flood hazard analysis and delineation of Flood Insurance Map for FEMA Region X, including Whatcom County, Island County, Skagit County, Mason County, Snohomish County, Clallam County, and Jefferson County. In support of these efforts, Stantec developed wave hindcast models for Pacific Coast, Salish Sea, Straight of Georgia, and Puget Sound using SWAN and generated a full spectrum of dataset that is able to derive local wave climate for any combinations of water level, wind and offshore wave conditions. Local wave conditions associated with the historical events were derived to infer the 1-D transect analysis of wave runup and overtopping calculation. Stantec also performed the statistical analysis of stillwater and total water level (stillwater + wave runup) and produced the Flood Insurance Map associated with the 1-percent-annual-chance event for FEMA. During the Flood Insurance Study, Stantec was also appointed to the Primary Frontal Dune review committee for Grays Harbor County. Stantec also performed the H&H analysis for the Chehalis River watershed and produced the corresponding Flood Insurance Mapping.

Reference: Confidential Client - please contact Stantec Project Manager Donald Syriani. Email: donald.syriani@stantec.com Phone: 301-220-1863

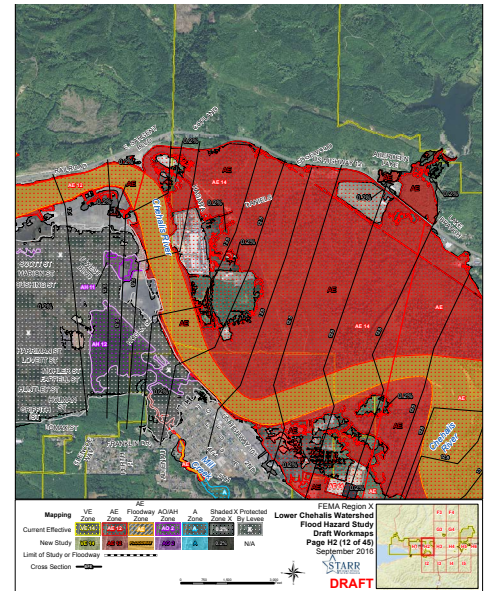


Figure: An example of draft workmap for Lower Chehalis Watershed

Coastal Watersheds Modeling Analysis of Hydrology, Carteret and Onslow County, North Carolina

Stantec was hired to develop a watershed-scale hydrologic model for two pilot coastal watersheds as part of a larger watershed assessment project for the development of a defensible and repeatable methodology to assess the functional health of coastal watersheds in North Carolina. The methodology is intended to be the basis for subsequent guidance that the NC Ecosystem Enhancement Program (NCEEP) can use to induce a degree of consistency in coastal watershed planning efforts.

The major stressor in both watersheds has been the alteration of natural hydrology due to ditching, agricultural practices, and increased impervious surfaces. Based on the Stantec team's knowledge and experience with soils, wetlands, geomorphology, and hydrology in the NC Coastal Plan, Stantec developed a 'natural conditions' scenario for both study areas to allow for the simulation of hypothetical runoff volumes associated with conditions prior to human intervention.



Stantec developed HEC-HMS hydrology models for natural, current, and predicted future conditions in the two study areas, predicting stream flow volume, velocity, and time to peak in the major tributaries of the watersheds. Stantec produced a technical memorandum describing modeling assumptions and input parameters to a repeatable level of detail. Additionally, a presentation was prepared and delivered to appropriate NCEEP staff and project team members to present the results of the modeling analysis.

Reference: David McNaught, Senior Policy Analyst - Environmental Defense Fund, (919) 881-2601

3. Methodology and Background

Project Background and Methodology

The Grays Harbor Bay has long been one of the most productive shellfish aquaculture areas in the US with 25% of United States oysters cultivated here and in neighboring Willapa Bay. Shellfish aquaculture and related jobs are key components of the local and regional economy. Shellfish aquaculture also provides ecological benefits to the estuary which include water filtration, juvenile fish and crustacean habitat, and healthy benthic fauna. Shellfish aquaculture has been suffering from excessive sediment movement due to geomorphological changes associated with the anthropogenic activities. This problem has been reported since 1990 and has been deteriorating, which has caused continuous degradation in the commercial shellfish cultivation.

The Grays Harbor Conservation District (GHCD) initiated a three-phased process in 2015 to investigate this problem. Phase I completed a literature review and general analysis to identify Phase II next steps. This proposal is for Phase II of the process, with the objectives of obtaining a better understanding of the sedimentation and erosion dynamics in Grays Harbor Bay and Willapa Bay, identifying areas of impact and potential new sites for shellfish aquaculture, and defining mitigation measures in greater detail to offset impacts to shellfish growing beds in Grays Harbor and Willapa Bay.

This proposal presents the methodology we propose to investigate the sedimentation and erosion dynamics in Grays Harbor Bay and Willapa Bay, develop mitigation options, and our approach to assess the performance of defined mitigation options.

To take advantage of our vast team and experience, and to save budget, we propose to present our work products and results in the form of webinars followed by written documentation of task completion. Much of the modeling results will be graphic and illustrated by the various programs we plan to use, making the webinar setting ideal for sharing and discussing the work. Each task will have a written report to present and summarize our findings, progress and completion of the task assignment. Data gaps, needs and recommendations will be presented as appropriate.

Task 1 - Data Collection and Preparation (4 weeks)

Stantec will perform literature review and investigate available datasets corresponding to the requirements outlined under this task in the RFQ. Specifically, we will obtain the most current and active ERDC model and calibration reports from the US Army Corps of Engineers

(USACE). The data review and analysis will not be limited to the Grays Harbor Bay and Willapa Bay, since the local sedimentation processes are part of a larger system that extends well beyond the bay, which includes the coastal sediment dynamics along the southwest Washington coast, sediment delivery to the estuary from the Chehalis Basin. In addition, Stantec will investigate the USACE dredging and other marine activities and their schedules. Furthermore, Stantec will perform necessary analysis of the existing data to provide a basic understanding of the physical environment affecting the project areas, including wind and wave rose analysis, statistical analysis of wind and waves, and propose forcing scenarios to model, which shall include up to four but no less than two wave conditions.

Task 2 – Model Assembly and Review (4 weeks)

Stantec will utilize the existing ERDC model obtained from Task 1 and regenerate the results for the current conditions (from available model runs) for verification and evaluation of its performance. Stantec will also set up the model on one GHCD computer and develop a series of scripts for graphic generations. The model GUI (i.e. SMS), although it's not necessary to run the model, will be at additional expense from GHCD if interested. Stantec proposes a webinar or in-person meeting to present the data investigation, simulation results, model validation and/or comparisons, and to discuss the forcing scenarios to be modeled.

Deliverable at Milestone 1: A webinar or in person meeting to present the simulation results, model validation and/or comparisons with a task summary report to follow incorporating comments and suggestions from the webinar presentation.

Task 3 – Update Models for Current Bathymetry (4 weeks)

Under this task, Stantec will interpolate the model elevations to the current bathymetry conditions and establish the baseline condition. The available modeling scenarios will be rerun and compared to the previously model runs. The difference will be analyzed to understand the impact from the current bathymetry compared with that used in the ERDC model.

Task 4 – CMS Flow/CMS Wave Coupled Run for Baseline Model (4 weeks)

Stantec will perform the CMS flow and CMS wave coupled simulations for the baseline condition under the forcing scenarios (minimum two wave conditions) as determined under Task 1. This will be the hydrodynamic basis for the sediment transport modeling and the subsequent analyses.

Task 5 – PTM Model Run for the Baseline Model (8 weeks)

Stantec proposes to use PTM to investigate the fate of sediments associated with the dredging activities. It should be noted that PTM has two main limitations with respect to the overall objective: (1) it's computationally demanding to model the system-wide sedimentation and erosion dynamics as the number of Lagrangian particles required to resolve system-wide sediments is substantial; (2) particle movements are normally calculated independently from the hydrodynamic, which fails to provide feedback to the hydrodynamic due to the morphological changes. With the acknowledgment of these limitations of PTM, Stantec also proposes to examine dredging induced sediment plume as well as the system-wide sedimentation and erosion dynamics using the typical advection and diffusion equation for sediment transport on a fixed Eulerian-Grid within the CMS flow. By examining the maximum suspended sediment concentration (SSC) and the total sedimentation and erosion on the seabed, the objectives are two folded: 1) identify areas of sedimentation and erosion therefore areas suitable and not suitable for future shellfish growing; and 2) find the driver for the excessive sedimentation over the existing growing beds for shellfish.

Deliverables at Milestone 2: A webinar or in person meeting to present the sediment transport modeling results including maximum SSC and total sedimentation and erosion on the seabed under analyzed forcing conditions and its interpretation in terms of the implication on the existing growing beds for shellfishes. A work session to discuss the mitigation alternatives to control the excessive sedimentation on the existing growing beds for shellfishes.

Task 6 – CMS Flow/CMS Wave Coupled Run for Baseline Model (4 weeks)

The mitigation alternatives proposed in Task 5 under the forcing scenarios from Task 1 will be analyzed using the coupled CMS flow and CMS Wave model developed in Task 4. Comparisons will be made with and without and among mitigation alternatives to determine the benefits and effectiveness of the alternatives from the hydrodynamic perspectives.

Task 7 – PTM Model Run for the Alternatives Models (6 weeks)

Sediment transport modeling in terms of PTM and/or Eulerian-Grid based approach will be performed under the mitigation alternatives proposed in Task 5 for the conditions that cause the excessive sedimentation over the exiting growing beds for shellfish. Results will be evaluated to determine the performance of each alternative by comparing the potential reduction in SSC and sedimentations over the impacted growing beds for shellfish. This will also be compared with the existing beds tolerance from the literature review to evaluate its actual benefits and effectiveness.

Deliverables at Milestone 3: An in person meeting to present the results with mitigation alternatives and its benefits and effectiveness in sedimentation control.

Task 8 – Reporting (6 weeks)

Stantec will produce a final report summarizing the modeling process, documenting model results, comparing the various mitigation alternatives, and summarizing conclusions and recommendations. The report will be provided as required under this task in the RFQ. This will be the final deliverable.

Deliverables at Final Milestone: Final Report

Task 9 – Communication (Continuous)

Stantec will communicate with GHCD per the requirements outlined under this task in the RFQ. Specifically, Stantec proposes to have a biweekly status update meeting, and two to three face-to-face in person meetings as outlined under Task 2, Task 5, and Task 8.

Task 10 – Contingencies

Corresponding to this task in the RFQ, one thing may be expected is that it's unclear at this time if the ERDC model are available and how long it may take to get the model. It's uncertain either that if the existing ERDC model covers the Willapa Bay and/or its performance. Stantec is expected to extend the ERDC model to include Willapa Bay. If the existing ERDC model is unavailable or proved to be insufficient upon further review, Stantec may also propose to develop a new model using Delft3D. Delft3D is a cutting edge, process-based numerical modeling system developed by Deltares (Delft, Netherlands) and is capable of simulating two- and three-dimensional hydrodynamics, waves, conservative and non-conservative constituent transport, and morphology. It's fully validated and widely used modeling suite in the coastal practices as compared with the CMS model developed by ERDC. If this is the case, Stantec will communicate with GHCD as early as possible, and the additional efforts will be covered under the contingencies.

One item to consider regarding the contingency options: GHCD may want to perform an assessment of the Delft3D and ERDC models side-by-side. This comparative analysis would provide an independent look at the results of the ERDC model used by the USACE to assess relative accuracy or consistency with the Delft3D model. We welcome the chance to discuss this option with you as the project develops.

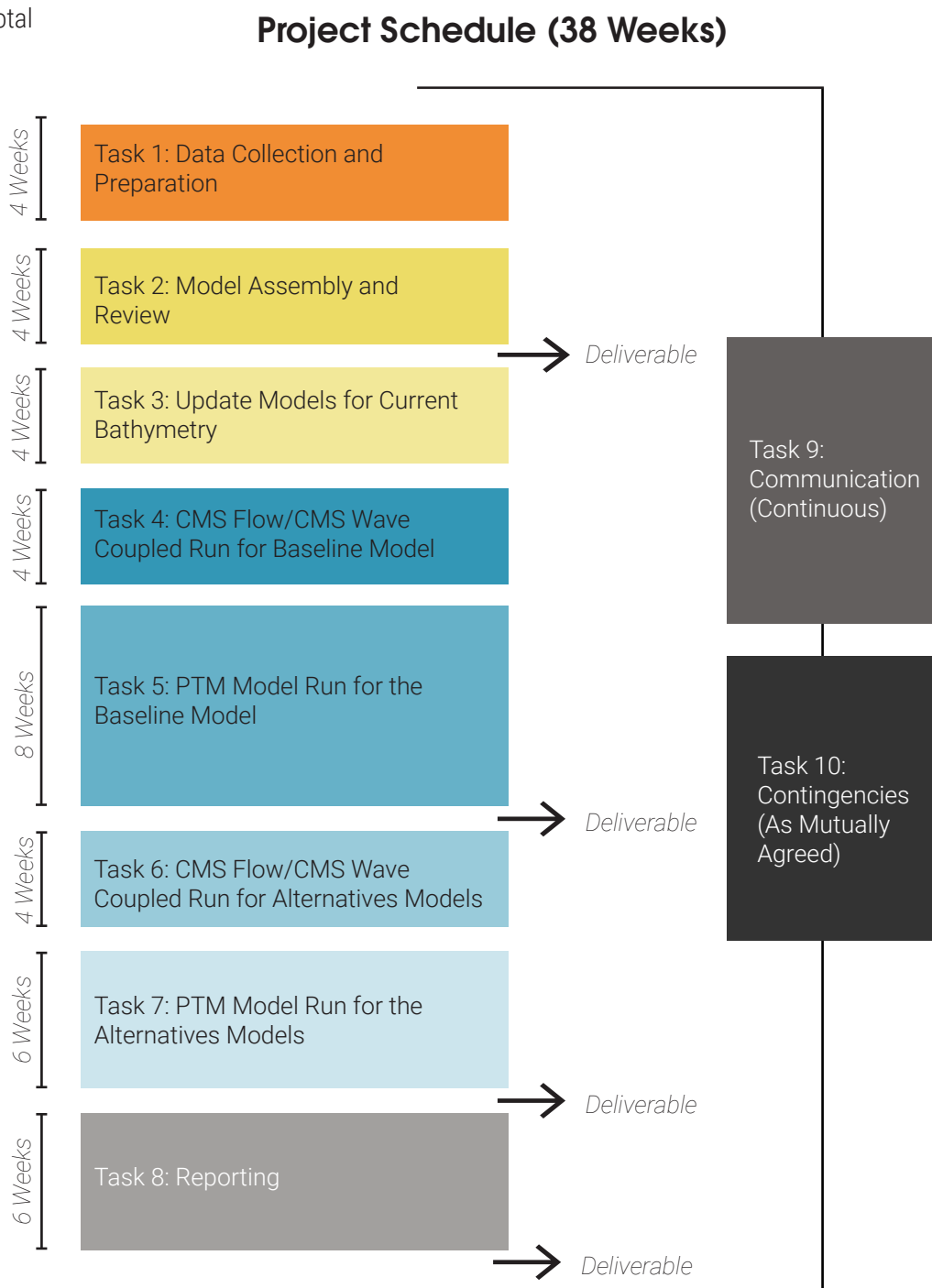
4. Schedule

As noted in the Methodology section above, up to 38 weeks has been identified as the time needed to complete the work we propose to complete the tasks defined in the RFQ. Our work will begin upon notice to proceed and we are prepared to begin immediately.

We recognize the need for product review and technical oversight by designated stakeholders. Without a better understanding of these entities, we have omitted that portion of the schedule in our work plan above. However, it is our experience that at least two weeks post-webinar is an appropriate time to allow for comments to be developed and transmitted back to Stantec.

Depending upon the nature of the initial results and webinar comments, we can move forward with subsequent tasks as we await formal comments from GHCD and reviewing stakeholders. This allows us to keep an expedited approach to the schedule for you should the results and webinar results meet general acceptance and favorable comments at the time of the webinar.

Overall, our assessment of the total project schedule with the assumptions made above is between 38 and 45 weeks.





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