Appendix B

Benthic Habitat Monitoring Plan

ADMIRALTY INLET PILOT TIDAL PROJECT
FERC PROJECT NO. 12690

BENTHIC HABITAT MONITORING PLAN

(submitted with the Final Application for a New Pilot Project License)

Submitted by:
Public Utility District No. 1 of Snohomish County

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1.0 INTRODUCTION

The Benthic Habitat Monitoring Plan (the Plan) defines Public Utility District No. 1 of Snohomish County's (the District) pilot license obligations with respect to the monitoring of benthic habitats in the local vicinity of the Admiralty Inlet Pilot Tidal Project, Project No. 12690 (the Project) and the evaluation of Project effects on such habitats. This plan was developed in consultation with the Marine Aquatic Resource Committee (MARC) and Project stakeholders.

The Project involves installation of two 6-meter OpenHydro tidal energy conversion turbines in Admiralty Inlet, as well as placement of transmission cables to shore. The turbines will be installed in the northeastern portion of Admiralty Inlet, approximately 1 kilometer west-southwest of Admiralty Head, in water depth of approximately 58 meters. Turbine 1 will be deployed at latitude 48.152867° N, longitude -122.686162° W. Turbine 2 will be deployed at latitude 48.152842° N, longitude -122.687099° W. The center-to-center separation distance between the two turbines will be approximately 70 meters. Each turbine will have its own transmission cable that will be connected to the grid at the Puget Sound Energy infrastructure on privately owned land east of Admiralty Head. Extending from the turbines, the transmission cables will be laid on the seafloor and continue for approximately 2 kilometers until reaching the horizontal directional drill (HDD) bore, located at a minimum depth of 18 meters. The cables will enter the HDD bore and continue under the seabed to shore.

The turbine foundations and subsea transmission cables will contact the benthic substrate at the deployment site and may affect the local subsea geology and seabed. The turbine deployment methodology developed by OpenHydro requires no invasive seabed preparation, and no drilling, piling or pinning works. The turbine foundation, placed on top of the seabed, is designed to penetrate the top layer of substrate to aid with stability and prevent any lateral movements of the turbine structures. It is estimated that the foundation legs will penetrate the seabed (small cobbles) to a depth no greater than 0.5 meters. Each foundation structure will consist of three legs, with a footprint covering a maximum area of approximately 10 square meters.

Changes to the local habitat associated with the installation of the Project may attract structure-oriented fish, such as rockfish. The Project may act as an artificial reef or fish aggregation device for pelagic fish and invertebrates. If so, related changes to the local marine community, predator-prey interactions, or the distribution and abundance of marine species around the Project installation site are also possible. The District will study the benthic habitats around the installation site, as well as reference sites outside the expected hydraulic influence of the Project to collect data to evaluate the potential Project effects on benthic habitats that support marine species. As outlined in the remotely operated vehicle (ROV) Scope of Work (Snohomish PUD 2010), the District characterized the site-specific benthic habitat and community by conducting ROV surveys in the Project area in August and late September 2010 (Greene 2010). In addition to characterizing the seafloor habitats, the ROV study also described fish and other aquatic species assemblages as opportunistically observed. The study effort will be replicated following Project installation. These data will be presented to the Admiralty Inlet Marine Aquatic Resource Committee (MARC) for evaluation of the degree and nature of Project effects on benthic habitats in the Project vicinity.

2.0 PLAN GOAL AND OBJECTIVES

The goal of the Plan is to detect and describe observed effects of the Project turbines and foundations on benthic habitats. To accomplish this goal, the District will (1) characterize and describe local benthic habitats following Project installation (as described in Section 3.4) in the vicinity of the two turbines and at six selected sampling locations; (2) provide observations of fish abundance and size; (3) provide habitat descriptions associated with observations of fish use in these areas; (4) review data relative to previous data sets; and (5) consult with the MARC to consider modification to this Plan in response to the results of benthic habitat monitoring efforts.

This study will complement and be coordinated with the District's use of an ROV to periodically inspect Project components and monitor for derelict gear.

3.0 METHODS

3.1 Equipment

The District will use a suitable ROV equipped with lighting, tracking system, and a digital video camera for the monitoring of benthic habitats, and with an acoustic positioning system linked to a Global Positioning System (GPS) on board the ROV support vessel. An example of a suitable ROV is the SAAB Seaeye Cougar XT that was used during 2010 ROV deployments.

The video recording will be in NTSC, AVI, MPEG or other common digital format and shall be of a resolution able to detect those benthic and bottom features with dimensions 2.5 centimeters or smaller. Video lighting will be required and LED lighting is preferred. Lighting shall be arranged to minimize backscatter. A means of identifying size in x, y, z axis using orthogonal scales is to be provided and recorded. A means of identifying swath coverage of the video is to be provided. Depth and altitude are to be recorded. Time, position, and events are to be recorded. Absolute position reference resolution of the video and subbottom profile shall be ≤4 meters and relative accuracy shall be ≤1 meter. Depth shall have a resolution of ≥0.3 meters.

3.2 Monitoring Frequency

The District will monitor benthic habitats and opportunistically observe aquatic species during ROV deployments required as part of standard operations and maintenance (O&M) procedures. During the first year following Project installation, The District will deploy a ROV at a minimum of once every three months. For the duration of the Pilot License after the first year and so long as the Project structures are within the water, the District will deploy a ROV at a minimum of twice annually. However, based upon the results of the monitoring, the District, with the approval of the MARC, may modify the frequency of the ROV deployments.

Sampling will be conducted during low-tidal current conditions to ensure accuracy of ROV placement and consistency in data collection. If possible, ROV survey efforts will be conducted during the same months in each annual cycle. During each sampling effort, the ROV will collect video data as described below for each monitoring location, as feasible within the time frame and conditions available during Project O&M ROV deployments.

3.3 Monitoring Locations

Hydrodynamic modeling conducted by the District demonstrates that the local hydraulic effects of an operating turbine should extend laterally (due to flow acceleration around the rotor disc) and longitudinally (due to the rotor wake). Lateral flow disturbance is likely to be limited to one device diameter, concentric with the rotor disc (i.e., lateral flow disturbance is an area with a 10-meter radius from the turbine centerpoint). The axial disturbance extends both upstream and downstream of the rotor disc; the District's modeling demonstrates that the downstream disturbance is not likely to persist more than ten device diameters (100 meters) and may not be detectable beyond five diameters (50 meters) (Polagye 2009). Monitoring locations are each selected with reference to this analysis.

Benthic habitats and detected marine species will be characterized both in areas affected by the Project and at reference sites that the District's hydrodynamic modeling predicts will be outside the influence of the Project (see below for data collection and analysis methods). During each ROV deployment, the District will use the ROV to inspect benthic habitats in the vicinity of the turbines and foundations for accumulation or scour, and will document the site-specific conditions at the Project site, and a series of six sampling sites that will be revisited during each deployment (Figure 1). Each of these sampling locations is described below in Section 3.3.1.

3.3.1 Sample Points

The District will employ a point sampling approach to monitor six sample sites over time (see Figure 1). These points have been selected to provide "near-field" (i.e. within expected Project influence) and "far-field" (i.e., outside expected Project influence) sites to evaluate benthic conditions in both directions aligned with tidal flow through the turbines.

The sampling locations follow from the District's estimate of the area potentially affected by Project hydrodynamic changes (Polagye 2009). Because lateral disturbance is limited, any changes to sediment transport from lateral disturbances will be captured during limited turbine site surveys around the device foundation (see below). To evaluate the areas upstream and downstream of the turbines, four sample points will be established, each approximately 25 meters away from the turbines and perpendicular to the turbine face and within the area that could be affected by changes to sediment transport in the device wake. These sample locations will be recorded using the ROV georeferencing system, and also by placement of an immobile marker for relocation purposes. Each sample location will target a surveyed area of approximately 5 meters by 5 meters, representing the expected video coverage areas around a single point at the target ROV height of 2 meters above the seabed (Snohomish PUD 2010).

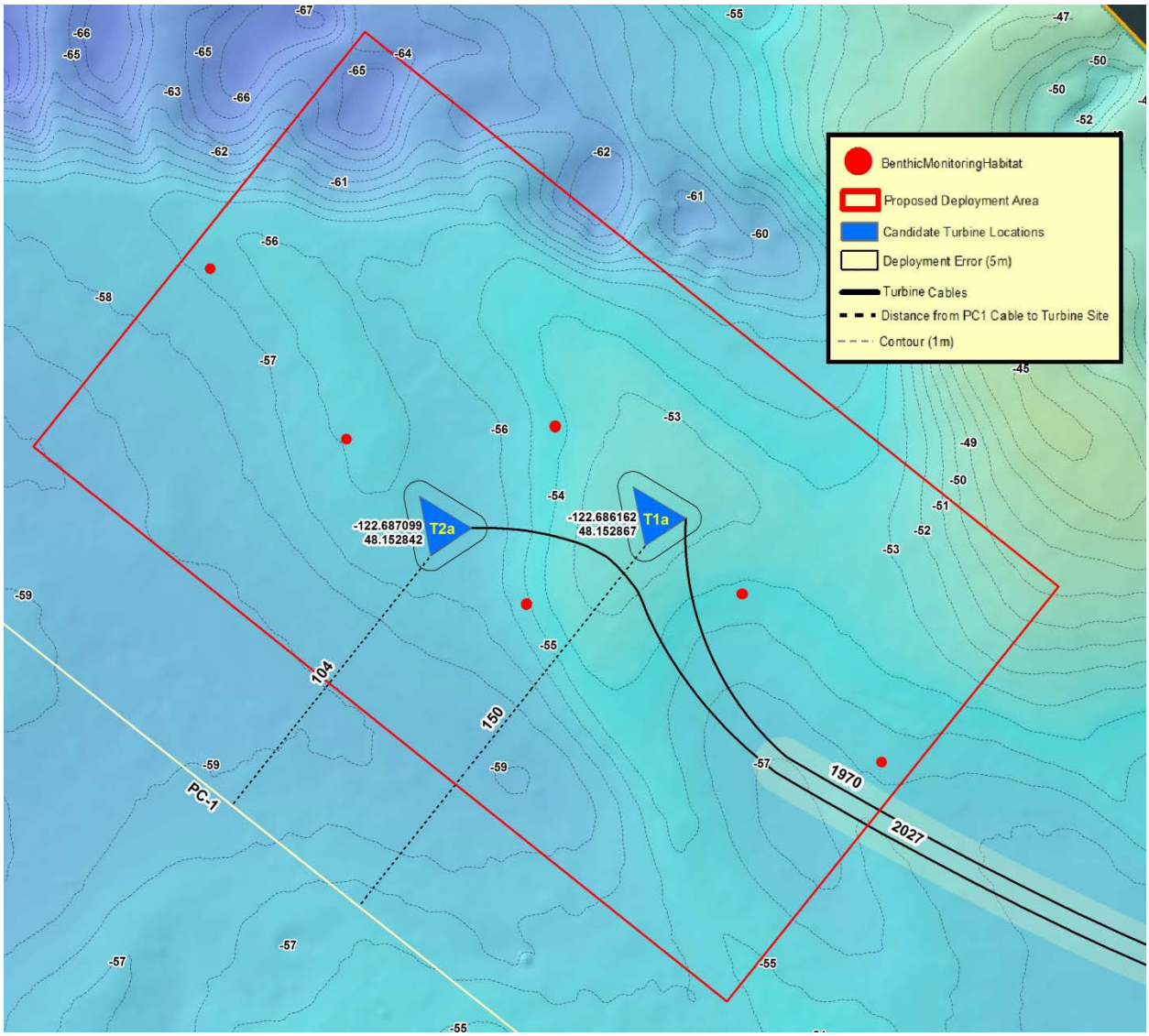

Figure 1. Proposed benthic habitat sampling points and turbine installation locations.

3.3.2 Turbine-Area Monitoring

Benthic habitats surrounding the turbine foundations will be monitored using ROV video surveys conducted as part of Project O&M. Each of the foundation legs surrounding area will be targeted for video observation and subsequent assessment of the presence of sediment accumulation or scour. If feasible, one leg of each turbine foundation will be marked with high-visibility scale bars so as to support these assessments.

During each survey, a ROV will record video of the turbine foundation legs and the seabed extending approximately 10 meters around the entire turbine. This area represents the expected maximum extent of Project hydrodynamic effects lateral to the turbines (Polagye 2009). Surveys will be scheduled during slack tide and/or neap tide conditions whenever possible, but the duration and actual extent of the survey will depend on local marine conditions. Based on ROV

work conducted to date, the District expects the ROV to work from approximately 2 meters above the seabed, and to record video for at least 75 percent of the 10 meter diameter surrounding each turbine foundation.

3.4 Data Collection

All ROV video imagery from the surveys will be subject to real-time annotation at designated monitoring locations, and will also be recorded for later analyses if required. During real-time and follow-up analyses, a marine biologist or geologist will review video data collected in each sampling area for evidence of scour, accumulation of sediment, or discernible changes in benthic habitats. The marine biologist will also describe benthic habitats in each sampling area as detailed below, and will identify any observed marine life, as feasible. In addition, all video footage collected during ROV deployments will be reviewed with a goal of identifying detected marine species and preparing qualitative assessments of relative abundance of detected marine species, as well as size and habitat associations for each. The District will provide an e-mail summarizing the survey to the MARC within 30 days following the deployment. This summary will include a narrative with a description of the techniques employed, results of the analysis of the ROV video data with still video capture photos, as well as a description of notable initial findings (e.g., fish assemblages or potential evidence of habitat change).

At each sampling point or other monitoring location, a marine biologist will describe overall substrate composition and topography as well as any marine species detected. Substrate will be described on the basis of grain size and bedrock exposures with grain size characterized as dominant and minor constituents (e.g., CP for Cobble Pebble with cobble being the dominant (greater than 50 percent) constituent and pebble being the minor (less than 50 percent) constituent). Morphologic descriptions such as the presence of pavement, mounds, sediment waves, and other morphologies will also be included in substrate and habitat characterization. In addition, the presence of fish, epifauna, flora, and infaunal bioturbation will be described to the lowest taxonomic level discernible. Individual species of fish, if present, will be noted along with size, life history stage and any other readily visible characteristic of the species of note, as well as habitat associations for each. Sizes and qualitative assessments of relative abundances of detected marine species will be given when discernible.

Opportunistic observations of fish and macroinvertebrates will be reported as the number of fish observed per unit sampling effort per sampling station per sampling date. “Unit of sampling effort” is expected to be a combination of video minutes and area or volume (derived from [area of bed]*[meters off the bed]). The same unit of effort will be used in reporting for all stations on all sampling dates.

To increase the power of the comparison of numbers of fish inside and outside the area influenced by the turbine and its base, the District will report opportunistic fish and macroinvertebrate observations aggregated across functional groups (e.g., rockfish, forage fish (such as herring), flatfish, squid, salmonids, crabs/shrimp, starfish). To compare numbers within and outside the area influenced by the turbine, the District will report the numbers of each functional group observed per station on each sampling date, and will also aggregate these data across sampling dates within a year. The District will also report numbers within versus outside the area influenced by the turbines between years, and aggregated across years. Reporting the

numbers "within" and "outside" the area influenced by the turbines (structures and operations) by functional group and in the aggregate allows the District to build the data sets for this comparison from its most basic data units to increase the likelihood of detecting a difference if one actually exists.

To support an analysis of particle size distributions, video footage collected by the ROV at each sample point will be sub-sampled to obtain quantitative measurements of a random selection of 100 particles to determine particle size distribution for each occasion where the ROV is deployed. Random selection of particles will occur without replacement (i.e., particles once selected will not be measured again).

3.5 Data Analyses

The results of benthic habitat monitoring will be subject to qualitative analyses within and between years, including a comparison of pre-installation conditions relative to post-installation conditions. All analyses as to the effect of Project installation on benthic habitat and associated communities will be conducted in consultation with the MARC. Initially, these analyses will consist of (1) qualitative comparisons of video and still imagery before and after Project installation, and during subsequent years; (2) comparisons of habitat data describing dominant and subdominant habitat type before and after Project installation, and during subsequent years, including substrate depth and the presence or absence of scour or accumulation; and (3) presentation of data on observed fish and marine species detected during survey work. If these initial analyses suggest that additional study or analyses, including quantitative efforts, are warranted, the District will work with the MARC to modify this monitoring plan and implement additional efforts as warranted.

Particle size distribution data will be analyzed over time and may be compared directly or certain metrics may be compared if appropriate (i.e., if a normal distribution, comparison of means would be appropriate). Expected metrics include mean, mode, standard deviation, ratio of D84 to D50 particle sizes (a measure of substrate heterogeneity, as presented in Cardinale et al. 2002), skewness, and kurtosis. We suspect that the type of measurements that are conducted may be susceptible to underestimation of the smallest particle sizes. Therefore, analytical methods which are robust to the tails of the distribution will be preferred (Blott and Pye 2001), such as graphical methods (Folk and Ward 1957). If appropriate, the District may use software such as GRADISTAT (Blott and Pye 2001) to analyze substrate composition.

4.0 ADAPTIVE MANAGEMENT AND REPORTING

In implementing this Plan, the District will consult with the MARC as appropriate on the technical issues described above and data interpretation associated with the monitoring. Such consultation will include consideration of results from monitoring efforts and subsequent adjustments to monitoring methods. In particular, the District will adopt the following triggers and subsequent actions:

- **Adaptive Management Trigger 1:** If monitoring shows substantial differences in benthic habitat or associated ecological communities between the Project-affected sites

and reference sites or over time at any one site, the District will, after consultation with the MARC, determine whether one or more of the following actions are necessary:

- Modify the monitoring plan and/or sampling frequency to determine if ecological interactions have negative effects on protected species;
- Modify the Project to mitigate for Project effects[1] if necessary; and/or
- Conduct additional sampling or studies.

■ **Adaptive Management Trigger 2:** If benthic habitat monitoring or other study efforts find that benthic habitat reference points are in areas influenced by the Project, the District will coordinate with the MARC to adjust the location of reference points outside the region of hydrodynamic disturbance from the Project.

The District will follow the procedures described in the Adaptive Management Framework Plan when consulting with the MARC on implementation of the Plan. By June 30 of each year, the District will develop and file an annual report to FERC fully describing its implementation of the Plan during the previous calendar year and a list of the proposed activities during the current calendar year. The MARC will have at least 30 days to review and comment on a draft report prior to the District finalizing and filing the report with FERC. The annual report will provide the following:

■ A summary of the monitoring results.

■ A summary of any issues or concerns identified by members of the MARC during the year regarding implementation of the Plan.

■ A list of any changes to the Plan proposed by consensus of the MARC during the year.

■ A list of Plan activities planned for the current year.

5.0 REFERENCES

Blott, S.J. and Pye, K. 2001. Gradistat: A grain size distribution and statistics package for the analysis of unconsolidated sediments. Earth Surf. Process. Landforms 26:1237-1248.

Cardinale, B.J., Palmer, M.A., Swan, C.M., Brooks, S., and Poff, N.L. 2002. The influence of substrate heterogeneity on biofilm metabolism in a stream ecosystem. Ecol. 83(2):412-422.

Folk, R.L. and Ward, W.C. 1957. Brazos River bar: a study in the significance of grain size parameters. J. Sediment. Petrol. 27:3-26, 1957.

[1] To the extent that the modification is inconsistent with the Pilot License, the District will gain approval from FERC prior to implementation.

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