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2005 Pre-Construction Eelgrass Monitoring and Propagation for King County Outfall Mitigation

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March 2006

Prepared for
King County Department of Natural Resources and Parks
Wastewater Treatment Division, Brightwater Project
Under a Related Services Agreement
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Second Annual Report: 2005 Pre-Construction Eelgrass Monitoring and Propagation for King County Outfall Mitigation

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Executive Summary

King County proposes to build a new sewer outfall discharging to Puget Sound near Point Wells, Washington. Construction is scheduled for 2009. The Point Wells site was selected to minimize effects on the nearshore marine environment; however, unavoidable impacts to eelgrass (*Zostera marina*) beds are anticipated during construction. To mitigate for these impacts and prepare for post-construction restoration, King County began implementation of a multi-year eelgrass monitoring and restoration program in 2004, with the primary goal of returning intertidal and shallow subtidal habitat and eelgrass to pre-construction conditions. Major program elements are a) pre-construction monitoring, i.e., documenting initial eelgrass conditions and degree of fluctuation over 5 years prior to construction, b) eelgrass transplanting, including harvesting, offsite propagating and stockpiling of local plantstock, and post-construction planting, and c) post-construction monitoring. The program is detailed in the *Final Eelgrass Restoration and Biological Resources Implementation Workplan* (King County 2005).

This report describes preconstruction activities that occurred in calendar year 2005. Activities in 2005 included continued propagation of eelgrass shoots from the marine outfall corridor and monitoring of the experimental harvest plots in the marine outfall corridor area to determine recovery rates relative to harvest rates. This information will help project managers determine an optimum harvest rate that allows for rapid recovery of donor eelgrass beds.

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1.0 Introduction

King County's Wastewater Treatment Division is planning to construct a new sewer outfall, the Brightwater Outfall, that discharges into Puget Sound near the King-Snohomish County line just south of Point Wells, Washington. The site was chosen to minimize impacts to the nearshore marine environment: the shallow nearshore zone is narrower, and biological resources such as eelgrass are less abundant than at other potential sites. Because of the native eelgrass (*Zostera marina*) on the proposed outfall alignment, King County is implementing a mitigation program to monitor and restore eelgrass beds that will be unavoidably disturbed by construction.

This report is the second in a series of annual reports on pre-construction activities conducted by the Pacific Northwest National Laboratory (PNNL) for the King County Brightwater Outfall eelgrass and biological resource mitigation program. Work related to this program is described in a *Draft Eelgrass Restoration and Monitoring Plan* (King County 2004), which was refined and further detailed in a *Final Eelgrass Restoration and Biological Resources Implementation Workplan* (King County 2005). PNNL tasks include the pre-construction mapping that was completed in 2004 (Woodruff et al. 2006), monitoring of eelgrass beds in the outfall survey area, and eelgrass stockpiling and propagation for post-construction restoration.

The Brightwater Outfall survey area encompasses the Eelgrass (Outfall) Study Area, Marine Outfall Corridor, Eelgrass Reference Area, Eelgrass Reference Corridor, and Eelgrass Donor Site. These areas are defined below and depicted in Figure 1. The Eelgrass (Outfall) Study Area extends 210 feet both north and south of the outfall pipeline alignment centerline, between 0 ft mean lower low water (MLLW) and -25 ft MLLW, which is the zone in which eelgrass and associated macroalgae grow. Within the Eelgrass Study Area is the Marine Outfall Corridor, a narrow zone (6.1 m; 20 ft wide) centered on the outfall pipeline alignment that includes 1.2 m (4 ft) on either side of the 3.7-m (12-ft) wide sheeted trench. In 2005, only the Eelgrass Study Area was surveyed.

In 2004, PNNL conducted side-scan sonar and underwater video surveys of the entire area, analyzed the survey data for eelgrass extent and cover class, and prepared maps delineating eelgrass beds in the study and reference areas. These data and maps document the pre-construction condition of eelgrass beds and nearshore habitat in general, and will serve as the basis of comparison for the next 5 years of pre-construction monitoring (Woodruff et al. 2006). PNNL also harvested eelgrass shoots from the Marine Outfall Corridor to begin offsite propagation of plants for post-construction restoration (Woodruff et al. 2006). This approach to restoration eliminates the need to dig and transplant eelgrass meadows that would otherwise be undisturbed, while ensuring that the resident population is restored at the site. To determine the optimum harvest range at which eelgrass will best recover, study plots were established within the Marine Outfall Corridor area from which a designated percentage of eelgrass shoots were removed (i.e., 0%, 5%, 10%, 25%, 50%, and 100%). Approximately 300 shoots were harvested from the site and planted in tanks at the PNNL Marine Sciences Laboratory, Sequim, Washington, to begin propagation of plants for restoration. Eelgrass propagation activities and progress during 2005 are detailed in Section 2 of this report. Documentation of monitoring activities and eelgrass recovery rates are provided in Section 3.

Figure 1. Brightwater Outfall Survey Area

2.0 Eelgrass Stockpile and Propagation

The purpose of the eelgrass stockpile and propagation task is to transplant a population of eelgrass from the construction site, and use a variety of techniques to increase the population for post-construction restoration planting. Propagation of plants from the site eliminates the need to disturb a natural eelgrass bed for the purpose of transplanting to another location; it also ensures that the same genetic population is restored to the site. In 2004, divers selectively and systematically harvested 305 eelgrass shoots from the Marine Outfall Corridor using a "bare-root method" (Woodruff et al. 2006). The harvested shoots were transported to the Marine Sciences Laboratory, where they were planted in outdoor tanks containing sand and supplied with continuously flowing raw seawater.

Stockpile and propagation activities scheduled for 2005 included supplementation of the stockpiled eelgrass population with flowering shoots collected from the construction area, and maintenance and monitoring of eelgrass in the propagation tanks at the Marine Sciences Laboratory.

2.1 Eelgrass Stockpile and Propagation Methods

Divers surveyed the Eelgrass Study Area in late August 2005. Divers located markers delineating three of the previously harvested areas. The general vicinity of the remaining two harvested areas was also located, but all of the plot markers were missing. Divers located only one flowering shoot in the three well-delineated plots. Because very few flowering shoots were observed anywhere in the Eelgrass Study Area, none were harvested for propagation purposes.

In 2004 and 2005, maintenance and monitoring of the propagation tanks continued. These tasks involved occasional removal of excess macroalgae and invertebrates, and annual population counts to track progress toward the target adult plant population needed for post-construction restoration.

2.2 Eelgrass Stockpile and Propagation Results

Initially, 305 eelgrass shoots were planted in October 2004. The first annual count was performed in November 2004, after the shoots had acclimated to the tanks for 1 month. In that 1-month period, the eelgrass stockpile population experienced a 36% decline; only 195 shoots were counted. The second annual count was conducted in September 2005. The number of shoots had rebounded to 397, a 30% increase in shoots from the initial October 2004 planting, and a 104% increase in shoots since November 2004. No shoots were added to the tanks during 2005; the additional shoots were a result of vegetative reproduction. The primary reproduction mechanism for *Z. marina* in the Pacific Northwest is through growth of underground stems (rhizomes) that produce roots belowground and progressively send up shoots aboveground.

2.3 Eelgrass Stockpile and Propagation: Future Activity

Maintenance and monitoring of the propagation tanks will continue. If possible, to supplement the stock of eelgrass in propagation tanks, flowering shoots containing seeds will be collected from the construction area in the summer of 2006, and dispersed in the propagation tanks. In 2006, additional shoots will also be harvested from the Marine Outfall Corridor but outside the established plots, to provide additional stock for propagation and stockpiling. This phased approach to harvest minimizes the loss of function provided by eelgrass in the impact area and allows harvested areas to recover between harvest events.

3.0 Eelgrass Monitoring

A common uncertainty with many eelgrass restoration projects is the effect of removal of eelgrass from donor meadows. Harvest levels have typically been restricted to 10% or less of the total abundance to minimize effects; however, there are no published studies or quantitative data to support anecdotal observations that harvest has a small, short-term effect on eelgrass density. The *Eelgrass Restoration and Biological Resources Implementation Workplan* details a pre- and post-harvest monitoring plan to provide quantitative data on eelgrass recovery rates after shoot harvest. Prior to the 2004 eelgrass harvest, eelgrass shoot density was determined in the Marine Outfall Corridor (Woodruff et al. 2006).

Plots were established as semi-permanent 2-m^2 (1- by 2-m) rectangular plots, randomly located in the Marine Outfall Corridor. Each 2-m^2 plot was then divided into eight 0.25-m^2 treatment subplots, randomly assigned to one of five harvest treatments (5% [n=1], 10% [n=1], 25% [n=1], 50% [n=1], and 100% [n=2] harvest) or to two control subplots (0% harvest [n=2]). Methods and results of 2005 eelgrass monitoring are described below.

The primary eelgrass monitoring activity scheduled for 2005 was monitoring of the experimental harvest plots established in 2004 for eelgrass shoot density (recovery) 1 year after initial harvest.

3.1 Eelgrass Monitoring Methods

The 2005 eelgrass monitoring of the experimental harvest plots was conducted by PNNL's scientific dive team. An initial survey was conducted on August 25. Divers located several of the markers associated with three of the five previously harvested areas and counted eelgrass shoots in these plots. The remaining two areas from which eelgrass had been harvested were located, but all marker stakes/flags were missing. Without specific information on the exact underwater location of these plots, divers were unable to count eelgrass from these two areas. It was determined that a second survey would be required to relocate the plots using detailed measurements that had been recorded in 2004.

Underwater video footage of the eelgrass within the Eelgrass Study Area was recorded. In general, the Eelgrass Study Area was still sparsely populated with eelgrass, but did not appear to have changed

significantly since the previous survey in 2004. The presence of drift eelgrass (i.e., not attached) was confirmed in the deep end of the corridor. This eelgrass wrack was tangled and drifting down slope.

The second survey was conducted on October 3. Divers laid out a baseline measuring tape on a compass bearing from an existing re-bar reference point within the Outfall Corridor. Using detailed measurements recorded in 2004, the five eelgrass harvest plots were relocated and re-marked. The southeast corner of each plot was marked with a sand anchor and donut float on a short line. Eelgrass was re-counted in four of the five plots (2, 3, 4, and 5). Eelgrass in Plot 1 was not re-counted due to time constraints.

3.2 Eelgrass Monitoring Results

Eelgrass shoots were counted within each subplot. The following graphics depict the plot locations and the percentage of eelgrass harvested in 2004 within each subplot (Figure 2).

The maximum number of eelgrass shoots counted in a single subplot (n=67) was divided into thirds to establish a gradient scale indicating low, moderate, and high densities of shoots for the Eelgrass Study Site (Figure 3). The number of eelgrass shoots counted in each subplot prior to harvest in 2004, after harvest in 2004, and again in 2005, is presented graphically in Figures 4 through 8.

Finally, the changes in mean eelgrass densities over time were graphed by plot (Figure 9) and by the six categories of percentage of eelgrass harvested in 2004 (Figure 10).

The 2 mid-water depth plots (Plots 1 and 3) have shown an increase in shoot counts between 2004 and 2005 from 91 to 185 and 172 to 308, respectively. The 2 deep plots (Plots 4 and 5) and 1 shallow plot (Plot 2) have shown a slight decrease from 228 to 201 (Plot 4), 67 to 46 (Plot 5), and 87-73 (Plot 2). There was also an increase in shoot density in all but the control plots (0 % harvested) and the 25 % harvested plots (Figure 10). Although these observations are interesting, it is difficult to discuss trends with only one time period of data collected beyond the initial counts. In addition, the exact location of the subplots was questionable for 2 of the 5 plots due to missing markers which could have had an impact on the shoot counts. The remarking of plots with a more permanent marking system during the summer of 2005 should hopefully eliminate those ambiguities in the future.

3.3 Eelgrass Monitoring: Future Activity

The experimental harvest plots established in 2004 and monitored in 2005 will again be monitored for eelgrass shoot density (recovery) in 2007 and 2009, 3 and 5 years after initial harvest, and concurrent with the planned side-scan sonar and video mapping efforts in 2009. To prevent bias of the 2007 and 2009 assessments, additional eelgrass shoots (including flowering shoots) will be harvested during the summer of 2006 from the Marine Outfall Corridor in areas outside the plots established in 2004. The harvested shoots will be brought to the Marine Sciences Laboratory and added to the King County eelgrass stock for propagation.

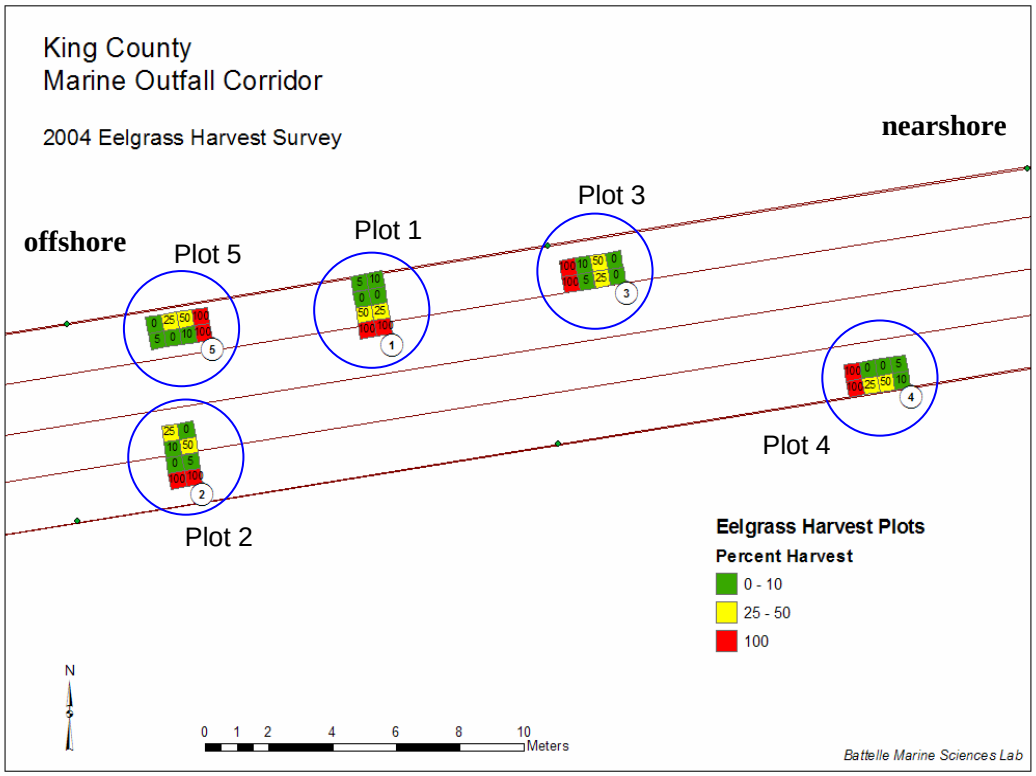

Figure 2. Site Map Indicating Plot Locations and the Percentage of Eelgrass Shoots Harvested in 2004

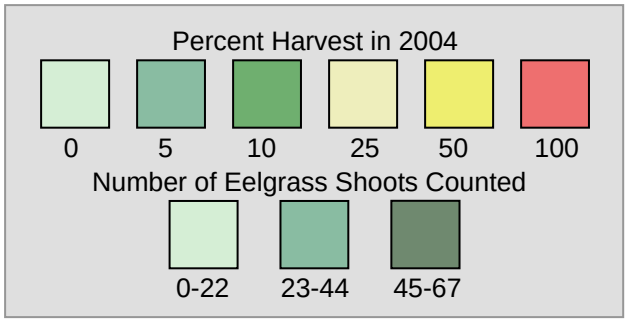

Figure 3. Legend Indicating Color Codes Used in Figures 4 through 8 to Indicate the Percentage of Eelgrass Harvested Per Subplot in 2004, and the Relative Number of Shoots Counted within Each Subplot

PLOT 1

10	0	25	100
5	0	50	100

Percent Harvest 2004

8	26	16	22
12	28	14	24

Pre-Harvest 2004

7	26	12	0
11	28	7	0

Post-Harvest 2004

41	23	6	24
33	10	8	40

2005

Shoot Counts

Figure 4. Shoot Counts for Plot 1

PLOT 2

0	50	5	100
25	10	0	100

Percent Harvest 2004

14	28	18	18
10	26	12	9

Pre-Harvest 2004

14	14	17	0
7	23	12	0

Post-Harvest 2004

19	15	12	1
11	11	1	3

2005

Shoot Counts

Figure 5. Shoot Counts for Plot 2

PLOT 3

100	10	50	0
100	5	25	0

Percent Harvest 2004

32	38	10	54
8	7	42	40

Pre-Harvest 2004

0	34	5	54
0	7	32	40

Post-Harvest 2004

15	67	54	37
33	49	15	38

2005

Shoot Counts

Figure 6. Shoot Counts for Plot 3

PLOT 4

100	0	0	5
100	25	50	10

Percent Harvest 2004

48	50	48	43
9	44	62	28

Pre-Harvest 2004

0	50	48	41
0	33	31	25

Post-Harvest 2004

4	32	61	32
17	25	7	23

2005

Shoot Counts

Figure 7. Shoot Counts for Plot 4

PLOT 5

0	25	50	100
5	0	10	100

Percent Harvest 2004

9	10	10	17
18	13	17	8

Pre-Harvest 2004

9	8	5	0
17	13	15	0

Post-Harvest 2004

1	19	12	0
1	13	0	0

2005

Shoot Counts

Figure 8. Shoot Counts for Plot 5

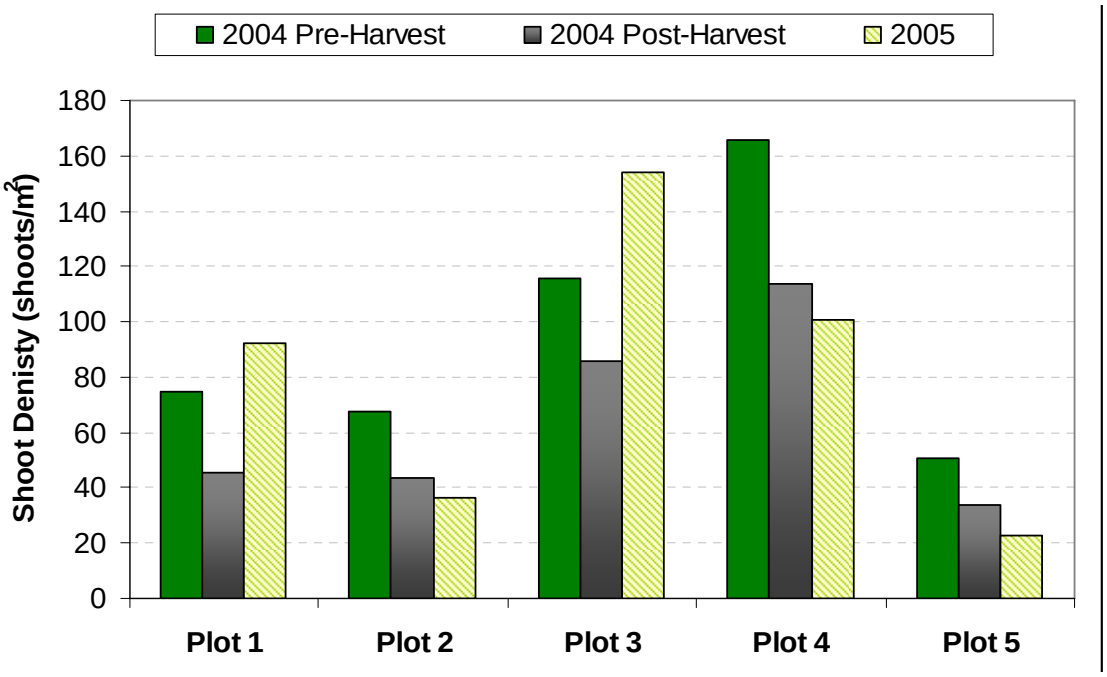

Figure 9. Mean Eelgrass Shoot Densities Pre-Harvest and Post-Harvest by Plot

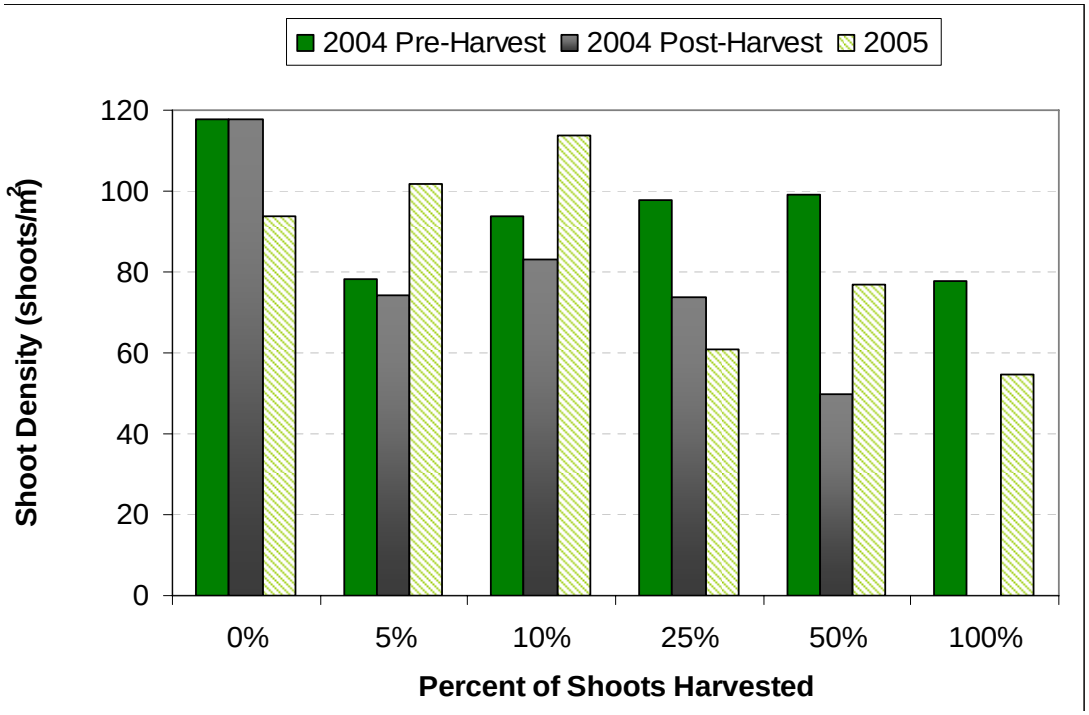

Figure 10. Mean Eelgrass Shoot Densities Before and After Harvest Within the Control (0% Harvest) and Treatment (5%, 10%, 25%, 50%, and 100% Harvest) Subplots

4.0 References

King County. 2005. *Final Eelgrass Restoration and Biological Resources Implementation Workplan*. Prepared by Grette Associates, Battelle Marine Sciences Laboratory, and King County Department of Natural Resources and Parks. Seattle, Washington.

King County. 2004. *Draft Eelgrass Restoration and Monitoring Plan*. King County, Department of Natural Resources and Parks, Wastewater Treatment Division, Seattle, Washington.

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