King County
Brightwater
TREATMENT SYSTEM

BRIGHTWATER POST-CONSTRUCTION

Eelgrass Program:
2010 Eelgrass Dive Survey Report

Task 500

Subtask 560

January 2011

Rev 1

Prepared by:
Grette Associates, LLC
Tacoma, Washington

King County
Department of Natural Resources and Parks
Wastewater Treatment Division

Table of Contents

List of Tables

List of Figures

List of Appendices

Chapter 1
Introduction

As part of the Brightwater Treatment System, King County (County) completed construction of a new marine outfall in 2008, immediately south of Point Wells, Washington (Figure 1). Although the outfall was sited at Point Wells to minimize effects on nearshore marine areas, specifically native eelgrass (*Zostera marina*) beds, unavoidable impacts to eelgrass during the construction phase of this project occurred (King County 2003a, b). The County prepared an Eelgrass Restoration and Biological Resources Implementation Work Plan (Work Plan) that describes a multi-year eelgrass monitoring program for the Brightwater Outfall project (King County 2008a). The eelgrass monitoring component of the Work Plan includes both dive-based density surveys and a combination of sonar and underwater video-based coverage surveys. The construction schedule called for pre-construction monitoring surveys to be conducted in 2004, 2006, and 2008 in order to establish baseline site conditions.

Disturbed areas of eelgrass within the Marine Outfall Corridor were restored in May 2009 by Grette Associates (King County 2009). As specified in the Work Plan (King County 2008a) and Work Plan Addendum (King County 2010a), post-transplant monitoring of the Marine Outfall Corridor and Reference Area is required from 2009 through 2014 (for years in which no dive survey will be completed, an ROV survey will occur). This report provides methods and results for the second post-transplant monitoring dive survey conducted September 21 through 23 and October 5, 2010.

1.1 Previous Eelgrass Surveys

Pre-construction dive surveys were conducted at the site using the methods described in detail in Chapter 2 of this document and in previous survey reports (e.g., King County 2006, 2008b & 2010b). These surveys utilized 2 sets of transects spaced at 5-ft intervals with density measurements (triplicate counts) conducted every 10 ft in the Outfall Area and every 20 ft at the Reference Area location (Figure 2). Also, in 2004 and again in 2008, the eelgrass within the entire Study Area (defined below) was mapped using Side-Scan sonar and roughly quantified using underwater videography (PNNL 2006, 2010). The results of those efforts are presented under a separate cover.

During the final pre-construction (2008) diver survey in the Marine Outfall Corridor, eelgrass was observed above -15 ft MLLW and within 34 of 105 sample quadrats (32 percent). Density of eelgrass within the Outfall Corridor ranged from 1 to 227 shoots/m^2, with an average density of 80 shoots/m^2 where present. Within all sample quadrats including those where eelgrass was absent, eelgrass density in the Outfall Corridor averaged 26 shoots/m^2.

The first post-construction survey was completed in September of 2009, only 4 months after the May 2009 transplant efforts. Due to the short time period between transplant and survey,

a large difference in eelgrass density was neither expected nor observed within the transplanted Corridor; bands A and B remained in the approximate size and shape as they had been planted. In 2009, where present, average eelgrass density in the Outfall Corridor was 107 shoots/m^2. Individual density measurements ranged from 1 to 237 shoots/m^2 (Figure 3). Across all sample points, including those where eelgrass was not present, eelgrass density in the outfall corridor was 43 shoots/m^2.

1.2 Survey Areas

For pre-construction monitoring, the Work Plan defines three specific monitoring areas at Point Wells: the Eelgrass Study Area (sonar and underwater video only), the Marine Outfall Corridor, and the Eelgrass Reference Area (Figure 2). Based on 2003 eelgrass distribution at this site (King County 2003b), all monitoring areas include elevations between approximately 0 ft MLLW and -25 ft MLLW. The diver surveys in 2004, 2006, 2008, 2009, and 2010 (described in this report) were conducted only in the Marine Outfall Corridor and the Eelgrass Reference Area. For clarification purposes, a description of the Eelgrass Study Area is also included.

The Eelgrass Study Area surrounds the proposed Outfall Alignment and is bounded from east to west by the upper and lower range of potential eelgrass habitat, and from north to south by the area in which unanticipated impacts from construction, boats, and barges would have been confined during 2008 construction.

The Marine Outfall Corridor is within the greater Eelgrass Study Area. It is a 23-ft wide area centered along the outfall pipeline alignment, including allowances for the 12-ft wide sheeted trench area with an additional 5.5-ft wide area on either side of the sheeted trench to account for potential localized effects from 2008 construction (i.e., driving sheet pile walls, excavating material with a clamshell dredge, backfilling, etc…).

The Eelgrass Reference Area is approximately 332 ft SSE of the Marine Outfall Corridor, well outside of the area in which construction impacts would have been anticipated.

1.3 Dive Survey Monitoring Schedule

A total of three pre-construction dive surveys were conducted in the Outfall Corridor and Reference areas in 2004, 2006, and 2008 (Table 1) as directed by the Work Plan. The Work Plan also calls for dive surveys in 2009, 2010, 2011, 2012 and 2014. The 2010 monitoring effort is the second post-transplant survey and represents Year 1 of the post-transplant monitoring schedule (Table 1).

Table 1. Dive Survey Monitoring Schedule.

Year, Season	Eelgrass Post-Transplant Monitoring Year	Survey Areas	Survey Purpose
2004, Summer	Year -5	Marine Outfall Corridor, Reference Area	Establish baseline and variation
2006, Summer	Year -3	Marine Outfall Corridor, Reference Area	Establish variation
2008, Spring	Year -1	Marine Outfall Corridor, Reference Area	Establish variation
2009, Summer	Year 0*	Marine Outfall Corridor, Reference Area	Transplant monitoring
2010, Summer	Year 1	Marine Outfall Corridor, Reference Area	Transplant monitoring
2011, Summer	Year 2	Marine Outfall Corridor, Reference Area	Transplant monitoring
2012, Summer	Year 3	Marine Outfall Corridor, Reference Area	Transplant monitoring
2014, Summer	Year 5	Marine Outfall Corridor, Reference Area	Transplant monitoring

*Year 0 indicates the transplanting of eelgrass

Chapter 2
Methods

Pre-construction eelgrass density monitoring occurred in two survey areas: the Marine Outfall Corridor and the Eelgrass Reference Area. Five transects were defined ahead of time in each area, and end point coordinates were identified on base maps. Transects 1, 3, and 5 at the Marine Outfall Corridor were defined using the shallow endpoints for the three center transects from the 2003 eelgrass diver survey (King County 2003b). For both survey areas, transects were spaced five ft apart (Figures 3 and 4). As noted in previous reports, permanent rebar stakes were placed at the shoreward and waterward endpoints of both sets of transects in 2004. Also in 2004, additional rebar stakes were placed in the interior every 50 ft (Corridor) and 40 ft (Reference Area) to assist in tape placement during transect surveys. Prior to construction of the Outfall, the 50 ft, 100 ft, and 150 ft stakes were removed from the Outfall Corridor; following construction, stakes were placed every 40 ft. The stakes in the Reference Area remained as originally placed (every 40 ft).

2.1 Identification of Survey Areas

During the 2010 survey, a dGPS was used to relocate shallow end points marked by rebar stakes at both the Marine Outfall Corridor and the Eelgrass Reference Area (Table 2). Transect tapes were deployed from these markers and extended to the deep end point markers. Most of the rebar stakes were located in the Marine Outfall Corridor and the Eelgrass Reference Area. In instances where a rebar stake was not located, a compass bearing was used to find the next rebar (40 ft beyond the missing stake) and the transect line continued. Missing/non-located rebar markers were replaced once transects were established.

At the Eelgrass Reference Area, shallow endpoint markers were located using the dGPS points from King County. Transects were deployed from the rebar markers found at that point, and all but the deepest markers were located during the dive survey. During review of field data, it was determined that transects in the Eelgrass Reference Area had been started at the second set of rebar markers 40-ft waterward of the actual start points. Therefore, sampling extended an extra 40 ft into deeper water than intended and did not include the first 40 ft of each of the five Eelgrass Reference Area transects. Eelgrass had not been documented landward of the 80-ft transect point in any of the four previous eelgrass Reference Area surveys. This is reflected by the “no data” entries for the 0 and 20 ft sampling points for Reference Area transects in Appendix A.

Table 2. Transect End and Reference Point Coordinates (NAD 83).

Area, Transect, Point	Northing	Easting
WDNR Survey Monument 1	287663.56	1256628.75
WDNR Survey Monument 2	287662.59	1256670.75
Marine Outfall, 1, onshore	288247.63	1255853.58
Marine Outfall, 5, onshore	288227.55	1255854.88
Marine Outfall, 1, offshore	288218.42	1255671.01
Marine Outfall, 5, offshore	288197.56	1255667.62
Eelgrass Reference, 1, onshore	287924.36	1255927.13
Eelgrass Reference, 5, onshore	287905.71	1255937.91
Eelgrass Reference, 1, 200-ft midpoint	287863.86	1255505.96
Eelgrass Reference, 5, 200-ft midpoint	287842.75	1255498.97
Eelgrass Reference, 1, offshore	287863.86	1255729.16
Eelgrass Reference, 5, offshore	287877.26	1255739.94

2.2 Survey Methods

The eelgrass survey methods are based on 2003-2007 Washington Department of Fish and Wildlife (WDFW) Eelgrass/Macroalgae Habitat Survey Guidelines. At each sample location, divers recorded triplicate shoot counts within a 0.25-m^2 quadrat rotated around the sample location to the 2, 6, and 10 o'clock positions (relative to waterward orientation on the survey tape). The inside corner of the quadrat pivoted around the same center point to ensure repeatability. This center point was the pre-determined distance measured on a fiberglass survey tape stretched between permanent markers, in sample intervals specific to each survey area. Underwater video of the transects within the Corridor is also recorded during each annual dive survey.

As previously noted, divers stretched a fiberglass survey tape along each transect based on endpoint rebar stakes and interior stakes. Triplicate shoot counts were recorded at 10-ft intervals in the Marine Outfall Corridor and at 20-ft intervals in the Eelgrass Reference Area. Qualitative observations of macroalgae species presence and distribution as well as qualitative notes on substrate type were recorded within each sample quadrat. In addition, divers noted the edges of eelgrass area along each transect (e.g., begin at 25 ft, end at 32 ft; begin at 54 ft, end at 67 ft) for each of the 10 transects. At the Marine Outfall Corridor, 21 sample locations were recorded along each transect, for a total of 105 samples. At the Eelgrass Reference Area, a total of 22 sample locations were recorded along each transect, for a total of 110 samples.[1]

[1] Because the start of the Eelgrass Reference Area survey was offset 40 ft waterward of transect start point, the 2010 survey included the area from 40 to 460 ft along the Eelgrass Reference Area transects and an additional 40 ft that is not part of the Eelgrass Reference Area. Data from the additional 40 ft (below -25 ft MLLW) were not included in this report.

Starting in 2010, a visual underwater delineation of the eelgrass areas at both the Outfall Corridor and the Reference Area was also included in the survey. The purpose of this delineation is to make between-year comparisons of areal coverage within both the Marine Outfall Corridor and the Eelgrass Reference Area to compare against post-construction performance standards. Divers sketched the boundaries of all eelgrass areas using rebar markers and transect lines as reference (Figures 5 and 6). Note that the delineations only capture eelgrass located between transects 1 and 5 for each sampling area, and not the broader native eelgrass bands extending to the north and south.

2.3 Density Calculations

Eelgrass shoot density for each sample, reported as the number of eelgrass shoots per square meter, is calculated from the mean of the triplicate shoot count at the sample location multiplied by four (since the quadrats are 0.25 m^2). The 2003-2007 WDFW method requires that samples with eelgrass in at least one replicate are included for density calculations for the entire survey area; samples for which all three replicates have a shoot count of zero are not included. This method results in a density calculation that is specific to each transect, not the entire transect area.

Chapter 3
Survey Results

3.1 Marine Outfall Corridor

3.1.1 Density of transplanted bands

Eelgrass was planted in May 2009 within the Outfall Corridor according to the Work Plan guidelines. Plants were placed in two distinct bands (A and B), replicating the approximate area of eelgrass in pre-construction conditions (King County 2009; Figures 3, 5 and 7). The bands are located between approximately -2 and -12 ft MLLW; band A is located within the 0 to -5 ft MLLW contours (between 50 and 70 ft on the Outfall Corridor transects) and band B between the -5 to -15 ft MLLW contours (between 100 and 140 ft on the Outfall Corridor transects). Eelgrass was planted at densities greater than those measured during pre-construction surveys in order to maximize the likelihood of transplant success. The number of individual plants placed into the Corridor in 2009 was approximated to be between 10,000 and 16,000.

During the September 2010 survey, the location of eelgrass corresponded closely to the two bands planted in 2009, as well as spreading into the area between bands on Transects 4 and 5 (Figures 3, 5, and 7). The density of band A in September 2010 was 271 shoots/m^2 (compared to 151 shoots/m^2 in 2009) and the density of band B was 66 shoots/m^2 (compared to 82 shoots/m^2 in 2009) (Figure 8).

3.1.2 Overall eelgrass density

In the Marine Outfall Corridor, 43 of the 105 samples (41 percent) included eelgrass (Table 3). Where present, average eelgrass density in this area was 148 shoots/m^2. Individual density measurements ranged from 13 to 582 shoots/m^2 (Figure 3). Across all sample points, including those where eelgrass was not present, eelgrass density in the outfall corridor was 61 shoots/m^2. Generally, eelgrass was present only above -15 ft MLLW, though one portion of Transect 3 exhibited a small area of eelgrass deeper than -15 ft MLLW. The greatest average eelgrass density by elevation was 247 shoots/m^2 between 0 and -5 ft MLLW; greatest coverage (100 percent of sampled locations) occurred between -5 and -10 ft MLLW (Table 3). No rooted eelgrass was observed in the debris mat at the toe of the slope (-25 ft MLLW, 190 ft along transects) in the Marine Outfall Corridor.

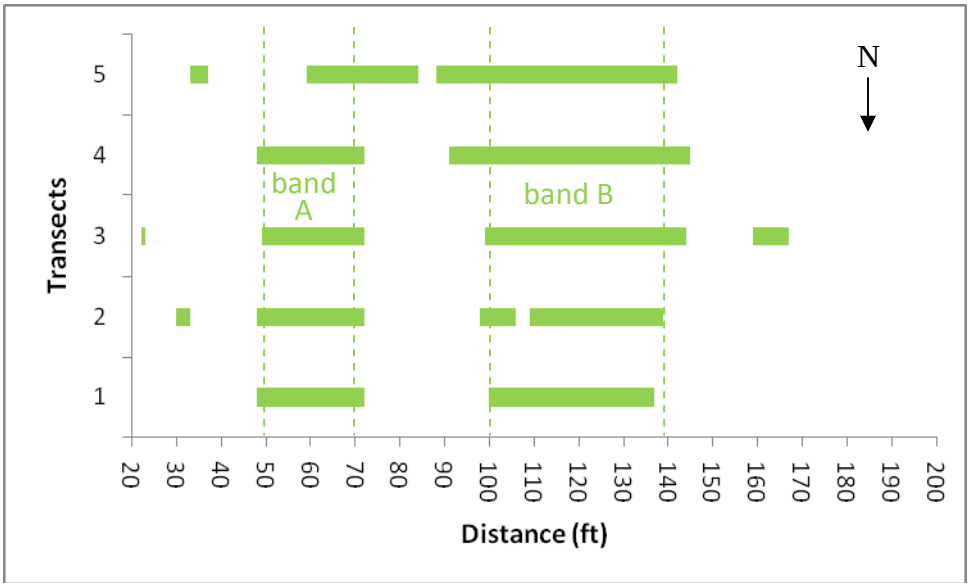


Figure 7. Eelgrass edge locations in the Outfall Corridor, September 2010. For clarity, the shallowest portion of the corridor (0-20 ft distance), where no eelgrass was present, is not displayed on the figure. Bands A and B denote areas transplanted in May of 2009.

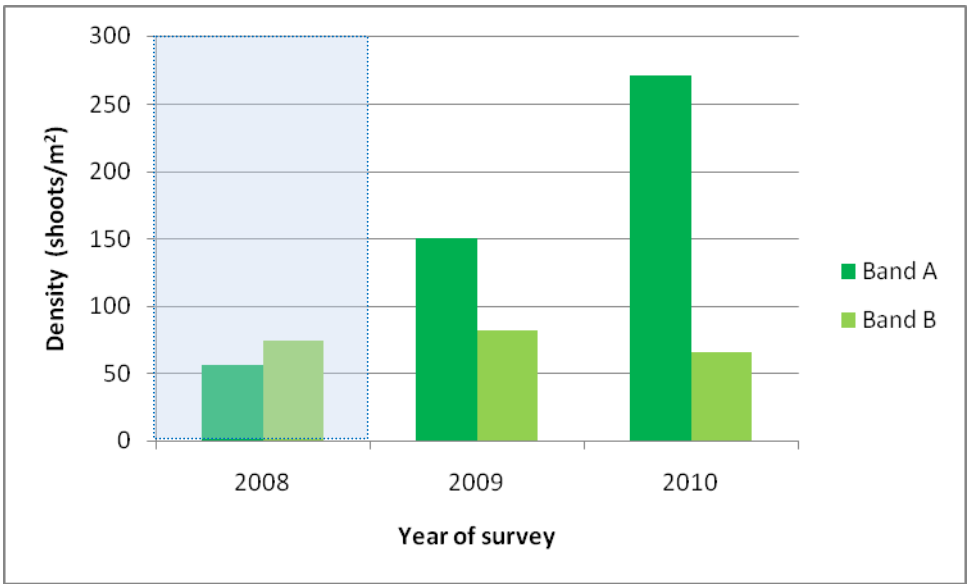


Figure 8. Mean density of eelgrass in bands A and B in the Outfall Corridor over time. Density measurements are based on all observations made in each band. The blue shading indicates pre-construction, pre-transplant eelgrass density data.

3.1.3 Substrate and macroalgae cover

Patterns of substrate composition and algae coverage were similar on all five survey transects (Appendix A). Substrate was generally sandy for the extents of each transect, with some gravel and cobble interspersed. The greatest diversity of macroalgae coverage (which was primarily comprised of *Ulva* spp.) correlated to coarser substrate and shallower elevations

(although there were also areas of macroalgae cover in deeper, sandy substrates). Macroalgae presence in the Marine Outfall Corridor is presented in Table 4.

3.2 Eelgrass Reference Area

3.2.1 Eelgrass density

In the Eelgrass Reference Area, 63 of the 110 samples (57 percent) included eelgrass (Figure 4). Where present, average eelgrass density in the Reference Area was 128 shoots/m^2 (Table 3). Across all sample points, including those where eelgrass was not present, eelgrass density in the Reference Area was 67 shoots/m^2. Individual density measurements ranged from 1 to 547 shoots/m^2. Eelgrass was present between 100 ft and 400 ft on the transects (Figures 4. 6 and 9). Greatest eelgrass density (where present) by elevation was 299 shoots/m^2 between 0 and -5 ft MLLW; greatest coverage (79 percent of sampled locations) occurred between -10 and -15 ft MLLW (Table 3). Similar to the 2009 survey results, a division between two main eelgrass bands was noted between approximately 130 and 160 ft on Transects 1-3, and between 150 and 170 ft on Transects 4 and 5 (Figures 6 and 9). A second division in the deeper band was observed on Transects 3-5 around 205 ft to 310 ft distance. This second, deeper division appeared in correlation with increased macroalgae coverage in an area where bathymetry changes quickly between -10 and -15 MLLW, before flattening out between -15 and -20 MLLW. Eelgrass along the Reference Area transects ended between 380 and 400 ft, just above -20 ft MLLW.

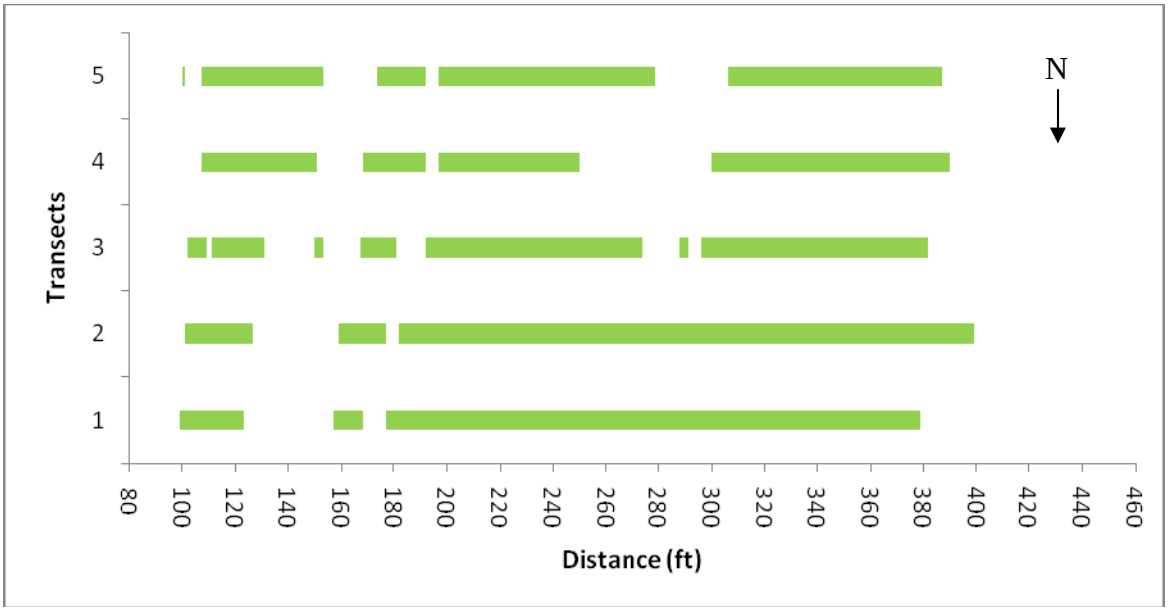


Figure 9. Eelgrass Edge Locations in the Reference Area, September 2010. For clarity, the shallowest portion of the transects (0-80 ft distance), where no eelgrass was present, is not displayed on the figure.

3.2.2 Substrate and macroalgae cover

Similar to the Marine Outfall Corridor, substrate in the Reference Area was generally coarser above -5 ft MLLW and was similar in composition along all five transects, starting with cobble and gravel substrates at the shallow end and transitioning to mostly sandy substrate beyond 80 ft (Appendix A). Macroalgae species were observed in areas of coarse substrate in the shallow end of the survey area as well as on the slope or its toe between -10 and -15 ft MLLW (Table 4). Macroalgae composition in this area included large blades of *Saccharina latissima* (formerly *Laminaria* spp.) and a diverse assemblage of smaller species. *Ulva* and *Gracilaria* spp. were also observed at all five depth bins within the Reference Area (Table 4).

Table 3. 2010 Eelgrass Observations by Elevation at Each Survey Area.

	Marine Outfall Corridor				Eelgrass Reference Area			
Elevation (ft below MLLW)	Average shoots/m^2 eelgrass*	n*	Average shoots/m^2 entire sample**	Samples**	Average shoots/m^2 eelgrass*	n*	Average shoots/m^2 entire sample**	Samples**
0 – 5	247	19	94	50	299	8	96	25[†]
5 – 10	79	20	79	20	233	18	168	25
10 – 15	19	3	6	10	62	11	48	14
15 – 20	16	1	3	6	30	26	25	31
20 – 25	0	0	0	19	0	0	0	5
>25	--	--	--	--	0	0	0	10
All	148	43	61	105	156	60	67	110[†]

* Based on observations with eelgrass (each observation is a density based on triplicate shoot counts)
** Based on all observations made at each elevation
[†] The 2010 survey did not include the 10 shallowest sample points within the 0-5 ft MLLW elevation of the Eelgrass Reference Area

Table 4. 2010 Macroalgae Species Observed at Each Survey Area.

Elevation (ft below MLLW)	Marine Outfall Corridor			Reference Area		
	Species	**n***	**Samples****	**Species**	**n***	**Samples****
0 – 5	*Ulva* spp.	30	50	*Ulva* spp.	16	35††
	Saccharina latissima†	16		*Saccharina latissima*†	7	
	Polyneura latissima	1		Coralline algae	2	
	Gracilaria spp.	1		*Gracilaria* spp.	2	
	Sparlingia pertusa	1		*Mazzaella splendens*	1	
				Sparlingia pertusa	1	
5 – 10	*Ulva* spp.	13	20	*Ulva* spp.	17	25
	Ceramium spp.	1		*Gracilaria* spp.	3	
	Saccharina latissima†	5		*Saccharina latissima*†	2	
	Gracilaria spp.	2		*Ceramium* spp.	1	
10 – 15	*Ulva* spp.	9	10	*Ulva* spp.	12	14
	Ceramium spp.	1		*Ceramium* spp.	1	
	Gracilaria spp.	1		*Microcladia coulteri*	1	
	Saccharina latissima†	4		*Gracilaria* spp.	8	
	Microcladia coulteri	3		*Saccharina latissima*†	5	
	Mazzaella splendens	1		*Polyneura latissima*	1	
	Polyneura latissima	1		*Porphyra* spp.	4	
				Prionitis spp.	3	
				Desmarestia ligulata	1	
15 – 20	*Ulva* spp.	5	6	*Ulva* spp.	28	31
	Mazzaella splendens	1		*Ceramium* spp.	1	
	Saccharina latissima††	4		*Chondracanthus* spp.	1	
				Gracilaria spp.	7	
				Saccharina latissima†	15	
				Mazzaella splendens	3	
				Polyneura latissima	2	
				Porphyra spp.	2	
				Sparlingia pertusa	4	
				Neodilsea borealis	1	
				Microcladia coulteri	1	
				Costaria costata	1	
20 – 25	*Ulva* spp.	18	19	*Ulva* spp.	4	5
	Saccharina latissima†	6		*Saccharina latissima*†	2	
	Chondracanthus spp.	2		*Chondracanthus* spp.	2	
	Polyneura latissima	3				
	Porphyra spp.	3				
>25	n/a			*Ulva* spp.	8	10
				Saccharina latissima†	6	
				Gracilaria spp.	4	
				Coralline algae	1	
All		79	105		93	110††

* Number of sampling locations where each species was observed
** Total number of observations made at each elevation
† Formerly *Laminaria* spp.
†† The 2010 survey did not include the ten shallowest sample points within the 0-5 ft MLLW elevation of the Eelgrass Reference Area

Chapter 4
Discussion

4.1 Outfall Corridor and Reference Area Eelgrass

In 2010, average shoot density of eelgrass observed from 0 to -5 ft MLLW in the Outfall Corridor was greater than that recorded in the 2009 dive survey, while average density between -5 and -10 ft MLLW remained similar to past years, and average density between -10 and -15 ft MLLW decreased. The density of band A (shallow) increased by approximately 80 percent, while band B (deeper) decreased by approximately 20 percent (Figure 8). In terms of coverage within the Corridor, eelgrass plants were observed to cover almost all of bands A and B, and appeared to extend both between and outside of the two bands. A number of small, non-contiguous eelgrass areas were observed above and below the transplanted bands. Despite the small decrease in density of eelgrass plants in band B, overall, eelgrass in the Outfall Corridor increased both in average density and areal coverage compared to the survey completed within three months post-transplant in 2009 (King County 2010b).

Density of eelgrass shoots in the Reference Area decreased about 20 percent overall in 2010 compared to values reported in 2009 (Table 5). The number of samples with eelgrass and observations of continuous eelgrass along each sampling transect did not change greatly from 2009 to 2010, indicating that the eelgrass beds in the Reference Area were less dense, but did not necessarily decrease in spatial coverage.

The elevation range at which eelgrass was observed in 2010 remained similar to that observed in previous years at both study sites (Table 5). A small area of eelgrass was observed at a depth greater than -15 ft MLLW in the Outfall Corridor during the 2010 survey, which is deeper than in previous surveys. The Reference Area did not appear to expand significantly shallower or deeper than in previous years' surveys.

In Puget Sound, eelgrass typically becomes light limited at around -7 m (-22.96 ft) relative to Mean Sea Level (MSL) (Thom et al. 1999), which is approximately -13.5 ft MLLW based on 9.47 ft MSL at Edmonds. A number of other factors contribute to the survival of eelgrass, including substrate, current, water quality, and light transmission. These conditions may affect local differences in eelgrass plant density as well as differences observed at sites throughout Puget Sound. Inter-annual variation in site conditions, including light availability, water temperature, and nutrients may have influenced the decreased densities observed at the Reference Area compared to previous years.

Table 5. 2004, 2006, 2008, 2009 and 2010 Eelgrass Observations by Elevation at Each Survey Area.

	Marine Outfall Corridor		Eelgrass Reference Area	
Elevation (ft below MLLW)	Average shoots/m^2	n*	Average shoots/m^2	n*
2004				
0 – 5	26	9	18	3
5 – 10	29	10	52	11
10 – 15	20	4	29	12
15 – 20	3	1	23	24
20 – 25	7	4	0	0
All	23	28	30	50
2006				
0 – 5	63	9	62	4
5 – 10	59	14	91	11
10 – 15	33	5	35	12
15 – 20	0	0	35	24
20 – 25	0	0	0	0
>25	--	--	0	0
All	55	28	30	50
2008				
0 – 5	73	12	84	3
5 – 10	108	16	68	14
10 – 15	24	5	25	14
15 – 20	0	0	22	24
20 – 25	0	0	0	0
>25	--	--	0	0
All	80	33	38	55
2009				
0 – 5	143	17	398	5
5 – 10	90	20	288	17
10 – 15	50	5	91	13
15 – 20	0	0	52	25
20 – 25	0	0	0	0
>25	--	--	--**	--**
All	107	42	156	60
2010				
0 – 5	247	19	299	8
5 – 10	79	20	233	18
10 – 15	19	3	62	11
15 – 20	16	1	30	26
20 – 25	0	0	0	0
>25	--	--	0	0
All	148	43	128	63

* Number of observations with eelgrass (each observation is a density based on triplicate shoot counts)
**This section of the Reference Area transects was not surveyed in 2009

4.2 Short-term Performance Standards

The short-term performance standard to evaluate transplant survival is defined on p. 24 of the Work Plan (King County 2008a): "Short-term (i.e., one year after planting in 2010) survival of transplanted eelgrass constitutes no more than 50 percent loss in eelgrass cover (area), or no greater than 75 percent loss in density." Additionally, the Work Plan Addendum 1 (King County 2010a) states, "Because areal eelgrass cover was not measured pre-construction, survival of planted eelgrass within the Corridor will be determined by a comparison of the mean density of each band (A and B) in the pre-construction 2008 survey and the mean density of each band in 2010. The amount of variation between 2008 and 2010 values will be analyzed statistically with a two-tailed t-test."

Work Plan Performance Standard

The short-term performance standard for survival as described above requires comparison of the (2008) pre-construction eelgrass measurements against those of the first year of the transplant (2010) for both areal coverage and density. However, prior to the 2010 survey, areal coverage was not measured via delineation by divers. To comply with the Work Plan directive, eelgrass was transplanted in approximately the same locations (and densities) as observed prior to construction. The total area of each band that was planted (band A: 20 ft by 20 ft; band B: 20 ft by 40 ft), then serves as both the 2008 and the 2009 areal extent of eelgrass within the Corridor. The 2010 areal extent was calculated using the diver-drawn delineation of the eelgrass superimposed on the drawings of the Outfall Corridor in AutoCad (Figure 5). An increase in areal coverage of 76 percent and 64 percent for bands A and B (respectively) and an overall increase of 68 percent was observed between 2008 and 2010 (Table 6). The short-term performance standard for areal coverage was a loss of no more than 50 percent: as observed, there was an overall increase in areal coverage as well as an increase within each band. **Therefore, using available data, the areal coverage component of the performance standard was met.**

Between 2008 and 2010, density increased by 383 percent and decreased by 11 percent for bands A and B (respectively); there was an overall increase of 113 percent between 2008 and 2010 (Table 6). The short-term performance standard for density was a loss of no more than 75 percent. **Since there was an overall increase in density, the density component of the performance standard was met.**

Addendum Performance Standard

The performance standard described in the Work Plan requires comparison of the mean densities within each band between 2008 and 2010 (Table 6). This comparison is between pre-construction and post-construction monitoring Year 1 densities but does not indicate transplant survival. The mean density of band A was over 300 percent more in 2010 compared to 2008. The mean density of band B was 11 percent less in 2010 compared to 2008. **In neither case did density decrease more than 75 percent in 2010 compared to 2008; therefore the performance standard was met.** Statistical analyses indicate the

difference in band A mean densities was significant (df 28, t-stat = -5.17, $p < 0.0001$); the difference in band B mean densities was not (df 48, t-stat = 0.46, $p < 0.65$) (Figure 8).

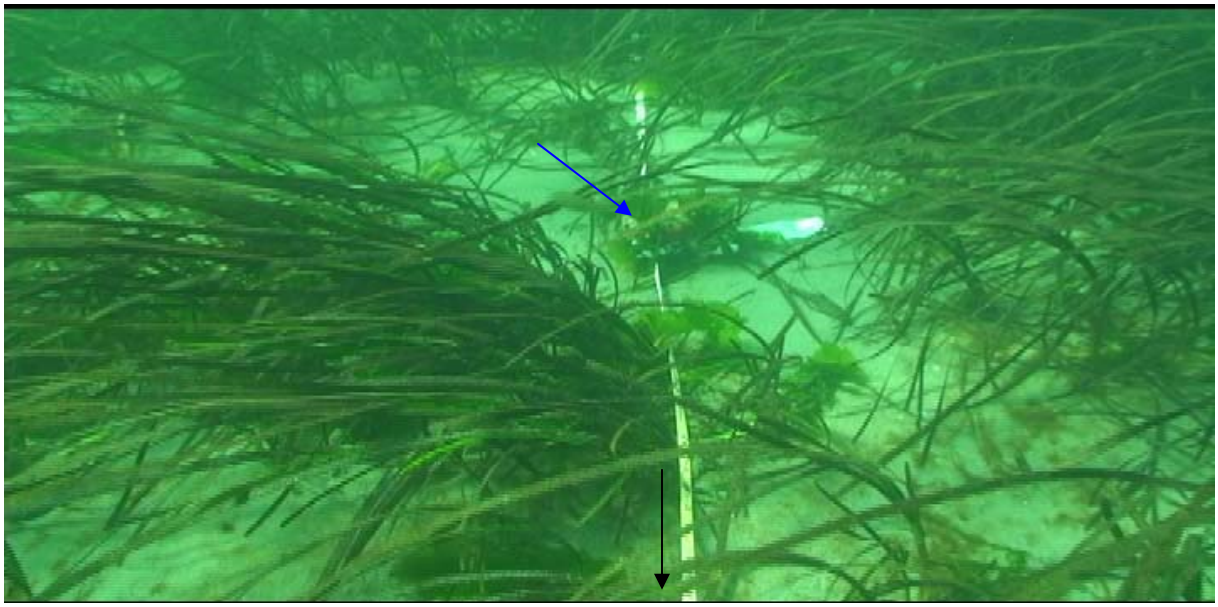
Table 6. Evaluation of Post-construction Performance Standards for the Outfall Corridor.

Location	2008 pre-transplant*	2009 transplant	2010 post-transplant	2008 to 2010	Performance Standard
Areal coverage (ft^2)					
Band A	400	400	704	+76%	
Band B	800	800	1312	+64%	≥-50%
Total A+B	1200	1200	2016	+68%*	
Mean density (shoots/m^2)					
Band A	56	151	271	+383%	
Band B	74	82	66	-11%	≥-75%
Total A+B	67	108	143	+113%	

*** based on area identified for transplanting.**

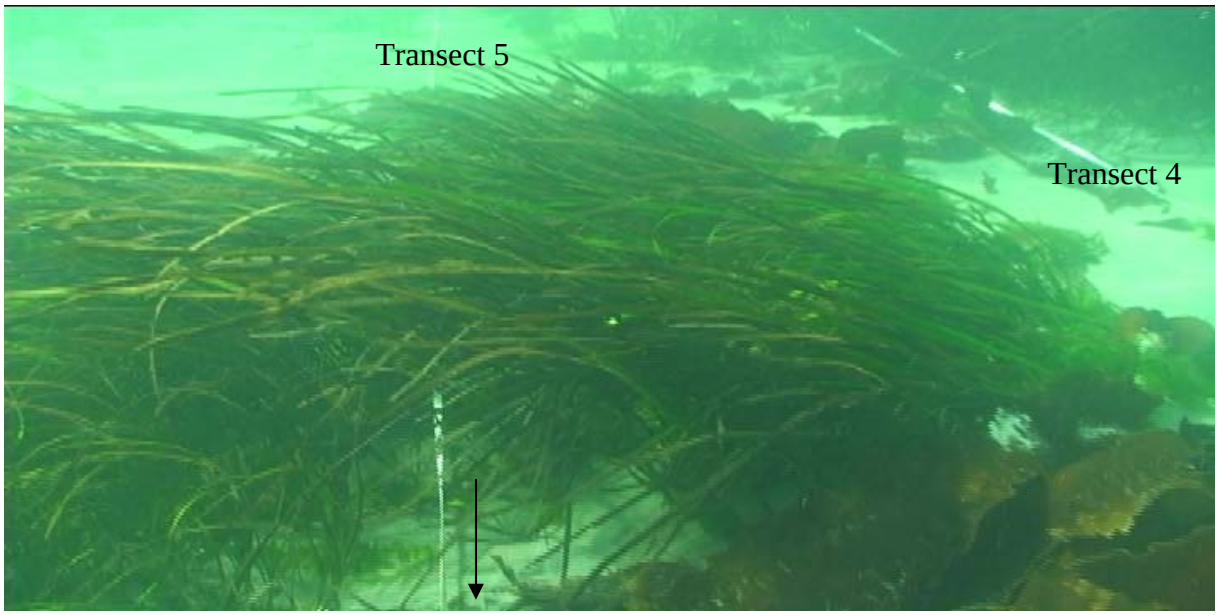
4.3 Photographs

The following photographs, captured from stills of underwater video, were taken by divers within the Marine Outfall Corridor during the September 2010 survey.



Photograph 1. Transect 3 at 120 ft. Blue arrow points to rebar marker. Black arrow indicates direction of shore.

Photograph 2. Transect 4 at approximately 93 ft. Black arrow indicates direction of shore.



Photograph 3. Transect 5 at approximately 38 ft. Black arrow indicates direction of shore.

References Cited

King County, 2003a. *Final Environmental Impact Statement for the Brightwater Regional Wastewater Treatment System*. Prepared by Department of Natural Resources and Parks, Seattle, WA. November 2003.

King County, 2003b. Appendix 7-F Eelgrass *Survey Results for the Brightwater Marine Outfall Alternatives*. Final. Prepared for the Brightwater Project, Seattle, WA. September 2003.

King County, 2006. *Eelgrass Program: 2006 Dive Survey Report*. Prepared by Grette Associates, LLC. December 2006.

King County, 2008a. *Eelgrass Restoration and Biological Resources Implementation Workplan.* Prepared by Department of Natural Resources and Parks, Seattle, WA. April 2008.

King County, 2008b. *Eelgrass Program: 2008 Dive Survey Report*. Prepared by Grette Associates, LLC. July 2008.

King County, 2009. *Eelgrass Program: 2009 Eelgrass Transplant Report.* Prepared by Grette Associates, LLC. December 2009.

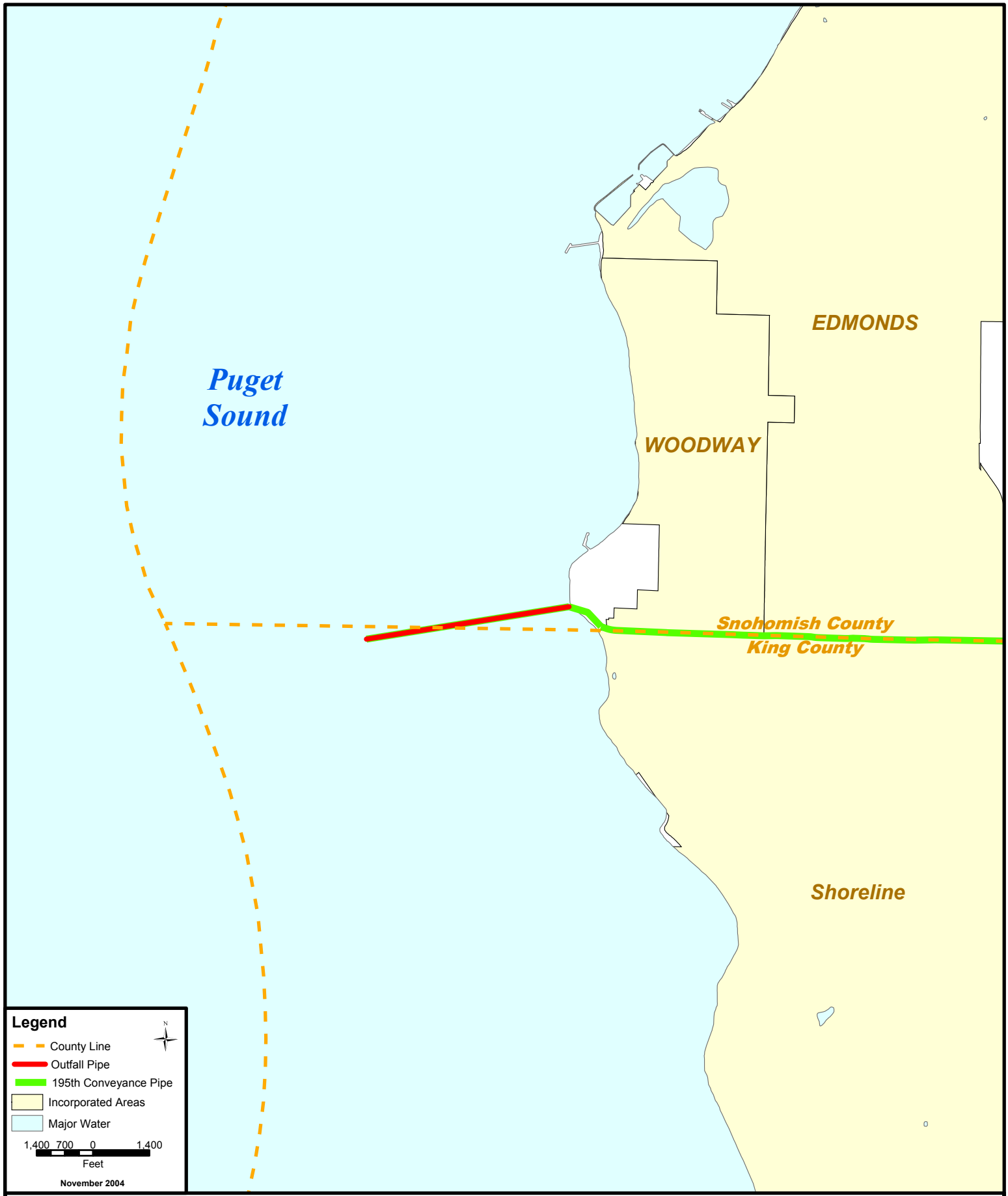
King County, 2010a. *Restoration and Biological Resources Implementation Work Plan Addendum 1*. Prepared by Grette Associates, LLC. April 2010.

King County, 2010b. *Eelgrass Program: 2009 Dive Survey Report*. Prepared by Grette Associates, LLC. February 2010.

PNNL, 2006. *2005 Pre-Construction Eelgrass Monitoring and Propagation for King County Outfall Mitigation.* Prepared for King County Department of Natural Resources and Parks Wastewater Treatment Division, Brightwater Project. March 2006.

PNNL, 2010. *2006 Fifth Annual Report: 2008 Pre-Construction Eelgrass Monitoring and Propagation for King County Outfall Mitigation.* Prepared for King County Department of Natural Resources and Parks Wastewater Treatment Division, Brightwater Project. January 2010.

Thom, R.M., L.D. Antrim, A.B. Borde, W.W. Gardiner, D.K Shreffler, P.G. Farley, J.G. Norris, S.W. Echeverria, and T.P. McKenzie. 1999. *Puget Sound's Eelgrass Meadows: Depth Distribution and Spatial Patchiness. in Puget Sound Research '98, from Basic Science to Resource Management*, Olympia, Washington.



King County

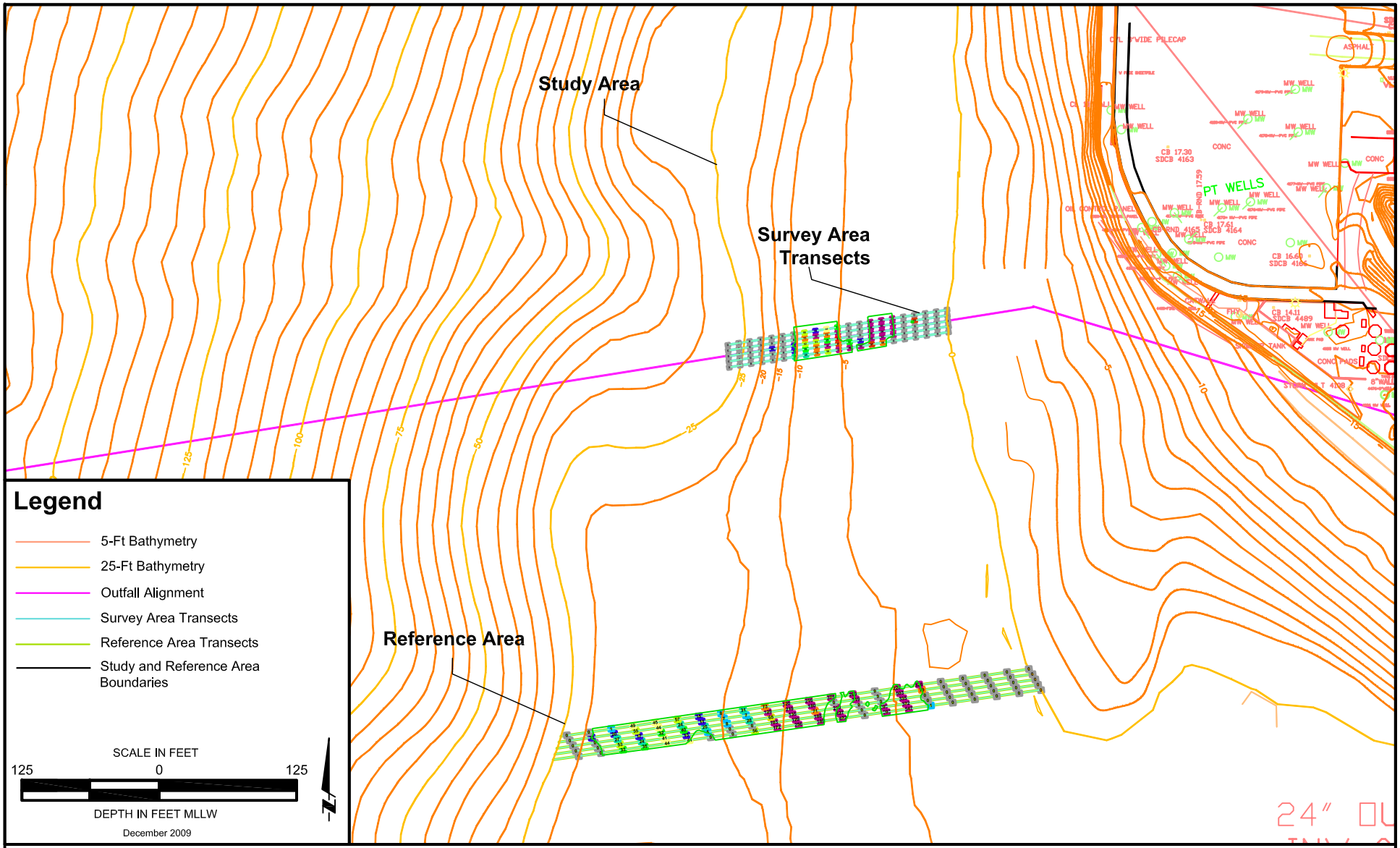
Natural Resources and Parks
Wastewater Treatment Division

File Name: Q:\WTD\Projects\MOSS\Projects\outfall_vicinity.mxd SC

Figure 1

Marine Outfall Location

BRIGHTWATER REGIONAL WASTEWATER TREATMENT SYSTEM



King County
Department of Natural Resources and Parks
Wastewater Treatment Division

File Name: 500-560-2
Prepared By: Grette Associates, LLC

FIGURE 2

Marine Outfall Site
Study Area, Survey Area and Reference Area

band A

band B

TRANSECTS

T1 0 0 0 0 0 0 0 0 56 16 44 39 0 0 269 333 239 0 0 81 0 0 0 T1
T2 0 0 0 0 0 0 0 0 75 132 72 231 0 0 340 583 481 0 0 0 0 0 0 T2
T3 0 0 0 0 0 0 16 19 52 51 35 92 0 0 287 296 329 0 0 0 0 0 0 T3
T4 0 0 0 0 0 0 0 13 36 80 101 81 31 15 269 307 160 0 0 0 0 0 0 T4
T5 0 0 0 0 0 0 0 25 29 73 56 232 259 255 87 80 0 0 0 0 0 0 0 T5

-25 -20 -15 -10 -5 0

Legend

Mean Eelgrass Density (Shoots per Meter Sq)

- 0
- 1 - 10
- 11 - 20
- 21 - 30
- 31 - 40
- 41 - 50
- 51 - 60
- 61 - 70
- 71 - 80
- 81 - 90
- 91 - 100
- 101+

Survey Plot (1-m²)

N

SCALE IN FEET

10 0 10

DEPTH IN FEET MLLW
SURVEY TRANSECTS
OUTFALL ALIGNMENT

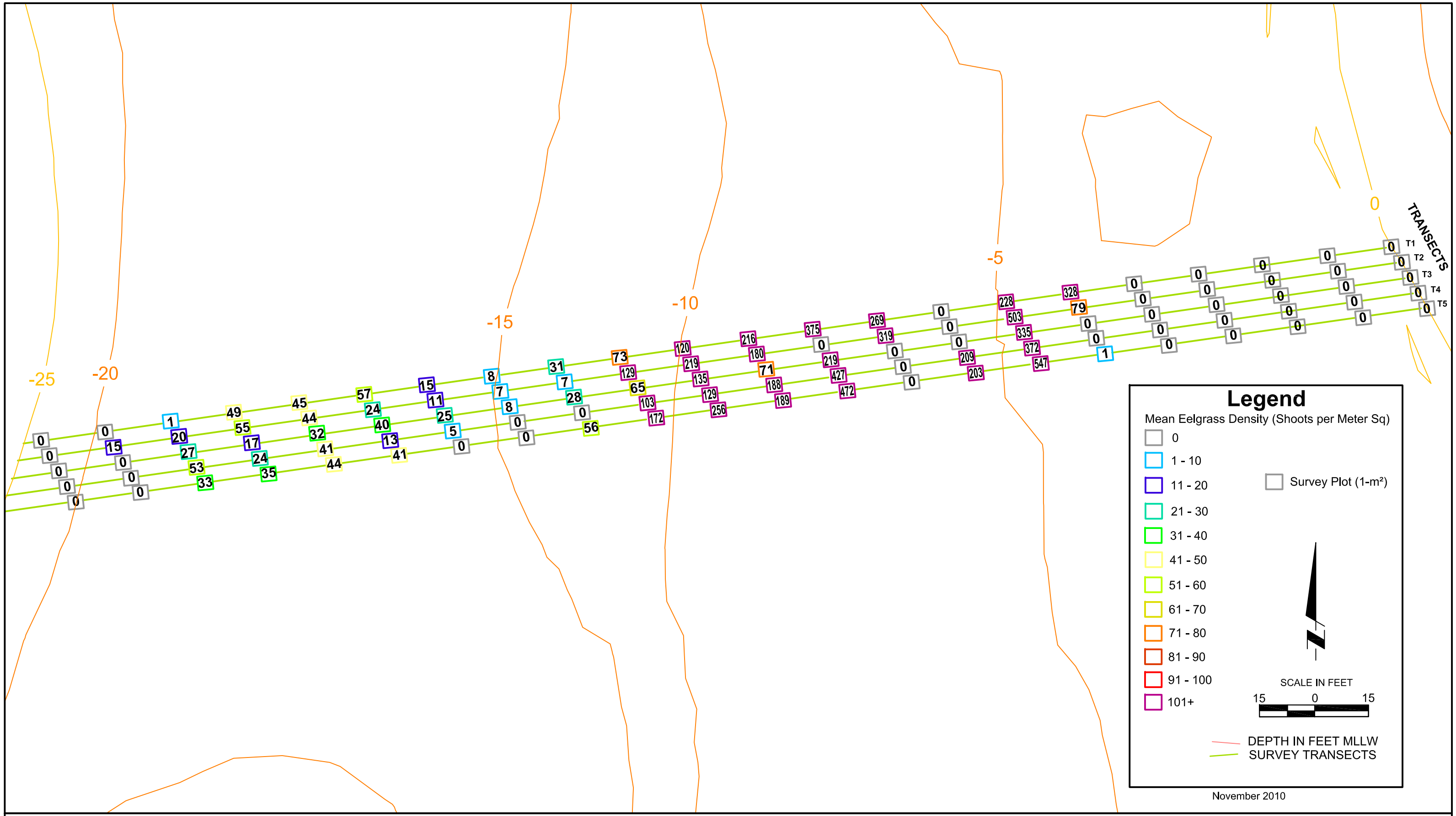
November 2010

King County
Department of Natural Resources and Parks
Wastewater Treatment Division

File Name: 500-560-5
Prepared By: Grette Associates, LLC

FIGURE 3

MARINE OUTFALL CORRIDOR EELGRASS DENSITY 2010 DATA



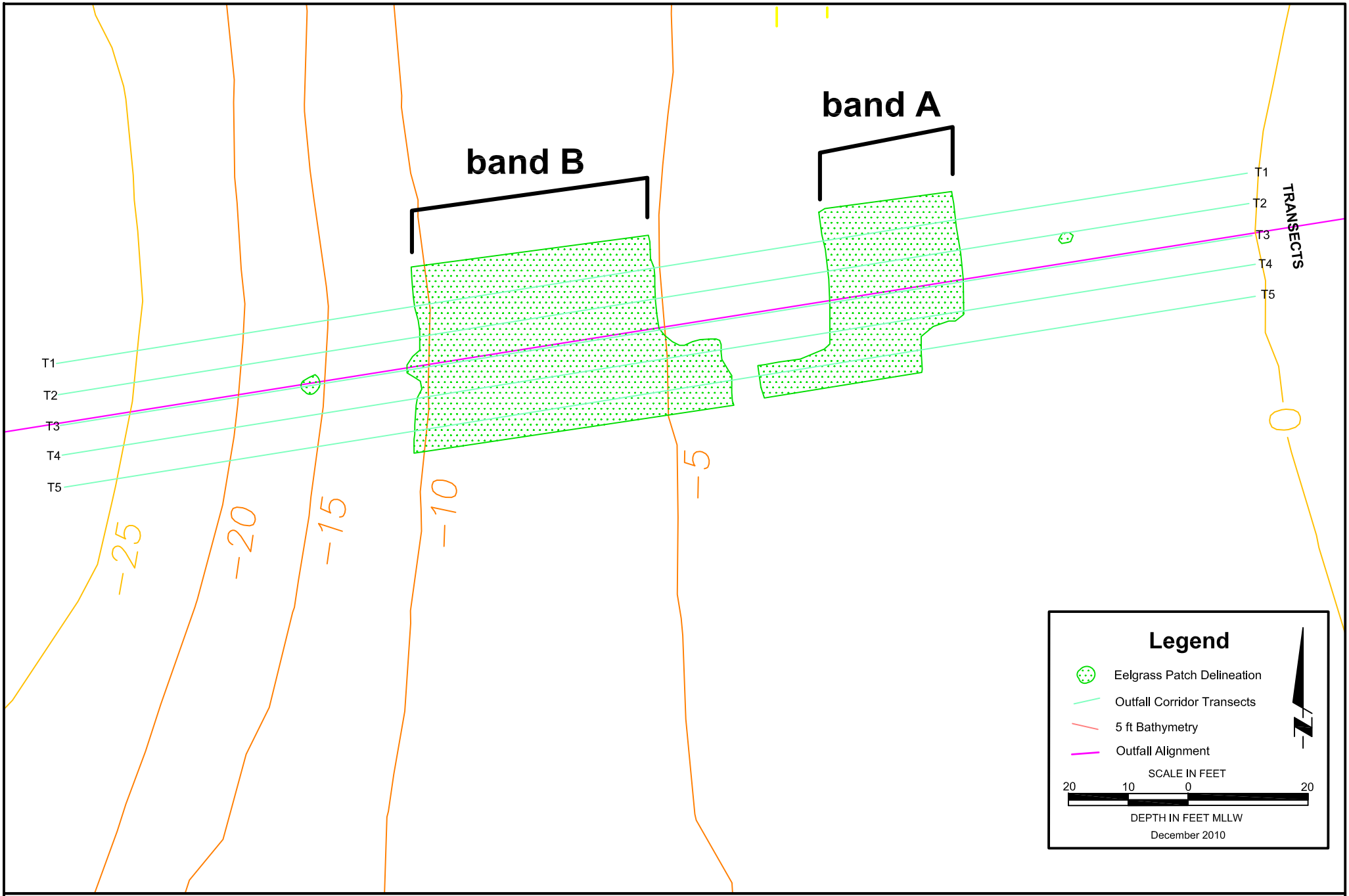
November 2010

King County
Department of Natural Resources and Parks
Wastewater Treatment Division

File Name: 500-560-5
Prepared By: Grette Associates, LLC

FIGURE 4

REFERENCE AREA EELGRASS DENSITY
2010 DATA



King County
Department of Natural Resources and Parks
Wastewater Treatment Division

File Name: 312001100-4
Prepared By: Grette Associates, LLC

FIGURE 5

MARINE OUTFALL CORRIDOR EELGRASS DELINEATION 2010 DATA

King County
Department of Natural Resources and Parks
Wastewater Treatment Division

File Name: 312001100-4
Prepared By: Grette Associates, LLC

FIGURE 6

REFERENCE AREA EELGRASS DELINEATION
2010 DATA

Appendix A

Brightwater Eelgrass Survey Data Table 2010

Table Legend

Transect:

SA; Study Area
RA; Reference Area

Depth Bin:

1; 0 to -5 ft MLLW
2; -5 to -10 ft MLLW
3; -10 to -15 ft MLLW
4; -15 to -20 ft MLLW
5; -20 to -25 ft MLLW

Substrate (qualitative):

co; cobble
gr; gravel
sa; sand
sh; shell hash

Eelgrass edge:

b, e; begin, end

Macroalgae Taxa:

ce	*Ceramium* spp.
ch	*Chondracanthus exasperatus*
cl	*Cladophora sericea*
co	Coralline algae
cos	*Costaria costata*
de	*Desmarestia ligulata*
fa	*Fauchea* spp.
pt	*Pterothamnion* spp.
gr	*Gracilaria* spp.
grp	*Gracilariopsis* spp.
la	*Saccharina latissima**
ma	*Mazzaella splendens*
mc	*Microcladia coulteri*
ne	*Neodilsea borealis*
po	*Porphyra perforata*
pn	*Polyneura latissima*
pr	*Prionitis lanceolata*
sa	*Sargassum muticum*
sm	*Smithora naiadium*
sp	*Sparlingia pertusa*
ul	*Ulva* spp.

*Formerly *Laminaria saccharina*

Transect #	Distance along transect	2 o'clock	6 o'clock	10 o'clock	Density	Macroalgae taxa	Invertebrates	Substrate	Eelgrass edge	notes
SA-1	0	0	0	0	0.00	ul, la		co		
SA-1	10	0	0	0	0.00	ul, la		sa, sh		
SA-1	20	0	0	0	0.00			sa, sh		
SA-1	30	0	0	0	0.00	la		sa		
SA-1	40	0	0	0	0.00			sa		
SA-1	50	68	36	75	238.67	ul	kc, ms	sa	b 48, e 72	
SA-1	60	83	71	96	333.33	ul	kc, rc, unk a, unk n	sa		
SA-1	70	51	82	69	269.33	ul, la	kc	sa		
SA-1	80	0	0	0	0.00	ul, la		sa		
SA-1	90	0	0	0	0.00	ul	hc	sa		
SA-1	100	1	0	28	38.67	ul, la, ce		sa	b 100, e 137	
SA-1	110	6	2	25	44.00	ul	hc, unk n, dc	sa		
SA-1	120	0	0	12	16.00	ul, la, gr	unk n, rc	sa		
SA-1	130	0	23	19	56.00	ul, la	dc, kc	sa		
SA-1	140	0	0	0	0.00	ul, la, mc		sa		
SA-1	150	0	0	0	0.00	ul, la, pn		sa		
SA-1	160	0	0	0	0.00	ul, la	rc	sa		
SA-1	170	0	0	0	0.00	ul, la, ch	rc	sa		
SA-1	180	0	0	0	0.00	ul		sa		
SA-1	190	0	0	0	0.00	ul, pn		sa		
SA-1	200	0	0	0	0.00	ul		sa		
SA-2	0	0	0	0	0.00	ul, la		sa, co		
SA-2	10	0	0	0	0.00			sa		
SA-2	20	0	0	0	0.00			sa		
SA-2	30	61	0	0	81.33			sa	b 30, e 33	
SA-2	40	0	0	0	0.00			sa		
SA-2	50	131	185	45	481.33	ul		sa	b 48, e 72	
SA-2	60	124	171	142	582.67	ul		sa		
SA-2	70	51	75	129	340.00	ul, la, pn		sa		
SA-2	80	0	0	0	0.00	la		sa		
SA-2	90	0	0	0	0.00	mc, ul		sa		
SA-2	100	52	69	52	230.67			sa	b 98, e 106	
SA-2	110	23	17	14	72.00	ul		sa	b 109, e 139	
SA-2	120	35	33	31	132.00	ul		sa		
SA-2	130	26	14	16	74.67	ul, la		sa		

Transect #	Distance along transect	2 o'clock	6 o'clock	10 o'clock	Density	Macroalgae taxa	Invertebrates	Substrate	Eelgrass edge	notes
SA-2	140	0	0	0	0.00	ul, mc		sa		
SA-2	150	0	0	0	0.00	ul, mc, la	rc	sa		
SA-2	160	0	0	0	0.00	ul, la		sa		
SA-2	170	0	0	0	0.00	pn, la, ul		sa		
SA-2	180	0	0	0	0.00	ch, pn, ul		sa		
SA-2	190	0	0	0	0.00	ul		sa		
SA-2	200	0	0	0	0.00	la, ul		sa		
SA-3	0	0	0	0	0.00	ul		sa, co		
SA-3	10	0	0	0	0.00	ul, la		sa	b 22, e 22	4 turions @ 22 ft
SA-3	20	0	0	0	0.00			sa		
SA-3	30	0	0	0	0.00			sa		
SA-3	40	0	0	0	0.00			sa	b 49, e 72	
SA-3	50	76	80	91	329.33		kc	sa		
SA-3	60	68	71	83	296.00			sa		
SA-3	70	87	68	60	286.67		unk n	sa		
SA-3	80	0	0	0	0.00			sa		
SA-3	90	0	0	0	0.00	ul		sa	b 99, e 144	
SA-3	100	30	9	30	92.00	ul, la		sa		reproductive shoots
SA-3	110	8	9	9	34.67	gr		sa		
SA-3	120	8	18	12	50.67	ul		sa		
SA-3	130	24	5	10	52.00			sa		
SA-3	140	3	7	4	18.67	ul		sa		
SA-3	150	0	0	0	0.00	ul, ma, la, ce, gr		sa		
SA-3	160	0	3	9	16.00	ul, la		sa	b159, e 167	
SA-3	170	0	0	0	0.00	ul		sa		
SA-3	180	0	0	0	0.00	ul, la, po		sa		
SA-3	190	0	0	0	0.00	ul, la, po		sa		
SA-3	200	0	0	0	0.00	ul, la, po		sa		
SA-4	0	0	0	0	0.00			sa		
SA-4	10	0	0	0	0.00			sa		
SA-4	20	0	0	0	0.00			sa		
SA-4	30	0	0	0	0.00	ul		sa		
SA-4	40	0	0	0	0.00	la, ul		sa		
SA-4	50	72	22	26	160.00	ul		sa	b 48, 3 72	
SA-4	60	85	77	68	306.67	la		sa		

Transect #	Distance along transect	2 o'clock	6 o'clock	10 o'clock	Density	Macroalgae taxa	Invertebrates	Substrate	Eelgrass edge	notes
SA-4	70	88	78	36	269.33	la		sa		
SA-4	80	0	11	0	14.67	ul		sa		
SA-4	90	0	0	23	30.67	ul		sa	b 91, e 145	
SA-4	100	26	19	16	81.33			sa		
SA-4	110	16	31	29	101.33			sa		
SA-4	120	24	17	19	80.00			sa		
SA-4	130	9	7	11	36.00	ul		sa		
SA-4	140	5	4	1	13.33	ul		sa		
SA-4	150	0	0	0	0.00			sa		
SA-4	160	0	0	0	0.00	ul		sa		
SA-4	170	0	0	0	0.00	ul		sa		
SA-4	180	0	0	0	0.00	ul		sa		
SA-4	190	0	0	0	0.00	ul		sa		
SA-4	200	0	0	0	0.00	ul		sa		
SA-5	0	0	0	0	0.00	ul, la		co, sa		
SA-5	10	0	0	0	0.00	ul		sa, co		
SA-5	20	0	0	0	0.00	ul		sa		
SA-5	30	0	0	0	0.00	la, ul		sa		
SA-5	40	0	0	0	0.00	la, ul		sa	b 43, e 47	
SA-5	50	0	0	0	0.00	la, ul		sa		
SA-5	60	0	56	4	80.00	sp, gr, ul		sa	b 59, e 84	
SA-5	70	28	27	10	86.67	ul		co, gr, sa		
SA-5	80	104	41	46	254.67	ul		sa, co	b 88, e 142	
SA-5	90	64	92	38	258.67	ul		sa		
SA-5	100	69	88	17	232.00		kc, unk s	sa		
SA-5	110	22	3	17	56.00	ul		sa		
SA-5	120	25	12	18	73.33	ul	dc, kc	sa		
SA-5	130	14	0	8	29.33	ul	unk a, kc	sa		
SA-5	140	4	15	0	25.33	ul	hc, ss	sa		
SA-5	150	0	0	0	0.00	ul		sa		
SA-5	160	0	0	0	0.00	ul, ma, la		sa		
SA-5	170	0	0	0	0.00		kc	sa		
SA-5	180	0	0	0	0.00			sa		
SA-5	190	0	0	0	0.00	ul	ss	sa		
SA-5	200	0	0	0	0.00	ul		sa		

Transect #	Distance along transect	2 o'clock	6 o'clock	10 o'clock	Density	Macroalgae taxa	Invertebrates	Substrate	Eelgrass Edge	Notes
RA-1	0	no data								
RA-1	20	no data								
RA-1	40	0	0	0	0.00	ul	ms	co, sa		
RA-1	60	0	0	0	0.00	ul, la		co, sa		
RA-1	80	0	0	0	0.00			sa	b 99, e 123	
RA-1	100	142	103	1	328.00			sa		
RA-1	120	98	15	58	228.00			sa		
RA-1	140	0	0	0	0.00			sa		
RA-1	160	95	24	83	269.33	ul		sa	b 157, e 168	
RA-1	180	104	97	80	374.67			sa	b177, e 379	
RA-1	200	75	32	55	216.00			sa		
RA-1	220	25	27	38	120.00	ul		sa		
RA-1	240	15	18	22	73.33			sa		
RA-1	260	10	9	4	30.67			sa		
RA-1	280	0	1	5	8.00	ul, gr, mc		sa		
RA-1	300	2	3	6	14.67	ul		sa		
RA-1	320	13	18	12	57.33	la, ul, ch		sa		
RA-1	340	7	14	13	45.33	ma, ul		sa		
RA-1	360	3	25	9	49.33	la, ul		sa		
RA-1	380	0	0	1	1.33	ul		sa		
RA-1	400	0	0	0	0.00	ul, ce		sa		
RA-1	420	0	0	0	0.00	ch, ul		sa		
RA-1	440	0	0	0	0.00	cos, ul		sa		
RA-1	460	0	0	0	0.00	ul, la		sa		
RA-2	0	no data								
RA-2	20	no data								
RA-2	40	0	0	0	0.00	ul, co		co, sa		
RA-2	60	0	0	0	0.00	ul, la, co, ma, sp		sa, co, gr		
RA-2	80	0	0	0	0.00	ul	rc	sa		
RA-2	100	14	0	45	78.67			sa	b 101, e 127	
RA-2	120	163	65	149	502.67	la	rc, dc	sa		
RA-2	140	0	0	0	0.00	ul		sa		
RA-2	160	147	43	49	318.67			sa	b 159, e 177	
RA-2	180	0	0	0	0.00	ul		sa	b 182, e 399	
RA-2	200	59	27	49	180.00	ul, la	kc, rc	sa		

Transect #	Distance along transect	2 o'clock	6 o'clock	10 o'clock	Density	Macroalgae taxa	Invertebrates	Substrate	Eelgrass Edge	Notes
RA-2	220	68	40	56	218.67	gr, ul	kc, rc	sa		
RA-2	240	32	24	41	129.33	ul, de, pr		sa		
RA-2	260	0	5	0	6.67	ul, ce, po, gr		sa, co		
RA-2	280	0	0	5	6.67	ul, gr, po, la	hc	sa		
RA-2	300	8	0	0	10.67	gr, la,sp, ul, po		sa		
RA-2	320	11	1	6	24.00	sp, ul, gr	unk n	sa		
RA-2	340	6	14	13	44.00	la, ul	dec, rc	sa		
RA-2	360	15	13	13	54.67	po, ul	unk n, kc	sa		
RA-2	380	0	5	10	20.00	la, ul	hc	sa		
RA-2	400	0	3	8	14.67	ul, la	rc, dc	sa		
RA-2	420	0	0	0	0.00	ul, la	unk a	sa		
RA-2	440	0	0	0	0.00	ul, la		sa		
RA-2	460	0	0	0	0.00	gr, ul ,la		sa		
RA-3	0	no data								
RA-3	20	no data								
RA-3	40	0	0	0	0.00	ul	b, hc	sa. co		
RA-3	60	0	0	0	0.00	ul		sa, co, gr		
RA-3	80	0	0	0	0.00	ul		sa		
RA-3	100	0	0	0	0.00	la	unk a	sa	b 102, e 109	
RA-3	120	99	78	74	334.67		ss	sa	b 111, e 131	
RA-3	140	0	0	0	0.00	ul		sa		
RA-3	160	0	0	0	0.00			sa	b 150, e 153	
RA-3	180	34	60	70	218.67	ul, gr	kc, rc	sa	b 167, e 181	
RA-3	200	5	27	21	70.67		unk a	sa	b 192, e 274	
RA-3	220	42	30	29	134.67	ul	ss	sa		
RA-3	240	22	9	18	65.33	pr, ul	unk a, b	sa		
RA-3	260	3	13	5	28.00	ul, gr, pr	unk a	sa	b 281, e 282	
RA-3	280	0	0	6	8.00	ul, gr		sa	b 288, e 291	
RA-3	300	8	7	4	25.33	ul, ma, la, gr	unk s, rc	sa	b 296, e 382	
RA-3	320	7	5	18	40.00	ma, ul, ne	unk a	sa		
RA-3	340	11	6	7	32.00	ul	hc, unk a	sa		
RA-3	360	0	9	4	17.33	pn		sa		
RA-3	380	4	9	7	26.67	pn, sp, ul		sa		
RA-3	400	0	0	0	0.00	la		sa		
RA-3	420	0	0	0	0.00	ul	hc	sa		
RA-3	440	0	0	0	0.00	gr		sa		

Transect #	Distance along transect	2 o'clock	6 o'clock	10 o'clock	Density	Macroalgae taxa	Invertebrates	Substrate	Eelgrass Edge	Notes
RA-3	460	0	0	0	0.00			sa		
RA-4	0	no data								
RA-4	20	no data								
RA-4	40	0	0	0	0.00	ul, la		co, sa		
RA-4	60	0	0	0	0.00	ul, la, gr		co, sa, gr		
RA-4	80	0	0	0	0.00	ul, la, gr		sa		
RA-4	100	0	0	0	0.00			sa	b 107, e 151	
RA-4	120	138	54	87	372.00	ul		sa		
RA-4	140	49	52	56	209.33	ul		sa, gr		
RA-4	160	0	0	0	0.00			sa	b 168, e 192	
RA-4	180	81	126	113	426.67	ul		sa, gr		
RA-4	200	31	48	62	188.00			sa	b 197, e 250*	
RA-4	220	25	33	39	129.33	ul		sa		
RA-4	240	24	13	40	102.67	ul, gr, po, la	rc, hc	sa		
RA-4	260	0	0	0	0.00	la, ul, gr		sa		
RA-4	280	0	0	0	0.00	po, gr, ul		sa		
RA-4	300	4	0	0	5.33	la,ul		sa	b 300*, e 390*	
RA-4	320	4	6	0	13.33	la, gr		sa		
RA-4	340	17	6	8	41.33	ul, sp		sa		
RA-4	360	0	11	7	24.00	la, cos, ul		sa		
RA-4	380	20	5	15	53.33	ul		sa		
RA-4	400	0	0	0	0.00	ul		sa		
RA-4	420	0	0	0	0.00	ul		sa		
RA-4	440	0	0	0	0.00	ul, la, gr		sa		
RA-4	460	0	0	0	0.00	ul, la		sa		
RA-5	0	no data								
RA-5	20	no data								
RA-5	40	0	0	0	0.00	ul		co, sh, sa		
RA-5	60	0	0	0	0.00	ul	ms	co, sh, gr		
RA-5	80	0	0	0	0.00			sa		
RA-5	100	1	0	0	1.33	ul		sa	b 100, e 100	
RA-5	120	134	155	121	546.67	ul		sa	b 107, e 153	
RA-5	140	22	61	69	202.67	ul		sa		
RA-5	160	0	0	0	0.00	ul, ce		sa	b 174, e 192	
RA-5	180	165	71	118	472.00	ul		sa	b 197, e 279	
RA-5	200	36	59	47	189.33	ul, gr		sa		

Transect #	Distance along transect	2 o'clock	6 o'clock	10 o'clock	Density	Macroalgae taxa	Invertebrates	Substrate	Eelgrass Edge	Notes
RA-5	220	78	50	64	256.00	ul, la		sa		
RA-5	240	43	29	57	172.00	ul		sa		
RA-5	260	16	17	9	56.00	ul, pn, mc, la		sa		
RA-5	280	0	0	0	0.00	gr, la, ul		sa		
RA-5	300	0	0	0	0.00	gr, la, ul		sa	b 306, e 387	
RA-5	320	3	18	10	41.33	ul		sa		
RA-5	340	14	9	10	44.00	ul		sa		
RA-5	360	11	14	1	34.67	ul, la, gr		sa		
RA-5	380	3	15	7	33.33	ul		sa		
RA-5	400	0	0	0	0.00	ul, la		sa		
RA-5	420	0	0	0	0.00	la		sa		
RA-5	440	0	0	0	0.00	ul, la, gr		sa		
RA-5	460	0	0	0	0.00	ul		sa		

* estimated begin/end points based on sample point counts (exact begin/end points were not marked on data sheet).