APPENDIX C

SPI Reports (Year 2 and Year 3)

SPI REPORTS (YEAR 2 AND YEAR 3)

Enhanced Natural Recovery/Activated Carbon Pilot Study

Lower Duwamish Waterway

Prepared for:

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TABLE OF CONTENTS

TABLES

FIGURES

FIGURES (continued)

ATTACHMENTS

SPI/PV SURVEY RESULTS – YEAR-BY-YEAR SUMMARIES
Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway

1.0 SPI/PV BASELINE SURVEY

The baseline Sediment profile imaging/plan view (SPI/PV) survey was conducted in July 2016 prior to placement of at Enhanced Natural Recovery (ENR) and ENR amended with activated carbon (ENR+AC) material on the test plots. For the baseline SPI/PV survey, three replicate SPI/PV images were collected from 12 stations in each plot (six stations per subplot, one station in each of six grid cells). The baseline SPI survey report is provided in Appendix F in Wood et al., 2019.

1.1 INTERTIDAL PLOT

Baseline surface sediments at the intertidal plot were silt or finer throughout the entire area, i.e., both subplots. All replicates at all stations showed a predominately silt/clay substrate alone or silt and clay with a thin veneer of fine sand at the sediment surface. Figure C-1 shows representative intertidal plot SPI images from the baseline survey.

SPI penetration depths ranged from 2.2 to 14.6 centimeters (cm) with an average of 9.7 cm (Table C-1 and Figure C-2). Penetration variation was attributed to the presence of macroalgal mats at the sediment-water interface (Figure C-1), which inhibited prism penetration at several stations, and not to variation in grain size or sediment bearing strength.

The apparent redox-potential discontinuity (aRPD; depth of the oxic surface sediments layer) measured from the intertidal plot ranged from 0.8 to 4.6 cm with a mean aRPD of 2.2 cm (Table C-1 and Figure C-3). Stage 3 infauna were observed at 67% (8 of 12) intertidal stations indicating the presence of head-down deposit feeders across most of the area at the time of the baseline survey (Table C-2).[1]

1.2 SCOUR PLOT

Baseline surface sediments at the scour plot were predominantly silt/clay in the upper sediment column. Surface veneers of sand and some gravel were present at nine of 12 stations sampled. Representative SPI images from the scour ENR and ENR+AC subplots are shown in Figure C-4.

[1] Images not designated as Stage 3 were either Stage 1, Stage 2, or indeterminate (i.e., Stage 3 could not be ruled in or out) due to limited penetration. No stations were azoic, i.e., lacking evidence of macrofauna presence.

The presence of the coarse-grained sediment overlying fine-grained sediment was inferred to be a lag deposit generated when finer-grained material is periodically winnowed away by high bottom currents. The sand/gravel lag deposits were more prevalent in the ENR+AC subplot and thought to be related to episodic hydrodynamic forces, such as prop wash (Wood et al., 2019 Appendix F).

Baseline SPI penetration depths ranged from 0.3 to 16.6 cm with an average depth of 13.8 cm (Table C-1 and Figure C-5). Prism penetration showed wide variation due to the presence of the surface sands/gravel in the ENR+AC subplot where all replicates that had a mean prism penetration of less than 10 cm were located (Figure C-5). The SPI images in Figure C-4 illustrate these texture and penetration differences between the scour subplots.

The aRPD depths ranged from 1.0 to 2.8 cm with an average aRPD depth of 2.0 cm (Table C-1 and Figure C-6). The aRPD depths were consistently lower in replicates from the ENR+AC subplot compared to the ENR subplot, likely reflecting the higher physical disturbances in the ENR+AC plot. Stage 3 infauna were observed at all 12 scour plot stations indicating the widespread presence of head-down deposit feeding infauna (Table C-2); this suggests the physical disturbance inferred to be caused by vessel traffic is limited to just the near-surface sediments.

1.3 SUBTIDAL PLOT

Baseline surface sediments were predominantly silts and clays with scattered surface veneers of fine sand. Representative SPI images from the subtidal ENR and ENR+AC subplots are shown in Figure C-7.

Subtidal prism penetration depths ranged from 5.8 to 21.6 cm with an average depth of 12.7 cm (Table C-1 and Figure C-8). Prism penetration variation appeared to be due to variable sediment consolidation in this navigation channel setting.

Baseline aRPD depths ranged from 0.2 to 3.0 cm with an average 1.3 cm. Stage 3 infauna were observed at 50% (six of 12) of the stations (Table C-1 and Figure C-9). Stage 1 and 2 areas were also observed. This pattern and the sedimentary fabric observed in some images (see right image in Figure C-7) suggested that surface sediments in areas of this plot had been physically disturbed through mechanical mixing (e.g., by anchors or tow chain drags). The aRPDs and benthic communities appeared to be re-establishing themselves in these areas during the baseline survey.

2.0 SPI/PV YEAR 0 SURVEY

The Year 0 SPI/PV surveys were conducted in January and February 2017, 6 to 23 days following construction at each plot. The objective was to assess surface sediment conditions immediately

after the placement of ENR and ENR+AC materials. A total of 72 stations, 12 per subplot, were sampled. The Year 0 SPI survey report is provided in Attachment 5 in Amec Foster Wheeler et al., 2018.

Figure C-10 shows one representative Year 0 SPI image from each plot. The substrate at both intertidal and scour plots was sandy gravel at all stations. The subtidal plot was predominantly coarse sand with some scattered fine gravel and a thin veneer (~1 cm) of recently deposited fine-grained sediment at the surface.

Despite the placement of coarse-grained sediments at the study plots, SPI prism penetration was relatively deep, apparently due to the lack of consolidation of the recently-placed material. Table C-1 and Figures C-2, C-5, and C-8 show that penetration depths at the intertidal, scour, and subtidal plots averaged about 8, 10, and 11 cm, respectively.

Due to the short, elapsed time between construction and the SPI/PV surveys and the minimal silt accumulation, aRPD depths were largely indeterminate in Year 0 at the intertidal and scour plots (Table C-1 and Figures C-3 and C-6). At the subtidal subplot, the thin layers of recently deposited, oxidized fine-grained material allowed aRPDs to be measured and were comparable, (averages of 1.4 and 1.5 cm) between subplots (/Table C-1 and Figure C-9); this reflects the thickness of the silt deposits overlying the ENR and ENR+AC materials.

In the short time since construction, very little recolonization of the infaunal benthic community was observed at any of the plots during the Year 0 survey, and no successional stages were estimated.

3.0 SPI/PV YEAR 1 SURVEY

The Year 1 SPI/PV survey was conducted in March 2018. Three replicate SPI/PV images were collected from 24 stations in each plot (12 stations per subplot, two stations in each of the six grid cells) for a total of 72 SPI and PV image replicates per plot. The Year 1 SPI survey report is provided in Appendix F in Wood et al., 2019.

3.1 INTERTIDAL PLOT

Year 1 surface sediment textures at the intertidal plot were generally ENR sands and gravels, with ambient silts mixed into or overlaying the ENR/ENR+AC layers in some locations. Figure C-11 shows the range of textures observed.

Evidence of the ENR material (i.e., sands and gravels) was observed in either the SPI or the PV images (typically both) from all stations in both the ENR and ENR+AC subplots. SPI penetration

depths were comparable between subplots, averaging 5.1 and 5.6 cm in the ENR and ENR+AC subplots, respectively (Table C-1). These values are notably less than the baseline average depth of 9.7 cm (Figure C-2), and also less than the Year 0 penetration depths. This provides further evidence of the presence of coarse-grained ENR/ENR+AC material throughout intertidal plot, and that the material appears to be consolidating over time.

The measured Year 1 aRPD depths averaged 2.5 and 2.3 cm in the intertidal ENR and ENR+AC subplots, respectively; results were comparable between subplots. These values are comparable to the baseline average aRPD value of 2.2 cm (Table C-1 and Figure C-3).

The percent of stations exhibiting Stage 3 infauna in the ENR+AC subplot matched the baseline value (67%). In the ENR subplot, the percent of stations exhibiting Stage 3 infauna in Year 1 (92%) was greater than the baseline value. These results indicate that the benthic community had recolonized the intertidal plot within 15 months of the placement of the ENR/ENR+AC materials.

3.2 SCOUR PLOT

The Year 1 SPI/PV images revealed a distinct transition in surface sediment texture from south to north across the scour plot. Stations in the southern ENR subplot showed surface layers of silt (up to 12-cm thick) overlying the ENR material. Similarly, the ENR+AC grid cells adjacent to the ENR subplot) also exhibited silt layers (up to 11 cm thick). However, the three northern-most cells in the ENR+AC subplot showed minimal or no silt accumulation in March 2018. Figure C-12 shows SPI images from the scour plot that illustrate these textural differences. The lack of silt buildup across the northern tier of cells of the ENR+AC subplot is presumed to be due to chronic prop wash from vessel traffic in that area.

Despite the widespread silt deposited across ¾ of the scour plot in Year 1, visual evidence of gravels/sands near the bottom of the SPI images, gravels evident in the collocated PV images, and the reduced SPI penetration depths relative to the baseline survey (Table C-1 and Figure C-5) all point to the presence of ENR or ENR+AC material throughout the scour plot. The Year 1 SPI penetration depths at the scour plot (Table C-1 and Figure C-5) reflect the differences in overlying silt between the two subplots, averaging 9.3 cm at the ENR subplot and 7.8 cm at the ENR+AC subplot.

The deeper penetration in siltier substrate at the ENR subplot also resulted in deeper aRPD depths there (average of 1.9 cm) than at the ENR+AC subplot (average of 1.4 cm) (Table C-1 and Figure C-6), as well more widespread evidence of Stage 3 infauna. Stage 3 infauna were present in at least one SPI replicate image from all 12 ENR subplot stations (100% of the stations), as in the baseline. Stage 3 infauna were detected in only 75% on the ENR+AC stations, but this was

because successional stage could not be determined at the grid cells 1 and 3 stations that lacked silt and where penetration was limited (Table C-2 and right image in Figure C-12). Overall, the benthic community had recolonized much of the scour plot in Year 1, 15 months after construction.

3.3 SUBTIDAL PLOT

Most of the Year 1 SPI/PV images from the subtidal plot showed surface sediments that were mixtures of ENR materials and silt. The thicknesses of the ENR/ENR+AC layers generally exceeded the prism penetration depth (Figure C-13). However, the ENR material layer was as thin as 3 cm at one station in cell 6 of the ENR subplot (see middle image in Figure C-14). Additionally, ENR+AC material was not evident in locations within grid cells 5 and 6 in the ENR+AC subplot (see right image in Figure C-14). The disturbance of the ENR/ENR+AC has been attributed to barge chain dragging in this area (Amec Foster Wheeler et al., 2016).

The Year 1 SPI penetration depths at the subtidal plot (Table C-1 and Figure C-8) were less than both baseline and Year 0 penetration depths, suggesting consolidation of the ENR/ENR+AC material over time. In the few locations where the ENR+AC material is absent, penetration was deep in the silt substrate. The aRPD depths were deeper in the ENR subplot in Year 1 than during baseline and Year 0, while aRPD depths on the ENR+AC subplot were comparable to the previous surveys (Table C-1 and Figure C-9). The chain disturbed areas in the ENR+AC subplot have very thin aRPDs (right image in Figure C-14); this lowers the average aRPD depth value for the ENR+AC subplot.

The percentage of stations exhibiting evidence of Stage 3 infauna in Year 1 in both subplots (50 to 58%) was comparable to the baseline levels (50%). The Year 1 aRPD depths and infaunal successional stage data indicated that the benthic community had recolonized the subtidal plot within 15 months of the placement of the ENR/ENR+AC materials. Recolonization was less advanced in the physically disturbed areas.

4.0 SPI/PV YEAR 2 SURVEY

The Year 2 SPI/PV survey was conducted in March 2019. Three replicate SPI/PV images were collected from 24 stations in each plot (12 stations per subplot, two stations in each of the six grid cells) for a total of 72 SPI and PV images replicates per plot. The Year 2 SPI survey report is provided in Attachment 1.

4.1 INTERTIDAL PLOT

In Year 2, ENR/ENR+AC material was evident in 71 of the 72 locations surveyed in the intertidal plot. Surface sediment textures included sands and gravels (the ENR material) with ambient silts

mixed into the ENR/ENR+AC matrix. Compact silt overlying ENR/ENR+AC material was observed in a few locations. Figure C-15 shows representative Year 2 intertidal plot surface textures, including the single image where ENR+AC material was not evident.

SPI prism penetration depths in Year 2 were about half those observed in Year 1 (Table C-1 and Figure C-2) in both intertidal subplots. This pattern of reduced penetration was observed in both subplots and appears to be due to ENR/ENR+AC material compaction over time. This ENR/ ENR+AC compaction, perhaps combined with the infiltration of fines into the ENR/ENR+AC material interstices, created a substrate that was more resistant to SPI prism penetration.

The Year 2 aRPD depths were comparable between the intertidal ENR and ENR+AC subplots, averaging 1.1 and 1.6 cm, respectively (Table C-1 and Figure C-3). These values are less than the baseline and Year 1 aRPD depths.

Evidence of high-order (Stage 3) successional assemblages was noted at 33% of the stations in both subplots (Table C-2), suggesting that benthic infaunal assemblages/recolonization were comparable across both intertidal subplots. The proportion of stations with Stage 3 assemblages in Year 2 was lower than in baseline (67%) and Year 1 (67 to 92%). This appears to be due to the lower penetration obtained resulting in more indeterminate successional stage designations.

4.2 SCOUR PLOT

ENR/ENR+AC material was observed throughout the scour plot in Year 2. As in Year 1, a silt deposit (up to 8 cm thick in Year 2) was evident overlying the ENR material throughout the ENR subplot and in the immediately adjacent portion of the scour ENR+AC subplot (cells 2, 4, and 6). The farthest downstream cells (cells 1, 3, and 5) in the scour ENR+AC subplot lacked this silt material and were predominately comprised of ENR+AC gravel and sands at sediment surface (Figure C-16). This is the same pattern observed in the Year 1 SPI/PV survey and suggests the seasonal deposition of silt in the scour plot area. This silt material accumulates throughout the ENR subplot and the adjacent half of the scour ENR+AC subplot. But the higher vessel traffic and prop wash in the northern half of the ENR+AC subplot appears to prevent either the deposition or the long-term accumulation of silt on the surface in that area.

The Year 2 penetration depths were notably less than those obtained in Year 1 in both subplots; this is attributed to ENR/ENR+AC material consolidation and the physical (e.g., settling) and biological (e.g., bioturbation) mixing of fines into the ENR/ENR+AC matrix over time (Table C-1 and Figure C-5). Penetration was somewhat greater overall on the ENR subplot than on the ENR+AC subplot, likely due to the more widespread presence of silt deposits in the ENR subplot.

The Year 2 images showed evidence of benthic community re-establishment since the ENR/ ENR+AC material placement. The average aRPD depths for the ENR and ENR+AC subplots were 1.5 and 1.9 cm, respectively; this compares to the baseline average of 2.0 cm (Table C-1 and Figure C-6).

Stage 3 infauna were evident at all (100%) ENR stations and 58% (7 of 12) of the ENR+AC stations, similar to that observed in the baseline and Year 1 surveys (75 to 100%). As in Year 1, the percentage of locations with Stage 3 infauna are likely lower in the ENR+AC plot due to the scoured portions of the ENR+AC plot, which was kept silt-free likely due to propeller wash. At these scour ENR+AC locations, which were predominately sand and gravel, the successional stage was indeterminate. The Year 2 PV images from the scour plot also showed evidence of widespread surface/epifaunal biological activity, including tracks and trails on the silt bottom.

4.3 SUBTIDAL PLOT

The SPI/PV images from the parallel east and west lane subtidal ENR and ENR+AC subplots showed similar patterns of ENR/ENR+AC material presence in Year 2 and in Year 1. Downstream cells 1 through 4 showed compact silts overlying ENR/ENR+AC materials (inferred from the shallow prism penetrations) and/or ENR/ENR+AC sands (left and middle images in Figure C-17). ENR and ENR+AC material appeared to be disturbed/not present at ENR subplot Station 6B and from Stations 5B and 6B in the ENR+AC subplot (right image in Figure C-17 shows a residual 3-4 cm layer of coarse-grained ENR+AC material overlying reduced, ambient silt). In this portion of the subtidal plot (cells 5 and 6), the Lower Duwamish Waterway bottom is subject to disturbance by barge chain dragging (Amec Foster Wheeler et al., 2016).

Year 2 SPI prism penetration depths were approximately half of those obtained in Year 1 (Table C-1 and Figure C-9), due to settling/compaction of the ENR material in combination with mixing silts into the ENR/ENR+AC sands.

Benthic community colonization was evident in Year 2, although the limited penetration depths resulted in many indeterminate aRPD depths and successional stages. Averaged aRPDs depths in both the ENR and ENR+AC subplots (1.2 and 1.5 cm, respectively) were comparable to the baseline average of 1.3 cm (Table C-1).

The percentages of subtidal locations with Stage 3 infauna in Year 2 were slightly lower than in the baseline and Year 1 (50 to 58%). Stage 3 infauna were detected at 33% of the subtidal ENR stations in Year 2 but were indeterminate at another 50% of the locations due to limited penetration. Stage 3 infauna were present at only 17% of the ENR+AC subplot locations, indicating that the benthic recolonization was less advanced than in the adjacent ENR subplot.

Five of the eight assigned Stage 1 successional stages in the ENR+AC subplot were located in the physically disturbed cells 5 and 6. The more extensive physical disturbance in the ENR+AC subplot appeared to explain the lower percentages of locations with Stage 3 successional stages in Year 2.

5.0 SPI/PV YEAR 3 SURVEY

The Year 3 SPI/PV survey was conducted in June 2020. As in previous surveys, three replicate SPI/PV images were collected from 24 stations in each plot (12 stations per subplot, two stations in each of six grid cells) for a total of 72 SPI and PV image replicates per plot. The Year 3 SPI survey report is provided in Attachment 2.

5.1 INTERTIDAL PLOT

ENR or ENR+AC material was observed or inferred present at all 72 replicates sampled in the intertidal plot in Year 3. Ambient silts were mixed into the ENR or ENR+AC material or overlying it in a thin, compact layer (Figure C-18). Some images showed predominately ENR/ENR+AC material with minimal silt addition.

Prism penetration averaged 3.4 and 2.8 cm in the ENR and ENR+AC subplots, respectively; this was comparable to the shallow penetration obtained in Year 2 (Table C-1 and Figure C-2) and less than the penetration reported in Years 0 and 1. Reduced penetration is due to the settling/compaction of the ENR/ENR+AC materials combined with the mixing of ambient fine-grained sediment into the ENR/ENR+AC material.

The aRPD depths could be measured in six replicates from each subplot and were similar between the ENR and ENR+AC subplots and comparable to the Year 2 aRPD depths (Table C-1). Benthic community colonization was evident at both intertidal subplots in Year 3. However, due to limited prism penetrations, infaunal successional stages could only be assigned to five replicate images in each subplot. The reduced penetration limited the detection of high-order (Stage 3) successional assemblages to 25% of the stations in each subplot (Table C-2)and is similar to the percentage of stations with Stage 3 assemblages that was observed in Year 2 (33%) when penetration was also minimal. Although the presence Stage 3 taxa could not be confirmed, surface-dwelling organisms macrofauna (Stage 1 and 2 taxa) were evident in the images.

5.2 SCOUR PLOT

As in Years 1 and 2, silt deposits overlay the entire ENR Subplot and the adjacent half of ENR+AC subplot. The deposited material average thickness was approximately 9 cm in the ENR subplot and 4 cm in the ENR+AC subplot. The silt deposit was not present along the northern portion of

the subplot, where ENR+AC material was observed at the sediment-water interface. This is same pattern observed in Years 1 and 2 and is attributed to vessel/tugboat traffic and prop wash in that area that prevents the silt from depositing and/or accumulating in those downstream cells.

Figure C-19 shows representative examples of surface sediment textures at the scour plot in Year 3, including the overlying silt deposit (left image in Figure C-19), ENR+AC material with no silt (middle image in Figure C-19), and one location where a 3-4 cm layer of ENR+AC material was evident overlying reduced silt (right image in Figure C-19). This station is located at the very northern edge of the ENR+AC subplot.

Silt deposits obscured the observation of ENR or ENR+AC material in many of the scour plot images. Nonetheless, the SPI penetration depths, sand sub-fractions evident within the silt matrix, and the presence of silt-covered gravels in many of the PV images indicated that the ENR/ENR+AC materials remained present throughout the plot. Prism penetration was deeper in Year 3 than in Year 2, reflecting the thicker silt deposits present in Year 3 (Table C-1 and Figure C-5). Penetration was deeper on the ENR Subplot than on the ENR+AC subplot due to the more extensive silt deposit cover.

In Year 3, the aRPD depths in the ENR subplot are comparable to the Year 1 and 2 values (Table C-1 and Figure C-6). The aRPD depths in the ENR+AC subplot are somewhat reduced relative to Year 1 and 2 levels.

The scour plot showed evidence of benthic community establishment in Year 3, especially in the ENR subplot. In Year 3, Stage 3 infauna were evident in 35 of the 36 scour ENR SPI images and in 19 of the 36 scour ENR+AC SPI images (97% and 67% of the stations, respectively) (Table C-2). Successional stages were indeterminate at 16 ENR+AC SPI replicates where the bottom texture was sand and gravel; this accounts for the difference in the extent of Stage 3 successional stages between subplots. Overall, the percentage of stations with Stage 3 assemblages that was observed in Year 3 were similar to that observed in baseline, Year 1, and Year 2 monitoring events (58 to 100%). All Year 1, Year 2, and Year 3 results confirm lower benthic community establishment in the portion of the ENR+AC subplot that is devoid of silt, due to the effects of propeller wash from vessel traffic in this area.

5.3 SUBTIDAL PLOT

The Year 3 SPI/PV images from the subtidal plot showed silt deposited over the ENR/ENR+AC material across the northern (downstream) two-thirds of the parallel subplots. The silt deposit thins from downstream to upstream and was thicker over the western ENR+AC subplot lane compared to the eastern ENR lane.

As noted in prior years, the ENR/ENR+AC material in Year 3 was observed to be partially disturbed/not present in cells 5 and 6 of both subplots. Figure C-20 shows examples of subtidal Year 3 surface sediment textures, including surface silt overlying ENR+AC material (left image in Figure C-20), compact silt mixed with ENR material (middle image in Figure C-20), and a location where ENR+AC material is not evident (right image in Figure C-20). Cells 5 and 6 are subject to anthropogenic disturbance by barge chain dragging (Amec Foster Wheeler et al., 2016).

Table C-1 and Figure C-8 show the Year 3 subtidal plot SPI prism penetration depths. Penetration was notably greater in the ENR+AC subplot than in the ENR subplot reflecting the thicker silt deposits there. Penetration in the ENR subplot was relative shallower than in the ENR+AC subplot, reflecting the thinner silt deposits there. ENR subplot penetration was similar to the levels obtained in Year 2.

Benthic community colonization is evident in Year 3. The aRPD depths are included in Table C-1 and Figure C-9 and the aRPD depths in both subplots are comparable to baseline levels. Due to the limited penetration in the ENR subplot, successional stage designations could only be assigned to eight SPI replicates with Stage 3 infauna observed at 25% of the ENR locations (Table C-2). In the ENR+AC subplot, 67% of the stations showed evidence of Stage 3 infauna. Less developed assemblages were associated with the physically disturbed areas in cells 5 and 6 of the ENR and ENR+AC subplots. Overall, the percentage of stations with Stage 3 assemblages that was observed in Year 3 (25 to 67%) were similar to that observed in baseline, Year 1, and Year 2 monitoring events (17 to 58%). All Year 1, Year 2, and Year 3 results confirm lower benthic community establishment in the portions of the ENR+AC and ENR subplots that are physically disturbed due to barge chain dragging.

6.0 REFERENCES

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TABLES

Table C-1
SPI Prism Penetration and aRPD Depth Summary Statistics – Baseline through Year 3

Prism Penetration Depths (cm)					
Statistic	**Intertidal ENR**				
	Baseline*	**Year 0**	**Year 1**	**Year 2**	**Year 3**
N	*37*	*36*	*36*	*36*	*36*
Mean	9.7	7.4	5.1	2.5	3.4
Min	2.9	5.4	2.8	0.5	1.6
Max	14.6	12.6	14.3	4.8	5.3
	Intertidal ENR+AC				
N	--	*36*	*35*	*35*	*36*
Mean	--	8	5.6	2.8	2.8
Min	--	2.9	2.3	2.3	0.7
Max	--	10.8	9	12.1	8.3

aRPD Depths (cm)					
Statistic	**Intertidal ENR**				
	Baseline*	**Year 0**	**Year 1**	**Year 2**	**Year 3**
N	*30*	*0*	*26*	*5*	*6*
Mean	2.2	Ind.	2.5	1.1	1.5
Min	0.8	Ind.	1.1	0.7	1.1
Max	4.6	Ind.	3.5	2.3	2.0
	Intertidal ENR+AC				
N	--	*2*	*23*	*10*	*6*
Mean	--	3.8	2.3	1.6	1.0
Min	--	3.3	0.4	1.0	0.5
Max	--	4.3	3.6	3.4	2.0

Statistic	**Scour ENR**				
	Baseline*	**Year 0**	**Year 1**	**Year 2**	**Year 3**
N	*36*	*36*	*36*	*30*	*36*
Mean	13.8	9.9	9.3	5.2	9.0
Min	0.3	6.2	0.0	3.4	6.2
Max	16.6	16.4	13.5	8.5	12.1
	Scour ENR+AC				
N	--	*36*	*36*	*35*	*36*
Mean	--	9.9	7.8	3.9	5.9
Min	--	6.5	4.1	0.8	1.4
Max	--	19.1	13.9	8.1	10.5

Statistic	**Scour ENR**				
	Baseline*	**Year 0**	**Year 1**	**Year 2**	**Year 3**
N	*35*	*0*	*33*	*29*	*36*
Mean	2.0	Ind.	1.9	1.5	1.6
Min	1.0	Ind.	1.1	1.0	0.9
Max	2.8	Ind.	3.2	2.2	2.6
	Scour ENR+AC				
N	--	*4*	*21*	*13*	*20*
Mean	--	0.8	1.4	2.1	0.8
Min	--	0.5	0.5	1.5	1.3
Max	--	1.25	2.5	2.9	1.9

Statistic	**Subtidal ENR**				
	Baseline*	**Year 0**	**Year 1**	**Year 2**	**Year 3**
N	*36*	*36*	*33*	*36*	*36*
Mean	12.7	10.5	5.4	2.4	3.2
Min	5.8	6.1	3.0	0.3	0.9
Max	21.6	16.0	13.4	8.4	9.4
	Subtidal ENR+AC				
N	--	*36*	*36*	*36*	*36*
Mean	--	10.8	7.4	3.0	9.0
Min	--	6.6	1.9	0.7	1.6
Max	--	20.4	19.9	11.9	17.5

Statistic	**Subtidal ENR**				
	Baseline*	**Year 0**	**Year 1**	**Year 2**	**Year 3**
N	*34*	*18*	*20*	*5*	*26*
Mean	1.3	1.5	2.6	1.2	0.8
Min	0.2	0.2	1.7	0.3	0.4
Max	3.0	2.0	4.3	3.4	1.9
	Subtidal ENR+AC				
N	--	*23*	*22*	*17*	*33*
Mean	--	1.4	1.3	1.5	1.3
Min	--	0.3	0	0.2	0.2
Max	--	3	3.8	3	3.6

Abbreviations:

aRPD = apparent redox potential discontinuity
cm = centimeter(s)
ENR = Enhanced natural recovery
ENR+AC = Enhanced natural recovery amended with activated carbon
Ind. = Indeterminate
SPI = Sediment profile imaging

Table C-2
Percent of SPI Stations Exhibiting Stage 3 Infauna [1] – Baseline through Year 3 [2]

	Baseline	Year 1		Year 2		Year 3	
		ENR	ENR+AC	ENR	ENR+AC	ENR	ENR+AC
Intertidal	67%	92%	67%	33%	33%	25%	25%
Scour	100%	100%	75%	100%	58%	100%	67%
Subtidal	50%	58%	50%	33%	17%	25%	67%

Abbreviations:

ENR = Enhanced natural recovery

ENR+AC = Enhanced natural recovery amended with activated carbon

Notes:

1. Images not designated as Stage 3 were either Stage 1, Stage 2, or indeterminate (Stage 3 could not be ruled in or out) due to limited penetration.
2. In Year 0, all successional stages were indeterminate on the newly-deposited ENR and ENR+AC material.

FIGURES

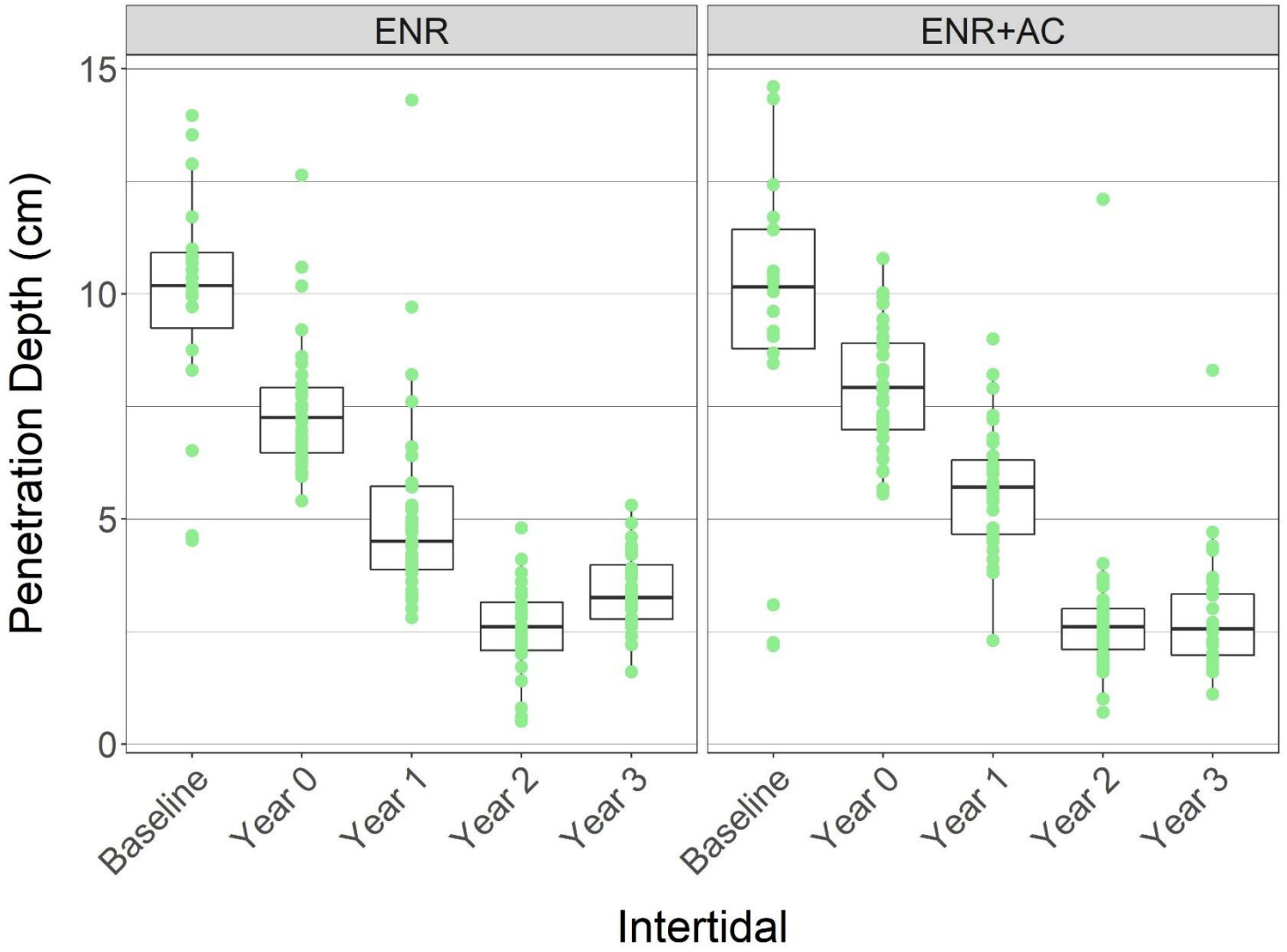
BA-IN-ENR+AC-5A-R1

BA-IN-ENR+AC-2A-R2

Lower Duwamish Waterway Group
Port of Seattle / City of Seattle / King County / The Boeing Company

ENR/AC Pilot Study
Year 3 Monitoring Report
Lower Duwamish Waterway

Figure C-1
Representative Intertidal Plot
Baseline SPI Images



Abbreviations:
cm = centimeter(s)
ENR = Enhanced natural recovery
ENR+AC = Enhanced natural recovery amended with activated carbon

Boxes show first quartile, median, and third quartile. Dots show data points.

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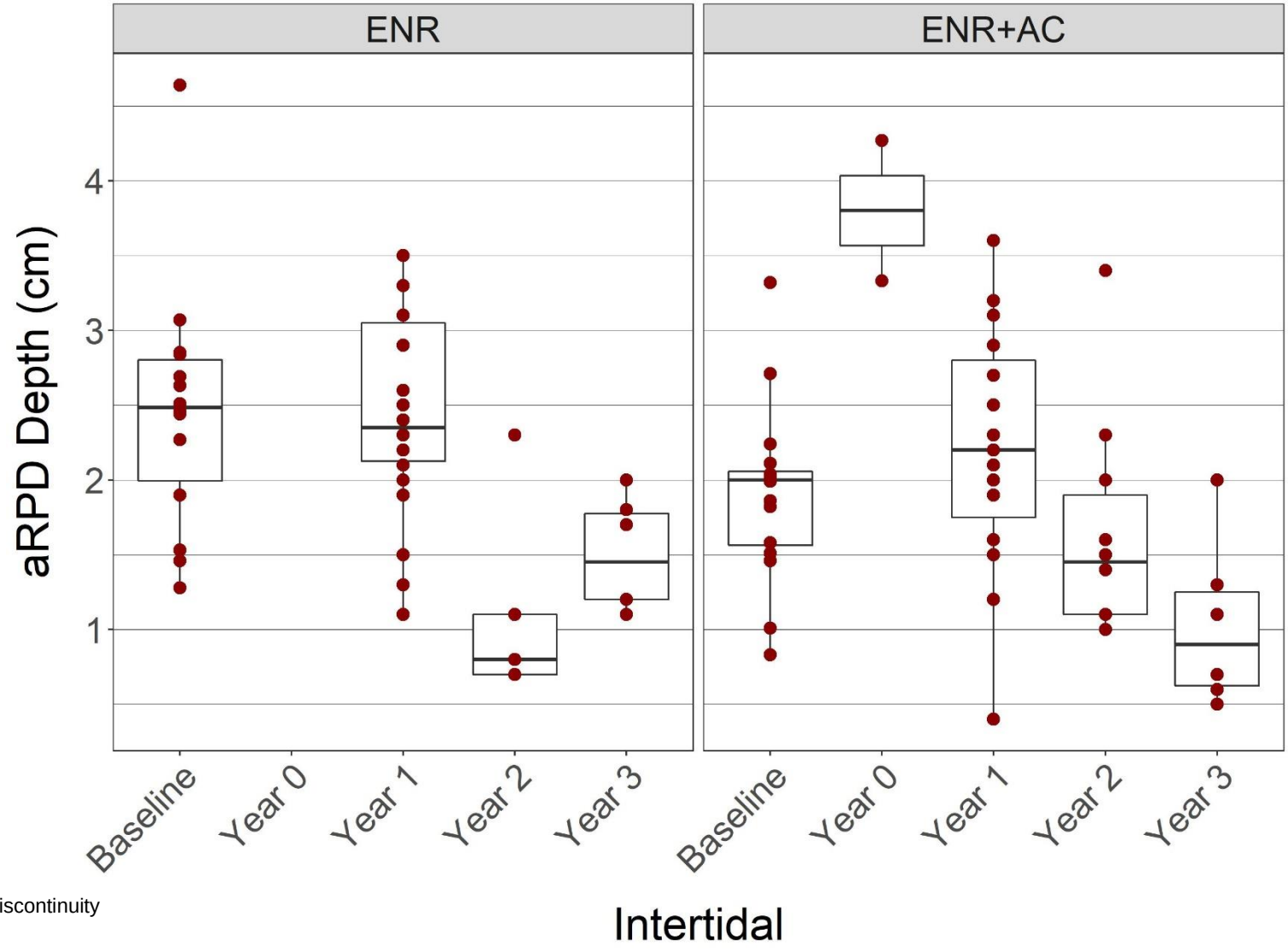
ENR/AC Pilot Study
Year 3 Monitoring Report
Lower Duwamish Waterway

Figure C-2
Intertidal Plot SPI Penetration Depths - Baseline through Year 3

3/10/2021



Abbreviations:
aRPD = apparent redox-potential discontinuity
cm = centimeter(s)
ENR = Enhanced natural recovery
ENR+AC = Enhanced natural recovery amended with activated carbon

Boxes show first quartile, median, and third quartile. Dots show data points.

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ENR/AC Pilot Study
Year 3 Monitoring Report
Lower Duwamish Waterway

Figure C-3
Intertidal Plot aRPD
Depths - Baseline through Year 3

BA-SC-ENR-1A-R1

BA-SC-ENR+AC-1A-R1

Lower Duwamish Waterway Group
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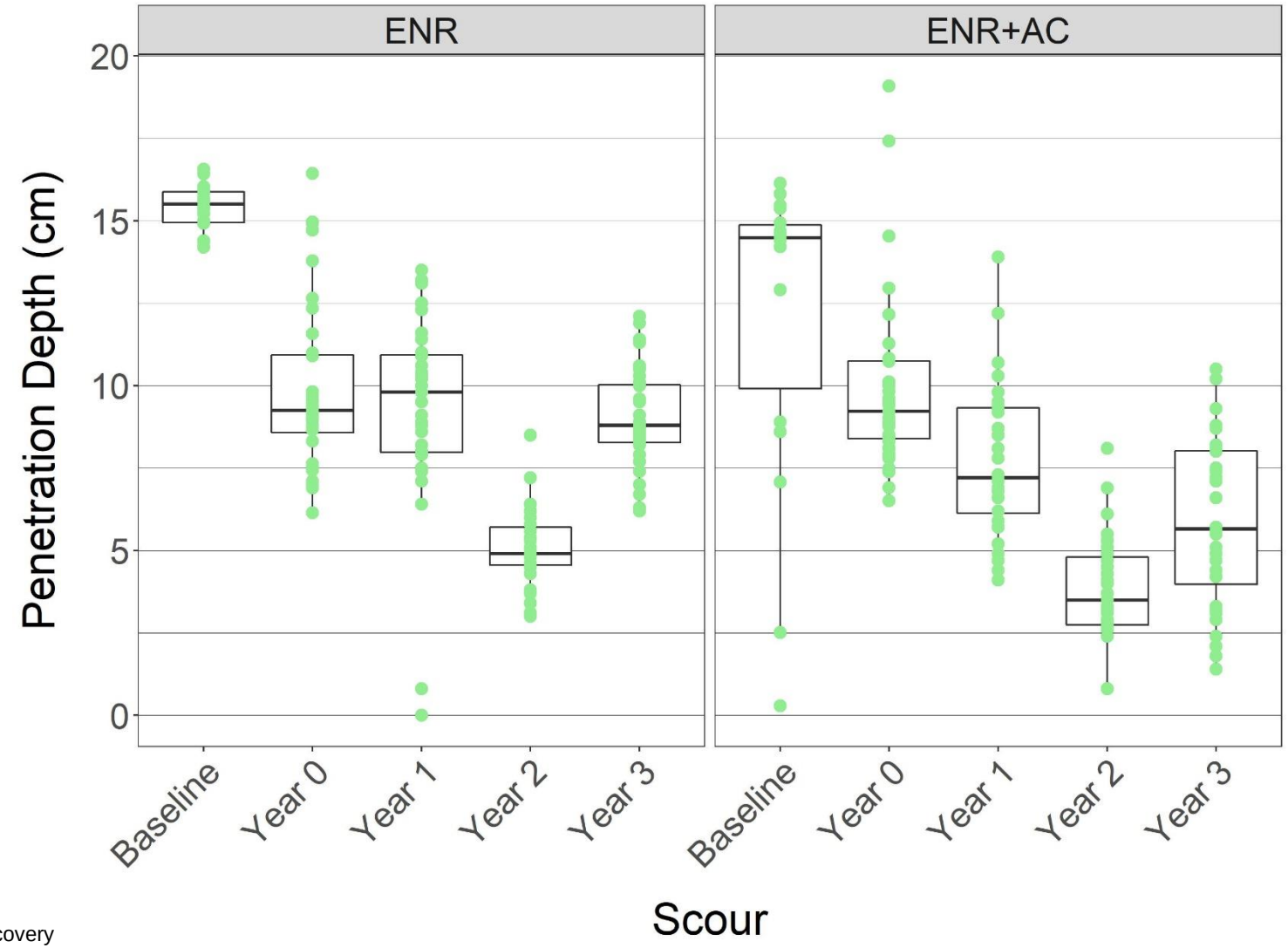
ENR/AC Pilot Study
Year 3 Monitoring Report
Lower Duwamish Waterway

Figure C-4
Representative Baseline Scour Plot
SPI Images



Abbreviations:
cm = centimeter(s)
ENR = Enhanced natural recovery
ENR+AC = Enhanced natural recovery amended with activated carbon
SPI = Sediment profile imaging

Boxes show first quartile, median, and third quartile. Dots show data points.

Lower Duwamish Waterway Group
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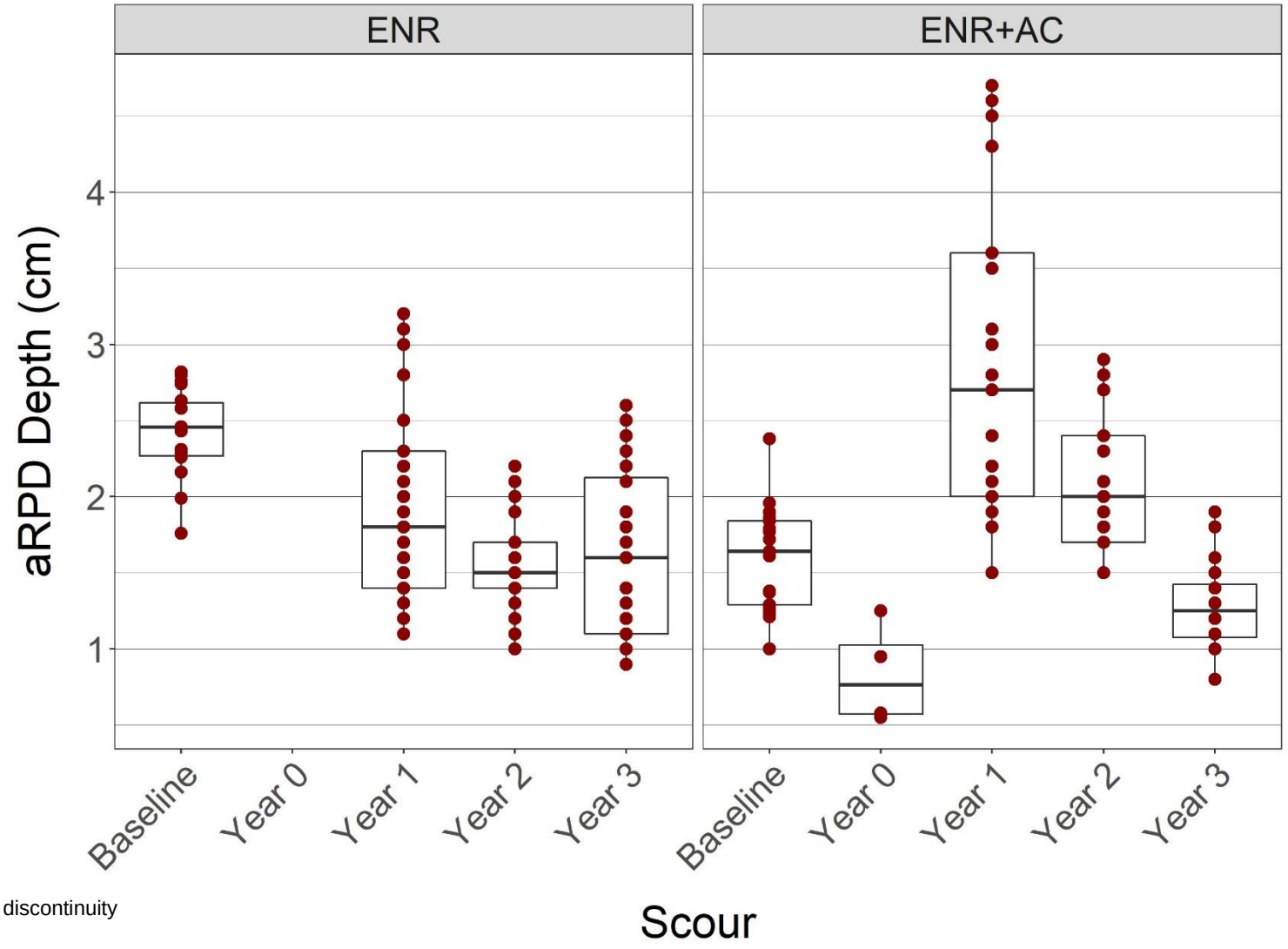
ENR/AC Pilot Study
Year 3 Monitoring Report
Lower Duwamish Waterway

Figure C-5
Scour Plot SPI Penetration Depths - Baseline through Year 3

3/10/2021



Boxes show first quartile, median, and third quartile. Dots show data points.

Abbreviations:
aRPD = apparent redox-potential discontinuity
cm = centimeter(s)
ENR = Enhanced natural recovery
ENR+AC = Enhanced natural recovery amended with activated carbon

Lower Duwamish Waterway Group
Port of Seattle / City of Seattle / King County / The Boeing Company

ENR/AC Pilot Study
Year 3 Monitoring Report
Lower Duwamish Waterway

Figure C-6
Scour Plot aRPD
Depths - Baseline through Year 3

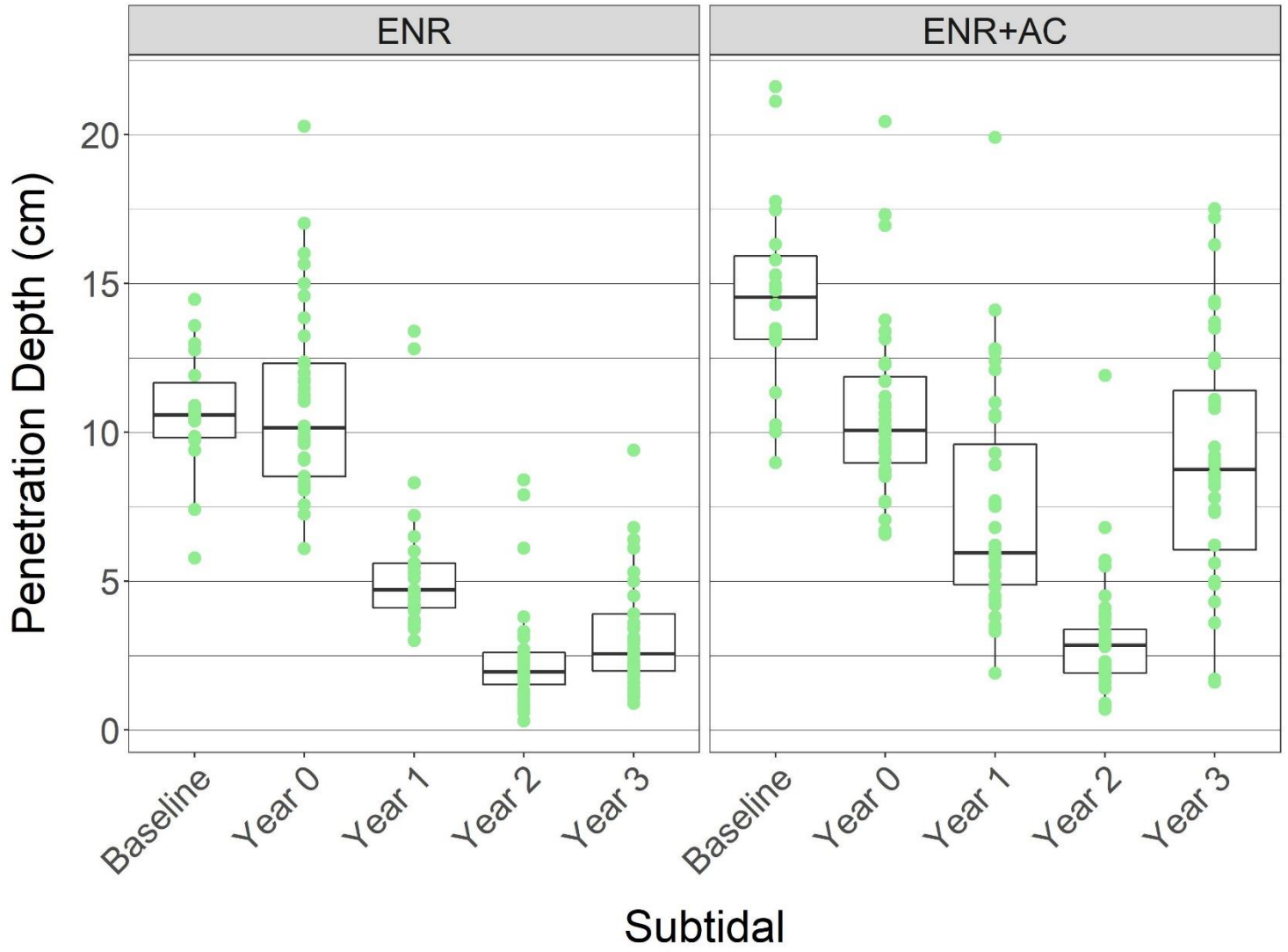
BA-SU-ENR-6A-R2

BA-SU-ENR+AC-4A-R1

Lower Duwamish Waterway Group
Port of Seattle / City of Seattle / King County / The Boeing Company

ENR/AC Pilot Study
Year 3 Monitoring Report
Lower Duwamish Waterway

Figure C-7
Representative Baseline Subtidal Plot
SPI Images



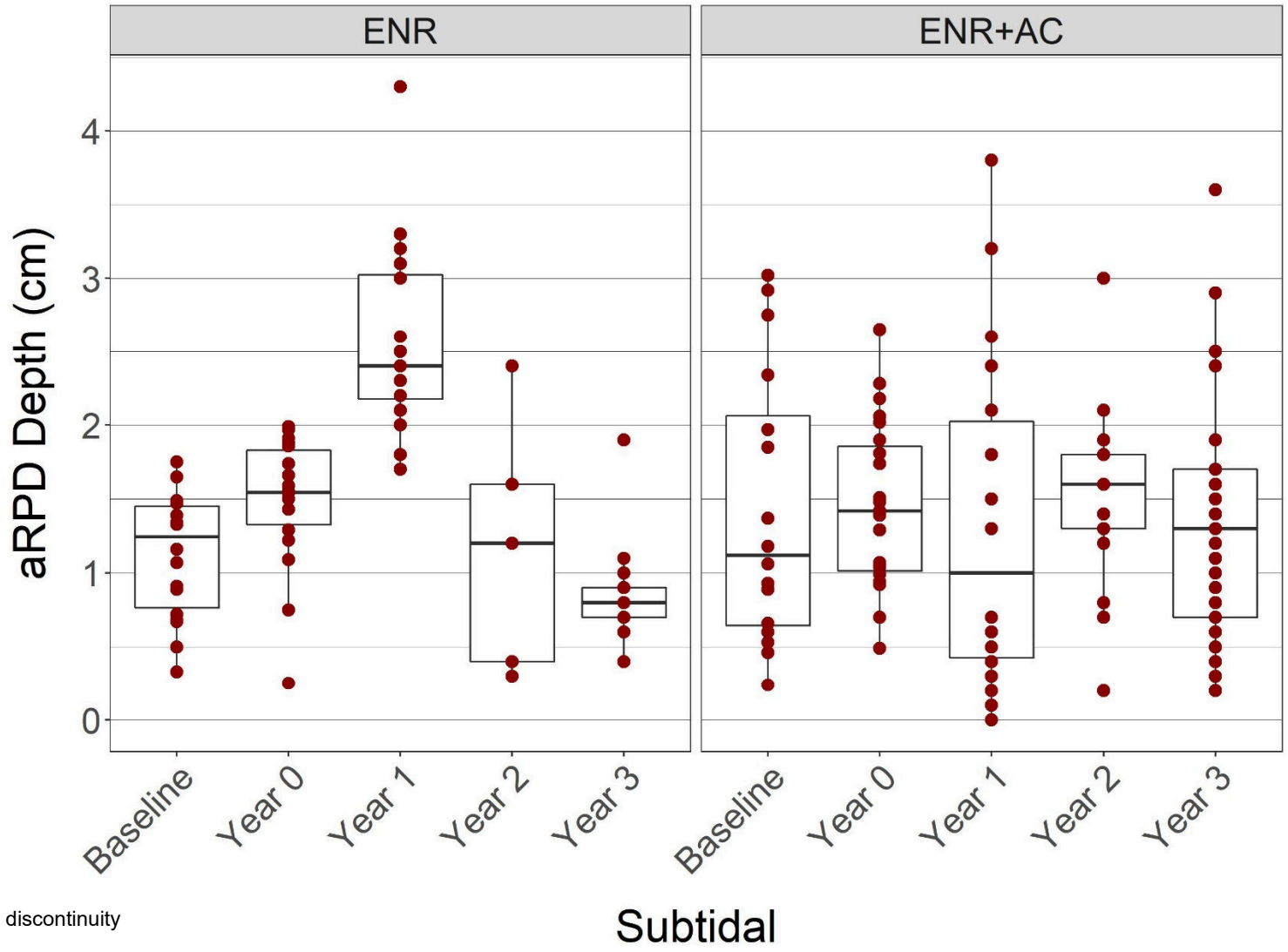
Abbreviations:
cm = centimeter(s)
ENR = Enhanced natural recovery
ENR+AC = Enhanced natural recovery amended with activated carbon

Boxes show first quartile, median, and third quartile. Dots show data points.

Lower Duwamish Waterway Group
Port of Seattle / City of Seattle / King County / The Boeing Company

ENR/AC Pilot Study
Year 3 Monitoring Report
Lower Duwamish Waterway

Figure C-8
Subtidal Plot SPI Penetration Depths - Baseline through Year 3



Abbreviations:
aRPD = apparent redox-potential discontinuity
cm = centimeter(s)
ENR = Enhanced natural recovery
ENR+AC = Enhanced natural recovery amended with activated carbon

Boxes show first quartile, median, and third quartile. Dots show data points.

Lower Duwamish Waterway Group
Port of Seattle / City of Seattle / King County / The Boeing Company

ENR/AC Pilot Study
Year 3 Monitoring Report
Lower Duwamish Waterway

Figure C-9
Subtidal Plot aRPD
Depths - Baseline through Year 3

Intertidal Plot

Y0-IN-ENR-2B-R1

Scour Plot

Y0-SC-ENR-1A-R3

Subtidal Plot

Y0-SU-ENR+AC-6A-R1

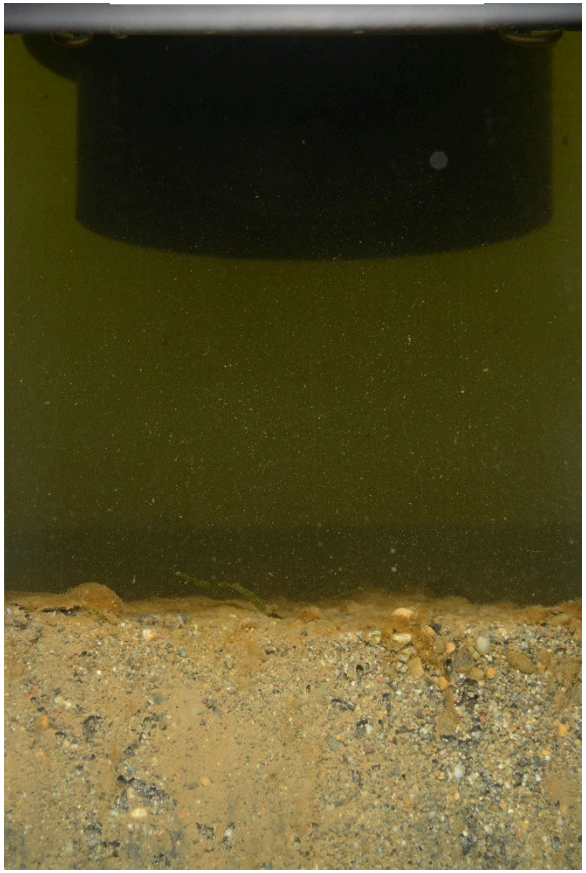
Lower Duwamish Waterway Group
Port of Seattle / City of Seattle / King County / The Boeing Company

ENR/AC Pilot Study
Year 3 Monitoring Report
Lower Duwamish Waterway

Figure C-10
Representative Year 0 SPI Images – All Plots

Y1-IN-ENR+AC-4A-R2

Y1-IN-ENR-4A-R1



Y1-IN-ENR+AC-6B-R3

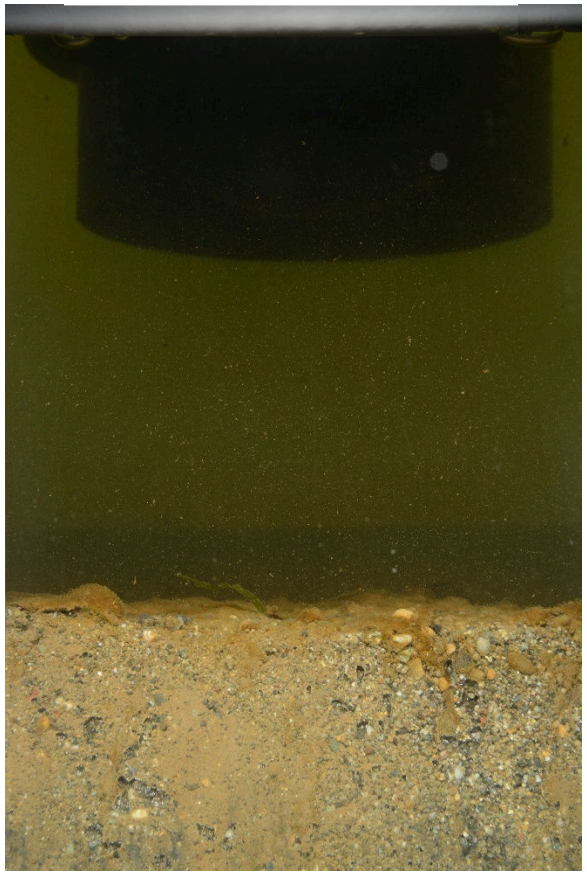
Lower Duwamish Waterway Group
Port of Seattle / City of Seattle / King County / The Boeing Company

ENR/AC Pilot Study
Year 3 Monitoring Report
Lower Duwamish Waterway

Figure C-11
Year 1 Intertidal Plot Sediment Textures

Y1-SC-ENR-1A-R1

Y1-SC-ENR+AC-5A-R3



Y1-SC-ENR+AC-3B-R1

Lower Duwamish Waterway Group
Port of Seattle / City of Seattle / King County / The Boeing Company

ENR/AC Pilot Study
Year 3 Monitoring Report
Lower Duwamish Waterway

Figure C-12
Year 1 Scour Plot Sediment Textures

Y1-SU-ENR-1B-R4

Y1-SU-ENR-4A-R3

Y1-SU-ENR-5B-R3

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ENR/AC Pilot Study
Year 3 Monitoring Report
Lower Duwamish Waterway

Figure C-13
Year 1 Subtidal Plot Sediment Textures

Y1-SU-ENR-6A-R2

Y1-SU-ENR-6A-R1

Y1-SU-ENR+AC-5A-R1

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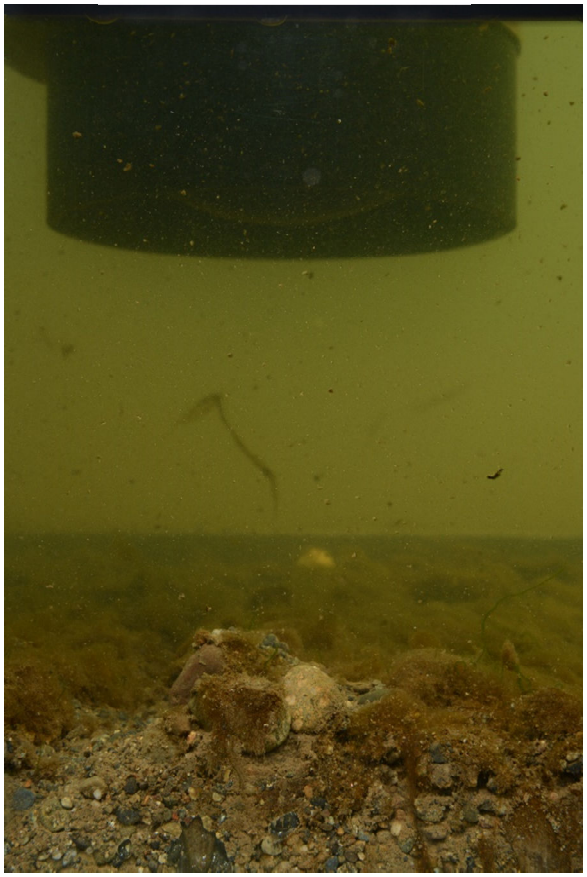
ENR/AC Pilot Study
Year 3 Monitoring Report
Lower Duwamish Waterway

Figure C-14
Year 1 Subtidal Plot
Disturbed ENR/ENR+AC Locations

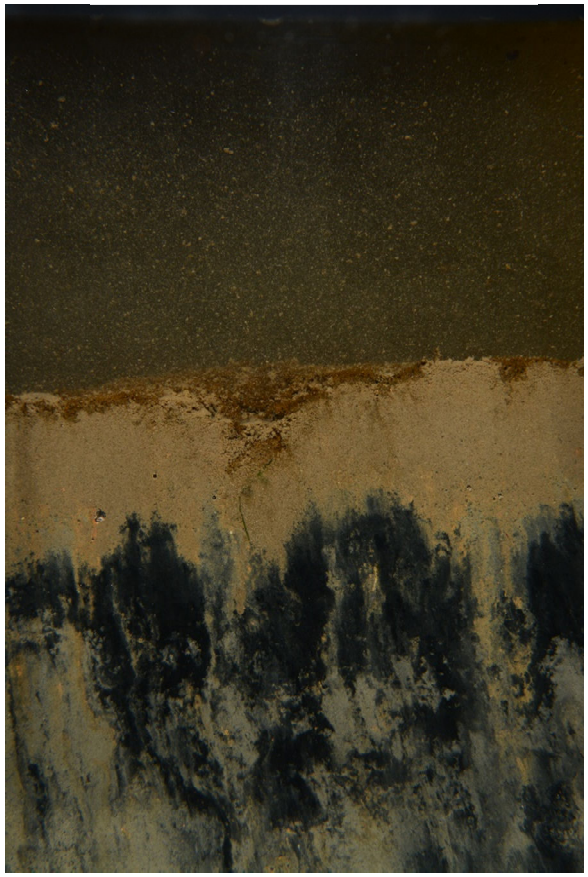
3/10/2021

Y2-IN-ENR-2A-R3



Y2-IN-ENR-3A-R3

Y2-IN-ENR+AC-2B-R1



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ENR/AC Pilot Study
Year 3 Monitoring Report
Lower Duwamish Waterway

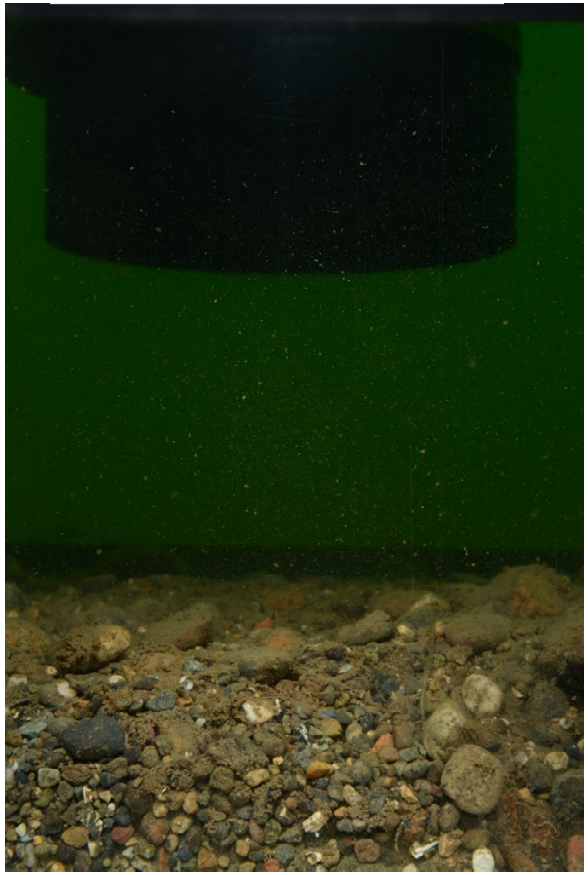
Figure C-15
Year 2 Intertidal Plot Sediment Textures

3/10/2021

Y2-SC-ENR-6A-R2

Y2-SC-ENR+AC-4B-R1

Y2-SC-ENR+AC-1A-R2



Lower Duwamish Waterway Group
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ENR/AC Pilot Study
Year 3 Monitoring Report
Lower Duwamish Waterway

Figure C-16
Year 2 Scour Plot Sediment Textures

Y2-SU-ENR+AC-2B-R1

Y2-SU-ENR-3B-R3

Y2-SU-ENR+AC-5B-R3

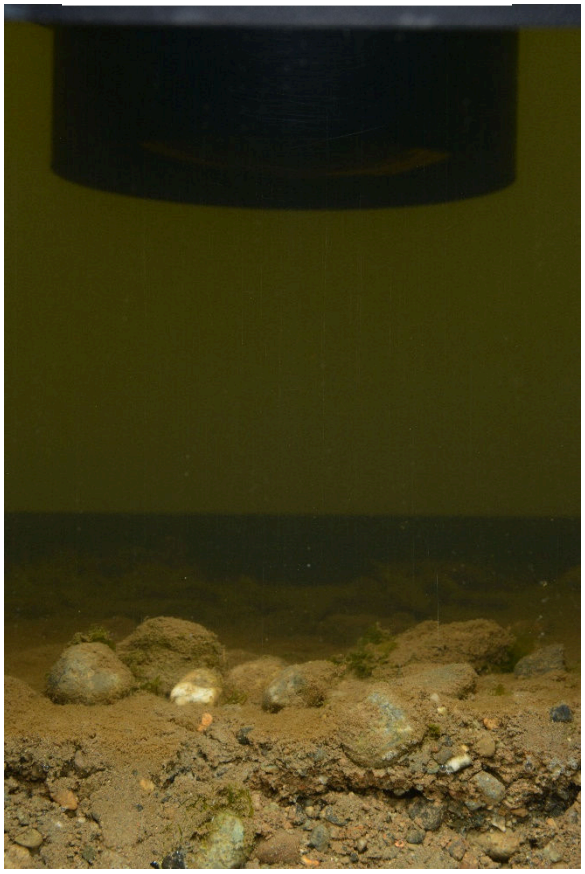
Lower Duwamish Waterway Group
Port of Seattle / City of Seattle / King County / The Boeing Company

ENR/AC Pilot Study
Year 3 Monitoring Report
Lower Duwamish Waterway

Figure C-17
Year 2 Subtidal Plot Sediment Textures

Y3-IN-ENR+AC-2A-R1

Y3-IN-ENR+AC-4A-R2



Y3-IN-ENR-6A-R3

Lower Duwamish Waterway Group
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ENR/AC Pilot Study
Year 3 Monitoring Report
Lower Duwamish Waterway

Figure C-18
Year 3 Intertidal Plot Sediment Textures

3/10/2021

Y3-SC-ENR-2B-R4

Y3-SC-ENR+AC-1A-R1

Y3-SC-ENR+AC-3A-R1

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Port of Seattle / City of Seattle / King County / The Boeing Company

ENR/AC Pilot Study
Year 3 Monitoring Report
Lower Duwamish Waterway

Figure C-19
Year 3 Scour Plot Sediment Textures

Y3-SU-ENR+AC-3A-R1

Y3-SU-ENR-3A-R3

Y3-SC-ENR+AC-5B-R4

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ENR/AC Pilot Study
Year 3 Monitoring Report
Lower Duwamish Waterway

Figure C-20
Year 3 Subtidal Plot Sediment Textures

ATTACHMENT 1

Year 2 SPI/PV Data Report

YEAR 2 SPI/PV DATA REPORT

Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway

Prepared for
Wood Environment & Infrastructure Solutions, Inc.

Prepared by

1205 West Bay Drive NW
Olympia, WA 98502

February 4, 2021

CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

AC	activated carbon
aRPD	apparent redox potential discontinuity
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
DGPS	digital global positioning system
DQO	data quality objective
ENR	enhanced natural recovery
ENR+AC	enhanced natural recovery amended with activated carbon
GAC	granular activated carbon
GUI	graphical use interface
Integral	Integral Consulting Inc.
LDW	Lower Duwamish Waterway
Order	Administrative Order on Consent
PCB	polychlorinated biphenyl
QA	quality assurance
QAPP	Quality Assurance Project Plan
RSS	Research Support Services
R/V	research vessel
SLR	single-lens reflex
SPI/PV	sediment profile imaging and plan view

1 INTRODUCTION

1.1 BACKGROUND

The Lower Duwamish Waterway Group is conducting a pilot study of an innovative sediment technology in the field to evaluate the potential effectiveness of the technology in the Lower Duwamish Waterway (LDW). The study will evaluate whether enhanced natural recovery (ENR) amended with activated carbon (AC) can be successfully used to decrease bioavailability of contaminants in sediment in the LDW. The study compares the effectiveness of ENR amended with AC (ENR+AC) against that of ENR without added AC. This is being tested in three habitat types: the subtidal, the intertidal, and an area where vessel scour is possible. For the purposes of this project, ENR involves the placement of a thin layer of clean material over subtidal or intertidal sediments. ENR+AC involves the placement of a thin layer of clean material augmented with AC over subtidal or intertidal sediments.

This pilot study was specified under the Second Amendment (July 2014) to the Administrative Order on Consent (Order) for Remedial Investigation/Feasibility Study for the LDW, CERCLA Docket No. 10-2001-0055, issued on December 20, 2000.

The goals of the pilot study, as stated in the Order Amendment, are the following:

- Verify that ENR+AC can be successfully applied in the LDW by monitoring physical placement success (uniformity of coverage and percent of carbon in a placed layer).
- Evaluate performance of ENR+AC compared to ENR alone in locations with a range of polychlorinated biphenyl (PCB) concentrations.
- Assess potential impacts to the benthic community in ENR+AC compared to ENR alone.
- Assess changes in bioavailability in ENR+AC compared to ENR alone.
- Assess the stability of ENR and ENR+AC in scour areas (such as berthing areas).

The sediment profile imaging monitoring work described in this report was performed consistent with the Quality Assurance Project Plan (QAPP; Amec et al. 2016a).

1.2 GOAL OF THE YEAR 2 SEDIMENT PROFILE IMAGING AND PLAN VIEW SURVEY

This Year 2 sediment profile imaging and plan view (SPI/PV) survey was one of several methods used to address data quality objective (DQO)-2: Evaluate the stability of ENR and ENR+AC materials in Years 1, 2, and 3 (Amec et al. 2016a). Specifically, the goal of the Year 2 SPI/PV survey of the pilot project was to collect information on the stability of the ENR and

ENR+AC materials. Digital images collected during the SPI/PV survey to assess ENR and ENR+AC materials' stability allow visual observations of physical sediment properties such as grain size, layering, and mixing that would indicate the presence of the ENR and ENR+AC materials with reference to baseline and Year 0 conditions. The extent of overlying sediment deposition on the ENR and ENR+AC materials was also assessed. By noting the presence and distribution of biota and biogenic structures in the SPI/PV images in comparison to previous surveys, the Year 2 SPI/PV results will be used to assess and compare the apparent extent of benthic community recolonization of the ENR and ENR+AC subplots. This line of evidence will support the evaluation of DQO-4: Assess the Potential Impacts of AC on Benthic Communities (Amec et al. 2016a).

2 METHODS

2.1 FIELD COLLECTIONS

The Year 2 SPI/PV survey of the LDW pilot areas was conducted on March 7 and 8, 2019. The intertidal plot was sampled on both March 7 and 8 around the high tide, the scour plot was sampled on March 8, and the subtidal plot was sampled on March 7.

The surveys were conducted aboard the research vessel (R/V) *Carolyn Dow*, owned and operated by Research Support Services (RSS) of Bainbridge Island, Washington. All positioning and navigation during the survey was conducted by RSS using a digital global positioning system (DGPS). Scientists from Amec Foster Wheeler[1] provided oversight of navigation and positioning during the survey as well as record keeping. Scientists from Integral Consulting Inc. (Integral) operated the SPI/PV camera, kept field notes, and ensured successful image acquisition. The SPI/PV camera was fully loaded with all additional weight (250 lb) for the entire survey anticipating the firm, ENR material substrate. This allows SPI prism penetration depth to be used as a relative measure of bed firmness/consolidation between locations.

A total of 72 stations, 24 from each plot (12 from each subplot), were occupied using the SPI/PV camera during the Year 2 monitoring event. At each station, the R/V was piloted to the target location and the SPI/PV system was lowered to the sediment bed only when the vessel was within 2 m of the target location. A minimum of three replicate image sets were collected at each target location. Therefore, a total of 72 SPI/PV paired images were collected at each plot (24 stations x 3 replicates). Twelve stations were occupied in the ENR-only subplot and 12 stations were occupied in the ENR+AC subplot, two stations in each grid cell. The 12 stations were collected from "A" and "B" cells during the Year 2 sampling event. The SPI/PV locations for each plot, including replicates, are shown in Figures 2-1, 2-2, and 2-3. All SPI/PV images are provided electronically in Exhibit 1 (provided on DVDs).

Acquisition of high-resolution SPI images was accomplished using a Nikon D7100 digital single-lens reflex (SLR) camera with a 24.1-megapixel image sensor mounted inside an Ocean Imaging Model 3731 pressure housing system. Camera settings were f8, ISO 640, and 1/320 shutter speed. A total of 216 sediment profile images were selected for analysis (3 replicate images from each of 72 stations).

PV images were collected using a Nikon D7100 SLR camera with a 24.1-megapixel image sensor mounted inside an Ocean Imaging Model DSC2400 camera housing and attached to the front of the SPI camera frame. As in Year 1, a PV camera focal distance of 2 ft was used. This relatively short trigger length reduces PV image field, but increases the likelihood of obtaining relatively

[1] Amec Foster Wheeler is now Wood Environment & Infrastructure Solutions, Inc.

clear, analyzable images in the relatively turbid LDW estuarine setting. In addition, sediment re-suspended from the first replicate drop at each location can affect the quality of the second and third PV replicate image. Throughout the survey, images were downloaded periodically in the field to review image quality.

The table below summarizes the number of SPI and PV images collected and analyzed from each subplot. The target 36 SPI images were analyzed from each subplot. Two to seven PV images from four of the six subplots were not analyzable due to high near-bottom turbidity levels that obscured the seafloor.

Number of Year 2 SPI/PV Images Analyzed from Each Subplot

	Intertidal Plot		Scour Plot		Subtidal Plot	
Image Type	ENR	ENR+AC	ENR	ENR+AC	ENR	ENR+AC
SPI	36	36	36	36	36	36
PV	36	29	31	34	36	30

2.2 SEDIMENT PROFILE AND PLAN VIEW IMAGE ANALYSIS

Integral analyzed the Year 2 SPI/PV survey images using its integrated, MATLAB-based image analysis software (iSPI v1.1). The image files along with the metadata-containing Microsoft® Excel files generated during the field survey were imported directly into iSPI for analysis. A menu-structured graphical use interface (GUI) in iSPI allows the image analyst to measure and/or add descriptive comments for key imaged features (Figure 2-4). The draft data were stored in the system for review by a senior scientist. Following the quality assurance (QA) check of all measured and descriptive parameters, the SPI/PV data set was compiled and identified as final; the data was then exported and evaluated.

The iSPI software facilitates and standardizes the measurement, storage, and QA review of data from SPI and PV images. However, the approach and underlying interpretive rationale used to identify and measure the suite of parameters and features observed in the images (e.g., grain size, apparent redox potential discontinuity [aRPD] depth, infaunal successional stage) is comparable to the approach used for the baseline and Year 0 surveys by Browning Environmental Services. It is identical to the Year 1 survey approach used by Integral. The overall image analysis approach and interpretive framework are detailed in the previous SPI/PV data reports for this project (e.g., Construction Report Attachment 5 [Amec et al. 2018]), and are not repeated here.

Specific to the QAPP requirements for this study, the Year 2 SPI/PV image analysis included:

1. Visually identifying ENR and ENR+AC layers in the SPI images, and if present, measuring the layer thickness if the SPI camera penetrated the ENR material
2. Noting the presence and distribution of granular activated carbon (GAC) in the images, if visually discernable
3. Noting and scoring (low, medium, high) the apparent surface roughness in each PV image
4. Measuring the size and depth of all feeding voids observed in each SPI image.[2]

[2] Feeding voids are formed by subsurface deposit-feeding polychaetes and are indicative of higher order successional stage benthic infauna presence; examples of feeding voids can be seen in Figure 3-3b (near the bottom of image Y2-SC-ENR-6-A-R2).

3 RESULTS

The Year 2 SPI/PV survey image analysis results/observations are provided for each plot (intertidal, scour, and subtidal) and subplot treatment (ENR and ENR+AC) in Tables 3-1a through 3-6b. In each case, the SPI results are presented in the "a" table and the PV results are in the "b" table.

The results for each plot and subplot treatment are described in the sections that follow.

3.1 INTERTIDAL PLOT

The sediment texture (i.e., grain-size), observed in the SPI images from the intertidal plot vary widely from silt through coarse sands and into gravels, < -1 phi units, as indicated in Tables 3-1a and 3-2a. This variety reflects the ENR materials placed there combined with inputs of ambient fine-grained sediments since construction.

3.1.1 Intertidal ENR Subplot

Evidence of the ENR material (i.e., sands and gravels) was directly observed, or inferred to be present based on limited SPI prism penetration at all stations sampled in the intertidal ENR subplot. Figure 3-1 shows three SPI images that illustrate the range of textures observed in this subplot: ENR gravels and sands, ENR gravels/sands mixed with post-placement silt deposits, and compact, thin (3-4 cm) silt layers overlying ENR material. The SPI image Y2-IN-ENR-6A in Figure 3-1 is an example of an image when ENR material is not evident in the sediment profile, but the shallow penetration of the silt substrate strongly suggests that coarse-grained ENR lies just below the frame. Table 3-1a includes a column noting these textures. Table 3-1a also includes an ENR Layer Thickness column. In all cases where the ENR material was evident in an image, it extended to the bottom of the SPI prism window and so is noted as >P (greater than penetration) in the data tables.

The average penetration depth (cm) for each image is also included in the tables. SPI images in which ENR material was not evident are indicated by an LNA (layer not apparent) in the table (only 3 of the 36 SPI replicates analyzed). As noted above, it is suspected that the ENR material is present just below the depth of camera penetration at these locations based on the limited penetration and visual evidence of coarse ENR material in the other replicates from these stations (all station replicates were collected within each 10- x 10-ft grid cell; Figure 2-1).

The SPI prism penetration depth for the intertidal ENR subplot in Year 2 averaged just 2.5 cm (see bottom of Table 3-1a). This is further evidence that ENR material is present and intact throughout the placement area. Tables 3-1a through 3-6a include summary statistics for the SPI

numerical parameters—penetration depth, boundary roughness, and aRPD depth—at the bottom of each table. Table 3-7 lists the summary statistics for the prism penetration and aRPD depths for all plots/subplots from the baseline (2016) through the Year 2 survey (2019). Prior to ENR material placement, the baseline survey penetration depth at the intertidal plot averaged 9.7 cm. It has steadily decreased about 2 cm since that survey, which suggests that the ENR material is becoming more consolidated over time.[3] This may be due to both settling/ compaction of the gravels and sand with time, as well as the settlement and infiltration of ambient fine-grained sediment (silts) into the ENR material interstices creating a substrate that is more resistant to SPI prism penetration.

In many of the Year 2 SPI images there is visual evidence of mixing of ENR materials with ambient fine-grained sediments (see image Y2-IN-ENR-3-A in Figure 3-1). This fine-grained sediment has been deposited at the site in the approximately 26 months between the Year 0 and Year 2 surveys. Some fines are also possibly being mixed upward from below the ENR layer. The mixing of ENR material and ambient sediments is likely due to both physical (tides, waves, currents) and biological (bioturbation, demersal foraging) forces.

Features observed in the SPI images that indicate the presence of benthic infauna include oxidized surface sediments (aRPDs); large, surface polychaete tubes; worms at depth in the sediment column; and feeding voids formed by subsurface deposit feeders. Due to limited penetration depths, however, the aRPD depth was only evident/measurable in five replicates and ranged from 0.7 cm to 2.3 cm, with an average value of 1.1 cm (Table 3-1a). This is less than the average aRPD depths measured in Year 1 and during the baseline survey (Table 3-7), but this may be an artifact of fewer records of the aRPD depth due to the shallower penetration. For most of the 31 replicates where it could not be measured, the aRPD depth extends to the bottom of the frame, i.e., it is deeper than the penetration depth (e.g., see image Y2-IN-ENR-3A in Figure 3-1).

Also due to the limited penetration, an infaunal successional stage could only be assigned for six replicate images. However, four of those replicates exhibited evidence of Stage 3 (67%) infauna, such as subsurface feeding voids, suggesting advanced, benthic recolonization of the subplot. The PV images show minimal evidence of epifauna in the intertidal ENR subplot, although tubes and tracks are seen in about 20% of the images analyzed. A thin, brown algal film overlying the mixed gravel, sand, and silt bottom is evident in many of the SPI and PV images from this subplot (see images Y2-IN-ENR-2-A and Y2-IN-ENR-6-A in Figure 3-1).

[3] Note that the SPI camera was fully loaded with all 250 lb of weight for each of the LDW ENR/AC Pilot Study surveys so that the relative penetration obtained between surveys is a relative measure of substrate firmness.

3.1.2 Intertidal ENR+AC Subplot

The Year 2 SPI/PV results from the intertidal ENR+AC subplot are similar to the ENR subplot. Evidence of the ENR+AC layer (i.e., sands and gravels) greater than prism penetration was observed in all but three of the SPI images (Table 3-2a). Those replicates were from three different stations (2B, 3A, 4B) with the two other replicates clearly showing ENR+AC material (Figure 3-2). ENR+AC material is not evident at one replicate from IN-ENR+AC-2-B-R1, where the SPI image shows relatively deep penetration into a soft, silty sediment column with reduced sediment at depth (2-B-R1; left image in Figure 3-2). Given that the other two replicates from this location clearly show ENR material (2-B-R2; middle image in Figure 3-2), this appears to be an isolated feature in the ENR cover, perhaps a small topographic depression being backfilled with silt. The other two replicates where ENR+AC material is not apparent in the SPI images appear to be compact silt overlying ENR+AC material. This is based on the minimal penetration obtained (4-B-R1; right image in Figure 3-2), and the presence of ENR+AC material (pebbles/cobbles) in the PV images from Station 4-B. No obvious AC material was observed in any of the SPI/PV images from the intertidal ENR+AC subplot in Year 2.

The SPI prism penetration depth for this subplot ranged from 0.7 to 12.1 cm with an average value of 2.8 cm; this is comparable to the intertidal ENR subplot. The deepest penetration of 12.1 cm was obtained at the location where ENR+AC material was absent in the image. The next deepest penetration was 4.0 cm. As noted for the intertidal ENR subplot, penetration has steadily decreased about 2 cm per survey since the Year 0 immediate post-construction, pointing to ENR+AC material consolidation over time (Table 3-7).

As at the intertidal ENR subplot, there is evidence of mixing of ENR materials with ambient fine-grained sediments at many stations (Table 3-2a), i.e., silts mixed with the ENR+AC material.

Evidence of benthic community presence and recolonization in the intertidal ENR+AC subplot is comparable to that observed for the intertidal ENR subplot. The average aRPD depth for this subplot is 1.6 cm with a range from 1.0 to 3.4 cm. This is less than the average aRPD depths measured in Year 1 and during the baseline survey (Table 3-7). But, again, this may be an artifact of the shallower penetration depths; aRPD depths could only be measured at 7 stations of the 12 (10 SPI replicates). Due to the limited penetration, an infaunal successional stage could only be assigned for eight replicate SPI images across six stations, but four of those stations (67%) show evidence of Stage 3 infauna, suggesting advanced, benthic recolonization across much of the subplot. The PV images show minimal evidence of epifauna in the intertidal ENR+AC subplot, although tracks are seen in about 44% of the images analyzed. As at the ENR subplot, a thin, brown algal film overlying the mixed gravel, sand, and silt bottom cover is evident in many of the SPI and PV images from this subplot (see Y2-IN-ENR+AC-2-B-R1 and Y2-IN-ENR+AC-2-B-R2 in Figure 3-2).

3.2 SCOUR PLOT

As in Year 1, the Year 2 SPI/PV images from the scour plot show a change in surface sediment textures from upstream to downstream. The upstream ENR subplot is predominantly fine-grained. Surface textures in the downstream ENR+AC subplot are also predominantly fine-grained sediment at the upstream end adjacent to the ENR subplot, but they are predominantly gravel and sands at the downstream end in ENR+AC subplot in grid cells 1, 3, and 5 (Figure 2-2).

3.2.1 Scour ENR Subplot

Surface sediments in the SPI images from the scour ENR subplot are predominantly silt or silt and ENR material mixtures. Figure 3-3a shows collocated SPI and PV images from Station 1A, the downstream end of the subplot. While predominantly silt, ENR gravel and cobbles can be seen in the upper sediment column and on the sediment surface. While there are subfractions of sands and gravels in a number of images, the major mode evident in 24 of the 36 SPI replicates is either >4 phi, silt or finer, or 4-3 phi, very fine sand (Table 3-3a). Figure 3-3b shows a SPI and PV image from Station 6A, the upstream end of the subplot; this area is predominantly silt, although ENR material is often evident at the bottom of the SPI images and in the feeding voids and burrows, indicating ENR material underlies the deposited silts. Scattered gravel-sized material is also seen in many of the PV images from this subplot.

The mean SPI prism penetration depth for this subplot ranged from 3.4 to 8.5 cm with an average value of 5.2 cm (Table 3-7). This is less than average penetration depth of 9.3 cm obtained in Year 1, suggesting thinner silt deposits overlying the ENR material in Year 2 than in Year 1 and/or ENR material consolidation over time.

Evidence of benthic infauna presence is widespread in the images from the scour ENR subplot. The SPI images in Figures 3-3a and 3-3b both show subsurface feeding voids and small, tubiculous polychaetes at the sediment surface. The PV images in Figure 3-3a show numerous tracks and trails on the sediment surface and a large, polychaete tube. Stage 3 infauna are evident in 34 of the 36 replicates from this subplot, indicating the re-establishment of a benthic infaunal community. The average aRPD depth for this subplot is 1.5 cm with a range from 1.0 to 2.2 cm, which compares closely to the mean aRPD depth of 1.9 cm and range of 1.1 to 3.2 cm measured in Year 1 (Table 3-7).

Consistent with the SPI benthic infauna observations, the PV images from the scour ENR subplot (Table 3-3b) show widespread evidence of biological activity. This evidence is mostly in the form of widespread tracks and tubes, but some epifaunal organisms are also captured in the images (Table 3-3b). Reflecting the silt deposit covering the subplot area, the reported surface roughness was low or medium in all of the scour ENR subplot PV images.

3.2.2 Scour ENR+AC Subplot

Coarse ENR+AC material is evident at the sediment surface across the northern tier of the scour ENR+AC subplot (grid cells 1, 3, and 5 in Figure 2-2). Table 3-4a shows that the grain size major modes in these cells are all in the coarse sand and gravel range. Figure 3-4a is a SPI and PV image pair from Station 1A illustrating the sediment texture in these cells. Silt is predominant in the surface sediment south of this area (cells 2, 4, and 6), but ENR material is still evident, either underlying the deposited silt or scattered across the sediment surface, as in the scour ENR subplot. Figure 3-4b shows the surface sediment texture at Station 4A. ENR+AC material is not clearly evident in 14 of the 36 images from this subplot (Table 3-4a). However, due to the limited prism penetration depth throughout the subplot as well as scattered, coarse-grained material observed on the surface in the collocated PV images, the ENR+AC material appeared to be intact and underlying the silt deposit throughout the subplot. No obvious AC material was observed in any of the SPI/PV images from the scour ENR+AC subplot in Year 2.

The mean SPI prism penetration depth for this subplot ranged from 0.8 to 8.1 cm with an average value of 3.9 cm, less than the average of 5.2 cm at the adjoining ENR subplot, reflecting the thinner silt overburden (Table 3-7).

In the Year 1 survey, black particles, possibly GAC, were subtly evident in some of the SPI images with ENR+AC material and silt mixtures. In the Year 2 survey, there is no visual evidence of the black particles in the ENR+AC SPI images, i.e., the images from both subplots have similar color and texture subfractions.

Evidence of subsurface deposit-feeding benthic infauna is present in 15 of the 36 images from this subplot, again indicating benthic infaunal recolonization of the area. This is much less than the 34 replicates with Stage 3 fauna at the ENR subplot; however, an infaunal successional stage could not be assigned in 19 of the 36 images dominated by gravel and coarse sand. This accounts for the detection difference in Stage 3 infauna between the subplots. The average aRPD depth for the ENR+AC subplot is 2.1 cm with a range from 1.0 to 2.9 cm. Although the aRPD could only be measured in 13 images (36%), it is deeper than the average aRPD depth measured in Year 1 and comparable to that measured during the baseline SPI survey for this area (Table 3-7).

The PV image data from the scour ENR+AC subplot (Table 3-4b) also point to a more dynamic setting than the ENR subplot. Surface roughness was scored as high or medium in 27 of the 34 PV replicates, reflecting the relative lack of silt cover in some areas. Surface tracks, tubes, and burrows, which are more obvious/persistent in fine-grained sediment, were less frequently observed in the ENR+AC ENR subplot, compared with the ENR subplot.

3.3 SUBTIDAL PLOT

The Year 2 SPI/PV images from the subtidal parallel east and west lane subplot (Figure 2-3) show similar trends in surface sediments textures/ENR material presence from north (downstream) to south (upstream). Grid cells 1 through 4 generally show compact silts and very fine overlying ENR materials. ENR material is generally evident at the surface in grid cell 5, and ENR+AC material is disturbed or largely not present in a number of images from cells 5 and 6 of the ENR+AC subplot and some images from cell 6 of the ENR subplot. As noted previously, surface sediments in this area (cells 5 and 6) have reportedly been disturbed by barge chain dragging (Amec et al. 2016b).

3.3.1 Subtidal ENR Subplot

Surface sediments from the subtidal ENR subplot range from compact silt/fine sands (Figure 3-5a), to ENR medium and coarse sands (Figure 3-5b), to reduced silts and with residual ENR material (Figure 3-5c). Table 3-5a lists the SPI data for the 36 replicates analyzed from the ENR subplot. The ENR material is not apparent in cells 1 through Station 3A, but is presumed to be immediately below the compact deposited silts/fine sands based on the limited prism penetration. From Station 3B to 6A (Figure 2-3), ENR material is evident to the penetration depth. At Station 6B, a measurable ENR layer is observed in one replicate. The ENR material appears to not be present in the other two replicates from this location, but patchy residual ENR material can be seen in the PV images (Figure 3-5c).

The prism penetration depths for the ENR subplot are quite shallow (see SPI images in Figures 3-5a and 3-5b), averaging 2.4 cm and ranging from 0.3 to 8.4 cm (Table 3-7). This is much less than the subtidal plot baseline average penetration of 12.7 cm. As in the other subplots, the Year 2 penetration is notably less than the penetration obtained in Year 1, and again may reflect ENR material consolidation and silt infiltration over time.

Due to the limited SPI penetration, aRPD depths could be measured in only five SPI replicates (across four stations) and successional stages could only be assigned for six replicates (five stations). The average aRPD depth for this subplot was 1.2 cm with a range from 0.3 to 2.4 cm; this is less than the 2.6 cm average measured in Year 1, but is comparable to the mean aRPD depth of 1.3 cm measured during the baseline SPI survey (Table 3-7). Of the six successional stages, four were Stage on 1 on 3, indicating the presence of high-order successional stage benthos (i.e., larger, subsurface deposit feeders). The two Stage 1 replicates were found at Station 6B where the ENR/surface sediment layer had been physically disturbed (Table 3-5a). Although few epifaunal organisms were captured in the PV image set, the images do show evidence of both infauna and epifauna presence with surface worm tubes evident in 31 images and epibenthic tracks detected in 16 of the 36 PV images, respectively (Table 3-5b). Figure 3-5a shows epifaunal tracks on the sediment surface in the PV image from Station 1B.

3.3.2 Subtidal ENR+AC Subplot

Surface sediments from the subtidal ENR+AC subplot show the same general gradients as the adjacent ENR subplot. Compact silt and fine sands overlie ENR+AC material in cells 1 to 3, and ENR+AC material is generally evident from the surface to the penetration depth in cells 4 to 6. However, only residual ENR+AC material is present in some replicates at Stations 5B and 6B, again apparently due to barge chain dragging in this portion of the subtidal plot (Table 3-6a). Figure 3-6 provides examples of the surface sediment textures at Stations 2B (compact silt/fine sand) and 5B (residual and removed ENR+AC material). A black, fine-grained surface layer, possibly AC material, was observed in one Year 2 SPI replicate, Y2-SU-ENR+AC-6-A-R1 (Table 3-6a).

The prism penetration depths for the subtidal ENR+AC subplot are relatively shallow, averaging 3.0 cm and ranging from 0.7 to 11.9 cm (Table 3-7). This is slightly deeper than the penetration at the subtidal ENR subplot and may reflect slightly more disturbance of the ENR material in cells 5 and 6. As in the other subplots, the Year 2 penetration is notably less than the penetration obtained in Year 1.

The average aRPD depth for this subplot was 1.5 cm (n = 17) with a range from 0.2 to 3.0 cm, which is comparable to the 1.3 cm average depth measured in both Year 1 at this subplot and the across the entire subtidal plot in the baseline SPI survey (Table 3-7). Of the 11 successional stages measured, eight were Stage 1 only, perhaps indicating recent disturbance or that the benthic recolonization is less advanced than in the adjacent ENR subplot. The sample sizes are low and five of the eight Stage 1 successional stages are the physically disturbed cells 5 and 6, which could account for lack of advance recolonization. As with the ENR subplot, few epifaunal organisms were captured in the PV images, but they do show widespread evidence of both infauna and epifauna with surface worm tubes evident in 26 images and epibenthic tracks detected in 19 of the PV images, respectively (Table 3-6b).

4 SUMMARY OF FINDINGS

The objectives of the Year 2 SPI/PV survey were to document the presence and appearance of the ENR and ENR+AC material layers, including the distribution of GAC (if discernable); measure specific SPI/PV parameters (e.g., penetration and aRPD depths, feeding voids) in the images; and assess evidence of benthic community recolonization in each study subplot. The ENR and ENR+AC materials were readily identifiable in the SPI and PV images due to their coarse-grained nature relative to the finer-grained ambient sediments. In most instances, the ENR or ENR+AC layers exceeded SPI prism penetration depths so layer thicknesses could generally not be determined. Also, with the exception of one replicate SPI image from Station 6A of the subtidal ENR+AC subplot, there was no obvious visual evidence in the SPI or PV images of black particles in the ENR+AC subplots (i.e., the imaged particle color, texture, and granularity were similar between the two treatments).

4.1 INTERTIDAL PLOT

ENR/ENR+AC material was observed or inferred to be present at 71 of the 72 replicates sampled in the intertidal plot. Where evident as a sand and gravel layer, it exceeded the depth of prism penetration, which averaged only 2–3 cm in this plot. In most images, ambient silt deposited since material placement (Year 0; 2017 survey) was mixed into the ENR material and/or overlying it in a thin veneer. Some images showed only ENR material with no or minimal silt additions. Prism penetration was about half of that obtained in Year 1 in both subplots. This pattern of reduced penetration relative to Year 1 was observed at all plots (Table 3-7). It is hypothesized that this is due to both settling/compaction of the ENR/ENR+AC gravels and sands over time in combination with the settlement and infiltration of ambient fine-grained sediment (silts) into the ENR/ENR+AC material interstices, creating a substrate that is more resistant to SPI prism penetration.

Benthic community recolonization was evident at both intertidal subplots. The measured aRPD depths were comparable between the ENR and ENR+AC subplots (averaging 1.1 and 1.6 cm, respectively), which is less than the Year 1 aRPD depths, but this may be an artifact of the reduced penetration. Evidence of high-order (Stage 3) successional assemblages was noted in two-thirds to three-quarters the images where successional stage could be determined.

When voids were present in SPI images[4], the image analyst tagged each feeding void with a polygon that approximately traces the structure's boundary. The iSPI software can then generate a list of the number, size, and depth distribution of all feeding voids observed in the images. As specified in the QAPP (Amec et al. 2016a), voids were grouped into the following

[4] Good examples of feeding voids can be seen in image Y2-SC-ENR-6-A-R2 (included in Figure 3-3b).

sediment depth categories: 0–2 cm, 2–5 cm, 5–10 cm, and >10 cm. The bottom or deepest portion of the void determined the depth bin into which it was placed. Table 4-1 shows these data for each subplot in Year 2. The intertidal plot shows comparable overall void numbers, depths, and size between the two subplots.

4.2 SCOUR PLOT

A 3 to 8 cm silt deposit overlying ENR material was observed throughout the upstream ENR subplot. As a result, the ENR layer was not evident in 25 of the 36 SPI images. The limited SPI penetration depths, sand subfractions within the silt matrix, and the presence of silt-covered gravel in many of the PV images provide evidence that the ENR sediments were present throughout the subplot underlying the silt deposit.

While the adjacent, upstream portion of the scour ENR+AC subplot showed a similar silt deposit as the ENR subplot, the farthest downstream cells (1, 3, and 5) showed the gravel and sand material with no significant fines subfraction. This same pattern was observed in the Year 1 SPI/PV survey and indicates different sediment accumulation/sediment transport dynamics between the two subplots. It is hypothesized that this gradient in sediment accumulation is to due higher vessel traffic and prop wash in the northern portion of the ENR+AC subplot that prevents the buildup of silts in those downstream cells.

As in Year 1, the scour plot shows significant evidence of benthic community re-establishment since the ENR material placement, especially in the ENR subplot. Stage 3 infauna were evident in 34 of the 36 ENR images and in 15 of the 36 ENR+AC images. But successional stage could not be assigned to 19 of the ENR+AC SPI replicates where the bottom texture was sand and gravel. The PV images from the scour plot also show evidence of widespread surface/epifaunal biological activity, i.e., tracks and trails where the bottom was silty. The higher number and somewhat larger size of feeding voids in the ENR subplot versus the ENR+AC subplot reflects the greater silt accumulation and perhaps the lower physical disturbance levels in the ENR subplot.

4.3 SUBTIDAL PLOT

The Year 2 SPI/PV images from the parallel subtidal subplots show similar patterns of ENR/ENR+AC material presence. The downstream cells 1 through 4 show compact silts and fine sand, which overlies ENR/ENR+AC materials, inferred from the shallow prism penetration (see Figure 3-5a). ENR was present and intact at all stations sampled in the ENR subplot with the exception of Station 6B. At that location, two replicates show reduced mud at the sediment-water interface in the SPI images and scattered patches of ENR material in the PV images (see Figure 3-5c). ENR+AC material is disturbed at Stations 5B and 6B in the ENR+AC subplot (see

images from 5B in Figure 3-6). The bottom in this portion of the subtidal plot area has reportedly been disturbed by barge chain dragging (Amec et al. 2016b).

Overall, SPI prism penetration in the subtidal plot was approximately half of that obtained in Year 1, again perhaps due to settling/compaction of the ENR material in combination with infiltration of silts into the ENR/ENR+AC coarse-grained matrix.

Benthic community re-colonization is evident at the subtidal plot, although the limited penetration resulted in many indeterminate aRPD depths and successional stages (Tables 3-5a and 3-6a). Averaged aRPDs depths in both the ENR and ENR+AC subplots (1.2 and 1.5 cm, respectively) are comparable to the baseline subtidal plot average of 1.3 cm (Table 3-7). Two-thirds (4 of 6) of the assigned successional stages in the ENR subplot were Stage 1 on 3.

Only two of the 11 successional stages in the ENR+AC subplot were designated as Stage 1 on 3, suggesting that the benthic recolonization is less advanced than in the adjacent ENR subplot. Five of the eight Stage 1 successional stages were present in the physically disturbed cell 5 and 6 images, which could account for lack of advanced recolonization. Few epifaunal organisms were captured in the subtidal PV images, but widespread evidence of both infauna (e.g., tubes) and epifauna (e.g., tracks) is present (Tables 3-5b and 3-6b; see Figure 3-5a).

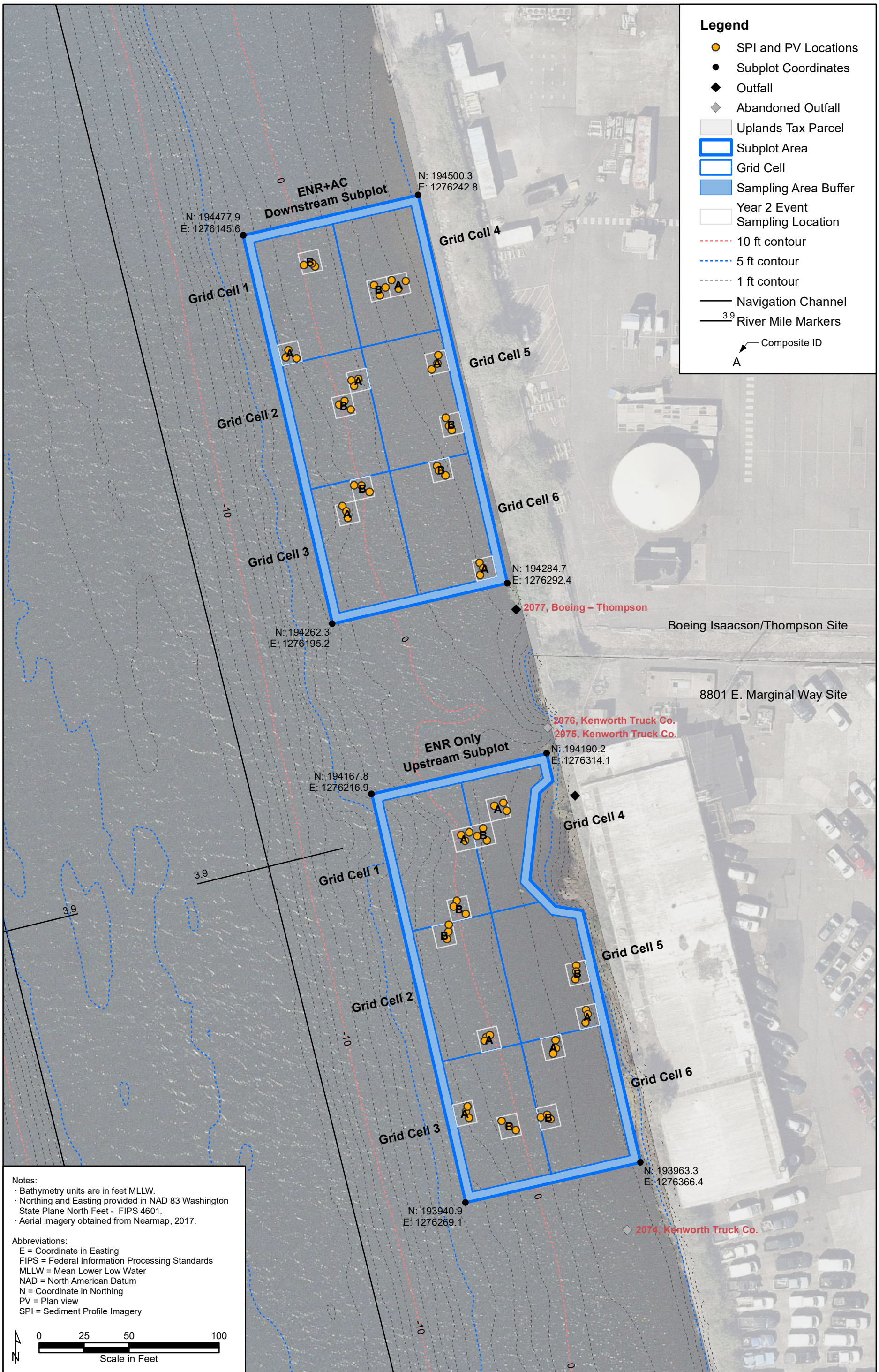
5 REFERENCES

Amec Foster Wheeler; Dalton, Olmsted & Fuglevand, Inc.; Ramboll Environ; Floyd|Snider; and Geosyntec Consultants. 2016a. Quality Assurance Project Plan, Enhanced Natural Recovery/Activated Carbon Pilot Study, Lower Duwamish Waterway. Lower Duwamish Waterway Group, Seattle, WA. February 22.

Amec Foster Wheeler; Dalton, Olmsted & Fuglevand, Inc.; Ramboll Environ; Floyd|Snider; and Geosyntec Consultants. 2016b. Construction Quality Assurance Project Plan (CQAPP) Addendum 1, Enhanced Natural Recovery/Activated Carbon Pilot Study, Lower Duwamish Waterway, ENR Layer Thickness Measurement during Construction at the Subtidal Plot and Grade Stakes at Test, Intertidal, and Scour Plots. Lower Duwamish Waterway Group, Seattle, WA. November 23.

Amec Foster Wheeler; Dalton, Olmsted & Fuglevand, Inc.; Ramboll Environ; Floyd|Snider; and Geosyntec Consultants. 2018. Quality Assurance Project Plan Construction Report, Enhanced Natural Recovery/Activated Carbon Pilot Study, Lower Duwamish Waterway, Lower Duwamish Waterway. Lower Duwamish Waterway Group, Seattle, WA. June.

Figures



Lower Duwamish Waterway Group
Port of Seattle / City of Seattle / King County / The Boeing Company

ENR/AC Draft
Year 2 Monitoring Report
Lower Duwamish Waterway

Figure 2-1
ENR/AC Pilot Study, Intertidal Plot
Year 2 SPI/PV Sampling Locations

I:\GIS\Projects\Wood-KC-ENR\MXD\Project Monitoring and Data Reports\Year 2 Figures\ENR AC Draft Year 2 Monitoring Report\Figure 2-1 ENR AC Pilot Study, Intertidal Plot Year 2 SPIPV Sampling Locations.mxd
1/27/2021

Legend

- SPI and PV Locations
- Subplot Coordinates
- Outfall
- Berthing
- Uplands Tax Parcel
- Subplot Area
- Grid Cells
- Sampling Area Buffer
- Year 2 Event Sampling Location
- 10 ft contour
- 5 ft contour
- 1 ft contour

Notes:
· Bathymetry units are in feet MLLW.
· Northing and Easting provided in NAD 83 Washington State Plane North Feet - FIPS 4601.
· Aerial imagery obtained from Nearmap, 2017.

Abbreviations:
E = Coordinate in Easting
FIPS = Federal Information Processing Standards
MLLW = Mean Lower Low Water
NAD = North American Datum
N = Coordinate in Northing
PV = Plan view
SPI = Sediment Profile Imagery

Composite ID
A

2154, Port of Seattle

N: 211257.9
E: 1267009.2

N: 211223.5
E: 1267122.2

N: 211168.3
E: 1267138.2

N: 211114.3
E: 1266965

N: 211070.7
E: 1267108.5

N: 210975.3
E: 1266922.8

N: 210932.1
E: 1267065

Grid Cell 1
Grid Cell 3
Grid Cell 5
Grid Cell 2
Grid Cell 4
Grid Cell 6

ENR+AC Downstream Subplot
ENR Upstream Subplot

-20
-10
0
-30

0 25 50 100
Scale in Feet

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Year 2 Monitoring Report
Lower Duwamish Waterway

Figure 2-2
ENR/AC Pilot Study, Scour Plot
Year 2 SPI/PV Sampling Locations

I:\GIS\Projects\Wood-KC-ENR\MXD\Project Monitoring and Data Reports\Year 2 Figures\ENR AC Draft Year 2 Monitoring Report\Figure 2-2 ENR AC Pilot Study, Scour Plot Year 2 SPIPV Sampling Locations.mxd
1/27/2021

Legend

- SPI and PV Locations
- Subplot Area Coordinates
- Subplot Area
- Grid Cell
- Sampling Area Buffer
- Year 2 Event Sampling Location
- 10 ft contour
- 5 ft contour
- 1 ft contour
- Navigation Channel
- 1.2 River Mile Markers

Notes:
- Bathymetry units are in feet MLLW.
- Northing and Easting provided in NAD 83 Washington State Plane North Feet - FIPS 4601.
- Aerial imagery obtained from Nearmap, 2017.

Abbreviations:
E = Coordinate in Easting
FIPS = Federal Information Processing Standards
MLLW = Mean Lower Low Water
N = Coordinate in Northing
NAD = North American Datum
PV = Plan view
SPI = Sediment Profile Imagery

A — Composite ID

ENR+AC West Lane
ENR East Lane
N: 205645.4
E: 1267937.2
N: 205629.4
E: 1267887.9
N: 205613.5
E: 1267838.7
Grid Cell 1
Grid Cell 2
Grid Cell 3
Grid Cell 4
Grid Cell 5
Grid Cell 6
-30
-20
1.2
N: 205202.2
E: 1268080.8
N: 205186.2
E: 1268031.6
N: 205170.3
E: 1267982.4
0 25 50 100
Scale in Feet
N

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Year 2 Monitoring Report
Lower Duwamish Waterway

Figure 2-3
ENR/AC Pilot Study, Subtidal Plot
Year 2 SPI/PV Sampling Locations

I:\GIS\Projects\Wood-KC-ENR\MXD\Project Monitoring and Data Reports\Year 2 Figures\ENR AC Draft Year 2 Monitoring Report\Figure 2-3 ENR AC Pilot Study, Subtidal Plot Year 2 SPIPV Sampling Locations.mxd
1/27/2021

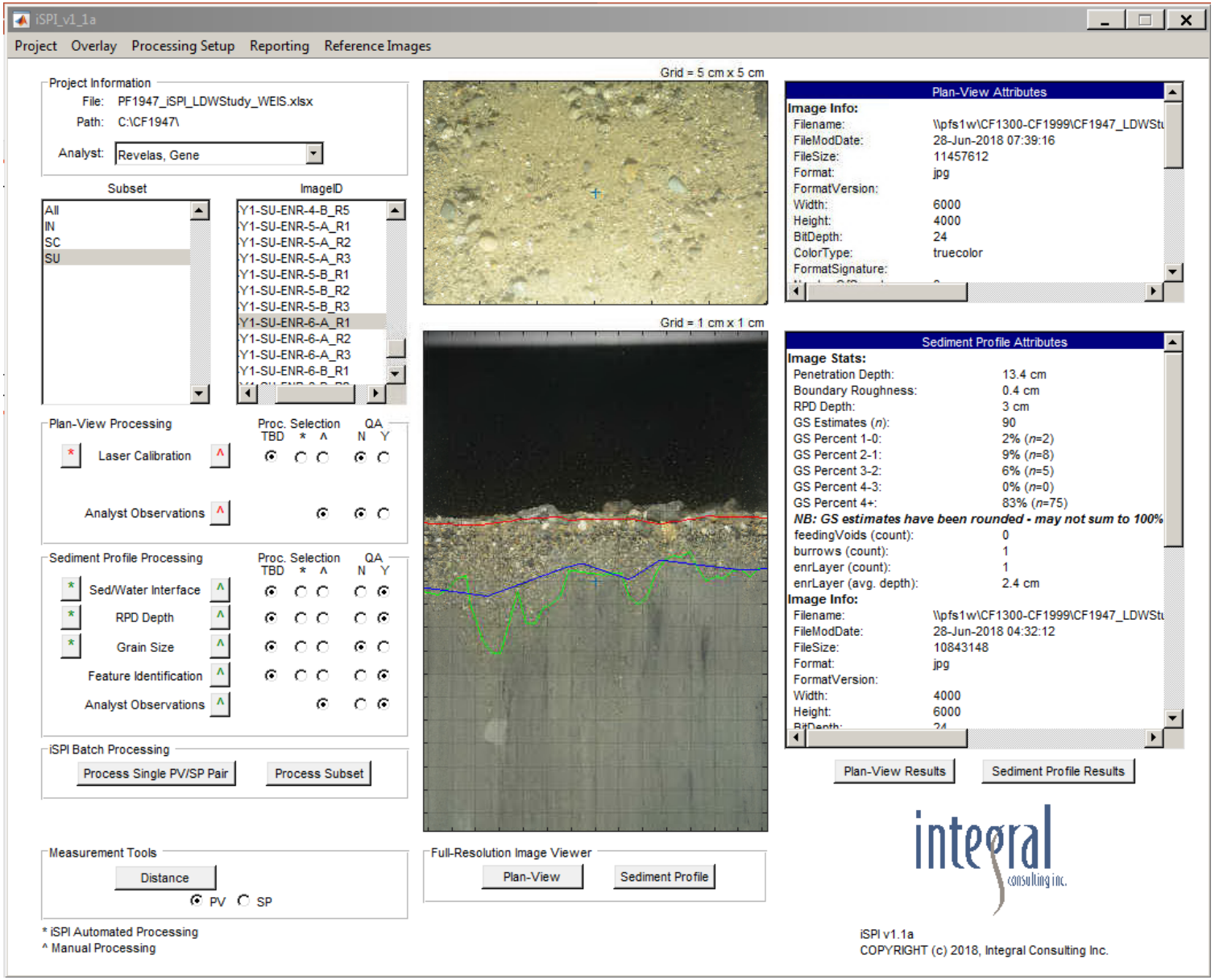
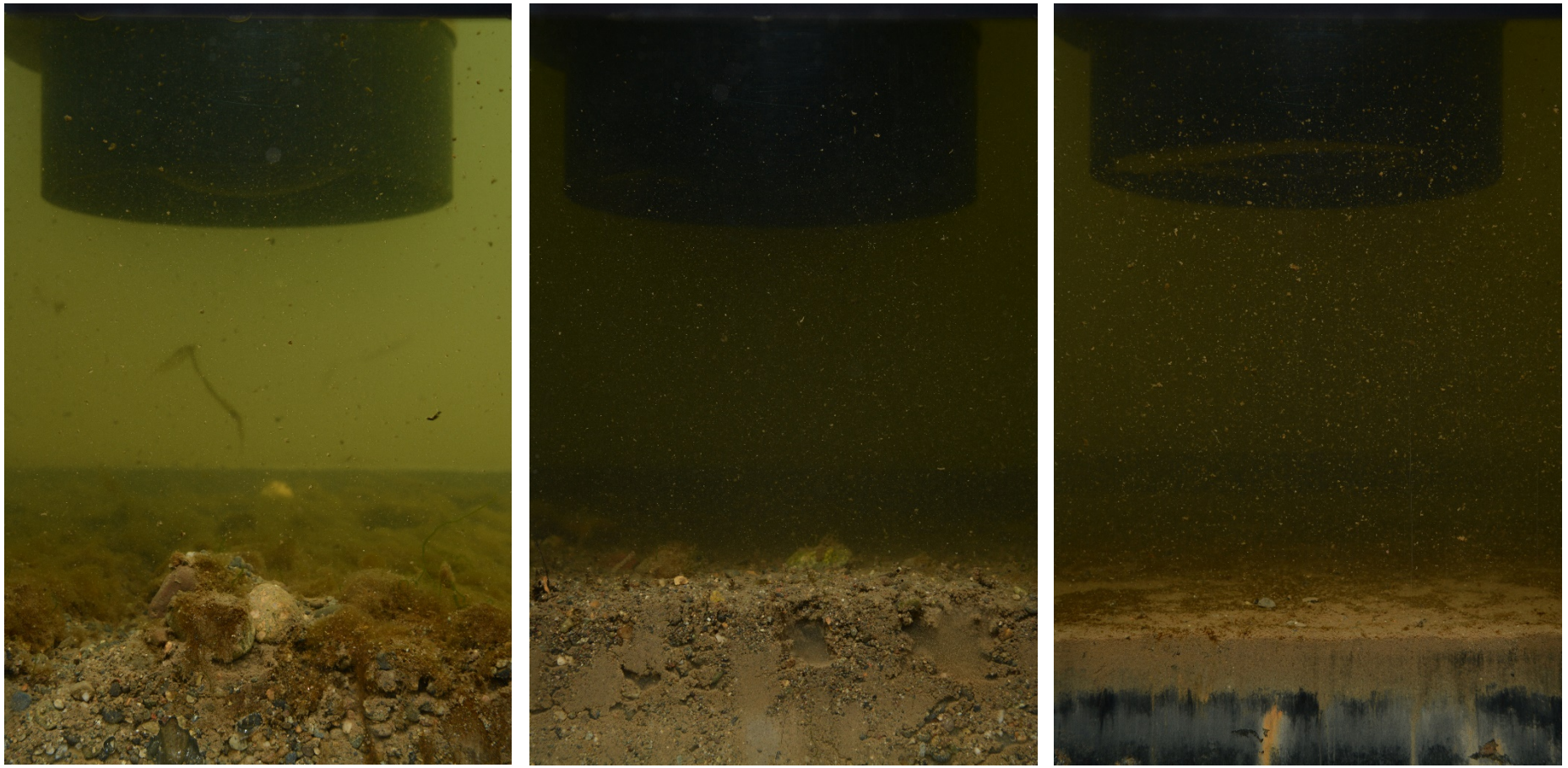


Figure 2-4.
iSPI v1.1a SPI/PV Image Analysis User Interface
ENR/AC Pilot Study Lower Duwamish Waterway

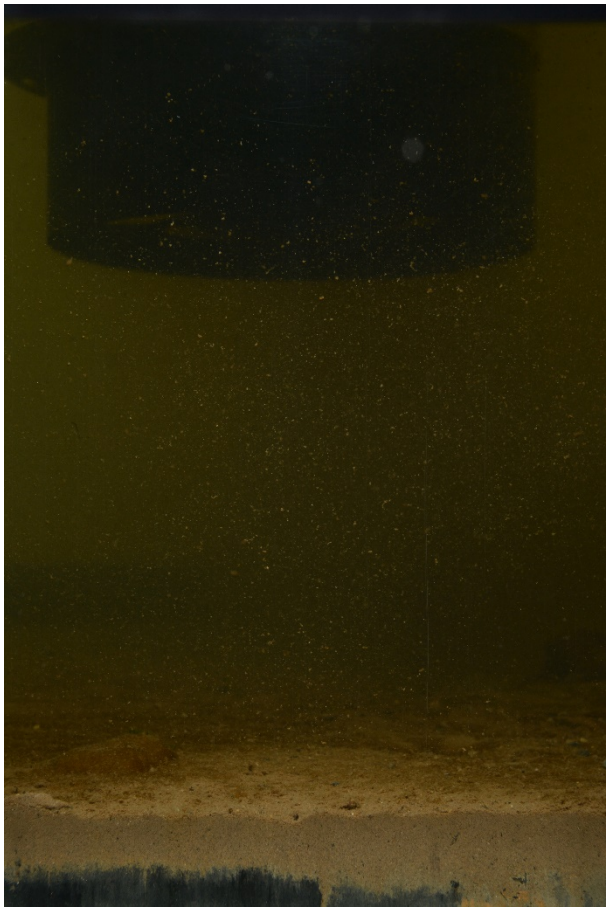


Y2 -IN-ENR-2-A-SPI-R3 Y2-IN-ENR-3-A-SPI-R3 Y2-IN-ENR-6-A-SPI-R2

Figure 3-1.
Three SPI images from IN-ENR showing the range of textures observed: gravel and cobbles (left), gravel, sand, and silt mix (middle), and compact silt overlying ENR material based on the limited penetration (right). Width of each image = 14.42 cm.
ENR/AC Pilot Study Lower Duwamish Waterway

Y2-IN-ENR+AC-2-B-SPI-R1

Y2-IN-ENR+AC-2-B-SPI-R2

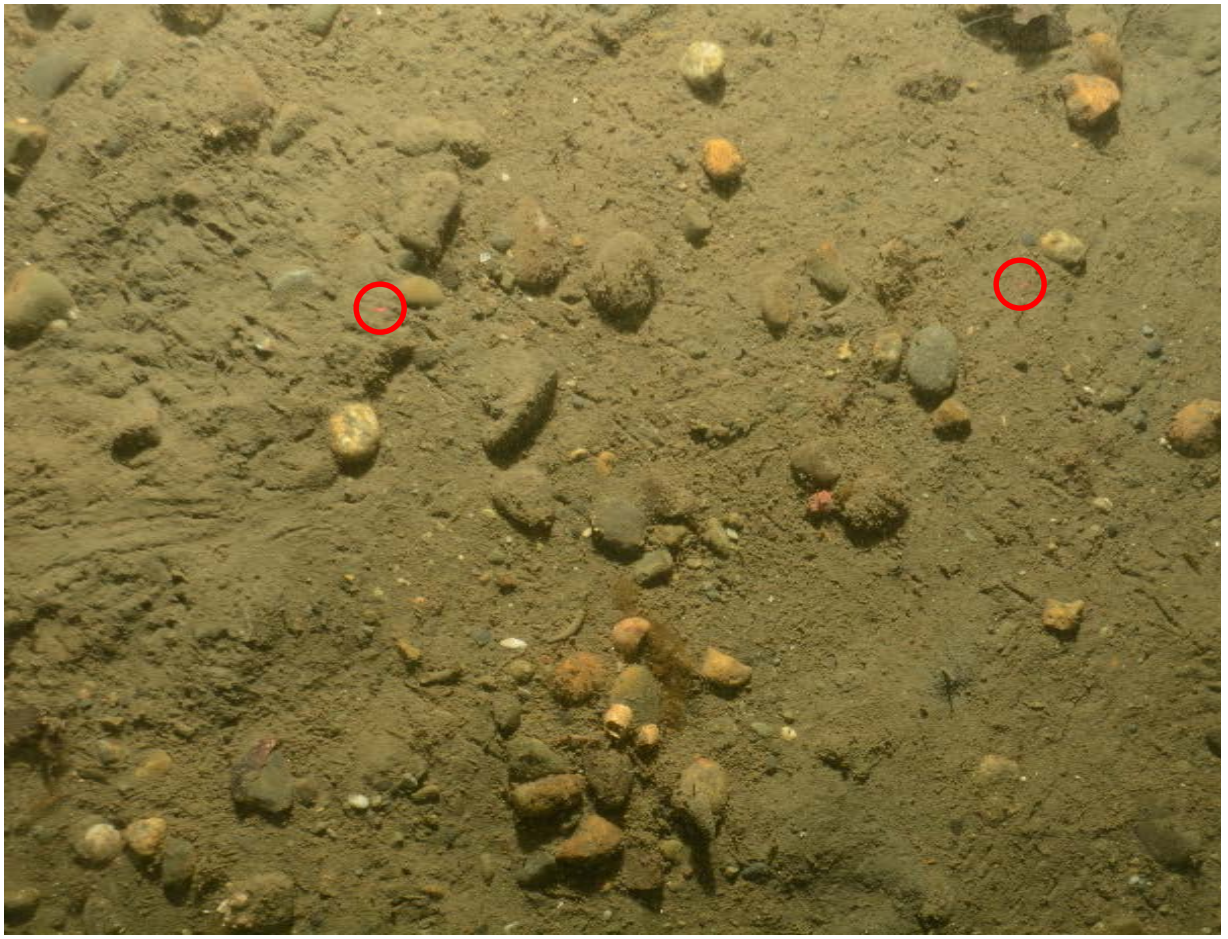


Y2-IN-ENR+AC-4-B-SPI-R1

integral consulting inc.

Figure 3-2.
Three SPI images from IN-ENR+AC subplot showing the one replicate where ENR material appears to absent (left), a second replicate from that station showing the ENR gravel/cobbles (middle), and an image showing compact silt over ENR. Width of each image = 14.42 cm.
ENR/AC Pilot Study Lower Duwamish Waterway

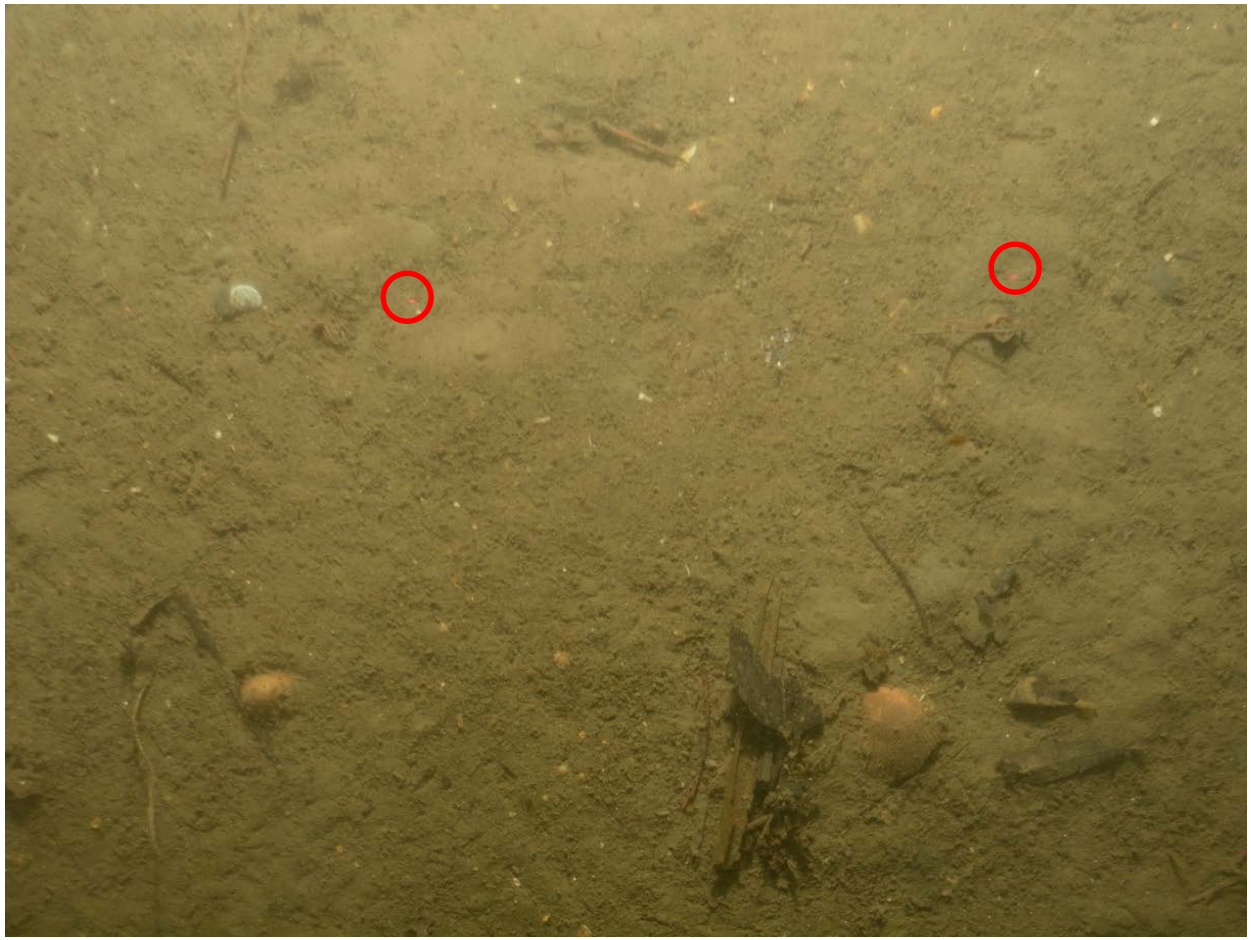
Y2-SC-ENR-1-A-R1-SPI



Y2-SC-ENR-1-A-R1-PV

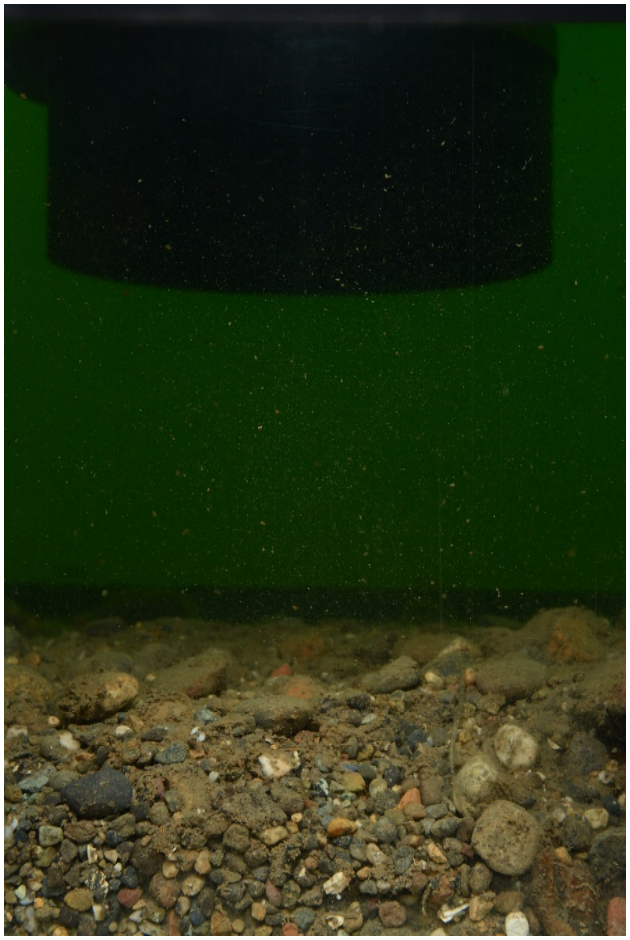
Figure 3-3a.
Collocated SPI (left) and PV (right) images from Station 1A in the SC-ENR subplot showing mixed ENR material and ambient, deposited silt. Width of SPI image = 14.42 cm.
The circled, faint, red lasers in the PV image are 26 cm apart.
ENR/AC Pilot Study Lower Duwamish Waterway

Y2-SC-ENR-6-A-R2-SPI

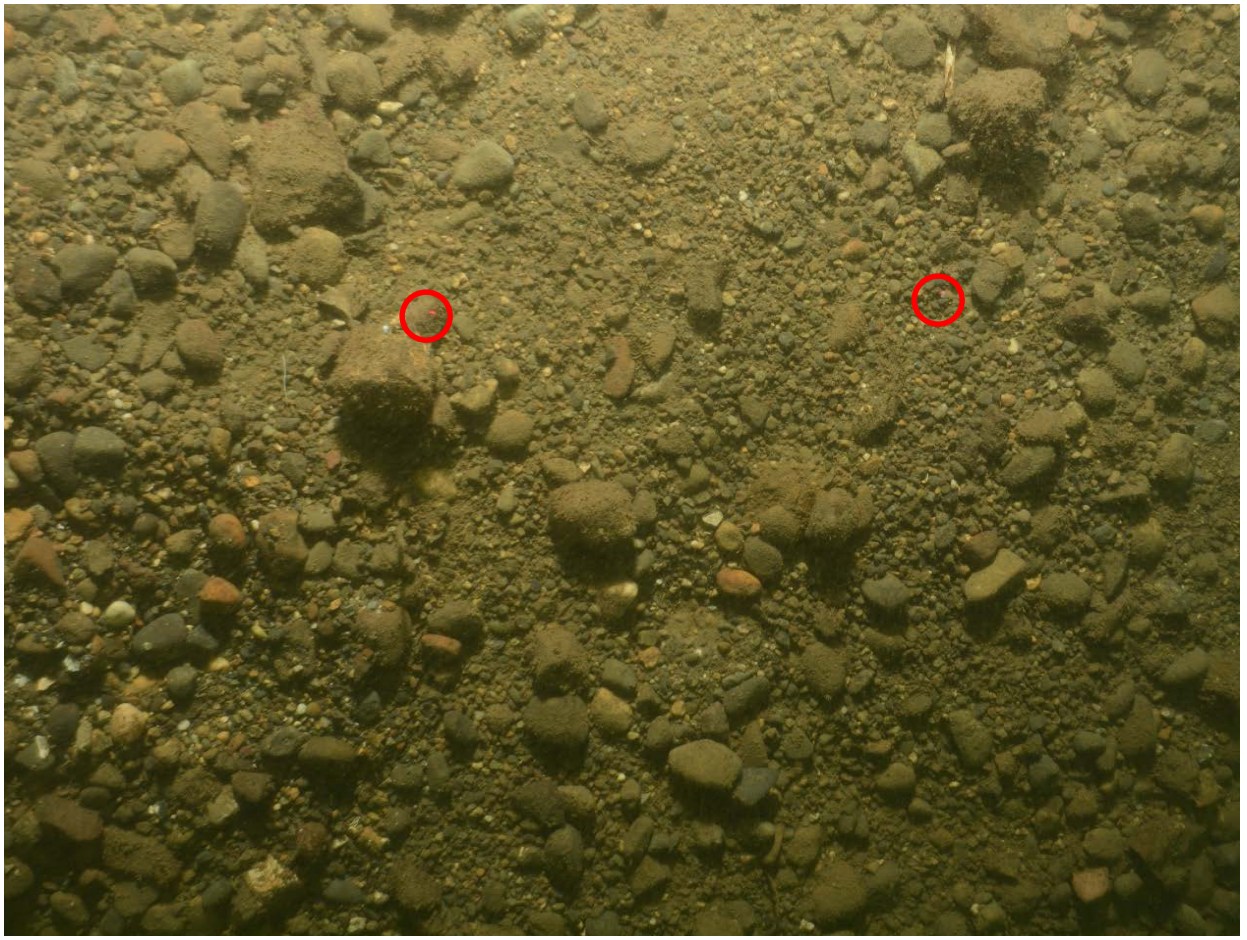


Y2-SC-ENR-6-A-R3-PV

Figure 3-3b.
SPI (left) and PV (right) images from Station 6A in the SC-ENR subplot showing a predominantly deposited silt bottom overlying ENR material that is evident at bottom of the SPI image. Width of SPI image = 14.42 cm. The circled, faint, red lasers in the PV are 26 cm apart.
ENR/AC Pilot Study Lower Duwamish Waterway

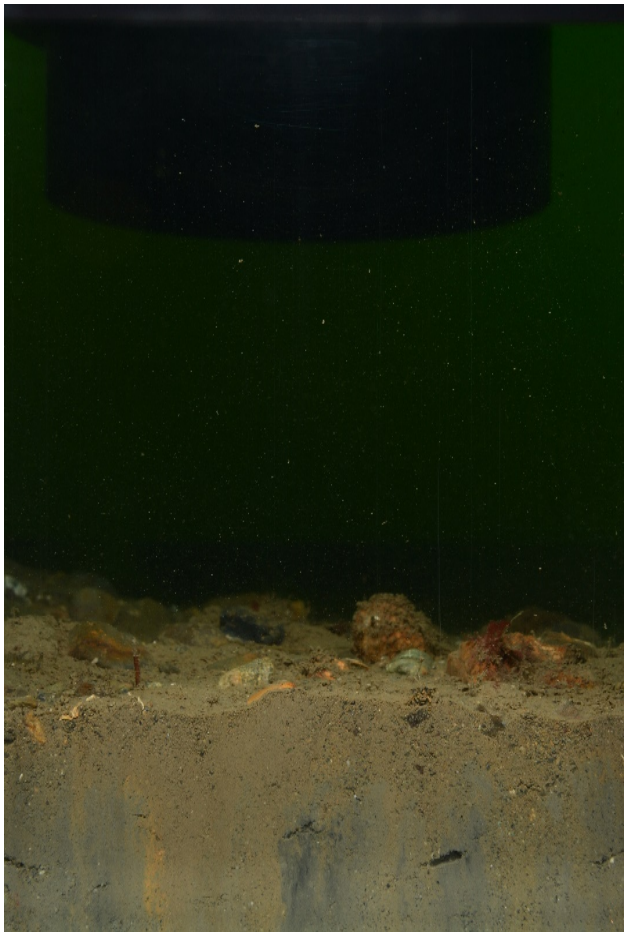


Y2-SC-ENR+AC-1-A-R2-SPI

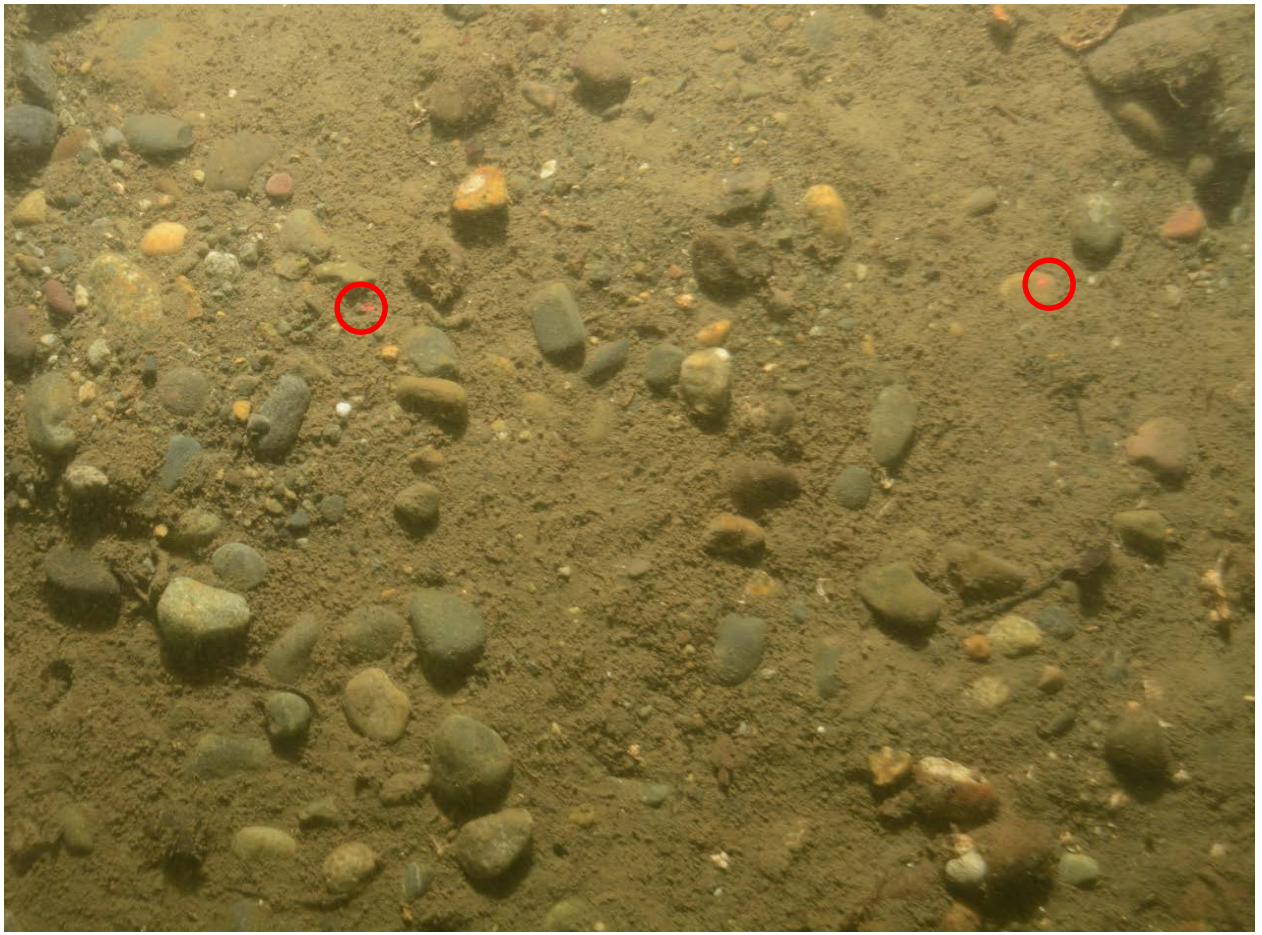


Y2-SC-ENR+AC-1-A-R2-PV

Figure 3-4a.
SPI (left) and PV (right) images from Station 1A in the SC-ENR+AC subplot showing an ENR coarse sand and gravel without appreciable silt inputs. Width of SPI image = 14.42 cm. The circled, faint, red lasers in the PV image are 26 cm apart.
ENR/AC Pilot Study Lower Duwamish Waterway



Y2-SC-ENR+AC-4-A-R1-SPI



Y2-SC-ENR+AC-4-A-R1-PV

Figure 3-4b.
SPI (left) and PV (right) images from Station 4A in the SC-ENR+AC subplot showing a silt overlying and mixed with ENR material. Width of SPI image = 14.42 cm. The circled, faint, red lasers in the PV image are 26 cm apart.
ENR/AC Pilot Study Lower Duwamish Waterway

Y2-SU-ENR-1-B-R2-SPI

Y2-SU-ENR-1-B-R1-PV

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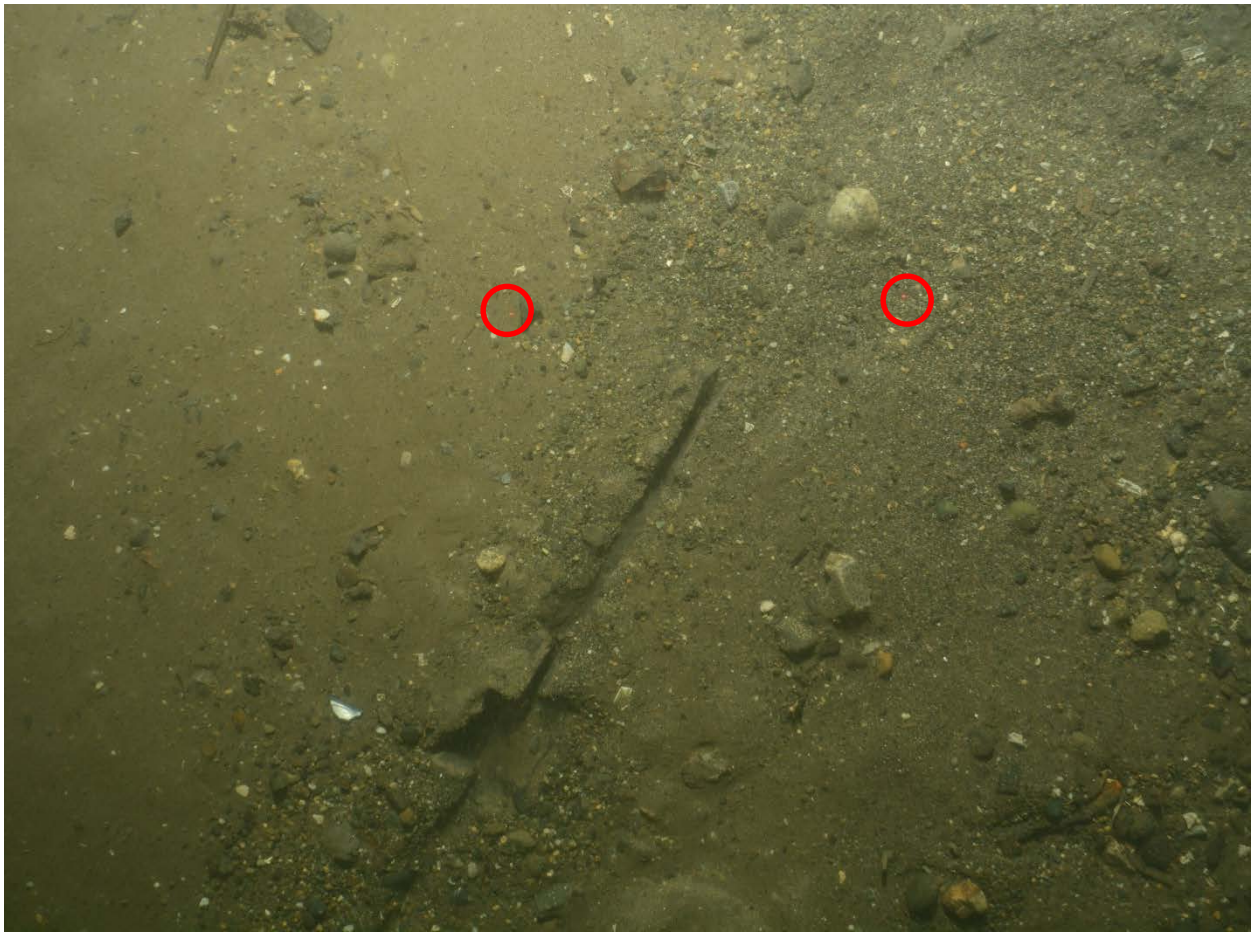
Figure 3-5a.
SPI (left) and PV (right) images from Station 1B in the SU-ENR subplot showing a silt/very fine sand surface sediments overlying ENR material based on the limited penetration. Faunal tracks and trails and plant debris are evident in the PV image. Width of SPI image = 14.42 cm. The circled red lasers in the PV image are 26 cm apart.
ENR/AC Pilot Study Lower Duwamish Waterway

Y2-SU-ENR-4-B-R2-SPI

Y2-SU-ENR-4-B-R3-PV

Figure 3-5b.
Paired SPI (left) and PV (right) images from Station 4B in the SU-ENR subplot showing intact ENR material at the sediment surface. Minimal SPI penetration was obtained in the coarse sand substrate. ENR material is evident throughout the PV image. Width of SPI image = 14.42 cm. The circled red lasers in the PV image are 26 cm apart.
ENR/AC Pilot Study Lower Duwamish Waterway

Y2-SU-ENR-6-B-R3-SPI



Y2-SU-ENR-6-B-R3-PV

Figure 3-5c.
Paired SPI (left) and PV (right) images from Station 6B in the SU-ENR subplot showing disturbed/not present ENR material. Reduced silt is present at the sediment surface in the SPI image. Patchy coarse-grained ENR material is evident in the PV image. Width of SPI image = 14.42 cm. The circled red lasers in the PV image are 26 cm apart.
ENR/AC Pilot Study Lower Duwamish Waterway

Y2-SU-ENR+AC-2-B-SPI-R1

Y2-SU-ENR+AC-5-B-SPI-R3

Y2-SU-ENR+AC-5-B-SPI-R1

Figure 3-6.
Three SPI images from the SU-ENR+AC subplot. Station 2B has a silt/very fine sand at sediment surface (left). Two replicates from Station 5B: R3 shows a residual 4-cm ENR layer (middle); at R1, the ENR appears to completely removed/disturbed. Width of each image = 14.42 cm.
ENR/AC Pilot Study Lower Duwamish Waterway

Tables

Table 3-1a. Year 2 Intertidal ENR Pilot Subplot SPI Results

Station	Replicate	Image Date	Water Depth (ft)	Penetration Depth (cm)	ENR Layer Thickness (cm)	Texture and Other Observations	Surface Boundary Roughness (cm)	RPD Depth (cm)	Grain Size Major Mode (phi units)	Grain Size Maximum (phi units)	Grain Size Minimum (phi units)	Methane	Successional Stage
LDW-Y2-IN-ENR-1A	R2	3/7/2019	3.7	2.8	>P	Coarse sand, some silt, brown algae, cobbles on SWI.	0.8	Ind	1-0	<-4	>4	Y (or trapped air)	Ind
LDW-Y2-IN-ENR-1A	R3	3/7/2019	3.7	3.3	>P	Very coarse sand with some silt, brown algae, gravel on SWI.	0.9	Ind	0-(-1)	<-4	>4	Y (or trapped air)	Ind
LDW-Y2-IN-ENR-1A	R5	3/8/2019	5.1	1.7	>P	Sand fraction concealed silt, "voids" created by SWI slumping.	2.1	Ind	>4	< -4	>4	N	Ind
LDW-Y2-IN-ENR-1B	R3	3/7/2019	4	2.2	>P	Silt concealing coarse-grained material, brown algal cover, cobbles on SWI.	1.4	Ind	>4	<-2	>4	Y (or trapped air)	Ind
LDW-Y2-IN-ENR-1B	R4	3/7/2019	5.6	2.1	>P	Cobbles, sand, silt, brown and green algae.	3.2	Ind	>4	<-4	>4	N	Ind
LDW-Y2-IN-ENR-1B	R6	3/7/2019	5.6	2.6	>P	Silt and coarse sand, gravel, brown algae.	2.7	Ind	>4	<-4	>4	N	Ind
LDW-Y2-IN-ENR-2A	R1	3/7/2019	3.9	3	>P	Coarse sand and few gravel. Substrate covered with algae.	1.6	Ind	0-(-1)	-2	>4	N	Ind
LDW-Y2-IN-ENR-2A	R2	3/7/2019	3.9	2.3	>P	Coarse sand and small gravels intermixed with silt. Algae covering substrate.	0.8	Ind	1-(-1)	-2	>4	Y (Trapped air)	Ind
LDW-Y2-IN-ENR-2A	R3	3/7/2019	3.9	3	>P	Coarse sand with gravel. Pebbles above SWI. Algae covering substrate.	1.3	Ind	0-(-1)	-3	>4	N	Ind
LDW-Y2-IN-ENR-2B	R1	3/7/2019	4.7	2.4	>P	Few air pockets. Substrate covered with algae.	1	Ind	3-2	-2	>4	N	1 on 3
LDW-Y2-IN-ENR-2B	R2	3/7/2019	4.7	2.2	>P	Trapped air pockets in bottom of image. Algae covering substrate.	0.7	Ind	4-3	-2	>4	Y (or trapped air)	Ind
LDW-Y2-IN-ENR-2B	R3	3/7/2019	4.7	0.6	>P	Algae covering substrate. Minimal penetration.	0.5	Ind	4-3	-2	>4	N	Ind
LDW-Y2-IN-ENR-3A	R1	3/7/2019	7.3	3.6	>P	Large tubes on surface. Algae covering portion of substrate.	2	Ind	2-1	-5	>4	N	3
LDW-Y2-IN-ENR-3A	R2	3/7/2019	7.3	3.8	>P	Algae covering substrate.	0.8	Ind	2-1	-3	>4	N	Ind
LDW-Y2-IN-ENR-3A	R3	3/7/2019	7.3	4.8	>P	Large tubes at surface.	0.7	Ind	2-1	-2	>4	N	1 on 3
LDW-Y2-IN-ENR-3B	R1	3/7/2019	4.5	3.1	>P	Sand and silt mix. Large tubes at surface.	0.5	2.3	3-2	0	>4	N	3
LDW-Y2-IN-ENR-3B	R2	3/7/2019	4.5	2.9	>P	Algae covering coarse sand.	0.9	Ind	0-(-1)	-4	>4	N	Ind
LDW-Y2-IN-ENR-3B	R3	3/7/2019	4.5	2.5	>P	Algae on surface.	1.2	Ind	1-0	-4	>4	N	Ind
LDW-Y2-IN-ENR-4A	R1	3/8/2018	5.3	2.5	>P	Algae over coarse sand; subsurface worm.	1.3	Ind	0-(-1)	-3	>4	N	Ind
LDW-Y2-IN-ENR-4A	R2	3/8/2018	5.3	2.9	>P	Compact silt in coarse matrix. Shallow feeding voids.	1	Ind	>4	-3	>4	N	1 on 3
LDW-Y2-IN-ENR-4A	R3	3/8/2018	5.3	1.4	LNA	Burrow evident along SWI and possibly subsurface so given Stage 3 designation.	0.9	Ind	>4	0	>4	Y (or air pockets)	3
LDW-Y2-IN-ENR-4B	R1	3/8/2018	4.5	0.8	>P	Algae covering substrate.	1.2	Ind	>4	-2	>4	N	Ind

Table 3-1a. Year 2 Intertidal ENR Pilot Subplot SPI Results

Station	Replicate	Image Date	Water Depth (ft)	Penetration Depth (cm)	ENR Layer Thickness (cm)	Texture and Other Observations	Surface Boundary Roughness (cm)	RPD Depth (cm)	Grain Size Major Mode (phi units)	Grain Size Maximum (phi units)	Grain Size Minimum (phi units)	Methane	Successional Stage
LDW-Y2-IN-ENR-4B	R3	3/7/2019	4.5	2.8	>P	Algae covering substrate. Silt in ENR material.	1.6	Ind	0-(-1)	-4	>4	N	Ind
LDW-Y2-IN-ENR-4B	R4	3/7/2019	4.5	3.8	>P	Dark reduced sediment or gravel at ~ 2 cm. Algae covering substrate.	1.3	Ind	>4	-2	>4	N	Ind
LDW-Y2-IN-ENR-5A	R1	3/8/2018	5	2.6	>P	Air pockets below SWI. Thin layer of algae over substrate. Cobble in background on surface.	0.9	Ind	2-1	-2	>4	N	Ind
LDW-Y2-IN-ENR-5A	R2	3/8/2018	5	1.7	>P	Thin layer of algae on surface. Darker sediments at 1 cm.	0.7	1.1	>4	2	>4	N	Ind
LDW-Y2-IN-ENR-5A	R3	3/8/2018	5	0.6	>P	Thin layer of algae on surface.	0.4	Ind	>4	0	>4	N	Ind
LDW-Y2-IN-ENR-5B	R1	3/8/2018	5	2.8	>P	Algae covering substrate.	1.1	Ind	4-3	<-4	>4	N	Ind
LDW-Y2-IN-ENR-5B	R2	3/8/2018	5	3.3	>P	Algae covering substrate.	1.4	Ind	2-1	-2	>4	N	Ind
LDW-Y2-IN-ENR-5B	R3	3/8/2018	5	0.5	>P	Minimal penetration.	1	Ind	-3-(2)	-4	>4	N	Ind
LDW-Y2-IN-ENR-6A	R1	3/8/2018	3.2	3.4	>P	Dark sediment evident. ENR sand at depth.	1.5	0.8	>4	-2	>4	N	1
LDW-Y2-IN-ENR-6A	R2	3/8/2018	3.2	3.6	LNA	Possible relict void at depth. Reduced sediment > 2 cm. ENR material not evident.	0.2	0.7	>4	3	>4	N	1
LDW-Y2-IN-ENR-6A	R3	3/8/2018	3.2	4.1	LNA	Dark reduced sediments from 2 to 4.1 cm. Possible methane.	0.3	0.7	>4	1	>4	N	Ind
LDW-Y2-IN-ENR-6B	R1	3/7/2019	3.7	2.5	>P	Algae covering substrate. Some gravels on surface.	0.7	Ind	2-1	-4	3	N	Ind
LDW-Y2-IN-ENR-6B	R2	3/7/2019	3.7	2	>P	Algae covering substrate. Some gravels on surface. Air pockets.	0.9	Ind	0-1	-3	>4	N	Ind
LDW-Y2-IN-ENR-6B	R3	3/7/2019	3.7	0.6	>P	Algae, pebbles on surface. Minimal penetration.	0.5	Ind	>4	-2	>4	N	Ind

Summary Statistics for Some Numerical Parameters

	Penetration Depth (cm)	Surface Boundary Roughness (cm)	RPD Depth (cm)
N	36	36	5
Average	2.5	1.1	1.1
Median	2.6	0.95	0.8
Minimum	0.5	0.2	0.7
Maximum	4.8	3.2	2.3

Notes:
-- = not analyzed
aRPD = apparent redox potential discontinuity
ENR = enhanced natural recovery
Ind = indeterminate
LNA = layer not apparent
N = no
P = penetration
SPI = sediment profile imaging
SWI = sediment-water interface
Y = yes

Table 3-1b. Year 2 Intertidal ENR Pilot Subplot PV Results

				Lebensspuren											
Station	Replicate	Sediment Type	Bedforms	Burrows	Tubes	Tracks	Total Abundance	Epifauna	Epifauna Type (Count)	Mud Clasts	Debris Type	Debris Cover	*Beggiatoa*	Surface Boundary Roughness (cm)	Comments
LDW-Y2-IN-ENR-1A	R4	Gravel and silt	N	N	N	N	N	N	NA	N	NA	N	N	H	Gravel covered with algae and silt.
LDW-Y2-IN-ENR-1A	R5	Gravel and silt	N	N	N	N	N	N	NA	N	Sticks	L	N	H	Algae covering gravel. One laser visible.
LDW-Y2-IN-ENR-1A	R6	Silt and sand	N	N	Y	Y	L	N	NA	N	NA	N	N	L	One laser visible. High concentration of algae covering substrate.
LDW-Y2-IN-ENR-1B	R4	Gravel and silt	N	N	N	N	N	N	NA	N	NA	N	N	H	One laser visible. High concentration of algae covering substrate.
LDW-Y2-IN-ENR-1B	R5	Silt and sand	N	N	Y	N	N	N	NA	N	NA	N	N	M	One laser visible. Imprint is an artifact from the SPI frame. Algae covering substrate.
LDW-Y2-IN-ENR-1B	R6	Silt, gravel, and sand	N	N	N	N	N	N	NA	N	Sticks	L	N	M	Algae covering substrate.
LDW-Y2-IN-ENR-2A	R1	Sand and silt	N	N	N	N	N	N	NA	N	Stick	L	N	L	Image partially obscured by suspended sediment.
LDW-Y2-IN-ENR-2A	R2	Sand and silt	N	N	N	N	N	N	NA	N	NA	N	N	M	One laser visible due to suspended sediment. Algae covering substrate.
LDW-Y2-IN-ENR-2A	R3	Sand and gravel	N	N	N	N	N	N	NA	N	NA	N	N	M	Algae covering the majority of substrate.
LDW-Y2-IN-ENR-2B	R1	Sand	N	N	N	N	N	N	NA	N	NA	N	N	M	Algae covering the majority of substrate. Lasers not visible due to turbidity in water column.
LDW-Y2-IN-ENR-2B	R2	Sand	N	N	N	N	N	N	NA	N	NA	N	N	L	Imprint is an artifact of the SPI frame. Algae covering the majority of the substrate.
LDW-Y2-IN-ENR-2B	R3	Sand and gravel	N	N	N	N	N	N	NA	N	NA	N	N	L	One laser visible. Algae covering the majority of substrate. Few gravel.
LDW-Y2-IN-ENR-3A	R1	Sand, silt, and gravel	N	N	Y	N	N	N	NA	N	Leaf	L	N	M	Few gravel.
LDW-Y2-IN-ENR-3A	R2	Sand, silt, and gravel	N	N	Y	N	N	N	NA	N	Organic detritus	L	N	M	Few gravel.
LDW-Y2-IN-ENR-3A	R3	Sand, silt, and gravel	N	N	Y	N	N	N	NA	N	NA	N	N	M	Imprint is an artifact from the SPI frame. Shell fragments.
LDW-Y2-IN-ENR-3B	R1	Sand, silt, and gravel	N	N	Y	N	N	N	NA	N	NA	N	N	M	Few algae and few gravel. Shell fragments.
LDW-Y2-IN-ENR-3B	R2	Sand and gravel	N	N	N	Y	L	N	NA	N	Macroalgae	L	N	M	Few gravel. Thin film of algae covering substrate.
LDW-Y2-IN-ENR-3B	R3	Sand and gravel	N	N	N	N	N	N	NA	N	NA	N	N	M	Some algae covering substrate. Shell fragments. Imprint is an artifact from the SPI frame. Lasers not visible.
LDW-Y2-IN-ENR-4A	R1	Gravel and sand	N	N	N	N	N	N	NA	N	Sticks	L	N	M	Algae covering gravel. Shell fragments.
LDW-Y2-IN-ENR-4A	R2	Sand and gravel	N	N	N	Y	L	N	NA	N	NA	N	N	M	Some gravel. Algae covering gravel.
LDW-Y2-IN-ENR-4A	R3	Sand and silt	N	N	Y	Y	L	N	NA	N	Stick	L	N	L	Very few gravel pieces. Algae covering majority of substrate.
LDW-Y2-IN-ENR-4B	R1	Sand, silt, and gravel	N	N	N	N	N	N	NA	N	NA	N	N	L	Few gravel. Algae covering majority of substrate.
LDW-Y2-IN-ENR-4B	R3	Sand and gravel	N	N	N	N	N	N	NA	N	NA	N	N	M	One laser visible. Algae covering majority of substrate. Imprint is an artifact of the SPI frame.
LDW-Y2-IN-ENR-4B	R4	Sand and gravel	N	N	N	N	N	N	NA	N	Stick	L	N	L	One laser visible. Algae covering majority of substrate. Few gravel.
LDW-Y2-IN-ENR-5A	R1	Sand and gravel	N	N	N	Y	L	N	NA	N	Leaf, stick	L	N	M	Lasers not visible. Few gravel. Algae covering substrate.
LDW-Y2-IN-ENR-5A	R2	Sand and gravel	N	N	N	N	N	N	NA	N	NA	N	N	M	One laser visible. Algae covering substrate.
LDW-Y2-IN-ENR-5A	R3	Sand and gravel	N	N	N	N	N	N	NA	N	NA	N	N	M	Algae covering substrate.
LDW-Y2-IN-ENR-5B	R1	Gravel and sand	N	N	N	N	N	N	NA	N	Leaves, stick	L	N	H	Algae covering substrate.
LDW-Y2-IN-ENR-5B	R2	Gravel and sand	N	N	N	N	N	N	NA	N	NA	N	N	H	Algae covering substrate. Few shell fragments. Imprint is an artifact of the SPI frame.
LDW-Y2-IN-ENR-5B	R3	Gravel and sand	N	N	N	N	N	N	NA	N	NA	N	N	H	Algae covering substrate. Imprint is an artifact from the SPI frame.
LDW-Y2-IN-ENR-6A	R1	Sand and silt	N	N	N	Y	L	N	NA	N	NA	N	N	L	Algae covering substrate. One piece of gravel.
LDW-Y2-IN-ENR-6A	R2	Sand and silt	N	N	N	N	N	N	NA	N	NA	N	N	L	Algae covering substrate.
LDW-Y2-IN-ENR-6A	R3	Sand and silt	N	N	N	Y	L	N	NA	N	NA	N	N	L	Algae covering majority of substrate.
LDW-Y2-IN-ENR-6B	R1	Sand and gravel	N	N	N	N	N	N	NA	N	NA	N	N	M	One laser visible. Algae covering majority of substrate. Few shell fragments

Table 3-1b. Year 2 Intertidal ENR Pilot Subplot PV Results

				Lebensspuren											
Station	Replicate	Sediment Type	Bedforms	Burrows	Tubes	Tracks	Total Abundance	Epifauna	Epifauna Type (Count)	Mud Clasts	Debris Type	Debris Cover	*Beggiatoa*	Surface Boundary Roughness (cm)	Comments
LDW-Y2-IN-ENR-6B	R2	Gravel and sand	N	N	N	N	N	N	NA	N	Sticks	L	N	M	One laser visible. Algae covering substrate.
LDW-Y2-IN-ENR-6B	R3	Sand and gravel	N	N	N	Y	L	N	NA	N	Sticks	L	N	L	One laser visible. Imprint is an artifact from the SPI frame. Few gravel pieces.

Notes:

-- = not analyzed
Lebensspuren = biologically formed sedimentary structures
ENR = enhanced natural recovery
H = high
L = low
M = medium
N = no
NA = not applicable
PV = plan view
SPI = sediment profile imaging
Y = yes

Table 3-2a. Year 2 Intertidal ENR+AC Pilot Subplot SPI Results

Station	Replicate	Image Date	Water Depth (ft)	Penetration Depth (cm)	ENR+AC Layer Thickness (cm)	Texture and Other Observations	Surface Boundary Roughness (cm)	RPD Depth (cm)	Grain Size Major Mode (phi units)	Grain Size Maximum (phi units)	Grain Size Minimum (phi units)	Methane	Successional Stage
LDW-Y2-IN-ENR-AC-1A	R1	3/7/2019	6.9	2.4	>P	Large tubes evident on surface. Algae on surface.	1.4		3-2	-4	>4	N	1 on 3
LDW-Y2-IN-ENR-AC-1A	R2	3/7/2019	6.9	1.9	>P	Algae on surface. Silt, sand, and gravel.	0.4		3-2	-4	>4	N	Ind
LDW-Y2-IN-ENR-AC-1A	R3	3/7/2019	6.9	2.3	>P	Large tubes evident on surface. Patchy distribution of algae on surface.	0.4		1-0	-2	>4	N	1 on 3
LDW-Y2-IN-ENR-AC-1B	R1	3/7/2019	4.7	3	>P	Air pocket. Algae covering surface. Silt and gravel.	1		>4	-4	>4	N	Ind
LDW-Y2-IN-ENR-AC-1B	R2	3/7/2019	4.7	3	>P	Gravel and silt. Algae covering surface. Air bubbles.	1.2		>4	-4	>4	N	Ind
LDW-Y2-IN-ENR-AC-1B	R3	3/7/2019	4.7	2.6	>P	Bimodal grain size distribution, large gravel and silt.	1.8		>4 and -4-(-3)	-4	>4	N	Ind
LDW-Y2-IN-ENR-AC-2A	R1	3/7/2019	4	1	>P	Algae over gravel.	0.5		-1 -(-2)	-4	>4	N	Ind
LDW-Y2-IN-ENR-AC-2A	R2	3/7/2019	4	2.6	>P	Top layer of silt dragged down over coarse sand/gravel. Algae on surface.	1.1		1-0	-2	>4	N	Ind
LDW-Y2-IN-ENR-AC-2A	R3	3/7/2019	4	2.2	>P	Air pockets. Algae on surface. Gravel in background on surface.	0.5		4-3	-1	>4	N	3
LDW-Y2-IN-ENR-AC-2B	R1	3/7/2019	4.4	12.1	LNA	No tubes on SWI. Dark reduced sediments from 4 to 10 cm. No ENR material evident.	1.6	3.4	>4	3	>4	Y	1
LDW-Y2-IN-ENR-AC-2B	R2	3/7/2019	4.4	2.7	>P	Some algae on surface. Silt with coarse sand and gravel.	1.8		>4	-5	>4	N	Ind
LDW-Y2-IN-ENR-AC-2B	R3	3/7/2019	4.4	2.6	>P	Bimodal grain size, silt and coarse sand. Algae on surface.	0.7		>4 and 1-0	-5	>4	N	Ind
LDW-Y2-IN-ENR-AC-3A	R1	3/7/2019	6	1.8	LNA	Silt with fine sand. Algae on surface. RPD minimum estimate.	1.8	1	4-3	2	>4	N	Ind
LDW-Y2-IN-ENR-AC-3A	R2	3/7/2019	6	3.7	>P	Algae on surface. Silt with sand, gravel. aRPD > Penetration.	1.1		4-3	-5	>4	N	1 on 3
LDW-Y2-IN-ENR-AC-3A	R3	3/7/2019	6	3.6	>P	Two large burrows. RPD > penetration.	2.4	2.3	4-3	0	>4	N	1 on 3
LDW-Y2-IN-ENR-AC-3B	R1	3/7/2019	4.6	1.7	>P	Algae on surface.	0.9	1.1	>4	-1	>4	N	Ind
LDW-Y2-IN-ENR-AC-3B	R2	3/7/2019	4.6	2.8	>P	Layer of algae on surface. Silt over medium to fine sand.	0.8	1.5	>4/3-2	-1	>4	N	1 on 3
LDW-Y2-IN-ENR-AC-3B	R3	3/7/2019	4.6	2.8	>P	Air pockets at depth. Silt with some gravel and coarse sand. aRPD > penetration.	0.7		4-3	-5	>4	N	Ind
LDW-Y2-IN-ENR-AC-4A	R1	3/8/2018	3.2	2.7	>P	Wood on surface. Coarse sand with gravel. Algae on surface.	1.2		1-0	-5	>4	N	Ind
LDW-Y2-IN-ENR-AC-4A	R2	3/8/2018	3.2	4	>P	Algae covering surface. Gravels on surface atop coarse sand.	1.3		0-(-1)	-5	>4	N	Ind
LDW-Y2-IN-ENR-AC-4A	R3	3/8/2018	3.2	3.2	>P	Algae over surface. Surface gravel over coarse sand and silt.	1.3		0-(-1) and > 4	-5	>4	N	Ind
LDW-Y2-IN-ENR-AC-4B	R1	3/8/2018	3.4	2.3	LNA	No ENR material evident. Reduced sediment at depth.	0.6	1.6	>4	3	>4	N	1

Table 3-2a. Year 2 Intertidal ENR+AC Pilot Subplot SPI Results

Station	Replicate	Image Date	Water Depth (ft)	Penetration Depth (cm)	ENR+AC Layer Thickness (cm)	Texture and Other Observations	Surface Boundary Roughness (cm)	RPD Depth (cm)	Grain Size Major Mode (phi units)	Grain Size Maximum (phi units)	Grain Size Minimum (phi units)	Methane	Successional Stage
LDW-Y2-IN-ENR-AC-4B	R2	3/8/2018	3.4	2.6	>P	Algae covers substrate. Gravel pieces on surface.	1.3		-1-(-2)	-5	>4	N	Ind
LDW-Y2-IN-ENR-AC-4B	R3	3/8/2018	3.4	2	>P	Silt over coarse sand.	1.4		0-1	-2	>4	N	Ind
LDW-Y2-IN-ENR-AC-5A	R1	3/8/2018	3	3.5	>P	Algae atop gravel. Gravel and coarse sand.	2		-1-(-2)	-5	>4	N	Ind
LDW-Y2-IN-ENR-AC-5A	R2	3/8/2018	3	2.5	>P	Silt and gravel. Algae covers substrate. Wood on SWI.	1.4		4-3	-4	>4	N	Ind
LDW-Y2-IN-ENR-AC-5A	R3	3/8/2018	3	1.6	>P	Silt atop coarse sand. Algae on surface. Gravel on surface.	0.6		0-(-1)	-5	>4	N	Ind
LDW-Y2-IN-ENR-AC-5B	R1	3/8/2018	3.2	2.9	>P	Algae on surface. Piece of macroalgae. Gravel on surface. Possible methane.	0.6	2	>4	-2	>4	Y (or air pocket)	Ind
LDW-Y2-IN-ENR-AC-5B	R2	3/8/2018	3.2	0.7	>P	No penetration. Algae covering substrate of gravel.	1.2		Ind	Ind	Ind	N	Ind
LDW-Y2-IN-ENR-AC-5B	R3	3/8/2018	3.2	2.5	>P	Algae covering substrate. aRPD > penetration. Crack from prism penetration.	0.4		3-2	-5	>4	N	Ind
LDW-Y2-IN-ENR-AC-6A	R1	3/8/2018	4.6	2	>P	Reduced sediment from 1–2 cm in portion of image. Gravel on surface. Divot is an artifact.	0.8	1.1	4-3	-4	>4	N	Ind
LDW-Y2-IN-ENR-AC-6A	R2	3/8/2018	4.6	3	>P	Thin layer of silt with coarse sand and few pieces of gravel.	1.3		4-3	-4	>4	N	Ind
LDW-Y2-IN-ENR-AC-6A	R3	3/8/2018	4.6	3.1	>P	Large void/air pocket at 2 cm is artifact, entire width of image.	0.5		>4	0	>4	N	Ind
LDW-Y2-IN-ENR-AC-6B	R1	3/8/2018	3.2	0	>P	Not analyzable, no penetration. Algae covering substrate. Some gravel and coarse sand visible.	--	--	--	--	--	--	--
LDW-Y2-IN-ENR-AC-6B	R2	3/8/2018	3.2	1.7	>P	Gravel on surface. Algae and organic detritus on surface. Dark reduced sediments at 1.5 cm.	0.5	1	4-3	-4	>4	N	Ind
LDW-Y2-IN-ENR-AC-6B	R3	3/8/2018	3.2	2.9	>P	Reduced sediments at 1 cm. Wood piece on surface. Bright orange sediment patch.	1.3	1.4	4-3	-3	>4	N	Ind

Summary Statistics for Some Numerical Parameters

	Penetration Depth (cm)	Surface Boundary Roughness (cm)	RPD Depth (cm)
N	36	35	10
Average	2.7	1.1	1.6
Median	2.6	1.1	1.5
Minimum	0	0.4	1.0
Maximum	12.1	2.4	3.4

Notes:
AC = activated carbon
aRPD = apparent redox potential discontinuity
ENR = enhanced natural recovery
Ind = indeterminate
LNA = layer not apparent
N = no
P = penetration
SPI = sediment profile imaging
SWI = sediment-water interface
Y = yes

Table 3-2b. Year 2 Intertidal ENR+AC Pilot Subplot PV Results

				Lebensspuren											
Station	Replicate	Sediment Type	Bedforms	Burrows	Tubes	Tracks	Total Abundance	Epifauna	Epifauna Type (Count)	Mud Clasts	Debris Type	Debris Cover	*Beggiatoa*	Surface Boundary Roughness (cm)	Comments
LDW-Y2-IN-ENR-AC-1A	R1	Sand and gravel	N	N	N	N	N	N	NA	N	NA	N	N	L	Lasers not visible due to suspended sediment. Algae covering substrate.
LDW-Y2-IN-ENR-AC-1A	R2	--	--	--	--	--	--	--	--	--	--	--	--	--	Not analyzable due to turbidity in the water column.
LDW-Y2-IN-ENR-AC-1A	R3	--	--	--	--	--	--	--	--	--	--	--	--	--	Not analyzable due to turbidity in the water column.
LDW-Y2-IN-ENR-AC-1B	R1	--	--	--	--	--	--	--	--	--	--	--	--	--	Not analyzable due to turbidity in the water column.
LDW-Y2-IN-ENR-AC-1B	R2	Sand and gravel	N	N	N	N	N	N	NA	N	NA	N	N	M	Lasers not visible due to high turbidity in water column. Algae covering substrate. Some gravel.
LDW-Y2-IN-ENR-AC-1B	R3	--	--	--	--	--	--	--	--	--	--	--	--	--	Not analyzable due to turbidity in the water column.
LDW-Y2-IN-ENR-AC-2A	R1	Gravel and sand	N	N	N	N	N	N	NA	N	NA	N	N	M	One laser visible. Algae covering substrate. Few shell fragments.
LDW-Y2-IN-ENR-AC-2A	R2	Sand and gravel	N	N	N	N	N	N	NA	N	Sticks	L	N	M	Lasers not visible due to turbidity in the water column. Algae covering substrate.
LDW-Y2-IN-ENR-AC-2A	R3	Sand and gravel	N	N	N	Y	L	N	NA	N	NA	N	N	L	Imprint is an artifact from the SPI frame. Algae covering substrate. Few shell fragments. One laser visible.
LDW-Y2-IN-ENR-AC-2B	R1	Sand	N	N	N	N	N	N	NA	N	NA	N	N	L	Lasers not visible due to turbidity in the water column. Algae covering majority of substrate.
LDW-Y2-IN-ENR-AC-2B	R2	Sand and gravel	N	N	N	N	N	N	NA	N	NA	N	N	L	Lasers not visible due to turbidity in water column. Patchy distribution of algae on substrate.
LDW-Y2-IN-ENR-AC-2B	R3	--	--	--	--	--	--	--	--	--	--	--	--	--	Not analyzable due to turbidity in the water column.
LDW-Y2-IN-ENR-AC-3A	R1	Sand	N	N	N	Y	L	N	NA	N	NA	N	N	L	One laser visible. Algae covering majority of substrate.
LDW-Y2-IN-ENR-AC-3A	R2	Sand and gravel	N	N	N	Y	L	N	NA	N	Sticks	L	N	M	One laser visible. Algae covering majority of substrate. Few gravel.
LDW-Y2-IN-ENR-AC-3A	R3	--	--	--	--	--	--	--	--	--	--	--	--	--	Not analyzable due to turbidity in the water column.
LDW-Y2-IN-ENR-AC-3B	R1	--	--	--	--	--	--	--	--	--	--	--	--	--	Not analyzable due to turbidity in the water column.
LDW-Y2-IN-ENR-AC-3B	R2	Sand	N	N	N	Y	L	N	NA	N	NA	N	N	M	Algae covering majority of substrate.
LDW-Y2-IN-ENR-AC-3B	R3	Sand	N	N	N	N	N	N	NA	N	NA	N	N	L	Lasers not visible due to turbidity in the water column. Imprint is an artifact of the SPI frame. Algae covering some of substrate.
LDW-Y2-IN-ENR-AC-4A	R1	Sand and gravel	N	N	N	Y	L	N	NA	N	Stick	L	N	M	Algae covering substrate. One laser visible.
LDW-Y2-IN-ENR-AC-4A	R2	Sand and gravel	N	N	N	N	N	N	NA	N	NA	N	N	M	Lases not visible due to turbidity in water column.
LDW-Y2-IN-ENR-AC-4A	R3	Sand and gravel	N	N	N	N	N	N	NA	N	NA	N	N	M	Lasers not visible due to turbidity in water column. Algae covering substrate.
LDW-Y2-IN-ENR-AC-4B	R1	Sand	N	Y	N	Y	M	N	NA	N	Sticks	L	N	L	Algae covering majority of substrate.
LDW-Y2-IN-ENR-AC-4B	R2	Gravel and sand	N	N	N	N	N	N	NA	N	Stick	L	N	H	Algae covering substrate.
LDW-Y2-IN-ENR-AC-4B	R3	Sand and gravel	N	N	N	Y	L	N	NA	N	NA	N	N	M	Algae covering majority of substrate.
LDW-Y2-IN-ENR-AC-5A	R1	Gravel and silt	N	N	N	N	N	N	NA	N	Sticks	L	N	M	Substrate covered by algae.
LDW-Y2-IN-ENR-AC-5A	R2	Silt, sand, and gravel	N	N	N	N	N	N	NA	N	NA	N	N	M	Algae covering substrate.
LDW-Y2-IN-ENR-AC-5A	R3	Silt, gravel, and sand	N	N	N	N	N	N	NA	N	NA	N	N	M	Algae covering substrate.
LDW-Y2-IN-ENR-AC-5B	R1	Sand, gravel, and silt	N	N	N	Y	L	N	NA	N	Sticks and macroalgae	L	N	M	Algae covering substrate.
LDW-Y2-IN-ENR-AC-5B	R2	Gravel, sand, and silt	N	N	N	Y	L	N	NA	N	Sticks and macroalgae	L	N	M	Algae covering substrate.
LDW-Y2-IN-ENR-AC-5B	R3	Gravel, silt, and sand	N	N	N	N	N	N	NA	N	Macroalgae	L	N	M	Imprint is an artifact from the SPI frame. Algae covering substrate. Few shell fragments.
LDW-Y2-IN-ENR-AC-6A	R1	Sand and silt	N	N	N	Y	L	N	NA	N	Leaf	L	N	L	Algae covering substrate.
LDW-Y2-IN-ENR-AC-6A	R2	Gravel, sand, and silt	N	N	N	Y	L	N	NA	N	Leaves and macroalgae	L	N	M	Algae covering substrate.
LDW-Y2-IN-ENR-AC-6A	R3	Sand and silt	N	Y	N	Y	L	N	NA	N	Sticks	L	N	L	Imprint is an artifact of the SPI frame. Few gravel pieces. Algae covering a portion of the substrate.
LDW-Y2-IN-ENR-AC-6B	R1	Gravel, sand, and silt	N	N	N	N	N	N	NA	N	NA	N	N	M	Algae covering substrate.

Table 3-2b. Year 2 Intertidal ENR+AC Pilot Subplot PV Results

Station	Replicate	Sediment Type	Bedforms	*Lebensspuren*				Epifauna	Epifauna Type (Count)	Mud Clasts	Debris Type	Debris Cover	*Beggiatoa*	Surface Boundary Roughness (cm)	Comments
				Burrows	Tubes	Tracks	Total Abundance								
LDW-Y2-IN-ENR-AC-6B	R2	Gravel and silt	N	N	N	N	N	N	NA	N	NA	N	N	H	Algae covering substrate.
LDW-Y2-IN-ENR-AC-6B	R3	Sand and gravel	N	N	N	Y	L	N	NA	N	Leaf	L	N	M	Imprint is an artifact of the SPI frame. Few gravel pieces. Algae covering substrate.

Notes:

Shaded rows indicate replicate not analyzable due to turbidity.

-- = not analyzed

Lebensspuren = biologically formed sedimentary structures

AC = activated carbon

ENR = enhanced natural recovery

H = high

L = low

M = medium

N = no

NA = not applicable

PV = plan view

SPI = sediment profile imaging

Y = yes

Table 3-3a. Year 2 Scour ENR Pilot SPI Results

Station	Replicate	Image Date	Water Depth (ft)	Penetration Depth (cm)	ENR Layer Thickness (cm)	Texture and Other Observations	Surface Boundary Roughness (cm)	RPD Depth (cm)	Grain Size Major Mode (phi units)	Grain Size Maximum (phi units)	Grain Size Minimum (phi units)	Methane	Successional Stage
LDW-Y2-SC-ENR-1A	R1	3/8/2018	34.6	3.1	>P	Silt with large piece of gravel. RPD is Ind. Light brown silt above darker reduced sediment. Barnacle on cobble at surface.	1.4	1.1	>4	-5	>4	N	1 on 3
LDW-Y2-SC-ENR-1A	R2	3/8/2018	34.6	4.3	>P	Layer of silt and fine sand over coarse sand and gravel. Bryozoan in the background on surface.	0.6	1.4	>4	-4	>4	N	1 on 3
LDW-Y2-SC-ENR-1A	R3	3/8/2018	34.6	5.3	>P	Tubes on surface. Sand/silt/sand. Gravel on surface.	1.6	1.6	>4 and 3-2	0	>4	N	1 on 3
LDW-Y2-SC-ENR-1B	R1	3/8/2018	34	3	>P	Gravel on surface. Silt mixed into sand.	0.5	1.7	>4	-5	>4	N	1 on 3
LDW-Y2-SC-ENR-1B	R2	3/8/2018	34	5.8	>P	Feeding voids at depth. Silt mixed with sand. Stage 3 feeding voids clearly evident.	0.6	2.2	3-2	0	>4	N	1 on 3
LDW-Y2-SC-ENR-1B	R3	3/8/2018	34	0.3	>P	Not analyzable, under penetration. Gravel pieces on surface, with silt and few shell fragments.	--	--	--	--	--	--	--
LDW-Y2-SC-ENR-2A	R1	3/8/2018	33.5	4.6	>P	Few shell fragments.	1.8	1.5	>4	-4	>4	N	1 on 3
LDW-Y2-SC-ENR-2A	R3	3/8/2018	35.6	5	>P	Large void at 4 cm, likely enlarged by prism. Sand atop silt, with gravel on surface.	1.7	1.4	4-3	-4	>4	N	1 on 3
LDW-Y2-SC-ENR-2A	R6	3/8/2018	36.6	5.6	>P	Fine sand atop silt. Shell fragments in top 2 cm.	1.3	1.7	>4	2	>4	N	1 on 3
LDW-Y2-SC-ENR-2B	R3	3/8/2018	35.6	5.8	LNA	Shell fragments in top 2 cm. Fine sand atop silt. Gravel on surface.	0.7	1.5	3-2/>4	-2	>4	N	1 on 3
LDW-Y2-SC-ENR-2B	R4	3/8/2018	39.2	4.5	LNA	Large void at 3 cm enhanced by prism. Shell fragments on surface.	1.6	1.3	4-3	0	>4	N	1 on 3
LDW-Y2-SC-ENR-2B	R6	3/8/2018	39.2	5	LNA	Few cobble pieces on surface. Macro red algae. Silt mixed in with sand.	1.1	1.4	>4	-4	>4	N	1 on 3
LDW-Y2-SC-ENR-3A	R1	3/8/2018	32.3	4.9	LNA	Shell fragments and sand in surface sediments.	0.8	1.6	3-2/ >4	0	>4	N	1 on 3
LDW-Y2-SC-ENR-3A	R2	3/8/2018	32.3	3.7	LNA	Macroalgae on surface. Shell fragments in top 2 cm.	1.7	1.6	3-2/>4	1	>4	N	1 on 3
LDW-Y2-SC-ENR-3A	R3	3/8/2018	32.3	7.2	LNA	Cobble/stick on surface. Wood at 4 cm. Sand over silt.	1.3	2.1	3-2/>4	-5	>4	N	1 on 3
LDW-Y2-SC-ENR-3B	R1	3/8/2018	28.5	3.4	LNA	Mud clast on surface is an artifact from the SPI frame. Sand over silt.	1.1	1.5	3-2	-2	>4	N	1 on 3
LDW-Y2-SC-ENR-3B	R2	3/8/2018	28.5	4.6	LNA	Shell fragments in surface. Tubes on surface.	0.5	1.4	3-2/>4	0	>4	N	1 on 3
LDW-Y2-SC-ENR-3B	R3	3/8/2018	28.5	4.9	LNA	Shell fragments. Sand at surface and in voids at depth; silt conceals sand matrix.	0.7	1.2	3-2/>4	2	>4	N	1 on 3
LDW-Y2-SC-ENR-4A	R2	3/8/2018	31.8	6.2	LNA	Few shell fragments in surface sediments. Sand over silt; sand in voids.	0.7	1.9	>4	0	>4	N	1 on 3
LDW-Y2-SC-ENR-4A	R3	3/8/2018	31.8	6.4	LNA	Shell fragments in surface sediments. Sand over silt.	0.7	1.2	>4	0	>4	N	1 on 3
LDW-Y2-SC-ENR-4A	R7	3/8/2018	36.8	6.2	LNA	Shell fragments in surface sediments. Sand at surface and in voids.	1.7	1.5	>4	1	>4	N	1 on 3
LDW-Y2-SC-ENR-4B	R1	3/8/2018	33.6	5.4	LNA	Sand over silt. Shell fragments in surface sediments. Voids likely > penetration.	0.5	1.7	>4	1	>4	N	1 on 3

Table 3-3a. Year 2 Scour ENR Pilot SPI Results

Station	Replicate	Image Date	Water Depth (ft)	Penetration Depth (cm)	ENR Layer Thickness (cm)	Texture and Other Observations	Surface Boundary Roughness (cm)	RPD Depth (cm)	Grain Size Major Mode (phi units)	Grain Size Maximum (phi units)	Grain Size Minimum (phi units)	Methane	Successional Stage
LDW-Y2-SC-ENR-4B	R3	3/8/2018	33.6	4.8	LNA	RPD partially disturbed by prism pull down. Cobbles on surface. Large worm in burrow. Void likely enlarged by prism.	1.4	1.1	>4	-4	>4	N	1 on 3
LDW-Y2-SC-ENR-4B	R5	3/8/2018	38.6	8.5	LNA	Fine sand over silt. Fecal pellets from polychaetes on surface.	0.9	1.5	>4	-2	>4	N	1 on 3
LDW-Y2-SC-ENR-5A	R1	3/8/2018	25.6	4.9	LNA	Cockle shell on surface. Gravel piece on surface. Sand over silt.	0.5	1.7	>4	-3	>4	N	1 on 3
LDW-Y2-SC-ENR-5A	R2	3/8/2018	25.6	5.3	LNA	Shell fragments on surface. Sand over silt.	1	1	>4	1	>4	N	1 on 3
LDW-Y2-SC-ENR-5A	R3	3/8/2018	25.6	3.8	LNA	Shell fragments on surface. Gravel pieces. Leaf litter.	0.8	1.1	4-3	1	>4	N	1 on 3
LDW-Y2-SC-ENR-5B	R1	3/8/2018	26.3	4.5	LNA	Sand over silt.	0.5	1.1	>4	0	>4	N	1 on 3
LDW-Y2-SC-ENR-5B	R2	3/8/2018	26.3	3.8	LNA	SWI disturbed by large cavity. RPD = Ind.	0.8	Ind	>4	1	>4	N	1 on 3
LDW-Y2-SC-ENR-5B	R3	3/8/2018	26.3	5.1	>P	Boundary roughness is artifact of prism tilt. Sand and silt mix.	6.4	1.6	> 4 and 2-1	-5	>4	N	1 on 3
LDW-Y2-SC-ENR-6A	R1	3/8/2018	29.9	4.6	LNA	Gravel, plant debris on surface.	0.7	1.6	3-2 and > 4	-4	>4	N	1 on 3
LDW-Y2-SC-ENR-6A	R2	3/8/2018	29.9	6	LNA	Sand in voids at depth.	1	2.2	>4	0	>4	N	1 on 3
LDW-Y2-SC-ENR-6A	R3	3/8/2018	29.9	4.9	>P	Small and larger tubes on surface. Gravel on surface. Large void between silt layer and gravel layer, at 4 cm, is likely artifact of prism penetration.	2.1	1.6	>4	-5	>4	N	1 on 3
LDW-Y2-SC-ENR-6B	R1	3/8/2018	31.1	4.8	LNA	Large possible bivalve burrow. Shell fragments at surface.	2.8	2	>4	-3	>4	N	1 on 3
LDW-Y2-SC-ENR-6B	R2	3/8/2018	31.1	4.8	LNA	Tubes on surface. Shell fragments and few pieces of gravel on surface.	2.3	1.4	>4	2	>4	N	1
LDW-Y2-SC-ENR-6B	R3	3/8/2018	31.1	6.2	LNA	Gravel and cobble on surface.	0.9	1.9	>4	-4	>4	N	1 on 3

Summary Statistics for Some Numerical Parameters

	Penetration Depth (cm)	Surface Boundary Roughness (cm)	RPD Depth (cm)
N	36	35	34
Average	4.9	1.3	1.5
Median	4.9	1.0	1.5
Minimum	0.3	0.5	1.0
Maximum	8.5	6.4	2.2

Notes:
-- = not analyzed
aRPD = apparent redox potential discontinuity
ENR = enhanced natural recovery
Ind = indeterminate
LNA = layer not apparent
N = no
P = penetration
SPI = sediment profile imaging
SWI = sediment-water interface

Table 3-3b. Year 2 Scour ENR Pilot PV Results

				Lebensspuren											
Station	Replicate	Sediment Type	Bedforms	Burrows	Tubes	Tracks	Total Abundance	Epifauna	Epifauna Type (Count)	Mud Clasts	Debris Type	Debris Cover	*Beggiatoa*	Surface Boundary Roughness (cm)	
LDW-Y2-SC-ENR-1A	R1	Silt, sand, and gravel	N	N	Y	Y	M	Y	Barnacles (3)	N	Leaves	L	N	M	Scattered pieces of gravel. Shell fragments. Algae on gravel.
LDW-Y2-SC-ENR-1A	R2	Sand and gravel	N	N	Y	Y	L	N	NA	N	NA	N	N	M	Image partially obscured by suspended sediment. Lasers not visible. Imprint is an artifact of the SPI frame.
LDW-Y2-SC-ENR-1A	R3	Sand, silt, and gravel	N	N	Y	Y	L	N	NA	N	Macroalgae	L	N	M	Scattered gravel. Imprint is an artifact from the SPI frame.
LDW-Y2-SC-ENR-1B	R1	Sand, silt, and gravel	N	N	Y	Y	L	N	NA	N	Leaves	L	N	M	Shell fragments. Scattered pieces of gravel.
LDW-Y2-SC-ENR-1B	R2	Sand, silt, and gravel	N	N	Y	Y	L	N	NA	N	Wood	L	N	M	Scattered pieces of gravel.
LDW-Y2-SC-ENR-1B	R3	--	--	--	--	--	--	--	--	--	--	--	--	--	Not analyzable due to turbidity in the water column.
LDW-Y2-SC-ENR-2A	R4	Silt, sand, and gravel	Y	N	Y	Y	N	Y	Barnacles (2)	N	Wood	L	N	M	Dispersed gravel pieces. Shell fragments.
LDW-Y2-SC-ENR-2A	R5	Silt, sand, and gravel	Y	N	Y	Y	M	Y	Crab (1)	N	NA	N	N	M	Few pieces of scattered gravel.
LDW-Y2-SC-ENR-2A	R6	Silt, sand, and gravel	N	N	Y	Y	L	Y	Barnacles (2)	N	Wood and leaves	M	N	M	Scattered pieces of gravel. Shell fragments.
LDW-Y2-SC-ENR-2B	R3	Silt, sand, and gravel	N	N	Y	Y	M	Y	Barnacle (1)	N	Organic detritus	L	N	L	Few shell fragments and very few pieces of gravel and sand.
LDW-Y2-SC-ENR-2B	R4	Silt, sand, and gravel	N	N	Y	Y	L	N	NA	N	Macroalgae	L	N	L	Very few pieces of gravel. Frame imprint is an artifact from the SPI frame.
LDW-Y2-SC-ENR-2B	R6	Sand, gravel, and silt	N	N	Y	N	L	N	NA	N	Sticks	L	N	M	Few shell fragments and algae on gravel.
LDW-Y2-SC-ENR-3A	R1	Silt and gravel	N	N	Y	Y	L	N	NA	N	Sticks	L	N	M	Shell fragments and bivalve shell. Scattered pieces of gravel.
LDW-Y2-SC-ENR-3A	R2	--	--	--	--	--	--	--	--	--	--	--	--	--	Not analyzable due to turbidity in the water column.
LDW-Y2-SC-ENR-3A	R3	--	--	--	--	--	--	--	--	--	--	--	--	--	Not analyzable due to turbidity in the water column.
LDW-Y2-SC-ENR-3B	R1	Silt, sand, and gravel	N	N	Y	Y	L	Y	Barnacles (4)	N	Wood and macroalgae	L	N	M	Scattered gravel and shell fragments.
LDW-Y2-SC-ENR-3B	R2	Silt, sand, and gravel	N	N	Y	Y	N	N	NA	N	Leaf	L	N	M	Few shell fragments, scattered gravel. Bivalve shell.
LDW-Y2-SC-ENR-3B	R3	Silt and gravel	N	N	Y	Y	L	N	NA	N	NA	N	N	L	Few gravel pieces. Image partially obscured by suspended sediment.
LDW-Y2-SC-ENR-4A	R1	Silt, wood, and gravel	N	N	Y	Y	L	Y	Barnacles (3)	N	Wood and leaves	M	N	M	Few gravel pieces and shell fragments.
LDW-Y2-SC-ENR-4A	R2	Silt and gravel	N	N	Y	Y	L	N	NA	N	Wood	L	N	L	Very few gravel pieces and shell fragments.
LDW-Y2-SC-ENR-4A	R5	Silt and gravel	N	N	Y	Y	H	Y	Snails (2)	N	Wood and leaves	L	N	M	Few gravel pieces.
LDW-Y2-SC-ENR-4B	R4	Silt, sand, and gravel	N	N	Y	Y	M	Y	Barnacles (5)	N	Macroalgae	L	N	L	Fish carcass, few shell fragments. Anthropogenic imprint on sediment surface.
LDW-Y2-SC-ENR-4B	R5	Silt and sand	N	N	Y	Y	M	N	NA	N	Wood	L	N	L	Very few gravel pieces. Piece of crustacean shell.
LDW-Y2-SC-ENR-4B	R6	Silt and gravel	N	N	Y	Y	L	N	NA	N	Leaf	L	N	M	Lasers not visible due to suspended sediment. Few gravel pieces.
LDW-Y2-SC-ENR-5A	R1	Silt, sand, and gravel	N	N	Y	Y	M	Y	Barnacles (3)	N	Wood and leaves	L	N	L	Shell fragments and few gravel pieces.
LDW-Y2-SC-ENR-5A	R2	Sand, gravel, and silt	N	N	N	Y	M	Y	Barnacles (>10)	N	Wood and brick	M	N	M	Many shell fragments. Some scattered gravel pieces.
LDW-Y2-SC-ENR-5A	R3	--	--	--	--	--	--	--	--	--	--	--	--	--	Not analyzable due to turbidity in the water column.
LDW-Y2-SC-ENR-5B	R1	Silt and gravel	N	N	Y	Y	M	N	NA	N	Wood and macroalgae	L	N	L	Few gravel pieces and shell fragments.
LDW-Y2-SC-ENR-5B	R2	--	--	--	--	--	--	--	--	--	--	--	--	--	Not analyzable due to turbidity in the water column.
LDW-Y2-SC-ENR-5B	R3	Silt, sand, and gravel	N	N	Y	Y	H	Y	Barnacles (10)	N	Wood and macroalgae	L	N	M	Few shell fragments and very few pieces of gravel.
LDW-Y2-SC-ENR-6A	R1	Silt and gravel	N	N	N	Y	L	--	Barnacles (>10)	N	Sticks, macroalgae, detached eelgrass	M	N	L	Scattered gravel on silt/sand, brown algal cover, eelgrass is detached green leaf.
LDW-Y2-SC-ENR-6A	R2	Silt and gravel	N	N	Y	Y	M	Y	Barnacles (6)	N	Leaves and sticks	L	N	M	Few dispersed gravel pieces.
LDW-Y2-SC-ENR-6A	R3	Silt	N	N	Y	Y	L	N	NA	N	Wood	L	N	L	Two pieces of gravel. Few shell fragments.
LDW-Y2-SC-ENR-6B	R1	Sand and gravel	N	N	Y	Y	M	Y	Barnacles (10)	N	Wood	L	N	M	Scattered gravel pieces.

Table 3-3b. Year 2 Scour ENR Pilot PV Results

Station	Replicate	Sediment Type	Bedforms	*Lebensspuren*				Epifauna	Epifauna Type (Count)	Mud Clasts	Debris Type	Debris Cover	*Beggiatoa*	Surface Boundary Roughness (cm)	
				Burrows	Tubes	Tracks	Total Abundance								
LDW-Y2-SC-ENR-6B	R2	Silt, sand, and gravel	N	N	Y	Y	L	N	NA	N	NA	N	N	L	One laser visible. Image partially obscured by suspended sediment. Imprint is an artifact from the SPI frame.
LDW-Y2-SC-ENR-6B	R3	Silt and gravel	N	N	Y	Y	L	N	NA	N	Leaves, sticks	L	N	M	Imprint is an artifact from the SPI frame. Few gravel pieces and shell fragments.

Notes:

Shaded rows indicate replicate not analyzable due to turbidity.

-- = not analyzed

Lebensspuren = biologically formed sedimentary structures

ENR = enhanced natural recovery

H = high

L = low

M = medium

N = no

NA = not applicable

PV = plan view

SPI = sediment profile imaging

Y = yes

Table 3-4a. Year 2 Scour ENR+AC SPI Results

Station	Replicate	Image Date	Water Depth (ft)	Penetration Depth (cm)	ENR+AC Layer Thickness (cm)	Texture and Other Observations	Surface Boundary Roughness (cm)	RPD Depth (cm)	Grain Size Major Mode (phi units)	Grain Size Maximum (phi units)	Grain Size Minimum (phi units)	Methane	Successional Stage
LDW-Y2-SC-ENR-AC-1A	R1	3/8/2018	26.5	0.0	>P	No penetration. High density of gravel and coarse sand with thin veneer of silt on surface.		Ind	-3-(-4)	-5	>4	N	Ind
LDW-Y2-SC-ENR-AC-1A	R2	3/8/2018	26.5	5.5	>P	Thin film of silt and algae on surface. One tube on surface.	1.9	Ind	-1-(-2)	-4	>4	N	Ind
LDW-Y2-SC-ENR-AC-1A	R3	3/8/2018	26.5	3.3	>P	Tubes on surface. Light film of silt and algae on surface of gravel and coarse sand.	1.1	Ind	-1-(-2)	-5	>4	N	1
LDW-Y2-SC-ENR-AC-1B	R1	3/8/2018	28	2.6	>P	Cobbles, coarse sand, and silt clast. Thin film of silt and algae on surface.	1.3	Ind	-1-(-2)	-5	>4	N	Ind
LDW-Y2-SC-ENR-AC-1B	R2	3/8/2018	28	3.5	>P	Tubes on surface. RPD is Ind.	1.4	Ind	1-0	-5	>4	N	Ind
LDW-Y2-SC-ENR-AC-1B	R3	3/8/2018	28	3.1	>P	Thin layer of algae and silt on surface. Possible jellyfish on surface.	3	Ind	-4-(-5)	-5	>4	N	Ind
LDW-Y2-SC-ENR-AC-2A	R1	3/8/2018	34.6	4	LNA	Sand and silt mix.	1.3	1.7	3-2 and > 4	-2	>4	N	1 on 3
LDW-Y2-SC-ENR-AC-2A	R2	3/8/2018	34.6	2.7	LNA	Leaf and macroalgae on surface.	0.8	1.5	>4	1	>4	N	1 on 3
LDW-Y2-SC-ENR-AC-2A	R3	3/8/2018	34.6	2.9	LNA	Gravel on surface.	1.6	1.7	3-2	-4	>4	N	1 on 3
LDW-Y2-SC-ENR-AC-2B	R1	3/8/2018	33.9	2.6	LNA	RPD is minimum estimate. Stick and macroalgae on surface. Shell fragments. Gravel on surface.	1.9	1.9	>4 and 3-2	-1	>4	N	1 on 3
LDW-Y2-SC-ENR-AC-2B	R2	3/8/2018	33.9	2.4	LNA	RPD is Ind. Shell drug down, obscuring RPD. Gravel and shell fragments on surface.	1.1	Ind	>4 and 3-2	1	>4	N	Ind
LDW-Y2-SC-ENR-AC-2B	R3	3/8/2018	33.9	4.1	>P	Few gravel pieces on surface. Tubes on surface.	1.3	2	1-0 and >4	-3	>4	N	1 on 3
LDW-Y2-SC-ENR-AC-3A	R1	3/8/2018	24	0.8	>P	Gravel substrate, minimal penetration. Barnacles on gravel.	1.1	Ind	-2-(-3)	-5	1	N	Ind
LDW-Y2-SC-ENR-AC-3A	R2	3/8/2018	24	6.1	>P	Gravel and coarse sand, grading finer with depth.	1.3	Ind	-1-(-2)	-5	2	N	Ind
LDW-Y2-SC-ENR-AC-3A	R3	3/8/2018	24	8.1	>P	Gravel and coarse sand. Some barnacles on surface. RPD = Ind for all reps.	2.3	Ind	-1-(-2)	-5	>4	N	Ind
LDW-Y2-SC-ENR-AC-3B	R1	3/8/2018	24.6	4.9	>P	Gravel and coarse sand. RPD = Ind.	1.1	Ind	-1-(-2)	-5	>4	N	Ind
LDW-Y2-SC-ENR-AC-3B	R2	3/8/2018	24.6	2.8	>P	Gravel and coarse sand.	2.6	Ind	-4-(-5)	-5	3	N	Ind
LDW-Y2-SC-ENR-AC-3B	R3	3/8/2018	24.6	5.5	>P	Gravel and coarse sand. RPD = Ind.	1.6	Ind	-1-(-2)	-5	>4	N	Ind
LDW-Y2-SC-ENR-AC-4A	R1	3/8/2018	28.2	5.3	LNA	Gravel on surface.	0.8	2.8	>4 and 3-2	-5	>4	N	1 on 3
LDW-Y2-SC-ENR-AC-4A	R2	3/8/2018	28.2	5.1	LNA	Gravel pieces on surface.	2.6	2.7	>4 and 3-2	-5	>4	N	1 on 3
LDW-Y2-SC-ENR-AC-4A	R3	3/8/2018	28.2	6.9	LNA	Gravel, wood pieces on surface.	1.4	2.9	>4 and 3-2	-5	>4	N	1 on 3
LDW-Y2-SC-ENR-AC-4B	R1	3/8/2018	32.6	4.5	LNA	Few tubes on surface. Expanded voids due to prism penetration through gravel.	0.9	1.8	>4 and 3-2	-3	>4	N	1

Table 3-4a. Year 2 Scour ENR+AC SPI Results

Station	Replicate	Image Date	Water Depth (ft)	Penetration Depth (cm)	ENR+AC Layer Thickness (cm)	Texture and Other Observations	Surface Boundary Roughness (cm)	RPD Depth (cm)	Grain Size Major Mode (phi units)	Grain Size Maximum (phi units)	Grain Size Minimum (phi units)	Methane	Successional Stage
LDW-Y2-SC-ENR-AC-4B	R4	3/8/2018	34.9	5.5	LNA	Gravel on surface. PV shows footprint of camera frame.	3.4	2.3	>4 and 3-2	-4	>4	N	1 on 3
LDW-Y2-SC-ENR-AC-4B	R5	3/8/2018	34.9	4.7	LNA	Gravel and organic debris on surface. Silt subfraction.	1.6	2.4	3-2	-4	>4	N	1 on 3
LDW-Y2-SC-ENR-AC-5A	R1	3/8/2018	21.9	3.2	>P	Gravel and coarse sand on surface. RPD is Ind. Silt subfraction.	0.8	Ind	2-1	-4	>4	N	Ind
LDW-Y2-SC-ENR-AC-5A	R2	3/8/2018	21.9	4.3	>P	RPD is Ind. Gravel and coarse sand on surface, grading finer with depth. Small tubes on surface.	0.5	Ind	2-1	-3	>4	N	1 on 3
LDW-Y2-SC-ENR-AC-5A	R3	3/8/2018	21.9	3.1	>P	Coarse sand and gravel.	2.2	Ind	0-(-1)	-4	3	N	Ind
LDW-Y2-SC-ENR-AC-5B	R1	3/8/2018	21.6	2.4	>P	Gravel and coarse sand.	0.8	Ind	0-(-1)	-4	>4	N	Ind
LDW-Y2-SC-ENR-AC-5B	R2	3/8/2018	21.6	3.3	>P	Macroalgae on surface. Bimodal grain size, very coarse sand and silts.	1	Ind	0-(-1) and > 4)	-5	>4	N	Ind
LDW-Y2-SC-ENR-AC-5B	R3	3/8/2018	21.6	2.9	>P	Coarse sand and gravel at surface.	0.9	Ind	2-1 and > 4	-2	>4	N	Ind
LDW-Y2-SC-ENR-AC-6A	R1	3/8/2018	25.1	4.5	LNA	Gravel on surface.	0.8	1.7	>4 and 3-2	-2	>4	N	1 on 3
LDW-Y2-SC-ENR-AC-6A	R2	3/8/2018	25.1	2.4	LNA	Gravel, shell fragments. Small tubes on surface, small worm at 1 cm. RPD = Ind.	1.6	Ind	>4 and 3-2	-5	>4	N	Ind
LDW-Y2-SC-ENR-AC-6A	R3	3/8/2018	25.1	4	LNA	Gravel, worm tubes on surface.	1.3	2.1	>4 and 3-2	-3	>4	N	1 on 3
LDW-Y2-SC-ENR-AC-6B	R1	3/8/2018	24.5	3.7	>P	Gravel and cobble on surface. Minimal penetration through gravel layer.	1.5	Ind	-4-(-5) / 4-3	-5	>4	N	Ind
LDW-Y2-SC-ENR-AC-6B	R2	3/8/2018	24.5	2.4	>P	Coarse sand over silt.	1.7	Ind	3-2	-3	>4	N	1 on 3
LDW-Y2-SC-ENR-AC-6B	R3	3/8/2018	24.5	2.7	>P	RPD is Ind. Tubes on surface. Sand and silt mix.	1.9	Ind	>4 and 3-2	-2	>4	N	1 on 3

Summary Statistics for Some Numerical Parameters

	Penetration Depth (cm)	Surface Boundary Roughness (cm)	RPD Depth (cm)
N	36	35	13
Average	3.8	1.5	2.1
Median	3.4	1.3	2.0
Minimum	0	0.5	1.5
Maximum	8.1	3.4	2.9

Notes:
-- = not analyzed
AC = activated carbon
aRPD = apparent redox potential discontinuity
ENR = enhanced natural recovery
Ind = indeterminate
LNA = layer not apparent
N = no
P = penetration
PV = plan view
SPI = sediment profile imaging

Table 3-4b. Year 2 Scour ENR+AC PV Results

Station	Replicate	Sediment Type	Bedforms	*Lebensspuren*				Epifauna	Epifauna Type (Count)	Mud Clasts	Debris Type	Debris Cover	*Beggiatoa*	Surface Boundary Roughness (cm)	Comments
				Burrows	Tubes	Tracks	Total Abundance								
LDW-Y2-SC-ENR-AC-1A	R1	Gravel, sand, and silt	N	N	N	N	N	Y	Barnacles (4)	N	Wood	L	N	H	Few cobble pieces.
LDW-Y2-SC-ENR-AC-1A	R2	Gravel and sand	N	N	N	N	N	N	NA	N	NA	N	N	M	Few shell fragments.
LDW-Y2-SC-ENR-AC-1A	R3	Sand and gravel	N	N	N	N	N	Y	Barnacles (2)	N	Sticks	L	N	M	Few shell fragments.
LDW-Y2-SC-ENR-AC-1B	R1	Gravel and sand	N	N	N	N	N	Y	Bivalve siphon (1)	N	NA	N	N	H	Bivalve siphon and few shell fragments.
LDW-Y2-SC-ENR-AC-1B	R2	Gravel and sand	N	N	N	Y	L	N	NA	N	Macroalgae	L	N	H	Few shell fragments.
LDW-Y2-SC-ENR-AC-1B	R3	Sand and gravel	N	N	N	N	N	N	NA	N	Sticks	L	N	M	Piece of cobble. Shell fragments.
LDW-Y2-SC-ENR-AC-2A	R1	Sand and gravel	N	N	Y	Y	M	N	NA	N	Leaves	L	N	L	Few gravel pieces and few shell fragments.
LDW-Y2-SC-ENR-AC-2A	R2	Sand and gravel	N	N	Y	Y	L	Y	Barnacles (3)	N	Leaves	L	N	L	Image partially obscured by suspended sediment. Few shell fragments and gravel.
LDW-Y2-SC-ENR-AC-2A	R3	--	--	--	--	--	--	--	--	--	--	--	--	--	Not analyzable due to turbidity in the water column.
LDW-Y2-SC-ENR-AC-2B	R1	Silt, sand, and gravel	N	N	Y	Y	M	Y	Barnacles (3)	N	Leaf	L	N	L	Few gravel pieces and shell fragments.
LDW-Y2-SC-ENR-AC-2B	R2	Sand and gravel	N	N	Y	Y	H	Y	Barnacles (8)	N	Wood and plastic	L	N	L	Crab shell, few gravel pieces and shell fragments.
LDW-Y2-SC-ENR-AC-2B	R3	--	--	--	--	--	--	--	--	--	--	--	--	--	Not analyzable due to turbidity in the water column.
LDW-Y2-SC-ENR-AC-3A	R1	Sand and gravel	N	N	N	N	N	N	NA	N	NA	N	N	M	Few shell fragments.
LDW-Y2-SC-ENR-AC-3A	R2	Sand and gravel	N	N	N	N	N	Y	Barnacles (5)	N	Macroalgae	L	N	H	Few cobble pieces. Shell fragments.
LDW-Y2-SC-ENR-AC-3A	R3	Gravel, sand, and cobble	N	N	N	N	N	Y	Barnacles (12)	N	NA	N	N	H	Shell fragments.
LDW-Y2-SC-ENR-AC-3B	R1	Gravel and sand	N	N	N	N	N	Y	Barnacles (13)		Leaf and macroalgae	L	N	H	Bivalve siphon. Shell fragments.
LDW-Y2-SC-ENR-AC-3B	R2	Gravel and sand	N	N	N	N	N	Y	Barnacles (5)	N	NA	N	N	H	Shell fragments.
LDW-Y2-SC-ENR-AC-3B	R3	Gravel and sand	N	N	N	N	N	Y	Barnacles (>30)	N	Macroalgae	L	N	H	Some cobble and shell fragments.
LDW-Y2-SC-ENR-AC-4A	R1	Sand and gravel	N	N	Y	Y	L	N	NA	N	NA	N	N	M	Few shell fragments.
LDW-Y2-SC-ENR-AC-4A	R2	Silt, sand, and gravel	N	Y	Y	Y	L	Y	Barnacles (6)	N	NA	N	N	M	Shell fragments. Dispersed pieces of gravel.
LDW-Y2-SC-ENR-AC-4A	R3	Gravel and sand	N	N	Y	Y	L	Y	Barnacles (20)	N	Leaves and sticks	M	N	M	Shell fragments.
LDW-Y2-SC-ENR-AC-4B	R1	Gravel and sand with overlying silt	N	N	Y	Y	L	Y	Barnacles (13)	N	Leaf	L	N	M	Patchy distribution of gravel.
LDW-Y2-SC-ENR-AC-4B	R4	Sand and gravel	N	N	Y	Y	L	Y	Barnacles (2)	N	Leaf	L	N	M	Imprint is an artifact of the SPI frame. Some gravel.
LDW-Y2-SC-ENR-AC-4B	R6	Gravel and sand	N	N	Y	Y	M	N	NA	N	Stick	L	N	M	Algae on some of gravel pieces.
LDW-Y2-SC-ENR-AC-5A	R1	Sand and gravel	N	N	N	N	N	Y	Barnacles (4)	N	NA	N	N	M	Shell fragments, piece of cobble.
LDW-Y2-SC-ENR-AC-5A	R2	Gravel and sand	N	N	N	N	N	N	NA	N	NA	N	N	H	Lasers not visible due to suspended sediments. Image partially obscured.
LDW-Y2-SC-ENR-AC-5A	R3	Sand and gravel	N	N	N	Y	L	Y	Barnacles (2)	N	NA	N	N	M	Bivalve siphon visible. Scattered pieces of gravel.
LDW-Y2-SC-ENR-AC-5B	R1	Sand and gravel	N	N	N	N	N	Y	Barnacles (9)	N	NA	N	N	M	Few shell fragments.
LDW-Y2-SC-ENR-AC-5B	R2	Sand and gravel	N	N	Y	Y	L	Y	Barnacles (10)	N	Leaves	L	N	M	Shell fragments. Fecal casts.
LDW-Y2-SC-ENR-AC-5B	R3	Sand and gravel	N	N	Y	Y	L	Y	Barnacles (>30)	N	NA	N	N	M	Patchy distribution of gravel. Shell fragments.
LDW-Y2-SC-ENR-AC-6A	R1	Silt, sand, and gravel	N	N	Y	Y	H	Y	Barnacles (9)	N	Sticks and leaves	L	N	M	Shell fragments.
LDW-Y2-SC-ENR-AC-6A	R2	Silt, gravel, and sand	N	N	N	Y	L	N	NA	N	Sticks	L	N	L	Image partially obscured by suspended sediment.
LDW-Y2-SC-ENR-AC-6A	R3	Silt and gravel	N	N	Y	Y	L	Y	Barnacles (2)	N	Sticks	L	N	L	Image partially obscured by suspended sediment. One laser visible. Dispersed pieces of gravel.
LDW-Y2-SC-ENR-AC-6B	R1	Gravel and silt	N	N	N	N	N	Y	Barnacles (>50)	N	Leaves	L	N	H	Dense gravel/cobble cover, clam shells.

Table 3-4b. Year 2 Scour ENR+AC PV Results

				Lebensspuren											
Station	Replicate	Sediment Type	Bedforms	Burrows	Tubes	Tracks	Total Abundance	Epifauna	Epifauna Type (Count)	Mud Clasts	Debris Type	Debris Cover	*Beggiatoa*	Surface Boundary Roughness (cm)	Comments
LDW-Y2-SC-ENR-AC-6B	R2	Sand, gravel, and silt	N	N	Y	Y	L	Y	Barnacles (12)	N	Macroalgae	L	N	M	Bivalve siphon. Shell fragments.
LDW-Y2-SC-ENR-AC-6B	R3	Silt, sand, and gravel	N	N	Y	Y	M	N	NA	N	Leaves	L	N	L	Very few pieces of gravel. Shell fragments.

Notes:
Shaded rows indicate replicate not analyzable due to turbidity.
-- = not analyzed
Lebensspuren = biologically formed sedimentary structures
AC = activated carbon
ENR = enhanced natural recovery
H = high
L = low
M = medium
N = no
NA = not applicable
PV = plan view
SPI = sediment profile imaging
Y = yes

Table 3-5a. Year 2 Subtidal ENR Pilot Subplot SPI Results

Station	Replicate	Image Date	Water Depth (ft)	Penetration Depth (cm)	ENR Layer Thickness (cm)	Texture and Other Observations	Surface Boundary Roughness (cm)	RPD Depth (cm)	Grain Size Major Mode (phi units)	Grain Size Maximum (phi units)	Grain Size Minimum (phi units)	Methane	Successional Stage
LDW-Y2-SU-ENR-1A	R1	3/7/2019	41.9	1.9	LNA	Very fine to medium sand. RPD > penetration.	0.8	Ind	4-3	2	>4	N	Ind
LDW-Y2-SU-ENR-1A	R2	3/7/2019	41.9	1.9	LNA	RPD > penetration. Compact fine sand.	0.4	Ind	4-3	2	>4	N	Ind
LDW-Y2-SU-ENR-1A	R3	3/7/2019	41.9	3.3	LNA	Few shell fragments on surface.	0.2	2.4	3-2	2	>4	N	Ind
LDW-Y2-SU-ENR-1B	R1	3/7/2019	43.1	0.3	LNA	Minimal penetration. RPD is Ind. Tubes on surface.	1.1	Ind	4-3	2	>4	N	Ind
LDW-Y2-SU-ENR-1B	R2	3/7/2019	43.1	3.8	LNA	Fine to medium sand. Physical bedform?	2.3	1.6	3-2 and >4	2	>4	N	1 on 3
LDW-Y2-SU-ENR-1B	R3	3/7/2019	43.1	2.2	LNA	RPD > pene. Worm tubes on surface.	0.8	Ind	4-3	2	>4	N	Ind
LDW-Y2-SU-ENR-2A	R1	3/7/2019	43	2.4	LNA	RPD > pene. Very fine to medium sand. Few shell fragments.	1	Ind	4-3	1	>4	N	1 on 3
LDW-Y2-SU-ENR-2A	R2	3/7/2019	43	1.6	LNA	RPD > pene. Worm tubes on surface.	1.2	Ind	4-3	2	>4	N	Ind
LDW-Y2-SU-ENR-2A	R3	3/7/2019	43	1.2	LNA	Worm tube on surface. Compact fine to medium sand.	0.4	Ind	4-3	2	>4	N	Ind
LDW-Y2-SU-ENR-2B	R1	3/7/2019	43.1	2	LNA	Burrow extends > pene, but may be artifact. RPD is Ind.	1.3	Ind	4-3	1	>4	N	1 on 3
LDW-Y2-SU-ENR-2B	R2	3/7/2019	43.1	2	LNA	Worm tubes on surface. Few shell fragments. RPD is Ind.	0.7	Ind	3-2	0	>4	N	Ind
LDW-Y2-SU-ENR-2B	R3	3/7/2019	43.1	1.8	LNA	Worm tubes on surface. Few shell fragments. RPD is Ind.	1	Ind	3-2	1	>4	N	Ind
LDW-Y2-SU-ENR-3A	R1	3/7/2019	43.1	0.9	LNA	Minimal penetration. Worm tube on surface. RPD > pene.	0.4	Ind	3-2	1	>4	N	Ind
LDW-Y2-SU-ENR-3A	R2	3/7/2019	43.1	1.8	LNA	Worm tubes on surface. Lens of silt an artifact from silt adhering to prism. RPD > pene.	0.5	Ind	3-2	1	>4	N	1 on 3
LDW-Y2-SU-ENR-3A	R3	3/7/2019	43.1	1.6	LNA	RPD > pene. Bedform?	0.5	Ind	3-2	1	>4	N	Ind
LDW-Y2-SU-ENR-3B	R1	3/7/2019	42.8	0.8	>P	Shell fragments on surface. RPD > pene.	0.6	Ind	2-1	-2	>4	N	Ind
LDW-Y2-SU-ENR-3B	R2	3/7/2019	42.8	1.1	>P	RPD > pene. Very fine sand, subfraction of medium to coarse sand.	0.7	Ind	4-3	-2	>4	N	Ind
LDW-Y2-SU-ENR-3B	R3	3/7/2019	42.8	2.2	>P	RPD is Ind. Very coarse and coarse sand.	0.7	Ind	0-(-1)	-3	>4	N	Ind
LDW-Y2-SU-ENR-4A	R1	3/7/2019	43.9	0.6	LNA	RPD > pene.	0.7	Ind	4-3	1	>4	N	Ind
LDW-Y2-SU-ENR-4A	R2	3/7/2019	43.9	0.3	LNA	Minimal penetration. Very compact sand.	0.5	Ind	3-2	2	>4	N	Ind
LDW-Y2-SU-ENR-4A	R3	3/7/2019	43.9	1.7	>P	Minimal penetration. Tubes on surface. Primarily silt and fine sand.	0.4	1.2	3-2	-1	>4	N	Ind
LDW-Y2-SU-ENR-4B	R1	3/7/2019	43.7	1.2	>P	RPD is Ind. Shell fragments.	0.5	Ind	1-0	-2	>4	N	Ind
LDW-Y2-SU-ENR-4B	R2	3/7/2019	43.7	1.3	>P	RPD is Ind. Shell fragments.	0.7	Ind	0-(-1)	-3	>4	N	Ind

Table 3-5a. Year 2 Subtidal ENR Pilot Subplot SPI Results

Station	Replicate	Image Date	Water Depth (ft)	Penetration Depth (cm)	ENR Layer Thickness (cm)	Texture and Other Observations	Surface Boundary Roughness (cm)	RPD Depth (cm)	Grain Size Major Mode (phi units)	Grain Size Maximum (phi units)	Grain Size Minimum (phi units)	Methane	Successional Stage
LDW-Y2-SU-ENR-4B	R3	3/7/2019	43.7	1.8	>P	RPD is Ind. Some shell fragments.	1.2	Ind	1-0	-3	>4	N	Ind
LDW-Y2-SU-ENR-5A	R1	3/7/2019	44.3	1.7	>P	Silt mixed into coarse sand. Shell fragment and piece of wood on surface. RPD is Ind.	1.1	Ind	1-0 and >4	-2	>4	N	Ind
LDW-Y2-SU-ENR-5A	R2	3/7/2019	44.3	2.4	>P	Thin layer of silt atop coarse sand. RPD is Ind. Shell fragments.	0.5	Ind	0-(-1)	-4	>4	N	Ind
LDW-Y2-SU-ENR-5A	R3	3/7/2019	44.3	2.6	>P	Very coarse sand and some shell fragments.	1.8	Ind	0-(-1)	-2	3	N	Ind
LDW-Y2-SU-ENR-5B	R1	3/7/2019	44.3	2.7	>P	Silt on sand. Shell fragments. RPD is Ind.	0.9	Ind	2-1	-3	>4	N	Ind
LDW-Y2-SU-ENR-5B	R2	3/7/2019	44.3	2.3	>P	Silt and sand mix. RPD is Ind. Shell fragments. Wood on surface.	1.8	Ind	2-1 and >4	-3	>4	N	Ind
LDW-Y2-SU-ENR-5B	R3	3/7/2019	44.3	3.1	>P	Silt on sand. Shell fragments. RPD is Ind.	2.6	Ind	1-0	-2	>4	N	Ind
LDW-Y2-SU-ENR-6A	R1	3/7/2019	46.3	2.5	>P	RPD is Ind. Silt on top of coarse sand. Shell fragments.	0.7	Ind	0-(-1)	-3	>4	N	Ind
LDW-Y2-SU-ENR-6A	R2	3/7/2019	46.3	2.6	>P	RPD is Ind. Thin layer of coarse sand/gravel. Shell fragments.	1.4	Ind	-1-(-2)	-3	>4	N	Ind
LDW-Y2-SU-ENR-6A	R3	3/7/2019	46.3	3.1	>P	Silt on top of very coarse sand. RPD is Ind. Shell fragments.	1.2	Ind	0-(-1)	-4	>4	N	Ind
LDW-Y2-SU-ENR-6B	R1	3/7/2019	47	7.9	4.6	ENR layer (4.6 cm) over reduced silt. RPD could be ENR layer depth, but considered Ind.	0.6	Ind	1-0/>4	-3	>4	N	Ind
LDW-Y2-SU-ENR-6B	R2	3/7/2019	47	6.1	Disturbed/Removed	Very thin layer of brown silt and some coarse sand/gravel, over black reduced silt. ENR material has apparently been disturbed.	1.1	0.4	>4	-2	>4	N	1
LDW-Y2-SU-ENR-6B	R3	3/7/2019	47	8.4	Disturbed/Removed	Thin layer of brown silt and few coarse sand (residual ENR material?) over black/gray silt.	0.7	0.3	>4	-1	>4	N	1

Summary Statistics for Some Numerical Parameters

	Penetration Depth (cm)	Surface Boundary Roughness (cm)	RPD Depth (cm)
N	36	36	5
Average	2.4	0.9	1.2
Median	2.0	0.7	1.2
Minimum	0.3	0.2	0.3
Maximum	8.4	2.6	2.4

Notes:
aRPD = apparent redox potential discontinuity
ENR = enhanced natural recovery
Ind = indeterminate
LNA = layer not apparent
N = no
P = penetration
SPI = sediment profile imaging

Table 3-5b. Year 2 Subtidal ENR Pilot Subplot PV Results

				Lebensspuren											
Station	Replicate	Sediment Type	Bedforms	Burrows	Tubes	Tracks	Total Abundance	Epifauna	Epifauna Type (Count)	Mud Clasts	Debris Type	Debris Cover	*Beggiatoa*	Surface Boundary Roughness (cm)	Comments
LDW-Y2-SU-ENR-1A	R1	Silt	N	N	Y	Y	L	N	NA	N	Wood	L	N	L	Piece of cobble.
LDW-Y2-SU-ENR-1A	R2	Silt and sand	N	N	N	Y	L	N	NA	N	NA	N	N	L	Image partially obscured by suspended sediment. Few shell fragments. Imprint is an artifact from the SPI frame.
LDW-Y2-SU-ENR-1A	R3	Sand and silt	N	N	Y	Y	L	N	NA	N	Leaf	L	N	L	Shell fragments. Indentation possibly anthropogenic.
LDW-Y2-SU-ENR-1B	R1	Silt	N	N	Y	Y	M	N	NA	N	Wood	L	N	L	Silt with sticks, leaves, tracks and trails of epifauna.
LDW-Y2-SU-ENR-1B	R2	Silt and sand	Y	N	Y	Y	L	N	NA	Y	Sticks	L	N	L	Imprint is an artifact from the SPI frame. Very few shell fragments.
LDW-Y2-SU-ENR-1B	R3	Sand and silt	N	N	Y	N	N	N	NA	N	NA	N	N	L	Imprint is an artifact from the SPI frame. Few pieces of gravel. Few shell fragments.
LDW-Y2-SU-ENR-2A	R1	Silt and sand	N	N	N	N	N	N	NA	N	NA	N	N	L	Image partially obscured by suspended sediment. Lasers not visible.
LDW-Y2-SU-ENR-2A	R2	Silt and sand	N	N	Y	Y	L	N	NA	N	Wood	L	N	L	Imprint is an artifact from the SPI frame.
LDW-Y2-SU-ENR-2A	R3	Silt and sand	Y	N	Y	Y	L	N	NA	N	Wood	L	N	L	Piece of gravel, few shell fragments.
LDW-Y2-SU-ENR-2B	R1	Silt and sand	N	N	Y	N	N	Y	Barnacles (12)	N	Wood	L	N	L	Piece of gravel. Few shell fragments.
LDW-Y2-SU-ENR-2B	R2	Silt and sand	Y	N	Y	Y	L	N	NA	N	Organic detritus	L	N	L	Few shell fragments.
LDW-Y2-SU-ENR-2B	R3	Silt and sand	Y	N	Y	Y	L	Y	Barnacles (2)	N	NA	N	N	L	Few shell fragments. Two cobble pieces.
LDW-Y2-SU-ENR-3A	R1	Sand and silt	Y	N	Y	Y	L	N	NA	N	Organic detritus	L	N	L	Few shell fragments.
LDW-Y2-SU-ENR-3A	R2	Sand and silt	Y	N	Y	Y	L	N	NA	N	Leaf and organic detritus	L	N	L	Few shell fragments.
LDW-Y2-SU-ENR-3A	R3	Silt and sand	Y	N	Y	N	N	N	NA	N	Plastic and organic detritus	L	N	L	Shell fragments.
LDW-Y2-SU-ENR-3B	R1	Silt and sand	Y	N	Y	Y	L	N	NA	N	Sticks	L	N	L	Shell fragments.
LDW-Y2-SU-ENR-3B	R2	Sand, silt, and gravel	N	N	Y	N	N	N	NA	N	Wood	L	N	L	Shell fragments.
LDW-Y2-SU-ENR-3B	R3	Sand and silt	N	N	Y	Y	M	N	NA	N	Sticks	L	N	M	Shell fragments. Depression possibly caused by organism. Very few gravel.
LDW-Y2-SU-ENR-4A	R1	Sand and silt	N	N	Y	N	N	Y	Barnacle (1)	N	Leaves and organic detritus	L	N	L	Few dispersed gravels. Shell fragments.
LDW-Y2-SU-ENR-4A	R2	Sand and silt	N	N	Y	N	N	N	NA	N	Leaves	L	N	L	Imprint is an artifact from the SPI frame. Few gravel.
LDW-Y2-SU-ENR-4A	R3	Sand and silt	N	N	Y	N	N	N	NA	N	Organic detritus	L	N	L	Few shell fragments.
LDW-Y2-SU-ENR-4B	R1	Sand and gravel	N	N	Y	N	N	Y	Hermit Crab (1), Barnacle (1)	N	Organic detritus	L	N	L	Many shell fragments, very few gravel pieces.
LDW-Y2-SU-ENR-4B	R2	Sand and gravel	N	N	N	N	N	N	NA	N	NA	N	N	L	Very few gravel pieces. Many shell fragments. Imprint is an artifact from the prism.
LDW-Y2-SU-ENR-4B	R3	Sand	N	N	N	N	N	Y	Barnacles (9)	N	NA	N	N	L	One piece of gravel. Imprint is an artifact of the SPI frame. Shell fragments.
LDW-Y2-SU-ENR-5A	R1	Sand, silt, and gravel	N	N	Y	N	N	Y	Barnacles (2)	Y	Wood, leaves, and plastic	M	N	M	Mud clasts are not an artifact from the SPI frame. Shell fragments.
LDW-Y2-SU-ENR-5A	R2	Sand, silt, and gravel	N	N	Y	N	N	Y	Barnacles (6)	N	Wood and leaves	L	N	L	Shell fragments.
LDW-Y2-SU-ENR-5A	R3	Sand, silt, and gravel	N	N	Y	N	N	Y	Barnacle (1)	N	Wood	L	N	M	Shell fragments. Imprint is an artifact from the SPI frame.
LDW-Y2-SU-ENR-5B	R1	Sand and silt	N	N	Y	N	N	N	NA	N	Wood	L	N	L	Shell fragments. Very few pieces of gravel.
LDW-Y2-SU-ENR-5B	R2	Silt, sand, gravel, and wood	N	N	Y	N	N	Y	Barnacles (4)	N	Wood	M	N	M	Shell fragments.
LDW-Y2-SU-ENR-5B	R3	Sand, silt, and gravel	Y	N	Y	Y	L	N	NA	N	Wood	L	N	L	Shell fragments and few gravel.
LDW-Y2-SU-ENR-6A	R1	Sand and silt	N	N	Y	Y	L	N	NA	N	Wood	L	N	L	Shell fragments. Two pieces of cobble.
LDW-Y2-SU-ENR-6A	R2	Sand, silt, and gravel	N	N	Y	N	N	N	NA	N	Wood and plastic	L	N	L	Shell fragments.
LDW-Y2-SU-ENR-6A	R3	Sand, gravel, and silt	N	N	Y	N	N	N	NA	N	Wood	L	N	L	Imprint is an artifact from the SPI prism. Shell fragments. One piece of cobble.
LDW-Y2-SU-ENR-6B	R1	Sand, gravel, and silt	N	N	Y	Y	L	Y	Barnacles (4)	N	Wood and plastic	L	N	M	Shell fragments. A couple pieces of cobble.

Table 3-5b. Year 2 Subtidal ENR Pilot Subplot PV Results

				Lebensspuren											
Station	Replicate	Sediment Type	Bedforms	Burrows	Tubes	Tracks	Total Abundance	Epifauna	Epifauna Type (Count)	Mud Clasts	Debris Type	Debris Cover	*Beggiatoa*	Surface Boundary Roughness (cm)	Comments
LDW-Y2-SU-ENR-6B	R2	Silt, sand, and gravel	N	N	N	N	N	N	NA	N	Wood and metal	L	N	M	Image partially obscured by suspended sediment. Lasers not visible.
LDW-Y2-SU-ENR-6B	R3	Sand, silt, and gravel	N	N	Y	N	N	N	NA	N	Wood	L	N	M	Imprint is an artifact from an anthropogenic source, not SPI. Shell fragments.

Notes:

Lebensspuren = biologically formed sedimentary structures
ENR = enhanced natural recovery
H = high
L = low
M = medium
N = no
NA = not applicable
PV = plan view
SPI = sediment profile imaging
Y = yes

Table 3-6a. Year 2 Subtidal ENR+AC Pilot Subplot SPI Results

Station	Replicate	Image Date	Water Depth (ft)	Penetration Depth (cm)	ENR+AC Layer Thickness (cm)	Texture and Other Observations	Surface Boundary Roughness (cm)	RPD Depth (cm)	Grain Size Major Mode (phi units)	Grain Size Maximum (phi units)	Grain Size Minimum (phi units)	Methane	Successional Stage
LDW-Y2-SU-ENR-AC-1A	R1	3/7/2019	43.2	1.9	LNA	Gray silt is an artifact from the prism. Wood pieces on surface.	1.4	1.2	3-2	2	>4	N	Ind
LDW-Y2-SU-ENR-AC-1A	R2	3/7/2019	43.2	4.1	LNA	Mud clasts on surface are an artifact from the SPI frame. Shell fragments. Tubes on surface Grading finer with depth.	2.2	2.1	3-2	-1	>4	N	1
LDW-Y2-SU-ENR-AC-1A	R3	3/7/2019	43.2	3.9	LNA	Tubes on surface. RPD contrast minimal.	0.4	1.3	4-3	1	>4	N	1
LDW-Y2-SU-ENR-AC-1B	R1	3/7/2019	43	2.3	LNA	Worm at depth, some biogenic reworking.	1.4	1.4	4-3	2	>4	N	2
LDW-Y2-SU-ENR-AC-1B	R2	3/7/2019	43	2.2	LNA	Large piece of wood on surface. Shell fragments.	0.5	1.4	4-3	1	>4	N	Ind
LDW-Y2-SU-ENR-AC-1B	R3	3/7/2019	43	2.3	LNA	Stick on surface, few shell fragments. Tubes on surface.	1	1.6	3-2	1	>4	N	Ind
LDW-Y2-SU-ENR-AC-2A	R1	3/7/2019	44.2	1.9	LNA	Shell fragments on surface. RPD = Ind.	1.1	Ind	4-3	2	>4	N	1 on 3
LDW-Y2-SU-ENR-AC-2A	R2	3/7/2019	44.2	1.9	LNA	Tubes on surface. Medium sand over very fine sand/silt. RPD = Ind.	0.6	Ind	4-3	2	>4	N	Ind
LDW-Y2-SU-ENR-AC-2A	R3	3/7/2019	44.2	3	LNA	Tubes on surface.	1.3	1.8	4-3	2	>4	N	Ind
LDW-Y2-SU-ENR-AC-2B	R1	3/7/2019	44.4	5.5	LNA	Fine sand grading to very fine sand. Surface tubes.	0.5	1.6	4-3	2	>4	N	1
LDW-Y2-SU-ENR-AC-2B	R2	3/7/2019	44.4	3.8	LNA	Boundary roughness an artifact from R1. Tubes on surface.	2.1	1.8	3-2/4-3	2	>4	N	Ind
LDW-Y2-SU-ENR-AC-2B	R3	3/7/2019	44.4	1.6	LNA	RPD > pene. Stick on surface.	1.2	Ind	4-3	3	>4	N	Ind
LDW-Y2-SU-ENR-AC-3A	R1	3/7/2019	45.4	3.1	LNA	Tubes on surface. Physical bedform? Rippled bottom in PV image.	1	1.6	4-3	3	>4	N	Ind
LDW-Y2-SU-ENR-AC-3A	R2	3/7/2019	45.4	2.1	LNA	RPD = Ind. Tubes on surface.	0.8	Ind	4-3	2	>4	N	Ind
LDW-Y2-SU-ENR-AC-3A	R3	3/7/2019	45.4	3.1	LNA	Gray/black silt at 3 cm below brown fine sand/silt. Boundary roughness is partially an artifact from previous replicate drop.	1.9	1.9	4-3	2	>4	N	Ind
LDW-Y2-SU-ENR-AC-3B	R1	3/7/2019	42.7	2.1	>P	Numerous tubes on surface. RPD is Ind. Gray silt is an artifact from SPI prism.	1.1	Ind	3-2	-1	>4	N	Ind
LDW-Y2-SU-ENR-AC-3B	R2	3/7/2019	42.7	2	>P	Mud clasts on surface are an artifact from previous replicate. RPD is Ind.	1.5	Ind	3-2	-2	>4	N	Ind
LDW-Y2-SU-ENR-AC-3B	R3	3/7/2019	42.7	2.8	>P	Piece of wood on surface. RPD is Ind. Silt subfraction.	1.2	Ind	1-0	-2	>4	N	Ind
LDW-Y2-SU-ENR-AC-4A	R1	3/7/2019	44.4	1.6	>P	RPD is Ind. Shell fragments. Sand and silt mix.	1.2	Ind	0-1 and >4	-2	>4	N	Ind
LDW-Y2-SU-ENR-AC-4A	R2	3/7/2019	44.4	0.7	>P	Silt on top of medium to coarse sand.	0.8	Ind	0-1 and >4	0	>4	N	Ind
LDW-Y2-SU-ENR-AC-4A	R3	3/7/2019	44.4	1.4	>P	Piece of wood on surface. RPD is Ind. Sand and silt mix.	0.5	Ind	2-1 and >4	0	>4	N	Ind
LDW-Y2-SU-ENR-AC-4B	R1	3/7/2019	45	0.8	>P	Pieces of wood on surface and shell fragments. RPD is Ind.	1.3	Ind	2-1 and >4	0	>4	N	Ind

Table 3-6a. Year 2 Subtidal ENR+AC Pilot Subplot SPI Results

Station	Replicate	Image Date	Water Depth (ft)	Penetration Depth (cm)	ENR+AC Layer Thickness (cm)	Texture and Other Observations	Surface Boundary Roughness (cm)	RPD Depth (cm)	Grain Size Major Mode (phi units)	Grain Size Maximum (phi units)	Grain Size Minimum (phi units)	Methane	Successional Stage
LDW-Y2-SU-ENR-AC-4B	R2	3/7/2019	45	3.3	>P	Few shell fragments. Limited penetration but void trace and large tubes at surface point to Stage 3.	2.4	1.6	3-2 and >4	1	>4	N	1 on 3
LDW-Y2-SU-ENR-AC-4B	R3	3/7/2019	45	1.8	>P	Tubes on surface. RPD > pene. Dark reduced sediment at 1.5 cm depth.	1.4	Ind	2-1 and >4	0	>4	N	Ind
LDW-Y2-SU-ENR-AC-5A	R1	3/7/2019	51.4	1.8	>P	Silt on top of very coarse sand.	1.7	Ind	0-(-1)	-2	>4	N	Ind
LDW-Y2-SU-ENR-AC-5A	R2	3/7/2019	51.4	3.2	>P	RPD is Ind. Coarse sand and some gravel, grading slightly finer with depth.	0.9	Ind	1-0	-3	>4	N	Ind
LDW-Y2-SU-ENR-AC-5A	R3	3/7/2019	51.4	2.9	>P	Thin film of silt atop coarse sand. RPD is Ind.	0.7	Ind	1-0	-3	>4	N	Ind
LDW-Y2-SU-ENR-AC-5B	R1	3/7/2019	50	5.7	Disturbed/Removed	Only residual coarse ENR material evident. Thin RPD suggest recent disturbance, highly reduced sediment at depth.	1.1	0.8	>4	-4	>4	N	1
LDW-Y2-SU-ENR-AC-5B	R2	3/7/2019	50	4.5	Disturbed/Removed	Only residual ENR material evident. Possible AC material at surface.	1.2	0.2	>4	-3	>4	N	1
LDW-Y2-SU-ENR-AC-5B	R3	3/7/2019	50	11.9	4	ENR layer over reduced silt.	2.3	3	0-(-1)/>4	-4	>4	N	1
LDW-Y2-SU-ENR-AC-6A	R1	3/7/2019	48.4	6.8	>P	Black layer, possible AC, on top of sand. RPD is 0.	1.9	Ind	>4/2-1	0	>4	N	1
LDW-Y2-SU-ENR-AC-6A	R2	3/7/2019	48.4	2.9	>P	Black silt is likely an artifact from previous rep. Thin layer of brown silt over coarse sand.	0.8	Ind	0-(-1)	-5	>4	N	Ind
LDW-Y2-SU-ENR-AC-6A	R3	3/7/2019	48.4	3.1	>P	Limited on very coarse sand. RPD is Ind.	0.6	Ind	0-(-1)	-3	>4	N	Ind
LDW-Y2-SU-ENR-AC-6B	R1	3/7/2019	47.6	3.6	1.4	Coarse sand over reduced silt. Residual ENR material only.	2.3	1.4	1-0/>4	-2	>4	N	Ind
LDW-Y2-SU-ENR-AC-6B	R2	3/7/2019	47.6	0.9	>P	Coarse sand and silt on surface, gravel. Reduced silt lower right but penetration suggests ENR layer present.	1.3	Ind	2-1 and >4	-3	>4	N	Ind
LDW-Y2-SU-ENR-AC-6B	R3	3/7/2019	47.6	2.9	>P	Large worm tube on surface. Some coarse sand present with silt. Reduced sediment just subsurface, penetration suggests ENR material present but some recent disturbance evident.	3.3	0.7	>4	-4	>4	N	1

Summary Statistics for Some Numerical Parameters

	Penetration Depth (cm)	Surface Boundary Roughness (cm)	RPD Depth (cm)
N	36	36	17
Average	3.0	1.3	1.5
Median	2.9	1.2	1.6
Minimum	0.7	0.4	0.2
Maximum	11.9	3.3	3.0

Notes:
AC = activated carbon
aRPD = apparent redox potential discontinuity
ENR = enhanced natural recovery
Ind = indeterminate
LNA = layer not apparent
N = no
P = penetration
PV = plan view
SPI = sediment profile imaging

Table 3-6b. Year 2 Subtidal ENR+AC Pilot Subplot PV Results

				Lebensspuren											
Station	Replicate	Sediment Type	Bedforms	Burrows	Tubes	Tracks	Total Abundance	Epifauna	Epifauna Type (Count)	Mud Clasts	Debris Type	Debris Cover	*Beggiatoa*	Surface Boundary Roughness (cm)	Comments
LDW-Y2-SU-ENR-AC-1A	R1	Silt and sand	Y	N	Y	Y	L	N	NA	N	Sticks	L	N	L	Few shell fragments.
LDW-Y2-SU-ENR-AC-1A	R2	Silt and sand	Y	N	Y	Y	M	N	NA	N	Leaf	L	N	L	Few shell fragments.
LDW-Y2-SU-ENR-AC-1A	R3	Silt and sand	Y	N	Y	Y	M		Unidentified org. (1)	N	Wood and leaf	L	N	L	Few shell fragments.
LDW-Y2-SU-ENR-AC-1B	R1	--	--	--	--	--	--	--	--	--	--	--	--	--	Not analyzable due to turbidity in the water column.
LDW-Y2-SU-ENR-AC-1B	R2	Silt and sand	Y	N	Y	Y	L	N	NA	N	Leaf	L	N	L	Few shell fragments.
LDW-Y2-SU-ENR-AC-1B	R3	Silt and sand	N	N	Y	Y	L	N	NA	N	NA	N	N	L	Imprint is an artifact from the SPI frame. Image partially obscured by suspended sediment. Few shell fragments.
LDW-Y2-SU-ENR-AC-2A	R1	Sand and silt	Y	N	Y	Y	M	N	NA	N	Sticks	L	N	L	Shell fragments.
LDW-Y2-SU-ENR-AC-2A	R2	Silt and sand	N	N	Y	Y	M	N	NA	N	Wood	L	N	L	Shell fragments.
LDW-Y2-SU-ENR-AC-2A	R3	Sand and silt	Y	N	Y	Y	L	N	NA	N	NA	N	N	L	Frame imprint is an artifact from the SPI frame. Shell fragments.
LDW-Y2-SU-ENR-AC-2B	R1	Sand and silt	Y	N	Y	Y	L	N	NA	N	Sticks	L	N	L	Shell fragments. Few pieces of gravel.
LDW-Y2-SU-ENR-AC-2B	R2	Silt and sand	Y	N	Y	Y	L	Y	Fish (1)	N	NA	N	N	M	Shell fragments, crab claw. Imprint is an artifact from the SPI frame.
LDW-Y2-SU-ENR-AC-2B	R3	Silt and sand	Y	N	Y	Y	L	N	NA	N	Sticks	L	N	L	Imprint is an artifact from the SPI frame. Few pieces of gravel.
LDW-Y2-SU-ENR-AC-3A	R1	Sand and silt	Y	N	Y	Y	L	N	NA	N	Wood	L	N	L	Few shell fragments.
LDW-Y2-SU-ENR-AC-3A	R2	Silt and sand	N	N	Y	N	N	N	NA	N	NA	N	N	L	Image partially obscured by suspended sediment. Imprint is an artifact from the SPI frame.
LDW-Y2-SU-ENR-AC-3A	R3	Sand and silt	N	N	Y	Y	L	N	NA	N	Sticks	L	N	L	Imprint is an artifact from the SPI frame.
LDW-Y2-SU-ENR-AC-3B	R1	Sand, silt, and gravel	Y	N	Y	N	N	N	NA	N	Sticks	L	N	L	Many shell fragments. Very few gravels.
LDW-Y2-SU-ENR-AC-3B	R2	--	--	--	--	--	--	--	--	--	--	--	--	--	Not analyzable due to turbidity in the water column.
LDW-Y2-SU-ENR-AC-3B	R3	Sand and silt	Y	N	Y	N	L	N	NA	N	Sticks	L	N	L	Shell fragments, few gravel pieces.
LDW-Y2-SU-ENR-AC-4A	R1	Silt and sand	N	N	Y	N	N	N	NA	N	NA	N	N	L	Shell fragments, few gravel pieces.
LDW-Y2-SU-ENR-AC-4A	R2	Silt and sand	N	N	Y	N	N	N	NA	N	Sticks	L	N	L	Shell fragments. Crab leg.
LDW-Y2-SU-ENR-AC-4A	R3	Sand and silt	Y	N	Y	N	N	N	NA	N	Sticks	L	N	L	Image partially obscured by suspended sediment. Few cobble pieces. Shell fragments.
LDW-Y2-SU-ENR-AC-4B	R1	Sand, silt, and gravel	N	N	Y	Y	L	N	NA	N	Sticks and macroalgae	L	N	L	Very few gravel, few pieces of cobble. Shell fragments.
LDW-Y2-SU-ENR-AC-4B	R2	Silt and sand	Y	N	Y	Y	L	N	NA	N	Wood	L	N	L	Shell fragments. Very few gravel pieces.
LDW-Y2-SU-ENR-AC-4B	R3	Sand and silt	Y	Y	Y	Y	N	N	NA	N	Sticks	L	N	L	Shell fragments. One piece of gravel.
LDW-Y2-SU-ENR-AC-5A	R1	Sand and silt	N	N	Y	N	N	N	NA	N	Sticks	L	N	L	Shell fragments and few pieces of gravel.
LDW-Y2-SU-ENR-AC-5A	R2	Sand and silt	N	N	N	N	N	N	NA	N	Sticks	L	N	L	Shell fragments. Imprint is an artifact from the SPI frame.
LDW-Y2-SU-ENR-AC-5A	R3	--	--	--	--	--	--	--	--	--	--	--	--	--	Not analyzable due to turbidity in the water column.
LDW-Y2-SU-ENR-AC-5B	R1	Silt, sand, and gravel	Y	Y	Y	Y	L	N	NA	N	Sticks	L	N	L	Few gravel visible. Some shell fragments.
LDW-Y2-SU-ENR-AC-5B	R2	--	--	--	--	--	--	--	--	--	--	--	--	--	Not analyzable due to turbidity in the water column.
LDW-Y2-SU-ENR-AC-5B	R3	Sand, gravel, and silt	N	N	N	N	N	Y	Barnacles (8)	N	Leaf	L	N	M	Shell fragments, few pieces of cobble.
LDW-Y2-SU-ENR-AC-6A	R1	Silt, gravel, and sand	Y	N	N	N	N	Y	Barnacles (3)	N	Wood and leaves	L	N	M	Many shell fragments and few cobble pieces.
LDW-Y2-SU-ENR-AC-6A	R2	Silt, gravel, and sand	N	N	N	Y	L	Y	Barnacles (3), shrimp (1)	N	Metal, wood, and leaves	M	N	H	Large piece of painted metal. Shell fragments. Shrimp (1).
LDW-Y2-SU-ENR-AC-6A	R3	--	--	--	--	--	--	--	--	--	--	--	--	--	Not analyzable due to turbidity in the water column.
LDW-Y2-SU-ENR-AC-6B	R1	Silt, sand, and gravel	Y	N	Y	Y	L	N	NA	N	Organic detritus	L	N	M	Few shell fragments and few gravel pieces.

Table 3-6b. Year 2 Subtidal ENR+AC Pilot Subplot PV Results

				Lebensspuren											
Station	Replicate	Sediment Type	Bedforms	Burrows	Tubes	Tracks	Total Abundance	Epifauna	Epifauna Type (Count)	Mud Clasts	Debris Type	Debris Cover	*Beggiatoa*	Surface Boundary Roughness (cm)	Comments
LDW-Y2-SU-ENR-AC-6B	R2	Silt and sand	Y	N	Y	N	N	N	NA	N	NA	N	N	M	Imprint is an artifact from the SPI frame. Shell fragments. Few gravel pieces.
LDW-Y2-SU-ENR-AC-6B	R3	--	--	--	--	--	--	--	--	--	--	--	--	--	Not analyzable due to turbidity in the water column.

Notes:

Shaded rows indicate replicate not analyzable due to turbidity.

-- = not analyzed

Lebensspuren = biologically formed sedimentary structures

AC = activated carbon

ENR = enhanced natural recovery

H = high

L = low

M = medium

N = no

NA = not applicable

PV = plan view

SPI = sediment profile imaging

Y = yes

Table 3-7. Prism Penetration and aRPD Depth Summary Statistics from the Baseline, Year 0, Year 1, and Year 2 SPI Surveys

Prism Penetration Depths (cm)				
Statistic	**Intertidal ENR**			
	Baseline	***Year 0***	***Year 1***	***Year 2***
N	*37*	*36*	*36*	*36*
Mean	9.7	7.4	5.1	2.5
Min	2.9	5.4	2.8	0.5
Max	14.6	12.6	14.3	4.8
	Intertidal ENR+AC			
N	--	*36*	*35*	*35*
Mean	--	8	5.6	2.8
Min	--	2.9	5.6	2.3
Max	--	10.8	9	12.1
Statistic	**Scour ENR**			
	Baseline	***Year 0***	***Year 1***	***Year 2***
N	*36*	*36*	*36*	*30*
Mean	13.8	9.9	9.3	5.2
Min	0.3	6.2	0.0	3.4
Max	16.6	16.4	13.5	8.5
	Scour ENR+AC			
N	--	*36*	*36*	*35*
Mean	--	9.9	7.8	3.9
Min	--	6.5	4.1	0.8
Max	--	19.1	13.9	8.1
Statistic	**Subtidal ENR**			
	Baseline	***Year 0***	***Year 1***	***Year 2***
N	*36*	*36*	*33*	*36*
Mean	12.7	10.5	5.4	2.4
Min	5.8	6.1	3.0	0.3
Max	21.6	16.0	13.4	8.4
	Subtidal ENR+AC			
N	--	36	36	36
Mean	--	10.8	7.4	3.0
Min	--	6.6	1.9	0.7
Max	--	20.4	19.9	11.9

aRPD Depths (cm)				
Statistic	**Intertidal ENR**			
	Baseline	***Year 0***	***Year 1***	***Year 2***
N	*30*	*0*	*26*	*5*
Mean	2.2	Ind.	2.5	1.1
Min	0.8	Ind.	1.1	0.7
Max	4.6	Ind.	3.5	2.3
	Intertidal ENR+AC			
N	--	*2*	*23*	*10*
Mean	--	3.8	2.3	1.6
Min	--	3.3	0.4	1.0
Max	--	4.3	3.6	3.4
Statistic	**Scour ENR**			
	Baseline	***Year 0***	***Year 1***	***Year 2***
N	*35*	*0*	*33*	*29*
Mean	2.0	Ind.	1.9	1.5
Min	1.0	Ind.	1.1	1.0
Max	2.8	Ind.	3.2	2.2
	Scour ENR+AC			
N	--	4	21	13
Mean	--	0.8	1.4	2.1
Min	--	0.5	0.5	1.5
Max	--	1.25	2.5	2.9
Statistic	**Subtidal ENR**			
	Baseline	***Year 0***	***Year 1***	***Year 2***
N	*34*	*18*	*20*	*5*
Mean	1.3	1.5	2.6	1.2
Min	0.2	0.2	1.7	0.3
Max	3.0	2.0	4.3	3.4
	Subtidal ENR+AC			
N	--	*23*	*22*	*17*
Mean	--	1.4	1.3	1.5
Min	--	0.3	0	0.2
Max	--	3	3.8	3

Notes:
AC = activated carbon
aRPD = apparent redox potential discontinuity
ENR = enhanced natural recovery
Ind. = Indeterminate
SPI = sediment profile imaging

Table 4-1. Number, Distribution, and Size of Feeding Voids Observed in Year 2 SPI Images

	Intertidal Plot			
	ENR		ENR+AC	
Sediment Depth (cm)	No. of Voids	Average Void Area (cm)	No. of Voids	Average Void Area (cm)
0–2	3	1.78	1	0.44
2–5	4	1.13	5	2.16
5–10	0	NA	0	NA
>10	0	NA	0	NA
Total or Mean Area	**7**	**1.46**	**6**	**1.30**

	Scour Plot			
	ENR		ENR+AC	
Sediment Depth (cm)	No. of Voids	Average Void Area (cm)	No. of Voids	Average Void Area (cm)
0–2	0	NA	0	NA
2–5	38	1.27	23	1.05
5–10	36	1.23	1	0.04
>10	0	NA	0	NA
Total or Mean Area	**74**	**1.25**	**24**	**1.05**

	Subtidal Plot			
	ENR		ENR+AC	
Sediment Depth (cm)	No. of Voids	Average Void Area (cm)	No. of Voids	Average Void Area (cm)
0–2	1	0.19	0	NA
2–5	0	NA	0	NA
5–10	0	NA	0	NA
>10	0	NA	0	NA
Total or Mean Area	**1**	**0.19**	**0**	**NA**

Notes:
AC = activated carbon
ENR = enhanced natural recovery
NA = not applicable
SPI = sediment profile imaging

ATTACHMENT 2

Year 3 SPI/PV Data Report

YEAR 3 SPI/PV DATA REPORT

Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway

Prepared for
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Prepared by

1205 West Bay Drive NW
Olympia, WA 98502

March 22, 2021

CONTENTS

LIST OF FIGURES

Figure 3-6b. SPI (left) and PV (right) images from Station 5B in the SU-ENR+AC, where the ENR+AC is not present

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

AC	activated carbon
aRPD	apparent redox potential discontinuity
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
DGPS	digital global positioning system
DQO	data quality objective
ENR	enhanced natural recovery
ENR+AC	enhanced natural recovery amended with activated carbon
GAC	granular activated carbon
GUI	graphical use interface
Integral	Integral Consulting Inc.
LDW	Lower Duwamish Waterway
Order	Administrative Order on Consent
PCB	polychlorinated biphenyl
QA	quality assurance
QAPP	Quality Assurance Project Plan
RSS	Research Support Services
R/V	research vessel
SLR	single-lens reflex
SPI/PV	sediment profile imaging and plan view

1 INTRODUCTION

1.1 BACKGROUND

The Lower Duwamish Waterway Group is conducting a pilot study of an innovative sediment technology in the field to evaluate the potential effectiveness of the technology in the Lower Duwamish Waterway (LDW). The study will evaluate whether enhanced natural recovery (ENR) amended with activated carbon (AC) can be successfully used to decrease bioavailability of contaminants in sediment in the LDW. The study compares the effectiveness of ENR amended with AC (ENR+AC) against that of ENR without added AC. This is being tested in three habitat types: the subtidal, the intertidal, and an area where vessel scour is possible. For the purposes of this project, ENR involves the placement of a thin layer of clean material over subtidal or intertidal sediments. ENR+AC involves the placement of a thin layer of clean material augmented with AC over subtidal or intertidal sediments.

This pilot study was specified under the Second Amendment (July 2014) to the Administrative Order on Consent (Order) for Remedial Investigation/Feasibility Study for the LDW, CERCLA Docket No. 10-2001-0055, issued on December 20, 2000.

The goals of the pilot study, as stated in the Order Amendment, are the following:

- Verify that ENR+AC can be successfully applied in the LDW by monitoring physical placement success (uniformity of coverage and percent of carbon in a placed layer).
- Evaluate performance of ENR+AC compared to ENR alone in locations with a range of polychlorinated biphenyl (PCB) concentrations.
- Assess potential impacts to the benthic community in ENR+AC compared to ENR alone.
- Assess changes in bioavailability in ENR+AC compared to ENR alone.
- Assess the stability of ENR and ENR+AC in scour areas (such as berthing areas).

The sediment profile imaging monitoring work described in this report was performed consistent with the Quality Assurance Project Plan (QAPP; Amec et al. 2016a).

1.2 GOAL OF THE YEAR 3 SEDIMENT PROFILE IMAGING/PLAN VIEW SURVEY

This Year 3 sediment profile imaging and plan view (SPI/PV) survey was one of several methods used to address data quality objective (DQO)-2: Evaluate the stability of ENR and ENR+AC materials in Years 1, 2, and 3 (Amec et al. 2016a). Specifically, the goal of the Year 3 SPI/PV survey of the pilot project was to collect information on the stability/integrity of the ENR

and ENR+AC materials three years after placement. Measurements collected during the SPI/PV survey to assess ENR and ENR+AC materials' stability are visual (photographic) observations of physical sediment properties such as grain size, layering, and mixing that would indicate the presence of the ENR and ENR+AC materials relative to the conditions observed in the SPI/PV surveys conducted in previous years. The extent of overlying sediment deposition on the ENR and ENR+AC materials was also noted. By noting the presence and distribution of biota and biogenic structures in the SPI/PV images in comparison to previous surveys, the Year 3 SPI/PV results will be used to assess and compare the apparent extent of benthic community recolonization of the ENR and ENR+AC subplots. This line of evidence will support the evaluation of DQO-4: Assess the Potential Impacts of AC on Benthic Communities (Amec et al. 2016a).

2 METHODS

2.1 FIELD COLLECTIONS

The Year 3 SPI/PV survey of the LDW pilot areas was conducted on June 27, 28, and 29, 2020. The intertidal plot was sampled on June 27; the subtidal plot was sampled on June 28; and the scour plot was sampled on June 27, 28, and 29. Note that the Year 1 and 2 SPI/PV surveys were conducted in March of 2018 and 2019, respectively. The Year 3 survey was unavoidably delayed due to Washington State–mandated work closures as a result of the 2020 COVID-19 pandemic.

The surveys were conducted aboard the research vessel (R/V) *Carolyn Dow*, owned and operated by Research Support Services (RSS) of Bainbridge Island, Washington. All positioning and navigation during the survey was conducted by RSS using a digital global positioning system (DGPS). Scientists from Amec Foster Wheeler[1] provided oversight of navigation and positioning during the survey as well as record keeping. Scientists from Integral Consulting Inc. (Integral) operated the SPI/PV camera, kept field notes, and ensured successful image acquisition. As in the Year 0, 1, and 2 surveys, the SPI/PV camera was fully loaded with all additional weight (250 lb) for the entire survey anticipating the firm, ENR material substrate. This allows SPI prism penetration depth to be used as a relative measure of bed firmness/ consolidation both between plots within a survey and over time across surveys.

A total of 72 stations, 24 from each pilot plot, were occupied using the SPI/PV camera during the Year 3 monitoring event. At each station, the R/V was piloted to the target location and the SPI/PV system was lowered to the sediment bed only when the vessel was within 2 m of the target location. A minimum of three replicate image sets were collected at each target location. Therefore, a total of 72 SPI/PV images were collected at each plot (24 stations x 3 replicates). Twelve stations were occupied in the ENR-only subplot and 12 stations were occupied in the ENR+AC subplot, two stations in each grid cell. The 12 SPI/PV stations were collected from the "A" and "B" cells during the Year 3 sampling event. The SPI/PV locations for each plot, including replicates, are shown in Figures 2-1, 2-2, and 2-3. All SPI/PV images collected are provided electronically in Exhibit 1 (provided on DVDs).

Acquisition of high-resolution SPI images was accomplished using a Nikon D7100 digital single-lens reflex (SLR) camera with a 24.1-megapixel image sensor mounted inside an Ocean Imaging Model 3731 SPI camera system. Camera settings were f11, ISO 640, and 1/250 shutter speed. A total of 216 SPI images were selected for analysis (3 replicate images from each of 72 stations).

[1] Amec Foster Wheeler is now Wood Environment & Infrastructure Solutions, Inc.

PV images were collected using a Nikon D7100 SLR camera with a 24.1-megapixel image sensor mounted inside an Ocean Imaging Model DSC2400 camera housing and attached to the front of the SPI camera frame. As in prior years, a PV camera focal distance of 2 ft was used. This relatively short trigger length reduces PV image field, but increases the likelihood obtaining relatively clear, analyzable images in the relatively turbid LDW estuarine setting. In addition, sediment re-suspended from the first replicate drop at each location can affect the quality of the second and third PV replicate images. Throughout the survey, images were downloaded periodically in the field to review image quality.

The table below summarizes the number of SPI and PV images collected and analyzed at each subplot. The target 36 SPI images were analyzed from each subplot. Two PV images from the intertidal plot and five from the subtidal plot were not analyzable due to high near-bottom turbidity levels that obscured the seafloor in the second or third replicates. Overall, analyzable SPI and PV were obtained at all target locations.

Number of Year 3 SPI/PV Images Analyzed from Each Subplot

	Intertidal Plot		Scour Plot		Subtidal Plot	
Image Type	ENR	ENR+AC	ENR	ENR+AC	ENR	ENR+AC
SPI	36	36	36	36	36	36
PV	34	36	36	36	31	36

2.2 SEDIMENT PROFILE AND PLAN VIEW IMAGE ANALYSIS

Integral analyzed the Year 3 SPI/PV survey images using its integrated, MATLAB-based image analysis software (iSPI v1.2a). The image files along with the metadata-containing Microsoft® Excel files generated during the field survey are imported directly into iSPI for analysis. A menu-structured graphical use interface (GUI) in iSPI allows the image analyst to measure and add descriptive comments for key imaged features (Figure 2-4). The draft data were stored in the system for review by a senior scientist. Following the quality assurance (QA) check of all measured and descriptive parameters, the SPI/PV data set was compiled and identified as final; the data was then evaluated and exported as desired.

The iSPI software facilitates and standardizes the measurement, storage, and QA review of data from SPI and PV images. However, the approach and underlying interpretive rationale used to identify and measure the suite of parameters and features observed in the images (e.g., grain size, apparent redox potential discontinuity [aRPD] depth, infaunal successional stage) is comparable to the approach used for the baseline and Year 0 surveys performed by Browning Environmental Services. It is identical to the Year 1 and Year 2 survey analytical approach used by Integral. The overall image analysis approach and interpretive framework are detailed in the

previous SPI/PV data reports for this project (e.g., Construction Report Attachment 5 [Amec et al. 2018), and are not repeated here.

Specific to the QAPP requirements for this study, the Year 3 SPI/PV image analysis included:

1. Visually identifying ENR and ENR+AC layers in the SPI images, and if present, measuring the layer thickness if the SPI camera penetrated the ENR material
2. Noting the presence and distribution of granular activated carbon (GAC) in the images, if visually discernable
3. Noting and scoring (low, medium, high) the apparent surface roughness in each PV image
4. Measuring the size and depth of all feeding voids observed in each SPI image.[2]

[2] Feeding voids are formed by subsurface deposit-feeding polychaetes and are indicative of higher order successional stage benthic infauna presence; examples of feeding voids can be seen in Figure 3-3b (near the bottom of all images).

3 RESULTS

The Year 3 SPI/PV survey image analysis results/observations are provided for each plot (intertidal, scour, and subtidal) and subplot treatment (ENR and ENR+AC) in Tables 3-1a through 3-6b. In each case, the SPI results are presented in the "a" table and the PV results are in the "b" table.

The results for each plot and subplot treatment are summarized in the sections that follow.

3.1 INTERTIDAL PLOT

The sediment texture, e.g., the grain-size major mode, observed in the SPI images from the intertidal plot (both subplots) varies widely from predominantly silt through fine, medium, coarse sands and into gravels, < -1 phi units, as indicated in Tables 3-1a and 3-2a. This variety reflects the ENR/ENR+AC materials placed there combined with inputs of ambient fine-grained sediments since construction.

3.1.1 Intertidal ENR Subplot

Evidence of the ENR material (i.e., sands and gravels) was observed, or inferred to be present based on limited SPI prism penetration at all stations sampled in the intertidal ENR subplot. Figure 3-1 shows three SPI images that illustrate the range of textures observed in this subplot, including ENR gravel and sands with a veneer layer of silt; ENR gravel and sands mixed with post-placement silt deposits; and compact, thin (< 4 cm) silt layers overlying ENR material. SPI image Y3-IN-ENR-6A in Figure 3-1 is an example of an image when ENR material is not evident in the sediment profile, but the shallow penetration of the silt substrate strongly suggests that coarse-grained ENR lies just below the frame. Table 3-1a includes a column noting these textures. Table 3-1a also includes an ENR Layer Thickness column. In all cases where the ENR material was evident in an image, it extended to the bottom of the SPI prism window and so is noted as >P (greater than penetration) in the data tables.

The average penetration depth (cm) for each image is also included in the tables. SPI images in which ENR material was not evident are indicated by an LNA (layer not apparent) in the table (only 4 of the 36 replicates analyzed). It is inferred or evident that the ENR material is present just below the depth of camera penetration at these locations are based on the limited prism penetration and most often visual evidence of coarse ENR material in the other replicates from these stations (all station replicates were collected within each 10- x 10-ft grid cell; Figure 2-1).

The SPI prism penetration depth for the intertidal ENR subplot in Year 3 averaged 3.4 cm (see bottom of Table 3-1a). Table 3-7 lists prism penetration depth summary statistics obtained at

each plot/subplot over the course of the pilot study. Prior to ENR material placement, the baseline survey penetration depth at the intertidal plot averaged 9.7 cm. The average penetration depth decreased about 2 cm from Year 0 through Year 2. In Year 3, the penetration depth in the intertidal ENR subplot is slightly increased relative to Year 2. This could reflect additional silt deposition in that area and/or a seasonal impact of the survey being conducted in June rather than in March, when both sedimentation and biogenic activity might be greater resulting in a slightly less firm substrate.

In many of the Year 3 SPI images there is visual evidence of mixing of ENR materials with ambient fine-grained sediments (see image Y3-IN-ENR-2-B-SPI-R1 in Figure 3-1). This fine-grained sediment has been deposited at the site in the approximately 41 months between the Year 0 and Year 3 surveys. The mixing of ENR material and ambient sediments is likely due to both physical (tidal currents, waves) and biological (bioturbation, demersal foraging) forces.

Features observed in the SPI images that indicate the presence of benthic infauna include oxidized surface sediments (aRPDs); surface polychaete tubes; worms at depth in the sediment column; and feeding voids formed by subsurface deposit feedings. Due to limited penetration depths, aRPD depths were only evident/measurable in six replicates and ranged from 1.1 to 2.0 cm, with an average value of 1.5 cm (Table 3-1a). This is comparable to the average aRPD depth in Year 2, but less than the average from the Year 1 and baseline surveys, when many more aRPD depths were measurable due to the deeper penetration depths achieved during those surveys (Table 3-7). Due to the limited penetration in Year 3, an infaunal successional stage could only be designated to five SPI replicate images; all five of those replicates were either Stage 3, 1 on 3, or 2 -> 3, respectively, suggesting advanced, benthic recolonization of the subplot. The PV images show minimal evidence of epifauna in the intertidal ENR subplot. A thin, brown algal film overlying the mixed gravel, sand, and silt bottom is present in many of the PV images.

3.1.2 Intertidal ENR+AC Subplot

The Year 3 SPI/PV results from the intertidal ENR+AC subplot are similar to the intertidal ENR subplot. Evidence of the ENR+AC layer (i.e., sands and gravels) greater than prism penetration was observed in all but two of the SPI images (Table 3-2a). The two replicates where ENR+AC material is not apparent are compact silt presumed to be overlying ENR+AC material based on the limited penetration obtained (4B-R3; right image in Figure 3-2a). In addition, both of those replicates were from Station 4B; the three collocated PV images from that location show some evidence of ENR+AC material on the sediment surface and the third replicate from this station shows a mix of ENR+AC material and compact silt (Figure 3-2b).

The SPI prism penetration depth for this subplot ranged from 1.8 to 8.3 cm with an average value of 2.8 cm, which matches the average penetration obtained in Year 2 (Table 3-7). As noted for the intertidal ENR subplot, penetration had decreased steadily about 2 cm from Year 0

through Year 2, suggesting the consolidation of ENR material over time. Given the slight increase in penetration depths at the ENR subplot and the lack of change in penetration at the ENR+AC subplot in Year 3, the ENR material consolidation/compaction process appears to have stopped.

As at the intertidal ENR subplot, there is evidence of mixing of ENR+AC materials with ambient fine-grained sediments at nearly all stations (see textural observations in Table 3-2a). There was no obvious visual evidence of GAC in the ENR+AC images compared with the ENR only images.

Evidence of benthic community presence and recolonization in the intertidal ENR+AC subplot is comparable to that observed for the intertidal ENR plot. The average aRPD depth for this subplot is 1.0 cm with a range from 0.5 to 2.0 cm. This is less than the average aRPD depths measured in previous years and may be an artifact of the minimal penetration obtained in this subplot; only six replicates had sufficient penetration to discern the aRPD depth (Table 3-7). For the same reason, an infaunal successional stage could only be assigned to five replicate SPI images and as with the ENR subplot, all five were either Stage 3 or 2 -> 3 (100%), suggesting relatively robust benthic recolonization of the subplot. The PV images from both intertidal subplots are similar, with widespread and varying distributions of brown algal mats and patches of green algae on the surface sediments, but with minimal evidence of epifauna (Tables 3-1b and 3-2b).

3.2 SCOUR PLOT

As in Years 1 and 2, the Year 3 SPI/PV images from the scour plot show differences in surface sediment textures between the two subplots. The Year 3 survey was conducted in June 2020 and up to 12 cm of deposited silt was evident overlying the ENR material across the ENR subplot. Deposited silt was also present overlying the ENR+AC material in grid cells 2, 4, and 6 of the ENR+AC subplot. The three downstream cells of the ENR+AC subplot (cells 1, 3, and 5) do not have a surface silt deposit, with ENR material evident at the sediment surface.

3.2.1 Scour ENR Subplot

ENR material layer was not evident at the sediment surface in any of the SPI images from the scour ENR subplot (Table 3-3a), and isolated gravel or cobbles were observed in only 5 of the 36 PV images analyzed (Table 3-3b). Figure 3-3a shows examples of the silt bottom present at this subplot. Because overall penetration is less than observed during the baseline survey (Table 3-7), it is assumed that the ENR material lies immediately below the silt layer captured in the SPI images. The penetration depths obtained are an approximation of the silt deposit thickness across the subplot, which ranged from 6 to 12 cm (see bottom of Table 3-3a) and represents a minimum estimate of silt deposit thickness at the ENR subplot in June 2020.

Table 3-7 lists the penetration depths obtained at ENR subplot for all pilot study surveys. The Year 3 depths are comparable to those obtained in Year 0 and Year 1, and deeper than the penetration achieved in Year 2. The Year 0 result reflects the lack of consolidation of the freshly placed ENR material. The Year 1 through 3 results suggest comparable silt deposition over the ENR material in Year 1 (March 2018) and Year 3 (June 2020), and less overburden of silt in Year 2 (March 2019).

There is widespread evidence of benthic infauna in the SPI images from the ENR subplot. All three images in Figure 3-3a show well-developed aRPD depths, subsurface feeding voids, and tubiculous polychaetes at the sediment surface (Stage 1 on 3). Stage 3 infauna are evident in 35 of the 36 replicates from this subplot, indicating a re-established subsurface benthic infaunal community. The average aRPD depth for this subplot was 1.6 cm with a range from 0.9 to 2.6 cm, which is comparable the aRPD depth measured previously at this subplot (Table 3-7).

Consistent with the SPI benthic infauna observations, the PV images from the scour ENR subplot (Table 3-3b) show evidence of biological activity mostly in the form of widespread burrows, tracks, and tubes on the silt bottom. Occasional epifaunal organisms are captured in a few images (Figure 3-3b). Reflecting the silt deposit covering the area, the surface roughness was low or medium in all but three of the scour ENR PV images.

3.2.2 Scour ENR+AC Subplot

Figure 3-4a shows the range of sediment textures at the scour ENR+AC subplot in June 2020. ENR+AC material (gravel and cobbles) greater than prism penetration is generally observed in cells 1, 3, and 5, and a few images show silt and gravel mixes (Table 3-4a). In ENR+AC subplot cells 2, 4, and 6, immediately adjacent to the ENR subplot, surface silt layers were observed. At Station 3A, along the northern edge of subplot, measurable layers (3 and 6 cm) of ENR+AC material were observed (see image 3A-R1 in Figure 3-4a and image 3A-R2 in Figure 3-4b). The ENR material overlies reduced silt in both replicates. The collocated PV images from these replicates show a contiguous cover of ENR+AC material (Figure 3-4b). There was no obvious visual evidence of GAC in the scour ENR+AC images compared with the scour ENR plot images.

The mean SPI prism penetration depth for this subplot ranged from 1.4 to 10.5 cm with an average value of 5.9 cm, less than the average of 9.0 cm at the adjoining ENR subplot (Table 3-7). This reflects the absent silt deposit in the northern portion of the subplot.

Evidence of subsurface deposit-feeding benthic infauna is present in 19 of the 36 images from this subplot, again indicating advanced benthic infaunal recolonization (see feeding voids in image 2B in Figure 3-4a). The infaunal successional was indeterminate in the gravel and coarse-sand substrates in 16 of the 36 images. The average aRPD depth for this subplot is 1.3 cm with a range from 0.8 to 1.9 cm; this is somewhat lower than in the ENR subplot and the baseline SPI

survey for this area (Table 3-7). This may reflect the higher physical disturbance (and the related lack of silt deposition and/or accumulation) than in the ENR subplot.

The PV image data from the ENR+AC subplot also point to a more dynamic setting than the ENR subplot. Surface roughness was scored as medium or high in 27 of the images, reflecting the presence of coarse-grained ENR+AC material at the surface (Table 3-4b) in the downstream portion of the area. The PV images show the presence of wood and anthropogenic debris (e.g., metal cable) in the area, as well as widespread macroalgae and a variety range of epifauna, such as crab, bryozoans, and barnacles (Table 3-4b).

3.3 SUBTIDAL PLOT

The SPI/PV images from the subtidal plot show silt deposited over the ENR material across the northern (downstream) two-thirds of the parallel plots (Figure 2-3). The silt deposit thins from downstream to upstream and is thicker over the western ENR+AC subplot material relative to the ENR subplot. As noted in previous years, the ENR/ENR+AC material is partially disturbed/not present in cells 5 and 6 of both subplots and as reported repeatedly, this area of the subtidal plot is subject to anthropogenic disturbance by barge chain dragging (Amec et al. 2016b).

3.3.1 Subtidal ENR Subplot

Figure 3-5a shows examples of the surface sediment textures observed in the SPI images from the ENR subplot. Thin (2 to 6 cm) silt and fine sand deposits were evident in cells 1 and 2. The limited penetration depths indicate the ENR material underlies these deposits. In cells 3, 4, and 5, compact silt and ENR sand mixtures are evident, prism penetration is minimal, and the ENR material is greater than penetration. The ENR material layer is disturbed/not present in cell 6; image 6A-R3 in Figure 3-5a shows reduced silt at the sediment-water interface and large-scale, mounded sediment on the sediment surface. Figure 3-5b presents SPI and PV images from another replicate at Station 6A, showing reduced silt near the sediment-water interface in the SPI image overlain by a sand and silt deposit. The sharp, vertical transition suggests a disturbance event with subsequent deposition of sands and silt. The PV image shows large, reduced mud clumps and some wood debris on the sediment surface, suggesting a large-scale disturbance.

The prism penetration depths for this subplot were shallow, ranging from 0.9 to 9.4 cm with an average value of 3.2 cm (Table 3-7). This is much less than the baseline average of 12.7 cm, indicating that the ENR material is present below the imaged sediment profiles throughout most of the subplot. A number of images from the subtidal ENR subplot show apparent bedforms (i.e., contoured or rippled surface sediment boundaries; see image 1B in Figure 3-5a),

suggesting periodic high-bottom shear stresses in this deeper channel setting, perhaps from vessel traffic/prop wash.

The average aRPD depth for this subplot was 0.8 cm with a range from 0.4 to 1.9 cm; this is less than the averages measured in Years 1 and 2, and during the baseline SPI survey (Table 3-7). Due to the limited penetration, only eight successional stages could be assigned; four (50%) of these showed evidence of Stage 3, indicating the presence of larger, subsurface benthic infauna. Although few epifaunal organisms were captured in the PV images, the images do show evidence of both infauna and epifauna with surface worm tubes evident in 18 images and epibenthic tracks detected in 23 of the 31 PV images analyzed (Table 3-5b).

3.3.2 Subtidal ENR+AC Subplot

Surface sediments from the subtidal ENR+AC subplot in Year 3 show textual gradients similar to the parallel ENR subplot, but the silt and fine sand deposits that overlie the ENR+AC material at the downstream end of the subplot (cells 1 to 4) are thicker than the deposits in ENR subplot, and the level of disturbance/lack of presence of the ENR+AC material in cells 5 and 6 is more widespread (Table 3-6a). Figure 3-6a shows examples of the surface sediment textures at Stations 1A (thick silt deposit), 3A (thinner deposit over ENR+AC material), and 5A (disturbed/not present ENR+AC material). Figure 3-6b shows SPI and PV images from Station 5B, another location where the ENR+AC material is not present. As noted for the ENR subplot, the very sharp, vertical transition from the oxidized (brown) surface sediment layer to highly reduced (black) sediment at depth in in the SPI image suggests a disturbance event (i.e., chain dragging) followed by a hiatus and the subsequent deposition of silt. The collocated PV images show no evidence of residual ENR+AC material or disturbance in contrast to the PV image in Figure 3-5b, perhaps suggesting the passage of more time since the disturbance event. There was no obvious visual evidence of GAC in the Year 3 subtidal ENR+AC images compared with the Year 3 subtidal ENR images.

The prism penetration depths for the subtidal ENR+AC subplot were deep compared with the adjacent ENR plot, averaging 9.0 cm and ranging from 1.6 to 17.5 cm (Table 3-7). This is due to the thicker silt deposits in this subplot. Penetration is still less than the baseline average of 12.7 cm due to the underlying ENR+AC material inferred to be present throughout most of the subplot.

The average aRPD depth for this subplot was 1.3 cm (n = 33) with a range from 0.2 to 3.6 cm, which is comparable to the aRPD depths measured in Years 1 and 2 and across the entire subtidal plot in the baseline SPI survey (Table 3-7). Of the 33 successional stages designated, 20 showed evidence of advance benthic recolonization, Stage 1 on 3 or 2-> 3 (Table 3-6a). The image from Station 3A in Figure 3-6a shows a feeding void on the right side of the image. Most of the Stage 1 assemblages were associated with the physically disturbed areas in cells 5 and 6. The PV images from this subplot show widespread evidence of both infauna and epifauna with

burrows and worm tubes present in 32 images (of the 36 images) and epibenthic tracks observed 31 of the images (Table 3-6b). The PV image from Station 5A in Figure 3-6b shows many burrows and tracks on the sediment surface.

4 SUMMARY OF FINDINGS

The objectives of the Year 3 SPI/PV survey were to document the presence and appearance of the ENR and ENR+AC material layers, including the distribution of GAC (if discernable); measure specific SPI/PV parameters (e.g., penetration and aRPD depths, feeding voids) in the images; and assess evidence of benthic community recolonization in each study plot. The ENR and ENR+AC materials were readily identifiable in the SPI and PV images due to their coarse-grained nature relative to the finer-grained ambient sediments. In most instances, the ENR or ENR+AC layers exceeded SPI prism penetration depths so layer thicknesses could generally not be determined. Also, there was no obvious visual evidence in the SPI or PV images of black particles in the of ENR+AC subplots (i.e., the imaged particle color, texture, and granularity were similar between the two treatments). The SPI/PV survey results from each subplot are detailed above in Section 3 of this report; the overall findings are summarized below for each study plot.

4.1 INTERTIDAL PLOT

ENR or ENR+AC material was observed or inferred to be present at all 72 replicates sampled in the intertidal plot. Where evident as a sand and gravel layer, it exceeded the depth of prism penetration, which averaged approximately 3 cm in this plot. In many images, ambient silt deposited since material placement (Year 0; 2017 survey) was mixed into the ENR or ENR+AC material and/or overlying it in a thin, compact veneer. Some images showed only ENR material with no silt addition. Brown and some green macroalgal films were evident on the sediment surface throughout much of the area.

Prism penetration was comparable to the shallow penetration obtained in Year 2 in both subplots. This penetration is less than obtained in Years 0 and 1 at the intertidal plot (see Table 3-7), and it is hypothesized that this is due to both settling/compaction of the ENR/ENR+AC gravels and sands over time in combination with the settlement and infiltration of ambient fine-grained sediment (silts) into the ENR/ENR+AC material interstices, creating a substrate that is more resistant to SPI prism penetration.

Benthic community recolonization was evident at both intertidal subplots. The measured aRPD depths were similar at the ENR and ENR+AC subplots (averaging 1.5 and 1.0 cm, respectively), and also comparable to the Year 2 aRPD depths. These aRPD depths are less than those measured in Year 1, but this may be an artifact of the reduced penetration over time. Due to the limited penetration and coarse substrate, infaunal successional stages could only be assigned to five replicate images in each subplot. However, where assigned, evidence of high-order (Stage 3) successional assemblages were present indicating benthic community recolonization of the area. Table 4-1 shows the numbers, depth, and average size of feeding voids (i.e., Stage 3

biogenic structures data measured in the Year 3 SPI images). The intertidal plot shows comparable void numbers, depths, and size between the two subplots.

4.2 SCOUR PLOT

As in Years 1 (March 2018) and 2 (March 2019), significant silt deposition overlying the ENR and ENR+AC material was observed at the scour plot in Year 3 (June 2020). The deposit covered 75 percent of the plot, ranging from 0 to 12 cm across both subplots, with an average thickness of 9 cm in the upstream ENR subplot and 4 cm in the ENR+AC subplot. The silt deposit was only observed in the upstream half of the ENR+AC plot, it was not present along the northern/downstream half of the subplot where ENR+AC material was observed at the sediment-water interface. This is same pattern observed in Years 1 and 2 and is believed to be due to vessel/tugboat traffic and prop wash in the area that regularly re-suspends finer sediment and prevents a surface silt layer from forming in those downstream cells.

Although ENR or ENR+AC material was not directly observed in many of the scour plot images due to the silt deposits, the SPI penetration depths, sand subfractions evident in the silt matrix, and the presence of silt-covered gravels in many of the PV images provide evidence that the ENR/ENR+AC materials were still present at depth throughout plot. Overall, prism penetration was deeper in Year 3 than in Year 2 and comparable to that obtained in Year 1. This reflects the thicker silt deposits present in Years 1 and 3 compared with Year 2.

As in previous years, the scour plot shows significant evidence of benthic community re-establishment since the ENR/ENR+AC material placement, especially in the ENR subplot. Stage 3 infauna were evident in 35 of the 36 ENR images and in 19 of the 36 ENR+AC images. Successional stage could not be assigned to 16 of the ENR+AC SPI replicates where the bottom texture was sand and gravel. The relatively high abundance of subsurface deposit-feeder feeding voids in the scour plot is shown in Table 4-1; this reflects the recolonized silt bottom (deposits) across 75% of the scour plot area.

4.3 SUBTIDAL PLOT

Some silt deposition over the ENR/ENR+AC material was also observed at the subtidal plot. The downstream two-thirds of the parallel subplots showed predominantly silt at the sediment-water interface. The deposits ranged from 0 to 16 cm across both subplots, but the average thickness was greater over the ENR+AC subplot where it averaged 6 cm. Over the ENR subplot, it averaged 1 cm. As at the scour plot, the limited SPI penetration depths in most images where only silt was evident provide evidence that the ENR/ENR+AC material was present at depth in this downstream portion of subtidal plot.

As in previous years, there was evidence of significant physical disturbance/lack of presence of the ENR material in cells 5 and 6 of both subplots. In Year 3, cell 5 of the ENR subplot was impacted and ENR+AC material was disturbed or not present in cells 5 and 6 in the ENR+AC subplot. As discussed and reported previously, the bottom in this portion of the subtidal plot area is subject to large-scale disturbance by barge chain dragging (Amec et al. 2016b).

SPI prism penetration was notably greater in the ENR+AC subplot than in the ENR plot reflecting the thicker silt deposits there. Evidence of benthic community re-colonization is evident at the subtidal plot. Successional stage designations could only be assigned to 8 replicates in the ENR subplot due to limited penetration, but 50% of those images showed Stage 3 fauna. Of the 33 successional stages designated in the ENR+AC subplot, 61% showed evidence of advanced benthic recolonization, Stage 1 on 3 or 2-> 3. Most of the Stage 1 only assemblages were associated with the physically disturbed areas in cells 5 and 6. Table 4-1 shows the number, depth, and size of the feeding voids measured in each subtidal subplot. The higher number of voids in the in the ENR+AC subplot reflects the deeper penetration obtained there than in the ENR subplot.

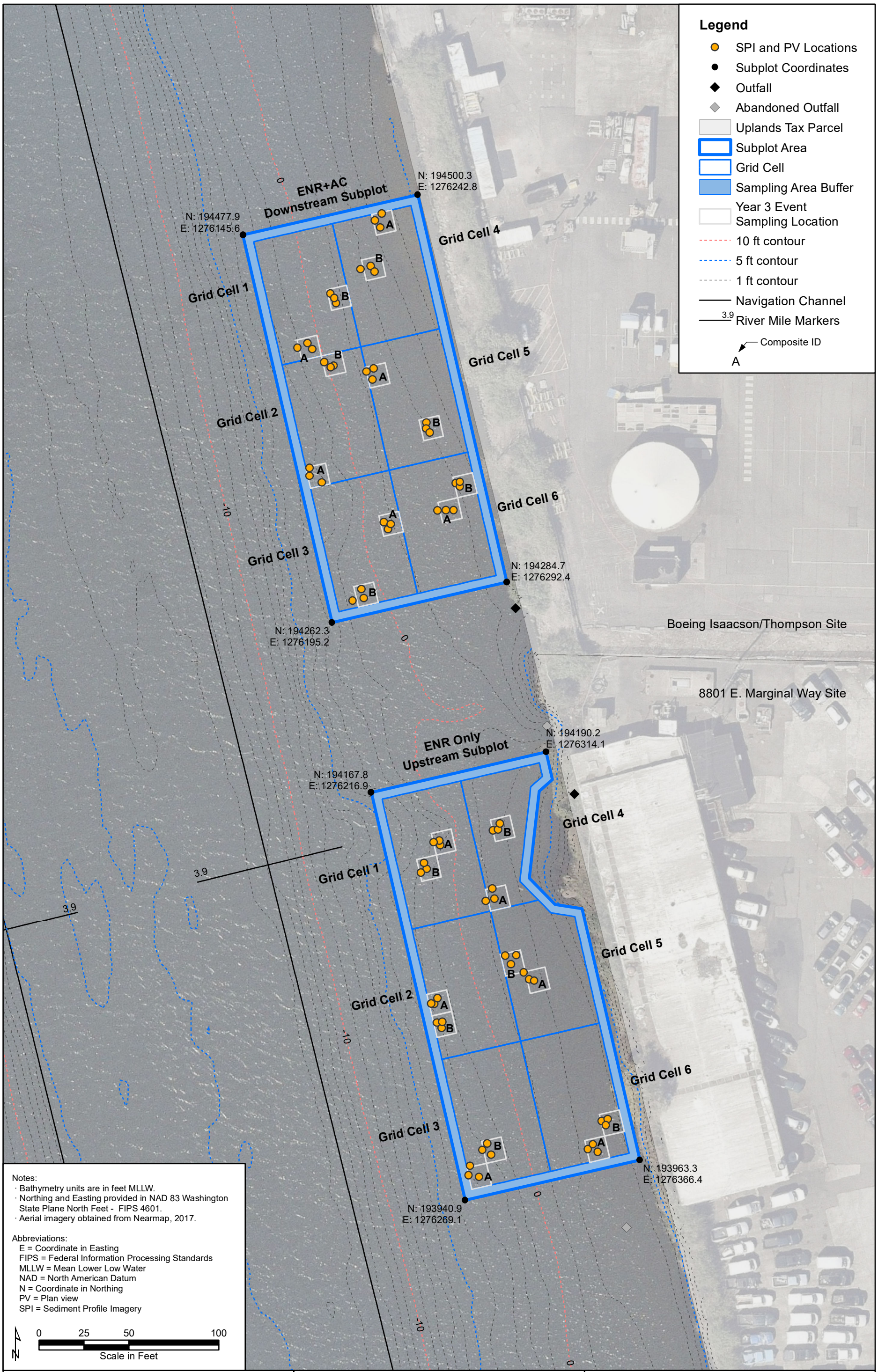
5 REFERENCES

Amec Foster Wheeler; Dalton, Olmsted & Fuglevand, Inc.; Ramboll Environ; Floyd|Snider; and Geosyntec Consultants. 2016a. Quality Assurance Project Plan, Enhanced Natural Recovery/Activated Carbon Pilot Study, Lower Duwamish Waterway. Lower Duwamish Waterway Group, Seattle, WA. February 22.

Amec Foster Wheeler; Dalton, Olmsted & Fuglevand, Inc.; Ramboll Environ; Floyd|Snider; and Geosyntec Consultants. 2016b. Construction Quality Assurance Project Plan (CQAPP) Addendum 1, Enhanced Natural Recovery/Activated Carbon Pilot Study, Lower Duwamish Waterway, ENR Layer Thickness Measurement during Construction at the Subtidal Plot and Grade Stakes at Test, Intertidal, and Scour Plots. Lower Duwamish Waterway Group, Seattle, WA. November 23.

Amec Foster Wheeler; Dalton, Olmsted & Fuglevand, Inc.; Ramboll Environ; Floyd|Snider; and Geosyntec Consultants. 2018. Quality Assurance Project Plan Construction Report, Enhanced Natural Recovery/Activated Carbon Pilot Study, Lower Duwamish Waterway, Lower Duwamish Waterway. Lower Duwamish Waterway Group, Seattle, WA. June.

Figures



Lower Duwamish Waterway Group
Port of Seattle / City of Seattle / King County / The Boeing Company

ENR/AC Draft
Year 3 Monitoring Report
Lower Duwamish Waterway

Figure 2-1
ENR/AC Pilot Study, Intertidal Plot
Year 3 SPI/PV Sampling Locations

I:\GIS\Projects\Wood-KC-ENR\MXD\Project Monitoring and Data Reports\Year 3 Figures\Y3 SPI Report\Figure 2-1 ENR AC Pilot Study, Intertidal Plot Year 3 SPIPV Sampling Locations.mxd
1/27/2021

Legend

- SPI and PV Locations
- Subplot Coordinates
- Outfall
- Berthing
- Uplands Tax Parcel
- Subplot Area
- Grid Cells
- Sampling Area Buffer
- Year 3 Event Sampling Location
- 10 ft contour
- 5 ft contour
- 1 ft contour

Notes:
· Bathymetry units are in feet MLLW.
· Northing and Easting provided in NAD 83 Washington State Plane North Feet - FIPS 4601.
· Aerial imagery obtained from Nearmap, 2017.

Abbreviations:
E = Coordinate in Easting
FIPS = Federal Information Processing Standards
MLLW = Mean Lower Low Water
NAD = North American Datum
N = Coordinate in Northing
PV = Plan view
SPI = Sediment Profile Imagery

Composite ID
A

2154, Port of Seattle

N: 211257.9
E: 1267009.2

N: 211223.5
E: 1267122.2

N: 211168.3
E: 1267138.2

N: 211114.3
E: 1266965

N: 211070.7
E: 1267108.5

N: 210975.3
E: 1266922.8

N: 210932.1
E: 1267065

Grid Cell 1
Grid Cell 3
Grid Cell 5
Grid Cell 2
Grid Cell 4
Grid Cell 6

ENR+AC Downstream Subplot
ENR Upstream Subplot

0 25 50 100
Scale in Feet

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Year 3 Monitoring Report
Lower Duwamish Waterway

Figure 2-2
ENR/AC Pilot Study, Scour Plot
Year 3 SPI/PV Sampling Locations

I:\GIS\Projects\Wood-KC-ENR\MXD\Project Monitoring and Data Reports\Year 3 Figures\Y3 SPI Report\Figure 2-2 ENR AC Pilot Study, Scour Plot Year 3 SPIPV Sampling Locations.mxd
1/27/2021

Legend

- SPI and PV Locations
- Subplot Area Coordinates
- Subplot Area
- Grid Cell
- Sampling Area Buffer
- Year 3 Event Sampling Location
- 10 ft contour
- 5 ft contour
- 1 ft contour
- Navigation Channel
- 1.2 River Mile Markers

Notes:
- Bathymetry units are in feet MLLW.
- Northing and Easting provided in NAD 83 Washington State Plane North Feet - FIPS 4601.
- Aerial imagery obtained from Nearmap, 2017.

Abbreviations:
E = Coordinate in Easting
FIPS = Federal Information Processing Standards
MLLW = Mean Lower Low Water
N = Coordinate in Northing
NAD = North American Datum
PV = Plan view
SPI = Sediment Profile Imagery

A — Composite ID

ENR+AC West Lane
ENR East Lane
N: 205645.4
E: 1267937.2
N: 205629.4
E: 1267887.9
N: 205613.5
E: 1267838.7
Grid Cell 1
Grid Cell 2
Grid Cell 3
Grid Cell 4
Grid Cell 5
Grid Cell 6
N: 205202.2
E: 1268080.8
N: 205186.2
E: 1268031.6
N: 205170.3
E: 1267982.4
-20
-30
1.2
0 25 50 100
Scale in Feet
N

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Year 3 Monitoring Report
Lower Duwamish Waterway

Figure 2-3
ENR/AC Pilot Study, Subtidal Plot
Year 3 SPI/PV Sampling Locations

I:\GIS\Projects\Wood-KC-ENR\MXD\Project Monitoring and Data Reports\Year 3 Figures\Y3 SPI Report\Figure 2-3 ENR AC Pilot Study, Subtidal Plot Year 3 SPIPV Sampling Locations.mxd
1/27/2021

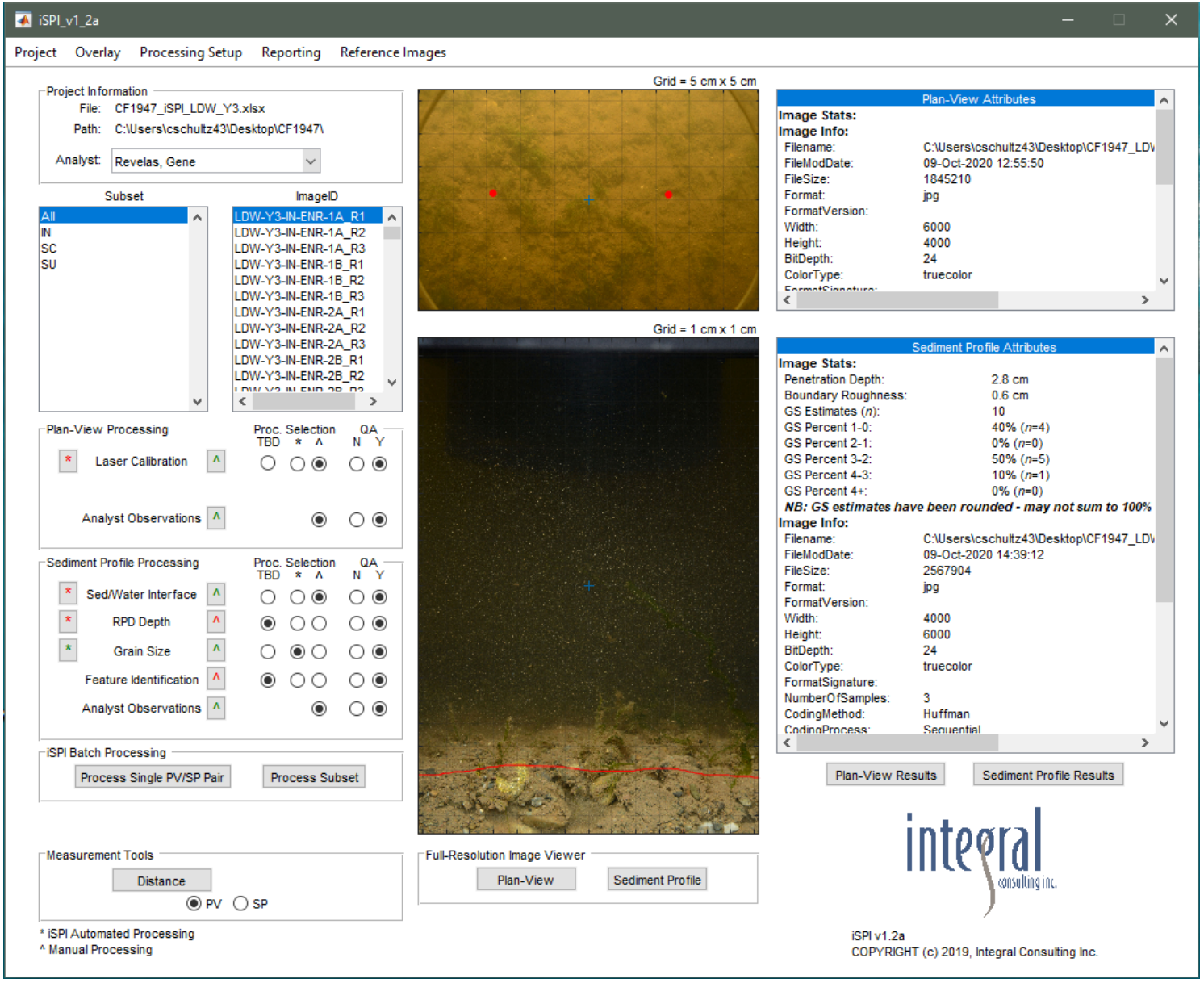
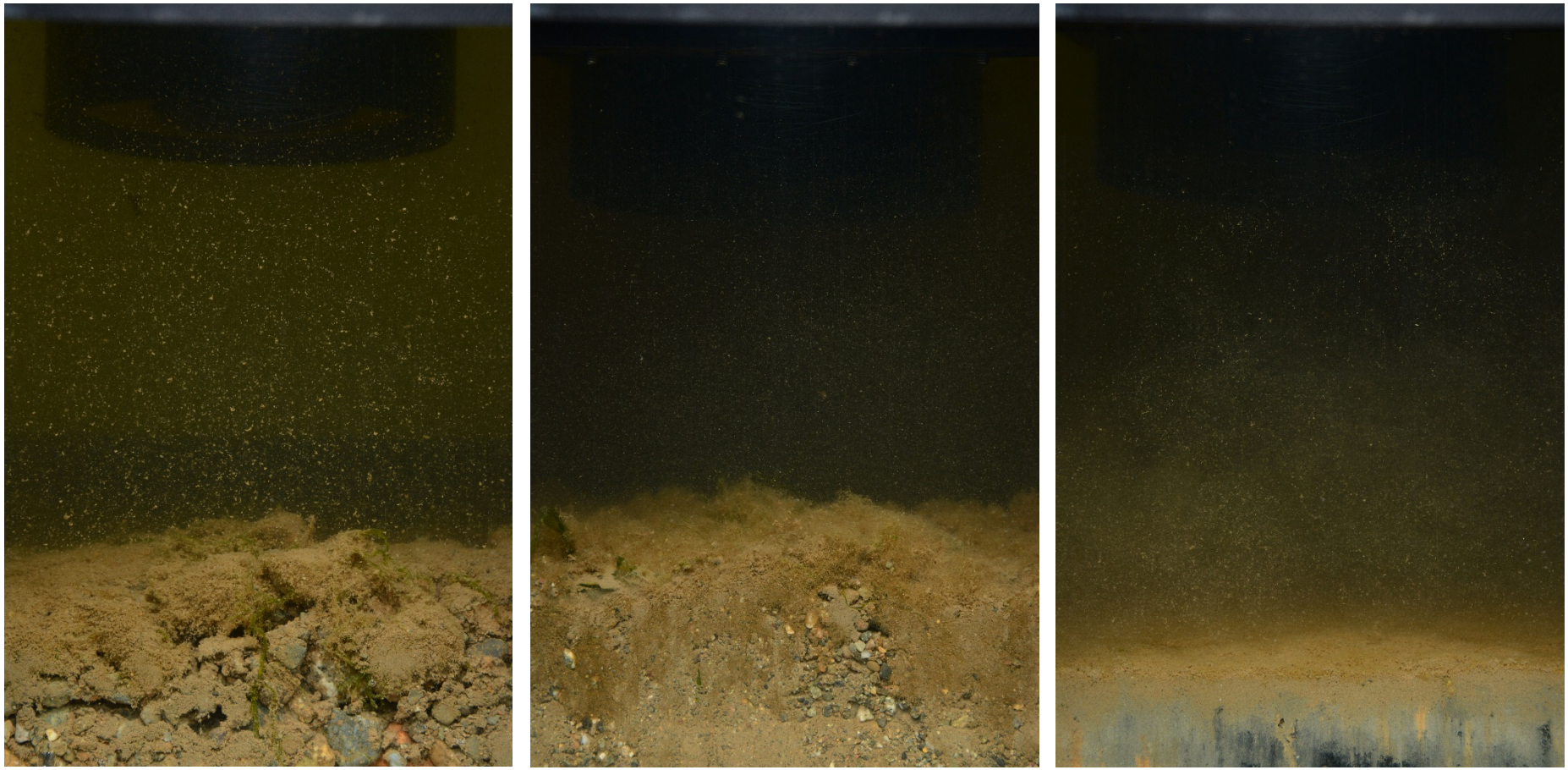


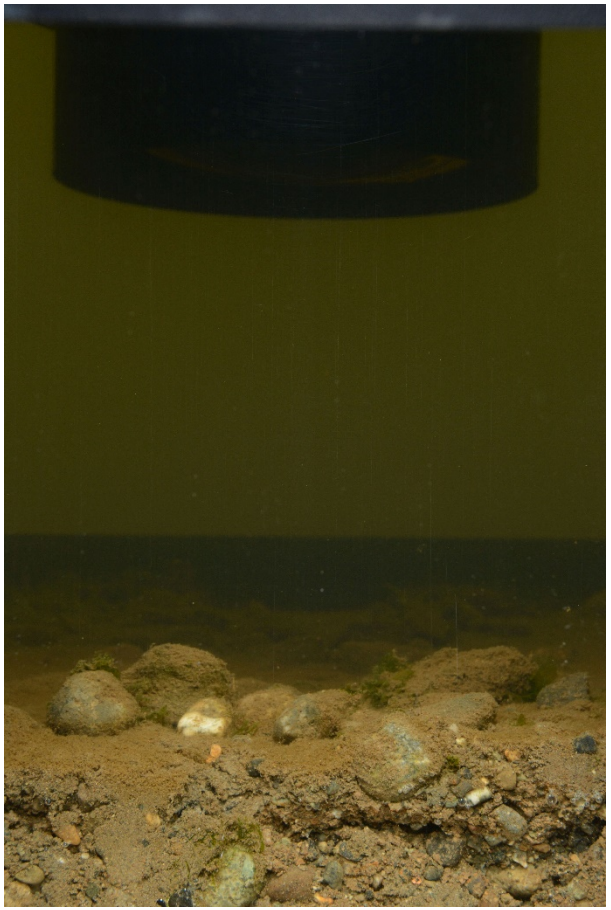
Figure 2-4.
iSPI v1.2a SPI/PV Image Analysis User Interface
ENR/AC Pilot Study Lower Duwamish Waterway



Y3-IN-ENR-6-A-SPI-R2 Y3-IN-ENR-2-B-SPI-R1 Y3-IN-ENR-6-A-SPI-R3

Figure 3-1.
Three SPI images from IN-ENR showing the range of textures observed: gravel and cobbles with veneer layer of silt (left); gravel, sand, and silt mix (middle); and compact silt overlying ENR material based on the limited penetration (right). Width of each image = 14.42 cm.
ENR/AC Pilot Study Lower Duwamish Waterway

Y3-IN-ENR+AC-2-A-SPI-R1



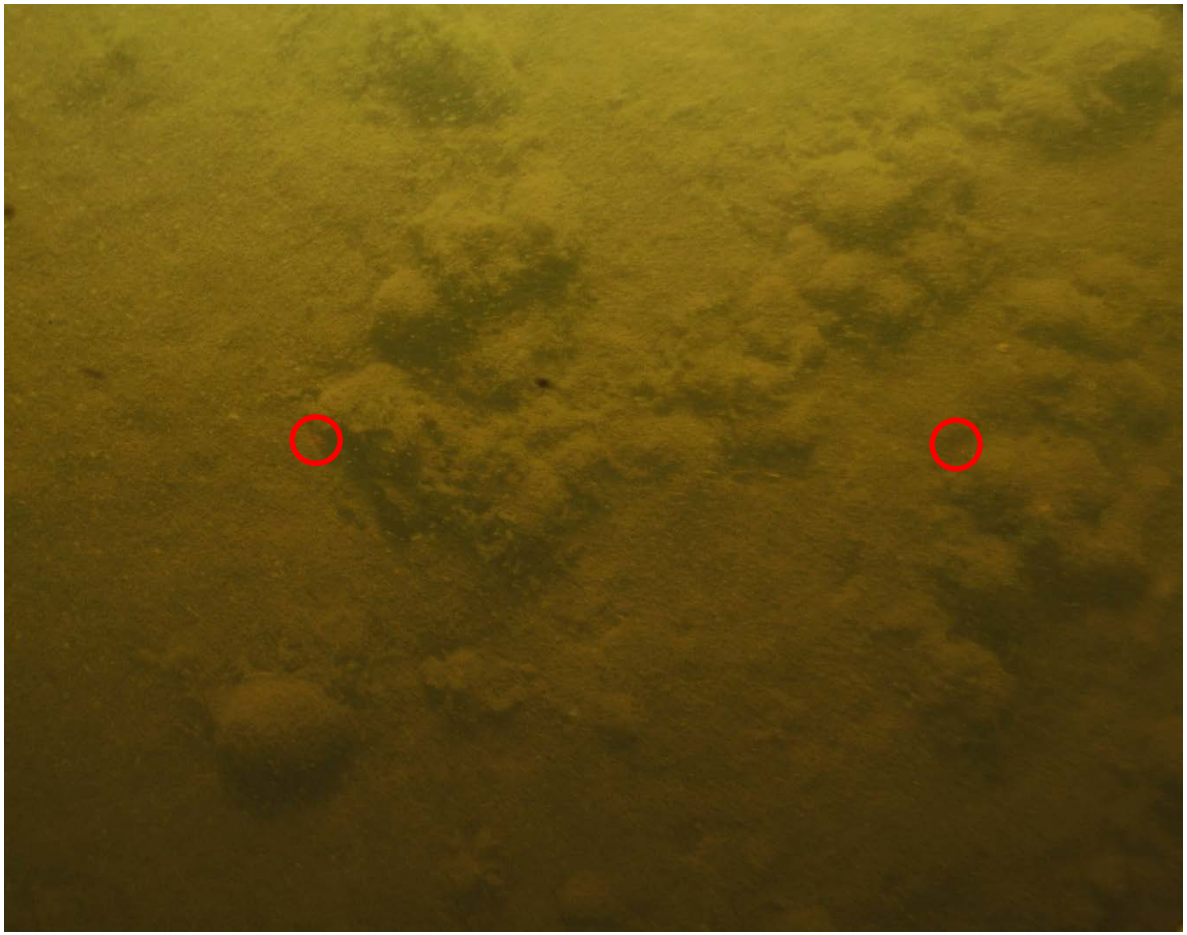
Y3-IN-ENR+AC-4-A-SPI-R2

Y3-IN-ENR+AC-4-B-SPI-R3

integral consulting inc.

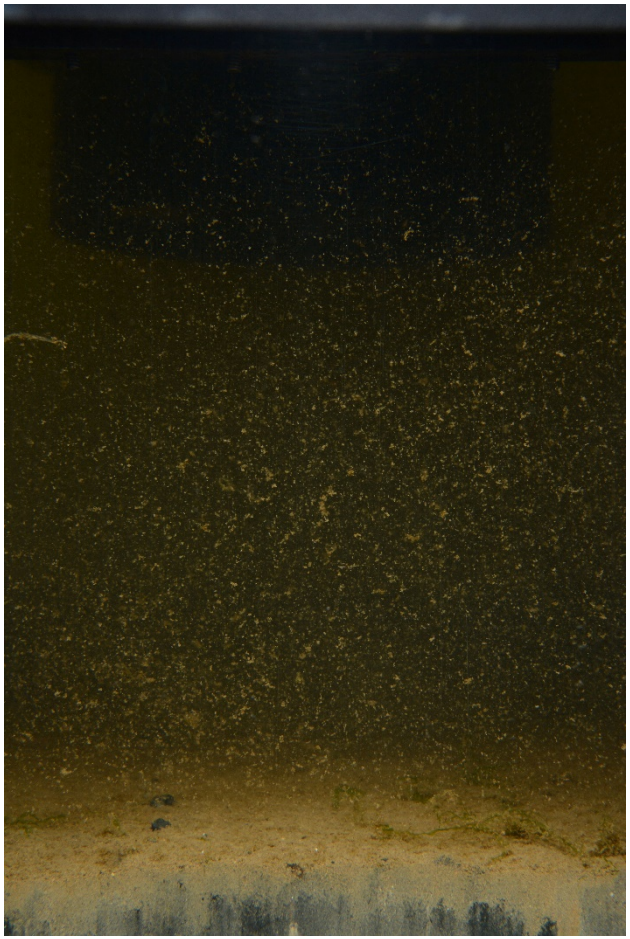
Figure 3-2a.
Three SPI images from IN-ENR+AC subplot showing two replicates where ENR material is evident and mixed with ambient silts (left and middle), and an image showing compact silt over ENR (right). Width of each image = 14.42 cm.
ENR/AC Pilot Study Lower Duwamish Waterway

Y3-IN-ENR+AC-4-B-R2-SPI

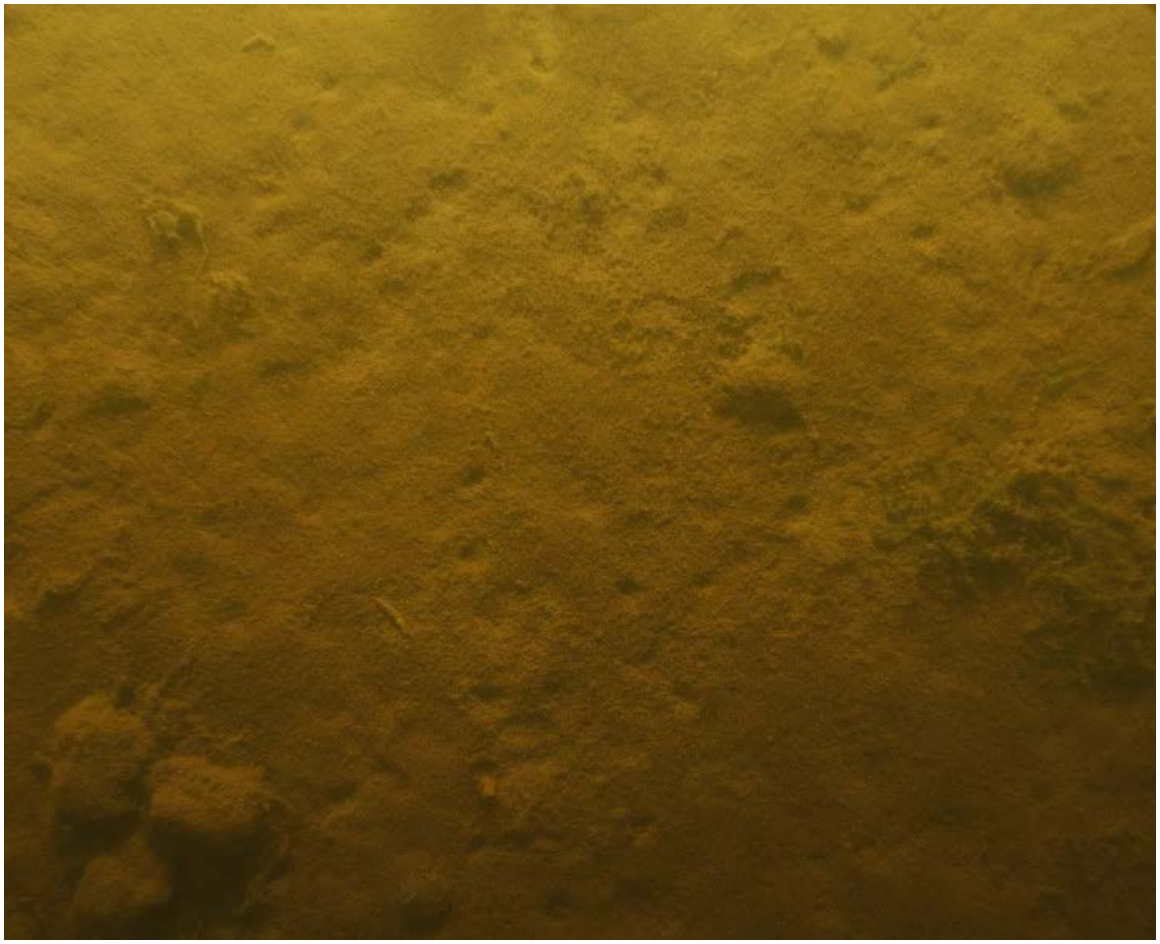


Y3-IN-ENR+AC-4-B-R1-PV

Figure 3-2b.
Collocated SPI (left) and PV (right) images from Station 4B in the IN-ENR+AC subplot showing compact silt mixed with ENR+AC material in SPI and evidence of ENR+AC material in PV. Width of SPI image = 14.42 cm. The circled, faint, red lasers in the PV are 26 cm apart.
ENR/AC Pilot Study Lower Duwamish Waterway



Y3-IN-ENR+AC-6-B-R1-SPI



Y3-IN-ENR+AC-6-B-R1-PV

integral consulting inc.

Figure 3-2c.
Collocated SPI (left) and PV (right) images from Station 6B in the IN-ENR+AC subplot showing a compact mix of sand and silt and green macroalgae. Width of SPI image = 14.42 cm. Scale of PV images is estimated to be ~ 40 cm across (lasers not detected).
ENR/AC Pilot Study Lower Duwamish Waterway

Y3-SC-ENR-2-B-R4-SPI

Y3-SC-ENR-3-B-R3-SPI

Y3-SC-ENR-6-B-R3-SPI

Figure 3-3a.
SPI images from the SC-ENR subplot cells 2, 3, and 6 showing the 8–11 cm of deposited silt overlying the ENR material. Feeding voids and surface worm tubes are evident in all images. Methane gas pockets (glossy black voids) are seen at Station 3B. Width of each image = 14.42 cm.
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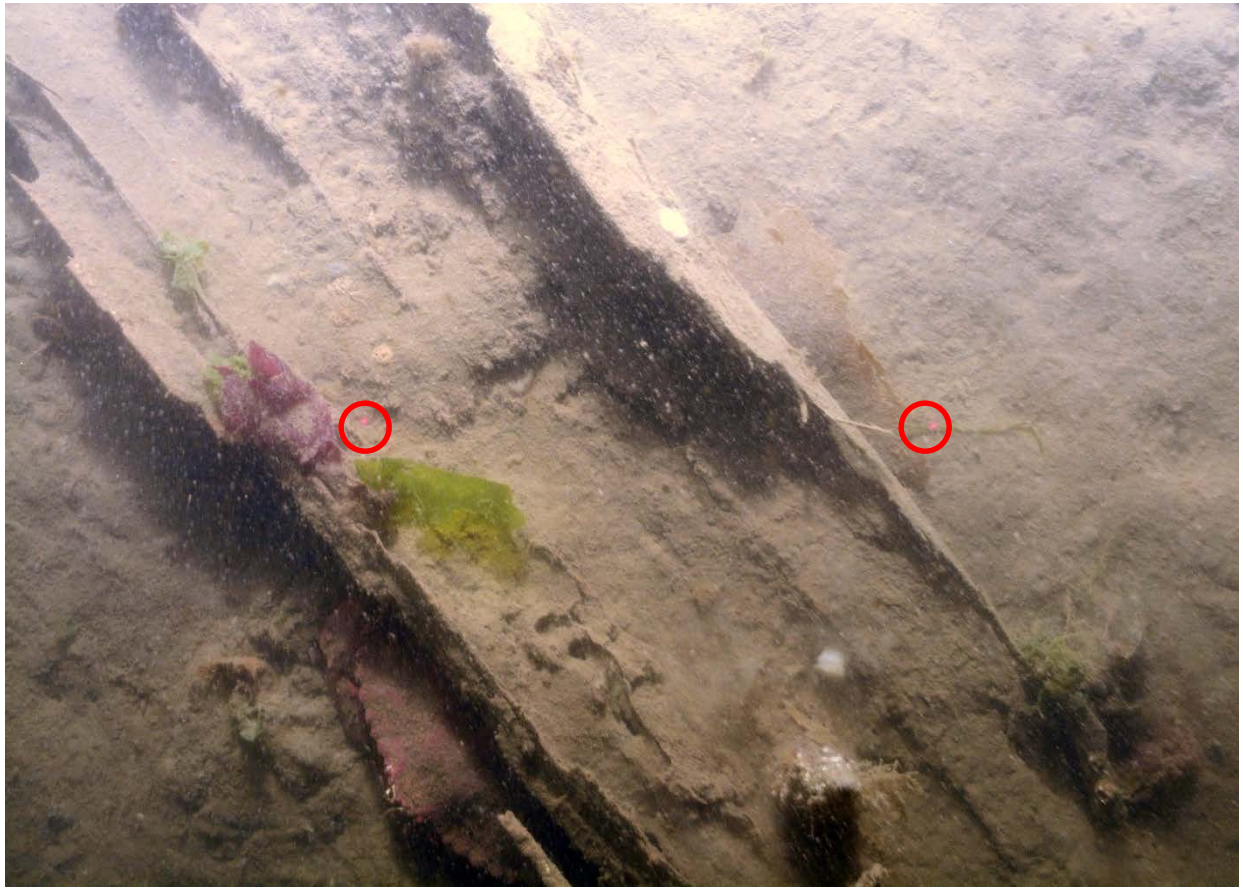
Y3-SC-ENR-4-B-R1-SPI



Y3-SC-ENR-4-B-R1-PV

Figure 3-3b.
Paired SPI (left) and PV (right) images from Station 4B in the SC-ENR subplot showing a silt bottom (left) with wood debris on the surface (right). The PV image also shows a large red rock crab, barnacles, and red and green macroalgae. Width of SPI image = 14.42 cm. The circled red lasers in the PV are 26 cm apart.
ENR/AC Pilot Study Lower Duwamish Waterway

Y3-SC-ENR+AC-1-A-R1-SPI

Y3-SC-ENR+AC-2-B-R6-SPI

Y3-SC-ENR+AC-3-A-R1-SPI

integral consulting inc.

Figure 3-4a.
SPI images from the SC-ENR+AC subplot cells 1, 2, and 3 showing ENR material only at 1A (left), a 7-cm silt layer at 2B (middle), and a thin (3 cm) ENR material layer at 3A overlying reduced silt. Width of each image = 14.42 cm.
ENR/AC Pilot Study Lower Duwamish Waterway

Y3-SC-ENR+AC-3-A-R2-SPI

Y3-SC-ENR+AC-3-A-R3-PV

Figure 3-4b.
Paired SPI (left) and PV (right) images from Station 3A in the SC-ENR+AC subplot showing relatively thin ENR material cover at this location at the northern edge of the subplot. The PV image shows contiguous ENR material cover. Width of SPI image = 14.42 cm. The circled red lasers in the PV are 26 cm apart.
ENR/AC Pilot Study Lower Duwamish Waterway

Y3-SU-ENR-1B-R1-SPI

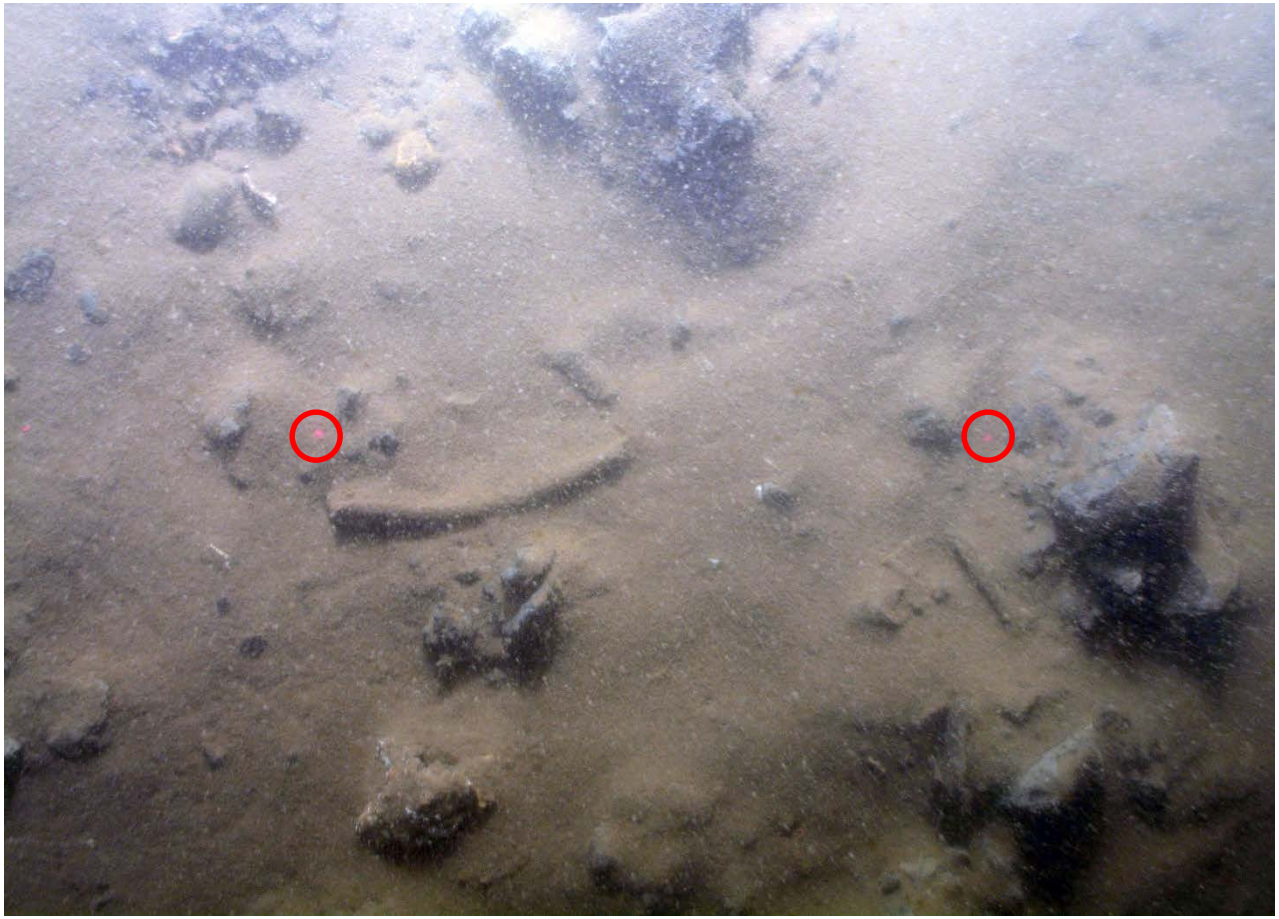
Y3-SU-ENR-3A-R3-SPI

Y3-SU-ENR-6A-R3-SPI

integral consulting inc.

Figure 3-5a.
Three SPI images from SU-ENR showing the range of textures observed: silt and fine sand overlying ENR material (left); compact silt and ENR sand and silt mix (middle); and reduced silt where the ENR material has been disturbed (right). Width of each image = 14.42 cm. *ENR/AC Pilot Study Lower Duwamish Waterway*

Y3-SU-ENR-6A-R4-SPI



Y3-SU-ENR-6A-R4-PV

Figure 3-5b.
SPI (left) and PV (right) images from Station 6A in the SU-ENR subplot showing an area where the ENR material has been disturbed. The SPI image shows reduced silt below 3 cm overlain by a sand and silt deposit. The PV image reveals reduced mud clumps and surface debris. Width of SPI image = 14.42 cm. The circled red lasers in the PV are 26 cm apart.
ENR/AC Pilot Study Lower Duwamish Waterway

Y3-SU-ENR+AC+1-A-SPI-R1

Y3-SU-ENR+AC+3-A-SPI-R1

Y3-SU-ENR+AC+5-A-SPI-R1

integral consulting inc.

Figure 3-6a.
Three SPI images from SU-ENR+AC subplot showing a thick silt deposit (left), a thinner silt and fine sand deposit (middle), and location where ENR+AC material has been disturbed/ removed (right). Width of each image = 14.42 cm.
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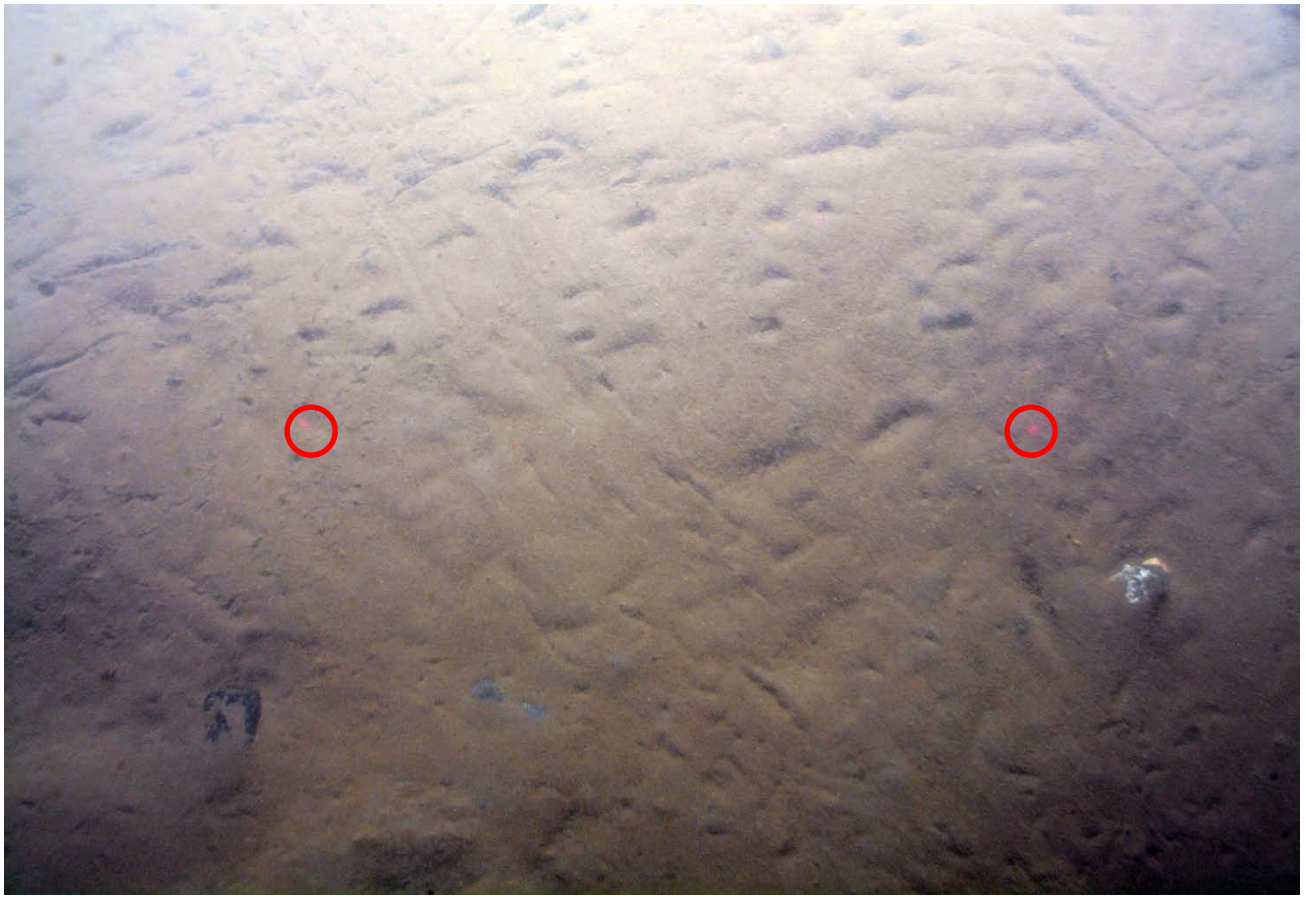
Y3-SU-ENR+AC-5B-R4-SPI



Y3-SU-ENR+AC-5B-R3-PV

Figure 3-6b.
SPI (left) and PV (right) images from Station 5B in the SU-ENR+AC, where the ENR+AC is not present. The sharp vertical transition from the brown surface sediment layer to reduced sediment at depth in the SPI image suggests a scour event then deposition of silt. Burrows and tracks are evident in the PV image. Width of SPI image = 14.42 cm. The circled red lasers in the PV are 26 cm apart.
ENR/AC Pilot Study Lower Duwamish Waterway

Tables

Table 3-1a. Year 3 Intertidal ENR Pilot Subplot SPI Results

Station	Replicate	Image Date	Water Depth (ft)	Penetration Depth (cm)	ENR Layer Thickness (cm)	Texture and Other Observations	Surface Boundary Roughness (cm)	RPD Depth (cm)	Grain Size Major Mode (phi units)	Grain Size Maximum (phi units)	Grain Size Minimum (phi units)	Methane	Successional Stage
LDW-Y3-IN-ENR-1A	R1	6/27/2020	5.6	2.8	>P	Silt over granules and few pebbles on SWI. Ulva and brown algae within substrate and on surface. ENR material > penetration.	0.6	Ind.	-1 to -2	-4	>4	N	Ind.
LDW-Y3-IN-ENR-1A	R2	6/27/2020	5.7	4.4	>P	Silt with coarse sand subfraction and varying sizes of granules and few pebbles, one on SWI. Air bubbles and ulva contained within substrate. Brown algae on surface. "Void" created by sloping SWI. ENR material > penetration.	0.8	Ind.	>4 and 0-1	-4	>4	N	Ind.
LDW-Y3-IN-ENR-1A	R3	6/27/2020	5.9	3.1	>P	Silt with few granules. Air bubbles at bottom left of frame. Ulva and brown algae on surface, few pieces of ulva contained within sediment. ENR material > penetration.	0.7	Ind.	>4 and 1-0	0	>4	N	Ind.
LDW-Y3-IN-ENR-1B	R1	6/27/2020	6.5	2.7	>P	Silt and coarse sand/granule mix. Some ulva and brown algae. ENR material > penetration.	0.7	Ind.	>4 and 0 to -1	-4	>4	N	Ind.
LDW-Y3-IN-ENR-1B	R2	6/27/2020	6.2	4.4	>P	Silt over coarse sand, granules. Brown algae and ulva on surface, few pieces of ulva contained within substrate. Air bubbles. "Voids" created by sloping SWI. ENR material > penetration.	1.1	Ind.	>4/0 to -1	-4	>4	N	Ind.
LDW-Y3-IN-ENR-1B	R3	6/27/2020	6.1	4.3	>P	Silt with sand subfraction. Ulva and brown algae in frame. Possible methane. ENR material > penetration.	0.3	1.8	>4	-1	>4	Y	2 -> 3
LDW-Y3-IN-ENR-2A	R1	6/27/2020	5.8	3.8	>P	Silt and sand mix with granules. Ulva and brown algae on surface. ENR material > penetration. RPD = Ind.	0.5	Ind.	>4 and 1-0	-2	>4	N	1 on 3
LDW-Y3-IN-ENR-2A	R2	6/27/2020	6.1	3.4	>P	Silt and granules, coarse pebble on SWI. Few pieces of ulva and brown algae on surface. A few air bubbles. ENR material > penetration.	1	Ind.	-1 to -2 and >4	-4	>4	N	Ind.
LDW-Y3-IN-ENR-2A	R3	6/27/2020	6.2	3.5	>P	Very coarse sand with silt, pebbles on SWI. Ulva and brown algae contained within substrate and on surface. Air bubbles. ENR material > penetration.	0.7	Ind.	0 to -1	-3	>4	N	Ind.
LDW-Y3-IN-ENR-2B	R1	6/27/2020	7	5.3	>P	Silt and granules. Abundant brown algae and some ulva on surface, brown algae contained within substrate. ENR material > penetration.	1.2	Ind.	-1 to -2 and >4	-3	>4	N	Ind.
LDW-Y3-IN-ENR-2B	R2	6/27/2020	6.9	3.9	>P	Very coarse sand and silt, granules. Brown algae and ulva on surface, brown algae contained within substrate. ENR material > penetration.	1.2	Ind.	0 to -1 and >4	-2	>4	N	Ind.
LDW-Y3-IN-ENR-2B	R3	6/27/2020	6.5	4.9	>P	Very coarse sand and silt with granules, pebbles on SWI. Ulva and brown algae on surface. "Voids" created by slumping SWI. ENR material > penetration.	0.4	Ind.	0 to -1 and >4	-4	>4	N	Ind.
LDW-Y3-IN-ENR-3A	R1	6/27/2020	11	4.4	LNA	Oxidized silt with few granules, cobble on SWI. Ulva and brown algae on surface, some brown algae contained within substrate. Silt overlying ENR based on limited penetration.	1	Ind.	>4	-2	>4	N	Ind.
LDW-Y3-IN-ENR-3A	R2	6/27/2020	11.4	4.9	LNA	Oxidized silt with few granules. Ulva and brown algae on surface and contained within substrate. Feeding void. Silt overlying ENR.	1	Ind.	>4	-2	>4	N	3

Table 3-1a. Year 3 Intertidal ENR Pilot Subplot SPI Results

Station	Replicate	Image Date	Water Depth (ft)	Penetration Depth (cm)	ENR Layer Thickness (cm)	Texture and Other Observations	Surface Boundary Roughness (cm)	RPD Depth (cm)	Grain Size Major Mode (phi units)	Grain Size Maximum (phi units)	Grain Size Minimum (phi units)	Methane	Successional Stage
LDW-Y3-IN-ENR-3A	R3	6/27/2020	10.8	4.2	LNA	Oxidized silt with a few granules. Brown algae abundant on surface, few pieces of ulva. Possible feeding voids. Silt (4 cm) over ENR based on limited penetration.	0.5	Ind.	>4	-1	>4	N	3
LDW-Y3-IN-ENR-3B	R1	6/27/2020	9.5	3.8	>P	Gravel with varying sizes of granules, silt subfraction. Ulva contained within substrate. "Voids" created by slumping SWI. ENR material > penetration.	0.5	Ind.	-1 to -2	-3	>4	N	Ind.
LDW-Y3-IN-ENR-3B	R2	6/27/2020	9.1	2.4	>P	Silt with granules, coarse pebbles on SWI. Abundance of ulva and brown algae on surface. ENR material > penetration.	0.6	Ind.	>4 and 0 to -1	-3	>4	N	Ind.
LDW-Y3-IN-ENR-3B	R3	6/27/2020	10.3	4.6	>P	Coarse sand, gravel with some silt, pebbles on SWI. Brown algae and ulva on surface. ENR material > penetration.	0.8	Ind.	1 to 0	-4	>4	N	Ind.
LDW-Y3-IN-ENR-4A	R1	6/27/2020	6	3.7	>P	Silt and granules, pebble on SWI. Ulva and brown algae on surface. Possible methane appears to be air bubbles. ENR material > penetration.	0.3	Ind.	0 to -1 and >4	-3	>4	N	Ind.
LDW-Y3-IN-ENR-4A	R2	6/27/2020	5.6	2.6	>P	Silt and coarse sand, granules. Ulva and brown algae on surface, few pieces of ulva contained within substrate. Possible methane appears to be air bubbles. ENR material > penetration.	0.7	Ind.	>4 and 1-0	-3	>4	N	Ind.
LDW-Y3-IN-ENR-4A	R3	6/27/2020	5.8	2.8	>P	Sand and silt mix, some granules. Ulva and brown algae on surface. ENR material > penetration.	0.5	Ind.	3-2 and >4	-3	>4	N	3
LDW-Y3-IN-ENR-4B	R1	6/27/2020	5.7	3.3	>P	Silt and silt mix, some granules, cobble on SWI. Large air bubbles. Reduced sediment at 1 cm, some clay intermixed. Ulva contained within substrate, brown algae on surface. ENR material > penetration.	0.6	1.1	>4 and 3-2	-1	>4	N	Ind.
LDW-Y3-IN-ENR-4B	R2	6/27/2020	5.5	3.2	>P	Silt coarse sand mix, granules. Reduced sediment at 1 cm. Brown algae and ulva on surface. Possible methane or air bubbles. ENR material > penetration.	0.4	1.2	>4 and 0 to -1	-3	>4	N	Ind.
LDW-Y3-IN-ENR-4B	R3	6/27/2020	5.3	3.1	>P	Silt, sand, and granules. "Void" created by sloping SWI. Ulva and brown algae on surface, ulva contained within substrate. Slightly reduced sediment and some clay. Trapped air bubbles. ENR material > penetration.	0.5	Ind.	>4 and 0 to -1	-3	>4	N	Ind.
LDW-Y3-IN-ENR-5A	R1	6/27/2020	5.4	2.4	>P	Silt, sand, granules, and pebbles. Ulva and brown algae on surface. Air pockets trapped within substrate. Reduced darker sediments starting at 1 cm. ENR material > penetration.	0.6	1.7	>4 and 2-1	-5	>4	N	Ind.
LDW-Y3-IN-ENR-5A	R2	6/27/2020	5.1	2.4	>P	Fine sand and silt with granules. Coarse pebble on SWI. Ulva and brown algae on surface, ulva contained within substrate. Gas voids are likely air pockets. ENR material > penetration.	0.2	2	3-2	-4	>4	N	Ind.
LDW-Y3-IN-ENR-5A	R3	6/27/2020	5.1	1.6	>P	Fine sand and silt with granules, cobble on SWI. Ulva and brown algae on surface. ENR material > penetration. Possible voids appear to be fractures.	0.5	Ind.	3-2	-3	>4	N	Ind.
LDW-Y3-IN-ENR-5B	R1	6/27/2020	5.4	3.9	>P	Silt with fine to coarse pebbles. "Voids" created by sloping SWI. Ulva and brown algae on surface, few pieces of ulva contained within substrate. Some air bubbles. ENR material > penetration.	0.5	Ind.	>4 and -1 to -2	-4	>4	N	Ind.

Table 3-1a. Year 3 Intertidal ENR Pilot Subplot SPI Results

Station	Replicate	Image Date	Water Depth (ft)	Penetration Depth (cm)	ENR Layer Thickness (cm)	Texture and Other Observations	Surface Boundary Roughness (cm)	RPD Depth (cm)	Grain Size Major Mode (phi units)	Grain Size Maximum (phi units)	Grain Size Minimum (phi units)	Methane	Successional Stage
LDW-Y3-IN-ENR-5B	R2	6/27/2020	5.4	2.8	>P	Silt with gravel. Ulva and brown algae on SWI. Few air bubbles. ENR material > penetration.	0.3	Ind.	>4 and 0 to -1	-2	>4	N	Ind.
LDW-Y3-IN-ENR-5B	R3	6/27/2020	5.9	3	>P	Silt with gravel. Few pieces of ulva and brown algae on surface, some contained within sediment. Air bubbles. ENR material > penetration.	0.5	Ind.	>4 and 0 to -1	-3	>4	N	Ind.
LDW-Y3-IN-ENR-6A	R1	6/27/2020	4.6	3.1	>P	Silt and gravel. Pebbles on SWI. "Voids" created by sloping SWI. Ulva and brown algae on surface and contained within substrate. Air bubbles. ENR material > penetration.	0.5	Ind.	>4 and -1 to -2	-4	>4	N	Ind.
LDW-Y3-IN-ENR-6A	R2	6/27/2020	4.4	3.8	>P	Gravel with some silt, pebbles on SWI. Ulva and brown algae on surface. Few pieces of ulva and air bubbles contained within substrate. ENR material > penetration.	0.6	Ind.	-2 to -3	-5	>4	N	Ind.
LDW-Y3-IN-ENR-6A	R3	6/27/2020	4.5	2.8	LNA	Very fine sand to silt at depth. Possible methane contained within substrate. ENR material not evident but assumed to underlie silt based on penetration.	0.5	1.2	>4	1	>4	N	Ind.
LDW-Y3-IN-ENR-6B	R1	6/27/2020	4.3	2.7	>P	Silt with/concealing gravel. "Voids" created by sloping SWI. Layer of brown algae and some ulva on surface. Possible methane or air bubbles. ENR material > penetration.	1.2	Ind.	>4	-1	>4	N	Ind.
LDW-Y3-IN-ENR-6B	R2	6/27/2020	4.2	2.2	>P	Silt and gravel, pebbles on SWI. Prism is tilted, potentially landed on rock or wood debris, boundary roughness is an artifact. Air bubbles trapped within substrate. ENR material > penetration.	4.2	Ind.	>4 and -2 to -3	-4	>4	N	Ind.
LDW-Y3-IN-ENR-6B	R3	6/27/2020	3.5	2.7	>P	Silt and gravel. Cobble in background on surface. "Void" is created by sloping SWI. Possible void at depth. Debris and air bubbles contained within substrate. ENR material > penetration.	0.3	Ind.	>4 and -2 to -3	-3	>4	N	Ind.

Summary Statistics for Some Numerical Parameters

	Penetration Depth (cm)	Surface Boundary Roughness (cm)	RPD Depth (cm)
N	36	36	6
Average	3.4	0.7	1.5
Median	3.3	0.6	1.5
Minimum	1.6	0.2	1.1
Maximum	5.3	4.2	2.0

Notes:
AC = activated carbon
aRPD = apparent redox potential discontinuity
ENR = enhanced natural recovery
Ind. = indeterminate
LNA = layer not apparent
N = no
P = penetration
SPI = sediment profile imaging
SWI = sediment-water interface
Y = yes

Table 3-1b. Year 3 Intertidal ENR Pilot Subplot PV Results

				Lebensspuren											
Station	Replicate	Sediment Type	Bedforms	Burrows	Tubes	Tracks	Total Abundance	Epifauna	Epifauna Type (Count)	Mud Clasts	Debris Type	Debris Cover	*Beggiatoa*	Surface Boundary Roughness	Comments
LDW-Y3-IN-ENR-1A	R1	Silt, sand, and gravel	N	Y	Y	N	L	N	NA	N	Algae	H	N	M	Spotty distribution of algae on surface. Few gravel pieces.
LDW-Y3-IN-ENR-1A	R2	Silt, sand, and gravel	N	N	Y	N	L	N	NA	N	Algae	M	N	M	Spotty distribution of algae on substrate. Few gravels.
LDW-Y3-IN-ENR-1A	R3	Silt, sand, and gravel	N	N	N	N	N	N	NA	N	Algae	M	N	M	Spotty distribution of algae on substrate. Few gravel pieces. One laser visible. Imprint is an artifact from the SPI frame.
LDW-Y3-IN-ENR-1B	R1	Silt and sand	N	N	N	N	N	N	NA	N	Algae	H	N	M	Spotty distribution of algae on substrate.
LDW-Y3-IN-ENR-1B	R2	Silt, sand, and gravel	N	N	N	N	N	Y	Snail (1)	N	Algae	M	N	M	Spotty distribution of algae on substrate. Few gravel pieces. Imprint is an artifact from the SPI frame.
LDW-Y3-IN-ENR-1B	R3	Silt and sand	N	Y	N	N	L	N	NA	N	Algae	H	N	L	Algae covering majority of substrate. One laser visible.
LDW-Y3-IN-ENR-2A	R1	Silt, sand, and gravel	N	N	N	N	N	N	NA	N	Algae	H	N	L	Algae covering majority of substrate. Very few gravel pieces.
LDW-Y3-IN-ENR-2A	R2	Sand, silt, and gravel	N	N	N	N	N	N	NA	N	Algae	H	N	L	Algae covering majority of substrate. Some gravel pieces evident.
LDW-Y3-IN-ENR-2A	R3	Sand, silt, and gravel	N	N	N	N	N	N	NA	N	Algae	H	N	L	Algae covering majority of substrate. Imprint is an artifact from the SPI frame.
LDW-Y3-IN-ENR-2B	R1	Silt, sand, and gravel	N	N	N	N	N	N	NA	N	Algae	H	N	L	Algae covering majority of substrate. Some gravels.
LDW-Y3-IN-ENR-2B	R2	Sand, silt, and gravel	N	N	N	N	N	N	NA	N	Algae	M	N	L	Spotty distribution of algae on substrate. Some gravels.
LDW-Y3-IN-ENR-2B	R3	Sand, silt, and gravel	N	N	N	N	N	N	NA	N	Algae	M	N	L	Spotty distribution of algae on substrate. Some gravels evident.
LDW-Y3-IN-ENR-3A	R1	Sand	N	N	N	N	N	N	NA	N	Algae and stick	M	N	L	Image clarity impacted by particulates in water column. No lasers visible. Spotty distribution of algae on substrate.
LDW-Y3-IN-ENR-3A	R2	Sand	N	N	N	N	N	N	NA	N	Algae	H	N	L	Algae covering majority of substrate. Particulates in water column impacting clarity of image. Algae covering majority of substrate. No lasers visible.
LDW-Y3-IN-ENR-3A	R3	Sand	N	N	N	N	N	N	NA	N	Algae	H	N	L	Algae covering majority of substrate. Particulates in water column impacting image clarity. No lasers visible.
LDW-Y3-IN-ENR-3B	R1	Sand, silt, and gravel	N	N	N	N	N	N	NA	N	Algae	L	N	L	Spotty distribution of algae on substrate. Particulates in water column impacting image clarity. No lasers visible. Few gravels.
LDW-Y3-IN-ENR-3B	R2	Sand, silt, and gravel	N	N	N	N	N	N	NA	N	Algae	M	N	M	Spotty distribution of algae on substrate. Particulates in water column impacting image clarity. No lasers visible. Some gravel evident.
LDW-Y3-IN-ENR-3B	R3	--	--	--	--	--	--	--	--	--	--	--	--	--	Not analyzable due to turbidity in the water column.
LDW-Y3-IN-ENR-4A	R1	Silt, sand, and gravel	N	N	N	N	N	N	NA	N	Algae	M	N	M	Spotty distribution of algae on substrate. Silt overlying sand and gravel. No lasers visible.
LDW-Y3-IN-ENR-4A	R2	Silt, sand, and gravel	N	N	N	N	N	N	NA	N	Algae and stick	L	N	M	Spotty distribution of algae on substrate. Silt overlying sand and some gravel. No lasers visible.
LDW-Y3-IN-ENR-4A	R3	--	--	--	--	--	--	--	--	--	--	--	--	--	Not analyzable due to turbidity in the water column.
LDW-Y3-IN-ENR-4B	R1	Silt, sand, and gravel	N	N	N	Y	L	N	NA	N	Algae	M	N	M	Spotty distribution of algae on substrate. Lasers not visible. High amount of particulates in water column. Few gravels and cobble piece.
LDW-Y3-IN-ENR-4B	R2	Silt, sand, and gravel	N	N	N	N	N	N	NA	N	Algae	M	N	M	Spotty distribution of algae on substrate. Silt overlying sand and some gravel.
LDW-Y3-IN-ENR-4B	R3	Silt, sand, and gravel	N	N	N	N	N	N	NA	N	Algae	L	N	L	Spotty distribution of algae on substrate. Silt overlying sand and few gravels. One laser visible. Particulates in water column.
LDW-Y3-IN-ENR-5A	R1	Silt, sand, and gravel	N	N	N	N	N	N	NA	N	Algae	L	N	H	Spotty distribution of algae on substrate. Lasers not visible. Particulates in water column.
LDW-Y3-IN-ENR-5A	R2	Silt, sand, and gravel	N	N	N	N	N	N	NA	N	Algae	L	N	M	Spotty distribution of algae on substrate. Silt overlying sand and gravel. No lasers, particulates in water column.
LDW-Y3-IN-ENR-5A	R3	Silt, sand, and gravel	N	N	N	N	N	N	NA	N	Algae	M	N	M	Spotty distribution of algae on substrate. Silt overlying sand and some gravels. One laser visible. Particulates in water column.
LDW-Y3-IN-ENR-5B	R1	Silt, gravel, and sand	N	N	N	N	N	N	NA	N	Algae	L	N	H	Spotty distribution of algae on substrate. Silt overlying gravel and sand. No lasers visible, particulates in water column.
LDW-Y3-IN-ENR-5B	R2	Silt, sand, and gravel	N	N	N	N	N	N	NA	N	Algae	M	N	M	Spotty distribution of algae on substrate. Silt overlying sand and gravel. No lasers visible, particulates in water column.
LDW-Y3-IN-ENR-5B	R3	Silt, sand, and gravel	N	N	N	N	N	N	NA	N	Algae	L	N	L	Few pieces of algae. Silt overlying sand and very few gravel. One laser visible. Particulates in water column.
LDW-Y3-IN-ENR-6A	R1	Silt, sand, and gravel	N	N	N	N	N	N	NA	N	Algae	L	N	M	Few pieces of algae on substrate. Silt overlying sand and gravel. No lasers visible. Particulates in water column.

Table 3-1b. Year 3 Intertidal ENR Pilot Subplot PV Results

				Lebensspuren											
Station	Replicate	Sediment Type	Bedforms	Burrows	Tubes	Tracks	Total Abundance	Epifauna	Epifauna Type (Count)	Mud Clasts	Debris Type	Debris Cover	*Beggiatoa*	Surface Boundary Roughness	Comments
LDW-Y3-IN-ENR-6A	R2	Silt, sand, and gravel	N	N	N	N	N	N	NA	N	Algae	L	N	M	Spotty distribution of algae on substrate. Silt overlying sand and gravel. No lasers visible. Particulates in water column.
LDW-Y3-IN-ENR-6A	R3	Silt	N	Y	N	N	L	N	NA	N	Algae	L	N	L	Very few pieces of algae. Silt. Particulates in water column, no lasers visible.
LDW-Y3-IN-ENR-6B	R1	Silt and gravel	N	N	N	Y	L	N	NA	N	Algae	L	N	M	Some algae on substrate. Silt overlying some gravel. Few tracks. No lasers visible, particulates in water column.
LDW-Y3-IN-ENR-6B	R2	Gravel, silt, and sand	N	N	N	N	N	N	NA	N	Algae	M	N	H	Some algae on substrate. Silt overlying gravel and sand. No lasers visible, particulates in water column.
LDW-Y3-IN-ENR-6B	R3	Sand, gravel, and silt	N	N	N	N	N	N	NA	N	Algae	L	N	H	Spotty distribution of algae on substrate. Imprint is an artifact from the SPI frame. No lasers visible, particulates in water column. Frame imprint exposed gravel and coarse sand at depth.

Notes:
Shaded rows indicate replicate not analyzable due to turbidity.
-- = not analyzed
Lebensspuren = biologically formed sedimentary structures
ENR = enhanced natural recovery
H = high
L = low
M = medium
N = no
NA = not applicable
PV = plan view
SPI = sediment profile imaging
Y = yes

Table 3-2a. Year 3 Intertidal ENR+AC Pilot Subplot SPI Results

Station	Replicate	Image Date	Water Depth (ft)	Penetration Depth (cm)	ENR+AC Layer Thickness (cm)	Texture and Other Observations	Surface Boundary Roughness (cm)	RPD Depth (cm)	Grain Size Major Mode (phi units)	Grain Size Maximum (phi units)	Grain Size Minimum (phi units)	Methane	Successional Stage
LDW-Y3-IN-ENR-AC-1A	R1	6/27/2020	6.9	2.6	>P	Silt with varying sizes of pebbles. "Void" created by sloping SWI. Ulva and brown algae on surface, few pieces of ulva contained within substrate. ENR material > penetration.	0.4	Ind.	>4 and -1 to -2	-3	>4	N	Ind.
LDW-Y3-IN-ENR-AC-1A	R2	6/27/2020	5.9	1.9	>P	Sand, silt, gravel. Minimal penetration. High abundance of brown and green algae. ENR material > penetration.	0.2	Ind.	2-1	-1	>4	N	Ind.
LDW-Y3-IN-ENR-AC-1A	R3	6/27/2020	6.3	3.4	>P	Silt and sand with a few pebbles. Air bubbles. Ulva and brown algae on surface, few pieces of ulva contained within substrate. ENR material > penetration.	1	1.3	>4 and 3-2	1	>4	N	Ind.
LDW-Y3-IN-ENR-AC-1B	R1	6/27/2020	4.3	1.8	>P	Silt and very coarse sand, gravel. Brown algae and green algae on surface. Few air bubbles. ENR material > penetration.	0.4	Ind.	>4 and 0 to -1	-2	>4	N	Ind.
LDW-Y3-IN-ENR-AC-1B	R2	6/27/2020	4	3.4	>P	Predominantly gravel with overlying silt. Brown algae on surface. Very coarse pebbles on SWI. Few air bubbles. ENR material > penetration.	0.4	Ind.	0 to -1	-4	>4	N	Ind.
LDW-Y3-IN-ENR-AC-1B	R3	6/27/2020	4.3	2.5	>P	Predominantly gravel with overlying silt. Coarse pebble on SWI. Brown and green algae on surface. Some ulva contained within substrate. "Voids" created by sloping SWI. Few air bubbles. ENR material > penetration.	1.1	Ind.	>4 and -1 to -2	-5	>4	Y	Ind.
LDW-Y3-IN-ENR-AC-2A	R1	6/27/2020	8.5	8.3	>P	Silt with gravel, very fine to coarse pebbles. Ulva and brown algae on surface, some contained within substrate. Feeding voids. ENR material > penetration.	0.6	Ind.	>4 and -1 to -2	-3	>4	N	3
LDW-Y3-IN-ENR-AC-2A	R2	6/27/2020	8.5	4.7	>P	Silt and sand with gravel. Brown algae and ulva on surface. ENR material > penetration.	0.9	Ind.	>4 and 2-1	-2	>4	N	2 -> 3
LDW-Y3-IN-ENR-AC-2A	R3	6/27/2020	7.3	4.4	>P	Silt with some sand gravel. Ulva and brown algae on surface and contained within substrate. Possible methane or air bubbles. ENR material > penetration.	0.5	Ind.	>4	-2	>4	N	3
LDW-Y3-IN-ENR-AC-2B	R1	6/27/2020	4.7	1.9	>P	Gravel with overlaying silt. Brown algae and ulva on surface and contained within substrate. Few air bubbles. ENR material > penetration.	0.7	Ind.	0 to -1	-2	>4	N	Ind.
LDW-Y3-IN-ENR-AC-2B	R2	6/27/2020	4.6	4.3	>P	Gravel and silt. Ulva and brown algae on surface and within substrate. Few air bubbles. ENR material > penetration.	1	Ind.	>4 and 0 to -1	-4	>4	N	Ind.
LDW-Y3-IN-ENR-AC-2B	R3	6/27/2020	4.8	2.7	>P	Gravel and silt. Ulva and brown algae on surface and within substrate. ENR material > penetration.	2	Ind.	1 to 0 and >4	-3	>4	N	Ind.
LDW-Y3-IN-ENR-AC-3A	R1	6/27/2020	4.4	2.3	>P	Silt and medium to coarse sand. Methane voids possibly air bubbles. Brown algae abundant on surface. ENR material > penetration.	0.5	2	>4 and 2-1	-1	>4	N	Ind.
LDW-Y3-IN-ENR-AC-3A	R2	6/27/2020	4.2	2.2	>P	Gravel with overlaying silt, pebble on SWI. Ulva and brown algae on surface. Few air bubbles. ENR material > penetration.	0.9	Ind.	>4 and -1 to -2	-3	>4	N	Ind.

Table 3-2a. Year 3 Intertidal ENR+AC Pilot Subplot SPI Results

Station	Replicate	Image Date	Water Depth (ft)	Penetration Depth (cm)	ENR+AC Layer Thickness (cm)	Texture and Other Observations	Surface Boundary Roughness (cm)	RPD Depth (cm)	Grain Size Major Mode (phi units)	Grain Size Maximum (phi units)	Grain Size Minimum (phi units)	Methane	Successional Stage
LDW-Y3-IN-ENR-AC-3A	R3	6/27/2020	3.8	2.6	>P	Gravel, sand and with silt, few pebbles. Some brown algae on surface. Air bubbles contained within substrate. ENR material > penetration.	0.4	Ind.	-1 to -2 and >4	-3	>4	N	Ind.
LDW-Y3-IN-ENR-AC-3B	R1	6/27/2020	6.5	3.7	>P	Gravel, sand and silt, coarse pebble on SWI. Ulva and brown algae on surface and few pieces of ulva contained within substrate. Few air bubbles. ENR material > penetration.	1.7	Ind.	>4 and 2-1	-5	>4	N	Ind.
LDW-Y3-IN-ENR-AC-3B	R2	6/27/2020	5.9	3.6	>P	Silt and coarse sand. Ulva and brown algae on surface and contained within substrate. Air bubbles. ENR material > penetration.	0.9	Ind.	>4 and 1-0	-4	>4	N	3
LDW-Y3-IN-ENR-AC-3B	R3	6/27/2020	5.4	3	>P	Silt, sand, and gravel, few coarse pebbles on SWI. Ulva and brown algae on surface and contained within substrate. "Voids" artifact of sloping SWI and prism penetration. ENR material > penetration.	1	Ind.	>4 and 2-1	-2	>4	N	Ind.
LDW-Y3-IN-ENR-AC-4A	R1	6/27/2020	4	3.3	>P	Gravel with overlaying silt. Coarse pebbles on SWI and cobbles in background. Thin layer of brown algae on surface. Few air bubbles. ENR material > penetration.	0.8	Ind.	>4 and 0 to -1	-3	>4	N	Ind.
LDW-Y3-IN-ENR-AC-4A	R2	6/27/2020	4.5	3.3	>P	Gravel with overlaying silt. Coarse pebbles on SWI, cobbles in background. Thin layer of brown algae on surface and ulva contained within substrate. ENR material > penetration.	0.5	Ind.	-1 to -2	-4	>4	N	Ind.
LDW-Y3-IN-ENR-AC-4A	R3	6/27/2020	4	3.3	>P	Silty sand and gravel. Coarse pebbles on SWI, cobble in background. Thin layer of brown algae and ulva on surface. ENR material > penetration.	0.3	Ind.	3-2 and 0 to -1	-5	>4	N	Ind.
LDW-Y3-IN-ENR-AC-4B	R1	6/27/2020	4.3	1.1	LNA	Fine sand to silt. Thin layer of brown algae and ulva on surface, few pieces of ulva contained within substrate. Minimal penetration. 1 cm silt over ENR.	0.5	Ind.	4-3	2	>4	N	Ind.
LDW-Y3-IN-ENR-AC-4B	R2	6/27/2020	3.6	3	>P	Gravel with silt overlaying, coarse pebbles on SWI and within substrate. Brown algae and ulva on surface. Air bubbles and possible methane. ENR material > penetration.	0.6	Ind.	>4 and -1 to -2	-3	>4	N	Ind.
LDW-Y3-IN-ENR-AC-4B	R3	6/27/2020	3.6	2.5	LNA	Silt and very fine sand. Thin layer of brown algae and ulva on surface. Methane may be air bubbles. Reduced darker sediment at 1 cm. No ENR material evident.	0.6	0.7	>4	2	>4	N	Ind.
LDW-Y3-IN-ENR-AC-5A	R1	6/27/2020	5.4	2.6	>P	Gravel with overlaying silt, coarse pebble near SWI. Ulva and brown algae on surface. Large air bubble. ENR material > penetration.	0.8	Ind.	>4	-5	>4	N	Ind.
LDW-Y3-IN-ENR-AC-5A	R2	6/27/2020	5	1.1	>P	Silt with few granules and a coarse pebble on SWI. Minimal penetration. Layer of brown algae on surface. ENR material > penetration.	0.3	Ind.	>4	-4	>4	N	Ind.
LDW-Y3-IN-ENR-AC-5A	R3	6/27/2020	5.2	3.4	>P	Gravel with some silt. Reduced darker sediment SWI to 3 cm in middle of frame. Brown algae and ulva on surface. ENR material > penetration.	0.4	Ind.	0 to -1	-4	>4	N	Ind.
LDW-Y3-IN-ENR-AC-5B	R1	6/27/2020	4.2	2.2	>P	Gravel with overlaying silt. Coarse pebbles subsurface. Thin layer of brown algae on surface, some ulva. Crack from prism penetration. Debris and air bubbles within substrate. ENR material > penetration.	0.5	Ind.	>4	-4	>4	N	Ind.

Table 3-2a. Year 3 Intertidal ENR+AC Pilot Subplot SPI Results

Station	Replicate	Image Date	Water Depth (ft)	Penetration Depth (cm)	ENR+AC Layer Thickness (cm)	Texture and Other Observations	Surface Boundary Roughness (cm)	RPD Depth (cm)	Grain Size Major Mode (phi units)	Grain Size Maximum (phi units)	Grain Size Minimum (phi units)	Methane	Successional Stage
LDW-Y3-IN-ENR-AC-5B	R2	6/27/2020	4.1	2.2	>P	Coarse pebbles with silt overlaying. Brown algae and ulva in frame. Crack from prism penetration. ENR material > penetration.	0.3	Ind.	>4 and -3 to -4	-5	>4	N	Ind.
LDW-Y3-IN-ENR-AC-5B	R3	6/27/2020	4	1.9	>P	Silt with few granules and coarse pebble on right side of frame. Thin layer of brown algae on surface, ulva in background. ENR material > penetration.	0.3	Ind.	>4	-3	>4	N	Ind.
LDW-Y3-IN-ENR-AC-6A	R1	6/27/2020	4.7	2.3	>P	Silt and very fine sand. Coarse pebbles in background. Thin layer of brown algae and ulva on surface, few pieces of ulva within substrate. 2 cm silt over ENR.	0.5	0.6	>4	2	>4	N	Ind.
LDW-Y3-IN-ENR-AC-6A	R2	6/27/2020	4.6	2.5	>P	Silt on gravel. Very coarse pebble on SWI. Crack from prism penetration. Thin layer of brown algae and ulva on surface. ENR material > penetration.	0.3	Ind.	>4	-5	>4	N	Ind.
LDW-Y3-IN-ENR-AC-6A	R3	6/27/2020	4.8	2	>P	Primarily silt and very fine sand with few coarse and very coarse pebbles on surface. Layer of brown algae and ulva on surface, ulva contained within substrate. Possible feeding void and methane or air bubble. ENR material > penetration.	1	1.1	>4	3	>4	N	3
LDW-Y3-IN-ENR-AC-6B	R1	6/27/2020	4.3	1.6	>P	Silt and very fine sand. Layer of brown algae, ulva and few granules on surface. 1 cm of silt over ENR material > penetration.	0.3	0.5	4-3	2	>4	N	Ind.
LDW-Y3-IN-ENR-AC-6B	R2	6/27/2020	3.9	1.8	>P	Fine sand with silt. Thin layer of brown algae, ulva and coarse pebbles on surface. ENR material > penetration.	0.4	Ind.	3-2	-1	>4	N	Ind.
LDW-Y3-IN-ENR-AC-6B	R3	6/27/2020	3.8	1.7	>P	Fine sand and gravel, few coarse pebbles. Cobble in background. Brown algae and ulva on surface and within substrate. Crack from prism penetration. ENR material > penetration.	0.6	Ind.	3-2 and -1 to -2	-3	>4	N	Ind.

Summary Statistics for Some Numerical Parameters

	Penetration Depth (cm)	Surface Boundary Roughness (cm)	RPD Depth (cm)
N	36	36	6
Average	2.8	0.7	1.0
Median	2.6	0.5	0.9
Minimum	1.1	0.2	0.5
Maximum	8.3	2	2.0

Notes:
AC = activated carbon
aRPD = apparent redox potential discontinuity
ENR = enhanced natural recovery
Ind. = indeterminate
LNA = layer not apparent
N = no
P = penetration
SPI = sediment profile imaging
SWI = sediment-water interface
Y = yes

Table 3-2b. Year 3 Intertidal ENR+AC Pilot Subplot PV Results

				Lebensspuren											
Station	Replicate	Sediment Type	Bedforms	Burrows	Tubes	Tracks	Total Abundance	Epifauna	Epifauna Type (Count)	Mud Clasts	Debris Type	Debris Cover	*Beggiatoa*	Surface Boundary Roughness (cm)	Comments
LDW-Y3-IN-ENR-AC-1A	R1	Silt, sand, and gravel	N	N	N	N	N	N	NA	N	Algae	M	N	M	Spotty distribution of algae on substrate. Few gravel pieces. No lasers visible, particulates in water column.
LDW-Y3-IN-ENR-AC-1A	R2	Algae, sand, silt, and gravel	N	N	N	N	N	N	NA	N	Algae	H	N	H	Algae covering entire surface. Imprint is an artifact from the SPI frame. Sculpin (1).
LDW-Y3-IN-ENR-AC-1A	R3	Algae, sand, and silt	N	N	N	N	N	N	NA	N	Algae	H	N	M	Algae covers majority of substrate. Imprint is an artifact of the SPI frame. No lasers visible, particulate in the water column.
LDW-Y3-IN-ENR-AC-1B	R1	Silt, sand, and gravel	N	N	N	N	N	N	NA	N	Algae	M	N	M	Spotty distribution of algae on substrate. Silt overlying gravel and sand. No lasers visible, particulates in water column.
LDW-Y3-IN-ENR-AC-1B	R2	Silt, gravel, and sand	N	N	N	N	N	N	NA	N	Algae	L	N	H	Spotty distribution of algae on substrate. Silt overlying gravel. One laser visible, particulates in water column.
LDW-Y3-IN-ENR-AC-1B	R3	Silt, gravel, and sand	N	N	N	N	N	N	NA	N	Algae	L	N	M	Spotty distribution of algae on substrate. Silt overlying gravel and sand. No lasers visible, particulates in water column. Imprint is an artifact of the SPI frame.
LDW-Y3-IN-ENR-AC-2A	R1	Silt, sand, and gravel	N	N	N	N	N	N	NA	N	Algae	H	N	H	Algae covering majority of substrate. Silt overlying gravel and sand. One laser visible, particulates in water column.
LDW-Y3-IN-ENR-AC-2A	R2	Sand, silt, and gravel	N	N	N	N	N	N	NA	N	Algae	H	N	H	Spotty distribution of algae on substrate. Particulates in water column.
LDW-Y3-IN-ENR-AC-2A	R3	Sand, silt, and gravel	N	N	N	N	N	N	NA	N	Algae	H	N	M	Algae covering majority of substrate. One laser visible, particulates in water column.
LDW-Y3-IN-ENR-AC-2B	R1	Sand, silt, and gravel	N	N	N	N	N	N	NA	N	Algae	H	N	M	Algae covering majority of substrate. No lasers visible, particulates in water column.
LDW-Y3-IN-ENR-AC-2B	R2	Sand, silt, and gravel	N	N	Y	N	N	N	NA	N	Algae	L	N	H	Spotty distribution of algae on substrate. Silt overlying sand and gravel. One laser visible, particulates in water column.
LDW-Y3-IN-ENR-AC-2B	R3	Silt, sand, and gravel	N	N	N	N	N	N	NA	N	Algae	H	N	H	Algae covering majority of substrate. No lasers visible, particulates in water column.
LDW-Y3-IN-ENR-AC-3A	R1	Silt and sand	N	N	Y	Y	L	N	NA	N	Algae	L	N	L	Juvenile flat fish (1). Few pieces of algae on substrate.
LDW-Y3-IN-ENR-AC-3A	R2	Silt, gravel, and sand	N	N	N	N	N	N	NA	N	Algae	L	N	H	One laser visible, particulates in water column. Spotty distribution of algae on substrate.
LDW-Y3-IN-ENR-AC-3A	R3	Silt, sand, and gravel	N	N	N	Y	L	N	NA	N	Algae	L	N	H	Imprint is an artifact from the SPI frame. One laser visible, particulates in water column.
LDW-Y3-IN-ENR-AC-3B	R1	Sand and silt	N	N	N	N	N	N	NA	N	Algae	M	N	M	Spotty distribution of algae on substrate.
LDW-Y3-IN-ENR-AC-3B	R2	Sand and silt	N	N	N	N	N	N	NA	N	Algae	H	N	M	Algae covering majority of substrate. Sculpin (1).
LDW-Y3-IN-ENR-AC-3B	R3	Silt, sand, and gravel	N	N	N	N	N	N	NA	N	Algae	H	N	M	Algae covering majority of substrate. Few gravel pieces. Unidentifiable juvenile fish (1).
LDW-Y3-IN-ENR-AC-4A	R1	Silt, sand, and gravel	N	N	N	N	N	N	NA	N	Algae	L	N	H	Spotty distribution of algae on substrate. Moderate amount of gravel on surface.
LDW-Y3-IN-ENR-AC-4A	R2	Silt, sand, and gravel	N	N	N	N	N	N	NA	N	Algae and macroalgae	L	N	H	Spotty distribution of algae and few pieces of macroalgae.
LDW-Y3-IN-ENR-AC-4A	R3	Silt, sand, and gravel	N	N	N	N	N	N	NA	N	Algae and stick	L	N	M	Spotty distribution of algae on substrate. Moderate amount of gravel.
LDW-Y3-IN-ENR-AC-4B	R1	Silt, sand, and gravel	N	N	N	N	N	N	NA	N	Algae	L	N	M	Spotty distribution of algae on substrate. Moderate amount of gravel pieces.
LDW-Y3-IN-ENR-AC-4B	R2	Silt, sand, and gravel	N	N	N	N	N	N	NA	N	Algae and sticks	L	N	M	Very spotty distribution of algae on larger substrate particles. Few gravel.
LDW-Y3-IN-ENR-AC-4B	R3	Silt and gravel	N	N	N	N	N	N	NA	N	Algae and leaves	L	N	L	Very few pieces of algae and leaves. Very few pieces of gravel. Imprint is an artifact of the SPI frame.
LDW-Y3-IN-ENR-AC-5A	R1	Silt, sand, and gravel	N	N	N	N	N	N	NA	N	Algae	L	N	M	Spotty distribution of algae on substrate. One laser visible, particulates in water column. Moderate amount of gravel pieces on surface.
LDW-Y3-IN-ENR-AC-5A	R2	Silt and gravel	N	N	N	N	N	N	NA	N	Algae	L	N	L	Very few pieces of algae on gravel pieces. Very few gravel pieces. Anchor line from boat in image. One laser visible, particulates in water column.
LDW-Y3-IN-ENR-AC-5A	R3	Silt, sand, and gravel	N	N	N	N	N	N	NA	N	Algae	L	N	M	Very few pieces of algae, few gravel pieces. One laser visible, particulates in water column.

Table 3-2b. Year 3 Intertidal ENR+AC Pilot Subplot PV Results

				Lebensspuren											
Station	Replicate	Sediment Type	Bedforms	Burrows	Tubes	Tracks	Total Abundance	Epifauna	Epifauna Type (Count)	Mud Clasts	Debris Type	Debris Cover	*Beggiatoa*	Surface Boundary Roughness (cm)	Comments
LDW-Y3-IN-ENR-AC-5B	R1	Silt and gravel	N	N	N	N	N	N	NA	N	Algae and sticks	M	N	M	Spotty distribution of algae on substrate. Moderate amount of gravel. No lasers visible, particulates in water column.
LDW-Y3-IN-ENR-AC-5B	R2	Silt and gravel	N	Y	Y	N	L	N	NA	N	Algae, sticks, feather	L	N	M	Spotty distribution of algae on substrate. Lasers not visible, particulates in water column. Very few tubes and burrows.
LDW-Y3-IN-ENR-AC-5B	R3	Silt, sand, and gravel	N	N	N	N	L	N	NA	N	Algae, leaves	L	N	M	Spotty distribution of algae on substrate. Few gravel pieces.
LDW-Y3-IN-ENR-AC-6A	R1	Silt and gravel	N	N	N	N	N	N	NA	N	Algae	L	N	M	Spotty distribution of algae on substrate. Moderate amount of gravel. One laser visible, particulates in water column.
LDW-Y3-IN-ENR-AC-6A	R2	Silt and gravel	N	N	N	N	N	N	NA	N	Algae	M	N	M	Moderate amount of gravel and algae evident. One laser visible, particulates in water column.
LDW-Y3-IN-ENR-AC-6A	R3	Silt and gravel	N	N	N	N	N	N	NA	N	Algae	L	N	L	Few gravel and algae. No lasers visible, particulates in water column.
LDW-Y3-IN-ENR-AC-6B	R1	Silt and gravel	N	N	N	Y	L	N	NA	N	Algae and sticks	L	N	L	Very few gravel pieces and algae. One laser visible, particulates in water column.
LDW-Y3-IN-ENR-AC-6B	R2	Silt and gravel	N	N	N	N	N	N	NA	N	Algae	L	N	H	Moderate amount of gravel with few algae. Very few shell fragments.
LDW-Y3-IN-ENR-AC-6B	R3	Silt, gravel, and sand	N	N	N	N	N	N	NA	N	Algae and sticks	L	N	L	Very few algae on substrate, few gravel pieces. Imprint is an artifact from the SPI frame.

Notes:
-- = not analyzed
Lebensspuren = biologically formed sedimentary structures
AC = activated carbon
ENR = enhanced natural recovery
H = high
L = low
M = medium
N = no
NA = not applicable
PV = plan view
SPI = sediment profile imaging
Y = yes

Table 3-3a. Year 3 Scour ENR Pilot SPI Results

Station	Replicate	Image Date	Water Depth (ft)	Penetration Depth (cm)	ENR Layer Thickness (cm)	Texture and Other Observations	Surface Boundary Roughness (cm)	RPD Depth (cm)	Grain Size Major Mode (phi units)	Grain Size Maximum (phi units)	Grain Size Minimum (phi units)	Methane	Successional Stage
LDW-Y3-SC-ENR-1A	R1	6/29/2020	33.4	7.9	LNA	Fine to very fine sand grading to silt with depth, few patches of gravel and some wood fragments. Feeding voids at depth. Large piece of wood debris on SWI. No ENR material evident, but penetration suggests just below frame.	1.2	2.6	>4	1	>4	N	1 on 3
LDW-Y3-SC-ENR-1A	R3	6/29/2020	33	9.1	LNA	Fine sand grading to silt at 1.5 cm, few wood fragments and a granule. Ulva on surface and contained within substrate. Feeding void and worm at depth. No ENR material evident.	0.7	2.2	>4	-1	>4	N	1 on 3
LDW-Y3-SC-ENR-1A	R4	6/29/2020	33.3	9.1	LNA	Fine sand grading to silt with depth, some wood fragments. High concentration of feeding voids at depth, voids accentuated by prism penetration. ENR material evident in feeding voids at 7 cm, 7–9 cm of silt deposit over ENR.	0.3	2.1	>4	-1	>4	N	1 on 3
LDW-Y3-SC-ENR-1B	R1	6/29/2020	30.9	8.6	LNA	Very fine sand grading to silt, few granules. 9 cm of silt over ENR material which is not evident.	1.1	1.7	>4	-1	>4	N	1 on 3
LDW-Y3-SC-ENR-1B	R2	6/29/2020	30.8	8.2	LNA	Fine to very fine sand grading to silt. Mud clast is artifact, tube and algae on surface. Feeding voids at depth. No ENR material evident, 8 cm silt deposit.	0.4	2.6	>4	2	>4	N	1 on 3
LDW-Y3-SC-ENR-1B	R4	6/29/2020	32.4	8.8	LNA	Feeding voids and worm at depth. 8 cm silt deposit over ENR. ENR material evident at 7 cm in feeding void.	0.8	1.8	>4	-1	>4	N	1 on 3
LDW-Y3-SC-ENR-2A	R1	6/28/2020	34.2	11.4	LNA	Worms of varying sizes at depths. Possible tube at surface. No ENR material evident, but likely below 11 cm silt deposit.	1.2	1.7	>4	2	>4	N	1 on 3
LDW-Y3-SC-ENR-2A	R4	6/29/2020	35.2	9.5	LNA	Silt and fine to very fine sand. Feeding voids at depth. Few shell fragments throughout image. ENR material at bottom of feeding voids, 9 cm silt deposit over ENR.	1.3	2.4	>4	-1	>4	N	3
LDW-Y3-SC-ENR-2A	R5	6/29/2020	35.4	8.6	LNA	Fine to very fine sand grading to silt. Shell fragments throughout image. Worms and partial feeding void at depth. No ENR material evident, 9 cm of silt deposit.	0.4	2.3	>4	2	>4	N	1 on 3
LDW-Y3-SC-ENR-2B	R1	6/28/2020	33	8.5	LNA	Very fine sand and silt. Few granules and fine to coarse pebbles in substrate. Mud clast on surface artifact from SPI frame. Small tubes on surface, feeding voids and worm at depth. Silt deposit of 9 cm over ENR material.	0.9	1.6	>4	-1	>4	N	1 on 3
LDW-Y3-SC-ENR-2B	R3	6/28/2020	33.2	9.6	LNA	Very fine sand grading to silt. Shell fragments in surface sediments. Feeding voids and worm at depth. Few tubes on surface. No ENR material evident, 10 cm silt deposit.	1.1	1.2	>4	1	>4	N	1 on 3
LDW-Y3-SC-ENR-2B	R4	6/29/2020	33.8	10.6	LNA	Fine to very fine sand grading to silt at 2 cm. Feeding voids at depth. Surface tubes in background. Silt deposit of 11 cm, ENR material below silt.	0.9	2.5	>4	0	>4	N	1 on 3
LDW-Y3-SC-ENR-3A	R1	6/28/2020	28.5	8.7	LNA	Fine to very fine sand and silt. surface worms, feeding voids at depth. Large tube and few small tubes on surface. Evidence of ENR at base of feeding voids, ENR under 8 cm of silt deposit.	0.4	1	>4	0	>4	N	1 on 3
LDW-Y3-SC-ENR-3A	R2	6/28/2020	28.3	7.7	LNA	Fine to very fine sand and silt. Abundance of worms and few feeding voids at depth, few worm tubes on surface. No ENR material evident, 8 cm silt deposit.	0.5	1	>4	2	>4	N	1 on 3

Table 3-3a. Year 3 Scour ENR Pilot SPI Results

Station	Replicate	Image Date	Water Depth (ft)	Penetration Depth (cm)	ENR Layer Thickness (cm)	Texture and Other Observations	Surface Boundary Roughness (cm)	RPD Depth (cm)	Grain Size Major Mode (phi units)	Grain Size Maximum (phi units)	Grain Size Minimum (phi units)	Methane	Successional Stage
LDW-Y3-SC-ENR-3A	R3	6/28/2020	28.8	10.5	LNA	Fine sand to very fine sand grading to silt. Large worms, feeding voids at depth. Few tubes and possible fecal casts on SWI. Shell fragments, few possible wood fragments scattered throughout image. ENR material not evident, 11 cm silt deposit.	0.7	1.9	>4	1	>4	N	1 on 3
LDW-Y3-SC-ENR-3B	R1	6/28/2020	29.5	8.9	LNA	Fine to very fine sand grading to silt, few pockets of coarser sand near SWI. Feeding void and worms at depth. Possible relict burrow. Long piece of green algae. Tubes and fecal casts on surface. ENR material not evident. 9 cm of silt deposit.	0.7	1.9	>4	-2	>4	N	1 on 3
LDW-Y3-SC-ENR-3B	R2	6/28/2020	29.6	9.1	LNA	Fine to very fine sand and silt and shell fragments. Feeding voids and worms at depth. Possible fecal casts or granules near SWI. 9 cm silt deposit, no ENR material evident.	0.4	1.8	>4	-2	>4	N	1 on 3
LDW-Y3-SC-ENR-3B	R3	6/28/2020	29.8	8.3	LNA	Fine to very fine sand grading to silt. Some granules at bottom of feeding void. Feeding voids, worms and methane at depth. Tubes, fecal casts and algae on surface. 8 cm of silt over ENR material.	1	1.2	>4	-1	>4	Y	1 on 3
LDW-Y3-SC-ENR-4A	R1	6/28/2020	32.3	10.3	LNA	Fine to very fine sand and silt. Few pebbles on surface, coarse pebble and large piece of algae in background. Tubes on SWI and voids at depth. 10 cm of silt, no ENR material evident.	1.2	1.2	>4	1	>4	N	1 on 3
LDW-Y3-SC-ENR-4A	R2	6/28/2020	31.9	8.5	LNA	Fine to very fine sand and silt, few granules. Tubes on surface, feeding voids at depth. ENR material at base of feeding voids, 9 cm of silt over ENR.	0.7	1.6	>4	-2	>4	N	1 on 3
LDW-Y3-SC-ENR-4A	R4	6/29/2020	33.2	8.5	LNA	Sandier at surface grading to silt. Feeding voids and worms at depth. 8 cm silt over ENR material which is not evident.	1	1.9	>4	-2	>4	N	1 on 3
LDW-Y3-SC-ENR-4B	R1	6/28/2020	30.5	10.1	LNA	Fine to very fine sand and silt. Few shell fragments near SWI. Few tubes on surface, many worms at depth. 10 cm silt, no ENR material evident.	0.8	2.2	>4	2	>4	N	1 on 3
LDW-Y3-SC-ENR-4B	R2	6/28/2020	30.7	7	LNA	Fine to very fine sand grading to silt. Few granules, wood and shell fragments Disturbed sediment and mud clast suspended in water column. Few tubes on surface and worms at depth. 7 cm of silt and no ENR material evident.	0.5	1.4	>4	0	>4	N	1 on 3
LDW-Y3-SC-ENR-4B	R3	6/28/2020	30.7	8.4	LNA	Sand layer atop silt. Few granules and shell fragments near SWI. Few large mud clasts on surface artifact of SPI frame. Tubes on surface, worms at depth. 8 cm of silt, no ENR material evident.	1.4	1	>4	2	>4	N	1 on 3
LDW-Y3-SC-ENR-5A	R1	6/29/2020	26.1	7.4	LNA	Fine to very fine sand grading to silt. Large feeding void at depth. Worms of varying sizes. Few mud clasts on surface, potentially artifact from SPI frame. 7 cm of silt, no ENR material evident.	0.7	1.1	>4	1	>4	N	1 on 3
LDW-Y3-SC-ENR-5A	R2	6/29/2020	26.1	9.1	LNA	Fine to very fine sand grading to silt. Few granules and shell fragments near SWI. Coarser material at depth right side of frame. Sand in voids at depth. Disturbed sediment suspended in water column. 9 cm silt, no ENR material evident.	0.4	1.2	>4	-1	>4	N	1 on 3
LDW-Y3-SC-ENR-5A	R4	6/29/2020	28.2	8.8	LNA	Sand in top cm overlying silt. Feeding voids and worm at depth. Few granules, shell and wood fragments near SWI. No ENR material evident.	1.2	1	>4	-1	>4	N	1 on 3
LDW-Y3-SC-ENR-5B	R1	6/28/2020	26.7	6.3	LNA	Sand with few granules grading to silt. Few shell fragments in top 4 cm. Many worms at depth, few tubes on surface. Red algae contained within substrate. 6 cm silt over ENR material.	1.4	1	>4	-2	>4	N	2 -> 3

Table 3-3a. Year 3 Scour ENR Pilot SPI Results

Station	Replicate	Image Date	Water Depth (ft)	Penetration Depth (cm)	ENR Layer Thickness (cm)	Texture and Other Observations	Surface Boundary Roughness (cm)	RPD Depth (cm)	Grain Size Major Mode (phi units)	Grain Size Maximum (phi units)	Grain Size Minimum (phi units)	Methane	Successional Stage
LDW-Y3-SC-ENR-5B	R3	6/28/2020	26.4	6.2	LNA	Fecal pellets at SWI. Feeding voids at depth. 6 cm silt over ENR material.	0.6	1.1	>4	1	>4	N	1 on 3
LDW-Y3-SC-ENR-5B	R4	6/29/2020	27.2	6.7	LNA	Fine to very fine sand grading to silt. Few shell fragments near SWI, red algae and small worm tubes on surface. Abundance of diverse worms and partial feeding void at depth. Plant debris suspended in water column. 7 cm silt over ENR material.	0.6	1	>4	2	>4	N	1 on 3
LDW-Y3-SC-ENR-6A	R1	6/28/2020	30.6	11.9	LNA	Feeding voids and worms at depth. Coarser sand in voids. Small tubes on surface. Mud clast an artifact from SPI frame. 12 cm of silt over ENR material.	0.3	1.6	>4	1	>4	N	1 on 3
LDW-Y3-SC-ENR-6A	R2	6/28/2020	29.9	10.1	LNA	Very fine sand grading to silt. Few shell fragments near SWI, small tubes on surface. Feeding voids and worms at depth. Coarser material in voids. 10 cm silt over ENR material.	1.5	1.3	>4	1	>4	N	1 on 3
LDW-Y3-SC-ENR-6A	R3	6/28/2020	29.4	11.3	LNA	Small tubes on surface. Boundary roughness artifact of prism tilt. Partial feeding void and few worms at depth. 11 cm of silt over ENR material.	1.9	0.9	>4	0	>4	N	1 on 3
LDW-Y3-SC-ENR-6B	R1	6/28/2020	29.2	12.1	LNA	Black fine sand in surface silts grading to silt only. Red algae on surface, ulva and shell fragments within substrate. Disturbed sediment and plant debris suspended in water column. Residual ENR material at surface, 12 cm deposit.	1.5	2.4	3-2/>4	-1	>4	N	3
LDW-Y3-SC-ENR-6B	R3	6/28/2020	29.4	10	LNA	Shell fragments scattered throughout image. Few tubes and algae on surface. Large piece of ulva within substrate. Few worms and feeding voids at depth. Sand in voids. 10 cm over ENR material.	1.6	2.2	>4	2	>4	N	1 on 3
LDW-Y3-SC-ENR-6B	R4	6/29/2020	30	8.2	LNA	Few small tubes on surface, feeding voids and worm at 3 cm. 8 cm of silt over ENR material.	1	0.9	>4	-1	>4	N	1 on 3

Summary Statistics for Some Numerical Parameters

	Penetration Depth (cm)	Surface Boundary Roughness (cm)	RPD Depth (cm)
N	36	36	36
Average	9.0	0.9	1.6
Median	8.8	0.85	1.6
Minimum	6.2	0.3	0.9
Maximum	12.1	1.9	2.6

Notes:
AC = activated carbon
aRPD = apparent redox potential discontinuity
ENR = enhanced natural recovery
Ind. = indeterminate
LNA = layer not apparent
N = no
P = penetration
SPI = sediment profile imaging
SWI = sediment-water interface
Y = yes

Table 3-3b. Year 3 Scour ENR Pilot PV Results

				Lebensspuren											
Station	Replicate	Sediment Type	Bedforms	Burrows	Tubes	Tracks	Total Abundance	Epifauna	Epifauna Type (Count)	Mud Clasts	Debris Type	Debris Cover	*Beggiatoa*	Surface Boundary Roughness (cm)	Comments
LDW-Y3-SC-ENR-1A	R1	Silt	N	Y	N	Y	M	N	NA	N	Leaf and macroalgae	L	N	M	Piece of red macroalgae and green filamentous algae. Few burrows.
LDW-Y3-SC-ENR-1A	R3	Silt	N	Y	Y	Y	L	N	NA	Y	NA	N	N	L	Few larger diameter burrows. Mud clasts are an artifact from the SPI frame.
LDW-Y3-SC-ENR-1A	R4	Silt	N	Y	Y	Y	M	N	NA	Y	Macroalgae	L	N	L	Few pieces of macroalgae. Unidentifiable fish (3), small in size. Mud clasts are an artifact from the SPI frame.
LDW-Y3-SC-ENR-1B	R1	Silt	N	Y	Y	Y	H	Y	Snail (1)	N	NA	N	N	M	Numerous tracks and biogenic depressions. Few burrows and tubes.
LDW-Y3-SC-ENR-1B	R2	Silt and gravel	N	Y	Y	Y	M	Y	Barnacle (1)	N	Macroalgae	L	N	M	Stray piece of green macroalgae. Few scattered pieces of grave. Fish (1). Lasers not visible, particulates in water column.
LDW-Y3-SC-ENR-1B	R4	Silt	N	Y	Y	Y	M	N	NA	N	Macroalgae	L	N	M	Fine silt with few pieces of brown macroalgae. Many tracks, few tubes and burrows.
LDW-Y3-SC-ENR-2A	R1	Silt	N	Y	Y	Y	H	N	NA	N	NA	N	N	M	Silt, with few larger diameter burrows, many tracks, few tubes.
LDW-Y3-SC-ENR-2A	R4	Silt	N	Y	Y	Y	M	N	NA	N	NA	N	N	M	Silt, with tracks, few tubes and burrows. Unidentifiable small fish (1).
LDW-Y3-SC-ENR-2A	R5	Silt	N	Y	Y	Y	M	N	NA	Y	NA	N	N	M	Imprint and mud clasts are an artifact from the SPI frame. Some burrows and few tubes and tracks visible.
LDW-Y3-SC-ENR-2B	R1	Silt	N	Y	Y	Y	M	Y	Amphipod (4)	Y	NA	N	N	M	Silt, with biogenic depressions, some burrows, tracks and few tubes. Amphipods are orange in color.
LDW-Y3-SC-ENR-2B	R3	Silt	N	Y	N	Y	M	N	NA	Y	NA	N	N	M	Image partially obscured from previous rep. Mud clasts are an artifact from the SPI frame. Unidentifiable fish (2).
LDW-Y3-SC-ENR-2B	R4	Silt	N	Y	Y	Y	H	N	NA	N	Macroalgae	L	N	M	Silt, with many tracks, one large burrow (shrimp), some smaller diameter burrows, some tubes.
LDW-Y3-SC-ENR-3A	R1	Silt and piece of gravel	N	Y	Y	Y	M	Y	Amphipod (2)	N	Macroalgae	L	N	M	Silt, with moderate amount of tubes, burrows and tracks. Few small pieces of macroalgae. One piece of gravel.
LDW-Y3-SC-ENR-3A	R2	Silt and gravel	N	Y	Y	Y	M	Y	Amphipod (3)	N	Algae, stick	L	N	L	One stray piece of algae and stick. One piece of gravel.
LDW-Y3-SC-ENR-3A	R3	Silt	N	Y	Y	Y	M	Y	Bryozoan	N	NA	N	N	M	Image partially obscured by suspended sediment. One laser visible.
LDW-Y3-SC-ENR-3B	R1	Silt	N	Y	Y	Y	M	Y	Amphipod (2)	N	Macroalgae	L	N	M	Fine silt with large piece of brown macroalgae. Some tubes, burrows and many tracks. Small finfish (1).
LDW-Y3-SC-ENR-3B	R2	Silt	N	Y	Y	Y	M	Y	Amphipod (2), Snail (1)	N	Macroalgae	L	N	M	Silt with burrows, tubes and moderate amount of tracks.
LDW-Y3-SC-ENR-3B	R3	Silt and macroalgae	N	Y	Y	Y	L	Y	Amphipod (4)	N	Macroalgae	M	N	L	Silt with pieces of macroalgae in 1/3 of image. Tracks, with few tubes and burrows.
LDW-Y3-SC-ENR-4A	R1	Silt	N	Y	Y	Y	M	Y	Amphipod (2)	N	Macroalgae	L	N	M	Silt, with moderate amount of tracks, with some tubes and burrows.
LDW-Y3-SC-ENR-4A	R2	Silt with very few gravels	N	N	Y	Y	M	N	NA	Y	NA	N	N	H	Imprint and mud clasts are an artifact from the SPI frame. Small finfish (1). Numerous tracks few tubes.
LDW-Y3-SC-ENR-4A	R4	Silt	N	Y	Y	Y	H	Y	Amphipod (2), Snail (1)	Y	Macroalgae	L	N	M	Silt with many tracks, few burrows and tubes. Mud clast is an artifact from the SPI frame.
LDW-Y3-SC-ENR-4B	R1	Wood and silt	N	Y	Y	Y	M	Y	Barnacles (3), Red Rock Crab (1)	N	Wood, macroalgae	H	N	H	Large decomposed log with macroalgae. Few tracks, tubes and burrows.
LDW-Y3-SC-ENR-4B	R3	Silt	N	Y	Y	Y	M	Y	Amphipod (2)	N	Macroalgae, sticks	L	N	M	Silt with few burrows, moderate amount of tubes and tracks.
LDW-Y3-SC-ENR-4B	R4	Wood, silt, and very few gravel	N	Y	Y	Y	M	N	NA	N	Wood	H	N	H	Log, with very few pieces of gravel. Few tracks, tubes and burrows.
LDW-Y3-SC-ENR-5A	R1	Silt	N	Y	Y	Y	L	Y	Amphipod (5)	N	Macroalgae, wood	L	N	L	Silt, with some tracks, burrows and tubes. Small piece of wood.
LDW-Y3-SC-ENR-5A	R2	Silt	N	Y	Y	Y	L	N	NA	Y	NA	N	N	L	Mud clast is an artifact from the SPI frame. Finfish (1). Few tracks and tubes, some burrows.
LDW-Y3-SC-ENR-5A	R4	Silt	N	Y	Y	Y	M	N	NA	N	NA	N	N	L	Silt with few tracks, tubes and burrows.
LDW-Y3-SC-ENR-5B	R1	Silt	N	Y	Y	Y	M	Y	Amphipod	N	Macroalgae	L	N	L	Silt with few burrows and tubes. Bivalve shells. Finfish (2).
LDW-Y3-SC-ENR-5B	R3	Silt and few gravel pieces	N	Y	Y	Y	L	N	NA	N	Macroalgae	L	N	L	2 pieces of gravel. Very few tracks, few tubes and burrows.

Table 3-3b. Year 3 Scour ENR Pilot PV Results

				Lebensspuren											
Station	Replicate	Sediment Type	Bedforms	Burrows	Tubes	Tracks	Total Abundance	Epifauna	Epifauna Type (Count)	Mud Clasts	Debris Type	Debris Cover	*Beggiatoa*	Surface Boundary Roughness (cm)	Comments
LDW-Y3-SC-ENR-5B	R4	Silt	N	Y	Y	Y	M	Y	Amphipod (2)	N	Wood and macroalgae	L	N	L	Silt with some tracks and few tubes and burrows.
LDW-Y3-SC-ENR-6A	R1	Silt	N	Y	Y	Y	M	N	NA	N	NA	N	N	L	Silt with some tracks, few burrows and tubes. Finfish (1).
LDW-Y3-SC-ENR-6A	R2	Silt	N	N	Y	Y	L	N	NA	N	Macroalgae	L	N	L	The hole on left side of image is an artifact from the SPI prism from Rep 1. Finfish (1). Few tracks and few tubes.
LDW-Y3-SC-ENR-6A	R3	Silt	N	Y	Y	Y	L	N	NA	N	Wood	L	N	L	Few tracks, burrows and tubes. Finfish (1). Fecal cast on left side of image.
LDW-Y3-SC-ENR-6B	R2	Silt	N	N	Y	Y	M	Y	Amphipods	N	NA	N	N	M	Imprint is an artifact from the SPI frame. Numerous tubes and tracks. Finfish (1).
LDW-Y3-SC-ENR-6B	R3	Silt	N	Y	Y	Y	M	Y	Amphipod (2)	N	NA	N	N	L	Silt with few burrows, some tubes and tracks. Finfish (1).
LDW-Y3-SC-ENR-6B	R4	Silt	N	Y	Y	Y	M	Y	Amphipod (1)	N	Macroalgae	L	N	M	Silt with few burrows, some tracks and tubes. Many biogenic depressions.

Notes:
-- = not analyzed
Lebensspuren = biologically formed sedimentary structures
ENR = enhanced natural recovery
H = high
L = low
M = medium
N = no
NA = not applicable
PV = plan view
SPI = sediment profile imaging
Y = yes

Table 3-4a. Year 3 Scour ENR+AC SPI Results

Station	Replicate	Image Date	Water Depth (ft)	Penetration Depth (cm)	ENR+AC Layer Thickness (cm)	Texture and Other Observations	Surface Boundary Roughness (cm)	RPD Depth (cm)	Grain Size Major Mode (phi units)	Grain Size Maximum (phi units)	Grain Size Minimum (phi units)	Methane	Successional Stage
LDW-Y3-SC-ENR-AC-1A	R1	6/27/2020	21.7	3.3	>P	Coarse pebbles to granules. Few wood fragments. Red algae suspended in water column. ENR material > penetration.	1.4	Ind.	-4 to -5	-5	-1	N	Ind.
LDW-Y3-SC-ENR-AC-1A	R2	6/27/2020	21.8	2.1	>P	Coarse pebbles to very coarse sand. Very coarse pebbles on surface. Large tube with algae. ENR material > penetration.	0.5	Ind.	-1 to -2	-5	0	N	Ind.
LDW-Y3-SC-ENR-AC-1A	R3	6/27/2020	21.5	1.4	>P	Coarse to fine pebbles. Tubes on surface. ENR material > penetration.	0.1	Ind.	-1 to -2	-5	-1	N	Ind.
LDW-Y3-SC-ENR-AC-1B	R1	6/28/2020	32	1.8	>P	Granules with coarse pebbles on surface. ENR material > penetration.	0.5	Ind.	-1 to -2	-4	0	N	Ind.
LDW-Y3-SC-ENR-AC-1B	R2	6/28/2020	31.5	2.4	>P	Pebbles and some silt. Coarse pebbles and diverse tube structures on surface. ENR material > penetration.	1.2	Ind.	-1 to -2	-3	>4	N	Ind.
LDW-Y3-SC-ENR-AC-1B	R3	6/28/2020	31.7	4.2	>P	Coarse to fine pebbles overlaying silt. Cobble on SWI. Layer of brown algae on gravel. ENR material > penetration.	0.6	Ind.	-2 to -3	-5	>4	N	Ind.
LDW-Y3-SC-ENR-AC-2A	R1	6/29/2020	31.9	10.2	LNA	Silt. Wood and shell fragments near SWI. Tubes and ulva on surface. 10 cm of silt over ENR material (not evident).	0.5	1.5	>4	2	>4	N	1 on 3
LDW-Y3-SC-ENR-AC-2A	R4	6/29/2020	33.1	8	LNA	Silt. Wood and shell fragments near SWI. Tubes on surface, worms and feeding void at depth. 8 cm over ENR material (not evident).	0.4	1.2	>4	2	>4	N	1 on 3
LDW-Y3-SC-ENR-AC-2A	R5	6/29/2020	33.7	8.7	LNA	Silt. Wood and few shell fragments near SWI. Few tubes on surface, worms at depth. 9 cm silt over ENR material (not evident).	1	1.4	>4	2	>4	N	2 -> 3
LDW-Y3-SC-ENR-AC-2B	R4	6/28/2020	31	7.4	LNA	Silt. Feeding voids and worms at depth, voids greater than penetration. Sediment and plant debris suspended in water column, few tubes on surface. 7 cm silt over ENR material (not evident).	1.2	1	>4	0	>4	N	1 on 3
LDW-Y3-SC-ENR-AC-2B	R5	6/28/2020	31.1	5.6	LNA	Silt. Tubes and mud clast on surface. 6 cm of silt over ENR material.	1	1.3	>4	-1	>4	N	1 on 3
LDW-Y3-SC-ENR-AC-2B	R6	6/28/2020	30.8	7.2	LNA	Silt. Feeding voids and worms at depth, worm in void at 6 cm bottom left of frame. Coarser sand in some voids. Piece of ulva contained within substrate. 7 cm silt over ENR material (not evident).	0.5	1	>4	-2	>4	N	1 on 3
LDW-Y3-SC-ENR-AC-3A	R1	6/27/2020	20.4	10.5	3.1	Thin (3 cm) layer of ENR material over reduced silt. aRPD indeterminate, but minimal.	2	Ind.	-1 to -2/>4	-5	>4	N	Ind.
LDW-Y3-SC-ENR-AC-3A	R2	6/27/2020	20.9	8.8	5.6	5–6 cm of ENR material over reduced silt. aRPD = Ind.	1.4	Ind.	-2 to -3/>4	-5	>4	N	Ind.

Table 3-4a. Year 3 Scour ENR+AC SPI Results

Station	Replicate	Image Date	Water Depth (ft)	Penetration Depth (cm)	ENR+AC Layer Thickness (cm)	Texture and Other Observations	Surface Boundary Roughness (cm)	RPD Depth (cm)	Grain Size Major Mode (phi units)	Grain Size Maximum (phi units)	Grain Size Minimum (phi units)	Methane	Successional Stage
LDW-Y3-SC-ENR-AC-3A	R3	6/27/2020	19.7	5.7	>P	Gravel. Cobble and attached brown algae on surface. ENR material > penetration (6 cm).	1.5	Ind.	-2 to -3	-4	0	N	Ind.
LDW-Y3-SC-ENR-AC-3B	R1	6/27/2020	23	3.1	>P	Thin layer of silt and brown algae overlaying gravels grading to very fine sand and silt. Coarse pebbles, red algae and two crustaceans on surface. ENR material > penetration.	1.6	Ind.	-2 to -3	-5	>4	N	Ind.
LDW-Y3-SC-ENR-AC-3B	R2	6/27/2020	23.7	4.7	>P	Gravel atop fine sand to silt. Coarse pebbles, red algae and few worm tubes on surface. ENR material > penetration.	1.1	Ind.	-1 to -2/>4	-2	>4	N	Ind.
LDW-Y3-SC-ENR-AC-3B	R3	6/27/2020	23.7	5.1	>P	Gravel sand and silt mix. Coarse pebbles, tubes, and red algae on surface. Large void is an artifact of prism penetration. ENR material > penetration.	1.3	Ind.	-1 to -2 and >4	-4	>4	N	3
LDW-Y3-SC-ENR-AC-4A	R1	6/27/2020	24.7	6.6	LNA	Silt. Few granules, worm tube and sand/silt clasts on surface. 7 cm silt deposit over ENR material (not evident).	0.5	1	>4	1	>4	N	1 on 3
LDW-Y3-SC-ENR-AC-4A	R2	6/27/2020	24.5	7.5	LNA	Fine and very fine sand in surface cm, silt. Burrow is an artifact of prism penetration. Feeding voids and worms at depth, coarse pebble in void. Few tubes on surface, piece of ulva contained within substrate. Only ENR material evident in void. 8 cm silt deposit.	0.7	0.8	>4	-4	>4	N	1 on 3
LDW-Y3-SC-ENR-AC-4A	R4	6/28/2020	28.1	7.1	LNA	Silt. Feeding voids and worms at depth. Mud clast, granules and few tubes on surface. 7 cm silt deposit over ENR material (not evident).	1	1.2	>4	0	>4	N	1 on 3
LDW-Y3-SC-ENR-AC-4B	R1	6/29/2020	27.7	8.1	LNA	Silt and very fine sand mix. Few tubes and stick on SWI. Feeding voids and worms at depth, some gravel (possibly ENR+AC material) in void bottom left. 8 cm silt sediment over ENR material (not evident).	0.9	1.3	>4	-1	>4	N	1 on 3
LDW-Y3-SC-ENR-AC-4B	R2	6/29/2020	27.7	9.3	LNA	Some atop silt with pockets with slight sand subfraction. Worms and few partial feeding voids at depth. Few tubes and granule on surface. 9 cm of silt over ENR material (evident in voids/patches).	0.8	1.1	>4	-1	>4	N	1 on 3
LDW-Y3-SC-ENR-AC-4B	R3	6/29/2020	27.3	8.1	LNA	Some fine sand in silt. Feeding voids and worms at depth, sand present in few of the voids. 8 cm silt over ENR.	0.9	1	>4	0	>4	N	1 on 3
LDW-Y3-SC-ENR-AC-5A	R4	6/28/2020	22.4	4.4	>P	Silt with few granules and sand subfraction right side of frame. Medium to coarse pebbles, red and green algae on surface. Veneer layer of brown algae. SWI is disturbed, void created by prism penetration. ENR material > penetration.	1.3	Ind.	>4	-3	>4	N	Ind.
LDW-Y3-SC-ENR-AC-5A	R5	6/28/2020	22.1	3.2	>P	Medium pebbles with overlaying silt. Veneer layer of brown algae, few pieces of ulva and red algae on surface. ENR material > penetration.	0.5	Ind.	>4 and -2 to -3	-4	>4	N	Ind.
LDW-Y3-SC-ENR-AC-5A	R6	6/28/2020	22.9	4.7	>P	Silt with sand subfraction and few granules. Veneer layer of brown algae, some red algae, gravel on surface. Divot is SWI created by prism penetration, boundary roughness is an artifact. ENR material > penetration.	1.6	Ind.	>4 and 2-1	-2	>4	N	Ind.
LDW-Y3-SC-ENR-AC-5B	R4	6/27/2020	17.4	2.9	>P	Silt, sand gravel, few coarse pebbles. Ulva and layer of brown algae on surface. Void created by prism penetration. ENR material > penetration.	0.8	Ind.	>4 and 2-1	-4	>4	N	Ind.

Table 3-4a. Year 3 Scour ENR+AC SPI Results

Station	Replicate	Image Date	Water Depth (ft)	Penetration Depth (cm)	ENR+AC Layer Thickness (cm)	Texture and Other Observations	Surface Boundary Roughness (cm)	RPD Depth (cm)	Grain Size Major Mode (phi units)	Grain Size Maximum (phi units)	Grain Size Minimum (phi units)	Methane	Successional Stage
LDW-Y3-SC-ENR-AC-5B	R5	6/28/2020	20	5.5	>P	Silt with granules. Algae and few pebbles on surface, some red algae contained within top 2 cm of substrate. Few small voids and worm at depth. ENR material > penetration.	1	1.6	>4 and 1-0	-2	>4	N	1 on 3
LDW-Y3-SC-ENR-AC-5B	R6	6/28/2020	20.4	2.4	>P	Layer of sand and gravel over silt. Granules and pebbles on surface with algae overlaying. Red algae pressed against prism partially obscuring image. ENR material > penetration. Void created by sloping SWI caused by prism penetration. Boundary roughness is an artifact.	3.2	1.1	>4	-2	>4	N	Ind.
LDW-Y3-SC-ENR-AC-6A	R4	6/28/2020	22.5	4.9	>P	Silt matrix with coarse sand subfraction and few granules. Large boulder with layer of algae and some granules on surface. ENR material > penetration.	0.9	1.8	>4	1	>4	N	1
LDW-Y3-SC-ENR-AC-6A	R5	6/28/2020	22.4	5.5	>P	Fine sand with a few shell fragments and granules in silt matrix. Brown algae overlaying coarse pebbles, few tubes and fecal casts on surface. ENR material > penetration.	0.3	1.9	>4 and 3-2	0	>4	N	1 on 3
LDW-Y3-SC-ENR-AC-6A	R6	6/28/2020	22	7.5	LNA	Medium to fine sand atop silt, granules and shell fragments near SWI. Burrow accentuated by prism penetration. Feeding voids and worm at depth. 8 cm silt over ENR material.	1.3	1.6	>4	-2	>4	N	3
LDW-Y3-SC-ENR-AC-6B	R1	6/28/2020	25.8	8.1	LNA	Layer of fine to very fine sand atop silt. Feeding voids and worms at depth, sand in voids. Mud clast and tube on surface. 8 cm over ENR material (not evident).	0.8	1.4	>4	-1	>4	N	1 on 3
LDW-Y3-SC-ENR-AC-6B	R4	6/28/2020	25.6	8	LNA	Fine sand with few pieces of coarser material atop silt matrix. Tubes, algae and mud clast on surface. Voids greater than penetration. 8 cm silt over ENR material (not evident).	1.9	1.2	>4	1	>4	N	1 on 3
LDW-Y3-SC-ENR-AC-6B	R5	6/28/2020	25.2	8.2	LNA	Top layer of medium sand grading to silt. Few pockets of sand in base of voids. Worms abundant at depth, few partial feeding voids. Mud clast and plant debris on surface. 8 cm silt over ENR material.	0.6	1.3	>4	0	>4	N	1 on 3

Summary Statistics for Some Numerical Parameters

	Penetration Depth (cm)	Surface Boundary Roughness (cm)	RPD Depth (cm)
N	36	36	20
Average	5.9	1.0	1.3
Median	5.7	0.95	1.3
Minimum	1.4	0.1	0.8
Maximum	10.5	3.2	1.9

Notes:
AC = activated carbon
aRPD = apparent redox potential discontinuity
ENR = enhanced natural recovery
Ind. = indeterminate
LNA = layer not apparent
N = no
P = penetration
SPI = sediment profile imaging
SWI = sediment-water interface
Y = yes

Table 3-4b. Year 3 Scour ENR+AC PV Results

				Lebensspuren											
Station	Replicate	Sediment Type	Bedforms	Burrows	Tubes	Tracks	Total Abundance	Epifauna	Epifauna Type (Count)	Mud Clasts	Debris Type	Debris Cover	*Beggiatoa*	Surface Boundary Roughness (cm)	Comments
LDW-Y3-SC-ENR-AC-1A	R1	Gravel, sand, and few cobbles	N	N	N	N	L	Y	Red Rock Crab (1), Barnacle (1)	N	Pipe	L	N	H	Gravel, coarse sand with few cobble pieces. Thin film of silt on surface. Piece of pipe encrusted with alga growth.
LDW-Y3-SC-ENR-AC-1A	R2	Gravel and sand	N	N	N	N	L	N	NA	N	Macroalgae, pipe	L	N	H	Gravels with coarse sand and fine silt on surface. Pipe encrusted with algae. Imprint is an artifact from the SPI prism at R1.
LDW-Y3-SC-ENR-AC-1A	R3	Gravel and sand and boulder	N	N	N	N	N	Y	Barnacles (10+), Bryozoan (1)	N	NA	N	N	H	Gravel with coarse sand and one boulder. Boulder is encrusted with Bryozoan and barnacles.
LDW-Y3-SC-ENR-AC-1B	R1	Sand, gravel, cobble, and silt	N	N	N	N	L	Y	Tunicate (1)	N	Macroalgae	L	N	H	Coarse sand, gravel and cobble with fine silt.
LDW-Y3-SC-ENR-AC-1B	R2	Gravel, sand, silt, and cobble	N	N	Y	N	N	N	NA	N	Macroalgae	L	N	H	Imprint is an artifact from the SPI frame. Gravel, coarse sand covered with film of silt. One cobble piece.
LDW-Y3-SC-ENR-AC-1B	R3	Gravel, sand, and silt	N	N	N	N	N	Y	Possible Bryozoan	N	NA	N	N	H	Gravel with coarse sand covered with film of silt.
LDW-Y3-SC-ENR-AC-2A	R1	Silt	N	Y	Y	Y	L	Y	Amphipod (4)	N	Macroalgae	L	N	L	Silt with few tracks, burrows and tubes.
LDW-Y3-SC-ENR-AC-2A	R4	Silt and wood	N	Y	Y	Y	H	N	NA	N	Wood	M	N	M	Silt with sticks. Many tracks, some burrows and few tubes.
LDW-Y3-SC-ENR-AC-2A	R5	Silt	N	Y	Y	Y	M	Y	Amphipod (1)	N	Macroalgae	L	N	L	Silt with some burrows, tracks and tubes. Some larger diameter polychaete tubes evident. Some biogenic depressions. Finfish (1).
LDW-Y3-SC-ENR-AC-2B	R4	Silt and gravel	N	Y	Y	Y	M	N	NA	N	Macroalgae and wood	M	N	M	Silt with few gravel pieces. Finfish (1).
LDW-Y3-SC-ENR-AC-2B	R5	Silt and wood	N	Y	Y	Y	M	Y	Amphipod (3), Barnacle (1)	N	Wood, macroalgae	H	N	H	Silt with log, pieces of wood. Moderate amount of tracks and tubes, few burrows. Fecal cast. Finfish (1).
LDW-Y3-SC-ENR-AC-2B	R6	Silt	N	Y	Y	Y	M	Y	Amphipod (2)	N	Metal, macroalgae	L	N	L	Silt with very few sand. Sand is evident at opening of burrow, bottom of image. Finfish (1). Moderate amount of tracks, few burrows and tubes.
LDW-Y3-SC-ENR-AC-3A	R1	Gravel, sand, and cobble	N	N	Y	N	L	Y	Barnacles (>100), Bryozoan (1)	N	NA	N	N	H	Gravel with coarse sand, few cobble pieces. Bryozoan on large piece of cobble. Some fecal casts.
LDW-Y3-SC-ENR-AC-3A	R2	Gravel, sand, and cobble	N	N	N	N	N	Y	Bryozoan (1)	N	Macroalgae	L	N	H	Gravel, coarse sand and few cobble pieces. Bryozoan on larger cobble pieces. Few macroalgae.
LDW-Y3-SC-ENR-AC-3A	R3	Gravel, sand, shells, and cobble	N	N	N	N	N	Y	Barnacle (25), Bryozoan	N	Macroalgae	L	N	H	Gravel, coarse sand, shell fragments and few cobbles. Algae and silt covering larger particles.
LDW-Y3-SC-ENR-AC-3B	R1	Gravel, sand, silt, and shells	N	N	N	N	N	Y	Bryozoan (6)	N	Macroalgae	L	N	H	Light film of silt covering gravel, coarse sand and shell fragments. Small clusters of bryozoan on larger gravel pieces.
LDW-Y3-SC-ENR-AC-3B	R2	Sand, gravel, shell, and silt	N	N	Y	N	N	Y	Bryozoan (6)	N	Macroalgae	L	N	H	Coarse sand with gravel, silt and few shell fragments. Bryozoan on larger gravel pieces. Fecal casts.
LDW-Y3-SC-ENR-AC-3B	R3	Sand, gravel, silt, and shells	N	N	Y	N	L	Y	Barnacles (10)	N	NA	N	N	H	Coarse sand, gravel with silt overlying substrate. Some shell fragments. Few tubes.
LDW-Y3-SC-ENR-AC-4A	R1	Silt	N	Y	Y	Y	M	Y	Amphipod (1)	N	NA	N	N	L	Silt with some tracks burrows and tubes. Some biogenic depressions.
LDW-Y3-SC-ENR-AC-4A	R2	Silt	N	Y	Y	Y	M	N	NA	N	NA	N	N	L	Image is partially obscured by suspended sediment from the previous rep.
LDW-Y3-SC-ENR-AC-4A	R4	Silt	N	Y	Y	Y	M	Y	Bryozoan (1)	N	Macroalgae, sticks	M	N	L	Silt with few burrows, some tracks and tubes.
LDW-Y3-SC-ENR-AC-4B	R1	Silt and Gravel	N	Y	Y	Y	M	N	NA	N	Macroalgae	L	N	M	Silt with very few gravel pieces. Some tracks and tubes, few burrows.
LDW-Y3-SC-ENR-AC-4B	R2	Silt	N	Y	Y	Y	M	N	NA	Y	Macroalgae, stick	L	N	M	Mud clasts are an artifact from the SPI frame. Silt with some burrows, many tracks and some tubes.
LDW-Y3-SC-ENR-AC-4B	R4	Silt	N	N	Y	Y	Ind.	N	NA	Y	Sticks, macroalgae	L	N	M	Mud clasts and frame imprint are an artifact from the SPI frame. Finfish (3).

Table 3-4b. Year 3 Scour ENR+AC PV Results

Station	Replicate	Sediment Type	Bedforms	*Lebensspuren*				Epifauna	Epifauna Type (Count)	Mud Clasts	Debris Type	Debris Cover	*Beggiatoa*	Surface Boundary Roughness (cm)	Comments
				Burrows	Tubes	Tracks	Total Abundance								
LDW-Y3-SC-ENR-AC-5A	R4	Gravel, sand, silt, and shells	N	N	Y	N	L	Y	Barnacles (30), Bryozoan (9), Crab (1)	N	Macroalgae	L	N	H	Gravel, coarse sand with some silt and few shell fragments. Few tubes. Bryozoan on larger gravel pieces.
LDW-Y3-SC-ENR-AC-5A	R5	Gravel, sand, silt, and shells	N	N	Y	N	L	Y	Bryozoan (8), Snail (1)	N	Macroalgae, metal cable and sticks	M	N	H	Gravel with coarse sand covered with thin film of silt, few shell fragments. Finfish (1).
LDW-Y3-SC-ENR-AC-5A	R6	Sand, gravel, silt, and shells	N	N	N	N	N	Y	Bryozoan (11)	N	Macroalgae	L	N	H	Imprint is an artifact from the SPI frame. Bryozoan are attached to larger gravel pieces.
LDW-Y3-SC-ENR-AC-5B	R3	Sand, silt, and gravel	N	N	Y	N	L	Y	Bryozoan (5)	N	Macroalgae	L	N	M	Sand with silt covering surface, some gravel. Few small clusters of bryozoan attached to pieces of gravel.
LDW-Y3-SC-ENR-AC-5B	R5	Silt, sand, and gravel	N	N	N	N	N	Y	Bryozoan (4)	N	Macroalgae, Reed grass	L	N	M	Silt and medium sand with few gravel. Bryozoan attached to larger gravel pieces. Finfish (1).
LDW-Y3-SC-ENR-AC-5B	R6	Sand, silt, and gravel	N	N	Y	N	L	Y	Bryozoan	N	Macroalgae	L	N	H	Coarse sand, silt and some gravel. Surface disturbed from frame imprint from previous replicate.
LDW-Y3-SC-ENR-AC-6A	R1	Silt, sand, and gravel	N	N	Y	Y	L	Y	Bryozoan (3)	N	Stick, macroalgae	L	N	H	Silt film covering sand or some gravel. Few bryozoan attached to larger gravel pieces.
LDW-Y3-SC-ENR-AC-6A	R4	Sand, silt, and gravel	N	Y	Y	Y	M	N	NA	N	NA	N	N	M	Medium sand, silt and some gravel pieces.
LDW-Y3-SC-ENR-AC-6A	R5	Sand, silt, and gravel	N	Y	Y	Y	L	N	NA	N	Macroalgae	L	N	M	Medium sand with silt and few gravels.
LDW-Y3-SC-ENR-AC-6B	R1	Silt	N	Y	Y	Y	M	N	NA	N	Wood and macroalgae	L	N	L	Silt with many tracks, some tubes and few burrows. Biogenic depressions. Finfish (1).
LDW-Y3-SC-ENR-AC-6B	R4	Silt	N	N	Y	Y	M	Y	Bryozoan	N	Plastic or metal tool. Macroalgae.	M	N	L	Tool clearly has a handle. Encrusted with algae, silt and some bryozoan. Silt with some tracks and few tubes.
LDW-Y3-SC-ENR-AC-6B	R5	Silt	N	Y	Y	Y	L	Y	Worms (2)	N	Macroalgae	L	N	L	Silt with very few shell fragments. Finfish (1). Few tracks, burrows and tubes.

Notes:
-- = not analyzed
Lebensspuren = biologically formed sedimentary structures
AC = activated carbon
ENR = enhanced natural recovery
H = high
L = low
M = medium
N = no
NA = not applicable
PV = plan view
SPI = sediment profile imaging
Y = yes

Table 3-5a. Year 3 Subtidal ENR Pilot Subplot SPI Results

Station	Replicate	Image Date	Water Depth (ft)	Penetration Depth (cm)	ENR Layer Thickness (cm)	Texture and Other Observations	Surface Boundary Roughness (cm)	RPD Depth (cm)	Grain Size Major Mode (phi units)	Grain Size Maximum (phi units)	Grain Size Minimum (phi units)	Methane	Successional Stage
LDW-Y3-SU-ENR-1A	R1	6/28/2020	40.7	2.9	LNA	Thin layer of silt atop fine to very fine sand. ENR material not evident, but presumed to be below 3 cm penetration depth.	2.3	0.6	4-3	1	>4	N	Ind.
LDW-Y3-SU-ENR-1A	R2	6/28/2020	40.8	5	LNA	Layer of silt atop compact very fine sand. ENR material not evident, but assumed below 5 cm based on penetration.	1.9	0.8	4-3	1	>4	N	Ind.
LDW-Y3-SU-ENR-1A	R4	6/28/2020	39.8	2.7	LNA	Thin layer of silt atop very fine sand. ENR material not evident but below 3 cm penetration.	1.3	0.9	4-3	1	>4	N	Ind.
LDW-Y3-SU-ENR-1B	R1	6/28/2020	40.7	6.1	LNA	Very fine sand and silt. Worm at depth. No ENR material evident but assumed below 6 cm silt deposit.	3.3	0.9	>4	1	>4	N	1
LDW-Y3-SU-ENR-1B	R3	6/28/2020	40.5	3.6	LNA	Very fine sand. Few shell fragments and granules on surface. Disturbed sediment in water column. Mud clast on surface. Worm at depth. 4 cm over ENR material (not evident).	1.2	0.8	4-3	1	>4	N	Ind.
LDW-Y3-SU-ENR-1B	R4	6/28/2020	39.7	5.3	LNA	Fine sand grading to very fine sand/silt. Debris on surface. Worm at depth. ENR material not evident.	0.8	0.6	3-2/>4	1	>4	N	Ind.
LDW-Y3-SU-ENR-2A	R1	6/28/2020	40.7	2.3	LNA	Veneer layer of silt atop very fine sand. Small worm at depth. ENR material not evident.	1	0.9	4-3	1	>4	N	Ind.
LDW-Y3-SU-ENR-2A	R2	6/28/2020	40.5	3.1	LNA	Silt atop very fine sand. Partial feeding voids at depth. ENR material not evident but assumed below 3 cm deposit.	1.8	0.8	4-3	1	>4	N	3
LDW-Y3-SU-ENR-2A	R3	6/28/2020	40.6	1.1	LNA	Very fine sand. Minimal penetration. ENR material not evident but below penetration.	2	Ind.	4-3	2	>4	N	Ind.
LDW-Y3-SU-ENR-2B	R1	6/28/2020	40.8	1.4	>P	Thin layer of silt atop fine sand. ENR material at surface and > penetration.	1.1	0.6	3-2	0	>4	N	Ind.
LDW-Y3-SU-ENR-2B	R2	6/28/2020	41.1	2.2	>P	Thin layer of silt overlaying sand with shell fragments. Possible relic burrow. Few tubes on surface. ENR material > penetration.	1.2	0.4	4-3	-1	>4	N	Ind.
LDW-Y3-SU-ENR-2B	R3	6/28/2020	41.2	2.1	>P	Thin layer of silt grading to fine sand. Shell fragments on surface and within substrate. Residual ENR material on surface, ENR material > penetration.	1.2	0.6	4-3	1	>4	N	Ind.
LDW-Y3-SU-ENR-3A	R1	6/28/2020	41.3	1.3	>P	Medium sand and few granules and shell fragments. ENR material > penetration.	0.5	Ind.	3-2	-2	>4	N	Ind.
LDW-Y3-SU-ENR-3A	R2	6/28/2020	40.9	2	>P	Very fine sand over coarse sand. Granules and shell fragments on surface. "Void" created by sloping SWI. ENR material > penetration.	0.7	Ind.	4-3/0 to -1	-2	>4	N	Ind.
LDW-Y3-SU-ENR-3A	R3	6/28/2020	41	1.9	>P	Very fine sand over coarse sand, few granules. ENR material > penetration.	0.6	Ind.	4-3/1 to 0	-1	>4	N	Ind.

Table 3-5a. Year 3 Subtidal ENR Pilot Subplot SPI Results

Station	Replicate	Image Date	Water Depth (ft)	Penetration Depth (cm)	ENR Layer Thickness (cm)	Texture and Other Observations	Surface Boundary Roughness (cm)	RPD Depth (cm)	Grain Size Major Mode (phi units)	Grain Size Maximum (phi units)	Grain Size Minimum (phi units)	Methane	Successional Stage
LDW-Y3-SU-ENR-3B	R1	6/28/2020	41.3	1.8	>P	Thin layer of silt on very fine sand, possibly rippled. ENR material > penetration.	2.3	Ind.	4-3	-2	>4	N	Ind.
LDW-Y3-SU-ENR-3B	R2	6/28/2020	41.2	2.6	>P	Very fine sand. ENR material at surface and > penetration.	1.8	0.7	4-3	-1	>4	N	Ind.
LDW-Y3-SU-ENR-3B	R4	6/28/2020	39.6	1.6	>P	Thin layer of silt over very fine sand with a subfraction of medium sand and a few granules. Minimal penetration. ENR material > penetration.	1	0.7	4-3	-2	>4	N	Ind.
LDW-Y3-SU-ENR-4A	R1	6/28/2020	41.2	2.3	>P	Silt over fine sand. Area of reduced silt at 2 cm right side of frame. Debris on surface. ENR material > penetration.	0.7	1.1	>4/3-2	0	>4	N	Ind.
LDW-Y3-SU-ENR-4A	R2	6/28/2020	41.4	3	>P	Silt over fine sand. ENR material > penetration. Rippled bottom.	1.2	0.8	>4/3-2	-1	>4	N	Ind.
LDW-Y3-SU-ENR-4A	R3	6/28/2020	41.6	2.2	>P	Bimodal grain size distribution of silt and coarse sand, possibly rippled. ENR material > penetration.	1.2	1	0 to -1 and >4	-2	>4	N	Ind.
LDW-Y3-SU-ENR-4B	R1	6/28/2020	42.1	3.4	>P	Fine sand. ENR material > penetration.	0.8	0.7	4-3	-2	>4	N	Ind.
LDW-Y3-SU-ENR-4B	R2	6/28/2020	42	3.9	>P	Rippled fine sand grading to finer material at depth. ENR material > penetration.	2	0.8	3-2	0	>4	N	Ind.
LDW-Y3-SU-ENR-4B	R3	6/28/2020	41.9	3.6	>P	Silt with and fine sand. Feeding voids at depth. ENR material > penetration.	0.6	0.7	>4 and 3-2	-2	>4	N	1 on 3
LDW-Y3-SU-ENR-5A	R2	6/28/2020	41.4	2.2	>P	Very fine sand subfraction of silt. Tubes on surface. Crack from prism penetration. RPD and ENR material > penetration.	0.5	Ind.	4-3	-3	>4	N	Ind.
LDW-Y3-SU-ENR-5A	R3	6/28/2020	41.5	0.9	>P	Silt on coarse sand and granules. Piece of wood on surface. RPD and ENR material > penetration.	0.3	Ind.	0 to -1 and >4	-4	>4	N	Ind.
LDW-Y3-SU-ENR-5A	R4	6/28/2020	41.3	1.2	>P	Silt and coarse sand with granules. Pebbles on surface. RPD and ENR material > penetration.	0.3	Ind.	0 to -1 and >4	-4	>4	Y	Ind.
LDW-Y3-SU-ENR-5B	R1	6/28/2020	41.2	2	>P	Silt overlaying coarse to medium sand. Pebble on SWI. ENR material > penetration.	0.5	Ind.	1-0 and >4	-3	>4	N	Ind.
LDW-Y3-SU-ENR-5B	R2	6/28/2020	41.3	1.2	>P	Thin layer of silt atop very coarse sand and granules. ENR material > penetration.	0.5	Ind.	0 to -1	-2	>4	N	Ind.
LDW-Y3-SU-ENR-5B	R3	6/28/2020	41.2	2.5	>P	Thin layer of silt overlaying layer of medium sand, grading back to very fine sand and silt at depth. Gravel on surface. ENR material > penetration.	1	0.9	2-1 and >4	1	>4	N	Ind.

Table 3-5a. Year 3 Subtidal ENR Pilot Subplot SPI Results

Station	Replicate	Image Date	Water Depth (ft)	Penetration Depth (cm)	ENR Layer Thickness (cm)	Texture and Other Observations	Surface Boundary Roughness (cm)	RPD Depth (cm)	Grain Size Major Mode (phi units)	Grain Size Maximum (phi units)	Grain Size Minimum (phi units)	Methane	Successional Stage
LDW-Y3-SU-ENR-6A	R2	6/28/2020	44.6	3.9	>P	Silt overlaying medium sand. Feeding void possibly created by prism penetration. ENR material > penetration.	1.1	0.9	>4/2-1	-2	>4	N	Ind.
LDW-Y3-SU-ENR-6A	R3	6/28/2020	44.6	9.4	Residual	Silt mixed with sand, cobbles. Wood debris on SWI. Pebbles and possible on surface. Residual ENR material evident, but ENR layer not intact. Two small voids.	1.8	1	>4	1	>4	N	3
LDW-Y3-SU-ENR-6A	R4	6/28/2020	42.2	4.5	Residual	Silt and fine sand atop band of medium/coarse sand and grading to silt. Pebbles on surface. Burrow at surface, feeding voids and worm at depth. Residual ENR material evident, but layer disturbed.	1.3	1.9	>4	-1	>4	N	3
LDW-Y3-SU-ENR-6B	R3	6/28/2020	45.3	6.8	Disturbed/Removed	Layer of silt atop reduced silt with slight subfraction of fine sand. Macroalgae on surface and contained within substrate. ENR material disturbed/removed.	2.2	1.1	>4	1	>4	N	1
LDW-Y3-SU-ENR-6B	R4	6/28/2020	42.6	6.4	2.2	Thin layer of brown silt atop band of medium to fine sand over reduced silt. Worm and few shell particles at depth. Residual ENR layer of 2 cm.	0.6	0.7	2-1/>4	-1	>4	N	1
LDW-Y3-SU-ENR-6B	R5	6/28/2020	43.2	6.8	Disturbed/Removed	Primarily silt with subfraction of fine to very fine sand. Reduced sediment starting at .5 cm. Silt clasts, pebbles and a cobble on surface. ENR material disturbed/removed.	1.5	0.8	>4	-4	>4	N	1

Summary Statistics for Some Numerical Parameters

	Penetration Depth (cm)	Surface Boundary Roughness (cm)	RPD Depth (cm)
N	36	36	26
Average	3.2	1.2	0.8
Median	2.6	1.15	0.8
Minimum	0.9	0.3	0.4
Maximum	9.4	3.3	1.9

Notes:
AC = activated carbon
aRPD = apparent redox potential discontinuity
ENR = enhanced natural recovery
Ind. = indeterminate
LNA = layer not apparent
N = no
P = penetration
SPI = sediment profile imaging
SWI = sediment-water interface
Y = yes

Table 3-5b. Year 3 Subtidal ENR Pilot Subplot PV Results

				Lebensspuren											
Station	Replicate	Sediment Type	Bedforms	Burrows	Tubes	Tracks	Total Abundance	Epifauna	Epifauna Type (Count)	Mud Clasts	Debris Type	Debris Cover	*Beggiatoa*	Surface Boundary Roughness (cm)	Comments
LDW-Y3-SU-ENR-1A	R1	Silt and sand	N	Y	N	Y	M	N	NA	N	NA	N	N	M	Silt with some fine sand. Moderate amount of tracks and few burrows. Particulates in water column.
LDW-Y3-SU-ENR-1A	R3	--	--	--	--	--	--	--	--	--	--	--	--	--	Not analyzable due to turbidity in the water column.
LDW-Y3-SU-ENR-1A	R4	Silt and sand	N	N	N	Y	M	N	NA	N	Wood	L	N	M	Silt with fine sand. Moderate amount of tracks. Piece of wood. Particulates in water column.
LDW-Y3-SU-ENR-1B	R1	Silt and sand	Y	N	Y	Y	L	N	NA	N	Wood	L	N	H	Silt and fine sand, very few tracks and tubes. Piece of wood and possibly a buried log.
LDW-Y3-SU-ENR-1B	R4	Silt and sand	Y	N	N	N	N	N	NA	N	NA	N	N	H	Silt and fine sand. Ripples evident. Excessive particulates in water column partially obscuring image.
LDW-Y3-SU-ENR-1B	R5	Silt and Sand	N	N	N	N	N	N	NA	N	NA	N	N	H	Excessive particulates in water column. Deep furrow in left part of image.
LDW-Y3-SU-ENR-2A	R1	Silt	N	N	Y	Y	L	N	NA	N	NA	N	N	M	Silt with few tracks and tubes. Particulates in water column.
LDW-Y3-SU-ENR-2A	R3	Silt	Y	N	Y	N	N	N	NA	N	NA	N	N	M	Excessive amount of particulates in water column partially obscures image.
LDW-Y3-SU-ENR-2A	R4	--	--	--	--	--	--	--	--	--	--	--	--	--	Not analyzable due to turbidity in the water column.
LDW-Y3-SU-ENR-2B	R1	Silt, sand, and gravel	N	N	Y	N	N	N	NA	Y	NA	N	N	L	Silt with some sand and very few gravel pieces.
LDW-Y3-SU-ENR-2B	R2	Silt and sand	N	N	N	N	N	N	NA	N	Wood	L	N	M	Silt and fine sand. Image is partially obscured due to suspended sediment in water column.
LDW-Y3-SU-ENR-2B	R3	Silt and sand	N	N	Y	N	N	N	NA	N	Macroalgae	N	N	L	Silt and fine sand. Bivalve shell. Imprint is an artifact from the SPI prism.
LDW-Y3-SU-ENR-3A	R1	Sand and silt	N	N	Y	Y	L	N	NA	N	NA	N	N	L	Fine sand and silt. Very few tracks and tubes.
LDW-Y3-SU-ENR-3A	R2	--	--	--	--	--	--	--	--	--	--	--	--	--	Not analyzable due to turbidity in the water column.
LDW-Y3-SU-ENR-3A	R3	Sand and silt	N	N	Y	Y	L	N	NA	Y	NA	N	N	L	Fine sand and silt with one piece of gravel. Mud clast is an artifact from the SPI frame.
LDW-Y3-SU-ENR-3B	R1	Silt and sand	Y	N	Y	Y	L	N	NA	N	NA	N	N	M	Silt and fine sand. Few tracks, burrows and tubes. Few scattered pieces of gravel.
LDW-Y3-SU-ENR-3B	R3	Sand, silt, and shells	Y	N	Y	Y	L	Y	Amphipod (1)	Y	NA	N	N	M	Imprint is an artifact from the SPI frame. Few pieces of gravel exposed in frame imprint.
LDW-Y3-SU-ENR-3B	R4	Silt and sand	N	Y	Y	Y	M	N	NA	N	Macroalgae, stick	L	N	L	Small portion of image has SPI frame imprint. Few pieces of gravel exposed from frame imprint. Some tracks, very few burrows and tubes.
LDW-Y3-SU-ENR-4A	R1	Silt, sand, and gravel	Y	N	N	Y	L	N	NA	N	NA	N	N	L	Silt with fine sand. Very few scattered pieces of gravel.
LDW-Y3-SU-ENR-4A	R2	Silt and sand	N	N	Y	Y	L	N	NA	N	Metal	L	N	M	Silt with fine to coarse sand. Debris appears to be either metal or asphalt. Possible scour marks from barges in vicinity.
LDW-Y3-SU-ENR-4A	R3	Silt, sand, and gravel	N	N	Y	Y	L	N	NA	N	Stick	L	N	H	Imprint is an artifact from the SPI frame. Silt with coarse sand and some gravels exposed by frame imprint.
LDW-Y3-SU-ENR-4B	R1	Silt and sand	Y	Y	Y	Y	L	Y	Gastropod (1)	N	Macroalgae	L	N	M	Silt with fine sand and few shell fragments.
LDW-Y3-SU-ENR-4B	R2	--	--	--	--	--	--	--	--	--	--	--	--	--	Not analyzable due to turbidity in the water column.
LDW-Y3-SU-ENR-4B	R3	Silt and sand	N	N	N	N	N	N	NA	N	N	N	N	M	Image not completely analyzable due to suspended sediment.
LDW-Y3-SU-ENR-5A	R2	Silt, sand, and gravel	Y	N	N	Y	L	N	NA	N	Sticks	L	N	M	Silt with fine sand and very few gravels and shell fragments.
LDW-Y3-SU-ENR-5A	R3	Silt, sand, and gravel	Y	N	Y	Y	L	N	NA	N	NA	N	N	M	Silt, fine sand and some gravel, few shell fragments.
LDW-Y3-SU-ENR-5A	R4	Silt, sand, and gravel	N	N	Y	Y	L	N	NA	N	Stick	L	N	L	Silt, medium sand and few gravel. Very few tracks and tubes. Some shell fragments.
LDW-Y3-SU-ENR-5B	R1	Silt, sand, and gravel	Y	N	Y	Y	L	N	NA	N	NA	N	N	L	Silt, medium sand and few gravel. Some shell fragments. Very few tracks and tubes.
LDW-Y3-SU-ENR-5B	R2	Silt and sand	Y	N	Y	Y	L	N	NA	N	NA	N	N	M	Silt and medium to coarse sand. Few shell fragments. Some tracks and few tubes.
LDW-Y3-SU-ENR-5B	R3	Sand, silt, and gravel	N	N	N	N	N	Y	Barnacles (4)	N	Stick	L	N	H	Imprint may be an artifact from the SPI frame or evidence of chain/anchorage drag marks. Coarse sand, silt shell fragments and few gravels.
LDW-Y3-SU-ENR-6A	R2	Silt, sand, gravel, and cobble	N	N	N	Y	L	N	NA	N	Metal and wood	M	N	H	Silt, with a piece of cobble and few gravel.
LDW-Y3-SU-ENR-6A	R3	--	--	--	--	--	--	--	--	--	--	--	--	--	Not analyzable due to turbidity in the water column.

Table 3-5b. Year 3 Subtidal ENR Pilot Subplot PV Results

				Lebensspuren											
Station	Replicate	Sediment Type	Bedforms	Burrows	Tubes	Tracks	Total Abundance	Epifauna	Epifauna Type (Count)	Mud Clasts	Debris Type	Debris Cover	*Beggiatoa*	Surface Boundary Roughness (cm)	Comments
LDW-Y3-SU-ENR-6A	R4	Silt, cobble, and gravel	N	N	Y	Y	L	Y	Barnacles (5)	N	Sticks	L	N	H	Silt with some cobble and gravel. Gravel and cobble angular, not rounded.
LDW-Y3-SU-ENR-6B	R3	Silt, gravel, and cobble	N	Y	N	Y	L	N	NA	N	Leaf	L	N	M	Silt with some gravel and cobble pieces.
LDW-Y3-SU-ENR-6B	R4	Silt, gravel, and cobble	N	Y	N	Y	L	Y	Barnacles (2)	N	NA	N	N	H	Silt overlying few cobble and gravel pieces.
LDW-Y3-SU-ENR-6B	R5	Silt	N	N	N	Y	L	N	NA	Y	NA	N	N	H	Silt. Mud clasts appear large in size and possibly an artifact from barge anchor chains.

Notes:
Shaded rows indicate replicate not analyzable due to turbidity.
-- = not analyzed
Lebensspuren = biologically formed sedimentary structures
ENR = enhanced natural recovery
H = high
L = low
M = medium
N = no
NA = not applicable
PV = plan view
SPI = sediment profile imaging
Y = yes

Table 3-6a. Year 3 Scour ENR+AC Pilot Subplot SPI Results

Station	Replicate	Image Date	Water Depth (ft)	Penetration Depth (cm)	ENR+AC Layer Thickness (cm)	Texture and Other Observations	Surface Boundary Roughness (cm)	RPD Depth (cm)	Grain Size Major Mode (phi units)	Grain Size Maximum (phi units)	Grain Size Minimum (phi units)	Methane	Successional Stage
LDW-Y3-SU-ENR-AC-1A	R1	6/28/2020	38.3	16.3	LNA	Fine sand grading to silt. Tubes on surface, worms at depth. 16 cm deposit over ENR material, not evident.	0.7	1.4	3-2/>4	2	>4	N	2 -> 3
LDW-Y3-SU-ENR-AC-1A	R2	6/28/2020	38	17.5	LNA	Silt, some fine sand in surface sediments. Worm at depth. 17 cm of silt, no ENR material evident.	0.7	1.6	>4	-1	>4	N	2 -> 3
LDW-Y3-SU-ENR-AC-1A	R4	6/28/2020	37	17.2	LNA	Silt with fine sand in top 2 cm. Feeding void and worm at depth, few small tubes on surface. No ENR material evident.	1.7	1.3	>4	2	>4	N	1 on 3
LDW-Y3-SU-ENR-AC-1B	R1	6/28/2020	38.2	8.9	LNA	Silt with very fine sand surface sediments. Few worms and small feeding void at depth. Tubes and few granules on surface. 9 cm silt, no ENR material evident.	0.9	1.9	>4	2	>4	N	1 on 3
LDW-Y3-SU-ENR-AC-1B	R3	6/28/2020	38.1	12.5	LNA	Fine to very fine sand grading to silt with depth. Feeding voids and worms at depth. ENR material not evident.	1	1.2	4-3/>4	2	>4	N	1 on 3
LDW-Y3-SU-ENR-AC-1B	R4	6/28/2020	36.9	13.7	LNA	Very fine sand grading to silt at depth. Tubes on surface, feeding voids at depth. ENR material not evident.	0.9	3.6	4-3/>4	2	>4	N	1 on 3
LDW-Y3-SU-ENR-AC-2A	R1	6/28/2020	37.2	9.2	LNA	Silt, some fine sand in surface sediments. Feeding void and worm at depth, few tubes on surface. ENR material not evident.	0.8	1.1	>4	0	>4	N	1 on 3
LDW-Y3-SU-ENR-AC-2A	R2	6/28/2020	36.9	6.2	LNA	Very fine sand grading to silt. Few tubes on surface. 6 cm deposit over ENR material (not evident) inferred from penetration.	2.9	1.4	4-3	1	>4	N	1
LDW-Y3-SU-ENR-AC-2A	R3	6/28/2020	37.1	12.3	LNA	Silt. Stage 1 and Stage 3 tubes on surface. Worm and small feeding voids at depth. ENR material not evident. SWI disturbed from previous drop.	1	0.8	4-3	1	>4	N	1 on 3
LDW-Y3-SU-ENR-AC-2B	R1	6/28/2020	36.3	13.5	LNA	Silt with subfraction of very fine sand in top 3 cm. Shell fragments. Few tubes at surface, small feeding voids and worm at depth. ENR material not evident.	1.6	1.6	4-3/>4	2	>4	N	1 on 3
LDW-Y3-SU-ENR-AC-2B	R2	6/28/2020	37.2	14.4	LNA	Silt with subfraction of very fine sand in top 2 cm. Tubes on surface, small feeding voids at depth. ENR material not evident.	1.6	1	>4	1	>4	N	1 on 3
LDW-Y3-SU-ENR-AC-2B	R4	6/28/2020	36.7	14.3	LNA	Silt with subfraction of very fine sand in top few cm. Tubes on surface, feeding voids and worms at depth. ENR material not evident.	0.4	1.1	4-3/>4	-1	>4	N	1 on 3
LDW-Y3-SU-ENR-AC-3A	R1	6/28/2020	38.5	8.6	LNA	Silt with subfraction of very fine sand in top few cm. Tubes and possible fecal casts on surface, voids and worm at depth. No ENR material evident.	0.9	1.7	>4	2	>4	N	1 on 3
LDW-Y3-SU-ENR-AC-3A	R2	6/28/2020	38.1	8.6	LNA	Silt with subfraction of very fine sand in top few cm. Tubes on surface, thin worms at depth. No ENR material evident.	0.7	2.4	>4	0	>4	N	2 -> 3
LDW-Y3-SU-ENR-AC-3A	R3	6/28/2020	38.5	4.9	LNA	Very fine sand and silt. Subfraction of medium sand left side of frame. No ENR material evident.	1.1	1.7	4-3	0	>4	N	Ind.

Table 3-6a. Year 3 Scour ENR+AC Pilot Subplot SPI Results

Station	Replicate	Image Date	Water Depth (ft)	Penetration Depth (cm)	ENR+AC Layer Thickness (cm)	Texture and Other Observations	Surface Boundary Roughness (cm)	RPD Depth (cm)	Grain Size Major Mode (phi units)	Grain Size Maximum (phi units)	Grain Size Minimum (phi units)	Methane	Successional Stage
LDW-Y3-SU-ENR-AC-3B	R1	6/28/2020	37.7	8.6	LNA	2 cm medium to fine sand over silt. Tubes on surface and worm at depth. 9 cm deposit overlying ENR material which is not evident.	2.6	2.5	3-2/>4	1	>4	N	2 -> 3
LDW-Y3-SU-ENR-AC-3B	R2	6/28/2020	37.6	7.4	LNA	Silt with subfraction of very fine sand in top few cm. Tubes on surface, worms within substrate. 8 cm deposit overlying ENR material which is not evident.	2.9	1.7	>4	1	>4	N	2 -> 3
LDW-Y3-SU-ENR-AC-3B	R3	6/28/2020	37.3	7.3	LNA	Very fine sand grading to silt. Tubes at surface, worms at depth. 7 cm deposit overlying ENR material which is not evident.	1.2	2.9	4-3	1	>4	N	2 -> 3
LDW-Y3-SU-ENR-AC-4A	R1	6/28/2020	38.4	1.7	LNA	Silt with few shell fragments and subtle very fine sand subfraction. Cobble in background. 2 cm deposit overlying ENR material which is not evident.	1.6	Ind.	>4	3	>4	N	1
LDW-Y3-SU-ENR-AC-4A	R2	6/28/2020	38	4.3	LNA	Fine to very fine sand over silt. Feeding voids and worms at depth, tubes and stick on surface. 4 cm deposit overlying ENR material which is evident in feeding voids.	1.2	1.1	4-3/>4	0	>4	N	1 on 3
LDW-Y3-SU-ENR-AC-4A	R3	6/28/2020	38.1	5	LNA	Very fine sand overlaying silt with sand subfraction. Tubes and sand clasts on surface, worms at depth. 5 cm deposit overlying ENR material which is not evident.	2.3	1.7	4-3	2	>4	N	2 -> 3
LDW-Y3-SU-ENR-AC-4B	R1	6/28/2020	38.1	5.6	LNA	Very fine sand. Tubes on surface. 6 cm deposit overlying ENR material which is not evident.	1	1.3	4-3	0	>4	N	1
LDW-Y3-SU-ENR-AC-4B	R2	6/28/2020	38.1	1.7	LNA	Very fine sand. Tubes and shell on surface. RPD = Ind. 2 cm deposit overlying ENR material which is not evident.	2.1	Ind.	4-3	1	>4	N	Ind.
LDW-Y3-SU-ENR-AC-4B	R3	6/28/2020	38.1	1.6	Disturbed/Removed	Very fine sand with slightly coarser sand intermixed. Red algae on surface. 2 cm deposit overlying ENR material which is not evident.	0.6	Ind.	4-3	1	>4	N	Ind.
LDW-Y3-SU-ENR-AC-5A	R1	6/28/2020	42.1	9.1	Disturbed/Removed	Disturbed SWI and thin RPD suggest recent disturbance. Tubes on surface, worms within substrate. Highly reduced sediment at depth. No ENR material evident, ENR material disturbed/removed.	1.4	0.5	>4	2	>4	N	1
LDW-Y3-SU-ENR-AC-5A	R2	6/28/2020	42.5	9	Disturbed/Removed	Very fine sand over silt. Oxidized deposit over eroded reduced silt interface. ENR material disturbed/removed.	1	0.3	4-3/>4	2	>4	N	1
LDW-Y3-SU-ENR-AC-5A	R3	6/28/2020	42	11.1	Disturbed/Removed	Silt with subfraction of very fine sand in top few cm. Highly reduced subsurface sediment. ENR disturbed/removed.	2.4	0.7	>4	1	>4	N	1
LDW-Y3-SU-ENR-AC-5B	R1	6/28/2020	43.6	8.9	Disturbed/Removed	Oxidized silt deposit overlying eroded, banded, reduced silt. ENR material disturbed/removed.	0.8	0.2	>4	3	>4	N	1
LDW-Y3-SU-ENR-AC-5B	R2	6/28/2020	43.8	10.8	Disturbed/Removed	Oxidized silt deposit overlying eroded, banded, reduced silt. ENR material disturbed/removed.	0.5	0.3	>4	0	>4	N	1
LDW-Y3-SU-ENR-AC-5B	R4	6/28/2020	42.8	8.2	Disturbed/Removed	Oxidized silt deposit overlying eroded, banded, reduced silt. ENR material disturbed/removed.	0.7	0.6	>4	2	>4	N	1 on 3

Table 3-6a. Year 3 Scour ENR+AC Pilot Subplot SPI Results

Station	Replicate	Image Date	Water Depth (ft)	Penetration Depth (cm)	ENR+AC Layer Thickness (cm)	Texture and Other Observations	Surface Boundary Roughness (cm)	RPD Depth (cm)	Grain Size Major Mode (phi units)	Grain Size Maximum (phi units)	Grain Size Minimum (phi units)	Methane	Successional Stage
LDW-Y3-SU-ENR-AC-6A	R1	6/28/2020	43.2	8.4	Disturbed/Removed	Oxidized silt deposit overlying eroded, reduced silt. ENR material disturbed/removed.	1.1	0.4	4-3/>4	1	>4	N	1
LDW-Y3-SU-ENR-AC-6A	R2	6/28/2020	43.4	9.5	Disturbed/Removed	Silt with subfraction of very fine sand, highly reduced sediment at depth. ENR material disturbed/removed.	1.5	1.5	>4	0	>4	N	1 on 3
LDW-Y3-SU-ENR-AC-6A	R3	6/28/2020	43.3	7.8	Disturbed/Removed	Oxidized silt deposit overlying eroded, banded, reduced silt. ENR material disturbed/removed.	1.1	0.4	>4	2	>4	N	1
LDW-Y3-SU-ENR-AC-6B	R1	6/28/2020	41.4	11	Disturbed/Removed	Silt with subfraction of very fine sand in top few cm. Reduced subsurface sediment. ENR not evident and disturbed/removed.	2.1	0.9	>4	1	>4	N	1 -> 2
LDW-Y3-SU-ENR-AC-6B	R2	6/28/2020	41.3	5.6	LNA	Very fine sand, reduced sediment. No ENR material evident but possibly below 6 cm deposit.	1	0.6	4-3	1	>4	N	1
LDW-Y3-SU-ENR-AC-6B	R3	6/28/2020	40.9	3.6	LNA	Silt with very fine sand subfraction. No ENR material evident but possibly below 4 cm deposit.	3.9	1.3	4-3/>4	2	>4	N	1

Summary Statistics for Some Numerical Parameters

	Penetration Depth (cm)	Surface Boundary Roughness (cm)	RPD Depth (cm)
N	36	36	33
Average	9.0	1.4	1.3
Median	8.8	1.1	1.3
Minimum	1.6	0.4	0.2
Maximum	17.5	3.9	3.6

Notes:
AC = activated carbon
aRPD = apparent redox potential discontinuity
ENR = enhanced natural recovery
Ind. = indeterminate
LNA = layer not apparent
N = no
P = penetration
SPI = sediment profile imaging
SWI = sediment-water interface
Y = yes

Table 3-6b. Year 3 Subtidal ENR+AC Pilot Subplot PV Results

				Lebensspuren											
Station	Replicate	Sediment Type	Bedforms	Burrows	Tubes	Tracks	Total Abundance	Epifauna	Epifauna Type (Count)	Mud Clasts	Debris Type	Debris Cover	*Beggiatoa*	Surface Boundary Roughness (cm)	Comments
LDW-Y3-SU-ENR-AC-1A	R1	Silt	Y	Y	N	Y	L	N	NA	N	NA	N	N	L	Silt with few tracks and burrows.
LDW-Y3-SU-ENR-AC-1A	R2	Silt	N	Y	Y	Y	L	N	NA	N	NA	N	N	M	Silt with very few shell fragments. One large burrow, some tubes and tracks.
LDW-Y3-SU-ENR-AC-1A	R3	Silt	N	N	Y	N	N	Y	Shrimp (1)	Y	NA	N	N	H	Mud clasts are an artifact from either SPI frame or barge chain/anchor.
LDW-Y3-SU-ENR-AC-1B	R1	Silt	N	Y	N	Y	L	N	NA	N	NA	N	N	L	Some burrows and tracks.
LDW-Y3-SU-ENR-AC-1B	R3	Silt	N	Y	Y	Y	M	N	NA	Y	NA	N	N	M	Mud clasts are an artifact from the SPI frame. Biogenic depressions. Some tracks, few burrows and tubes.
LDW-Y3-SU-ENR-AC-1B	R4	Silt	N	Y	N	Y	M	Y	Amphipod (1)	N	NA	N	N	M	Some burrows and tracks.
LDW-Y3-SU-ENR-AC-2A	R1	Silt	N	Y	Y	Y	M	N	NA	N	NA	N	N	M	Tracks, some tubes and few burrows. One large burrow with tubes along margins.
LDW-Y3-SU-ENR-AC-2A	R2	Silt	Y	Y	Y	Y	M	N	NA	N	NA	N	N	M	Particulates in water column.
LDW-Y3-SU-ENR-AC-2A	R3	Silt	N	Y	Y	Y	M	Y	Amphipod (1)	Y	NA	N	N	H	Boundary roughness score H due to imprint from SPI frame. Mud clasts are an artifact from the SPI frame and prism.
LDW-Y3-SU-ENR-AC-2B	R1	Silt	N	Y	Y	Y	M	N	NA	N	Detritus	L	N	L	Silt, with extensive tracks bottom part of image. Few burrows and tubes.
LDW-Y3-SU-ENR-AC-2B	R2	Silt	N	N	N	N	N	N	NA	Y	NA	N	N	H	Boundary roughness is high due to disturbed bottom. Mud clasts are most likely an artifact from chain or anchor.
LDW-Y3-SU-ENR-AC-2B	R4	Silt	N	Y	Y	Y	L	Y	Amphipod (1)	Y	Sticks	L	N	M	Silt with some tracks, tubes and few burrows. Fecal casts.
LDW-Y3-SU-ENR-AC-3A	R1	Silt	N	Y	Y	Y	M	N	NA	N	NA	N	N	M	Silt with some biogenic depressions.
LDW-Y3-SU-ENR-AC-3A	R2	Silt	N	Y	Y	Y	M	N	NA	Y	NA	N	N	H	Imprint may be an artifact from frame, or anchor/chain from barges.
LDW-Y3-SU-ENR-AC-3A	R3	Silt	N	N	Y	N	L	N	NA	Y	N	NA	N	H	Imprint may be an artifact from the SPI frame or chain from barges.
LDW-Y3-SU-ENR-AC-3B	R1	Silt	N	Y	Y	Y	M	N	NA	N	NA	N	N	L	Few shell fragments.
LDW-Y3-SU-ENR-AC-3B	R2	Silt	N	Y	Y	Y	M	N	NA	N	NA	N	N	M	One piece of gravel, few shell fragments. Prism footprint.
LDW-Y3-SU-ENR-AC-3B	R3	Silt	N	Y	Y	Y	M	N	NA	N	NA	N	N	L	Finfish (1).
LDW-Y3-SU-ENR-AC-4A	R1	Silt	N	Y	Y	N	L	N	NA	N	NA	N	N	L	One piece of gravel.
LDW-Y3-SU-ENR-AC-4A	R2	Silt, sand, gravel, and cobble	N	N	Y	N	N	N	NA	N	NA	N	N	H	Two pieces of cobble, few gravel and coarse sand. Few shell fragments. Imprint is an artifact from the SPI frame.
LDW-Y3-SU-ENR-AC-4A	R3	Silt and sand	N	Y	Y	Y	L	N	NA	Y	NA	N	N	H	Boundary roughness high due to imprint of SPI prism in portion of image. Few shell fragments. Sand exposed in prism imprint.
LDW-Y3-SU-ENR-AC-4B	R1	Silt	N	Y	Y	Y	M	N	NA	N	NA	N	N	M	One large diameter burrow.
LDW-Y3-SU-ENR-AC-4B	R2	Silt and sand	Y	Y	Y	Y	L	N	NA	N	Stick	L	N	L	Piece of gravel.
LDW-Y3-SU-ENR-AC-4B	R3	Silt	N	Y	Y	Y	M	N	NA	N	Macroalgae	M	N	L	Second laser not visible. One piece of gravel.
LDW-Y3-SU-ENR-AC-5A	R1	Silt	N	Y	Y	Y	L	N	NA	Y	NA	N	N	H	Mud clasts may be an artifact from anchors or chains from barges. Few shell fragments.
LDW-Y3-SU-ENR-AC-5A	R2	Silt	N	Y	Y	Y	L	N	NA	Y	NA	N	N	M	Imprint is an artifact of the SPI prism. Few shells.
LDW-Y3-SU-ENR-AC-5A	R3	Silt	N	Y	Y	Y	M	Y	Shrimp (1)	Y	Macroalgae	L	N	H	Mud clasts are not from SPI frame, may be due to barge anchors or chains.
LDW-Y3-SU-ENR-AC-5B	R1	Silt	N	Y	Y	Y	H	N	NA	N	NA	N	N	L	Silt with abundance of tracks and biogenic depressions. Some tubes and burrows.
LDW-Y3-SU-ENR-AC-5B	R3	Silt	N	Y	Y	Y	H	Y	Barnacle (2)	N	NA	N	N	L	Few pieces of gravel.
LDW-Y3-SU-ENR-AC-5B	R4	Silt	Y	Y	Y	Y	L	N	NA	N	NA	N	N	L	Image is slightly disturbed by turbidity in the water column. Silt with some tracks and biogenic depressions. Few burrows and tubes.
LDW-Y3-SU-ENR-AC-6A	R1	Silt and sand	Y	Y	Y	Y	M	N	NA	N	NA	N	N	M	Biogenic depression and evidence of recently excavated reduce sediment.
LDW-Y3-SU-ENR-AC-6A	R2	Silt	N	Y	Y	Y	H	Y	Amphipod (3)	N	NA	N	N	M	Many tracks.
LDW-Y3-SU-ENR-AC-6A	R3	Silt	N	Y	Y	Y	H	Y	Shrimp (1)	N	NA	N	N	M	Finfish (1). Many tracks.
LDW-Y3-SU-ENR-AC-6B	R1	Silt	N	Y	Y	Y	H	N	NA	N	Detritus	L	N	M	One piece of gravel. Many tracks.
LDW-Y3-SU-ENR-AC-6B	R2	Silt	N	Y	Y	Y	M	N	NA	N	NA	N	N	M	Few shell fragments.

Table 3-6b. Year 3 Subtidal ENR+AC Pilot Subplot PV Results

				Lebensspuren											
Station	Replicate	Sediment Type	Bedforms	Burrows	Tubes	Tracks	Total Abundance	Epifauna	Epifauna Type (Count)	Mud Clasts	Debris Type	Debris Cover	*Beggiatoa*	Surface Boundary Roughness (cm)	Comments
LDW-Y3-SU-ENR-AC-6B	R3	Silt	N	Y	Y	Y	H	N	NA	N	NA	N	N	M	One laser visible. Finfish (1). Large diameter burrow, possible shrimp burrow.

Notes:
-- = not analyzed
Lebensspuren = biologically formed sedimentary structures
AC = activated carbon
ENR = enhanced natural recovery
H = high
L = low
M = medium
N = no
NA = not applicable
PV = plan view
SPI = sediment profile imaging
Y = yes

Table 3-7. Prism Penetration and aRPD Depth Summary Statistics from the Baseline, Year 0, Year 1, Year 2, and Year 3 SPI Surveys

Prism Penetration Depths (cm)					
Statistic	**Intertidal ENR**				
	Baseline	***Year 0***	***Year 1***	***Year 2***	***Year 3***
N	*37*	*36*	*36*	*36*	*36*
Mean	9.7	7.4	5.1	2.5	3.4
Min	2.9	5.4	2.8	0.5	1.6
Max	14.6	12.6	14.3	4.8	5.3
	Intertidal ENR+AC				
N	--	*36*	*35*	*35*	*36*
Mean	--	8	5.6	2.8	2.8
Min	--	2.9	5.6	2.3	0.7
Max	--	10.8	9	12.1	8.3
Statistic	**Scour ENR**				
	Baseline	***Year 0***	***Year 1***	***Year 2***	***Year 3***
N	*36*	*36*	*36*	*30*	*36*
Mean	13.8	9.9	9.3	5.2	9.0
Min	0.3	6.2	0.0	3.4	6.2
Max	16.6	16.4	13.5	8.5	12.1
	Scour ENR+AC				
N	--	*36*	*36*	*35*	*36*
Mean	--	9.9	7.8	3.9	5.9
Min	--	6.5	4.1	0.8	1.4
Max	--	19.1	13.9	8.1	10.5
Statistic	**Subtidal ENR**				
	Baseline	***Year 0***	***Year 1***	***Year 2***	***Year 3***
N	*36*	*36*	*33*	*36*	*36*
Mean	12.7	10.5	5.4	2.4	3.2
Min	5.8	6.1	3.0	0.3	0.9
Max	21.6	16.0	13.4	8.4	9.4
	Subtidal ENR+AC				
N	--	*36*	*36*	*36*	*36*
Mean	--	10.8	7.4	3.0	9.0
Min	--	6.6	1.9	0.7	1.6
Max	--	20.4	19.9	11.9	17.5

aRPD Depths (cm)					
Statistic	**Intertidal ENR**				
	Baseline	***Year 0***	***Year 1***	***Year 2***	***Year 3***
N	*30*	*0*	*26*	*5*	*6*
Mean	2.2	Ind.	2.5	1.1	1.5
Min	0.8	Ind.	1.1	0.7	1.1
Max	4.6	Ind.	3.5	2.3	2.0
	Intertidal ENR+AC				
N	--	*2*	*23*	*10*	*6*
Mean	--	3.8	2.3	1.6	1.0
Min	--	3.3	0.4	1.0	0.5
Max	--	4.3	3.6	3.4	2.0
Statistic	**Scour ENR**				
	Baseline	***Year 0***	***Year 1***	***Year 2***	***Year 3***
N	*35*	*0*	*33*	*29*	*36*
Mean	2.0	Ind.	1.9	1.5	1.6
Min	1.0	Ind.	1.1	1.0	0.9
Max	2.8	Ind.	3.2	2.2	2.6
	Scour ENR+AC				
N	--	*4*	*21*	*13*	*20*
Mean	--	0.8	1.4	2.1	0.8
Min	--	0.5	0.5	1.5	1.3
Max	--	1.25	2.5	2.9	1.9
Statistic	**Subtidal ENR**				
	Baseline	***Year 0***	***Year 1***	***Year 2***	***Year 3***
N	*34*	*18*	*20*	*5*	*26*
Mean	1.3	1.5	2.6	1.2	0.8
Min	0.2	0.2	1.7	0.3	0.4
Max	3.0	2.0	4.3	3.4	1.9
	Subtidal ENR+AC				
N	--	*23*	*22*	*17*	*33*
Mean	--	1.4	1.3	1.5	1.3
Min	--	0.3	0	0.2	0.2
Max	--	3	3.8	3	3.6

Notes:
AC = activated carbon
aRPD = apparent redox potential discontinuity
ENR = enhanced natural recovery
Ind. = Indeterminate
SPI = sediment profile imaging

Table 4-1. Number, Distribution, and Size of Feeding Voids Observed in Year 3 SPI Images

	Intertidal Plot			
	ENR		ENR+AC	
Sediment Depth (cm)	No. of Voids	Average Void Area (cm)	No. of Voids	Average Void Area (cm)
0–2	0	0.00	1	0.26
2–5	7	1.40	6	2.50
5–10	0	0.00	0	0.00
>10	0	0.00	0	0.00
Total or Mean Area	**7**	**0.35**	**7**	**0.69**

	Scour Plot			
	ENR		ENR+AC	
Sediment Depth (cm)	No. of Voids	Average Void Area (cm)	No. of Voids	Average Void Area (cm)
0–2	0	0.00	0	0.00
2–5	11	0.25	16	0.45
5–10	132	0.53	47	0.70
>10	19	1.24	1	0.11
Total or Mean Area	**162**	**0.50**	**64**	**0.31**

	Subtidal Plot			
	ENR		ENR+AC	
Sediment Depth (cm)	No. of Voids	Average Void Area (cm)	No. of Voids	Average Void Area (cm)
0–2	3	0.80	3	0.20
2–5	10	0.40	10	0.39
5–10	0	0.00	20	0.29
>10	0	0.00	3	0.40
Total or Mean Area	**13**	**0.30**	**36**	**0.32**

Notes:
AC = activated carbon
ENR = enhanced natural recovery
NA = not applicable
SPI = sediment profile imaging