2012 Peninsula Harbour
Cap Movement and Vegetation Survey

July 7, 2013

Prepared for:
Environment Canada

Prepared by:
Dr. Robert F. Foster
Brian Ratcliff

Abstract

Approximately 23ha of Jellicoe Cove in the Peninsula Harbour Area of Concern was capped during the summer of 2012 with approximately 15 to 20 cm of medium to coarse sand in order to enhance natural recovery and reduce exposure of organisms to contaminated sediments. Post-capping monitoring of submerged aquatic vegetation and potential sediment movement was conducted September 26-28 and October 3-4, 2012 by Northern Bioscience. Underwater video was collected using a boat-mounted SeaViewer "Sea Drop 950" color video camera along about 30km of transects at approximate 50 m spacing. In addition, 19 grabs were taken with a petite ponar grab to confirm substrate composition at selected locations in and adjacent to the cap. A total of 3712 georeferenced video images were extracted and interpreted at approximately 5 m intervals along the transects; of which 1840 were in the actual cap area. Interpretation of underwater video showed that only sparse patches of stonewort and other submerged aquatic vegetation remained after capping, compared to much more dense patches of stonewort, pondweeds and other submergents outside the cap zone. Interpretation of substrate type and movement was hindered in portions of the video by a layer of fine silt overlaying the coarser cap material, presumably settling after the capping operation or fines from outside the cap area moving into the capped area . Nonetheless, cap material was observable in much of the cap. No mobilization of cap material beyond the cap or adjacent 3 m transition zone could be detected. Dense submergents along portions of the cap margin in shallow water also support this interpretation. Continued monitoring of substrate movement and vegetation recovery is recommended.

Contents

List of Figures

List of Tables

List of Appendices

1 Introduction

1.1 General

Peninsula Harbour, a large embayment adjacent to the town of Marathon on Lake Superior, was identified as an Area of Concern in 1985. Jellicoe Cove encompasses approximately 97 ha of Peninsula Harbour south of Skin Island (Figure 1) and has been the focus of numerous studies due to elevated concentrations of mercury and polychlorinated biphenyls (PCBs) in sediment and fish as the result of industrial activities.

Figure 1. Map of Peninsula Harbour Area of Concern near town of Marathon (Beak 2001).

Capping of the contaminated sediment with a layer of clean sand was proposed with the following objectives:

- To reduce risk to biota from contaminated sediment in Jellicoe Cove thus reducing bioaccumulation into the food chain;
- To reduce the spread of contaminated sediment from Jellicoe Cove to the rest of Peninsula Harbour;
- To expedite the natural recovery of Jellicoe Cove; and
- To facilitate ecosystem recovery in Peninsula Harbour which will contribute to “delisting” as an Areas of Concern (AOC) identified in the *Great Lakes Water Quality Agreement between Canada and the United States*).

1.2 Capping Operation

The field portion of the capping program was conducted from May 28 to August 10, 2012 (AECOM 2012). The cap (Figure 2, Appendix 1) was to cover approximately 23 ha, or about ¼ of Jellicoe Cove or about 2.5% of Peninsula Harbour and even less of the Peninsula Harbour AOC, which extends further out into Lake Superior. As described in AECOM (2012), the thin layer capping operation was performed mechanically, using a capping barge consisting of a long-reach excavator (Sennebogen) and a deck (material barge), as well as a tug boat and two support vessels. The bucket attached to Sennebogen, stationed at the capping barge, was used to grab the sand (capping material) from the material barge, and place the capping material over the target location. After release, the sand descended in the water column through a sediment (turbidity) curtain beneath the barge, before the sediment settled on the lake bottom. The length of the turbidity curtain attached to the capping barge varied from approximately 3 to 0.70 m below water surface depending on the depth of the lake bottom.

The thin layer cap placement criteria required a minimum of 20 cm average depth of coarse sand in near shore areas less than 5 m water depth and a minimum of 15 cm average depth of medium sand in deeper water portions of the cap area (Table 1). Coarse sand used for capping was imported from Manitoulin Island and medium sand was obtained locally (AECOM 2012). Quality assurance/quality control (QA/QC) sampling indicated that a minimum of 98.8% of the medium sand from Marathon passed through a 12.5 mm sieve (AECOM 2012).

Table 1.Medium and coarse sand thin layer cap criteria (AECOM 2012).

	Coarse Sand Cap	Medium Sand Cap
Minimum Cap Thickness	12.5 cm	10 cm
Average Cap Thickness	>=20 cm	> =15 cm
Maximum Cap Thickness	37.5 cm	30 cm

An initial test phase was conducted, with cap depth verified with sediment cores, before production capping occurred form June 12 to August 5. Capping of the primary cap area (Area 1) was generally conducted before capping of the supplementary cap (Area 2).

A total of 216,402 m^3 of cap material was placed on the 20.3 ha of Area 1 and associated transition zones, with approximately 62% medium sand by volume, and 38% coarse sand (AECOM 2012)(Figure 2). Cap material was placed in a 3 m wide transition zone surrounding Area 1 to slope the new cap to the surrounding substrate or sediment, with the exception of areas less than 1.5 m water depth along the rocky shoreline where no capping was to be applied. A piston core sampler was used to obtain core samples for sand placement thickness verification during project test and production phases (Appendix 2); core sampling was conducting in each cell to ensure the minimum cap depth was achieved (AECOM 2012).

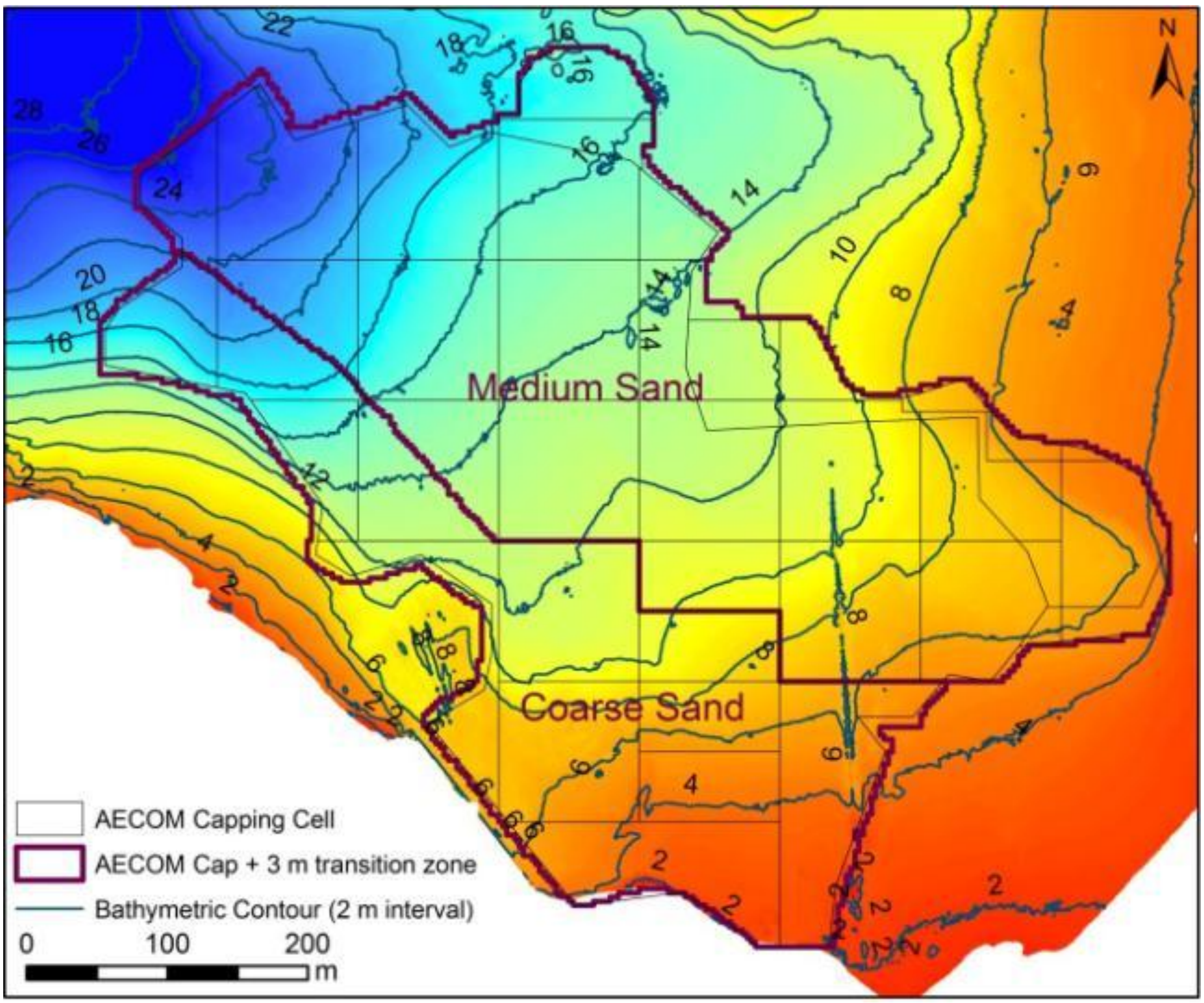


Figure 2. Cap area in Jellico Cove showing location of coarse and medium sand capping (AECOM 2012) overlain on bathymetry (DFO unpublished data).

The methodology for confirmation of performance (thickness and spatial coverage) of capping consisted of measurement of cores taken at selected locations, supported by review and oversight of information provided by the contractor on the quantity and location of sand placed (AECOM 2012). Sand quantity placed was determined from records of sand displacement measurements on the barge from which the sand was placed. According to AECOM (2012), capping activities across multiple cells in the same day and uncertainty in use of barge displacement measurements (influenced by weather, load balancing, etc.) generated challenges in confirming quantities placed in individual cells.

1.3 Study Purpose

The cap materials were specified based on calculations affirming stability, and although there remains potential for cap material to shift over time, movement is not anticipated to be substantial or widespread (AECOM 2012).

This current study was designed to provide post construction baseline data to monitor:

- the distribution and potential movement of the sand cap and
- the recovery of SAV in the proposed cap and adjacent areas.

2 Methods

Fieldwork for the Peninsula Harbour Sediment Movement and Submerged Aquatic Vegetation Monitoring Protocol (60119893 Sub-consultant Agreement) was conducted September 26-28 and October 3-4, 2012, after the capping operation was finished. Field personnel included Dr. Robert F. Foster, Brian Ratcliff, and Michael Butler. Harbour conditions were relatively calm with good weather during the survey.

Video was collected using a boat-mounted SeaViewer “Sea Drop 950” color video camera (with LED lighting), the “Sea Trak” GPS video overlay unit, and a video capture unit (DVR-SD) for storing the video to SD cards (Figure 1). This system allows for GPS coordinates and time/date to be overlain on the video as it is recorded, which allowed for precise georeferencing of all images. The camera unit was suspended by hand over the side of the boat using the kevlar-reinforced video cable (Figure 2). Alternate deployment methods using a downrigger were also tested, but this method allowed the greatest precision in maintaining the desired depth of the video camera above the bottom substrate. A 50 cm length of 1/2" copper pipe was attached to the camera to provide scale in the video and to disturb the substrate when needed to assess the substrate composition.

Figure 1.SeaViewer unit.

Figure 2.Suspending the underwater video camera.

A 5 lb downrigger ball attached to the camera helped maintain depth of the camera as the boat cruised along predetermined transects at approximately 1-2 km/hr. A handheld GPS (Garmin GPSMap 60CSx) was used to maintain position along transects and record locations of particular features (e.g. vegetation beds, ponar grabs). A grid of transects spaced approximately 50 m apart was surveyed over the cap and adjacent areas (Figure 5). Approximately 30 km of underwater video was collected.

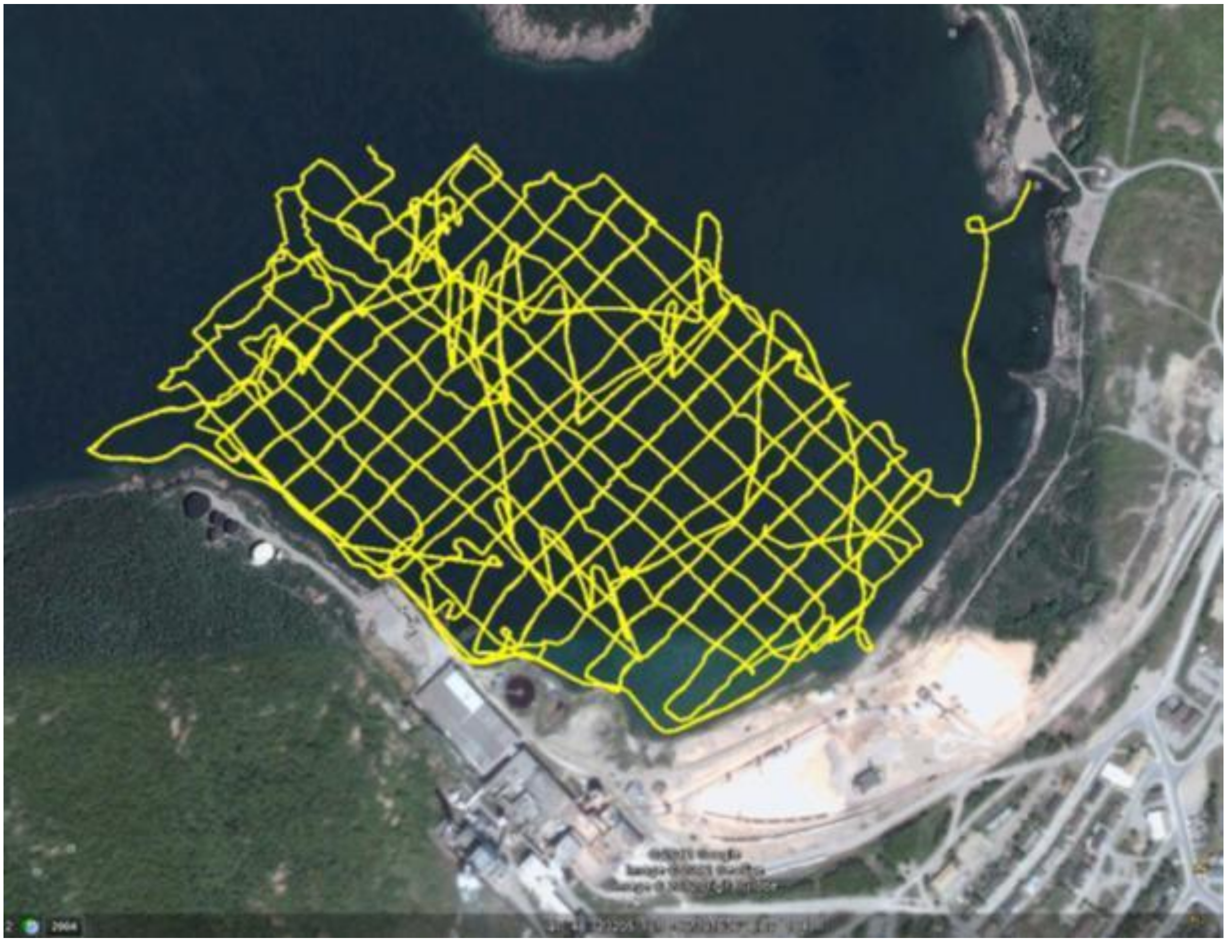


Figure 3. GPS track of video taken during transects and ponar grabs, September-October 2012.

A total of 19 grabs were taken with a petite ponar grab to confirm substrate composition at selected locations in and adjacent to the cap. Video was recorded of the substrate where the grabs were taken, and digital photographs of the material were also taken once the grab was retrieved (Figure 5). A visual assessment of particle size was conducted in the field; no laboratory analyses were conducted.

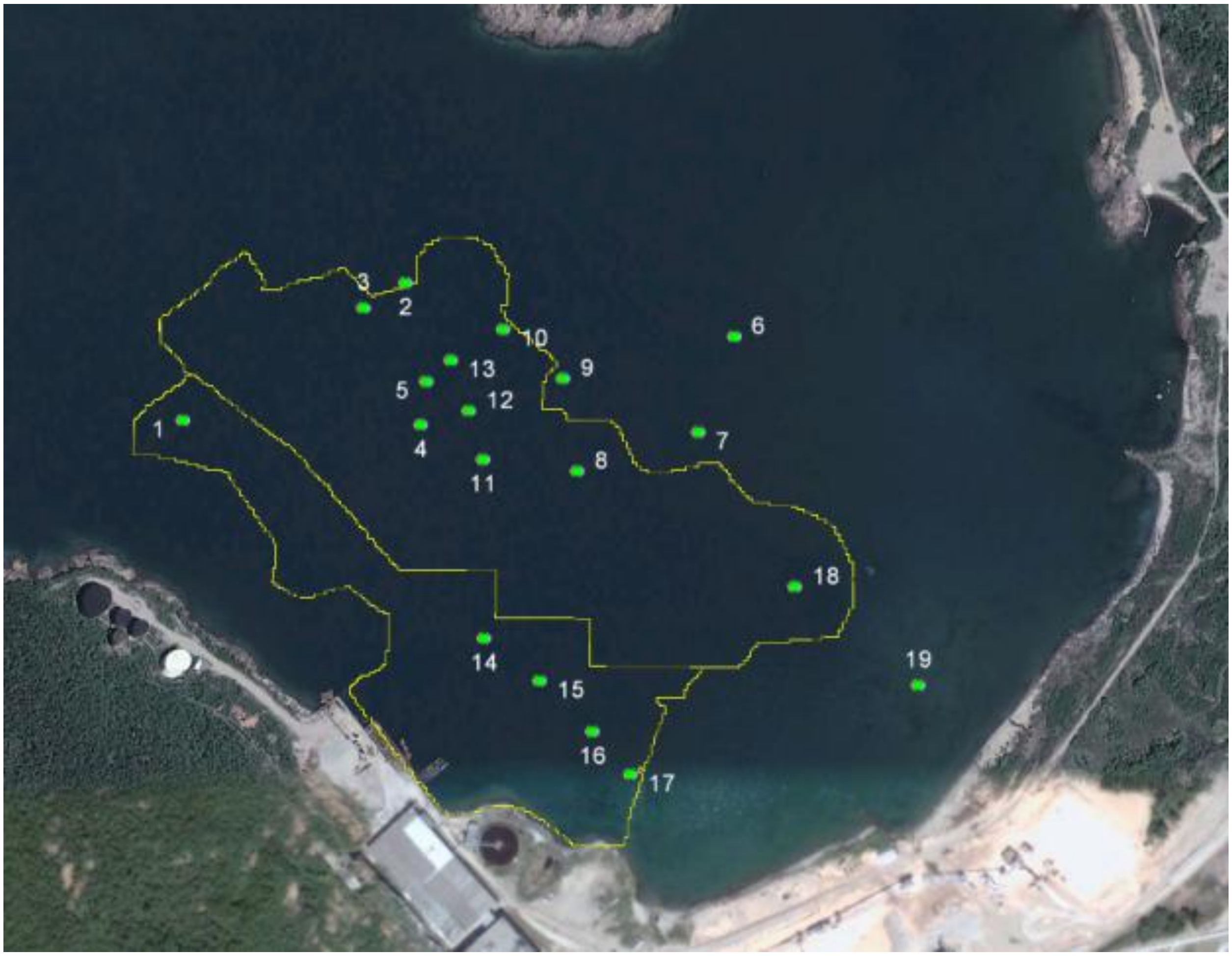


Figure 3.October 3, 2012 ponar grab locations in relation to the cap (GoogleEarth imagery).

Figure 4.Petite ponar grab in action (left) and medium sand ponar grab sample (right).

Video data were interpreted by Northern Bioscience personnel involved with the field survey. Videos were downloaded and viewed on-screen using custom software provided by SeaView as well as Windows MediaPlayer. Georeferenced sample points were be extracted approximately every 5 m along the survey tracks and attribute data entered into a spreadsheet, which was then brought into ArcGIS for mapping and analysis. The sampling interval of interpreted video frames from the 2005 and 2007 Environment Canada videos was variable, but a 5 m interval was fairly consistent and allowed comparison pre-and post-capping. The entire video footage was viewed during the analysis, and representative still images (jpeg) were extracted from the video.A total of 3766 video points were extracted (3712 with an interpretable image), of which 1840 were in the actual cap area.

At each sample point the following was recorded/ interpreted:

- Submerged aquatic vegetation (SAV) abundance in the following cover classes: <5%, 5-25%, 26-50%, 50-75%, >75% (these can be pooled to approximate the sparse, moderate and dense classes used in the Environment Canada videos);
- Approximate SAV height (cm);
- SAV species composition (where possible) (ponar grabs will be taken at select locations in the field to confirm species identifications);
- Other habitat features (e.g., coarse woody debris);
- Substrate type (e.g., fine sediments, medium to coarse sand, gravel, cobble, bark, mixed).
- Photo number (for selected points).

Water depth was interpolated from existing bathymetric data in conjunction with the GPS coordinates. Video analysis of substrate types has some inherent limitations that must be recognized. Different classes of fine sediments are impossible to discriminate, therefore clays (<.002 mm), silts (0.002 - 0.05 mm), and fine to very fine sands (0.002 - 0.25mm) silts were pooled as “fine sediments”.

3 Results and Discussion

3.1 Substrate

3.1.1 Substrate Types

Angular coarse sand derived from crushed Manitoulin Island limestone could be easily distinguished from more rounded, multi-coloured medium sand derived from local granite (Marathon area sources) in samples taken by ponar grabs (Figure 5). See Appendix 3 for map and photos of ponar grab samples. Ponar grab samples taken outside the cap zone, had easily distinguished fine-textured sediments, with silt present in deeper water and fine sand in shallow water east of the cap zone (Figure 6). Several ponar grab samples within the cap zone had a range of particles sizes with some silts mixed in with medium or coarse sand.

Figure 5. Coarse (Ponar # 17, left) and medium (Ponar # 2, right) sand capping material.

Figure 6.Silty (Ponar #6, left) and fine sandy sediment (Ponar #19, right) from outside the cap zone.

Table 2. Summary of ponar grabs taken in October 3, 2012 post-capping. See Appendix 3 for map and photos of ponar grab samples.

Ponar Grab	Easting	Northing	Water Depth (m)	Substrate Notes
1	544169	5396956	18.3	limestone coarse sand
2	544403	5397103	17.1	looks like fine silt and sand on video but actually granite medium sand when sampled
3	544359	5397077	18.6	granite medium sand with some silt
4	544420	5396954	14.6	virtually empty grab with some trace medium granite sand
5	544426	5396999	14.6	silt, sand, and gravel with some Chara
6	544750	5397049	7.3	greyish fine sand (or vfS) and brownish silt (outside cap zone?)
7	544713	5396948	7.0	two-tone, very fine, more silty than sandy; some brown wood and bark fragments
8	544586	5396906	11.9	empty
9	544570	5397004	13.1	empty
10	544506	5397055	14.9	a bit of granite coarse sand
11	544486	5396917	13.1	coarse to very fine sand, with some silt and very little gravel; looked fine-textured on video
12	544476	5396972	14.0	empty
13	544451	5397022	14.6	granite sand and gravel, some silt
14	544489	5396730	10.4	limestone coarse sand with silt, and some silty brown sand
15	544548	5396685	7.0	limestone coarse sand, small fraction of silt
16	544604	5396632	4.3	limestone coarse sand; also some silt; looked like coarse sand on video as well
17	544644	5396588	3.0	limestone coarse sand with more silt than last ponar grab
18	544816	5396786	5.8	granite medium sand, with fine sand as well
19	544947	5396684	1.5	homogenous fine sand; off cap

3.1.2 Constraints

Underwater video was generally capable of differentiating between capped and uncapped areas (Figure 7, Figure 8), but with some limitations and it was often difficult to differentiate between coarse and medium sand in the cap. The ability to differentiate different substrates in the underwater video varied with a number of factors including water depth, video speed, and homogeneity of substrate. Water clarity was generally very good in Peninsula Harbour and colour video was shot with ambient light. At water depths greater than about 15 msupplemental LED lighting and infra-red video was required (it automatically changes modes), although this varied with time of day and degree of cloud cover (Figure 9). Sediment type was often more difficult to differentiate at these greater depths, and approximately 22% of the cap is greater than 16 m deep. Survey speed was generally kept to below 2 km/hr, and reduced where necessary to ensure that the video was interpretable. Video could also be paused post-hoc in the viewing software to examine individual frames in more detail where necessary.

Figure 7. Coarse sand used for capping (left) and uncapped silt (right).

Figure 8.Rippled fine sand in shallow water outside the cap zone (left) and pulp logs (right).

Figure 9. Video image at 18 m and adjacent Ponar #1 grab sample.

The greatest constraint in determining substrate type using underwater video was that for much of cap area, there appeared to be a thin layer (typically several mm) of silt over the medium and coarse sand cap material. Substrate type was particularly difficult to discern at depths where infra-red lighting was required, although this was confirmed at a small number of locations using ponar grabs. Underlying substrate was routinely exposed by disturbing the upper layer of sediment with the probe or downrigger ball attached to the camera during surveying. The resulting plume of sediment also helped confirm the silty texture of the upper sediment (Figure 10). It is presumed that this silt was disturbed during capping operations and remained in suspension until settling on top of the cap material. There could be some natural sedimentation but natural sedimentation rates in Peninsula Harbour are believed to be relatively low (AECOM 2009b) due to the lack of large sediment-bearing tributaries in Peninsula Harbour.

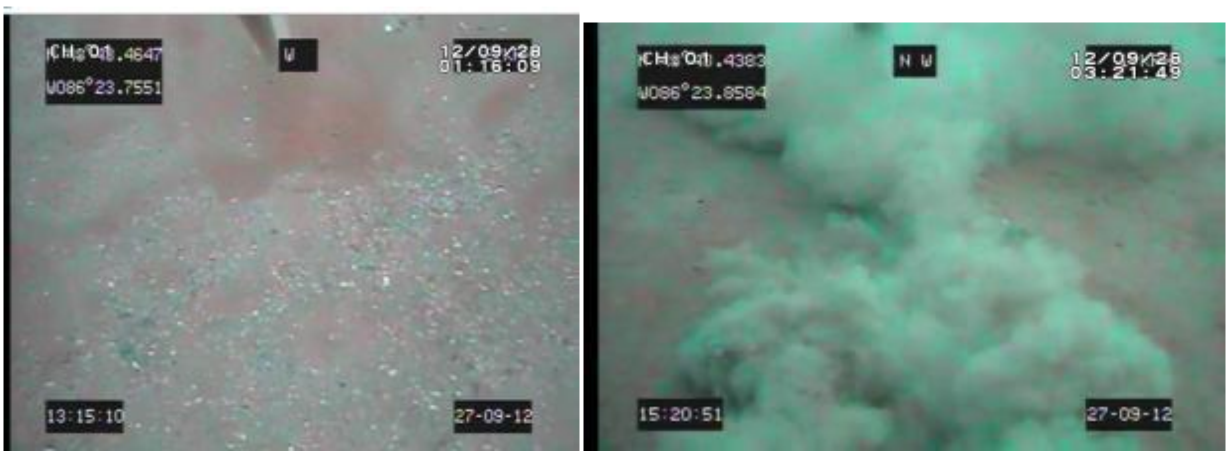


Figure 10.Cap material with silt (left) and silt plume disturbed by camera (right).

3.1.3 Cap Distribution and Mobilization

Based on video interpretation of substrate, most of the cap appeared to be medium or coarse sand, although in deeper areas numerous images showed silt as the predominant surface substrate (Figure 12). Cap material is presumed to be present below the silt, which was confirmed in the locations where ponar grabs were taken or where the upper silt was disturbed by the video camera. In addition, there was relatively little submergent vegetation remaining in the cap area (see 3.2), indicating successful cap deposition. Although somewhat difficult to confirm directly by video interpretation of substrates, it generally appears that most of the medium and coarse sand deposited in the cap area has remained in situ. Dense submergent growth (see 3.2 Submerged Aquatic Vegetation) along at least some of the margin of the cap provides strong evidence for a lack of mobilization of cap material at the time of the survey in late September.

There was no evidence of cap mobilization in shallow waters to the southwest of the cap along the bedrock, cobble and sheet piling shore. There did not appear to be much, if any cap movement along gently sloping southeast sandy shore either. There may perhaps have been some movement along deeper edge of cap but it is difficult to determine if it is from the cap. Limited previous video and relatively unreliable substrate data from acoustic mapping (AECOM 2009a) (see Foster and Harris 2012 for discussion) in deeper water off the cap limits comparison with pre-capping conditions. Coarse material was observed outside the cap area on the video. Some of this could potentially originate from capping operations, but at least some may be original substrate. For example, Figure 11 shows angular coarse sand, gravel, and rock near a rock outcrop at the northern edge of the cap.

Figure 11. Coarse material (left) outside northern edge of cap by rock outcrop (right).

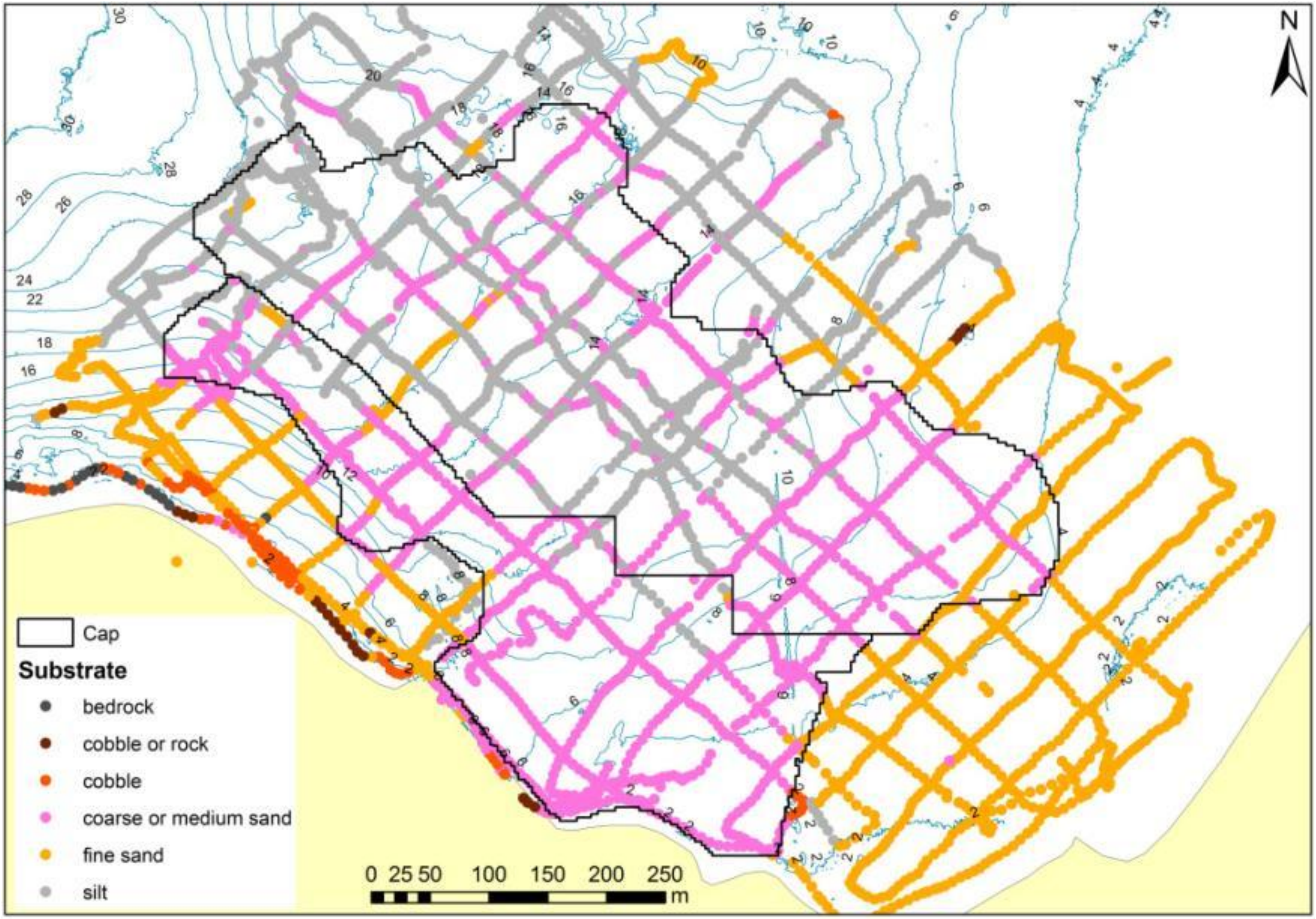


Figure 12. Sediment type interpreted from underwater video taken post-capping, Sept-Oct 2012.

3.1.4 Comparison with Pre-capping Conditions

In georeferenced underwater video taken in 2005 and 2007 by Environment Canada and BioSonics (Foster and Harris 2011), substrate was classified as fine sediments (<2 mm), gravel (2-64 mm), cobbles and boulders (>64 mm) and bedrock. Of the 576 points in or within 100 m of the proposed cap that were interpreted by Environment Canada from their 2005 and 2007 videos, 78% were visually classified as soft sediments and 18% as mixed substrates(Figure 13).

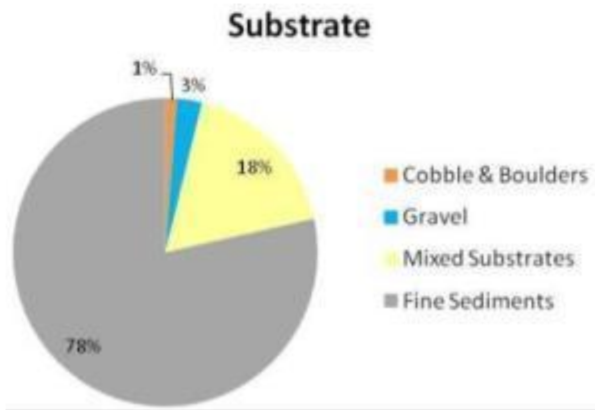


Figure 13. Substrate composition based on 568 interpreted Environment Canada 2005 &2007) video points within the proposed cap area and 100 m buffer.

At least in the area of the cap for which 2005 and 2007 video was available, there was a narrow band (perhaps 10-20 m) of coarser sediments close to shore in shallower (<5 m approximately) water where there is too much wave energy for finer silts to settle out, at least during the ice-free season. The substrate consists of patches of rounded, natural–looking cobble and larger, darker, angular, rocks that are presumably rip rap used for fill and shoreline armouring. There are also areas of coarse sands rippled from wave action and mixed substrates (Figure 14). Farther west along The Peninsula was an area along the shore mapped as bedrock by Beak/AECOM. The characterization of the substrates in these areas was confirmed by video interpretation from the 2012 survey. Video from 2012 surveys also confirmed the existence of rock outcrops in deeper water of the cap (e.g. Figure 11), as identified by AECOM (2009a; Figure 13). No clay, as was mapped by Beak (2001), was observed in the cap area however in 2012.

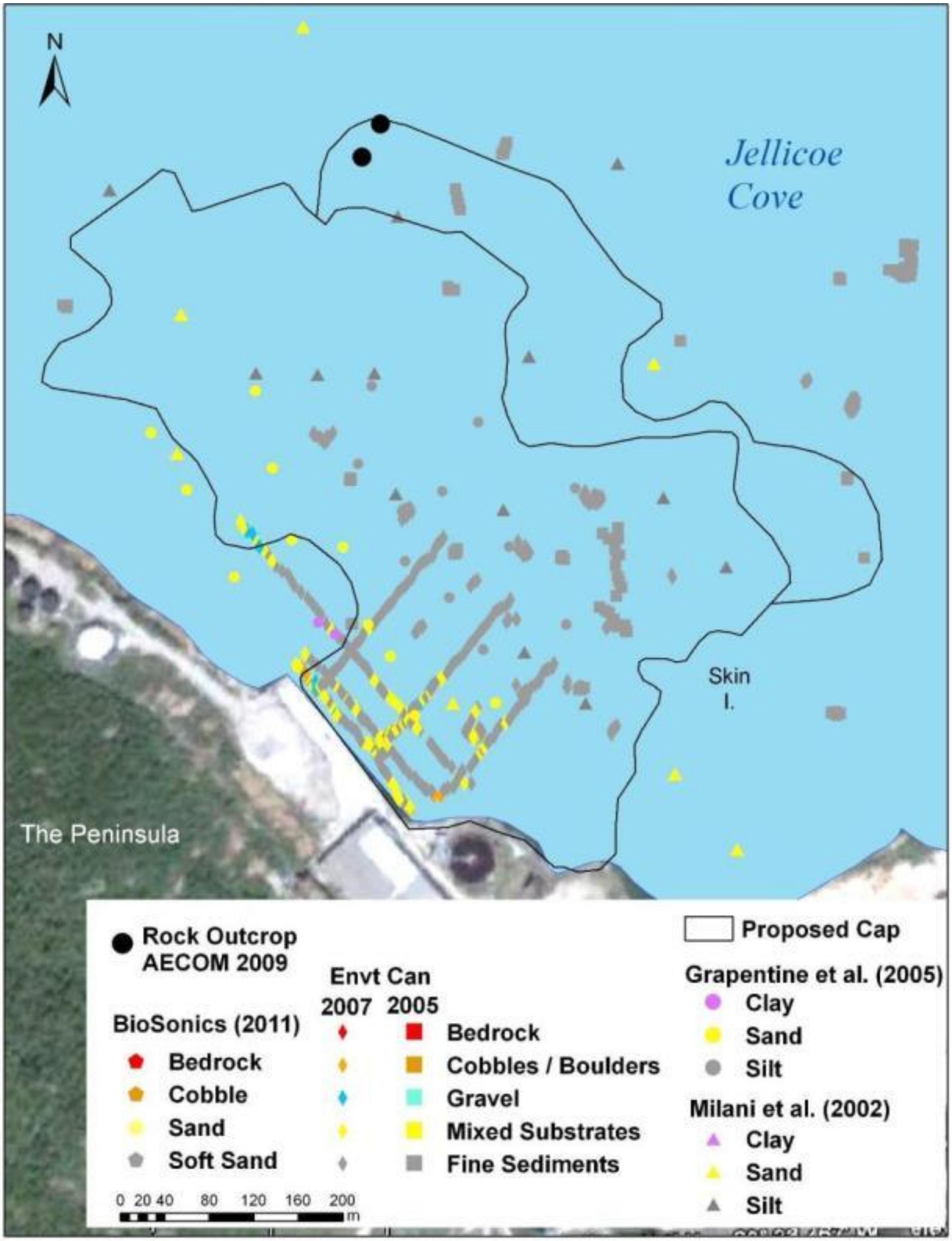


Figure 14. Detail of substrate verification points for proposed cap area in Jellicoe Cove based on underwater video review and sediment grabs.

3.2 Submerged Aquatic Vegetation

3.2.1 Species

Submergents were easily detectable on the video where they remained in the cap or were present outside the cap (Figure 21). Within the cap area, stonewort or muskgrass (*Chara* cf. *vulgaris*), was the most abundant species based on video interpretation (Figure 15). Stonewort is actually a jointed, filamentous macroalgae that resembles vascular plants. Although less abundant, Canada smartweed (*Elodea canadensis*) and several species of pondweeds (*Potamogeton* spp.) could be also distinguished in the 2012 videos (Figure 16, Figure 17). These were the same species observed by Beak (2001) and were present on the 2005-2007 Environment Canada underwater videos. A couple of globular clumps of what appears to be algae was observed in the cap zone in approximately 5-6 m of water and approximately 130 to 160 m offshore (Figure 18). Several fragments of algae were also observed outside the cap in shallow water (<1 m) on cobble substrate that appears to have washed in (Figure 19).

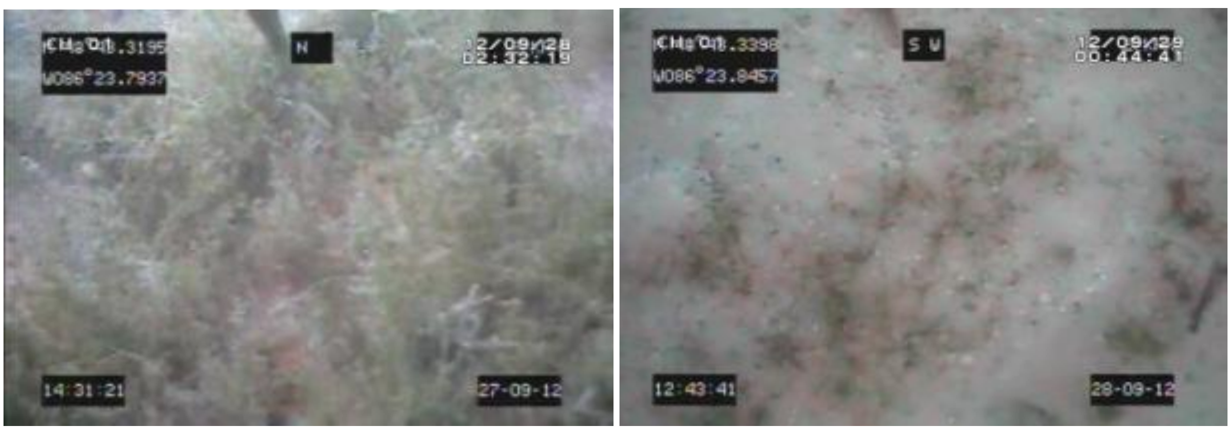


Figure 15. Dense and sparse stonewort (*Chara*) post-capping.

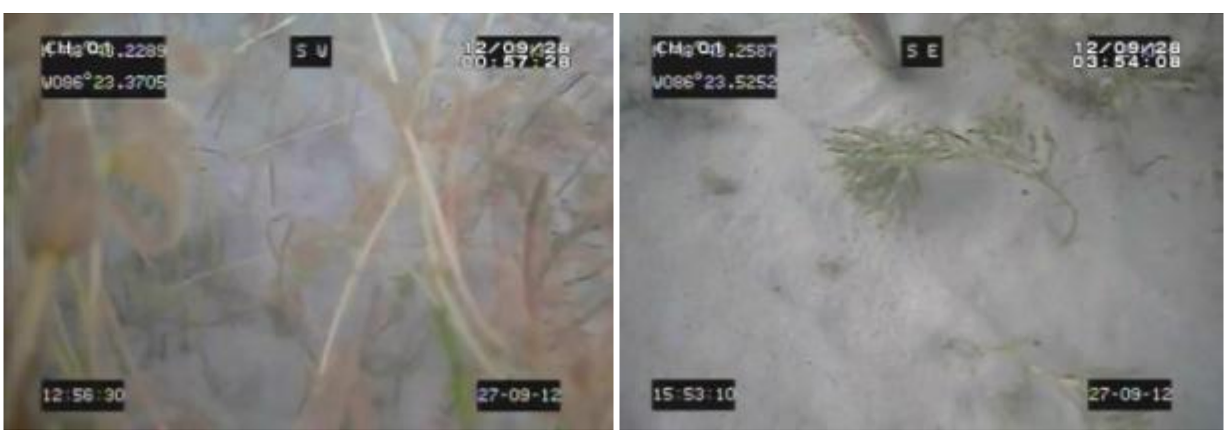


Figure 16. Pondweeds (*Potamogeton* spp.) observed post-capping during 2012.

Figure 17. Submergents observed during 2012: pondweeds, *Potamogeton* spp. (left) and Canada waterweed, *Elodea canadensis* (right).

Figure 18. Clumps of apparent algae in cap.

Figure 19. Fragments of algae in nearshore zone outside cap.

3.2.2 Abundance and Distribution

Only 2.9% (n=53) of the 1826 images interpreted from the cap showed evidence of submerged aquatic vegetation (Table 3). Of these, 24 were of pondweeds and 27 were of stonewort (several images had more than one species present). Stonewort was most commonly observed closer to the southeast shore of the cove compared to the pondweed which was scattered throughout more of the cap area, including deeper water (up to 10+ m). Stonewort was more common near the docks compared to farther offshore; this may be due in part possible nutrient enrichment near the docks. In contrast, approximately 30% of the 1886 images from outside the cap zone showed evidence of submergents. Both pondweeds and stonewort were more wide spread outside the cap, with pondweeds were particularly widespread in the shallow (<2 m) water on sandy substrates to the southeast of the cap (Figure 21). Only a few occurrences of algae or Canada smartweed were observed, although the latter may have been overlooked in moderate to dense patches of other submergents.

Table 3.Summary of submergent abundance within and outside the cap, Sept-Oct 2012.

	SUBMERGENT ABUNDANCE			
	Dense	**Moderate**	**Sparse**	**Grand Total**
WITHIN CAP				
Algae	0	0	2	2
Pondweed	1	5	18	24
Stonewort	1	1	25	27
All Species	2	6	45	53
No Submergents				**1773**
OUTSIDE CAP				
Algae	0	0	1	1
Canada Waterweed	0	0	2	2
Pondweed	41	167	221	429
Stonewort	20	23	103	146
All Species	61	190	327	578
No Submergents				**1308**

With respect to abundance (i.e. density), most of the submergent beds in the cap were relatively sparse, with few patches of moderate to dense pondweed or stonewort (Table 3). Although much of the submergent vegetation outside the cap was sparse, there were also moderate to dense patches of pondweed, and to a lesser extent, stonewort.

In comparison, underwater video transects in 2005 and 2007 showed a much more extensive distribution and abundance of aquatic macrophytes within the cap area, including approximately 10 ha of the southern portion of the cap (Figure 22). The areas where submerged macrophytes were found ranged from shallow water to approximately 12 m, with the greatest density in 4-10 m of water. Density ranged from sparse to very dense beds up to 30-50 cm in height (Figure 20). Most of these beds have now been capped with medium to coarse sand, with few if any scattered stems poking through the cap material (Figure 20).

Figure 20. Dense stonewort along southern edge of cap zone in 2005 and at the same location (±2 m) in Sept 2012 after the application of coarse capping material.

Approximately 5 ha of aquatic macrophytes were mapped by Beak along the southeast shore of Jellicoe Cove in 2000, of which approximately only 0.5 ha overlapped the proposed cap area (Figure 22). Although this entire area was not surveyed in 2012 since it was well beyond the cap, the mapping from the available video (Figure 21) indicates that there are more extensive submergent beds in the shallow water off the beach than previously mapped.

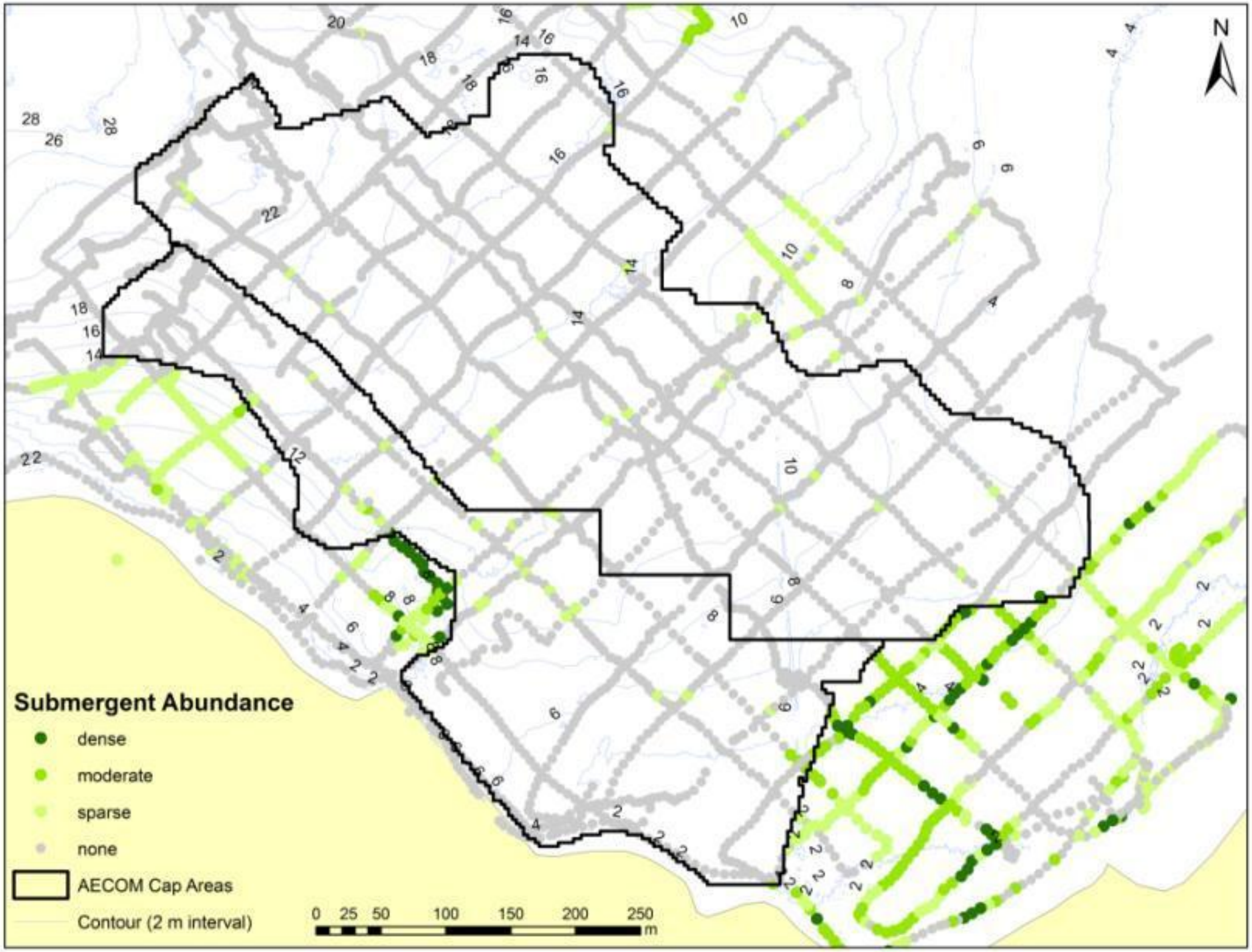


Figure 21.Distribution of submerged aquatic vegetation post-capping, September 2012.

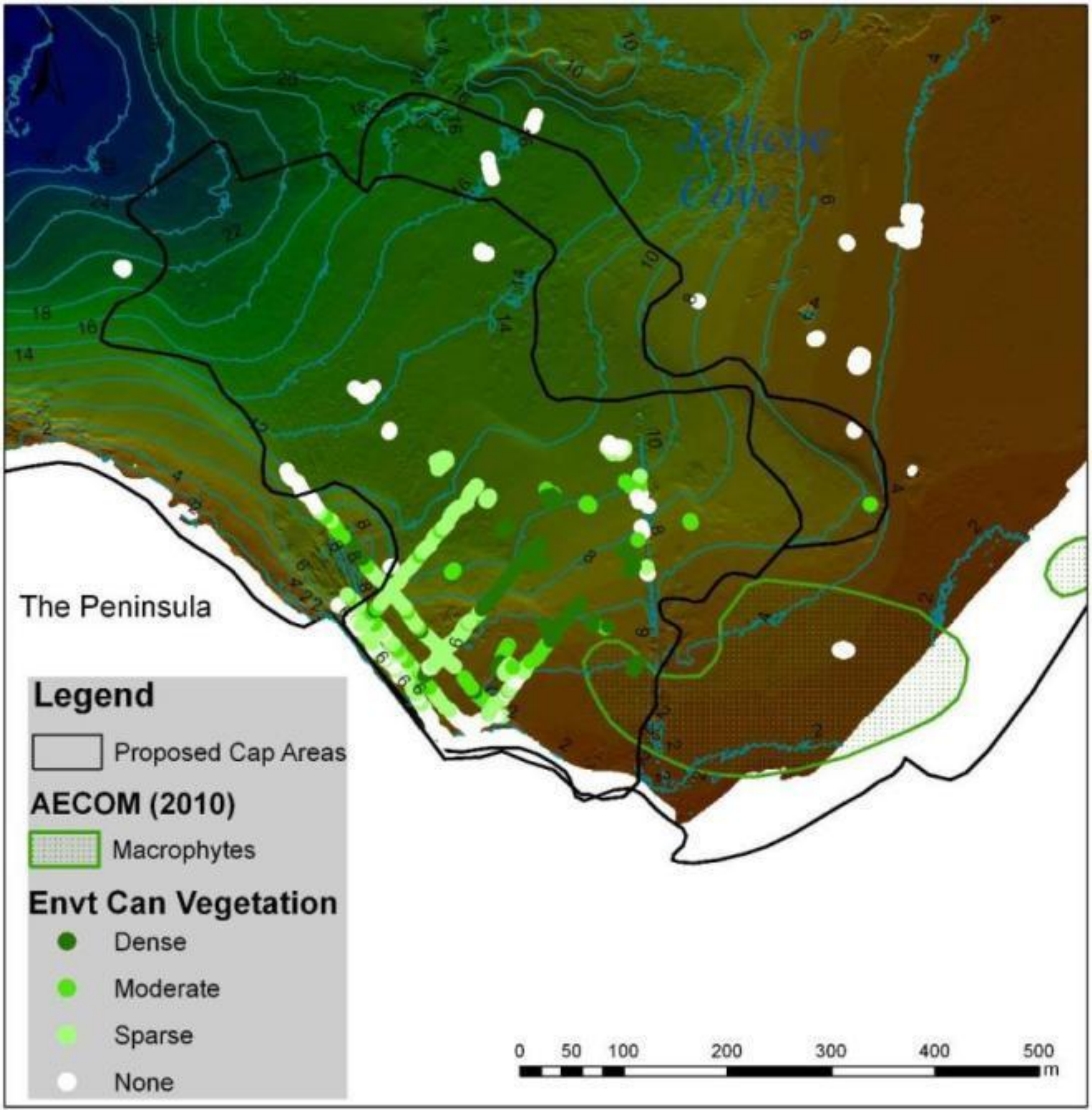


Figure 22. Distribution of submerged aquatic vegetation (macrophytes) in proposed cap area based on interpreted Environment Canada video (2005 & 2007) in relation to polygon in AECOM (2010; reproduced from Beak 2001) and bathymetry (AECOM 2009a contours; BioSonics 2010 hillshade).

3.3 Fish Habitat and Other Features

Underwater video taken for substrate and vegetation monitoring indicated some use of the cap area in late September-October, 2012. Two large brook trout (*Salveliniusfontinalis*) observed in the shallow water over a bare sand substrate and siltier vegetated bottom as well (Figure 23).

20130131-120013

Figure 23. Coaster brooktrout (*Salveliniusfontinalis*) observed in the cap zone.

Underwater video showed extensive amounts of pulpwood on the bottom of Jellico Cove in and near the cap (Figure 24), as a result of log booming in Peninsula Harbour that ceased in 1987 (AECOM 2012). Pulpwood logs were observed in 13% of the 1826 images in the cap and 9% of the 1886 images from outside the cap, across a range of water depths (Figure 25). Although there were more interpreted images with logs in the cap, most occurrences were sparse accumulations of logs, and most of the large concentrations of logs were found outside of the cap to the northeast. Bark was observed only in 0.3 % of the cap images compared to 2.9% outside the cap, where it was typically associated with pulpwood logs or firmer, sandy substrates. This likely reflects burying of bark by cap materials or silt. Small woody debris was rare throughout the cove, with sticks visible in only 11 images from both the cap and outside. Approximately 50 images (mainly outside the cap) had identifiable industrial objects or debris with many of them showing the large diameter pipe and cribbing that was a former intake or outtake for the mill (Figure 26).

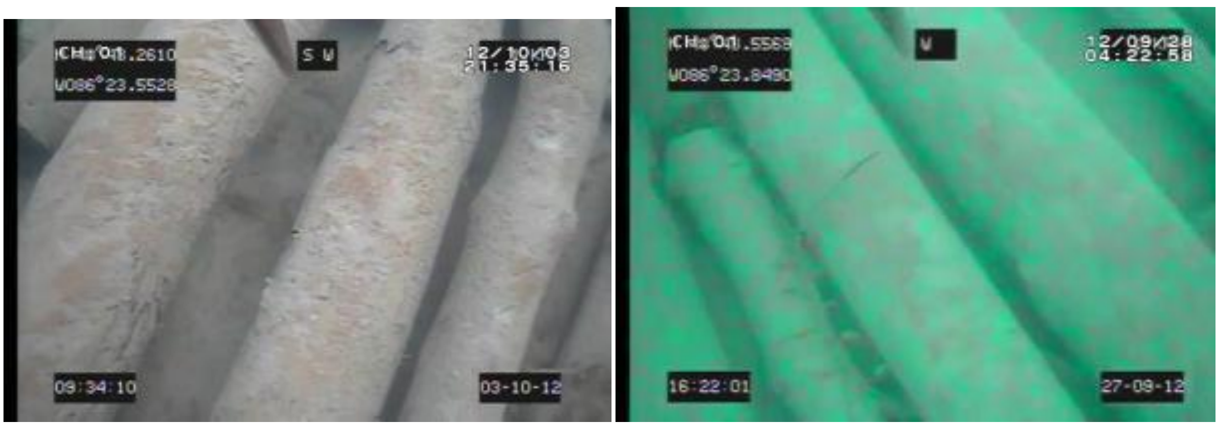


Figure 24. Abundant pulp logs in shallow water outside cap zone as well as in deep water.

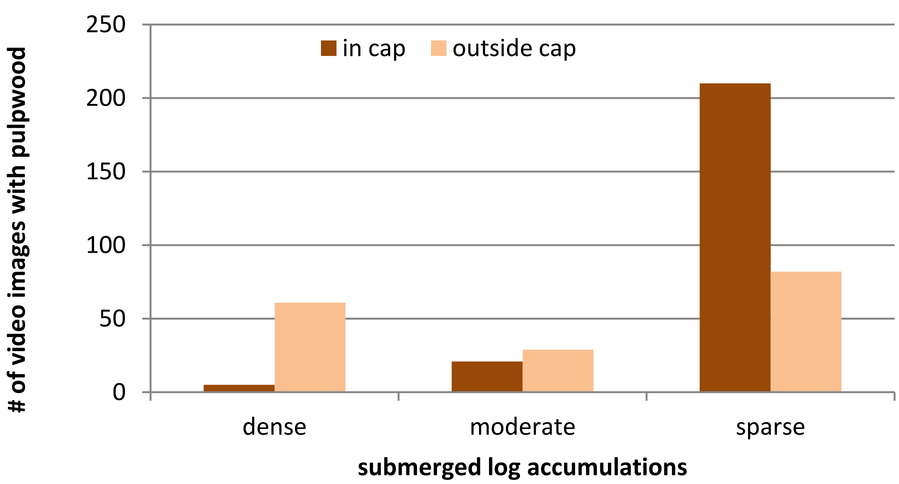


Figure 25. Abundance of submerged pulp logs in and outside the Jellico Cove cap.

Figure 26. Industrial debris and large water intake pipe observed in or near cap zone.

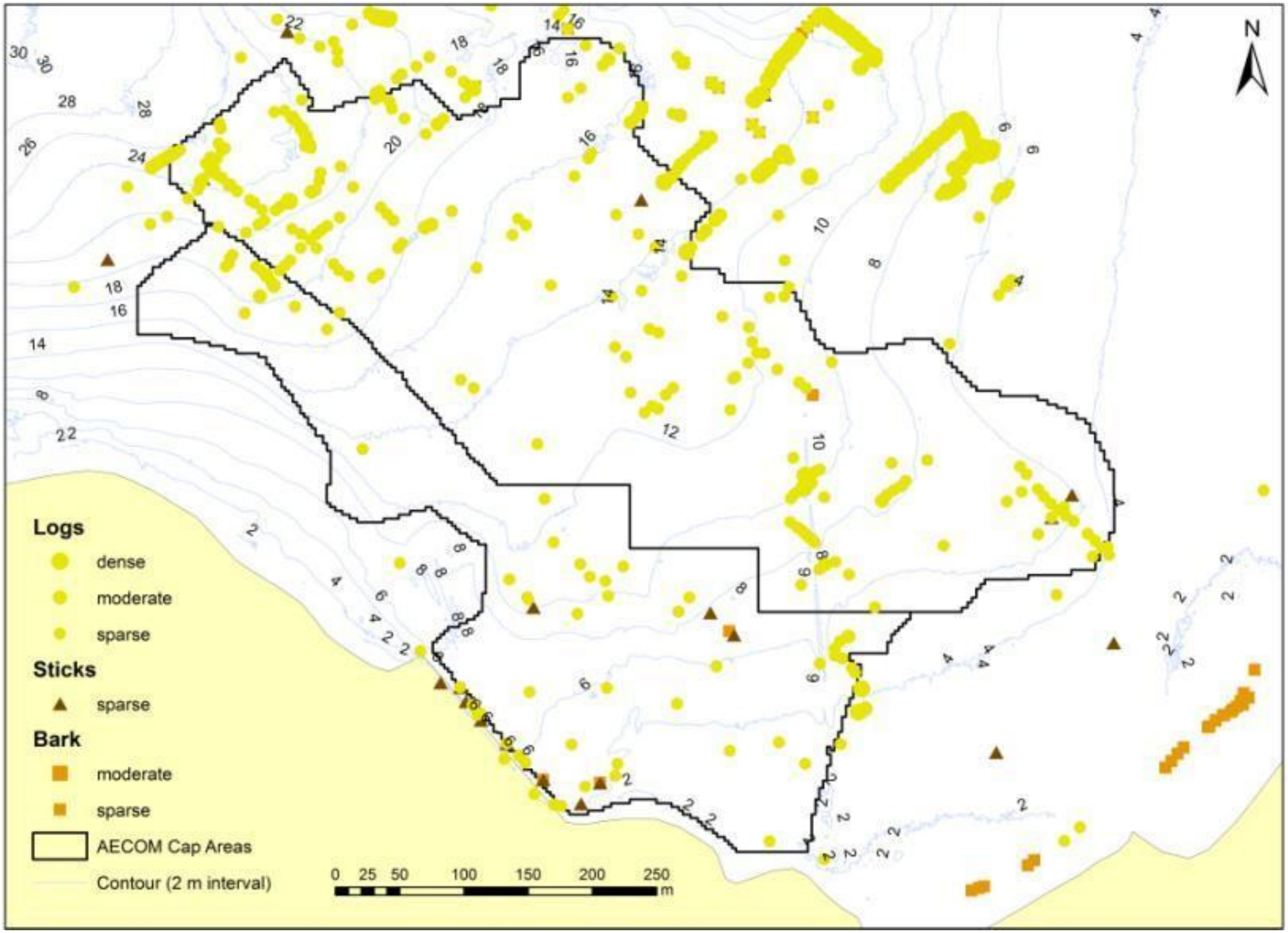


Figure 27.Distribution of coarse woody debris in and near the Jellicoe Cove cap based on interpretation of 2012 underwater video.

4 Discussion

Based on video examination of cap substrates and submergent vegetation, it appears that the capping operation was successful in the placement of cap materials in the designated cells. There appears to be a fine layer of silt over top of coarse and medium sand cap material in portions of the cap. The exact mechanism resulting in this is unknown; it may reflect disturbed and suspended silt that ultimately settled out on the cap material. The degree to which this has occurred is difficult to determine by video analysis. Little of the original submergent vegetation remains in the cap and there is moderate to dense submergents around at least some of the margins of portions of the cap, indicating that cap materials had not mobilized at the time of the survey, less than two months after the capping operation. Additional monitoring will be required to determine if the cap material remains in place over the longer term. Underwater video is suitable for determining general distribution of sediments, but additional substrate sampling with a petite ponar grab or hydraulic corers (as used during operations) is recommended for determining depth of capping and confirm video interpretation, especially along the cap margin (AECOM 2012).

The most significant negative impact from the capping may be the potential reduction in aquatic macrophyte abundance in the proposed cap area, which could reduce the habitat suitability for fish, particularly longnose suckers, northern pike, and yellow perch. The response of SAV to disturbances such as the proposed capping is poorly understood for oligotrophic systems like Peninsula Harbour but various lines of evidence suggest that the plant species present in Jellico Cove will be able to recover in the short to medium term (less than 5 years) through remaining plants, fragmentation, and reproductive structures (e.g., stonewort oospores). Continued monitoring will be required to track submergent recovery over time.

The long-term benefit of reducing exposure to contaminated sediments by capping it with a layer of sand probably outweighs the any potential short-term negative impacts to fish habitat (Foster and Harris 2011). There is already demonstrated use of the cap area by fish, as evidenced by images of coaster brook trout taken during the 2012 surveys.

5 Literature Cited

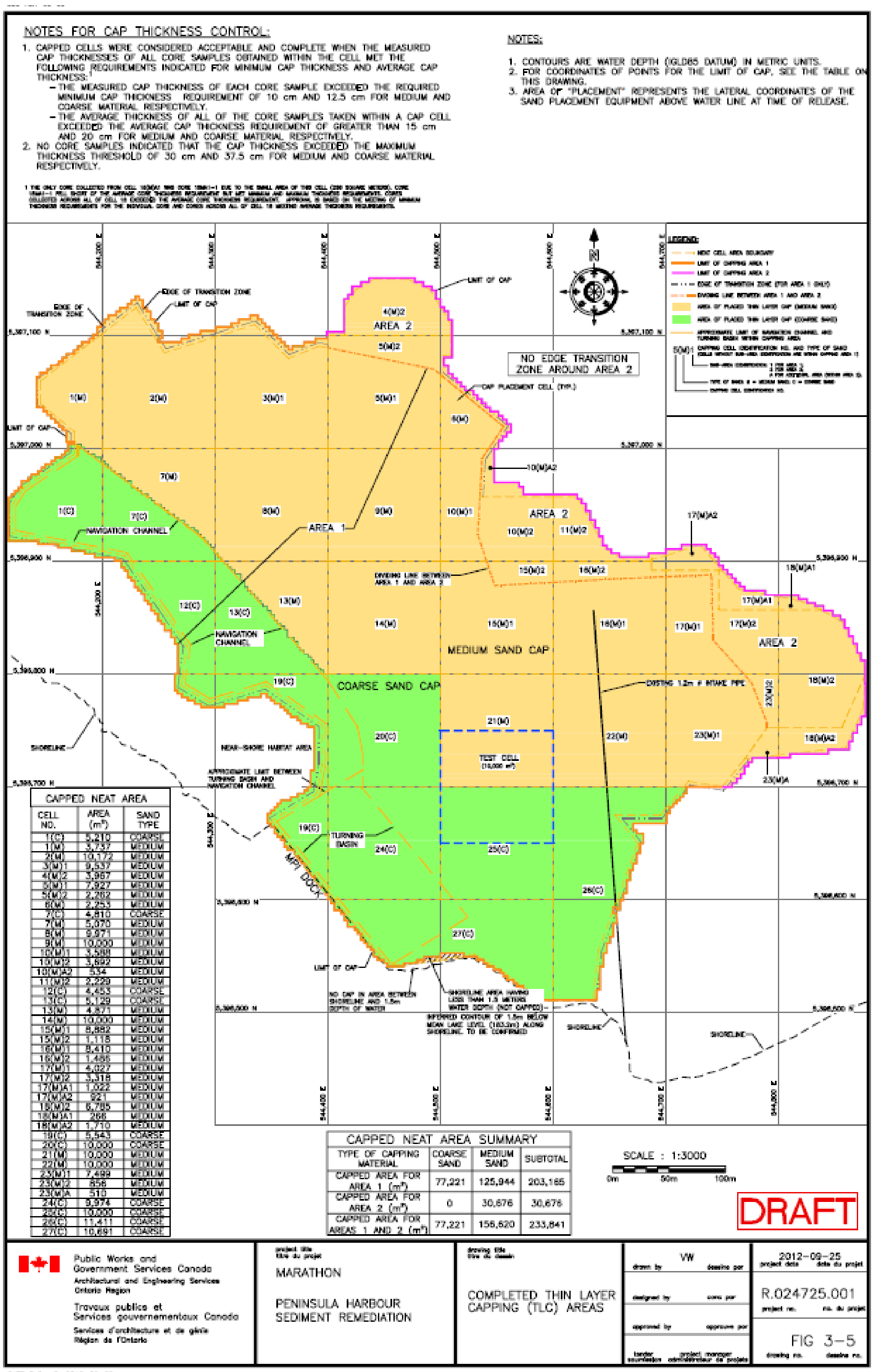
AECOM.2009a. Bathymetry and Side-Scan Survey in Jellicoe Cove, Peninsula Harbour, Marathon,Ontario.Prepared for PWGSC.

AECOM. 2009b. DRAFT CEAA Screening DocumentPeninsula Harbour Sediment RemediationProject. Draft report prepared for Environment Canada. December 4, 2009. 124 p.

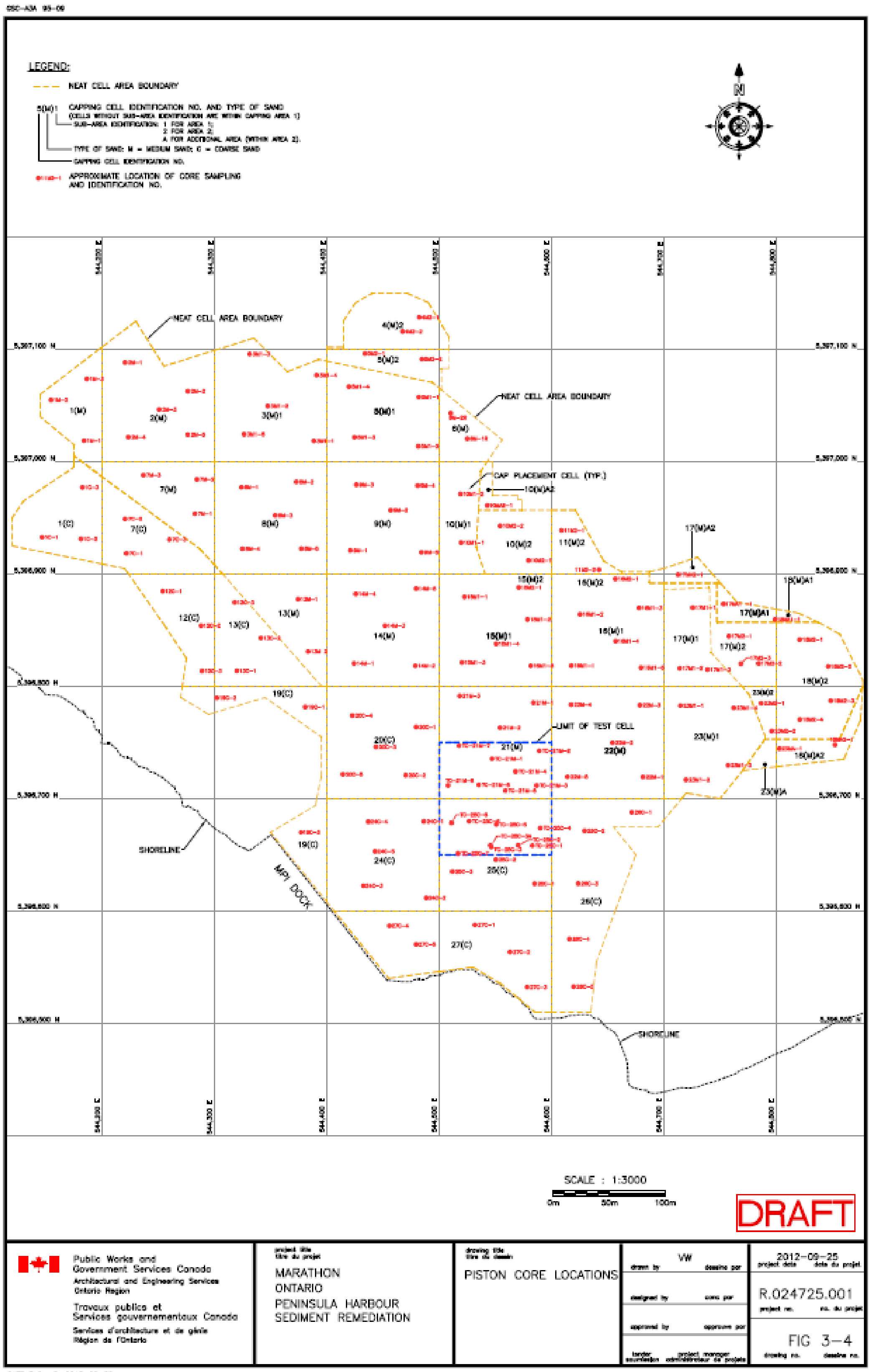
AECOM. 2012. Peninsula Harbour Sediment Remediation Project: Closure Report. Unpublished September 2012 Draft for Discussion.Prepared for Public Works and Government Services Canada.69 p.

Foster, R.F. and Harris. 2011. Peninsula Harbour Fish Habitat Assessment. Unpublished report prepared for Environment Canada by Northern Bioscience, Thunder Bay, ON. 82 pp.

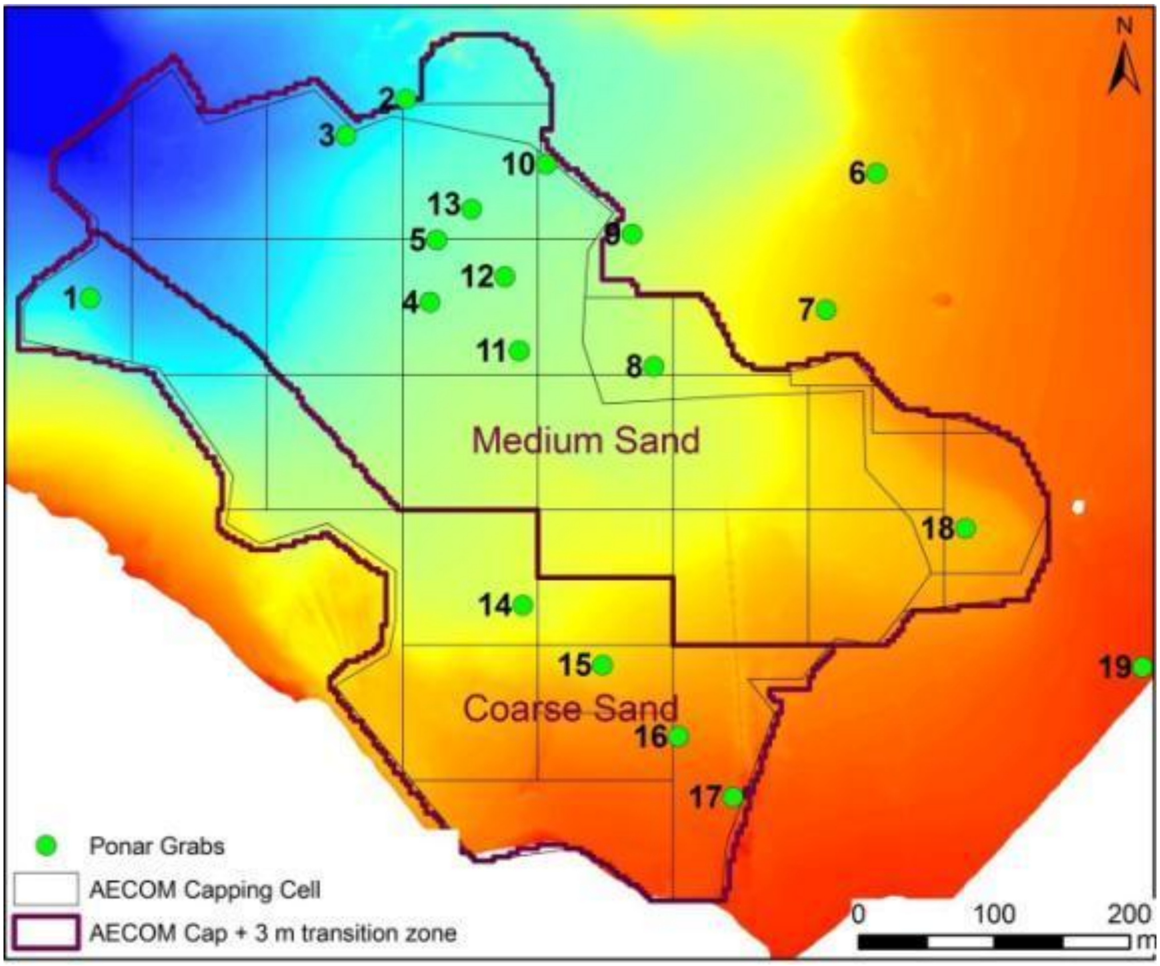
Appendix 1.Completed Thin Layer Capping (AECOM 2012).

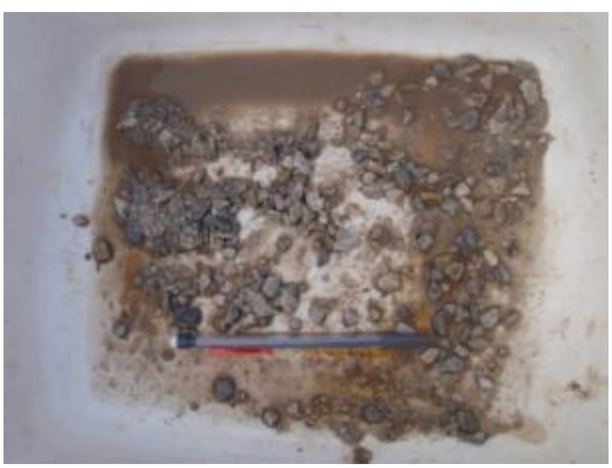


Appendix 2.Approximate location of piston core sampling to verify cap thickness (AECOM 2012).



Appendix 3.Location(overlain with DFO bathymetry) and photographs of 2012 ponar grabs.





Ponar Grab #1

Ponar Grab #2

Ponar Grab #3

Ponar Grab #5

Ponar Grab #6

Ponar Grab #7

Ponar Grab #10

Ponar Grab #11

Ponar Grab #13

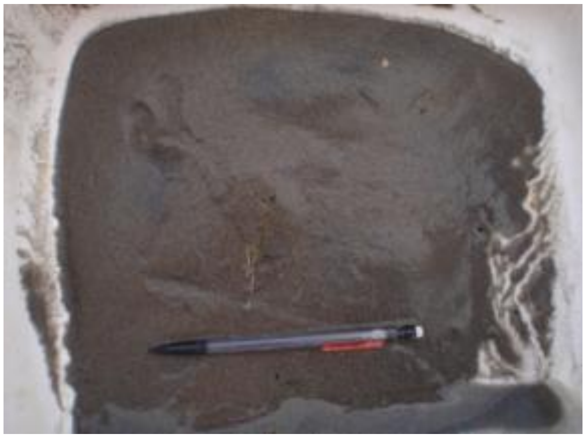
Ponar Grab #14

Ponar Grab #15

Ponar Grab #16

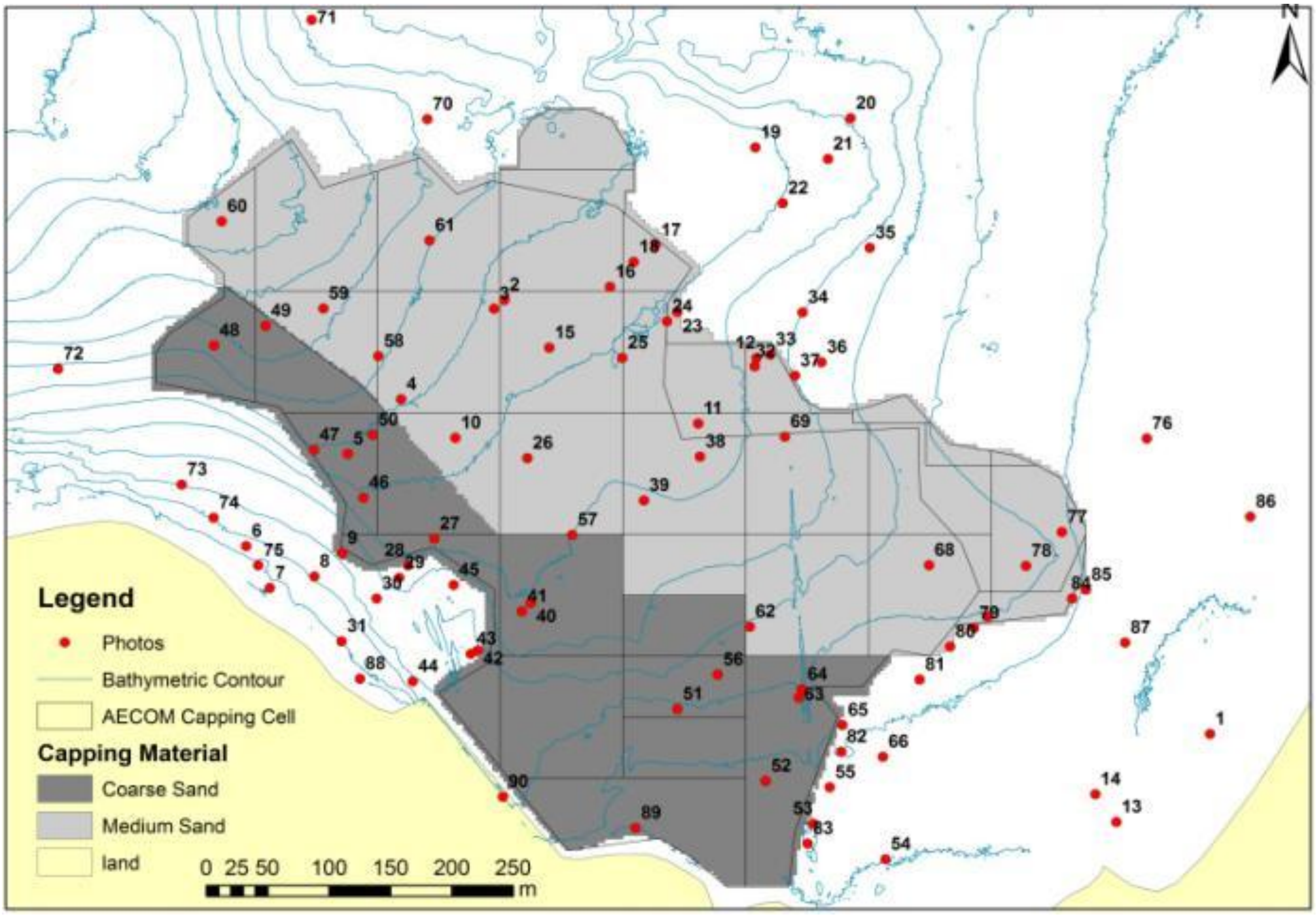
Ponar Grab #17

Ponar Grab #18



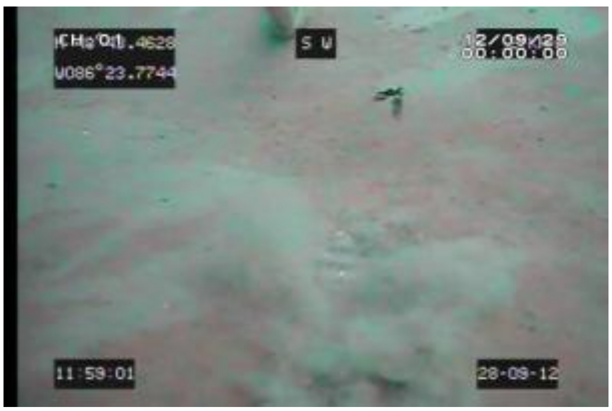
Ponar Grab #19

Appendix 4.Selected 2012 underwater video images for Peninsula Harbour.



Map of proposed cap area with location of following images from underwater video.


S W
W086°23.3078
12:53:50
27-09-12
#1


S W
W086°23.7744
11:59:01
28-09-12
#2


S W
W086°23.7812
11:59:21
28-09-12
#3


S
W086°23.8435
12:02:41
28-09-12
#4


S W
W086°23.8792
12:04:31
28-09-12
#5


S W
W086°23.9472
12:07:41
28-09-12
#6


W086°23.9317
S E
12/09/29
00:09:42
12:08:43
28-09-12
#7


W086°23.9021
N E
12/09/29
00:10:50
12:09:51
28-09-12
#8


W086°23.8835
N E
12/09/29
00:11:31
12:10:31
28-09-12
#9


W086°23.8077
N E
12/09/29
00:15:20
12:14:21
28-09-12
#10


W086°23.6462
N E
12/09/28
00:13:58
16:13:00
27-09-12
#11

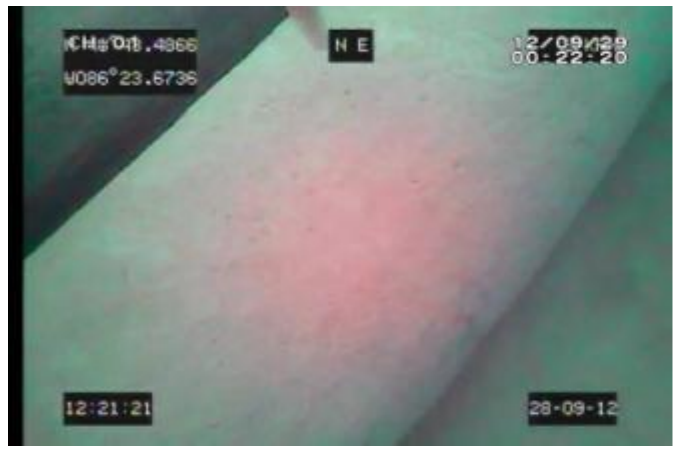

W086°23.6071
N
12/09/28
00:16:08
16:15:10
27-09-12
#12

#13.

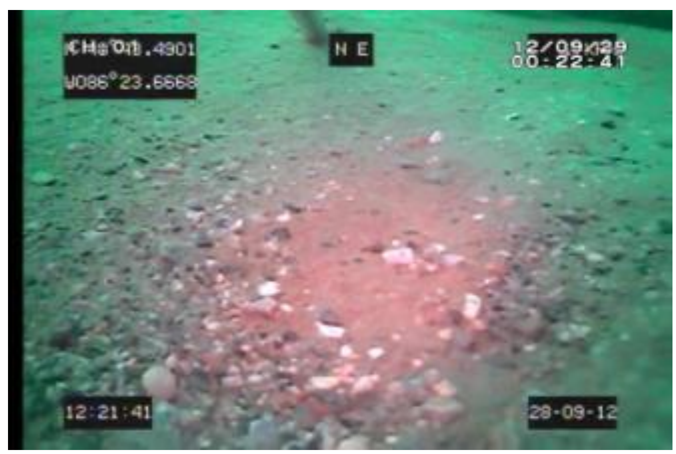
#14

#15

#16

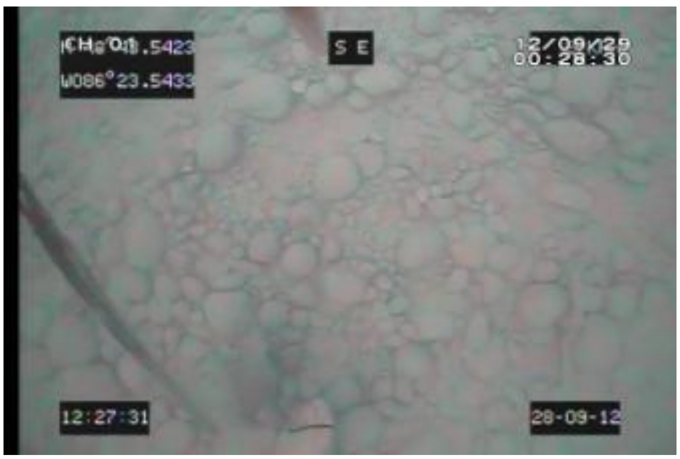


#17 .



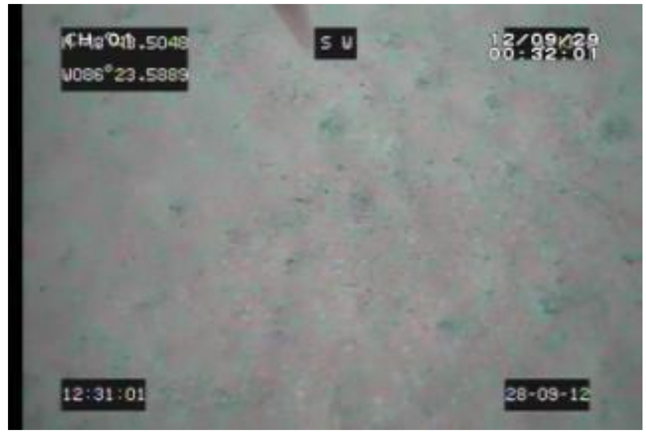
#18

#19



#20

#21



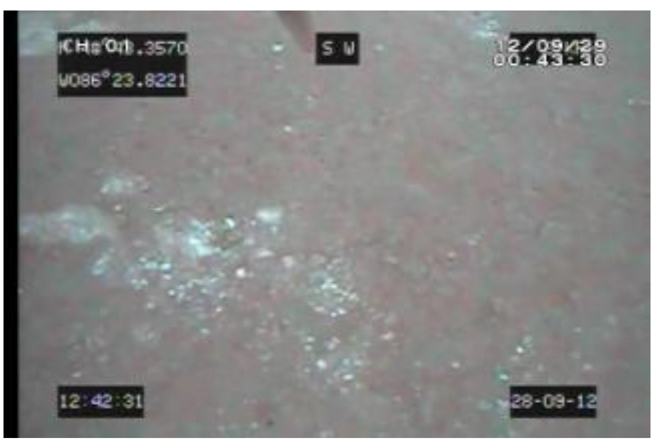
#22

#23

#24

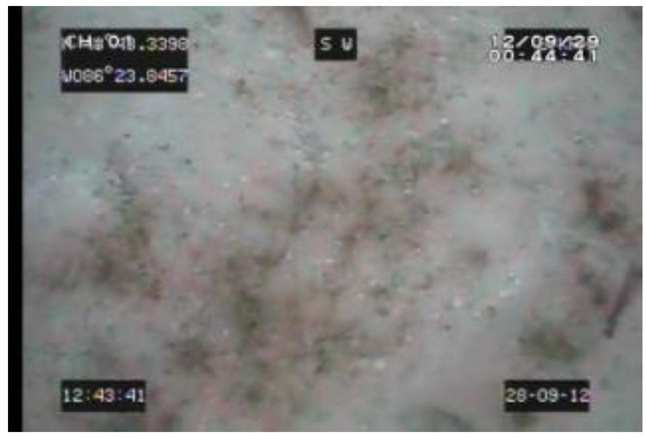
#25

#26



#27

#28



#29

#30

#31

#32 .

#33

#34

#35

#36

#37

#38

#39

#40

#41

#42

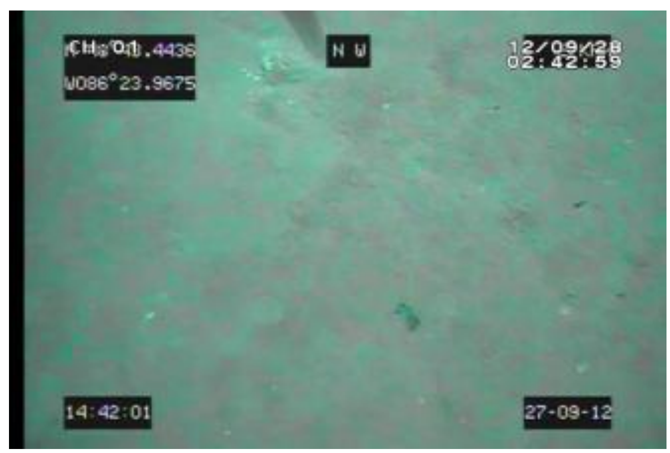
#43

#46

#44

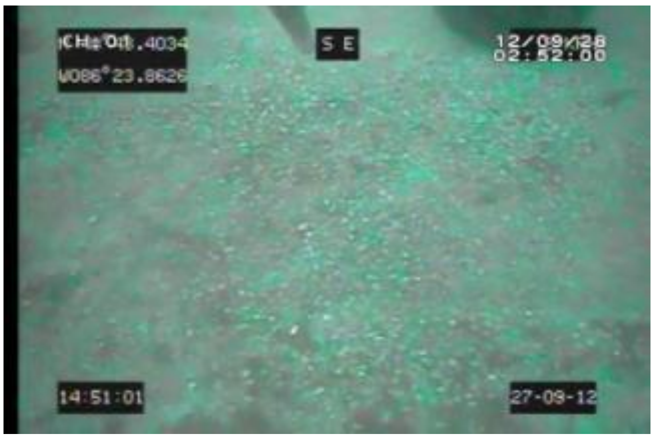
#47

#45



#48

#49



#50

#51

#52

#53

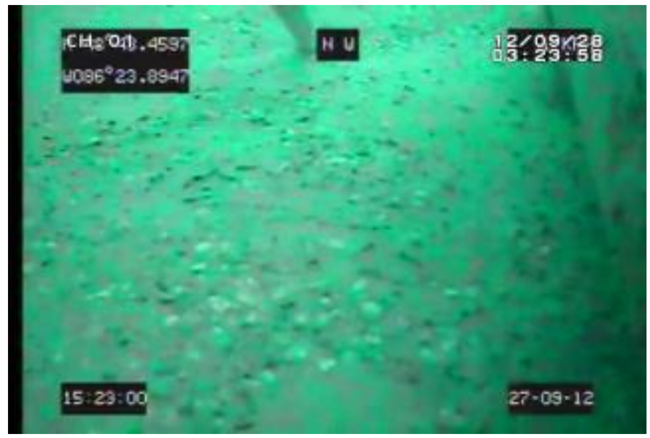
#54

#55

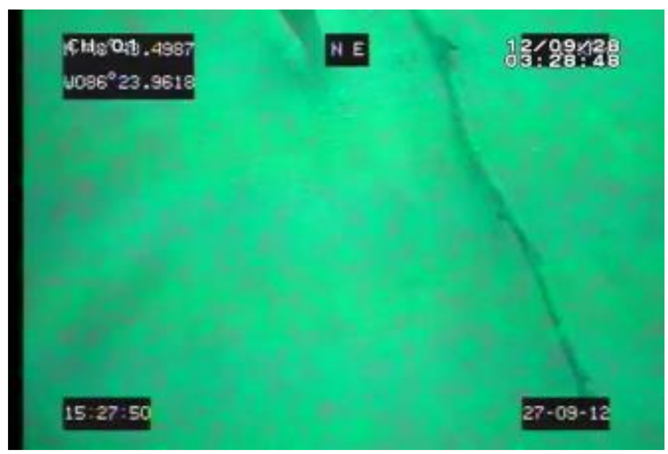
#56

#57

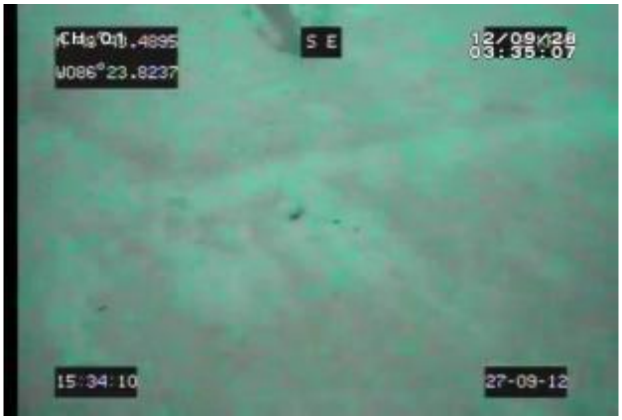
#58



#59

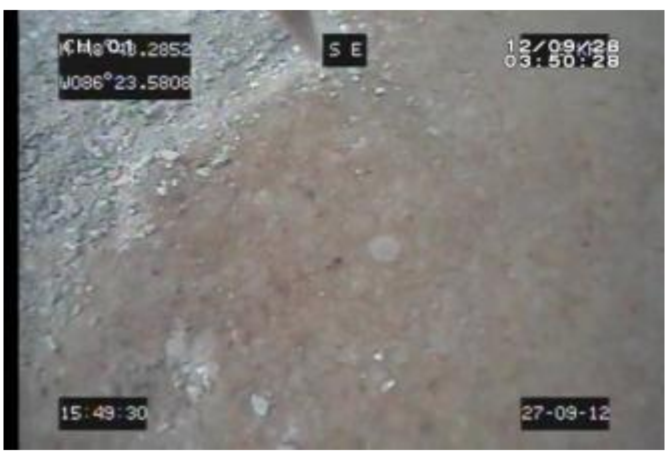


#60



#61

#62



#63

#64

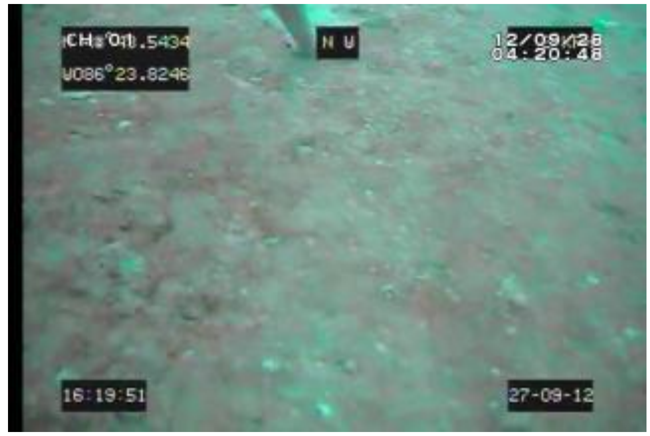
#65

#66

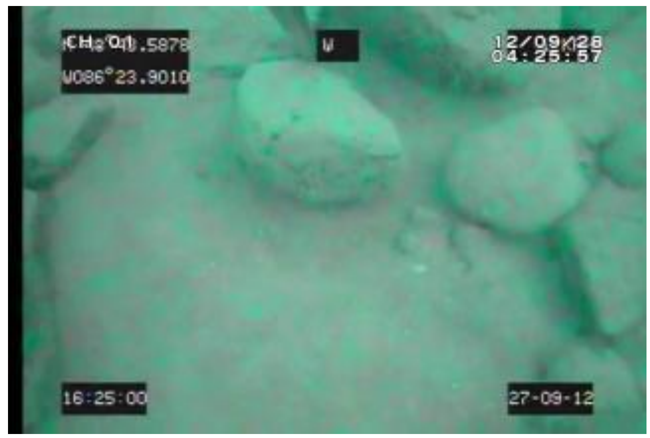
#67

#68

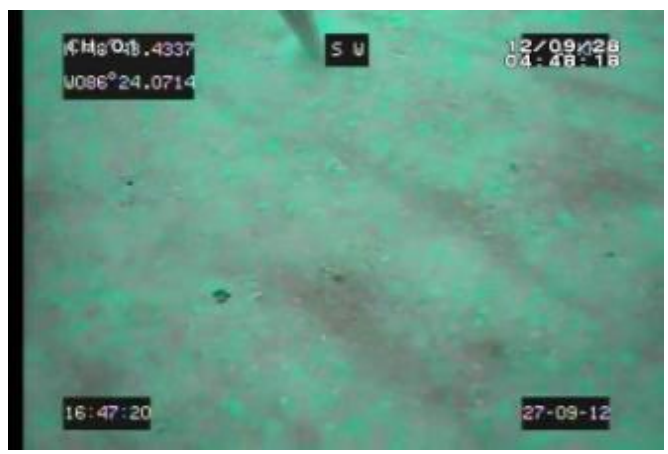
#69



#70



#71



#72

#73

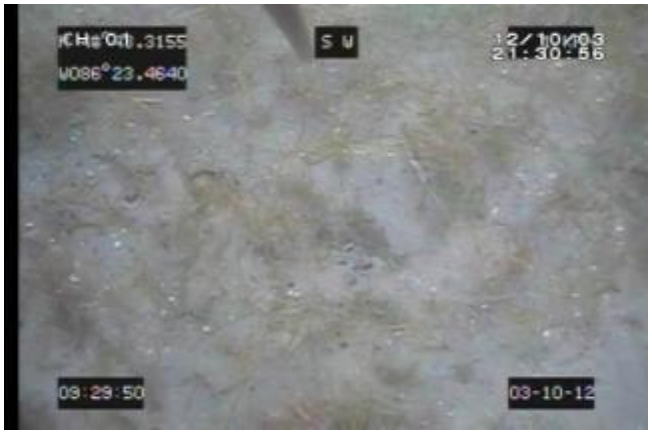
#74

#75

#76

#77

#78



#79

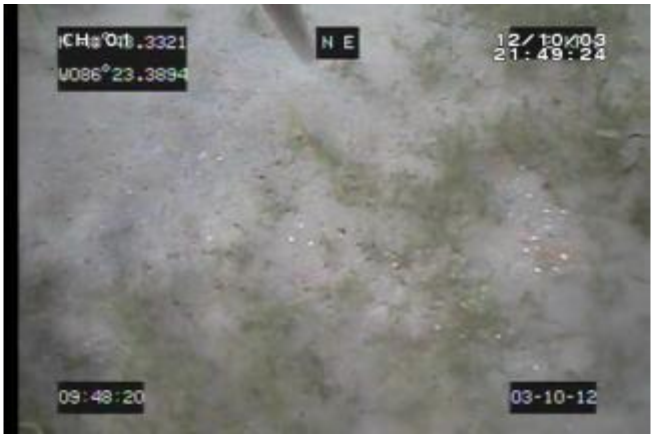
#80.

#81

#82

#83

#84



#85

#86

#87

#88

#89

#90