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Bear Cove Coastline Reestablishment

Chris Ryan
Memorial University
St. John's, NL, Canada
Cpr530@mun.ca

ABSTRACT

Bear Cove is a small community on the Northern Peninsula of Newfoundland and Labrador in the Straits – St. Barbe region. Originally settled for proximity to fishing and hunting grounds, Bear Cove still maintains a small population of approximately 83 people [1]. The cove itself is a small, shallow inlet unsheltered from the Strait of Belle Isle. By current standards, the cove is far from optimal for a typical Newfoundland outport; many residents of Bear Cove still own small fishing vessels of 26 feet or less. Very few stages exist in the area, and most vessels are stored on the beach out of reach of the land-wash or in a large field bordering the beach.

During an undefined period prior to the year 2010, the coastline of Bear Cove transitioned from what was once a well-defined, exposed cove to a partially protected and stationary body of water. This transition was the result of a sandbar formation that stretched from the western point of the cove. This berm was naturally formed as a result of ocean transport and deposition, consisting of sand, cobbles, and boulders.

While this berm initially provided protection for any coastal structures and vessels on the shore and was welcomed by the residents of the community, over time it began to develop a significant problem. Sediment was also being deposited behind the berm, creating a progressively shallow basin. This continued until the floor had been raised such that no water existed in the basin during low tide. In addition to the sediment deposit behind the berm, a form of aquatic algae - kelp was also being deposited. During the transition from high tide to low tide when water would vacate the area protected from the berm, this seaweed would settle and become exposed in the absence of water. Over time there became a significant deposit of seaweed which began to decompose and essentially create a 'mat' of seaweed along the floor of the cove. Ultimately, as a result of the berm formation, seaweed deposition and decomposition, an unbearable stench was generated, creating an unfavourable environment for the residents of the community.

This paper serves as a discussion of the natural process' leading to the development of a coastal berm, the progression which resulted in the development of an issue, and the actions taken to rectify the problem.

1 INTRODUCTION

Bear cove is a former fishing outport located on the Northern Peninsula of Newfoundland approximately 300 kilometers north of Deer Lake. The site, while in operation consisted of a wooden breakwater and an L-shaped wharf which acted as a groyne, a marginal wharf with a fish-plant, gear repair shed and an ice-plant (See Figure 1 – Former Site Conditions). Over the past several decades, the area has become less active, and the breakwater was destroyed by the ocean. As a result of the breakwater destruction, the L-shaped wharf began to sustain damage as well. Given the decline in fishing activity and closure of the fish plant in the area, the Department of Fisheries and Oceans – Small Craft Harbours (DFO-SCH) contracted the removal of the L-shaped wharf.

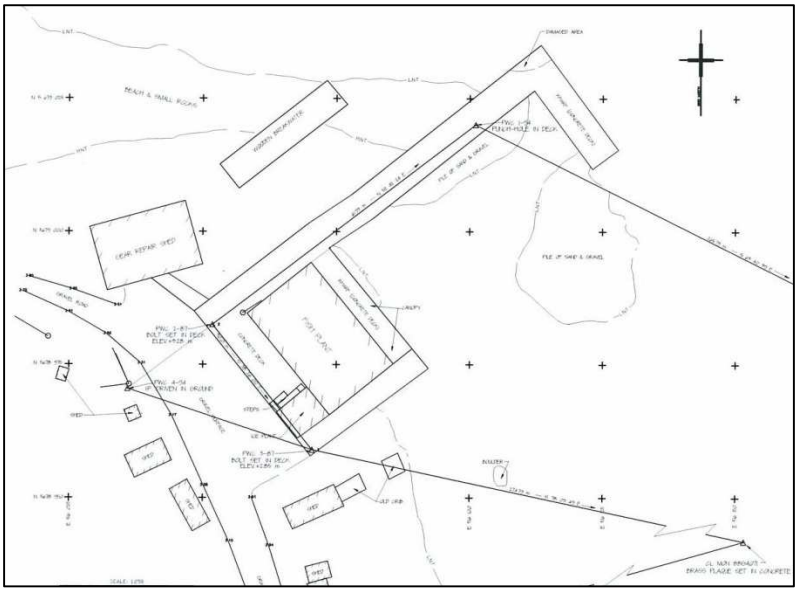

Figure 1 – Former Site Conditions

2 SITE CONDITIONS

2.1 Erosion

Following the demolition of the L-shaped wharf seen in Figure 1, the material located immediately west of the wharf (left in Figure 1) began eroding. This resulted in the shoreline being pushed further back nearly to the gear repair shed at high normal tide (HNT). This presented the potential danger of undermining for the gear repair shed which still exists today.

This erosion was the direct result of the wharf removal, which was acting as a groyne. Groynes are structures used to impact the near-shore sediment transport processes to modify beach response to wave and tidal conditions [2]. The wharf forced the deposition of sediment to the west due to the west to east net transport in the location. The reflection of waves from the breakwater and wharf resulted in destructive interference between reflected and oncoming waves. This interference resulted in the loss of energy from the waves and ultimately the settling and deposition of material contained in the water. It can also be noted that on the East side of the L-shaped wharf, a sediment pile can also be seen in Figure 1. This is a result of the loss of energy from the waves diffracting around the wharf structure.

In the absence of these structures, waves maintain their energy and minimal settling and deposition occurs. This increased wave energy is also responsible for the erosion of the shoreline once the wharf was removed. The loose sediment that was once deposited in the area was now exposed to higher energy waves, begins eroding and resuming its west to east transport.

2.2 Sandbar

As higher energy waves began transporting the eroded material northward, the marginal wharf which still existed became the next structure to remove energy from the waves. Most of the material which had eroded to the west was now becoming deposited to the southeast of the marginal wharf. This was mainly a result of the energy loss from the wave due to diffraction around the marginal wharf. As seen in Figures 2 and 3, this deposition began to form a large sand-bar which extended from the headland created by the north corner of the wharf. This sandbar continued to increase in size (height,

length and width) over time. Shown in figure 2 are the approximate extents of the sandbar at +0.25 m lowest normal tide (LNT), +1.0 m LNT, and +2.0 LNT in June of 2010.

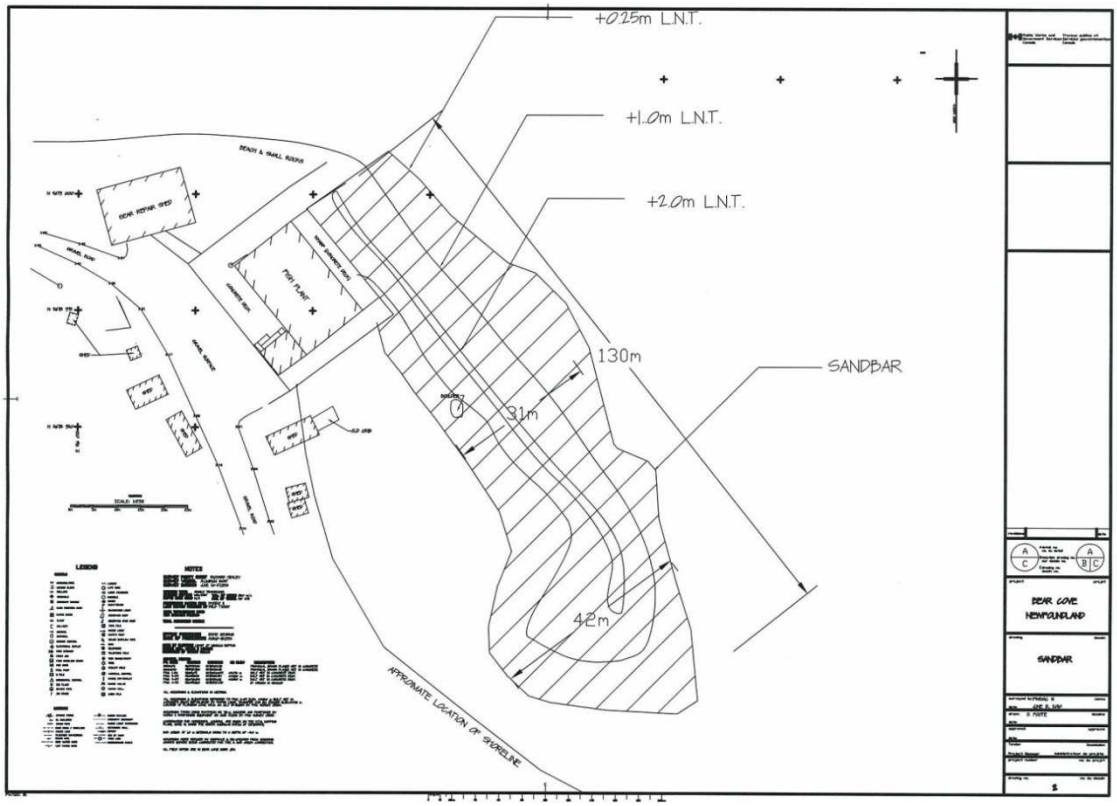

Figure 2 – Sandbar Survey

Figure 3 – Sandbar Aerial Photo

2.3 Basin

As a result of the sandbar formation, a small basin was created behind the sandbar, bordering the east side of the marginal wharf. This basin was becoming increasingly isolated from the ocean as the sandbar increased in size. As the basin became more isolated and protected, the water inside the basin became nearly stationary and received minimal impact from wave action.

Due to the stationary water, at high tide much of the sediment would settle out of the water onto the floor of the basin, resulting in the depth of the basin constantly decreasing. In addition to the sediment deposition, during a rising tide and flow of ocean water into the basin, kelp was also transported into the basin. This kelp would settle to the floor, and while the tide was lowering and water exited the basin, the settled kelp would remain. This process continued for an extended period of time until the floor of the basin was completely exposed at low tide, while still completely submerged at high-tide.

2.4 Decomposition

Initially the process outlined above did not pose a problem for the community given that the fishing industry had all but vacated the location. However, shortly thereafter it would begin to develop into an issue. During summer months the kelp would become exposed to the heat of the sun and began to decompose. The continuous flow of tides in and out of the basin meant that the kelp was not able to dry out and the decomposition cycle continued. This cycle resulted in a large mat of a sludge-like material which was permanently lodged in the basin. The continuous decomposition of the material began emitting an unbearable stench which was unpleasant for the residents of the community, and those driving by on the nearby highway.

3 REMEDIATION

3.1 Survey

The Department of Fisheries and Oceans – Small Craft Harbours (DFO-SCH) program is a nationwide program of the Department of Fisheries and Oceans. SCH operates and maintains a national system of harbours to provide commercial fish harvesters and other harbour users with safe and accessible facilities [4]. DFO-SCH requested Public Works and Government Services Canada (PWGSC) to survey the Bear Cove site to quantify the amount of material contained in the sandbar, and present potential solutions to rectify the problem.

Upon completion of the survey PWGSC were successful quantifying the amount of material and assessing the damage to the site. PWGSC surveyors made two important findings: the proximity of surf to the gear repair shed, and the massive quantity of material deposited in the sandbar [3].

It was noted that the erosion of the shoreline north of the gear repair shed had resulted in the exposure of the concrete foundations of the structure and continued erosion would likely continue undermining the structure and potentially result in its collapse [3].

The measurements of the sandbar were as follows: approximately 130m long, ranging from a width of 30 m to 45 m. The crest was approximately 2 m wide and had an average elevation of +2.55 m LNT. The sandbar was composed of approximately 35% sand and 65% stone. The stone particle size ranged from 25 mm to 600 mm (former protective armour stone located to the west of L-wharf). From the survey of the sandbar on June 12, 2010 it was estimated that 4,000 m^3 of the material was located above +0.00 m LNT, and 6,500 m^3 was located above -0.25 m LNT.

3.2 Solution

There were two potential solutions outlined by PWGSC to rectify the problem presented by DFO-SCH. One solution was a higher budget, long-term solution that would provide stability to the shoreline, while the other was a low budget, short-term solution that would rectify the issue at hand, but have minimal impact on preventing the issue from occurring again.

The long-term solution involved the construction of a new groyne in the approximate location of the former L-wharf, and protect the seaward side (West) with approximately 4 tonnes of armour stone. This would result in the expansion of the shoreline near the gear repair shed, and cease the deposition of material onto the sandbar.

The short-term solution involved the excavation of the sandbar to a depth of +0.00 m LNT and relocating the material to the shoreline. While this solution immediately address the issue at hand, it was likely that upon completion the deposition of material will continue and the sandbar will begin to reform. Whether a basin would form again would be unknown as the material would be relocated into the current basin location. The detailed outline included in the proposal was as follows [3]:

1) *Push the crest of the sandbar to the front of the marginal wharf. This will eliminate the 2m wide space presently between the sandbar and the wharf thus removing the kelp from collecting in this area. Slope the material toward the ocean.*
2) *Relocate the sandbar material east of the marginal wharf. Place this material to the intersection of the East side of the marginal wharf and the shoreline. This will remove the sandbar from its present location. It also fills the basin adjacent to the wharf eliminating an area that kelp collects.*
3) *Continue this infilling until the fill material until it reaches the berthing face of the marginal.*
4) *Relocated the sandbar material to the area west of the gear repair shed. It is presumed a large percent of this material was originally located in this area. This will replenish the shoreline where it has eroded and provide protection to the gear repair building.*
5) *Cover all deposited material will armour stone, minimum 2 to 4 tonnes to resist wave and ice action.*

Shown in the following figure (Figure 3) is the intended site view following the completion of the short-term solution.

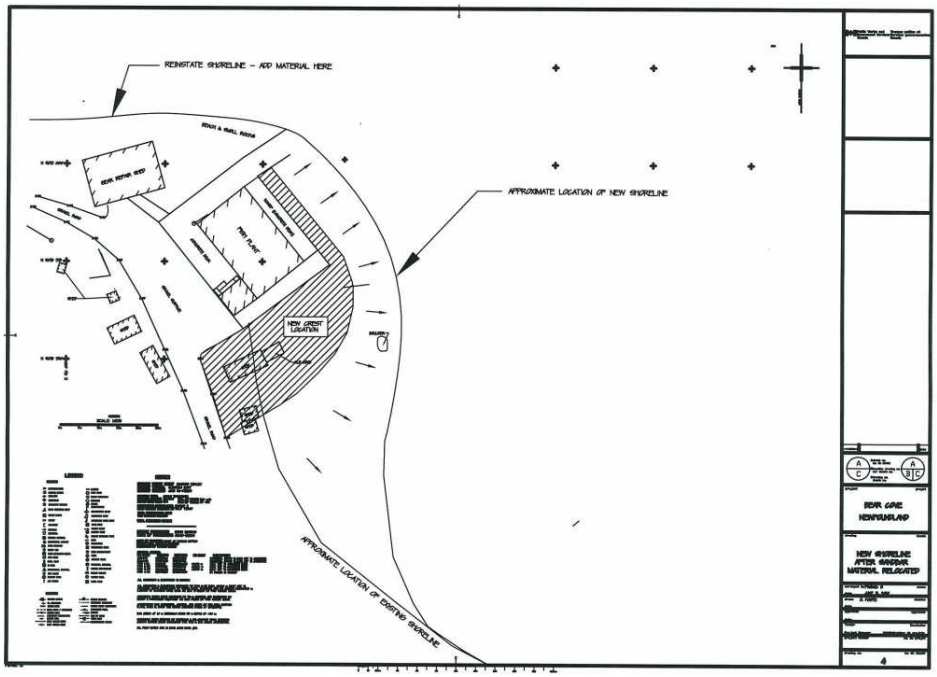

Figure 3 – Short Term Solution

Due to a limited budget for the project, it was determined that the short-term option would be the method of choice to remediate the area. This decision was mainly a result of the high cost of constructing a groyne when considering the limited activity in the cove.

On September 29, 2010 the Bear Cove Project commenced and was completed on October 3, 2010 by Floyd's Construction Ltd. The work was completed according to the outline provided in the project proposal with the exception of relocation of material to the north side of the gear shed. Upon further consideration it was determined that this effort would be too futile as the natural process of the ocean would quickly remove the material once again. PWGSC revised the project plan to include the creation of a small breakwater pointing northward from the north corner of the marginal wharf using the former armour stone that had been excavated from the sandbar. See figures 5 and 6 for photos of the site upon project completion.

Figure 5 – Relocated Material

Figure 6 – Bear Cove Project Completion

Upon completion of the project, an immediate flushing effect occurred. In the following days, much of the sludge previously located in the cove began working down the shoreline to the east and out into the ocean. This was a result of the increased wave energy that the cove had been deprived of while the sandbar was in place. It was also noted that the cove was returning to a more even depth. The increased wave every removed much of the sludge and loose sediment previously located in the stationary basin to more closely match the depth of the entire cove.

4 REFORMATION

As metioned previously, the project was performed as a short-term solution. Prior to beginning the project of receiving funding, it was fully anticipated that the sandbar would reform in some way. How similar in size, shape and the presence or absence of the stationary basin behnd the sandbar however, was more difficult to predict.

While completing the project, PWGSC received criticism for the method from several community locals. Many people who had lived in the community for their entire lives expressed their disapproval of the operation, as they believed the same issue would occur again shortly after.

When contacted for comment, PWGSC stated that they had not followed up on the project and had not yet been requested to do so by DFO-SCH. A PWGSC Project Officer stated that they belived that the infilling had continued immediately after the project was completed, and would continue to do so until a groyne was constructed. The following photo (Figure 7) was taken in March of 2013, and

despite ice conditions, a noticable sandbar can been seen to have reformed of the east corner of the embankment near the marginal wharf.

Figure 7 – Sandbar Reformation (photo courtesy of Chris Gaslard)

While no reports of the stationary basin or sludge responsible for creating the stench have been received since the project was completed. DFO-SCH realizes the potential for the reoccurence of the issue and holds the potential construction of a groyne in its future plans.

5 CONCLUSION

By viewing historical documents of the Bear Cove site and applying basic principles of wave action and ocean transport, it is relatively easy to determine the factors which contributed to the formation of the sandbar and basin. Given than the marginal wharf and the L-shaped wharf were constructed at the same time, it was unknown that upon the removal of the wharf that this phenomenon would occur to such a magnitude. Prior to the construction of either of these structures in the area, the cove remained open with very little deposition of material. Once these structures are implemented, the way in which wave action interacts with the shoreline changes. Changing the layout of these structures or removing one or more of them will simply result in altering the interaction of the waves and the shoreline yet again. This was apparent in the Bear Cove case as the response to the removal of the wharf was the erosion of material deposited on the shoreline near the gear shed which was redesposited in the sandbar as the waves diffracted around the headland created by the marginal wharf.

While the sandbar has already begun reforming in its former location, it is likely that it will form at a slower rate that it had previously due to the absence of loose material to erode near the gear shed. However it is uncertain if the basin will form in a similar manner due to the altered shoreline resulting from the project. If the basin does happen to reform, it is highly probable that the kelp will once again be deposited into the basin and decompose. The process of removing the sandbar and

placing the material in the basin location may even be repeated several times with a sandbar and basin developing each and every time.

When the ocean displays a particular pattern, simply cleaning up after it will do little to solve the problem in the end. To optimize the way in which the ocean interacts with the shoreline, engineers must intervene rather than perform damage control. In the Bear Cove situation this is interference would likely be to construct a new groyne in the proper location. Unfortunately, given the harsh environmental conditions in the area, lack of shelter from heavy ice conditions in the winter, the expected lifespan of a groyne in the required location is very low. It would be highly expensive to construct a groyne designed to withstand the harsh elements to which it would be exposed.

When considering all the factors at hand, DFO-SCH are met with a dilemma. Is is more cost effective to build a structure that is severely damaged year after year and will have high maintenance costs, or to return periodically to perform low-budget dredging that temporarily solves the problem? Possibly the best option is one that has not yet been presented; removing the marginal wharf and fish plant that is no longer usable. This would let the ocean run its natural course and interact with the shoreline the way it did before any of these structures existed. The ocean would likely restore the cove to a layout similar to before these structures existed and it requires absolutely no maintenance.

6 REFERENCES

[1] http://www.northernpeninsula.ca/home/bear_cove.htm

[2] Reeve, D., Chadwick, A. J., & Fleming, C. A. (2004) *Coastal Engineering: Process, theory, and design practice.* New York: Sponn Press.

[3] Public Works and Governemnt Services Canada, “Bear Cove Project Report”, June 2010

[4] http://www.dfo-mpo.gc.ca/sch-ppb/home-accueil-eng.htm