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Arnold's Cove Wharf Rehabilitation

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ABSTRACT

The Town of Arnold's Cove, NL is a medium sized community located in Placentia Bay, on the Isthmus of Avalon, in Newfoundland and Labrador. The Bull Arm Construction site, the North Atlantic Refining Ltd. oil refinery and the Newfoundland Transshipment Terminal are all in close proximity to Arnold's Cove, and as a result the need for a well maintained port is evident. The town's harbour and associated structures are used for a wide range of functions including shipping, fishing, tourism, and personal/recreation. These varying uses lead to a wide range of ships using the harbour, and reiterate the need for regular maintenance, repair, and upgrades.

In June of 2009, Public Works and Government Services Canada (PWSGC) hired a consultant to perform a conditional inspection of the existing wharf structures within the harbour, in order to determine the overall condition of the structures, both above and below water. If necessary, the consultant was also tasked with proposing repair/reconstruction recommendations.

The inspection revealed that many of the wharf structures were in a severely damaged and deteriorated condition and required substantial repairs in order to be brought back to a safe working condition. The following paper will outline the steps taken to repair/replace the Arnold's Cove harbour structures, and rehabilitate the harbour back to a working condition.

1 INTRODUCTION

The community of Arnold's Cove is located in Placentia Bay, on the Isthmus of Avalon. Located approximately 140 km from St. John's, Arnold's Cove is situated at the entrance to the Avalon Peninsula. The map below represents the location of the community with respect to other municipalities in Newfoundland.

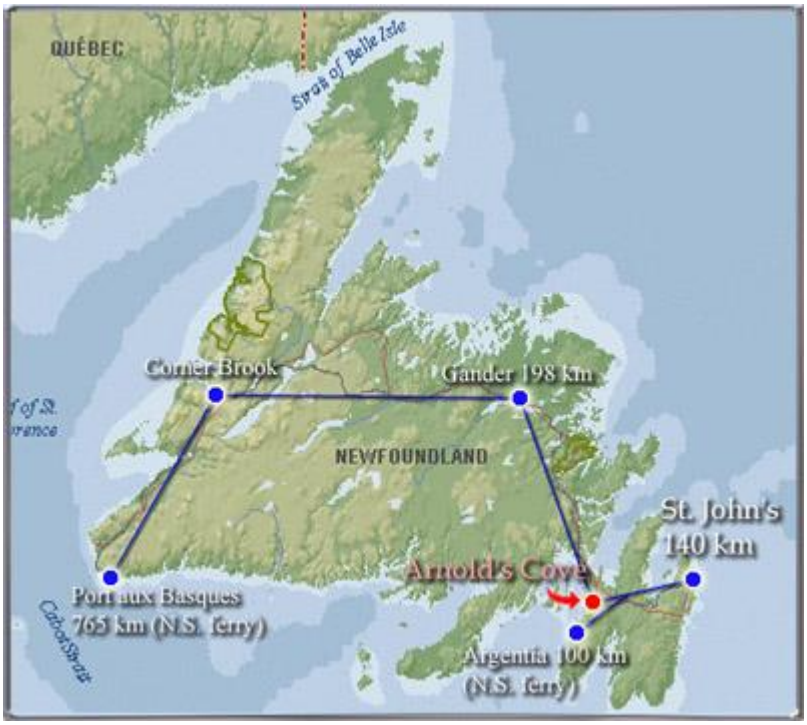

Figure 1: Map of Newfoundland showing location of Arnold's Cove
(Source: http://www.townofarnoldscove.com)

Arnold's Cove began, like most Newfoundland communities, as a fishing community. This constituted the use of small wharves and coastal structures which were associated with the inshore cod fishery. In 1845, the official census listed Arnold's Cove as having 23 inhabitants [1]. With the construction of the Newfoundland Railway, around 1900, the inhabitants of the Placentia Bay islands of Long Island and Merasheen Island began using the port of Arnold's Cove as a gateway to the Railway [1]. This grew the population of the town, as well as the activity in the town's port. During this time, Ocean traffic from these islands became an everyday occurrence [1].

Resettlement saw Arnold's Cove's population grow again, bringing 122 families from the nearby islands to the community, by 1969 [1].Since then, with the opening of the Come-By-Chance Oil Refinery and other large projects in the area, the population has grown to approximately 1200 residents [1].

During this time of growth, the Arnold's Cove's harbour was also growing. Arnold's Cove is the main port for access to the resettled communities of Placentia Bay. This resulted in a large amount of vessel traffic from recreational boaters and fishermen. Due to this growth, the main government wharves were constructed sometime in the 1960s and in 1975 [2]. After this, The Harbour Authority of Arnold's Cove was established in 1988 to help control the pressure on the harbour from vessel traffic [1]. Currently, The Harbour Authority controls the five wharves (totaling over 1200ft), a slipway, and a launching ramp [1].

By the middle of the 2000s the coastal structures which were built after resettlement were in a deteriorated condition and the harbour was in need of a refurbishment. Around the same time, the Department of Fisheries and Oceans (DFO) mandated to keep harbours critical to the fishing industry, like Arnold's Cove harbour, open and in good repair [4]. Because of this, Meridian Engineering Inc. (MEI) (formerly Rutter Inc.) was approached by Public Works and Government Services Canada (PWGSC) to complete a harbour rehabilitation plan for the Arnold's Cove Port.

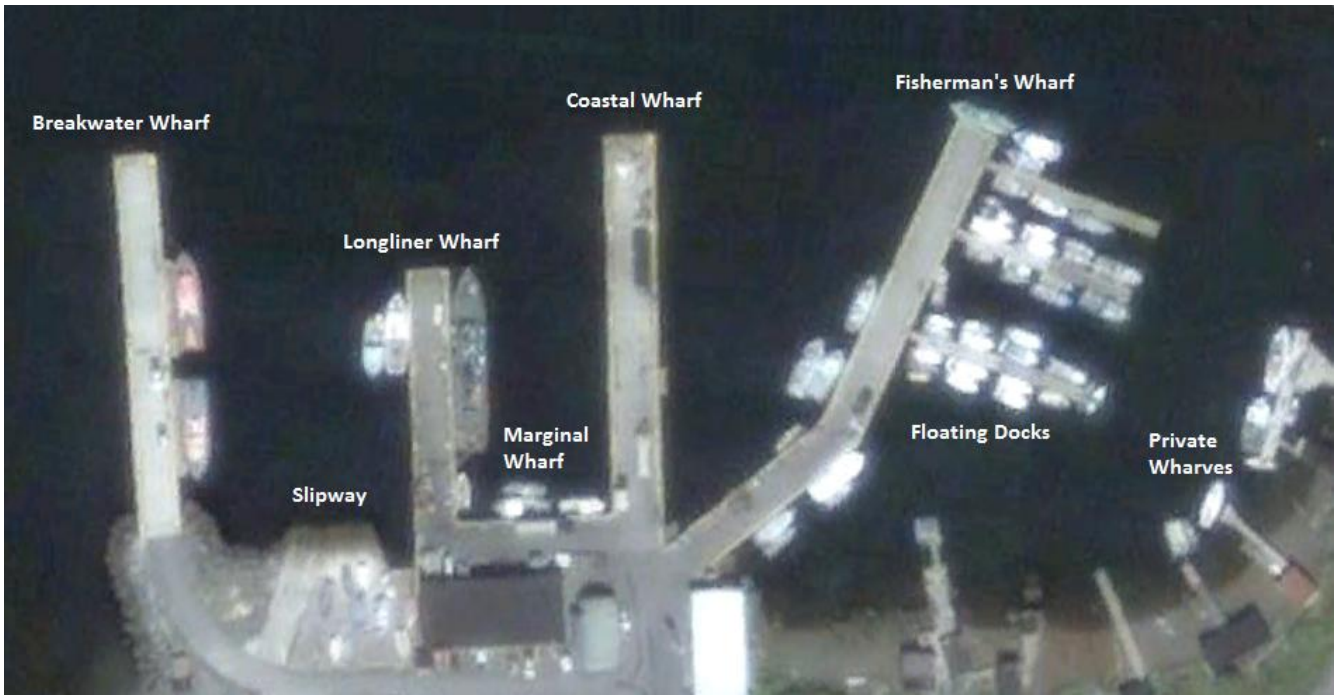

Figure 2: Arnold's Cove Harbour Structures, listed by their locally known names.
(Source: Google Earth)

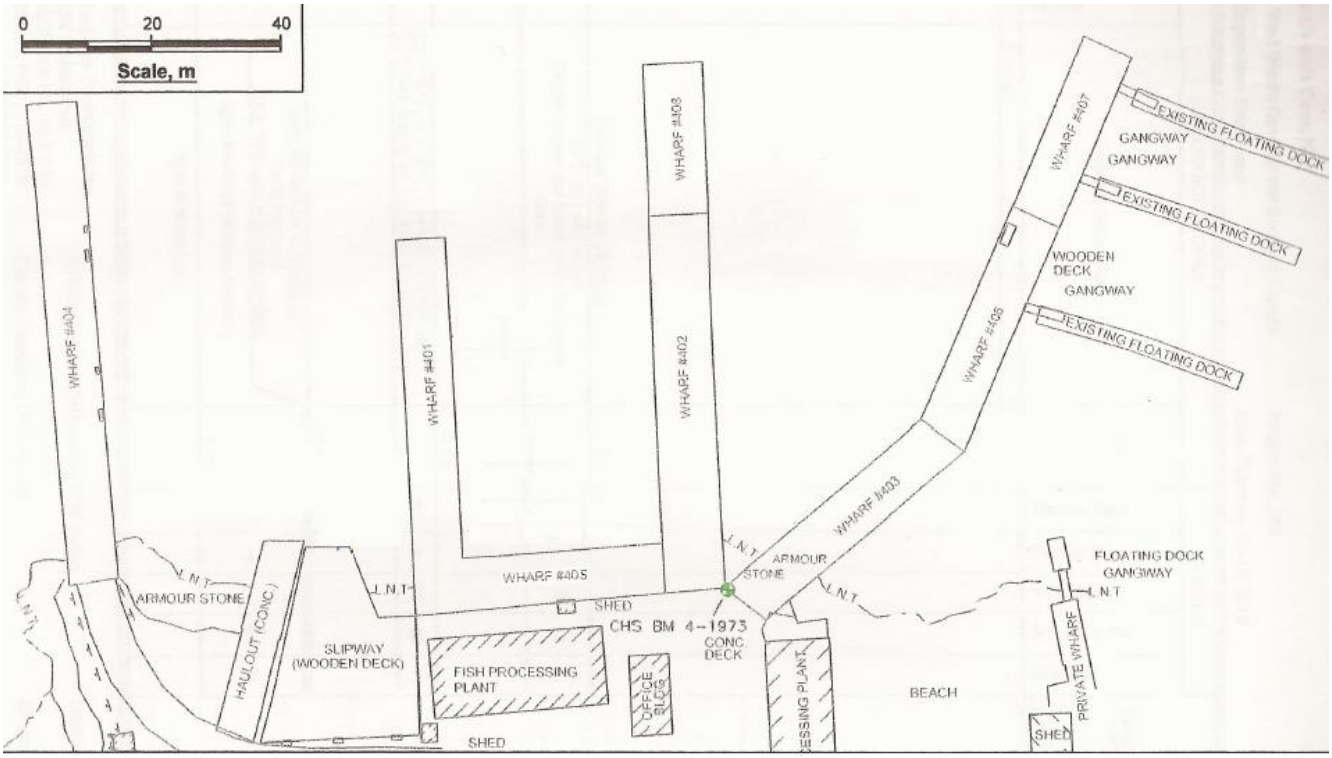

Figure 3: Arnold's Cove Harbour Structures, listed by their numerical designations [2].

2 EXISTING STRUCTURES

A description of the structures in Arnold's Cove harbour is given for the Breakwater Wharf, Longliner Wharf, Marginal Wharf, and the Fisherman's Wharf. The remaining structures were not included in the rehabilitation plan due to the fact that they were more recently constructed and were known to be in good working condition. These structures included the Coastal Wharf, Slipway, and Floating Docks.

2.1 Breakwater Wharf (Finger Pier #404)

The existing breakwater wharf in Arnold's Cove was made up of creosoted timber piles, pile caps and beams, and a concrete/timber composite deck in one section and treated timber cribwork with a reinforced concrete deck in another [3].

2.2 Longliner Wharf/Marginal Wharf (Finger Pier #401/Marginal Wharf #405)

Originally planned to be one (1) 88.2 m long structure (as stated by Harbour Authority representatives), this wharf was instead constructed as an "L" shape in 1975 [2]. It was comprised of a 30.9 m long marginal wharf tied into a 57.3 m long finger pier [2]. The marginal section had a 7.6 m wide reinforced concrete deck with laminated sub-deck and was founded on creosote treated timber piles [2]. The finger pier measured 7.8m wide and was constructed of both creosote treated timber piles and cribwork [2]. It had a reinforced concrete deck over the cribwork and a reinforced concrete deck with laminated sub-deck over the pile sections [2].

2.3 Fisherman's Wharf (Finger Pier #403/406/407)

Harbour Authority representatives noted that the existing finger pier was constructed in the 1960's, but no as-built information is available [2]. It is approximately 160 m long x 8 in wide and has a reinforced concrete deck with laminated sub-deck, founded on creosote treated timber piles [2]. The wharf has a bend located approximately 42.0 m from the beginning of the leeward side of the wharf [2]. There are three (3) floating docks attached to the leeward side of the wharf, which accommodate smaller type fishing vessels [2].

3 CHALLENGES

The main challenge with the current Arnold's Cove harbour structures was the lack of as-built information pertaining to the wharves' sub structures [3]. Due to this fact, it was unknown whether the existing wharves met all current codes and requirements, until the inspection was completed [3].

4 ASSESSMENTS

MEI conducted inspections of the existing structures to assess their condition and recommend any repairs or upgrades that the harbour may require. To do this, MEI availed of the services of Fracflow Consultants Inc. (FCI) and Sea-Force Diving Ltd. (SFDL) to carry out a geotechnical investigation of the harbour bottom and an underwater inspection of the wharf structures, respectively.

From the results of these investigations, and MEI's own investigation of the harbour, the following findings and recommendations were made by MEI.

4.1 Breakwater Wharf (Finger Pier #404)

Findings: Large vessels and barges loading and offloading at the headblock crib have caused extensive damage to that area [3]. The concrete deck was in a deteriorated condition, as well as the fendering, coping and wheelguards [3]. Being an older structure, the wharf did not comply with current standards [3]. The sub structure, which was made up of both creosote timber piles and creosote timber cribwork, showed signs of deterioration and would require extensive renovations in order to avoid complete replacement in the future [3].

Recommendation: The recommendations that came from the investigation of this structure included the removal and replacement of the entire deteriorated concrete deck, coping, wheelguard, bracing, select untreated fender system, salvage and reinstallation of twelve (12) Type "A" mooring cleats, and provisions for electrical shore power and area site lighting [6]. Removal and replacement of three (3) deteriorated treated timber bearing piles and timber fender piles along the seaward face was also suggested, as per an underwater diving report [6][3]. Placement of underwater concrete was recommended for a section of the undermined crib [3]. A final recommendation included installation of close faced fender piles around the head of the crib section, and new hardwood fendering along the leeward face of the pile section [3].

4.2 Longliner Wharf/Marginal Wharf (Finger Pier #401/Marginal Wharf #405)

Findings: The structure, being 34 years old, showed severe rotting in the timber piles [2]. The timber piles were at the end of their lives and severe rotting had been observed in them. This was most prominent in the area around the approach to the finger pier [2]. All three (3) bearing piles were 100% consumed in pile bent #1 [2]. The piles also appeared to only penetrate the sea bottom a small amount before reaching refusal [2]. For these reasons, and from the construction drawings of the timber piles, it was shown that the area was better suited for a timber cribwork and/or rock mattress structure [2]. Also, the section of the finger pier that was a timber cribwork structure had experienced significant settling [2]. This had caused the bottom timbers, which are crucial to structural integrity, to become completely submerged in the muddy bottom [2]. Because of the settlement, the bottom timbers of the cribwork could not be included in the inspection [2]. If only the timber pile sections of the wharf were replaced with cribwork structures, this would require excavation of the soft overburden material and would likely undermine the existing, sunken, cribwork [2]. For these reasons, it was recommended that a completely new structure be built and both the old pile sections and cribwork sections be removed [2]. The marginal wharf was being used to retain the fill on which the fish processing plant is constructed [2]. Therefore, directly replacing this wharf, in the exact location, would be difficult. Instead, the new marginal wharf was recommended to be constructed outside of the existing wharf [2]. This would allow the old wharf to be safely removed (with the use of bracing or sheet piling) and the area backfilled, once construction of the new wharf is complete [2]. This would also increase the size of the "cramped" laydown area. Lastly, the concrete deck; due to its insufficient thickness and the settling of the ballast; is of questionable structural capacity [2].

Recommendation: It was recommended that the existing marginal wharf and attached finger pier be demolished and replaced with a new, larger (30 m longer and 1.48 m wider) treated timber cribwork

structure [2]. The new wharf will also have a 250 mm thick concrete deck, designed to accommodate a CL-625 standard vehicle loading [2]. This is a requirement because of the wharf's use as an off-loading facility [2].

4.3 Fisherman's Wharf (Finger Pier #403/406/407)

Findings: The 30 m section at the head of the wharf is in a much deteriorated condition, especially at the timber pile level [2]. Some of the piles in this section are missing and others have rotted up to 90% through [2]. The piles on the rest of the wharf are in better condition, but could deteriorate in the coming years [2].

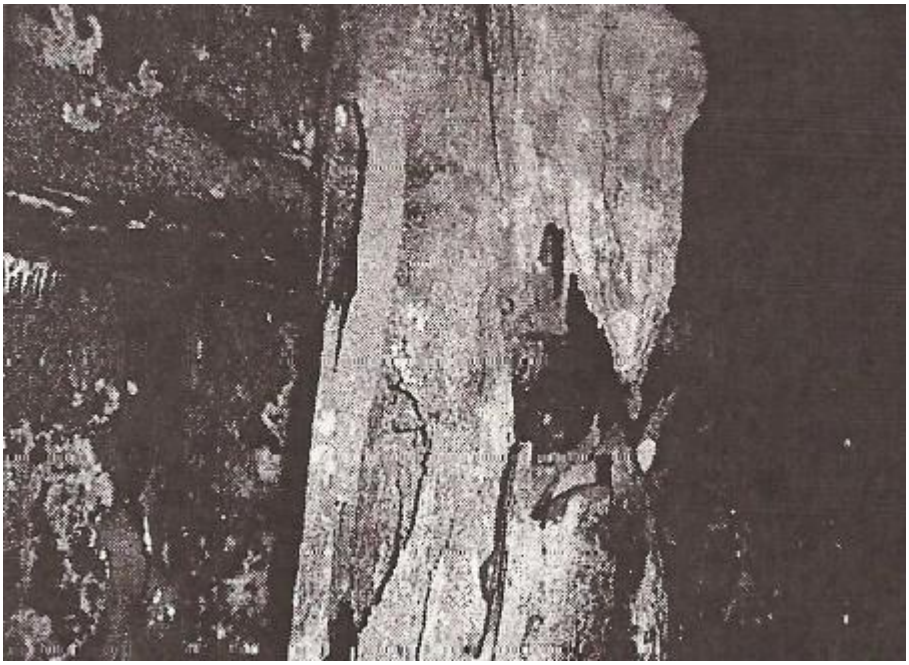

Figure 4: A creosote treated timber pile which is approximately 90% deteriorated due to rot [2].

Recommendation: It was recommended that a 30 m section at the head of the wharf be removed and replaced with floating docks to maintain the present berthage [2]. It was also suggested that a load restriction be placed on the wharf, and the two (2) jib cranes be relocated to a more suitable location [2]. It was determined that the structure would require continuous monitoring over the coming years to determine when the overall condition has deteriorated enough to constitute replacement [2].

4.4 New Breakwater

Findings: Finger pier #404 was originally acting as a breakwater structure, reducing the harsh wave action for the remaining structures in the harbour. However, the seaward side of this structure was completely exposed to storm undertow conditions and the wharf was not of an adequate length to completely shield the entire harbour [4]. These inadequacies caused unsafe berthage areas where vessels were unable to dock, thus limiting the efficiency of the existing harbour structures [4].

Recommendation: From these findings, the recommendation came to construct a rubblemound breakwater outside of the existing structures. The rubblemound breakwater will provide shelter to the existing wharves and safe access to all berthage areas [4]. The proposed breakwater will measure

approximately 160m by 45m and will require 24,785 m^3 of core stone, 6,930 m^3 of filter stone and 10,005 m^3 of armour stone [4]. As an addition, the area between the existing breakwater wharf and the new breakwater will be infilled using material such as core and filterstone to develop a laydown / service area [4]. See the figure below for a representation of the proposed breakwater structure.

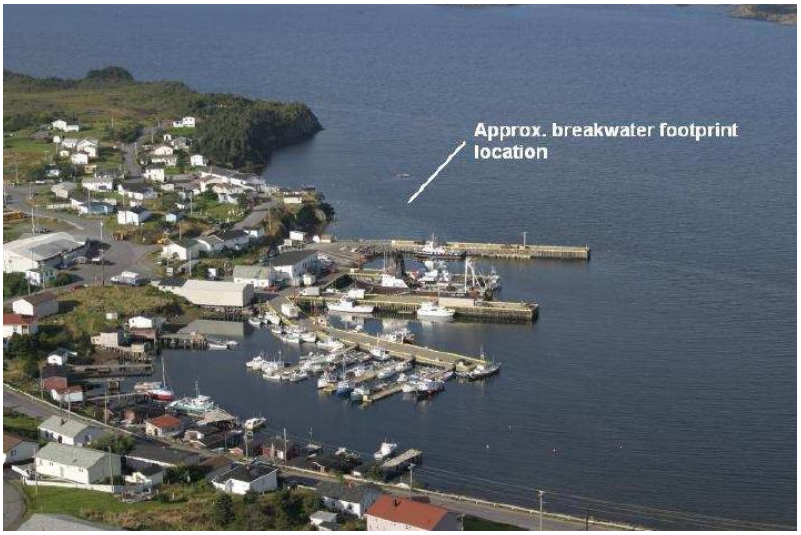

Figure 5: Arial photograph depicting the approximate location of the proposed breakwater [4].

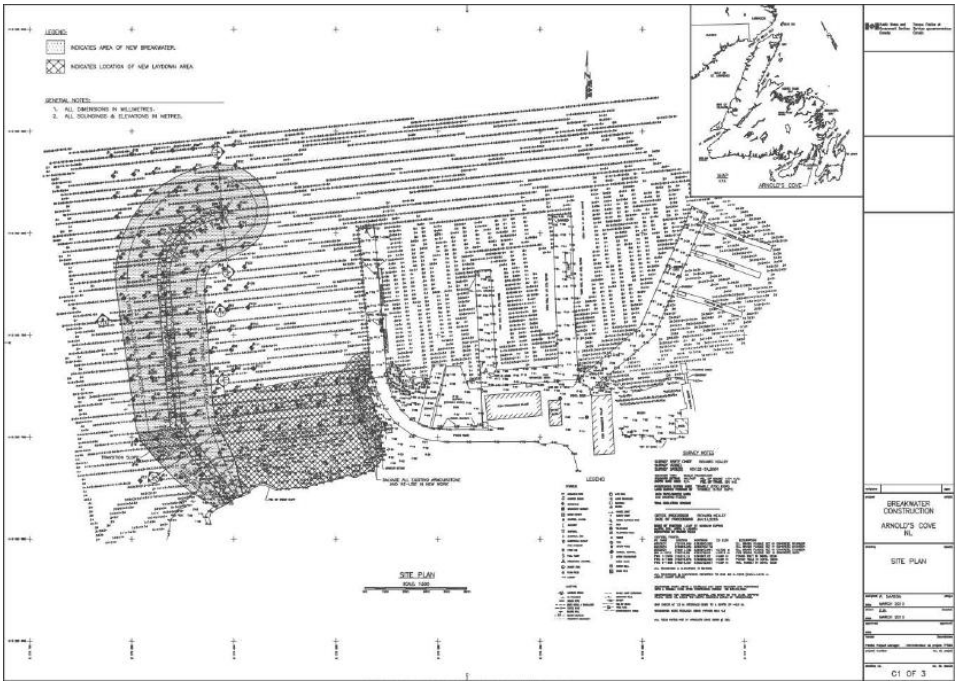

Figure 6: Plan view of proposed rubblemound breakwater and laydown area [4].

5 CONCLUSIONS

From the findings of MEI's investigation, there were apparent shortcomings in the design of the original wharf structures. The use of timber piles as the base of the wharf structures was an obvious design flaw due to the nature of the harbour bottom. Through a geotechnical investigation, it was revealed that the piles only penetrated the sea bottom a small amount before reaching refusal [2]. This

created an unstable base for the wharves, which would have been better suited for a timber cribwork and/or rock mattress structure. Another conclusion from the investigation is the importance of keeping good as-built information on coastal structures. Because of the absence of this information, in depth investigations were required to determine the details that would otherwise be known.

Overall, once all of the suggested improvements are put implemented, the harbour will be a much safer place for all users and will be in compliance with all codes and regulations. With these upgrades, the harbour should be in good working condition and require only regular maintenance for the next 50+ years. This will help to ensure that all the functions of the port; including shipping, fishing, tourism, and personal/recreation uses; are carried out with the required safe infrastructure. It will also allow the community of Arnold's Cove to preserve these industries, and take advantage of any economic opportunities which may present themselves in the future.

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[6] http://www.merx.com/English/SUPPLIER_Menu.asp?WCE=Show&TAB=1&PORTAL=MERX&State=7&id=PW-%24PWD-003-3795&src=osr&FED_ONLY=0&ACTION=&rowcount=&lastpage=&MoreResults=&PUBSORT=2&CLOSESORT=0&IS_SME=&hcode=byUoAcbVm8bjI%2b%2fr9t9GAw%3d%3d