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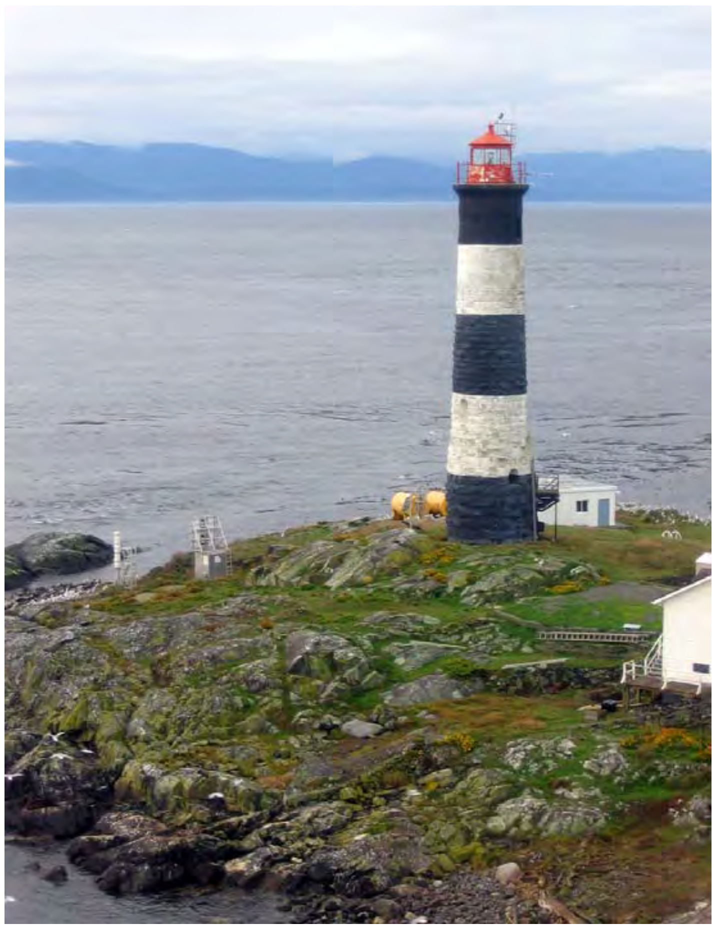
Race Rocks Lighthouse
Great Race Island, British Columbia
DFRP # 17447

Condition Assessment Including Indicative Cost Estimate



Date: December 14, 2007
HCD Project Number: 115365
Team Leader: Ève Wertheimer

Race Rocks Lighthouse

Great Race Island, British-Columbia

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Condition Assessment
Including Indicative Cost Estimate

Report Prepared for:
Department of Fisheries and Oceans

Prepared by:
Heritage Conservation Network
Professional and Technical Service Management
Public Works and Government Services Canada

HCD Project Number: 115365

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This report titled:

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has been reviewed by the following Senior Review Team Member*(s)* in accordance with Heritage Conservation Directorate's internal Quality Assurance System.

Susan Ross, Architect, Overall Team Leader — date: Dec. 5, 2007

Doug Stephenson, P.Eng, Senior Review Team Member — date: 07/12/07

María Inés Subercaseaux, Architect, Senior Review Team Member — date: 07/12/07

Heritage Conservation Network
Professional and Technical Service Management
Public Works and Government Services Canada

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Background

The Heritage Conservation Network (HCN) project team has completed the condition assessment and report for the Race Rocks Lighthouse located on Great Race Island in the Juan de Fuca Strait, south of Victoria, British Columbia, as part of the project for eighteen lighthouses for the Department of Fisheries and Oceans (DFO). The report contains structural and building envelope conditions, analysis of these conditions, recommendations and indicative cost estimates for mandatory and cyclical conservation work both in the short and the long term.

Conservation Approach

This condition assessment, report and related recommendations, follow the conservation approach of minimal intervention and least harm to preserve/protect heritage character. This approach will help provide DFO with information required to properly manage the Race Rocks lighthouse while ensuring that the building is safe in terms of both public and staff and that the existing heritage fabric will be protected and maintained.

Description

The Race Rocks Lighthouse is a pitched-face stone structure with a round, tapered shaft, painted with a series of horizontal black and white painted stripes. The tower corbels at the top forming a gallery around the cast iron lantern, which rises approximately 32 meters (105'-0") tall from grade, and tapers from a diameter of approximately 5.8 meters at its base to 3.8 meters at its narrowest point below the gallery. The tower is accessible through a curved metalic stair and arched door opening, located 3.20 meters (10'6") above grade. It is pierced with 4 window openings, the two lowest of which are arched and the top two, rectangular. The cast iron octagonal lantern, which sits atop the concrete parapet, can be reached by a continuous stone spiral staircase, which terminates just below it.

Heritage Value

The Race Rocks Lighthouse is a Recognized federal heritage building (FHBRO log number 90-85). It obtained a total score of 62, based on a score of 14 for historical associations, 23 for architecture, and 25 for environment. A review of the related Heritage Character Statement is provided in the report to help the lighthouse custodians identify and protect heritage fabric and aid in guiding future maintenance and repair interventions so as to maintain the lighthouse's heritage value. This section identifies all of the elements of the lighthouse that are important in defining the overall heritage values that require protection. Its character-defining elements reside in its robust stonework construction consisting of large rusticated blocks with limited decorative detailing, typical of "Imperial" lighthouse design, in its black and white day marking and in the interior spiral stone stairway. Other buildings on the islands are considered to contribute to the heritage character of the tower's environment, but were not investigated for this report.

Methodology
Background and historical documentation were consulted both before and after the on-site investigation. This included a review of documents related to environmental site assessments in the preparation of the Site Specific Safety Plan prior to the site visit. The on-site investigation consisted of a preliminary site orientation by the team members to gain a general understanding of the building and its surroundings. Detailed visual and tactile investigations were then carried out on both the exterior and interior of the lighthouse. All investigations were non-destructive by nature and any samples were gathered from loose or fallen materials.

Assessment

Building Structure:
Overall, the stone walls from the foundations to the top of the tower were found to be in fair to poor condition. Although there are no signs of displacements or structural instability, extensive damage was observed. Two large vertical cracks extend vertically from the base of the tower to a height of approximately 10 meters and will require mapping and monitoring. Deterioration of the stone also included delamination and salt formation, mostly visible on the interior walls, at the top of the tower, corresponding to exterior areas that were covered in "gunite" several decades ago. Water appears to be trapped in the walls at that level and the stone masonry will require rapid treatment in the affected area to limit further decay. Extensive cleaning, repointing and renewal of the impervious coating will also be required throughout.

Lantern and Gallery:
Deferred maintenance of the lantern and gallery has lead to deterioration of surfaces, with paint chipping and corrosion of the cast iron lantern and paint failure and concrete spalling of the underlying parapet. The gallery also shows traces of surface deterioration, with decayed paint and a failing membrane.

Building Envelope:
With the exception of an opening obstructed with fog-detection equipment, windows and the access door were found to be in good condition overall. The main recommendation with regards to the building envelope concerns the improvement of ventilation and heating levels to help resolve the stone deterioration on the interior face of the walls. Ventilation may for instance be provided through the windows and door openings.

Other Building Elements:
The exterior stair is a recent addition to the structure and is in good condition overall. It may warrant replacement in the future for reasons of code compliance and enhancement of the structure's heritage character.

Recommendations

The principal recommendations for this condition assessment would include:

- Examine and monitor the two vertical cracks at the base of the tower for a minimum of 1-2 years to verify if they are still active and identify their cause(s).
- Remove the "gunite" coating from the top of the exterior walls using an appropriate method.
- Clean, repair and repoint the stone on both interior and exterior faces of the tower.
- Remove all paint on the interior of the tower, using an appropriate non-abrasive method.
- Replace the existing impervious coating with a coating that allows circulation of water vapour and repaint the existing daymarking.
- Remove and repair the cast iron lantern (workshop conservation).
- Repair of the top of the parapet, at the base of the lantern.
- Provision of additional ventilation and heating inside the tower.
- Implement regular maintenance activities.

A detailed list of recommendations, identifying the recommended short- or long-term time frame is provided by building element in Section 4.0 and by type (mandatory, cyclical, investigation). Further investigation into building elements that were not accessible, research, and monitoring of conditions will also be an important future activity.

Cost Estimates

The estimated cost for all recommended mandatory and cyclical work for the next twenty-five (25) years is $3,503,600. The corresponding Net Present Value (NPV) is $1,782,000.

This amount corresponds to the sum (in NPV) of the mandatory generally short-term work $598,000, the cyclical generally long-term work $653,000 while also providing an allowance of $76,000 for further essential investigation, monitoring, and research, and $455,000 for overall fees, administration, etc.

The cost estimates for a Five Year Operating and Maintenance Plan, as provided by DFO, are included in Appendix J.

1.0 INTRODUCTION

1.1 Background

The Heritage Conservation Directorate (HCD), Professional and Technical Service Management, PWGSC, has been requested by David Burden, Director, Divestiture Branch, Real Property, Safety and Security Directorate, Fisheries and Oceans Canada (DFO), to carry out condition assessments of eighteen (18) heritage lighthouses in support of indicative cost estimates for mandatory and cyclical conservation work in both the short- and the longer-term.

The overall goal of this project is to provide the Divestiture Branch of Fisheries and Oceans Canada (DFO) with a report for each of the eighteen (18) designated heritage lighthouses that:

- outlines the typical structural and building envelope conditions found;
- provides a Long-term Conservation Project Plan that recommends a scope of mandatory and cyclical conservation work necessary in the short-term (1 to 5 years) and long-term (6 to 25 years) to preserve the heritage character of the lighthouse; and,
- provides indicative cost estimates for undertaking the recommended scope of work and the potential costs related to a demolition option, including related environmental remediation.

1.2 Historic Context

The Race Rocks tower is located on Great Race Island, a small and barren rock outcrop in the Strait of Juan de Fuca, about fifteen kilometres south of Victoria, British Columbia. Erected in 1860, simultaneously as Fisgard light, with which it was designed to function, the Race Rocks light tower is British Columbia's second oldest operating lighthouse and a forerunner of the extensive system of navigational aids built during the following century along Canada's West Coast.

Construction of both the Fisgard and Race Rocks towers was undertaken in 1859, at the initiative of colonial officials and with partial financial and technical support of the Imperial Government. The latter provided its expertise, the lighting apparatus, which according to the local legend, would have travelled from England with Fisgard's first light keeper, and 7000 pounds in funding, half as a grant, half as a loan. The colonial government oversaw the selection of the site and the construction following a plan of combined tower and dwelling, attributed to both JohnWright of London and to the Surveyor General of British Columbia, Joseph Pemberton.[1]

Race Rocks light tower is "the only known example of tall, pre-Confederation, unsheathed stone masonry tower, built outside of Ontario".[2] Along with towers of a similar design on the Great Lakes, it shares the classification of "Imperial" tower, a reference to its typology as a tall, tapered, circular, pitched-faced stone structure, rather than to the British involvement in its construction. Unlike the

[1] Martha Phemister: Race Rocks Lighthouse, FHBRO Building Report, 90-85.
[2] Ibid.

Imperial towers of Ontario, however, the interior configuration of the Race Rocks lighthouse was based on its being attached to the keeper's residence, and consists of a continuous stone spiral staircase rather than of superposed wooden floors linked by ladders.

The light at Race Rocks was lit on December 26, 1860, a month after that of the Fisgard tower. Until the construction of the landfall light at Carmanah Point in 1891, it was considered the most important lighthouse in British Columbia. It was attended to by a long succession of light keepers and their families, who lived in the attached stone residence until the construction of new dwellings in 1964, closely followed by the demolition of the original house in 1967. (*See Figs. 3 & 4*)

In the early 1980s, interest began to grow in safeguarding the rich wildlife and marine ecosystem of Race Rocks, and the islands were designated as an ecological reserve by the Province of British Columbia. This led to the transfer between 1997 and 2001 by the Coast Guard of all "surplus" buildings and land, with the exception of the light tower and a small area on which it stands, to the Provincial Park Services. Pearson College, based in Victoria, now runs a research center and manages the Race Rocks islands.

The lighthouse was de-staffed and automated in 1997. Although no longer employed by DFO, the former light keeper, Mike Slater, still resides on the island and is employed at the current time by Pearson College. The light itself is looked after by the Coast Guard, who has noted that the work recommended in recent condition surveys has not yet been carried out. [3]

[3] Among the most recently produced, the "Race Rocks Lightstation Condition Survey of the Stone Masonry Lighttower" prepared by G. Ovstaas & Associates Ltd. Consulting Engineers, in February 2005, lists a number of remedial work items, none of which appear to have been implemented.

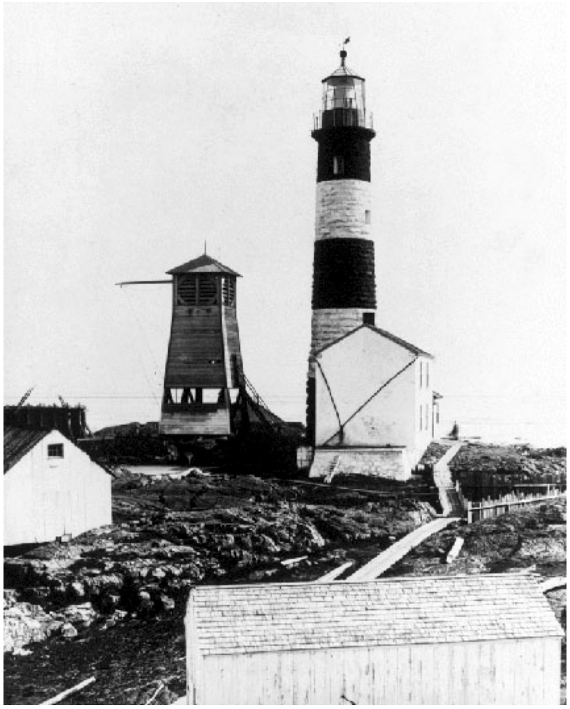

Figure 1: Race Rocks Island, showing the foghorn, tower and lightkeeper's residence circa the 1870s, as seen from the north side. (BC Archives / A-00535)

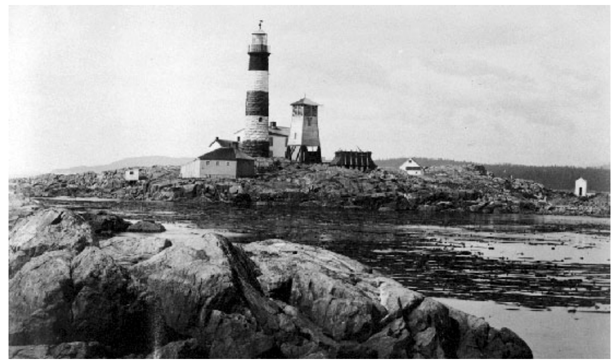

Figure 2: The Island in the 1910s, seen from the East. (BC Archives / B-04180)

Figure 3: The tower and attached residence, with a latter one-storey lean-to addition, in the mid-Twentieth Century. (www.racerocks.com)

Figure 4: The lighthouse prior to the demolition of the residence, in the 1960s. (BC Archives / I-03698)

Figure 5: Aerial view of the tower today. (HCN/2007)

1.3 Conservation Approach

Timely, respectful and effective repair and maintenance is a crucial component in the management and protection of heritage buildings. This project is being carried out to provide DFO with a strategy and the necessary information to develop and implement a plan to meet this objective.

The conservation approach taken to the project is in accordance with nationally and internationally accepted principles and practices for the conservation of heritage properties. This approach is enunciated in the *Standards and Guidelines for the Conservation of Historic Places in Canada*, which emphasizes the importance of understanding any heritage resource before beginning an intervention. All investigation techniques and proposed repair solutions are based on a minimum intervention approach, and functional goals are being met with the least harm to heritage character.

While all of the General Standards in the above document apply, in the context of this report's goals, it is useful to recall the principles articulated in the following General Standards:

- Standard 1: Conserve the heritage value of a historic place. Do not remove, replace, or substantially alter its intact or repairable character-defining elements. Do not move a part of a historic place if its current location is a character-defining element.
- Standard 2: Conserve changes to a historic place, which over time, have become character-defining elements in their own right.
- Standard 3: Conserve heritage value by adopting an approach calling for minimal intervention.
- Standard 6: Protect and, if necessary, stabilize a historic place until any subsequent intervention is undertaken. Protect and preserve archaeological resources in place. Where there is potential for disturbance of archaeological resources, take mitigation measures to limit damage and loss of information.
- Standard 7: Evaluate the existing condition of character-defining elements to determine the appropriate intervention needed. Use the gentlest means possible for any intervention. Respect heritage value when undertaking an intervention.
- Standard 8: Maintain character-defining elements on an ongoing basis. Repair character-defining elements by reinforcing their materials using recognized conservation methods. Replace in kind any extensively deteriorated or missing parts of character-defining elements, where there are surviving prototypes.
- Standard 9: Make any intervention needed to preserve character-defining elements physically and visually compatible with the historic place, and identifiable upon close inspection. Document any intervention for future reference.

Further work on the lighthouse should be guided by these principles, as well as the specific Guidelines for Buildings such as those for Masonry, Architectural Metals, Windows, and Structural Systems; Engineering Works; and Health and Safety found in the *Standards and Guidelines*. The complete text is available at http://www.historicplaces.ca/nor-sta/norm-stan_e.aspx

In the context of federal heritage lighthouses, an additional important international reference document is the *Historic Lighthouse Preservation Handbook* (first published 1997) by the US National Park Service. This detailed handbook for heritage lighthouse protection and project planning provides specific technical advice related to historic lighthouse materials, structures and site conditions, and provides the baseline vocabulary for describing lighthouse construction and techniques. It also makes reference to the USA Secretary of the Interior's Standards for Rehabilitation, standards that are largely consistent with Canadian conservation principles. (http://www.nps.gov/history/maritime/handbook.htm)

The project includes developing an understanding of the construction, history, heritage values, heritage fabric, and condition of the lighthouse. Based on this information, short- and long-term conservation plans identifying mandatory and cyclical work, complete with indicative cost estimates, have been developed. The recommendations for mandatory and cyclical conservation work focus on that which is necessary to ensure that:

a) the lighthouse does not pose a threat to the public and staff; and

b) the existing condition of the heritage fabric of the lighthouse is maintained.

In addition, the project will provide significant benefits to DFO, and potentially other federal departments that are custodians of lighthouses, in that it will serve to develop the standard methodology required to manage the protection of heritage character of designated heritage lighthouses as a whole.

In the limited time frame of this project, certain areas that were inaccessible, which will require additional investigation in order to assess their condition, are identified. In addition to developing the appropriate maintenance and repair approach, it is important to carry out this remaining investigation, to ensure that concealed deterioration is addressed. The necessary investigation is further discussed in Section 7.2.

Although this assessment was limited to the building envelope and structure, the solutions recommended to protect the heritage fabric and reduce deterioration may include provision of mechanical systems for ventilation. The need for an integrated ventilation strategy is further discussed in Section 4.4.1.

1.4 Project Team

Work was undertaken by a multidisciplinary team of PWGSC conservation professionals and technicians, including senior staff for quality assurance. In this report, the Heritage Conservation Network includes staff from PWGSC's Heritage Conservation Directorate in Gatineau.

The project team for this assessment included:

ÈveWertheimer, OAQ	Team Leader & Conservation Architect
Sarah Green, P.Eng.	Conservation Engineer
Ian Cameron	Conservation Technologist
Adam Jennex	Cost Estimator

Quality Review for this assessment is provided by:

María Inés Subercaseaux, M.Sc., OAQ	Senior Conservation Architect
Doug Stephenson, P.Eng.	Senior Structural Engineer
Randy Mosher	Cost Estimator
Susan Ross, OAQ, MRAIC	Senior Conservation Architect and overall team leader for all eighteen reports.

2.0 LIGHTHOUSE DESCRIPTION

The purpose of this section is to provide a detailed understanding of the construction of the Race Rocks Lighthouse, from the time of its original construction to today. Section 2.1 provides an overall description of the building, with emphasis on the structural system and the elements of the building envelope. Section 2.2 provides a chronological review of the building's original construction and subsequent modifications where they are known. The principal sources of information for this section are the FHBRO Building Report, the investigation of the existing building, the information provided on the website about the Race Rocks Islands maintained by Pearson College, as well as the review of the Canadian Coast Guard (CCG) archives in Victoria.

Current general overall photographs of each elevation can be found at the end of this section. Additional detailed photographs are found at the end of each subsection of Section 4.0.

See Appendix A for a list of additional reference documents.

2.1 Construction of the Lighthouse

The Race Rocks Lighthouse is a pitch-faced granite and sandstone structure with a round, tapered shaft. Its exterior is painted in a black and white daymarking, consisting of five horizontal stripes. The stone masonry is also entirely painted on the interior of the tower. The shaft corbels out at the top forming a platform at the gallery level. A concrete parapet wall at the gallery level forms the base for the lantern. The tower is approximately 105 feet (32 meters)[*] tall from grade and approximately 5.8 meters across at the ground floor. The foundation was constructed of roughly squared granite blocks, built upon one of Great Race Island's rocky outcrops, and stands 3.20 meters (10'6") above grade, where the door to the tower is located.

Officials recommended use of local construction materials as an efficient means of reducing costs, and the quarrying of granite from the island itself appears to have provided firm, stable masonry for the base of the tower, and for the top supporting the lantern[4]. More workable sandstone extracted from the Gulf Islands was apparently used to supplement the local granite, in constructing the tower shaft[5].

[*] General note to be applied to the entire document:
A conversion, from imperial units to metric units, was provided for all dimensions taken from written reports. The accuracy of these dimensions is however not guaranteed since not all dimensions were necessarily verified on site.

[4] Several sources claim that the stone would have been pre-cut, numbered and imported from Scotland serving as ballast in ships, to be assembled on location. Dale Mumford, of Fisgard Lighthouse National Historic Site, defends the other much more likely hypothesis of the extraction of local stone, as recounted on www.racerocks.com. Indeed, local extraction appears much more likely, given the abundance and quality of granite on the island and the difficulty posed by the island's topography in carrying imported stone onto it.

[5] Ibid.

The light tower was originally connected to a two storey, pitched-roof stone house for the light keeper, at its base, which was demolished in 1967. Traces of the former connection are visible in the irregular rounded profile of the tower and face of the stone, where it was once joined.

Four (4) small, window openings are staggered around the tower. The bottom two openings are arched, whereas the others are rectangular. The second opening from the top appears to have been slightly enlarged at its crown, and is now fitted with a fog-detector which obstructs it completely. All other openings are fitted with what may be original wood storm windows, painted shut, and no longer have any interior sash. Access to the tower is through a single entry 3.20 meters (10'6") above grade (corresponding to the second storey level of the light keeper's residence) consisting of a contemporary heavy steel door in a semi-circular arched opening. The transom area above the door has been enclosed with a fixed panel. This entrance is accessible by a curved metal stairway, built against the base of the tower.

The original lantern room would have been similar to the one that remains at Fisgard lighthouse, designed and manufactured in England. It appears to have been anchored into the masonry walls with a series of vertical metal ties that are still visible on the interior. The current lantern is a replacement is a prefabricated component, produced by Corbet Foundry & Machine Co. of Owen Sound, Ontario, dating from 1925. It consists of an octagonal, cast-iron structure, with a low-sloped roof, and a ventilator at the peak, all painted red. It sits on a tapered octagonal parapet wall, which was set on a new circular concrete slab serving as the floor, and is anchored to the stone structure with the prolongation of the parapet wall rebars, driven into holes at the top of the stone walls and grouted in with cement. (Refer to 1925 drawings in Appendix D.)

The gallery handrail on the exterior may however be original. The lantern is bolted into the top of the parapet with stainless steel bolts at each corner. Inside the lantern, the storm panels have a condensation gutter that permitted water to drain onto the interior sill and to the exterior but is now blocked-off.

The interior of the tower consists of a single flight circular spiral stone staircase, approximately 90 steps high, with a central circular pillar, resting on a stone floor supported by a solid base. There is no basement or storage area in the tower, a configuration explained by its prior connection to light keeper's residence, which would have housed all required support functions. The drawings prepared in 1925 for the installation of the new lantern indicated that the top stone steps were removed on a height of 7'-7" (2.31 meters), to allow for the installation of a landing and wood ladder leading up to the lantern.

2.2 Evolution of the Lighthouse

Early on in the tower's history adjustments proved necessary. After three years in service and at the request of mariners, the tower's exterior was painted in a striped black and white marking in order to increase its daytime visibility. In 1878, the apparently inferior quality of sandstone, quarried from locations below the high tide line, lead one consultant to recommend the complete demolition and reconstruction of the tower, a course of action that was not pursued and instead of which remedial measures proved sufficiently effective. [6] The nature of these deficiencies and repairs however remains unknown.

Later changes to the light tower include the replacement of the original British lantern with a cast iron one produced by Corbet Foundry & Machine Co. of Owen Sound, Ontario, in 1925. Various "repairs" were also carried out to the masonry, including a well-documented application of "gunite" on the upper portion of the exterior, in 1966. [7] Most dramatic was certainly the demolition of the light keeper's residence the following year, which had been replaced with two new free-standing houses in 1964, and the blasting of a wider door opening to the tower, followed by the construction of a new exterior access stair leading to it.

These modifications and other changes, as verified during the investigation, can be summarized as follows:

- The tower was painted with its current daymarking only a few years after completion. Repainting has been carried out as a regular maintenance procedure over time, and was reportedly preceded by sandblasting of the stone on some occasions.
- The lantern is a 1925 cast iron replacement of the original. Modifications associated with its installation included removal of the top stairs, on a height of approximately two meters, and creation of two concrete floor slabs.
- The top third of the tower's exterior was sandblasted and covered in "gunite" in 1966. Gunite or a similar cementitious parging is also apparent at the base of the tower.
- The adjoining lightkeeper's house was demolished in 1967 and blasting carried out to widen the door to the tower. [8] This entailed other significant changes to the structure, namely the construction of an exterior rounded metal stair, leading to the main door, and the replacement of the door itself with a steel leaf, and installation of a transom panel above it.
- A fog-detector was installed in the second window from the top, sometime during the1970's. The opening may have been enlarged from above in the process. The bay is now entirely clad in metal sheets on the interior.
- The counterweight mechanism of the rotational light remained in function until 1961. In 1983, the weight shaft opening through the stone stairs was partly blocked-off with concrete (electrical cables still rise along this former opening), and a metal railing installed on the outside perimeter of the stairway.
- More recent modifications include the addition of an emergency light ladder and antennas on lantern, and conversion of the tower to solar power.

Other than evidence of minimal maintenance, no further recent modifications or repairs were noted during the site investigations.

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[6] *Parks Canada: Occasional Papers in Archaeology and History No. 9*
[7] The specifications for this work were found in the Coast Guard archives.
[8] Video footage of the demolition and blasting was taken by the lightkeeper of the time, and can be viewed in the "Video Archives" section of www.racerocks.com

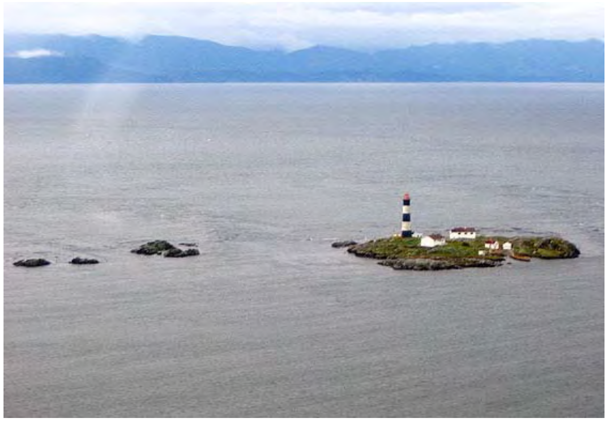

Figure 6: Race Rocks, the Juan de Fuca Strait and the Olympic Mountain Range in the distance. (HCN/2007)

Figure 7: Great Race Island and the Race Rocks Lightstation. (HCN/2007)

Figure 8: West view of the tower. (HCN/2007)

Figure 9: North view of the tower. (HCN/2007)

Figure 10: East view of the tower. (HCN/2007)

Figure 11: South view of the tower. (HCN/2007)

3.0 HERITAGE VALUE

The Race Rocks Lighthouse is a Recognized federal heritage building (FHBRO log number 90-85). It obtained a total score of 62, based on a score of 14 for historical associations, 23 for architecture, and 25 for environment. The complete FHBRO score sheet is provided in Appendix B. The following review of the Heritage Character Statement (HCS) is intended to help the lighthouse custodians identify and protect heritage fabric and aid in guiding future maintenance and repair interventions so as to maintain the lighthouse's heritage value. The purpose is to identify all of the elements of the lighthouse's structure and building envelope that are important in defining the overall heritage value of the lighthouse and that require protection.

The principal character-defining elements of the Race Rocks Lighthouse that relate to the building envelope and structure include:

The building's "Imperial" design, as demonstrated by:

- Its tall tapered profile, with limited decorative detailing and stately proportions;

The building's robust masonry construction, as manifested in:

- Its stonework, consisting in large rusticated blocks of granite composing the base and lantern, and similarly finished sandstone in the body of the tower;
- Its raised door and lower-level windows, set in arched openings in the thick masonry wall, and the small upper window rectangular openings;
- The painted black and white identifying colour scheme;
- The interior stone stairway;

The building's setting, as evidenced by:

- The rugged isolated character of the small island;
- The secondary structures associated with the light tower and which surround it.

These structures were not investigated as part of this study, although they are considered to be significant elements for the heritage character of the tower's setting.

The complete HCS is provided in Appendix B.

Additional information about the value of the Race Rocks light tower is found in the Appendix C on stone towers, in *The Evolution of Canadian Lighthouse Design*, a text prepared by Ian Doull, architectural historian, for the purposes of the overall lighthouse study. This text helps to relate this lighthouse to other similar lighthouses, and suggest some common areas of deterioration related to the original construction techniques and materials.

The complete text is provided in Appendix C.

4.0 CONDITION OBSERVATIONS, ASSESSMENT AND RECOMMENDATIONS

4.1 Methodology

Background and historical documentation were consulted both before and after the on-site investigation. These documents included the FHBRO Building Report and the Heritage Character Statement for Race Rocks Lighthouse, the historical overview on the website maintained by Pearson College, archives of the Canadian Coast Guard and documents relating to environmental site assessments.* A thorough review of the environmental site assessments was not in the scope of this work, but rather was carried out for preparation of the Site Specific Safety Plan prior to the site visit.

Following arrangements made with DFO regional representative Noel Taylor, Facilities Manager, and Vivian Skinner of the Canadian Coast Guard, the site investigation was conducted on October 29th, 2007. There had been light rainfall early in the day prior to the investigation, and most of the day was partly overcast with some longer clearing periods. Access to the site was made possible through a Coast Guard helicopter, which is the easiest and most rapid means of getting to Great Race Island, which is equipped with a helicopter pad. Otherwise, the island's rocky shores and modest dock only allow for the landing of small boats.

The on-site investigation consisted of a preliminary site orientation by the team members to gain a general understanding of the building and its surroundings. Detailed visual and tactile investigations were then carried out on both the exterior and interior of the lighthouse. All investigations were non-destructive by nature and any samples were gathered from loose or fallen materials. The exterior portion of the investigation was limited to viewing the lighthouse from grade level using binoculars, selective probing and sounding of the masonry with hand tools up to about two (2) m height off the ground, as well as visual inspection of the gallery exterior visible from the hatch opening. Digital photos were taken as well as field notes to document the overall and specific conditions noted during the inspection. The detailed photographs are located at the end of each section.

Due to the remote location of the lighthouse on an island and uneven terrain surrounding the lighthouse, elevated access equipment was not employed during the investigation.

The environmental assessment reports provided by the Coast Guard gave no recommendations for the use of protective clothing or equipment to carry out the investigation.

The following condition observations, assessment and recommendations are organized in four principle sections: the building structure, which includes the foundation, wall, floor and roof systems; the lantern and the gallery; the building envelope, which includes the roofing, exterior

* Refer to Appendix F: Executive Summaries of Environmental Assessment Reports.

walls, windows and doors; interior finishes; and other related elements of the building structure and envelope.

Within each section, specific conditions noted on site are listed, followed by an assessment of the condition and suggestion of sources of deterioration, and then the related recommended work. The recommended work is presented in the following order: mandatory health and safety considerations, further investigation, mandatory repair work required in the short term, then finally cyclical work required in the long-term, generally including a program of maintenance and inspection / monitoring. All proposed repair solutions are based on a minimum intervention approach, and functional goals being met with the least harm to heritage character.

General Note: All annual inspection and monitoring work should be coordinated and carried out at one time. Related inspection and monitoring recommendations in the other sections are therefore priced together in the summary of estimated costs in the Table of Costs (Section 8.1).

4.2 Building Structure

4.2.1 Foundation

The stone foundation wall is an extension of the masonry wall above, which is covered in part 4.2.2 and is a principal character-defining element. Its structural integrity is critical to the preservation of the lighthouse as a whole. For the purpose of this report, the stone foundation is defined as the portion of the walls located below the entrance door, between grade and the floor slab located 3.20 meters above it, where the tower is believed to be completely filled-in inside its perimeter walls.

According to all sources consulted, the base of the tower walls is constructed of large granite blocks, extracted on location and themselves bearing directly on one of the island's outcrops. The nature of the stone could not be verified by non-destructive means, as it is entirely coated in thick layers of an elastomeric paint, and it is unknown at what height granite gives way to sandstone. The base of the tower is assumed to be entirely solid, up to the level of the entrance door, 3.20 meters (10 '6 ") above grade, where it supports a floor consisting of large stone pavers. Therefore, investigation was limited to the exterior face of the foundation walls. Thick coatings of waterproof membrane and cement parging also impeded the assessment of a large area of underlying stone on the exterior surface.

The foundation walls consisted of hammer-dressed masonry, which have been covered with a cementitious parging on the west face of the tower, where it was once connected to the light keeper's house *(See Fig. 12)*, and has been formed to mimic the appearance of pitched face stone. *(See Fig. 13)*. Overall, the foundation walls are level and show no evidence of dislocated blocks. The following observations of conditions were noted and relate to figures located on page 23:

- Overall, the cement parging appeared to be in condition with no evidence of spalling or cracking.

- Two large cracks extend vertically from the base of the tower to approximately 10 meters above grade (as indicated in field observation drawings of Appendix H). The first, rises along the mortar joints almost mid-height to the south-west face of the tower, from the junction of the parged surface and adjacent stone blocks, increasing in width. Another finer vertical crack can also be seen to the north of the door opening, extending to the height of the height of the door and then diagonally through the courses above it *(See Fig.12)*. These two cracks approximately match the limit of the parged area around the door.
- A few breaks were also noted at the base of the bottom course. (*See Fig. 14*)
- Conduits to the tower are anchored vertically along the wall, leading to an opening next to the door – holes have been made into the parging to attach these, and the anchors themselves are corroded.
- Traces of algae growths, mould and calcite deposits were observed on the surface of the foundation walls.
- The grade around the base of the tower is irregular in surface. The area on the northern perimeter of the structure is paved, along with a patch at the base of the stair where the pathway ends, and the asphalt abuts directly onto the face of the lowest stone course. Asphalt has also been laid over horizontal conduits leading to the tower to protect them. The relief in the area east of the tower also tends to rise slightly, creating a drainage slope towards the foot of the structure, but with no apparent increase of dampness in this area. All other surfaces, to the east of the tower and below the metal stair are gravel. This mineral surface around the building has prevented any vegetation, other than a few blades of grass, from appearing at its base. (*See Fig. 15*)

Assessment

The foundation walls were generally difficult to assess because of being concealed behind a thick layer of cement parging in some areas, and coated with a thick waterproofing product throughout. In spite of these obstacles in visibility, condition of the walls appeared to be generally fair, with no evidence of structural distress due to earth pressure or settlement. Certainly, the rocky nature of the island itself has provided a very stable base for the structure.

An issue of concern are the two large cracks that extend vertically, along the south west side and north side of the tower, although they no longer appear active (the last coat of paint, at least several years old, is intact). There are several potential explanations for these cracks, discussed in detail in section 4.2, and these will require some visual monitoring to ensure they are stable.

The parged area around the door opening and at the foundation level correspond to the former portion of walls which were connected to the light keeper's residence. It is likely that the parging was applied to conceal the stone tailends and rubble masonry, or the poor quality or condition of the underlying stone. Investigations will be required to assess this, however, given the generally good condition of the parging on these areas, and insofar as this layer causes no deterioration of the underlying stone, it may be best to retain and repair it in the future.

As maintenance appears to have been minimal in recent decades, it can be assumed that extensive cleaning of algae and calcite and repointing of the foundation walls will be required on areas not covered in parging, before re-application of the waterproof membrane and re-painting.

Finally, although the surface around the tower is irregular and paved in a large part, moisture accumulation at the base of the walls does not appear to be an issue. Despite light rainfall earlier in the day, the walls appeared dry. Nevertheless, asphalt abutting the base of the wall should be eliminated to avoid standing water to seep into the stone masonry.

Recommendations

Based on the observations and assessment, the following recommendations are made to protect the historic stone structure and to reduce the risk to public from potential health and safety hazards. This work is anticipated to occur within the next 3 to 5 years.

<u>Further Investigations</u>

1. Examine and map the two vertical cracks for a minimum of 1to 2 years to determine if it they are still active and what may be their cause. If required, an appropriate repair can then be specified based on the findings.
2. Investigate the condition of the stone behind the parging with localized openings, for evidence of deterioration due to the cement coat. (within 3-5 years).

<u>Mandatory Repairs</u>

3. Remove the waterproofing and paint coatings from the walls using an appropriate method (soft abrasive), to allow a thorough inspection of the masonry. Clean off all algae growths mechanically, remove mould and calcite deposits, and repoint using mortar appropriate for the type of masonry, as required. Given the sensitive nature of the island's ecosystem and its status as an ecological reserve, suitable mitigation and abatement measures will be required in the removal of these materials to avoid contamination. (within 3-5 years)
4. Asphalt surfaces should be removed in a one (1) meter perimeter of the tower and replaced with gravel to help ensure better drainage at its foot and to avoid water from splashing back onto the stone wall. (within 3-5 years)
5. If investigations warrant a removal of the parging, proceed using an appropriate method (soft abrasive). Treatment of the underlying masonry will depend on condition identified in investigations, and may involve repair and partial stone replacement. (within 3-5 years).

Cyclical work

Between major repair cycles, an annual visual inspection and a regular maintenance program on a five-year cycle is recommended, including:

6. Verification of the cracks, and keeping them sealed to prevent water entry.
7. Cyclical maintenance and replacement of the parged coating over the stone.
8. Cleaning, repointing and repainting the walls.
9. Renewal of the impervious coating is anticipated on a 25-year cycle.

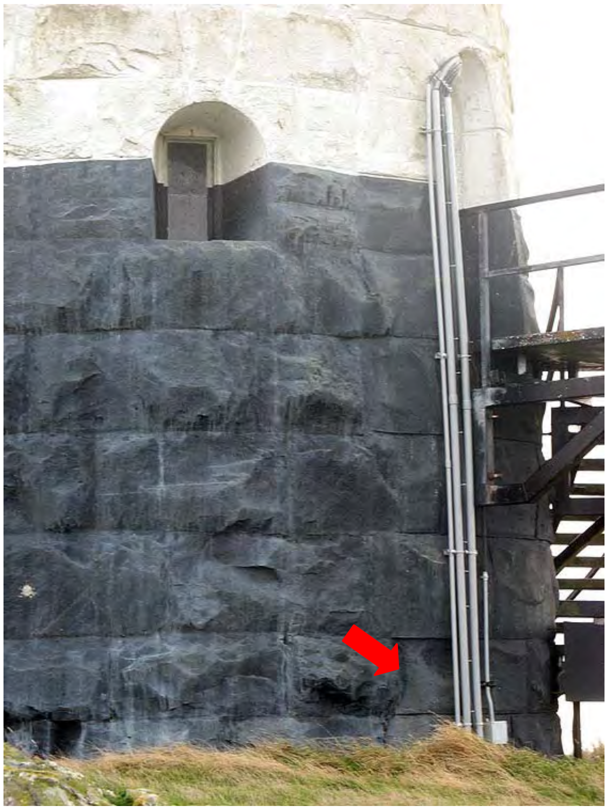

Figure 12: Large hammer-dressed coursings of the tower foundations, below the door opening. Note the transition from parging to natural stone right of the door opening, next to the conduits and the vertical crack along it. (HCN/2007)

Figure 13: Natural stone and formed cement parging at the foundation level. (HCN/2007)

Figure 14: Breaks in the base course and white streaking. (HCN/2007)

Figure 15: Asphalt surface abutting directly against the base of the tower. (HCN/2007)

4.2.2 Wall Structure

The stone wall structure of the lighthouse is not only a principal character-defining element, its structural integrity is critical to the preservation of the lighthouse as a whole.

The walls are constructed of a tapered exterior wythe of irregularly coursed granite and sandstone blocks, and a vertical interior wythe of coursed sandstone. Although not identified in any historic documents relating to the tower, it is likely rubble masonry fills the space between the exterior and interior wythes, as would be typical for this type and period of construction. It is also unknown if there are ties through the wall, although some granite blocks visible on the interior in the upper half of the tower, amidst predominantly sandstone blocks, may act as such. Generally, the nature of the stone was difficult to identify clearly, as it is coated in thick layers of paint, both inside and out. Only chipped and delaminated areas offered an opportunity for identification of the stone. Assessment is also based on observations made on the interior of the tower, where all surfaces were readily accessible from the stair. Exterior observations were carried out with binoculars, and their precision was limited by the gunited and waterproof coatings which cover the stone.

The wall thickness ranges from 0.7 m (2'-3") thick at the top of the tower and 1.6 m (5'3") thick at the lower level, the exterior diameter at the base being 5.80 m (19'-0"). With the exception of the lantern room, the interior diameter of the tower is 2.4 m (8'-0"). The lantern's interior diameter is 2.29 m (7'-6") and tapered parapet wall is 0.15 m thick at its top.

The exterior masonry is formed with pitched-face stone, laid in a running bond, in courses of varying width, which generally decrease in height towards the top. Pitched stone, or rock-faced stonework, is stone with clear arrises, but the exposed face has been tooled with pitching chisel to create a rough surface. At Race Rocks however, the tooling of the stone is not completely uniform, and some blocks are simply bush-hammered. Several blocks are also slightly caved-in, though this is likely not a deliberate finishing but rather the result of wear or delamination. All exterior surfaces of the stone have been painted in a elastomeric coating,[9] following a pattern of striped black and white day marking, though it is not clear whether the underlying coating on the stone and the visible layer of coloured paint are the same product.

In the top third of the tower, where the "gunite" was reportedly applied in 1966, the masonry is covered in a layer of parging that smoothens out most of the relief in the stone. According to the 1966 specifications,[10] this layer would have been applied down to an elevation 6.70 m (22 feet) below the gallery, over the sandblasted stone and gallery cleaned of dust and debris. The document specified the application of 2.5" square reinforcing mesh of #12 gauge wire, secured in position and covered in "standard gunite" (no further indication as to the mix content) to a

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[9] Referred to as "Towerthon," produced by "Cloverdale," a product specified in particular for providing waterproofing to hairline or "spider-web" cracked surfaces, it would have been used in 1996 and possibly later on, according to a memo found in the Coast Guard Archives. Prior to that, Multi-guard R-20, distributed by ProCraft would also have been utilized. Product information for "Towerthon" can be consulted at http://www.cloverdalepaint.com/html/catalog_spec.asp?prodcode=20150

[10] Department of Transport Work Order, dated March 4th 1966, indicated as completed on March 24th 1966.

minimum thickness of 2" with an applied rubber float finish. The current appearance of the top area of the tower indeed matches this description.

In the lower portion of the tower, around the door opening where the shaft was formerly attached to the lightkeeper's residence and all the way to the base, on the west and north faces, a cementious coating was also applied over the stone. It is uncertain whether this is also "gunite," as this area was not included in the 1966 specifications. Rather than having the smooth finish observed in the top third of the tower, in this area, the cement coat was formed to mimic the appearance of the pitch-faced stone.

At the top of the tapered shaft, the cement coated surface corbels outward, somewhat unevenly, supporting the gallery and guardrail. Once again, it was difficult to identify any change in the nature of the stone, from sandstone back to granite on the interior. According to drawings prepared in 1925, the one (1) meter wide gallery deck is formed by the top course of stone with overhanging sloped blocks, also apparently coated in "gunite" in 1966 to form a cement screed over the stone structure (Appendix D).

On the interior of the tower, where the stone walls meet the concrete slab supporting the lantern, a series of vertical metal strips, each approximately one (1) meter long, are tied into the masonry by an end anchor bolt. These were possibly ties used to secure the original lantern into the wall. Although coated in protective aluminium paint, they are for the most part heavily corroded. According to the section prepared in 1925, the current lantern is anchored by the reinforcing bars of the concrete parapet prolonged into hole drilled into the top stone of the wall and grouted in cement.

The windows consist of very simple openings in the stone, with no projecting sill or lintel. The lower two are set between two blocks of stone forming the jambs, with an arch consisting of two carved blocks joined with a keystone. A smoother margin created in the stone finish surrounds the opening. The top rectangular openings are even simpler, consisting simply of voids in the stone wall assembly. As for the door to the tower, it is also a simple opening, though the parging around it makes the stone assembly illegible.

Severe deterioration of the stone can be observed in several areas of the tower, both inside and out, and many of these conditions recur throughout. Specific observations of conditions noted during our inspection are as follows, and the related figures are located on pages 31 to 33.

<ins>Exterior</ins>

- The walls exhibit several large crack systems along mortar joints, often associated to open mortar joints, but which in some cases prolong through the stone. These include:
    - As described previously in section 4.1, two cracks extending from the base of the tower, the first on its south-west face, along the parged area to the west, then up to about a third of the tower's height, the second along the vertical conduits to the north side of the door, and diagonally through the stone above it *(See Figs. 18 & 19)*;

  - Shorter cracks at mid-height: a short vertical crack through two courses of stone below the second arched window, two short diagonal breaks through blocks on the East flank, and a longer spanning crack four courses through joints and a stone on the south-east side;
  - In the gunited area at the top, a series of horizontal cracks follow the coating line itself, at the height of the top window, while another extends below the corbelled gallery profile.
- Crazing, as well as a few small chips can be observed on all the surface of the parged area.
- The stone lintel above the window opening which houses the fog detector equipment has been partly broken off. The area of the missing chip is left exposed.
- A number of mortar joints are open – vertical joints within the white portions of the tower were most visible.
- In a few small isolated areas, the paint coating has begun to peel away from the stone.
- Some small corrosions stains are also visible. Most are associated with a series of short corroded metal rods protruding in a vertical alignment along the north elevation.
- White streaking stains can be observed in some areas of the black horizontal bands.
- Areas of algae growth, mainly concentrated on the South flank, were also noted. *(See Fig. 20)*
- Dirt accumulation on the irregular pitch-face surface of the stone is most obvious on the white painted bands of the tower

<u>Interior</u>

Extensive deterioration of the stone surface was observed throughout the interior of the tower, though it appeared to be concentrated in some specific areas, namely all wall surfaces above the top window, areas on the interior located on the south face of the building, and several other patches. This deterioration consists of extensive bubbling and chipping of paint, significant amounts of salt formation on the surface of the walls, and severe delamination of the sandstone, sometimes up to a few centimetres deep. *(See Figs. 21 - 23)* Dust and stone debris is falling away upon simple contact with the stone and accumulating rapidly on the exterior end of the steps. *(See Fig. 24)* This action appears to have been ongoing, as worn back stones stone have been painted over. The stone openings vary in condition, with damage concentrated mostly at the top of the openings, with delamination and salt formation taking place. Mortar joints could be examined where the paint had disappeared. Older lime-base joints are falling to dust in affected areas, and some have been repointed with a cementitious mortar. The condition of the interior stone was found to be much sounder towards the base of the tower, with almost no traces of delamination whatsoever.

Assessment

In spite of the presence of cracks and stone deterioration, the overall structure appears to be structurally stable, with level walls and no displaced stones, demonstrating the reasonable quality of the original construction. The various areas of failure that have become apparent can rather be attributed to inappropriate repair interventions made over time, as well as to the results of deferred maintenance. It is unfortunately not known what deficiencies were identified in the 1870's, when the tower was deemed to be irrecoverable, nor what were the successful measures used to refurbish it at the time, and whether these conditions relate in any way to what can be observed today. Also unknown are the reasons which prompted the application of gunite to the top of the tower in the 1960's. One can only presume that the poor condition of the underlying stone was what lead to the application of this solid coat in the first place.

The deterioration of the stone is most obvious on the interior of the tower, where it is literally falling to dust. Several explanations can be offered to this damage, which is most severe on sandstone blocks, made particularly vulnerable to the action of salts and water accumulation by their intrinsic softness and porosity.

Extensive damage of the stone on the interior was particularly evident at the top of the tower, in the area corresponding on the exterior to the approximately 7 meters in height where gunite was applied in 1966. A cement-rich coating such as this one tends to trap moisture, even more so when it is coated with a waterproof coating such as the elastomeric paint applied to the tower. And although the "Towerthon" product used at Race Rocks claims to be elastic and able to expand and contract to maintain a waterproof barrier, it is impossible that such an irregular and exposed surface as this would remain completely watertight years after its last application. Once an impervious protection is applied, it requires continuous maintenance, otherwise problems appears as soon as it begins to fail or crack.

Furthermore, cement will also tend to crack rather than absorb the natural movement of the structure (hence some, if not all of the crazing observed on the parged surfaces), leading to water infiltration through capillary action. Given the imperviousness of the outer layer, water cannot evaporate elsewhere than on the interior of the structure. This process would explain both the transport of salts from the cement coating and saline air, and the moisture transfer through the interior. However, this movement is blocked on the interior by a layer of paint, and can only make its way through when this coat fails through chipping. The cementitious mortar joints on the interior face of the wall have also further aggravated the process, forcing the water and salts even more so through the stone, with the resulting brittleness and deterioration of the sandstone.

Similar damage is also concentrated at mid-height of the tower, on the interior of the structure's southern face, where it is most exposed to prevailing winds and driving rains, as demonstrated by algae growths on the exterior face. Here, in addition to the impervious coat of paint and to the accumulation of humidity in the micro-organisms on the wall surface, the differential pressures of windward and leeward sides forces the saline water to evaporate on the interior side of the wall, with the same result as that observed above, namely delamination, salt formation, and paint chipping off to let the moisture out of the stone.

In both cases, it is impossible to assess the effects of repeated sandblasting on the tower's exterior. The softer surfaces of the stone thus exposed may very well facilitate water absorption through it. Furthermore, cracks in the walls and gallery (see section 4.4), and open mortar joints also offer points of entry for water into the wall assembly, and are likely provoke a similar deterioration pattern on the interior side of the wall.

The condition of the interior wythe of the stone wall appeared much sounder at the base of the tower, even in the area around the door which has been coated with a cementitious parging. Somehow, the coating in this area does not appear to pause any of the deterioration pattern described above, at least for the time being.

The cracks in the structure may be attributed to several possible sources, but only mapping, monitoring and further investigations will allow this to be determined with certainty. Given the temperate climate of southern British Columbia, it is unlikely that freeze-thaw would be liable, as is often the case in other Canadian masonry lighthouses. Seismic displacement of the structure is one potential explanation in this region of the country. Moisture-related expansion and the combined use of granite and sandstone, materials with different properties and behaviours may also be contributing factors. Most probable, however, is the impact of the blasting that took place in 1967 to widen the door opening, which would explain the concentration of significant cracks at the bottom of the tower. Cracks in the masonry may also have appeared, widened or extended when blasting later took place on the island, namely in 1978 during construction / renovation of the helicopter pad, an event which reportedly caused one of the lantern storm panels to break.[11]

Another potential mechanical failure that should be investigated is the crazing of the "gunited" surface at the top of the tower. This is likely to be at least in part due to the brittle nature of the cement coating, as described above, which unlike a lime wash, is incapable of absorbing the movement of the structure. Although there is currently no evidence of corrosion or loose pieces of parging, the significant levels of humidity in the walls, particularly in that area of the tower, pause a risk of corrosion of the wire mesh supporting the cement. This would cause the cement to burst, and potentially, to break-off, and such effects should therefore be monitored, as they would represent a significant concern for health and safety.

Finally, more minor issues such as the broken stone above fog detector (which likely occurred when the fog detector was installed), as well as dirt accumulation, corrosion stains and streaking on the exterior face of the masonry are not as critical to the structural or material integrity but can affect the heritage character.

Recommendations

Based on the observations and assessment, the following recommendations are made to protect the historic masonry structure and to reduce the risk to public from potential health and safety hazards.

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[11] A telegram dated August 17, 1978 reports that "large window west side building nr. 9 damaged during blasting operations this date," the blasting operations in question being related to the construction/repair of the helicopter pad located at the opposite end of Great Race Island.

<u>Mandatory Health & Safety</u>

10. Due to the potential hazard associated to slippage from the rapid accumulation of stone debris and dust on the tower steps, remove all loose stone fragments and dust from the interior surface of the stone walls and regularly sweep the steps. Cleaning of the wall and steps should be ensured on a regular basis before the root causes of the stone deterioration can be addressed. (within 1-2 years)

<u>Further Investigation</u>

11. As indicated in Recommendation 1, regarding the foundation walls, the most significant crack systems (namely the two vertical cracks at the base of the tower, the horizontal cracks at the top and the vertical crack at mid-height) should be mapped and monitored for a minimum of 1-2 years to determine their cause and whether they are still active. An appropriate repair can then be specified based on the findings. (within 1-2 years)
12. Localized investigation of the exterior stone masonry behind the parging and gunite at the base and top of the tower will be required to assess its condition and the extent of required repairs to the underlying stone masonry. (The services of masonry/building envelope specialist will be required). This elevated work will also call for access by Bosun's chair or other appropriate elevated access equipment. (within 3-5 years)
13. Investigate, to the extent possible, whether the metal ties at the top of the interior walls still play a role in relation to the structure of the lantern above. (within 3-5 years)
14. Re-evaluate the use of the current impervious coating applied to the exterior of the tower and examine its performance for signs of negative impact on the masonry. Both the coating and day marking should be waterproof yet allow for vapour transmission from the wall to the exterior. (within 1-2 years)

<u>Mandatory Repairs</u>

Major repairs are strongly recommended within 3 to 5 years to address the items of concern for the masonry:

15. Remove all paint on the interior of the tower, using an appropriate non-abrasive method. The interior of the tower should be devoid of any synthetic coating, left bare or coated in a thin layer of lime wash. Given the sensitive nature of the island's ecosystem and its status as an ecological reserve, suitable mitigation and abatement measures will be required in the removal of these materials to avoid contamination.
16. Metal ties in top of wall and anchors in stone: clean of all corrosion and coat with protective paint. Treat bolts set into stone to ensure they do not cause masonry to burst.
17. Remove the coating on the exterior of the tower, using an appropriate non-abrasive method. Once again, care should be taken in the disposal of these products.
18. Remove the gunite on the top third of the tower, using an appropriate method so as not to damage the underlying stone. As previously noted, proper mitigation and abatement measure are required for this work.

19. Treatment of the underlying masonry will depend on condition identified in investigations, and may involve repair and partial stone replacement. Partial repair and replacement in kind of damaged stone blocks is anticipated. Repairs should be carried out according to recognized conservation practice, and new stone should be physically and visually compatible
20. Remove all cement joints on the interior and exterior wall faces. Repoint open, cracked and cementitious joints using a mortar appropriate for the type of masonry and exposure, as required. Cement-rich mortar should be avoided.
21. Clean off all algae growths mechanically, as well as mould, stains and calcite deposits on the exterior. Specialized cleaning techniques may be required to extract the salts from the walls as thoroughly as possible.
22. Application of an impervious coating and day marking following evaluation of the current coating as per recommendation 14.

Cyclical Work

Between major repair cycles, an annual visual inspection and minor maintenance program following a five-year cycle is recommended is recommended, including:

23. Regular verification of the cracks, and keeping them sealed to prevent water entry into the wall.
24. Cyclical maintenance and replacement of the parging at the base of the tower.
25. Inspection of stonework for evidence of new spalling, as well as for performance of repairs. Inspection of the masonry is to precede the application of exterior coating.
26. Cleaning of the wall surfaces, with mechanical removal of algae growths and removal of stains, mould and calcite.
27. Renewal of the impervious coating on the exterior face of the lighthouse is anticipated on a 25-year cycle. Repainting of the day marking may be required at closer intervals.

Figure 16: Deformed exterior tower wall at its former point of connection with the demolished residence. (HCN/2007)

Figure 17: "Gunited" wall surfaces in the top third of the tower. (HCN/2007)

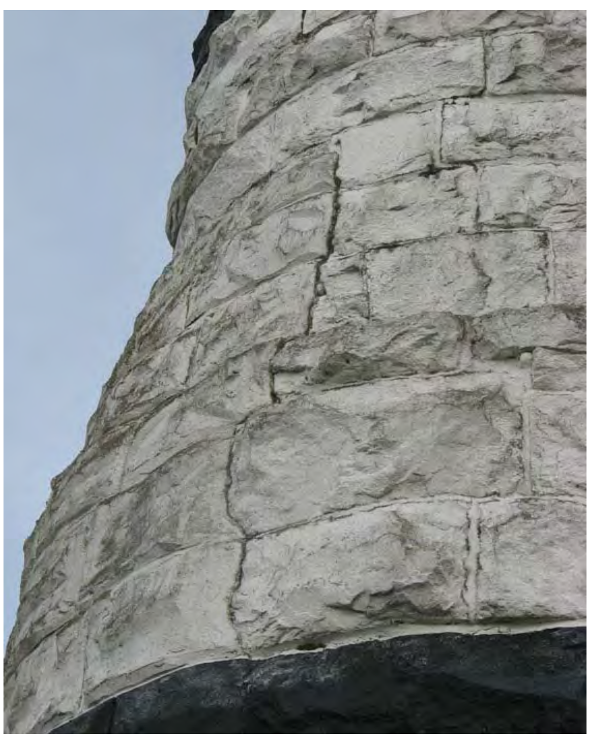


Figure 18: Vertical crack extending along the south-west face of the tower. (HCN/2007)

Figure 19: Crack prolonging diagonally above the door. (HCN/2007)

Figure 20: Algae growth on the south face of the tower. (HCN/2007)

Figure 21: Delamination of the stone on the interior face of the top walls. (HCN/2007)

Figure 22: Stone deterioration around the interior of the top window opening. (HCN/2007)

Figure 23: Paint failure on the interior face of the walls. (HCN/2007)

Figure 24: Debris accumulation on the steps. (HCN/2007)

Figure 25: Corroded metal ties at the top of the interior walls. (HCN/2007)

4.2.3 Floor Structure and Interior Stair

Although the floor structure is not specifically mentioned as a character-defining element, it is integral to the building's interior layout and functionality. The spiral stone stair that occupies most of the tower shaft is however one of its principal character-defining elements. The structural integrity of both floors and stair are critical to the preservation of the lighthouse as a whole.

Given the distinct interior layout of the tower, which consists a continuous spiral stair, floors as such are limited to three levels: the ground floor, the landing at the top of the stair and the lantern floor. The ground floor is made up of the original large stone slab paving set upon the solid base of the foundations, which form an even and smooth horizontal surface.

Above this stone floor, the spiral stone staircase occupies almost the full height of the tower. It consists of wedge-shaped stone blocks supporting one another, embedded into the exterior wall and supported at the center by a continuous circular stone pillar.

At the top of the spiral stair, a quarter-circular concrete slab landing supports the stair leading to the lantern. This slab consists of 9" thick reinforced and painted concrete, supported on its edge by a steel beam. Above it rests a small wedge-shaped wood platform, likely a latter addition, installed to provide access to the console suspended above which houses the electronic light and fog-detector controls. This wood platform is also supported below by a 2" x 4" post resting on a step.

A painted wood ladder connects the upper landing to the lantern. The floor of the lantern is a 9" painted reinforced concrete slab. According to 1925 drawings, it is connected to the parapet wall and rests on the interior edge of the top stones of the tower wall. It includes a 2'-0" by 3'-0" access hatch opening for the ladder, framed with steel angles and equipped with a steel door on hinges set on a pulley.

Overall, the interior stairs and floors were found to be in good condition. The stone stair has survived particularly well, testifying to the quality of materials and workmanship used in its construction. Minimal damage to the stone was in the staircase, and consisted mainly of limited delamination and salt deposits at the connection with severely affected wall portions, where there has no doubt been some moisture transfer. *(See Fig. 26)* Concerns are mostly related to Health and Safety, due to the important accumulation of debris on the treads from the adjacent deteriorating walls, and from the counterweight which is no longer in use and sits on the edge of one tread, at mid-height within the tower. (*See Fig. 27*)

No evidence of deterioration was apparent at the first floor, which was level and without cracks. With the exception of the vertical cracks in the walls described previously, the underlying structure appears to be sound, and no sign of movement or settlement could be detected.
The concrete landing at the top of the stair also appears sound, with no evidence of cracking on either its top or underside. The assembly of the wood platform, although somewhat clumsy in appearance, is also structurally sound. *(See Figs. 29 & 30)*

As for the slab supporting the lantern, traces of deterioration are visible on its underside, and at its connection with the wood stair, where paint and the surface of the concrete have begun to chip off in small areas, and are compromising the connection of the ladder. *(See Fig. 31)*

Assessment

The light delamination of the concrete slab underside is likely associated to the elevated moisture levels in the tower, and to some possible transfer of water from the walls. This is by no means as severe as the decay occurring in the walls, and can be simply resolved by cleaning and patching the surface to protect reinforcement bars from corrosion.

More immediate are the health and safety concerns regarding the stair's weakened attachment to the slab. Another element of concern with regards to the ladder was the wide spacing between treads, which makes it uncomfortable to use.

Recommendations

Based on the observations and assessment, the following recommendations are made to protect the floor structures and to reduce the risk to public from potential health and safety hazards.

<u>Mandatory Health and Safety</u> (within 1-2 years)

28. Relocate the counterweight at the bottom of the stair to limit trip hazard.
29. Implement regular cleaning of stair to limit accumulation of debris on the treads until the wall deterioration is resolved (as per recommendation 10).
30. Consolidate the ladder's attachment to the edge of the hatch opening, to ensure its stability.

<u>Mandatory Repairs</u>

31. Cleaning and patching of the deteriorated areas of the concrete floor slab. When removing the loose ends of the concrete, ensure the soundness of the rebars, if visible. Address traces of corrosion appropriately if identified. (within 3-5 years)

<u>Mandatory Repairs (long term)</u>

32. Review the configuration of the lantern ladder to provide more closely spaced risers. (in 11-15 years)

<u>Cyclical Work</u>

Between major repair cycles, an annual visual inspection and minor maintenance program following a five-year cycle is recommended, including:

33. Check floor surfaces and concrete slab underside for any breaks or cracking, and for damage to the wood platform. Patch and repaint as required.
34. Continued maintenance of stairs. Remove loose paint on steps and repaint as required.

Figure 26: Traces of deterioration at the junction between the stone steps and the tower walls. (HCN/2007)

Figure 27: The counterweight now rests at mid-height in the tower. (HCN/2007)

Figure 28: Wiring and conduits through the stairs and former counterweight opening now filled with concrete. (HCN/2007)

Figure 29: Concrete landing and wood platform at the top of the spiral stair. (HCN/2007)

Figure 30: Post supporting the wood platform. (HCN/2007)

Figure 31: Deterioration of the concrete slab at its connection to the ladder. (HCN/2007)

4.3 Lantern and Gallery

The lantern and gallery serve as the structure's roof and plays a critical role in the building envelope by providing a roof for the tower, a secure and weather tight envelope for the lamp, and shedding water away from the exterior walls. *(See Fig. 32)* Maintaining the integrity of the lantern and gallery is essential for the preservation of this feature as well as the protection of the building envelope.

Lantern:

The lantern is an 8-sided painted steel structure with an octagonal hipped roof and a ventilator at the peak. Each face, or storm panel, is fitted with a pane of single glazing, set with caulking and wood stops on the exterior. Each storm panel is equipped with a condensation gutter in its sill, which would have originally drained to the exterior through a cast iron drainage conduit set in the parapet. The drainage holes have however all been blocked off with caulking, and the conduits obstructed with wood plugs on the exterior. *(See Figs. 40 & 41)* Four circular ventilators are also set in every other segment of the parapet, and protected from infiltrations on the exterior by metal caps. *(See Fig. 42)* The roof is not equipped with any drainage system, gutters or downspouts, and sheds directly onto the gallery.

The lantern structure is a prefabricated component installed in 1925. It sits on a tapered, octagonal parapet wall anchored to the stone structure. An access hatch in the parapet wall leads out to the exterior gallery. The door is a steel panel, hinged on the exterior, set between a wood sill and jambs and closed with two bolts. *(See Fig. 43)* On the exterior, it is recessed in the face of the parapet wall, and thus protected from infiltrations at its top. Weather-stripping along the door edges is functioning well, making it completely tight when closed.

Gallery:

Most of the observations regarding the gallery were made from the interior of the lantern. The gallery is approximately one (1) meter wide, painted in two tones (red and white). Around the gallery is a cast iron guardrail, possibly dating to the original construction of the tower.[12] The circular posts are topped with a decorative ribbed head, and the railings between them comprised of three horizontal circular rails. *(See Fig. 46)* According to 1966 specifications, the gallery was also coated with gunite when it was applied to the top of the tower wall, yet this was impossible to verify.

An aluminium ladder was installed in recent years on the west side of the gallery, and acts as a support and means of access to several antennas.

The following conditions about the lantern and gallery were noted and the related figures are located on pages 42 to 45.

- The roof of the lantern is in generally good condition. The exterior coat of paint is uniform and sound, though somewhat discoloured. On the interior, the underside of the cupola is coated in smooth enamel paint which is cracked and stained with mildew. The

[12] The 1925 drawings indicate nothing about replacing the guardrail, which reinforces this hypothesis.

roof does no show any traces of water infiltrations, except at a small hole drilled into it to allow for the passage of wiring connected to one of the exterior antennas. *(See Fig. 33)*

- The lantern's storm panels are in variable condition, though no signs of water infiltration were observed. The west pane of glass is traversed by a long vertical crack, with some shards resting on the interior sill, and the pane at the opposite side of the lantern was patched in one of its bottom corners with a large amount of caulking. *(See Figs. 34 & 35)*
- The storm panel structure is beginning to deteriorate in several areas. On both the interior and exterior, corrosion is visible on the lower edges of the fame, on the jams and sill elements. The wood stops on the exterior are rotted and breaking apart in some areas. Most of the hand-holds on the exterior are also corroded. *(See Figs. 36 & 37)*
- Both inside and out, paint is failing on the concrete parapet wall surfaces. On the interior, this is also associated to spalling of the concrete and traces of corrosion in some areas. *(See Figs. 38 & 39)*
- Paint and whatever membrane coating is beneath it are failing on the surface of the gallery. Hairline cracks are forming at the edges. Algae growth has appeared throughout. *(See Fig. 45)*
- Most components of the iron guardrail appear to be intact and secure. Paint finishes have failed in some localised areas, allowing corrosion to set in. One section of the bottom rail is on the verge of breaking, where corrosion has eaten through half of it. *(See Fig. 47)*
- Hairline cracks are visible on the edges of the gallery deck and on the fascia, along with a significant amount of algae growth, adhering to the irregular surface formed by the flaking paint and membrane that cover the cement screed over the stone. (as described previously in section 4.2.2)

Assessment

The lantern component of the tower is structurally sound, but has suffered from years of deferred maintenance, which are starting to take their toll and will continue to accelerate deterioration processes. Paint failure is obvious on both the interior and exterior, on the window frames, parapet wall, gallery handrail and platform, and will need to be addressed in order to limit further corrosion and decay of the structure itself.

According to condition survey prepared in 2005,[13] high levels of chloride ions were contained in the concrete of the parapet wall. These concentrations are three times the recommended threshold and therefore considerably increase the risk of corrosion of the reinforcing steel, hence making the maintenance of the protective paint coating and patching of the concrete spalls a pressing issue.

The reason for the broken west storm-panel is unclear, although as previously stated in footnote 12, this same pane appears to have been damaged as far back as 1978, during the blasting that

[13] Refer to footnote 3.

took place for the construction / repairs of the helicopter pad. It however seems rather unlikely that the glazing would have been left in that condition for almost thirty years.

Although ventilation of the lantern appears to be functioning well, both through the roof vent and small circular vents in the parapet, the evidence points at condensation as being the source of most of the deterioration on the interior. Humidity levels were not high at the time of the inspection (for the measurements, refer to section 4.4.1), but it is unknown how effective ventilation is during the hot summer months. In order for the rooftop vent to be most effective, adequate draw is required at a lower level, and the interior configuration of the tower, with its continuous spiral stair, may hinder the chimney effect.

Provision for evacuating the condensation, namely the gutter below each window, have been obstructed, yet water finds its way into some of the drainage conduits where it is trapped, causing these to corrode and the parapet wall over it to fracture.

On the interior of the lantern, the hatch opening in the floor also presents a hazard with regard to health and safety, as it provides no fall protection when the trap door is ajar.

Damage to the gallery surface also appears to be the result of deferred maintenance and moisture accumulation. Although the structure itself does not appear to be affected, the poor condition of the paint and membrane coatings may lead to more severe failure if left unresolved. As in the case of the upper portions of the tower walls, the existence of a cement layer on the surface of the gallery may also be detrimental to the underlying stone and warrants further investigation.

Recommendations

Based on the observations and assessment, the following recommendations are made to protect the lantern and to reduce the risk to public from potential health and safety hazards.

<u>Mandatory Health & Safety</u>

Access to the upper levels of the lighthouse is restricted to trained DFO/Coastguard staff who maintain the light, and should remain so. In order to ensure their safety, the following measures are also recommended:

35. Installation of a sturdy guardrail along the two inner sides of the access hatch in the lantern to prevent fall hazard.
36. Verification of all the guardrail assembly connections.
37. Immediate repair of the corroded hand-holds around the lantern and of the broken lower rail of the guardrail.
38. Replacement in kind of the broken pane of glass and removal of all glass shards.

Further Investigation

39. Investigate the presence and condition of the gunite layer and underlying stone on the gallery platform. (within 1-2 years)

Mandatory Repairs

Major repairs are strongly recommended to address the items of concern for the lantern and gallery. In line with the conservation approach the following work is recommended within 3-5 years. All exterior work to the lantern and gallery is anticipated from the gallery platform with the use of appropriate fall restraint equipment.

40. The corrosion a the base of the storm panels will require major repairs and refurbishing which may warrant removal of the lantern for workshop repairs. Services of a metal conservator should be retained. All corroded elements should be cleaned, repaired or replaced as required. Wood stops on the exterior should be replaced with metal elements compatible with the existing structure. The drainage system of the condensation gutters should be reinstated, and the conduits cleaned of corrosion and unobstructed of any debris, or replaced if required.
41. Repair spalling concrete of the parapet wall to ensure structural integrity and protection of the rebars. Corroded rebars should be treated as required.
42. Remove paint, existing waterproofing membrane from gallery, clean off all algae growth and replace existing to ensure water tightness of the surface.
43. Repaint exterior and interior wall and floor surfaces, after scraping/brushing off of loose paint. This work is anticipated from the gallery with the use of appropriate fall restraint equipment.

Cyclical Work

Following the major repair work described in recommendations 40 to 43, an annual visual and minor maintenance program on a five-year cycle is recommended, including:

44. Inspection of lantern to identify any potential leaks or areas of deterioration to the metal and concrete parapet.
45. Inspection of guardrail ironwork for the formation of corrosion. Any new corrosion should be cleaned to bare metal, primed and painted, using methods provided by a metal specialist.
46. Annual inspection of glazing sealants for failure. Silicone caulking is appropriate for temporary repairs, but permanent repairs should be completed with butyl glazing tape.

Figure 32: Exterior view of the lantern. (HCN/2007)

Figure 33: Underside of the lantern cupola and mildew stains. (HCN/2007)

Figure 34: Vertical crack in the west pane of glass. (HCN/2007)

Figure 35: Large amount of caulking concentrated in the lower corner of a storm panel. (HCN/2007)

Figure 36: Corrosion and rotted exterior wood stops along the outer sill of a storm panel. (HCN/2007)

Figure 37: Corroded exterior hand-hold. (HCN/2007)

Figure 38: Exterior paint failure on the concrete parapet. (HCN/2007)

Figure 39: Corrosion and paint failure on the interior face of the parapet. (HCN/2007)

Figure 40: Condensation gutter and obstructed drain. (HCN/2007)

Figure 41: Plugged exterior condensation gutter drain. (HCN/2007)

Figure 42: Circular vent in the parapet. (HCN/2007)

Figure 43: Lantern door to gallery. (HCN/2007)

Figure 44: Access hatch to the lantern. (HCN/2007)

Figure 45: Coating failure and hairline cracks on the gallery. (HCN/2007)

Figure 46: Guardrail post and decorative ribbed head. (HCN/2007)

Figure 47: Corroded guardrail. (HCN/2007)

4.4 Building Envelope

4.4.1 Exterior Walls and Roof

Most observations, assessment and recommendations with respect to the exterior walls and roof are presented in Section 4.2 Masonry Structure and Section 4.4 Lantern and Gallery. As described in 4.2.2, it is believed that damage to the masonry is due to the layer of gunite on the exterior of its upper surfaces. The tower also lacks adequate ventilation (provided only at the entrance door and lantern levels – *See Fig. 48)* and has no heating (both electrical heaters were found to be extensively corroded and out of use – *See Fig. 49*). This section is therefore limited to additional observations and recommendations with respect to the local environmental conditions and requirements for supplementary ventilation and the assessments of the windows and doors.

Air humidity appeared to be relatively low at the level of the lantern during our investigation, with increased air moisture in the tower shaft. Relative humidity (Rh) measurements were taken, but may not be representative as they follow several days of dry weather. Measurements mid-height within the tower identified a relative humidity level of 68%, for a temperature of 12.5 ºC, and a resulting dew point of 7ºC.

Combined with low temperatures around freezing point, moisture build-up in masonry is also problematic, as it leads to internal freezing stresses within the stone and joints. Therefore, as a general rule, reduction of the moisture build-up in masonry prolongs the life of the structure. In addition to allowing the wall to evacuate vapour, through the removal of the exterior gunite and interior coat of paint, measures can also be taken to reduce excessive moisture build-up in the air and migration into the masonry.

Ventilation is particularly problematic at Race Rocks given the presence of the interior spiral stair, which may limit the strength of the stack effect, which would otherwise occur in a similar shaft with superposed open floor platforms. Provision of both active and passive ventilation measures along the tower and reinstating an operational heating system will also help in reducing the air moisture content. Monitoring of temperature and moisture levels is also critical to fully understand the patterns and deterioration processes within the structure. Additional expertise pertaining to building envelope may therefore also be required to resolve the conservation of the masonry, as this issue also depends on improvement of heating and ventilation within the building.

Related figures are located on page 48.

Recommendations

<u>Further Investigations</u>

47. Monitor the temperature and moisture levels regularly during the next 1-2 years in order to determine the required improvements in terms of heating and ventilation.

Mandatory Repairs

In summary, additional recommendations for within 3 to 5 years are:

48. Provide additional active and passive ventilation, such as the installation of a ventilator in the door transom at the base of the tower, and of vents in the windows in the tower.
49. Reinstate a functioning heating system within the tower.

Figure 48: Ventilator set into the entrance door. (HCN/2007)

Figure 49: Electrical heater, now out of use. (HCN/2007)

4.4.2 Windows

Race Rocks Lighthouse has four windows staggered around the tower, two rounded openings at the bottom, two rectangular at the top. These are identified as character-defining elements and their integrity is critical to the preservation of the lighthouse as a whole.

There are four window openings in the tower. Three of these are fitted with single wood storm windows, divided horizontally with fine mullions *(See Fig. 50)* , and set in cement frames into the stone openings (as described in section 4.2.2). The exception is the second window from the top, which has been fitted with a fog detection system, its surfaces on the interior covered with heavy metal plates *(See Fig. 52)* and could therefore only be assessed through binoculars on the exterior. The three other windows were in relatively sound condition, and only minor damage was identified. All three windows are stuck into place by over-painting and attached with corroded metal hooks that have stained the adjacent wood surfaces. *(See Fig. 51)* The opening appears to be watertight, and the wood appears in very good condition overall, with no evidence of rot.

Assessment

For the time being, only periodic maintenance is required on the three sound windows. Investigations will be necessary to assess the condition of the second opening from the top, to identify the extent of damage to the stone now covered with the metal plates, which may act as a thermal bridge, and on the exterior to identify the overall condition of the broken stone lintel. The boarding-up of this opening and exterior projection of the fog-detection equipment are also detrimental to the heritage character and visual integrity of the tower.

Windows offer an opportunity to provide ventilation throughout the tower shaft. The possibility of modifying existing sashes to incorporate a venting element (e.g. louver) while ensuring continued watertightness should be considered within 3 to 5 years. If replacement of the sashes is required, it should be based on historic precedent, and call upon study of archive documentation. The addition of the interior sash may be considered for reasons of historic accuracy, but should be compatible with the objective of providing passive ventilation.

Recommendations

Further Investigation

50. Within the next 1-2 years, remove the metal plates and fog–detection equipment from the second opening from the top in order to assess the overall condition of the stone opening. he possibility of relocating the fog-detector to less intrusive position, preferably outside the tower, should be examined, in order to allow reinstating the integrity of the window opening. If the current location within the tower is the only practicable alternative, consider recessing the equipment into the opening, to avoid protrusions beyond the face of the tower.
51. Examine the possibility of providing ventilation through the existing window sashes.

Mandatory Repairs

52. Within 3 to 5 years, repairs will likely be required to stone opening of the second opening from the top. These may include removal of paint, consolidation of the stone and repointing and should be coordinated with other stone conservation work (as described in section 4.2.2)

Cyclical Work

Between the major repair cycles, an annual visual and minor maintenance program on a five-year cycle is recommended, including:

53. Regular painting and maintenance program of the windows, with the periodic painting of sashes and frames.

Figure 50: Window opening at the base of the tower and its wood sash. (HCN/2007)

Figure 51: Typical deterioration of the wood sash: corroded metal hooks, staining and stone damage concentrated at the base of the opening. (HCN/2007)

Figure 52: Interior side of the second opening from the top, fitted with the fog-detector. (HCN/2007)

Figure 53: Exterior view of the fog-detector and the broken stone lintel above it. (HCN/2007)

4.4.3 Doors

The light tower is accessible through a single arched doorway, located 3.20 meters above grade, and which once connected the light keeper's residence to the tower. It is identified as a character-defining element and its integrity is critical to the preservation of the lighthouse as a whole.

The exact appearance of the original door opening is not known, as heavy blasting was used to widen the opening when the house was demolished.[14] The door itself is a modern addition, probably dating back to the demolition of the house in 1967. It is composed of a steel leaf, left unpainted, and semi-circular steel panel above, acting as a transom. *(See Fig. 54)* An opening on the edge of this panel allows for the passage of wiring from the exterior. *(See Fig. 55)* The door is equipped at its base with an electrified ventilator, which is no longer operational. Apart from this, there was no evidence of any deterioration.

If and when the time comes to change the current door, there may be an opportunity of adopting an alternate design, based on historic precedent , which would be more sympathetic with the heritage character of the tower.

Recommendations

<u>Mandatory Repairs</u>

54. Repair the existing ventilator in the door opening, or relocated it to the transom. (within 1-2 years)

<u>Cyclical Work</u>

55. Ensure maintenance as required, with the cleaning, repair and repointing of the stone opening, repair and replacement of the coat of parging as required, cleaning of any traces of corrosion on the door or hardware.

[14] Widening of the door is implied in the commentary that accompanies the video footages of the blasting, cited previously.

Figure 54: Exterior view of the door. (HCN/2007)

Figure 55: Interior view of the door transom and wiring entry. (HCN/2007)

4.5 Other Building Elements

Exterior Stair

The exterior stair is an addition related to the demolition of the light keeper's residence in 1967. It is not a character-defining element, but is critical for the use of the tower and its conformance to health and safety regulations. Construction drawings for it are dated to 1971, and it is unclear by what means the tower door was reached in the interim.

The stair and top landing consist of a painted steel structure, curving approximately 90 degrees along the exterior, north west face of the tower, on which sit a series of narrow 10" by 4'-6" concrete risers. Vertical steel posts set in concrete footings support the stringers and landing below. Brackets anchored in the tower wall also carry the landing. *(See Fig. 56)*

Some surface corrosion was observed on the structure. *(See Fig. 57)* Wall anchors set into the tower masonry appear particularly rusted. *(See Fig.59)* Some of the concrete treads were also damaged, with cracks appearing on their edges, representing a trip hazard. *(See Fig. 58)* Otherwise, the stair is in fair condition. An assessment of its compliance with building code, based on actual use, should be carried out.

Recommendations

Mandatory Health & Safety

56. Repair stair treads where the concrete is broken.

Further Investigation

57. Verify the solidity of the fasteners in wall and consider replacement with corrosion-proof hardware. Coordinate with stone conservation work.

Mandatory Repairs (short-term, within 1-2 years)

58. Clean corrosion and repaint as required.

Cyclical Work

Between the major repair cycles, an annual visual and minor maintenance program on a five-year cycle is recommended, including:

59. Clean and repaint the exterior stair as required.

Figure 56: The exterior stair leading to the tower door. (HCN/2007)

Figure 57: Surface corrosion on the structural members. (HCN/2007)

Figure 58: Cracked concrete treads. (HCN/2007)

Figure 59: Stair brackets and corroded anchors set into the stone wall. (HCN/2007)

5.0 ISSUES ANALYSIS

This report identifies a number of recommendations for continued maintenance and repair of the lighthouse, and more immediately, for work that must be undertaken to resolve health and safety issues and the severe decay of the stone masonry. As identified earlier, some of this decay is likely due to inappropriate interventions carried out over time and to deferred maintenance of the lighthouse in more recent years. Radical remedial measures are required to address the root causes of this deterioration and to ensure the long-term protection of the heritage fabric.

As stated in the conservation approach, the recommendations for mandatory and cyclical conservation work focus on that which is necessary to ensure that the lighthouse does not pose a threat to the public and staff, and that the existing condition of the heritage fabric of the lighthouse is improved and maintained.

5.1 Health and Safety

The general public is not admitted into the lighthouse, yet a number of visitors do land on Race Rocks to enjoy and study its nature and wildlife, most notably students from Pearson College. Some of the health and safety issues concern the exterior of the lightower and are therefore most urgent, yet all must be addressed without further delay. In addition to these concerns, issues relating to the protection of the heritage fabric could also become a safety concern if the deterioration is not addressed. More detailed discussion of the recommendations for these concerns follows. *(See Section 6.0 for a summary of all health and safety related recommendations)*

5.2 Protection of Heritage Character

With reference to the *Standards and Guidelines for the Conservation of Historic Places in Canada*, the general approach adopted in one of *Preservation,* which puts the emphasis on protection, maintenance and stabilization. Where greater levels of deterioration have led to more complete replacements, or changes are required to meet the requirements of current and planned uses, the interventions may correspond to *Rehabilitation*. This is an important distinction to understand when consulting the Standards and Guidelines, which provide additional guidelines for the rehabilitation elements of a conservation project, for example with respect to the approach for replacement of missing elements, or the addition of new elements. For further work, it is recommended to consult the appropriate Preservation or Rehabilitation Guidelines for Exterior Masonry, Architectural Metals, Windows, Health and Safety, etc. for additional advice.

5.3 Site-Specific Challenges to Future Planning Work

Several additional challenges related to the specific character of the site will impact the manner in which work to the lighthouse is planned and carried out.

Though remoteness is not necessarily a concern at Race Rocks given the proximity of Victoria, access to the island is somewhat problematic. Because of its rocky and sharp relief, and because it is only equipped with a modest dock, the island is not accessible otherwise than by helicopter or by small boat. This obviously complicates transport of construction material and equipment, not to mention labour itself.

Secondly, Race Rocks is at the heart of a marine ecological reserve, protected because of its sensitive ecosystem and rich wildlife. Hundreds of birds nest on the island, which is also frequented by seals and sea lions. In order to ensure that work will in no way impact the ecological integrity of the island and water around it, necessary mitigation and abatement measures will need to be taken into account in the early stages of planning, as contaminants are likely to be present in much of the cement gunite and paint to be removed, and possibly in some of the material required for the repairs.

In addition to this ecological sensitivity, Race Rocks is also known to have been a burial site for the local aboriginals in the past centuries, and a number of burial mounds are still visible in close proximity to the foot of the tower. Construction site installations will therefore need to be cautious to avoid any disturbances to these.

Appropriate masonry repair work as described in Section 4.2 is a multi-staged process that requires careful planning and time. High quality repairs will require a scaffold enclosure for both detailed examination of conditions and precise designation of repair areas as well as the actual repair work. This will have an impact in the context of access and potential impact to the site.

As suggested in Section 4.4, in order to address the high level of deterioration of the cast-iron elements of the lantern, it is considered necessary to remove the lantern for conservation. The intention is to carry out the conservation work in workshops and then return it to the site. The work of dismantling the lantern has certain risks in itself, and its removal will be very challenging because of the location and terrain. Interim measures for the protection and even location of the light source would also be required.

In the context of the lighthouse location and condition, planning of the work also requires an understanding of the dangers related to working on this site, and a capacity to address potential risks with appropriate site specific safety planning and protective equipment.

5.4 Materials Conservation Specialists Required

As indicated in the recommendations in Section 4.0 there is a need for specific specialized materials conservation for both the masonry restoration and for repairs to the cast iron lantern. Additional expertise pertaining to building envelope may also be required to resolve the conservation of the masonry, as this issue also depends on improvement of heating and ventilation within the building.

Both stone masonry and cast-iron are challenging materials to repair and protect, which require specialized knowledge of their composition, assembly, sources and patterns of deterioration, and appropriate repair techniques. This will involve the work of consultants and contractors with years of experience with these materials for further investigation, repair planning, and execution. If not properly performed, repairs to the cast-iron could cause irreversible damage to the character-defining elements and heritage value of the lighthouse.

5.5 Need for a Regular Maintenance Program

Some of the problems observed in Section 4.0 are related to the general lack of appropriate or sufficient maintenance of the lighthouse structure and envelope. Maintenance has included somewhat superficial repairs to the stone deterioration, exterior coatings and cast iron lantern. Once necessary investigation and subsequent repair work currently required are carried out, a regular programme of inspection, monitoring and maintenance is recommended. Maintenance is critical to preserve heritage character, adding years to the expected life cycle of all building materials, and is particularly important for a building exposed to the extremes of coastal weather such as the Race Rocks Light tower.

6.0 URGENT WORK TO PROTECT THE PUBLIC AND STAFF

As explained in Section 4.0, urgent health and safety issues are summarized as follows:

- The implementation of a regular cleaning of the wall faces and tower steps to remove all loose stone fragments and dust and thus limit slippage hazard in the tower, until the root causes of the stone deterioration are addressed.
- Relocation of the counterweight at the bottom of the interior stair.
- The consolidation of the wood ladder's attachment to the edge of the hatch opening leading into the lantern.
- The installation of a sturdy guardrail along the two inner edges of the hatch opening.
- Verification of all the gallery guardrail assembly connections and the repair of the broken lower rail.
- The repair of the corroded hand-holds around the lantern.
- Replacement of the broken storm-panel and removal of all glass shards of the lantern.
- The repair of broken concrete exterior stair treads.

7.0 LONG-TERM CONSERVATION PROJECT PLAN AND OPERATING AND MAINTENANCE PLAN

7.1 Urgent Work to Protect Heritage Character

The masonry structure is due for major repairs to protect the heritage character of the lighthouse. This is particularly evident in the top of the tower, where the exterior layer of "gunite" parging is causing moisture and salt transmission and decay. It is recommended work to this area be undertaken soon, as at least one year will be required for research, investigations, and design. If the root causes of this deterioration are not addressed rapidly, deterioration will continue at an accelerating pace, further compromising the heritage integrity of the tower and potentially becoming health and safety issues.

7.2 Recommendations for Further Investigation, Including Testing and Recording

A number of recommendations were made for further research and investigation with the masonry, the lantern, windows, and the building envelope. These include:

- Inspection, mapping and monitoring of the two large vertical cracks at the base of the tower, as well of smaller crack systems at mid-level and at the top of the tower;
- Localized investigation of the condition of the exterior masonry face behind the cement parging at the base of the tower, as well as behind the coat of gunite at the top of the tower;
- Investigation of the metal ties at the top of the interior walls;
- Re-evaluation of the use of the current impervious coating on the exterior of the walls for signs of negative impact on the masonry;
- Investigation of the presence of the presence and condition of the gunite coating over the stone gallery;
- Regular monitoring of the temperature and moisture levels in the tower;
- investigate the possibility of providing ventilation through the existing windows;
- Assessment of the stone condition under the metal plates and fog-detection equipment;
- Examine the possibility of relocating the fog-detector to a less intrusive position, preferably outside the tower, or consider recessing the equipment into the opening.
- Investigation and replacement of the fasteners of the exterior stair brackets.

As indicated in the foundation and masonry wall structure recommendations, prior to undertaking repairs, a detailed investigation including mapping existing cracks is required over the full height of the structure. This should be done by an experience material investigation and recording team. This investigation work is necessary to further the understanding of the existing conditions such that repairs can be well thought through and designed to achieve the conservation objectives.

Before conservation of the lantern is undertaken, conditions need to be investigated and recorded in detail by a metal conservator in order to define a scope of work for repair.

Research, e.g. in archival records, may help clarify the reasons for some of the past interventions, such as the repairs to the masonry in the 1870's, and more recently, the application of gunite at the top of the tower, and of parging around the door opening.

Monitoring of temperature and relative humidity (Rh) over the course of the next year will provide input into possible requirements for additional ventilation and requirements for heating. Conditions within the lantern should be monitored to determine the extent of condensation and infiltration.

<u>Additional Recording</u>

- A thorough range of photographs of current conditions was taken on October 29, 2007.
- When any repair work is complete, it is recommended to take photographs and create a written/drawn record of conditions.
- Copies of these documents should be provided to DFO, the local municipality and other organizations that serve as a documentation deposit for lighthouse archives.

7.3 Twenty-Five Year Mandatory and Cyclical Long-term Repairs/Replacements

An overall conservation plan for the next twenty-five (25) years includes further investigation, historic research, and mandatory and cyclical repair work. Once the proposed mandatory repairs are carried out and the related cyclical maintenance work plan is implemented, there is little expected need for replacement. The recommendations provided in Section 4.0 are summarized below in terms of short- and long-term priorities. The detailed summary of costs table provides more detail on the suggested schedule or cycle of repairs, monitoring, and investigation.

Short-term (0 to 5 years)

Most of these recommendations are considered mandatory and are required in the short-term or next 5 years.

Mandatory repairs required for the masonry structure and conservation of the cast-iron lantern will require full scaffold set-up around the lighthouse to provide a suitable work platform to complete the required work. The masonry conservation work can be carried out it phases, with priority given to the top third of the tower, yet there are logistical advantages to carrying all of the exterior work at once, using the same scaffold set-up.

Short-term masonry repair work includes:

- The complete removal of the paint layer on the interior walls, removal of cement joints, cleaning and repointing of surfaces where affected;

- Removal of the gunite on the upper third of the tower, cleaning, repair and repointing of stone as determined in conclusion of the investigations;
- Repair or sealing of cracks systems as determined in conclusion of the investigations;
- Cleaning of all other exterior surfaces of the tower, repointing of empty joints, recoating and repainting using vapour-permeable products;
- Cleaning corrosion off metal ties at the top of the interior walls and repainting;

Work involving the floors and interior stair is limited to cleaning and patching of the deteriorated areas of the concrete floor slab.

Work involving the lantern and gallery includes:

- full conservation of the cast-iron lantern. Work will involve dismantling the lantern and moving all components off-site for repair. All paint finishes to be removed down to bare metal, removal of all corrosion, and making repairs as required. All metal surfaces will require priming and repainting. Work would include reinstating condensation drains. Work should be carried out under the guidance of a metal conservator;
- Patching and repainting the concrete parapet wall;
- Removal of the paint and existing waterproofing membrane from gallery, clean-off all algae growths and recoat to ensure water tightness of the surface.

Work involving windows includes:

- Removal of the metal plates from the second opening from the top and repair of the stone as required.

Building envelope work will involve:

- Provision of additional ventilation, such as a louvred vents at the windows and an active ventilator at the front door, and heating.

The exterior stair also requires that corrosion be removed from its components and that these be repainted.

Long-term (6 to 25 years)

All mandatory repair/replacement work was recommended for the short-term, yet interventions to the masonry will also be required sooner than later in the longer-term if they cannot be undertaken before. These concern the base of the tower, with the repair and replacement of the parging and may involve repairs to the underlying stone.

The following are also to be considered:

- The removal of asphalt surfaces within a one (1) meter perimeter of the tower and its replacement with gravel;

- Reconfiguration of the lantern ladder to provide more closely spaced risers.

Cyclical work required would include annual visual inspections, as well as monitoring and maintenance of the following conditions following a five-year cycle:

- Inspect exterior coating exterior on stone, scraping/brushing off any loose paint, re-painting deteriorated areas on an annual basis. The replacement of the impervious coating will likely need to be undertaken every 25 years.
- Inspect, maintain and replace the parged surfaces at the base of the tower.
- Inspect stone for evidence of new spalling and for performance of repairs on an annual basis. Remove any loose fragments and touch-up paint. Repointing would typically be addressed at the ten (10)-year repair cycle.
- Inspect ironwork for the formation of corrosion annually. Any new corrosion should be cleaned to bare metal, primed and painted, using methods provided by a metal conservator. Inspect exterior paint on lantern and gallery guardrail, scraping/brushing off any loose paint, re-painting as required. This work is anticipated from the gallery with the use of appropriate fall restraint equipment.
- Inspect glazing sealants for failure annually. Failed sealants should be cut out and replaced as needed.
- Inspect ventilation improvements annually, implemented at first repair cycle.
- Inspect paint on windows annually, scraping/brushing off any loose paint, re-painting deteriorated areas on an annual basis.

7.4 Five Year Operating and Maintenance Plan

Refer to Appendix J for a description of the items covered in the Five Year Operating and Maintenance Plan. This information was provided by DFO.

7.5 Schedule

Refer to the table in Appendix I for a detailed breakdown of recommendations in Section 4.0 in terms of short-term (0 to 5 years) and long-term (6 to 25 years) scheduling.

8.0 COST ESTIMATES

Refer to Appendix I for a Detailed Table of Cost Estimates, in which the price has been provided for each of the recommendations included in the report above, with related quantities and scheduling/prioritization.

The last line item “Fees, admin, design, inspections, closeouts, pm fees” provides an all-encompassing category in order to avoid adding fees to those individual items which follow (4.2, 4.3, etc.). In approaching the fees in this manner the estimators have eliminated the parallel, and possibly duplicate, fees which would otherwise appear on an ‘item by item’ basis. As well, an omnibus annual inspection was the result of inspections identified and recommended for almost all elements of the structures: the addition of the “fee line” eliminated duplication of the annual inspections.

The assumptions made for this line item include:

1. These properties will remain as federal property and as such will be managed by federal employees.
2. The fee model is based on a multi-year standing offer maintenance contract, administered by the federal government, including:
   - Year One: initial contract set-up, including site visit/inspection by the project manager;
   - Subsequent Years: contract maintenance, site visit/inspection/maintenance scope definition, and a close-out visit to certify payments.

The annual inspection and scope definition would be included within the fees allotted to project management. (The main variance between lighthouses in this scenario is the travel distances from major urban centres, access issues, and the requirement of overnight trips to satisfy a day on site.)

Any inspection or testing of a highly specialized or technical level has been priced within the recommended item itself, for example the use of a metal conservator or the testing of hazardous materials. While these ‘one-off’ specialized inspections are not included within the last fee line, the management of these inspections by a PWGSC representative is included.

The other exception is a recommendation that is of such a scale that it would not be possible to manage under a maintenance contract. This item would then be treated as a project in itself including associated fees.

It is also important to note that while the total of the fees line is usually quite large, it is for 25 years of project management by PWGSC.

8.1 Twenty-five Year Project Plan

The following table provides a summary of the short-term and long-term costs for each section of the condition assessment.

REPORT SECTION	*SYSTEM DESCRIPTION*	*TOTAL COST*	*SHORT-TERM EXPENDITURES*		*LONG-TERM EXPENDITURES*			
			1-2 years	**3-5 years**	**6-10 years**	**11-15 years**	**16-20 years**	**21-25 years**
4.2.1	**Foundation**	$517,500	$15,000	$63,500	$73,500	$93,000	$119,500	$153,000
4.2	**Stone Wall Structure**	$1,632,000	$35,000	$488,000	$73,500	$93,000	$119,500	$823,000
4.3	**Floor Structure**	$66,400	$3,000	$24,400	$6,500	$8,000	$11,000	$13,500
4.4	**Lantern & Gallery**	$253,400	$15,000	$149,400	$15,000	$19,000	$24,000	$31,000
4.5.1	**Exterior Walls & roof**	$27,700	$7,000	$20,700	$0	$0	$0	$0
4.5.2	**Windows**	$53,600	$10,000	$0	$7,300	$9,300	$12,000	$15,000
4.5.3	**Doors**							
4.6.2	**Exterior Stair**	$48,000	$15,000	$3,800	$5,000	$6,200	$8,000	$10,000
8.0	**Fees, admin, design, inspections, closeouts, project management fees**	$905,000	$52,000	$70,000	$131,000	$167,000	$213,000	$272,000
	TOTALS	$3,503,600	$152,000	$819,800	$311,800	$395,500	$507,000	$1,317,500

The total cost for all recommended work is $,3,503,600, no taxes included.

The Net Present Value for this amount, with an assumed rate of inflation of 5%, is $1,782,000.

The breakdown of costs for each recommendation, with totals in Net Present Value (NPV) is shown in Appendix I in the Detailed Cost Table for All Recommendations.

In addition to the last line explained in 8.0, which covers overall costs, three types of recommended work are identified: Investigation, Mandatory and Cyclical.

- The price under the last line item including overall fees, administration, design, inspections, closeouts, and project management fees is $455,000 in NPV.

- Investigation work is further investigation of areas that were not accessible in this study, such as areas concealed by finishes. The cost would be based on related man-hours and / or equipment required to carry out the investigation. Most investigation is recommended in the short-term. Where related recommendations were provided, related costs have been included in the anticipated mandatory or cyclical section.
  - The total cost for further investigation is $76,000 in NPV.
- Mandatory work is work required to address conditions of deterioration to protect the staff and public or to protect the heritage character of the building. It is generally required in the short-term (0 to 5 years). Within Section 4.0 and the Detailed Cost Table of all Recommendations in Appendix H, Mandatory Health and Safety Work is identified as the first section in all recommendations. Once complete, this work will usually lead to a longer-term program of maintenance.
  - The total cost for mandatory work is $598,000 in NPV.
- Cyclical work is usually required where elements are in good condition and a maintenance program is now appropriate. The total costs may recur every so many years, or be spread over a number of years. This may include monitoring of conditions that could deteriorate. The inspection and monitoring should take place in coordination with maintenance and should not therefore incur additional man-hour costs. The cyclical work is generally long-term work (6 to 25 years) however the cycle may be recommended to begin in the short term, following current repairs.
  - The total cost for cyclical work is $653,000 in NPV.

8.2 Five Year Operating and Maintenance Plan

Refer to Appendix I for the cost estimates for the Five Year Operating and Maintenance Plan. These costs were provided by DFO.

The Costs related to the Five-year Operating and Maintenance Plan do not include the costs related to the recommended Cyclical work indicated in Section 8.1.

8.3 Demolition Option and Due Diligence

The potential demolition cost is provided here at the request of DFO for the purposes of investment analysis and does not constitute a recommendation of this report.

Any decisions regarding demolition should take into consideration the Treasury Board Policy on Real Property Management with respect to Heritage Conservation or other related issues.

The estimate to demolish and properly dispose of the lighthouse is:

- $450,000 total cost, including design and management fees and disbursements, and removal of all materials from the site.

Broad assumptions for this estimate include:

- The approach would be to “demolish” vs. “deconstruct” stick by stick;
- Obvious salvage items - copper etc become property of demolition contractor;
- Basic sorting of wood, plastic, metals, asphalt, balance occurs on site and (reduced) tipping fees reflect the sorting;
- Very few items are sent to a out of province landfills (for example certain quantities of lead paint might require disposal in BC, which has the necessary facilities); and,
- $5000 included for testing of materials to determine proper method/place of disposal.

APPENDIX A: REFERENCE DOCUMENTS

In addition to the references cited in the body of the text, the project team referred to the following additional documents:

Race Rocks Lightstation - Condition Survey of Stone Masonry Lighttower, prepared by G. Ovstaas & Associates Ltd., Consulting Engineers. Project No. 04-001.7, dated February 09th, 2005.

Race Rocks, Major Shore Light, Structural Condition Review, prepared by SPAR Consultants, Structural & Civil Engineers. Project No. 2333, dated March 2005.

8010-1946

Race Rocks Lightstation
Condition Survey of the
Stone Masonry Lighttower

Prepared for

Department of Fisheries and Oceans
Victoria, B.C.

Contract No. F1701-040062/001/PWY
Material Engineering & Testing
Services For Major Shore Lights

By

G. Ovstaas & Associates Ltd.
Consulting Engineers
Victoria, B.C.

February 09, 2005
Project No. 04-001.7

1.0 INTRODUCTION

An investigation has been completed to assess the present condition of the stone masonry lighthouse tower at the Race Rocks Light Station located at Race Rocks, B.C.. This study represents the first condition survey of the structure and provides the baseline data for all future surveys in addition to cataloguing the locations where repairs are now required. The investigation was performed during December 2005 by Messr. G. Ovstaas, P.Eng., D. Anidjar-Romain, P.Eng. and J. Lauder, P.Eng.. This report presents our findings and provides recommendations for remedial maintenance work.

2.0 STRUCTURE DESCRIPTION

The lighthouse was constructed in approximately 1860. It consists of a circular stone masonry tower as illustrated in the appended photograph 1. The lamphouse is a cast iron structure supported on a concrete base. The structure will be subject to splashing and salt spray during periods of high wind velocity. The tower is reportedly made with an outer wythe of granite imported from Scotland. The inner wythe appears to be sandstone from a local source, however this has not been confirmed. The tower is approximately 105 ft in height. The inside diameter of the tower is 8 feet. The outside diameter varies from 19 ft at the base to 12 ft at the top.

3.0 SURVEY OBSERVATIONS

The objectives of this condition survey are twofold. The main objective has been to identify the areas on the structure where the stone or mortar is deteriorating due to water penetration or where the metal lamphouse is deteriorating due to corrosion and repairs are now required. Secondly this study provides a baseline of information in order that the condition of the structure can be tracked and that any changes in the condition can be identified and addressed earlier in its life rather than later.

3.1 Stone Masonry Tower

The exterior surface of the stone masonry tower is painted in black and white bands. According to the records the tower was painted soon after construction to aid in the visibility of the tower. There are likely now several layers of paint and it is difficult to comment on the condition of the exterior surface, however if the stone is granite, as reported, the stone is likely in good condition.

The interior surface of the tower appears to be sandstone and there is significant scaling occurring at some locations (photo 2). This type of damage is typical for many of the local Vancouver Island sandstones and is usually referred to as "Contour Scaling". It is caused by various agents but is mostly the result of repeated wetting and drying of the sandstone surface and deposition of various salts in the surface of the stone. As is normal in these cases, the depth of the scaling is of the order of 5 to 10 mm. The surface of the stone was visibly damp at the time of our inspection and there were visible areas where the interior paint was peeling. This indicates that the source of the moisture is the exterior of the wall and not condensation from the interior, although moisture from condensation likely has contributed to the overall moisture levels in the walls.

Additional inspections are recommended to further evaluate the condition of the stone masonry. It is intended that this inspection work be performed using a small swing stage.

3.2 Concrete Lamphouse base and Cast Iron Top

3.2.1 Visual and Sounding Inspection

No large scale damage due to corrosion of reinforcing steel or other deterioration of concrete was observed. However, there is a small area of corrosion damage as shown in Photograph 3, and both the lamphouse base and top are in need of painting and sealant repairs. At the present time water ingress is occurring at the joint of the lamphouse base to the top. The condition of the lamphouse is summarized in the following list:-

1. As shown in Photograph 4, the exterior paint on the concrete lamphouse is in very poor condition.

2. Photograph 5 shows that the membrane material is eroded and or peeled from the deck surface.

3. There is water leakage at the lamphouse glazing. New glazing seals are required throughout.

3.2.2 Chloride ion Content

The samples used for chloride ion determination were obtained by dry drilling at one location in the lamphouse base. Typically samples were obtained at depths of 25mm, 50 mm, 75 mm and 100 mm. The chloride ion test procedure used was the 'water soluble' method and the concentrations have been calculated for a concrete with average density of 2350 kg/m^3 and cement content of 300 kg/m^3. The results are presented in Table 1.

Table 1. Chloride Ion Concentrations

Sample	Depth (mm)	Chloride Ion Content (% by mass of cement)
1. Lamphouse base (drilling from outside surface in)	25 50 75 100	0.408 0.447 0.525 0.447

The American Concrete Institute (ACI) proposed threshold for chloride concentration in conventionally reinforced concrete is 0.15 % by mass of cement. At levels higher than 0.15 % there is a significant increase in the potential for chloride induced corrosion of the reinforcing steel.

As shown in Table 1, all of the chloride concentrations are above the ACI threshold value. They are quite uniform through the depth of the wall. This suggests that the chlorides may have been introduced by using seawater in the manufacture of the concrete. The chloride levels are a concern in the lamphouse base and it will be important to maintain a sound paint coating on the exterior to minimize water penetration.

3.2.3 Rebound Hammer

Rebound hammer readings were obtained at one location on the lamphouse base. These results are presented in the following Table 2.

Table 2. Rebound Number Data

Location	Rebound Number	Est. Compressive Strength (MPa)
1. – Lamphouse Base	41.1	36

The test results indicate that the concrete compressive strength of the lamphouse base is approximately 36 MPa. It is concluded that the concrete strengths are adequate for the intended use of the structure.

4.0 DISCUSSION AND RECOMMENDATIONS

The present condition of the lighthouse structure at the Race Rocks Light Station can be summarized as follows:-

1. Visually, the paint on the tower exterior appears OK however there is considerable water penetration occurring which is resulting in significant contour scaling damage to the interior wythe of sandstone. It seems likely that the water penetration is originating at the exterior face of the tower and it is likely repainting is now necessary. It is recommended that an additional inspection be carried out using a small swing stage to better assess the condition of the

exterior surface. In the cost estimate below, we have assumed that the tower requires considerable crack and joint treatment and repainting.

2. There is some delamination damage to the concrete lamphouse base. This is relatively minor however it indicates that corrosion of the reinforcing steel has been initiated. The area must be chipped out to remove all damaged or loose concrete and then patched accordingly. Consideration may be given to the installation of an anode at the affected steel.

3. There is significant chloride contamination of the concrete lamphouse and it is important to maintain a sound paint coating on the exterior surface in order to minimize water penetration.

4. The membrane on the top exposed deck is largely deteriorated and should be replaced as soon as possible. This work must wait for appropriate weather. The new membrane shall include a "heel bead" along the base of the lamphouse to provide a seal at this joint.

5. The glazing in the lamphouse requires resealing.

4.1 Estimated Cost of Remedial Work

The proposed remedial work and approximate costs are listed below. Engineering work including the preparation of construction specifications, tendering and inspections are expected to cost approximately $14,000.00. Engineering fees do not include transportation to and from the site. It is assumed that helicopter transportation will be provided by the Coast Guard for both the tender meeting and the inspection visits.

The cost for the painting work and various repairs is estimated to be approximately $73,000.00. This cost includes a mobilization of $25,000. This cost is based on transporting a work crew to Race Rocks each day by helicopter. This expense may be reduced if the work crew can use the existing Race Rocks accommodation.

Table of Unit Rates

	Units	Cost/Unit	Cost ($)
1.0 Mobilization	LS		25,000.00
2.0 Repairs			
- Surface preparation	30 man days	320	9,600.00
- Pressure washing	4 man days	320	1,280.00
- Painting tower	20 man days	320	6,400.00
- Waterproofing deck	2 man days	320	640.00
- Replace hatch weather stripping	1 man day	320	320.00
- Reseal glazing	15 man days	320	4,800.00
- Paint lamphouse	3 man days		960.00
- Equipment and Materials			15,000.00

2.0 Enviro. Protectn - Collect and dispose of all loose paint.	LS		4,000.00
4.0 Demobilization	LS		5,000.00
		Total Cost Excluding GST	$73,000.00

Engineering
Additional Inspection Work..............................$3000.00
Project Administration....................................$1000.00
Contract Documents.......................................$3000.00
Tendering..$1000.00
Site Inspections...$6,000.00
Total.........$14,000.00

I trust this information is sufficient. Please call if you have any questions.

Sincerely
per: G. Ovstaas & Associates

Greg Ovstaas, P. Eng.
go/racerocksconditionreport/04-001.7

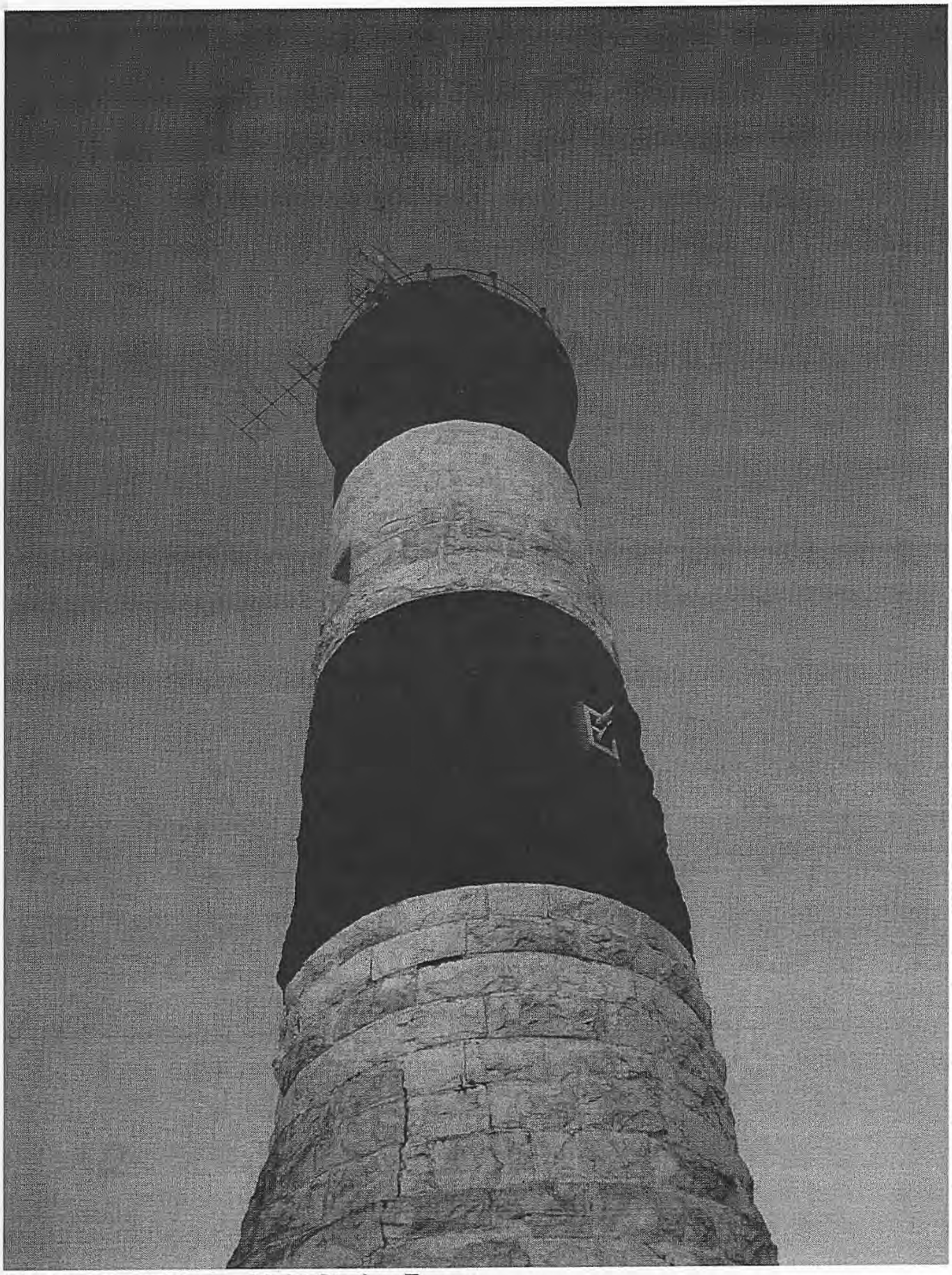


Photo 1 Race Rocks Light Station Tower.

Photo 2. Scaling of Interior Sandstone.

Photo 3. Interior of Lamphouse showing deteriorated concrete.

Photograph 4. Exterior of Lamphouse showing Peeling Paint.

Photograph 5. Deck of Lamphouse showing Peeling Membrane.

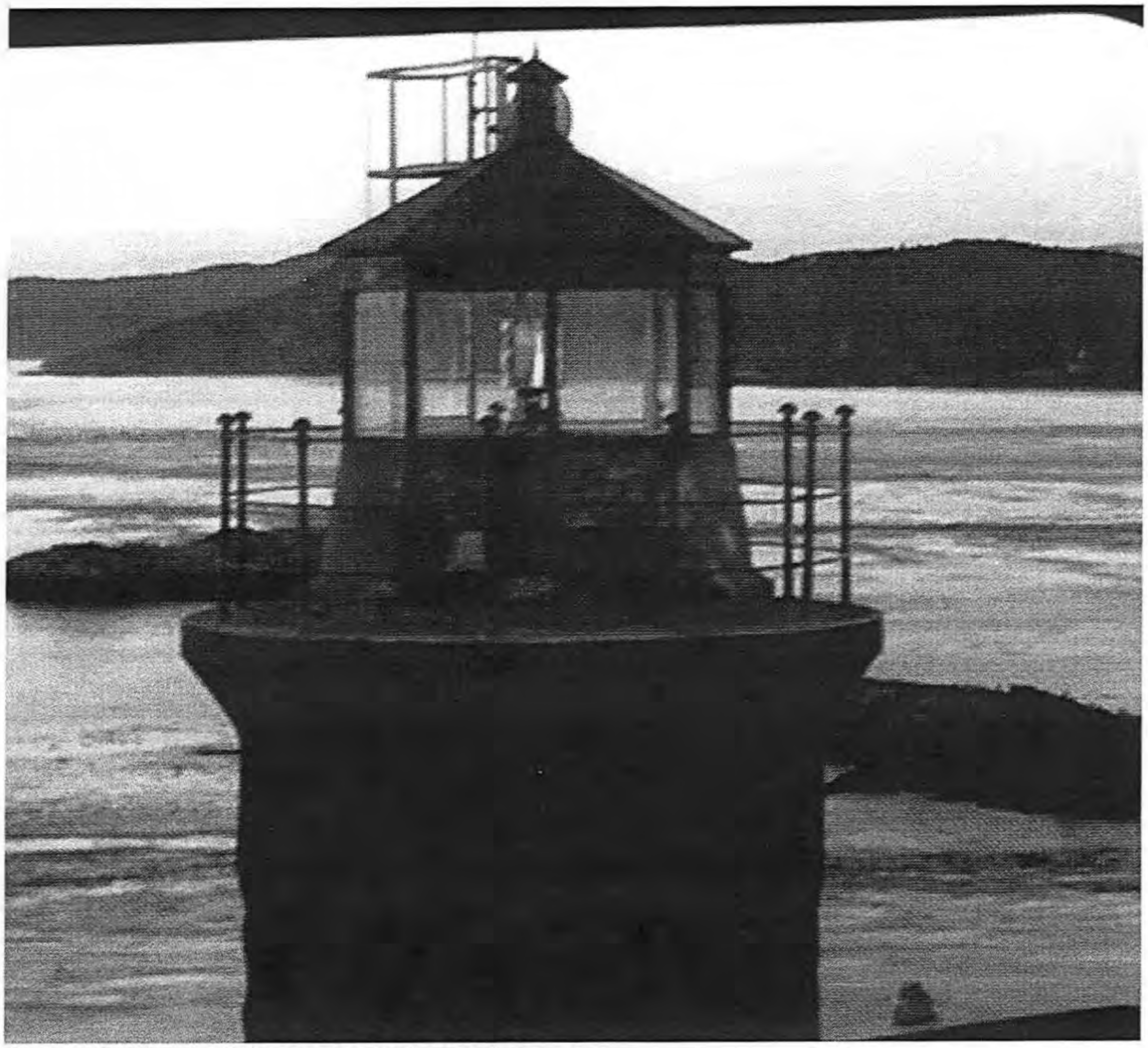


Photo 6. View of Race Rocks Lamphouse

CAVENDISH ANALYTICAL LABORATORY LTD.
400 - 2389 Health Sciences Mall, Vancouver. B.C. V6T 1Z4
Ph: 604-251-4456 Fax: 604-258-9497
www.cavendish.ca inorganics@cavendish.ca

To: **G. Ovstaas & Associates**
966 Eagle Rock Terrace
Victoria BC Canada
Attention: **Greg Ovstaas**
Project: **04-001.7 Race Rocks**

Samples: **51**
Date Received: **1/5/2005**
Date Out: **1/11/2005**

Certificate of Analysis: **050105F**

Sample Type: **Pulp**

Units	ug/g		> .15%
Sample Name	**Cl-**	**% of Mass**	**Threshold**
Race Rocks #1 0-25	520	0.408	Yes
Race Rocks #1 25-50	570	0.447	Yes
Race Rocks #1 50-75	670	0.525	Yes
Race Rocks #1 75-100	570	0.447	Yes

Cl- Method CSA A23.2-4B

Race Rocks - Rebound Hammer - Test Results
December 20, 2004

Location	Lamphouse Base test area 1				
Readings	40	35	40	39	
	38	46	46	46	
	42	45	39	36	
Rbnd. #					**41.1**

Rebound Hammer Test Results

Location	Rebound Number	Psi	Mpa
Lamphouse Base Test area 1	41.1	5200	35.9

Average Compressive Strength
of Test areas 1 = 35.9 MPa

8010-1946

RACE ROCKS
MAJOR SHORE LIGHT
STRUCTURAL CONDITION REVIEW

DEPARTMENT OF FISHERIES AND OCEANS

Project F1701-040063/001/PWY
Structural Engineering Services for
Major Shore Lights

SPAR CONSULTANTS
STRUCTURAL AND CIVIL ENGINEERS
VICTORIA, BC

PROJECT 2333
MARCH 2005

D. M. ANIDJAR-ROMAIN, P.ENG., C.ENG., M.I.C.E.

Project F1701/040063/001/PWY

Structural Engineering Services for Major Shore Lights

Site:	Race Rocks
Constructed: 1860	Reviewed: 20 Dec 2004

STRUCTURAL CONDITION REVIEW

Description	Photo
A tapered circular stone tower 32m tall of sandstone blocks surmounting 5.8m of granite blocks, topped with a granite cap forming the top platform. Tower diameter is 5.8m at the base and 3.8m at the top, with a central shaft 2.4m in diameter. The walls are 1.6m thick at the base and 0.7m thick at the top. A reinforced concrete slab forms the lamphouse floor over the central shaft and integral1m high walls form the lower lamphouse walls. This reinforced concrete rests on the granite top cap and is dowelled into it. A circular staircase in stone provides access to the top. The tower is painted in three bands of black with two of white between.	1 → verify meas
The top platform and lamphouse have remnants of paint.	2
The concrete walls of the lamphouse are cracked vertically and water is penetrating to the inside, possibly through these cracks. Paint on the walls and glazing seals is peeling.	3
Iron railings on the top platform are badly corroded, despite previous repairs.	4,1
Stonework is leaching salts from the joints on the outside, indicating that water is present in the stonework. In the upper section, the sandstone is crumbling on the inside surface, possibly from the same cause.	5

Load Resistance	Gravity Loads: Adequate	Lateral Loads: Wind – Adequate, Earthquake - Inadequate

Significant Defect	Consequence
(HXS issue ?) Inadequate lateral resistance to design earthquake. Preliminary estimate indicates at best approximately 19% of required resistance to toppling	Serious damage and possible toppling in less than design earthquake. Loss of facility.
Effects of water on sandstone masonry	Continuing crumbling of stone, degrading of interior and exterior surface, loss of paint adhesion and protection

Recommendations for Remediation

1. Undertake seismic reinforcing in a retrofit. However, the nature and form of this stone tower may not lend itself to economical remediation. While technically feasible, a seismic retrofit will be costly and may negatively affect the appearance. Structural design fees $19000
2. Continue monitoring for painting requirements.
3. Restore concrete lamphouse walls and glazing seals.
4. Paint lamphouse and re-coat top platform surface.

APPENDIX B: FHBRO Heritage Character Statement, Score and Building Report

90-85

Race Rocks, British Columbia
Race Rocks Lighttower
Vancouver Island

HERITAGE CHARACTER STATEMENT

The Race Rocks Lighttower was built in 1860 by the Crown Colony of Vancouver Island, with the assistance of the British Colonial Office. Its light was replaced in 1988. The manned station continues to serve its original function. The Canadian Coast Guard is the custodian. See FHBRO Building Report 90-85.

Reasons for Designation

The Race Rocks Lighttower was designated Recognized as a result of its environmental significance, its early association with the provision of navigational aids on the Pacific Coast, and its functional design and use of materials.

The Race Rocks Lighttower dominates its site, a small barren island located about twelve miles from Victoria in an area of strong tides and reefs. Given its important function in these treacherous waters, the Lighttower is a regional landmark among mariners.

The Lighttower, one of the first built on the west coast, was constructed in response to the increased maritime traffic arising from the Fraser River gold rush. By locating the light on an island in the Strait of Juan de Fuca, local authorities aided merchant and passenger ships headed to Victoria and naval vessels destined for the base at Esquimalt. The influx of settlers hoping to benefit from the gold strike quickly changed Victoria from a fur-trading fort to an incorporated city, and ensured the continued need for a lighttower.

The Race Rocks Lighttower is one of a very few Canadian examples of its type. The design is derived from one commonly employed by the British for "Imperial" lighthouses associated with colonial trade routes. Built of local stone and by local craftsmen, the lantern and original light were supplied by the British.

Character Defining Elements

The heritage character of the Race Rocks Lighttower is defined by its profile, functional design and materials, and by its importance in its environment.

The tall tapered profile of the Race Rocks Lighttower is typical of the "Imperial" design, with limited decorative detailing and stately proportions. The character of the Race

.../2

Rocks Lighttower is found in its robust stonework: large, rusticated blocks of granite composing the base and lantern, and similarly finished sandstone in the body of the tower. The raised door and lower-level windows are set in arched openings in the thick masonry wall, while the upper window-openings form small squares.

In 1962 the original lightkeeper's residence, which was physically connected to the lighttower, was demolished. This required the provision of an exterior staircase to the second-floor tower entrance and some patching of the tower stonework. Care should be taken to avoid further changes to the tower's profile.

Given the highly exposed site, remedial masonry work has been required on several occasions and will continue to be required periodically. Since the stonework determines to a large extent the character of this structure, inspection and maintenance by qualified masonry conservation professionals should be undertaken regularly. The black and white identifying colour scheme is original, and should be retained. The interior stone stairway should be preserved, as should all original interior fittings.

The light station is the sole occupant of the eight-acre Race Rocks in the Juan de Fuca Strait. Secondary structures associated with its operation surround the lighttower, and merit preservation. The surging tides make the island relatively inaccessible except by helicopter; the rugged isolated character of the site should be preserved.

1994.12.02

For further guidance, please refer to the *FHBRO Code of Practice*.

FEDERAL HERITAGE BUILDINGS REVIEW OFFICE
BUREAU D'EXAMEN DES ÉDIFICES FÉDÉRAUX DU PATRIMOINE

BUILDING EVALUATION RECORD
FICHE D'ÉVALUATION D'ÉDIFICE

I IDENTIFICATION:

File/Dossier n°.: 2.5.11

BUILDING/ÉDIFICE
- City/Ville, Prov.: RACE ROCKS, B.C.
- Name/Nom: Lighttower
- Address/Adresse: Vancouver Island
- Custodian/Min. responsable: TC

FHBRO/BEEFP
- Meeting/Réunion n°.: 91-09
- Held on/Tenue le: 91.08.01
- Report/Rapport n°.: 90-85

II EVALUATION/ÉVALUATION:

CRITERIA/CRITÈRES	LEVEL NIVEAUX	SCORE POINTS	TOTAL
A. HISTORY/ASSOCIATIONS HISTORIQUES			
1. Thematic / Thématique	B	8	
2. Person/Event / Personnage/événement	D	0	
3. Local Development / Histoire locale	B	6	14
B. ARCHITECTURE			
1. Aesthetic Design / Conception esthétique	C	9	
2. Functional Design / Conception fonctionnelle	B	8	
3. Craftmanship & Materials / Exécution & matériaux	B	6	
4. Designer / Concepteur	D	0	23
C. ENVIRONMENT/ENVIRONNEMENT			
1. Site / Emplacement	B	6	
2. Setting / Cadre	B	11	
3. Landmark / Point d'intérêt	B	8	25
TOTAL SCORE: / TOTAL DES POINTS:			62

FEDERAL HERITAGE BUILDINGS REVIEW OFFICE
BUREAU D'EXAMEN DES ÉDIFICES FÉDÉRAUX DU PATRIMOINE

BUILDING EVALUATION RECORD
FICHE D'ÉVALUATION D'ÉDIFICE

Report/Rapport n°.: 90-85 (Lighttower)

III **FHBRO RECOMMENDATION:** It is recommended that the above building should
RECOMMANDATION DU BEEFP: Nous recommandons que cet édifice

[ ] NOT BE DESIGNATED as a federal heritage building at this time.
NE SOIT PAS DÉSIGNÉ édifice du patrimoine fédéral en ce moment.

[X] BE DESIGNATED as a RECOGNIZED federal heritage building:
a Heritage Character Statement is attached.
SOIT DÉSIGNÉ édifice RECONNU du patrimoine fédéral:
Un Énoncé du caractère patrimonial accompagne ce rapport.

Terence Smythe for
Margaret Archibald
A/Chief, FHBRO
Chef intérimaire, BEEFP

Date: 91.08.01

IV **NCC RECOMMENDATION** (if applicable):
RECOMMANDATION DE LA CCN (si nécessaire):

I concur
Je suis d'accord

Date: ____________

Jean E. Pigott
Chairman, NCC
Président, CCN

V **APPROVAL:**
APPROBATION:

I approve this Building Evaluation Report
J'approuve ce Rapport d'évaluation

Date: ____________

Minister of the Environment
Ministre de l'Environnement

FEDERAL HERITAGE BUILDINGS REVIEW OFFICE

BUILDING REPORTS: 90-85

TITLE: Race Rocks Lighthouse
Victoria, British Columbia

SOURCE: Martha Phemister, Architectural History Branch

INTRODUCTION

The Race Rocks tower in British Columbia dates to 1860. It was built jointly by the British Colonial Office and the crown colony on Vancouver Island and was completed two years after the 1858 gold discovery on the Fraser River. The tower sits on a grouping of small islands, in the Strait of Juan de Fuca, three miles from the mainland of Vancouver Island and about 12 miles from Victoria (Figures 1 and 2). The Canadian Coast Guard plans to continue its present manned use.

HISTORICAL ASSOCIATIONS

Along with the Fisgard light, the Race Rocks Lighthouse was the forerunner of an extensive system of west coast navigational aids. For a number of years, until the construction of the Carmanah Point light (1891), the 105-ft. It was considered to be the most important in the province.[1] It was lit in December of 1860 to service the then separate colonies of Vancouver Island and British Columbia, which were created crown colonies in 1849 and 1858, respectively. Although there previously had been maritime traffic in the waters adjoining the colonies, the gold rush brought about a tremendous increase.[2] In April of 1858, a ship reached San Francisco carrying a consignment of Fraser River gold, the first to be registered at the assay office. In spite of efforts by Governor James Douglas to conceal it, the news of a strike spread rapidly. The resulting increase of immigrants placed pressure on Colonial and Imperial authorities to reduce the dangers to shipping, the major method of entry into the colony.

The need for a lighthouse at Race Rocks was apparent to colonial officials, who viewed the arrival of boatloads of miners (see Local Development) with some trepidation.[3] The hazards of the strong tidal currents on the entry to Esquimalt were well known to officials and to navigators.[4] Governor James Douglas wrote to the British Colonial Office in 1859, "on a subject of the highest importance to the progress and prosperity of the Colonies of Vancouver Island and British Columbia." He urged the construction of two lighthouses - for Fisgard (on the entry to Esquimalt) and for Race Rocks. Douglas bolstered his argument by stressing that the United States had already established navigational aids "in their part of the Straits." The colonies should be "honour bound to reciprocate the benefit."[5] (British Admiral Baynes also called for construction of a lighthouse on Race Rocks to facilitate navigation of the Juan de Fuca Strait).[6]

In responding to these appeals, the Imperial Government was willing to offer expertise and provision of the lighting apparatus but declined to undertake "any responsibility as to the selection of the site or the construction of the towers."[7] Since the two colonies did not have the funds to construct the lighthouses themselves, it was suggested that the two towers be included in the Imperial class of lights. The misleading term of "Imperial" has, in the past, been applied to a grouping of lighthouse types of tapered circular stone, built in Ontario and having some connection (however tenuous) with Britain (see FHBRO 90-204..., "Four Imperial Towers ...").[8]

There was, indeed, a definitive class of lighthouse known as the "Imperial Tower." They were designed and built by the Home

Government and were used to assist the network of British colonial trade throughout the world. To suggest an "Imperial tower" meant that the tower was built and funded by Britain and was intended to aid, not the economy of any particular colony, but the whole shipping and naval enterprise of the British Empire. Britain's involvement would include the siting, tendering, planning, superintending of the erection and, presumably, assumption of the total cost. Whether any of these Imperial types, as defined in such manner, actually were built in Canada is conjectural. A few were known to have been erected in other British colonies (viz. Ceylon).[9]

Apparently, Race Rocks could not be classed by British officials as an Imperial tower because: 1) the responsibility for selecting the site and superintending the work was to be delegated to the colonial governor (Douglas) at Victoria and not to the British Trade Office, British Colonial Office or the Admiralty 2) the cost of the two towers (L7000) was not assumed by England, and the colonies of Vancouver Island and British Columbia agreed to jointly repay half the cost of establishing the lights 3) most important, it was felt that the light "would benefit trade coming to, rather than, passing the colony" and it therefore would be revenue-generating.[10]

After some delay, the Colonial Office in 1858 advanced the amount of L7,000 out of the "Lighthouses Abroad" fund for the construction of Race Rocks and Fisgard, stipulating that half that amount was to be repaid by the colonies. It also allocated a sum for the maintenance of Cape Race, Newfoundland, and for towers in Australia, the Bahamas, the Cape of Good Hope, the Falkland Islands and the Ionian Islands.[11] The two British Columbia towers were to be built under the eye of the colonial governor and officials stressed the use of local materials to reduce costs. "...The plan of sending iron towers and buildings from England has been attended with very great expense."[12] Fisgard, thus, in 1860 became the first navigational aid to be located on the west coast and Race Rocks was completed a month later. As a coastal light, Race Rocks was of greater historical significance than the harbour light at Fisgard. In assisting the shipping and trade to the small colony on the West Coast it represents the joint undertaking of the Imperial and Colonial governments in safe navigation.

Person/Event

George Davies was a long-time resident keeper at Race Rocks, but it is doubtful that he had any particular significance to the community beyond that of his professional duties at the lightstation.

Local Development

As one of two lighthouses built in a colony that was primarily accessible by water (except overland to Fort Langley), the Race Rocks tower had importance to shipping and navigation. Its construction followed the sudden influx of gold-seekers in the summer of 1858. Boatloads of miners arrived in Victoria, headed for the mainland interior. Estimates of those who disembarked vary between 25,000 and 30,000.[13] By 1860, statistics show that 394 vessels arrived at Victoria from nearby ports, 117 from San Francisco, five from Oregon, 30 from overseas...with an extensive trade in mail, goods and passengers.[14] As a fur-trading post, Victoria's constant link with "civilization" was the British Royal Navy, which established its first naval buildings at Esquimalt in 1855 (in case of American invasion) and continued surveying of the coastline.

The dangers at Race Rocks were very apparent from the "notice to mariners," issued by the Colonial Secretary's Office after the tower's 1860 completion:

> As strong tides and races occur in the neighbourhood of the Race Rocks they should not be rounded nearer than from half a mile. A reef with 3 feet of water lies S.E. from the Great Race...The Race Passage (between the Rocks and Bentick Island) may be used by steamers acquainted with the locality

> but sailing vessels are by no means recommended to use it unless with a commanding breeze. The ebb tide sets directly from the Haro and neighbouring channels towards the Race Rocks and vessels inward bound ...should give them a good berth before shaping a course for Esquimalt or Victoria Harbour.[15]

It is assumed that the tower brought a degree of security to navigators and, despite the shipwrecks that continued in this locale for nearly one hundred years, it came at a juncture in Victoria's development, from trading post (Fort Victoria) to incorporated city (1862).[16] For this reason, the tower is a significant example of immigrant entry into the colony and of its future commercial development.

ARCHITECTURE

Aesthetic Design

A circular tower rising 105 ft. in height (Figures 3 and 4), Race Rocks retains the impressive qualities of the "Imperial" towers often debated in Canadian lighthouse lore. Its present visual quality is good, although its original attached dwelling was demolished in 1962. The tower now stands shorn of this feature, with visible reminders left in the re-worked masonry around the entrance (Figure 4 - arrow) and the awkward second-storey staircase. It nevertheless continues the legacy of pre-Confederation masonry towers in its towering height, good proportion and the even-coursed stonework worked in rusticated fashion. The distinctive black and white colour scheme is atypical (most tend to be have a solid white day marking), but highly attractive.

Many of these towers had connections to the building traditions established by the British Lighthouse Board or the British Trinity House. The elegant proportions and overall "stateliness" were hallmarks of the type, which appeared primarily in Ontario during the 1850s. Like most, the decorative detailing was kept to a minimum. Here, deep-set doorway and lower window openings are round-headed (Figure 4), while the remaining fenestration is simply treated in small, squared openings. At Race Rocks, it is not the decorative elements, but the rough-hewn and "robust" stonework, that adds most to its visual appeal. The Race Rocks lantern, rather small in proportion to the tower, is a replacement for the original light that burned colza oil and dog fish liver oil.

Of those loosely classed as "Imperial" towers, Race Rocks is similar to Chantry Island and Christian Island (Figures 9 and 10), both of high aesthetic quality (not yet evaluated; FHBRO 90-213-24).[17] Of the other masonry types, Burlington Canal (FHBRO 88-94), built 1857, was rated as "Recognized" (54; 13 for Aesthetic Design), but lost points for its incompatible site (Figure 11). Francois Baby's Point Amour (FHBRO 83-38), covered in firebrick, achieved the score of 76 (25 for Aesthetic). Another close comparative is Point Clark, on Lake Huron, which displays the similar rough-hewn stonecourses (laid in 19-in. courses) and Nottawasaga Island, Georgian Bay. In many cases, this type was designed to have an attached keeper's dwelling, a form still retained at Cove Island and Point Clark. In loosing this feature, Race Rocks actually represents a tradition of severing the dwelling from the tower.

Race Rocks is the only known example of the tall, pre-Confederation, unsheathed stone masonry tower, built outside of Ontario. (Fisgard, a possible contender, was built in brick and is stylistically unique in its decorative approach). Three other notable round/cylindrical masonry towers (FHBROs 87-87, 88, 91), built in Québec a decade earlier (1843, 1844 and 1848), do not have any stylistic affinity to the tapered and more elegant type that evolved more than a decade later with Race Rocks.

Functional Design

As in all lighthouse planning, the functional design of the tower usually was drawn up to suit the particular exigencies of the site. For the crowded and rocky locale at Race Rocks (Figures 2 and 5), Surveyor General Joseph Pemberton (seemingly, the only senior official with engineering training in the colony, at the time)[18] chose a plan that called for a slender tower with attached keeper's house:

> Where the site is a Rock on which there is space enough & no danger to be apprehended from the Waves, it is more economical & convenient to have the narrowest Tower, with dwelling attached, than a Broader Tower, with dwelling rooms in it.[19]

The combined tower/keeper's dwelling was a perfect adaptation to this locale. The tower acted solely as a base for the light (and possibly for storage), with residential functions reserved for the dwelling. The concern for proper living conditions for the attached dwelling is apparent from Pemberton's design request - "[the keeper's dwelling] sh. be of same material as the tower, four roomed, made exceedingly comfortable & slated."[20] Similar to Fisgard in exterior configuration, the dwelling probably consisted of two rooms on each floor and an entrance hall. A staircase connected the entrance hall with a landing on the second floor and thus provided a means of access into the tower.

Specifications called for "strength, durability and rigid economy"[21] in the design of Race Rocks and the tower was planned to include good ventilation to combat the dampness and for the proper functioning of the light. The tower was constructed of rough-faced stone blocks that were laid in regular courses, while the now-demolished dwelling was executed in rubble stone. The 105-ft. structure displays the standardized design principles associated with tall, coastal lights subject to wind and wave action. To increase the stability of this tall tower, the lower 19 ft. of the base was constructed of solid granite, quarried on the site.[22] Because of its strength and durability, granite was also utilized at the top of the tower, since the walls of a lighthouses are thinnest just below the lantern room.[23] The rest of the tower was worked in sandstone, less durable, but more easily shaped and manipulated. The tower's overall form is that of a cone, tapering from 19 ft. at the base to 12 ft. at the top, with a 5 ft. 3 in. thickness "of solid stone wall" at the bottom and 2 ft. 3 in. at the top.

The specifications for installing the lantern and apparatus (shipped from England) caused some problems for the builders since no engineer had been sent out to survey the site. Assuming the involvement of British know-how, they nevertheless would reflect state-of-the-art technology, since the lighting mechanism was the raison d'etre of the light.

Craftsmanship and Materials

Exclusive of the lanterns and lighting apparatus, which were shipped from Britain, the lighthouse probably was built with locally-purchased materials. The use of granite (for the base and upper tower support) and sandstone (for the shaft) was, as above, a choice made directly in keeping with the peculiarities of Race Rocks. Where brick was preferable for Fisgard, stone masonry construction was ideal for Race Rocks's isolated situation, a "greater distance from Victoria," where currents made landing supplies difficult.[24]

The tower was constructed by local craftsmen in the colony and while it remains a good testimonial to these craftsmen, this has not always been the case. The "rigid economy of construction" overriding its construction subsequently may have led to structural problems. Whether it was the design, or the craftsmanship, the tower suffered structural distress only 20 years after completion. The exposure to storm, wind and rain precipitated some remedial work as early as 1867, apparently remedied by re-pointing. A later report found the sandstone to be of an inferior grade because it had been quarried from locations below high tide. In 1878, a consultant considered the tower "unsound" and called for its demolition.[25] This was not carried out, however, and whatever was done at that time has remained effective, for the structure stands one hundred and forty-one years later.

Recently, the former attached keeper's dwelling was dynamited away from the tower (Figures 6 and 7), with little apparent loss of integrity to the remaining column. The old light was removed (1988) and was replaced with a new electric light.[26] In 1959, the crumbling lantern needed repair where the capping stone had broken away and by 1965 the exterior granite work was repaired.[27] Although funds were allocated for a circular cast-iron stairway (at Fisgard), the tower was designed with a stone stairwell.

Architect/Builder

The attribution of the designer/builder for the Race Rocks tower is yet to be clarified. According to Lambeth and Jeune, in A History of Fisgard Lighthouses,[28] the tower was designed by John Wright of London, England and constructed by John Morris of Victoria. Morris was awarded the contract to erect the lighthouse and the work was performed by labourers and the crew of H.M.S. Topaz.

It is unlikely that credit for the design rests solely with Wright. Others involved in the conceptualization[29] were the first Surveyor General of British Columbia, Joseph Despard Pemberton, draftsman H. O. Tidieman (or, Tiedemann) and Captain Sulivan [sic], who sent a sketch of a lighthouse tower to the Colonial Office. J. J. Cochrane is also given credit for superintending the construction of Race Rocks. Given the uncertainty as to the attribution, it is difficult to assess the quality of a designer's work.

ENVIRONMENT

Site

Race Rocks lightstation occupies the whole of a small rocky island of eight acres. The only significant modification to the tower and its site was the loss of the attached keeper's residence. An ample, two-storey, masonry structure, it was removed in 1962[30] when the Canadian Coast Guard decided to demolish it. (The Coast Guard corresponded with the Historic Sites and Monuments Board, before the demolition, as to the tower's possible heritage value. They were assured that there would be no objection to demolishing the attached dwelling).[31] To-day, two keeper's residences, a fog alarm, helipad, oil shed and boathouse occupy the island, along with the tower (Figure 12). Their arrival has not significantly changed the relationship of the tower to its locality.

Setting

While the physical prominence of Race Rocks, as a coastal light, should be greater than Fisgard (a shorter harbour light), its visibility from land is hampered by its virtual isolation and inaccessibility. The setting, therefore, is best described in terms of its island position, remote and rugged but nevertheless part of the marine environment. Within this environs, the tower, as a navigational aid, reinforces (if not establishes) the present maritime character of the island.

Landmark

Race Rocks is an "important heritage structure," according to Visitor Services, Fort Rodd Hill (with jurisdiction for Fisgard lighthouse)[32] but it is inaccessible and virtually invisible to those on shore. Nearby Pearson College uses the island for biological studies and for viewing killer whales and sea lions, but the dangers of landing there would preclude much use of the island. A plaque erected in 1960 by the Pacific Command (Figure 13), Royal Canadian Navy, reveals the naval community's interest in the station. It commemorates the tower's service to "faithfully marking the final approaches to a safe haven in Esquimalt, home port for ships of the Royal Navy and the Royal Canadian Navy, 1860-1960."

The Fisgard lighttower at Ford Rod Hill has a higher level of community interest because it is part of a national historic site, it is highly accessible, beautifully sited and successfully interpreted (it was designated a national historic site in 1958 and is now owned and interpreted by the Parks Service).[33] Race Rocks, more historically significant than Fisgard because of its strategic location, suffers from its isolated position.[34] It is appropriately labelled as the "second oldest functioning lighthouse in the province," a point which is brought to the attention of the visiting public in the interpretation program at Fisgard Lighthouse. While Race Rocks possesses little of Fisgard's symbolic role, it is nevertheless a familiar element within the region.

Endnotes

1. Edward F. Bush, "The Canadian Lighthouse" in Canadian Historic Sites: Occasional Papers in Archaeology and History, No. 9 (Ottawa: Parks Canada, 1974), p. 77.

2. Susan Lambeth and Suzanne L. Jeune, A History of Fisgard Lighthouse and the West Coast Lighthouse System to 1920 (Ottawa: Parks Canada, 1980) Part I, Manuscript Report Number 356, p. 3.

3. The first mention of the need for a lighthouse was in a transmission from Captain Richards to Governor Douglas, cited in Lambert and Jeune, History of Fisgard Lighthouse, p. 3. Source from Great Britain. Public Record Office., CO 60/1, Enclosure in Richards to Douglas, 23 October 1858.

4. The name originated with surveyor Captain Kellett who, in surveying these waters in 1846, noted, "This dangerous group is appropriately named, for the tide makes a perfect race around it." Donald Graham, Keepers of the Light: A History of British Columbia's Lighthouses and their Keepers (Madeira Park, B.C.: Harbour Publishing, 1987), p. 19.

5. Letter dated 15 January 1859 from Governor James Douglas to Sir E. B. Lytton, Her Majesty's Principal Secretary of State for the Colonial Department. Quoted in Lambeth and Jeune, A History of Fisgard Lighthouse, Part I, p. 33.

6. Race Rocks is also known as Race Islands Lighthouse.

7. Lambeth and Jeune, A History of Fisgard Lighthouse..., p. 44.

8. Namely, Griffith Island, Chantry Island, Christian Island and Cove Island, Ontario.

9. Lambeth and Jeune, A History of Fisgard Lighthouse, p. 44.

10. Lambeth and Jeune, A History of Fisgard Lighthouse, p. 41-2.

11. Estimate for Erecting and Maintaining Lighthouses Abroad for the Year Ending 31 March 1860 (contained in Great Britain. Kew Gardens, Public Record Office, Minute Paper 5205 of 1859, MT 9/9). Cited in Lambeth and Jeune, A History of Fisgard Lighthouse, p. 339.

12. Lambeth and Jeune, A History of Fisgard Lighthouse, p. 39.

13. George Woodcock, British Columbia. A History of the Province (Vancouver: Douglas & McIntyre, 1990), p. 93.

14. L, p. 3-4.

15. The British Colonist 29 January 1861.

16. Woodcock, British Columbia. A History of the Province, pp. 88 and 101.

17. See Edward Bush and Dana Johnson, "The Christian Island Lighthouse and Keeper's House, Christian Island, Ontario" Historic Sites and Monuments Board. Agenda Paper 1983-21.

18. Lambeth and Jeune, A History of Fisgard Lighthouse, pp. 54-55.

19. Lambeth and Jeune, A History of Fisgard Lighthouse, p. 51.

20. Ibid.

21. Lambeth and Jeune, A History of Fisgard Lighthouse, p. 54.

22. Construction details, dimensions, etc. provided from Lambeth and Jeune, A History of Fisgard Lighthouse Part II, p 540.

23. Mary Weeks-Mifflin and Ray Mifflin, The Light on Chantry Island (Erin, Ontario; The Boston Mills Press, 1986), p. 14.

24. Lambeth and Jeune, A History of Fisgard Lighthouse, p. 51.

25. Bush, "The Canadian Lighthouse", p. 77.

26. Conversation with Glenda Graham, Canadian Coast Guard, Victoria, 27 May 1991.

27. File on Race Rocks Lightstation, Transport Canada, Canadian Coast Guard.

28. Lambeth and Jeune, A History of Fisgard Lighthouse.

29. For a detailed accounting of these individuals, see Lambeth and Jeune, A History of Fisgard Lighthouse, pp. 54-61.

30. File on Race Rocks Lightstation, Transport Canada, Canadian Coast Guard.

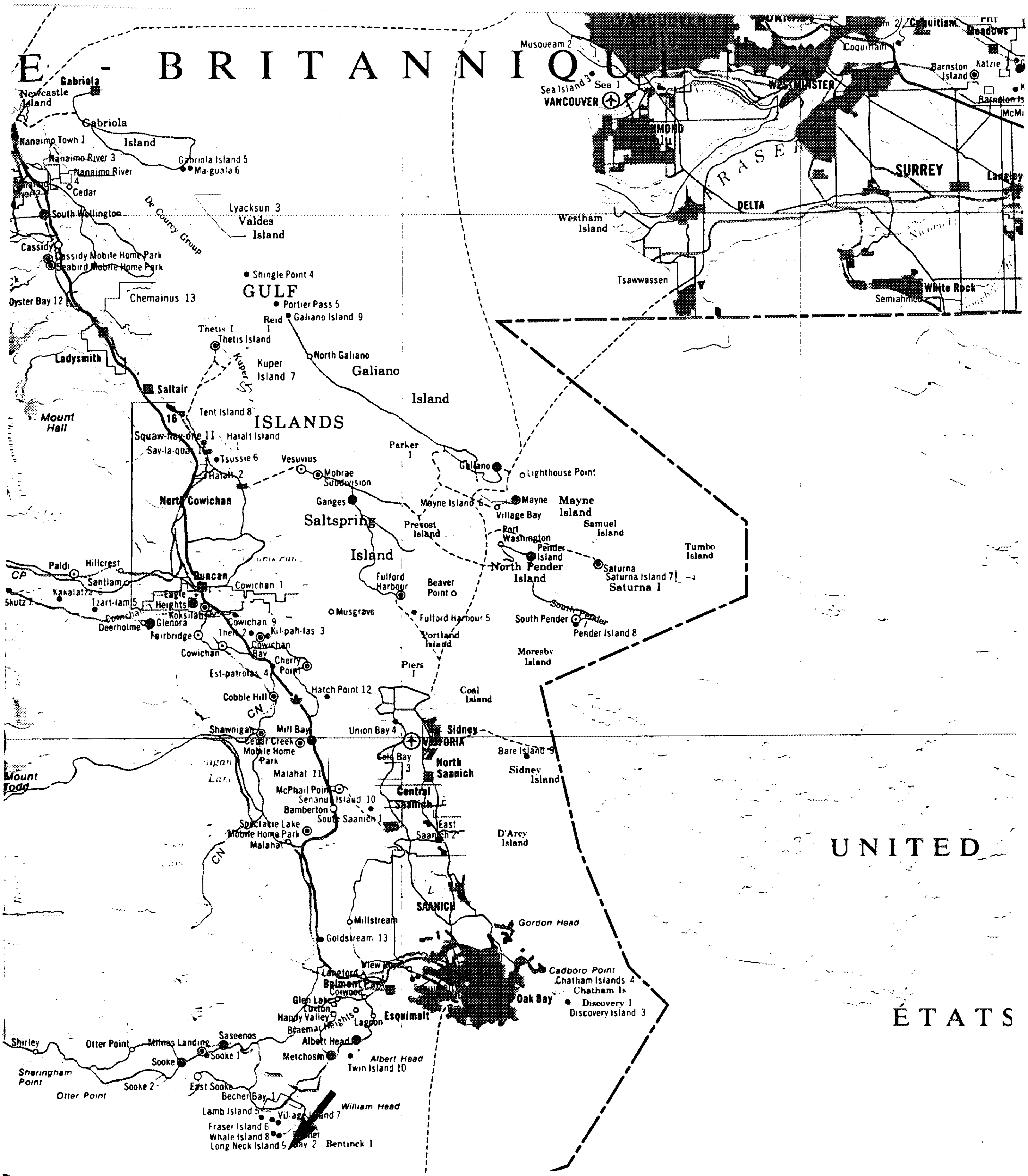
31. Transmitted in a memo from A. K. Laing, Coast Guard to Victoria. Dated 10/8/62. Transport Canada (CCG), "Race Rocks Lighthouse."

32. Conversation with Dale Mumford, Visitor Services, Fort Rodd Hill, 14 June 1991.

33. According to HSMBC Minutes, Fort Rodd Hill (including Fisgard Lighthouse) was positively recommended in 1958. HSMBC Minutes 1958 (November 3), p. 31.

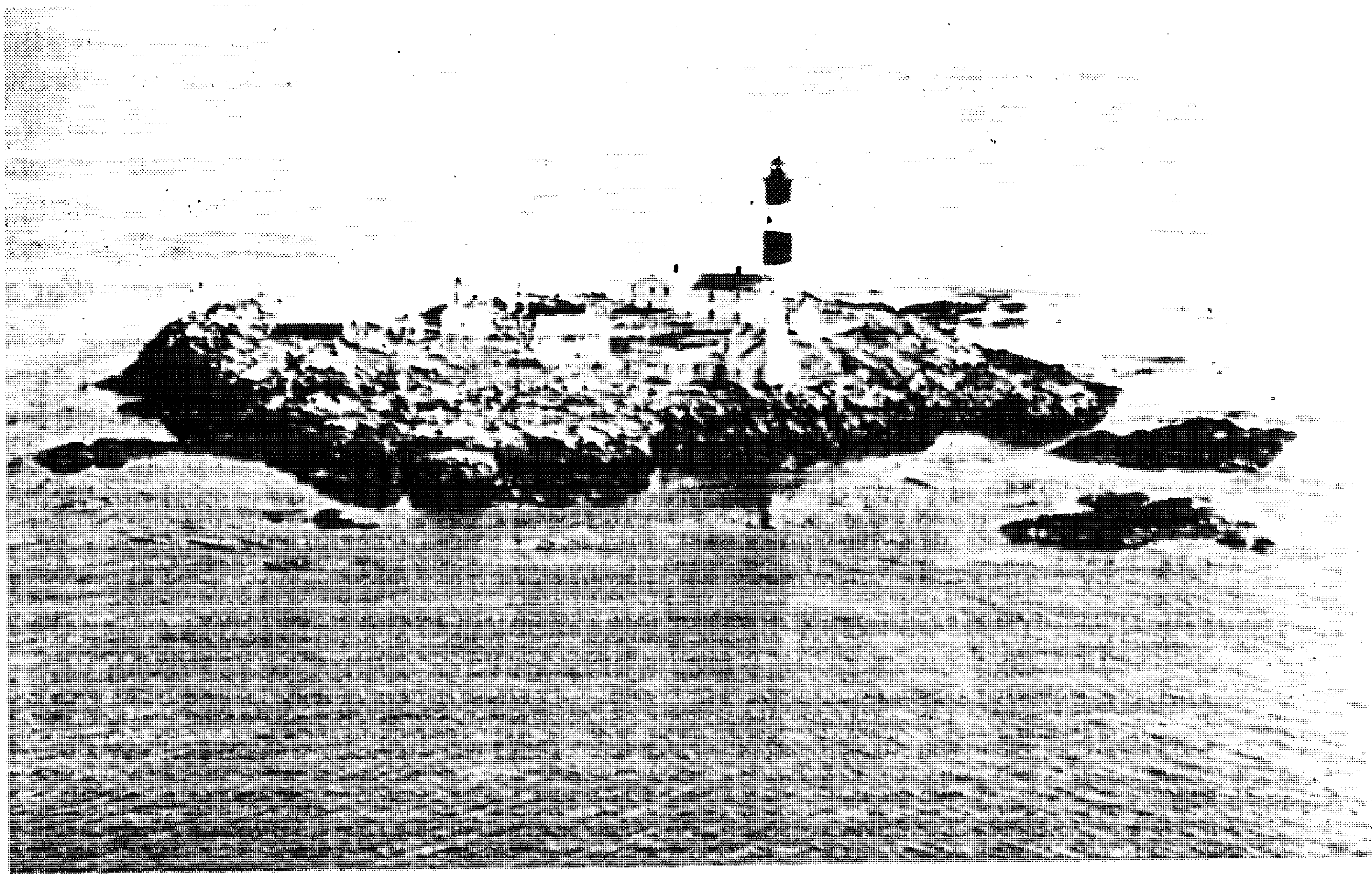
34. The best view of the tower is from DND property at the southern tip of Vancouver Island, an area which, unfortunately, is not open to the public.

RACE ROCKS LIGHTHOUSE, VANCOUVER ISLAND, BRITISH COLUMBIA

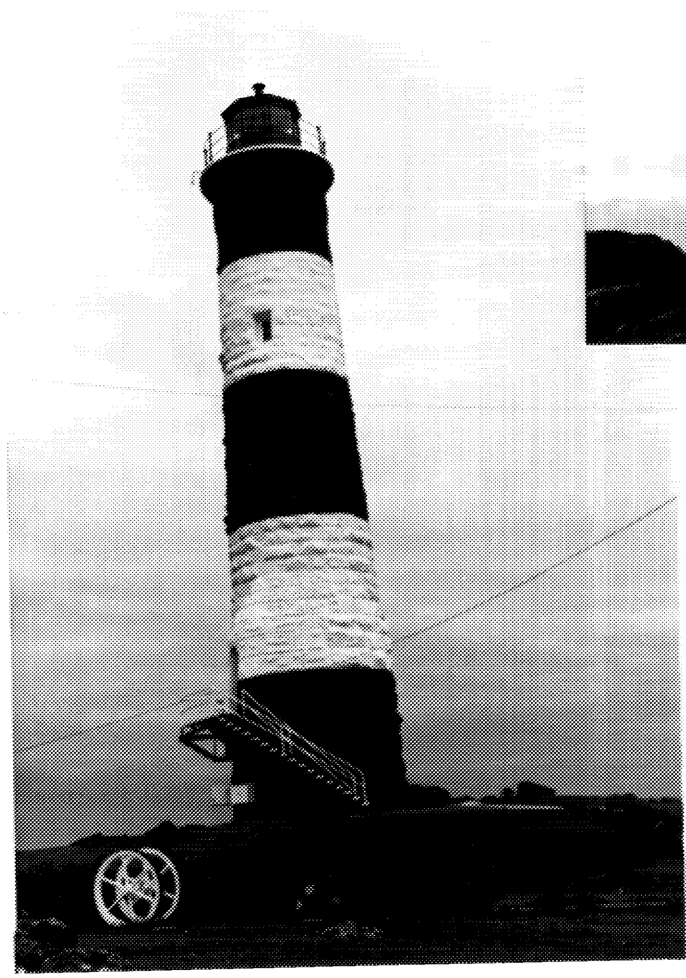


1 Location of Race Rocks Lightstation, Race Rocks, Strait of Juan de Fuca, British Columbia. (CCG.)

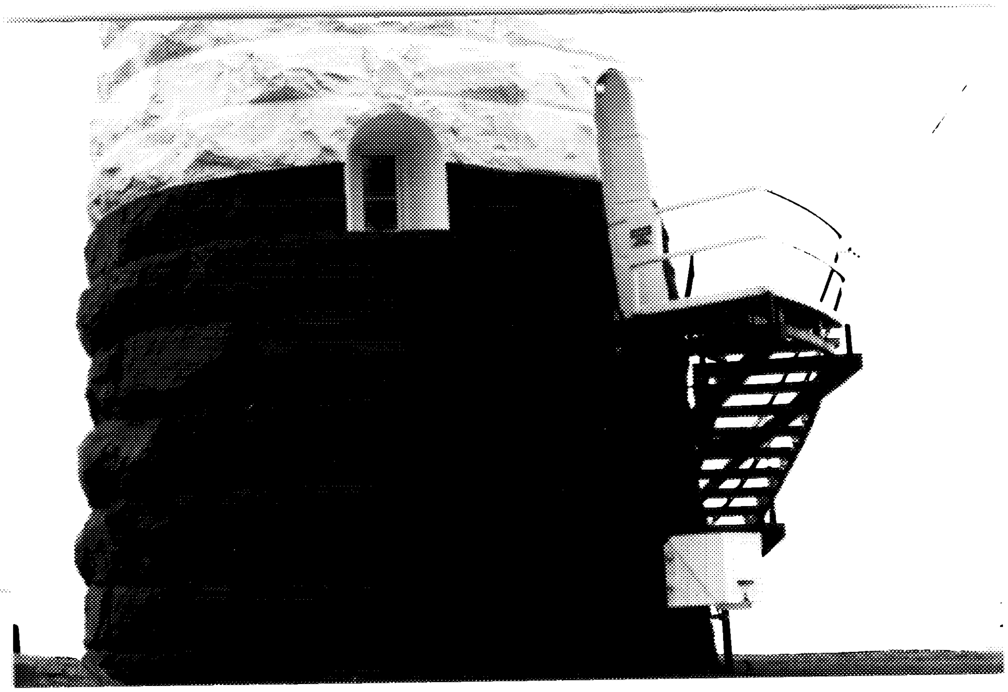
RACE ROCKS LIGHTHOUSE, VANCOUVER ISLAND, BRITISH COLUMBIA

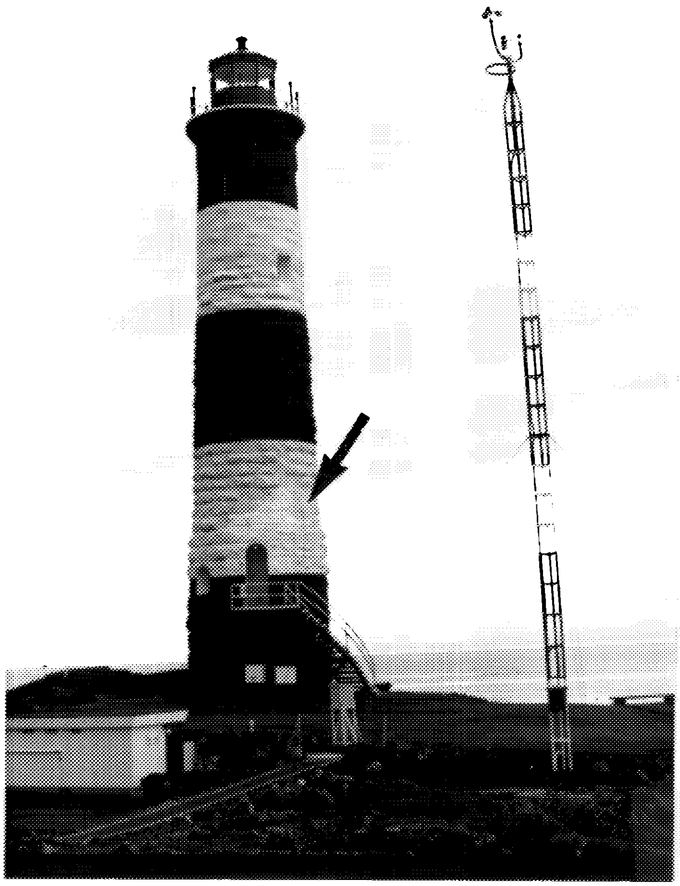


2 Race Rocks from the air. (Jim Ryan photograph. Reproduced in Donald Graham, Keepers of the Light: A History of British Columbia's Lighthouses and their Keepers [Madeira Park, B.C.: Harbour Publishing, 1987], p. 29).

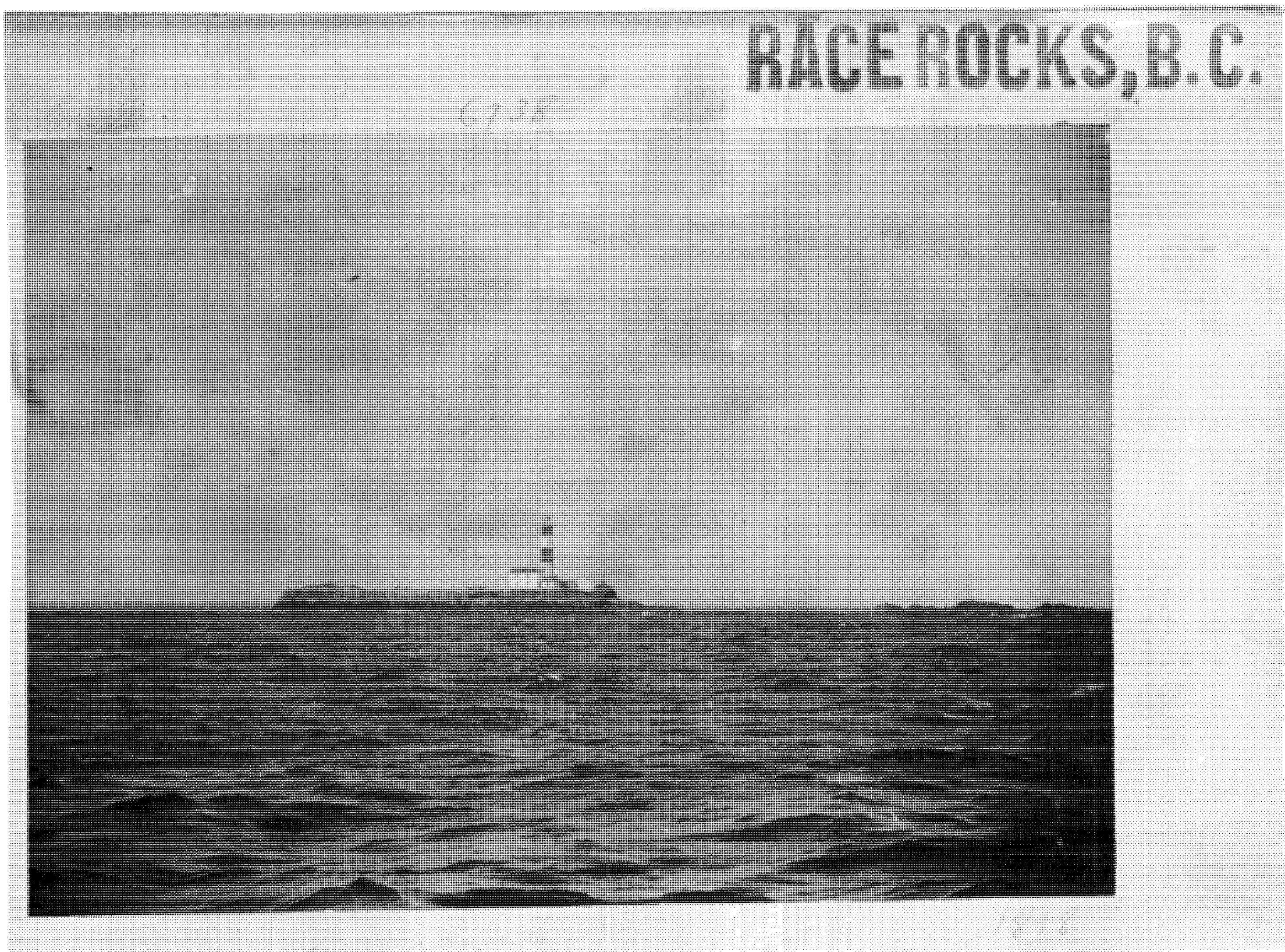


3 Race Rocks Lighttower. (CCG, ca.1990.)

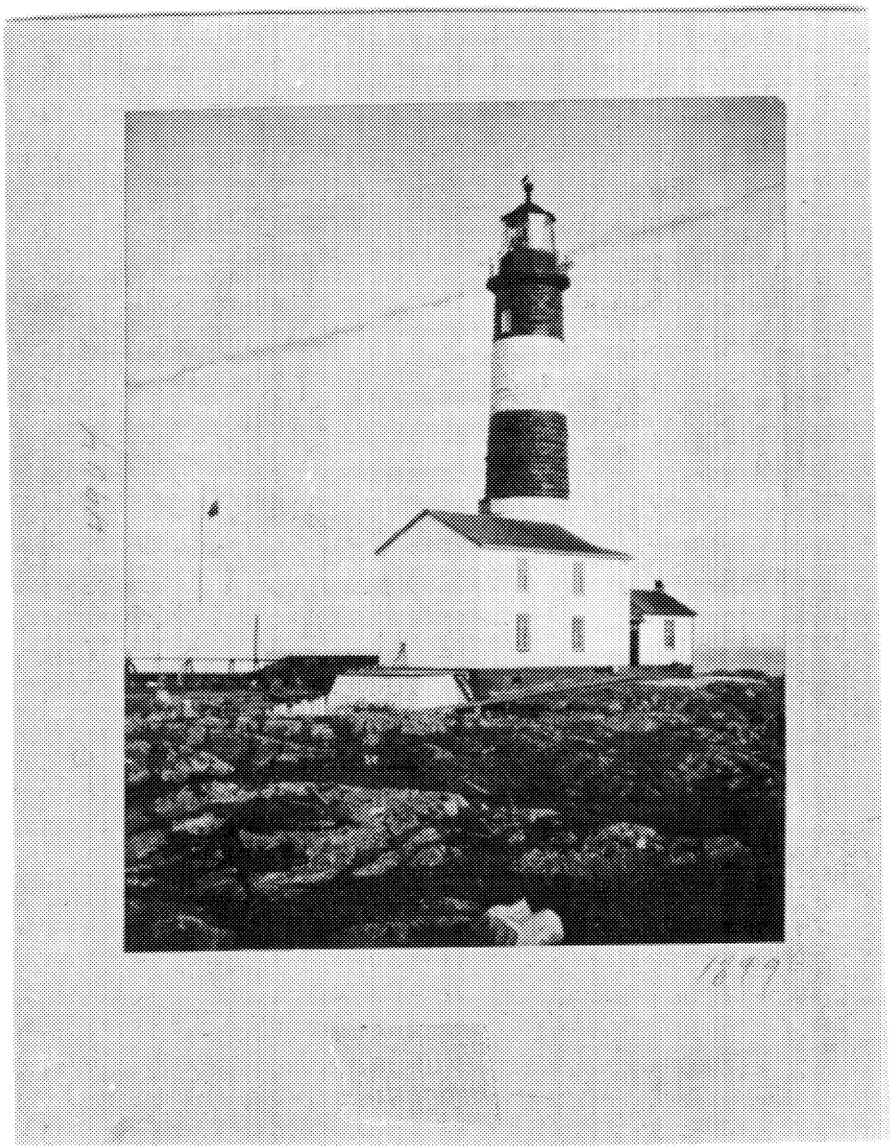




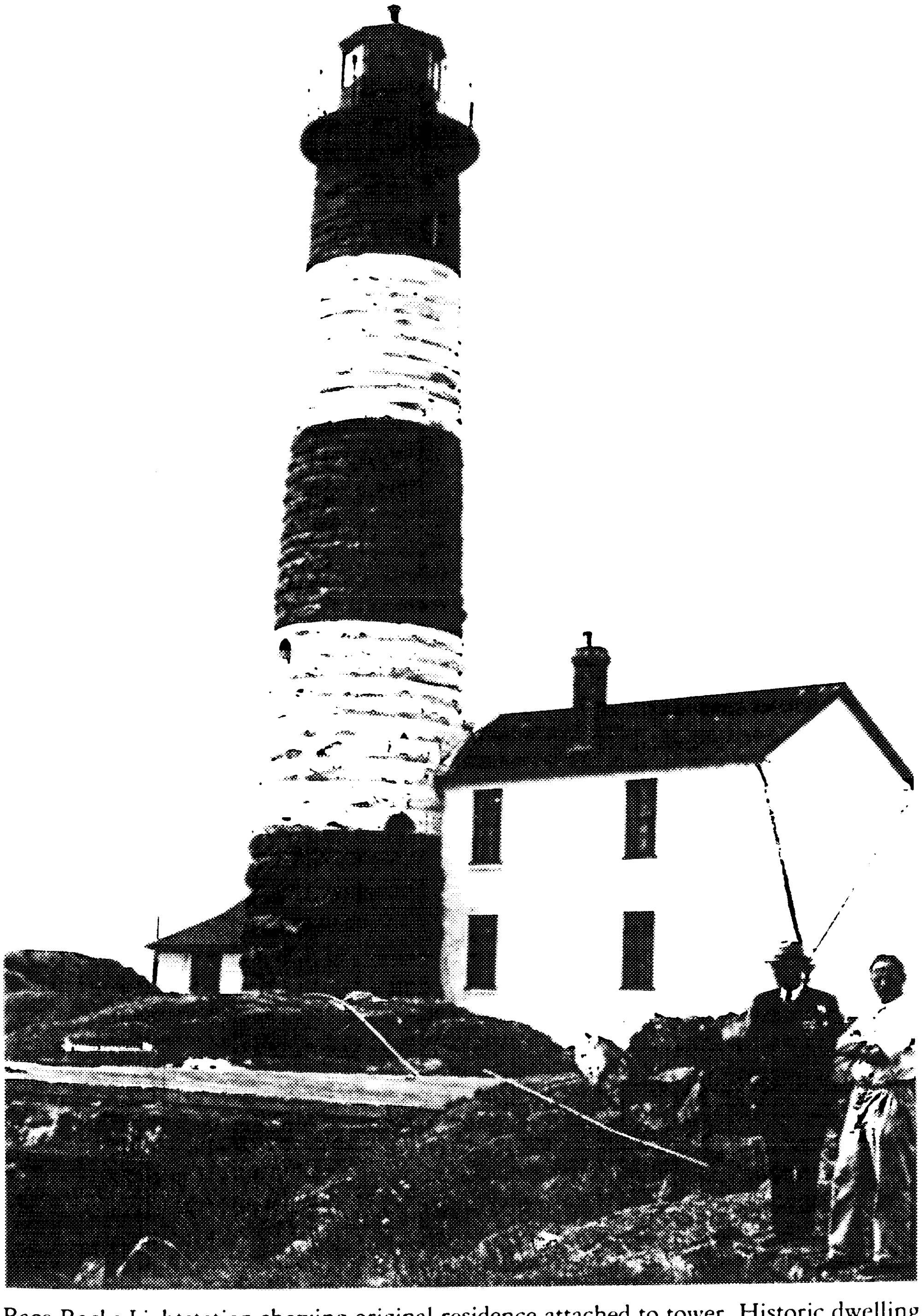
4 Race Rocks Lighttower. (CCG.)



5 The Race Rocks tower in 1898, situated on a small 8-acre island. (<u>No source</u>.)



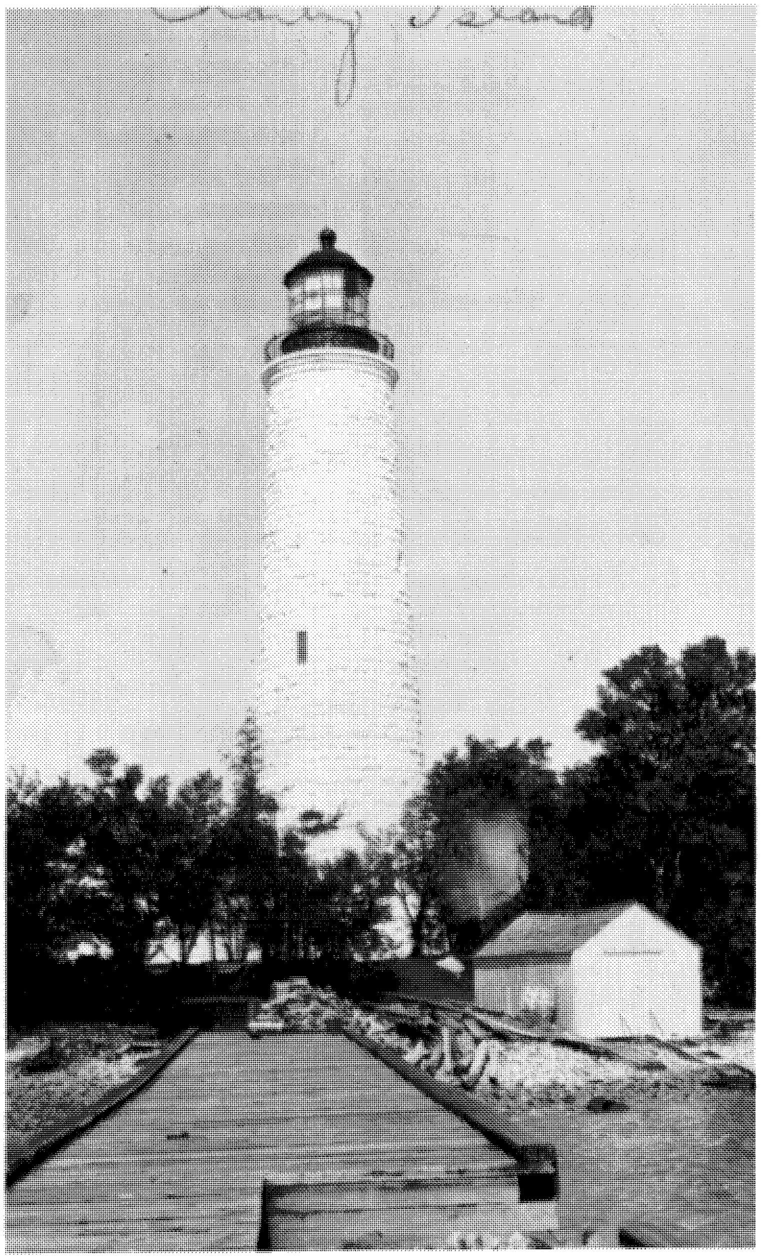
6 The tower, with former attached keeper's dwelling. (No source.)



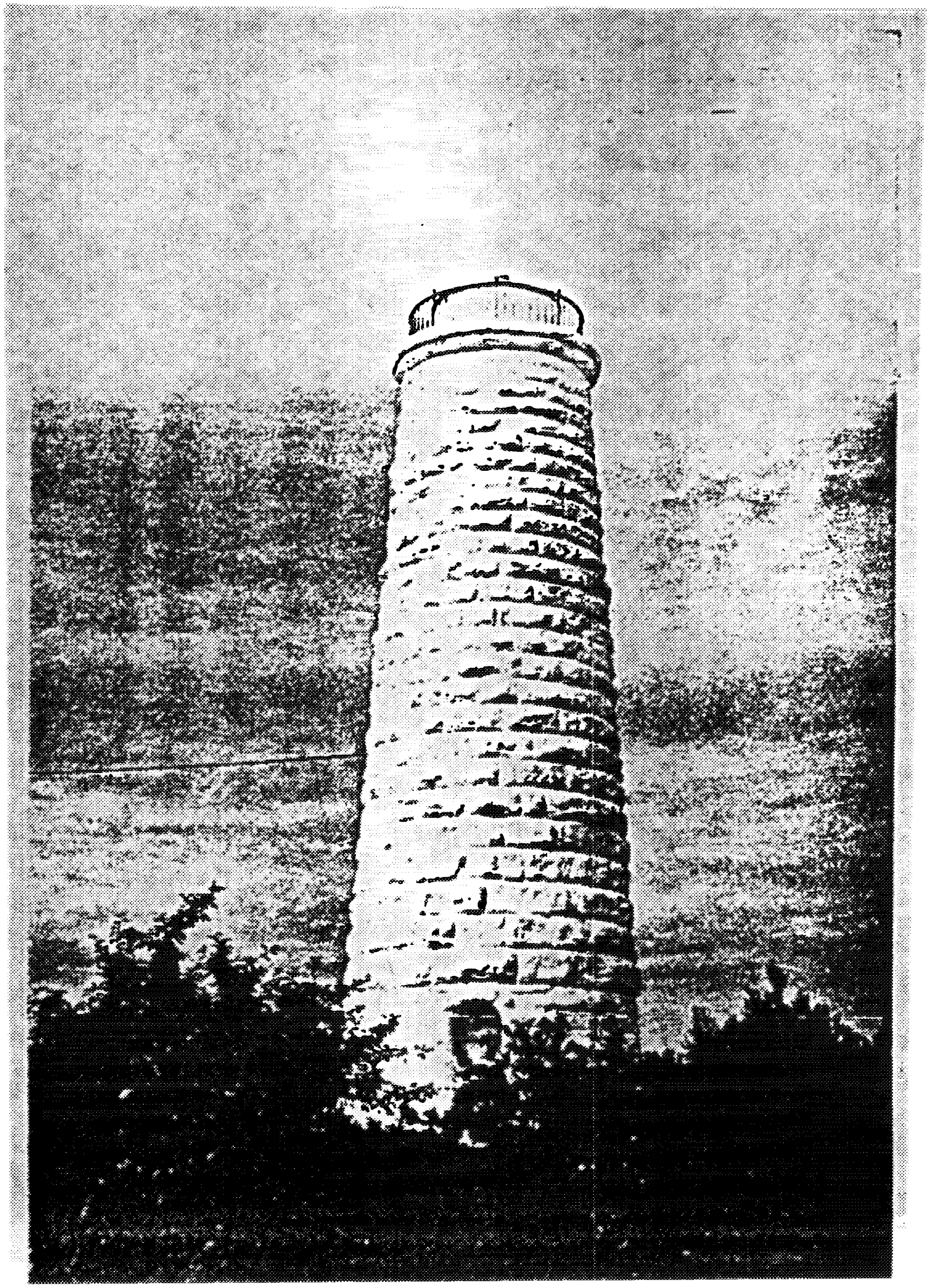
Race Rocks Lightstation showing original residence attached to tower. Historic dwelling was recently demolished.

7 Race Rocks Lightstation, circa 1940. (Donald Graham, Keepers of the Light: A History of British Columbia's Lighthouses and their Keepers (Madeira Park, B.C.: Harbour Publishing, [1987].

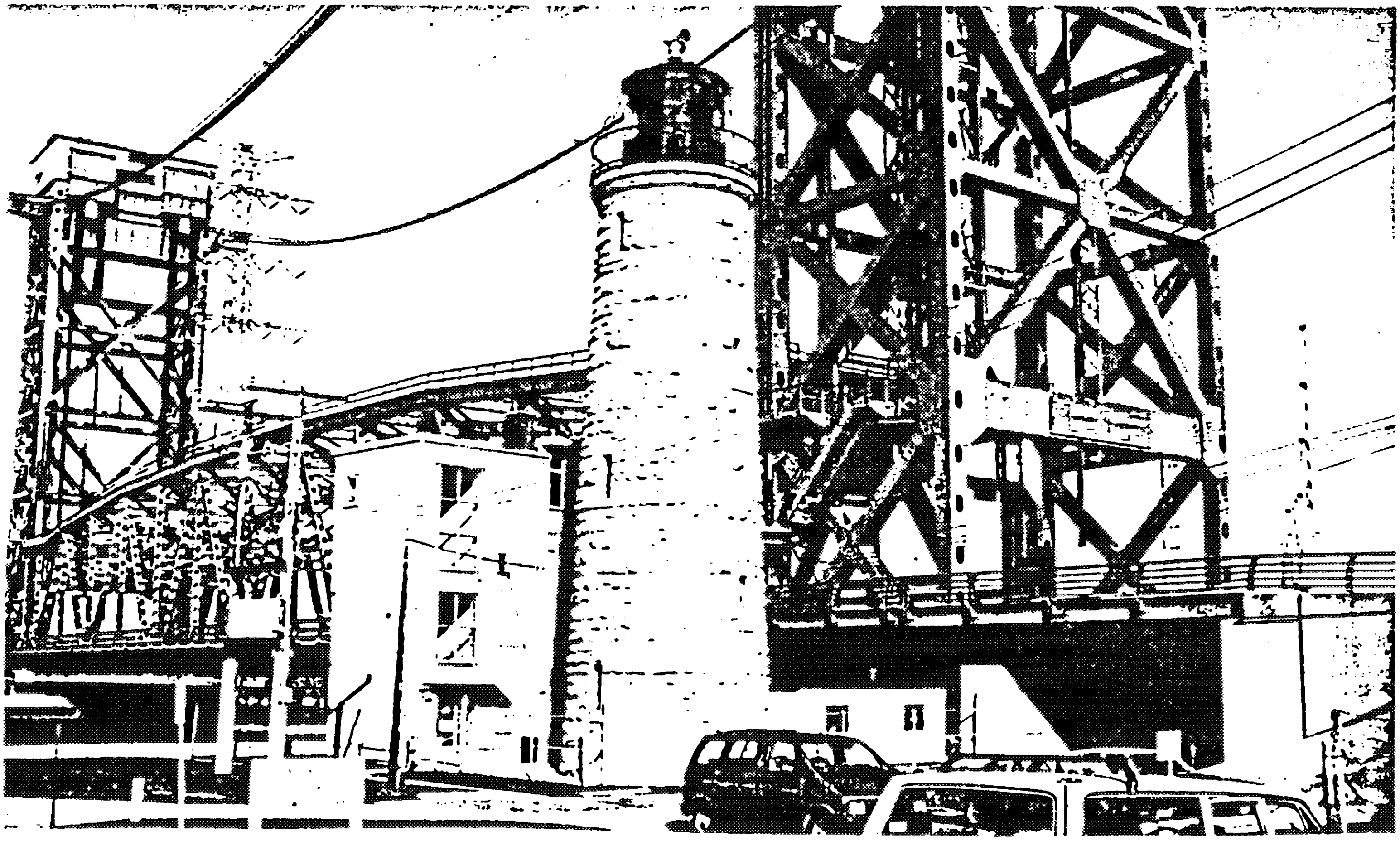
8 Race Rocks Lightstation, a more recent view. (Donald Graham, Keepers of the Light: A History of British Columbia's Lighthouses and their Keepers (Madeira Park, B.C.: Harbour Publishing, [1987], p. 32.



9 Chantry Island Lighthouse, Ontario; constructed 1855-59. (No Source.)

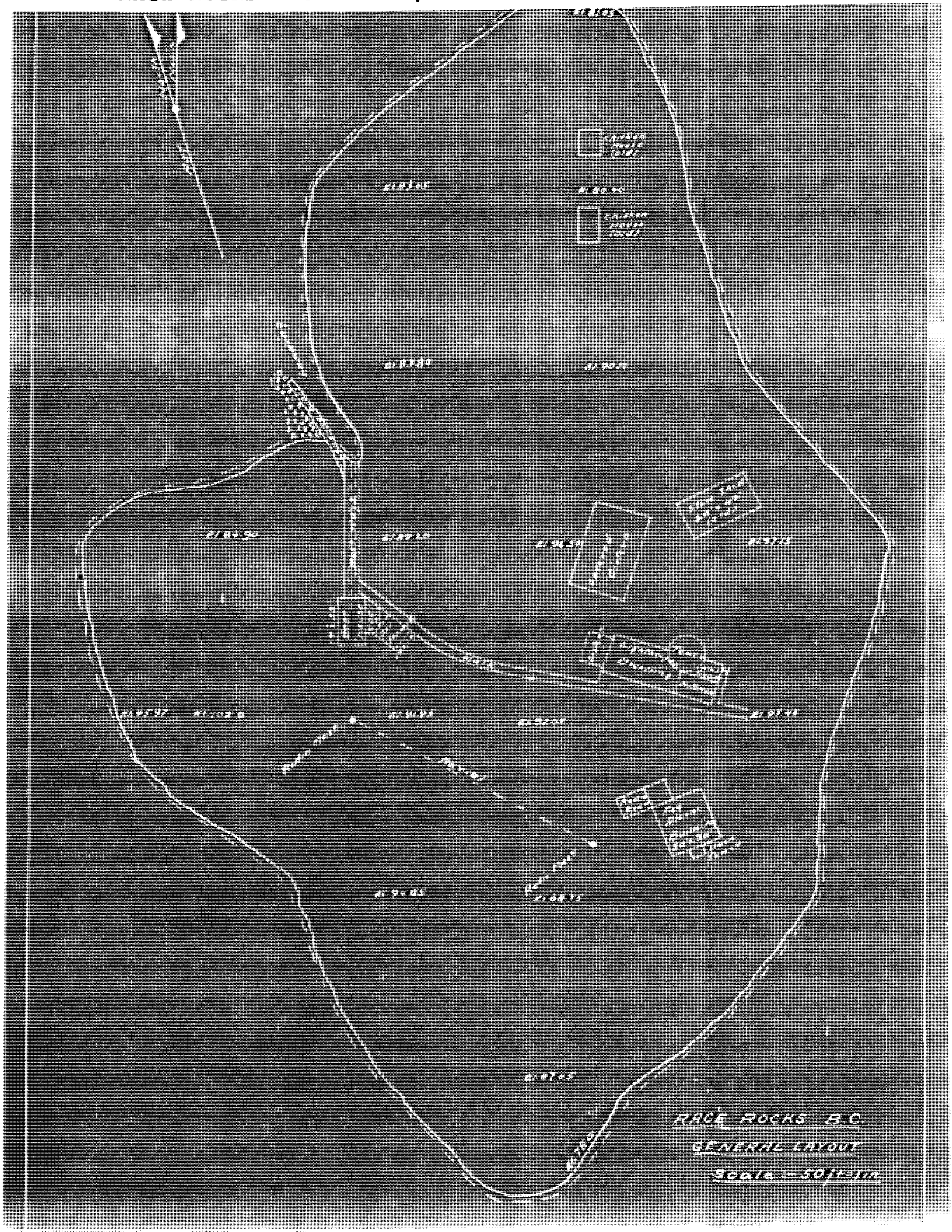


10 Christian Island Lighthouse, Ontario; constructed 1855-59. (CCG, 1990.)



11 Burlington Island, Hamilton, Ontario; built 1858. (CCG, 1989.)

RACE ROCKS LIGHTHOUSE, VANCOUVER ISLAND, BRITISH COLUMBIA



12 General lay-out of the station. (Transport Canada, CCG, File on "Race Rocks".)

13 Plaque erected by Pacific Command, Royal Canadian Navy, 1960. (CCG.)

APPENDIX C: The Stone Tower

Excerpt from *The Evolution of Canadian Lighthouse Design* by Ian Doull, architectural historian, Parks Canada, 2007

THE STONE TOWER

"There are five stone towers to be examined during this project, dating from 1855 to 1860 and spanning the country. Stone as a principal building material was used sparingly in Canadian lighthouses, and only in the 18th and 19th-centuries. Canada's oldest standing lighthouse, on Sambro Island, Nova Scotia, is a stone tower, clad in wood shingles, erected in 1758.

<u>Christian Island and Cove Island Imperial Towers, 1855-59</u>
These are two of six so-called "Imperial Towers" constructed on the Great Lakes in the 1850s. The title is a misnomer as all were built under the authority of the Board of Works, Canada West. The towers are tall, elegantly tapered structures, many of which featured compatible stone cottages either attached or adjacent to them. While 11 towers were planned only six were built: at Griffith Island; Chantry Island; Christian Island; Cove Island; Nottawasaga Island; and Point Clark.

The Imperial towers were of the same general plan as towers built at Point Amour, Cap des Rosiers, West Point on Anticosti Island, and Belle Isle, Newfoundland. (also built by the same agency, the Board of Works of the United Province of Canada).

Although of different heights the towers share many common design elements. Each is circular and tapered, and is corbelled out slightly at the top to form a gallery and base for the lantern. Detailing is kept to a minimum. The Cove Island lighthouse, along with that at Chantry Island, ranks higher in aesthetic values than the Christian Island light; in addition, the latter has had its lantern removed. The Cove Island light displays an elegance of design and richness of detail rarely seen in other Canadian lighthouses. It stands 100 feet tall and originally featured a second-order light used only for major coastal lights. Six vertical Fresnel lenses remain in place. The lantern is a magnificently designed twelve-sided structure with three rows of rectangular glass panes; and a segmentally ridged, domed roof topped by ventilators. Twelve bronze lions' heads grace each angle of the lantern's eave lines; they support a rain-gutter which is barely visible from the ground. The Christian Island lighthouse, lacking its lantern, is 55 feet tall.

HCD has previously conducted condition assessment reports on the Chantry Island and Nottawasaga towers and so is well informed on the structural data. However, to summarize, the towers are very similar in structure and materials. (FHBRO report, from condition assessments in the 1960s and from archival sources in E.F. Bush Agenda paper, and other APs). The structural systems used both wood and stone. Heavy timber frames give them lateral stability, while inner and outer rows of cut stone, with rubble infill, provide effective resistance to compressive forces. Further stability is achieved through the slope of the walls, which vary from 5-7 feet thick at the bottom to 2-3 feet thick at the top (depending on the height of the tower). The interior space remains at a constant 10 foot-6 inch diameter through the height of the tower. The towers are horizontally divided into several levels, nine at Cove Island. Stairways are a combination of straight and curved, according to level, and of wood and metal construction. Zinc fuel stands are found in the stairways. Local white dolomite limestone was used, hammer-dressed to achieve a rusticated appearance, and was employed up to the corbelled gallery at which level a metal flooring was installed, set on I beams and lengths of "railway iron"; these in turn were mortared into the stonework. Lanterns were bolted directly onto rings of granite on top of the limestone. It is noted that while stone towers had the advantage of being fireproof in an age when flammable fuels were used, they have often not performed well in a wet climate with freeze-thaw cycles. Several have been lost over time due to deterioration. Many surviving stone towers have been covered with wood clapboard or shingles, or firebrick. A significant additional value of the Cove Island Lighthouse is that it retains its original stone keeper's dwelling, which survive at only a minority of the Imperial lightstations.

<u>Point Amour, 1857</u>
This elegant Newfoundland stone tower is the second tallest lighthouse in Canada, standing 109 feet from base to vane. It was built as a major coastal light with a 2nd-order light, and stands at the Gulf entrance to the Strait of Belle Isle, Newfoundland. It was built under the authority of the Board of Works of Canada, as were the Imperial Towers, and was one four built to the same design but of different heights; the others are at Cap des Rosiers, West Point Anticosti (demolished), and Belle Isle, Nfld. The limestone tower is 24 feet 6 inches in diameter at the bottom, where the walls are about 6 feet thick, tapering to 8 feet 9 inches at the cornice. The exterior was covered with English firebrick, laid in cement. The outer walls were shingled in the 1890s, but it is believed that the fire brick is still in place. The original light apparatus, of French make, was still in place in the 1980s. The values of the Point Amour lighthouse relate to its importance to Trans-Atlantic shipping and to the gulf entrance, and its role as an early and excellent example of a Canadian major coastal light. Character defining elements relate to the tower's solid proportions, clean and graceful form, smooth masonry construction and height. The tower features a semi-detached dwelling, whose values are incorporated into the FHBRO heritage character statement.

<u>Cap des Rosiers, 1858, NHS 1977</u>
This first-order, major coastal light stands at the head of the Gaspé peninsula, and serves all marine traffic entering the St. Lawrence estuary from the Gulf. At 112 feet, base to vane (the tower itself is 95 feet) it is Canada's tallest lighthouse. Its construction was linked indirectly to pressure exerted by owners of shipping lines in Montreal and Québec who had suffered heavy losses in the lower St. Lawrence.

Cap des Rosiers lighthouse is a gracefully tapered circular stone tower, standing nine storeys tall, and measuring 25.5 feet in diameter at the base, tapering to 17 feet in diameter at the top. The limestone walls are just over 7 feet thick at the base and 3 feet thick at the summit, all resting on a foundation 8 feet deep. A spiral staircase extends the height of the interior. Architectural detailing is kept to a minimum: the window openings and support brackets for the gallery are small and functional. The large lantern, which in 1993 was original, is well-scaled for the diameter and height of the tower, and fits well with its utilitarian aesthetic.

This tower has had a comparatively complex structural history, with successive interventions required to ensure its integrity. As built, the limestone was faced with "the best quality English firebrick" (Fulton, FHBRO report). In 1861 the firebrick was covered in a cement/sand stucco finish. Unspecified repairs were done in 1929-30, and in 1954 the badly deteriorated brickwork was replaced. In 1984 doors and windows were replaced and the brickwork was replaced with white marble as water had collected between the brick and stone, causing the brick to crack. In 1993 the marble itself was repaired due to cracking, and a ventilation and dehumidifying system installed. Gordon Fulton, author of the 1993 FHBRO report, indicates that the tower was constructed with careful attention to construction materials and techniques, and that the frequent repairs likely meant that the materials had been pushed beyond their limits in the brutal climate. The light source has been upgraded several times, but the original 1st-order optical system was still in place in the 1990s.

<u>Race Rocks, 1860</u>
Built jointly by the British Colonial Office and the Crown Colony of Vancouver Island, the coastal light at Race Rocks, on the Juan de Fuca Strait, and its companion at Fisgard near Victoria were the forerunners of the extensive west-coast lighthouse system. At 105 feet in height Race Rocks resembles the Imperial towers in its great height, good proportions and even-coursed, rusticated stonework. For stability purposes the tower's first 19 feet are of granite, also used at the top. The middle section is of less durable but more easily worked sandstone. The overall shape is conical. Race Rocks is the only known tall, pre-Confederation, unsheathed stone tower of its aesthetic type found outside of Ontario. The lantern is a replacement; the unusual door placement is a result of the original attached two-storey keeper's dwelling having been removed.

APPENDIX D: Supplementary Chronology of Historical Information

Supplementary Chronology

550AD:	Early traces of human occupation of island (aboriginal burial mounds)
1858:	Letter from Captain Richards identifying need for lights on the Race Rocks group and Esquimalt Harbour
1859	Governor James Douglas writes to the British Colonial Office uring for the construction of the Fisgard and RaceRocks lighthouses as a matter fof “highest importance to the progress and prosperity of the Colonies of Vancouver Island and Brtish Columbia”.
1860	
summer	construction of lighthouse underway
dec. 26	Lighthouse lit for the first time
ca. 1863	black and white bands painted on the exterior of the tower[1]
1867	remedial work (apparently repointing)
1871	Department of Marine and Fisheries takes over the operation of the lighthouse from the British Admiralty when BC joins the Dominion of Canada
1873	tender for “repairs & C” to the tower and dwelling house are stated as completed
1886	Extensive repairs at the lighthouse (unknown)
1892	Department of Marine and Fisheries installs a steam plant and two compressed air foghorns at Race Rocks
1925	Replacement of lantern with new steel lantern, produced by the Corbet Foundry & Machine Co.of Owen Sound.
1927	Race Rocks is the first station on Canada’s West Coast to be fitted with a radio beacon
1959	repair to crumbling lantern where caping stone had broken (?)
1961	counterweight rotational mechanism replaced

[1] According to James A Gibb jr., in Sentinels of the North Pacific: the Story of Pacific Coast Lighthouses and Lightships, 1955, “the tower was painted 3 years after completion as a result of mariners’ complaints of its shape blending into the seascape”.

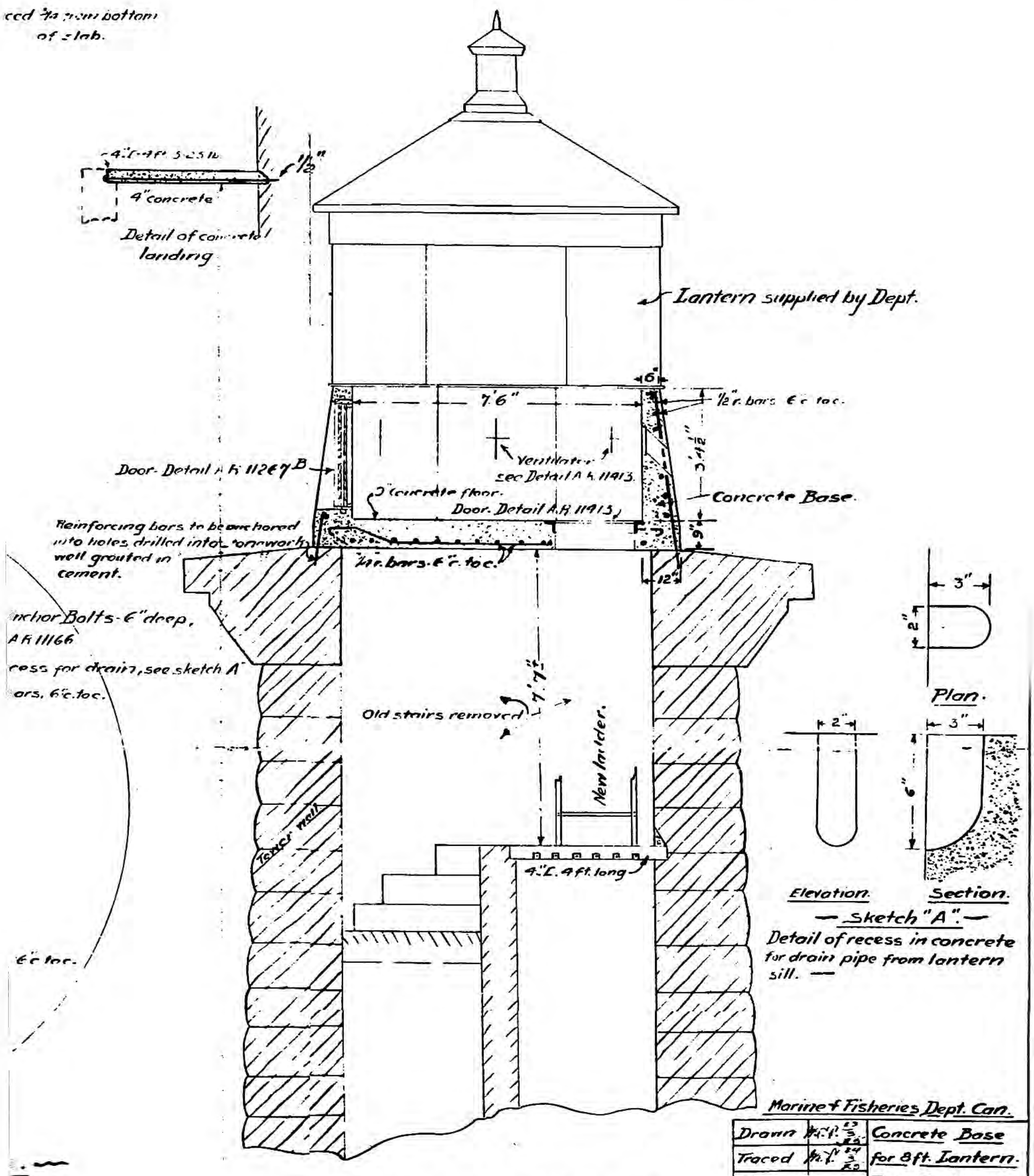
1964	Specification developed for the construction of two new residences on the island calls for the demolition of the existing house, connected to the lighthouse
1966	application of "gunite" on the top of the tower (preceded by sandblasting)
1967	Demolition of light keeper's house, opening is blasted in the tower's second storey and new access stair to it is built on the exterior of the tower (following prior removal of slate roof from original lightkeeper's residence).
1970s	demolition of the engine room and the foghorn tower
1977	new foghorn (+ possible installation of fog-detector equipment)
1978	construction of new helicopter pad telegram dated August 17 1978 reports that "large window west side building nr. 9 damaged during blasting operations this date"
1980	Race Rocks Islands established as an ecological reserve
1981	note dated August: "We discussed the inside of the lighttower; he [Mr. Anderson, the lightkeeper] said that he was having a problem with some sort of deposit which appeared to be coming from the sandstone, and it was suggested that possible [sic] the inside of the tower could be sandblasted and sealed to prelude the formation of the deposit, and subsequent peeling of the paint."
1982	sandblasting, one coat of waterproofing and 2 coats of vinylistic type paint (exterior most likely)
1983	installation of railing on the outside perimeter of the stairway, removal of weight shaft and infill of openings in stairs with concrete ventilator installed at entrance door and two thermostatically controlled 1000W electric heaters
1984	repainting of the tower on the interior
1988	old light replaced with new electric light installation of emergency light ladder on lantern work order to "hire glazing contractor to replace broken lantern housing window at Race Rocks lightstation
1989	work order to "construct planned maintenance and renovations at Race Rocks lightstation", including light tower air vents" in welding shop (?)

1992	installation of “temporary” microwave dish on the tower
1996	Solarization of the lighttower
1997	Lighttower de-staffed and automated.
2001	Transfer of Race Rocks facilities from the Coast Guart to BC Parks,as surplus lightstation buildings.

APPENDIX E: Archival Drawings

The following drawings show the changes to the top of the tower to allow for the replacement of the original lantern. These documents were provided by the Canadian Coast Guard from the Victoria, B.C. base archives.

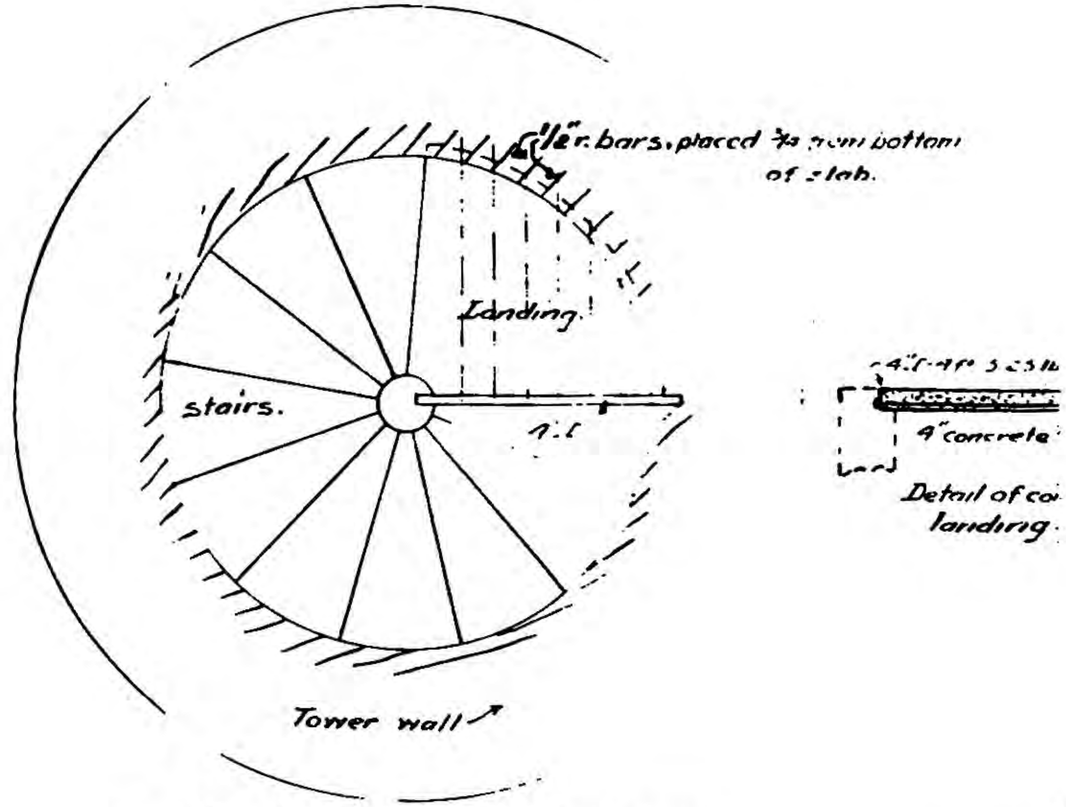
— Scale: 1/2" = 1'. —



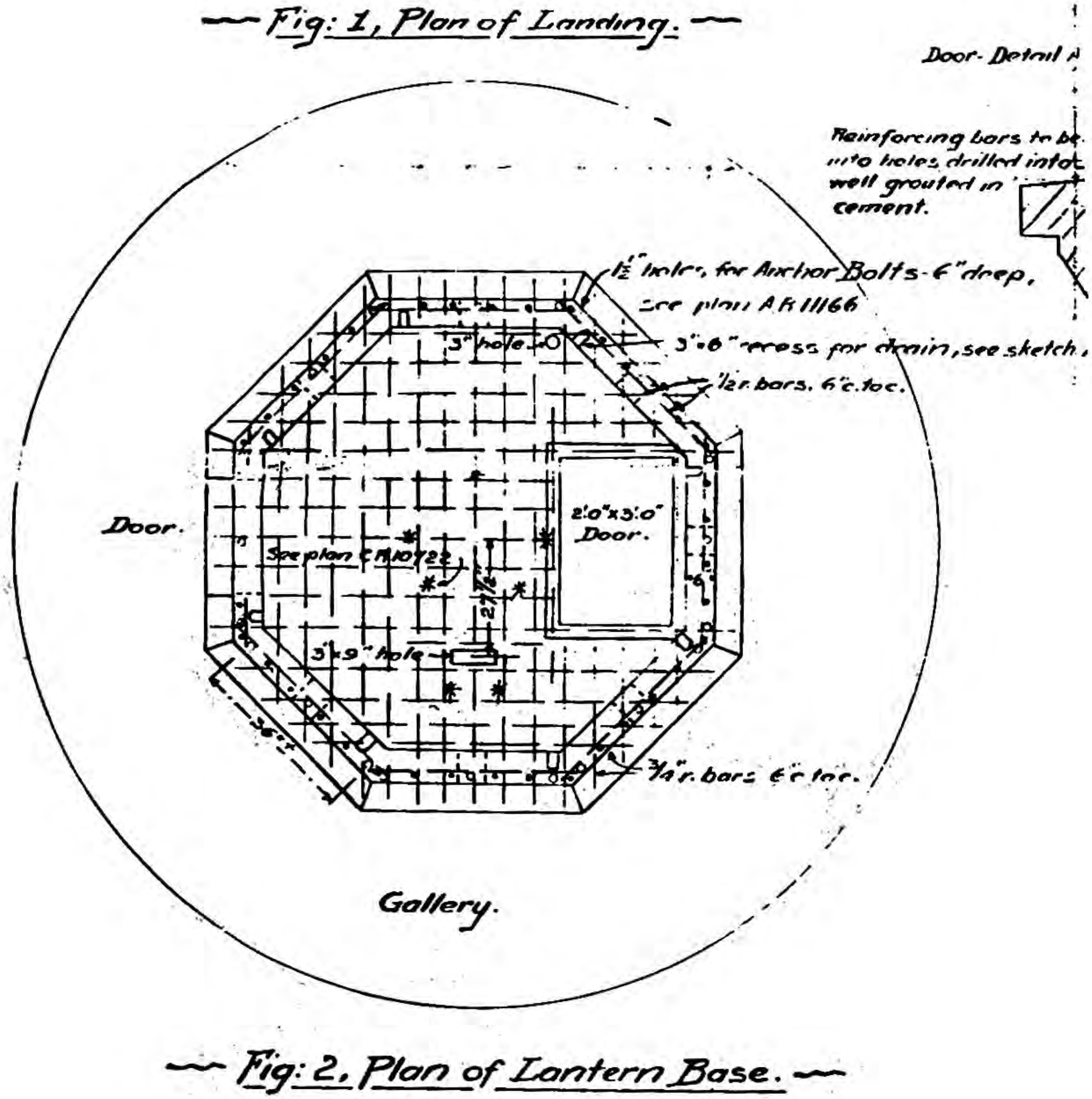
— Fig: 3, Section. —

Marine & Fisheries Dept. Can.

Drawn		Concrete Base for 8ft. Lantern. Race Rocks, B.C.	
Traced			
Checked			
Asst. Ch. Eng.		File No	22268 A
Reference No BR 13159.		Gns. File No	73509



— Fig: 1, Plan of Landing. —



— Fig: 2. Plan of Lantern Base. —

APPENDIX F: Executive Summaries of Environmental Assessment Reports

This section contains the executive summary for the report listed below. This report was obtained from the files of the DFO offices in British Columbia.

1. **Phase II Environmental Assessment, Race Rocks Lightstation, Race Rocks B.C.** prepared for The Canadian Coast Guard by Reid Crowther & Partners Ltd., March 30, 2000, Project No. 19022-03.
2. **Copy of electronic mail message, subject: Annual mercury vapour sampling at Race Rocks – June 28, 2004**, author: Michael Mitchell, Lightstation Services Officer, Canadian Coast Guard.

Phase II Environmental Site Assessment
Race Rocks Lightstation
Race Rocks, B.C.

Prepared for:

Canadian Coast Guard
25 Huron Street
Victoria, BC V8V 4V9

Prepared by:

Reid Crowther & Partners Ltd.
Consulting Engineering Worldwide
203 – 4430 Chatterton Way
Victoria, BC V8X 5J2

Phone: (250) 744-2100
Fax: (250) 744-1700

March 30, 2000

Project No. 19022-03

Phase II Environmental Site Assessment - Race Rocks Lightstation
Race Rocks, British Columbia

Table of Contents

SECTION		TITLE	PAGE NO.

List of Figures

List of Tables

List of Appendices:

EXECUTIVE SUMMARY

ES.1 Introduction and Background

The Canadian Coast Guard (CCG) retained Reid Crowther & Partners Ltd. (Reid Crowther) in July 1999 to conduct a Phase II Environmental Site Assessment (ESA) at their lighthouse facility at Race Rocks, B.C.

A Phase 1 Environmental Site Assessment was conducted at the Canadian Coast Guard Race Rocks Lighthouse Station in 1996 by Jacques Whitford Ltd. (Jacques Whitford). The findings of that investigation indicated that this site began operating as a lightstation in 1859. During the early period of operation, coal was used as the primary fuel. The use of mineral oil, dogfish oil, petroleum vapour and kerosene were reported at different times from the mid 1880's to 1925. The original combined lighthouse/dwelling was reportedly demolished and replaced with the current structures in 1964. Diesel storage tanks were installed around 1973. Burning and dumping of garbage and at least one spill of petroleum hydrocarbon were reported in Coast Guard documents as identified during the Phase 1 ESA.

Based on the results of the Jacques Whitford findings, the CCG initiated this Phase II ESA.

ES.2 Work Program

Reid Crowther reviewed the Phase I Environmental Site Assessment by Jacques Whitford. Based on the information provided in that report, Reid Crowther identified the following areas of environmental concern and developed a work program:

1. Metal contamination in the vicinity of the light tower. Assessment of potential soil contamination.

2. Petroleum hydrocarbon use and storage. Assessment of potential soil contamination by petroleum hydrocarbons.

3. Suspect asbestos containing materials. Survey and sampling of suspect asbestos containing materials.

4. PCB containing equipment. Survey of suspect PCB containing equipment.

5. Lead based paint. Sampling and chemical analysis of painted surfaces.

6. Risk Potential. Classify the site in accordance to the National Classification System for Contaminated Sites.

ES.3 Results

Results of the site investigation and the chemical analysis suggests the following:

Soil Investigation

Metals

The investigation identified metal concentrations exceeding the CCME guidelines/criteria for residential/parkland land use and/or the BC CSR standards for residential land use in the vicinity of the lighthouse.

The investigation identified metal and polycyclic aromatic hydrocarbons (PAH) concentrations exceeding the CCME guidelines/criteria for residential/parkland land use and the BC CSR standards for residential land use in the vicinity of the fog horn.

Petroleum Hydrocarbons

The investigation identified concentrations of light extractable petroleum hydrocarbons (LEPH) and concentrations of heavy extractable petroleum hydrocarbons (HEPH) exceeding the BC CSR standards for residential land use in the vicinity of the abandoned fuel fill hose at the north end of the site.

Contaminated Soil Volumes and Characterization

The total volume (mass) of the soils contaminated with metals and petroleum hydrocarbons is estimated at approximately 280 m^3 (420 metric tonnes). Of these, approximately 240 m^3 (360 tonnes) can be classified as waste and 40 m^3 (60 tonnes) can be classified as industrial quality in accordance with the BC CSR standards. It is anticipated that additional quantities of soil in exceedance of the CCME guidelines/criteria for residential/parkland use and/or BC CSR standards for residential land use may be identified following further step-out sampling.

Soil Acidity

Soil samples exhibiting pH levels below the CCME criteria of 6 and otherwise exhibiting concentrations of regulated substances below the CCME guidelines and criteria and/or BC CSR standards are believed to reflect background conditions and therefore are not considered significant.

Data Gaps

Data gaps exist on the degree of contamination at the distal areas of the lighthouse. Additional step-out sampling is needed in distal areas of the lighthouse, especially in the vicinity of the residences, the marine research building, the boathouse and the fuel fill hose to clearly define the horizontal extent of soil contamination at the site.

ACMs

Asbestos containing materials (ACMs) were identified at two different locations in the main keeper's residence. ACMs were identified in the form of duct tape around the furnace ducts which is considered friable and was found damaged and exposed. ACMs were also identified in asbestos insulation around the heating vents which was found in good condition, but is considered to be friable and was found exposed.

Lead Based Paint and Building Materials

The analytical results confirmed that lead based paints are present at the site in the following locations:

Light Tower: Black interior paint.

Lantern: Yellow and older paint layers, white interior paint and metal trim paint.

Abandoned aboveground storage tanks: Yellow exterior paint.

Building materials in the lighttower were identified to contain low concentrations of mercury (<28 ppm). The materials include the concrete of the floor of the lantern, the wood of the stairs to the lantern, and interior parging of the lantern.

PCB

The PCB survey confirmed the existence of PCB containing equipment in the form of fluorescent light ballast at the site.

National Classification System

The environmental condition of the site was compared to the CCME National Classification System for Contaminated Sites. The results indicate that the site has a medium risk potential and that further action requirement is likely to reduce the risk from the site.

General Comments

The identified heavy metal concentrations at the site have the potential of migrating off-site. Potential pathways are erosion by wind, surface water and leaching into runoff water.

During the site investigation, the sewage outfall was found to be damaged above the low tide mark.

Six abandoned fuel storage tanks are present on the site. The tanks are reportedly scheduled for decommissioning and disposal in the year 2000.

ES.4 Recommendations

Considering the above, Reid Crowther recommends the following:

Issues of Environmental Concern/Action Plan

The issues of environmental concern, identified during this investigation are summarized in the Baseline Summary Chart below.

The identified concerns are prioritized and recommendations provided for further investigative and remedial action.

The identified issues are:

Investigative Action/Data Gaps

The review of the data collected during this investigation identified that data gaps exist regarding the full spatial extent of metal contamination of soil.

Reid Crowther recommends further delineation the soil impacted by metals over the entire area of the lightstation, including the perimeter of the residences, the marine research building and the boathouse. Where soil samples are found to contain high concentrations of specific metals, a Special Waste Extraction Procedure (SWEP) analysis should be performed to determine if the material is a special waste under the Special Waste Regulation of BC.

Mitigative Action

Health and Safety Plan

Short-term mitigation efforts should be implemented to reduce the risk to human health and safety associated with heavy metal exposure and other potential contaminants. This includes the preparation of a health and safety plan for the residents of the light station. The health and safety plan should address exposure pathways and mitigative barriers for heavy metals, hydrocarbons, PCBs and ACM. The health and safety plan should also include recommendations for the managing of painted surfaces. The health and safety plan should include recommendations to reduce the risk of off-site migration of heavy metals.

Asbestos Containing Materials

The identified friable ACMs should be encapsulated or removed by an experienced asbestos abatement contractor. All friable and non-friable ACMs should be removed and disposed of by an experienced asbestos abatement contractor prior to renovation or demolition activities that may disturb them.

PCBs

All waste ballasts should be checked prior to disposal and any found or suspected to contain PCBs be handled and disposed of in accordance with the Special Waste Regulation of BC. All non identifiable light ballasts, capacitors or transformers should be regarded as suspect PCB containing and handled accordingly.

Aboveground Fuel Storage Tanks

The six abandoned aboveground fuel storage tanks should be properly decommissioned and removed from the site. The paint on the tanks was identified as having a lead content of 4.5 %. A SWEP test is recommended to verify if the paint is considered a special waste.

Marine Outfall

The marine outfall from the main lightkeeper's septic system should be repaired. The status of this outfall should be reviewed to determine if it meets the requirements of the Municipal Sewage Regulation of BC.

Soil Remediation

Heavy Metal Contaminated Soils

The investigation identified metal and petroleum hydrocarbon contaminated soil in exceedance of CCME guidelines/criteria for residential/parkland land use and/or BC CSR standards for residential land use. The identified soils are located in the vicinity of the lighthouse and the fog horn. The identified soil mass in exceedance of the CCME guidelines/criteria and/or BC CSR standards is estimated at 220 m^3 (330 metric tonnes). The complete spatial extent of the metal contamination could not be delineated in the course of this investigation. It is anticipated that further soil investigation will identify additional quantities of contaminated soil that are not included in this estimate. Based on the current data, Reid Crowther recommends the following approach for the remediation of the area:

The identified soil should be excavated using a small track mounted excavator or bobcat. The soil would be transported to the jetty and loaded onto a barge. The barge would transport the soil to a transfer station where the soil would be loaded onto trucks and disposed of at a licensed landfill.

Petroleum Hydrocarbon Contaminated Soil

This investigation identified petroleum hydrocarbon contaminated soil in exceedance of BC CSR standards for residential land use. The identified soils are located in the vicinity of the fill pipe of the abandoned fuel storage tanks and are estimated at 60 m^3 (90 metric tonnes). The complete spatial extent of the petroleum hydrocarbon contamination could not be delineated in the course of this investigation. It is anticipated that further soil investigation may identify additional quantities of contaminated soil that are not included in this estimate. Based on the current data, Reid Crowther recommends the following approach for the remediation of the area:

The soils should be excavated using a small track mounted excavator or bobcat. The soil would be transported to the jetty and loaded onto a barge. The barge would transport the soil to a transfer station where the soil would be loaded onto trucks and disposed of at a licensed landfill.

Alternatively, the petroleum hydrocarbon contaminated soil could be treated in an on site bioremediation cell. The bioremediation cell would be located on the concrete pad of the fuel tank enclosure after removal of the tanks. The costs for mobilization and demobilization of equipment to the site makes the maintenance of the cell relatively expensive and financially not viable if the bioremediation cell is not maintained by light station staff.

Ecological and Human Health Risk Assessment

As an alternative to the remediation of all identified contaminated areas, Reid Crowther recommends a remediation approach that would combine an Ecological and Human Health Risk Assessment and the removal of a limited amount of contaminated soil and/or the installation of exposure pathway barriers that may be identified in the risk assessment.

Site Reclamation

Site reclamation would include the import of soil and topsoil. Excavated areas would be backfilled and to some degree regraded. The backfilled areas would subsequently be seeded and fertilized.

The costs associated with the recommended activities are estimated as summarized below.

-----Original Message-----
From: Mitchell, Mike
Sent: July 11, 2004 3:15 PM
To: Weber, Terry; Gray, Don; Clark, Don; Skinner, Vivian; Caw, Greg; Burow, Robert
Cc: Chiang, Eric; Mitchell, Mike
Subject: Annual mercury vapour sampling at Race Rocks-June 28,2004-FILED

Mercury vapour sampling was undertaken at the destaffed Race Rocks Lightstation on June 28,2004 by myself using a Jerome mercury vapour analyser 431-X which has a detection limit starting at .003mg/m3. The Jerome is a field screening device for the presence of mercury vapour.

The general condition of the tower and lantern house was fair. The epoxy paint that I applied last summer was in good shape and providing a good seal on the lantern house floor. It was noted that the tower is being heated.

S-sample taken at the surface level
1m-sample taken at 1 metre level
BZ-sample taken at the breathing zone level, normally 1.7m
ND-non detected air sample
All samples are taken as mg/m3

Bottom of tower:
Temp 20.8c, sunny conditions

S-ND X 3 samples
1m-ND X 3 samples
BZ-ND X 3 samples

Weight shaft area:
Temp 20.0c

S-ND X 3 samples
1m-ND X 3 samples
BZ-ND X 3 samples

Fog detector area:
Temp 20.1c

S-ND X 3 samples
1m-ND X 3 samples
BZ-ND X 3 samples

Landing below lantern house:
20.0c

S-ND X 3 samples
1m-ND X 3 samples
BZ-ND x 3 samples

Lantern house:
22.8c-37.0c

Sample area #1
S-ND X 3 samples
1m-ND X 3 samples
BZ-ND X 3 samples

Sample area #2
S-ND X 3 samples
1m-ND X 3 samples
BZ-ND X 3 samples

Sample area #3
S-ND X 3 samples
1m-ND X 3 samples
BZ-ND X 3 samples

Results:
There was no visible mercury present. As long as the safe work procedure for the tower is followed, the risk to workers health is considered low.
It should be noted that the air sampling results are indicators only for that date and the physical conditions. Any work undertaken which greatly disturbs the building materials or if elemental mercury is uncovered, may result in a hazardous situation for worker health.

Michael K Mitchell CD1
Lightstation Services Officer
Safety Officer Lightstations
Canadian Coast Guard
Marine Navigational Services
25 Huron St, Victoria BC
V8V-4V9
250-480-2605
250-480-2702 (Fax)

Check out Marine Navigational Services on the web: http://www.ccg-gcc.gc.ca/mns-snm/main_e.htm

APPENDIX G: Site Specific Safety Plan

The following Site Specific Safety Plan (SSSP) was prepared by the project team based on information available about specific conditions at Race Rocks prior to the site visit. The Job Hazard Analysis and Standard Operating Procedure documents referred to in the SSSP are internal PWGSC references developed for the Parliamentary Precinct Directorate projects which can be adapted to use on DFO site work. The Divestiture Branch of DFO has been provided with a copy for future reference on lighthouse related work.

Project Name: Condition Assessment Reports Including Indicative Cost Estimates for Nineteen (19) Heritage Lighthouses Across Canada Phase I & II	
Project Location – Race Rocks Lighthouse, Race Rocks Island, Victoria, British-Columbia	
On-site personnel : Ian Cameron, Sarah Green, Ève Wertheimer (team leader)	
Date : October 29 (and possibly 30th) 2007	

Cover Sheet - Site Specific Safety Plan (SSSP)

The Site Specific Safety Plan (SSSP) is a strategy, not a "form" to be completed. Completing an SSSP ensures a number of steps are taken to ensure a project has been thought through for potential health and safety hazards and that those hazards have been reduced by the selection of alternated processes, safe work practices and or personal protective equipment. Attached herewith are the forms completed in the documentation of the health and safety plan for this project.

Checklist:

- ☐ Hazard Assessment and Form
- ☐ Emergency Phone Number list
- ☐ Personal Protective Equipment (PPE) selection list
- ☐ JHA and SOP Forms

Note:

All team members should be provided with a copy. Those team members working on site must have a copy of the SSSP with them on site. It is recommended that where other parties are involved (i.e. crane operator, contractor, etc.), copies are provided to those individuals.

Project Name: Condition Assessment Reports Including Indicative Cost Estimates for Nineteen (19) Heritage Lighthouses Across Canada Phase I & II		
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Date : October 29 (and possibly 30th) 2007		

HAZARD ASSESSMENT

Hazard / Danger	Specific Safety Measures / Mesures de Sécurité Spécifique
Working at a remote site & exposure to the elements.	• **Refer to JHA – Remote Locations** • **Refer to SOP for Employees Working Alone** • Use recommended Personal Protective Equipment. Minimum recommended is: safety boots, hard hat, gloves, safety glasses. • Bring safety harness & lanyard in case it is needed. • Use sunblock, appropriate clothing to suit temperatures and weather. • Bring drinking water. • Multiple member teams to limit workload. • Cell phone / satellite phone for communication. • Bring extra cell phone battery • Two way radios for each team member to maintain contact while at site (optional). • Limit workload • Notify FOC site contact of presence on site and scheduled time on site. • Lighthouse team leader verifies weather forecast is suitable for safe working conditions
Accident/injury on site	• Have first aid kit with all teams • Stabilize the person Call for help (depends on severity of injury) • Take injured person to hospital/health clinic (depends on severity of injury)
Site access by boat / helicopter	• Hire reputable boat/herlicopter company - The operator must be certified. • For long water crossings, require that the boating co. files a trip plan (need to establish what length of trip initiates this requirement). • Follow boat/helicopter company's safety procedures. • Define who has the final say on calling off work when weather deteriorates (Boat captain or Team Leader). • Ensure one Personal Flotation Devices (PFDs) on board per person. • Two oar locks and 2 paddles on board.

	• Fire extinguisher on board. • Sound signalling device on board. • Additional mandatory onboard equipment may be necessary depending on size of boat – request proof that boat is properly equipped.
Confined spaces	• **Refer to JHA – Working in Confined Spaces** to help determine if you are dealing with a confined space and its classification (High, Medium, Low) • **Refer to SOP for Confined Spaces** • If lighthouse has been decommissioned and has been closed for a period of time, the interior may represent a confined space. • If the Lighthouse is currently in operation the interior likely is not a confined space. • Team member trained in confined spaces makes the classification evaluation • If the space is determined to be a confined space and is classified high, **do not enter**. • Refer to SOP – Respiratory Protection for other enclosed spaces – those classified as medium or low. • If harmful/designated substances or gases are suspected use air monitor (Min. one per team).
Wildlife (birds, rodents, bears, cougar, etc.)	• When working in an area with known wildlife concerns, continually monitor surroundings for wildlife. • Whistles/air horn for Bear/Cougar
Insects (ticks, stinging insects)	• Wear long pants, use insect repellent (Deet) and avoid tall grass • Bring After-bite for stings. • Bring an Epi-pen if allergic to stings.
Unstable structure or components.	• Decision on safety of structure/component to be made by team in consultation with team engineer. • **Stay out of the building and/or avoid unstable component(s).** • Notify Team Leader (Susan Ross) of the conditions. • Team Leader notifies client of the conditions. • Erect temporary barricades / caution tape if a public area.

Use of ladders	• **Refer to SOP for Step Ladders** • Ensure 3-point contact while using. • Secure base & top of ladder. If top cannot be secured, have second team member hold base of ladder. • Check ladder for defects. • Do not work above 10' high without fall arrest.
Hazardous substances on site (asbestos, lead paint, mercury, bird or animal droppings, etc.)	• **Refer to JHA – Contact with Designated Hazardous Substances** • **Refer to SOP for Chemicals** • **Refer to SOP for Respiratory Protection** • If lighthouse has been decommissioned, hazardous substances may be scattered about the site and interior from the decommissioning work. Treat interior as if it is contaminated, unless it is known to not be. • Do not disturb bird or animal droppings, plaster, mortar or finishes. • Wear a respiratory protection (mask) with organic vapour/gas cartridges. • Wear gloves, glasses and disposable overalls (need to determine disposal procedures for contaminated overalls)
Falling in the water / drowning.	• **Keep away from the water / precipice, etc., especially in windy / wet conditions.** • Have life preserver with rope available • Wear lifejacket when working near water. • All team members wear a whistle to alert other team members that they are in trouble.

Start Time of Work / Temps de Départ du Travail: 8:00 a.m.
Finish Time of Work / Temps du Travail Terminé: 16:00 p.m

Project Name: Condition Assessment Reports Including Indicative Cost Estimates for Nineteen (19) Heritage Lighthouses Across Canada Phase I & II	
Project Location – Race Rocks Lighthouse, Race Rocks Island, Victoria, British-Columbia	
On-site personnel : Ian Cameron, Sarah Green, Ève Wertheimer (team leader)	
Date : October 29 (and possibly 30th) 2007	

EMERGENCY PHONE NUMBERS

Ambulance		Police	
Fire Department		Electrical Utility	
FOC Regional or Site Contact	Noel Taylor (DFO, Vancouver) (604) 775-8813 Vivian Skinner (Coast Guard) (250) 480-2603 Christian Blondeau (Pearson College) phone (250) 391-2440 pager (250) 388-2599		

OTHER:

Coast Guard	Phone #:
Nearest Hospital Hospital's Phone #:	Located at: After Hours:
Nearest Clinic Clinic's Phone #:	Located at: After Hours:
POST NEAR PHONE **COPY IN VEHICLE**	

Project Name: Condition Assessment Reports Including Indicative Cost Estimates for Nineteen (19) Heritage Lighthouses Across Canada Phase I & II	
Project Location – Race Rocks Lighthouse, Race Rocks Island, Victoria, British-Columbia	
On-site personnel : Ian Cameron, Sarah Green, Ève Wertheimer (team leader)	
Date : October 29 (and possibly 30th) 2007	

PERSONNAL PROTECTIVE EQUIPMENT (PPE)

EQUIPMENT	**MANDATORY (M)** **RECOMMENDED (R)** **SPECIFIC JOBS (S)** **NOT APPLICABLE (N/A)** **circle appropriate**			
Hard Hat	M	R	S	N/A
Safety Boots (Grade 1)	M	**R**	S	N/A
Safety Glasses / Goggles	M	R	S	N/A
Face Shield	M	R	S	N/A
High Visibility Traffic Vests / Personal Flotation Device	M	R	S	N/A
Respirators	M	R	**S**	N/A
Disposable Coveralls	M	R	S	N/A
Safety Harness / Lanyard	M	R	S	N/A
Work Gloves	M	R	**S**	N/A
Hearing Protection	M	R	**S**	N/A
Communication Devices (cell / satellite phone)	**M**	R	S	N/A
Flashlight	M	**R**	S	N/A
Other: Personal Floatation Device (PFD)	**M**	R	S	N/A

Condition Assessment Reports Including Indicative Cost Estimates
for Eighteen (18) Heritage Lighthouses Across Canada Phase I & II

Questionnaire for Fisheries and Oceans Canada for input into Site Specific Safety Plan

Lighthouse Name : ***Team leader to type info in here***

Assessment Date : ***Team leader to type info in here***

Please complete this questionnaire to the best of your knowledge and return to:
Type Fax Number, Attention: ***Team Leader Name***

RACE ROCKS

Is cell phone coverage available at site? (Yes) No Unknown

Are life preservers available at site? Yes (No) Unknown

Does the building/site contain hazardous substances, for example mercury or asbestos? (Yes) No Unknown

If yes, specify substance type and its location (if known)

- ☐ Mercury
- ☐ Asbestos
- ☒ Other LEAD BASED PAINT

Has an environmental assessment been completed? (if yes, provide a copy) (Yes) No Unknown

Does the lighthouse area have 911 service? Yes (No) Unknown
CG CHANNEL 16 RESCUE COORDINATION CENTRE

Please provide local emergency phone numbers for:

- ☐ Hospital
- ☐ Ambulance
- ☐ Fire
- ☐ Police
- ☐ Coast Guard 1-800-567-5111

RCC - 1800 567-5111

Please identify local emergency services, indicating operating hours and address if known

- ☑ Hospital VICTORIA GENERAL - 1 HOSPITAL WAY - 24 HOURS.
- ☑ Clinic JAMES BAY Medical centre 110-230 MENZIES 7AM - 7PM

Are there known wildlife hazards, such as bears or cougar at the site? Yes (No) Unknown

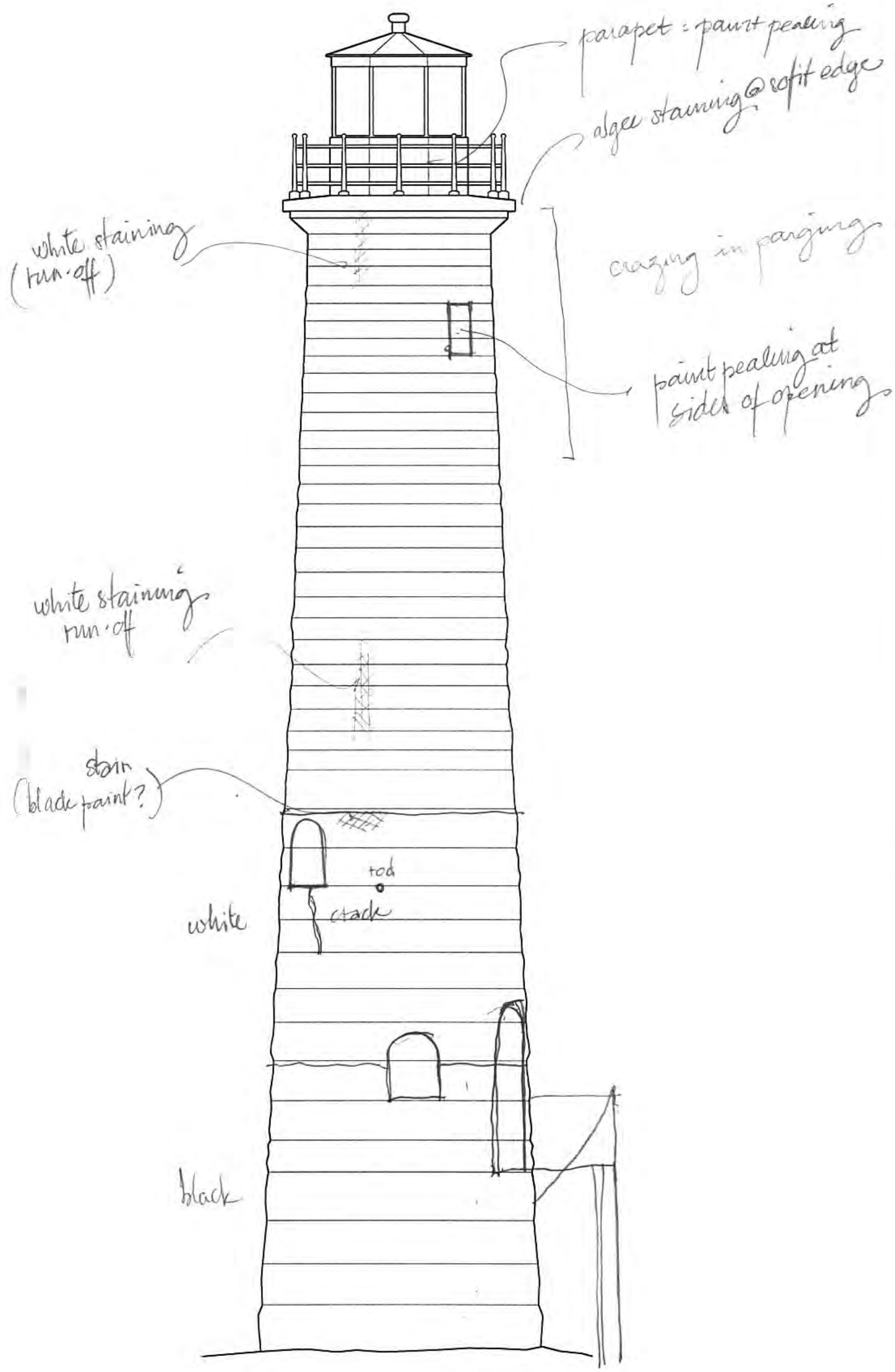
APPENDIX H: Field Observations

See attached drawings showing concrete conditions, as noted by the project team on existing drawings, as well as pages from the "Lighthouse Condition Assessment Checklist" which were completed on site.

Heritage Conservation Directorate PWGSC — Services de conservation du patrimoine TPSGC

Elevation

Project & Location / Nom et lieu du relevé	Condition Assessment of Race Rocks Lighthouse - Victoria, B.C.
Project No.	115365
Date	
Page	/ of
Measured by: / Mesures par	
Rec. by: / Noté par	
Scale / Échelle	NTS



North Elevation

Heritage Conservation Directorate PWGSC
Services de conservation du patrimoine TPSGC

Elevation

Project & Location / Nom et lieu du relevé: **Condition Assessment of Race Rocks Lighthouse - Victoria, B.C.**

Project No.: 115365

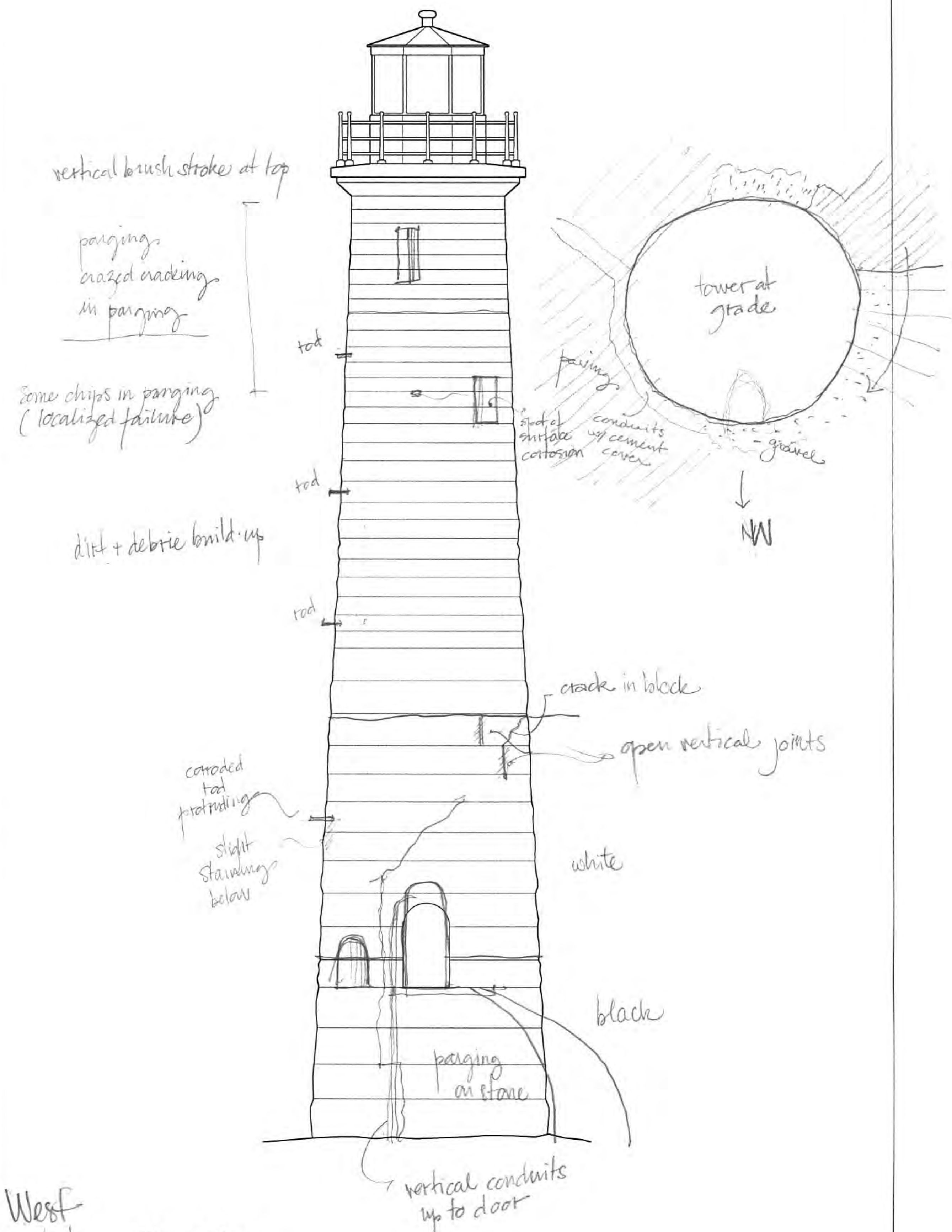
Date:

Page / of

Measured by: / Mesures par:

Rec. by: / Noté par:

Scale / Échelle: NTS



West ~~North~~ Elevation

Heritage Conservation Directorate
PWGSC

Services de conservation du patrimoine
TPSGC

Elevation

Project & Location
Nom et lieu du relevé

Condition Assessment of Race Rocks Lighthouse - Victoria, B.C.

Project No. 115365

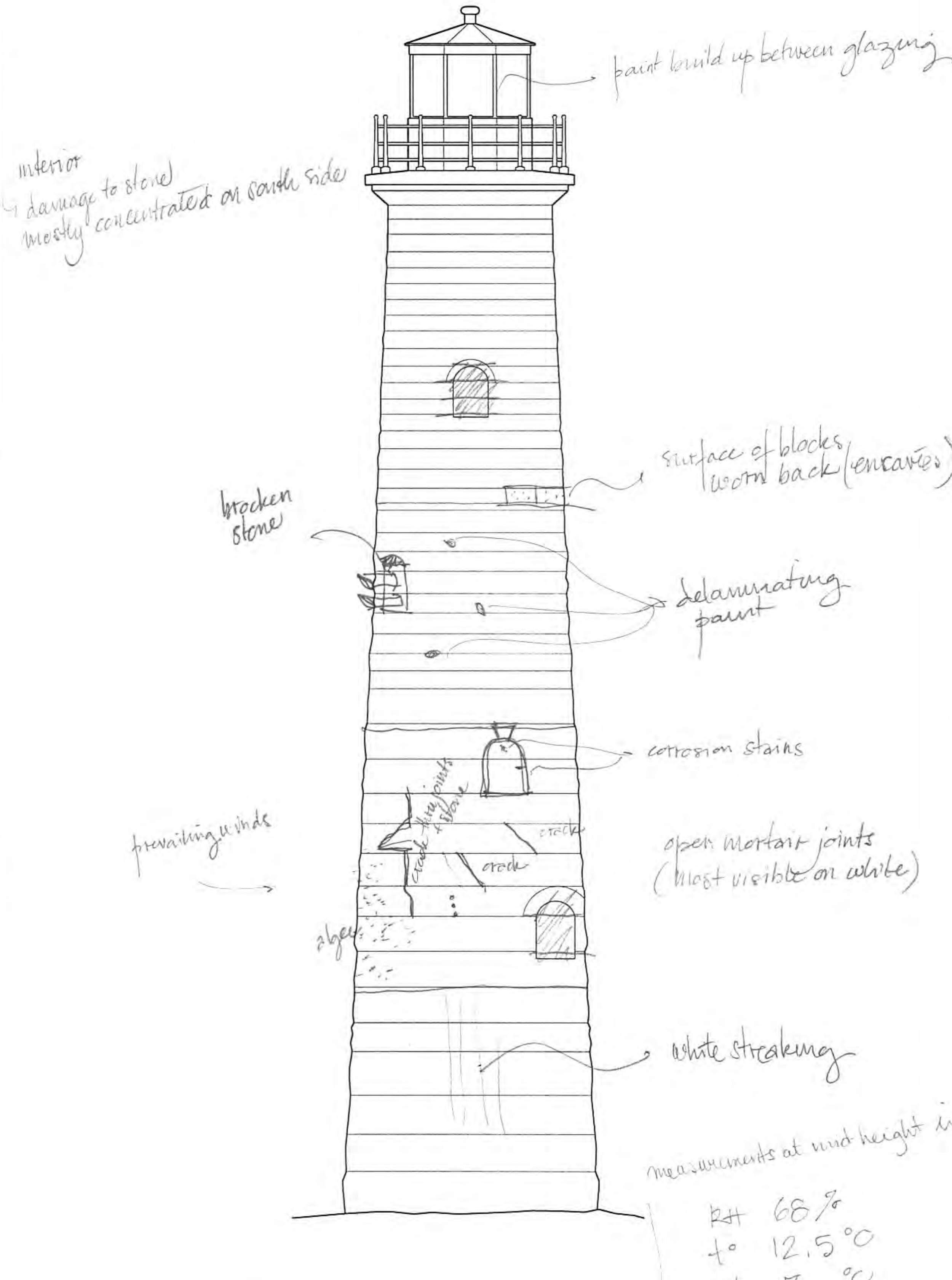
Date

Page / of

Measured by
Mesures par

Rec. by
Noté par

Scale
Échelle NTS



East Elevation

Heritage Conservation Directorate
PWGSC

Services de conservation du patrimoine
TPSGC

Project & Location
Nom et lieu du relevé

Condition Assessment of Race Rocks Lighthouse - Victoria, B.C.

______ Elevation

Project No. 115365

Date

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Measured by:
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Noté par

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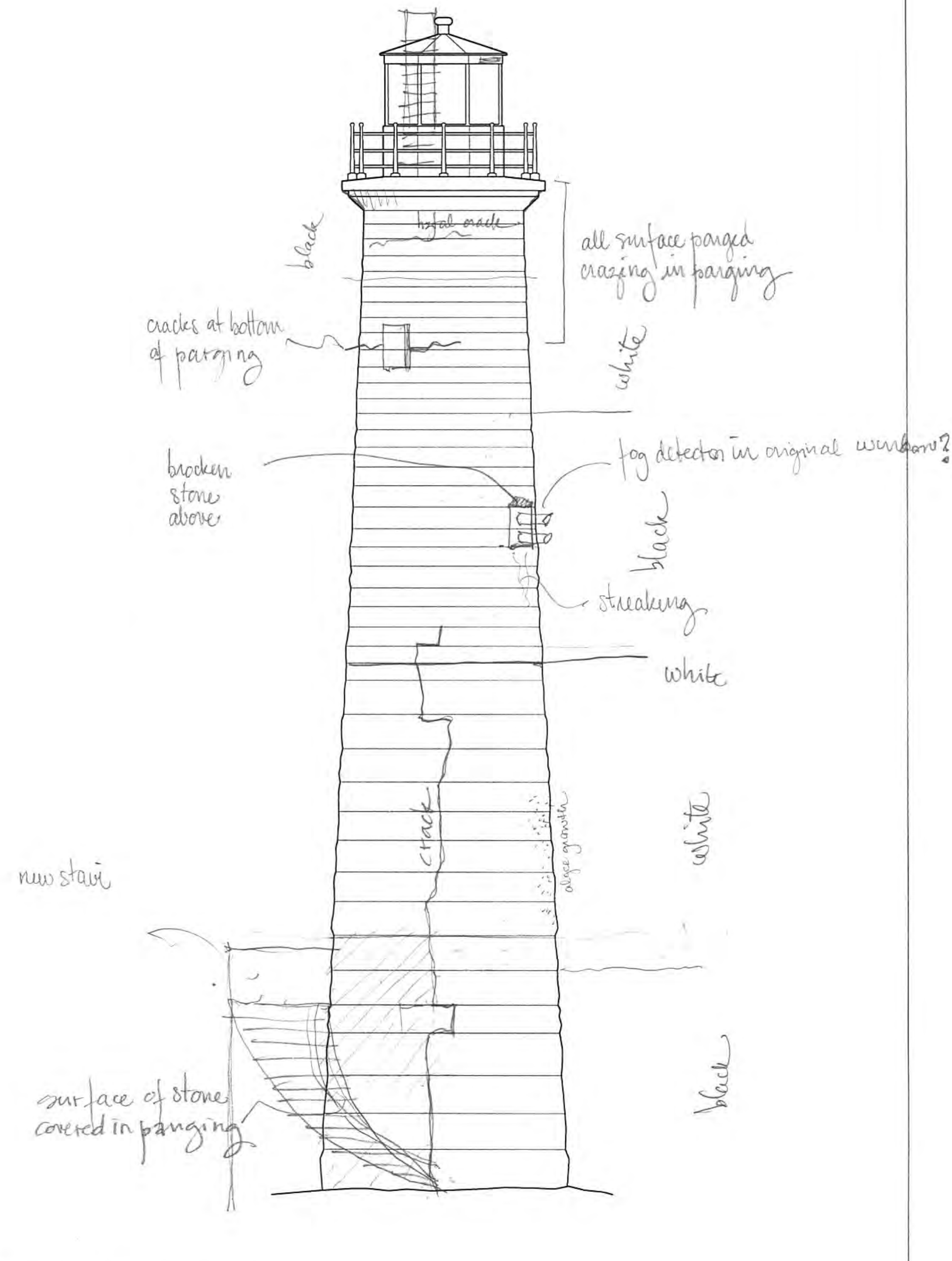
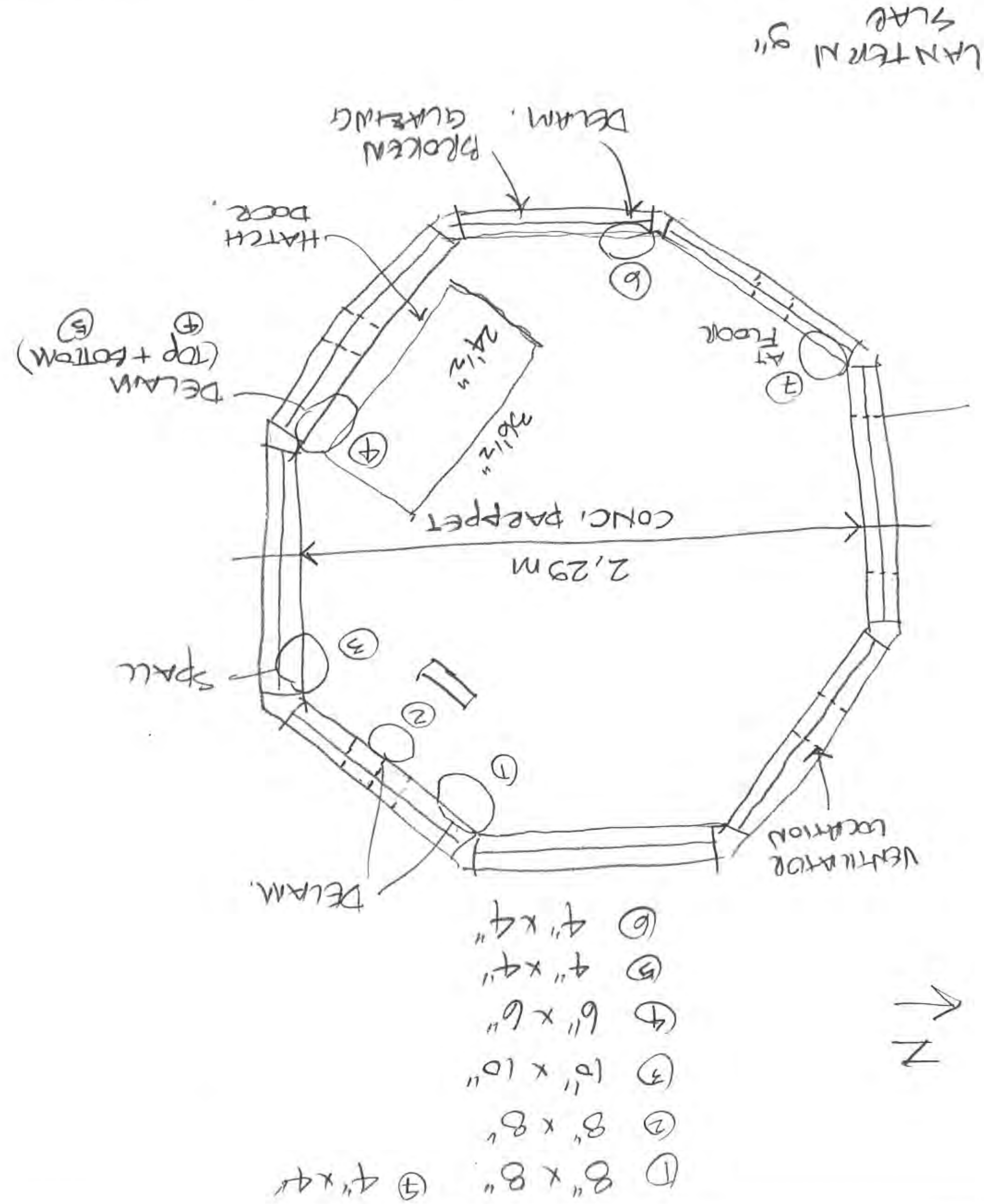
Échelle NTS



South-West Elevation

Heritage Conservation Directorate PWGSC — Services de conservation du patrimoine TPSGC

Project & Location / Nom et lieu du relevé: Condition Assessment of Race Rocks Lighthouse - Victoria, B.C.	Project No. 115365	Date	Page / of
Measured by: / Mesures par	Rec. by: / Noté par	Scale / Échelle: NTS	



APPENDIX I: Detailed Cost Table for all Recommendations

See attached detailed table of costs, identifying quantities and prices for each recommendation.

A breakdown in terms of short-term (0 to 5 years) or long-term (6 to 25 years) expenditures is provided, as well as a note on whether the work is mandatory, cyclical or related to further investigation.

REPORT SECTION	*SYSTEM DESCRIPTION*	*RECOMMENDED WORK*	*QUANTITY see note 1*	*TOTAL COST*	*SHORT-TERM EXPENDITURES*		*LONG-TERM EXPENDITURES*				*PRIORITY*
(Page number)					1-2 years	2-5 years	6-10 years	11-15 years	16-20 years	21-25 years	m=mandatory c=cyclical i=investigation see notes 2, 3, & 4
4.2 (p.16-25)	**Stone Structure**										
	Foundation										
4.2.1 (p.17)	**Further Investigation**										
		refer to 4.2.1 recommendation 1	2 cracks measuring approx. 8 and 10 m.		$						i
4.2.1 (p.17)	**Mandatory Repairs**										
		refer to 4.2.1 recommendation 2	cement parging at base of tower = approx. 20 sq.m.		$						m
		refer to 4.2.1 recommendation 3	asphalt at grade to remove = approx. 12 sq.m		$						m
4.2.1 (p.18)	**Cyclical Work**										
		refer to 4.2.1 recommendation 4	20% of tower			$	$	$	$	$	c
	Stone Wall Structure										
4.2.2 (p.23)	**Mandatory Health & Safety (within 12 months)**										
		refer to 4.2.2 recommendation 5	interim cleaning 1x per month		$						m
4.2.2 (p.23)	**Further Investigation**										
		refer to 4.2.2 recommendation 6	included in recommendation 1		$						i
		refer to 4.2.2 recommendation 7	top: 4 openings of 0.25 sq.m base: 2 openings of 0.25		$						i
		refer to 4.2.2 recommendation 8			$						i
		refer to 4.2.2 recommendation 9			$						i

REPORT SECTION	*SYSTEM DESCRIPTION*	*RECOMMENDED WORK*	*QUANTITY see note 1*	*TOTAL COST*	*SHORT-TERM EXPENDITURES*		*LONG-TERM EXPENDITURES*				*PRIORITY*
(Page number)					1-2 years	2-5 years	6-10 years	11-15 years	16-20 years	21-25 years	m=mandatory c=cyclical i=investigation see notes 2, 3, & 4
4.2.2 (p.24)	**Mandatory Repairs**										
		refer to 4.2.2 recommendation 10	interior wall surf.= 240 sq.m.			$					m
		refer to 4.2.2 recommendation 11	approx. 16 metal ties, each 1.5 m			$					m
		refer to 4.2.2 recommendation 12	parging= approx. 80 sq.m. total tower = 580 sq.m			$					m
		refer to 4.2.2 recommendation 13	localized			$					m
		refer to 4.2.2 recommendation 14	5% ?			$					m
		refer to 4.2.2 recommendation 15	25% of joints ?			$					m
4.2.2 (p.24)	**Cyclical Work**										
		refer to 4.2.2 recommendation 16					$	$	$	$	c
		refer to 4.2.2 recommendation 17					$	$	$	$	c
4.2.3 (p.26-27)	**Floor Structure**										
4.2.3 (p.27)	**Mandatory Health & Safety (within 12 months)**										
		refer to 4.3 recommendation 18	counterweight = 250 lbs		$						m
		refer to 4.3 recommendation 19	as per recommendation 5		$						m
		refer to 4.3 recommendation 20	install 2 brackes in concrete		$						m
4.3 (p.27)	**Mandatory Repairs**										
		refer to 4.3 recommendation 21	0.25 sq.m.			$					m
		refer to 4.3 recommendation 22	replace wood ladder					$			m
4.2.3 (p.28)	**Cyclical Work**										
		refer to 4.3 recommendation 23				$	$	$	$	$	c

REPORT SECTION	*SYSTEM DESCRIPTION*	*RECOMMENDED WORK*	*QUANTITY see note 1*	*TOTAL COST*	*SHORT-TERM EXPENDITURES*		*LONG-TERM EXPENDITURES*				*PRIORITY*
(Page number)					1-2 years	2-5 years	6-10 years	11-15 years	16-20 years	21-25 years	m=mandatory c=cyclical i=investigation see notes 2, 3, & 4
		refer to 4.3 recommendation 24				$	$	$	$	$	c
4.2.3 (p.29-32)	**Lantern and Gallery**										
4.3 (p.31)	**Mandatory Health & Safety (within 12 months)**										
		refer to 4.4 recommendation 25	hatch = 0.61m x 0.91m		$						m
		refer to 4.4 recommendation 26			$						m
		refer to 4.4 recommendation 27	8 hand-holds		$						m
		refer to 4.4 recommendation 28	pane = 1 sq.m.		$						m
4.3 (p.31)	**Further Investigation**										
		refer to 4.4 recommendation 29			$						i
4.3 (p.31)	**Mandatory Repairs**										
		refer to 4.4 recommendation 30	best method for accomplishing this tbd			$					m
		refer to 4.4 recommendation 31	approx. 1 sq.m.			$					m
		refer to 4.4 recommendation 32	approx. 12 sq.m.			$					m
		refer to 4.4 recommendation 33	approx. 22 sq.m.			$					m
4.3 (p.32)	**Cyclical Work**										
		refer to 4.4 recommendation 34				$	$	$	$	$	c
		refer to 4.4 recommendation 35				$	$	$	$	$	c
		refer to 4.4 recommendation 36				$	$	$	$	$	c
4.4 (p.33-38)	**Building Envelope**										
4.4.1 (p.33)	**Exterior Walls & Roof**										
4.4.1 (p.33)	**Mandatory Repairs**										

REPORT SECTION	*SYSTEM DESCRIPTION*	*RECOMMENDED WORK*	*QUANTITY see note 1*	*TOTAL COST*	*SHORT-TERM EXPENDITURES*		*LONG-TERM EXPENDITURES*				*PRIORITY*
(Page number)					1-2 years	2-5 years	6-10 years	11-15 years	16-20 years	21-25 years	m=mandatory c=cyclical i=investigation see notes 2, 3, & 4
		refer to 4.5.1 recommendation 37	4 windows + 1 door (mutually excl of 41-42)			$					m
		refer to 4.5.1 recommendation 38	2 electrical heaters			$					m
4.4.2 (p.35-36)	**Windows**										
4.4.2 (p.35)	**Further Investigation**										
		refer to 4.5.2 recommendation 39	surface = approx. 3 sq.m.		$						i
4.4.2 (p.35-36)	**Mandatory Repairs**										
		refer to 4.5.2 recommendation 40	surface = approx. 3 sq.m.			$					m
		refer to 4.5.2 recommendation 41	3 windows to be replaced (mutually exclusive of 37)			$					m
		refer to 4.5.2 recommendation 42	1 window replaced fog-detector relocated				$				m
4.4.2 (p.36)	**Cyclical Work**										
		refer to 4.5.2 recommendation 43					$	$	$	$	c
4.4.3 (p.37)	**Doors**										
4.4.2 (p.37)	**Mandatory Repairs**										
		refer to 4.5.3 recommendation 44	as per recommendation 37		$						m
		refer to 4.5.3 recommendation 45	1 new door						$		m
4.4.2 (p.37)	**Cyclical Work**										
		refer to 4.5.3 recommendation 46					$	$	$	$	c
4.5 (p.39)	**<u>Other Building Elements</u>**										
4.5 (p.39)	**Exterior Stairs**										
4.5 (p.39)	**Mandatory Health & Safety (within 12 months)**										
		refer to 4.6.1 recommendation 47	3 treads each 0.35 sq.m.	$							m

REPORT SECTION	*SYSTEM DESCRIPTION*	*RECOMMENDED WORK*	*QUANTITY see note 1*	*TOTAL COST*	*SHORT-TERM EXPENDITURES*		*LONG-TERM EXPENDITURES*				*PRIORITY*
(Page number)					1-2 years	2-5 years	6-10 years	11-15 years	16-20 years	21-25 years	m=mandatory c=cyclical i=investigation see notes 2, 3, & 4
4.5 (p.36)	**Mandatory Repairs**										
		refer to 4.6.1 recommendation 48			$						
		refer to 4.6.1 recommendation 49	10 fasterners		$						
		refer to 4.6.1 recommendation 50	new stair						$		m
4.5 (p.36)	**Cyclical Work**										
		refer to 4.6.1 recommendation 51			$	$	$	$	$	$	c

Note 1: see corresponding report sections and drawings for more detailed descriptions
Note 2: mandatory work is required for either Health & Safety or protection of Heritage Character
Note 3: cyclical work is carried out once in periods indicated
Note 4: investigation relates to future work required to establish conditions

APPENDIX J: Five Year Operating and Maintenance Plan

The following information on the Five Year Operating and Maintenance Plan and related costs were provided by DFO.

The costs related to the Five-year Operating Maintenance Plan do not include the costs related to the recommended cyclical work indicated in Section 8.1.

5 Years Operating & Maintenance Plan Race Rocks Lighthouse DFRP 17109

Real Property Management Operating Expenses	Actuals Expenditures ($000) Previous Year	Actuals Expenditures ($000) Current Year 2007/08	Planned Expenditures ($000) Planned year 2008/09	Planned Expenditures ($000) Planned year 2009/10	Planned Expenditures ($000) Planned year 2010/11	Notes
Minor Repairs		1.5	10.7	10.9	11.1	
Maintenance contracts						
Utilities		1.8	2.2	2.2	2.3	
Adm. Asset Mgmt.		1.2	3.3	3.4	3.4	
Fixed (PILT)		0.7	0.7	0.7	0.7	
Other (Travel)		1.1	2.7	2.8	2.8	
Total Actuals / Planned		**6.3**	**19.7**	**20.1**	**20.4**	

1) Actuals expenditures are based on available funding.
2) Planned expenditures are based on required funding for a level of preventive maintenance/prudent investor.

3) Costs related to operating and maintenance does not include the costs related to the recommended cyclical work of the 25 years plan.
4) Payments in lieu of taxes (PILT)